Candidate Number

Anglo-Chinese School

(INDEPENDENT)

Year 4 Express
Preliminary Examination 2017

CHEMISTRY
PAPER 2 Theory

5073/2

Wednesday 2 August 2017 1 hour 45 minutes

Additional materials:
Answer paper
Calculator

TIME 1 hour 45 minutes

INSTRUCTIONS TO CANDIDATES

Write your Candidate number in the spaces at the top of this page and on any separate answer paper used.

Section A
Answer all questions.
Write your answer in the spaces provided on the question paper.

Section B
Answer all **three** questions from this section.
The last question is in the form EITHER / OR and only one alternative should be attempted.
Write your answers on the answer paper provided.
At the end of the examination, hand up the paper in one bundle.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 16.
You may use a calculator.

FOR EXAMINER'S USE	
Section A	
B8	
B9	
B10	
TOTAL	

This question paper consists of 16 printed pages. [Turn over

For Examiner's use

Section A

Answer **all** questions in the spaces provided.

The total mark for this section is 50.

A1 Carbon dioxide can be formed by a number of different types of reaction. Suggest the identities for each of the following:

a a liquid that burns in excess oxygen to give carbon dioxide and water only.

_____

b a solid that burns to give carbon dioxide only.

_____

c a gas that burns to give carbon dioxide only.

_____

d a solid that when heated gives carbon dioxide as one of the two products.

_____

e a solution of a solid that produces carbon dioxide and ethanol with yeast.

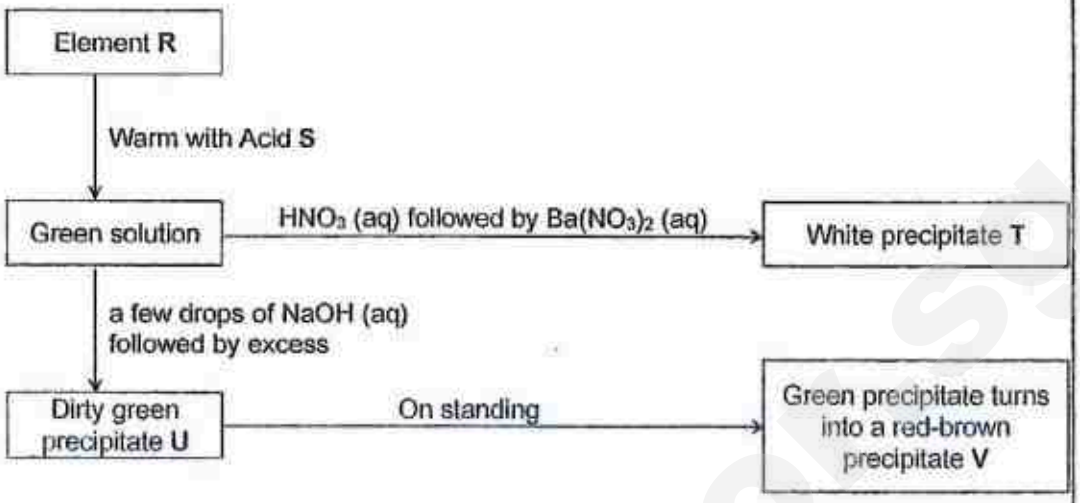
f a soluble compound that reacts with an acid to produce carbon dioxide.

_____

[Total : 6]

For Examiner's use

A2 The chart below shows the reaction scheme of an element R.



a Give the formulae of the following substances. [2]

T: _____

V: _____

b Write the ionic equation, with state symbols, for the formation of the precipitate **U**. [2]

_____

c **i** Acid **S** is a strong acid. What is a strong acid and name the ion needed for acidic properties? [2]

_____

_____

ii Write the equation for the reaction of element **R** and acid **S**. [1]

_____

iii Describe how a pure dry sample of green crystals can be prepared from the reaction between element **R** and acid **S**. [3]

_____

_____

_____

_____

_____

_____

[Total: 10]

For Examiner's use

A3 A metal cup is electroplated with silver using aqueous silver nitrate as the electrolyte. The anode is a piece of 20.0 g silver and the other electrode is the metal cup.

a Explain why a plastic cup is not suitable for electroplating. [1]

b Explain why the concentration of the electrolyte remains constant throughout the process. [2]

c The cup is plated with 2.7 g of silver and the final mass of the silver anode is 16.9 g. Calculate the percentage purity of the silver anode to 3 significant figures. [2]

[Total: 5]

A4 In the Haber process, ammonia is manufactured by the reaction between nitrogen and hydrogen. The equation is given below:

$$N_2\,(g) + 3\,H_2\,(g) \rightleftharpoons 2\,NH_3\,(g)$$

a Explain in terms of changes in the oxidation states, why this is a redox reaction. [2]

b Name a source of hydrogen for the above reaction. [1]

c Ammonia is mostly made into ammonium sulfate to be sold as fertilizers.

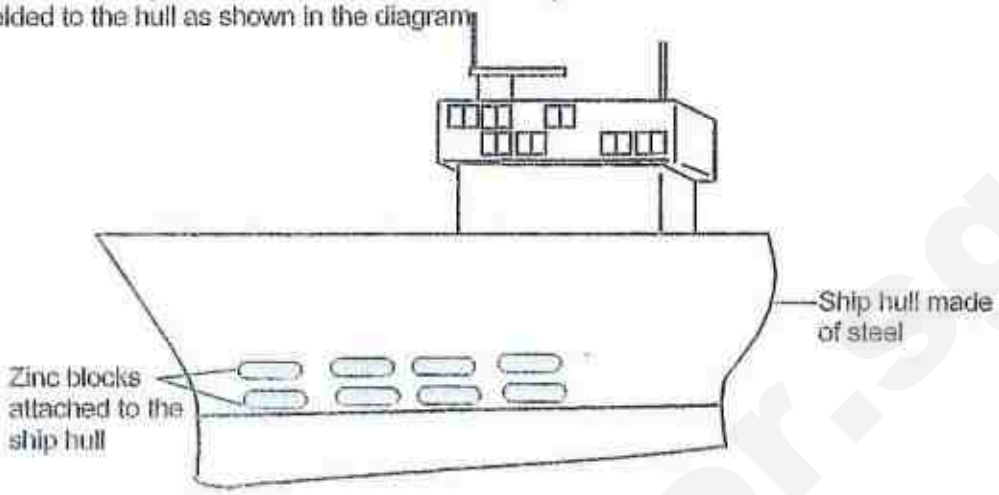
Farmers add these fertilizers to the soil to produce a good yield of crops. However, farmers should not add calcium hydroxide to the soil at the same time.

Explain why calcium hydroxide is not used together with these fertilizers. [2]

[Total: 5]

For Examiner's use

A5 The hulls of ships are built from steel. The hull is painted and also have zinc blocks welded to the hull as shown in the diagram.



a Steel is stronger than pure iron which makes it more suitable for building the hull of the ship. Explain why steel is stronger than iron. [3]

b Explain how the coat of paint on the hull of the ship reduces rusting. [2]

c i State and explain the role of the zinc blocks welded to the steel hull. [3]

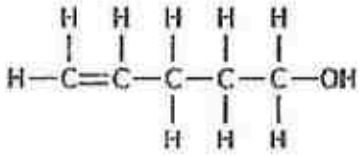
ii State the products when calcium is reacted with cold water. [1]

iii Explain why magnesium can be an alternative for zinc but calcium is unsuitable. [1]

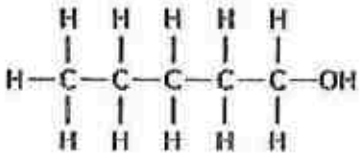
[Total: 10]

For Examiner's use

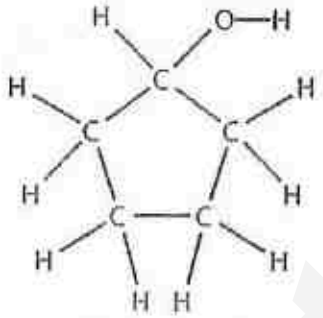
A6 The structural formulae of three alcohol molecules are given below.



Pentenol



Pentanol



Cyclopentanol

a Which of these molecules are isomers? Explain your answer. [2]

b One mole of cyclopentanol undergoes substitution reaction with one mole of chlorine. Use the structural formulae to construct the equation for the reaction. You should also indicate the conditions needed for the reaction. [2]

c When warmed with a strong oxidizing agent, pentanol can be oxidized. Name a suitable oxidizing agent and give the structural formula of the organic product. [2]

For Examiner's use

d Pentenol undergoes addition polymerization. By showing three repeat units, draw part of the molecule of poly(pentenol). [2]

[Total: 8]

A7 In an experiment, small amounts of three metals were added to three aqueous metal nitrate solutions.

The results are shown in the table.

	Aqueous zinc nitrate	**Aqueous iron(III) nitrate**	**Aqueous chromium(III) nitrate**
Zinc	No reaction	Orange solution turns colourless and zinc is coated with a shiny grey solid	Green solution turns colourless and zinc is coated with a shiny grey solid
Iron	No reaction	No reaction	No reaction
Chromium	No reaction	Orange solution turns pale yellow and chromium is coated with a shiny grey solid	No reaction

a Arrange the three metals in increasing order of reactivity. [2]

b Write the ionic equation, with state symbols, for the reaction between zinc and aqueous chromium(III) nitrate. [2]

c Aluminium metal was added to aqueous iron(II) nitrate in another experiment. Suggest why there is no visible reaction. [2]

[Total: 6]

For Examiner's use

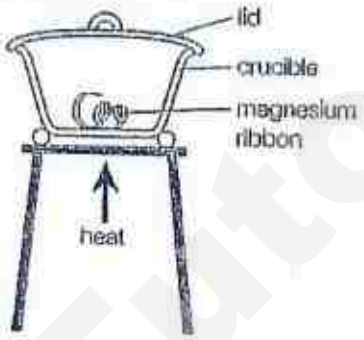
Section B

Answer all **three** questions from this section.

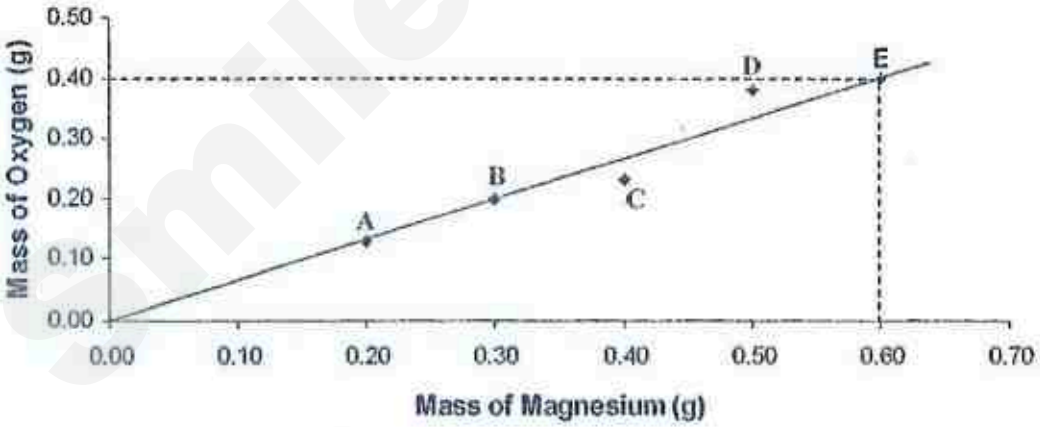
The last question is in the form **EITHER / OR** and **only one** alternative should be attempted.

Tie any extra sheets used loosely to this booklet.

B8 Five pupils (**A** to **E**) burnt different masses of magnesium in air using the apparatus in the diagram.



A graph of the mass of oxygen against the mass of magnesium is plotted as shown.



a Which pupil is most likely to have unburnt magnesium in the crucible at the end of the experiment? Explain your answer. [2]

_____

_____

_____

For Examiner's use

b Using data from student **E**, show that the formula of magnesium oxide is MgO. [2]

c Describe in terms of the bonding and structure, why magnesium oxide has a high melting point of 2800 °C. [2]

d Air contains about four times as much nitrogen as oxygen by volume.

i Suggest why, despite this, you would not expect much magnesium nitride to be formed in this experiment. [2]

ii Draw the dot and cross diagram to show the bonding in magnesium nitride. You only have to show the outer electrons. [2]

[Total: 10]

For Examiner's use

B9 Some margarine is made by hydrogenating carbon-carbon double bonds in vegetable oils. You can recognize the presence of this in food because the ingredients list will include words showing that it contains 'hydrogenated oils' or 'hydrogenated fats'.

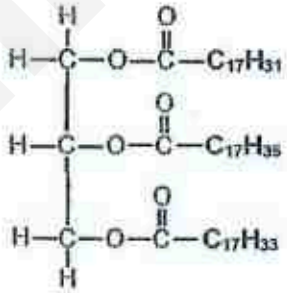
Fats and oil are similar molecules and they are polyesters with three ester linkages. They differ in their melting points which are largely determined by the presence of carbon-carbon double bonds in the molecules. The higher the number of carbon-carbon double bonds, the lower the melting point.

Sunflower oil is an example of a polyunsaturated vegetable oil. In a laboratory test, 0.2 mole of the oil is found to react with 160 g of bromine in an addition reaction.

a What is unsaturation? [1]

b Calculate the number of carbon-carbon double bonds in the sunflower oil. [2]

Sunflower oil is treated with hydrogen to form a <u>hydrogenated fat</u> molecule as shown below:



The hydrogenated fat molecule

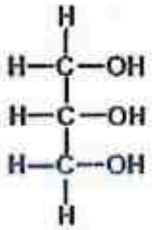
c Circle the 3 ester linkages in the hydrogenated fat molecule above. [1]

For Examiner's use

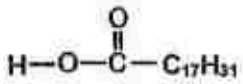
d When the hydrogenated fat undergoes a certain treatment with water, it can be broken down into four monomers (This treatment is the reverse process of polymerization). The monomers are:

glycerol,
linoleic acid,
stearic acid and
oleic acid.

The formulae of glycerol and linoleic acid are shown below.



This tri-alcohol is
glycerol



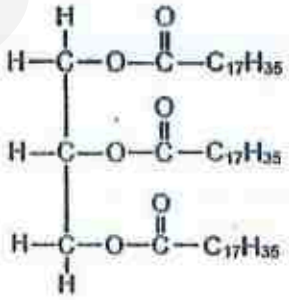
This carboxylic acid is
linoleic acid

i Deduce the formulae of stearic acid and oleic acid. [2]

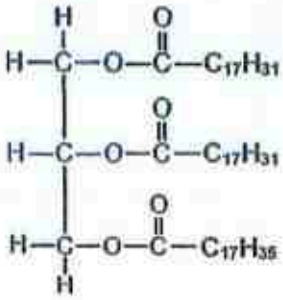
ii Stearic acid is a saturated monomer in **d(i)** above. From comparing the formulae of the acids, it can be deduced that oleic acid contains only one carbon-carbon double bond.

Deduce the number of carbon-carbon double bonds in linoleic acid. Explain your reasoning. [2]

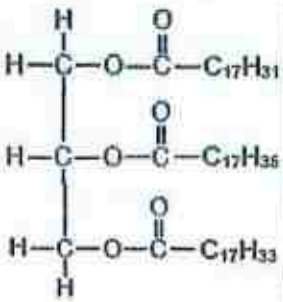
iii Three fat molecules are given below.



Fat molecule X



Fat molecule Y



Fat molecule Z

Arrange them in order of their melting points in descending order. [2]

[Total: 10]

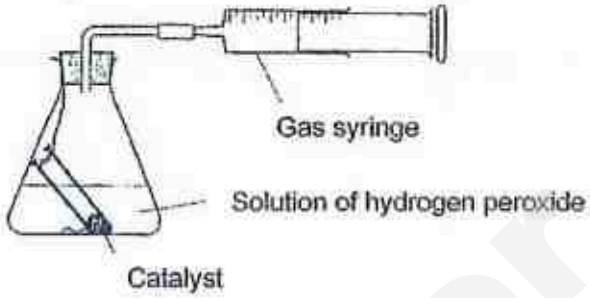
For Examiner's use

EITHER

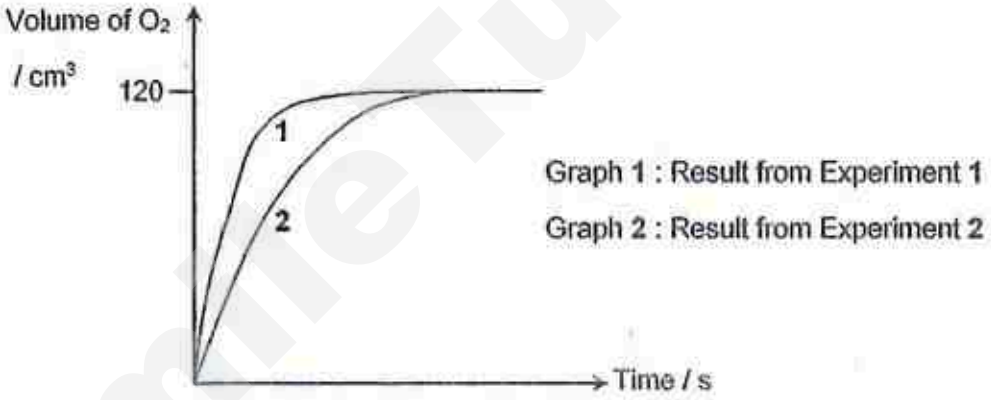
B10 Hydrogen peroxide decomposes according to the equation:

$$2\ H_2O_2\ (aq) \xrightarrow{\text{catalyst}} 2\ H_2O\ (l) + O_2\ (g)$$

The apparatus below was set up to compare the effects of two catalysts on the rate at which oxygen is evolved from the decomposition of hydrogen peroxide.



Two experiments were carried out with identical conditions except for the catalyst used. 0.5 g of manganese(IV) oxide was the catalyst used in Experiment 1 and 0.5 g of copper(II) oxide in Experiment 2. The graphs obtained is shown below.



a What is a catalyst? [1]

b Explain whether manganese(IV) oxide or copper(II) oxide is a better catalyst for this reaction? [1]

For Examiner's use

c In each experiment, the volume of the hydrogen peroxide used was 50 cm^3 and the volume of oxygen gas was collected at room temperature and pressure. Calculate the concentration of the hydrogen peroxide solution. [2]

d Pyrogallol absorbs oxygen. When the gas in the syringe was shaken with sufficient pyrogallol to absorb all the oxygen present, about 40 cm^3 of gas remained in the syringe.
Name this gas and state how it managed to get into the syringe. [2]

e Experiment 1 was repeated two more times; Experiment **3** and **4**, both with only one condition changed. On the same axes on page 12, sketch and label the graphs of these experiments. [2]

	The condition changed
Experiment 3	0.7 g manganese(IV) oxide
Experiment 4	25 cm^3 of hydrogen peroxide solution.

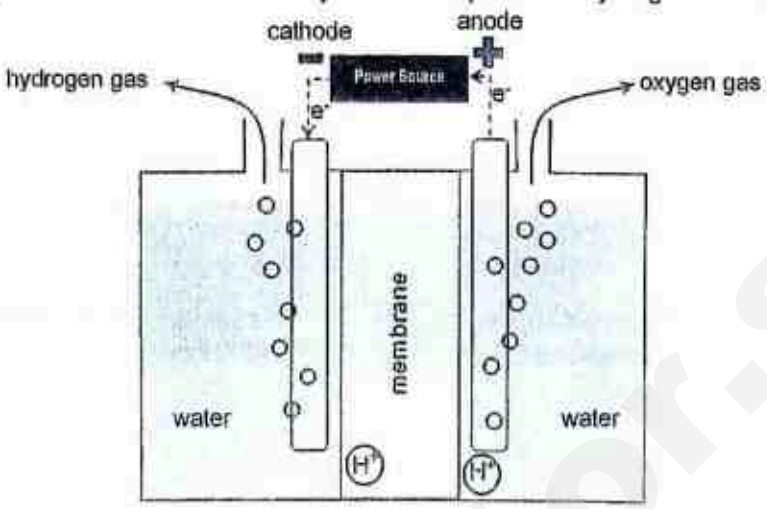
f The structural formula of hydrogen peroxide is H-O-O-H. Explain in terms of bond breaking and forming, why this is an exothermic reaction. [2]

[Total: 10]

For Examiner's use

OR

B10 The diagram below shows an electrolysis cell that produces hydrogen and oxygen from water.



(adapted from https://energy.gov/eere/fuelcells/hydrogen-production-electrolysis (U.S. Department of Energy)

Electrolysis is a promising option for hydrogen production from renewable resources. Hydrogen produced via electrolysis can result in zero greenhouse gas emissions, depending on the source of the electricity used. Most of the electricity generated today uses technologies that are energy intensive, because of the amount of fuel required due to the low efficiency of the electricity generation process. In many countries, today's power grid is not ideal for providing electricity required for electrolysis.

In the electrolysis cell above, the anode and cathode is separated by an electrolyte, known as a polymer electrolyte membrane (PEM) electrolyzer. This electrolyte is a solid specially plastic material.

At the anode, water undergoes a reaction to form oxygen gas and positively charged hydrogen ions, at the same time producing electrons. The electrons flow through an external circuit and the hydrogen ions selectively move across the membrane to the cathode. At the cathode, hydrogen ions combine with the electrons from the external circuit to form hydrogen gas.

a Write down the chemical equations, with state symbols, for the reaction at the anode and the cathode. [4]

Anode : _____

Cathode : _____

b Suggest why today's power grid is not ideal? [1]

_____

_____

For Examiner's use

c Give an example of renewable energy options that will result in virtually zero greenhouse gas emissions. [1]

d Name the major greenhouse gas that is produced when fossil fuels are burnt for energy. [1]

e The electrolysis is endothermic and the overall equation for the reaction is:

$$2\,H_2O\,(l) \rightarrow 2\,H_2\,(g) + O_2\,(g)\ ;\ \text{endothermic}$$

Draw the energy profile diagram for the reaction and label the activation energy and the enthalpy change. [3]

[Total: 10]

The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

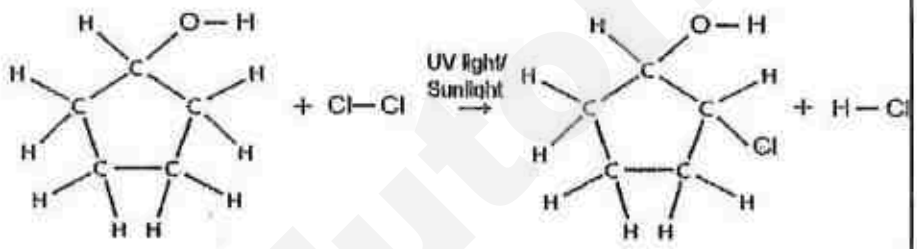
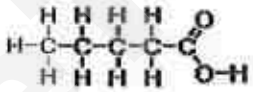
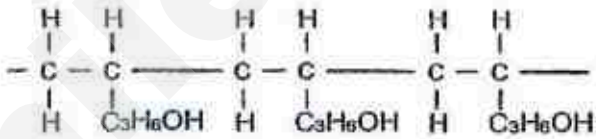
ACS(Independent) Year 4 Express
2017 Prelim Exam

P1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
C	A	C	D	B	D	A	A	D	B	B	C	D	A	B	D	C	D	A	B
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
B	A	C	B	B	A	C	C	D	D	A	B	C	C	D	D	C	B	A	C

P2

A1	a		Pentane/ pentene onwards, alcohols or any suitable organic compound	1
	b		Carbon/ graphite or suitable allotrope of carbon	1
	c		Carbon monoxide	1
	d		Any metal carbonate but not those of group I metals	1
	e		Sugars/ glucose	1
	f		Sodium carbonate, potassium carbonate, ammonium carbonate	1
A2	a		T: $BaSO_4$ V: $Fe(OH)_3$	1 1ii
	b		Fe^{2+} (aq) + 2 OH^- (aq) $\rightarrow Fe(OH)_2$ (s)	2
	c	i	A strong acid dissociates/ionises completely in water to produce hydrogen ions.	1 1
		ii	Fe (s) + H_2SO_4 (aq) $\rightarrow$ $FeSO_4$ (aq) + H_2 (g)	1 state sym opt
		iii	Add excess iron to warmed dilute sulfuric acid. Filter away excess iron. Heat to evaporate the solvent of filtrate to get a **hot saturated /concentrated** solution. Cool for crystals to form. Filter out crystals and dry with pieces of filter paper.	2 pts = 1m
A3	a		Plastic is not a conductor and the cup is acting as the cathode which must be an electrical conductor.	1
	b		Silver ions from the electrolyte discharged to form silver metal at the cathode. At the same rate, the silver anode dissolves/ oxidises to form silver ions that enter the electrolyte. Hence, concentration is constant.	1 1
	c		Mass loss at silver anode = 20 – 16.9 = 3.1g % purity of silver anode = 2.7/3.1 X 100 = 87.1 %	1 1
A4	a		Oxidation state of nitrogen decreases from 0 (in N_2) to -3 (in NH_3), this is reduction. Oxidation state of hydrogen increases from 0 (in H_2) to +1 (in NH_3), this is oxidation.	1 1
	b		Cracking of hydrocarbons / steam reforming	1
	c		Calcium hydroxide reacts with ammonium salts to produce ammonia gas. As a gas, it escape from the soil and the fertilizers would lose its nitrogen content.	1 1

A5	a		Pure iron consists of iron atoms orderly arranged in layers which slide pass each other easily. Steel is made up of different sized atoms of carbon and iron. The orderly arrangement is disrupted and the atoms do not slide easily.	1 1 1
	b		Paint forms a barrier between iron and air/ oxygen and water, the conditions for rusting	1 1
	c	I	Zinc provides sacrificial protection. Zinc is more reactive than iron in the steel. It loses electrons more easily and corrodes in place of iron.	1 11
		II	Calcium hydroxide and hydrogen gas or $Ca(OH)_2$ and H_2	1
		III	Magnesium and calcium are more reactive than iron. But calcium reacts readily with water instead of acting as a sacrificial metal for iron.	1
A6	a		Pentenol and cyclopentanol. They have the same molecular/ chemical formula but different structural formulae.	1 1
	b			2
	c		Acidified potassium manganate(VII) or potassium dichromate(VI)	1
				1
	d			2
A7	a		iron, chromium, zinc	2
	b		$3\ Zn\ (s) + 2\ Cr^{3+}\ (aq) \rightarrow 3\ Zn^{2+}\ (aq) + 2\ Cr\ (s)$	2
	c		Aluminium has an impervious/ non-porous/ protective layer of aluminium oxide.	2

B8 **a** Pupil C. 1
Mass of oxygen is proportional to magnesium in the graph. For pupil C, the mass of oxygen is less than expected. 1

b Using data from pupil E: 2

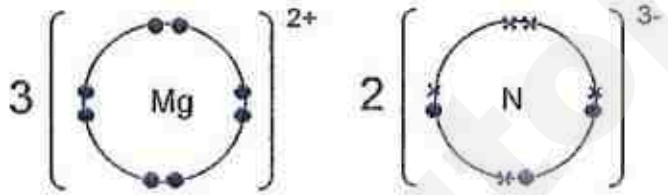
	Mg	O
mass	0.6g	0.4g
A_r	24	16
No of moles	0.6/24 = 0.025	0.4/16 = 0.025
ratio	1	1

Hence the formula is MgO

c Magnesium oxide has an ionic structure. The positive magnesium ions and negative oxide ions are held together by strong electrostatic forces of attraction in a giant lattice structure. A lot of energy is needed to over these strong forces. Hence, the high melting point. 2 pts = 1m

d **i** Nitrogen is unreactive as the nitrogen-nitrogen triple bond is very strong. 11

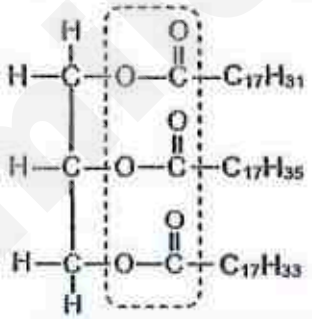
ii 2



B9 **a** Unsaturation is the presence of a carbon-carbon double bond which allows for addition reaction/ addition of atoms into the molecule. 1

b No of moles of Br_2 = mass / M_r of Br_2 = 160/160 = 1 mol 1
Ratio of sunflower oil : Br_2 is 1:5 1
Since 1 C=C uses up 1 Br_2, there are 5 carbon-carbon double bonds

c 1



d **i** 2

ii 2 carbon-carbon double bonds. 1
Linoleic acid has 4 hydrogen atoms less than stearic acid. 1

iii X, Z, Y 2

EITHER

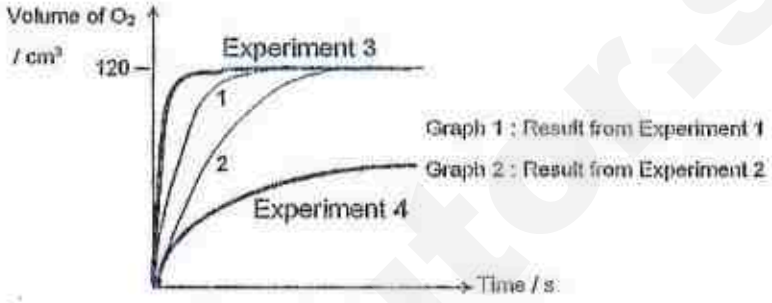
B10 a A catalyst is a substance that speeds up a chemical reaction but remains chemically unchanged. 1

b Manganese(IV) oxide is a better catalyst because graph 1 has a steeper gradient and a faster speed of reaction. 1

c From the graph, volume of O_2 gas = 120 cm^3
No. of mol of O_2 = 120/24000 = 0.005 mol 1
Hence, from the equation, no. of mol of H_2O_2 = 0.005X2 = 0.01 mol
Concentration = 0.01/ 50 X 1000 = 0.200 mol/dm^3 1

d The conical flask and the delivery tube has air at the start of the experiment. Air has 78% nitrogen. The 40cm^3 gas must be the unreactive nitrogen gas. 1 1

e



f The energy <u>taken in</u> to break 4 moles of O-H bonds and 2 moles of O-O bonds is less than the energy <u>given out</u> to make 4 moles of O-H bonds and 1 mole of O=O bonds.

OR

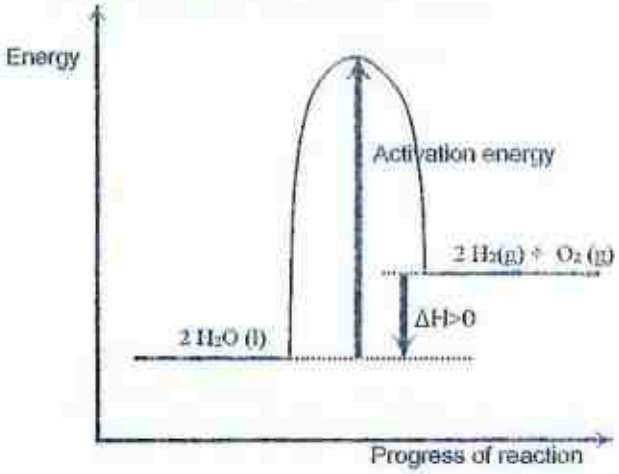
B10 a Anode: $2\ H_2O(l) \rightarrow O_2(g) + 4\ H^+(aq) + 4\ e^-$ 2
Cathode : $2\ H^+(aq) + 2\ e^- \rightarrow H_2(g)$ 2

b Greenhouse gas emissions due to the burning of fossil fuels/large amounts of fuel required/due to the low efficiency of the electricity generation process. 1

c Wind energy/ hydroelectric power/ nuclear energy. 1

d Carbon dioxide gas. 1

e 3



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ANDERSON SECONDARY SCHOOL
Preliminary Examination 2017
Secondary Four Express and Five (Normal) Academic

CANDIDATE NAME:

CLASS: /

INDEX NUMBER:

CHEMISTRY **5073/01**

Paper 1

29 August 2017

1 hour

0945 – 1045 h

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name and register number on the Question Paper and Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions.

For each question there are four possible answers **A**, **B**, **C**, and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate **Answer Sheet**.

Read the instructions on the answer sheet very carefully.

Each correct answer will score one mark.

A mark will not be deducted for a wrong answer.

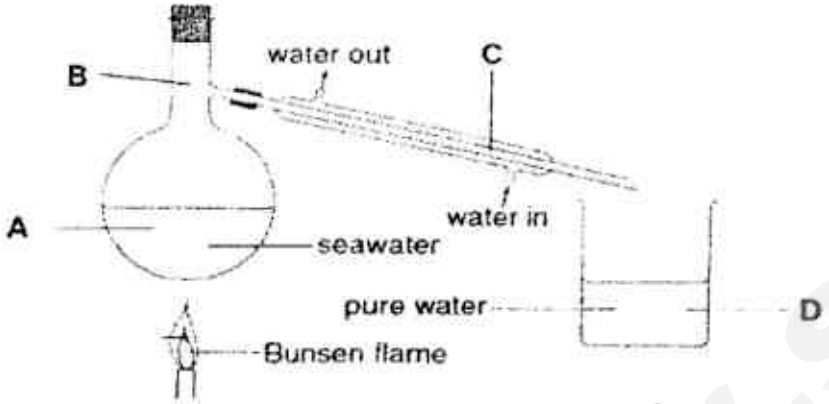
Any rough working should be done in this question paper.

A copy of the Periodic Table is printed on page **17**.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **17** printed pages.

1 The diagram below shows the set-up used to obtain pure water from seawater.



At which part of the set-up, **A**, **B**, **C** or **D**, do the water molecules lose the most energy?

2 Titan is the largest moon of Saturn. There is no water on Titan. The average surface temperature on Titan is -179°C.

Which of the substances in the table below would form oceans on Titan?

	substance	melting point / °C	boiling point / °C
A	argon	-189	-186
B	carbon monoxide	-205	-192
C	methane	-183	-164
D	nitrogen	-210	-196

3 The table below shows some information about four substances labelled **P** to **S**.

substance	appearance	change on heating
P	Colourless liquid	boils away, leaving a white residue.
Q	Colourless gas	burns in oxygen to form water and carbon dioxide only.
R	Yellow solid	splits up by electricity to form a metal and a gas.
S	White solid	burns in air to form an oxide as the only product.

Which of these substances **P**, **Q**, **R** and **S** are compounds?

A **P** and **Q** only

B **Q** and **R** only

C **R** and **S** only

D **Q**, **R** and **S** only

4 A student was tasked to separate a mixture containing an organic liquid **T** and aqueous sodium bromide.

Properties of organic liquid **T** were given as follows.

- It is miscible with water.
- It has a lower density than water.
- It is yellowish in colour.
- It boils at 120°C.

Which of the following experimental techniques should the student use to obtain samples of the organic liquid **T** and sodium bromide from the mixture?

A evaporation to dryness followed by chromatography

B fractional distillation followed by evaporation to dryness

C separating funnel followed by evaporation to dryness

D simple distillation followed by filtration

5 The R_f values for the coloured dyes, **D**, **E**, **F** and **G**, in four different solvents are shown in the table below.

	R_f in different solvents			
coloured dyes	water	ethanol	propanone	tetrachloromethane
D	0.3	0.9	0.7	0.5
E	0.0	0.8	0.6	0.2
F	0.5	0.7	0.6	0.1
G	0.2	0.6	0.4	0.2

Which solvent could be used to separate all four coloured dyes, **D**, **E**, **F** and **G** from a mixture?

A ethanol

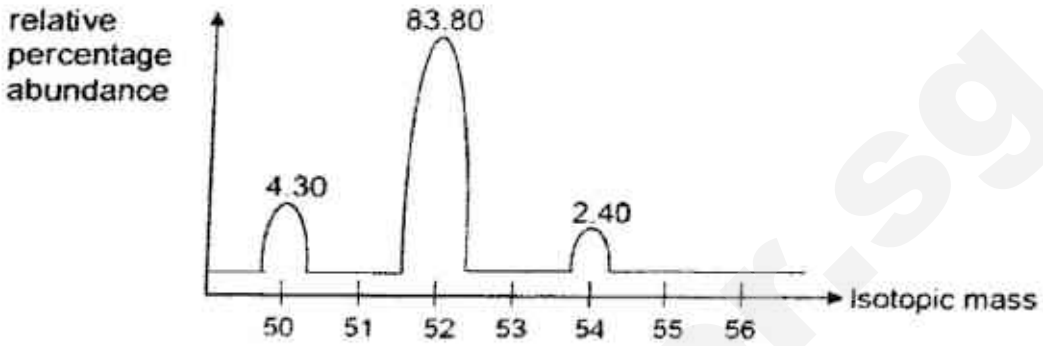
B propanone

C tetrachloromethane

D water

6 An element **Z** consists of four isotopes, three of which have isotopic masses of 50, 52 and 54.

The diagram below gives the mass spectrum of the element **Z** which shows the relative percentage abundance of three of its isotopes.



What is the isotopic mass of the fourth isotope if the relative atomic mass of element **Z** is 52.06?

A 52 **B** 53 **C** 55 **D** 56

7 An ion of an element, **X**, has 22 electrons and a nucleon (mass) number of 55. What is the charge on the ion if the number of neutrons is 30?

A 2-
B 2+
C 3-
D 3+

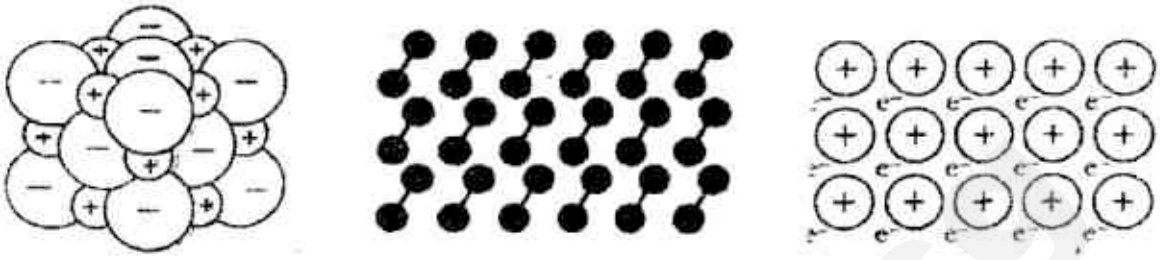
8 The proton numbers and nucleon (mass) numbers of elements **U** and **V** are given in the table below.

element	proton number	nucleon number
U	6	12
V	16	32

The relative molecular mass of the compound formed between **U** and **V** is

A 44
B 56
C 76
D 88

9 The structures of three substances **J**, **K** and **L** at room temperature and pressure, are represented as follows.



J K L

Which statement about the three substances is **incorrect**?

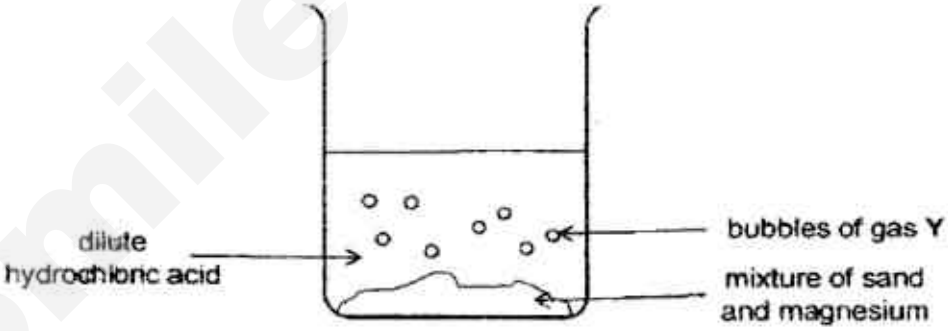
A All three substances are solids at room temperature and pressure.

B All three substances have high melting points.

C Substances, **K** and **L**, are elements while substance **J** is a compound.

D Substances, **J** and **L**, can conduct electricity in the molten state.

10 A mixture of magnesium and sand was added to dilute hydrochloric acid in a beaker as shown in the diagram below.



Which of the following options indicates correctly the type of particles present in the substances?

	magnesium	sand	dilute hydrochloric acid	gas Y
A	atoms	molecules	ions	atoms
B	ions and electrons	atoms	ions and molecules	molecules
C	ions and electrons	atoms	ions	molecules
D	ions and electrons	molecules	ions and molecules	molecules

11 Which of the following is/are suitable method(s) used to test the acid strength of two acids, hydrochloric acid and ethanoic acid, which are of the same concentration?

I using a pH meter
II measuring their electrical conductivity
III titration using sodium hydroxide solution

A I and II only
B I and III only
C II and III only
D I, II and III

12 Which of the following properties show that a certain substance, **M**, is alkaline?

A Addition of dilute hydrochloric acid to aqueous **M** produces no precipitate.
B Aqueous **M** can react with zinc oxide
C Aqueous **M** forms ammonia gas when warmed with ammonium chloride.
D Aqueous **M** forms a white precipitate with aqueous iron(III) sulfate.

13 Alvin attempted to prepare some salts by the methods shown in the table below.

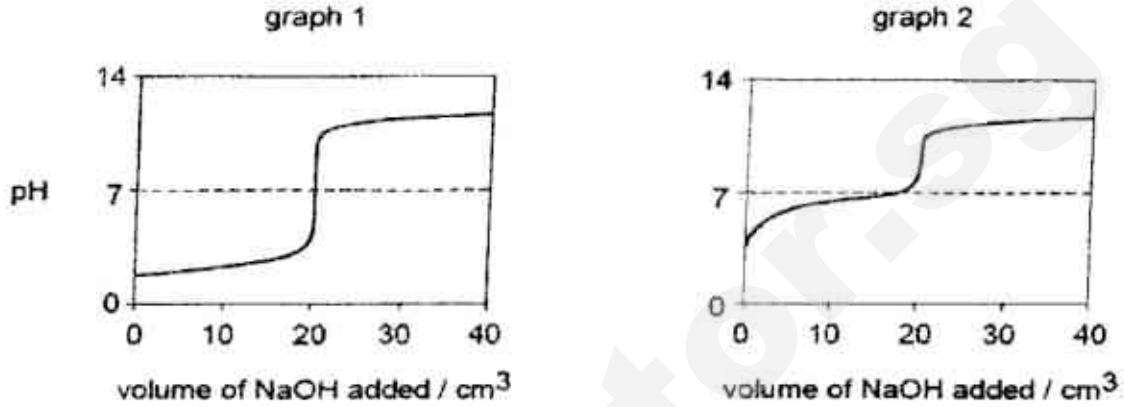
experiment	salt prepared	method used
I	zinc chloride	Mixing aqueous zinc nitrate and hydrochloric acid
II	sodium nitrate	Titrating aqueous sodium carbonate with nitric acid
III	calcium sulfate	Mixing aqueous calcium nitrate and sulfuric acid

Which of the experiment(s) give(s) a good yield?

A I only
B I and III only
C II and III only
D I, II and III

14 A titration was conducted by adding NaOH from a burette to HCl in a conical flask. The pH of the solution in the flask was recorded during the titration and graph 1 was produced.

A second titration was conducted by adding NaOH to a different acid, Acid **Z**. The pH of the solution in the flask was recorded during the titration and graph 2 was produced.



The table below shows some indicators that could be used to identify the endpoint of titrations. For the NaOH – HCl titration, the appropriate indicator is bromothymol blue.

indicator	acidic colour	range of colour change	alkaline colour
methyl orange	red	3.1 – 4.4	yellow
methyl red	red	4.4 – 6.2	yellow
bromothymol blue	yellow	6.0 – 7.6	blue
cresolphthalein	colourless	8.1 – 9.7	red
alizarin yellow	yellow	10.1 – 12.0	red

Which indicator in the table is appropriate for the NaOH – Acid **Z** titration?

A alizarin yellow

B cresolphthalein

C methyl orange

D methyl red

15 A mixture containing aqueous lead(II) nitrate and nitric acid, is tested with Universal indicator and potassium iodide solution separately.

Which set of results would the mixture produce in the tests?

	Universal indicator	potassium iodide solution
A	green	yellow precipitate
B	orange	yellow precipitate
C	red	colourless solution
D	red	yellow precipitate

16 Sulfuric acid and potassium hydroxide can react together to form potassium hydrogensulfate, $KHSO_4$, and water only.

Which of the following amounts of the reactants are required to form potassium hydrogensulfate?

A equal number of moles of sulfuric acid and potassium hydroxide

B equal volumes of sulfuric acid and potassium hydroxide

C one mole of sulfuric acid and two moles of potassium hydroxide

D two moles of sulfuric acid and one mole of potassium hydroxide

17 Elements, **X**, **Y** and **Z**, are all in the same period of the Periodic Table.

Oxides of **X** reacts with both acid and alkali.

Solid **Y** does not conduct electricity.

Z forms an ionic oxide, ZO.

Which of the following gives the correct order of the elements across the period?

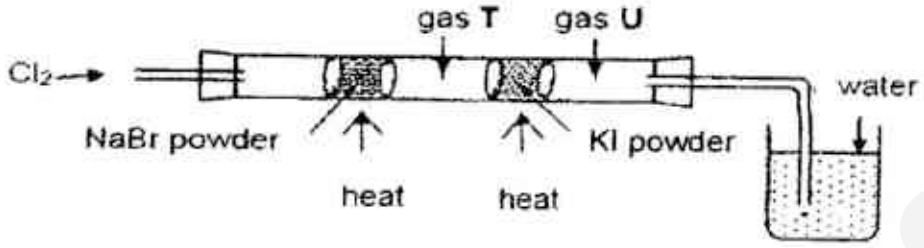
A $X \longrightarrow Y \longrightarrow Z$

B $Y \longrightarrow X \longrightarrow Z$

C $Z \longrightarrow X \longrightarrow Y$

D $Z \longrightarrow Y \longrightarrow X$

18 The diagram below shows a set-up used to investigate the relative reactivity of halogens.



Which of the following would be the correct colours observed for gas **T**, gas **U** and in the water during the experiment?

	gas T	gas U	water
A	brown	reddish-brown	colourless
B	colourless	violet	black
C	reddish-brown	brown	violet
D	reddish-brown	violet	brown

19 In some countries, anhydrous calcium chloride is used as a drying agent to reduce dampness in houses.

When the anhydrous salt absorbs enough water to form the dihydrate, $CaCl_2.2H_2O$, what is the percentage increase in mass for the anhydrous salt?

A 14%

B 24%

C 32%

D 36%

20 If 200 cm^3 of 0.1 mol/dm^3 hydrochloric acid were added to 1.24 g of copper(II) carbonate, which of would be obtained after the reaction?

A black solid and a blue solution

B green solid and a blue solution

C pink solid and blue solution

D blue solution only

21 Three electrolytic cells are set up using inert electrodes.

The electrolytes used are listed below.

Cell 1: concentrated aqueous rubidium chloride

Cell 2: dilute sulfuric acid

Cell 3: molten zinc bromide

In which of these cell(s) is/are gases formed at both electrodes?

A 2 only

B 3 only

C 1 and 2 only

D 1 and 3 only

22 During the electrolysis of an aqueous solution of a cerium salt, 70 g of cerium (A_r of Ce = 140) is deposited at the cathode by 2 moles of electrons.

What is the formula of the cerium ion?

A Ce^{+}

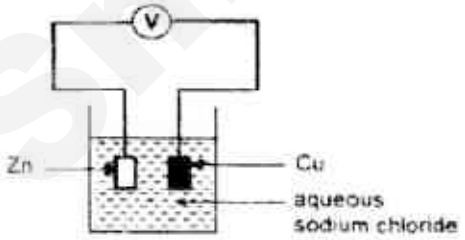
B Ce^{2+}

C Ce^{3+}

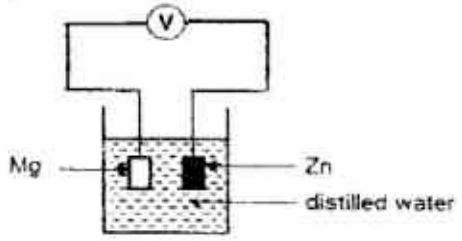
D Ce^{4+}

23 Which simple cell set-up would produce the greatest reading on the voltmeter?

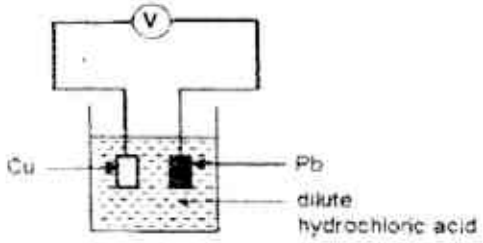
A



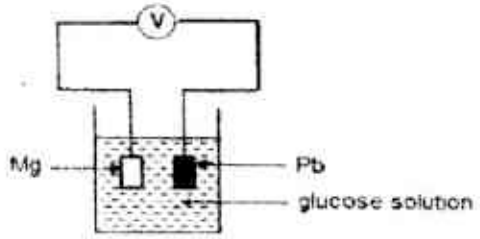
C



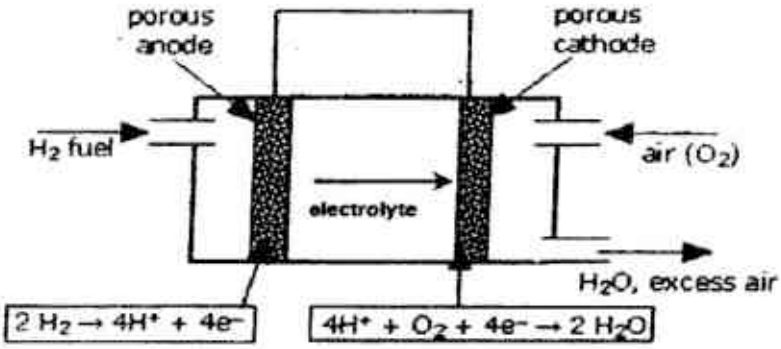
B



D



24 A diagram of the hydrogen-oxygen fuel cell is shown below.



Which of the following is/are correct statement(s) about the fuel cell?

I Electrons flow from the anode to the cathode in the electrolyte.
II Electricity is used to generate hydrogen and oxygen.
III Hydrogen and oxygen undergo redox reactions to generate electricity.
IV The anode and cathode are the negative and positive electrodes respectively.

A I and II only
B I and III only
C II and III only
D III and IV only

25 A student borrowed a friend's chemistry notes and copied out the notes wrongly in the box below.

> *"The temperature of molecules increases during an exothermic reaction and the products have less energy than their reactants."*

Which of the following should be the correct version of the notes?

A The temperature of molecules increases during an exothermic reaction, and the products have more energy than their reactants.

B The temperature of molecules deceases during an exothermic reaction, and the products have less energy than their reactants.

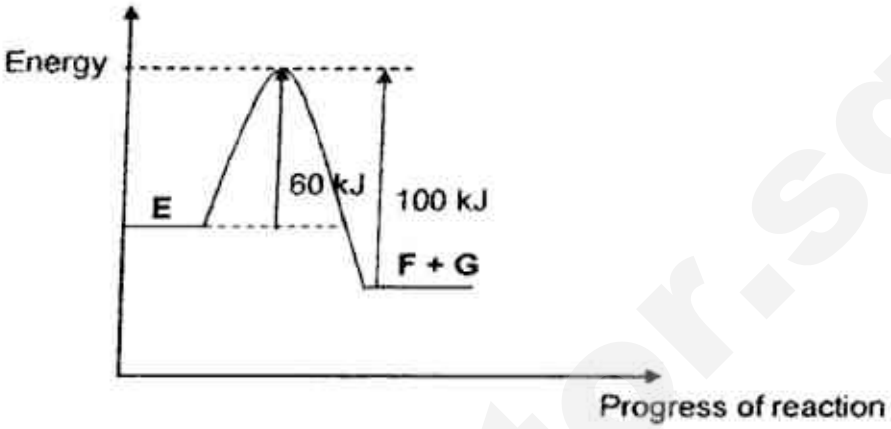
C The temperature of the surrounding increases during an exothermic reaction, and the products have less energy than their reactants.

D The temperature of the surrounding decreases during an exothermic reaction, and the products have more energy than their reactants.

26 The energy profile diagram of the following reversible reaction is shown below.

$$E \rightleftharpoons F + G$$

In the forward reaction, **E** decomposes to form **F** and **G** while in the backward reaction, **F** and **G** recombine to form **E**.



Which of the following could be inferred from the energy profile diagram?

	reaction	enthalpy change / kJ	activation energy / kJ
A	backward	+100	60
B	backward	+40	100
C	forward	+40	60
D	forward	-40	100

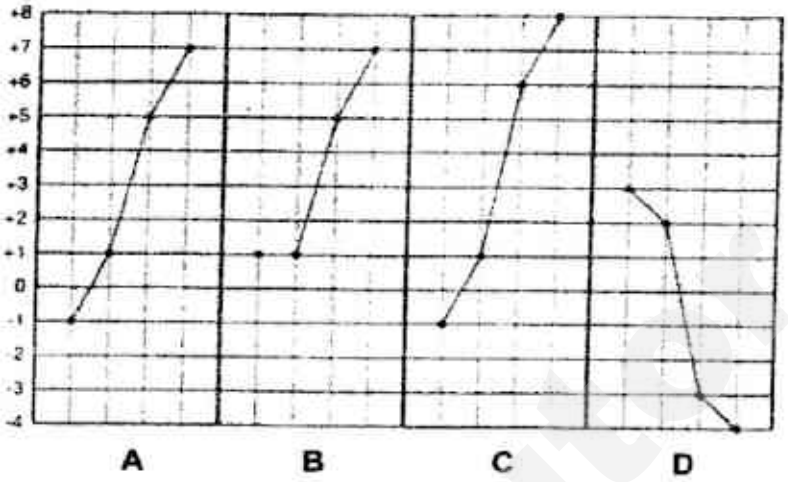
27 Which of the following correctly explains how a catalyst increases the rate of a reaction?

	effect of catalyst	activation energy of reaction
A	increases the kinetic energy of particles	decreases
B	increases the kinetic energy of particles	increases
C	provides an alternative reaction pathway	decreases
D	provides an alternative reaction pathway	increases

28 The formulae for four chloride compounds are given below.

PCl_3 Cl_2O ClO_3^- ClO_4^-

Which one of the following shows correctly the oxidation numbers of chlorine in the above chloride compounds respectively?



29 Disproportionation reaction occurs when an element is simultaneously oxidized and reduced.
Which one of the following named elements does not undergo disproportionation?

	element	equation of reaction
A	carbon	$H_2C_2O_4 \rightarrow H_2O + CO + CO_2$
B	nitrogen	$H_2O + 2NO_2 \rightarrow HNO_3 + HNO_2$
C	sulfur	$2FeSO_4 \rightarrow Fe_2O_3 + SO_2 + SO_3$
D	tin	$2Sn^{2+} \rightarrow Sn^{4+} + Sn$

30 The data gives the concentration (ppb), in parts of pollutant per billion parts of air, of polluting gases in four different industrial cities.

In which city are limestone buildings under the greatest threat from pollution?

	ozone	sulfur dioxide	nitrogen dioxide
A	11	38	40
B	21	45	14
C	23	17	46
D	30	32	33

31 To reduce atmospheric pollution, the following waste gases from a power station are passed through wet powdered calcium carbonate.

carbon monoxide	carbon dioxide
nitrogen monoxide	nitrogen dioxide
sulfur dioxide	phosphorus(V) oxide

How many waste gases will **not** be removed by the wet powdered calcium carbonate?

A 1 **B** 2 **C** 3 **D** 4

32 the past, CFC (chlorofluorocarbons) such as CF_3CH_2Cl were used as aerosol propellants.

Which element in CFC can cause a depletion of ozone?

A carbon

B chlorine

C fluorine

D hydrogen

33 In the Haber process,

I the hydrogen needed can be obtained from the cracking of petroleum.
II the reaction chamber is pressurized to speed up the reaction.
III the ammonia formed is removed by condensation.

Which of the above options are correct?

A I and II only

B I and III only

C II and III only

D I, II and III

34 Nickel is placed between iron and lead in the reactivity series.

Which of the following is true about the reactivity of nickel?

A Nickel can be obtained by moderate heating of nickel carbonate.

B Nickel can displace hydrogen rapidly from steam.

C Nickel can be displaced from an aqueous nickel salt by adding iron.

D Nickel cannot displace hydrogen from an acid.

35 Element **W** is a metal that is more reactive than aluminium.

Which of the following extraction methods would be the most suitable to produce element **W**?

A Electrolyzing concentrated chloride of **W**.

B Electrolyzing molten oxide of **W**.

C Heating oxide of **W** with carbon monoxide.

D Heating chloride of **W** with coke.

36 Approximately 40% of all iron and steel is produced by recycling.

Which of the following are correct reasons for recycling iron?

1. Iron, when obtained by a recycling process, produces less carbon dioxide than the blast furnace process.
2. Scrap steel contains a higher percentage of iron than iron ore.
3. Scrap metal, if not recycled, would cause environmental problems due to disposal by landfill.

A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

37 Which reaction is **not** a step in the production of iron from haematite in the blast furnace?

A Carbon is burnt in air to produce carbon dioxide.

B Carbon is reacted with carbon dioxide to produce carbon monoxide.

C Iron (III) oxide is reduced by carbon monoxide to form iron

D Iron is reacted with limestone to produce slag

38 Which statement about the fractional distillation of petroleum is correct?

A Only one compound is collected from each level of the fractionating column.

B The higher up the fractionating column, the greater is the temperature.

C The fractions collected at the bottom of the fractionating column are the most flammable.

D The fractions reaching the top of the fractionating column have the smallest relative molecular mass.

39 Which formula of alkenes does **not** change as the number of carbon atoms in the molecule increases?

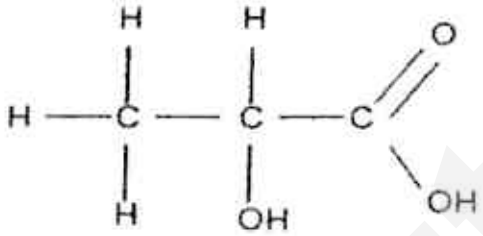
A Chemical formula

B Empirical formula

C Molecular formula

D Structural formula

40 Yoghurt contains lactic acid which has the structural formula shown below.



Which statement(s) about lactic acid is/are true?

I It can decolourise aqueous bromine in darkness.
II It can decolourise acidified potassium potassium manganate(VII).
III It can undergo polymerization by itself under suitable conditions.
IV One mole of lactic acid requires two moles of sodium hydroxide for complete neutralization.

A I and II only

B II and III only

C I, II and III only

D I, II, III and IV

END OF PAPER

2017 Prelim Chemistry Exam (5073/1)

Paper 1

Answers

1	C	11	A	21	C	31	B
2	C	12	C	22	D	32	B
3	B	13	C	23	A	33	D
4	B	14	B	24	D	34	C
5	A	15	D	25	C	35	B
6	B	16	A	26	B	36	D
7	D	17	C	27	C	37	D
8	C	18	D	28	A	38	D
9	B	19	C	29	C	39	B
10	B	20	D	30	A	40	B

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ANDERSON SECONDARY SCHOOL
Preliminary Examination 2017
Secondary Four Express and Five (Normal) Academic

CANDIDATE NAME:

CLASS: /

INDEX NUMBER:

CHEMISTRY **5073/02**

Paper 2

23 August 2017

1 hour 45 minutes

0800 – 0945h

No Additional Materials are required

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section A
Answer **all** questions.in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form either/or.
Answer **all** questions.in the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page **23**.

The use of an approved scientific calculator is expected, where appropriate.

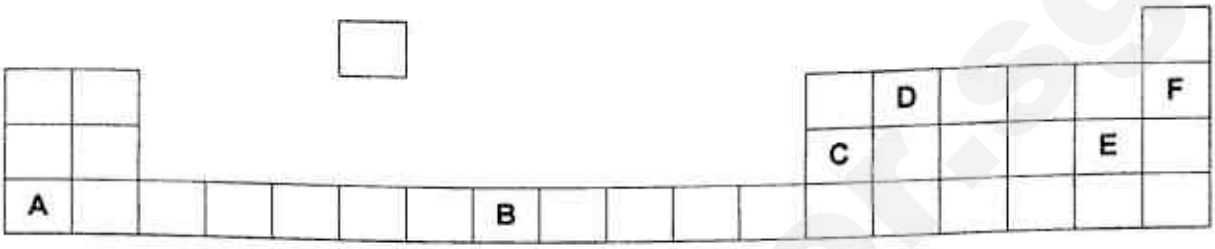
Section A	
Section B	
Total	

This document consists of **23** printed pages and **1** blank page.

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1 The position of six elements, represented by letters, **A**, **B**, **C**, **D**, **E** and **F** are shown in the Periodic Table below.



Select from the given letters, **A** to **F**, the element that best fits the following characteristics.

The elements, **A** to **F**, may be used once, more than once or not at all.

(a) An element which contains the smallest number of protons in each atom.

..... [1]

(b) An element which combines with element **D** to form a very volatile compound.

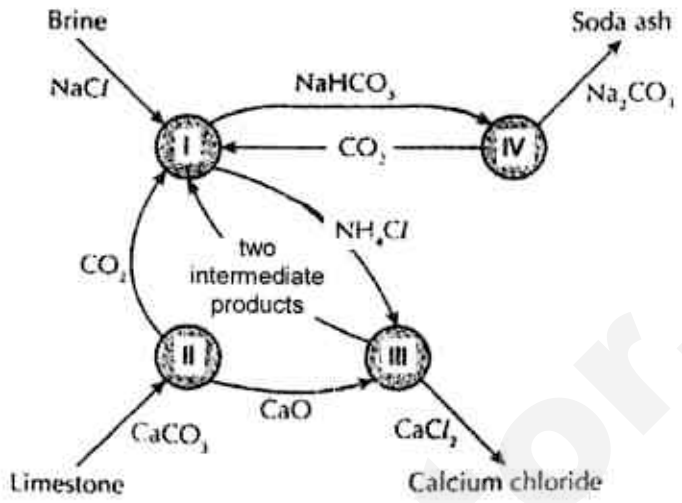
..... [1]

(c) Two elements which reacts the most vigorously.

..... [1]

[Total: 3]

A2 The Solvay process is used for the industrial preparation of sodium carbonate, also known as soda ash. The schematic diagram below shows the four reactions (labelled as I, II, III and IV) and the different chemicals involved.



The process produces many products, some of which are used for further reactions. Such products are termed as intermediate products. For example, the intermediate products formed in reaction I are $NaHCO_3$ and NH_4Cl. Products which are not involved in further reactions are collected as products.

(a) Complete the table below by giving the chemical formula(e) of the intermediate product(s), by-product(s) or main product(s).

reaction	Intermediate product	product
I	$NaHCO_3$ and NH_4Cl	----
II		----
III	two intermediate products	
IV		

[2]

(b) Two intermediate products, a pungent gas and a colourless liquid were formed in reaction III.
Name the two products.

pungent gas: ..... colourless liquid: ..... [1]

(c) Write an overall chemical equation for the Solvay process.

..... [1]

(d) Sodium bicarbonate ($NaHCO_3$), produced in reaction **I**, is an amphoteric compound. When dissolved in water, sodium bicarbonate ionizes to form carbonic acid and hydroxide ion.

$$NaHCO_3 + H_2O \rightarrow Na^+ + H_2CO_3 + OH^-$$

(i) What is the nature of an aqueous solution of sodium bicarbonate? Circle your choice below. [1]

strongly acidic mildly acidic mildly alkaline strongly alkaline

(ii) Explain your choice.

.....

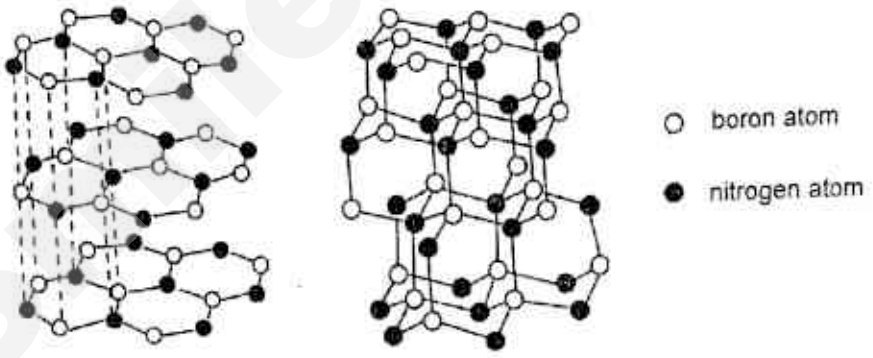
.....

..... [2]

[Total: 7]

A3 Nitrogen atoms easily react with most elements to form nitrides such boron nitride and aluminium nitride.

(a) Boron nitride exists in two possible forms, hexagonal boron nitride (h-BN) and cubic boron nitride (c-BN) as shown below.



Hexagonal boron nitride Cubic boron nitride

Based on the structures shown, explain the difference in **hardness** between h-BN and c-BN.

.....

.....

.....

.....

..... [3]

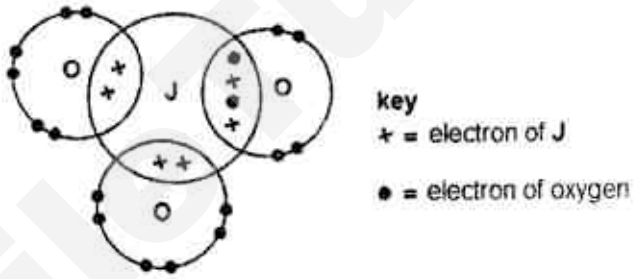
(b) The melting points of aluminium nitride and another compound, JO_3 are given below. J is not the actual chemical symbol of the element.

compound	melting point (°C)
aluminium nitride (A/N)	2200
JO_3	17

(i) Draw a 'dot-and-cross' diagram to show the bonding in aluminium nitride. Shows outer electrons only.

[2]

(ii) The diagram below shows the bonding found in a molecule of JO_3.



Explain in terms of the structures, why the melting points of aluminium nitride and JO_3 are different.

.....

.....

.....

.....

.....

..... [3]

[Total: 8]

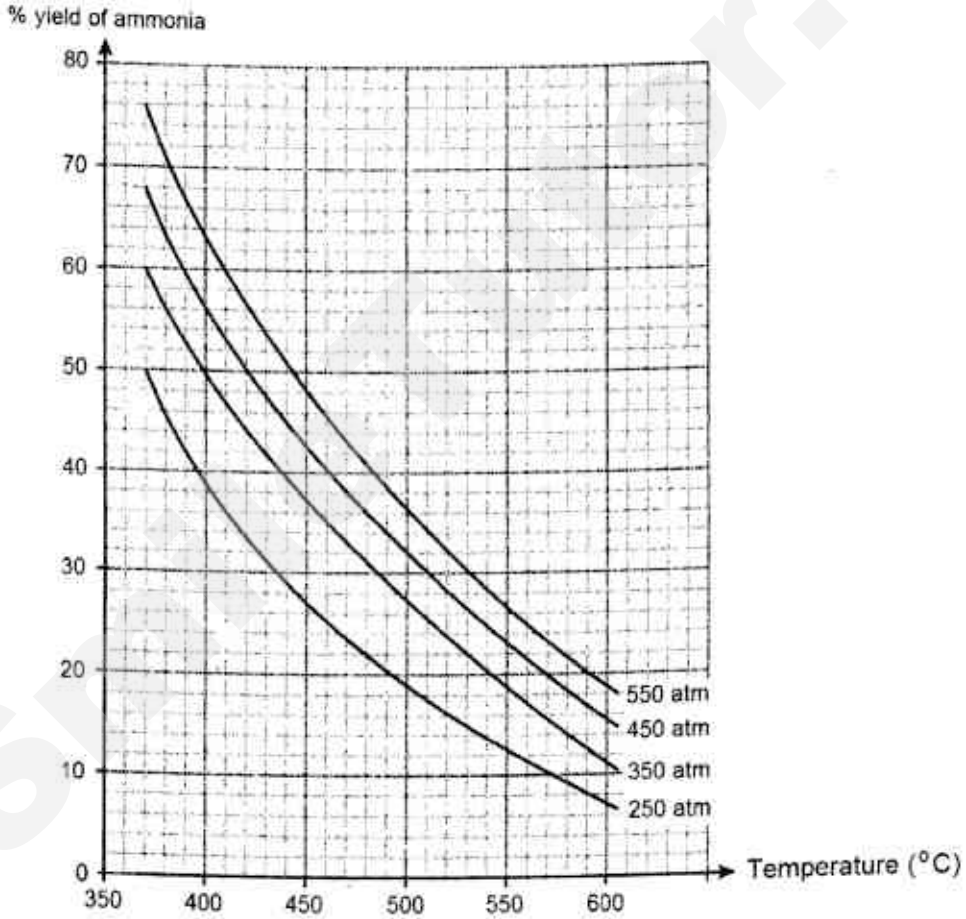
A4 In the chemical industry, Haber and Contact processes are used to manufacture ammonia and sulfuric acid respectively.

(a) In the Haber process, nitrogen reacts with hydrogen to form ammonia in a reversible reaction.

(i) State the optimum conditions of the Haber process.

..... [1]

The graphs below show the percentage yield of the Haber process under different conditions.



(ii) Use the graph to predict the percentage yield of ammonia formed at the optimum conditions given in **(a)(i)**.

..... [1]

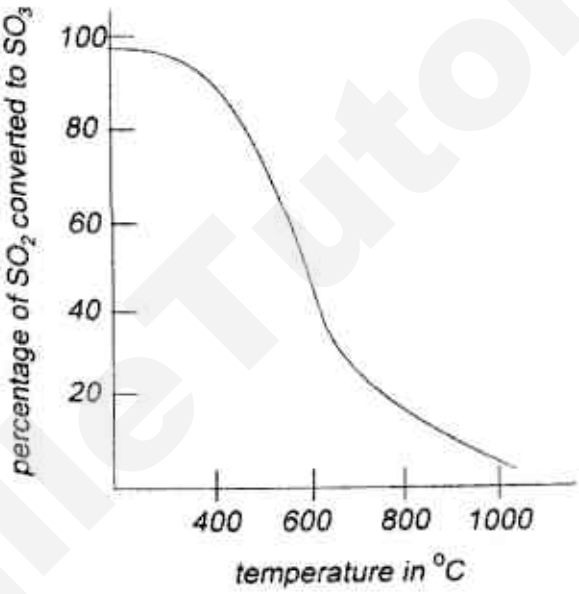
(b) Contact process comprises many stages.

In **Stage 2**, sulfur dioxide reacts with oxygen to form sulfur trioxide in a reversible reaction.

In the converter, sulfur dioxide and oxygen are passed over several beds of loosely packed porous vanadium oxide catalyst.

The reaction between sulfur dioxide and oxygen is exothermic and is carried out at an optimum pressure of 1 atm.

A graph showing the percentage conversion of sulfur dioxide into sulfur trioxide under different temperatures is given below.



(i) Write a balanced chemical equation for the conversion of sulfur dioxide into sulfur trioxide in **Stage 2** of the Contact Process.

..... [1]

(ii) The optimum temperature for **Stage 2** of the Contact process is the same as that for the Haber process.
Use the graph to predict the percentage conversion of sulfur trioxide obtained at the optimum temperature.

..... [1]

(iii) Using the given information about **Stage 2** of Contact process, suggest explanations for the following conditions.

The optimum temperature is used although it does not obtain the highest percentage conversion of sulfur trioxide.

.....

..... [1]

Vanadium oxide used is 'loosely packed'.

.....

..... [1]

The converter is not heated to its optimum temperature at the start of the reaction.

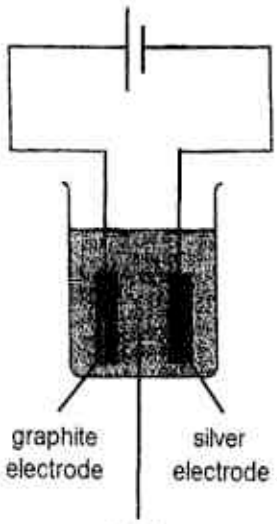
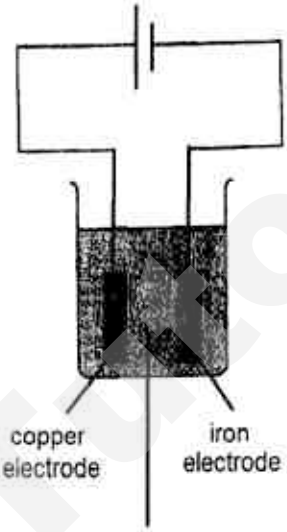
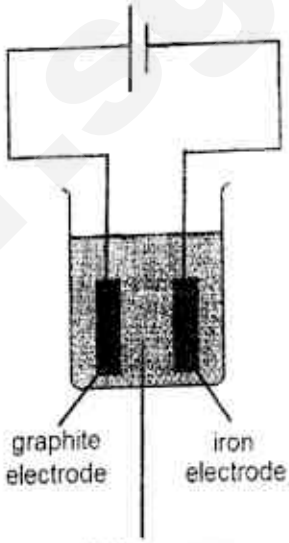
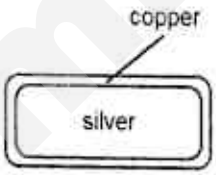
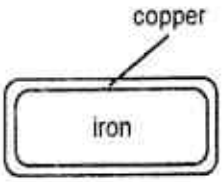
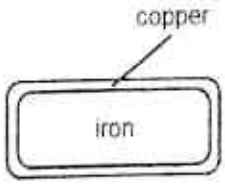
.....

..... [1]

[Total: 7]

A5 In metal-plating, a layer of coherent metal coating is used as a protective layer to prevent the underlying metal from corrosion or rusting. Metal-plating can be achieved via electrolysis.

The table shows the information about three different electrolytic set-ups that were used to electroplate either silver or iron with copper.

	Set-up 1	Set-up 2	Set-up 3
electrolytic set-ups	 concentrated aqeuous copper(II) chloride	 concentrated aqeuous copper(II) chloride	 dilute aqeuous copper(II) chloride
final product at the cathode	silver metal plated with copper 	iron metal plated with copper 	iron metal plated with copper 
ionic equation at the anode	.....	.....	.....
ionic equation at the cathode	.....		

(a) (i) Complete the table by filling in the missing ionic equation at each anode. [3]

(ii) Complete the table by filling in the missing ionic equation at the cathode. This equation is the same for all three set-ups. [1]

(b) Explain why the protective layer of copper obtained in **set-up 3** is inferior to that obtained in **set-up 2**.

.....

.....

.....

..... [2]

(c) Explain why the 'copper coated' silver obtained in **set-up 1** is more resistant to corrosion than the 'copper coated' iron obtained in **set-up 2**, when scratched or dented.

.....

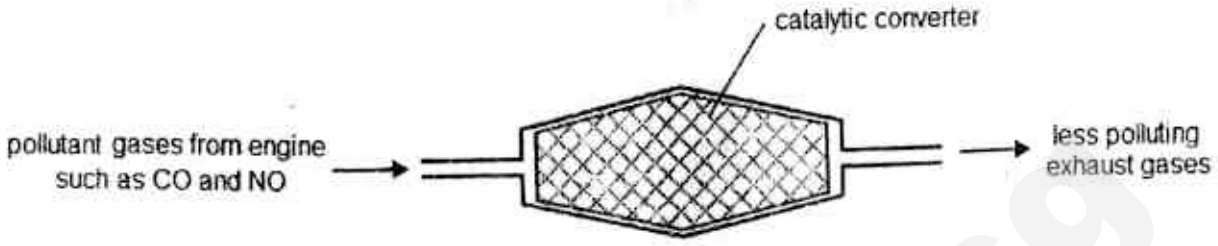
.....

.....

..... [2]

[Total: 8]

A6 The use of catalytic converters, as shown below, can decrease the emission of pollutant gases from cars.



(a) Name a suitable catalyst used in the converter.

..... [1]

(b) Carbon monoxide and nitrogen monoxide are pollutant gases produced from the car engines. These pollutant gases can react with one another in a redox reaction at the catalytic converter to form less polluting exhaust gases.

Explain, in terms of oxygen transfer, why the reaction between carbon monoxide and nitrogen monoxide at the catalytic converter is a redox reaction.

.....

.....

.....

..... [2]

(c) Explain why catalytic converters do not remove all the environmental problems caused by the exhaust gases.

.....

.....

.....

..... [2]

(d) Petrol contains mainly alkanes. One of them is alkane **X**.

(i) Given the information that alkane **X** is made up of 84.2% carbon and 15.8% hydrogen, find the empirical formula of alkane **X**.

Empirical formula is .....

[3]

(ii) Using the **molecular formula** of alkane **X**, write a balanced chemical equation for the complete combustion of alkane **X**.

..... [1]

(iii) Calculate the volume of oxygen gas needed to burn 3 moles of alkane **X** completely.

[2]

[Total: 11]

A7 A student carried out a series of experiments on five metals **P**, **Q**, **R**, **S** and **T**. The results are shown in the table below. The letters **P** to **T** do not represent the actual symbols of the metals.

Metal	reaction with steam when heated	reaction with dilute HCl	reaction with water	metal oxide reduced by carbon when heated
P	no	yes	no	yes
Q	yes	yes	yes	no
R	yes	yes	no	yes
S	yes	yes	no	no
T	no	no	no	yes

Note: 'yes' indicates a reaction took place; 'no' indicates no reaction took place.

(a) **(i)** Arrange the five metals in the descending order of reactivity. [2]

most reactive ..... least reactive

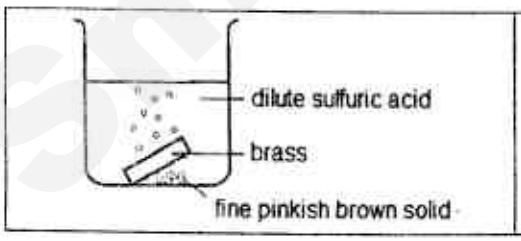
(ii) In the reactivity order of the five metals as arranged in **(a)(i)**, state the position which you would place the element carbon.

..... [1]

(iii) Suggest a possible identity for metal **R**.

..... [1]

(b) In another experiment, the student placed a piece of brass into dilute sulfuric acid.



The following observations were recorded by the student.

- Effervescence
- Fine pinkish-brown solid formed at the bottom of the beaker.

Explain the following observations:

Formation of effervescence: .....

..... [1]

Formation of pinkish-brown solid:.....

..... [1]

[Total: 6]

Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only **one** of the alternatives should be attempted.

B8 The transition metals are a block of elements in the centre of the Periodic Table. Transition metals usually have the following properties:

Some information about the transition metals in Period 4 are shown in the tables below.

Table 1

Element	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
density (g/cm^3)	2.99	4.50	5.96	7.20	7.20	7.86	8.90	8.90	8.92	7.14
melting point (°C)	1541	1660	1890	1857	1244	1535	1495	1455	1083	420

Table 2

element	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
common oxidation states that occur in compounds	+3	+4 +3 +2	+5 +4 +3 +2	+6 +5 +4 +3 +2	+7 +6 +5 +4 +3 +2	+6 +5 +4 +3 +2	+5 +4 +3 +2	+4 +3 +2	+3 +2	+2

(a) Across Period 4 of the Periodic Table, describe the trend in the number of oxidation states formed by the transition metals in their compounds.

.....

..... [1]

(b) Some scientists do not consider two of the metals found in Period 4 as 'transition metals'.

(i) **Name** the **two** metals.

..... and ..... [2]

(ii) Using your knowledge about transition elements and the information provided from **Tables 1** and **2**, explain your answers in **(b)(i)**.

.....

.....

.....

.....

.....

..... [3]

(c) Two equations showing the displacement reactions between transition metals in Period 4 are as follows.

equation 1: $Zn + Co(NO_3)_2 \rightarrow Zn(NO_3)_2 + Co$

equation 2: $Co + Ni(NO_3)_2 \rightarrow Co(NO_3)_2 + Ni$

A student wrote in his notes, '*the greater the number of oxidation states exhibited by a metal in its compounds, the higher will be the reactivity of that metal*'.

Do you agree with the student? Explain your reasoning.

.....

.....

.....

..... [2]

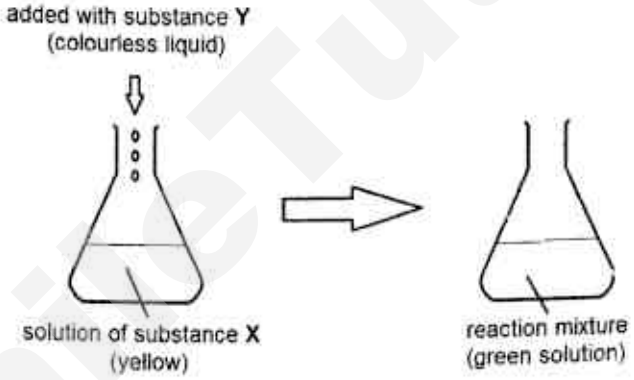
(d) **Table 3** shows the colours of different compounds formed by vanadium using different oxidation states.

Table 3

substance	*colour*	*oxidation state of vanadium*
$V(H_2O)_6^{3+}$	green	+3
VO_2^+	yellow	+5
$V(H_2O)_6^{2+}$	violet	
VO^{2+}	blue	

(i) Study the examples of oxidation states given.
Complete **Table 3** by filling in the missing oxidation states. [1]

(ii) Substance **X** is a compound containing vanadium. When dissolved in water, substance **X** forms a yellow solution.
When substance **Y** (a colourless liquid), is added to an aqueous solution of substance **X**, a green solution is obtained.



Two students, John and Sally, attempted to explain the observation.

John: 'I think substance **Y** acts as an oxidising agent in the reaction'.

Sally: 'I think substance **Y** acts as a reducing agent in the reaction'.

Which student is correct? Explain your reasoning.

.....

.....

.....

.....[2]

[Total: 11]

B9 This is a question about the rate of reaction in producing HBr.

Reaction of amine with bromine

Reaction: $C_6H_5NH_2 + 3Br_2 \rightarrow C_6H_2NH_2Br_3 + 3HBr$

The initial rate of this reaction was determined using different concentrations of the reactants as shown in the following experiments.

Table 1

experiment	concentration of $C_6H_5NH_2$ (mol/dm^3)	concentration of Br_2 (mol/dm^3)	initial rate of reaction (mol/dm^3 s)
1	0.001	0.001	0.007
2	0.001	0.002	0.014
3	0.001	0.003	0.021
4	0.002	0.003	0.084
5	0.003	0.003	0.189

From the data in **Table 1**, changes in the concentration of each reactant affect the rate of reaction differently. Knowing how the rate is affected by the concentration of each reactant will allow us to predict the rate of reaction.

Depending on how the rate is affected by concentrations of each reactant, we can classify reactions into the following two types as shown in **Table 2**.

Table 2

type pf reaction	characteristic	Example
First order reaction with respect to reactant **A**	The rate of reaction is proportional to the concentration of **A**	If you double the concentration of **A**, the rate doubles as well. If you increase the concentration of **A** by a factor of 4, the rate goes up 4 times as well.
Second order reaction with respect to reactant **A**	The rate of reaction is proportional to the square of the concentration of **A**	If you doubled the concentration of **A**, the rate would go up 4 times (2^2). If you tripled the concentration of **A**, the rate would increase 9 times (3^2).

(a) Using information from **Table 1**, show why the order of reaction with respect to Br_2 is **First order**.

.....

.....

.....

..... [3]

(b) **(i)** Using information from **Table 1**, describe how the rate of reaction changes as the concentration of $C_6H_5NH_2$ changes.

.....

.....

..... [2]

(ii) Hence, determine the order of reaction with respect to $C_6H_5NH_2$.

..... [1]

(c) Determine the rate of reaction when concentration of $C_6H_5NH_2$ is 0.002 mol/dm^3 and concentration of Br_2 is 0.001 mol/dm^3.

..... [1]

(d) Use ideas about collisions between particles to explain the effect of concentration on the speed of reaction.

.....

.....

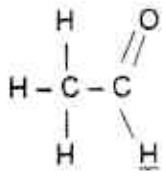
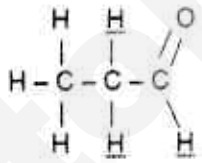
.....

..... [2]

[Total: 9]

EITHER

B10 (a) The table below shows some information about the homologous series of a class of organic compounds called aldehydes.

name	chemical formula	structural formula
ethanal	CH_3CHO	
propanal	C_2H_5CHO	

(i) Write the chemical formula of the next member of this homologous series.

..... [1]

(ii) Explain why ethanal and propanal belong to the homologous series, aldehydes.

.....

.....

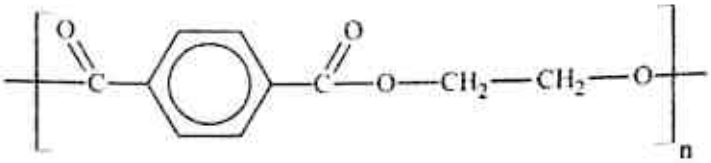
.....

..... [2]

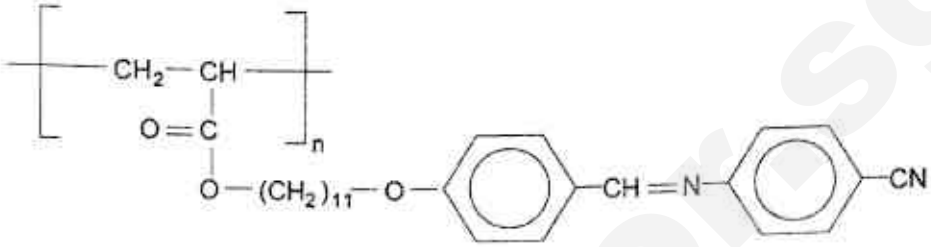
(iii) Propanal is an isomer of another organic compound, **Q**.
Draw the structure of this organic compound, **Q**.

[1]

(b) Polyethylene terephthalate, a type of plastic, is used extensively in the manufacture of plastic bottles. The structure of polyethylene terephthalate is shown below.



Another plastic, polymer **X**, has the following structure.



Both polyethylene terephthalate and polymer **X** are polymers. However, they belong to different types of polymers.

(i) Explain why they are polymers.

.....

..... [1]

(ii) Show the structural formulae of the monomers used to form polyethylene terephthalate in the space below.

[2]

(iii) Explain, with reference to the monomers and the polymerization involved, why polyethylene terephthalate and polymer **X** are different types of polymers.

.....

.....

.....

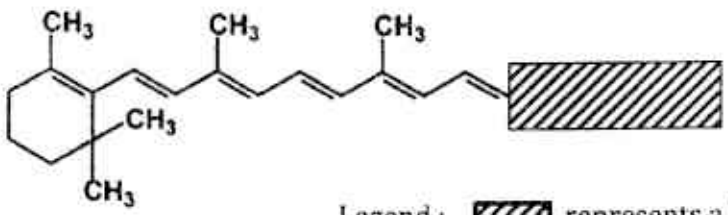
.....

..... [3]

[Total: 10]

OR

B10 (a) Beta-carotene, a pigment found in yellow and orange fruits and vegetables protects the body from free radicals and help to boost the body's immunity system. The diagram below shows the structure of beta-carotene.



Legend : represents a hydrocarbon group

(i) Beta-carotene is polyunsaturated.
Explain the term 'polyunsaturated'.

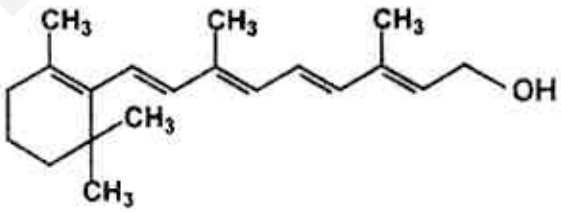
..... [1]

(ii) Describe a test to confirm the presence of unsaturation in beta-carotene.

.....

..... [1]

(iii) Beta-carotene is broken down in the human body to give vitamin **A** and a by-product, **M**. The diagram below shows the structure of vitamin **A**.



Explain how the body breaks beta-carotene down to vitamin **A**.

.....

.....

.....

..... [2]

(b) Methanoic acid can be produced by the oxidation of methanol with oxygen in the presence of bacteria.

(i) Showing the full structural formulae of the reactants and the products, construct a balanced equation for the reaction.

[2]

(ii) Methanoic acid reacts with sodium hydroxide to form sodium methanoate and water.

Draw a 'dot-and-cross' diagram to show the bonding in sodium methanoate. Show the outer shell electrons only.

[2]

(c) Methanoic acid and vitamin **A** can combine to form a larger molecule and this molecule is an example of a polyester.

Do you agree with this statement? Explain your answer.

.....

.....

.....

..... [2]

[Total: 10]

Paper 2

A1 (a) D

(b) E

(c) A and E

A2 (a)

reaction	Intermediate product	main or by-product (if any)
I	$NaHCO_3$ and NH_4Cl	—
II	CaO and CO_2	
III	two immediate products	$CaCl_2$
IV	CO_2	Na_2CO_3

(b) ammonia and water

(c) $2NaCl + CaCO_3 \rightarrow Na_2CO_3 + CaCl_2$

(di) circle 'mildly alkaline'

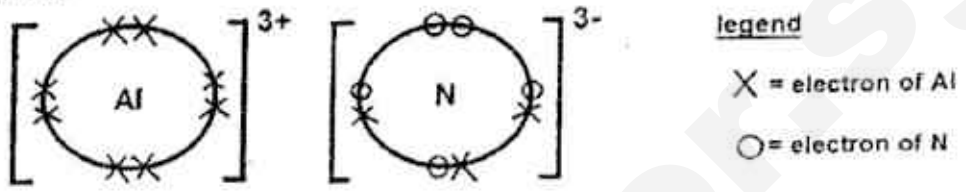
(dii) Carbonic acid, (a weak acid), partially ionises to form H^+ ions.

The concentration of OH^- is higher than the concentration of H^+ ions. Thus, the solution is mildly alkaline. (Accept "more OH- than H+ in the solution)

A3 (a) Hexagonal boron nitride (HBN) is soft while cubic boron nitride (CBN) is very hard

1. The layers of atoms in HBN is held by weak van der Waals' forces while the atoms in CBN are held by strong covalent bonds in tetrahedral arrangement.
2. When a force is applied, the layers of atoms in HBN can slide over another while atoms in CBN cannot slide as the structure is rigid.

(b)(i)



(ii) JO_3 has simple molecular structure while A/N has giant ionic (lattice) structure

(b) (I) Much less heat or energy is required to overcome the weak intermolecular / Van der Waals forces between the JO_3 molecules than the strong electrostatic forces of attraction between ions in A/N.

Thus, JO_3 has a low melting point while A/N has a very (high) melting point.

A4 (ai) 450°C, 250 atm and iron as catalyst

(aii) 27 %

(bi) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

(bii) 85 %

(biii) At the optimum temperature, the reaction will be faster/not be too slow and hence enable the conversion to be more economical / time or cost effective / productive.

'Loosely' packed vanadium provides a larger (total) surface area of contact with or exposed (to the reacting gases/particles) for the catalyst to increase the rate of reaction further / more effectively.

The (forward) reaction is exothermic. (Must be stated first)

If heated, the temperature in the converter may exceeds the optimum temperature (OR may become too high to favour the decomposition of sulfur trioxide) (and thus, causes the percentage conversion of sulfur trioxide to decrease).

OR Hence, the heat liberated by the reaction is sufficient to raise the temperature to the optimum temperature so heating is not required.

OR Heat liberated by the reaction to surroundings raises the temperature and not heating saves energy.

A5 (ai) anode equation at set-up 1: $2Cl^-(aq) \rightarrow Cl_2(g) + 2e$

anode equation at set-up 2: $Cu(s) \rightarrow Cu^{2+}(aq) + 2e$

anode equation at set-up 3: $4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e$

(aii) cathode equation: $Cu^{2+}(aq) + 2e \rightarrow Cu(s)$

(b) 1) The protective layer of copper in set-up 3 is thinner than in set-up 2.

2) The Cu^{2+} ions that were reduced at the cathode in set-up 3 are not replenished by copper anode, unlike that in set-up 2.

(Do not accept one-sided answer, Do not accept "the concentration of Cu^{2+} in the solution of set-up 3 is more concentrated")

(c) When the protective layer is scratched, water and oxygen in the air will enter.

Copper being more reactive than silver, will lose electrons more readily and will corrode in place of silver. Thus, silver metal is still protected.

Iron is more reactive than copper. Thus, iron will rust (even faster) when the copper layer is scratched.

A6 (a) platinum / rhodium

(b) Nitrogen monoxide loses oxygen to carbon monoxide and is reduced to nitrogen.

Carbon monoxide gains oxygen and is oxidized to carbon dioxide.

(c) Carbon dioxide gas is a greenhouse gas, and when emitted excessively, will cause global warming.

State any one detailed effect of global warming.

(di)

element	C	H
number of mole in 100 g	$\frac{84.2}{12} = 7.016$	$\frac{15.8}{1} = 15.8$
molar ratio	$\frac{7.016}{7.016} = 1$	$\frac{15.800}{7.016} = 2.25$
simplest ratio / multiply by 4	4	9

Thus, the empirical formula is C_4H_9.

(dii) $2C_8H_{18} + 25\ O_2 \rightarrow 16CO_2 + 18H_2O$

(diii) Number of mole of oxygen gas needed = 3/2 X 25 = 37.5
(ECF from dii only if the formula of X is that of an alkane)
volume of oxygen gas needed = 37.5 X 24 dm^3
= 900 dm^3 or 900 000 cm

A7 (ai) **Q, S, R, P, T**

(aii) between metals **S** and **R** (accept below S and above R)

(aii) zinc / iron

(b) Effervescence:
Sulfuric acid reacted with zinc (in brass) to form hydrogen gas.

Pinkish-brown solid: The copper (in brass) is unreactive to the dilute sulfuric acid and is left behind in the reaction.

B8 (a) Across period 4, the number of oxidation states increases (from Sc) to Mn, before decreasing (to Zn).

(bi) Scandium and zinc

(bii) 1) Both Sc and Zn have only one or a fixed oxidation state instead of the variable oxidation states shown by transition metals.
2) Sc has a low/lower density compared to the rest of the transition-metals of period 4 which has densities of at least 4.50 g/cm.
3) The melting point of Zn, 420 °C is low/lower than the high melting points of transition metals which are *above 1000/ at least1083°C.
(Note: need to compare with transition metals to score)

(c) No. / Disagree.

For equation 1, Zn is more reactive than Co as Zn displaces Co from its salt solution.

Zn exhibits only one oxidation state while Co can have four/many oxidation states.

(di)

$V(H_2O)_6^{2+}$	+2
VO^{2+}	+4

(dii) Sally is correct.

Substance Y acts as a reducing agent as it decreases the oxidation state of vanadium.

The oxidation states of vanadium decreases from +5 to +3 in the reaction.

B9 (a) The rate of the reaction doubles when the concentration of Br_2 doubles. From experiment 1 and 2, the rate of reaction increases from 0.007 mol/dm^3 s to 0.014 mol/dm^3 s when the concentration increases from 0.001 mol/dm^3 to 0.002 mol/dm^3. (OR expt 1 and 3, rate triples when conc triples with evidence)

(bi) The rate of the reaction increases by 4 times when the concentration of $C_6H_5NH_2$ doubles.

From experiment 3 and 4, the rate of reaction increases from 0.021 mol/dm^3 s to 0.084 mol/dm^3 s when the concentration increases from 0.001 mol/dm^3 to 0.002 mol/dm^3 (OR expt 3 and 5, when concentration triples, rate is 9X faster)

(bii) Second order reaction

(c) 0.028 mol/dm3 s

(d) 1) Increased concentration increases the number of particles per unit volume OR the distances between reacting particles decreases.

This increases the frequency of collisions between particles.

2) As a results, the number of effective collisions per unit time increases and the speed of reaction as well.

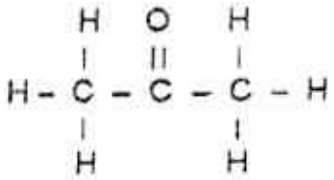
Either

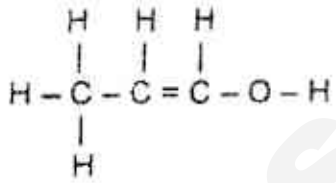
B10 (ai) C_3H_7CHO

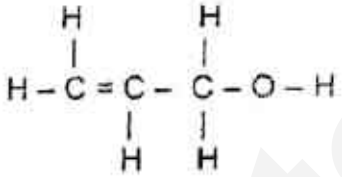
(aii) <u>same</u> general formula as aldehydes, $C_nH_{2n+1}CHO$

<u>same</u> functional group as aldehydes , -CHO

(aiii) *Draw structure as shown below (any one)*







(bi) <u>long-chain</u> molecules made up of <u>many</u> <u>repeating units (or many small / monomer molecules joined together)</u>.

(bii) *Draw structure as shown below*

(biii) Polymer X is an <u>addition polymer</u> while polyethylene terephthalene is a <u>condensation polymer</u>.

Monomers of Polymer X contain <u>C=C bonds/unsatureated</u> while monomers of polyethylene terephthalene have <u>different functional groups</u>.

Monomers of Polymer X add onto one another (at the C=C bonds) <u>without any loss of material/atoms</u> (reject: molecules) while <u>simple molecules of water</u> are removed/formed as by-products when monomers react with one another (at the functional groups).

OR

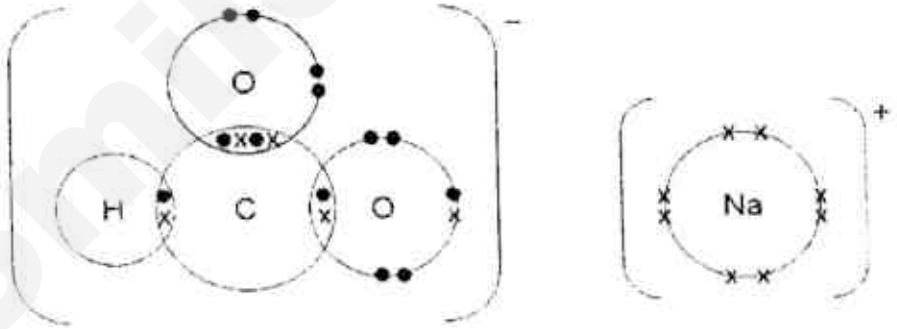
B10 (ai) multiple/many carbon-carbon double/C=C bonds

(aii) Add aqueous bromine to beta-carotene. The reddish-brown aqueous bromine will turn colourless/be decolourised immediately/rapidly if beta-carotene is unsaturated.

(aiii) Breakdown involves the reaction with water,
which results in the addition of hydrogen atom and hydroxyl group at the carbon-carbon double / C=C bond and the breakage of (carbon-carbon single) bond with the hydrocarbon group.

(bi) *Draw structure as shown below.*

(bii) *Draw structure as shown below.*



(c) Correct that a larger molecule is formed as they have the carboxyl and hydroxyl group to form an ester/ester linkage (with the removal of water molecules).
Incorrect that a polyester is formed as the product contains only one ester linkage/group per molecule (reject: does not contain many ester groups or linkages).

Name	Class	Class Register Number

中正中学

CHUNG CHENG HIGH SCHOOL (MAIN)

Parent's Signature

PRELIMINARY EXAMINATION 2017

SECONDARY 4

CHEMISTRY **5073/01**

Paper 1 Multiple Choice **14 September 2017**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your name, class and register number clearly in the spaces provided at the top of this page.

There are forty questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

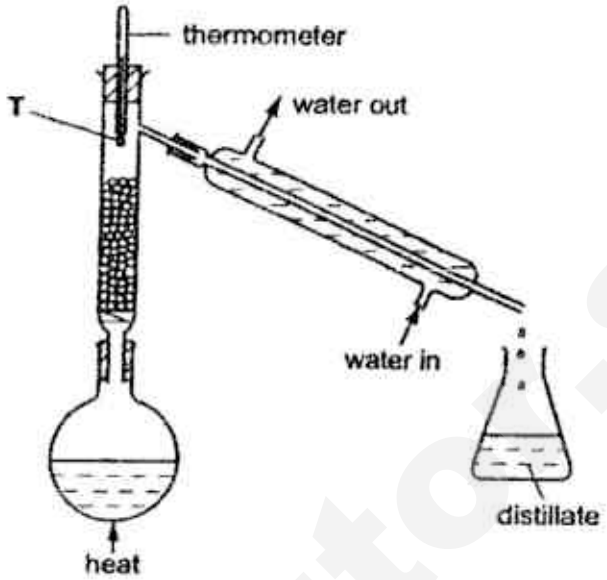
Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 18.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of 19 printed pages.

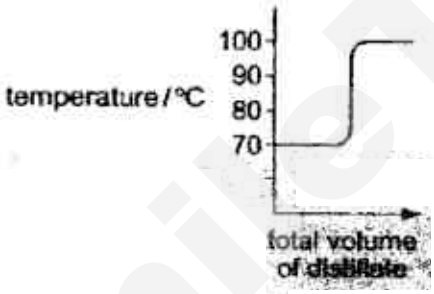
[Turn over

1 The diagram shows the apparatus used to separate hexane (boiling point, 70 °C) and heptane (boiling point, 98 °C).

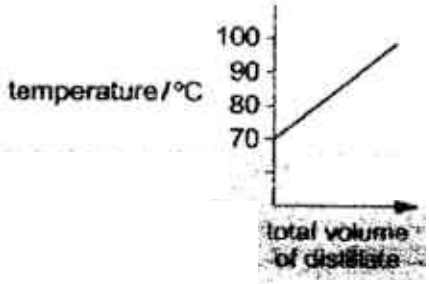


Which graph would be obtained if the temperature at point T was plotted against the total volume of distillate collected?

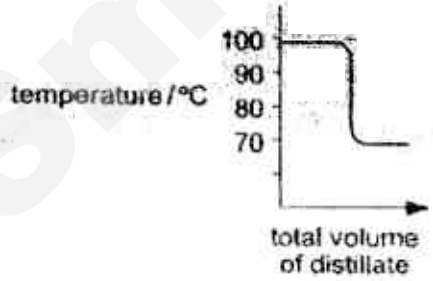
A



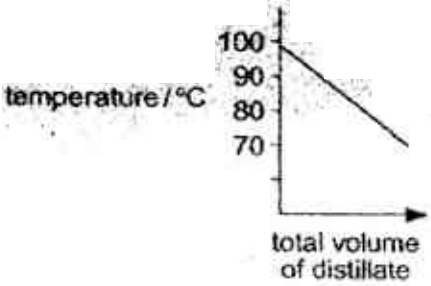
B



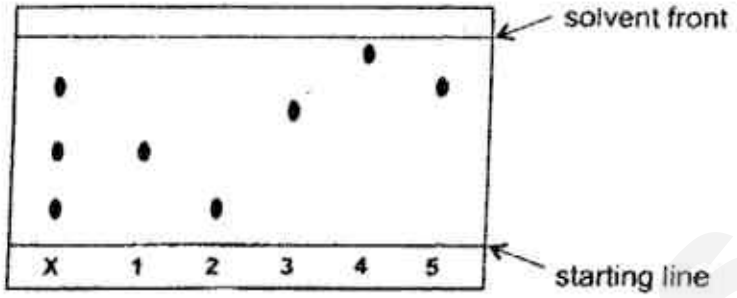
C



D



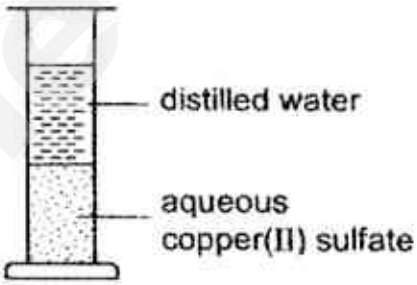
2 Chromatography is used to separate different dyes present in mixture **X**. The chromatogram of mixture **X** and individual dyes labelled **1** to **5** is shown below.



Which dyes are found in **X** and which dye in **X** has the smallest R_f value?

	dyes present in X	dye with the smallest R_f value
A	1, 2, 5	4
B	1, 2, 3	2
C	1, 2, 5	2
D	1, 3, 5	1

3 An experiment was set up as shown in the diagram below.



It was observed that after leaving to stand for several days, the liquid in the jar had the same colour throughout. This is due to the movement of

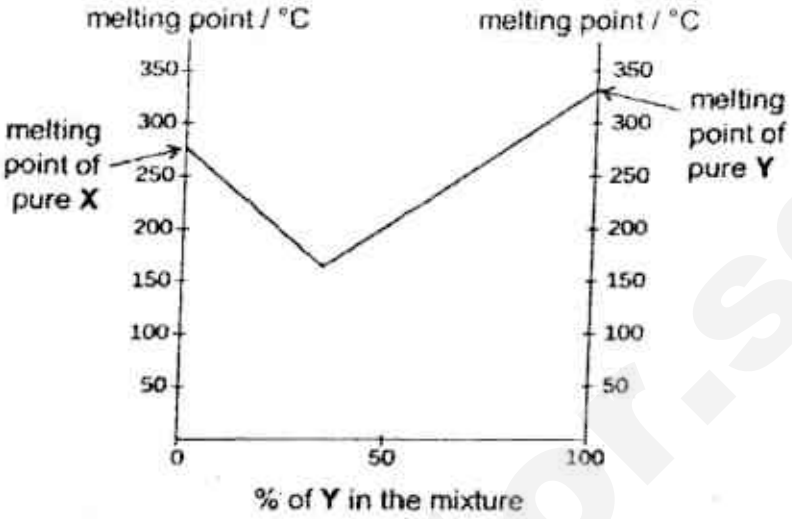
A the water molecules only.

B the copper and sulfate ions only.

C the copper(II) sulfate molecules only.

D the copper ions, sulfate ions and water molecules.

4 The figure below shows the melting points of mixtures containing different percentages of metals **X** and **Y**.



Which statement is true about the melting point of any mixture of metals **X** and **Y**?

A It must be above the melting point of pure **X**.

B It must be below the melting point of pure **Y**.

C It must be below the melting point of pure **X**.

D It must be between the melting points of pure **X** and pure **Y**.

5 In which of the following molecules are all the outer electrons of the atoms involved in bonding?

A CH_4

B NH_3

C CO_2

D HCl

6 The formula of the sulfate of element **X** is XSO_4. Which of the following is the correct formula for a compound formed between **X** and an oxalate ion, $C_2O_4^{2-}$?

A $X(C_2O_4)_2$

B $X_3C_2O_4$

C $X_2(C_2O_4)_3$

D XC_2O_4

7 The electronic configuration of element **M** is 2.8.6. **M** is known to react with element J which has a shiny appearance and floats on water. Which of the following best fits the compound formed between **M** and **J**?

	type of bonding	formula of compound formed
A	covalent	JM_2
B	covalent	J_2M
C	ionic	JM_2
D	ionic	J_2M

8 The empirical formula of a compound is C_2H_4O. Which of the following are possible molecular formulae for this compound?

I CH_3CH_2OH
II $CH_3CH_2COOCH_3$
III $HOCH_2CHCHCH_2OH$

A I only

B I and III

C II and III

D I, II and III

9 Which statement is true?

A Ar has more electrons than Cl^-.

B Cl^- has more electrons than K^+.

C Fe^{3+} has more electrons than Fe^{2+}.

D K has more electrons than K^+.

10 When a 200 g sample of impure potassium hydrogen carbonate, $KHCO_3$ (M_r = 100), was heated under a strong flame, 6.00 dm^3 of carbon dioxide gas (measured at room temperature and pressure), was collected. Determine the percentage purity of the potassium hydrogen carbonate sample.

$$2KHCO_3 \rightarrow K_2CO_3 + H_2O + CO_2$$

A 25%

B 50%

C 75%

D 100%

11 The table below shows the results of different experiments conducted on two acids, **A1** and **A2**, of equal concentration.

acids	conductivity of acid solution / arbitrary units	temperature change when excess acid was reacted with 100 cm^3 of 1.0 mol/dm^3 sodium hydroxide / °C	observation during reaction of acid with 3.0 cm magnesium strip
A1	1000	+6.9	rapid effervescence of a colourless gas
A2	7.0	+6.7	slow bubbling of a colourless gas

Which of the following deductions can be made about acids **A1** and **A2**?

A **A1** is a weak acid while **A2** is a strong acid.

B **A1** is a strong acid while **A2** is a weak acid.

C Both **A1** and **A2** are weak acids, except that **A1** is a dibasic acid.

D Both **A1** and **A2** are strong acids, except that **A2** is a dibasic acid.

12 In an experiment, 5 cm^3 of 2.0 mol/dm^3 aqueous potassium hydroxide was added to 10 cm^3 of 0.5 mol/dm^3 hydrochloric acid as shown in the diagram below. The acid solution was pre-treated with some Universal Indicator.

Which change, if any, would be observed in the colour of the Universal indicator?

A Remains red.

B Changes from red to blue.

C Changes from green to red.

D Changes from blue to red.

13 Which of the following burns in air to form an oxide which, when dissolved in water, gives a solution with a pH greater than 7?

A carbon

B copper

C hydrogen

D sodium

14 The effect of certain conditions on the speed of reaction between excess solid zinc carbonate and hydrochloric acid was investigated in experiments **1** and **2**.

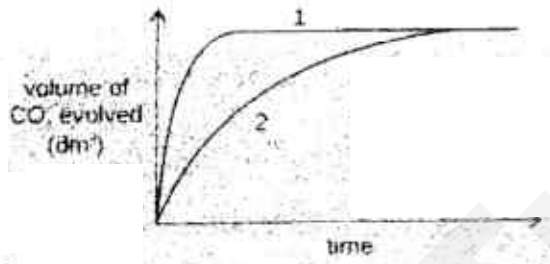
$$ZnCO_3\,(s) + 2HCl\,(aq) \rightarrow ZnCl_2\,(aq) + H_2O\,(l) + CO_2\,(g)$$

The table below shows the conditions used for the two experiments.

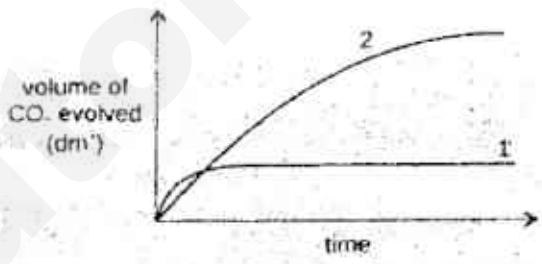
experiment	temperature / °C	concentration of acid used / mol/dm³	volume of acid used / cm³
1	40	4.00	100
2	30	2.50	400

The volume of gas given off was plotted against time. Which graph correctly shows the results in experiments **1** and **2**?

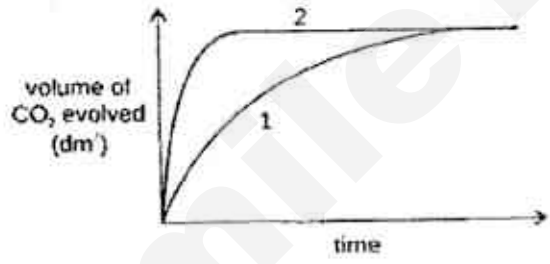
A



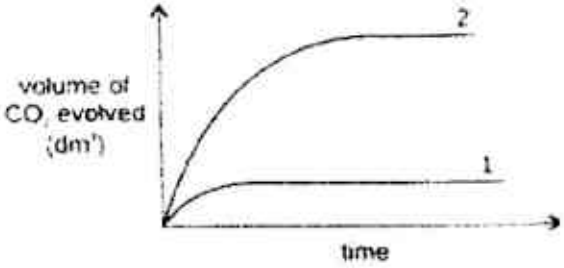
B



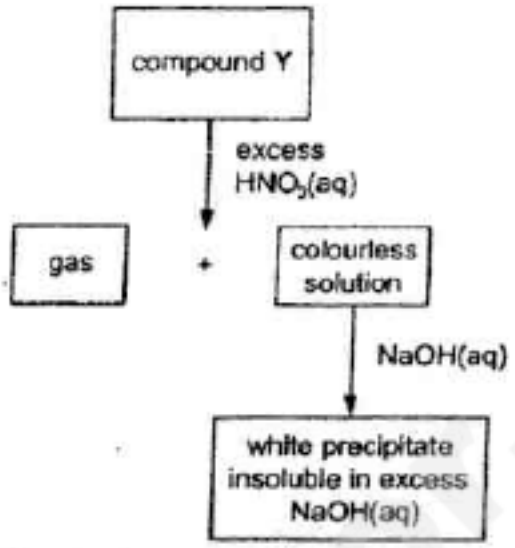
C



D



15 The scheme shows some reactions of a compound Y.



What could the compound Y be?

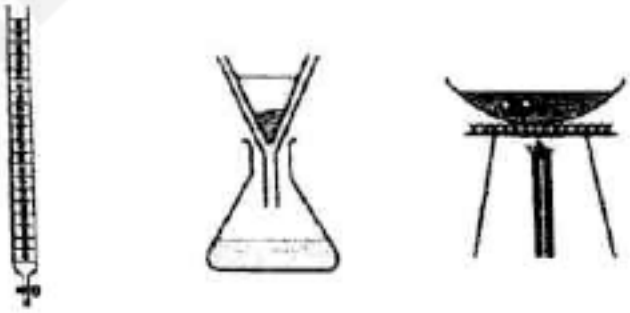
A aluminium sulfate

B calcium carbonate

C copper(II) carbonate

D zinc carbonate

16 A student attempts to prepare magnesium chloride using magnesium carbonate and hydrochloric acid. Which apparatus is / are necessary for this salt preparation method to help the student finally obtain a pure, dry sample of magnesium chloride crystals?



1 2 3

A 1 and 3

B 1 and 2

C 2 and 3

D 2 only

17 If an element with atomic symbol **Q** has an oxidation number of -1 in all its compounds, which of the following **cannot** be a compound of **Q**?

I MgQ_2
II KQ
III KQO_3

A I and II only

B I and III only

C III only

D I, II and III

18 Propanoic acid reacts with magnesium hydroxide to form magnesium propanoate salt and water as products. The incomplete chemical equation is given below.

$$2CH_3CH_2COOH + Mg(OH)_2 \rightarrow \text{.....} + 2H_2O$$

Which of the following gives the correct chemical formula of magnesium propanoate?

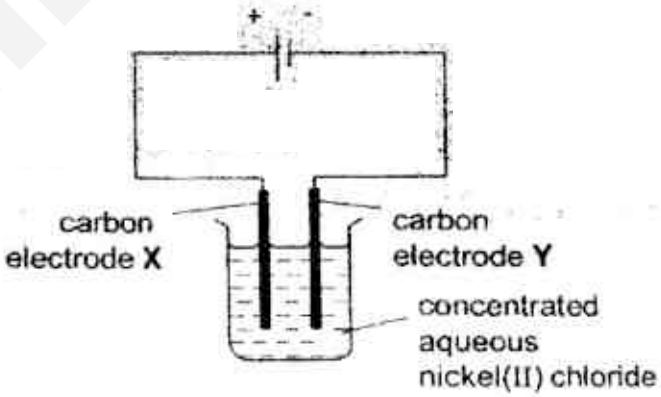
A $MgCOOH$

B CH_3CH_2COOMg

C $CH_3CH_2Mg_2$

D $(CH_3CH_2COO)_2Mg$

19 An experiment is set up as shown in the diagram.



What occurs at the carbon electrode **X**?

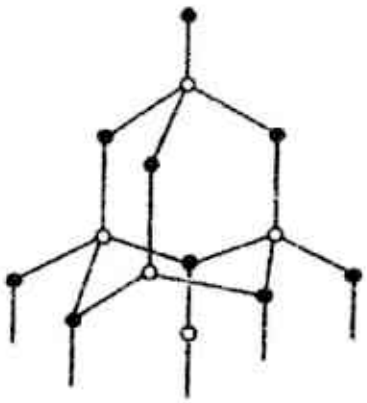
A Chloride ions are oxidized and chlorine gas is formed.

B Chloride ions are reduced and chlorine gas is formed.

C Hydroxide ions are reduced and oxygen gas is formed.

D Hydrogen ions are oxidized and hydrogen gas is formed.

20 The diagram shows the structure of a compound of silicon and carbon, $(SiC)_n$



key
● carbon atom
○ silicon atom

Which statement would be true for $(SiC)_n$?

A It acts as a lubricant.

B It conducts electricity.

C It is insoluble in water.

D It has a low melting point.

21 A new Chemistry student attempted to make a solution for his experiment by dissolving some potassium carbonate into a beaker of tap water. However, he noticed that the beaker of water began to turn cloudy with a suspension of white solids instead.

Which of the following could be a possible reason for this observation?

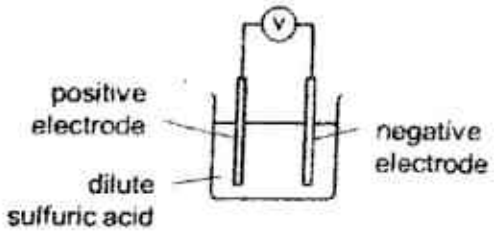
A The tap water contained sulfate ions.

B The tap water was acidic.

C The tap water contained nitrate ions.

D The tap water contained magnesium ions.

22 The diagram below shows a simple chemical cell.



The voltages produced by different combinations of metal electrodes are shown in the table below.

positive electrode	negative electrode	voltage / V
copper	zinc	1.10
copper	X	2.70
copper	Y	0.78
Z	copper	0.46

What is the order of the reactivity of the metals?

	most reactive →				least reactive
A	zinc	X	Z	Y	copper
B	X	zinc	Y	Z	copper
C	X	zinc	Y	copper	Z
D	Y	zinc	X	copper	Z

23 What is the volume of hydrogen produced at room temperature and pressure when 4.6 g of sodium is reacted with 9.0 g of water?
[1 mol of gas occupies 24 dm^3 at room temperature and pressure.]

$$2Na\ (s) + 2H_2O\ (l) \rightarrow 2NaOH\ (aq) + H_2\ (g)$$

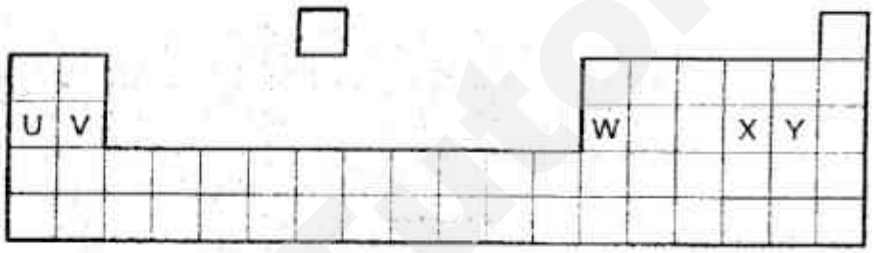
A 1.2 dm^3

B 2.4 dm^3

C 4.8 dm^3

D 12 dm^3

24 The following shows an outline of the Periodic Table.



Which of the elements **U**, **V**, **W**, **X** and **Y** would react with one another in the ratio of 1:1?

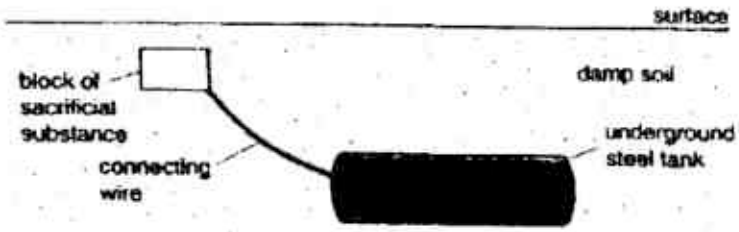
A **U** and **X**

B **U** and **Y**

C **V** and **Y**

D **W** and **X**

25 One way in which the corrosion of underground steel tanks can be prevented by sacrificial protection is shown in the diagram.



Which element is most suitable for use as the sacrificial substance?

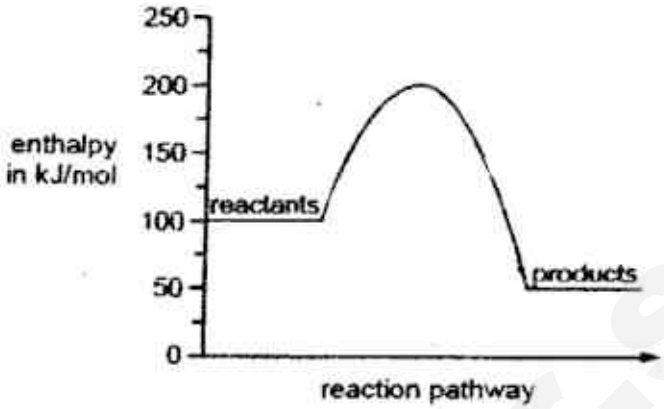
A carbon

B copper

C iron

D magnesium

26 The energy diagram below represents the energy changes in a chemical reaction.



What is the enthalpy change of this reaction?

A +50 kJ

B -50 kJ

C +100 kJ

D -100 kJ

27 In the extraction of iron in the blast furnace, which of the following results in the formation of a reducing agent?

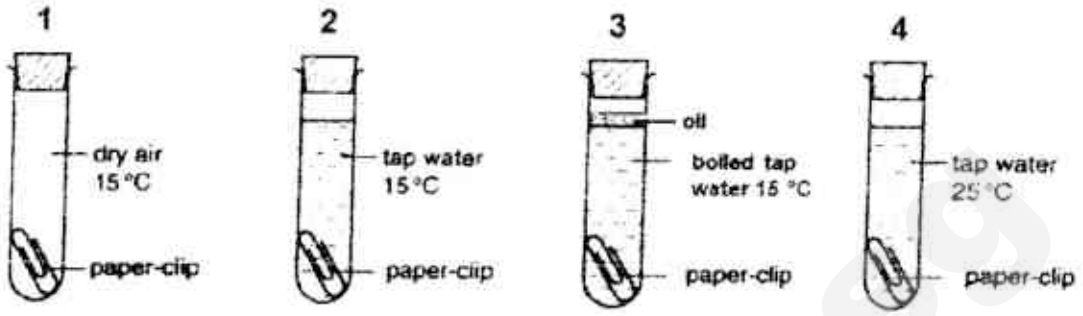
A $C + O_2 \rightarrow CO_2$

B $C + CO_2 \rightarrow 2CO$

C $CaCO_3 \rightarrow CaO + CO_2$

D $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

28 Four iron paper-clips are exposed to four different conditions in an experiment to study rusting.



Which two paper clips will rust after 1 week?

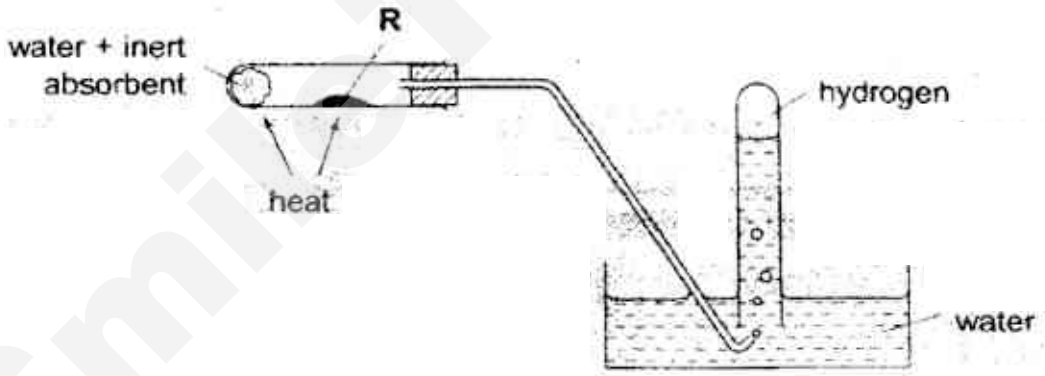
A 1 and **3**

B 1 and **4**

C 2 and **3**

D 2 and **4**

29 The diagram shows an experiment to produce and collect hydrogen gas.



What is R?

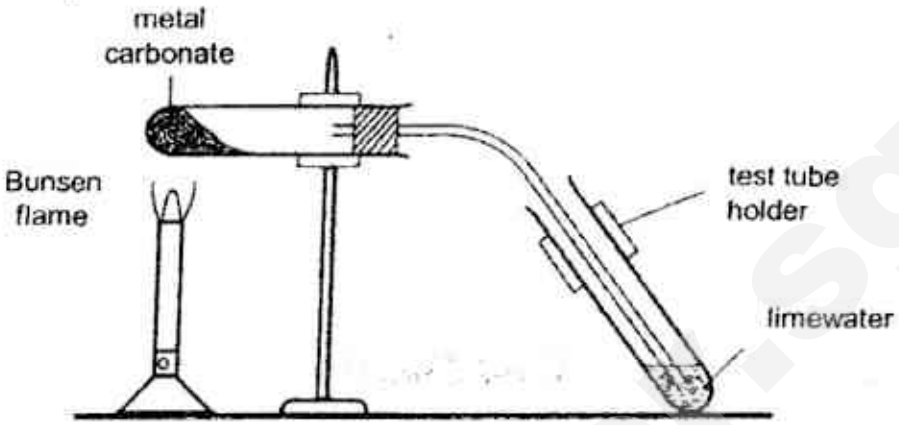
A lead

B iron

C lead(II) oxide

D copper(II) oxide

30 A fixed mass of the carbonates of four metals, J, L, **M** and **R**, were placed in a boiling tube and subjected to high temperatures from a strong Bunsen flame as shown in the diagram below.



The time taken for a white precipitate to be observed in the limewater was recorded in the table shown below.

carbonate of metal	time taken to observe white precipitate / s
J	20
L	252
M	not observed
R	110

Which of the following statements is true?

A Metal J is above metal R in the reactivity series.

B Metal L can displace ions of metal **M** from its salt solution.

C Metal **M** is an unreactive metal.

D Metal **M** is more reactive than metals J, L and R.

31 Which statement about the properties of ammonia is correct?

A It has strong forces of attraction between nitride and hydrogen ions.

B It reacts with alkalis to form salts.

C It is a product of the reaction between ammonium chloride and sodium hydroxide.

D It turns damp blue litmus paper red, and then bleaches the litmus paper.

32 The table below shows the composition of exhaust gases from a car engine.

gas	% of gas in the exhaust fumes
gas Y	71
carbon dioxide	14
water vapour	13
carbon monoxide	1
hydrocarbons (uncombusted)	0.3
oxides of nitrogen	0.2
sulfur dioxide	< 0.003

What is gas Y?

A ammonia

B argon

C chlorine

D nitrogen

33 Excess chlorine gas can be tested with damp blue litmus paper and by bubbling the gas through potassium iodide solution.

What colour would the damp blue litmus paper and potassium iodide solution be at the end of the test with excess chlorine?

	litmus paper	potassium iodide solution
A	bleached / white	brown
B	bleached / white	colourless
C	red	brown
D	red	colourless

34 Consider the two organic compounds shown in the diagram below.

Which of the following statements concerning these two compounds are correct?

A They have the same structural formula.

B They turn damp blue litmus paper red.

C They are both ionic compounds.

D They have different boiling points.

35 When 1 mole of hydrocarbon **Q** reacts with exactly 5 moles of oxygen gas, it forms carbon dioxide and water as the only products. What is hydrocarbon **Q**?

A methane, CH_4

B ethane, C_2H_6

C propane, C_3H_8

D butane, C_4H_{10}

36 Which row about the oxides SO_2, SiO_2, CO_2 and NO_2 is correct?

		CO_2	NO_2	SO_2	SiO_2
A	are acidic	✓	×	×	✓
B	are solids at room temperature	×	×	×	✓
C	may be present in air	✓	×	✓	×
D	react with acidified potassium manganate(VII)	×	×	✓	✓

37 When cracked, one mole of compound **X**, produces one mole of propene and one mole of hydrogen gas as shown in the chemical equation below

$$X \rightarrow C_3H_6 + H_2$$

What type of compound is **X**?

A an alcohol

B an alkane

C an alkene

D a carboxylic acid

38 Wine is an alcoholic drink. If wine is left exposed to air for too long, reactions can occur, and the wine turns acidic.

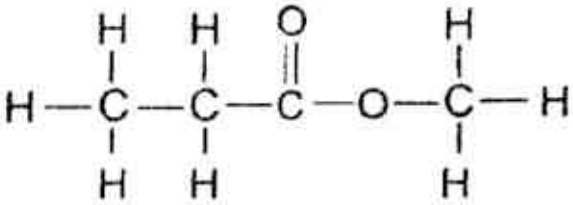
This is because the ethanol in wine is ....**1**.... to the acid ....**2**....

Which word and formula correctly fills blanks **1** and **2**?

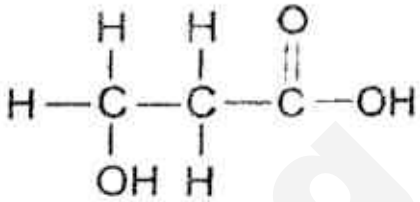
	1	2
A	oxidised	CH_3COOH
B	oxidised	CH_3CH_2COOH
C	reduced	CH_3COOH
D	reduced	CH_3CH_2COOH

39 Which of the following has been prepared by reaction between a carboxylic acid and an alcohol with the elimination of a water molecule?

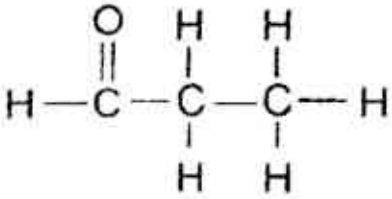
A



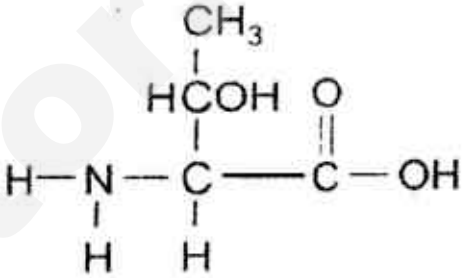
B



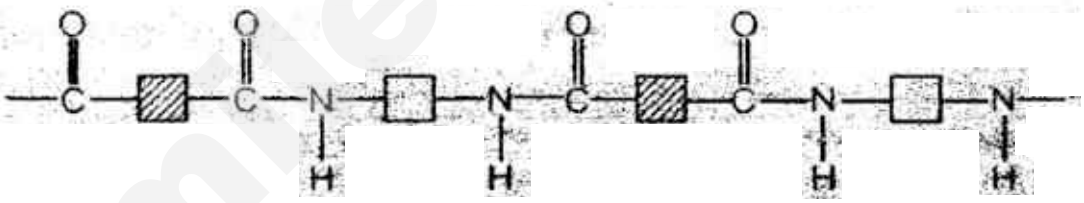
C



D



40 Polymer **W** is shown in the diagram below.



The following four terms can be used to describe polymers:

I addition polymer
II condensation polymer
III polyamide
IV polyester

Which two of the above terms are applicable to Polymer **W**?

A I and III

B I and IV

C II and III

D II and IV

CCHMS Sec 4 Preliminary Examination 2017

Marking Scheme

Paper 1

1. A	2. C	3. D	4. B	5. A
6. D	7. D	8. C	9. D	10. A
11. B	12. B	13. D	14. B	15. B
16. C	17. C	18. D	19. A	20. C
21. D	22. C	23. B	24. B	25. D
26. B	27. B	28. D	29. B	30. D
31. C	32. D	33. A	34. D	35. C
36. B	37. B	38. A	39. A	40. C

Name:	Class	Class Register Number

中正中学

CHUNG CHENG HIGH SCHOOL (MAIN)

Parent's Signature

_____

PRELIMINARY EXAMINATION 2017
SECONDARY 4

CHEMISTRY

5073/02

Paper 2

11 September 2017

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your name, class and register number clearly in the spaces provided at the top of this page. Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer all questions in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form either/or.
Answer **all** questions in the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic table is printed on page 21.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Paper 1	/ 40
Paper 2: Section A	/ 50
Paper 2: Section B	/ 30
Option E / O	
Paper 2 (A+B)	/ 80
Total	

This document consists of 20 printed pages and 2 blank pages.

[Turn over

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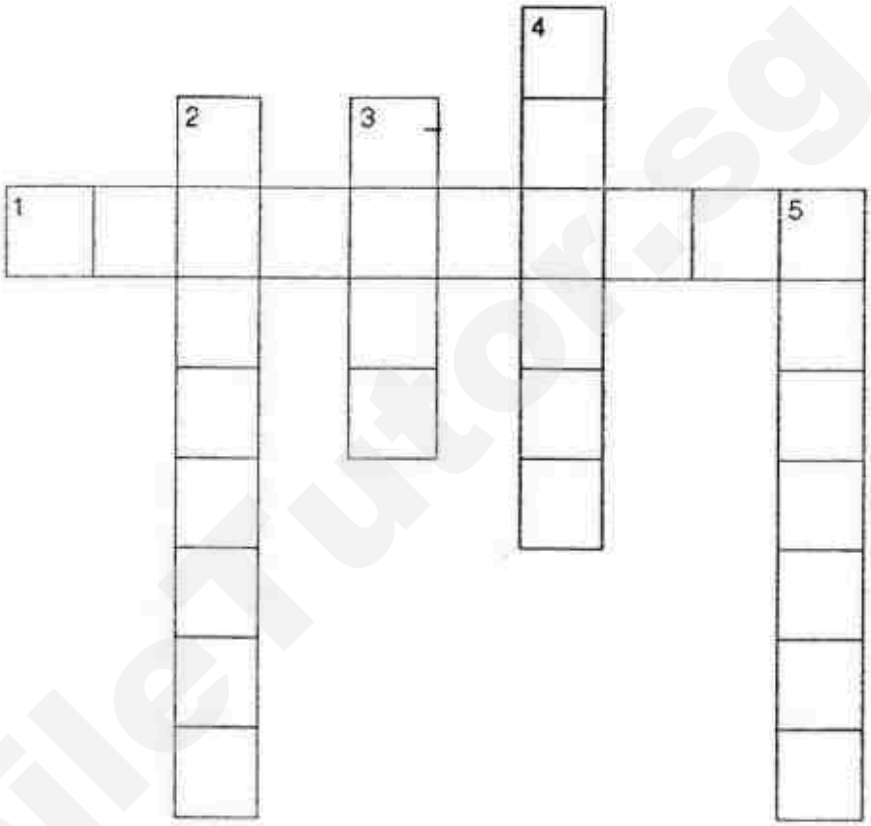
Section A

Answer **all** the questions in this section in the spaces provided.
The total mark for this section is 50.

A1 Use the following clues to complete the crossword puzzle.



(a) **1 across** A separation process which depends on the size of solid particles to work.

(b) **2 down** The most reactive halogen in the Periodic Table.

(c) **3 down** The catalyst used in the industrial production of ammonia.

(d) **4 down** An ion that would undergo reduction in electrolysis.

(e) **5 down** The total number of protons and neutrons in the nucleus of an atom is known as the ..... number.

[Total: 5]

A2 The table below lists some substances and their melting and boiling points.

substance	melting point / °C	boiling point / °C
iodine	114	184
lead(II) bromide	370	914
methane	-182	-161
bromine	-7	59
silicon dioxide	1610	2230
lithium	180	1360

Use the **names** of the substances in the table to answer the following questions.

(a) **(i)** Which substance sublimes readily when heated?

.....[1]

(ii) Which substance is a hydrocarbon?

.....[1]

(iii) Which substance(s) will conduct electricity when molten?

.....[1]

(iv) Which substance(s) react(s) violently with cold water?

.....[1]

(v) Which(s) substance(s) exist(s) as diatomic molecules?

.....[1]

(b) In terms of structure and bonding, explain the difference in the boiling points between bromine and silicon dioxide.

.....

.....

.....

.....[3]

(c) **(i)** Lead(II) bromide is insoluble in water. State **two** reagents that can be used to prepare lead(II) bromide.

reagent A: ..... [1]

reagent B: ..... [1]

(ii) Using reagents **A** and **B**, describe how a pure, dry sample of lead(II) bromide may be obtained.

.....

.....

.....

.....[2]

[Total: 12]

A3 When magnesium is burned in air on earth, a mixture of ionic solids are formed. Two main products can be obtained by the reaction between magnesium and the two abundant gases present in air.

One of the products formed is magnesium nitride. The chemical reaction for the formation of magnesium nitride is shown below:

$$3Mg + N_2 \rightarrow Mg_3N_2$$

(a) (i) Write a chemical equation for the formation of the second main product formed when magnesium is burned in air.

.....[1]

(ii) Draw a dot-and-cross diagram of the magnesium ion. Show only the outer electrons.

[1]

(b) Magnesium nitride, when added to water, reacts to form white insoluble magnesium hydroxide and a pungent, alkaline colourless gas. Describe a physical test that can be used to confirm the identity of this gas.

.....

.....

.....[2]

[Total: 4]

A4 Nickel is an important metal in the material science industry. The extraction and purification of nickel is known as the Mond Process, which involves converting its ore, nickel oxide, into pure nickel. The Mond Process consists of 3 steps as shown in the table below:

step	process	description
1	*extraction*	Reaction of nickel(II) oxide with hydrogen gas at 200 °C to give raw nickel solid and steam.
2	*purification*	Reaction of the raw nickel with carbon monoxide at 60°C to form an intermediate product, nickel tetracarbonyl, $Ni(CO)_4$. $Ni\ (s) + 4CO\ (g) \rightarrow Ni(CO)_4\ (g)$ Impurities are then separated from the nickel tetracarbonyl.
3	*Decomposition*	Remaining nickel tetracarbonyl is heated to 250 °C, which decomposes the nickel tetracarbonyl to obtain pure nickel solid.

(a) **(i)** Suggest the role of hydrogen gas in step 1 of the process.

.....[1]

(ii) Construct a chemical equation, with state symbols, for the reaction in step **1**.

.....[2]

(b) In a particular batch of nickel extract, 120 000 dm^3 of carbon monoxide was added in step **2** to an excess of raw nickel. The quality officer realized that the volume of nickel tetracarbonyl vapour obtained was 22 500 dm^3.

Calculate the percentage yield of nickel tetracarbonyl in this process. (You may make the assumption that at 60 °C and 1 atm pressure, 1 mole of gas occupies a volume of 24 dm^3.)

[2]

(c) Nickel is a transition metal. State one possible property of nickel compounds.

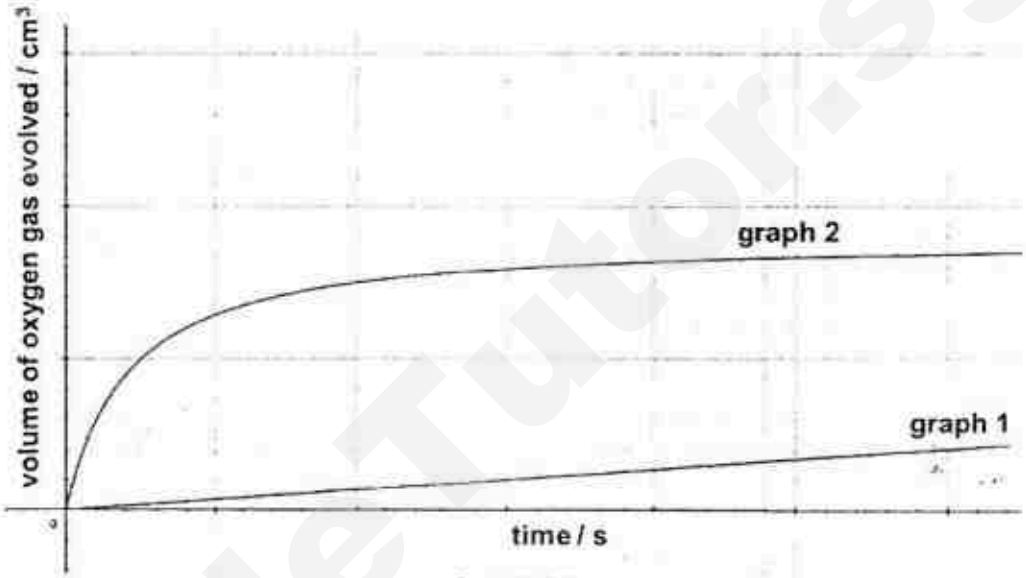
.....[1]

[Total: 6]

A5 Disproportionation is a reaction by which a substance undergoes oxidation and reduction simultaneously to give different products. The chemical equation below shows the disproportionation of hydrogen peroxide into water and oxygen gas. This is a highly exothermic reaction.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g) \qquad \Delta H = -196\ kJ/mol$$

The rate of this disproportionation reaction can be increased by the addition of a manganese(IV) oxide as a catalyst. **Graph 5.1 below** shows two graphs (**1 and 2**) for the disproportionation of hydrogen peroxide. One had a catalyst added to the set-up, while the other one did not have any catalyst added. The volume of hydrogen peroxide used was the same for both experiments.



Graph 5.1

(a) **(i)** Identify the graph that used a catalyst in the experiment.

.....[1]

(ii) Using **Graph 5.1**, explain your answer in **a(i)**.

.....

.....

.....[2]

(iii) Using ideas about collision of particles, explain how the catalyst works in this reaction.

.....

.....

.....

.....[3]

(b) **(i)** Complete the following table with the oxidation states of the elements found within the reactant and products of this reaction. [2]

	oxidation state of H	oxidation state of O
hydrogen peroxide		-1
oxygen gas		
water		–

(ii) Hence, explain why the above reaction is a disproportionation reaction.

.....

.....

.....

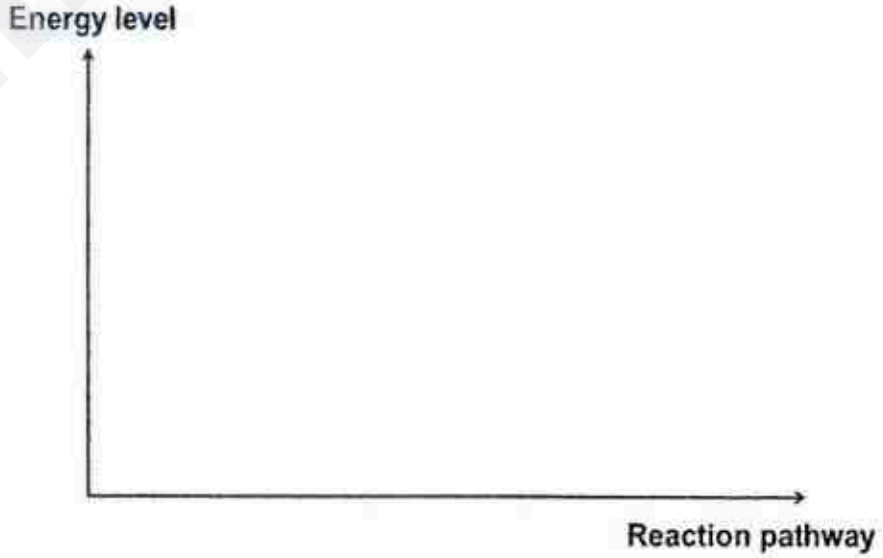
.....[2]

(c) Suggest why the disproportionation of hydrogen peroxide is too dangerous to be used as an industrial method to produce oxygen gas.

.....

.....[2]

(d) Sketch an energy profile diagram in the axes below for the disproportionation of hydrogen peroxide, labelling clearly the reaction enthalpy change (**ΔH**) and the activation energy (**E_a**).



[3]

[Total: 15]

A6 Acrylamide is an important chemical used in the making of paper, dyes and plastics. The chemical structure of acrylamide is seen in **Fig. 6.1** below.

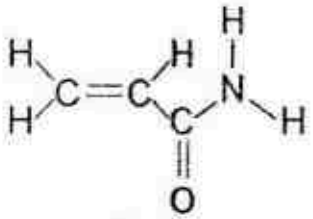


Fig. 6.1

(a) When acrylamide reacts with water under the right conditions, it undergoes a reaction called hydrolysis. One of the two products of hydrolysis is acrylic acid. The chemical structure of acrylic acid is shown below in **Fig. 6.2**

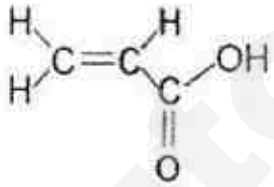


Fig. 6.2

(i) Suggest the identity of the other product in the hydrolysis of acrylamide.

.....[1]

(ii) Describe a physical test to distinguish between acrylamide and acrylic acid.

.....

.....

.....[2]

(iii) State the observations when acrylic acid reacts with aqueous bromine.

.....

.....[1]

(iv) Draw the structural formula of the product formed for the reaction in **a(iii)**.

[1]

(b) A synthetic pathway is a flowchart diagram used by organic chemists to plan their laboratory synthesis (formation) of a desired organic compound from a given starting material. A simple synthetic pathway involving 2 reaction steps can be represented as shown in **Fig. 6.3** below.

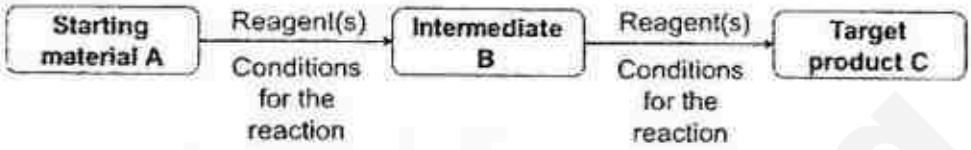
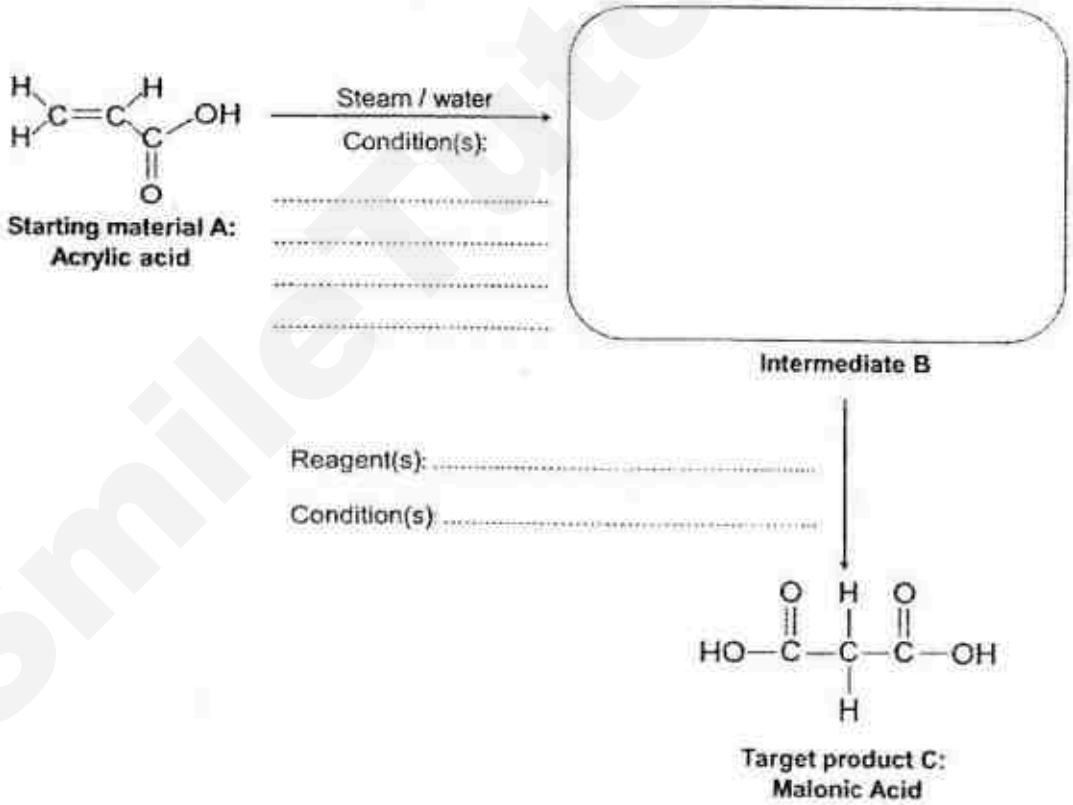


Fig. 6.3

Malonic acid is an important organic acid used as a preservative additive for foods.

Acrylic acid can be used as a starting material in the synthesis of malonic acid. The reactant required for step 1 has been provided. Complete the 2-step synthetic pathway below for the synthesis of malonic acid as the target product C.



[3]

[Total: 8]

Section B

Answer all **three** questions in this section.

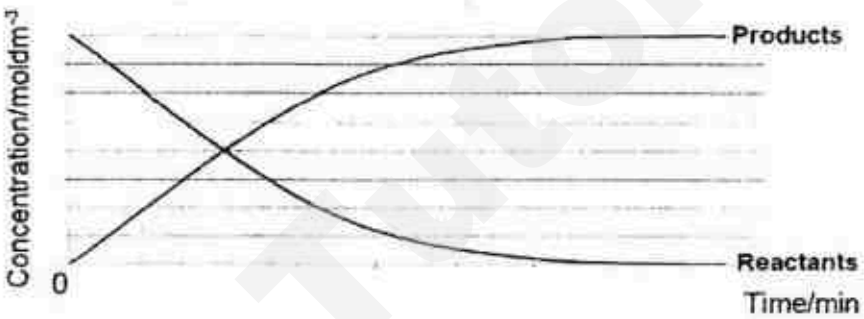
The last question is in the form of an either / or and only one of the alternatives should be attempted.

B7 Reversibility of reactions

Reactions can be classified as reversible or irreversible. The reversibility of a reaction can generally be represented by the use of a concentration-time graph, whereby the concentrations of the reactants and products in a reaction are tracked over time.

In an irreversible reaction, the reactants react to form products as such:

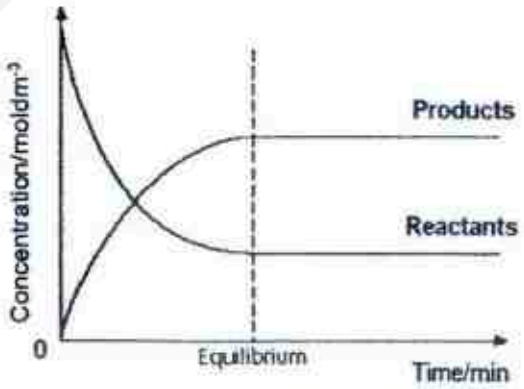
Reactant **A** + Reactant **B** → Product **C** + Product **D**



Graph 1: Concentration-time graph of an irreversible reaction

In a reversible reaction, the reactants react to form products as such:

Reactant **A** + Reactant **B** ⇌ Product **C** + Product **D**



Graph 2: Concentration-time graph of a reversible reaction

Examples of irreversible reactions include that of reactions between reactive metals and mineral acids, neutralisation reaction between strong acids and strong alkalis or decomposition of metal carbonates into metal oxides and carbon dioxide.

Equally frequent are reversible reactions, such as that between nitrogen and hydrogen to form ammonia as well as esterification between alcohols and carboxylic acids.

Reversible reactions and the Le Chatelier's Principle

Reversible reactions that take place in a closed system (i.e. one that happens in an enclosed vessel and there is no exchange of matter between the reaction mixture and the surrounding environment) can eventually reach a state of dynamic equilibrium. This means that the rate of the forward reaction (reactants → products) is the same as the rate of the backward reaction (products → reactants).

The Le Chatelier's Principle is a well-known scientific principle that applies to reversible reactions occurring in closed systems, such as the Haber Process. It states that when the system in dynamic equilibrium is subjected to a **change in conditions** (such as temperature, pressure and concentration), the system **will respond to counteract the effect of the change** so as to re-establish the state of equilibrium.

For example, in this reversible reaction: Reactant **A** + Reactant **B** ⇌ Product **C** + Product **D**

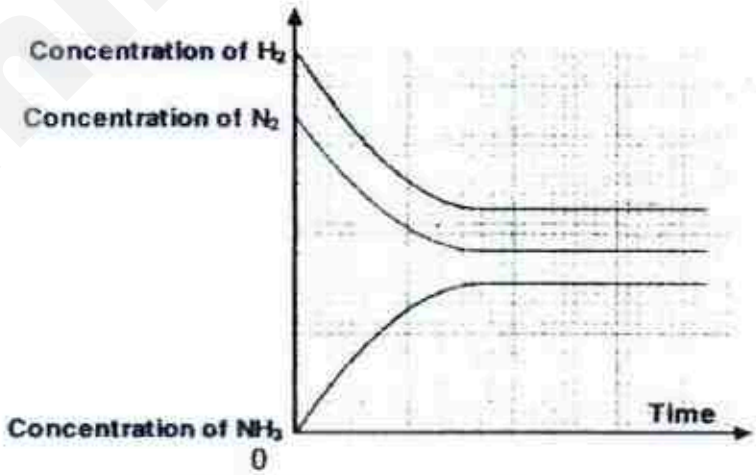
Le Chatelier's Principle **will apply** at dynamic equilibrium. **If** there is an **increase in the concentration of reactant A**:

- position of the equilibrium shifts to the right
- the rate of the forward reaction increases
  (so as to remove the additional reactant **A** in the system)
- equilibrium concentration of the products **C** and **D** increases
- concentration of reactants **A** and **B** decreases

The Haber Process

Nitrogen and hydrogen are used in the manufacturing of industrial ammonia, where nitrogen and hydrogen reacts in a reversible reaction to form ammonia. The changes in the concentrations of nitrogen, hydrogen and ammonia with time in a closed system can be represented by a graph as shown. The forward reaction (formation of ammonia) has an enthalpy change as shown.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H = -92$ kJ/mol



Graph 3: Concentration-time graph of the Haber Process

The Haber Process is a classic example of how the Le Chatelier's Principle is put to good application. The conditions selected for the production of ammonia in the Haber Process were carefully studied with reference to the Le Chatelier's Principle.

(a) Using **Graphs 1 and 2**, state and explain one difference between reversible and non-reversible reactions.

.....

.....

.....[2]

(b) Use information given about the Haber Process and Le Chatelier's Principle to answer the following questions.

(i) State and explain if the reaction to form ammonia absorbs or releases heat.

.....

.....[1]

(ii) State and explain the effect on the position of the equilibrium of the reaction between nitrogen and hydrogen if the reaction was carried out at a lower temperature.

.....

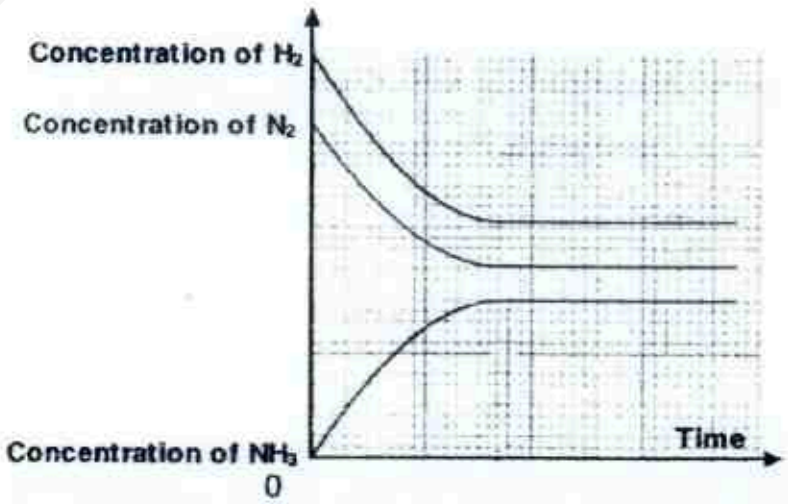
.....

.....[2]

(iii) Hence, state the effect on the equilibrium concentration of ammonia if the reaction was carried out at a lower temperature.

.....[1]

(iv) Using your answers from **b(i)** to **b(iii)**, sketch, on the diagram given, another line showing only the concentration of ammonia to illustrate what happens when the reaction is carried out at a lower temperature. Label your graph **P**.



[1]

(c) According to the Le Chatelier's Principle, using a high pressure in the Haber Process will favour the forward reaction and result in a higher equilibrium ammonia concentration.

(i) Explain why, despite knowing this, manufacturers of ammonia still do not choose to use very high pressures.

.....

.....[1]

(ii) When the pressure gets too high, gaseous ammonia begins to behave like a liquid. Describe the changes in the arrangement and movement of the ammonia molecules when this happens.

.....

.....

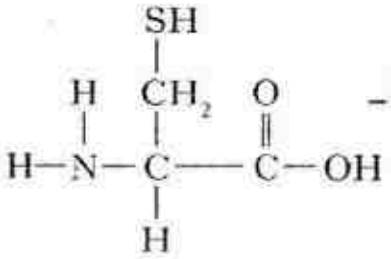
.....

.....[2]

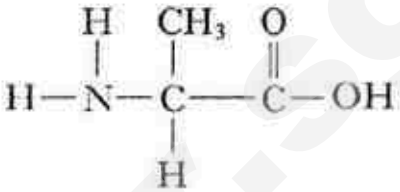
[Total: 10]

B8 Many biological molecules in the natural world (cells of living things) are polymers. Proteins, which are important compounds in our body for growth, repair and many other functions for example, are polymers made of many amino acids bonded together.

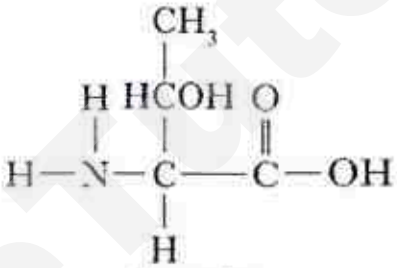
Amino acids are molecules with two key functional groups. Each of them consists of an amine group on one side, and a carboxyl group on the other, which allows them to polymerise into long chains known as "polypeptides" held essentially by amide linkages. There are currently twenty known naturally occurring amino acids, three of which are shown below.



Cysteine (Cys)



Alanine (Ala)



Threonine (Thr)

(a) **(i)** A section of a protein has the sequence –**Cys**–**Ala**–**Thr**–. Draw this section of the protein using the structures of the three amino acids provided.

[2]

(ii) State the type polymerisation reaction that the amino acids undergo to form the protein.

.....[1]

(iii) Explain your answer in a(ii)

.....

.....[2]

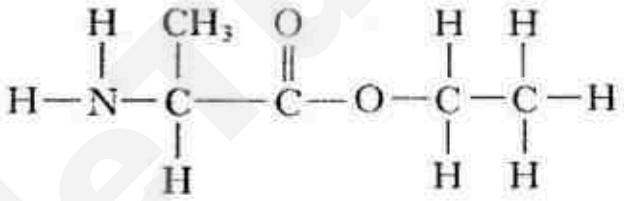
(iv) Suggest the name of a synthetic polymer that also has amide linkages.

.....[1]

(b) Alanine (condensed structural formula: H_2NCHCH_3COOH) reacts like a usual carboxylic acid because of its – COOH (carboxyl) group. For example, it readily undergoes neutralization with sodium hydroxide to form a soluble organic salt by the name of "*sodium aminopropanoate*" according to the following equation:

$$H_2NCHCH_3COOH + NaOH \rightarrow H_2NCHCH_3COONa + H_2O$$

Alanine also reacts with an alcohol to form an ester whose structural formula is shown.



(i) Write an ionic equation for the reaction of alanine with aqueous sodium hydroxide.

.....[2]

(ii) Using the information provided, name the ester formed above.

.....[1]

(iii) An isomer of this ester was added to a test tube of aqueous sodium carbonate. Effervescence of the colourless gas evolved gave a white precipitate when bubbled into limewater. Draw a possible structure of this isomer.

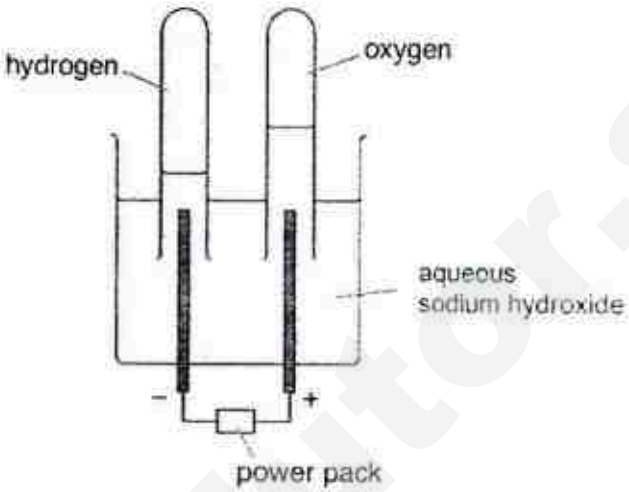
[1]

[Total: 10]

Either

B9 Instead of carrying many tanks of oxygen and adding to the mass of the submarine which makes it inefficient to move, naval forces sometimes make use of chemistry to constantly generate sufficient oxygen for the soldiers in the submarine to breathe.

One such method is the electrolysis of aqueous sodium hydroxide. The diagram below shows the schematic diagram of a set-up used for this purpose.

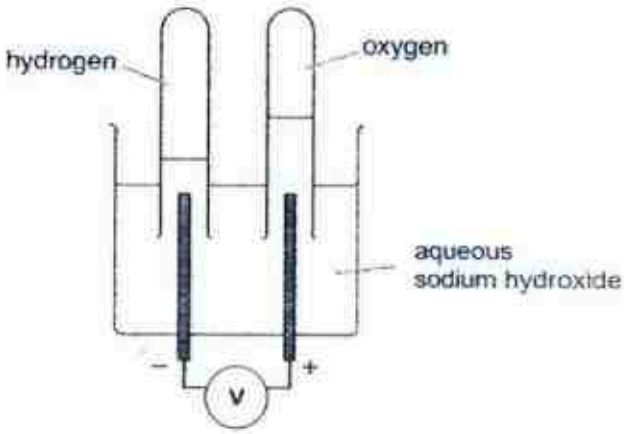


(a) State how the composition of the electrolyte changes after the electrolysis has been running for some time.

.....

.....[1]

(b) After some time, the power pack can be replaced by a voltmeter. This set-up, shown below, then acts like a fuel cell to provide additional electricity to power the submarine.



The left hand electrode in the diagram becomes the negative rod of the cell and the right hand electrode becomes the positive rod.

(i) State the direction of the electron flow in the external circuit.

.....[1]

(ii) Construct an equation to represent the reaction that occurs at the negative rod in this fuel cell.

.....[1]

(c) Other than submarines, cars can also be fitted with an engine powered by a hydrogen fuel cell or a conventional petrol engine.

One of the advantages of hydrogen fuel cells over the use of petrol in cars is that the only by-product is water, making it a clean fuel. A hydrogen fuel cell in operation, however, can sometimes achieve temperatures that are comparable to the conventional petrol engine.

(i) Give one environmental disadvantage of using petrol to power car engines.

.....

.....

.....[2]

(ii) Suggest why hydrogen as a fuel (in the fuel cell) may not be that economically viable.

.....

.....

.....[2]

(iii) Explain why it is possible for nitrogen oxides to be produced in both types of car engines.

.....

.....

.....[2]

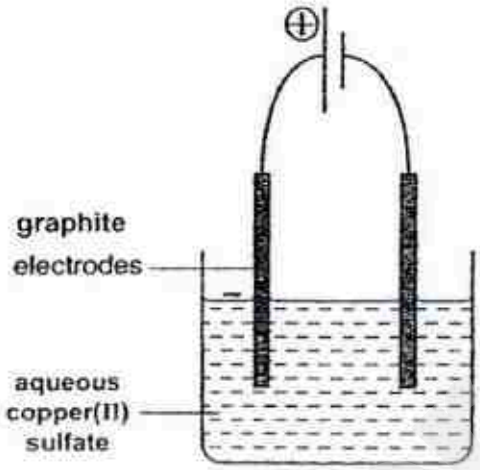
(iv) Suggest why a catalytic converter, if installed in a car that is powered by a hydrogen fuel cell, will fail to reduce nitrogen oxide levels as compared to that in a car powered by petrol.

.....

.....[1]

[Total: 10]

Or
B9 Aqueous copper(II) sulfate is electrolysed as shown in the set-up below.



(a) Write a half equation for the reaction that occurs at the cathode.

.....[1]

(b) Describe and explain any changes that occur in the electrolyte as the reaction continues for a period of time.

.....

.....

.....

.....[3]

(c) Suggest another type of electrodes that can be used to replace these graphite electrodes without changing the results of the experiment.

.....[1]

(d) Two students, **A** and **B** made statements about the electrolytic set-up.

Student **A**: "If we change the electrolyte to a highly concentrated solution of copper(II) sulfate, the results of this experiment will be entirely different."

Student **B**: "The concentration of the copper(II) sulfate electrolyte here does not affect the results of the experiment."

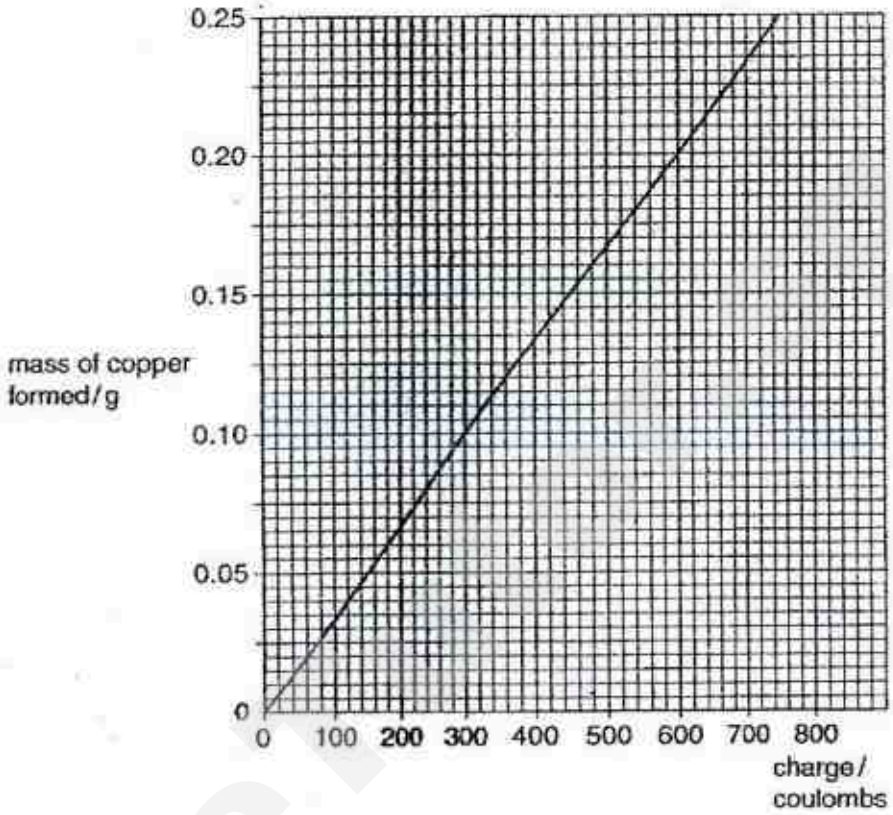
Which student made the correct statement? Give a reason for your answer.

.....

.....

.....[2]

(e) A student investigated the relationship between the mass of copper formed and the total charge passed through the solution. The graph of the results are seen below.



(i) Deduce the mass of copper formed when a charge of 600 coulombs is passed through the solution.

.....[1]

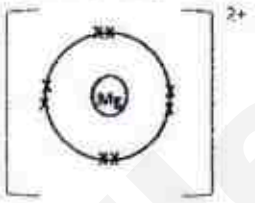
(ii) Use information given in the graph to predict the charge needed to form 1 g of copper, and hence deduce the charge needed to deposit 1 mole of copper.

[2]

[Total: 10]

End of Paper 2

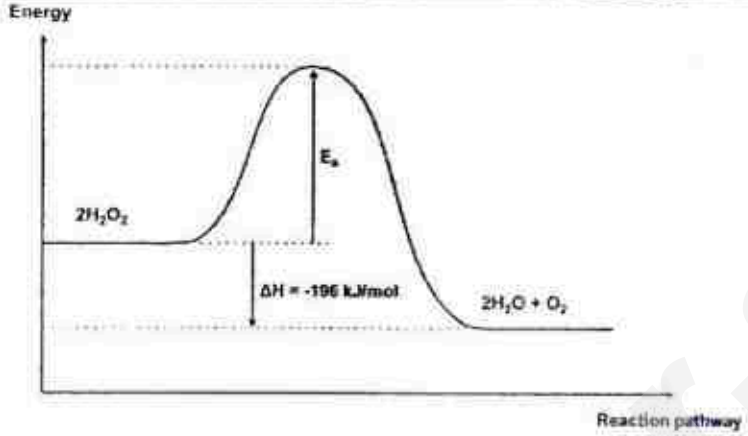
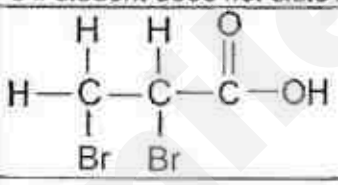
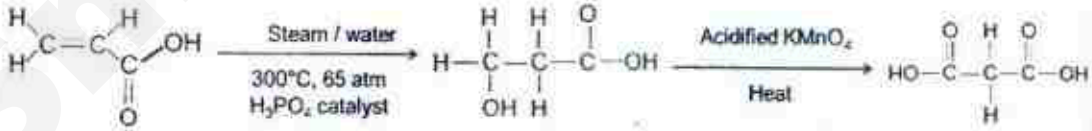
Paper 2

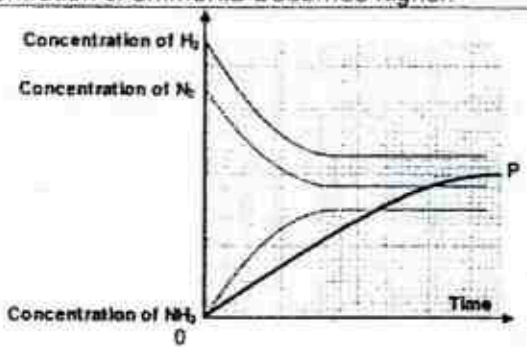
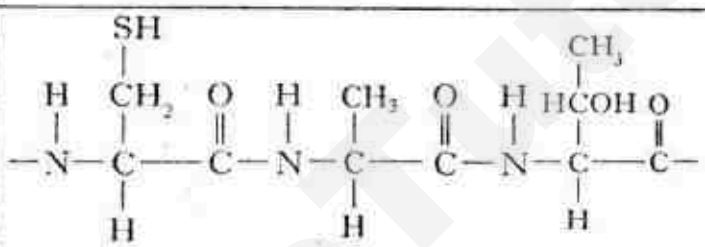
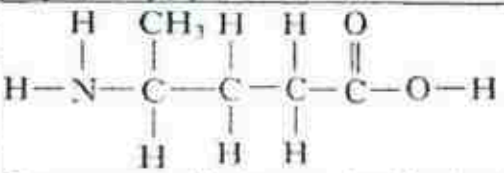
A1	(a)		1 across – **FILTRATION**
	(b)		2 down – **FLUORINE**
	(c)		3 down – **IRON**
	(d)		4 down – **CATION**
	(e)		5 down – **NUCLEON**
A2	(a)	(i)	Iodine
		(ii)	Methane
		(iii)	Lead(II) bromide, lithium
		(iv)	Lithium
		(v)	Iodine, bromine
	(b)		• Silicon dioxide has a **higher** boiling point than bromine [1] • Silicon dioxide has **giant covalent structure**, bromine has **simple molecular structure** [1] • **Less energy** required to **overcome weak intermolecular forces** of attraction in bromine than to **break strong** Si-O **covalent bonds** in silicon dioxide. [1]
	(c)	(i)	Reagent A: Lead(II) nitrate (@any soluble lead(II) salt) Reagent B: Sodium bromide (@any soluble bromide salt / acid)
		(ii)	• Add a solution of reagent A to a solution of reagent B in a beaker, stir to mix well. [1] • Filter to obtain lead(II) bromide precipitate; dry between pieces of filter paper. [1]
A3	(a)	(i)	$2Mg + O_2 \rightarrow 2MgO$
		(ii)	 *No penalty for missing key / did not write atomic symbol in the diagram.*
	(b)		• Place a piece of damp red litmus paper into the gas. [1] • If the damp red litmus paper turns blue, the gas is ammonia gas. [1] *Must identify ammonia gas.*

A4	(a)	(i)	Reducing agent
		(ii)	$NiO\ (s) + H_2\ (g) \rightarrow Ni\ (s) + H_2O\ (l)$ *[1] – correct and balanced equation* *[1] – correct state symbols (only awarded if equation is correct)*
	(b)		$Ni + 4CO \rightarrow Ni(CO)_4$ No . of moles of CO = $\frac{120\ 000}{24}$ = 5000 mol $\frac{No.of\ moles\ of\ CO}{No.of\ moles\ of\ Ni(CO)_4} = \frac{4}{1}$ No. of moles of $Ni(CO)_4$ expected = $\frac{5000}{4}$ = 1250 mol Mass of $Ni(CO)_4$ expected = 1250 × [59 + 4(12+16)] = 213750 g [1] No. of moles of $Ni(CO)_4$ obtained = $\frac{22\ 500}{24}$ = 937.5 mol Mass of $Ni(CO)_4$ obtained = 937.5 × [59 + 4(12+16)] = 160312.5 [1] Percentage yield = $\frac{160312.5}{213750}$ × 100% = **<u>75.0 % (3 s.f.)</u>** [1] **<u>OR</u>** Mole ratio of gas = volume ratio of gas → $\frac{No.of\ moles\ of\ CO}{No.of\ moles\ of\ Ni(CO)_4} = \frac{Volume\ of\ CO}{Volume\ of\ Ni(CO)_4} = \frac{4}{1}$ Volume of $Ni(CO)_4$ expected = $\frac{120\ 000}{4}$ = 30 000 dm^3 [1] Hence, % yield = $\frac{22\ 500}{30\ 000}$ × 100% = **<u>75.0% (3 s.f.)</u>** [1]
	(c)		Nickel compounds are likely to be coloured / Nickel exists in variable oxidation states in its compounds
A5	(a)	(i)	Graph 2
		(ii)	• Catalysts speed up chemical reactions. [1] • Graph 2 had a steeper initial gradient, which indicated a higher initial rate compared to graph 1. [1]
		(iii)	• Catalysts provide an alternative pathway with a lower activation energy for the reaction to occur. [1] • More reacting particles possess energy that is greater than or equal to the activation energy. [1] • Frequency of effective collisions between reacting particles increase, rate of reaction increases. [1]
	(b)	(i)	

	oxidation state of H	oxidation state of O
hydrogen peroxide	+1	-1
oxygen gas		0
water	+1	-2

[1] – correct oxidation states of H
[1] – correct oxidation states of O

		(ii)	• Hydrogen peroxide is reduced: oxidation state of oxygen increases from -1 in hydrogen peroxide to 0 in oxygen gas. [1] • Hydrogen peroxide is also oxidised: oxidation state of oxygen decreases from -1 in hydrogen peroxide to -2 in water. [1]
	(c)		• The reaction is highly exothermic / releases a lot of heat energy. [1] • Oxygen is one of the products – high risk of explosion [1]
	(d)		 *[1] – Correct shape of diagram* *[1] – Correct E_a* *[1] – Correct ΔH* *-1 mark if no indication of reactants + pdts*
A6	(a)	(i)	Ammonia / Ammonium hydroxide
		(ii)	Place a piece of blue litmus paper into a sample of both solutions. [1] The solution that turns the blue litmus paper red is acrylic acid. [1]
		(iii)	Reddish-brown aqueous bromine decolourises rapidly. *® if student does not state initial colour / no mention of 'rapidly'.*
		(iv)	
	(b)		 *[1] – correct condition for addition of steam to alkene* *[1] – correct structure of intermediate alcohol* *[1] – correct reagent and condition of oxidation* *@ any variation in structure as long as it is sound*
B7	(a)		In an irreversible reaction, the concentration of the reactant can reach 0, but this is not the case in a reversible reaction. [1] In a reversible reaction, the products can react to regenerate / form back the reactants. [1]
	(b)	(i)	It releases heat, because the reaction is exothermic. [1]
		(ii)	The reaction is exothermic. [1] When the temperature is lowered, the position of the equilibrium shifts to the right. [1] This is to release more heat, to counteract the effect of lowering the temperature. [1]

		(iii)	The equilibrium concentration of ammonia becomes higher.
		(iv)	 *Mark for:* • *Gentler gradient than original* • *Higher concentration of products than original (regardless of how high)*
	(c)	(i)	High pressures require large amounts of energy to maintain, which can **increase the cost** [1]
		(ii)	Ammonia molecules change from **being very far apart from each other to closely packed** together. [1] They change from **moving randomly in all directions at high speeds** to **sliding past each other throughout the liquid**. [1]
B8	(a)	(i)	 *[1] – correct amide linkage between Cys – Ala (including structure of amino acids)* *[1] – correct amide linkage between Ala – Thr (including structure of aminoa acids)* *@ if students did not leave "open bonds" at the edges of the sequence*
		(ii)	Condensation polymerisation
		(iii)	The **carboxyl group and amine group reacted** to form the amide linkage [1] In the process, a **molecule of water was eliminated** [1]
		(iv)	Nylon
	(b)	(i)	$H^+ (aq) + OH^- (aq) \rightarrow H_2O (l)$ *[1] – correct ionic equation* *[1] – correct state symbols (award only if equation is correct)*
		(ii)	Ethyl aminopropanoate
		(iii)	 *@ any reasonable isomer – look for structural differences and correct no. of bonds around C, H and O* *® if not acid*
B9	(a)		Concentration of Na^+ and OH^- increases; becomes more alkaline / pH increases
E	(b)	(i)	From the negative rod to the positive rod
		(ii)	$2H_2 (g) + 4OH^- (aq) \rightarrow 4H_2O (l) + 4e^-$ *State symboles not required*

	(c)	(i)	Formation of carbon dioxide [1] A greenhouse gas that can cause global warming, resulting in rising sea levels + melting ice caps [1] **OR** Formation of carbon monoxide due to incomplete combustion [1] Toxic gas that can cause difficulty in breathing and even death [1] **OR** Unburnt hydrocarbons may be released due to incomplete combustion [1] Formation of photochemical smog when present with other polluting gases [1]
		(ii)	To obtain hydrogen, we require cracking of longer-chain hydrocarbons [1] **OR** To obtain hydrogen, electrolysis of water must be carried out [1] Which requires large amount of heat and electricity that can be very costly [1]
		(iii)	At high temperatures, nitrogen reacts with oxygen in air to form nitrogen oxides [1] Both types of engines will function at high temperatures [1]
		(iv)	In a hydrogen fuel cell powered engine, there is **absence of carbon monoxide to function as a reducing agent** in the catalytic converter. **OR** For a catalytic converter to remove NO, the following must happen: $2CO + 2NO \rightarrow 2CO_2 + N_2$ However, there is **no carbon moxide present** in the engine powered by the fuel cell. **OR** NO is **soluble in water** present in the fuel cell, and **will not reach the catalytic converter** for reaction to occur.
B9 O	(a)		Cu^{2+} (aq) + 2e → Cu (s) *Must have state symbols.*
	(b)		The blue colour becomes less intense; pH of the solution decreases. [1] Cu^{2+} is discharged at the cathode and OH^- is discharged at the anode. [1] H^+ and SO_4^{2-} are the ions left in the solution forming sulfuric acid. [1]
	(c)		Platinum
	(d)		Even if concentrated copper(II) sulfate is used as the electrolyte, only Cu^{2+} and OH^- will be preferentially discharged. [1] Student B is correct. [1] *Award 2nd mark only if explanation is correct.* *@ any reasonable explanation with reference to electrochemical series and comparing ease of discharge for the various ions.*
	(e)	(i)	0.2 g
		(ii)	To discharge 0.1 g of copper → 300 coulombs (read from graph) Charge needed to form 1 g of copper = 300 x 10 = 3000 coulombs [1] Molar mass of copper = 64 g/mol Hence, charge needed to form 1 mol copper = 3000 x 64 = **192 000 coulombs** [1]

Class:	Register No:	Name:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION 2017

CHEMISTRY

Paper 1 Multiple Choice

5073/01
28 AUGUST 2017
1 hour

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluids.

Write your name, index number and class on the answer sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the answer sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet

A copy of the Periodic Table is printed on **page 2**.

This paper consists of **14** printed pages, including the cover page.

The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key: a / X / b
a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

1. The following apparatus can be used in the measurement of volumes of liquids:

I: 25 ml pipette
II: 25 ml beaker
III: 50 ml burette
IV: 25 ml graduated measuring cylinder

Which of the following shows the correct order of increasing accuracy of these apparatus?

A I, II, IV, III
B I, IV, II, III
C II, IV, I, III
D II, III, IV, I

2. A new substance was discovered and a series of experiments were conducted on it.

Which observation suggests that the substance **cannot** be an element?

A It has a sharp melting point.
B When heated in air, it could form two oxides.
C It dissolved in water to form a colourless solution.
D Electrolysis of the molten substance produced two products.

3. The table below shows some information about the physical properties of mercury and ethanol.

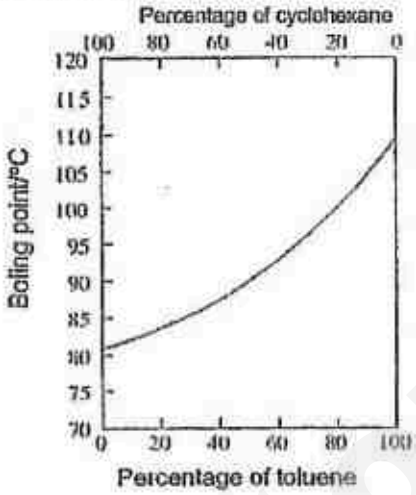
	Melting point/ °C	Boiling point/ °C	Solubility in water
Mercury	-38	357	No
Ethanol	-114	78	Yes

Which of the following can be used to separate a mercury-ethanol mixture dissolved in water at room temperature and pressure?

A distillation
B filtration
C paper chromatography
D separating funnel

4. Toluene and cyclohexane are two common organic solvents and they form a homogenous mixture when mixed together.

The following graph shows the boiling points of mixtures containing different percentages of toluene and cyclohexane.



Using information from the graph, which statement is true?

A The boiling point of pure toluene is 81 °C.

B The boiling point of pure cyclohexane is 110 °C.

C The boiling point of any cyclohexane and toluene mixture is below that of the boiling points of pure cyclohexane and pure toluene.

D The boiling point of any cyclohexane and toluene mixture is between the boiling points of pure cyclohexane and pure toluene.

5. Which gas(es) has/ have a pungent smell and causes a change in colour when tested with moist red litmus paper?

I: Ammonia
II: Carbon dioxide
III: Chlorine
IV: Hydrogen

A I only
B I and III
C II and III
D II and IV

6. A colourless solution T, was tested with aqueous sodium hydroxide. A precipitate was observed and it was insoluble in excess sodium hydroxide.

Which of the following could be solution T?

A $CaCl_2$
B $CuSO_4$
C $Fe(NO_3)_2$
D $Pb(NO_3)_2$

7. X, Y and Z are three covalent substances which are found in different states at the same temperature and pressure. X is a solid, Y is a gas and Z is a liquid.

Which of the following shows the order of increasing strength of their intermolecular forces?

A $X < Y < Z$

B $X < Z < Y$

C $Y < Z < X$

D $Z < X < Y$

8. Deuterium is an isotope of hydrogen and has the symbol D.

Which formula is **incorrect** for a compound of deuterium?

A PbOD

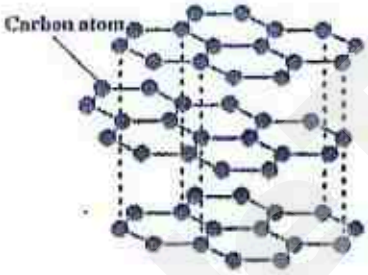
B ND_3

C D_2O

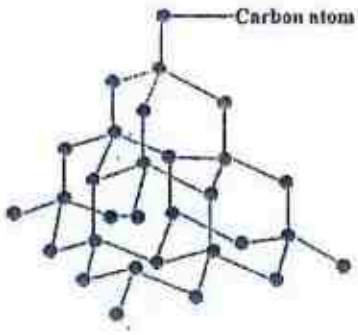
D CD_4

9. Which allotrope of carbon is a non-conductor of electricity?

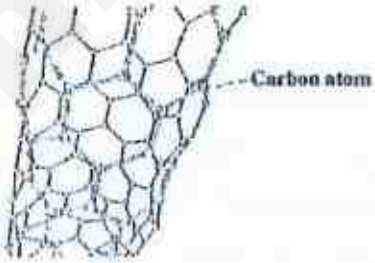
A



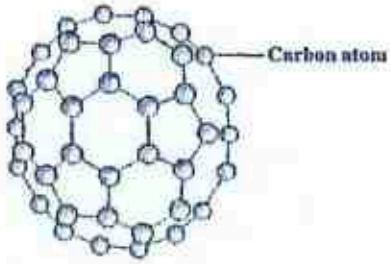
B



C



D



10. When heated, two moles of X give one mole of oxygen and two moles of chlorine.

What is the molecular formula of X?

A ClO_2

B Cl_2O

C Cl_2O_2

D Cl_4O_2

11. Which nitrogen compound contains the highest percentage by mass of nitrogen?

A NH_3
B NH_4NO_3
C $(NH_4)_2SO_4$
D CH_3NH_2

12. Sulfur trioxide decomposes according to the following equation:

$$2SO_3 \rightarrow 2SO_2 + O_2$$

What is the total volume of gas produced from the decomposition of 100 cm^3 of sulfur trioxide (all volumes of gases being measured at r.t.p.)?

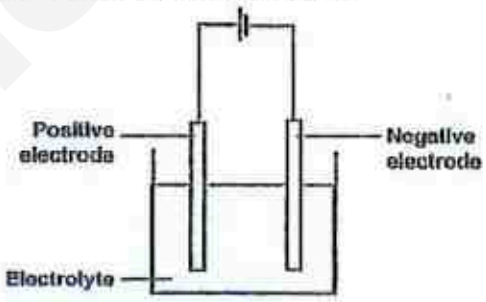
A 50 cm^3
B 150 cm^3
C 200 cm^3
D 300 cm^3

13. Which particles can be found in a solution of ethanoic acid, CH_3COOH?

I: H^+
II: $C_2O_2^-$
III: CH_3COO^-
IV: CH_3COOH

A I and III
B I, II and III
C I, III and IV
D All of the above

14. Electrolysis of different substances were carried out.



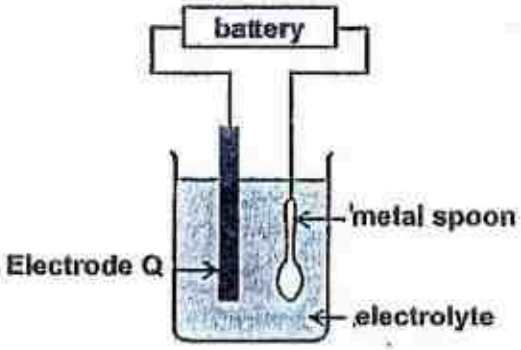
In one of the electrolysis, element X_2 was formed at the negative electrode.

For which combination of electrolyte and electrodes can the reaction for the formation of X_2 be represented by the equation shown below?

$$2X^+ + 2e^- \rightarrow X_2$$

A concentrated sodium chloride solution with inert electrodes
B dilute copper(II) nitrate solution with inert electrodes
C dilute silver nitrate solution with silver electrodes
D molten iron(III) bromide with inert electrodes

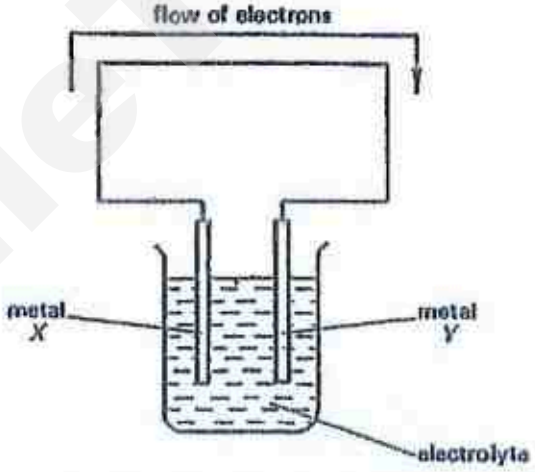
15. A metal spoon is to be electroplated with copper in the following set up:



What are the conditions required to electroplate the spoon successfully?

	Electrode Q	Spoon connected as	Electrolyte
A	Iron	Anode	Copper(II) chloride
B	Iron	Cathode	Copper(II) hydroxide
C	Copper	Anode	Copper(II) hydroxide
D	Copper	Cathode	Copper(II) chloride

16. An electrochemical cell was set up as shown below.



Which pair of metals would generate the flow of electrons as shown in the diagram above?

	Metal X	Metal Y
A	copper	zinc
B	iron	aluminium
C	lead	magnesium
D	zinc	lead

17. Hydrogen-powered cars use hydrogen fuel to produce electricity to run the car.

How is the electricity generated directly in the car?

A hydrogen is burnt to form steam

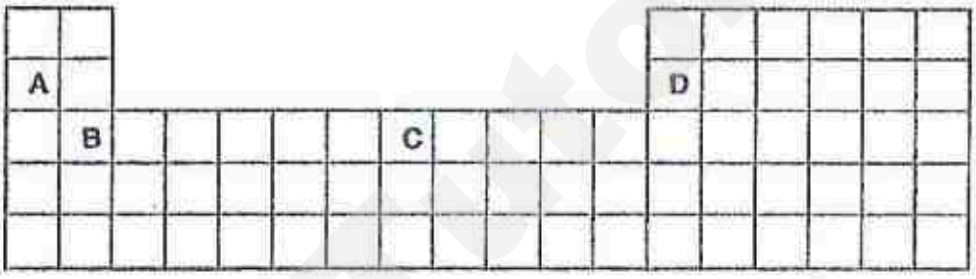
B hydrogen ions react with hydroxide ions to form water

C hydrogen and oxygen react at the electrodes to form water

D water is decomposed into hydrogen and oxygen at the electrodes

18. The positions of four elements, A, B, C and D, are shown in the outline of part of the Periodic Table. Element X has a high melting point and is a good conductor of electricity. It also forms two types of oxides, XO and XO_2, which exists as black solids at room temperature and pressure.

Which element is X?



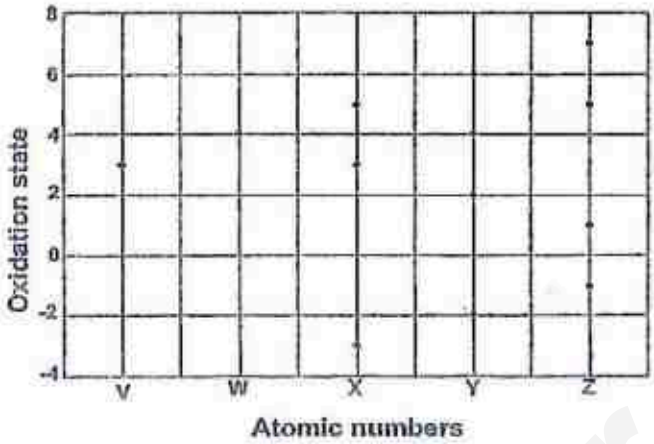
19. The table below shows the information about the chlorides of some elements in Period 3 of the Periodic Table.

Element	Formula of main chloride	Bonding present in chloride	pH of resulting solution when dissolved in water
Sodium	$NaCl$	Metallic	7
Magnesium	$MgCl_2$	Metallic	7
Aluminium	$AlCl_3$	Covalent	3
Phosphorous	PCl_3	Covalent	2
Sulfur	S_2Cl_2	Covalent	2

What will be the bonding present in the chloride of silicon and the pH value of the resulting solution when the chloride is dissolved in water?

	Bonding present in chloride	pH of resulting solution when dissolved in water
A	Covalent	2
B	Covalent	7
C	Metallic	2
D	Metallic	7

20. V, W, X, Y and Z are five consecutive elements in the Periodic Table. The following graph shows the oxidation states of the five elements plotted against their atomic numbers.



What is the atomic number of element Z?

A 7 B 10

C 17 D 19

21. Which reaction is an example of a redox reaction?

A $Ag^+ + Cl^- \rightarrow AgCl$

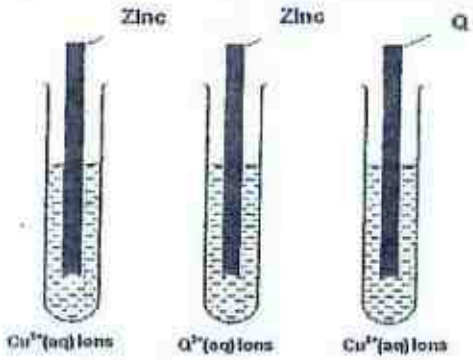
B $2SO_2 + O_2 \rightarrow 2SO_3$

C $H^+ + OH^- \rightarrow H_2O$

D $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$

22. Three test tubes were arranged as in the diagram below. The tests were conducted to determine the reactivity of three metals (zinc, copper and an unknown metal Q).

Each test tube contained a piece of one metal, half-immersed in an aqueous solution containing the ions of one of the other two metals. A deposit was formed in all three test tubes.



What could be the identity of metal Q?

A Calcium B Iron C Magnesium D Silver

23. Metal X reacts rapidly with dilute hydrochloric acid and can be used for the sacrificial protection of underwater pipes.

Metal Y does not corrode easily and can be used to manufacture jewellery.

Metal Z reacts rapidly with water to form hydrogen.

Which method of extraction of the metals from their ores is most likely to be used?

	Electrolysis of molten ore	Heating with carbon
A	X and Y	Z
B	X and Z	Y
C	Y	X and Z
D	Z	X and Y

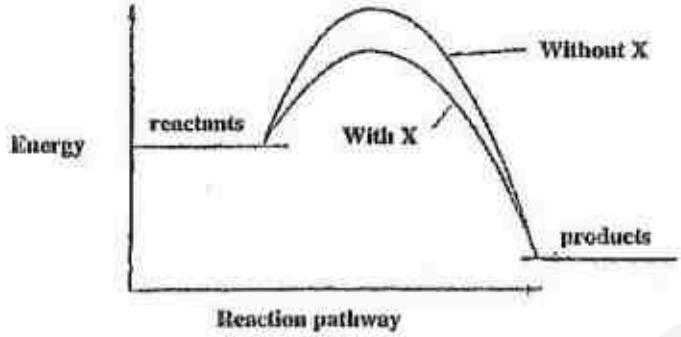
24. During the manufacture of iron, which substance is the main reducing gas in the middle of the furnace?

A carbon monoxide
B carbon dioxide
C nitrogen
D oxygen

25. Which process is exothermic?

A melting of ice
B evaporation of ethanol
C condensation of water vapour
D formation of iodine vapour from iodine crystals

26. The energy profile diagram shows how adding substance X to a reaction mixture changes the reaction pathway.



Which change is likely to be observed when X is added to the reaction mixture?

A an increase in yield of products obtained

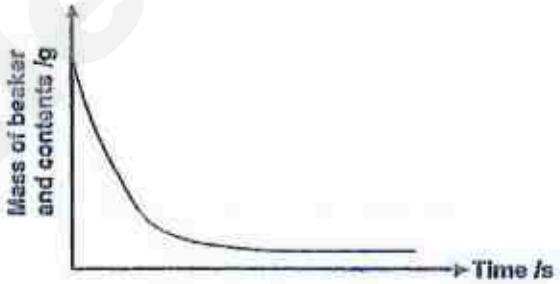
B a shorter time taken to complete the reaction

C a greater drop in temperatures of surroundings

D a greater increase in temperature of surroundings

27. Two reagents were mixed in a beaker and a chemical reaction took place.

The mass of the beaker and its contents were recorded as the reaction progressed and a graph of the results is obtained.



Which reaction could **not** have produced the graph?

A $NH_3 + HCl \rightarrow NH_4Cl$

B $Mg + 2HCl \rightarrow MgCl_2 + H_2$

C $NaNO_3 + NH_4Cl \rightarrow NaCl + 2H_2O + N_2$

D $ZnCO_3 + 2HNO_3 \rightarrow Zn(NO_3)_2 + CO_2 + H_2O$

28. 50 g of calcium carbonate granules is reacted with aqueous methanoic acid to produce carbon dioxide.

Which change is least likely to lead to an increase in the rate of formation of carbon dioxide from the reaction?

A grinding the calcium carbonate into fine powder

B using nitric acid instead of methanoic acid

C adding more calcium carbonate

D warming up the acid

29. The depletion of the ozone layer in the upper atmosphere reduces the Earth's natural protection from harmful ultraviolet radiation.

Which compound would cause the most severe depletion of the ozone layer?

A CCl_3F

B CF_4

C $CHClF_2$

D CH_2F_2

30. What is the minimum volume of air required for the complete combustion of 46 g of ethanol?

A 100 dm^3

B 250 dm^3

C 400 dm^3

D 450 dm^3

31. Photochemical smog is an effect of pollution seen occurring in many industrialised cities.

Which of the following is **not** responsible for its formation?

A nitrogen dioxide

B ozone

C pentane

D sulfur dioxide

32. When crude oil is fractionally distilled, which compounds will leave from the top of the fractional column?

A compounds that are the least flammable

B compounds that are the most viscous

C compounds with the highest relative molecular mass

D compounds with the lowest boiling point

33. Paraffin (kerosene), one of the fractions obtained from the fractional distillation of crude oil, is used as an energy source for various purposes.

In how many of the following can paraffin (kerosene) be used as an energy source?

aircraft	air conditioning units	cars
cooking	heavy lorries	power stations

A 1 B 2 C 3 D 4

34. Which statements concerning the process of cracking are correct?

I: It is an endothermic process.
II: It produces alkanes with lower relative molecular mass.
III: Gaseous products from cracking can decolourise aqueous bromine rapidly.

A I and II B I and III

C II and III D I, II and III

35. On complete combustion, one mole of a hydrocarbon X produces two moles of carbon dioxide and two moles of water.

Given that hydrocarbon X decolourises brown aqueous bromine rapidly, which is the molecular formula of hydrocarbon X?

A C_2H_4 B C_2H_6

B C_3H_6 D C_3H_8

36. Which bond in a molecule of ethanoic acid is broken when it reacts with magnesium?

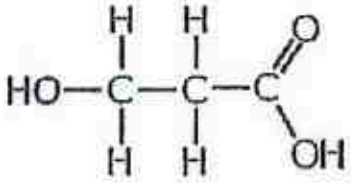
A C – H bond B C – C bond

C O – H bond D C = O bond

37. Which acid would react with ethanol to give the ester $C_3H_7CO_2C_2H_5$?

A butanoic acid
B ethanoic acid
C methanoic acid
D propanoic acid

38. The structure of an organic compound is shown below:



Which statement about the organic compound is **incorrect**?

A It produces ammonia gas when heated with aqueous sodium hydroxide.
B It produces carbon dioxide when reacted with sodium carbonate.
C It decolourises purple acidified potassium manganate(VII).
D It undergoes condensation polymerisation by itself.

39. In the polymerisation of ethene to form poly(ethene), which does not change?

A boiling point
B empirical formula
C density
D molecular mass

40. Which pair of organic compounds can be reacted to form a condensation polymer?

A $HOOC—CH_2—CH_2—COOH$ and $CH_3—CH_2—CH_2—NH_2$
B $HOOC—CH_2—CH_2—COOH$ and $H_2N—CH_2—CH_2—NH_2$
C $CH_3—CH_2—CH_2—OH$ and $CH_3—CH_2—CH_2—NH_2$
D $HO—CH_2—CH_2—OH$ and $H_2N—CH_2—CH_2—NH_2$

Class:	Register No:	Name: Mark Scheme

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION 2017

5073/02
21 August 2017
1 hr 45 mins

1.	C	11.	A	21.	B	31.	D
2.	D	12.	B	22.	B	32.	D
3.	D	13.	C	23.	B	33	B
4.	D	14.	A	24.	A	34.	D
5.	B	15.	D	25.	C	35.	A
6.	A	16.	D	26.	B	36.	C
7.	C	17.	C	27.	A	37.	A
8.	A	18.	C	28.	C	38.	A
9.	B	19.	A	29.	A	39.	B
10.	B	20.	C	30.	C	40.	B

This paper consists of 20 printed pages including cover page.

Class:	Register No:	Name:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION 2017

CHEMISTRY
Paper 2

5073/02
21 August 2017
1 hr 45 mins

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces provided at the top of this page.
Write in blue or black pen in the spaces provided on the Question Paper.
You may use a pencil for any diagrams, graphs, or rough working.
You may use a calculator.
All final answers for calculations are to be rounded off to **3 significant figures**.
Do not use staples, paper clips, highlighters, and glue or correction fluid.

Section A (50 Marks)
Answer **all** questions in the spaces provided.

Section B (30 Marks)
Answer all **THREE** questions from this section.
The last question is in the form of EITHER/OR and only ONE of the alternatives should be attempted.
Answer all questions in the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 20.

For Examiner's Use		
Section A		
Section B		
Deductions	Significant Figures	
	Units	
Total		80

This paper consists of **20** printed pages including cover page.

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1 The two states of matter, gas and liquid, have both commonalities and differences in terms of their characteristics.

(a) Complete the table below by choosing the characteristics that are only true for liquids; only true for gases; or true for both.

Put a tick (✓) in one box in each row.

Characteristic	only true for gas	only true for liquid	true for both
Particles are arranged disorderly			
Particles have high kinetic energy			
Attractive forces between particles are strong			
Diffusion can take place in this state			

[2]

(b) Chlorine exists as gaseous state while bromine exists as liquid state at room temperature and pressure.

Explain, in terms of bonding and structure, why there is a difference in the physical state although both are Group VII elements.

_____

_____

_____

_____ [3]

A1 **(c)** Potassium is vital in for normal organs function in human body and potassium chloride tablet is commonly used to treat low levels of potassium for patients.

(i) Draw a 'dot-and-cross' diagram to show the bonding in potassium chloride.

Show outer shell electrons only.

[2]

(ii) The medicine usually comes in a tablet form.

Describe an experiment that can be used to show that the tablet contains chloride ions.

State the expected observation from the experiment.

_____

_____

_____

_____ **[3]**

[Total: 10]

A2 Limescale is the hard, off-white deposit found in kettles, hot-water boilers and other electrical appliances. It is unsightly and may impair the operation or damage various components in these electrical appliances. Limescale is made up of mainly calcium carbonate.

Limescale can be removed by using descaling agents which contain ethanoic acid or hydrochloric acid.

(a) Write an equation to show the descaling process using ethanoic acid.

_____ **[1]**

A2 **(b)** Ethanoic acid is a weak acid.

(i) Explain the term *weak* acid.

_____ **[1]**

(ii) Explain, in terms of collisions between particles, which descaling agent, ethanoic acid or hydrochloric acid, would remove the limescale faster.

_____

_____

_____

_____ **[3]**

(iii) Descaling agents used should not contain sulfuric acid.

Explain why.

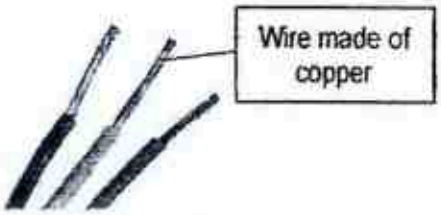
_____

_____

_____ **[2]**

[Total: 7]

A3 The diagram shows a dissection of an electrical wire.



(a) Copper is the most common material used to make electrical wire.

Give two reasons why copper is being used.

_____

_____

_____ **[2]**

A3 **(b)** Copper is extracted from its ore, chalcopyrite, $CuFeS_2$ in a 2-step reaction.

Copper(I) sulfide formed in **Step 1** is further reacted to form copper in **Step 2**.

[Step 1] $2CuFeS_2 + 2SiO_2 + 4O_2 \rightarrow Cu_2S + 2FeSiO_3 + 3SO_2$

[Step 2] $Cu_2S + O_2 \rightarrow 2Cu + SO_2$

(i) State and explain, in terms of electron transfer, which substance is reduced in **Step 2**.

Support your answer using half ionic equation(s).

_____

_____

_____

_____ **[3]**

(ii) The gaseous by-product is recycled to manufacture sulfuric acid.

Describe a simple test to show that the gaseous by-product is acidic.

_____

_____ **[1]**

(iii) Explain, other than cost, why the by-product should be recycled and not released directly into the environment.

_____

_____

_____ **[2]**

A3 (b) (iv) Some copper is used to make brass, which is a mixture of copper and zinc. Yellow brass is the industry standard brass commonly used in making musical instruments. It comprises of 30% zinc and 70% copper.

Draw a diagram to show the arrangement of atoms in brass. Explain why it is more useful in making musical instruments than pure copper. Label your diagram.

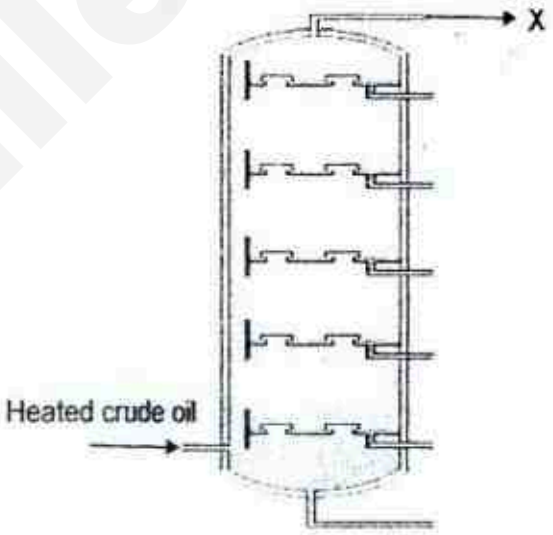
_____

_____

_____ [3]

[Total: 11]

A4 The diagram below shows the apparatus used for the fractional distillation of petroleum.



(a) State the name and one use of the fraction **X**.

_____

_____ [2]

A4 (b) Some motor vehicles use diesel fuel while some use petrol.

Explain why the combustion of diesel produce more soot than petrol.

_____

_____

_____ [2]

(c) Both petrol and diesel cars produces carbon monoxide.

Describe a harmful effect of carbon monoxide.

_____

_____ [1]

(d) Besides carbon monoxide, nitrogen dioxide is also produced in motor vehicles.

A device is installed in motor vehicles' exhaust to remove both gases.

State the name of the device and explain, using a single equation, how carbon monoxide and nitrogen dioxide is removed in motor vehicles using the device.

_____

_____

_____ [2]

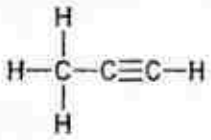
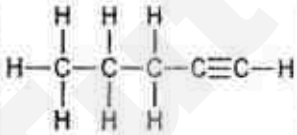
(e) Despite having the device mentioned above, explain why it does not solve all the pollution problems caused by motor vehicles.

_____

_____ [1]

[Total:8]

A5 Alkynes are a homologous series of organic compounds.

Alkyne	Chemical Formula	Structural formula	Boiling point / °C
ethyne	C_2H_2	H—C≡C—H	– 84
propyne	C_3H_4		– 23
butyne			8
Pentyne	C_5H_8		39

(a) Use the information in the table to give **two** pieces of evidence that suggest that the alkynes are a homologous series.

_____

_____

_____ **[2]**

(b) Give the chemical formula and full structural formula of butyne.

Chemical formula: _____

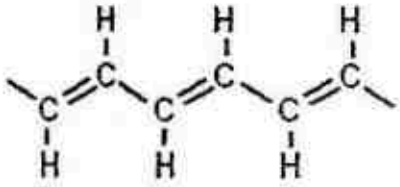
Full structural formula:

[2]

A5 **(c)** The first member of the homologous series is ethyne.
Explain why there is no alkyne with a single carbon.

_____ **[1]**

(d) Ethyne undergoes a similar polymerisation reaction like ethene. The diagram below shows the structure of polyehtyne.



Give one similarity and one difference between polyethyne and polyethene.

_____

_____

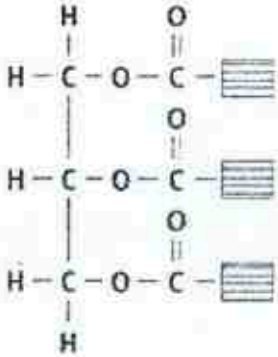
_____ **[2]**

[Total:7]

A6 Fats and protein are two natural polymers that are essential part of our diets and has a number of important roles in our body.

The diagrams below show examples of fats and protein molecules:

Fats



Protein

A6 (a) (i) Circle the amide linkage in the diagrams in Page 9. Label it "amide". [1]

(ii) Circle the ester linkage in the diagrams in Page 9. Label it "ester". [1]

(b) Draw the structures of the monomers that are used to form fats and protein. [3]

Fats:

Protein:

(c) (i) Name a synthetic polymer that has a similar linkage to fats.

_____ [1]

(ii) State one use for the polymer stated above.

_____ [1]

[Total: 7]

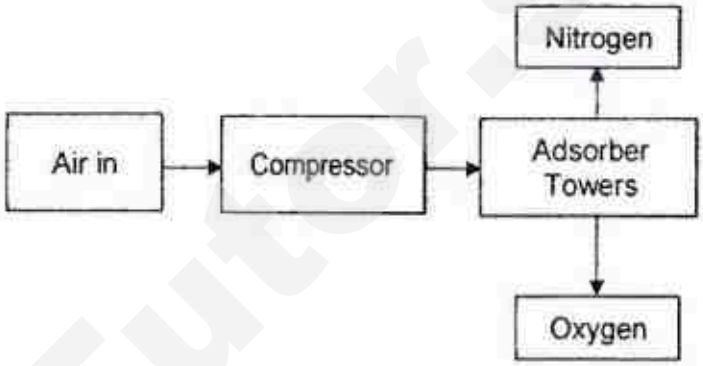
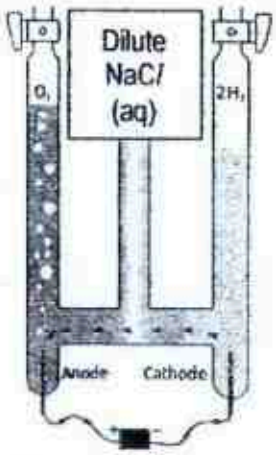
Section B (30 Marks)

Answer all **three** questions in this section.

The last question is in the form of an either/or and only **one** of the alternatives should be attempted.

B7 Read the information about the industrial production of oxygen.

There are many methods used in the industry to produce oxygen. Production cost, purity and volume desired are some of the key factors determining the selection criteria. The production of oxygen using Pressure Swing Adsorbers (PSA) and electrolysis are simplified in the diagrams below.

Pressure Swing Adsorbers (PSA)	 Air is pressurised in the compressor before passing into adsorber towers. In the adsorber towers, nitrogen and oxygen in the air are separated. The substance used in the adsorber towers needs to be replaced or regenerated after a certain volume of air has been separated as it will become saturated with nitrogen.
Electrolysis	 Dilute aqueous NaCl is electrolysed to produce oxygen and hydrogen using graphite electrodes. In theory, the ratio of hydrogen gas to oxygen gas collected should be 2:1. As oxygen is more soluble than hydrogen in water thus the ratio of gases collected will change.

B7 The table below shows more information about the two methods.

	Pressure Swing Adsorbers (PSA)	Electrolysis
Overall energy consumption (kWh per m^3 of O_2) 1 m^3 = 1000 dm^3	0.5	10
Purity of O_2 produced	<95 % (>99.9 % can only be achieved with extremely high-end device)	>99.9 %
By-product	Impure nitrogen is produced.	Produced hydrogen which can be used as fuel

(a) Give two disadvantages, other than lower purity, of producing oxygen using PSA.

_____

_____

_____

_____ **[2]**

(b) Explain why the theoretical volume ratio hydrogen to oxygen produced in electrolysis is 2:1.

_____

_____

_____ **[2]**

(c) State and explain how would the **final** volume of the gases collected in electrolysis change due to the difference in solubility of the gases in water.

_____

_____

_____ **[2]**

B7 (d) Calculate the energy consumption using electrolysis per mole of oxygen gas produced.

[2]

(e) What happens to the concentration of NaC*l* during the electrolysis?

Explain your reasoning.

_____

_____ [1]

(f) The electrolyte used in the electrolysis set up above needs to be replaced regularly.

Explain why the electrolyte needs to be replaced regularly.

Support your answer with equations explaining the reaction at each electrode.

_____

_____

_____

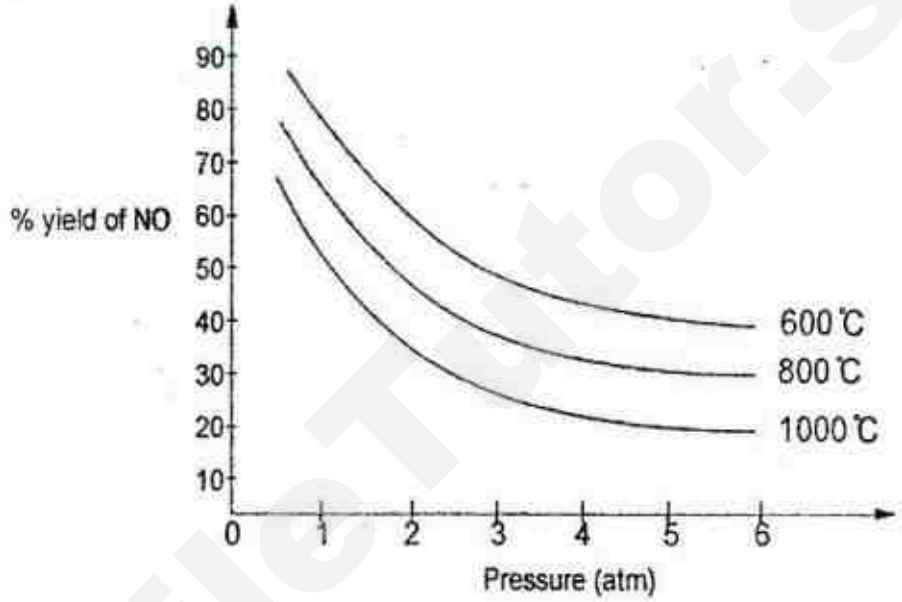
_____ [3]

[Total:12]

B8 Ostwald process is a chemical process for making nitric acid. The raw materials of Ostwald process are ammonia, water and oxygen gas. Platinum is used as catalyst for the process. There are multiple steps in the process. In the first step of the process, ammonia reacts with oxygen in a reversible reaction to form nitrogen monoxide. It gives 65% yield at the optimum temperature of 800℃ and pressure of 1 atm. The equation below shows the reaction between ammonia and oxygen.

$$4NH_3\,(g) + 5O_2\,(g) \rightleftharpoons 4NO\,(g) + 6H_2O\,(g) \qquad \Delta H = -104\ kJ/mol$$

The graph below shows the yield of nitrogen monoxide with varying temperature and pressure.



(a) State the conditions for the process to obtain ammonia in the industry.

_____

_____ **[1]**

(b) **(i)** Describe the relationship between percentage yield of nitrogen monoxide with temperature and pressure. **[1]**

_____

_____

B8 (b) (ii) Use the graph to explain why the optimum temperature and pressure is chosen for the first step of Ostwald process. [2]

_____

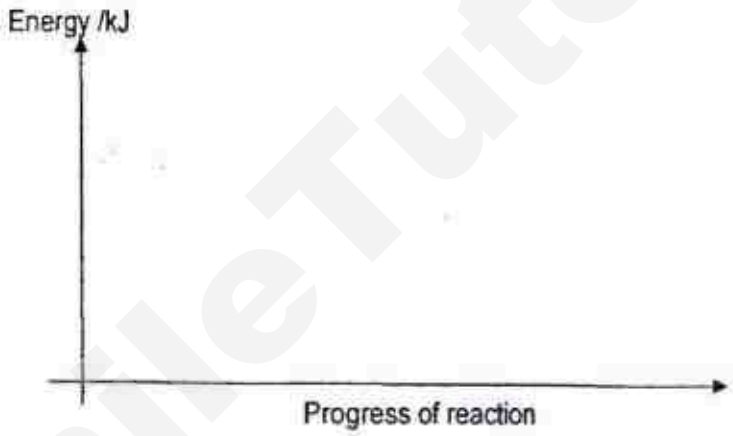
_____

_____

(c) Draw an energy profile diagram to show the effect of the catalyst on the first step of Ostwald process.

Your diagram should show and label

- reactants and products,
- the activation energy for the uncatalysed and catalysed reactions respectively,
- the enthalpy change of reaction.



[3]

(d) A reaction is carried out at 800 °C and 2 atm using 1 tonne of ammonia with excess oxygen.

With reference to the graph, calculate the volume of nitrogen monoxide produced. (1 tonne = 1×10^6 g)

[3]

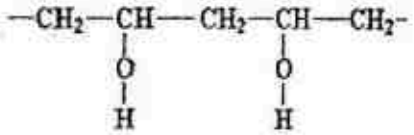
[Total:10]

EITHER

B9 Water soluble laundry bags are made of PVA (polyvinyl alcohol).

It is often used in hospital to reduce the hazards associated with storage and cleaning of contaminated washable items.

The structure of PVA is given below:



(a) **(i)** State the type of polymerisation occurred to form PVA.

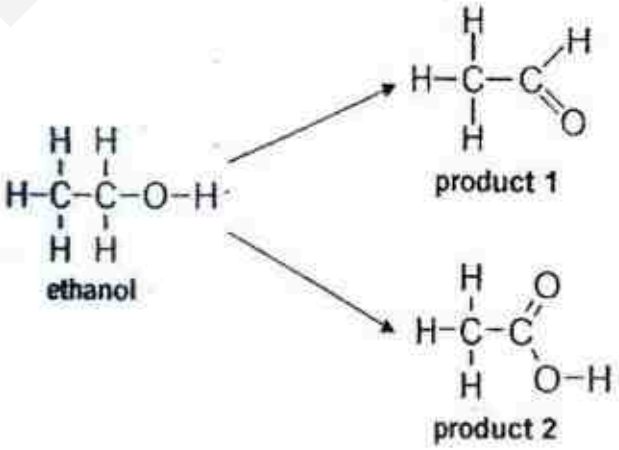
_____ **[1]**

(ii) Draw the structure of the monomer of PVA.

[1]

(b) The monomer reacts with hydrogen to form ethanol.

Ethanol can be oxidised to form two other products under different conditions.



(i) Suggest a suitable reagent that can be used to oxidise ethanol to form **product 2**.

_____ **[1]**

EITHER

B9 (b) (ii) Are **product 1** and **2** isomers of ethanol?
Explain your reasoning.

_____

_____

_____ [2]

(iii) Ethanol reacts with **product 2** to produce a sweet smelling substance.

Give the name and structure of the product formed.

Name of the product: _____

Structure:

[2]

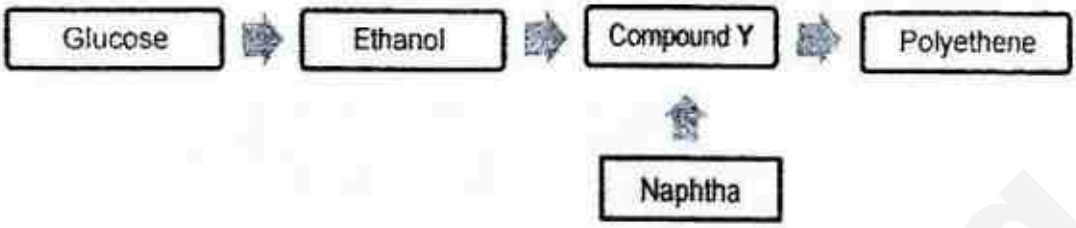
(iv) State a commercial use of the substance formed in **(iii)**.

_____ [1]

[Total:8]

OR

B9 The diagram below shows the two methods used to make polyethene.



(a) Name for the process use to make ethanol from glucose and state the optimum conditions for the reaction.

_____

_____ [2]

(b) State the possible source for the raw material to produce ethanol from glucose and give the balance chemical reaction for the reaction.

_____

_____

_____ [2]

(c) A student carried out an experiment to produce compound Y from ethanol.

Suggest a method for the student to check if compound Y has formed and state the expected observation.

_____

_____

_____ [2]

(d) Compound Y can also be obtained from naphtha.

Suggest one way in which it can be obtained from naphtha.

_____ [1]

OR

B9 (e) State an advantage, other than cost and percentage yield, of obtaining compound Y from glucose rather than naphtha.

_____

_____ [1]

[Total:8]

End of paper

The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series

†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key

a
X
b

a = relative atomic mass

X = atomic symbol

b = proton (atomic) number

ANSWER

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1 The two states of matter, gas and liquid, have both commonalities and differences in terms of their characteristics.

(a) Complete the table below by choosing the characteristics that are only true for liquids; only true for gases; or true for both.

Put a tick (✓) in **one** box in each row.

Characteristic	only true for gas	only true for liquid	true for both
Particles are arranged disorderly			✓
Particles have high kinetic energy	✓		
Attractive forces between particles are strong		✓	
Diffusion can take place in this state			✓

[2]

[4✓ - 2m; 2 – 3✓ - 1m; 1✓ - 0]

(b) Chlorine exists as gaseous state while bromine exists as liquid state at room temperature and pressure.

Explain why, in terms of bonding and structure, there is a difference in the physical state although both substances are from the same group.

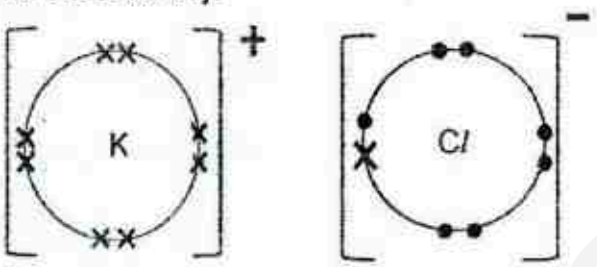
Both chlorine and bromine has **simple molecular structure** ✓ and **weak intermolecular forces of attraction** ✓. The intermolecular forces of attraction in bromine is **stronger** ✓ than chlorine as bromine has **higher molar mass** ✓. **Higher energy** ✓ is required to overcome the stronger forces of attraction. Thus, bromine has a **higher boiling point** ✓ and exist as liquid in RTP. **[3]**

[6✓ - 3m; 4 – 5✓ - 2m; 2 – 3✓ - 1m]

A1 **(c)** Potassium is vital in for normal organs function in human body and potassium chloride tablet is commonly used to treat low levels of potassium for patients.

(i) Draw a 'dot-and-cross' diagram to show the bonding in potassium chloride.

Show outer shell electrons only.



[2]

[1m for K^+; 1m for Cl^-]

(ii) The medicine usually comes in a tablet form.

Describe an experiment that can be used to show that the tablet contains chloride ions.

State the expected observation from the experiment.

Dissolve KCl tablet in water. [1]

Add HNO_3 and follow by $AgNO_3$ / $PbNO_3$ / acidified $AgNO_3$ / $PbNO_3$ [1]

White ppt observed showing the presence of Cl^- [1]

[3]

[Total: 10]

A2 Limescale is the hard, off-white deposit found in kettles, hot-water boilers and other electrical appliances. It is unsightly and may impair the operation or damage various components in these electrical appliances. Limescale is made up of mainly calcium carbonate.

Limescale can be removed by using descaling agents which contain ethanoic acid or hydrochloric acid.

(a) Write an equation to show the descaling process using ethanoic acid.

$2CH_3COOH + CaCO_3 \rightarrow Ca(CH_3COO)_2 + CO_2 + H_2O$ [1]

(b) Ethanoic acid is a weak acid.

(i) Explain the term *weak* acid.

Dissociate **partially in water** to give a lower concentration of **H^+**. [1]

A2 (ii) Explain, in terms of collisions between particles, which descaling agent, ethanoic acid or hydrochloric acid, would remove the limescale faster.

Hydrochloric acid should remove the limescale faster as it is a **strong** acid. [1]

It dissociates completely in water to give a **higher concentration of H^+**. [1]

Higher no. of mol. of H^+ for the same volume, higher **frequency of effective collision** thus faster speed of reaction. [1] [3]

(iii) Descaling agents used should not contain sulfuric acid.

Explain why.

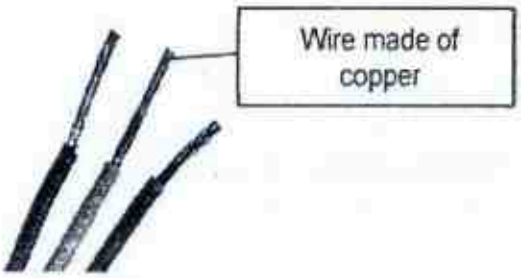
H_2SO_4 **reacts** with $CaCO_3$ to form **calcium sulfate**, **insoluble** in water. [1]

Thus, it **will not be removed** and remain as **ppt** in appliances. [1]

[2]

[Total: 7]

A3 The diagram shows a dissection of an electrical wire.



(a) Copper is the most common material used to make electrical wire.

Give two reasons why copper is being used.

Copper is **ductile** and can be drawn into a thin wire. [1]

Copper is a **good conductor of electricity** due to the presence of mobile electrons. [1] [2]

A3 **(b)** Copper is extracted from its' ore, chalcopyrite, $CuFeS_2$ in a 2-step reaction.

Copper(I) sulfide formed in **Step 1** is further reacted to form copper in **Step 2.**

[Step 1] $2CuFeS_2 + 2SiO_2 + 4O_2 \rightarrow Cu_2S + 2FeSiO_3 + 3SO_2$

[Step 2] $Cu_2S + O_2 \rightarrow 2Cu + SO_2$

(i) State and explain, in terms of electron transfer, which substance is reduced in Step 2.

Support your answer using half ionic equation(s).

Cu_2S is reduced. **[1]**

$Cu^+ (l) + e^- \rightarrow Cu (s)$ **[1]**

Cu^+ **gains electrons** to form Cu. Thus, it is reduced. **[1]**

[3]

(ii) The gaseous by-product is recycled to manufacture sulfuric acid.

Describe a simple test to show that the gaseous by-product is acidic.

Place a **moist blue litmus paper** at the mouth of a test tube.

The moist blue litmus paper will turn **red**. **[1]**

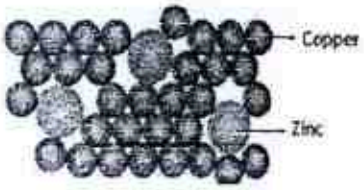
(iii) Explain, other than cost, why the by-product should be recycled and not released directly into the environment.

Sulfur dioxide is **acidic**.

It will **dissolve** in rain water to form **acid rain[1]**. Acid rain **destroy building / kill aquatic life**. **[1]** **[2]**

A3 **(b)** **(iv)** Some copper is used to make brass, which is a mixture of copper and zinc. Yellow brass is the industry standard brass commonly used in making musical instruments. It comprises of 30% zinc and 70% copper.

Draw a diagram to show the arrangement of atoms in brass. Explain why it is more useful in making musical instruments than pure copper. Label your diagram.



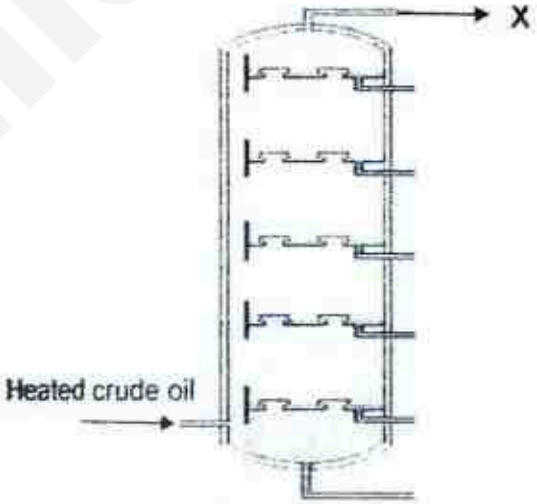
[1m for labelling and correct ratio of Cu and Zn]

Brass is **harder** ✓than pure copper. Zinc atoms has **different size**✓ from copper and **disrupted** ✓the regular arrangement in pure copper. The atoms of different sizes **cannot slide over each other easily**✓. **[3]**

[4✓ - 2m; 2 – 3✓ - 1m; 1✓ - 0]

[Total: 11]

A4 The diagram below shows the apparatus used for the fractional distillation of petroleum.



(a) State the name and one use of the fraction **X**.

Petroleum gas **[1]**

For cooking **[1]** **[2]**

A4 **(b)** Some cars use diesel as fuel while some use petrol.

Explain why the combustion of diesel produce more soot than petrol.

Diesel has a **longer carbon chain** / **number of carbon** than petrol. **[1]**

Thus, the **chances of incomplete combustion** of diesel is **higher** producing more soot. **[1]** **[2]**

(c) Both petrol and diesel cars produces carbon monoxide.

Describe a harmful effect of carbon monoxide.

Breathing in CO will cause **respiratory problem** / **combines with haemoglobin** to form **carboxyhaemoglobin** and **lead to death**. **[1]**

(d) Besides carbon monoxide, nitrogen dioxide is also produced in motor vehicles.

A device is installed in motor vehicles' exhaust to remove both gases.

State the name of the device and explain, using a single equation, how carbon monoxide and nitrogen dioxide is removed in motor vehicles using the device.

Catalytic converter. **[1]**

$4CO + 2NO_2 \rightarrow 4CO_2 + N_2$ CO and NO_2 **reacts** to form a **less harmful** products CO_2 and N_2. [1] **[2]**

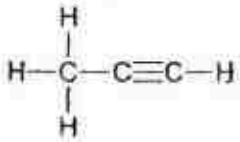
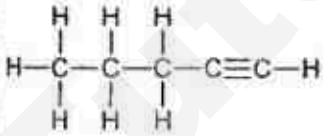
(e) Despite having the device mentioned above, explain why it does not solve all the pollution problems caused by motor vehicles.

CO_2 is not removed.

CO_2 is a **greenhouse gas** that cause global warming, melting ice caps and **flood** in low rise land. **[1]** **[1]**

[Total:8]

A5 **Alkynes** are a homologous series of organic compounds.

Alkyne	Chemical Formula	Structural formula	Boiling point / °C
ethyne	C_2H_2	H—C≡C—H	– 84
propyne	C_3H_4		– 23
butyne			8
Pentyne	C_5H_8		39

(a) Use the information in the table to give **two** pieces of evidence **that suggest** that the **alkynes** are a homologous series.

Alkynes have the same general formula of C_nH_{2n-2} [1]

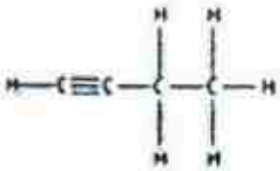
Alkynes have the same functional group C≡C [1]

[2]

(b) Give the chemical formula and full structural formula of butyne.

Chemical formula: C_4H_6 [1]

Full structural formula:



[1]

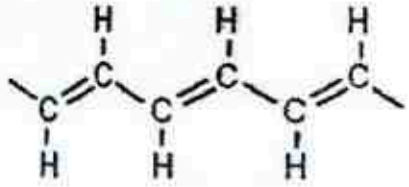
[2]

A5 **(c)** The first member of the homologous series is ethyne.
Explain why there is no alkyne with a single carbon.

The functional group is C≡C. Thus the **minimum number** of carbon in a molecule

of alkyne should be 2. [1] **[1]**

(d) Ethyne undergoes a similar polymerisation reaction like ethene. The diagram below shows the structure of polyehtyne.



Give one similarity and one difference between polyethyne and polyethene.

Polyethene is **saturated** while polyethyne is **unsaturated** hydrocarbon. [1]

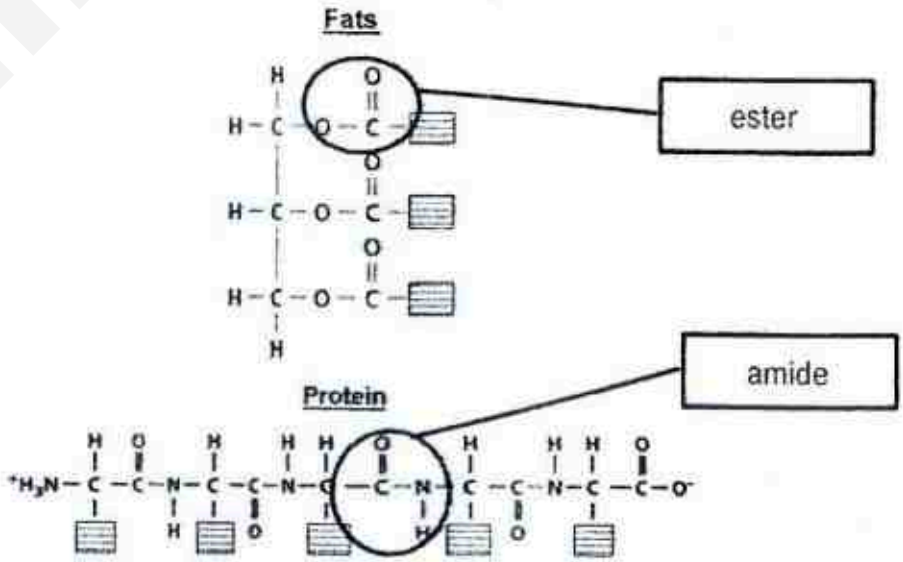
Both polyethyne and polyethene are **hydrocarbons**. [1]

[2]

[Total:7]

A6 Fats and protein are two natural polymers that are essential part of our diets and has a number of important roles in our body.

The diagrams below show examples of fats and protein molecules:



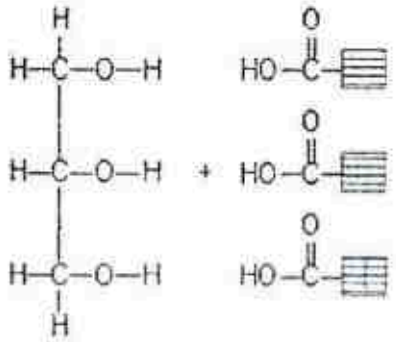
A6 **(a)** **(i)** Circle the amide linkage in the diagrams in Page 9. Label it "**amide**". **[1]**

(ii) Circle the ester linkage in the diagrams in Page 9. Label it "**ester**". **[1]**

[any of the ester and amide linkage in the molecule with label; 1 m each]

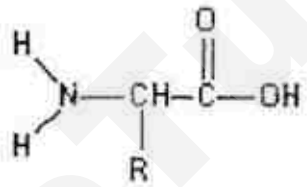
(b) Draw the structures of the monomers that are used to form fats and protein. **[3]**

Fats:



glycerol **fatty acids**

Protein:



(c) **(i)** Name a synthetic polymer that has a similar linkage to fat.

Terylene **[1]**

(ii) State **one** use for the polymer stated above.

Clothing / sleeping bag / parachutes **[1]**

[Total: 7]

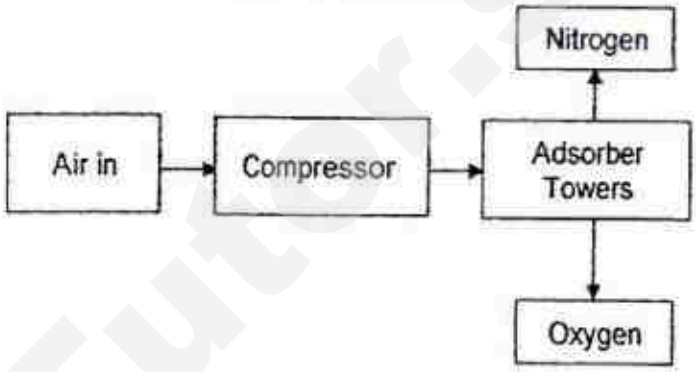
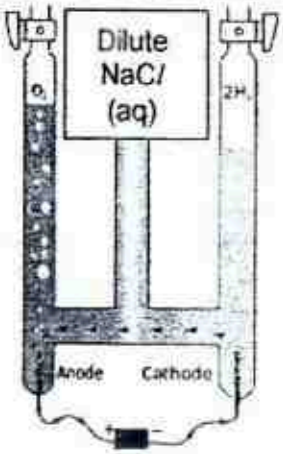
Section B (30 Marks)

Answer all three questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

B7 Read the information about the industrial production of oxygen.

There are many methods used in the industry to produce oxygen. Production cost, purity and volume desired are some of the key factors determining the selection criteria. The production of oxygen using Pressure Swing Adsorbers (PSA) and electrolysis are simplified in the diagrams below.

Pressure Swing Adsorbers (PSA)	 Air is pressurised in the compressor before passing into adsorber towers. In the adsorber towers, nitrogen and oxygen in the air are separated. The substance used in the adsorber towers needs to be replaced or regenerated after a certain volume of air has been separated as it will become saturated with nitrogen.
Electrolysis	 Dilute aqueous NaCl is electrolysed to produce oxygen and hydrogen using graphite electrodes. In theory, the ratio of hydrogen gas to oxygen gas collected to should be 2:1. As oxygen is more soluble than hydrogen in water thus the ratio of gases collected will change.

B7 The table below shows more information about the two methods.

	Pressure Swing Adsorbers (PSA)	Electrolysis
Overall energy consumption (kWh per m^3 of O_2) 1 m^3 = 1000 dm^3	0.5	10
Purity of O_2 produced	<95 % (>99.9 % can only be achieved with extremely high-end device)	>99.9 %
By-product	Impure nitrogen is produced	Produced hydrogen which can be used as fuel

(a) Give two disadvantages, other than lower purity, of producing oxygen using PSA.

Nitrogen produced is not usable as it is impure / contaminated . [1]

The adsorbents need to be replaced regularly and this may increase the cost of production. [1]

[2]

(b) Explain why the theoretical volume ratio hydrogen to oxygen produced in electrolysis is 2:1.

$2H_2O \rightarrow 2H_2 + O_2$ [1]

Water is electrolysed to form hydrogen and oxygen. The mole ratio of H_2O to H_2 is 1:1 while to O_2 is 2:1. [1] [2]

(c) State and explain how would the final volume of the gases collected in electrolysis change due to the difference in solubility of the gases in water.

The volume of oxygen collected will be lower than expected as it is soluble in water. [1] The volume of hydrogen collected should be the same as it is not soluble in water. [1] [2]

B7 (b) Calculate the energy consumption using electrolysis per mole of oxygen gas produced.

10 kWh of electricity produces 1000 dm^3 of oxygen

No of mol of O_2 produced = 1000 / 24
= 41.6666 mol [1]

Energy consumption per mol of O_2 produced = 10 / 41.6666
= 0.240 kWh [1] (3sf with unit) [2]

(e) What happens to the concentration of NaCl during the electrolysis?

Explain your reasoning.

The concentration of NaCl would **increase**. Water is being **electrolysed** to form gases and thus the solution become more concentrated. [1]

(e) The electrolyte used in the set up above needs to be replaced regularly.

Explain why the electrolyte needs to be replaced regularly.

Support your answer with equations explaining the reaction at each electrode.

Oxygen will not be produced in concentrated NaCl. Cl^- will be **selectively Discharged / oxidised** at the anode for concentrated NaCl. [1]

Anode: $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$ [1] Cathode: $2H^+(g) + 2e^- \rightarrow H_2(g)$ [1]

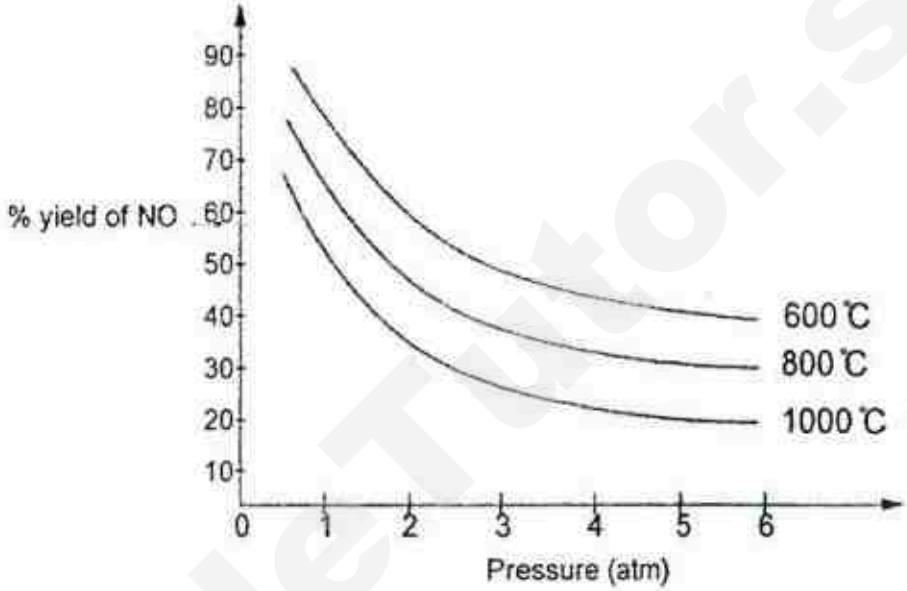
[3]

[Total:12]

B8 Ostwald process is a chemical process for making nitric acid. The raw materials of Ostwald process are ammonia, water and oxygen gas. Platinum is used as catalyst for the process. There are multiple steps in the process. In the first step of the process, ammonia reacts with oxygen in a reversible reaction to form nitrogen monoxide. It gives 65 % yield at the optimum temperature of 800 ℃ and pressure of 1 atm. The equation below shows the reactions between ammonia and oxygen.

$$4NH_3\,(g) + 5O_2\,(g) \rightleftharpoons 4NO\,(g) + 6H_2O\,(g) \qquad \Delta H = -104\ kJ/mol$$

The graph below shows the yield of nitrogen monoxide with varying temperature and pressure.



(a) State the conditions for the process to obtain ammonia in the industry.

200 – 250 atm, 400 – 450 ℃ and finely divided iron as catalyst [1]

[1]

(b) (i) Describe the relationship between percentage yield of nitrogen monoxide with temperature and pressure. [1]

The lower the temperature and pressure, the higher the yield. [1]

(b) (ii) Use the graph to explain why the optimum temperature and pressure is chosen for the first step of Ostwald process. [2]

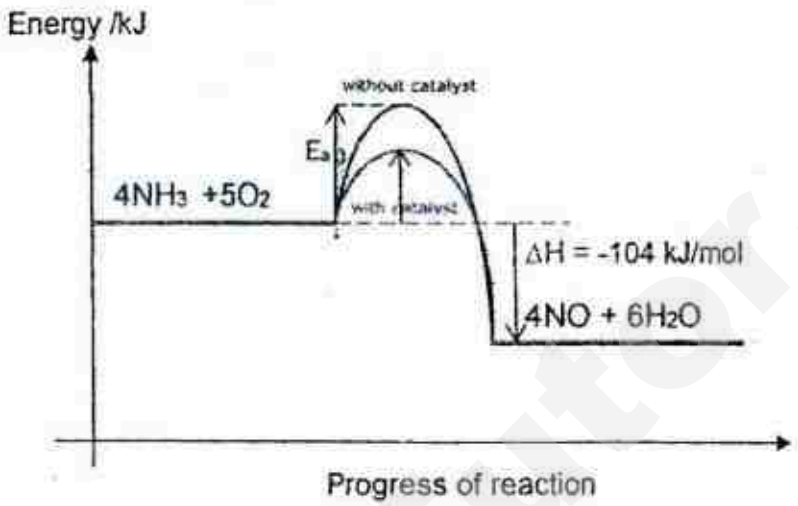
Low temperature and pressure high yield but slow speed of reaction. [1]

High temperature and pressure low yield and requires high end equipment. [1]

(c) Draw an energy profile diagram to show the effect of the catalyst on the first step of Ostwald process.

Your diagram should show and label

- reactants and products,
- the activation energy for the uncatalysed and catalysed reactions,
- the enthalpy change of reaction.



[3]

(d) A reaction is carried out at 800 °C and 2 atm using 1 tonne of ammonia with excess oxygen.

With reference to the graph, calculate the volume of nitrogen monoxide produced.
(1 tonne = 1×10^6 g)

The percentage yield at 800 °C and 2 atm is 50 %.
No mol of ammonia = 1 000 000 / 17
= 58823.53 mol **[1]**
$NH_3 : NO \cong 1 : 1$
No of mol of NO produced = 58823.53 mol
Volume of NO produced = 58823.53 x 24 x 50 % **[1]**
= 705882.4 dm^3
= 7.06×10^5 dm^3 (3s.f) **[1]**

[3]

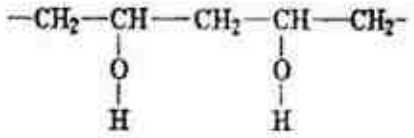
[Total:10]

EITHER

B9 Water soluble laundry bags are made of PVA (polyvinyl alcohol).

It is often used in hospital to reduce the hazards associated with storage and cleaning of contaminated washable items.

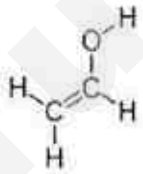
The structure of PVA is given below:



(a) **(i)** State the type of polymerisation occurred to form PVA.

Type of polymerisation: Addition polymerisation **[1]**

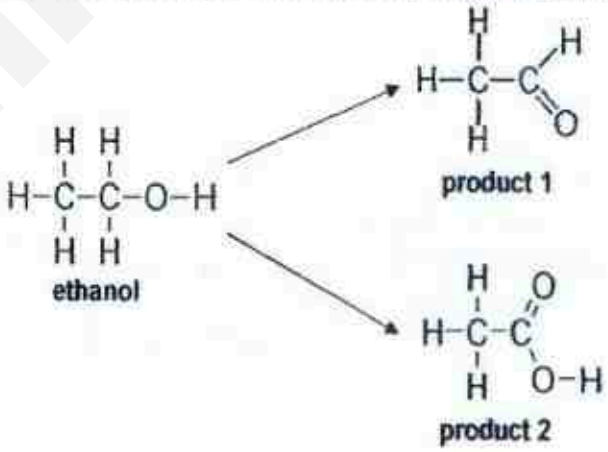
(ii) Draw the structure of the monomer of PVA.



[1]

(b) The monomer reacts with hydrogen to form ethanol.

Ethanol can be oxidised to form two other products under different conditions.



(i) Suggest a suitable reagent that can be used to oxidise ethanol to form the product 2.

Acidified $KMnO_4$ **[1]**

EITHER

B9 (b) (ii) Are **product 1 and 2** isomers of ethanol?
Explain your reasoning.

They are **not isomers** of ethanol. **[1]**

Both product 1 and 2 **don't have the same molecular formula** as ethanol.

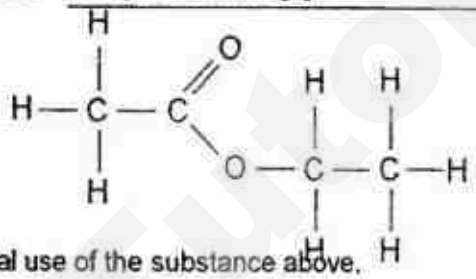
Product 1 is C_2H_4O and product 2 is $C_2H_4O_2$ while ethanol is C_2H_6O. **[1]** **[2]**

(iii) Ethanol reacts with **product 2** to produce a sweet smelling substance.

Give the name and structure of the product form.

Name of the product: Ethyl ethanoate **[1]**

Structure:



[2]

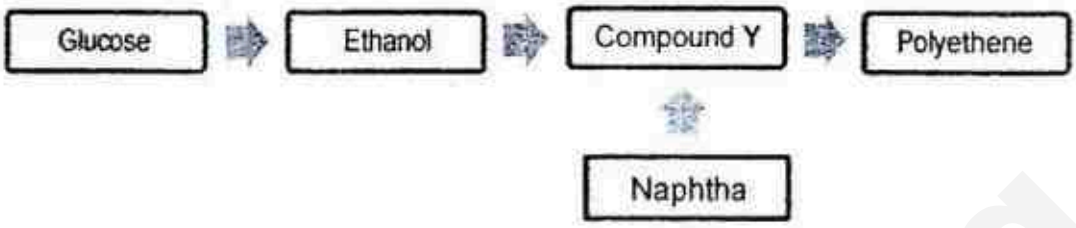
(iv) State a commercial use of the substance above.

Food flavouring / solvent / making perfume **[1]**

[Total:8]

OR

B9 The diagram below shows the two methods used to make polyethene.



(a) Name for the process use to make ethanol from glucose and state the optimum conditions for the reaction.

Fermentation [1]

Anaerobic condition with 37 ℃ [1] [2]

(b) State the possible source for the raw material to produce ethanol from glucose and give the balance chemical reaction for the reaction.

Sugarcane / fruits / rice [1]

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ [1]

[2]

(c) A student carried out an experiment to produce compound Y from ethanol.

Suggest a method for the student to check if compound Y has formed and state the expected observation.

Add aqueous bromine to the compound Y. [1]

Brown bromine solution turns colourless. [1]

[2]

(d) Compound Y can also be obtained from naphtha.

Suggest one way in which it can be obtained from naphtha.

Catalytic (thermal) cracking [1]

(e) State an advantage, other than cost and percentage yield, of obtaining compound **Y** from glucose rather than naphtha.

Glucose is a **renewable** source thus it is sustainable OR

It helps to **conserve** the **finite** natural resource of petroleum **[1]**

[Total:8]

End of Paper

Geylang Methodist School (Secondary)
Preliminary Examination 2017

CHEMISTRY **5073/01**

Paper 1 Multiple Choice **Sec 4 Express**

Additional materials : OAS **1 hour**

Setter : Mr Lim Zong Han **14 Aug 2017**

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class and register number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions.
For each question there are four possible answers **A, B, C** and **D**.
Choose the one you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

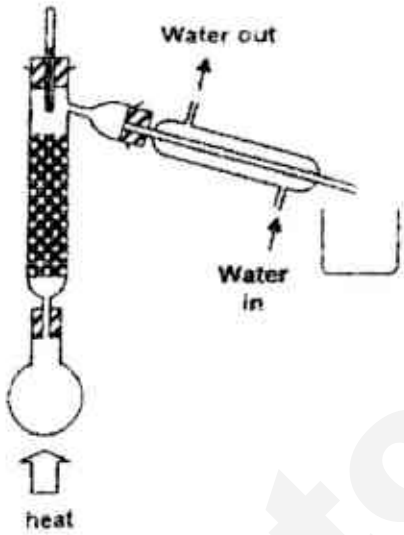
Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark.
A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic table is printed on page 17

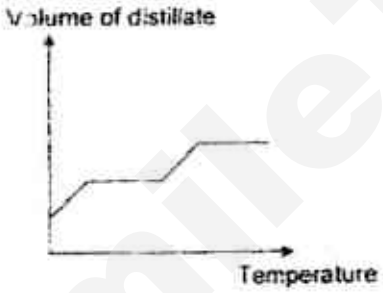
This document consists of **17** printed pages and **1** blank page

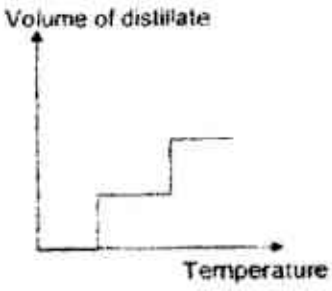
[Turn over

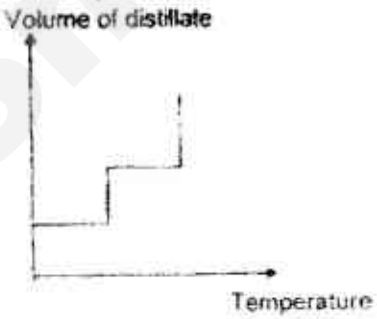
1 The diagram shows the apparatus used to separate Methylcyclopentane (boiling point 70°C) and heptane (boiling point 98°C).

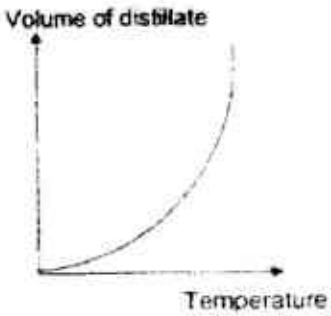


Which graph would be obtained if volume of distillate collected was plotted against temperature?

A


C


B


D


2 Which one of the following pairs of gases diffuses at the same speed?

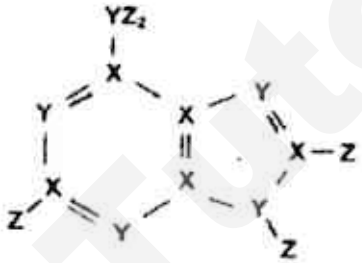
A nitrogen and oxygen
B nitrogen and carbon monoxide
C nitrogen and ammonia
D nitrogen and nitrogen dioxide

3 Sulfur dioxide gas is over twice as dense as nitrogen gas. A gas jar of sulfur dioxide was placed on top of a gas jar of nitrogen gas with the open ends together.

After half an hour, which of these statements would be true?

A The top gas jar contained nitrogen gas only.
B Some of each gas would have moved into the other gas jar.
C The gases would not have mixed.
D The bottom gas jar would contain nearly all the sulfur dioxide

4 A stable molecule containing atoms of the elements X, Y and Z has the following structure:



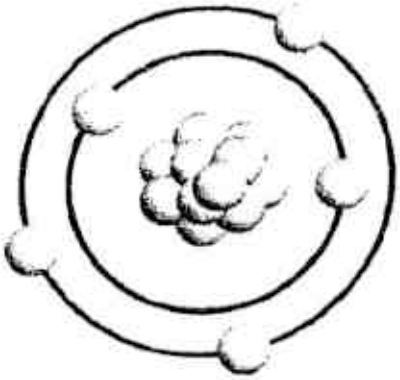
Which of the following is a possible combination of elements?

	X	Y	Z
A	Si	P	Na
B	P	Si	F
C	F	Si	P
D	Si	P	F

5 Which particle has the least number of electrons in its valence shell?

A I
B N^{3-}
C Ne
D O^{2-}

6 The diagram represents an atom of an isotope X of an element.



If the element consists of only two isotopes, which one of the following is likely to represent the particles of the other isotope of the element?

	Proton	Neutron	Electron
A	5	6	5
B	5	5	5
C	6	5	5
D	11	12	11

7 Which of the following substances contain delocalised electrons?

I copper
II graphite
III solid copper (II) chloride
IV molten copper (II) chloride

A I and II
B I and IV
C II and III
D III and IV

8 Elements P and R react to form compound S which is a liquid at room conditions. The formula of S is P_2R.

If R is a group VI element, P is

A sodium
B phosphorous
C hydrogen
D silicon

9 12.0 g of anhydrous magnesium sulfate combines with 12.6 g of water to form hydrated magnesium sulfate.

What is the formula of hydrated magnesium sulfate?

A $MgSO_4 \cdot 3H_2O$
B $MgSO_4 \cdot 5H_2O$
C $MgSO_4 \cdot 7H_2O$
D $MgSO_4 \cdot 9H_2O$

10 A hydrocarbon contains 86% carbon and 14% hydrogen by mass.

What is the probable molecular formula?

A CH_4
B C_4H_8
C C_6H_6
D C_8H_{16}

11 Compound X is a white solid. When X is warmed with sodium hydroxide solution, a gas with pungent smell is liberated. The gas turns moist red litmus paper blue. When a solution of X is treated with dilute hydrochloric acid, bubbles are seen in the solution.

What is X most likely to be?

A ammounium sulfate
B ammonium carbonate
C potassium nitrate
D potassium hydrogen carbonate

12 The following tests were carried out on a green solid.

I it produced water when it was gently heated alone.
II It gave a green precipitate when dissolved in water and added to aqueous ammonia
III It gave a white precipitate when dissolved in water and added to silver nitrate solution.

From these tests, identify the green solid.

A anhydrous copper (II) chloride
B hydrated iron (II) chloride
C hydrated iron (II) sulfate
D hydrated copper (II) sulfate

13 Which one of the following reagents gives a precipitate with a solution of $Cu^{2+}(aq)$, which dissolves in excess reagent?

A NaOH (aq)
B NH_3 (aq)
C $AgNO_3$ (aq)
D Na_2CO_3 (aq)

14 The table below gives information about three indicators.

indicator	colour in strongly acidic solution	pH at which colour changes	colour in strongly alkaline solution
methyl orange	red	4.5	Yellow
bromothylmol blue	yellow	6.5	Blue
phenolphthalein	colourless	9.0	Pink

If equal amounts of indicators were added to separate samples of pure water, what would be the colours of the resulting solutions?

	methyl orange	bromothylmol blue	phenolphthalein
A	yellow	blue	pink
B	red	yellow	colourless
C	yellow	yellow	colourless
D	yellow	blue	colourless

15 Which of the following mixtures produces ammonia when heated?

A $CH_3COONH_4 + Ba(OH)_2$
B $NH_4NO_3 + NaCl$
C $NH_4NO_3 + HCl$
D $NH_4NO_3 + Al$

16 Which of the equation does **not** represent a redox reaction?

A $3Cl_2(g) + 2Fe\ (s) \rightarrow 2FeCl_3\ (s)$
B $Ba^{2+}\ (aq) + SO_4^{2-}\ (aq) \rightarrow BaSO_4\ (s)$
C $Fe^{2+}\ (aq) + Mg\ (s) \rightarrow Fe\ (s) + Mg^{2+}\ (aq)$
D $Zn\ (s) + 2HCl\ (aq) \rightarrow ZnCl_2\ (aq) + H_2\ (g)$

17 In which reaction does chromium undergo a change in oxidation number?

A $Cr_2O_3 + 3H_2SO_4 \rightarrow Cr_2(SO_4)_3 + 3H_2O$
B $Cr_2(SO_4)_3 + 6NaOH \rightarrow 2Cr(OH)_3 + 3Na_2SO_4$
C $K_2Cr_2O_7 + 4H_2SO_4 + 6HCl \rightarrow Cr_2(SO_4)_3 + K_2SO_4 + 7H_2O + 3Cl_2$
D $2K_2CrO_4 + H_2SO_4 \rightarrow Kr_2Cr_2O_7 + K_2SO_4 + H_2O$

18 Small portions of aqueous potassium iodide (KI) and acidified potassium manganate (VII) ($KMNO_4$) were separately added to four solutions.

The colour changes are shown in the table below:

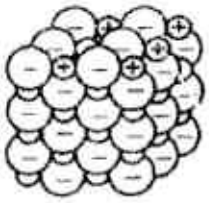
solution number	potassium iodide	potassium manganate
1	colourless to brown	purple to colourless
2	colourless to brown	no change
3	no change	purple to colourless
4	no change	no change

Which solution(s) contained an oxidising agent?

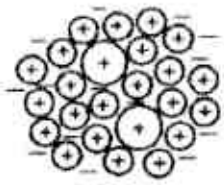
A 1 only
B 1 and 2
C 1 and 3
D 2 and 4

19 Which of the following diagrams shows the structure of bronze?

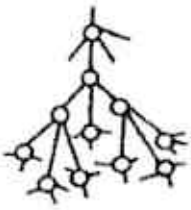
A



B

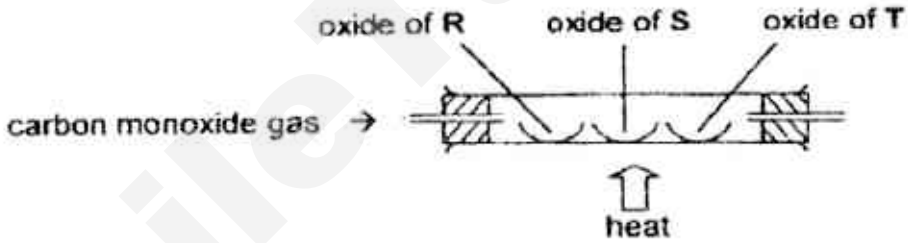


C



D

20 Three metallic oxide powders containing metals, R, S and T are heated strongly in a hard glass tube as shown below. At the same time, carbon monoxide gas is directed through the tube.



Oxide of R glows slightly, oxide of T glows strongly while oxide of S does not undergo any changes.

Based on these observations, which list shows the descending order of reactivity (most reactive first) of metal R, S and T?

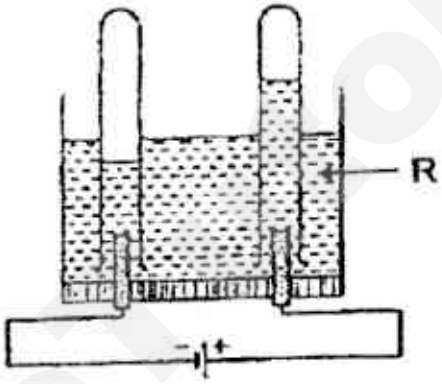
A R, S, T
B T, R, S
C S, R, T
D T, S ,R

21 Several properties of metals can be explained by the fact that layers of atoms can slide over each other.

Which one of the following properties of metals is **not** explained by this fact?

A Metals are malleable.
B Metals conduct electricity.
C Pure metals are softer than alloys.
D Metals are ductile.

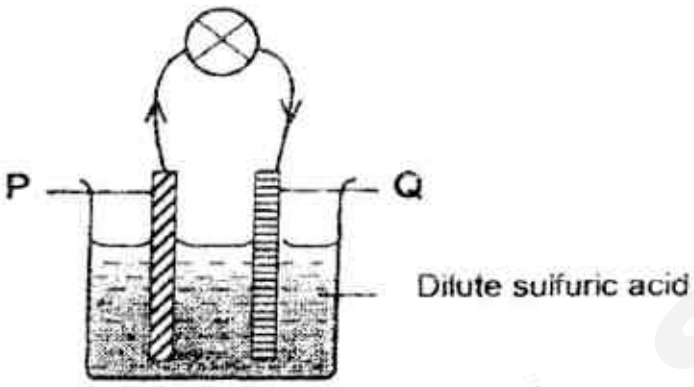
22 The diagram shows the results of an electrolysis using inert electrodes.



Which of the following could be liquid R?

A aqueous silver nitrate
B aqueous sodium carbonate
C concentrated hydrochloric acid
D molten magnesium iodide

23 The diagram below shows a simple electrochemical cell.



An electric current flows from P to Q. Suggest the identity of P and Q.

	P	Q
A	copper	magnesium
B	zinc	magnesium
C	zinc	iron
D	copper	iron

24 When an aqueous solution containing Fe^{2+} and V^{n+} ions is electrolysed, the same amount of charge produces 16.8 g of iron and 10.2 g of vanadium.

What is the value of n in V^{n+} ion?

A 1
B 2
C 3
D 4

25 The element astatine (At) is beneath iodine in Group VII of the Periodic Table.

Which one of the following is a likely property of astatine?

A It can be liberated from a solution of its salt by chlorine gas.
B It conducts electricity in molten state.
C It forms a basic oxide.
D It displaces iodine from aqueous potassium iodide.

26 The table below represents 8 elements P, Q, R, S, T, U V and W across Period 2 of the Periodic Table.

$_3$P	$_4$Q	$_5$R	$_6$S	$_7$T	$_8$U	$_9$V	$_{10}$W

Which of the following properties is **Incorrect**?

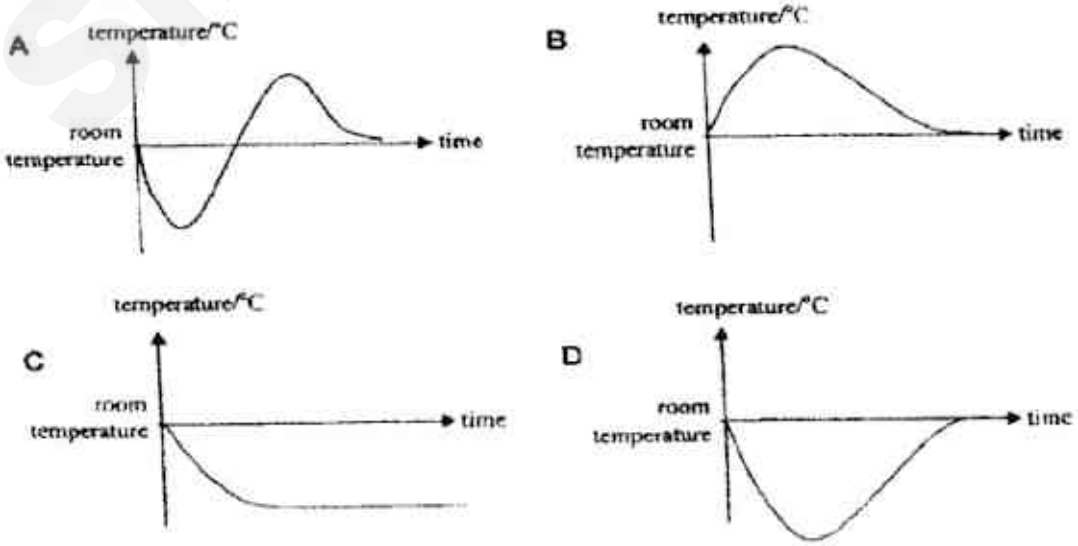
A The chlorides of T have high melting points whereas chlorides of P have low melting points.
B The oxides of T are acidic whereas the oxides of P are alkaline.
C P and Q are metals whereas V and W are non-metals.
D V atoms are smaller than P atoms.

27 Which statement about groups in the Periodic Table is correct?

A All elements form either positively charged ions or negatively charged ions.
B In Group I, all the elements form covalent compounds with hydrogen.
C In Group VII, all the elements form ionic bonds with most metals.
D All groups contain acidic and basic oxides.

28 The process of dissolving potassium iodide in water is endothermic.

Which of the following graphs shows the temperature changes that occur when potassium iodide is stirred with water until no further change in temperature is observed?



29 Which one of the following is an endothermic process?

A $C (s) + O_2 (g) \rightarrow CO_2 (g)$
B $HCl (aq) + NaOH (aq) \rightarrow NaCl (aq) + H_2O (l)$
C $6CO_2 (g) + 6H_2O (g) \rightarrow C_6H_{12}O_6(aq) + 6O_2(g)$
D $H_2O (g) \rightarrow H_2O (l)$

30 The combustion of methane is an exothermic process.

$$CH_4 (g) + 2O_2 (g) \rightarrow CO_2 (g) + 2H_2O (g) \qquad \Delta H = -890 \text{ kJ}$$

How much methane should be used to produce 2670 kJ of heat?

A 48 g
B 64 g
C 96 g
D 120 g

31 Sodium thiosulfate reacts with hydrochloric acid to form sulfur.

Which sodium thiosulfate solution gives the highest initial rate of reaction?

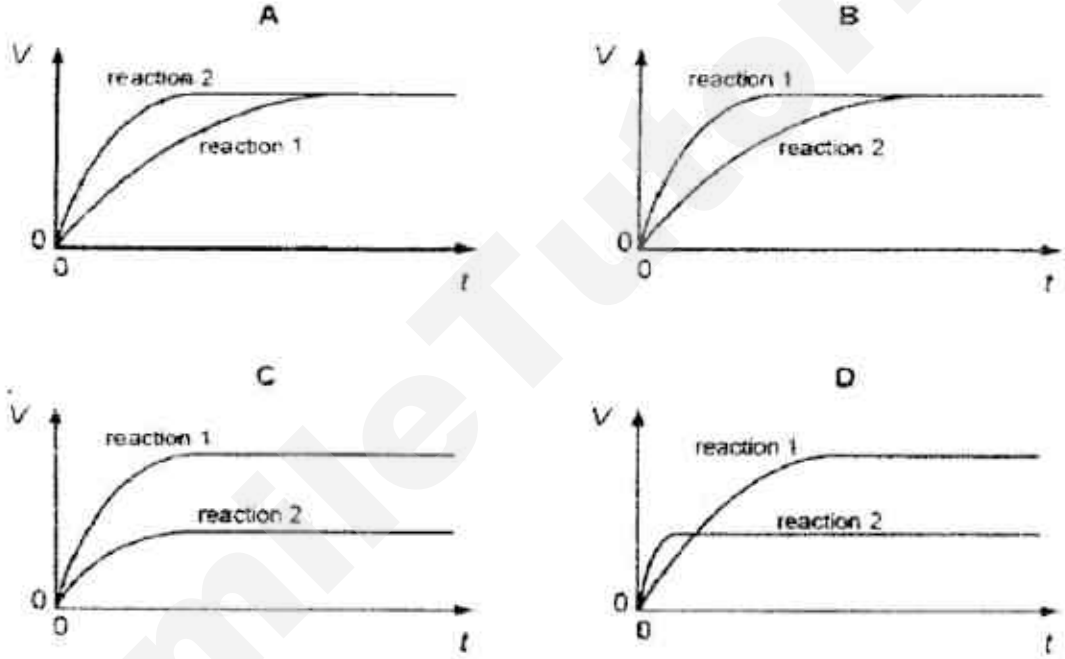
A 4 g of sodium thiosulfate dissolved in 50 cm^3 of water.
B 10 g of sodium thiosulfate dissolved in 100 cm^3 of water.
C 20 g of sodium thiosulfate dissolved in 500 cm^3 of water.
D 40 g of sodium thiosulfate dissolved in 2000 cm^3 of water.

32 A student performs two reactions.

Reaction 1	10 g of magnesium ribbon with excess 2.0 mol/dm^3 dilute hydrochloric acid
Reaction 2	5 g of magnesium powder with excess 2.0 mol/dm^3 dilute hydrochloric acid

In both experiments, the volume of hydrogen produced, V, is measured against time, t, and the result plotted graphically.

Which set of graphs is correct?



33 Ammonia is produced industrially by Haber process.

Which of the following statement is **not** true about the Haber process?

A Nitrogen is obtained from air.
B High temperature is applied to overcome the activation energy.
C A catalyst is added to decrease the enthalpy change of the forward reaction.
D High pressure is applied to increase the yield of ammonia.

34 Which one of the following pairs of gases are common pollutants of the atmosphere?

A nitrogen and sulfur dioxide
B chlorine and hydrogen
C carbon dioxide and ammonia
D sulfur dioxide and nitrogen dioxide

35 Which one of the following explains why carbon monoxide is poisonous?

A It is oxidised to carbon dioxide in the lungs.
B It is reduced to carbon in the lungs.
C It combines with haemoglobin.
D It is inflammable.

36 Which one of these pollutant gases in the air is mainly responsible for the greenhouse effect?

A sulfur dioxide
B carbon dioxide
C carbon monoxide
D nitrogen dioxide

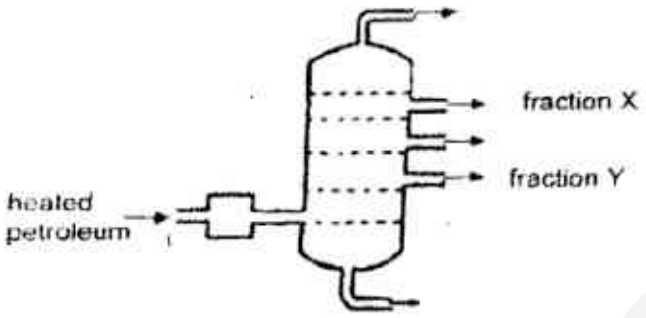
37 The reaction between the hydrocarbon C_xH_6 and hydrogen can be represented by the equation:

$$C_xH_6\ (g) + H_2\ (g) \rightarrow C_xH_8\ (g)$$

Which of the following statements about the above reaction is true?

A It is a substitution reaction.
B UV light is required for the reaction to take place.
C The molecular formula of the hydrocarbon is C_2H_6.
D The molecular formula of the hydrocarbon is C_3H_6.

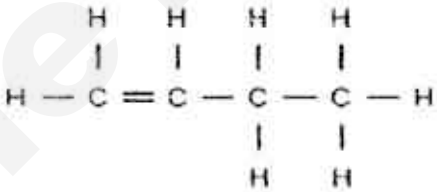
38 The diagram shows the fractional distillation of petroleum.



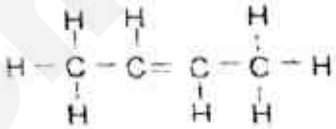
Which statements about fractions X and Y are correct?

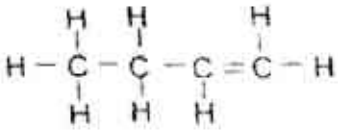
	X is more flammable than Y	X burns with a less sooty flame than Y	X is more viscous than Y
A	Yes	No	No
B	Yes	Yes	No
C	No	Yes	Yes
D	No	No	Yes

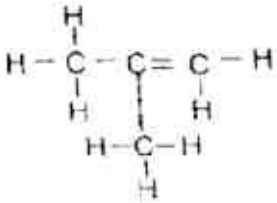
39 The diagram shows the structure of a hydrocarbon X.

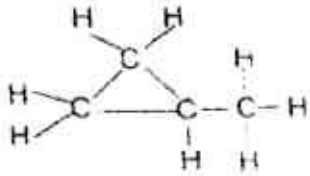


Which of the following structures are isomers of hydrocarbon X?

i 

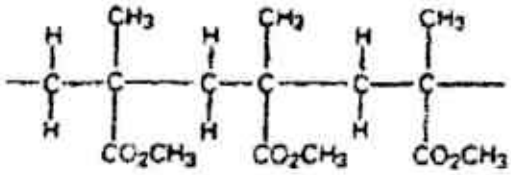
ii 

iii 

iv 

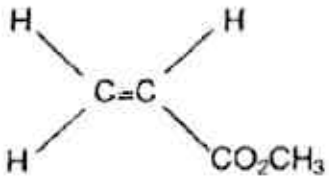
A i, ii
B i, iii
C i, iii, iv
D i, ii, iii, iv

40 The structure of the plastic Perspex is shown below.

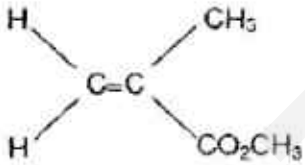


What is the molecular structure of the monomer from which this plastic is formed?

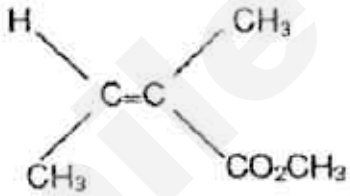
A



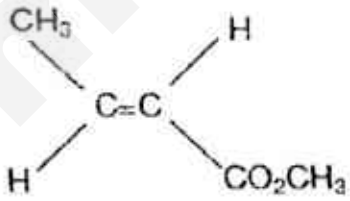
B



C



D



End of Paper

Marking Scheme

Geylang Methodist School (Secondary)
Prelim Exam 2017
Chemistry 5073

Paper 1

1	C	11	B	21	B	31	B
2	B	12	B	22	B	32	D
3	B	13	B	23	C	33	C
4	D	14	D	24	C	34	D
5	A	15	A	25	A	35	C
6	B	16	B	26	A	36	B
7	A	17	C	27	C	37	D
8	C	18	B	28	D	38	B
9	C	19	B	29	C	39	C
10	B	20	C	30	A	40	B

Geylang Methodist School (Secondary)
Preliminary Examination 2017

Candidate Name	
Class	Index Number

CHEMISTRY **5073/02**

Paper 2 **Sec 4 Express**

Additional materials : NIL **1 hour 45 minutes**

17 Aug 2017

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer **all three** questions, the last question is in the form either/or.
Write your answers in the spaces provided.

At the end of the examination, detach Section A from Section B and hand them in separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 22.

For Examiner's Use	
Section A	/50
B7	/12
B8	/ 8
B9	/10
Total	/80

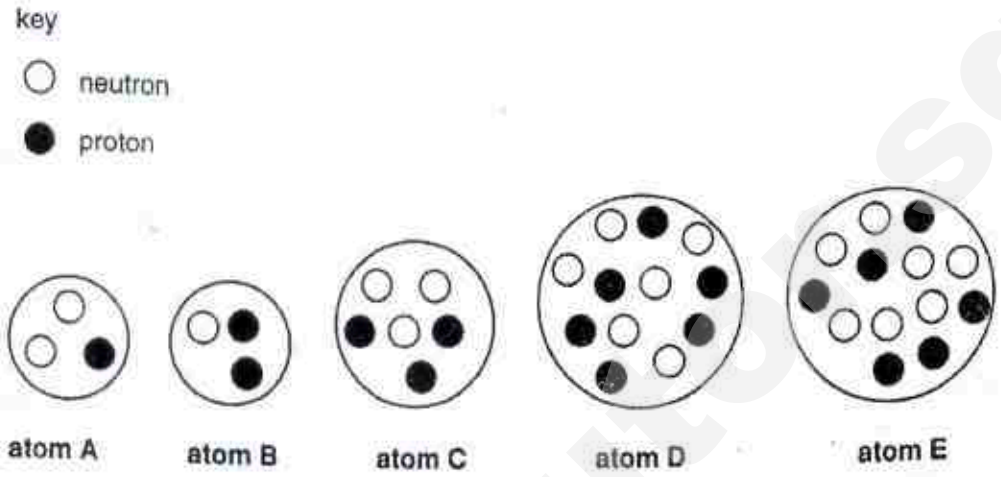
This document consists of **21** printed pages and **1** blank page.

[Turn over

Section A

Answer **all** the questions in this section in the spaces provided.
The total mark for this section is 50.

A1 The diagram shows the nuclei of five different atoms.



(a) Which atom is most likely to be in Group 0?

.....[1]

(b) Which atom has an atomic number of 3?

.....[1]

(c) Which atom has a nucleon number of 6?

.....[1]

(d) Which **two** atoms are isotopes of the same element?

.....and.....[1]

(e) Suggest the name of the element in **(d)**.

.....[1]

(f) Which **two** atoms lose an electron when they form ions?

.....[2]

[Total: 7]

A2 The table below shows the concentration of different ions found in a sample of aqueous industrial waste.

ion	concentration (mol/dm^3)
Ca^{2+}	0.125
H^+	2.300
K^+	0.234
NO_3^-	3.680
Cu^{2+}	0.450

Use the information in the table to answer the following questions.

(a) Write the chemical formula of a coloured salt that could be obtained from the sample.

.....[1]

(b) A student wants to obtain the salt in (a) using the following method.

metal + dilute nitric acid $\longrightarrow$ salt in **(a)** + hydrogen

Why is this method **not** feasible?

..... [1]

(c) Suggest a modification to the method in **(b)** to obtain a pure and dry sample of the salt in (a).

.....

.....

.....

.....

.....

..... [3]

(d) Is the sample of aqueous industrial waste acidic, neutral or alkaline? Explain your answer.

.....

..... [1]

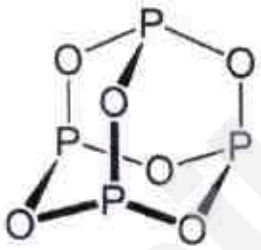
(e) What would be **observed** when aqueous sodium hydroxide is added to a sample of the aqueous industrial waste until no further change is seen?

.....

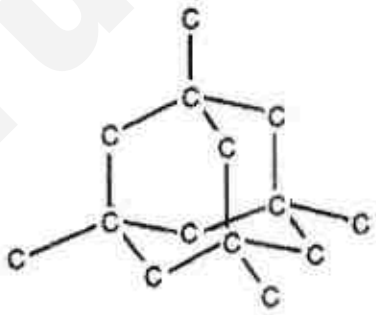
..... [2]

[Total: 8]

A3 The structures of phosphorus trioxide and diamond are shown below. Phosphorus trioxide is a covalent compound with a simple molecular structure. Diamond has a giant molecular structure of carbon atoms.



phosphorus trioxide



diamond

(a) Write down the molecular formula of phosphorus trioxide.

..... [1]

(b) Describe how a *simple molecular structure* differs from a *giant molecular structure*.

.....

.....

.....

.....

..... [2]

(c) Explain why the melting point of phosphorus trioxide is lower than that of diamond.

.....

.....

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.....

..... [3]

(d) An oxide was found to have the following composition by mass.

element	percentage by mass
phosphorus	43.7
oxygen	56.3

Deduce whether this oxide could be phosphorus trioxide by determining its empirical formula.

.....

.....

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.....

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.....

.....

..... [3]

[Total: 9]

A4 **(a)** Ammonia is manufactured by the Haber Process.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad \Delta H = -92.4 \text{ kJ/mol}$$

The table below shows how the percentage yield of ammonia at equilibrium varies with both temperature and pressure.

pressure / atm	percentage yield of ammonia at equilibrium			
	200 °C	300 °C	400 °C	500 °C
40	72	34	13	5
100	81	51	25	10
200	86	63	36	18
300	88	69	40	24

(i) Describe how the percentage yield of ammonia at equilibrium changes with temperature.

.....

.....[1]

(ii) Describe how the percentage yield of ammonia at equilibrium changes with pressure.

.....

.....[1]

(iii) Explain how using a catalyst in the Haber Process has an economic advantage.

.....

.....

.....[2]

(b) Ammonia is used to manufacture nitric acid by a two-stage process.

Stage 1 Ammonia is converted to nitrogen monoxide.

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

Stage 2 Nitrogen monoxide is converted to nitric acid.

$$4NO(g) + 2H_2O(g) + 3O_2(g) \rightarrow 4HNO_3(aq)$$

(i) It is possible to find out whether the reaction in **Stage 1** has completed by following the pH changes during the reaction.
Samples of gas are taken from the reaction vessel at regular time intervals and bubbled through water to form a solution. The pH of each solution is measured.
Explain why the measured pH changes during the reaction.

.....

.....

.....

.....

.....

.....[3]

(ii) Use the equations in the two stages to construct an overall equation for the conversion of ammonia to nitric acid.

.....[1]

[Total: 8]

A5 The manufacture of sulfuric acid is described below.

step 1: Sulfur is burnt in excess air to form sulfur dioxide.

$$S(s) + O_2(g) \rightarrow SO_2(g)$$

step 2: Sulfur dioxide reacts with more oxygen to form sulfur trioxide.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -196 \text{ kJ/mol}$$

step 3: Sulfur trioxide is dissolved in concentrated sulfuric acid to form oleum, $H_2S_2O_7$.

$$H_2SO_4(l) + SO_3(g) \rightarrow H_2S_2O_7(l)$$

step 4: Oleum can then react safely with water to produce concentrated sulfuric acid.

$$H_2S_2O_7(l) + H_2O(l) \rightarrow 2H_2SO_4(l)$$

(a) Is step 3 a redox reaction? Use ideas about oxidation states to explain your answer.

.....

.....

.....

..... [2]

(b) Explain, in terms of collisions between reacting particles, how a higher pressure affects the rate of reaction in step 1.

.....

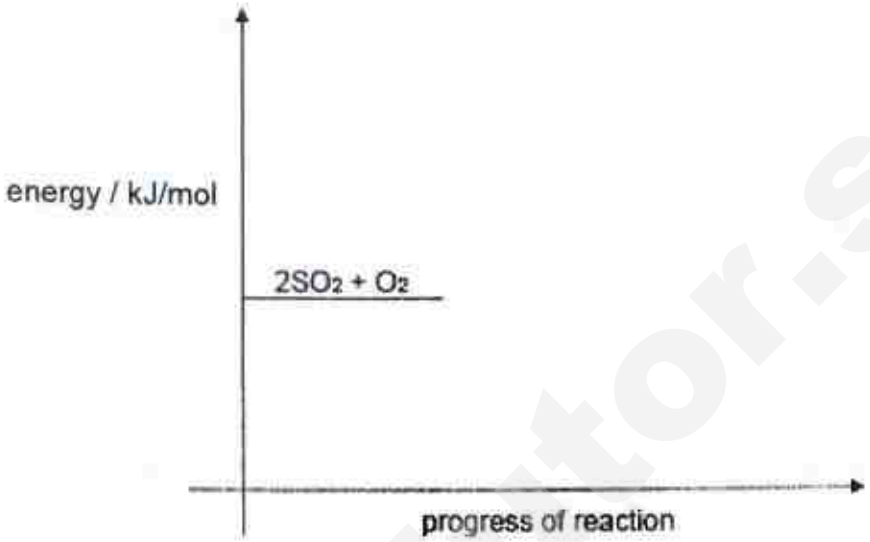
.....

.....

..... [2]

(c) (i) Complete the energy profile diagram below for the reaction of sulfur dioxide and oxygen to produce sulfur trioxide. The activation energy for this reaction is 2200 kJ/mol.

Label clearly the **reaction enthalpy change** and the **activation energy.**



[3]

(ii) State the values of the enthalpy change, ΔH, and the activation energy, Ea, of the reverse reaction.

ΔH = ...kJ/mol

Ea = ...kJ/mol [2]

[Total: 9]

A6 The atmosphere contains a large number of gases including oxygen, nitrogen, carbon dioxide, sulfur dioxide, oxides of nitrogen, methane and chlorofluorocarbons (CFCs).

(a) Carbon dioxide, methane and CFCs are greenhouse gases.

(i) State **one** effect of an increase in the atmospheric concentration of carbon dioxide and methane.

.....

.....[1]

(ii) State **one** source of methane gas.

.....

.....[1]

(iii) State one **other** environmental effect of the presence of CFCs in the atmosphere.

.....

.....[1]

(b) The formula of one chlorofluorocarbon is $CFCl_3$.
Draw a dot-and-cross diagram to show the bonding in a molecule of $CFCl_3$.
You only need to show outer shell electrons.

[2]

(c) Oxides of nitrogen are produced during the combustion of petrol (gasoline) in a car engine.

(i) Describe the chemical reaction that takes place within a car engine to form nitric oxide, NO.

.....

.....[1]

(ii) Most of the nitric oxide and other pollutants present in the exhaust gases of a car are removed in a catalytic converter.
Describe the redox reactions that happen within a catalytic converter.

.....

.....

.....

.....[2]

(d) Nitrogen dioxide is one of the causes of acid rain.
Two moles of nitrogen dioxide react with one mole of water to make an aqueous solution of two acids only.
One of these acids is nitric acid.
Deduce the formula of the other acid.

.....[1]

[Total: 9]

End of Section A

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Name: _____( ) **Class:** _____

Section B

Answer all **three** questions from this section.

The last question is in the form of an either/or and only **one** of the alternatives should be attempted.

The total mark for this section is 30.

B7 Alkenes are unsaturated hydrocarbons. They contain one or more carbon-carbon double bonds. Alkenes can exist as branched or unbranched hydrocarbons. Short-chain alkenes such as ethene and propene are used as starting materials for making ethanol and plastics.

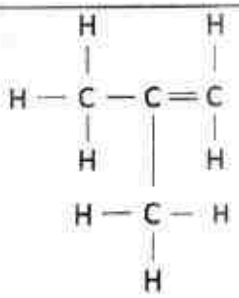
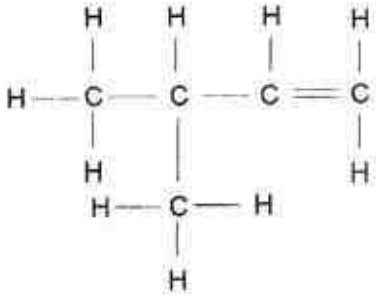
Table 1 shows the boiling points of some straight chain alkenes.

Table 1

name	formula	boiling point / °C
ethene	C_2H_4	-104
propene	C_3H_6	- 47
butene	C_4H_8	- 6
pentene	C_5H_{10}	30
hexene	C_6H_{12}	63

Table 2 shows properties of branched isomers of some of the alkenes.

Table 2

	number of carbon atoms in molecule	formula	boiling point / °C
branched alkene 1	4		-7
branched alkene 2	5		20

(a) How is the boiling point of a straight chain alkene affected by branching in isomerism?
Use evidence from **Table 1** and **Table 2** to explain your reasoning.

.....

.....

.....

.....

.....

.....

.....[3]

(b) **X** is a gaseous hydrocarbon which can decolourise a solution of bromine and has a density of 1.75 g/dm^3 at room temperature and pressure.

(i) Calculate the relative molecular mass of **X**.

.....

.....[1]

(ii) Hence, identify **X**. Explain your reasoning.

.....

.....

.....

.....[2]

(c) Both ethene and ethane can react with chlorine to form dichloroethane.
Give **two** differences between the two reactions.

.....

.....

.....

.....

.....[2]

(d) Alkynes are hydrocarbons containing carbon-carbon triple bond (C≡C). **Table 3** shows some properties of the first four members of the alkyne homologous series.

Table 3

alkyne	molecular formula	boiling point / °C
ethyne	C_2H_2	- 84
propyne	C_3H_4	- 23
butyne	C_4H_6	8
pentyne	C_5H_8	40

(i) Draw the full structural formula of the alkyne with 6 carbon atoms.

[1]

(ii) Do alkenes or alkynes burn with a smokier flame? Explain your answer.

.....

.....

.....[1]

(e) A Chemistry book has the following line.

.....in general, the higher the relative molecular mass of the molecule, the higher the melting and boiling points of the compound due to the higher intermolecular forces of attraction.

Use the data in **Table 1** and **Table 3** to justify whether the statement is valid.

.....

.....

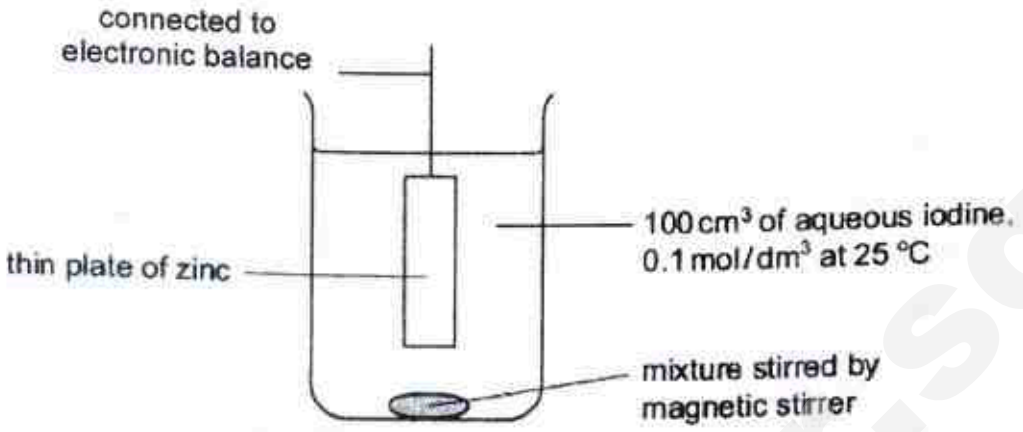
.....

.....

.....[2]

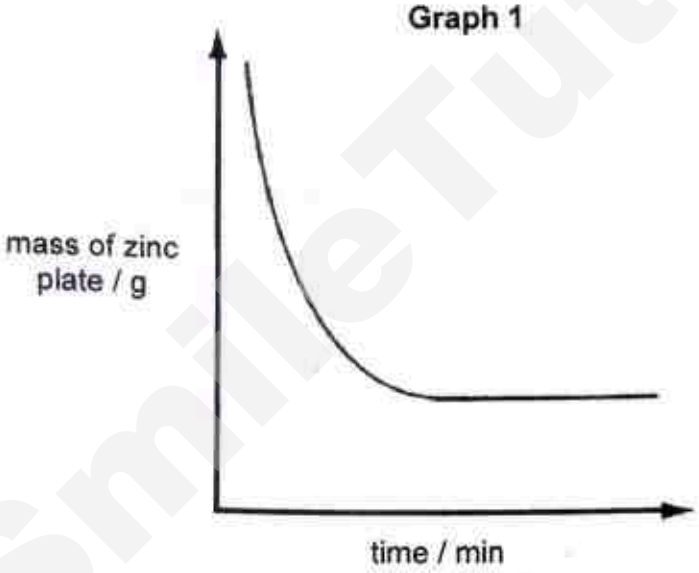
[Total: 12]

B8 Zinc reacts with aqueous iodine to form zinc iodide. The following apparatus was used to measure the rate of the reaction between zinc and aqueous iodine at 25°C.



The mass of the zinc plate was measured every minute until the reaction was complete.
Graph 1 shows the results obtained.

Graph 1



(a) Identify the reagent that was used in excess.

.....[1]

(b) (i) The experiment was repeated with 100 cm^3 of 0.05 mol/dm^3 aqueous iodine and keeping all other conditions the same. On the same axes as **Graph 1** above, sketch the curve that would be obtained and label it 'Y'. [1]

(ii) Explain the shape of the graph obtained in **(b)(i)**.

.....

.....

.....

.....

.....

.....[2]

(c) Explain, in terms of collisions between reacting particles, the effect on the speed of reaction if the experiment was repeated at 15°C with all other conditions kept constant.

.....

.....

.....

.....

.....

.....[2]

(d) Describe and explain what would be observed if aqueous chlorine was bubbled into the resulting zinc iodide solution.

.....

.....

.....

.....[2]

[Total: 8]

EITHER

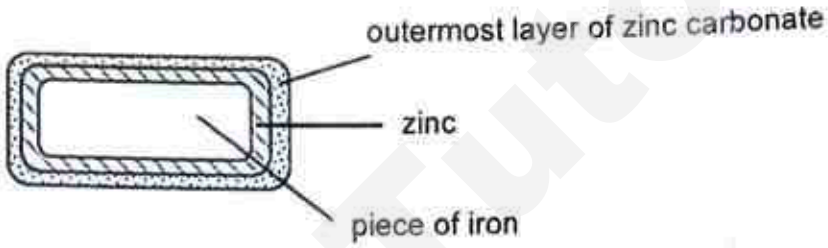
B9 Galvanisation is the process of coating the entire surface of a piece of iron with zinc to prevent it from rusting. Two common ways of galvanising iron are hot-dip galvanisation and electro-galvanisation.

(a) Hot-dip galvanisation

The piece of iron to be galvanised is dipped into a molten bath of zinc at a temperature of around 460°C. The piece of iron is then cooled and exposed to the air. The outermost layer of zinc then reacts with oxygen and carbon dioxide in the air as follows:

reaction 1: zinc reacts with oxygen to form zinc oxide
reaction 2: zinc oxide reacts with carbon dioxide to form zinc carbonate

The resulting iron piece is as shown.



(i) Write balanced chemical equations for reaction 1 and reaction 2.

reaction 1 .....[1]

reaction 2 .....[1]

(ii) Use reaction 2 to explain how zinc oxide acts as a basic oxide.

.....[1]

(b) A student says 'galvanising a piece of iron is more effective in preventing it from rusting than painting it.'

Do you agree with the student? Explain your reasoning.

.....

.....

.....

.....[2]

(c) Electro-galvanisation (electroplating an object with zinc)

The piece of iron to be galvanised and a piece of zinc are used as electrodes and dipped into an electrolyte containing a mixture of aqueous zinc cyanide, $Zn(CN)_2$, and aqueous sodium hydroxide at room temperature and pressure. An external electrical power supply is used. Zinc ions are discharged to form zinc atoms, which are coated onto the piece of iron.

(i) Draw a labelled diagram of the experimental setup for electro-galvanisation.

[2]

(ii) What is the formula for the cyanide ion?

.....[1]

(iii) Some processes of electro-galvanisation employ the use of dilute acids in the electrolyte instead of aqueous sodium hydroxide.

Explain what problem this could pose.

.....

.....[1]

(d) Suggest an **advantage** that electro-galvanisation has over hot-dip galvanisation.

.....

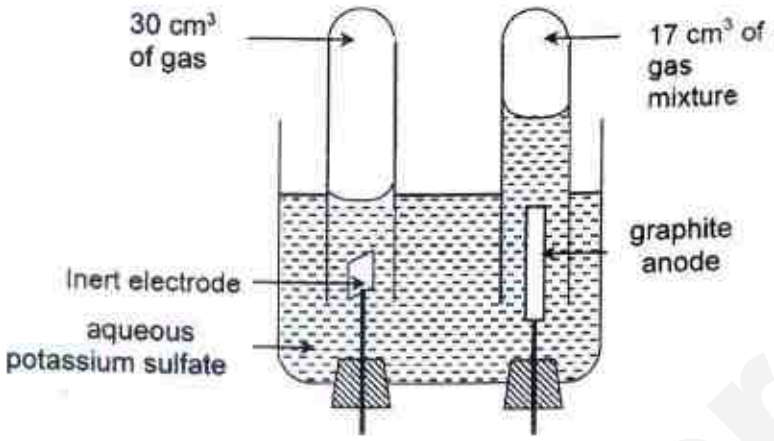
.....

.....[1]

[Total: 10]

OR

B9 The diagram below shows the electrolysis of an aqueous solution of potassium sulfate using inert electrodes.



(a) Write equations for the reactions that happen at each electrode during the electrolysis of aqueous potassium sulfate. Include state symbols.

At the cathode : .....

At the anode : .....

[3]

(b) When graphite anode and a very high current are used in this electrolysis, the gas liberated is a mixture of oxygen, carbon monoxide and carbon dioxide. In the experiment illustrated above, 30 cm^3 of gas formed above the cathode and 17 cm^3 of gas formed above the anode.

(i) Explain, with the help of **two** equations, why the oxides of carbon are produced at the anode.

.....

.....

.....

.....

.....[3]

(ii) Using the equations in **b(i)**, explain why the volume of gas collected at the anode is larger than expected.

.....

.....[1]

(iii) The gas at the anode was collected and its volume was reduced to 9 cm^3 when shaken with aqueous sodium hydroxide.
Deduce the volume of carbon dioxide in the gas mixture at the anode and explain the reaction that results in the reduction of volume.

.....

.....

.....[2]

(c) An experiment is set up to electroplate a fresh flower with silver.
Suggest why the fresh flower must be coated with carbon particles first.

.....

.....[1]

[Total: 10]

End of Paper

Marking Scheme

Geylang Methodist School (Secondary)
Prelim Exam 2017
Chemistry 5073

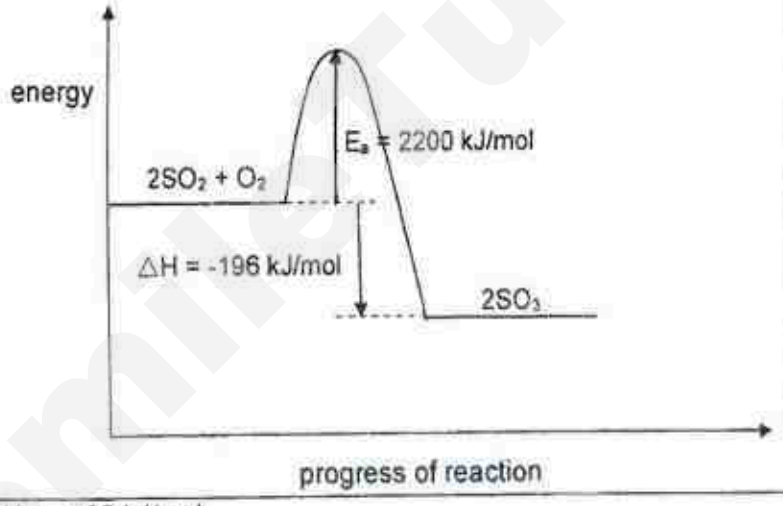
Paper 2

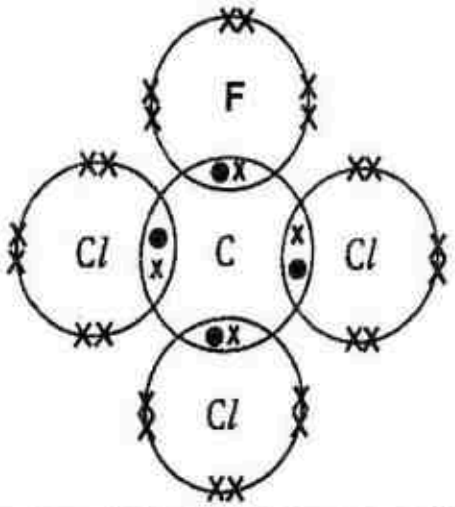
Qns	Answers	Marks
A1a	B	1
b	C	1
c	C	1
d	D and E	1
e	carbon	1
f	A and C	2
A2a	$Cu(NO_3)_2$	1
b	Copper does not react with dilute acids.	1
c	Add excess copper(II) oxide / copper(II) carbonate with dilute nitric acid and stir. Filter to remove the excess copper(II) oxide and collect copper(II) nitrate as the filtrate. Heat copper(II) nitrate solution until it is saturated. Cool the saturated solution. Wash the crystals with a little cold water and dry between sheets of filter paper.	1 1 1
d	Acidic. There are H^+ ions present.	1

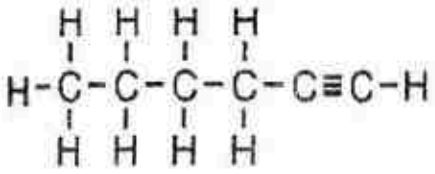
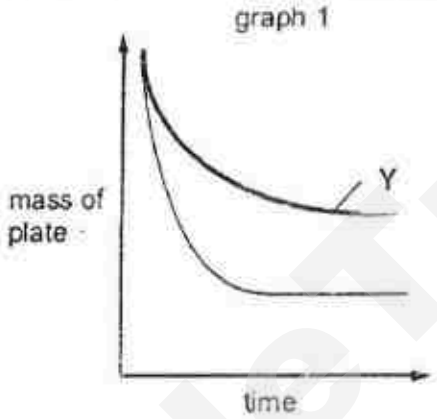
1

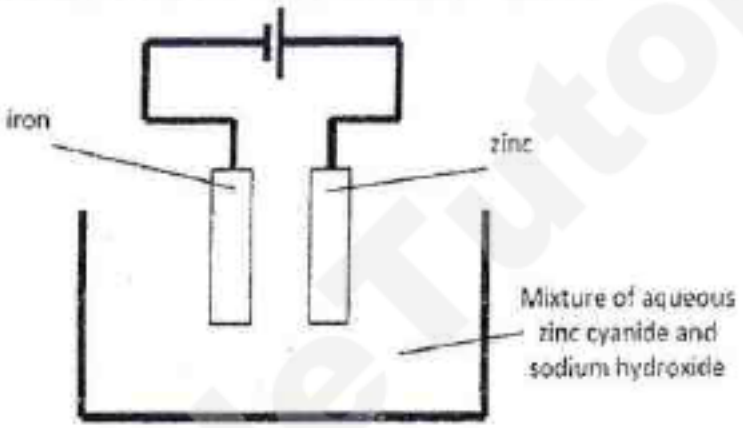
<table>
<tr><th>Qns</th><th>Answers</th><th>Marks</th></tr>
<tr><td>e</td><td>A white precipitate is formed.
The precipitate is insoluble in excess sodium hydroxide.
OR
A blue precipitate is formed.
The precipitate is insoluble in excess sodium hydroxide.</td><td>1
1

1
1</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>A3a</td><td>P_4O_6</td><td>1</td></tr>
<tr><td>b</td><td>A simple molecular structure has small discrete molecules with weak intermolecular forces while
a giant molecular structure is a lattice of many atoms covalently bonded together.</td><td>1
1</td></tr>
<tr><td>c</td><td>A small amount of energy is needed to overcome the weak intermolecular forces between the molecules in phosphorus trioxide.
A very large amount of energy is needed to overcome the strong covalent bonds between the carbon atoms in the structure of diamond.</td><td>1
1
1</td></tr>
<tr><td>d</td><td>
<table>
<tr><td>element</td><td>P</td><td>O</td></tr>
<tr><td>mass (g) / % by mass</td><td>43.7</td><td>56.3</td></tr>
<tr><td>number of moles</td><td>$\frac{43.7}{31} = 1.410$</td><td>$\frac{56.3}{16} = 3.519$</td></tr>
<tr><td>molar ratio</td><td>$\frac{1.410}{1.410} = 1$</td><td>$\frac{3.519}{1.410} = 2.5$</td></tr>
<tr><td>simplest ratio</td><td>2</td><td>5</td></tr>
<tr><td>empirical formula</td><td colspan="2">P_2O_5</td></tr>
</table>
Since the empirical formula of phosphorus trioxide is P_2O_3, not P_2O_5, this oxide cannot be phosphorus trioxide.</td><td>1
1
1</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>A4a(i)</td><td>The percentage yield of ammonia decreases with increasing temperature.</td><td>1</td></tr>
<tr><td>(ii)</td><td>Percentage yield of ammonia increases with increasing pressure.</td><td>1</td></tr>
<tr><td>(iii)</td><td>Catalyst speeds up the reaction / lowers activation energy.
Catalyst shortens the production time / lowers energy costs as less energy is used.</td><td>1
1</td></tr>
</table>

Qns	Answers	Marks
b(i)	Ammonia is an alkaline gas, while oxygen, nitrogen monoxide and water vapour are neutral gases. Ammonia gas is gradually used up, the pH decreases as the products are neutral. When pH value remains constant at 7, it indicates that ammonia gas is used up completely for reaction and left with the neutral gases.	1 1 1
(ii)	$NH_3 + 2O_2 \rightarrow HNO_3 + H_2O$	1
A5a	No. The oxidation states of S, O and H remains the same at +6, -2 and +1 respectively in both reactants and products.	Minus 1 mark for each mistake in oxidation states.
b	The rate of reaction is faster at higher pressure. The gas molecules are closer together. There are more molecules per unit volume of the gas and they collide more frequently.	1 1
c(i)		correct Ea – 1m correct ΔH – 1m correct exothermic graph – 1m
(ii)	ΔH = +196 kJ/mol Ea = 2396 kJ/mol	1 1
A6 a(i)	Global warming/ ice caps melting/ sea level rising	1
(ii)	One source of methane is rotting vegetation.	1
(iii)	CFCs cause ozone depletion.	1

Qns	Answers	Marks
b		Minus 1 mark for each mistake
c(i)	Reaction of nitrogen with oxygen at high temperature produces nitric oxide.	1
(ii)	Nitric oxide is reduced to form nitrogen gas. Carbon monoxide is oxidised to form carbon dioxide.	1 1
d	HNO_2	1
B7a	Branching in isomerism <u>decreases</u> the boiling point of straight chain alkenes. From the data, the boiling point of straight chain butene (-6 °C) is higher than the branched butene (-7 °C). The boiling point of straight chain pentene (30 °C) is also higher than the branched pentene (20 °C).	1 1 1
b(i)	M_r = density × 24 dm^3 = 1.75 × 24 = 42	1
(ii)	X is propene / C_3H_6 with M_r of propene = (12×3) + (1×6) = 42. As X decolourises aqueous bromine, it is unsaturated / an alkene with general formula C_nH_{2n}.	1 1
c	differences: any two - substitution in ethane requires UV light whereas addition in ethene does not. - substitution in ethane involves breaking of C-H bond whereas addition in ethene involves breaking of C=C bond. - substitution in ethane produces many products whereas addition in ethene produces only one product (dichloroethane). - substitution in ethane produces a by-product (HCl) whereas addition in ethene does not.	1m – each difference

Qns	Answers	Marks
d(i)		1
(ii)	Alkynes burn with a smokier flame because they have a higher percentage of carbon compared to alkenes.	1
e	Although ethyne (M_r = 26) has a relative molecular mass smaller than ethene (M_r = 28), the boiling point of ethyne is -84 °C whereas the boiling point of ethene is lower at -104 °C. The statement is invalid as alkynes have higher boiling points even though they have smaller relative molecular mass.	1 1
B8a	zinc	1
b(i)		1
(ii)	Gradient is less steep as the concentration of iodine is halved, resulting in a slower speed of reaction. Half the mass of zinc reacted since only half the number of mole of the limiting reagent, iodine is present.	1 1
c	At 15 °C, the zinc atoms and iodine molecules have lower kinetic energy. Hence, less particles have energy greater or equal to the activation energy. The frequency of effective collisions between the zinc atoms and iodine molecules decreases. Hence, speed of reaction decreases.	1 1
d	The colourless zinc iodide solution will turn brown. Chlorine displaces the iodine from zinc iodide solution as chlorine is more reactive than iodine.	1 1

Qns	Answers	Marks
EITHER B9a(i)	reaction 1: $2Zn + O_2 \rightarrow 2ZnO$ reaction 2: $ZnO + CO_2 \rightarrow ZnCO_3$	1 1
(ii)	It reacts with an <u>acidic oxide (carbon dioxide)</u> to form a salt (zinc carbonate).	1
b	Yes, galvanising protects the piece of iron from coming into contact with oxygen and water. If the protective layer is scratched, the exposed iron beneath will not rust as zinc is more reactive than iron and will corrode in place of iron. If the paint layer is scratched, the exposed iron beneath will start to rust when it reacts with oxygen and water.	1 1
c(i)	 Iron electrode connected to negative electrode of cell.	correct electrodes -1m correct electrolyte -1m
(ii)	CN^-	1
(iii)	The acids in the electrolyte will react with the zinc and iron pieces.	1
d	Electro-galvanisation is carried out at room temperature and no heating is needed. Hot-dip galvanisation is carried out at 460°C.	1

Qns	Answers	Marks
OR B9(a)	At the cathode : $2H^+(aq) + 2e^- \rightarrow H_2(g)$ At the anode : $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$	correct equations – 1m each correct state symbols – 1m
b(i)	Oxygen produced reacts with the carbon electrode to form carbon dioxide, which continues to react with the carbon electrode to form carbon monoxide. $C + O_2 \rightarrow CO_2$ $C + CO_2 \rightarrow 2CO$ or $2C + O_2 \rightarrow 2CO$	1 1 1
(ii)	1 mol of oxygen produces 2 mols carbon monoxide.	1
(iii)	$8\ cm^3$ Carbon dioxide, an acidic oxide reacts with the alkali, sodium hydroxide.	1 1
c	Carbon is a conductor of electricity.	1

Name: Register Number: Class:

For Marker's Use

南僑中學

NAN CHIAU HIGH SCHOOL

PRELIMINARY EXAMINATION 2 2017
SECONDARY FOUR EXPRESS

CHEMISTRY **5073/1**

Paper 1 **15 September 2017, Friday**

Additional Material – OTAS **1h**

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and register number on the OTAS in the spaces provided.

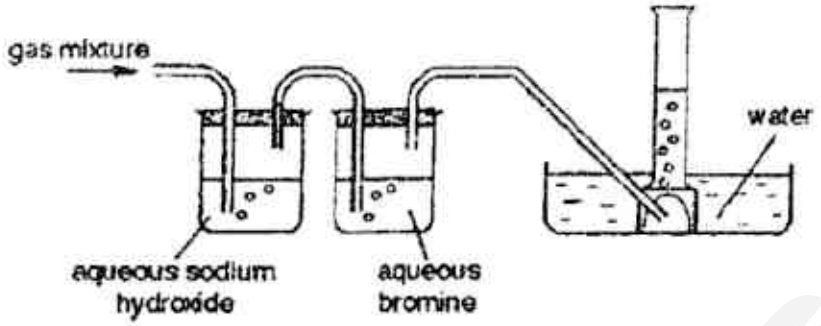
There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the OTAS.

Read the Instructions on the OTAS very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done on this paper.
A copy of the Periodic Table is printed on page 17.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **17** printed pages including the cover page.

1 A gaseous mixture of propene, oxygen and sulfur trioxide is passed through the apparatus as shown below.



What is the property of the gas collected?

A It turns damp blue litmus red.
B It relights with a glowing splint.
C It extinguishes lighted splint with a 'pop' sound.
D It turns purple acidified potassium manganate(VII) solution colourless.

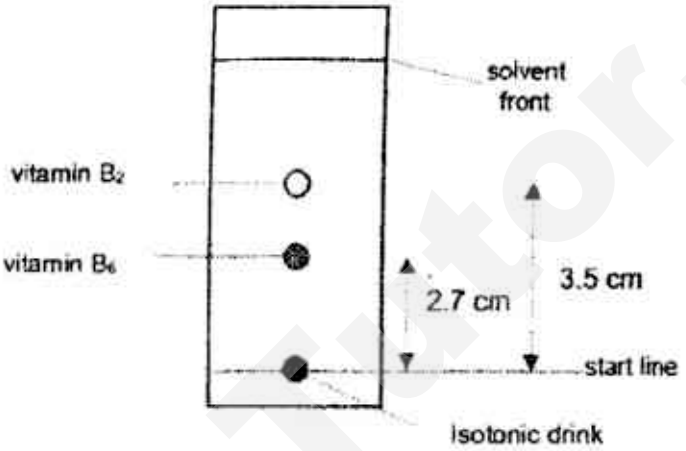
2 Carbonic acid is obtained by passing carbon dioxide gas into water. Which of the following best describes the movement and arrangement of the respective particles at room temperature?

	Carbon dioxide molecules in air	**Hydrogen ions, carbonate ions in the solution**	**Water molecules in the solution**
A	Quite closely packed, moving rapidly and randomly in all directions	Quite closely packed, rotate and vibrate about in fixed position	Quite closely packed, moving in constant random motion
B	Far apart, moving in constant random motion	Far apart, moving in constant random motion	Quite closely packed, slides past each other and move freely throughout the liquid
C	Quite closely packed, moving in constant random motion	Far apart, moving in constant random motion	Quite closely packed, slides past each other and move freely throughout the liquid
D	Far apart, moving in constant random motion	Quite closely packed, rotate and vibrate about in fixed position	Quite closely packed, moving in constant random motion

3 The word 'molecule' can be used to describe the structures of the following except for that of

A diamond
B limestone
C sugar
D nylon

4 A sample of isotonic drink containing two water- soluble vitamins was analysed during chromatography with water as a solvent. The following chromatogram (*not drawn to scale*) was obtained.



Given that the R_f value of vitamin B_2 is 0.35, determine the R_f value of vitamin B_6.

A 0.23
B 0.23cm
C 0.27
D 0.27cm

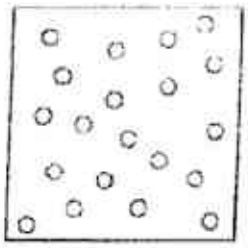
5 The following describes three separations of various mixtures:

1. Obtain pure ethanol from the fermentation of glucose.
2. Obtain solid sugar from sugar solution.
3. Obtain silicon dioxide from a mixture of silicon dioxide and aqueous silver nitrate.

Which of the following correctly describes the method used in each separation?

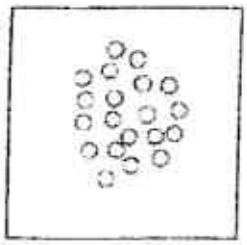
	1	2	3
A	distillation	evaporation	sublimation
B	distillation	crystallisation	filtration
C	separating funnel	crystallisation	sublimation
D	separating funnel	evaporation	filtration

6 Krypton has a melting point of -157 °C and a boiling point of -153 °C, and is much lighter than air. The following diagram represents krypton particles in a sealed container at 0 °C.

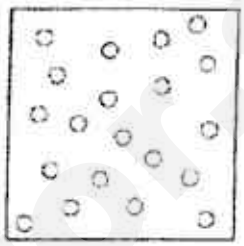


Which of the following shows krypton particles after the temperature is lowered to -100 °C?

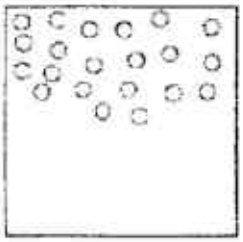
A



B

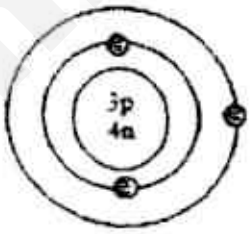


C

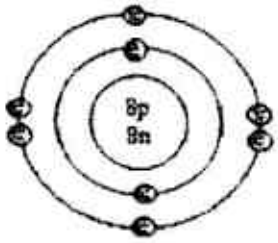


D

7 The diagrams show the structures of two atoms of the elements **J** and **W** respectively.



J

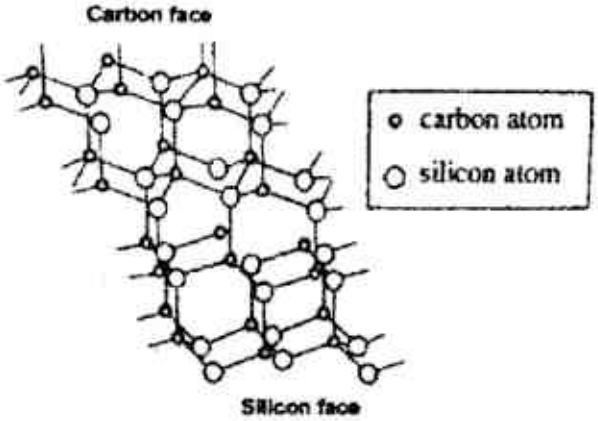


W

What is the mass of 1 mole of the compound formed by **J** and **W**?

A 11 g
B 12 g
C 23 g
D 30 g

8 Silicon carbide has a structure that is similar to diamond as shown below.



Which of the following sets of properties describes silicon carbide?

	Physical Properties		When strongly heated in oxygen
A	good conductor of electricity	rigid and extremely hard	does not undergo any chemical change
B	good conductor of electricity	soft and slippery	burns slowly, leaving no solid residue
C	does not conduct electricity	soft and slippery	decomposes into its elements
D	does not conduct electricity	rigid and extremely hard	burns slowly, forming a solid residue and a colourless gas

9 The formulae of some oxides are shown below.

Al_2O_3, CO, Na_2O, MgO, SO_2, ZnO

Which of the following gives the correct number of each type of oxide?

	Acidic	Amphoteric	Neutral	Basic
A	1	2	1	2
B	2	1	0	3
C	3	0	0	3
D	4	0	0	2

10 Which of the following involves the largest number of electrons for complete discharge during electrolysis?

A 5 mol of Al^{3+} ions
B 6 mol of OH^- ions
C 7 mol of O^{2-} ions
D 12 mol of K^+ ions

11 Ammonia is manufactured by the Haber process. $N_2 + 3H_2 \rightleftharpoons 2NH_3$

Which of the following is true about the Haber process?

I Iron catalyst is used to increase the speed of reaction and yield of ammonia.
II Nitrogen is reduced to form ammonia.
III Ammonia formed is condensed and collected as a liquid.
IV The reaction stops after a period of time.

A I and II only
B I and III only
C II and III only
D I, II, III and IV

12 One of Mars exploration rovers discovered vanadium jarosite mineral in the sedimentary rocks on Mars. It has the chemical formula $NaV_3(OH)_6(SO_4)_2$.
What is the oxidation state of vanadium in the mineral?

A +2
B +3
C -3
D -2

13 A commercial production of iodine involves the reduction of a solution of iodate(V) ions, IO_3^-, with hydrogen sulfite ions, HSO_3^-.

The equation for the reaction may be written as:

$$xIO_3^- + yHSO_3^- \rightarrow zSO_4^{2-} + I_2 + 3H^+ + H_2O$$

Which of the following shows the correct values of *x*, *y* and *z* respectively?

	x	y	z
A	2	5	5
B	2	5	2
C	5	2	2
D	5	5	2

14 During beta decay of an unstable nucleus in an atom, a neutron is decomposed into a proton with the emission of an electron.

Which of the changes below describes an unstable nucleus undergoing beta decay?

A $^{13}_{6}C \rightarrow ^{12}_{7}N$

B $^{22}_{11}Na \rightarrow ^{22}_{10}Ne$

C $^{131}_{53}I \rightarrow ^{131}_{54}Xe$

D $^{81}_{36}Kr \rightarrow ^{81}_{35}Br$

15 A 0.4764g sample of an oxide of iron was reduced by a stream of carbon monoxide. The mass of iron that remained was 0.3450g. What is the empirical formula of the oxide of iron?

A Fe_2O
B FeO
C Fe_2O_3
D Fe_3O_4

16 What is the mass of one molecule of water?
Hint: Given that $M_r(H_2O)=18$.

A 3.33×10^{25} g
B 3.33×10^{28} g
C 3.00×10^{-20} g
D 3.00×10^{-23} g

17 Iron(II)sulfate is a common nutritional supplement used in treating iron-deficiency anaemia. A 5.00g tablet containing iron(II)sulfate is dissolved in water and excess barium chloride solution is added. After mixing, 2.89g of barium sulfate is precipitated out as white solid. What is the percentage of iron(II)sulfate in the tablet?

A 18.9%
B 37.7%
C 42.2%
D 57.8%

18 A cell was set up by dipping 2 strips of metal, **R** and **S**, into a liquid **Q**. This cell is used to light a bulb up in an electrical circuit. Which of the following combination makes the bulb shine the brightest?

	Metal R	Metal S	Liquid Q
A	iron	zinc	dilute sulfuric acid
B	magnesium	iron	distilled water
C	aluminium	lead	dilute sulfuric acid
D	copper	magnesium	distilled water

19 Mohr's salt, is a compound with the formula $(NH_4)_2Fe(SO_4)_2.6H_2O$. Aqueous sodium hydroxide was added to a hot solution of the salt, stirred and left to stand over a period of time. Which of the observation would be **incorrect**?

A A green precipitate is formed.
B The precipitate dissolves in excess aqueous sodium hydroxide.
C A pungent gas which turns moist red litmus paper blue is produced.
D On standing, the precipitate turns red-brown.

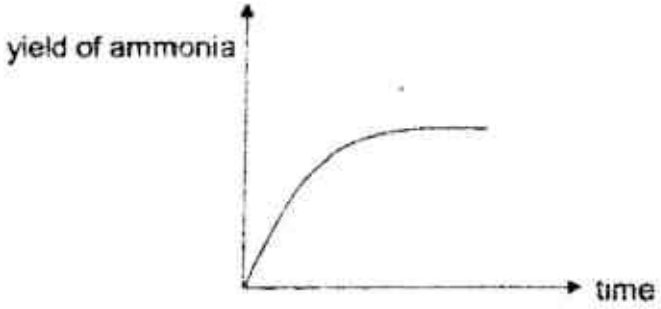
20 Which of the following electrolytes will produce gases at both electrodes during electrolysis with inert electrodes?

A concentrated aqueous silver chloride
B molten sodium fluoride
C dilute aqueous potassium iodide
D aqueous copper (II) nitrate

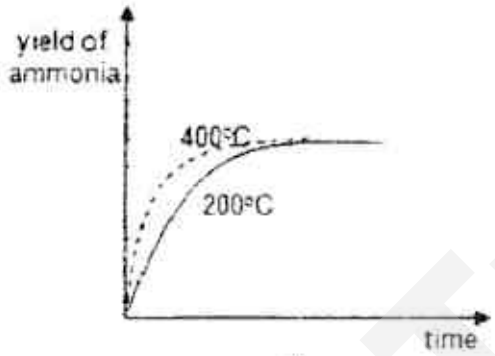
21 Which of the following methods would **not** produce ammonia?

A Heating ammonium chloride with aqueous calcium hydroxide.
B Heating ammonium chloride with aqueous strontium hydroxide.
C Heating ammonium chloride with dilute nitric acid.
D Heating solid ammonium chloride crystals.

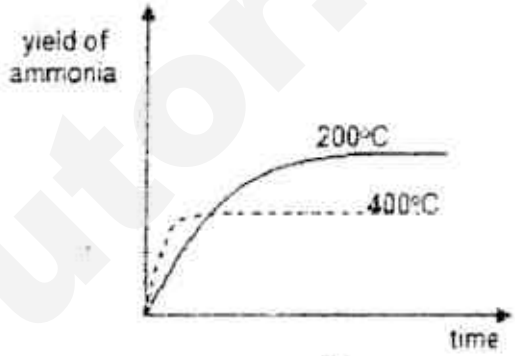
22 The graph shows the optimal yield of ammonia at 200 °C and 250 atm.



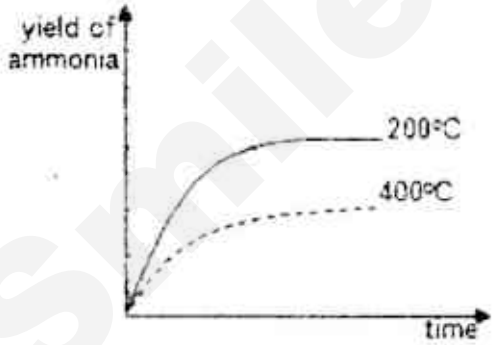
Which of the following graphs shows a correct comparison of the yield of ammonia produced at temperature of 400 °C and 250 atm?



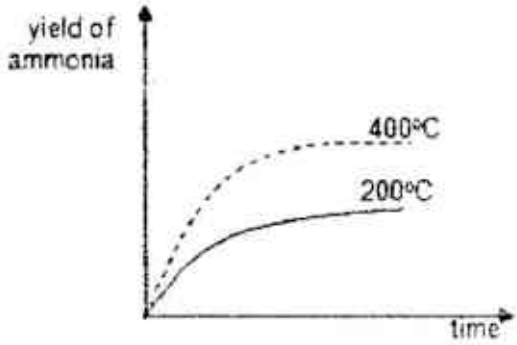
A



B

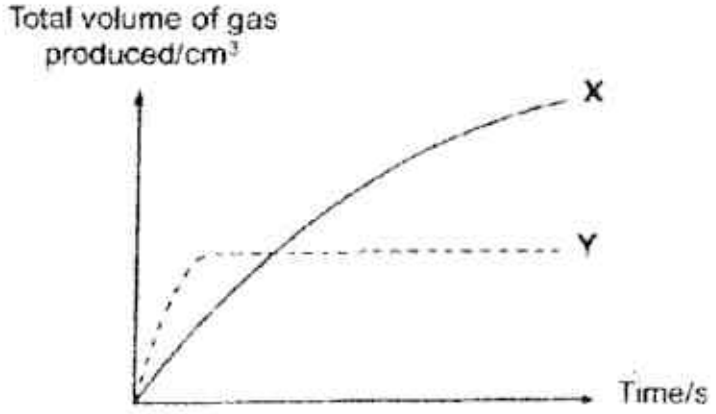


C



D

23 In the graph, curve **X** represent the results of the reaction between 2.0 g of magnesium ribbon with excess 1.0 mol/dm^3 of nitric acid at room temperature.



Which of the following changes will produce curve **Y**?

A Using 1.0 g of magnesium ribbon and 2.0 mol/dm^3 of nitric acid.
B Using 2.0 g of magnesium ribbon and 0.5 mol/dm^3 of nitric acid
C Using 1.0 g of magnesium ribbon at 10°C.
D Using 4.0 g of powdered magnesium at room temperature.

24 Bismuth(III) oxychloride is dissolved in concentrated hydrochloric acid to give a clear solution of bismuth(III) chloride. Addition of water re-forms the bismuth(III) oxychloride as a white precipitate

$$BiOCl(s) + 2HCl(aq) \rightleftharpoons BiCl_3(aq) + H_2O(l);\ \Delta H = -132\ kJ/mol$$

The activation energy for the forward reaction is 45 kJ/mol. The activation energy for the reverse reaction is

A -45 kJ/mol
B 87 kJ/mol
C -87 kJ/mol
D 177 kJ/mol

25 Iodine reacts with chlorine to form iodine chloride.

$$I_2 + Cl_2 \rightarrow 2\,ICl \qquad \Delta H = -11kJ$$

The bond energies for I—I and Cl—Cl are 151kJ/mol and 242kJ/mol respectively. What is the bond energy in kJ/mol for the I—Cl bond?

A 191 kJ/mol
B 202 kJ/mol
C 382 kJ/mol
D 404 kJ/mol

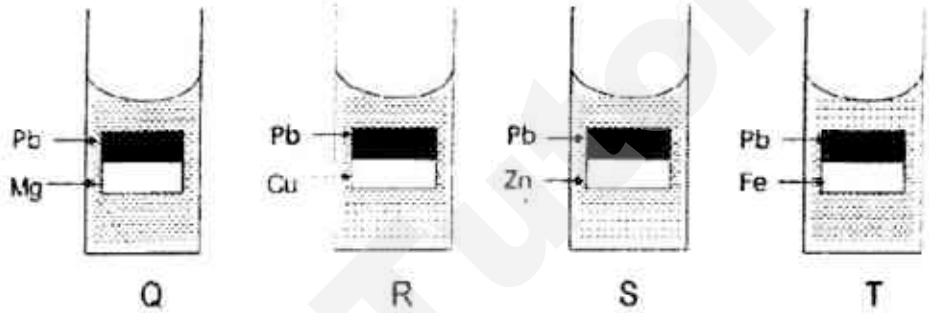
26 The nickel-cadmium rechargeable battery is based on the following overall reaction.

$$Cd + 2NiO(OH) + 4H_2O \rightarrow Cd(OH)_2 + 2Ni(OH)_2.H_2O$$

What is the oxidation number of nickel at the beginning and at the end of the reaction?

	Start	End
A	-1.5	0
B	+1.5	+2
C	+2	+3
D	+3	+2

27 The diagrams show pairs of metal strips of equal size placed in beakers Q, R, S and T with dilute nitric acid.



After 3 minutes, which of the following is true about concentration of lead(II) ions present in the solutions in the beakers?

	Highest concentration of Pb^{2+} ions	Lowest concentration of Pb^{2+} ions
A	R	Q
B	R	S
C	S	Q
D	S	R

28 Information on three metals, **X**, **Y** and **Z** are given in the table below.

Metal	Action of dilute acid on the metal	Action of carbon on the metal oxide	Action of placing the metal in aqueous iron(II) nitrate
X	Hydrogen evolved	Reduced	No reaction
Y	No reaction	Reduced	No reaction
Z	Hydrogen evolved	No reaction	Iron metal formed

Which of the following places the metals in order of decreasing reactivity?

A Y,Z,X
B Z,X,Y
C Y,X,Z
D X,Y,Z

29 Which of the following is/are true about the air and atmosphere?

I All air pollutants are acidic in nature.
II Acid rain can be caused by excessive burning of fossil fuels.
III Nitrous oxide and water vapour contributes to global warming.
IV At ground level, ozone is emitted directly from industries and the burning of fossil fuel.

A III only
B I and II
C II and III
D I, II, III and IV

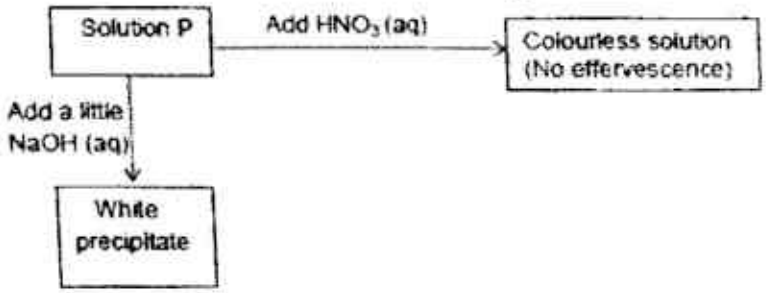
30 Which of the following is **least** commonly found in air yet is the **most** abundant element in the universe?

A Krypton
B Nitrogen
C Hydrogen
D Water vapour

31 Transition metals are often used as catalysts in industries. Which of the following is **not** an example of a transition metal acting as a catalyst?

A rhodium in catalytic converters
B iron in Haber process
C copper in the electroplating of cutlery
D nickel in the manufacture of margarine

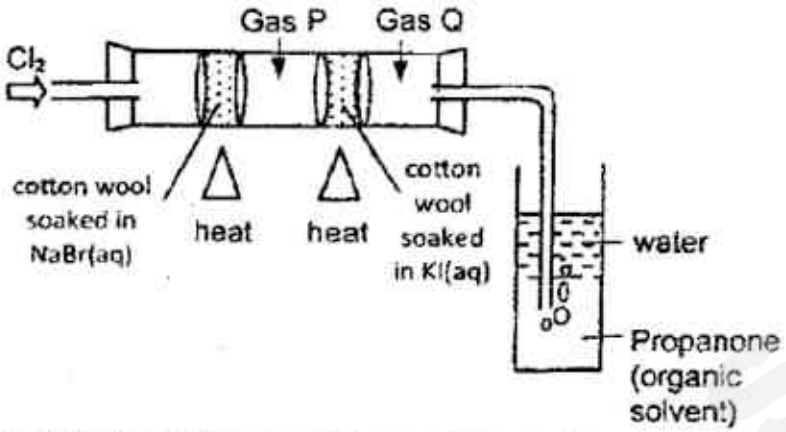
32 The diagram below shows a reaction scheme involving solution P.



What is the identity of solution P?

A aluminium sulfate
B potassium sulfate
C iron(II) nitrate
D zinc carbonate

33 The diagram below shows the setup for an experiment.



What are the main colours observed for propanone, water, gases **Q** and **P** during the experiment?

	Propanone	Water	Gas Q	Gas P
A	red-brown	purple	brown	yellow-green
B	red-brown	red-brown	purple	red-brown
C	purple	brown	purple	red-brown
D	purple	purple	red-brown	brown

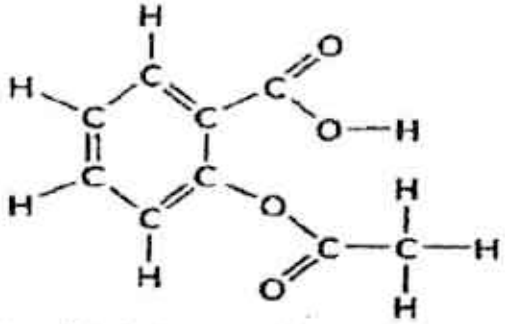
34 Wine is produced by fermentation of the natural sugars present in grapes. Which of the following equations describes fermentation correctly?

A $C_6H_{12}O_6(l) + 6O_2(g) \rightarrow 6CO_2(g) + 6\ H_2O(g)$
B $C_6H_{12}O_6(l) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$
C $C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$
D $C_6H_{12}O_6(aq) + 6O_2(g) \rightarrow 6CO_2(g) + 6\ H_2O(g)$

35 Which statement about fractional distillation of petroleum is correct?

A At each fraction in the fractionating column, only one compound is collected with a fixed boiling point.
B As the vapour rises up the column, the temperature increases.
C The hydrocarbons collected at the bottom of the fractionating column are the most flammable.
D The hydrocarbons collected at the top of the fractionating column have the smallest relative molecular mass

36 Aspirin is a commonly used drug to reduce pain. The structural formula of aspirin is shown below.



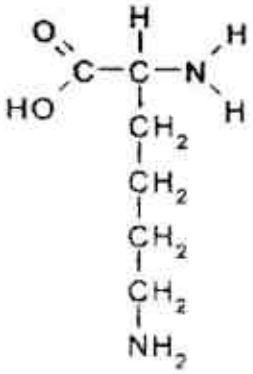
Which statement about aspirin is **incorrect**?

A It is an unsaturated hydrocarbon.
B It contains 3 different functional groups.
C It reacts with magnesium metal.
D Its aqueous solution reacts with potassium carbonate.

37 When a mixture of butanol and propanoic acid is allowed to react, what are the substances found in the final mixture?

A Propyl butanoate and water
B Butyl propanoate and water
C Propyl butanoate, water, butanol and propanoic acid
D Butyl propanoate, water, butanol and propanoic acid

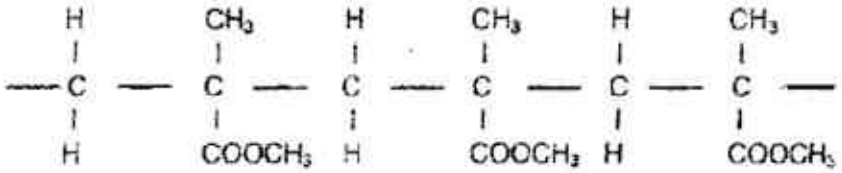
38 The diagram shows the structure of the amino acid, lysine. Lysine supplements have also been used to prevent eruptions of shingles, a viral infection that causes a painful rash.



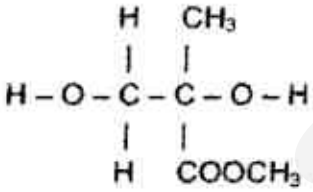
Which statement about lysine is true?

A It forms a polymer with the same linkage as nylon.
B It reacts with calcium to form salt and water only.
C It readily decolourises acidified potassium manganate (VII) solution.
D It burns in air to produce carbon dioxide and water only.

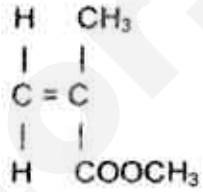
39 PMMA, is the most important commercial polymer of the acrylic class, often used in glazing applications. Which of the following correctly describes the polymer shown?



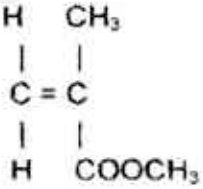
A Condensation



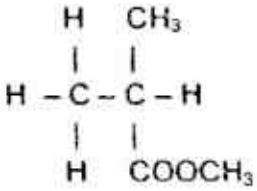
B Addition



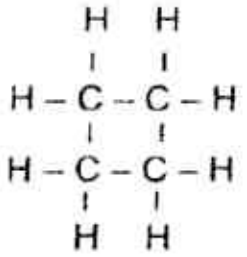
C Condensation



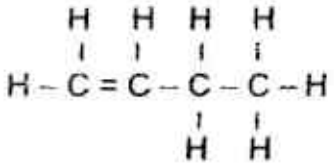
D Addition



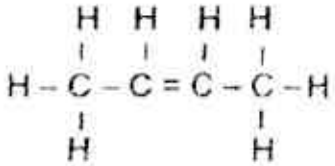
40 Which of the following compounds are isomers of each other?



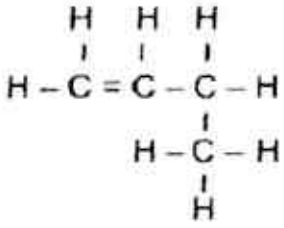
I



II



III



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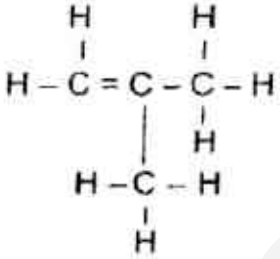
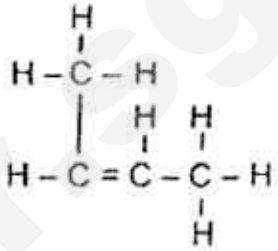


V



VI

A **II**, **III** and **V** only
B **I**, **II** and **III** only
C **I**, **II**, **III** and **V** only
D All of the above

Answers to 2017 Prelim 2 Chemistry Papers 1 & 2

Paper 1

1	B	**9**	A	**17**	B	**25**	B	**33**	C
2	B	**10**	A	**18**	C	**26**	D	**34**	C
3	B	**11**	C	**19**	B	**27**	A	**35**	D
4	C	**12**	B	**20**	C	**28**	B	**36**	A
5	B	**13**	A	**21**	C	**29**	C	**37**	D
6	B	**14**	C	**22**	B	**30**	C	**38**	A
7	D	**15**	D	**23**	A	**31**	C	**39**	B
8	D	**16**	D	**24**	D	**32**	A	**40**	C

Name: Register Number: Class:

For Marker's Use

南僑中學

NAN CHIAU HIGH SCHOOL

PRELIMINARY EXAMINATION 2 2017
SECONDARY FOUR EXPRESS

CHEMISTRY 5073/2

Paper 2 13 September 2017, Wednesday

1h 45 min

INSTRUCTIONS TO CANDIDATES
Write your name, register number and class in the spaces provided on the question paper.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A: Structured Questions [50 marks]
Answer all questions. Write your answers in the spaces provided on the question paper. All workings must be shown clearly.

Section B: Data-based and Free-response Questions [30 marks]
Answer **all** three questions in this section. The last question is in the form of an **either/or** and **only one** of the alternatives should be attempted. Write your answers in the spaces provided on the question paper. All workings must be shown clearly.

The number of marks is given in brackets [ ] at the end of each question or part question.
The total marks for this paper is 80.

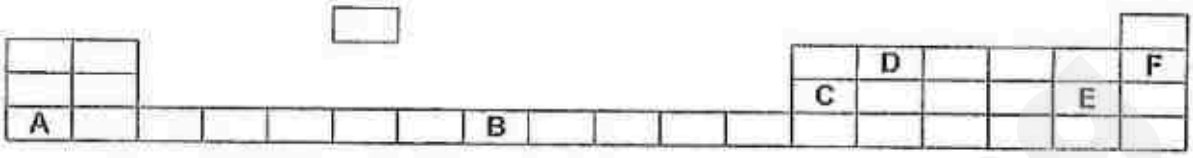
A copy of the Periodic Table is printed on page 19.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **19** printed pages including the cover page.

Section A – Structured Questions (50m)

Answer **all** questions in the spaces provided.

A1. The position of six elements from Period 1 to 4 of the Periodic Table is represented by letters **A**, **B**, **C**, **D**, **E** and **F** as shown below.



Select from the given letters, **A** to **F**, the element that best fits the following characteristics. They can be used once, more than once, or not at all. [5]

a) An element which combines with element **E** to form a very volatile compound.

_____

b) An element which contains the smallest number of protons in each atom.

_____

c) An element which is monatomic.

_____

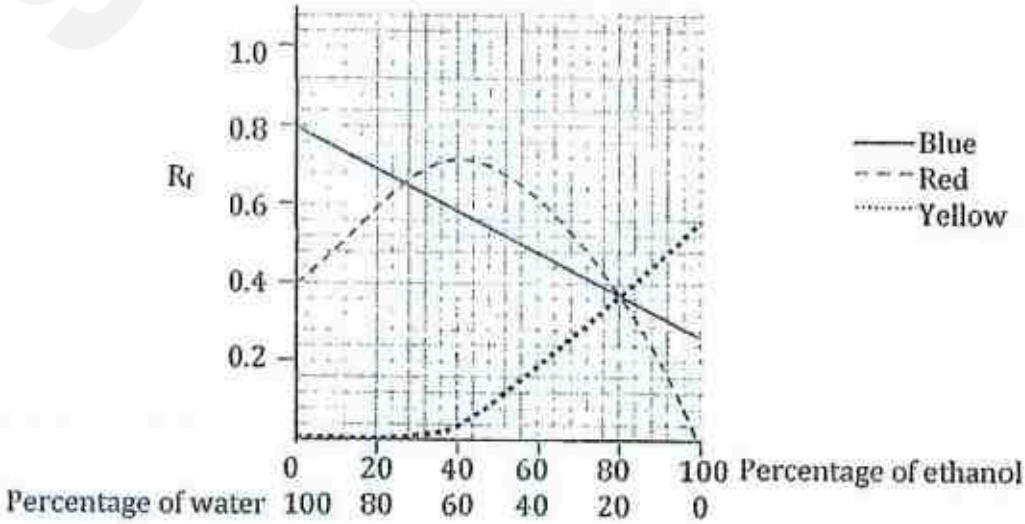
d) An element which is used as a catalyst in chemical reactions.

_____

e) An element which is the strongest reducing agent.

_____

A2. A sample of black ink contains a mixture of red, blue and yellow dyes. The solvent used to separate the dyes in the black ink is a mixture of ethanol and water.
The R_f values of the coloured dyes with different percentages of ethanol is as shown:



a) State the R_f value of blue dye on the chromatogram when the solvent is a mixture of 42 cm^3 of ethanol and 150 cm^3 of water. [1]

_____

b) Using data from the graph, explain why a pure solvent of either water or ethanol is not suitable for the separation of the black ink using paper chromatography. [2]

_____

_____

_____

c) Damien conducted a chromatography on the black ink using a certain mixture of ethanol and water as solvent. He concluded that his black ink is pure. Using data from the graph, explain why Damien could be wrong. [2]

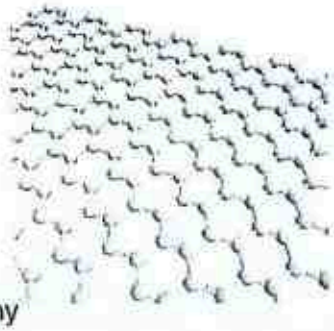
_____

_____

_____

A3. Since its discovery in 2003, graphene has been a hot topic in chemistry and materials science research. Graphene is a single layer of graphite and its properties include:

- high electrical conductivity,
- 200 times stronger than steel,
- thin and lightweight,
- transparent, and
- high thermal conductivity.



a) In terms of bonding and structure, explain why graphene is strong. [2]

_____

_____

_____

b) graphene is a good conductor of electricity. [2]

_____

_____

_____

c) State and explain why a sheet of graphite which has a large number of carbon layers would not be suitable for a touchscreen display on a handphone. [2]

A4. Some fruit drinks claim to be high in antioxidants such as vitamin C, $C_6H_8O_6$. The vitamin C content in a fruit drink can be determined by titrating it with iodine.

The redox reaction which takes place is shown:

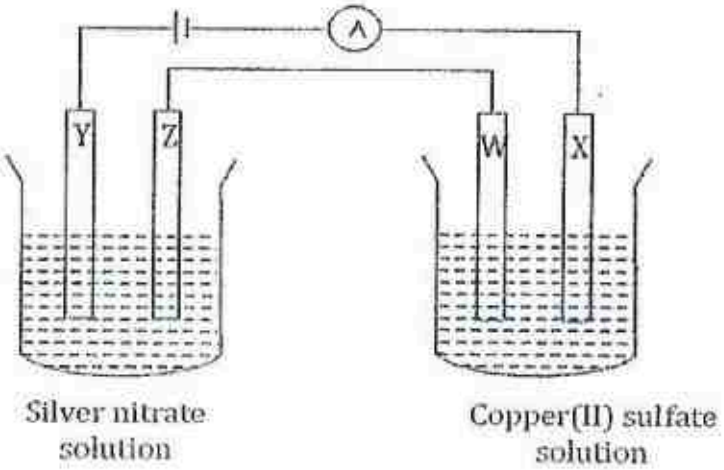
$$C_6H_8O_6(aq) + I_2(aq) \rightarrow C_6H_6O_6(aq) + 2H^+(aq) + 2I^-(aq)$$

a) Suggest if I_2 is an oxidising or reducing agent. State the colour change observed during the titration. [2]

b) Some students carried out an investigation of fruit drinks to determine their vitamin C content. An average of 25.4 cm^3 of 0.00125 mol/dm^3 of iodine solution was required for the complete titration of the vitamin C in a 20.0 cm^3 sample of fruit drink. Calculate the mass, in grams, of vitamin C in the 1 dm^3 carton of fruit drink. [2]

c) The recommended daily consumption for Vitamin C is 0.0600g per day. Calculate the mass of Vitamin C provided by 200 cm^3 of the drink in (b). Hence state whether this drink meets the recommended daily allowance for Vitamin C. [2]

A5. The diagram shows the set-up of an electrolysis experiment.



W and **X** are copper electrodes, while **Y** and **Z** are silver electrodes.

a) Give the formulae of all the ions present in (i) silver nitrate and (ii) copper(II) sulfate solution. [2]

_____

_____

bi) Which two electrodes would increase in mass? [1]

_____

ii) Write the half equations for each electrode in your answer (bi). [2]

_____

_____

iii) Which electrode would increase its mass at a faster rate? Give a reason for your answer. [2]

_____

_____

_____

_____

A6. An aqueous solution of ammonium nitrite, NH_4NO_2, decomposes when heated gently.

$$NH_4NO_2(aq) \rightarrow N_2(g) + 2H_2O(l)$$

a) Describe how you could show that aqueous ammonium nitrite contains ammonium ions. [2]

b) A sample of 25.0 cm^3 of 0.500 mol/dm^3 aqueous ammonium nitrite is heated. Calculate the volume of nitrogen formed, measured at room temperature and pressure. [2]

c) A cold pack, used to treat sporting injuries, contains a bag of water inside a larger bag of finely powdered ammonium nitrate, NH_4NO_3.
Squeezing the pack causes the bag of water to break and the NH_4NO_3 to dissolve, as shown below.

$$NH_4NO_3\ (s) \rightarrow NH_4NO_3\ (aq) \quad \Delta H = +25\ kJ/mol$$

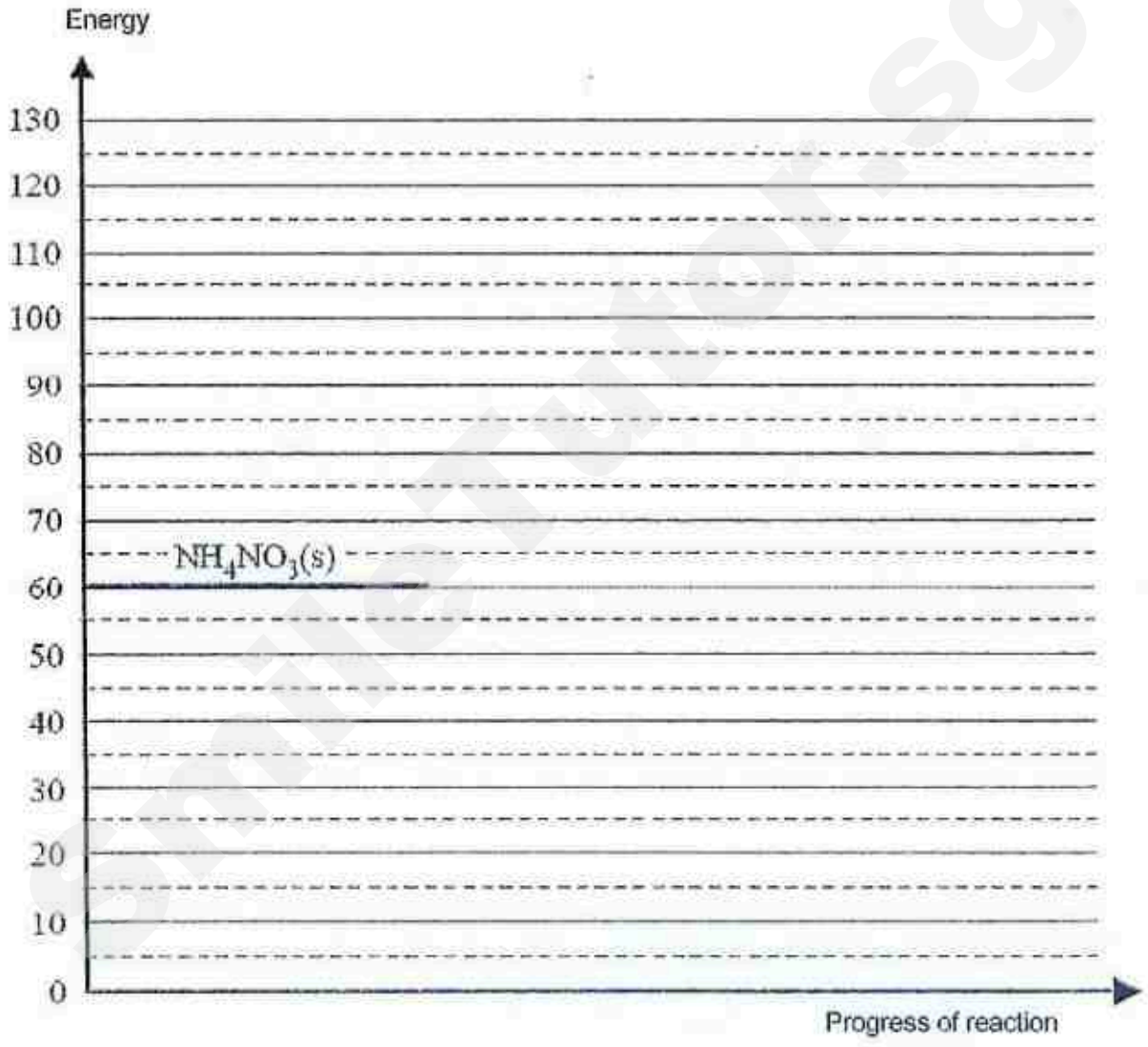
i) From the equation, state and explain if the dissolving process is exothermic or endothermic. [1]

ii) NH_4NO_3 (s) → NH_4NO_3 (aq) $\Delta H = +25$ kJ/mol

The activation energy for the above reaction is 35 kJ/mol.

On the graph below, complete the energy profile diagram showing the changes that occur in chemical energy as the NH_4NO_3 powder dissolves.

Label the activation energy, E_a, and the enthalpy change, ΔH. [3]



A7. The iodine clock reaction was discovered by Hans Heinrich Landolt and is mainly used to demonstrate speed of reaction.
In the experiment, the solutions used are hydrogen peroxide, H_2O_2, potassium iodide, KI, thiosulfate solution, $S_2O_3^{2-}$ and starch to test the presence of Iodine, I_2.

The reaction occurs in two stages:

Stage 1: The hydrogen peroxide, H_2O_2, reacts with the iodide ions in potassium iodide in acidic conditions.

$$H_2O_2 + 2I^- + 2H^+ \longrightarrow 2H_2O + I_2$$

Stage 2: The iodine produced is then absorbed by reaction with a fixed amount of thiosulfate ions.

$$2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2I^-$$

As soon as all the thiosulfate is used up, free iodine remains in solution and reacts with the starch to give a dark blue solution.

The time for the blue colour to appear can be recorded.

4 experiments were carried out with differing concentrations of H_2O_2 and thiosulfate solution. How quickly the blue colour appears is a good measurement of how fast the reaction takes place.

Expt	Concentration of H_2O_2 (mol/dm^3)	Concentration of $S_2O_3^{2-}$ (mol/dm^3)	Time taken for blue colour to appear (s)
1	0.020	0.030	2.00
2	0.040	0.030	0.50
3	0.030	0.040	0.75
4	0.040	0.060	0.25

a) What is the relationship between the concentrations of the reactants and the rate of reaction? Justify your answer using the results in the table, stating clearly the experimental data you are using. [3]

_____

_____

_____

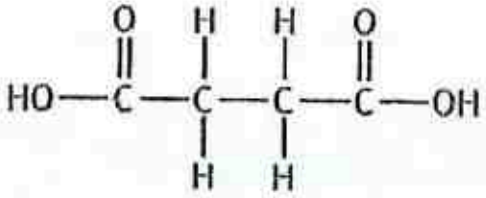
_____

b) Explain the effect of concentration on the rate of reaction in terms of collisions between particles. [2]

c) Predict the time taken for blue colour to appear if the experiment was conducted using 0.040 mol/dm^3 of H_2O_2 and 0.120 mol/dm^3 of $S_2O_3^{2-}$. [1]

d) Using oxidation states, state and explain which **element** is oxidised in Stage 2. [2]

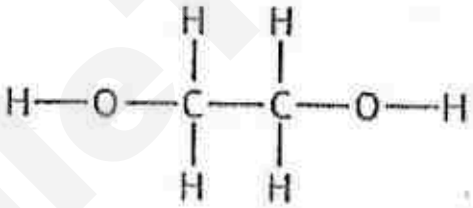
A8. Succinic acid, $C_2H_4(COOH)_2$, is a natural antibiotic and is a ***weak*** acid.
The structure of succinic acid is as shown.



a) Explain what it means by the term '***weak*** acid'. [1]

b) Succinic acid is also a ***dibasic*** acid.
Write an equation to show how a weak dibasic acid will behave. [1]

c) Succinic acid can form a polymer with ethane-1,2-diol. The structure is as shown.



i) Name the type of polymerisation which would take place between succinic acid and ethane-1,2-diol. [1]

ii) Draw the structural formula of the polymer formed between succinic acid and ethane-1,2-diol. [2]

Section B: Data-based and Free-response Questions [30 marks]

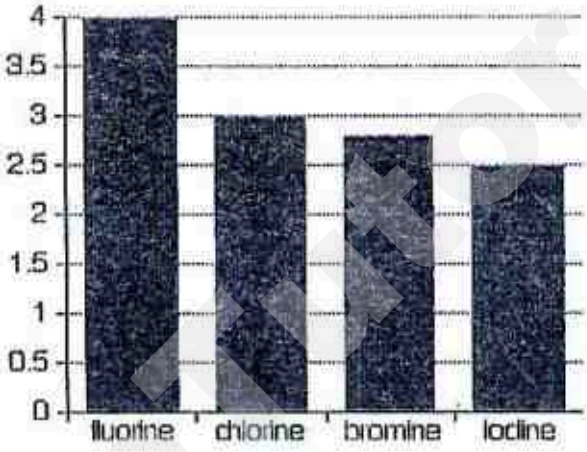
Answer **all** three questions in this section. The last question is in the form of an either/or and only one of the alternatives should be attempted. All working must be shown clearly.

B1a) The graph below shows the electronegativity of the Group VII elements.

Electronegativity is a measure of the tendency of an atom to attract electrons. It is usually measured on the Pauling scale, on which the most electronegative element (fluorine) is given an electronegativity of 4.0.

Group VII elements gain electrons to form ions of negative charge.

Electronegativity of the Group VII elements



i) From the information given above, describe and explain the trend of reactivity of the halogens on going down the group. [2]

_____

_____

_____

_____

ii) Describe what is seen when chlorine gas is passed through potassium bromide solution. [1]

_____

_____

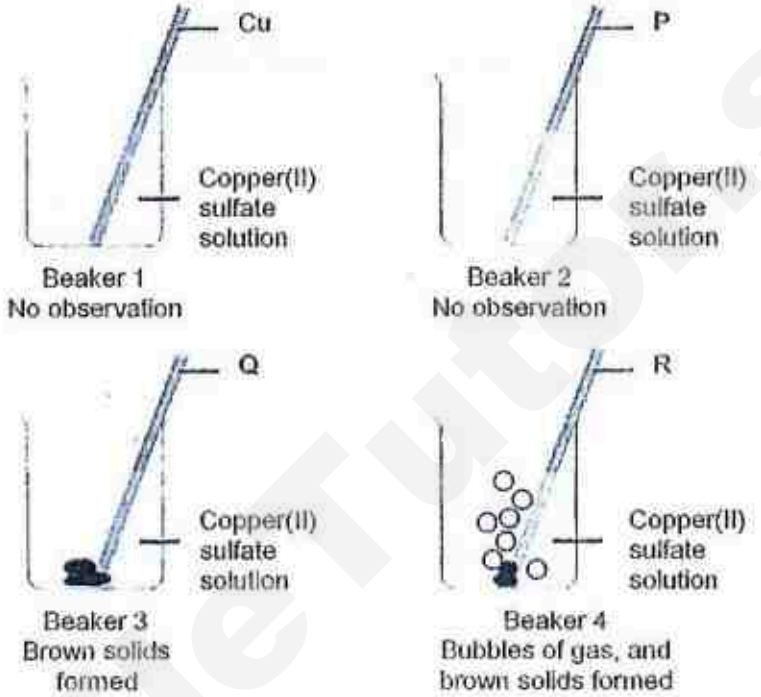
iii) Write an ionic equation with state symbols for the reaction in (aii) . [2]

_____

1b) The following experiments were conducted to determine the order of reactivity of four metals, copper, **P**, **Q** and **R**. In the first experiment, the oxides of the four metals were heated in the absence of oxygen. The results are shown in the table below.

Metal oxide	CuO	P_2O	QO	RO
Observation	No reaction	Silvery-grey solid deposits observed	No reaction	No reaction

In the second experiment, copper, **P**, **Q** and **R** are added separately to copper(II) sulfate solution. The observations are shown in the diagram below.



i) For the reaction between **Q** and copper(II) sulfate solution, give another observation that should be seen. Explain the observation. [2]

_____

_____

_____

ii) Explain the formation of bubbles in the reaction between R and copper(II) sulfate solution. [2]

_____

_____

_____

iii) Arrange the four metals in increasing order of reactivity. [1]

_____

B2 Ethanol is the most common alcohol and is an important drug and solvent in the chemical industry.

In some countries, ethanol is used as a substitute for petrol. This ethanol is produced by fermentation of glucose, obtained from sugarcane, using yeast enzymes. During the fermentation process, glucose is first converted into pyruvate. The pyruvate is then converted to ethanol in a two-step process.

Step 1 is catalysed by an enzyme. Enzymes are proteins that can act as catalysts because they have specific shapes.

a) Why does the rate of reaction decrease when the temperature is raised above a certain value? [1]

_____

_____

b) Why is **Step 2** described as a reduction reaction? [1]

_____

_____

c) Describe one advantage of the formation of ethanol from glucose. [1]

_____

_____

d) Ethanol undergoes complete combustion. Write the balanced chemical equation for this reaction. [1]

_____

The table below shows the bond energies of some bonds:

Type of bond	Bond energy (kJ/mol)
C – C	346
C = C	602
C – O	358
C = O	799
C – H	411
O – H	459
O – O	142
O = O	494
H – H	432

e) Use the table of bond energies above to calculate the amount of heat produced (in kJ) when ethanol undergoes complete combustion reaction represented by equation in d). [3]

f) The 3 tables show the boiling points of isomers of 3 different alcohols.

Table 1: Isomers of C_4H_9OH

Alcohol	Boiling point / °C
$CH_3CH_2CH_2CH_2OH$	118
$CH_3CH(CH_3)CH_2OH$	108
$CH_3CH_2CH(OH)CH_3$	98

Table 2: Isomers of $C_5H_{11}OH$

Alcohol	Boiling point / °C
$CH_3CH_2CH_2CH_2CH_2OH$	137
$CH_3CH_2CH(CH_3)CH_2OH$	128
$CH_3CH_2CH_2CH(OH)CH_3$	119
$CH_3CH_2C(OH)(CH_3)CH_3$	101

Table 3: Isomers of $C_6H_{13}OH$

Alcohol	Boiling point / °C
$CH_3CH_2CH_2CH_2CH_2CH_2OH$	159
$CH_3CH_2CH_2CH(CH_3)CH_2OH$	149
$CH_3CH_2CH_2C(OH)(CH_3)CH_3$	121

i) Using information from the tables, describe **one** way in which differences in the structures affect boiling point of isomeric alcohols. [2]

_____

_____

_____

ii) Predict a boiling point for hexan-2-ol. [1]

_____

B3 Either

Galvanisation is the process of coating the entire surface of a piece of iron with zinc to prevent it from rusting. The information below shows two common ways of galvanising iron – hot-dip galvanisation and electro-galvanisation.

Hot dip galvanisation

The piece of iron is dipped into molten zinc at 460°C. The piece of coated iron is then cooled and exposed to air. The outermost layer of zinc then reacts with oxygen and carbon dioxide in air in the following reactions:

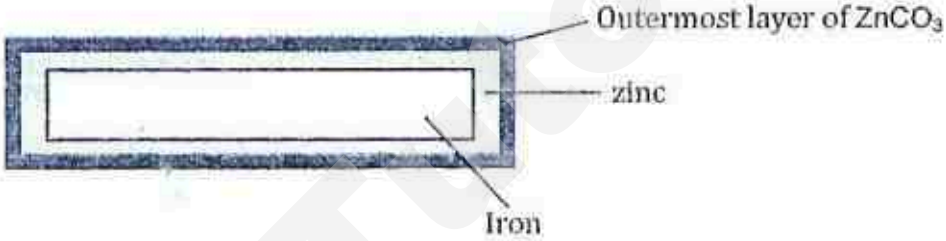
Reaction 1: Zinc reacts with oxygen to form zinc oxide.

$$2Zn + O_2 \rightarrow 2ZnO$$

Reaction 2: Zinc oxide then reacts with carbon dioxide to form zinc carbonate.

$$ZnO + CO_2 \rightarrow ZnCO_3$$

The resulting iron piece will appear as follows:



Electro-galvanisation.

The piece of iron to be galvanized and a piece of zinc are used as electrodes and dipped into an electrolyte containing a mixture of aqueous zinc cyanide, $Zn(CN)_2$ and aqueous sodium hydroxide.
Zinc cyanide is highly toxic and must be handled with care.

An external electrical supply is used.
Zinc ions are discharged to form zinc atoms, which are coated onto the piece of iron.

Other facts about both types of galvanisation

Hot dip galvanised iron	Electro-galvanised iron
Layer of zinc is coarse and thick	Layer of zinc is smooth and thin
Used to make alloy sheets for roofs	Used to make bolts and nuts
Done at high temperature of 460°C	Done at room temperature

a) In hot dip galvanisation, explain how zinc oxide displays basic properties in reaction 2. [1]

_____

_____

b) If 12.5g of zinc carbonate were found on a piece of hot dip galvanised iron, calculate the mass of zinc which reacted to form this mass of zinc carbonate. [3]

c) Draw a clearly-labelled diagram of the experimental set-up used in electro-galvanisation. Your diagram should include the battery and zinc and iron electrodes. [2]

d) From the information above, compare one advantage and disadvantage of electro-galvanisation over hot-dip galvanisation. [2]

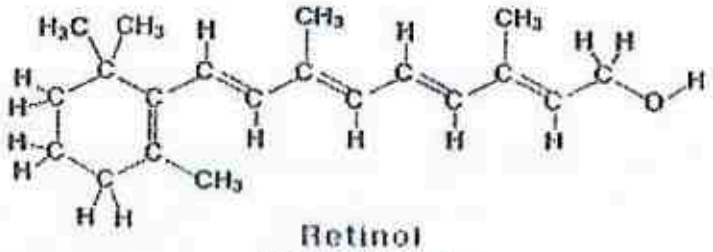
e) Some older processes of electro-galvanisation use dilute acid in the electrolyte instead of aqueous sodium hydroxide.

i) Explain why dilute acid is used as the electrolyte. [1]

ii) Suggest what problem this could cause. [1]

B3 OR

The structure of retinol, a common form of vitamin A, is shown below.



Retinol
(Vitamin A)

a) Write the empirical formulae of retinol. [1]

Empirical formula _____

b) Retinol undergoes oxidation reaction to produce an organic compound which can react with sodium carbonate. Suggest the name of the organic product formed and state the reactant required for this reaction. [2]

_____

_____

c) Name 2 functional groups that can be found in retinol. [2]

_____

d) Describe what will be observed when retinol reacts with aqueous bromine. Explain your answer. [2]

_____

_____

e) Retinol can react with hydrogen gas in the presence of nickel catalyst to give a saturated compound. Calculate the minimum volume of hydrogen gas, measured at room temperature and pressure, required to convert 2.86g of retinol into the saturated compound. [3]

Answers to 2017 Prelim 2 Chemistry Papers 1 & 2

Paper 1

1	B	9	A	17	B	25	B	33	C
2	B	10	A	18	C	26	D	34	C
3	B	11	C	19	B	27	A	35	D
4	C	12	B	20	C	28	B	36	A
5	B	13	A	21	C	29	C	37	D
6	B	14	C	22	B	30	C	38	A
7	D	15	D	23	A	31	C	39	B
8	D	16	D	24	D	32	A	40	C

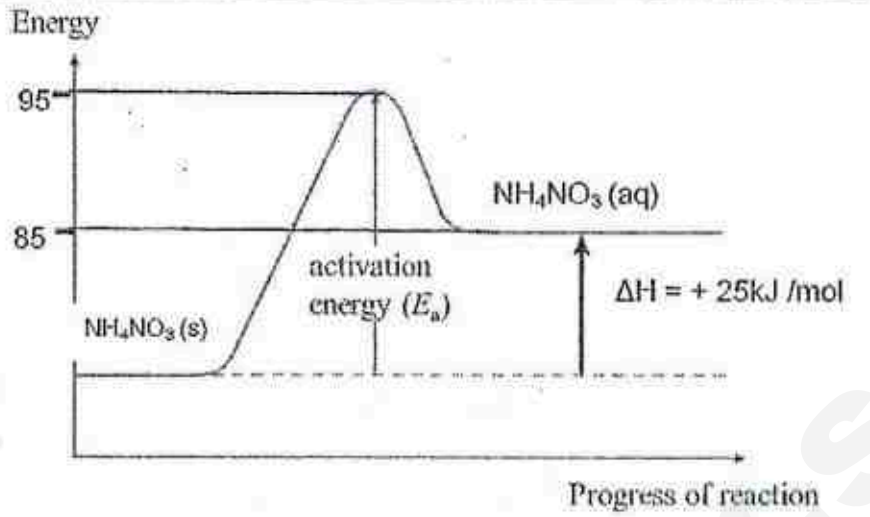
Paper 2

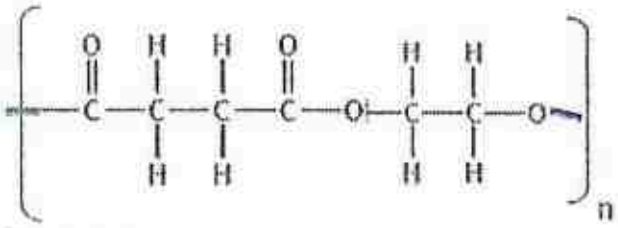
Section A – Structured Questions (50m)

No.	Answer	Marks Allocation
A1.	a) D	1
	b) D	1
	c) F	1
	d) B	1
	e) A	1
A2. a)	R_f for blue dye is 0.6	1
b)	When pure water is used as solvent, the R_f value of yellow dye is 0. When pure ethanol is used as solvent, the R_f value of red dye is 0.	1

	This indicates that the dye is insoluble in pure water and pure ethanol.	1
c)	Damien used a mixture with 80% ethanol and 20% water At 80% ethanol, all 3 dyes had the same R_f value / R_f value of 0.36.	1 1
A3. a)	Graphene has giant molecular / covalent structure where carbon atoms are bonded by strong covalent bonds.	1 1
b)	Each carbon atom of graphene uses 3 out of 4 valence electrons for bonding. Hence there are free moving electrons to conductor electricity.	1 1
c)	There are weak intermolecular forces of attraction between layers, hence, the screen will be soft and/or slippery / may be bent / easily broken / not hard enough OR Too many layers will cause the screen to be opaque / cannot see through / not transparent Not accepted answers: • too many layers hence resulting in the screen being too thick / too insensitive • mere mention of carbon layers can easily slide across one another without specifying property of why "this sliding" is not suitable	1 1 1 1
A4 a)	I_2 is a oxidizing agent. The colour change is brown to colourless / decolourises.	1 1
b)	(0.00125) (25.4) / conc (20.0) = 1/1 Conc = 0.00159 mol/dm^3 0·00159 x 176 = 0·279 g/dm^3 Hence mass is **0.279g** or (0.00125) (0.0254)= 0.00003175mol 0.00003175 x 176 = 0.00559g 0.00559 x (1000/20) = **0.279g**	1 1 1 1
c)	0.279 / 1000 * 200 = 0.0558g *(ecf from b))* No it doesn't meet the RDA for vitamin C. ECF: 1m for use of value from (b) x (1000/200) 1m for stating does not meet RDA	1 1
A5 a) i) ii)	Ag^+ , NO_3^- , H^+ , OH^- H^+ , OH^- , Cu^{2+} , SO_4^{2-}	1 1

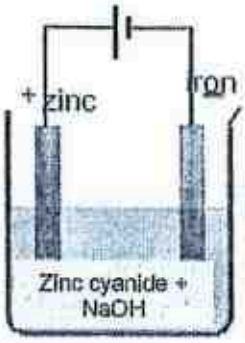
bi)	Z and X	1
ii)	Z : $Ag^+ + e^- \rightarrow Ag$ X: $Cu^{2+} + 2e^- \rightarrow Cu$ X and Z electrodes no need to be mentioned. marks given if correct half equations was written	1 1
iii)	Z (silver electrode / cathode) will increase in mass faster. For 1 mole of electrons, mass of silver increases (108g) more than copper (32g). OR For 2 moles of electrons, mass of silver increases (216g) more than copper (64g). OR For the same moles of electrons, mass of silver increases more than copper. OR In the same duration of time, less electrons required by silver ions to form silver atom compared to copper ions to form copper atoms. OR Each silver ion needs only 1 electron to form each silver atom compared to each copper ion needs 2 electrons to form each copper atom. rejected: silver ions need only 1 electron to form silver deposit / atom whereas copper ions need 2 electrons to form copper deposit / atom	1 1
A6 a)	Warming with **NaOH**. Ammonia gas formed turns **moist red** litmus paper **blue**.	1 1
b)	No. of moles of NH_4NO_2 = 0.500 x 25.0/1000 = **0.0125 mol** No. of moles of N_2 = 0.0125 mol Volume of N_2 = 0.0125 x 24 = **0.300 dm^3 (to 3 s.f. with unit)**	1 1
ci)	**Endothermic** because enthalpy change is **positive**.	1
ii)	1 mark for correct endothermic graph and NH_4NO_3 (s) and (aq) 1 mark for labelling Ea and correct energy levels (95 1 mark for labelling ΔH and correct energy levels (85) ii)	

		
A7 a)	as the concentration of reactants increases, rate of reaction increases Comparing Expts 1, 2 OR 2,4 as the concentration of reactants, H_2O_2 increases, while concentration of $S_2O_3^{2-}$ remain constant, the time taken for the blue colour to appear decreases, **OR** as the concentration of reactants, $S_2O_3^{2-}$ increases, while concentration of H_2O_2 remain constant, the time taken for the blue colour to appear decreases.	1 1 1
b)	The higher the concentration, the greater the number of particles per unit volume. **Reject:** ions or molecules; per unit mass/area Hence frequency of effective collisions, leading to an increase in the rate of reaction. **Accept:** successful collisions	1 1
c)	0.125s	1
d)	Oxidation state of sulfur increases from +2 in $S_2O_3^{2-}$ to +2.5 in $S_4O_6^{2-}$. Sulfur is oxidised.	1 1
A8 a)	A weak acid partially dissociates / ionises in water to produces lesser concentration of H^+ ions **Reject:** deionise	1
b)	$C_2H_4(COOH)_2 \rightleftharpoons C_2H_4(COO)_2^{2-} + 2H^+$ **Accept:** $C_4H_4O_4^{2-}$ instead of $C_2H_4(COO)_2^{2-}$	1
ci)	Condensation polymerisation **Accept:** Condensation	1

ii)	1 mark for repeating unit ; 1 mark for $[\ ]_n$ or ... - xxx - ....  -1m if H_2O is drawn	2

Section B: Data-based and Free-response Questions [30 marks]

B1 a)i)	When the electronegativity decreases on going down the group, the reactivity decreases. This is because the tendency of an atom to attract electrons decreases. *1 mark deducted if student describes trend up the group.*	1 1
ii)	The colourless potassium bromide solution turns red-brown	1
iii)	$Cl_2(g) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(aq)$ or $Br_2(l)$ 1 mark for equation, 1 mark for S.S. (only if equation correct)	2
bi)	The blue solution turns colourless / decolourise / fades . Or the blue solution turns green (assuming iron) Q is more reactive than copper, and hence will displace copper from the solution. (Copper ions not accepted)	1 1
ii)	R reacts with water in the solution to produce hydrogen gas.	1 1
iii)	P,Cu, Q, R	1
B2 a)	The enzymes are denatured/ yeast died/yeast enzymes denatured. not accepted - enzymes died/yeast enzymes died	1
b)	Hydrogen has been gained by ethanal. Or Oxidation state of carbon decreases from -1 in ethanal to -2 in ethanol.	1
c)	Glucose can be obtained from sugarcane and is a renewable source of fuel.	1
d)	$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$	1
e)	Energy absorbed for bond breaking = 5(411) + 346 + 358 + 459 + 3(494) = 4700 kJ	1

	Energy released for bond forming = 4(799) + 6(459) = 5950kJ ΔH = +4700 + (-5950) = -1250kJ amount of heat produced = 1250 kJ Or ΔH = 5(411) + 346 + 358 + 459 + 3(494) - 4(799) - 6(459) = -1250kJ	1 1
fi)	Straight chained molecules, higher boiling point or hydroxyl being on an end carbon, a higher boiling point or more branched the (isomeric) alcohol, the lower the boiling point or inclusion of methyl group, lowers the boiling point (both structural feature and effect must be correct)	1 1 1 1 1 1
ii)	Predicted boiling point to be 121 - 149 degree celsius.	1
B3 Either a)	Carbon dioxide is an acidic oxide / acidic gas, and thus zinc oxide reacts with it as a base. **Accept**: acidic compound **Reject:** acidic acid/ neutralisation	1
b)	No. of moles of $ZnCO_3$ = 12.5 / (65 + 12 + 16x3) = 0.100 mol No. of moles of Zn = 0.100 mol Mass of Zn = 65 x 0.1 mol = 6.50g (3s.f)	1 1 1
c)	1 mark for labelling anode and cathode correctly 1 mark for correct diagram set-up  0 marks - wrong set up	2

d)	**Advantage of electro-galvanisation:** / **Disadvantage of hot dip galvanisation** Can be done at room-temperature, require less energy, lower cost / Done at high temperature, more energy is required to maintain it, higher cost Layer of zinc is thinner and can be used to coat smaller objects / Layer of zinc is thicker and can **only** be used for bigger objects **Disadvantage of electro-galvanisation:** / **Advantage of hot dip galvanisation** The electrolyte, zinc cyanide is poisonous, may pose health threat if not handled carefully. / The reactants are non-toxic, safer to handle. ***Other possible answers:*** hot dip – galvanisation : more malleable electro- galvanisation: stronger ***Reject :*** reasons of more appealing aesthetically. ***Note:*** comparison must be made.	**1 mark for comparison** **1 mark for comparison**
ei)	Acids contain free-moving / mobile ions	1
ii)	Hydrogen ions or acid may react with the iron and zinc / metals / electrodes deposited at the cathode. Lesser zinc to be coated. or Hydrogen ions may be selectively discharged at cathode to form hydrogen gas. Hence, slow down electro-galvanisation process.	1
B3 OR a)	Empirical formula $C_{20}H_{30}O$ **Accept:** $C_{20}H_{29}OH$	1
b)	retinoic acid. **Reject:** retanoic/retinic acid acidified potassium manganate (VII)/acidified $KMnO_4$/ oxygen / atmospheric oxygen/ oxygen in air **Accept:** acidified potassium dichromate (VI) or acidified $K_2Cr_2O_7$	1 1
c)	carbon-carbon double bond and hydroxyl group **Reject:** Alkene/alcohol/carbon=carbon double bond/ C-C double bond/ O-H/ hydroxylic/ carbon double bonds **-1m** : if both name and formula given **Note:** functional group is not homologous series or family of organic compound. Also, question asked for "Name"	1 1
d)	Red-brown bromine decolourises **Accept: Reddish-brown/ brown** Retinol is unsaturated/ contains C=C bonds which can be broken and bromine atoms added.	1 1

	Reject: carbon=carbon double bond/ C-C double bond/ carbon double bonds	
e)	1 mol of retinol reacts with 5 moles of hydrogen gas. No. of moles of retinol = 2.86g / (20x12 + 30 + 16) = 0.0100mol No. of moles of hydrogen gas = 0.0100 x 5 = 0.0500 mol Volume of H_2 required = 0.500 x 24 = 1.20 dm^3 **Note:** no ecf is given, as moles are calculated with molar mass (by molecular formula not empirical formula)	1 1 1

Class	Index Number	Name

PRESBYTERIAN HIGH SCHOOL

CHEMISTRY **5073/1**

Paper 1 Multiple Choice

14 September 2017 **Thursday** **1 hour**

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2017 SECONDARY FOUR EXPRESS PRELIMINARY EXAMINATION

INSTRUCTIONS TO CANDIDATES:

DO NOT OPEN THIS QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO.

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and register number on the Answer Sheet in the spaces provided.

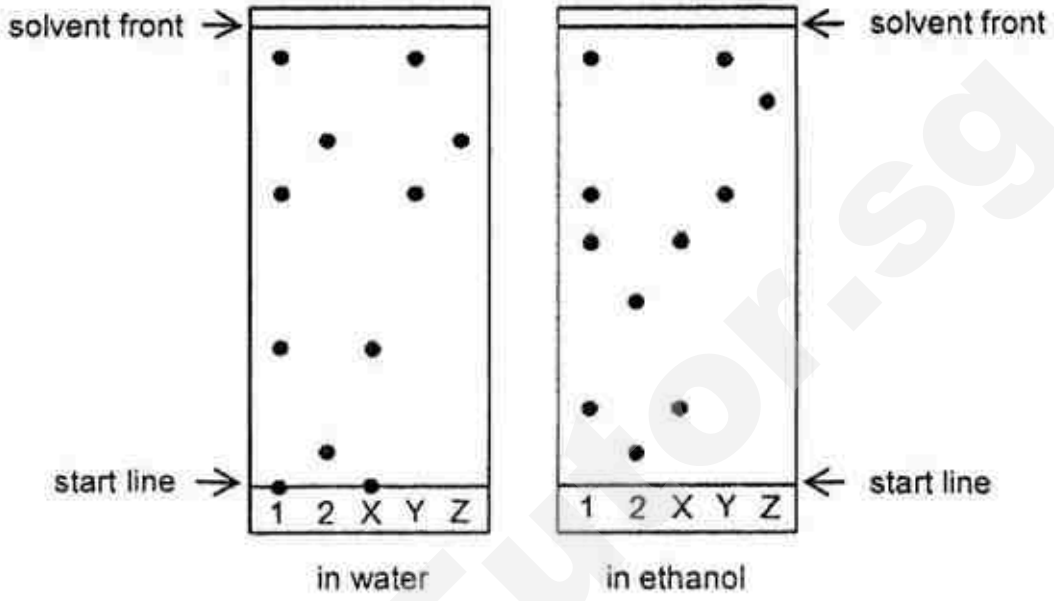
There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers, A, B, C and D.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 20.

This question paper consists of 20 printed pages (including this cover page) and 0 blank page.

1 Food dyes, 1 and 2 are known to contain one or more of the three substances X, Y and Z. Two chromatograms are developed; one used water as the solvent, and the other used ethanol. The results are shown in the diagram below.



Which of the following statement(s) is/are **correct**?

I Substance Z is likely to be pure.
II The component in Z is more soluble in water than in ethanol.
III There is a component in sample 1 that is insoluble in water but soluble in ethanol

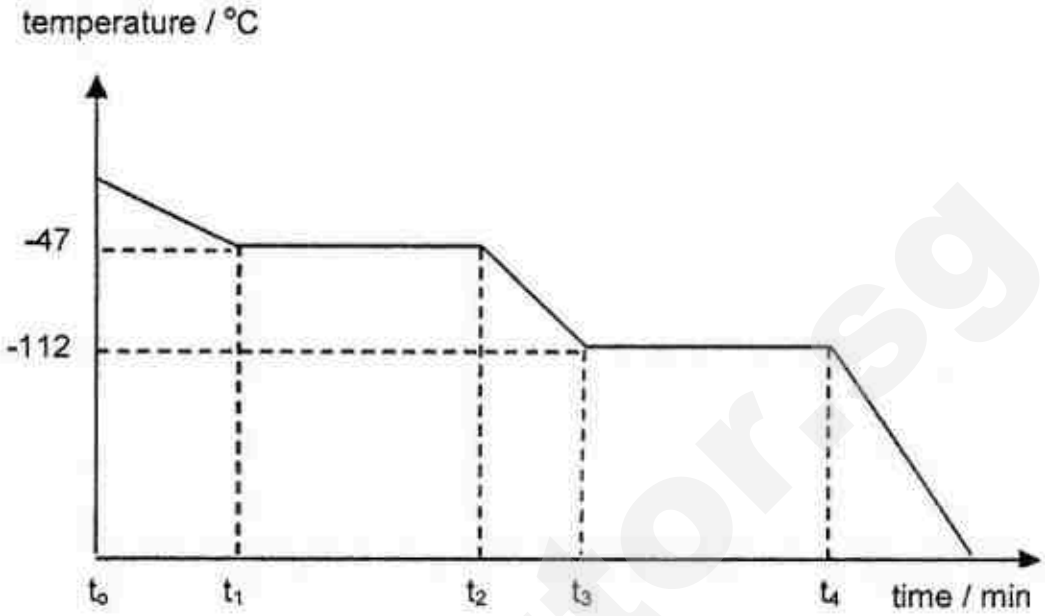
A I only
B II only
C I and III only
D II and III only

2 Lead(II) sulfate is soluble in hot water, but not in cold water. Lead(II) sulfate boils off at 2670 °C while sodium sulfate boils at 1430 °C.

Which method is **most** suitable for obtaining a pure, dry sample of lead(II) sulfate from a hot solution of lead(II) sulfate and sodium sulfate?

A Cool the mixture, filter and collect the residue.
B Cool the mixture, filter and evaporate the filtrate.
C Heat the mixture gently and collect the substance which boils off.
D Heat the mixture gently and collect the substance which is left in the boiling flask.

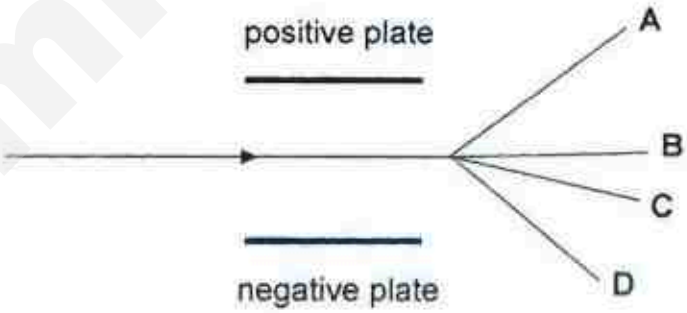
3 The diagram below shows a cooling curve of carbon disulfide.



Which of the following statements is **incorrect**?

A From t_0 to t_1, the particles are moving further apart.
B The freezing point of carbon disulfide is -112 °C.
C The particles are in a disorderly arrangement at -73 °C.
D The particles can only vibrate about their fixed positions after t_4.

4 A beam of particles containing electrons is passed through charged plates. Which path shows how the electrons move through the plates?



5 A sample of a white crystalline substance is heated in the absence of oxygen. It melts sharply at 120 °C, but on further heating, smoky fumes and a black solid are produced.

From this information, we can conclude that the white crystalline substance is

A a compound which decomposed to form simpler substances.
B a compound which undergoes combustion to form two products.
C a mixture of two pure substances.
D an element which undergoes combustion to form two products.

[Turn Over

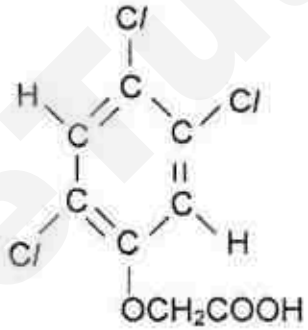
6 The table shows the number of protons, neutrons and electrons in particles S, T, U and V.

particle	S	T	U	V
proton	10	17	20	18
neutron	10	18	20	22
electron	10	18	18	18

Which of the following pairs of particles combine to form an ionic solid?

A S and T
B S and U
C T and U
D T and V

7 The figure below shows a molecule of an herbicide called 2,4,5-T which is often used for weed control. How many pairs of shared electrons are present in one molecule of the herbicide?



A 12
B 15
C 23
D 30

8 Silicon carbide, SiC, has a structure similar to diamond. Boron nitride, BN, has a structure similar to graphite. Bronze is an alloy of copper and tin.

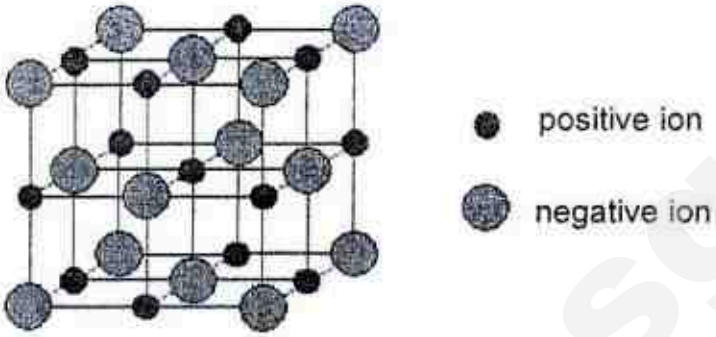
Which statements about silicon carbide, boron nitride and bronze are **correct**?

I All are bonded covalently.
II All except silicon carbide conduct electricity when solid.
III All have high melting points.

A I and II only
B I and III only
C II and III only
D I, II and III

[Turn Over

9 The diagram shows the arrangement of ions in an ionic crystal.



Which compound **cannot** have this arrangement of its ions?

A copper(II) sulfate
B iron(II) chloride
C magnesium oxide
D zinc carbonate

10 Aerials in portable radios are made of a mixture of oxides of calcium and iron known as 'ferrite'. It contains 18.5% of calcium and 51.9% of iron by mass.

Calculate the empirical formula of 'ferrite'.

A $CaFe_2O$
B $CaFe_2O_4$
C Ca_2FeO_2
D $Ca_2Fe_2O_3$

11 A mixture of 10 cm^3 of oxygen and 50 cm^3 of hydrogen is sparked continuously.

What is the maximum theoretical decrease in volume at room temperature and pressure?

A 10 cm^3
B 15 cm^3
C 20 cm^3
D 30 cm^3

[Turn Over

12 In a pathology laboratory, a sample of urine containing 0.120 g of urea, NH_2CONH_2 (M_r = 60) was treated with an excess of nitrous acid. The urea reacted according to the following equation:

$$NH_2CONH_2 + 2HNO_2 \rightarrow CO_2 + 2N_2 + 3H_2O$$

The gas produced was passed through aqueous sodium hydroxide and the final volume measured.

What was the final volume of gas left behind at room temperature and pressure?

A 9.6 cm^3
B 14.4 cm^3
C 48.0 cm^3
D 96.0 cm^3

13 In an experiment, 4.0 cm^3 of 1.0 mol/dm^3 of aqueous copper(II) sulfate was mixed with 8.0 cm^3 of 1.0 mol/dm^3 of aqueous sodium carbonate. The equation for the reaction is as shown below.

$$CuSO_4 + Na_2CO_3 \rightarrow Na_2SO_4 + CuCO_3$$

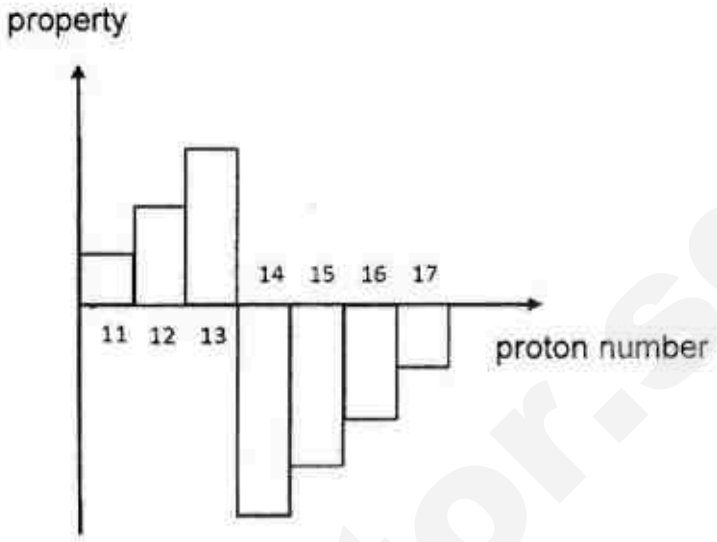
What did the reaction vessel contain when the reaction was completed?

A a blue solution only
B a green precipitate and a blue solution
C a green precipitate and a colourless solution
D a white precipitate and a blue solution

14 Astatine is a member of the halogen family. It has a proton number greater than the other halogens. Which of the following statements is **true** for astatine?

A It has the lowest melting point.
B It is a coloured liquid at room temperature.
C It is the halogen with the weakest oxidising power.
D It is the most reactive halogen.

15 The chart below shows how a property of the elements Na to Cl varies with proton number.



What is the property?

A the masses of their atoms
B the number of isotopes present
C the oxidation states of particles formed
D the oxidising power of the element

16 The table shows the properties of some elements, **W**, **X**, **Y** and **Z** in Period 3.

	W	X	Y	Z
appearance at room temperature	silvery grey solid	yellow solid	silvery grey solid	yellow green gas
reaction with cold water	extremely violent reaction	no reaction	no reaction	slow reaction
nature of oxide	reacts with acids	reacts with bases	reacts with acids and bases	reacts with bases

Which of the following shows the arrangement of these elements in the Periodic Table in **increasing** order of group number, from the smallest to the largest?

A **W, X, Y, Z**
B **W, Y, X, Z**
C **Y, W, X, Z**
D **Z, X, Y, W**

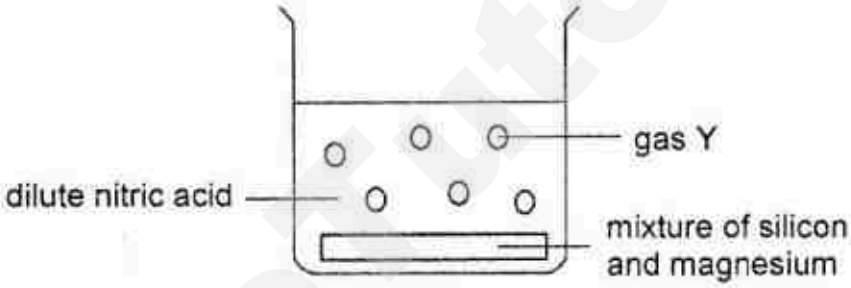
[Turn Over

17 Which of the following is/are suitable methods to test the strength of both hydrochloric acid and ethanoic acid of the same concentration?

I measuring their electrical conductivity
II titration using sodium hydroxide solution
III using a pH meter

A I and II
B I and III
C II only
D I, II and III

18 A mixture of silicon and magnesium was added to a beaker of excess dilute nitric acid as shown in the diagram. At the end of the reaction, the mixture was filtered to obtain the silicon as the residue.



Which of the following options indicates correctly the type of particles present in the substances shown in the diagram?

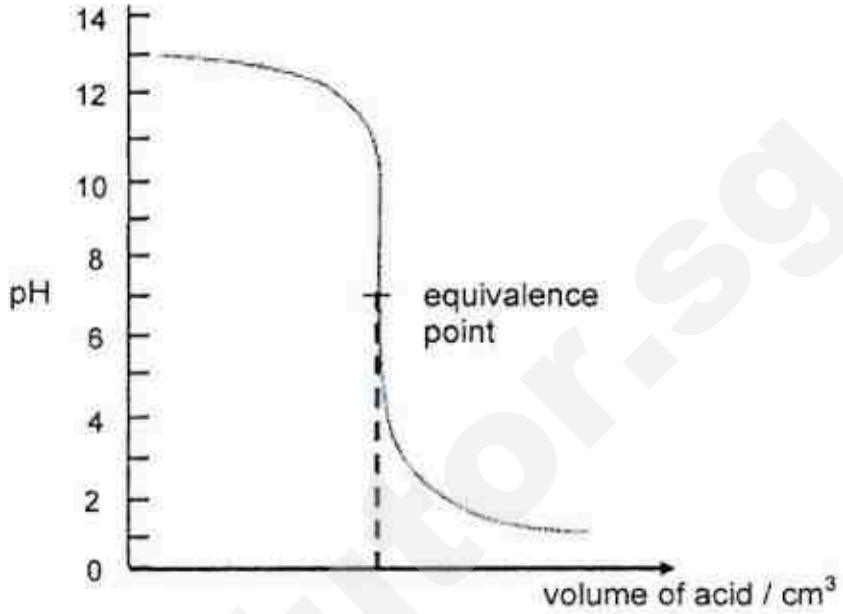
	magnesium	silicon	dilute nitric acid	gas Y
A	atoms	molecules	ions	atoms
B	ions and electrons	atoms	ions and molecules	molecules
C	ions and electrons	molecules	ions and molecules	molecules
D	ions and electrons	atoms	ions	molecules

19 Which pair of compounds could be used in the preparation of calcium sulfate?

A calcium carbonate and sodium sulfate
B calcium chloride and ammonium sulfate
C calcium hydroxide and barium sulfate
D calcium nitrate and lead(II) sulfate

[Turn Over

20 The graph represents the change in pH as 25.0 cm^3 of 0.1 mol/dm^3 of alkaline solution is titrated against 0.1 mol/dm^3 of an acidic solution.



Which of the following acid-alkali pairs could this graph represent?

	alkali	acid
A	aqueous ammonia	ethanoic acid
B	aqueous ammonia	hydrochloric acid
C	sodium hydroxide	ethanoic acid
D	sodium hydroxide	hydrochloric acid

21 When heated, solid **X** gives off a gas. When this gas is bubbled through limewater, a white precipitate is formed. The residue after heating solid **X** reacts with dilute acid and also with aqueous alkali.

What is X?

A aluminium oxide
B calcium hydroxide
C magnesium carbonate
D zinc carbonate

22 The table shows the results of adding pieces of zinc metal in salt solutions of metal **P**, **Q** and **R**.

salt solution of metal	initial mass of zinc / g	final mass of zinc after 15 minutes / g
P	6.0	0.0
Q	6.0	6.0
R	6.0	4.5

Which of the following shows the correct arrangement of metals in **decreasing** reactivity?

A P, R, zinc, Q
B Q, zinc, P, R
C Q, zinc, R, P
D R, P, zinc, Q

23 The solid carbonate of three metals **W**, **X** and **Y** are heated.

carbonate of metal	result
W	carbon dioxide produced; solid turns from green to black
X	carbon dioxide produced; solid does not change colour
Y	carbon dioxide not produced; solid does not change colour

Which of the following statements are correct?

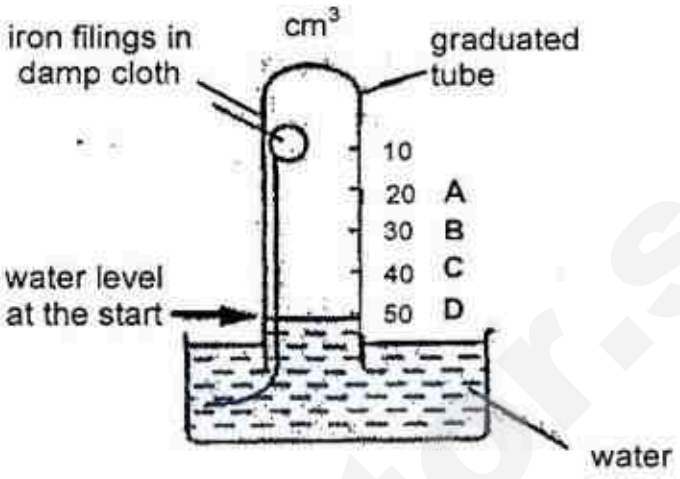
1 Metal **W** could be used as a catalyst.
2 Metal **Y** is a stronger reducing agent than metal **X**.
3 Only the carbonates of **W** and **X** produce carbon dioxide when added to dilute nitric acid.

A 1 and 2 only
B 1 and 3 only
C 2 and 3 only
D 1, 2 and 3

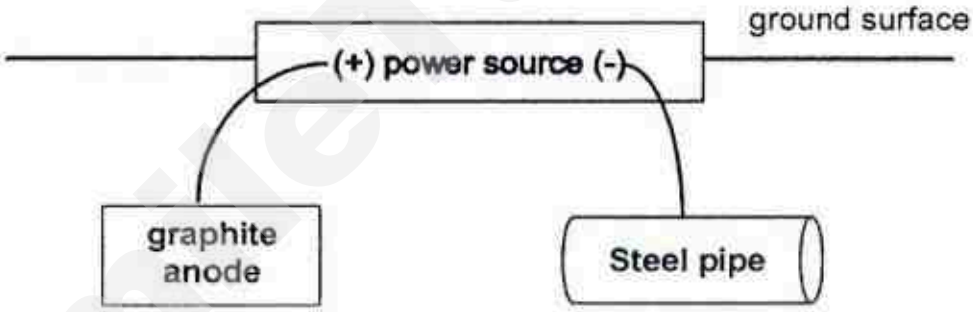
24 Scrap iron is often recycled. Which reason for recycling is **incorrect**?

A It reduces the amount of pollution at the site of the ore extraction.
B It reduces the amount of waste taken to landfill sites.
C It reduces the need to collect the scrap iron.
D It saves natural resources.

25 Iron filings are wrapped in a damp cloth and left to rust in the apparatus as shown below. Where will be the water level after rusting has completed?



26 The diagram shows a method of protecting iron in an underground steel pipe from rusting.



Which statement best explains how this method works?

A Electrons are flowing to graphite anode to prevent iron in steel from oxidising.
B Electrons are flowing to iron in steel to prevent the oxidation of iron in steel.
C The iron in steel loses electrons to graphite as it is more reactive.
D The iron in steel undergoes oxidation as it is more reactive.

27 Disproportionation reactions occur when an element is simultaneously oxidised and reduced. The oxidation number of the element will change to both a higher value and a lower value respectively.

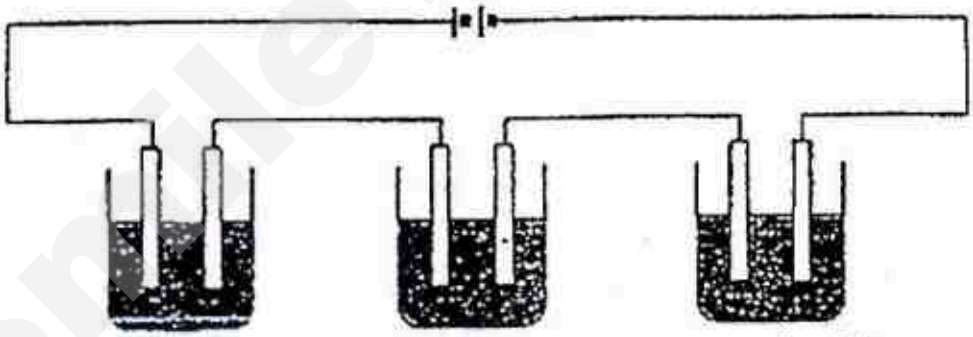
Which of the following named elements **does not** undergo disproportionation?

	element	equation of reaction
A	carbon	$H_2C_2O_4 \rightarrow H_2O + CO + CO_2$
B	chlorine	$3ClO^- \rightarrow ClO_3^- + 2Cl^-$
C	nitrogen	$H_2O + 2NO_2 \rightarrow HNO_3 + HNO_2$
D	sulfur	$2FeSO_4 \rightarrow Fe_2O_3 + SO_2 + SO_3$

28 In which of the following reaction does Fe^{2+} (aq) act as a reducing agent?

A Fe^{2+} (aq) + Mg (s) → Fe (s) + Mg^{2+} (aq)
B $4Fe^{2+}$ (aq) + SO_3^{2-} (aq) + $6H^+$ (aq) → $4Fe^{3+}$ (aq) + S (s) + $3H_2O$ (*l*)
C Fe^{2+} (aq) + $2OH^-$ (aq) → $Fe(OH)_2$ (s)
D Fe (s) + 2H+ (aq) → Fe^{2+} (aq) + H_2 (g)

29 Three electrolytic cells are set up as shown below. In all the cells, only carbon electrodes are used and the electrolytes are aqueous solutions of silver nitrate, copper(II) sulfate and aluminium nitrate respectively.



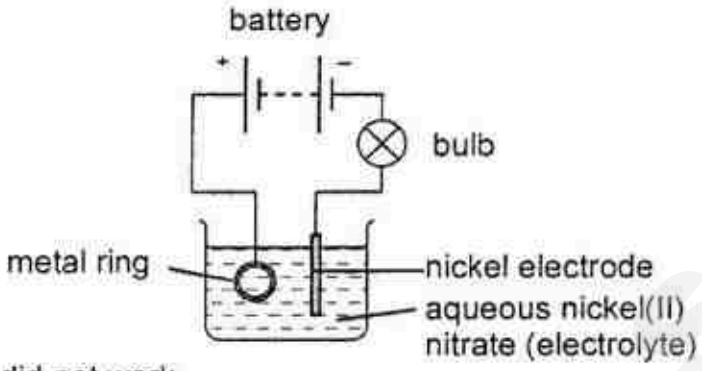
aqueous silver nitrate | aqueous copper(II) sulfate | aqueous aluminium nitrate

Which of the following correctly gives the masses of metals deposited at the cathode of each cell if 0.5 mole of electrons flows through the circuit?

	mass of silver / g	mass of copper / g	mass of aluminium /g
A	54	32	13.5
B	54	16	0
C	54	64	40.5
D	54	16	4.5

[Turn Over

30 The diagram shows the apparatus used to electroplate a metal ring with nickel.

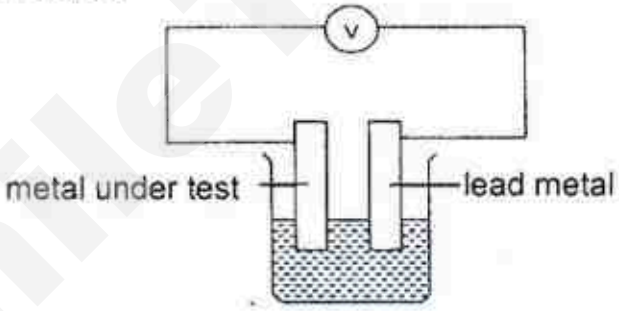


The experiment did not work.

Which change is needed in the experiment to make it work?

A Add solid nickel(II) nitrate to the electrolyte.
B Increases the temperature of the electrolyte.
C Replace the nickel electrode with a platinum electrode.
D Reverse the connection to the battery.

31 Five pieces of unknown metals **P**, **Q**, **R**, **S** and **T** were tested using the apparatus shown below.



The results were recorded in the table below.

metal	voltage / V
P	1.11
Q	0.65
R	-0.50
S	0.00
T	-0.77

Which of the following arrangements shows the metals in order of **decreasing** reactivity?

A P, Q, S, R, T
B Q, P, T, S, R
C R, S, Q, T, P
D T, S, R, Q, P

[Turn Over

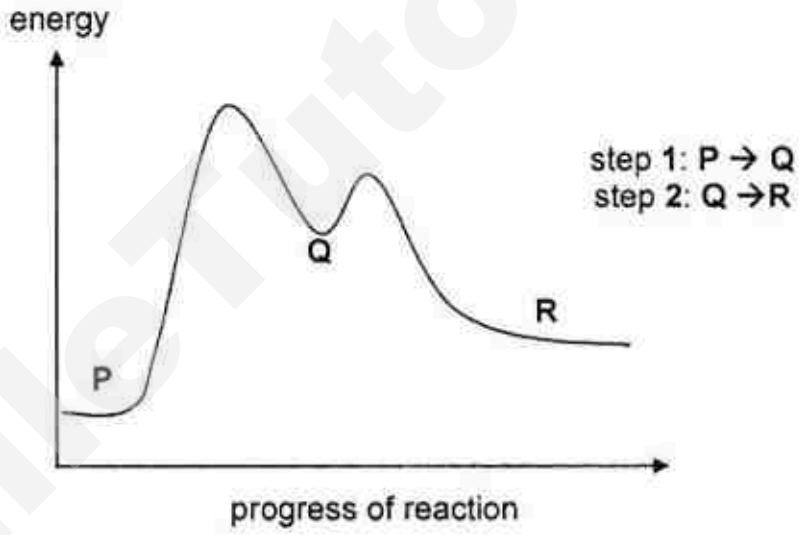
32 The reaction in the Haber process is represented as

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g) \qquad \Delta H = -92\ kJ$$

Which of the following statements about the Haber process is **incorrect**?

A 92 kJ of heat is given off when 2 moles of ammonia are formed.
B Iron catalyst does not affect the enthalpy change.
C The process is carried out at a high pressure of 250 atm.
D When 2 moles of nitrogen and 6 moles of hydrogen are used, 4 moles of ammonia are collected.

33 In the conversion of compound **P** into compound **R**, it was found that the reaction proceeded by way of compound **Q**. The following graph shows the energy profile diagram for the reactions.



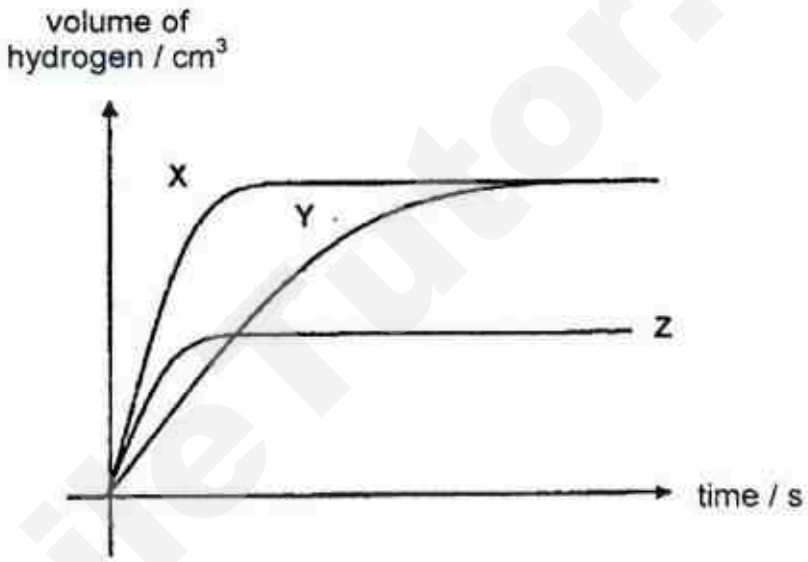
What can be deduced from the diagram?

A Both steps are endothermic.
B Step **1** is harder to take place than step **2** because more energy is needed for bond breaking.
C Step **2** involves breaking of stronger bonds than step **1** because **Q** is at higher energy level.
D The overall reaction to convert **P** to **R** is exothermic.

34 A student performed three experiments to produce hydrogen gas using excess zinc carbonate and dilute sulfuric acid at 30 °C.

experiment	zinc carbonate	dilute sulfuric acid	
	particle size	volume / cm^3	concentration / $moldm^{-3}$
1	powdered	20	1.00
2	lumps	40	0.50
3	lumps	10	1.00

Three graphs were plotted for the volume of hydrogen produced against time.



Which graph best represents each of the three experiments?

	experiment 1	experiment 2	experiment 3
A	X	Y	Z
B	Y	X	Z
C	Y	Z	X
D	Z	X	Y

[Turn Over

35 The table below shows some data about the composition of the mixtures of exhaust gases from two cars, one fitted with a catalytic converter and one without.

	% by volume of nitrogen monoxide	% by volume of carbon dioxide	% by volume of water vapour
car without catalytic converter	67.60	12.00	11.00
car with catalytic converter	23.60	32.35	41.10

Which statement **does not** explain the above data?

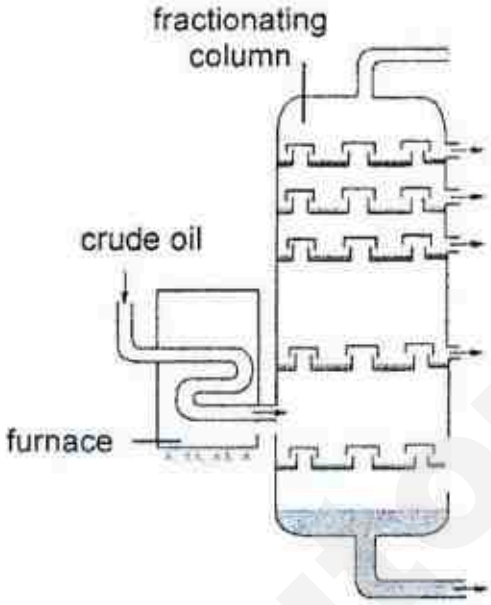
A The percentage of carbon dioxide increases as unburnt hydrocarbons undergo complete combustion in the catalytic converter.
B The percentage of nitrogen monoxide decreases as it is oxidised to form harmless nitrates, carbon dioxide and water in the catalytic converter.
C The percentage of nitrogen monoxide decreases as it is reduced to form nitrogen in the catalytic converter.
D The percentage of water vapour increases as unburnt hydrocarbons undergo complete combustion in the catalytic converter.

36 An ester is made by reacting alcohol **P** with a carboxylic acid **Q**. Alcohol **P** can be oxidised to form **Q** by warming with acidified potassium manganate(VII), under reflux.

What might be the structural formula for the ester made?

A CH_3OOCH_3
B $CH_3COOCH_2CH_3$
C $CH_3CH_2COOCH_2CH_3$
D $CH_3CH_2CH_2COOCH_2CH_3$

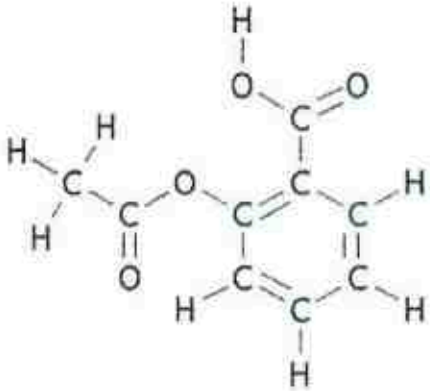
37 The diagram below represents the process of fractional distillation of crude oil.



Which statement about the fractional distillation of crude oil is **incorrect**?

A A pure compound is obtained at each level of the column.
B The fraction collected at the bottom of the column is the least flammable.
C The fraction collected at the top of the column has the lowest melting point.
D The molecules reaching the top of the column have the smallest relative molecular masses.

38 Aspirin as a drug is commonly used as a general painkiller. The full structural formula of aspirin is shown below.

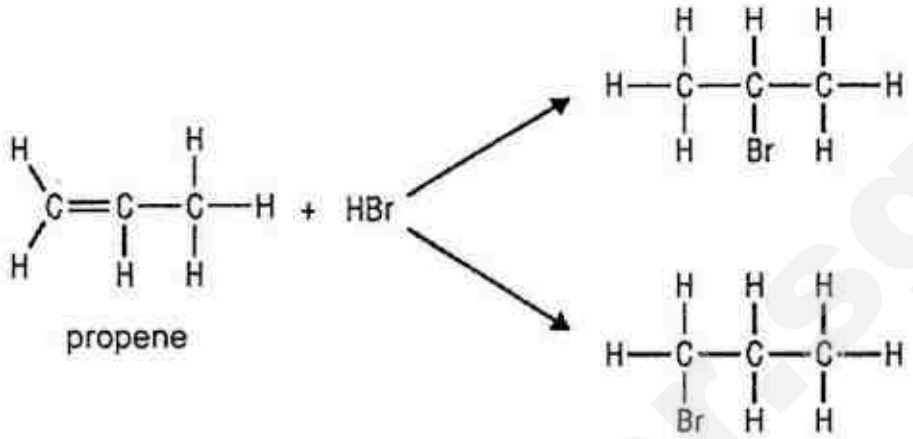


Which statement about aspirin is **incorrect**?

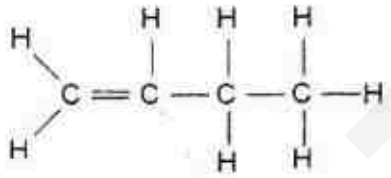
A It can undergo substitution reaction with chlorine under UV light.
B It is formed from an organic acid and an alcohol.
C It turns acidified potassium manganate(VII) solution from purple to colourless.
D Its aqueous solution reacts with sodium hydroxide.

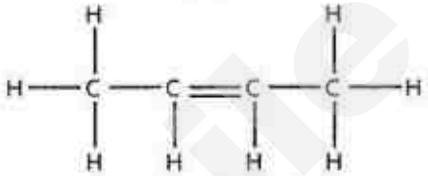
[Turn Over

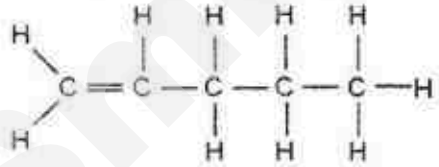
39 Propene reacts with hydrogen bromide to form two products.

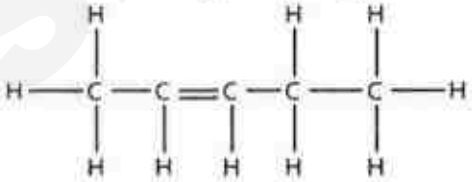


Which of the following alkenes **does not** form two products on reaction with hydrogen bromide?

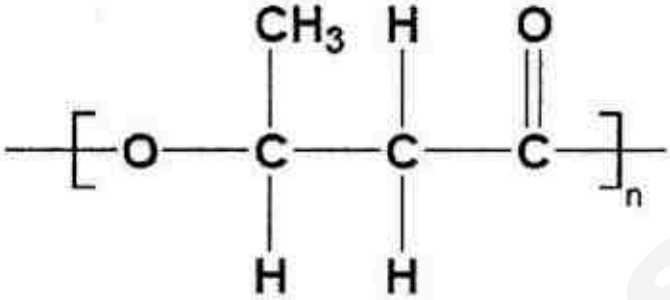
A


B


C


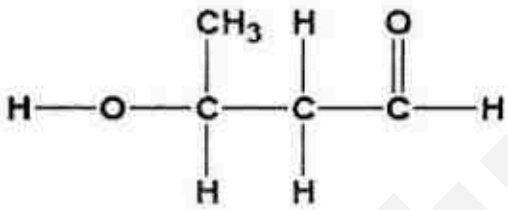
D


40 Polyhydroxyalkanoates are biodegradable plastics. The structure of one type of these plastics is shown below.

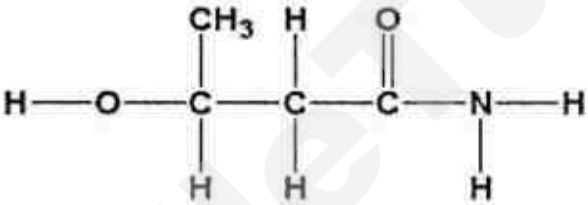


Which of the following molecules could be its monomer?

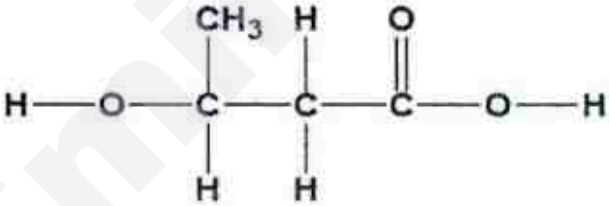
A



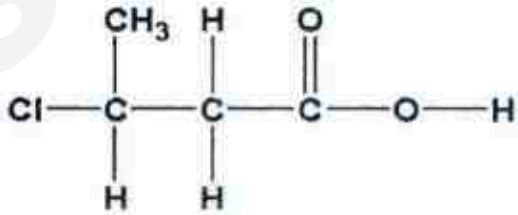
B



C



D



END OF PAPER

The Periodic Table of the Elements

Group I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										4* He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key

a
X
b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

PRESBYTERIAN HIGH SCHOOL

SCIENCE DEPARTMENT

Subject: Chemistry
Level: 4 Express

Exam: Prelim
Year: 2017

MARKING SCHEME

Paper 1 (40 marks)

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
C	A	A	A	A	C	C	C	B	B
Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
D	D	C	C	C	B	B	B	B	D
Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
D	C	A	C	C	B	D	B	B	D
Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40
A	D	B	A	B	B	A	C	B	C

Class	Index Number	Name

PRESBYTERIAN HIGH SCHOOL

CHEMISTRY **5073/2**

Paper 2

24 August 2017 **Thursday** **1 hour 45 minutes**

2017 SECONDARY FOUR EXPRESS PRELIMINARY EXAMINATION

INSTRUCTIONS TO CANDIDATES

Write your class, register number and name on all the work you hand in.
Write in dark blue or black pen.
Do not use correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section B
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

You are advised to spend no longer than one hour on Section A and no longer than 45 minutes on Section B.
At the end of the examination, submit Section A and B separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 23.

For Examiner's Use	
Section A	
Section B	
Total	

This question paper consists of 22 printed pages (including this cover page) and 2 blank pages.

SECTION A (50 marks)

Answer **all** questions in this section in the spaces provided.

1 Table 1.1 gives the composition of three particles.

Table 1.1

particle	number of protons	number of electrons	number of neutrons
A	15	15	16
B	15	18	16
C	15	15	17

(a) Using the information from Table 1.1, explain why

(i) particle **A** is an atom;

..... [1]

(ii) **A**, **B** and **C** are all particles of the same element;

..... [1]

(iii) particles **A** and **C** are isotopes of the same element.

.....

..... [2]

(b) Is element A, a metal or a non-metal? Give a reason for your answer.

.....

..... [1]

[Total: 5]

2 Chlorine exists as a gas at room temperature and pressure. A sample of chlorine gas is bubbled into a beaker of aqueous potassium iodide.

(a) Describe the movement of the chlorine molecules.

..... [1]

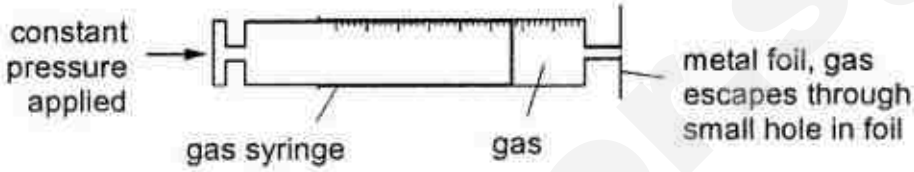
(b) Describe and explain what you would see when the chlorine is bubbled into the beaker of aqueous potassium iodide.

.....

.....

..... [2]

(c) The following apparatus can be used to measure the rate of diffusion of a gas.



The following results were obtained.

gas	temperature / °C	rate of diffusion in cm^3 / min
oxygen	25	0.88
chlorine	25	0.63

Explain why oxygen gas diffuses faster than chlorine gas.

.....

.....

..... [2]

[Total: 5]

3 An autocatalytic reaction is one where the reaction is catalysed by one of its products. An example of an autocatalytic reaction is the reaction between acidified potassium manganate(VII) and oxalic acid, $H_2C_2O_4$. The ionic equation is as follows:

$$2MnO_4^- (aq) + 6H^+ (aq) + 5H_2C_2O_4 (aq) \rightarrow 2Mn^{2+} (aq) + 8H_2O (l) + 10CO_2 (g)$$

In this reaction, Mn^{2+} ions act as the catalyst.

Fig. 3.1 shows the changes in concentration of oxalic acid over time when excess acidified potassium manganate(VII) solution is reacted with 1.0 mol/dm^3 of oxalic acid.

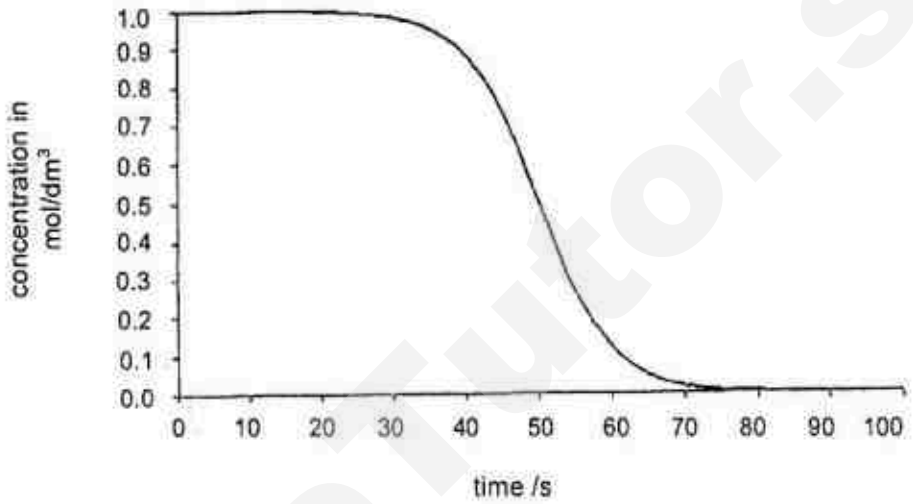


Fig. 3.1

(a) Explain how, in terms of activation energy and colliding particles, a catalyst speeds up the rate of reaction.

.....

.....

.....

.....

..... [3]

(b) Explain why, in terms of colliding particles,

(i) the rate of reaction increases in the first 50 seconds;

.....

.....

..... [2]

[Turn Over

(ii) the rate of reaction decreases after 50 seconds.

.....

.....

..... [2]

(c) Explain, in terms of oxidation states, why the reaction between acidified potassium manganate(VII) and oxalic acid is a redox reaction.

.....

.....

..... [2]

(d) State how one can tell that the reaction has completed.

..... [1]

[Total: 10]

4 An experiment on electrolysis is carried out using the apparatus shown in Fig. 4.1.

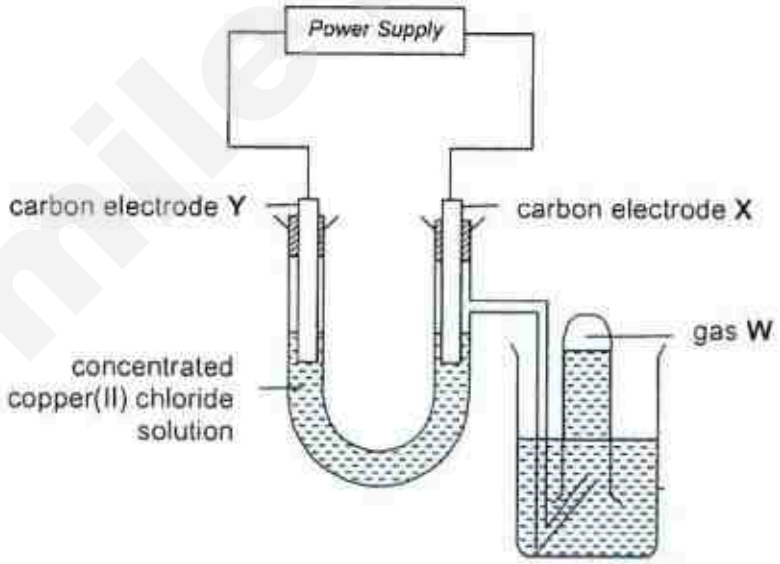


Fig. 4.1

A small volume of gas **W** is evolved at electrode **X** and is collected over water.

(a) (i) Is electrode **Y** the cathode or anode? Explain your answer.

.....

.....

..... [2]

(ii) What will be the colour change in the electrolyte after electrolysis is carried out for some time?

..... [1]

(iii) State and explain **two** differences that you will see if electrode **X** is now replaced by a piece of copper metal and the solution is replaced with <u>dilute</u> copper(II) chloride solution.

.....

.....

.....

.....

..... [4]

(b) (i) Describe a test for gas **W** and state the observations.

.....

..... [1]

(ii) Explain whether the displacement of water is a suitable method to collect gas **W**.

..... [1]

[Total: 9]

[Turn Over

5 Excess hydrochloric acid is added to powdered zinc. The hydrogen evolved is collected and its volume is measured every 20 seconds.

The experiment is repeated at the same temperature using the same number of moles of powdered magnesium and aluminium.

Fig. 5.1 shows the volume of hydrogen produced from each metal against time.

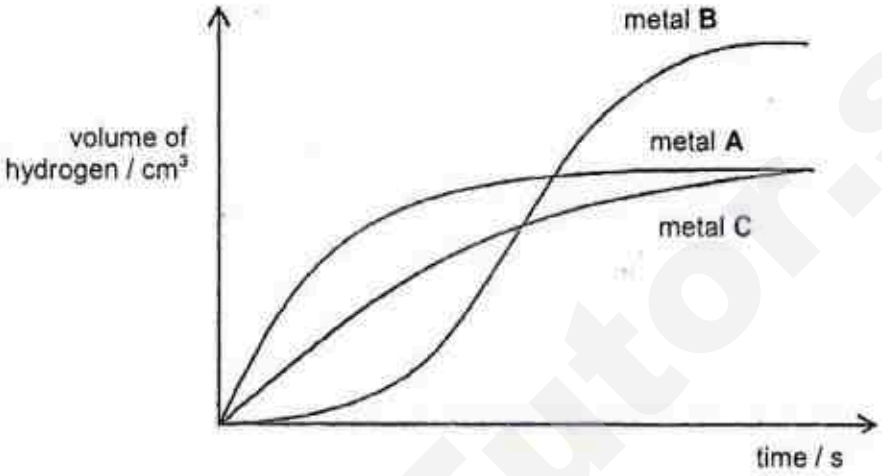


Fig. 5.1

(a) Identify metal **B** and explain the shape of the graph for metal **B**.

.....

.....

.....

.....

..... [3]

(b) Identify metals **A** and **C**.

..... [1]

(c) Use your understanding of *number of moles of particles* to explain why metals **A** and **C** produce the same volume of hydrogen but metal **B** produces a larger volume.

.....

.....

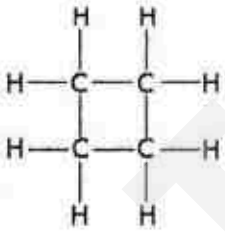
.....

..... [2]

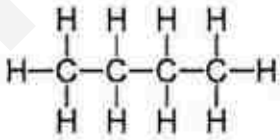
[Total: 6]

6 The alkanes are a homologous series of hydrocarbons.

(a) Student 1 and 2 had a discourse on the molecules below.



molecule A



molecule **B**

Student 1 says that both molecules **A** and **B** are in the same homologous series while Student 2 believes that molecules **A** and **B** are in a different homologous series.

From the information above,

(i) Suggest with a reason which of the two students is correct.

.....

..... [1]

(ii) State the condition(s) for the chemical reaction between an alkane and chlorine to take place.

..... [1]

(iii) In terms of bond breaking and bond forming, state whether the chemical reaction between an alkane and chlorine is an exothermic or endothermic reaction.

.....

.....

..... [2]

(iv) Draw an energy profile diagram for the reaction between molecule **A** and chlorine. Label the activation energy, enthalpy change and label the axes.

[2]

(b) (i) One mole of undecane, $C_{11}H_{24}$, is cracked to form a mixture containing one mole of ethene, one mole of propene and one mole of molecule **R**.

State the formula of molecule **R**.

..... [1]

(ii) Draw a branched isomer of molecule **R**.

[1]

(iii) 'Carbon-neutral' fuels are fuels that do not result in a change of carbon dioxide in the atmosphere.

Unlike obtaining ethanol through hydration of ethene, only obtaining ethanol through fermentation is considered as 'carbon-neutral'.

Explain why obtaining ethanol through fermentation is considered as 'carbon-neutral'.

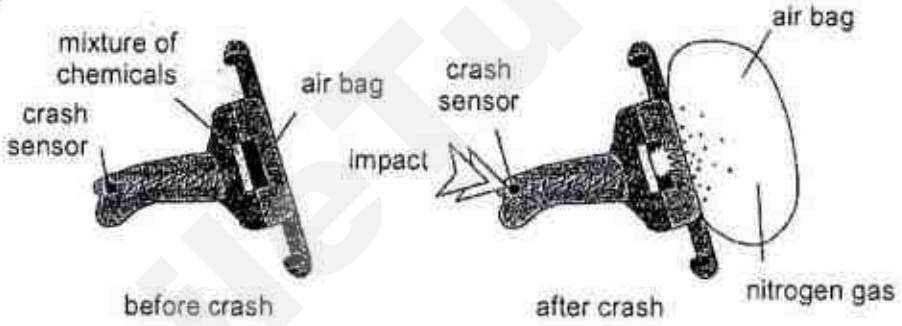
.....

.....

..... [2]

[Total: 10]

7 Air bags are used to protect passengers in a car during an accident. When the crash sensor detects an impact, it causes a mixture of chemicals to be heated to a high temperature. Reactions take place which produce nitrogen gas. The nitrogen fills the air bag.



(a) The mixture of chemicals contains sodium azide (NaN_3), which decomposes on heating to form sodium and nitrogen.

$$2NaN_3 \rightarrow 2Na + 3N_2$$

An air bag contains 130 g of sodium azide. When the sodium azide decomposes, 60 dm^3 of nitrogen gas is obtained at room temperature and pressure.

Calculate the percentage yield of nitrogen from the decomposition of sodium azide.

[3]

(b) The sodium produced when sodium azide decomposes is dangerous.
The mixture of chemicals in the air bag contains potassium nitrate and silicon dioxide which help to make the sodium safe. Sodium reacts with potassium nitrate to produce sodium oxide, potassium oxide and nitrogen.

Write the equation for the reaction between sodium and potassium nitrate.

..... [1]

(c) The silicon dioxide reacts with sodium oxide and potassium oxide to form silicates.

Suggest why sodium oxide and potassium oxide are dangerous in contact with the skin.

..... [1]

[Total: 5]

END OF SECTION A

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Class	Index Number	Name

SECTION B (30 marks)

Answer all **three** questions in this section.
The last question is in the form of an either/or and only one of the alternatives should be attempted.

8 Read the passage below, which explains the chemistry of how certain foods 'rise' during cooking.

Many food products such as bread, sponge cakes and buns have a honeycomb structure which contains many bubbles. During cooking, these bubbles are formed by a gas and the mixture 'rises'. In some cases, the gas is air which is whipped into the mixture before cooking and expands during cooking. In other cases, the gas is carbon dioxide.

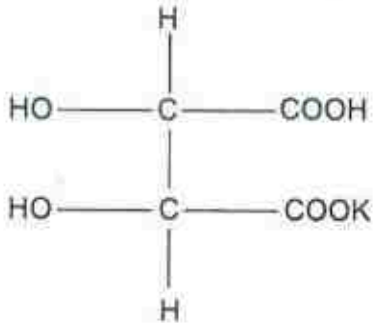
The most common chemical to do this is sodium hydrogen carbonate, $NaHCO_3$. Sodium hydrogen carbonate is found in both baking soda and baking powder.

Baking soda consists of only sodium hydrogen carbonate. When it is heated, it forms carbon dioxide gas according to the equation:

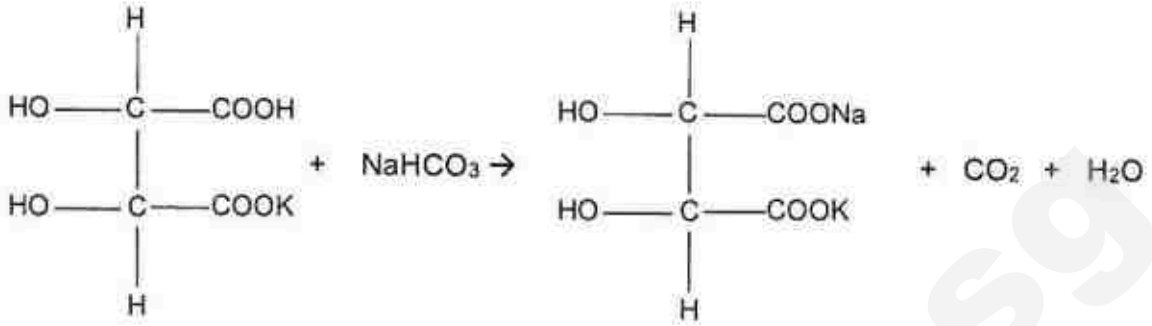
$$2NaHCO_3\,(s) \rightarrow Na_2CO_3\,(s) + CO_2\,(g) + H_2O\,(l)$$

Since the material is relatively cheap, it seems to be an excellent agent to produce carbon dioxide. The above chemical equation, however, also illustrates the disadvantages of baking soda. When used on its own, only half the available carbon dioxide is released and more seriously, the sodium carbonate produced gives the baked product a slightly bitter and 'soapy' taste. To overcome this problem, baking soda is usually mixed with some honey.

Baking powder consists of a mixture of sodium hydrogen carbonate and a weak acid such as potassium hydrogen tartrate (cream of tartar). The formula of this acid is:



Potassium hydrogen tartrate is a solid which means that it is possible to mix it with sodium hydrogen carbonate without the two reacting. The reaction is:



One problem with the use of potassium hydrogen tartrate is that it is very soluble in water. As soon as it becomes wet, it dissolves and reacts. This risks all the gas escaping while the cake mix is still in liquid form and before it goes into the oven.

(a) Using kinetic particle theory, explain how air which has been whipped into the mixture makes the dish 'rise' upon cooking.

.....

.....

.....

.....

..... [2]

(b) Predict the pH value of sodium carbonate when it is dissolved in water.

..... [1]

(c) The average pH of honey is 3.9. Explain how the addition of honey to baking soda makes the cake taste better.

.....

.....

.....

..... [2]

(d) Besides taste, explain why most bakers prefer to use baking powder instead of baking soda when they are baking cakes.

.....

.....

.....

.....

..... [2]

(e) Potassium hydrogen tartrate can be made from the reaction of potassium hydroxide with tartaric acid. Draw the structural formula of tartaric acid.

[1]

(f) The following instruction is found on a bottle of baking powder.

Store in a dry place.

Explain why this instruction is important.

.....

.....

.....

.....

..... [2]

(g) Both potassium hydrogen tartrate and hydrochloric acid react with sodium hydrogen carbonate to produce a salt, carbon dioxide and water.

However, the rate of reaction is faster in the reaction between hydrochloric acid and sodium hydrogen carbonate.

Explain the differences in the rate of reaction for the reaction between hydrochloric acid and sodium hydrogen carbonate as compared to potassium hydrogen tartrate and sodium hydrogen carbonate.

.....

.....

.....

.....

..... [2]

[Total: 12]

9 Table 9.1 shows some properties of the noble gases.

Table 9.1

element	electronic configuration	relative atomic mass	density / gdm^{-3}	melting point / °C	boiling point / °C
helium	2	4	0.17	-272	-269
neon	2.8	20	0.83	-249	-246
argon	2.8.8	40	1.67	-189	-186
krypton	2.8.18.8	84	3.50	-157	-152
xenon	2.8.18.18.8	131		-112	-105

(a) Using information from Table 9.1, suggest why noble gases are unreactive.

.....

.....

.....

.....

..... [2]

[Turn Over

(b) Complete Table 9.1 by calculating the density of xenon at room temperature and pressure.

[2]

(c) All Group 0 elements are gases at room temperature and pressure. State how the information from the table supports this.

.....

..... [1]

(d) Xenon has been found to form a compound xenon difluoride, XeF_2, which has a melting point of 128 °C. Using ideas of bonding and structure, explain the melting point of xenon difluoride.

.....

.....

.....

.....

.....

..... [3]

[Total: 8]

[Turn Over

10 EITHER

Esters are compounds which give fruits their flavours. They also provide the scent in flowers.

(a) The ester, $CH_3(CH_2)_2CO_2CH_3$, contributes to the aroma of apples.

(i) Draw the structure of the two starting materials needed to produce this ester.

[2]

(ii) State the catalyst required for esterification to take place.

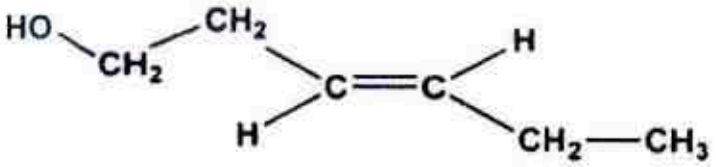
..... [1]

(iii) Apart from their uses as artificial food flavourings, state one major commercial use of esters.

..... [1]

(b) Leaf alcohol is a compound that exists as a colourless oily liquid. It has an intense grassy-green odour of freshly cut green grass and leaves. It is produced in small amounts by most plants and it acts as an attractant to many predatory insects.

The structure of leaf alcohol is as follows:



[Turn Over

(i) Leaf alcohol was reacted to form a product which increased the M_r value by 18 units.

Suggest a structure for this product and deduce the type of reaction that took place.

structure of product

[1]

type of reaction

..... [1]

(ii) Describe a chemical test to distinguish between leaf alcohol and the product formed in **b(i)**.

.....

.....

.....

..... [2]

(iii) Draw two repeat units of the polymer formed when leaf alcohol undergoes polymerisation.

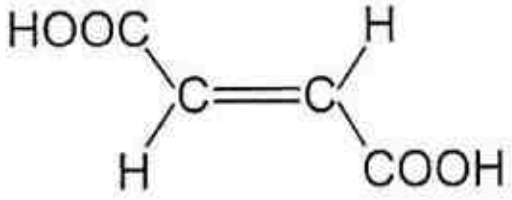
[2]

[Total: 10]

[Turn Over

OR

Fumaric acid is a colourless solid which can be extracted from plants.



(a) **(i)** Describe a chemical test that can be used to confirm that fumaric acid is an unsaturated compound.

.....

..... [1]

(ii) Draw the product formed between the chemical stated in **a(i)** and fumaric acid.

[1]

(b) A solution of fumaric acid is titrated against aqueous sodium hydroxide.

(i) Construct a chemical equation for the reaction between fumaric acid and sodium hydroxide.

..... [1]

[Turn Over

(ii) 18.0 cm^3 of 0.200 mol/dm^3 sodium hydroxide solution is required to neutralise 60.0 cm^3 of fumaric acid solution.

Calculate the concentration, in mol/dm^3, of fumaric acid solution.

[2]

(c) Draw the structural formula of the polymer which is made when fumaric acid reacts with ethane-1,2-diol, $HO(CH_2)_2OH$. Name the linkage formed.

structural formula of polymer

[1]

name of linkage

..... [1]

(d) Draw the structural formula of the polymer formed when fumaric acid undergoes polymerisation.

[1]

(e) Polymers are widely used today.

(i) State a problem caused by disposal of polymers.

.....

..... [1]

(ii) Despite the disadvantages, new polymers are made instead of recycling existing ones. Explain why.

.....

..... [1]

[Total: 10]

END OF PAPER

PRESBYTERIAN HIGH SCHOOL
SCIENCE DEPARTMENT
Marking Scheme

Subject: Chemistry

Exam: Prelim Exams
Year : 2017

Level : Sec 4 Express

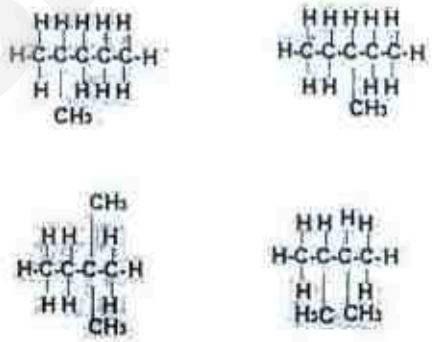
Qn	Section A (50 marks) Scoring Points	Sub-total	Total
1a(i)	Same number of protons and electrons	1	
(ii)	Same number of protons / same proton number / same atomic number	1	
(iii)	Same number of protons / same proton number / same atomic number; Different number of neutrons / different nucleon or mass number	1 1	5
b	Non-metal because it gains 3 electrons to form a negative ion / it is in Group V Note: need both non-metal and reason for one mark	1	
	In (a)i, most students stated the correct answer. However, there are students who mentioned that atom consists of protons, electrons and neutrons with no mention of the need for the charge of an atom to be neutral. **Part aii and iii are better answered** **Part (b) was a challenging question for the students as they wrote Group V as 5, hence no credit was awarded.** **Students also did not mentioned the need to gain electrons to form anion, rather just wrote that the non-metal element forms an anion, hence no credit awarded.**		
2a	Move randomly at high speeds in all directions	1	
	Badly answered as there was missing answer such as speed or the direction of motion.		5
b	Colourless (potassium iodide) solution turns brown; Chlorine is more reactive than iodine, displaces iodide ions from potassium iodide solution	1 1	
	Many students gained partial credit. Most did not mentioned colourless solution turns brown but wrote brown solution formed. There are students who wrote that iodine crystals are formed. The answer tend to be incomplete as students failed to mention the displacement reaction. **There are answers that focused on oxidation and reduction, not answering to the question.**		
c	oxygen gas has a smaller M_r (32) than chlorine gas (71); oxygen gas diffuse / move faster	1 1	

	Students who are familiar with diffusion did well.		
3a	Catalyst provides an alternative pathway of a lower activation energy; More reacting particles have energy equal or greater than E_a; Increases number of effective collisions **There are students who do not know that catalyst do not take part in the chemical reaction. Most students have the misconception that catalyst lowered the activation energy which is not true as catalyst offers an alternative pathway with lowered Ea.** **There are also quite a number of students who wrote that the reacting particles have more knietic energy for reaction due to catalyst hence reaction occurred faster. Students needs to better differantiate the difference between Ea and kinetic energy of particles**	1 1 1	10
b(i)	In first 50 s, concentration of Mn^{2+} increases; More Mn^{2+} ions per unit volume of solution, results increase in number of effective collisions	1 1	
(ii)	After 50 s, concentration of oxalic acid decreases; Less oxalic acid particles per unit volume, decreases in number of effective collisions **Part b(i) and (ii) are poorly answered. For part b(i), the students did not recognised that this question focused on the catalyst that are formed as reaction proceeded.** **There is a tendency for students to write answer for part (ii) that the reactants are used up hence reaction decrease without mentioning which reactants are used up. There is a need to emphaise that per unit volume is an important concept in speed of reaction**	1 1	
c	potassium manganate(VII) is reduced as the oxidation state of Mn decreases from +7 in MnO_4^- to +2 in Mn^{2+}; oxalic acid is oxidised as oxidation state of C increases from +3 in $H_2C_2O_4$ to +4 in CO_2. **Able students gained full credit. There is a concern that partial credit is not gained for potassium manganate (VII), a substance that most students are familiar, the os given for MnO_4^- are wrong. There are instances that maganese ion was given negative charged.**	1 1	
d	No more effervescence produced / no bubbles of gas observed Reject: solution turn from purple to colourless **There are students who wrote that the solution turn from purple to colourless as answer.**	1	

[Turn Over

4a(i)	Y is cathode; Cl^- are discharged at X, thus Cu^{2+} ions are discharged and reduced at Y	1 1	9
(ii)	Solution turns from blue to colurless	1	
(iii)	Copper anode becomes smaller; Copper anode ionises and oxidise to form Cu^{2+} ions	1 1	
	Solution remains blue; For every Cu^{2+} ion that is reduced at cathode, one Cu atom from anode ionises and oxidise at anode	1 1	
	Poorly answered as students did not read the question carefully. The question asked for what was observed during the electrolysis, there are responses that mentioned the discharged of copper ions but they did not menitoned the decrease in size fo the electrode or the answer was on the cathode Y.		
	A number of responses mentioned that the solution becomes diluted and not concentrated leading to gases such as oxygen and hydrogen being formed.		
	The explanation for the soultion remaining blue tends to be incompleted.		
b(i)	Gas W turns moist blue litmus paper red and bleaches it	1	
	Students did not gained credit as they missed out the word "damp litmus" or "moist litmus". There are also students who used red litmus paper.		
(ii)	No because gas W is soluble in water	1	
	Students are not familiar with gas collection methods, quite a number mentioned that gas W, chlorine is insoluble in water.		
5a	Metal B is aluminium; Reaction is slower at the start / gradient is less steep as the aluminium oxide is reacting with the acid first; Reaction is faster / gradient gets steeper as the oxide layer is removed, exposes the aluminium which then reacts with the acid	1 1 1	6
	Most students have difficulities explaining why the reaction for aluminium is slower at the start. The students forgot about the insoluble layer that existed on aluminium. Most explanations given involves the charge of the metals to relate to the volume of hydrogen given off.		
b	Metal A is magnesium, metal C is zinc	1	
c	For both magnesium and zinc, 1 mole of metal produces 1 mole of H_2, thus same volume of gas produced; For aluminium, 1 mole of metal produces 1.5 moles of H_2, hence higher volume of gas produced $2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$ $Zn + 2HCl \rightarrow ZnCl_2 + H_2$	1 1	

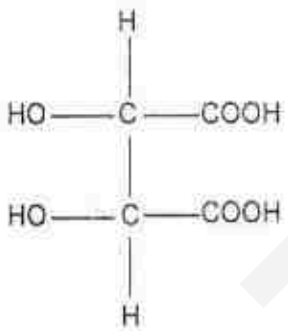
[Turn Over

	$Mg + 2HCl \rightarrow MgCl_2 + H_2$ **Part C was not well answered as students did not use mole to explain, this was stated in the question.**		
6a(i)	Student 2 is correct as the molecules do not have the same general formula and same functional group **Students need to differentiate between molecular formula, structural formula and general formula to do well.**	1	10
(ii)	UV light **There are students who do not know about UV light, instead radiation or ray was used.** **There are quite a number of students who combined UV light with other condtions (meant for other experiments).**	1	
(iii)	Endothermic reaction as more energy is absorbed in breaking Cl-Cl and C-H bonds; than energy released in forming C-Cl and H-Cl bonds **Students tend to give incomplete answers that do not mentioned the bonds broken or formed. There are students who did not use the terms "energy is absorbed" or "energy released".**	1 1	
(iv)	correct shape with labelled axes; label of activation energy and enthalpy change with single arrow heads **Students need to understand that sketching of graphs require labelled axes. Graphs that are sketched correctly have Ea or ΔH not shown, example ΔH is +ve. Arrows drawn for Ea and ΔH are not placed in correct postions.**	1 1 1	
b(i)	C_6H_{14}	1	
(ii)	 any one of the above practice ecf **Well answered by most students.**		
(iii)	the sugar used during fermentation was formed by absorption of carbon	1	

[Turn Over

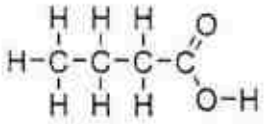
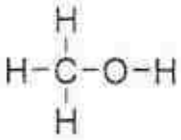
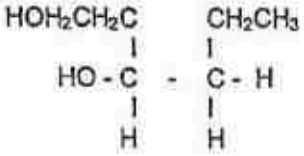
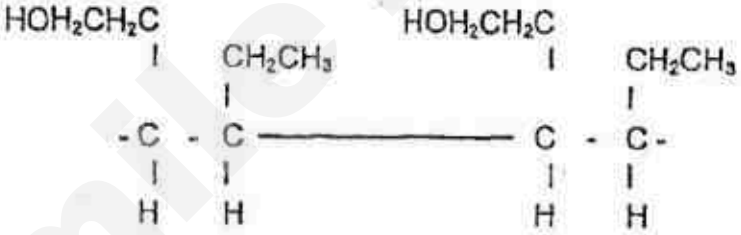
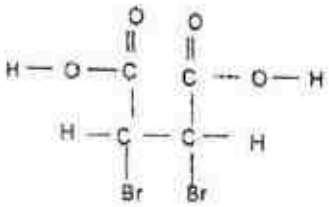
	dioxide during photosynthesis; burning of ethanol and fermentation of glucose to form ethanol releases carbon dioxide that was previously absorbed **Only some students gained credit as most students did not linked photosynthesis (the absorption of CO_2) and combustion of ethanol (released of CO_2). Majority of students focused on the fermenation process.**	1	
7a	No. of moles of sodium azide = 130 / (23 + 3 x 14) = 130 / 65 = 2.00 mol No. of moles of nitrogen = 2/2 x 3 = 3.00 mol Theoretical yield of nitrogen = 3 x 24 = 72.0 dm^3 Percentage yield = 60/72 x 100% = 83.3% Deduct 1 mark from overall if without units or 3 sig. fig **Majority of students gained partial credit.** **There are students who use number of mole to computate the percentage yield which is not acceptable.**	 1 1 1 1	5
b	$10Na + 2KNO_3 \rightarrow 5Na_2O + K_2O + N_2$ **Majority of students are not able to balance the equation.**	1	
c	Sodium oxide and potassium oxide form strong and corrosive alkalis when in contact with moisture from the skin **Students did not link the moisture from skin to the question. There are answers that focused on the silicon dioxide.**	1	
	Section B (30 marks) Scoring Points	**sub-total**	**total**
8a	At higher temperature, air particles gain energy and move faster; Particles move further from each other, increasing volume of air **Comment: Most students were able to state the increased movement of the particles due to the gain of thermal energy. However, many failed to mention about the increased spacing of particles that resulted in the volume increase of the gas that caused the rising effect.**	1 1	12
b	8 Accept pH values from 8-10 **Comment: Most students were able to state correct pH value within the range.**	1	
c	Honey is acidic; Reacts with sodium carbonate, removing the bitter taste from the cake Accept: honey neutralises sodium carbonate	1 1	

[Turn Over

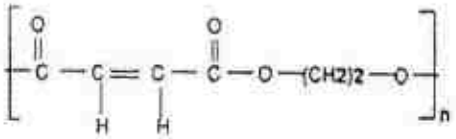
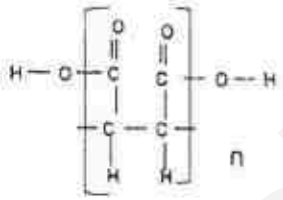
	Comment: Most students were able to explain the effect of adding honey to the reaction mixture but not stating the nature of honey that caused the neutralisation effect.		
d	Using baking powder produces twice the volume of carbon dioxide compared to baking soda; Makes the cake rise higher Accept: only half the volume of carbon dioxide gas produced hence not enough to cause the cake to rise	1 1	
	Comment: The better students were able to make use of the two chemical equations to link the mole ratio between the reactants and products involved in the reaction to come out with the volume of carbon dioxide produced when baking soda and baking powder were used. This question proved to be a challenging one for the weaker students.		
e	 	1	
	Comment: Most students struggled with the structure of the acid. The students failed to recognise the functional group (-COOH) that is present in all carboxylic acids.		
f	When dissolved in water, potassium hydrogen tartrate ionises to produce hydrogen ions; Absence of hydrogen ions when dry Accept: dissolves and reacts, thus risking all the gas escaping which causes the rising effect	1 1	
	Comment: Only a few students were able to mention the ionisation effect of the acid group when the substance is dissolved in water. Most students were given the credit when they used the information from the text.		
g	Potassium hydrogen tartrate is a weak acid, partially ionize in water to produce fewer hydrogen ions to react with sodium hydrogen carbonate; Hydrochloric acid is a strong acid, completely ionize in water to produce more hydrogen ions Reject: if no comparison is made between the two acids in terms of concentration of hydrogen ions	1 1	
	Comment: Most students were able to state the difference in the concentrations of hydrogen ions between the two acids due to the ionisation effect. However, some students did not clearly mention which acid produced more hydrogen ions.		

[Turn Over

	General comment: A handful of students left a few parts to this question unanswered due to time management issues.		
9a	Noble gases have duplet configuration for helium while octet configuration for neon, argon, krypton and xenon OR all the noble gases have 8 outer shell / valence electrons except for helium with 2;	1	
	Noble gases are unlikely to form ions resulting in a lack of reactivity OR noble gases do not need to lose or gain electrons	1	
	Comment: Many students failed to mention the duplet structure present in helium and just pure generalising that all the noble gases have an octet structure that explained their unreactivity.		**8**
b	Density of xenon = 131 / 24	1	
	= 5.46 g/dm^3	1	
	1 mark for correct calculation (ignore if without units) 1 mark to 3 sig. fig		
	Accept: 0.00546 g/cm^3		
	Comment: Most students were able to calculate the density of xenon with little difficulties.		
c	All the noble gases have boiling points lower than 25°C / room temperature	1	
	Comment: Many students failed to know that room temperature is 25°C and stated 37°C to be the incorrect room temperature. Students were not given the credit as they did not make a comparison between the boiling points of the noble gases with respect to the room temperature and just simply stated that all the noble gases have low boiling points. Most students are still weak in processing and analysing data in drawing conclusions.		
d	Xenon difluoride exists as discrete covalent molecules / simple covalent molecules / has a simple molecular structure	1	
	Weak intermolecular forces of attraction /weak van der waals' forces of attraction between molecules;	1	
	Little heat energy needed to overcome the weak forces of attraction	1	
	Comment: This question proved to be a challenging one for most students. Many students failed to recognise that the elements involved in xenon difluoride are non-metallic, hence forming covalent compounds. Some students mistook the compound as an ionic substance hence giving the wrong explanation. Many students are still weak in the topic of chemical bonding and structure of materials, hence unable to use the correct terms in explaining the properties of substances in terms of structure and bonding.		

10 EITHER			
a(i)	 	1,1	10
(ii)	Concentrated sulfuric acid	1	
(iii)	Solvents in perfumes	1	
b(i)		1	
	Addition reaction	1	
	Reject: hydration	1	
(ii)	Add aqueous bromine to both leaf alcohol and the product; Reddish brown aqueous bromine decolourises rapidly in leaf alcohol while aqueous bromine remains reddish brown in the product	1	
(iii)	 1 mark for each correct repeat unit	2	
	Comment: From this question, many students still failed in mastering the oragnic chemistry content. This was evident when pure recall kind of questions were asked and many students were not able to answer as they refused to memorise the reagents and conditions required for each organic reaction. Students need to spend time and effort in mastering the content in organic chemistry so that they can excel in their national examinations.		
OR a(i)	Add aqueous bromine to fumaric acid; Reddish brown aqueous bromine decolourises in fumaric acid	1	
(ii)		1	10

[Turn Over

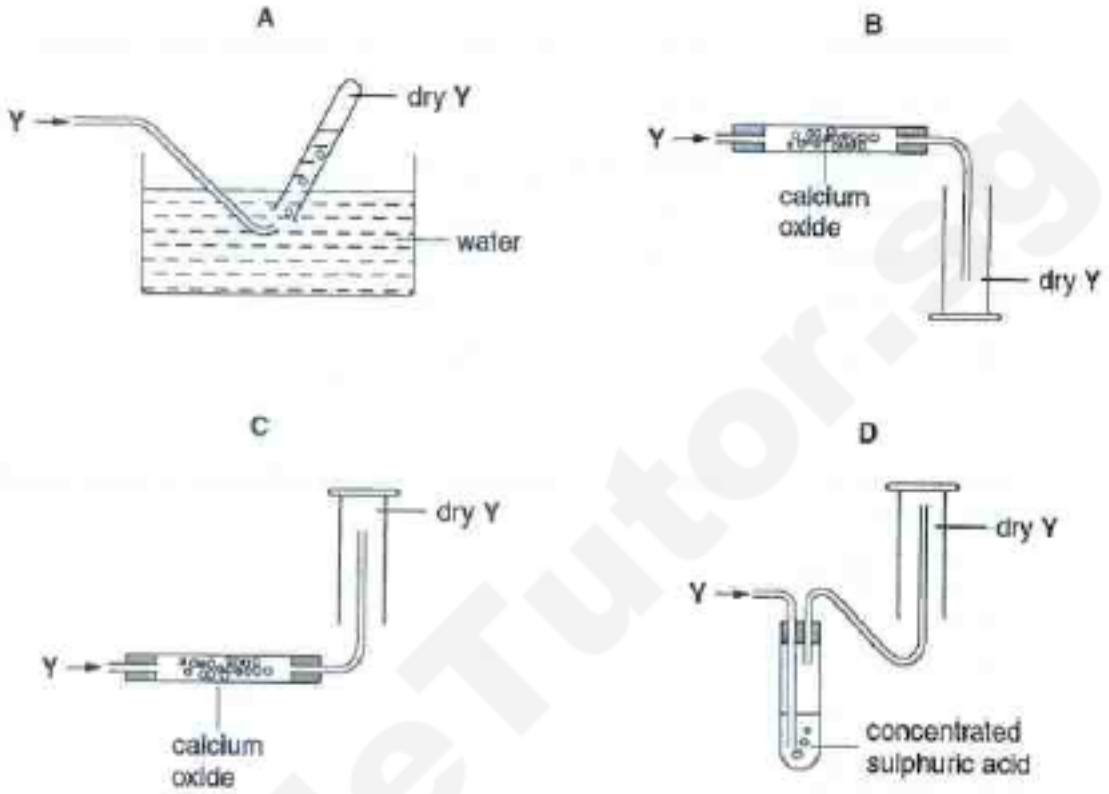
b(i)	$HO_2CCH{=}CHCO_2H + 2NaOH \rightarrow NaO_2CCH{=}CHCO_2Na + 2H_2O$	1	
(ii)	Number of moles of NaOH = 18/1000 x 0.200 = 0.00360 mol		
	Number of moles of fumaric acid = 0.00360 / 2 = 0.00180 mol	1	
	Concentration = 0.00180 / (60.0/1000) = 0.0300 mol/dm^3	1	
	Practice ecf from b(i)		
c	Ester linkage	1	
		1	
d		1	
e(i)	Polymers are non-biodegradable, thus need more landfills to contain polymers OR burning polymers produces toxic gases such as carbon monoxide	1	
(ii)	Difficult to sort into different types of polymers OR cheaper to recycle	1	
	Comment: in (a), most students were able to state the correct chemical test but did not further mention about the result obtained in the test. Some students failed to understand that after the addition reaction, the carbon-carbon double bonds would be broken to form single covalent bonds in the product structure. **Part (b) was a challenging question for the students as they failed to identify the two carboxyl groups that can undergo neutralisation recation with sodium hydroxide.** **Many students failed to include 'n' in the structural formula of the polymer and some students were still not able to draw the condensation polymer after the removal of water molecules.** **Part (e) was generally well answered as students better related the content to the subject mastery in humanities.**		

[Turn Over

SCGS 2017

1. A gas Y, is less dense than air, very soluble in water and is alkaline.

Which method is used to collect a dry sample of the gas?



2. The table gives data about four substances.

Which substance has particles that are closely packed in a disorderly arrangement at room temperature?

	melting point/°C	boiling point/°C
A	-114	- 80
B	-15	45
C	750	1407
D	1610	2230

3. Which of the following is the best method of obtaining pure water from ink?

A chromatography

B distillation

C filtration

D sublimation

4. The following measurements are made on a sample pure water: its boiling point, its freezing point, and its pH.

Sodium chloride is now dissolved in the water and the measurements repeated.

How do the measurements change?

	boiling point	freezing point	pH
A	higher	lower	no change
B	higher	higher	increases
C	lower	higher	no change
D	lower	lower	decreases

5. How many electrons in total are shared between the atoms in a molecule of ethene, C_2H_4, and in a molecule of water, H_2O?

	ethene	water
A	6	2
B	10	4
C	12	4
D	14	8

6. Which element forms a positive ion with the same electronic configuration as an atom of neon?

A chlorine

B magnesium

C lithium

D oxygen

7. How does rubidium bond with bromine?

A Each atom of rubidium receives an electron from a bromine atom.

B Each atom of rubidium shares a pair of electrons with a bromine atom.

C Each atom of rubidium shares an electron with a bromine atom.

D Each atom of rubidium gives an electron to a bromine atom.

8. Given that 1 mole of oxygen contains 6×10^{23} molecules, what is the number of molecules in 500 cm^3 of oxygen under room conditions?

A 1.25×10^{22}

B 1.34×10^{22}

C 3.0×10^{22}

D 3.0×10^{26}

9. When 1 volume of gas X reacts with exactly 5 volumes of oxygen it forms carbon dioxide and water only.

What is gas X?

A methane, CH_4

B ethane, C_2H_6

C propane, C_3H_8

D butane, C_4H_{10}

10. Which sulfide contains the greatest mass of sulfur in a 10 g sample?

sulfide	formula	mass of 1 mole/g
A	NiS	90
B	FeS_2	120
C	MoS_2	160
D	PbS	239

11. The relative atomic mass of oxygen is 16 and that of hydrogen is 1.

This means that ...(i)... of oxygen has the same mass as ...(ii)... of hydrogen.

Which words correctly complete the blanks (i) and (ii)?

	blank (i)	blank (ii)
A	an atom	thirty-two molecules
B	an atom	eight molecules
C	a molecule	sixteen atoms
D	a molecule	eight atoms

12. A 25 cm^3 sample of dilute sulfuric acid contains 0.025 moles of the acid.

What is the hydrogen ion concentration in the solution?

A 0.25 mol/dm^3

B 0.50 mol/dm^3

C 1.00 mol/dm^3

D 2.00 mol/dm^3

13. Which statement is most likely to be true for astatine, which is in Group VII of the Periodic Table?

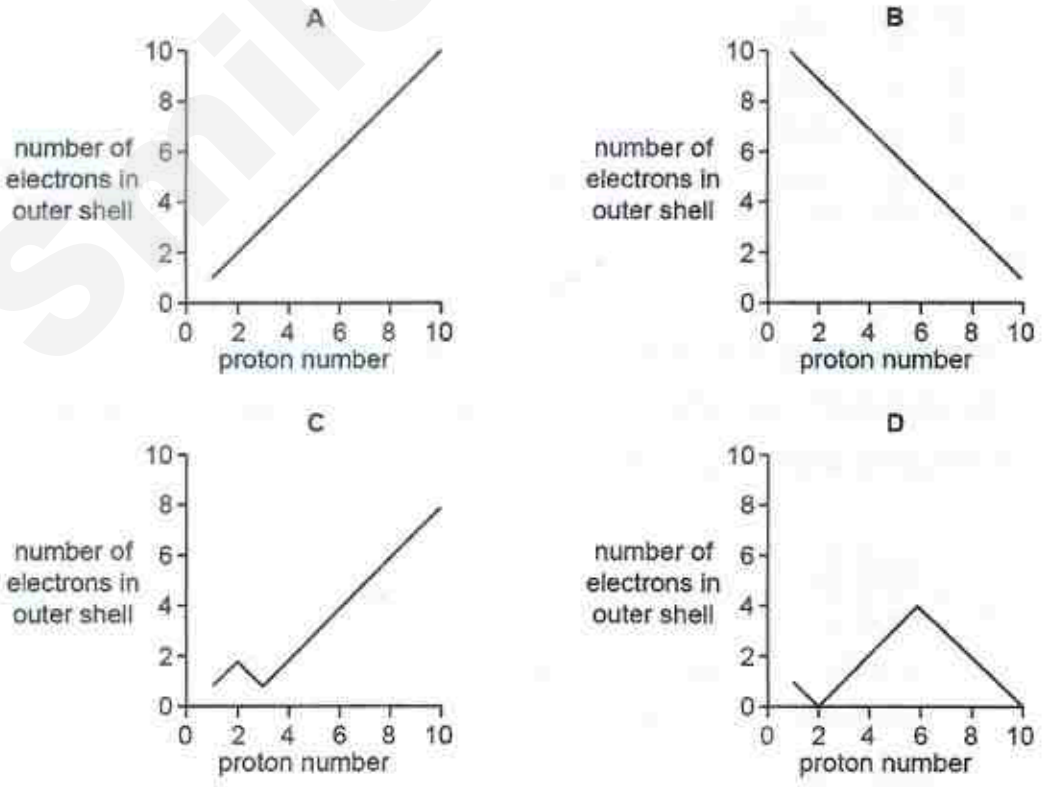
A Astatine and aqueous potassium chloride react to form aqueous potassium astatide and chlorine.

B Astatine reacts with hydrogen to form a compound with formula HAt_2.

C Aqueous potassium astatide reacts with aqueous silver nitrate to form aqueous silver astatide.

D Sodium astatide is less stable than sodium chloride.

14. Which graph shows the number of electrons in the outer shell of an atom, plotted against the proton (atomic) number for the first ten elements in the Periodic Table?



15. A chemist puts a sample of dilute aqueous hydrochloric acid into beaker 1. She adds a sample of zinc and measures the rate of production of hydrogen gas.

She then puts a different sample of dilute aqueous hydrochloric acid into beaker 2. She adds a different sample of zinc of the same mass and measures the rate of production of hydrogen gas.

The rate of the reaction in beaker 1 is slower than the rate of the reaction in beaker 2.

Which factors could help to explain this observation?

I The reaction in beaker 1 takes place at a lower pressure than the reaction in beaker 2.

II The zinc in beaker 1 is in larger pieces than the zinc in beaker 2.

III The acid in beaker 1 is at a lower concentration than the acid in beaker 2.

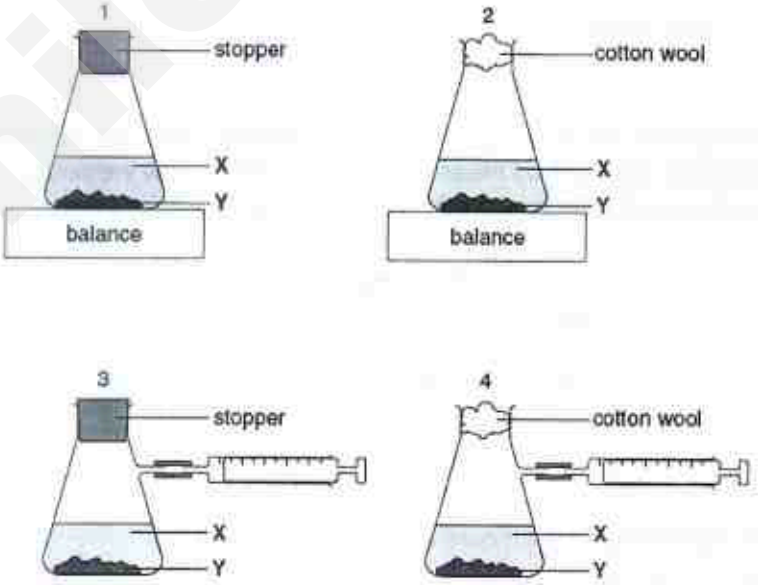
A I and II only

B II and III only

C I and III only

D I, II and III

16. A liquid X reacts with solid Y to form a gas. Which two diagrams show suitable methods for investigating the speed of the reaction?



A 1 and 3

B 1 and 4

C 2 and 3

D 2 and 4

17. The table gives information about the reactivity of three metals P, Q and R.

Metal	metal reaction with air	reaction with steam	reaction with dilute hydrochloric acid
P	burns with sparks	forms an oxide	forms hydrogen
Q	slowly forms an oxide	no reaction	no reaction
R	slowly forms an oxide	no reaction	forms hydrogen

What is the order of reactivity of P, Q and R?

	most reactive ⟶ least reactive		
A	P	Q	R
B	P	R	Q
C	Q	R	P
D	R	Q	P

18. Which of the following oxides can be reduced by heating with hydrogen?

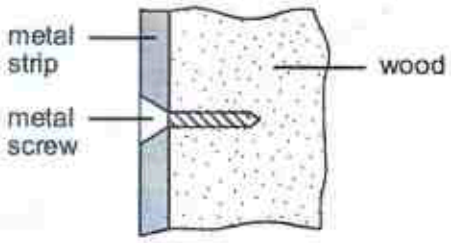
A copper(II) oxide

B calcium oxide

C potassium oxide

D zinc oxide

19. An old railway carriage is being restored. Metal strips are secured on to the outside of the wooden carriage by means of screws. After a few weeks open to the wind and rain, the screws are heavily corroded but the metal strips are not.



Which two metals would give this result?

	screws	strips
A	aluminium	steel
B	copper	aluminium
C	copper	steel
D	steel	aluminium

20. Which of the following is not a reaction that occurs when iron is extracted from haematite in the blast furnace?

A $CaCO_3 \rightarrow CaO + CO_2$

B $CO_2 + C \rightarrow 2CO$

C $FeO + CO \rightarrow Fe + CO_2$

D $CaO + SiO_2 \rightarrow CaSiO_3$

21. The oxide Pb_3O_4 reacts with dilute nitric acid to form lead(II) nitrate, lead(IV) oxide and another product.

What is the equation for this reaction?

A $Pb_3O_4 + 4HNO_3 \rightarrow 2Pb(NO_3)_2 + PbO_2 + 2H_2O$

B $Pb_3O_4 + 2HNO_3 \rightarrow 2PbNO_3 + PbO_4 + H_2$

C $Pb_3O_4 + 4HNO_3 \rightarrow Pb(NO_3)_4 + 2PbO + 2H_2O$

D $2Pb_3O_4 + 2HNO_3 \rightarrow 2Pb_2NO_3 + 2PbO_2 + H_2$

22. Magnesium oxide is added slowly to a beaker containing hydrochloric acid until the magnesium oxide is in excess.

Which of the following statements about this reaction are true?

I The temperature of the mixture increases.

II The pH of the mixture increases till pH 7.

III Effervescence is seen.

IV A white precipitate is observed.

A I and II only

B II and III only

C III and IV only

D I, II and IV only

23. Which reagent, when mixed and heated with ammonium sulfate, liberates ammonia?

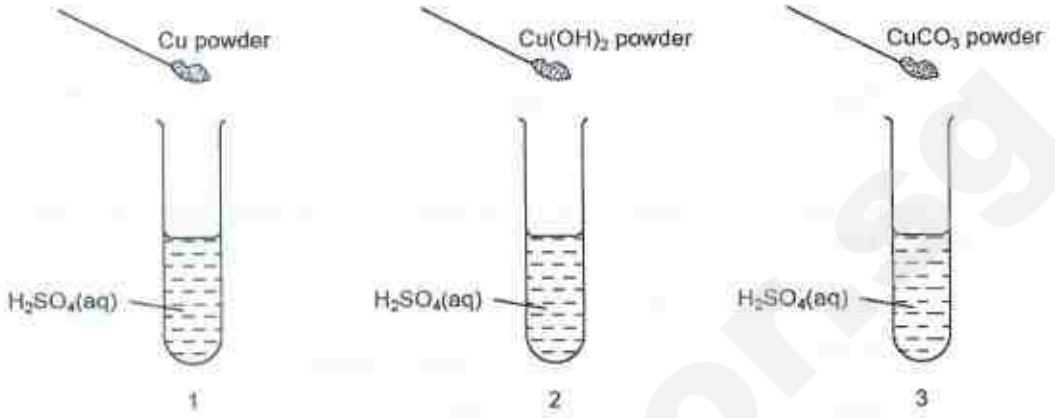
A aqueous bromine

B dilute hydrochloric acid

C limewater

D acidified potassium dichromate(VI)

24. The diagrams show three experiments using sulfuric acid. Three different powders are added to the acid. The mixtures are stirred.



Which test-tubes will contain aqueous Cu^{2+} ions?

A 1 and 2 only

B 2 and 3 only

C 1 and 3 only

D 1, 2 and 3

25. Which of the following reactants could be used to prepare a pure sample of potassium sulfate safely?

A potassium carbonate and sulfuric acid

B potassium and zinc sulfate

C potassium and sulfuric acid

D potassium nitrate and magnesium sulfate

26. A steel works and a chemical works are built near to a city. Limestone buildings in the city begin to crumble.

Which gas is most likely to cause this damage?

A oxygen

B carbon dioxide

C carbon monoxide

D nitrogen dioxide

27. Which of the following statements is true of sulfuric acid?

A It reacts with aqueous copper(II) chloride to produce a pale blue precipitate.

B It gives a white precipitate with aqueous barium nitrate.

C It reacts with aqueous silver nitrate to produce a white precipitate.

D It releases ammonia from aqueous ammonium sulfate.

28. The presence of nitrates in the soil can be shown by warming the soil with aqueous sodium hydroxide and aluminium foil. Which of the following shows that nitrates are present?

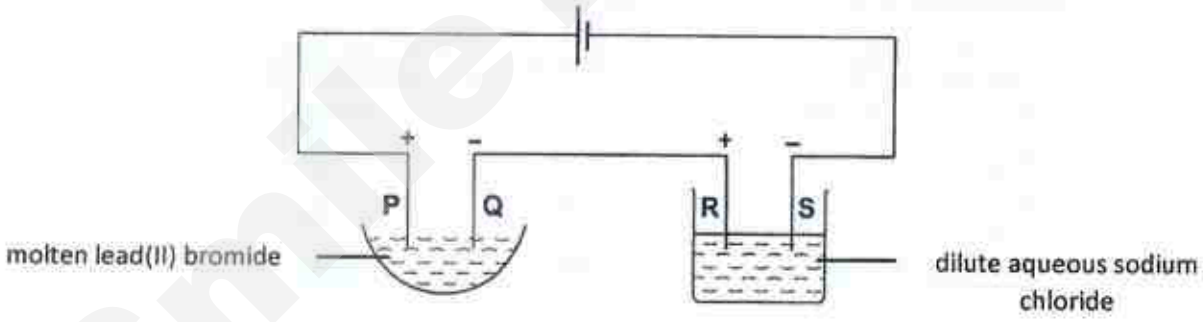
A A gas that extinguishes a lighted splint with a 'pop' sound is produced.

B A gas that turns moist red litmus blue is produced.

C A white precipitate is seen.

D Effervescence is seen.

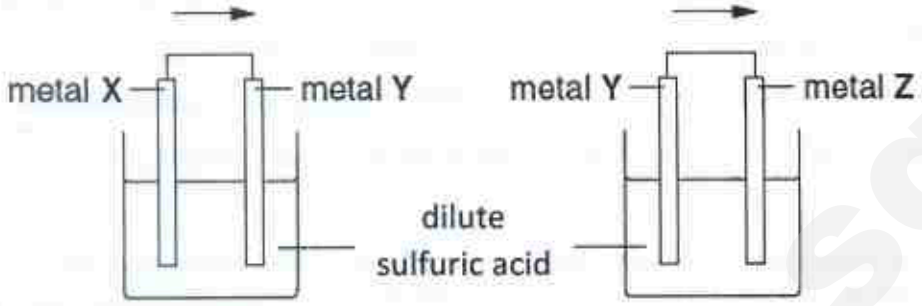
29. The following electrolysis circuit is set up, using inert electrodes P, Q, R and S.



At which of the electrodes is a Group VII element produced?

A P only B P and R only C Q only D Q and S only

30. Two cells were set up as shown in the diagram. The arrow shows the direction of electron flow in the external circuit.
Which set of metals would produce an electron flow in the direction shown?



	metal X	metal Y	metal Z
A	Ag	Cu	Zn
B	Ag	Zn	Cu
C	Cu	Zn	Ag
D	Zn	Cu	Ag

31. The table compares the strengths of the bonds for reactions of the type below.

$$X_2 + Y_2 \rightarrow 2XY$$

Which reaction would be most exothermic?

	bonds in X_2	bonds in Y_2	bonds in XY
A	strong	strong	strong
B	strong	strong	weak
C	weak	weak	strong
D	weak	weak	weak

32. In which reaction is the sign of energy change, ΔH, correctly shown?

	equation	ΔH
A	$2AgCl(s) \rightarrow 2Ag(s) + Cl_2(g)$	positive
B	$CH_4(g) \rightarrow C(g) + 4H(g)$	negative
C	$H_2O(l) \rightarrow H_2O(g)$	negative
D	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$	positive

33. Which compound contains two different elements with identical oxidation states?

A $HClO$ B $Mg(OH)_2$ C Na_2SO_4 D NH_4Cl

34. In which of the following reactions is the underlined substance reduced?

A $\underline{FeCl_2} + Cl_2 \rightarrow FeCl_3$

B $3CuO + \underline{2NH_3} \rightarrow 3Cu + 3\,H_2O + N_2$

C $\underline{MnO_2} + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

D $\underline{2H_2S} + SO_2 \rightarrow 2H_2O + 3\,S$

35. Bitumen is a substance obtained from the fractional distillation of crude oil. What are the boiling points and the sizes of the molecules in bitumen?

	boiling points	sizes of molecules
A	high	large
B	high	small
C	low	large
D	low	small

36. The table shows some properties of four hydrocarbons.

hydrocarbon	1	2	3	4
state at room temperature	gas	gas	liquid	liquid
reaction with aqueous bromine	decolourises bromine	no reaction	decolourises bromine	no reaction

Which of the following statements is true of the hydrocarbons?

A Hydrocarbons 1 and 2 are in the same homologous series.

B Hydrocarbons 2 and 4 are unsaturated.

C Hydrocarbon 1 has a lower relative molecular mass than hydrocarbon 3.

D Hydrocarbon 3 could be ethene.

37. Which of the following conditions are required to produce ethanol by fermentation?

	catalyst	temperature	Other condition
A	phosphoric acid	300°C	65 atm
B	enzymes in yeast	35 °C	Absence of oxygen
C	finely divided iron	450 °C	200 atm
D	nickel powder	150 °C	none

38. Which of the following compounds is produced in a reaction between propanoic acid and butanol?

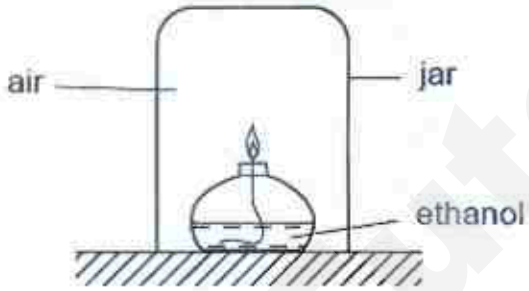
A $C_2H_5COOC_3H_7$

B $C_3H_7COOC_3H_7$

C $C_3H_7COOC_4H_9$

D $C_2H_5COOC_4H_9$

39. The diagram shows ethanol burning in a sealed jar.



The mass of one gas in the jar does not change. Which gas is this?

A oxygen

B nitrogen

C carbon dioxide

D water vapour

40. Which statement is correct about poly(chloroethene)?

A It is formed from the monomer chloroethane.

B It is a polymer formed when unsaturated monomers join together.

C Water molecules are eliminated in the process of polymerization.

D It is a macromolecule which conducts electricity like graphite.

2017 Sec 4 OLP Chemistry Preliminary Exam P1 answers

1-5	C	B	B	A	C
6-10	B	D	A	C	B
11-15	B	D	D	C	B
16-20	C	B	A	D	C
21-25	A	A	C	B	A
26-30	D	B	B	A	D
31-35	C	A	A	C	A
36-40	C	B	D	B	B

SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination
Secondary Four

CANDIDATE NAME

CLASS 4

INDEX NUMBER

CHEMISTRY

5073/02

Paper 2 Theory.

2 August 2017

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer **all three** questions, the last question is in the form either/or.
Answer all questions in the spaces provided.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 21.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	50
Section B	30
Total	80

This question paper consists of 20 printed pages and 2 blank pages.

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1 Sulfur and sulfur compounds are common in the environment.

(a) A sample of sulfur from a volcano contained 88.0% by mass of sulfur-32 and 12.0% by mass of sulfur-34.

(i) Complete the table below to show the atomic structure of each isotope of sulfur.

isotope	number of		
	protons	neutrons	electrons
sulfur-32			
sulfur-34			

[2]

(ii) Calculate the relative atomic mass of the volcanic sulfur. Your answer should be given to three significant figures.

[2]

(b) One of the gases produced during volcanic eruptions is hydrogen sulfide. Hydrogen sulfide is a poisonous, colourless gas which smells of rotten eggs.

(i) Draw a dot-and-cross diagram to represent the bonding in a hydrogen sulfide molecule. Show outer electrons only.

[2]

(ii) Using ideas of bonding and structure, explain why hydrogen sulfide gas does not conduct electricity.

.....

.....

.....

..... [2]

(c) Every year, between 20 and 50 million tonnes of sulfur are released into the atmosphere from the oceans in the form of DMS, a compound of carbon, hydrogen and sulfur.

The percentage composition by mass of DMS is 38.6% carbon, 9.7% hydrogen and 51.7% sulfur. Calculate the empirical formula of DMS, showing your working clearly.

[2]

[Total: 10]

A2 Zinc (proton number = 30) is not a typical transition element.

(a) State two properties of zinc that are not typical of transition elements.

.....

.....

..... [2]

(b) Name the reagents that can be used to prepare the following zinc salts and briefly describe how to obtain the solid product from the reaction mixture.

(i) Salt to be made: zinc carbonate

reagent 1: .....

reagent 2: .....

I could obtain solid zinc carbonate by: .....

.....

(ii) Salt to be made: zinc chloride

reagent 1: .....

reagent 2: .....

I could obtain solid zinc chloride by: .....

..... [4]

(c) A student is given a colourless solution **T**.

(i) Describe one chemical test and its result that would confirm that solution **T** contains zinc ions.

.....

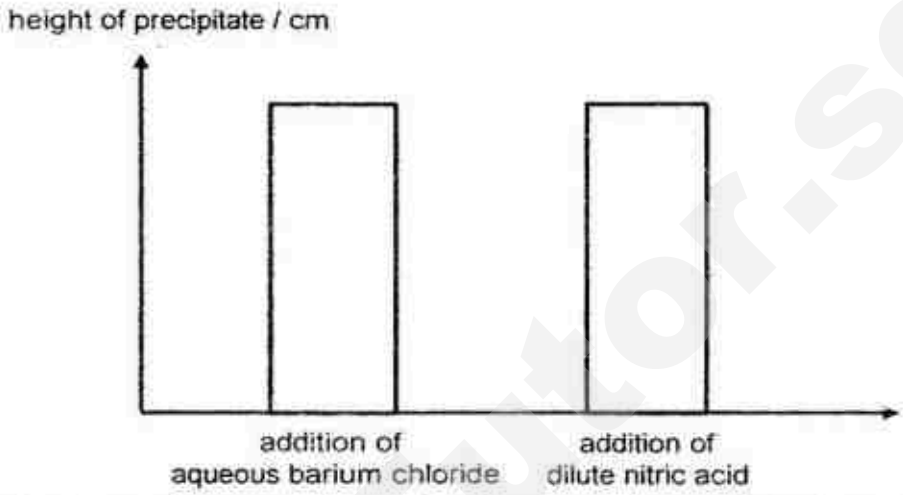
.....

..... [2]

(ii) To identify the anion present, the student performed the following tests.

1. Add aqueous barium chloride to solution **T**.
2. Measure height of precipitate formed after 5 minutes.
3. Add dilute nitric acid to the above mixture.
4. Measure height of precipitate formed after 5 minutes.

She presented her results obtained in a graph as shown below.



Deduce the anion present in solution **T** and explain your deduction with reference to the graph.

.....

.....

..... [2]

[Total: 10]

A3 Poly(propene) and nylon are synthetic polymers.
Poly(propene) is an addition polymer. Nylon is a condensation polymer.

(a) Describe two differences between addition polymers and condensation polymers.

.....

.....

.....

..... [2]

(b) Poly(propene) is formed by addition polymerisation of propene.

(i) Draw the structural formula of propene.

[1]

(ii) Draw the structural formula of the poly(propene).

[1]

(iii) Deduce the maximum mass of poly(propene) that could be produced from 1 kg of propene.

..... [1]

(c) The formula of the two monomers used to make nylon are shown below.

$HOOC(CH_2)_4COOH$ and $H_2N(CH_2)_6NH_2$

(i) Draw the repeat unit of nylon formed from these two monomers.

[1]

(ii) During the manufacturing process, the chain length of the nylon is controlled so that the nylon polymer molecules have an average relative molecular mass of 30 000.

What is the average number of repeat units in the nylon molecules? Show your working.

[2]

(d) Most synthetic polymers are non-biodegradable. Suggest one advantage and one disadvantage of using such polymers.

- advantage:

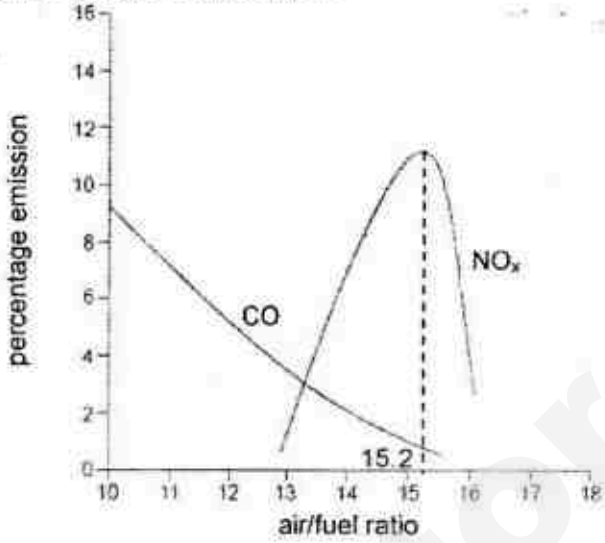
.....

- disadvantage:

..... [2]

[Total: 10]

A4 A car manufacturer conducted tests in which the air/fuel ratio in the engine was varied and the percentage emission of carbon monoxide, CO and nitrogen oxides, NO_x released was measured. The results are represented below.



(a) State and explain the effect of increasing the air/fuel ratio on CO emissions.

.....

..... [2]

(b) Explain why there is an increase followed by a decrease in the percentage emission of nitrogen oxides (NO_x) as the air/fuel ratio increases from 13 to 16.

.....

.....

..... [2]

(c) Catalytic converters are used in cars to reduce the amounts of carbon monoxide and nitrogen oxides produced.
The equation for one reaction that happens in the catalytic converter is:

$$2CO + 2NO \rightarrow 2CO_2 + N_2$$

(i) Use oxidation states to explain why is this a redox reaction.

.....

.....

..... [2]

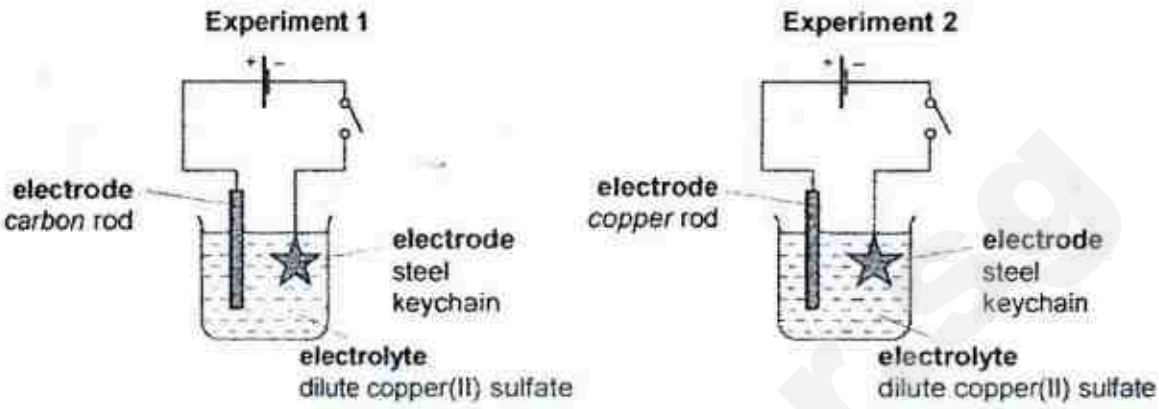
(ii) Explain why this reaction does not remove all the environmental problems caused by exhaust gases.

.....

..... [1]

[Total: 7]

A5 A student set up two experiments for electroplating steel keychains with copper. She closed both circuits for a period of time.



(a) Complete the table of information about the experiments.

experiment	electrodes	ionic equation, for reaction at each electrode
1	carbon rod	
	steel keychain	
2	copper rod	
	steel keychain	

[3]

(b) Describe and explain the **observations** seen in the electrolyte in each experiment.

Experiment 1:

.....

.....

.....

Experiment 2:

.....

.....

..... [4]

(c) **(i)** The student repeated **experiment 2** with another keychain. However, she left the keychain there without closing the circuit. Describe and explain one change she would **observe**.

.....

.....

.....

..... [2]

(ii) Intrigued by what she saw in **c(i)**, the student modified the set-up in **experiment 2**. She removed the battery, replacing it with a voltmeter. A deflection in the voltmeter is seen immediately upon closing the circuit.

Explain why a deflection in the voltmeter is observed, giving the relevant ionic equations for both electrodes.

.....

.....

.....

.....

..... [4]

[Total: 13]

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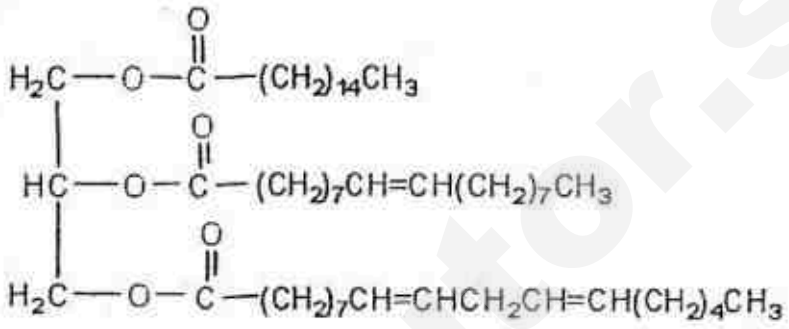
Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

B6 Fats and oils are triglycerides formed from the condensation reaction of propane-1,2,3-triol with long chain carboxylic acids (fatty acids). Each triglyceride is formed from three fatty acids.

The structural formula of a triglyceride likely to be found in peanut oil is shown below.



A triglyceride is considered a fat if it is a solid at 25 °C; it is an oil if it is a liquid at that temperature. These differences in melting points reflect differences in the degree of unsaturation and molar mass of the constituent fatty acids.

One method for checking the unsaturation level in fatty acids is by determining the iodine number. Iodine number is the number of grams of iodine consumed by 100 g of fat or oil. A higher iodine value indicates a higher degree of unsaturation.

The table below shows average figures for the percentage fatty acid composition of some common fats and oils.

source of fat or oil	% saturated fatty acids (total)	% monounsaturated fatty acid	% polyunsaturated fatty acids	
		oleic acid ($C_{17}H_{33}COOH$)	linoleic acid ($C_{17}H_{31}COOH$)	linolenic acid ($C_{17}H_{29}COOH$)
beef fat	59	38	3	-
coconut oil	90	8	2	-
corn oil	25	26	47	2
cotton seed oil	22	35	43	-
olive oil	15	78	7	-
soybean oil	14	28	50	8

The polyunsaturated/saturated (P/S) index of a fat or oil is the ratio of polyunsaturated fat to saturated fat. It is sometimes used to compare the relative health benefits of different fats and oils in the diet.

Passage is adapted from:

1. https://2012books.lardbucket.org/books/introduction-to-chemistry-general-organic-and-biological/s20-lipids.html
2. http://vlab.amrita.edu/?sub=3&brch=63&sim=1111&cnt=1

(a) Propane-1,2,3-triol reacts with fatty acids to form triglyceride.

(i) Based on the structural formula given, name the chemical linkage formed in the triglyceride.

..... [1]

(ii) Name the other product formed in this reaction.

..... [1]

(iii) Give the structural formulae of **two** reactants that are used to produce the triglyceride found in peanut oil.

- structural formula of propane-1,2,3-triol:

- structural formula of one of the carboxylic acids:

[2]

(b) Deduce, using data given in the table, which fat or oil from the table above has the lowest iodine number. Explain your answer.

.....

..... [1]

(c) Cotton seed oil and corn oil have similar iodine numbers but the melting point of cotton seed oil is higher than that of corn oil.
Suggest an explanation in terms of the structure and bonding in these two oils.

.....

.....

.....

..... [2]

(d) Linoleic acid is a polyunsaturated fatty acid with molecular formula of $C_{17}H_{31}COOH$.

How many double bonds between carbon atoms are present in one molecule of linoleic acid? Explain your answer.

.....

.....

.....

..... [2]

(e) A P/S value of greater than 1 is considered beneficial for health.

Calculate the P/S index of beef fat and soybean oil, giving your answers to 3 significant figures.

Hence determine which oil is more beneficial to health.

- P/S index of beef fat

- P/S index of soybean oil

..... [3]

[Total: 12]

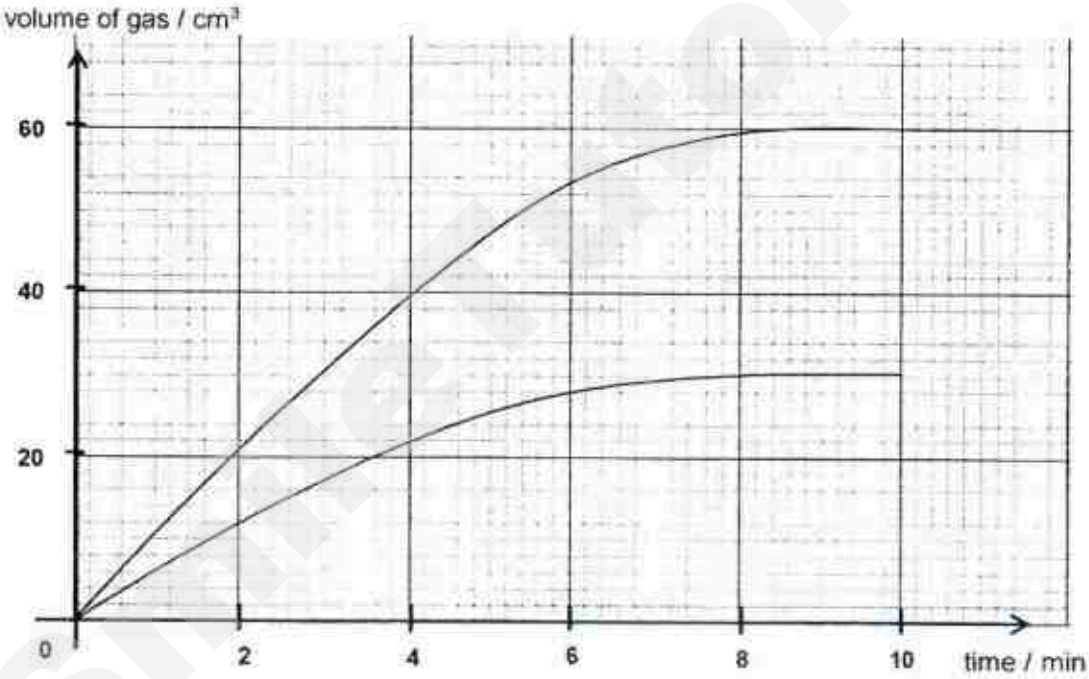
B7 A series of experiments was carried out to compare the rate of reaction of acid with magnesium carbonate under different conditions.

Excess magnesium carbonate and 25 cm^3 of acid were used. The conditions for each experiment are shown in the table below.

experiment	magnesium carbonate	type of acid used
A	lumps	0.1 mol/dm^3 of HCl
B	lumps	0.2 mol/dm^3 of HCl
C	lumps	0.1 mol/dm^3 of CH_3COOH
D	powder	0.2 mol/dm^3 of HCl

The gas given off was collected and its total volume was measured every 30 seconds for 10 minutes. The results obtained for experiment **A** and **B** were plotted in **Graph 1**.

Graph 1



(a) Label the curves **A** and **B** such that they correspond to the results for experiment **A** and experiment **B**. [1]

(b) Sketch and label on **graph 1** the curve you would expect for experiment **C**, assuming that the reaction stopped at the tenth minute. [1]

(c) Explain, in terms of collisions between reacting particles, why there is a difference in the initial rate of reaction between experiments **B** and **D**.

.....

.....

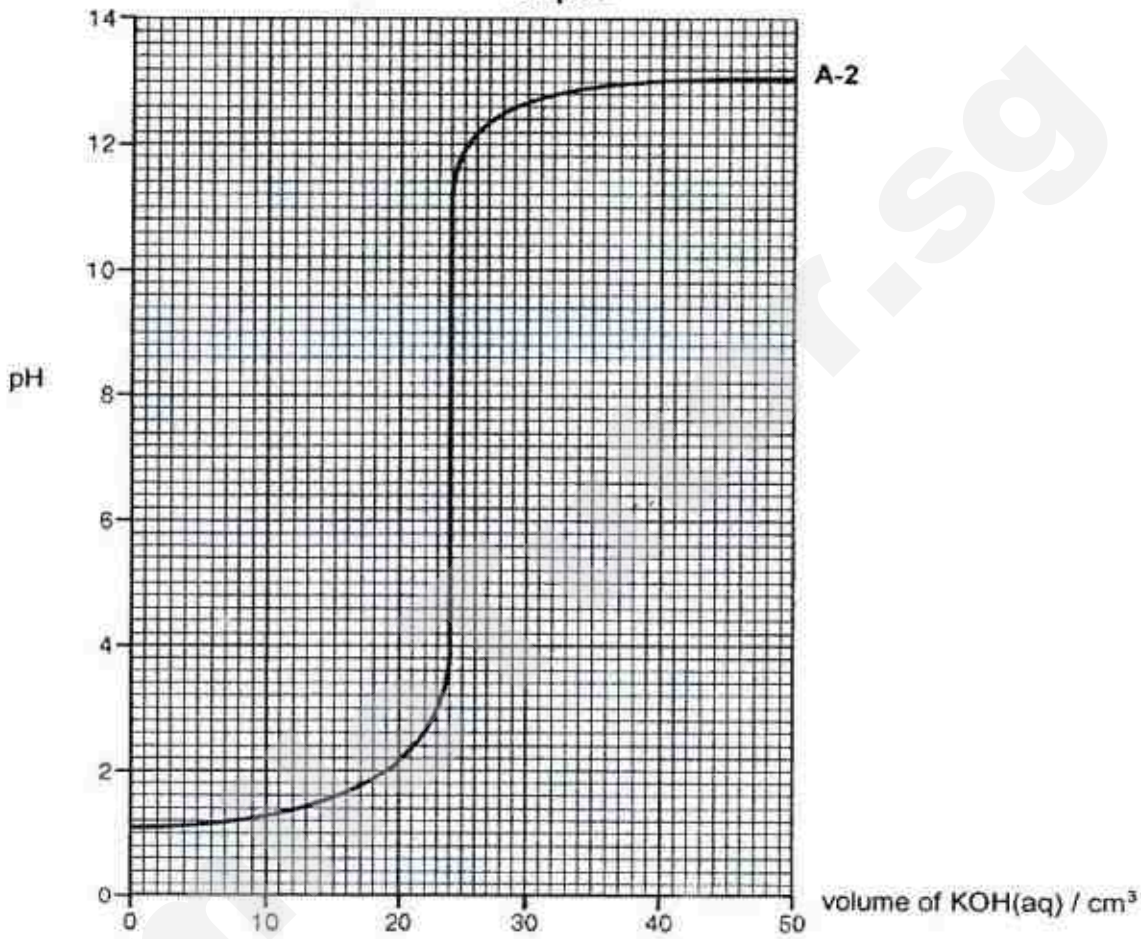
.....

..... [2]

The acids from experiments **A** and **C** are used in titration experiments with potassium hydroxide.

In **experiment A-2**, 0.1 mol/dm^3 of potassium hydroxide was added from a burette to 24.0 cm^3 of dilute hydrochloric acid. A pH probe attached to a computer measured the pH during the titration experiment. **Graph 2** below shows the results.

Graph 2



In **experiment C-2**, 0.1 mol/dm^3 of potassium hydroxide was added from a burette to 24.0 cm^3 of dilute ethanoic acid.

(d) State the pH value of hydrochloric acid used in **experiment A-2**. ..... [1]

(e) Given that the pH value of the ethanoic acid used in **experiment C-2** is **4**, sketch the curve you would expect for this experiment. You are to sketch the curve on **graph 2**. [1]

(f) The acids used in **experiment A-2** and **C-2** have the same concentration. Explain why they have different pH values.

.....

.....

.....

..... [2]

[Total: 8]

EITHER

B8 Petroleum is a naturally occurring yellow-to-black liquid found beneath the earth's surface. It consists of mainly hydrocarbons of various molecular masses.

(a) What is meant by the term *hydrocarbon*?

.....

..... [1]

(b) Dodecane is a hydrocarbon with molecular formula of $C_{12}H_{26}$. It undergoes cracking to produce butane and one other molecule **X**.

(i) Deduce the formula of **X**.

..... [1]

(ii) Draw the structure of

- straight chain **X**.

- branched chain isomer of **X**.

[2]

(iii) A few drops of aqueous bromine is added to separate samples of butane and **X**. Describe your observations.

.....

.....

.....

..... [2]

(c) The complete combustion of hydrocarbons produces carbon dioxide and water only.

10 cm^3 of a gaseous hydrocarbon **Y** was mixed with an excess of oxygen of volume 100 cm^3. The mixture was ignited. After cooling, the volume of remaining gases is 70 cm^3. When passed over aqueous sodium hydroxide, the total gas volume is further reduced to 20 cm^3.

Deduce the formula of the hydrocarbon **Y**, showing your workings clearly. All volumes were measured at r.t.p..

[4]

[Total: 10]

OR

B8 Ethanol is a renewable alcohol fuel made from plant material, such as sugar cane.

(a) Name the process used to produce ethanol from sugar.

..... [1]

(b) The complete combustion of ethanol is represented by the following equation.

$$CH_3CH_2OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l) \quad \Delta H = -1367 \text{ kJ/mol}$$

(i) Draw an energy profile diagram for the combustion of ethanol.

Your diagram should include labels for the reaction enthalpy change and activation energy.

[2]

(ii) Explain, in terms of bond breaking and bond making, why this reaction is exothermic.

.....

.....

.....

..... [2]

(c) Gasohol E10 is a mixture of ethanol and gasoline (petrol). The number after the "E" indicates the percentage of ethanol by volume. Most of the gasoline sold in the United States contains up to 10% ethanol.

Assume that the other 90% by mass of Gasohol E10 is octane, C_8H_{18}. 1.00 kg of this fuel mixture was burned.

$$CH_3CH_2OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l) \quad \Delta H = -1367 \text{ kJ/mol}$$

$$C_8H_{18}(l) + 12\tfrac{1}{2}O_2(g) \rightarrow 8CO_2(g) + 9H_2O(l) \quad \Delta H = -5470 \text{ kJ/mol}$$

(i) Complete the table by calculating the energy output for 1 g of each fuel, giving your answers to 3 significant figures.

name of fuel	enthalpy change of combustion / kJ per mole	energy output / kJ per gram
ethanol	– 1367	
octane	– 5470	

[2]

(ii) Calculate the total amount of energy, in kJ, released when 1.00 kg of the fuel mixture is completely burned, giving your answers to 3 significant figures.

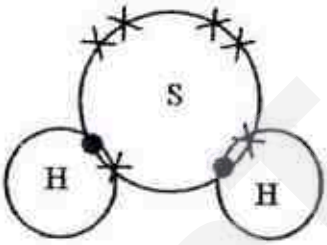
[3]

[Total: 10]

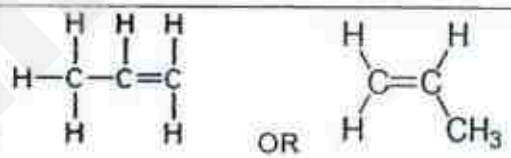
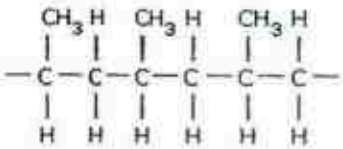
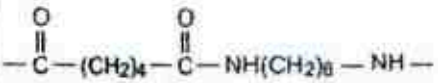
Singapore Chinese Girls' School
2017 Preliminary Exam
Secondary 4 OLP Chemistry

Suggested answers:

Section A [50 MARKS]

A1	(a)	(i)	Sulfur-32: 16, 16, 16 [1] Sulfur-34: 16, 18, 16 [1]		2
		(ii)	Relative atomic mass $= (\frac{88}{100} \times 32) + (\frac{12}{100} \times 34)$ [1] = 32.24 = 32.2 (3sf) [1]		2
	(b)	(i)		• 1M – sharing of electrons between H and S • 1M – correct valence electrons for S • Allow: 3 shells for S atom	2
		(ii)	Hydrogen sulfide has a <u>simple molecular / covalent structure</u> and exists as <u>neutral molecules</u>. [1] There are <u>no mobile charged particles</u> to conduct electricity. [1]		2
	(c)		Element: C; H; S Number of moles / mol: $\frac{38.6}{12}$ = 3.2167; $\frac{9.7}{1}$ = 9.7; $\frac{51.7}{32}$ = 1.6156 OR $\frac{51.7}{32.24}$ = 1.6036 Simplest ratio: $\frac{3.2167}{1.6156}$; $\frac{9.7}{1.6156}$; $\frac{1.6156}{1.6156}$	• 1M for correct number of moles • 1M for correct empirical formula	2

				= 2 OR $\frac{3.2167}{1.6036}$ = 2	= 6 OR $\frac{9.7}{1.6036}$ = 6	= 1 OR $\frac{1.6036}{1.6036}$ = 1		
			Empirical formula of DMS = C_2H_6S [1]					
A2	(a)		Any two: • Zinc does not have variable oxidation state in its compounds / Zinc has only one (fixed) oxidation state in its compounds. • Zinc does not form coloured compounds. • Zinc has low melting and boiling points.				• 1M for each point • Reject: Zinc has low density / its elements and/or compounds are not catalysts	2
	(b)	(i)	Reagent 1: zinc nitrate (or any other solution containing zinc ions) Reagent 2: sodium carbonate (or any other solution containing carbonate ions) Filter the mixture. (Wash the residue with deionised water.) Dry residue with filter papers.				• 1M for both reagents • 1M for brief description	2
		(ii)	Reagent 1: zinc / zinc oxide / zinc hydroxide / zinc carbonate Reagent 2: hydrochloric acid Filter the mixture. Heat filtrate till saturation. Cool to allow crystals to form. Filter and dry crystals with filter papers.				• 1M for both reagents • 1M for brief description	2
	(c)	(i)	Add a few drops, then in excess of aqueous ammonia to solution T. [1] White precipitate formed will dissolve in excess aqueous ammonia to form a colourless solution. [1]				Ignore test and results with NaOH(aq) – no credit	2
		(ii)	The height of the precipitate formed remained unchanged on adding barium chloride and dilute					2

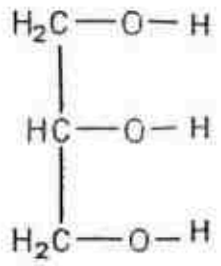
			nitric acid. This shows that an insoluble barium salt that does not react with acid is formed. [1] Hence, the anion present in solution T is sulfate ion / SO_4^{2-}. [1]		
A3	(a)		Any two: • Addition polymers are formed from (unsaturated) monomers containing carbon-carbon double bonds while condensation polymers are formed from monomers containing carboxyl and hydroxyl groups or carboxyl and amine groups. • Only the polymer is formed during the formation of addition polymers while the formation of condensation polymers produces the polymer and small molecules. • The empirical formula of the addition polymer is the same as its monomer while the empirical formula of condensation polymer is not the same as its monomer. • Addition polymers contain long chains of carbon-carbon atoms joined together while condensation polymers contain amide (or ester) linkages.	1M for each point	2
	(b)	(i)			1
		(ii)			1
		(iii)	1 kg		1
	(c)	(i)			1

		(ii)	M_r of each nylon repeating unit = (12 x 6 + 8 + 16 x 2) + (14 x 2 + 12 x 6 + 14) = 226 [1] Minimum number of repeat units $= \frac{30000}{226}$ = 132.7 = 132 or 133 (Allow either) [1]		2
	(d)		Advantage: The polymers can be used over a long period of time. / The polymers are long lasting / durable. [1] Disadvantage: More landfills sites will be required for disposal of these polymers, which takes up land space. [1]	Accept: Any other logical answers	2
A4	(a)		As the air/fuel ratio increase, the percentage of CO emissions decreases. [1] This is due to higher concentration of oxygen to allow more complete combustion (in car engine). [1]		2
	(b)		As air/fuel ratio increases from 13 to 15.2, the amount of air found in car engine increases. As a result, there will be <u>more nitrogen and oxygen</u> to react in the high temperature of the engine, increasing the percentage emission of nitrogen oxides. [1] However, as the air/fuel ratio increases from 15.2 to 16, the <u>temperature in engine decreases</u> with less fuel burning. As a result, there will be a decrease in the percentage emission of nitrogen oxides. [1]		2
	(c)	(i)	The oxidation state of carbon increase from +2 in CO to +4 in CO_2. [1]		2

			The oxidation state of nitrogen decreases from +2 in NO to 0 in N_2. [1] It is a redox reaction as CO is oxidised and NO is reduced.		
		(ii)	Carbon dioxide is produced and it is a greenhouse gas. It traps heat on Earth and causes temperature to rise / global warming.		1
A5	(a)		Experiment 1 Carbon rod: $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$ [1] Steel keychain: $Cu^{2+} + 2e^- \rightarrow Cu$ Experiment 2 Copper rod: $Cu \rightarrow Cu^{2+} + 2e^-$ [1] Steel keychain: $Cu^{2+} + 2e^- \rightarrow Cu$	1M for both equations at the steel keychain	3
	(b)		Experiment 1 The electrolyte changes from blue to colourless. [1] This is because the concentration of copper(II) ions decreases as the copper(II) ions are reduced at the cathode. [1] Experiment 2 No visible change for the electrolyte. / The electrolyte remains blue. [1] This is because the concentration of copper(II) ions remains the same, for every mole of copper(II) ions reduced at the cathode, one mole of copper is oxidised at the anode. [1]		4
	(c)	(i)	Any one: • 1st MP: The steel keychain is coated with a layer of reddish-brown / pink solid. OR Reddish-brown / pink solids are seen in the solution. OR The steel keychain decreases in size. 2nd MP:		2

			Iron (from the steel keychain) displaces copper(II) ions from its solution to form iron(II) ions and copper. • 1st MP: Copper(II) sulfate solution changes from blue to pale green. 2nd MP: Iron (from the steel keychain) displaces copper(II) ions from its solution to form iron(II) ions and copper.		
		(ii)	Iron being more reactive than copper, will oxidise/lose electrons to form iron(II) ions. [1] $Fe \rightarrow Fe^{2+} + 2e^-$ The electrons flow to the copper electrode. Copper(II) ions from the electrolyte gain electrons to form copper. [1] $Cu^{2+} + 2e^- \rightarrow Cu$ The movement of electrons causes the deflection in the voltmeter. [1]	1M for equations for both electrodes	4

Section B [30 MARKS]

B6	(a)	(i)	Ester linkage		1
		(ii)	Water		1
		(iii)	structural formula of propane-1,2,3-triol:  structural formula of one of the carboxylic acids:	1M each	2

			$HO-\overset{O}{\overset{\|\|}{C}}-(CH_2)_{14}CH_3$ OR $HO-\overset{O}{\overset{\|\|}{C}}-(CH_2)_7CH{=}CH(CH_2)_7CH_3$ OR $HO-\overset{O}{\overset{\|\|}{C}}-(CH_2)_7CH{=}CHCH_2CH{=}CH(CH_2)_4CH_3$		
	(b)		Coconut oil, as the percentage of unsaturation adds up to 10%, which is the lowest.		1
	(c)		Both cotton seed molecules and corn oil molecules have similar iodine numbers. Hence, their melting points is not dependent on the degree of unsaturation. Cotton seed oil molecules have higher molar mass / relative molecular mass than corn oil molecules. [1] Hence more energy is taken in to overcome the stronger intermolecular forces / Van der Waals' forces between molecules. [1]		2
	(d)		A saturated fatty acid with 18 carbon atoms has a molecular formula of $C_{17}H_{35}COOH$. [1] Since a decrease in 2 hydrogen atoms indicates the present of one carbon-carbon double bond in each molecule, each molecule of linoleic acid will contain two carbon-carbon double bonds. [1]	OWTTE	2
	(e)		P/S of beef fat $= \frac{3}{59} = 0.0508$ [1] P/S of soybean oil $= \frac{50+8}{14} = 4.14$ [1] Soybean oil is more beneficial to health. [1]		3
B7	(a)		Curve A – Produced 30 cm^3 of gas at the end of reaction	1M for both labels	1

			Curve B – Produced 60 cm^3 of gas at the end of reaction		
	(b)		Curve C – In comparison to curve A: (1) initial gradient to be more gentle & (2) same height		1
	(c)		Experiment B uses lumps of magnesium carbonate, which has bigger particle size and less exposed surface area. [1] This decreases the probability of collisions between magnesium carbonate particles and the hydrogen ions from the acids, which decreases the frequency of effective collisions, leading to a slower initial rate of reaction. [1]	Accept: Reverse argument for experiment D	2
	(d)		pH 1.1		1
	(e)		Similar curve to A-2, except for an initial pH value of 1.1 (same volume of KOH used & same height at the end of the reaction)		1
	(f)		1st MP: In experiment A, hydrochloric acid, a strong acid, ionises completely to produce hydrogen ions, while in experiment C, ethanoic acid, a weak acid, ionises partially to produce hydrogen ions. 2nd MP: Link pH value to concentration of hydrogen ions: Any one: • Ethanoic acid has a lower concentration of hydrogen ions and therefore has a higher pH value. • Hydrochloric acid has a higher concentration of hydrogen ions and therefore has a lower pH value. • Since the concentration of hydrogen ions is different, the pH value will be different.	1M for each Marking Point (MP)	2

E B8	(a)		Hydrocarbons are organic compounds containing hydrogen and carbon only.		1
	(b)	(i)	C_8H_{16}		1
		(ii)	Straight chain of C_8H_{16}	Correct diagram	1
			Any branched chain of C_8H_{16}	Correct diagram	1
		(iii)	There will be no visible change when aqueous bromine is added to butane. / Aqueous bromine remains reddish-brown when added to butane. [1] Aqueous bromine will change from reddish brown to colourless rapidly when added to X.		2
	(c)		Volume of CO_2 = 70 – 20 = 50 cm^3 [1] Volume of O_2 = 100 – 20 = 80 cm^3 [1] Let the formula of the hydrocarbon be represented by C_xH_y. C_xH_y : O_2 : CO_2 10 : 80 : 50 1 : 8 : 5 [1] $1C_xH_y + 8O_2 \rightarrow 5CO_2 + \_\_H_2O$ total no. of C atoms = 5 total no. of O atoms = 16 no. of O atoms in H_2O = 16 – 10 = 6 total no. of H atoms = 12 Formula of hydrocarbon = C_5H_{12} [1]		4
O B8	(a)		Fermentation		1
	(b)	(i)	Correct diagram	• 1M for Reactants, R labelled as	2

				$CH_3CH_2OH + 3O_2$ and Products, P labelled as $2CO_2 + 3H_2O$ AND correct shape of curve (R higher than P) and • 1M for correct labels for enthalpy change (R to P) AND activation energy (R to tip of curve)	
		(ii)	Energy taken in to break bonds in ethanol and oxygen is less than energy given out to form bonds in carbon dioxide and water. [1]	1M for identifying that the energy taken in is less than energy given out	2
	(c)	(i)	Energy given out for 1 g of ethanol $= \frac{1367}{2\times12+5+16+1} = \frac{1367}{46} = 29.7$ kJ / g (3 sf) [1] Energy given out for 1 g of octane $= \frac{5470}{8\times12+18} = \frac{5470}{114} = 48.0$ kJ / g (3 sf) [1]		2
		(ii)	Energy released when 1 kg of the fuel mixture is burned $= (\frac{10}{100} \times 1000 \times 29.717) + (\frac{90}{100} \times 1000 \times 47.982)$ = 2971.7 [1] + 43183.8 [1] = 46155.5 = 46200 kJ [1]		3

ST. MARGARET'S SECONDARY SCHOOL

Preliminary Examinations 2017

CANDIDATE NAME			
CLASS		REGISTER NUMBER	

CHEMISTRY **5073/01**

Paper 1 Multiple Choice **29 August 2017**

Secondary 4 Express **1 hour**

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and register number on the cover page in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions.
For each question, there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the Multiple Choice Answer Sheet provided.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 15.

For Examiner's Use	
Total	40
Parent's Signature	

This document consists of 15 printed pages.

1. Jamie wishes to measure the change in pH of solution as 48.0 cm^3 of sulfuric acid is added drop-wise to approximately 90 cm^3 of aqueous sodium hydroxide.

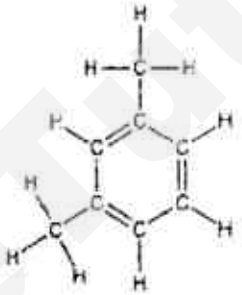
   Which of the following sets of apparatus should she use?

   I 25.0 cm^3 pipette
   II 50 cm^3 measuring cylinder
   III 50.0 cm^3 burette
   IV Data Logger

   A I and II only
   B II and III only
   C I, II and IV
   D II, III and IV

Use the following information to answer Questions **2**, **3** and **4**.

Xylene melts at −48°C and boils at 140°C. It has the following structural formula.



2. Which of the following rows of information about the temperature and movement of molecules in xylene is correct?

	temperature / °C	movement of molecules
A	−60	sliding over each other
B	−20	vibrating about fixed positions
C	80	sliding over each other
D	120	freely and randomly at high speeds

3. Which of the following substances is the least likely to dissolve in xylene?

   A iodine
   B methyl hexanoate
   C octane
   D sodium hexanoate

4. How many electrons in xylene are **not** used to form bonds?

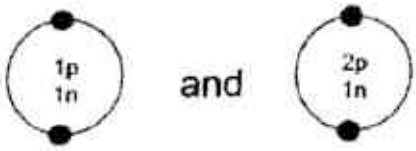
   A 8
   B 16
   C 21
   D 42

5. Which of the following statements about condensation is **false**?

A Average kinetic energy of the molecules decreases during condensation.
B Condensation is an exothermic process.
C Distance between particles greatly decreases during condensation.
D Particles are still in a disorderly arrangement after condensation.

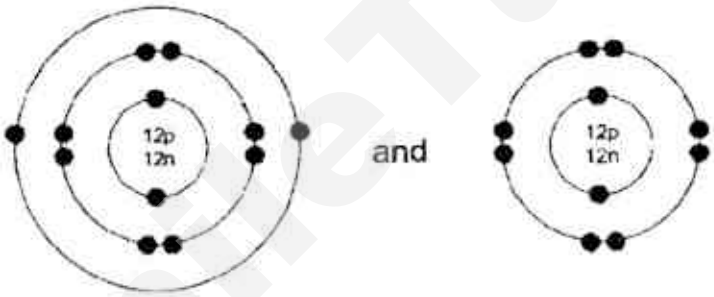
6. Which of the following diagrams correctly shows a pair of isotopes?

A

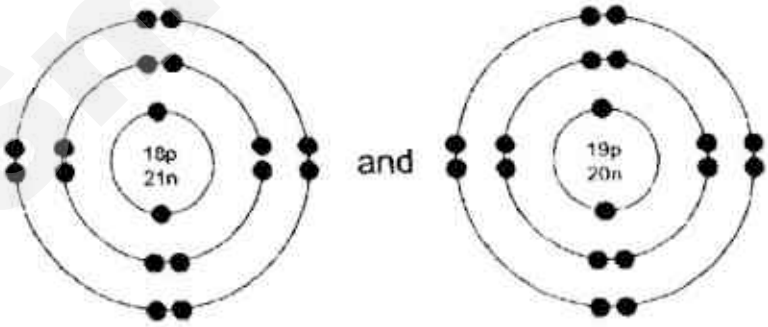


B

C



D



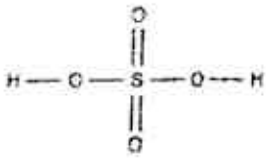
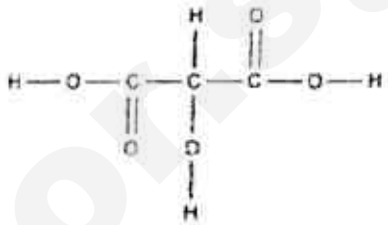
7. Which of the following substances contains only ionic bonds?

A hydrogen sulfide
B lithium sulfate
C manganese(II) oxide
D water

8. Which of the following can conduct electricity in only one physical state?

A diamond
B magnesium sulfate
C steel
D nitric acid

9. The structural formulae of four acids, **I** to **IV**, are shown below.

I	II
	
III	**IV**
	H — Cl

Which of the following statements about these four acids is **false**?

A I has the same basicity as **II**.
B I has a lower basicity than **III**.
C II is stronger than **IV**.
D II is weaker than **III**.

10. Which of the following pairs of reactants react to produce an acidic gas when warmed?

A ammonium chloride and calcium hydroxide
B lithium carbonate and sulfuric acid
C lead and nitric acid
D zinc and iron(II) nitrate

11. Which of the following rows of information correctly displays the reactants used to safely prepare a salt with the highest possible yield?

	reactants	salt to be prepared
A	calcium oxide and sulfuric acid	calcium sulfate
B	copper and hydrochloric acid	copper(II) chloride
C	lithium and hydrochloric acid	lithium chloride
D	zinc oxide and sulfuric acid	zinc sulfate

12. In which of the following processes is the underlined substance **not** acting as a basic oxide?

A $\underline{CaO} + 2\ HNO_3 \rightarrow Ca(NO_3)_2 + H_2O$
B $\underline{CaO} + SO_2 \rightarrow CaSO_3$
C $\underline{CuO} + ZnO \rightarrow CuZnO_2$
D $\underline{CuO} + Mg \rightarrow MgO + Cu$

13. Which of the following pairs of reactants can cause a colour change when mixed together?

A potassium bromide and bromine
B potassium bromide and iodine
C potassium chloride and bromine
D potassium iodide and chlorine

14. Which of the following statements about Group VII elements are true?

I They form diatomic molecules because they have the same number of valence electrons.
II They have increasing density down the group.
III Their strength as oxidising agents increases down the group.

A I only
B I and II only
C II and III only
D I, II and III

15. Which of the following metals reacts most vigorously with a beaker of cold water, without sinking to the bottom of the beaker?

A Li
B Ca
C Na
D Rb

16. Which of the following chemical equations represents a redox reaction?

A $H^+ (aq) + OH^- (aq) \rightarrow H_2O (l)$
B $Ag^+ (aq) + Cl^- (aq) \rightarrow AgCl (s)$
C $Fe (s) + 2\ HCl (aq) \rightarrow FeCl_2 (aq) + H_2 (g)$
D $CaCO_3 (s) + 2\ HNO_3 (aq) \rightarrow Ca(NO_3)_2 (aq) + CO_2 (g) + H_2O (l)$

17. Which of the following statements about the extraction of iron in the blast furnace is **false**?

A The formation of carbon monoxide happens in two steps.
B Silicon dioxide is removed by adding a basic oxide to it.
C Carbon monoxide reduces iron(III) oxide.
D The exhaust gases are composed mainly of carbon dioxide.

18. The following table provides information on the colours displayed by a few pH indicators.

pH indicator	Colour in strong acid	pH at which colour changes	Colour in strong alkali
Bromophenol Blue	yellow	3.0 – 4.6	blue
Clayton Yellow	yellow	12.2 – 13.2	orange
Resorcin Blue	red	4.2 – 6.2	blue
Thymophthalein	colourless	9.4 – 10.6	blue

Which of the following statements about these indicators is most likely to be true?

A Ethanoic acid will cause Bromophenol Blue to turn yellow only.
B Hydrochloric acid will cause Clayton Yellow to turn yellow.
C Sodium chloride will cause Resorcin Blue will turn red.
D Weak alkalis cause Thymophthalein to turn blue only.

19. Which of the following comprises the largest number of atoms?

A 2 mol of PCl_5
B 3 mol of CH_4
C 4 mol of H_2O
D 5 mol of CO

20. The equation for the complete combustion of ethane is shown below.

$$2\ C_2H_6 + 7\ O_2 \rightarrow 4\ CO_2 + 6\ H_2O$$

20 cm^3 of C_2H_6 is combusted with 140 cm^3 of O_2. The resulting mixture of gases is cooled to room temperature and pressure.

Which of the following statements about this is true?

A 60 cm^3 of liquid H_2O is formed.
B 70 cm^3 O_2 is not reacted.
C 80 cm^3 of gaseous CO_2 is formed.
D 100 cm^3 of gaseous products are left behind.

21. Which of the following substances has the highest percentage composition of the underlined element?

A $C_6H_{12}\underline{O}_6$
B $C\underline{O}_2$
C $\underline{N}H_3$
D $\underline{N}HF_2$

22. Which of the following statements about Group VII elements is true?

A Colour intensity decreases down the group.
B Density decreases down the group.
C Strength of intermolecular forces of attraction increases down the group.
D Tendency to gain electrons increases down the group.

23. Which of the following statements best shows that an element is a transition metal?

A It has good electrical conductivity.
B It has a high density.
C It has a tendency to lose electrons.
D It has variable oxidation states.

24. Which of the following rows of information about the gases in the table below is correct?

	gas	causes global warming	causes irritation to respiratory system	causes acid rain	is poisonous
A	CH_4	yes	no	no	yes
B	CO	no	yes	yes	no
C	NO_2	no	no	yes	yes
D	O_3	no	yes	no	yes

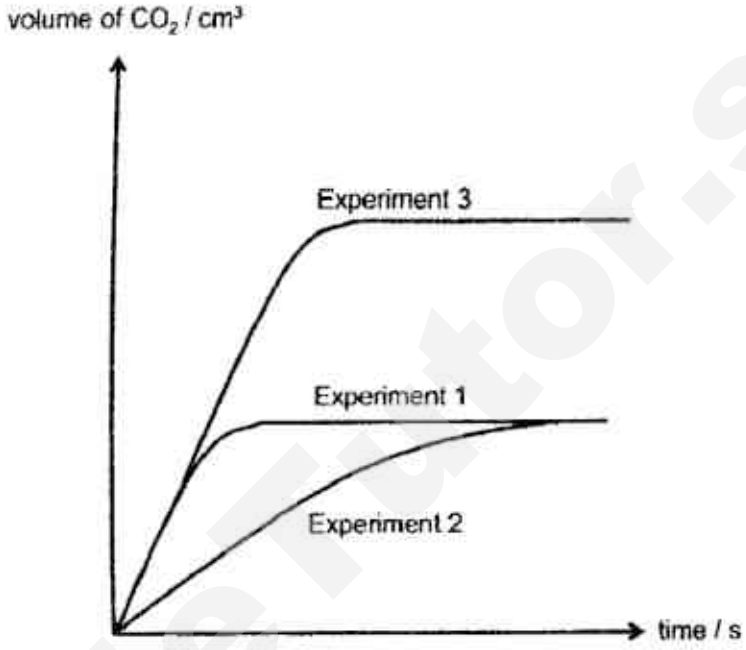
25. Which of the following chemical equations does **not** represent a process that occurs in the catalytic converter of a car?

A $2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$
B $2\ CO + O_2 \rightarrow 2\ CO_2$
C $2\ N_2 + O_2 \rightarrow 2\ N_2O$
D $2\ NO + 2\ CO \rightarrow N_2 + 2\ CO_2$

26. In **Experiment 1**, 10 g of fine powdered $CuCO_3$ was reacted with excess 1 mol/dm^3 HNO_3.

Experiments 2 and **3** were also carried out by using $CuCO_3$ and excess HNO_3, but with varying masses, particle size and concentration of HNO_3.

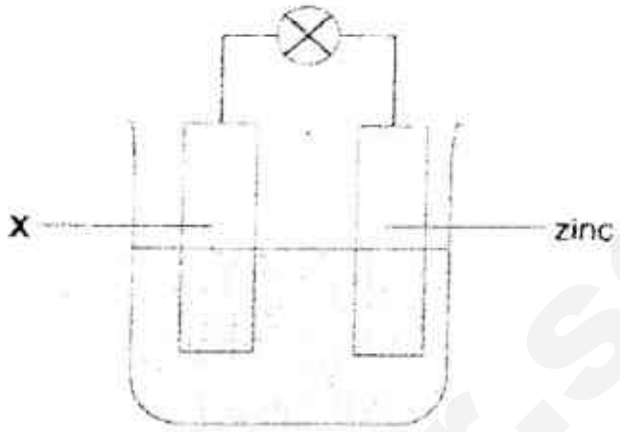
The volume of CO_2 evolved in each experiment was measured over time, and the results shown in the corresponding graph below.



Which of the following sets of conditions corresponds to **Experiments 2** and **3**?

	Experiment 2			Experiment 3		
	particle size of $CuCO_3$	mass of $CuCO_3$ / g	concentration of HNO_3 / (mol/dm^3)	particle size of $CuCO_3$	mass of $CuCO_3$ / g	concentration of HNO_3 / (mol/dm^3)
A	coarse	5	1	fine	10	2
B	coarse	10	1	coarse	10	2
C	fine	5	0.5	coarse	20	1
D	fine	10	0.5	fine	20	1

27. Metal **X** and zinc are connected to a lightbulb, as shown in the following diagram.



Which of the following metals should **X** be, such that the bulb shines the brightest?

A Aluminium
B Copper
C Lead
D Magnesium

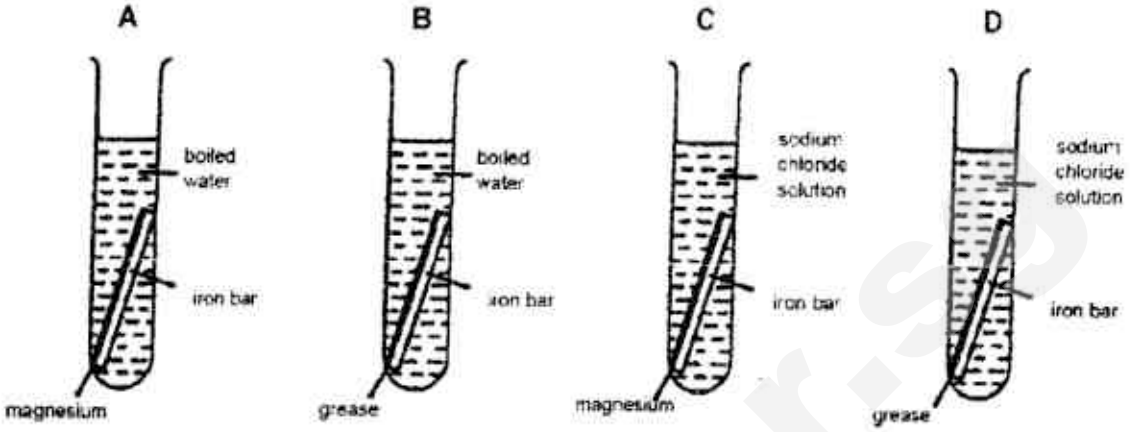
28. The following information is provided on three metals, **X**, **Y** and **Z**.

X is obtained when its metal oxide is strongly heated.
Y reacts vigorously with cold water.
Z can be extracted from its oxide by reduction with carbon, but not hydrogen.

What is the order of reactivity of the metals, from the most to least reactive?

A X, Z, Y
B Y, X, Z
C Y, Z, X
D Z, Y, X

29. Four iron bars were coated on one side with different materials and placed in separate test-tubes, as shown below. In which test tube would corrosion of the iron bar be the slowest?

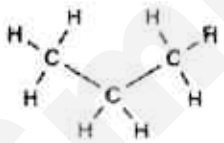


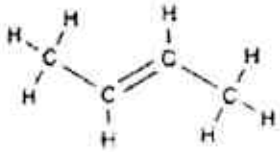
30. Sulfur dioxide gas is bubbled through solutions of potassium manganate (VII) and potassium iodide separately.

Which of the following observations are correct?

	potassium manganate (VII)	potassium iodide
A	no visible reaction	colourless solution turns brown
B	no visible reaction	no visible reaction
C	purple solution decolourises	no visible reaction
D	purple solution decolourises	colourless solution turns brown

31. Which of the following molecules has only one other possible isomer?

A


B


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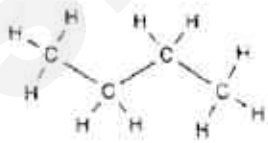
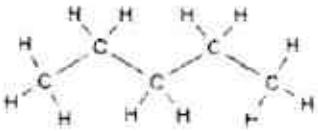
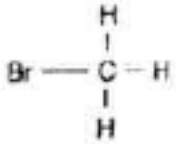


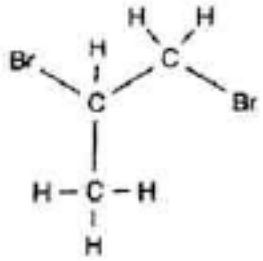
D


32. Which of the following molecules could **not** have been formed from the reaction of one molecule of bromine with a hydrocarbon?

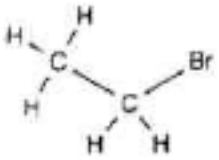
A



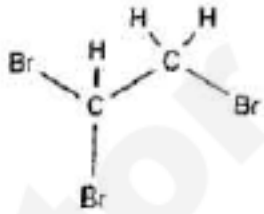
B



C



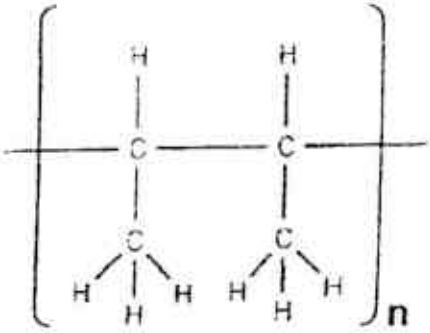
D



33. Which of the following rows of information about reactions of organic molecules is correct?

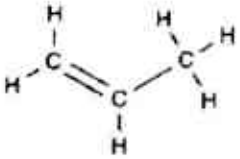
	chemical reaction	temperature / °C	catalyst
A	addition of steam to alkene	300	none
B	cracking of long chain alkanes	30	SiO_2
C	esterification of alcohols and carboxylic acids	15	H_2SO_4
D	hydrogenation of alkenes	150	Ni

34. The structural formula of a polymer is shown below.

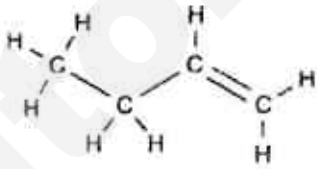


Which of the following correctly represents the structural formula of the monomer used to make this polymer?

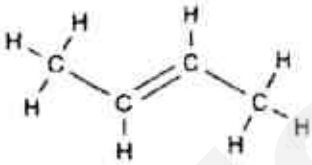
A



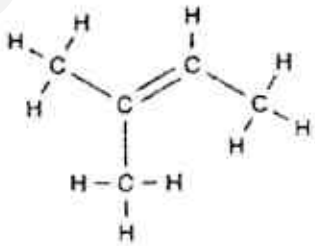
B



C



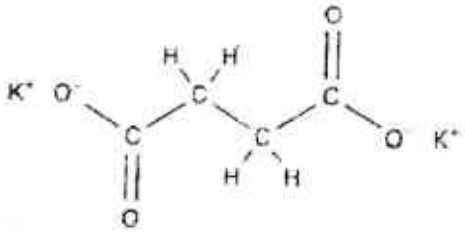
D



35. Which of the following uses of petroleum fractions is **incorrect**?

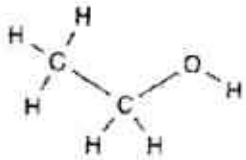
	petroleum fraction	**use**
A	diesel	fuel for road vehicles
B	kerosene	fuel for aircraft
C	naphtha	fuel for candles
D	petroleum gas	fuel for cooking stoves

36. An alcohol, **X**, was completely oxidised to produce a carboxylic acid. This carboxylic acid was reacted with potassium hydroxide to produce a salt, which has the structural formula displayed below.

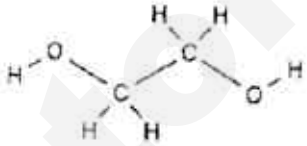


Which of the following represents the structure of alcohol **X**?

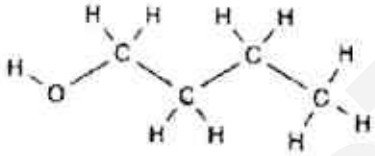
A



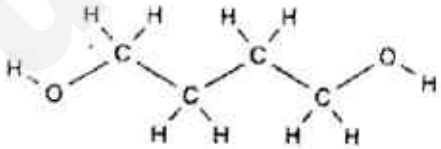
B



C



D



37. Which process would produce water as a by-product?

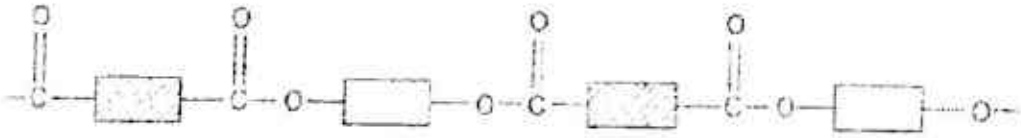
A formation of an amide from an amine and a carboxylic acid
B manufacture of margarine from vegetable oils
C photosynthesis in plants
D polymerisation of propene

38. Within a simple molecular structure, the strength of the intermolecular forces of attraction is dependent on the M_r of the molecules.

Which of the following has the largest intermolecular forces of attraction?

A ethane
B hexane
C monochloroethane
D monochlorohexane

39. Part of the structural formulae of terylene is shown below.



Which statement about terylene is **incorrect**?

A Each monomer has a hydroxyl group and a carboxyl group.
B It is formed from many reactions between carboxyl groups and hydroxyl groups.
C Terylene contains ester linkages.
D The process that forms terylene is called condensation polymerisation.

40. Which of the following rows of information about the complete combustion of organic compounds is most likely to be correct?

	compound	**products of complete combustion**
A	$CH_2ClCONHCH_3$	CO_2, NO_2 and H_2O only
B	CH_3SH	CO_2 and SO_2 only
C	CH_3CH_2Cl	CO_2, H_2O and Cl_2O only
D	$C_6H_5NO_2$	CO_2 and H_2O only

SMSS 4E Chem 5073 Prelim 2017

P1 Answers

1	D	6	B	11	D	16	C	21	C	26	D	31	C	36	D
2	C	7	C	12	D	17	D	22	C	27	B	32	D	37	A
3	D	8	D	13	D	18	B	23	D	28	C	33	D	38	D
4	B	9	C	14	B	19	B	24	D	29	A	34	C	39	A
5	A	10	B	15	C	20	B	25	C	30	C	35	C	40	C

ST. MARGARET'S SECONDARY SCHOOL

Preliminary Examinations 2017

Founded 1842

CANDIDATE NAME			
CLASS		REGISTER NUMBER	

CHEMISTRY **5073/02**

Paper 2 **28 August 2017**

Secondary 4 Express **1 hour 45 minutes**

Additional Materials: NIL; candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use an 2B pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form either/or.
Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 20.
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	50
Section B	30
Total	80

This document consists of 20 printed pages.

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1. A list of substances is provided for you in the space below. You may use each substance once, more than once, or not at all.

zinc hydroxide	sodium chloride	nitrogen dioxide	potassium nitrate
magnesium oxide	ammonium sulfate	lead(II) hydroxide	carbon monoxide
iron(II) carbonate	carbon dioxide	calcium carbonate	hydrogen peroxide

From the list above, choose one substance that

(a) forms a green solution when added to hydrochloric acid.

_____ [1]

(b) causes an aqueous solution of Universal Indicator to turn red when added to it.

_____ [1]

(c) reacts separately with sulfuric acid and sodium hydroxide to form salts.

_____ [1]

(d) dissolves in excess sodium hydroxide, but not in excess aqueous ammonia.

_____ [1]

(e) produces an alkaline gas only when heated with sodium hydroxide and a piece of aluminium foil.

_____ [1]

(f) can be used to extract iron from its oxide.

_____ [1]

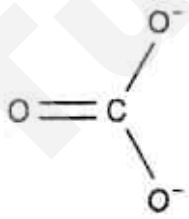
[Total: 6 marks]

A2. *Refractory* materials are used to line the insides of ovens and furnaces, due to their *ability to withstand high temperatures without melting*. One example of this is magnesite, an ionic compound which has the formula $MgCO_3$.

(a) Draw the electronic structure of the positive ion in magnesite.
Show only the valence electrons.

[2]

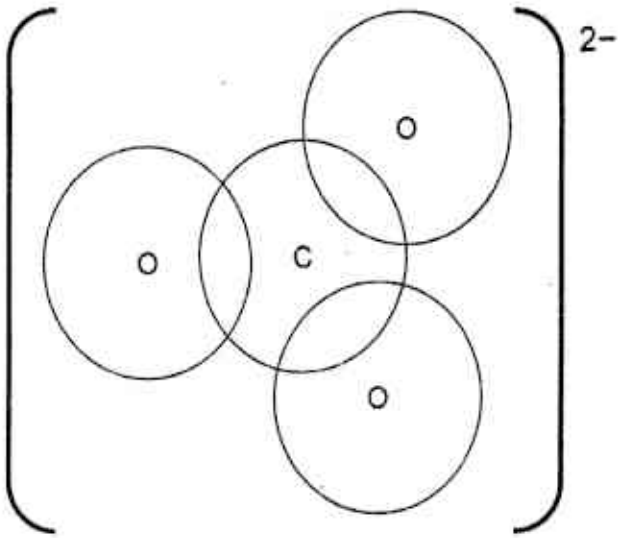
(b) The carbonate ion has the structural formula shown below.



carbonate ion

The negative charge on each single bonded oxygen atoms show that an electron has been gained by that oxygen atom.

Hence, complete the dot-and-cross diagram for the carbonate ion below, showing only the valence electrons.



[2]

(c) With prolonged exposure high temperature, magnesite decomposes to form two compounds, solid **A** and gas **B**.

(i) Identify **A** and **B**.

A: _____

B: _____ [1]

(ii) Describe a chemical test for the formation of gas **B**.

_____

_____ [2]

(iii) Magnesite decomposes to form solid **A**, which still can be used as a *refractory* material. Explain why, using ideas about the *bonding*, *structure* and *particles* present in solid **A**.

_____

_____

_____

_____ [3]

[Total: 10 marks]

A3. The outcome of an electrolysis experiment can be affected by two factors: the type of electrolyte used and the type of electrode used.

(a) In three separate experiments, molten zinc chloride, dilute zinc chloride and concentrated zinc chloride were electrolysed using *inert* graphite electrodes.

(i) Explain what is meant by *inert electrode*.

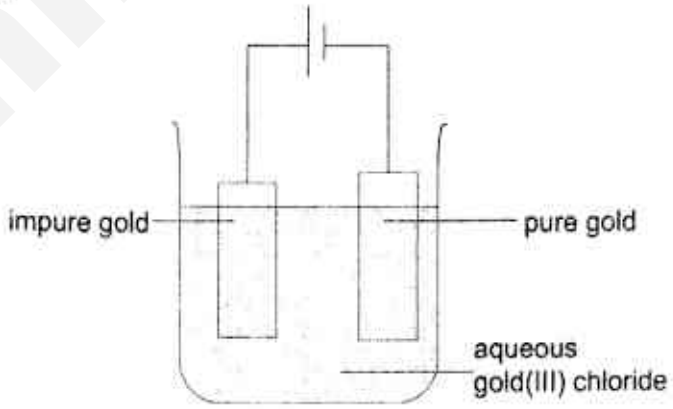
_____ [1]

(ii) Complete the table below.

electrolyte	molten zinc chloride	dilute zinc chloride	concentrated zinc chloride
product formed at cathode			
product formed at anode	chlorine		
substance left behind after electrolysis	none	zinc chloride	

[3]

(b) Gold electrodes are used in the electrolytic refining of gold metal. The electrolyte used is dilute aqueous gold(III) chloride, an orange solution. This is shown in the diagram below.



(i) Write down half equations, with state symbols, for the reactions occurring at the anode and cathode.

Anode: _____

Cathode: _____ [3]

(ii) Describe what is observed at the positive and negative electrodes, when the setup shown above is used for electrolysis.

_____

_____ [1]

(iii) Describe what is observed at the *positive electrode* and *in the electrolyte*, when an inert platinum electrode is used instead of an impure gold electrode.

_____

_____ [2]

[Total: 10 marks]

A4. **(a)** For most metallic objects in everyday use, great care is taken to prevent or slow down the effect of corrosion on the metal.

(i) Most chefs "season" their iron cooking pans by strongly heating a thin layer of cooking oil until it forms a coating on the surface of the pan.

Explain how this coating slows down the effect of corrosion.

_____

_____ [2]

(ii) The steel hulls of ships usually protected from corrosion by attaching a block made of magnesium to the hull.

Explain how this prevents the corrosion of the steel hull.

_____

_____ [2]

(b) In the early 1800s, Sir Humphry Davy discovered that sodium metal could be added to water to produce an alkali and a gas.

(i) Write down a balanced chemical equation for this reaction.

_____ [1]

(ii) 23.85 cm^3 of 1.5 mol/dm^3 of the alkali mentioned in **(b)(i)** is required to neutralise 1.82 g of $C_6H_4O_8$, which is a carboxylic acid.

Determine the number of –COOH groups present in one molecule of $C_6H_4O_8$.

[4]

[Total: 9 marks]

A5. Ethanoic acid is a weak acid. It can be used to prepare lead(II) ethanoate, a soluble ionic compound.

(a) Define the term *weak acid*.

_____

_____ [2]

(b) Describe what will be observed when a few drops of Universal Indicator are added to a 1 mol/dm^3 solution of ethanoic acid.

_____ [1]

(c) Briefly outline a method for the preparation of an aqueous solution of lead(II) ethanoate from ethanoic acid.

_____

_____

_____ [2]

(d) The lab technician has discovered that the labels on the bottles of ethanoic acid and nitric acid have fallen off.

Describe a test to show how you would distinguish between both acids, without the use of a data logger or pH indicators.

_____

_____ [2]

[Total: 7 marks]

A6. Among the Period 2 elements, nitrogen possesses the rare property of being able to form a few different types of oxides. These oxides of nitrogen can be found in waste gases that are produced by factories that operate at high temperature.

(a) An oxide of nitrogen was discovered to contain 69.6% of oxygen by mass.

(i) Calculate its empirical formula.

[2]

(ii) Given that the M_r of this oxide of nitrogen is 92, determine its molecular formula.

[1]

(iii) Hence write down a balanced chemical equation for the formation of this oxide of nitrogen, from nitrogen and oxygen.

_____ [1]

(b) Write down the chemical formula of a solid substance that can be used to remove this oxide of nitrogen from factory waste gases.

_____ [1]

(c) Apart from waste gases from factories, suggest one other source that produces oxides of nitrogen as a pollutant.

_____ [1]

(d) Describe one negative impact of the release of oxides of nitrogen into the atmosphere.

_____

_____ [2]

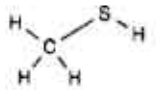
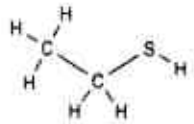
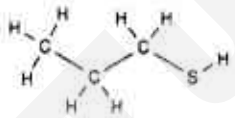
[Total: 8 marks]

Section B

Answer all **three** questions from this section.
The last question is in the form of an either/or and only **one** of the alternatives should be attempted.

B7. Thiols are organic compounds that contain the sulfhydryl functional group, −S−H. They are considered to be similar to alcohols in some aspects. The table below shows the structural formulae of the first three members of the thiol homologous series.

Table 7.1: Names and structural formulae of thiols

name	structural formula
methanethiol	
ethanethiol	
propanethiol	

The chemical reactions of thiols have been studied widely by chemists, due to their ability to be synthesised into various products.

Thiols are able to react with carboxylic acids to form thioesters. **Figure 7.2** shows the reaction between propanethiol and ethanoic acid, to form propyl ethanethiolate and product **A**.

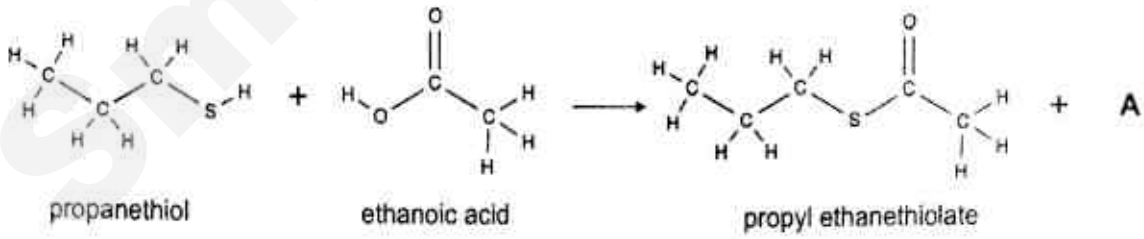


Figure 7.2: Formation of propyl ethanethiolate, a thioester

Thiols undergo oxidation to form sulfonic acids, as shown in **Figure 7.3** below.

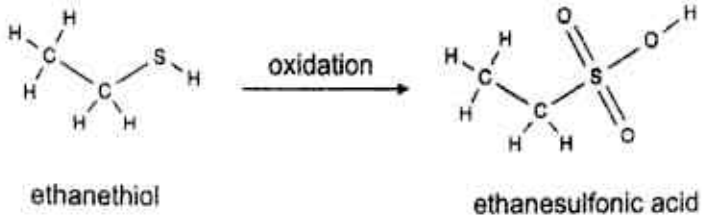


Figure 7.3: Formation of ethanesulfonic acid, a sulfonic acid

(a) Write down the name of the thiol with the formula $C_6H_{13}SH$.

_____ [1]

(b) Draw the structural formula of product **A**, which is shown in **Figure 7.2**.

[1]

(c) Propanethiol can be formed from an addition reaction between an alkene an molecule **B**. Write down the name of molecule **B**.

_____ [1]

(d) Molecules **C** and **D** are two possible isomers of propanethiol.

C contains the sulfhydryl functional group, while **D** does not.

(i) Define the term *isomer*.

_____ [1]

(ii) Draw the structural formulae of **C** and **D** in the spaces below.

C:	**D:**

[2]

(e) Predict and explain the electrical conductivity of methanethiol.

_____

_____ [2]

(f) Based on the data in **Figure 7.3**, list two differences between the reactions of alcohols and thiols.

_____

_____

_____

_____ [2]

[Total: 10 marks]

B8. Concentrated nitric acid is able to oxidise unreactive metals like copper, to form nitrogen dioxide, a salt and water. An equation for this reaction is shown below:

$$Cu + 4\ HNO_3 \rightarrow Cu(NO_3)_2 + 2\ NO_2 + 2\ H_2O$$

(a) Explain, in terms of oxidation state, why this is a redox reaction.

_____

_____

_____

_____ [4]

(b) Write down an ionic equation, with state symbols, for this reaction.

(Assume that this reaction occurs at room temperature and pressure)

_____ [2]

(c) A 1000 g bar of copper was placed into a beaker of concentrated nitric acid, and the gas evolved was collected and measured at room temperature and pressure.

At the end of the reaction, the remaining copper was collected by filtration and weighed. The temperature of the acid was also measured, before and after the experiment.

The results are shown in the table below.

	before experiment	after experiment
mass of copper / g	1000	344
temperature of concentrated nitric acid / °C	25	121

(i) Calculate the volume of NO_2 collected at room temperature and pressure.

[3]

(ii) Before the gas is cooled to room temperature and pressure, its volume is approximately double that of the value calculated in **(c)(i)**. Apart from expansion of gas due to heat, suggest another reason for this.

_____ [1]

[Total: 10 marks]

EITHER

B9. Hydrogen peroxide, H_2O_2, decomposes when exposed to sunlight, to form water and oxygen gas.

Four experiments were conducted to investigate the decomposition of H_2O_2. The concentrations of H_2O_2 were measured and recorded at the start of the experiment and after 60 seconds. The results are shown in the table below.

In **Experiment 2**, the temperature of H_2O_2 at the start of the reaction was increased to 30.0 °C.

In **Experiment 4**, a small amount of MnO_2 was mixed with the H_2O_2 at the start of the experiment.

Experiment	concentration of H_2O_2 / (mol/dm^3)		decrease in concentration of H_2O_2 after 60 s/ (mol/dm^3)	mass of MnO_2 / g		initial temperature of H_2O_2 / °C
	initial	after 60 s		initial	after 60 s	
1	5.00	4.31		–	–	20.0
2	5.00	3.49		–	–	30.0
3	10.00	8.62	1.38	–	–	20.0
4	10.00	0.00		0.5	0.5	20.0

(a) Calculate the decrease in concentration of H_2O_2 for **Experiments 1, 2** and **4**. Fill in your answers in the table above. [1]

(b) Explain the effect of concentration of H_2O_2 on the rate of reaction by comparing the data from two appropriate experiments.

_____

_____

_____

_____

_____ [4]

(c) **(i)** State the role of MnO_2 in **Experiment 4**.

_____ [1]

(ii) With reference to the data from two appropriate experiments, give two reasons to explain your answer in **(c)(i)**.

_____

_____

_____ [2]

(d) Explain the effect of the difference in temperature between **Experiments 1** and **2** on the rate of reaction, using ideas about *energy* and *reacting particles*.

_____

_____ [2]

[Total: 10 marks]

OR

B9. The table below displays the average bond energies for various covalent bonds.

Average Bond Energies

bond	energy / (kJ/mol)
Br–Br	193
C–C	348
C–H	413
C–O	358

bond	energy / (kJ/mol)
Cl–Cl	358
F–F	155
H–H	436
O–H	463

bond	energy / (kJ/mol)
I–I	151
O–O	146
C=O	799
C=C	614

(a) "The strength of the **X–X** covalent bond decreases down the Group, where **X** represents a Group VII element."

Comment on whether the data in the table fully supports this statement.

_____

_____

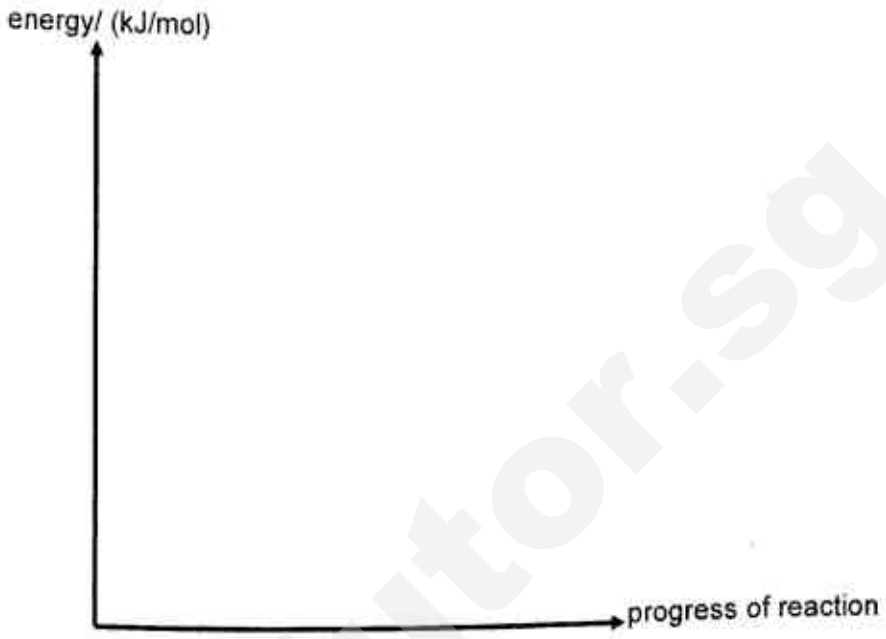
_____ [

(b) "Hydrogenation of alkenes is always exothermic."

(i) Use data from the table above, with suitable calculations, to show that this statement is true.

[2]

(ii) Hence, draw a labelled energy profile diagram for the hydrogenation of propene, on the axes below.



[3]

(iii) "The size of the enthalpy change is always smaller than the activation energy for endothermic reactions."

By drawing an appropriate energy profile diagram, and using ideas about *energy levels*, briefly explain why this statement is true.

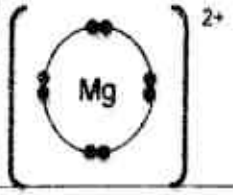
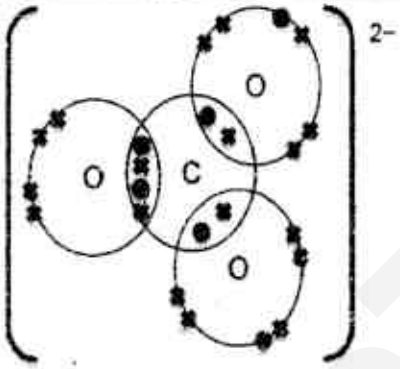
_____

_____

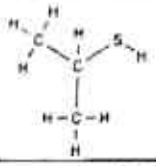
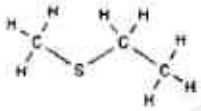
_____ [3]

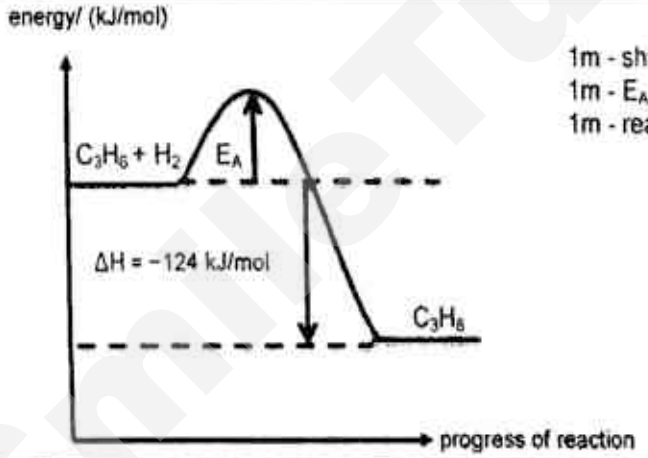
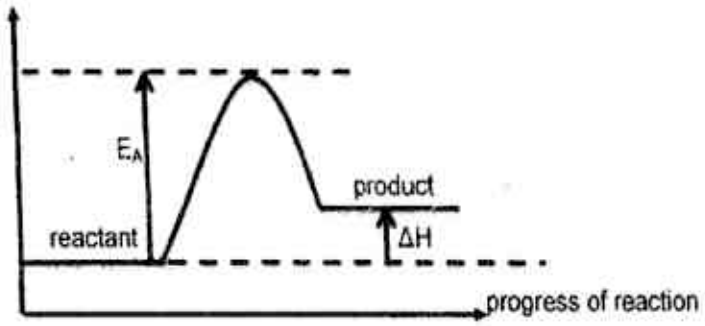
[Total: 10 marks]

P2 Answers

Qn	Ans	Mks
1a	Iron(II) carbonate	1
1b	Nitrogen dioxide (reject: carbon dioxide, as it dissolves to give a weakly acidic solution)	1
1c	Zinc hydroxide OR lead(II) hydroxide	1
1d	Lead(II) hydroxide	1
1e	Potassium nitrate	1
1f	Carbon monoxide	1
2a	 1m for correct charge 1m for everything else correct	2
2b	 1m for correct covalent bonding electrons 1m for correct non-covalent bonding electrons (The electrons gained in by oxygen have to be drawn using a different symbol, e.g. symbols other than cross).	2
2ci	**A:** Magnesium oxide / MgO 1m for both **B:** carbon dioxide / CO_2	1
2cii	Bubble the gas through aqueous calcium hydroxide (accept: limewater) A white precipitate will be formed (reject: turns chalky / milky)	1 1
2ciii	The magnesium oxide left behind has a giant ionic lattice structure. A high amount of (reject: "more") thermal energy is required to overcome the strong electrostatic forces of attraction between the oppositely charged ions. (max 1m if students have stated Mg in 2ci instead of MgO)	1 1 1
3ai	The electrode is unreactive / does not react.	1

3aii	**electrolyte**	**molten zinc chloride**	**dilute aqueous zinc chloride**	**concentrated aqueous zinc chloride**	3
	product formed at cathode	zinc	hydrogen	hydrogen	
	product formed at anode	chlorine	oxygen (and water)	chlorine	
	substance left behind after electrolysis	none	zinc chloride	zinc hydroxide	
	(2 – 3 correct – 1m ; 4 – 5 correct - 2m; all correct - 3m)				
3bi	Anode: $Au (s) \rightarrow Au^{3+} (aq) + 3e$ Cathode: $Au^{3+} (aq) + 3e \rightarrow Au (s)$ (1m for each equation, consequential 1m for state symbols)				3
3bii	The positive electrode becomes smaller in size (accept: wears down), while the negative electrode increases in size (accept: becomes bigger).				1
3biii	Bubbles of gas are formed at the positive electrode (reject: it does not wear down) The orange colour of the electrolyte fades (reject: electrolyte becomes acidic)				1 1
4ai	The coating provides a physical barrier which prevents contact between the iron and molecules of oxygen and water (reject: air)				1 1
4aii	The magnesium reacts preferentially over the iron present in steel (reject: reacts faster) as it is more reactive than iron.				1 1
4bi	$2 Na + 2 H_2O \rightarrow 2 NaOH + H_2$				1
4bii	Moles of alkali = 1.5 x (23.85 / 1000) = 0.03578 mol Moles of $C_6H_4O_8$ = 1.82 / [(6 x 12) + (4 x 1) + (8 x 16)] = 0.008922 mol Mole ratio of alkali : $C_6H_4O_8$ 0.03578 : 0.008922 4.01 : 1 There are 4 –COOH groups				1 1 1 1
5a	It undergoes partial ionisation to produce a low concentration of (accept: some) H^+.				1 1
5b	The indicator changes colour from green to orange (accept yellow, reject red) (accept: Solution turns from colourless to orange/yellow)				1
5c	Add an excess of lead(II) carbonate (accept: lead(II) oxide & reject: lead metal) to the ethanoic acid. Filter the mixture to remove the excess lead(II) carbonate, and obtain lead(II) ethanoate as the filtrate.				1 1
5d	Add a strip of magnesium metal (accept: add a metal) to a beaker of each acid. The magnesium ribbon takes a longer time to completely react with the ethanoic acid (accept: nitric acid reacts faster) (accept any reasonable answer that shows that ethanoic acid possesses a lower concentration of H^+. E.g., add ethanol and conc. H_2SO_4 / add NaOH and Al)				1 1
6ai		N	O		
	Mass of atoms / (g per 100g)	30.4	69.6		
	Number of moles	30.4 / 14 = 2.171	69.6 / 16 = 4.35		1
	Mole ratio	1	2		
	Empirical formula is NO_2 (common mistake: Using N_2 and O_2 instead of their atoms)				1
6aii	Molecular formula is N_2O_4 (working not required)				1
6aiii	$N_2 + 2 O_2 \rightarrow N_2O_4$				1
6b	CaO (or any basic oxide / metal carbonate)				1

6c	Lightning activity OR car	1
6d	It causes acid rain, which can cause harm to crops/ buildings made out of limestone or metal/ aquatic life (Award only 1m if students state breathing difficulties as answer)	1 1
7a	Hexanethiol (no mark for wrong spelling)	1
7b	H–O–H	1
7c	Dihydrogen monosulfide (accept: hydrogen sulfide, sulfur dihydride) (If prefixes are used, they have to be used consistently)	1
7di	They have the same molecular (reject: "chemical") formula but different structural formula (accept "different structure").	1
7dii	C:  1m D:  1m	2
7e	It has poor electrical conductivity in all states. Methanethiol is composed of simple molecules that are neutral.	1 1
7f	**Oxidation of thiols** / **Oxidation of alcohols** sulfur-oxygen double bonds are formed / carbon-oxygen double bonds are formed two double bonds to oxygen are formed / only one double bond to oxygen is formed sulfur atom in sulfonic acid has 12 valence electrons (OR has 6 covalent bonds in total) / carbon atom in carboxylic acid still has only 8 valence electrons (OR has 4 covalent bonds in total) sulfonyl functional group has three oxygen atoms (OR: gains three O atoms, does not lose H atoms) / carboxyl functional group has two oxygen atoms (OR: gains one O atom, loses two H atoms) (any two differences) (answers must make reference to elemental composition of the functional group) (reject: water is not formed when thiols are oxidised) (reject: answers referring to Figure 7.2)	2
8a	Oxidation state of copper increases from 0 in Cu to +2 in $Cu(NO_3)_2$. Oxidation state of nitrogen decreases from +5 in HNO_3 to +4 in NO_2.	1 1 1 1
8b	$Cu\ (s) + 4\ H^+\ (aq) + 2\ NO_3^-\ (aq) \rightarrow Cu^{2+}\ (aq) + 2\ NO_2\ (g) + 2\ H_2O\ (l)$ (1m for correct equation, 1 mark for correct state symbols) Mark for state symbols will only be given if basic concept of writing ionic equation is right. E.g., writing $CuSO_4$ (aq) will not give students any mark unless they split it into Cu^{2+} (aq) + SO_4^{2-} (aq)	2
8ci	Mass of Cu reacted = 1000 − 344 = 656 g Mol of Cu reacted = 656 / 64 = 10.25 mol Mol of NO_2 = 2 x 10.25 = 20.5 mol (ECF, max 1m) Volume of NO_2 = 20.5 x 24 dm^3 = 492 dm^3	1 1 1
8cii	Water vapour (accept: water in the gaseous state) also makes up part of the gas collected before it is cooled.	1
E9a	Expt 1: 0.69 Expt 2: 1.51 Expt 4: 10.00	1

E9b	Comparing Experiment [illegible] concentration of H_2O_2 and shows a greater decrease in concentration after 60 s. This shows that more H_2O_2 is reacted 60 s in Experiment 3 than in Experiment 1. (1m for quoting values of initial concentrations of Experiment 1 and 3, and decrease in concentration after 60 s) The higher the initial concentration of reactants, the faster the initial rate.	1 1 1 1
E9ci	Catalyst	1
E9cii	Addition of MnO_2 in Expt 4 causes concentration of H_2O_2 to decrease by a greater amount than in Expt 3 Mass of MnO_2 stays constant at 0.5 g from start to end of Expt 4.	1 1
E9d	As temperature increases, rate of reaction increases. More reacting particles have energy equal to or greater than activation energy. Thus, frequency of effective collisions increases.	1 1
O9a	This statement is not fully supported. Bond energy decreases from Cl−Cl to Br−Br to I−I, showing a decrease in bond strength. However, the F−F bond is weaker than the Cl−Cl bond. 1m – inconsistent trend 1m – relate bond strength to bond energy	1 1
O9bi	Enthalpy change for hydrogenation = + (1 x C=C) + (1 x H−H) − (1 x C−C) − (2 x C−H) = 614 + 436 − 348 − 2(413) = −124 kJ 1m only if calculation are for a specific alkene	1 1
O9bii	 1m - shape of graph 1m - E_A and ΔH 1m - reactants and products labelled	3
O9biii	 1m - correct graph drawn Maximum point on the graph is always higher than product energy level. Activation energy must always be larger than the difference between energy levels for an endothermic reaction.	1 1 1

Name: _____ ( ) Class:_____

CHIJ ST. NICHOLAS GIRLS' SCHOOL
Secondary 4
Preliminary Examination (40 Marks)

CHEMISTRY (SPA)5073

29 August 2017

1 hour

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class on the OAS sheet using a **soft pencil.**

There are **forty** questions in this paper.
Answer all questions.
For each question there are four possible answers **A**, **B**, **C** and **D.**
Choose the correct answer and record the corresponding letter using a **soft pencil** on the OAS sheet.
Amendments may be done using a soft eraser.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
A calculator may be used.

A copy of the Periodic Table is provided on page 2.
The total number of marks for this paper is 40.

	Marks
Total (40)	

This document consists of 20 printed pages.

圣尼各拉女校
CHIJ ST NICHOLAS GIRLS' SCHOOL
Girls of Grace · Women of Strength · Leaders with Heart

[Turn over

The Periodic Table of the Elements

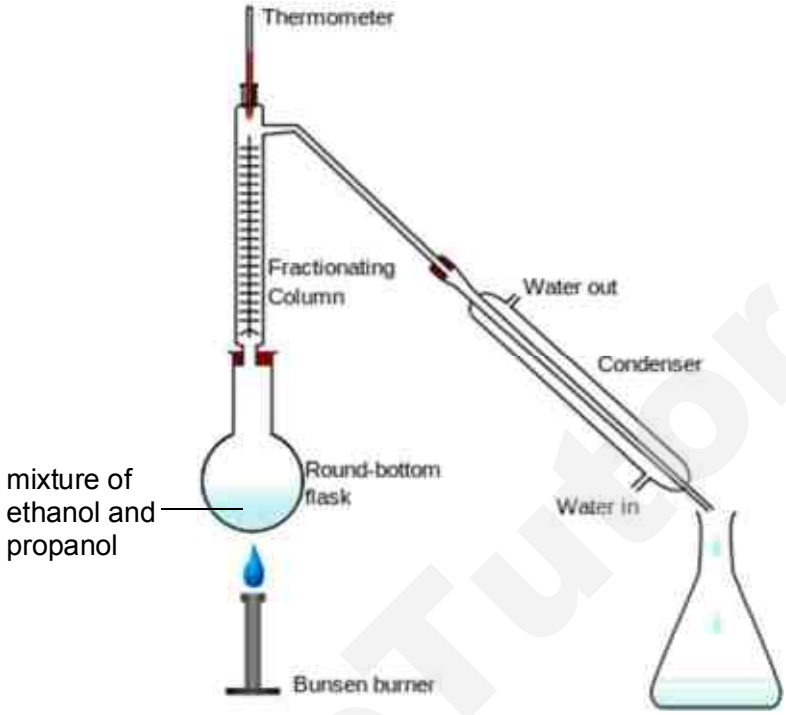
Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

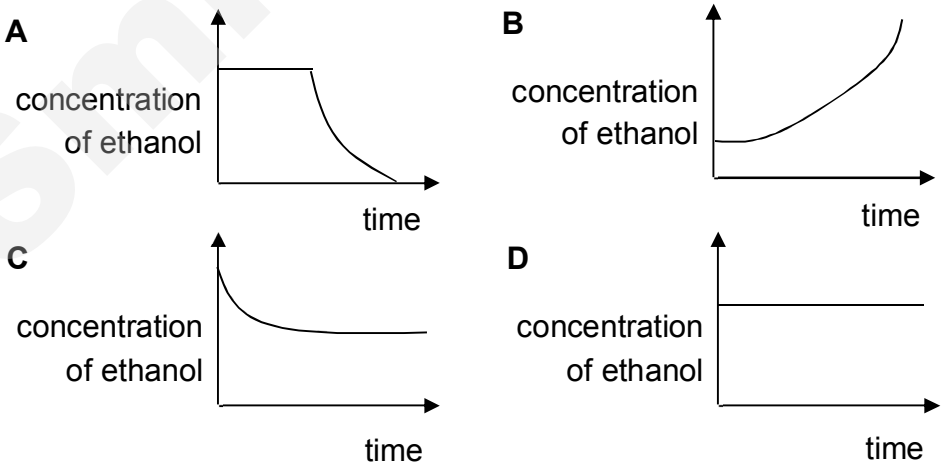
140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

1 The diagram shows apparatus used to separate ethanol (boiling point, 78 °C) and propanol (boiling point, 98 °C).

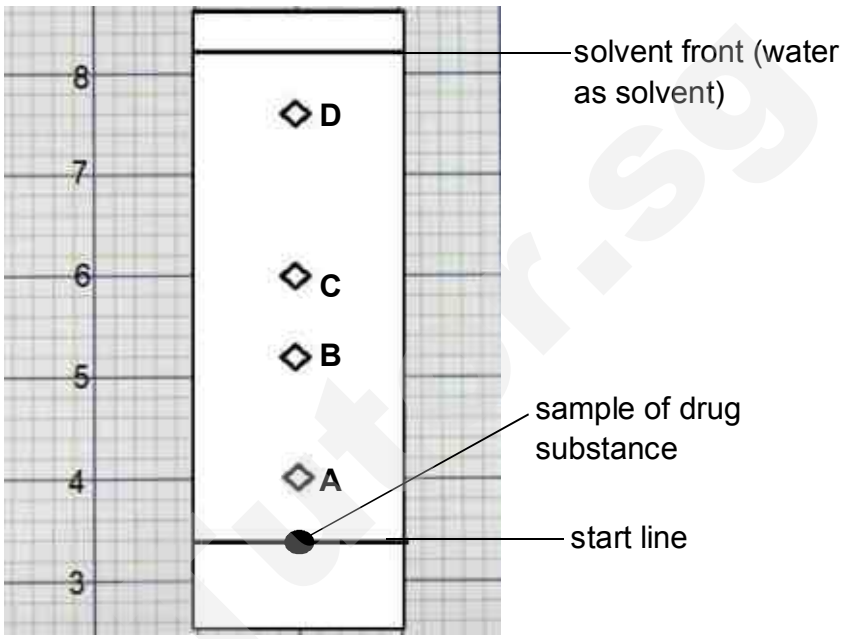


Which graph best shows the change in concentration of the ethanol in the round-bottomed flask as the distillation proceeds from room temperature?

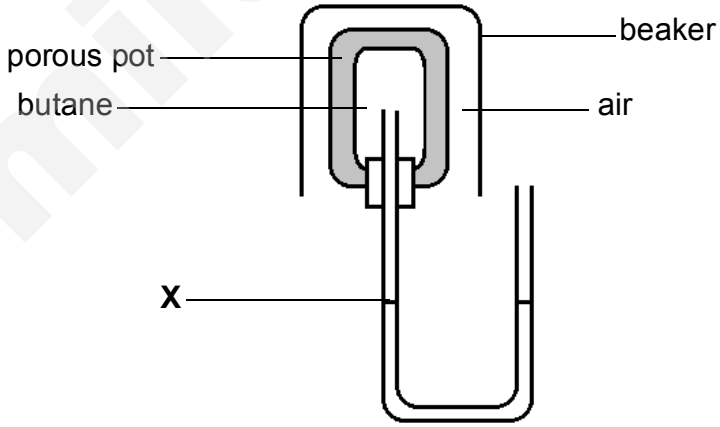


2 A drug substance has an R_f value of 0.375 using water as the solvent.

What would be the position of this drug substance in the chromatogram shown below?



3 The apparatus below consists of a porous pot containing butane which is surrounded by air in a beaker.



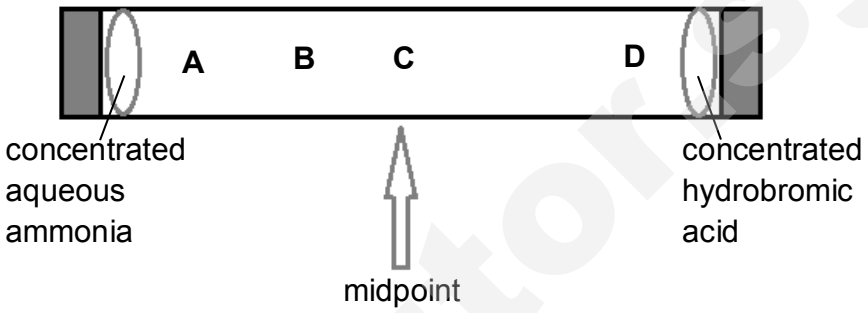
Over a period of time, which one of the following series of changes of water level at **X** will be observed?

A falls and remains at a lower level
B rises and remains at higher level
C falls then rises and returns to **X**
D rises then falls and returns to **X**

4 The diagram below shows an apparatus in which ammonium bromide is formed by the reaction between ammonia gas and hydrogen bromide gas. The chemical equation is shown below.

$$NH_3 + HBr \rightarrow NH_4Br$$

At which position in the apparatus is ammonium bromide most likely to be found?



5 The boiling points of some elements are given below.

element	boiling point / ºC
X	-137
Y	-152
Z	-141

A mixture of elements **X**, **Y** and **Z** is heated gradually from -159 ºC to -139 ºC. Which of the element(s) would still remain as a liquid at -139 ºC?

A Element **X** only
B Elements **X** and **Y** only
C Elements **Y** and **Z** only
D Elements **X**, **Y** and **Z**

6 What is the atomic structure of $\mathbf{X}^{2+}$ ion if it has atomic number 13 and mass number 27?

	Number of protons	Number of neutrons	Number of electrons
A	11	27	13
B	13	14	11
C	13	14	15
D	13	27	13

7 An element **X** which has 2 different isotopes, **X**-11 and **X**-12, exists as diatomic molecules, $\mathbf{X}_2$. The relative molecular mass of $\mathbf{X}_2$ is 22.48.

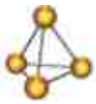
What is the relative abundance of **X**-11?

A 24.0% **B** 38.0%
C 48.0% **D** 76.0%

8 The following diagram shows structure of diamond and white phosphorus. Both structures show atoms bonded in a tetrahedral arrangement. However, diamond has a high melting point of 4723 ^{o}C while white phosphorus has a low melting point of 280 ^{o}C.

Which of the option explains the difference in the melting point of diamond and white phosphorus?

Diamond



White phosphorus

A Both diamond and white phosphorus have covalent bonds between atoms.
B Diamond has covalent bonds in between carbon atoms in a vast network, whereas white phosphorus has Van der Waals' forces between phosphorus atoms in a vast network.
C Diamond has covalent bonds in between carbon atoms in a vast network, whereas white phosphorus has Van der Waals' forces between the discrete molecules.
D Diamond has ionic bonds in between carbon atoms in an ionic lattice, whereas white phosphorus has Van der Waals' forces between phosphorus atoms in a vast network.

9 The reaction between magnesium and dilute nitric acid is as shown below:

$$Mg(s) + 2HNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + H_2(g)$$

From the equation, it can be deduced that

A 1 g of magnesium reacts with 2 g of nitric acid in a complete reaction.
B 6 g of magnesium reacts with 31.5 g of nitric acid in a complete reaction.
C 24 dm^3 of magnesium reacts with 48 dm^3 of nitric acid in a complete reaction.
D 1 mol of magnesium reacts with 0.5 mol of nitric acid in a complete reaction.

10 In a titration, it was found that 8 cm^3 of 0.5 mol/dm^3 of acid **X** needed 20 cm^3 of 0.4 mol/dm^3 of potassium hydroxide solution for complete reaction.

Which of the following is the molecular formula of acid **X**?

A HCl
B H_2SO_4
C H_3PO_4
D CH_3COOH

11 Which experiment does not show a redox reaction?

	Experiment	Observations
A	aqueous chlorine added to sodium iodide solution	brown solution observed
B	copper solid dipped into a beaker of silver nitrate solution	grey solid formed on copper and a blue solution observed
C	aqueous hydrogen peroxide added to a mixture of potassium manganate(VII) and dilute sulfuric acid	mixture changed from purple to colourless
D	aqueous barium nitrate added to copper(II) sulfate solution	white precipitate formed in blue solution

12 Transition metals are well known for having several stable oxidation states and manganese has more than any other. In its compounds, manganese exhibits oxidation states from +2 to +7.

The common oxidation states are +2, +4, and +7, while the less common oxidation states are +3, +5, and +6.

Which of the following contains manganese in all six oxidation states?

A $KMnO_4$, MnO, MnO_2, MnC*l*, $Mn(SO_4)_3$, $Mn(NO_3)_2$
B $KMnO_4$, $NaMnO_4$, $Mn(SO_4)_2$, $Mn(SO_4)_3$, $Mn(NO_3)_2$, $Mn(NO_3)_2.4H_2O$
C MnO, MnO_2, MnF, $NaMnO_4$, $Mn(SO_4)_3$, MnCl_2
D $KMnO_4$, MnO_2, MnF_3, $Mn_2(CO_3)_5$, $Mn(SO_4)_3$, $Mn(NO_3)_2.4H_2O$

13 In a reaction between copper(II) oxide and carbon monoxide, which of the following is the reducing agent?

A CuO
B CO
C Cu
D CO_2

14 In a chemical analysis, excess silver nitrate solution is added to dilute hydrochloric acid. The reaction mixture is then filtered.

What are the ions present in the filtrate after filtration?

A H^+ and NO_3^- only
B Ag^+, Cl^- and NO_3^- only
C Ag^+ and NO_3^- only
D H^+, Ag^+ and NO_3^- only

15 Which of the following substances would not produce copper(II) nitrate crystals with dilute nitric acid?

A copper(II) hydroxide
B copper(II) sulfate
C copper(II) carbonate
D copper(II) oxide

16 Which one of the options below matches the correct salt preparation methods used to prepare the salts?

	titration	precipitation	adding excess base to acid
A	ammonium nitrate	lead(II) sulfate	sodium chloride
B	calcium carbonate	lead(II) chloride	magnesium chloride
C	copper(II) sulfate	lead(II) nitrate	lead(II) nitrate
D	potassium ethanoate	lead(II) bromide	zinc sulfate

17 Which statement correctly describes the changes in the elements from left to right across a period of the Periodic Table?

A The size of atoms increases.
B The number of electron shells increases.
C The number of valence electrons increases.
D The elements changes from non-metallic to metallic.

18 Each of the halogens, $\mathbf{X}_2$, $\mathbf{Y}_2$ and $\mathbf{Z}_2$ was added to separate solutions containing ions of one of the other two halogens.
The table shows the results.

halogen added	Na**X** solution	Na**Y** solution	Na**Z** solution
$\mathbf{X}_2$	–	$\mathbf{Y}_2$ displaced	No visible reaction
$\mathbf{Y}_2$	No visible reaction	–	No visible reaction
$\mathbf{Z}_2$	$\mathbf{X}_2$ displaced	$\mathbf{Y}_2$ displaced	–

Which of the following shows the order of **increasing** reactivity of elements **X**, **Y** and **Z**?

A **Y**, **X**, **Z**
B **Y**, **Z**, **X**
C **X**, **Y**, **Z**
D **Z**, **X**, **Y**

19 The chemical equation below shows the reaction between element **X** and cold water. The element **X** has an atomic number of 55.

$$2\mathbf{X} + 2H_2O \rightarrow 2\mathbf{X}OH + H_2$$

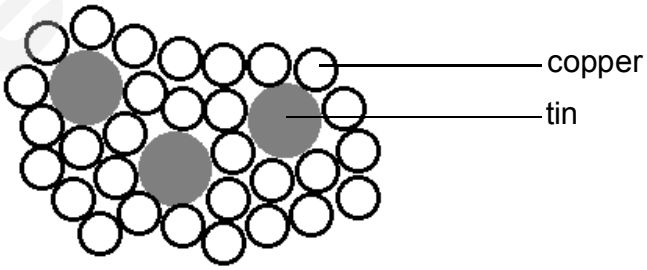
Which statement about element **X** is correct?

A It displaces metallic potassium from aqueous potassium chloride.
B It is produced during the electrolysis of XC*l*(aq).
C It forms a carbonate that is readily decomposed by heat.
D Its reactivity with cold water is the same as potassium.

20 Astatine (At) is a member of the halogen family. It has a proton number greater than the other halogens. It is expected that astatine

A has the lowest melting point.
B is a coloured liquid at room temperature.
C is the halogen with the weakest oxidising power.
D is the most reactive halogen.

21 The diagram shows the structure of bronze.



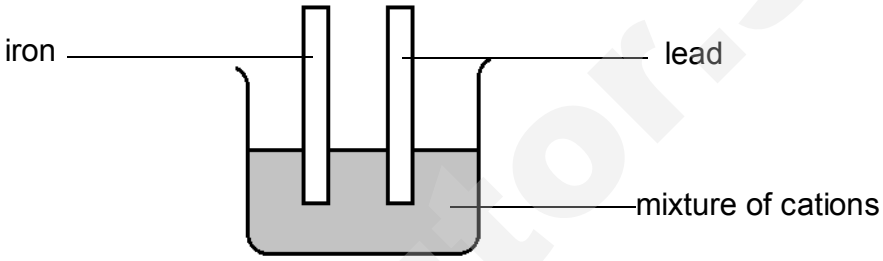
Why is bronze harder than pure copper?

A The tin atoms form strong covalent bonds with the copper atoms.
B The tin atoms prevent layers of copper atoms from sliding past one another easily.
C The tin atoms prevent the sea of delocalised electrons from moving freely among the copper atoms.
D Tin atoms have more electrons than the copper atoms.

22 Which of the following reactions produce both carbon dioxide and oxygen gas?

A decomposition of hydrogen peroxide
B decomposition of copper(II) carbonate
C decomposition of silver carbonate
D reaction between hydrochloric acid and sodium carbonate

23 The diagram below shows two metal strips, iron and lead, placed in a beaker containing a mixture of cations.



In which of the following mixture of cations, would the two metal strips remain unchanged?

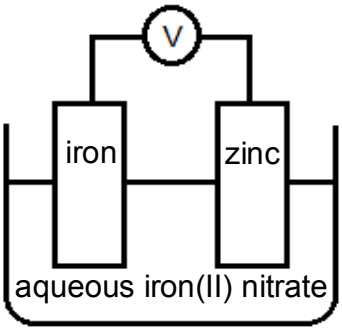
A Na^+, Ca^{2+}, Al^{3+}, K^+
B Ag^+, Zn^{2+}, Ca^{2+}, Mg^{2+}
C Fe^{2+}, Pb^{2+}, Cu^{2+}, Zn^{2+}
D Zn^{2+}, Ag^+, Cu^{2+}, Ca^{2+}

24 When a current was passed through acidified aqueous copper(II) sulfate, there was simultaneous liberation, at the cathode, of x mol of copper and y dm^3 of hydrogen (measured at room temperature and pressure).

How many moles of electrons passed through the solution?

A $x + \frac{y}{24}$
B $x + \frac{y}{12}$
C $2x + \frac{y}{12}$
D $2x + \frac{y}{24}$

25 The apparatus was set up in the diagram shown below.

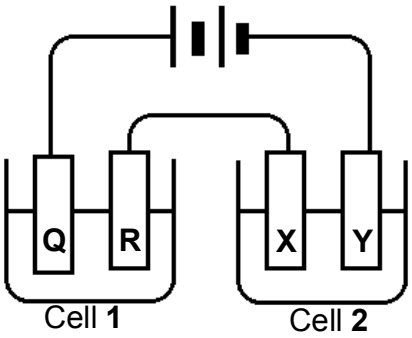


Which of the following observation(s) would be seen?

1. Bubbles of colourless gas are formed around the zinc electrode.
2. The aqueous iron(II) nitrate fades from green to colourless.
3. The iron electrode decreases in size.

A 2 only
B 1 and 3 only
C 1, 2 and 3
D None of the above

26 In the diagram below, each cell contains an aqueous solution of a single salt and all four electrodes are graphite. Electrodes **R** and **Y** increase in mass during the electrolysis but no gas is given off at **R** and **Y.**

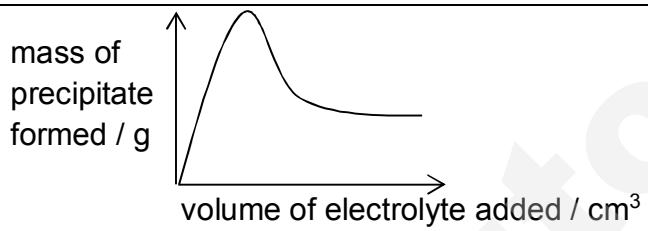
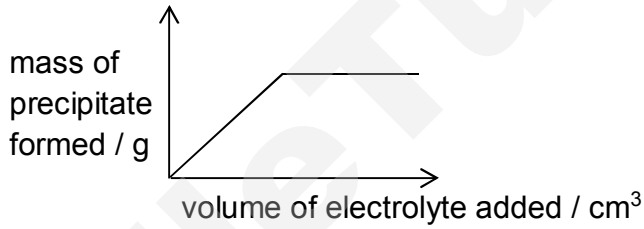
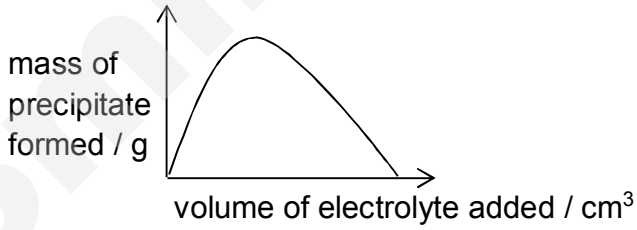
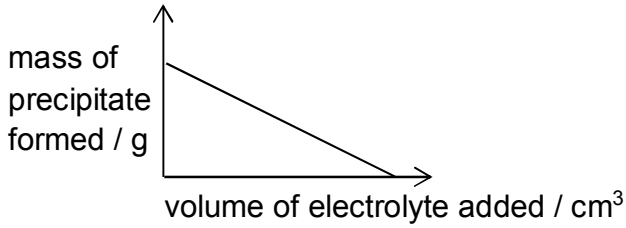


If an increase in mass of **R** is greater than the increase in mass of **Y** in the same time, which of the following statements is necessarily true?

A The anions of the solutions in cells **1** and **2** are different.
B The cations of the solutions in cells **1** and **2** are different.
C The current flowing in cell **1** is greater than the current flowing in cell **2**.
D The solution in cell **1** is more concentrated than the solution in cell **2**.

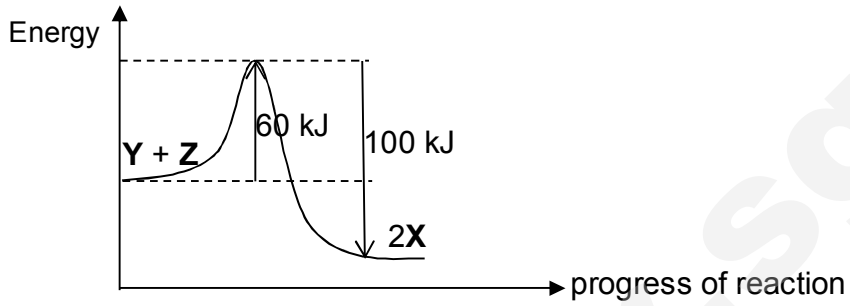
27 Dilute sodium chloride was electrolysed using inert electrodes. After some time, the remaining electrolyte was then added in excess to an unknown colourless solution.

The graph of mass of precipitate formed against volume of electrolyte added was plotted. Which of the following shows the correct graph and the possible identity of the cation in the unknown colourless solution?

	Graph	**Possible cation in unknown solution**
A		Zn^{2+}
B		Ag^{+}
C		Al^{3+}
D		Cu^{2+}

28 The diagram below represents the energy profile diagram for the following reaction:

Y + **Z** → 2**X**



What is the enthalpy change for the decomposition of 4 moles of **X** to substances **Y** and **Z**?

A +40 kJ
B -40 kJ
C +80 kJ
D -80 kJ

29 Which of the following processes are endothermic?

1 $F_2 \rightarrow 2F$
2 combustion of ethane
3 obtaining lime (CaO) from limestone ($CaCO_3$)
4 reacting hydrogen with oxygen

A 1 and 2
B 1 and 3
C 2 and 4
D 3 and 4

30 Nonane is a hydrocarbon with molecular formula, C_9H_{20}.
One of the reactions of nonane is shown by the equation below.

$$C_9H_{20} \rightarrow C_5H_{12} + C_4H_8 \quad \Delta H = +114 \text{ kJ/mol}$$

Which of the following statements about the reaction is correct?

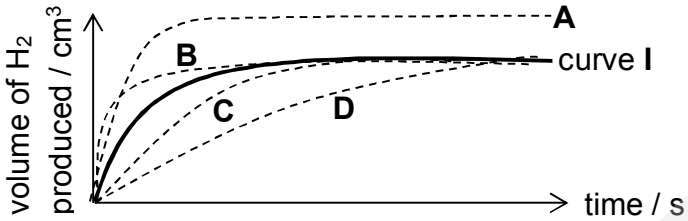
A It is a substitution reaction.
B The enthalpy change of combustion is 114 kJ per mole of nonane.
C The products possess more energy than the reactants.
D The total energy change in bond formation is more than that in bond breaking.

31 In an experiment, magnesium powder is added to dilute hydrochloric acid at room temperature. When the temperature of the same reaction was increased to 50 ^{o}C, the speed of the reaction increased.

This is because an increase in temperature

A results in the particles to possess more kinetic energy which in turn increases the frequency of collision between the particles.
B lowers the activation energy of the reaction which in turn increases the frequency of effective collisions.
C produces chemical energy which causes the particles to move faster which in turn increases the frequency of collision between the particles.
D causes magnesium to expand resulting in larger surface area to volume ratio which in turn increases the frequency of collision between the particles.

32 Curve **I** shows the total volume of hydrogen gas produced after 1.0 g of zinc strips were added to 25 cm^3 of 1.0 mol/ dm^3 hydrochloric acid.



The equation for this reaction is: Zn (s) + 2HC*l* (aq) → ZnCl_2 (aq) + H_2 (g)

A second experiment was conducted using 5.0 g of zinc powder with 25 cm^3 of 1.0 mol/ dm^3 hydrochloric acid.

Which of the curves, **A**, **B**, **C** or **D**, would be obtained for the second experiment?

33 Potassium chlorate, KC*l*O_3, undergoes thermal decomposition as shown in the chemical equation below:

$$2KClO_3\ (s) \rightarrow 2KCl\ (s) + 3O_2\ (g)$$

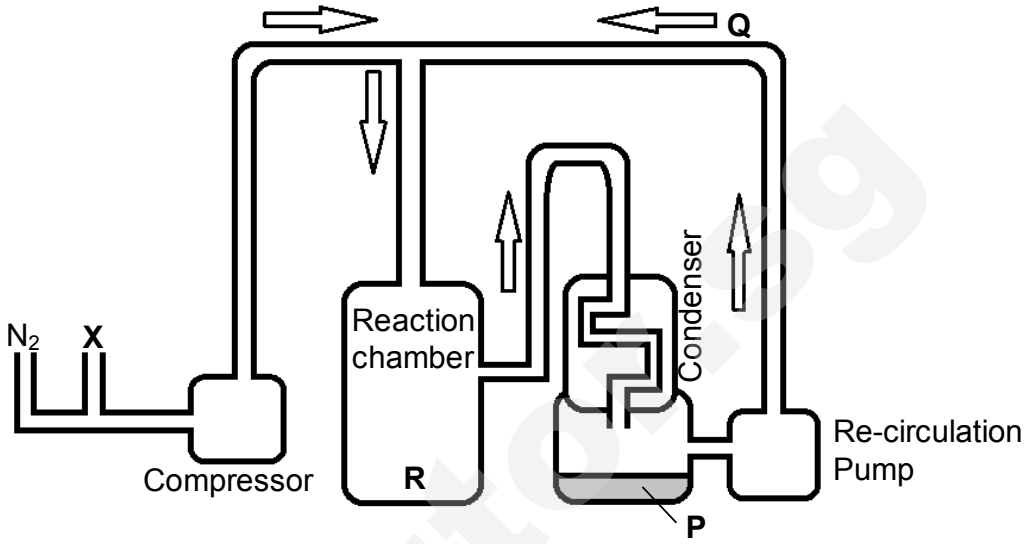
A student would like to investigate the factors affecting the rate of thermal decomposition of potassium chlorate, KC*l*O_3, in the presence of manganese(IV) oxide as catalyst. The student performs the investigation as follows:

Experiment 1	Experiment 2
25 cm^3 of 0.50 mol/dm^3 of KC*l*O_3 and powdered manganese(IV) oxide	50 cm^3 of 0.50 mol/dm^3 of KC*l*O_3 and lump manganese(IV) oxide

What would be the effect on the rate and on the final volume of O_2 released in experiment 2 compared to experiment 1?

	Rate of reaction	Volume of O_2 released
A	Decrease	Unchanged
B	Decrease	Increase
C	Increase	Unchanged
D	Increase	Increase

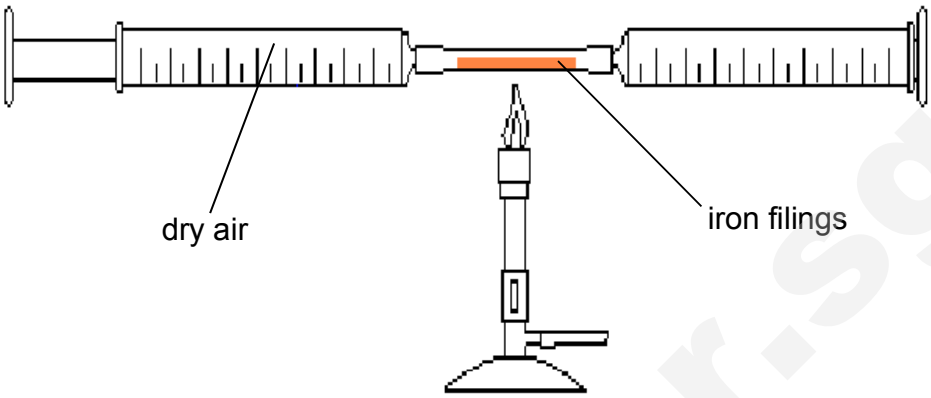
34 The diagram below shows the setup of manufacturing ammonia using the Haber Process.



Which of the following statements is true?

A **P** dissolves in water to form an alkaline solution.
B **Q** is a compound consisting of two elements.
C **R** is a compound of a transition metal.
D **X** is obtained from the distillation of air.

35 A sample of dry air trapped in a syringe is slowly passed over excess heated iron filings in a tube until there is no further decreased in volume.



The original volume of dry air is 150 cm^3. When the tube is cooled to room temperature, what is the expected volume left in the syringe?

A 30 cm^3
B 45 cm^3
C 80 cm^3
D 120 cm^3

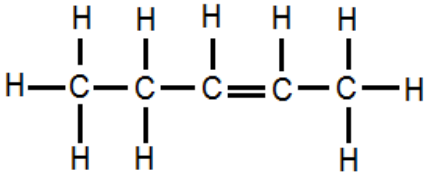
36 Which atmospheric pollutants, emitted by internal combustion engines, may react together in the presence of palladium catalyst to convert them into more environmentally-friendly products?

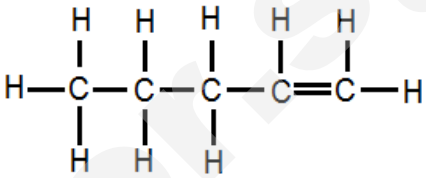
A carbon monoxide and unburnt hydrocarbons
B carbon monoxide and nitrogen dioxide
C nitrogen dioxide and sulfur dioxide
D sulfur dioxide and unburnt hydrocarbons

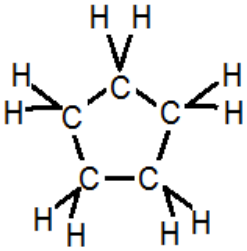
37 Which of the following shows the correct uses of paraffin?

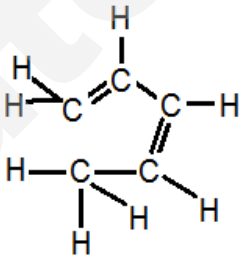
A fuel for jet engines and cooking
B fuel for car engines and heating
C for making waxes and road surfaces
D feedstock for petrochemicals and fuel for cooking

38 Which of the following structural formulae is not an isomer of each other?

A


B


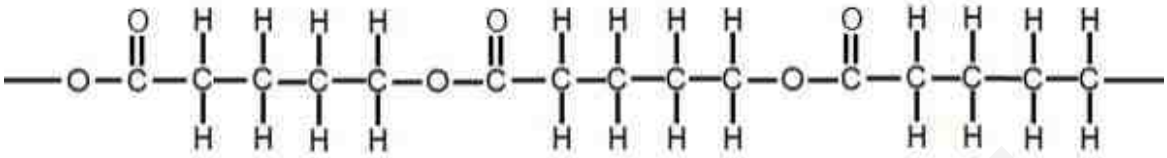
C


D


39 Which substance is formed when butan-1-ol, C_4H_9OH, is oxidised by aqueous acidified potassium manganate(VII), $KMnO_4$?

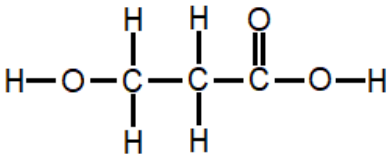
A C_4H_{10}
B $C_3H_7CO_2K$
C $C_3H_7CO_2H$
D $C_4H_9CO_2H$

40 The diagram below shows the structure of a part of polymer **X**.

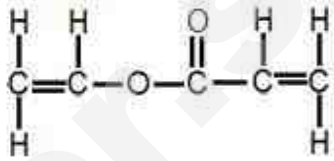


Which is the monomer that makes up polymer **X**?

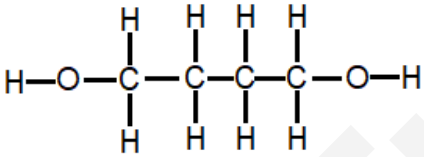
A



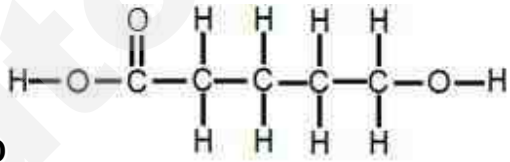
B



C



D



~~End of Paper~~

Answers (2017 Prelim Paper 1)

1	A
2	B
3	C
4	D
5	A
6	B
7	D
8	C
9	B
10	B
11	D
12	D
13	B
14	D
15	B
16	D
17	C
18	A
19	A
20	C

21	B
22	C
23	A
24	C
25	A
26	B
27	B
28	C
29	B
30	C
31	A
32	B
33	B
34	A
35	D
36	B
37	A
38	D
39	C
40	D

Name: _____ ( )
Class:_____

CHIJ ST. NICHOLAS GIRLS' SCHOOL
Secondary 4
Preliminary Examination (80 Marks)

CHEMISTRY (SPA) 5073

21 August 2017

1hour 45minutes

READ THESE INSTRUCTIONS FIRST

Write your name, register number, and class clearly in the spaces provided at the top of this page.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.
Do not use highlighters, glue, and correction fluid or correction tape.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form of either/or.
Answer **all** questions in the spaces provided.

A copy of Periodic Table is provided on page 2.
The number of marks is given in brackets [ ] at the end of each question or part question.
The use of a scientific calculator is expected, where appropriate.

	Marks
Section A (50)	
Section B (30)	
Total (80)	

This document consists of **22** printed pages.

圣尼各拉女校
CHIJ ST NICHOLAS GIRLS' SCHOOL
Girls of Grace · Women of Strength · Leaders with Heart

[Turn over

The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key: a / X / b
a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

Section A

Answer **all** the questions in this section in the space provided.

The total mark for this section is 50.

A1 Using only the substances in the following list, answer the questions below.

Each substance may be used once, more than once or not at all.

propanol	sodium iodide	methyl ethanoate
silicon dioxide	carbon monoxide	water
bromine	hydrogen peroxide	lead(II) sulfate

(a) Which substance is an insoluble compound that contains both ionic and covalent bonds? [1]

.....

(b) Which substances excluding water, when mixed together, can be separated by fractional distillation? [1]

.....

(c) Which substance can be separated from water by a separating funnel? [1]

.....

(d) Which substance is best obtained by simple distillation when mixed with potassium chloride? [1]

.....

(e) Which two substances can react to form a brown solution? [1]

.....

(f) Which substance is removed by limestone in the extraction of iron? Explain why this substance has a very high melting point in terms of bonding and structure. [3]

……
……
……
……

[Total: 8 marks]

A2 The relative atomic mass of magnesium can be determined in the laboratory by finding the volume of hydrogen given off when magnesium reacts with dilute hydrochloric acid.

0.0360 g of magnesium reacts at room temperature and pressure with excess dilute hydrochloric acid to produce 36 cm^3 of hydrogen.

(a) **(i)** Define the term relative atomic mass. [1]

……
……

(ii) Write a balanced equation, including state symbols, for the reaction of magnesium and dilute hydrochloric acid. [2]

……

(iii) Show, by calculation, that the relative atomic mass of magnesium is 24.0 [2]

(b) Magnesium reacts with oxygen in the air to form magnesium oxide. [2]

If the yield of the reaction is 75%, calculate the mass of magnesium oxide formed when 12 kg of magnesium burns in excess air.

(c) Another magnesium compound can also be formed when magnesium burns in air.

One mole of this magnesium compound reacts with excess water to produce magnesium hydroxide and a colourless gas in the mole ratio 3:2. The gas turns damp red litmus paper blue.

(i) State the name of the gas evolved and suggest the chemical formula of the magnesium compound. [2]

……

……

(ii) Explain how this magnesium compound is formed when magnesium burns in air. [1]

……

[Total: 10 marks]

A3 Aluminium has a low density, high ductility, good corrosion resistance and good conductivity, which makes it suitable to be used as an electric conductor for transmission and distribution of electricity. Aluminium is also able to react with fluorine to form aluminium fluoride. The physical properties of aluminium fluoride and fluorine are shown in the table below.

	melting point / °C	conducts electricity in molten state
aluminium fluoride	1290	Yes
fluorine	- 220	No

(a) Explain, in terms of bonding and structure, why aluminium is often used in electrical transmission. [2]

……
……
……

(b) In terms of kinetic particle theory, explain how the arrangement and movement of particles in fluorine change when the temperature increases from -240 °C to -200° C. [3]

……
……
……
……

(c) Draw a 'dot-and-cross' diagram to show the bonding in aluminium fluoride. You only need to show the outer shell electrons. [2]

(d) Explain, in terms of bonding and structure, the difference between the melting points of aluminium fluoride and fluorine. [3]

……
……
……
……
……
……

[Total: 10 marks]

A4 In chemical analysis, the identity of aqueous cations can be found by using aqueous ammonia.

A colourless sulfate solution with missing label is suspected to contain either aluminium or zinc ions.

(a) A student suggested that lead(II) ion is another possible cation in the salt solution. [1]

Do you agree with this student? Explain your answer.

……
……
……

(b) The student conducted an experiment to identify the cation:

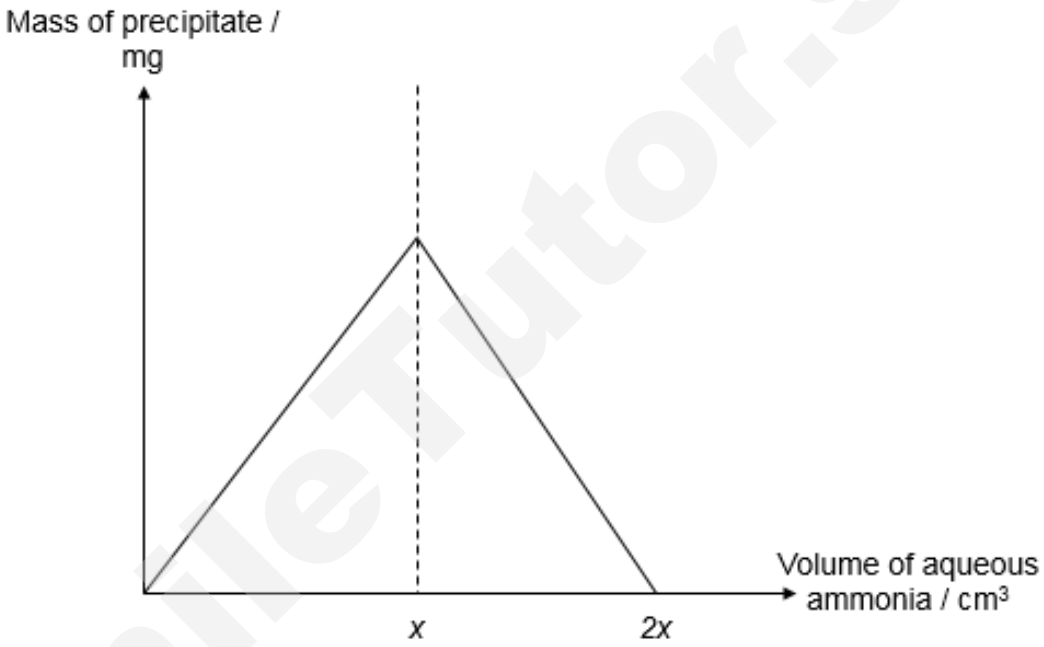
Step 1:

Several salt solutions of the same volume and same concentration were prepared.

Step 2:

To each of the salt solutions, a known volume of aqueous ammonia was added and the mass of any resulting precipitate was measured.

The results of the experiment is shown in the graph below.



(i) State the formula of the cation present in the salt solution. [1]

……

(ii) Write an ionic equation, with state symbols, for the formation of precipitate when x cm^3 of aqueous ammonia was added. [2]

……

(iii) State your observations as $2x$ cm^3 of aqueous ammonia was added drop-wise to the salt solution. [2]

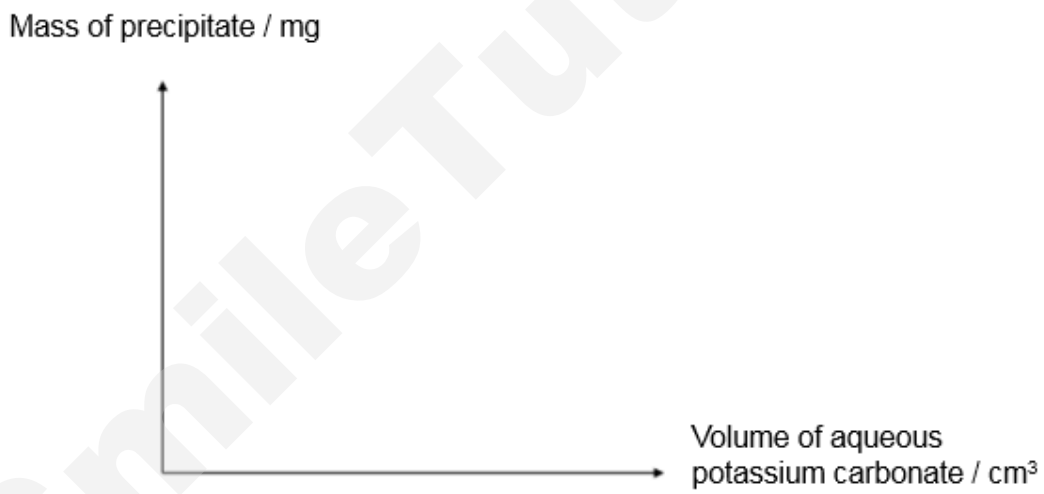
……

……

……

(c) A second experiment was conducted replacing aqueous ammonia with aqueous potassium carbonate. [1]

Sketch a graph in the axes below to show the change in mass of precipitate when aqueous potassium carbonate was added drop-wise to the salt solution until no further change was observed.



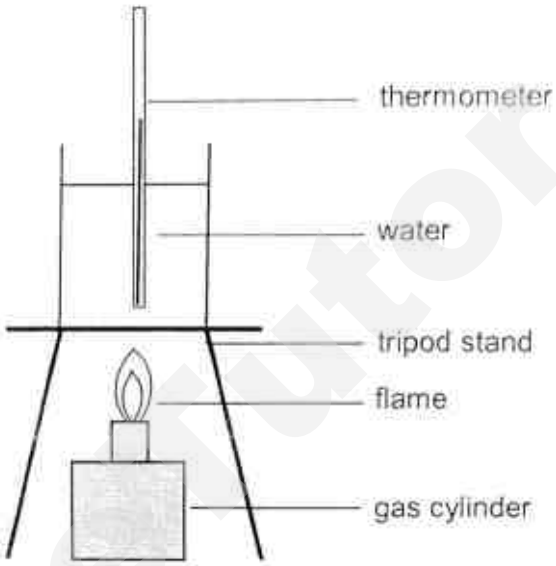
[Total: 7 marks]

A5 Propyne (C_3H_4), can undergo combustion according to the equation below:

$$C_3H_4 + 4O_2 \rightarrow 3CO_2 + 2H_2O$$

A student carried out an experiment to determine the enthalpy change of combustion for one mole of gaseous propyne in the gas cylinder.

A beaker of water was heated during the reaction and the initial and highest temperature reached were recorded. The gas cylinder containing propyne was also weighed before and after the experiment.



The following data was recorded by the student.

Mass of propyne before combustion / g	4.60
Mass of propyne after combustion / g	2.16
Mass of water in beaker / g	750
Initial temperature of water / °C	28.0
Highest temperature of water / °C	48.5

(a) Given that 4.18 J of energy is needed to raise the temperature of 1 g of water by 1 °C, calculate the heat absorbed by the water. [2]

(b) Calculate the number of moles of propyne burnt in this experiment. [1]

(c) Using your answers in **(a)** and **(b)**, calculate the enthalpy change of combustion for propyne in kJ/mol. [1]

(d) The expected enthalpy change of combustion for propyne is -1850 kJ/mol. [1]
Suggest a reason for the difference between this expected value and the value calculated in **(c)**.

……
……

(e) Sketch the energy level diagram of the combustion of propyne. [3]

[Total: 8 marks]

A6 Thallium is a metal in Group III of the Periodic Table. It has oxidation states of +1 and +3.

(a) Thallium(I) chloride is a white solid which is insoluble in water. It can be prepared using thallium(I) sulfate solution.

Describe how you would obtain a pure dry sample of thallium(I) chloride from thallium(I) sulfate solution. [3]

……
……
……
……
……

(b) Thallium(I) hydroxide is an alkali. It has similar properties as aqueous sodium hydroxide.

Aqueous thallium(I) hydroxide was added in excess to a sample of aqueous iron(II) sulfate and left to stand.

(i) Describe your observations for this chemical reaction. [2]

……
……
……

(ii) Explain your observations in **b(i)**. [2]

……
……
……

[Total: 7 marks]

Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only **one** of the alternatives should be attempted.

B7 The Pollutant Standards Index (PSI) is an air quality indicator. It is based on five pollutants: particulate matter (PM10), sulfur dioxide, carbon monoxide, ozone and nitrogen dioxide.

This table below gives some information about the overall PSI and the corresponding concentrations for each of the five pollutants.

i	PSI value (P_i)	Concentration (C_i)				
		PM10 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	CO (mg/m^3)	O_3 ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)
1	50	50	80	5.0	118	-
2	100	150	365	10.0	157	-
3	200	350	800	17.0	235	1130
4	300	420	1600	34.0	785	2260
5	400	500	2100	46.0	980	3000
6	500	600	2620	57.5	1180	3750

Table 1: Overall PSI and the corresponding concentrations for each of the five pollutants.

[1 μg = 1 x 10^{-6} g ; 1 mg = 1 x 10^{-3} g]

To calculate the overall PSI, the PSI value is first calculated for each of the five pollutants. The overall PSI is the maximum value out of the 5 calculated PSI pollutant values.

Given the concentration of a pollutant (with units stated as above), the PSI of pollutant can be calculated as follows:

PSI of Pollutant = $[(P_{i+1} - P_i) \div (C_{i+1} - C_i) \times (\text{concentration of pollutant} - C_i)] + 100$

where C_{i+1} > concentration of pollutant > C_i

In Singapore, the 24-hour PSI is used by the National Environment Agency (NEA) to provide health advisory to different groups of people. This can be summarised as shown in the table:

24-hr PSI	Healthy Persons	Elderly, Pregnant women, Children	Persons with chronic lung disease, heart disease, stroke
< 100	Normal activities		
101 - 200	Reduced prolonged or strenuous outdoor physical exertion.	Reduced prolonged or strenuous outdoor physical exertion.	Avoid prolonged or strenuous outdoor physical exertion.
201 - 300	Minimise prolonged or strenuous outdoor physical exertion.	Minimise all outdoor activities.	Avoid outdoor activities.
> 301	Minimise all outdoor activities	Avoid outdoor activities.	

Table 2: Health advisory based on 24-hour PSI.

Sources:

Table 1: http://www.haze.gov.sg/docs/default-source/faq/computation-of-the-pollutant-standards-index-(psi).pdf

Table 2: http://www.haze.gov.sg/

(a) **(i)** Explain why, when the 24-hour PSI exceeds 301, NEA would advise people to avoid outdoor activities. [3]

.....

.....

.....

.....

(ii) Unlike nitrogen dioxide, sulfur dioxide is present in air even at PSI less than 100. Suggest a source for the production of sulfur dioxide. [1]

……

(iii) Describe a simple chemical test to show that sulfur dioxide is present in a sample of air. State all your observations. [2]

……
……
……
……

(iv) Desulfurisation can reduce the concentration of sulfur dioxide in air. Write **two** chemical equations to show the reactions that occur in the desulfurisation process. [2]

……
……

(b) **(i)** Given that in a 1 m^3 sample of air, the PSI value of PM10, sulfur dioxide, carbon monoxide, ozone and nitrogen dioxide are 100, 150, 190, 112 and 133 respectively. Determine the overall PSI and explain your answer. [1]

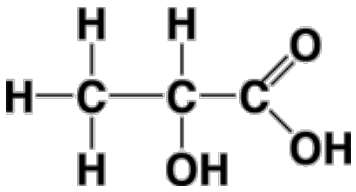
……
……

(ii) Assuming that the current PSI is according to your answer in (b)(i), what advice would you give to a 8 year old who wants to play at the outdoor playground? [1]

……

[Total: 10 marks]

B8 Hydroxypropanoic acid, also known as lactic acid, can be produced through anaerobic metabolism. It has the following structure:



(a) Draw the full structural formula of an isomer of hydroxypropanoic acid which will react with aqueous sodium hydroxide. [1]

(b) Describe a chemical test to show the **similar** chemical property shown by both hydroxypropanoic acid and propanoic acid. [2]

……..
……..
……..
……..
……..
……..

(c) Describe a chemical test to show the **difference** in chemical property shown by both hydroxypropanoic acid and propanoic acid. [2]

……..
……..
……..
……..

(d) PLA, or poly(lactic acid), is a biodegradable plactic that is used in medical implants and decomposable packaging materials.

(i) Name the reaction that produces this plastic from hydroxypropanoic acid. [1]

……

(ii) Draw 3 repeating units of PLA. [2]

(iii) What is the name of the group that links the monomers together in PLA? [1]

……

(e) Explain if the percentage mass of carbon changes when lactic acid forms PLA. [1]

……

……

[Total: 10 marks]

EITHER

B9 An application of electrolysis is in electroplating, which is a process of depositing a thin layer of metal over another metal with the help of electric current.

(a) Draw a well labelled diagram, including all the chemical reagents used, to show how copper can be plated on a steel spoon. [2]

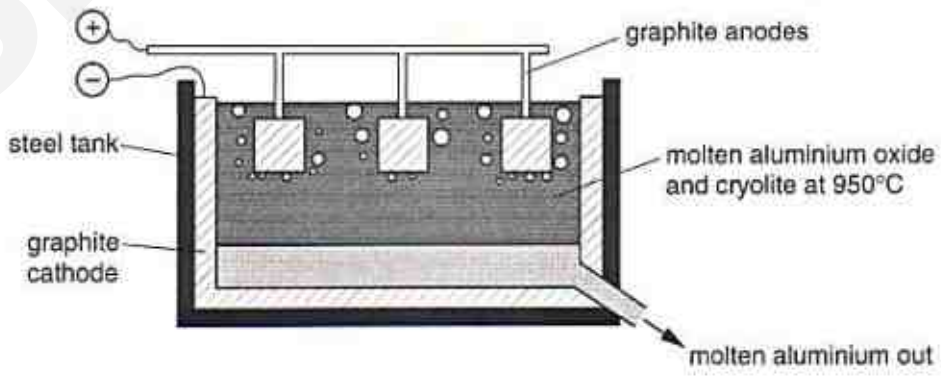
(b) Explain how galvanising prevents the rusting of the steel spoon. [2]

……

……

(c) Besides electroplating, electrolysis can also be used to extract metals from its ore. One example would be the extraction of aluminium from bauxite.

The diagram below shows an electrolysis tank used industrially to produce aluminium from aluminium oxide.



(i) Write the ionic equation for the reaction at the anode. [1]

……

(ii) Hence, explain why the graphite anodes need to be replaced regularly. [1]

……

……

(iii) Construct a balanced overall chemical equation for the decomposition of aluminium oxide. [1]

……

……

(iv) Hence, calculate the mass of aluminium obtained if 1020 g of electrolyte is being electrolysed. [1]

(d) In another experiment, rubidium chloride was electrolysed using inert electrodes.
Write the ionic equation for the reaction occuring at the anode if

(i) dilute rubidium chloride solution was electrolysed, [1]

……

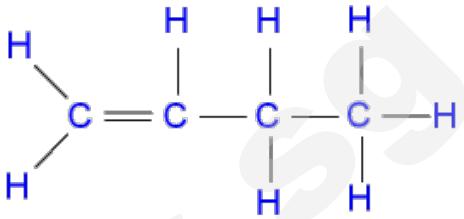
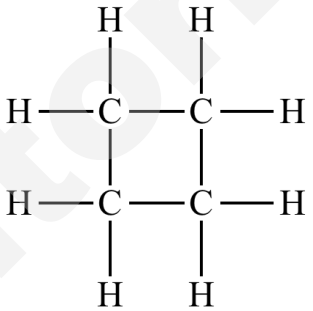
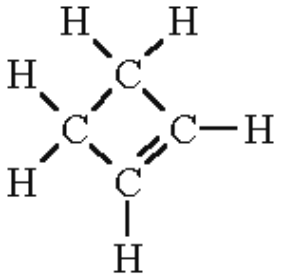
(ii) molten rubidium chloride solution was electrolysed. [1]

……

[Total: 10 marks]

OR

B9 The table below shows the displayed formulae of organic compounds from three homologous series: alkenes, cycloalkanes and cycloalkenes.

homologous series	name	displayed formula
alkenes	butene	
cycloalkanes	cyclobutane	
cycloalkenes	cyclobutene	

(a) Suggest a test that can be used to distinguish between cyclobutane and cyclobutene. [2]

……..

……..

……..

(b) Butene is one of the components found in petroleum gas which is commonly used as fuel for heating and cooking. There is a large demand for petroleum gas and cracking ensures that the supply meets demand. [2]

Explain how cracking helps to meet the demand for petroleum gas.

……

……

……

(c) Butene and cyclobutene can undergo an addition reaction to produce alcohols.

(i) State the conditions for this addition reaction. [1]

……

(ii) Draw the structural formulae of all the possible products of the addition reaction. [3]

(iii) Using a product from **(c)(ii)**, draw the structure of the compound formed when it reacts with propanoic acid. [1]

(d) Butene and cyclobutene can undergo combustion according to the equations: [1]

$$C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$$

$$2C_4H_6 + 11O_2 \rightarrow 8CO_2 + 6H_2O$$

Using the equations, explain which compound will burn with a more smoky flame.

……

……

……

[Total: 10 marks]

-- End of Paper --

Section A

A1(a) Lead(II) sulfate [1]

(b) Propanol, methyl ethanoate [1]
Bromine, Methyl Ethanoate
Bromine, Propanol

(c) Methyl ethanoate [1]

(d) Water [1]

(e) Bromine and sodium iodide [1]
Hydrogen peroxide and sodium iodide

(f) Silicon dioxide [3]
It has a giant molecular structure / giant convalent structure/compound
Si and O atoms are bonded by strong covalent bonds in a vast/giant network.
A lot of energy is required to overcome the strong covalent bonds hence boiling point is very high.

A2(a) **(i)** Average mass of one atom of the element compared with 1/12 of the mass of a carbon-12 atom. [1]

(ii) $Mg\ (s) + 2HCl\ (aq) \rightarrow MgCl_2\ (aq) + H_2\ (g)$ [2]

(iii) No of moles of H_2 = 36 / 1000 ÷ 24 = 0.0015 mol [2]
No of moles of Mg = 0.0015 mol
Relative atomic mass of Mg = 0.0360 ÷ 0.0015 = 24.0 [shown]

(b) $2Mg + O_2 \rightarrow 2MgO$ [2]

No of moles of magnesium burnt: 12000 ÷ 24 = 500 mol

No of theoretical moles of magnesium oxide formed = 500 mol

Actual mass of magnesium oxide formed = 0.75 x [500 x (24 + 16)] = 15000 g

(c) **(i)** Ammonia gas [2]

$X + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$

Hence, the compound is Mg_3N_2

(ii) Magnesium reacts with nitrogen present in the air. [1]

A3 Aluminium has a giant metallic structure. [2]

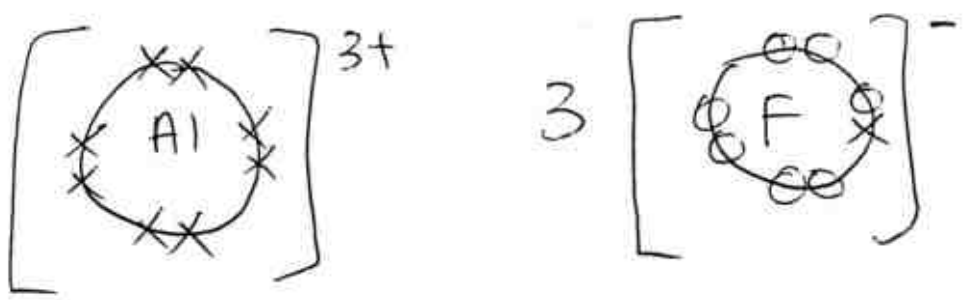
(a) The metallic cations are surrounded by a sea of delocalised electrons that are free / mobile to conduct electricity.

(b) At -240 °C, the fluorine molecules are closely and orderly/regularly arranged (vibrating about their fixed position. As temperature increases, the molecules gain kinetic energy which causes them to vibrate faster. [3]

At -220 °C, the fluorine molecules are able to overcome the forces of attraction to move out of their fixed position, to slide and roll over each other in a disorderly/random manner but closely arranged.

[2]

(c)



(d) Aluminium fluoride has a giant ionic structure. [3]

Strong electrostatic forces of attraction/strong ionic bonds between oppositely charged ions.

A lot of energy required to overcome the strong electrostatic forces of attraction.

Fluorine has a simple covalent / molecular structure.

Weak intermolecular forces of attraction / VDW between discrete molecules

Little amount of energy required to overcome the weak IMF / VDW

Aluminium fluroide has high mp while fluorine has low mp.

A4 Disagree. [1]

(a) Lead(II) sulfate is insoluble / is a precipitate but this is a solution.

(b) **(i)** Zn^{2+} [1]

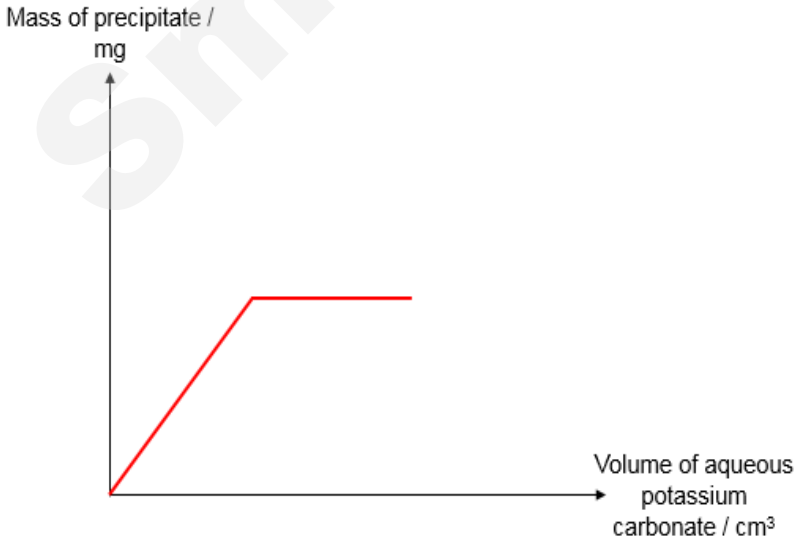
(ii) Zn^{2+} (aq) + $2OH^-$ (aq) → $Zn(OH)_2$ (s) [2]

(iii) A white precipitate is formed [2]

dissolves in excess aqueous ammonia

to form a colourless solution

(c) [1]



A5

(a) Temperature change = 48.5 - 28.0 = 20.5

Heat absorbed = 4.18 x 750 x (20.5) [2]

= 64267.5 J

= 64.3 KJ

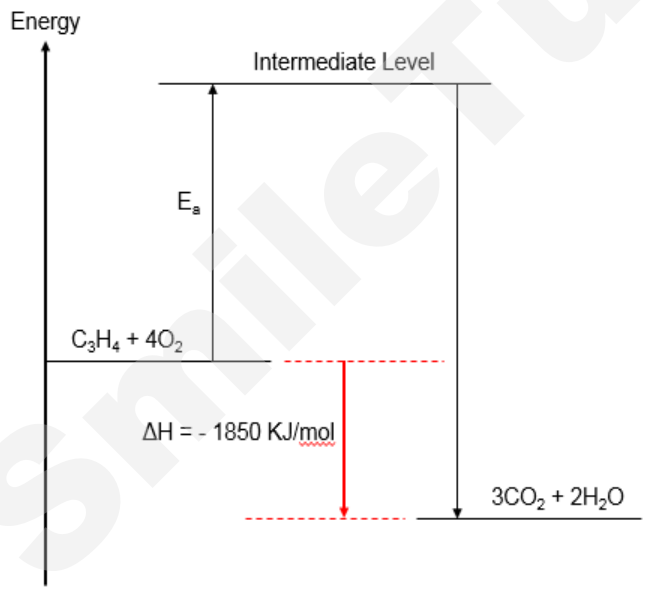
(b) Mass of propyne burnt = 4.60 – 2.16 = 2.44 g [1]

No of moles of propyne burnt = 2.44 ÷ 40 = 0.0610 mol

(c) Enthalpy change = 64.3 ÷ 0.0610 = - 1054 kJ/mol [1]

(d) Heat is lost to the surrounding (0.5m), hence the heat released is lower than expected (0.5m). [1]

(e) [3]



A6 [3]

(a) Add aqueous sodium chloride (or any identified Group I chloride / ammomium chloride or hydrochloric acid) to thallium(I) sulfate solution to obtain a white precipitate of thallium(I) chloride.

Filter the mixture to obtain the residue thallium(I) chloride.

Wash the residue with plenty of distilled water.

Dry the residue in between sheets of filter paper.

(b) **(i)** Dirty green precipitate formed which is insoluble in excess thallium(I) hydroxide. [2]

Upon standing, dirty green precipitate turns reddish brown.

(ii) $Fe(OH)_2$ an insoluble base is formed as the dirty green precipitate [2]

$Fe(OH)_2$ will oxidised (0.5m) upon standing to form $Fe(OH)_3$.

Section B

B7 **(i)** [3]

(a)

- Higher concentration of SO_2, CO and NO_2
- NO_2 and SO_2 will cause respiratory problems
- CO will combine with haemoglobin in red blood cells to form a very stable compound, carboxyhaemoglobin and it reduces the red blood cells' ability to transport oxygen around the body, eventually leading to death

(ii) [1]

- Combustion/burning of fossil fuels/coal in power stations / factories
- Volcanic activities

(iii) Bubble gas through acidified aqueous potassium manganate (VII) / filter paper with acidified aqueous potassium manganate (VII) [2]

Purple acidified aqueous potassium manganate (VII) turns colourless / decolourises

(iv) $SO_2 + CaCO_3 \rightarrow CaSO_3 + CO_2$ [2]

$2CaSO_3 + O_2 \rightarrow 2CaSO_4$

OR

$SO_2 + H_2O \rightarrow H_2SO_3$

$H_2SO_3 + CaCO_3 \rightarrow CaSO_3 + H_2O + CO_2$

OR

$SO_2 + H_2O + O_2 \rightarrow H_2SO_4$

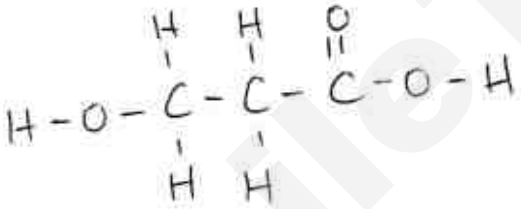
$H_2SO_4 + CaCO_3 \rightarrow CaSO_4 + H_2O + CO_2$

(b) **(i)** Since the overall PSI is the maximum value out of the 5 calculated PSI pollutant values, the overall PSI is 190. [2]

(ii) Advise the child to reduce playing outdoor for too long [1]

B8 [1]

(a)



(b) Add Zn (other metals not accepted) to an aqueous solution of the acids. [2]

Both reactions will produce effervescence of a colourless and odourless gas that will extinguish a lighted splint with a pop sound.

OR

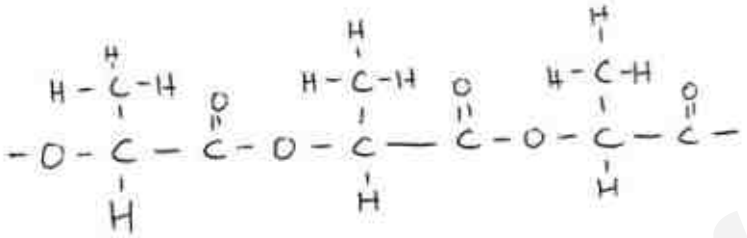
Add aqueous sodium carbonate (or any identified aqueous carbonate) to the acids.

Both reactions will produce effervescence of a colourless and odourless gas which will produce a white precipitate in limewater.

(c) Add aqueous acidified potassium manganate (VII) to both solutions and warm. [2]
Hydroxypropanoic acid will decolourise purple potassium manganate (VII) solution while there will be no visible change when added to propanoic acid.

(d) **(i)** Condensation polymerisation [1]

(ii) [2]



(iii) ester [1]

(e) The percentage mass of C will not be the same. [1]
There is loss of water / loss of H and O atoms during the polymerisation process, resulting in a decrease in the number of O and H atoms.

EITHER

B9 [2]

(a) Diagram of electrolysis set up with copper as the anode, spoon as the cathode immersed in electrolyte
Identified electroyte (e.g. aq $CuSO_4$ / $Cu(NO_3)_2$)

(b) Zinc is more reactive than iron [2]
Zinc loses electrons more easily than iron.
Zinc corrodes in place of iron.

(c) **(i)** $2O^{2-} \rightarrow O_2 + 4e$

(ii) The graphite anodes will react with oxygen produced / oxidised under high temperature to from oxides of carbon. [1]

(iii) $2Al_2O_3 \rightarrow 4Al + 3O_2$ [1]

(iv) no. of moles of Al_2O_3 = 1020 ÷ 102 = 10 mol [1]

no. of moles of Al = 20 mol

mass of Al = 20 x 27 = 540 g

(d) **(i)** dilute rubidium chloride solution was electrolysed.

$4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

(ii) Molten rubidium chloride was electrolysed.

$2Cl^- \rightarrow Cl_2 + 2e^-$

OR

B9 Aqueous bromine / bromine water [2]

(a) Reddish brown aqueous bromine will decolourise spontaneously when added to cyclobutene.

Remain reddish brown / no visible change in cyclobutane.

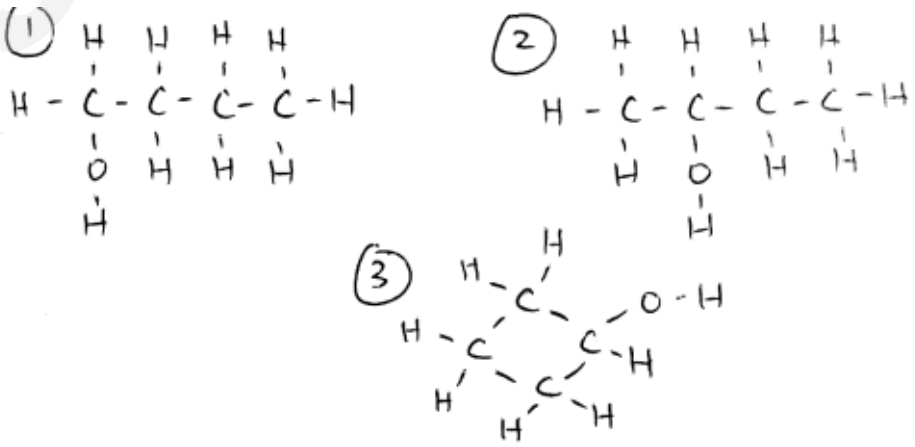
(b) Large alkanes are low in demand [2]

Cracking of large chain alkanes results in smaller alkanes / short chained alkanes [0.5m] which are higher in demand.

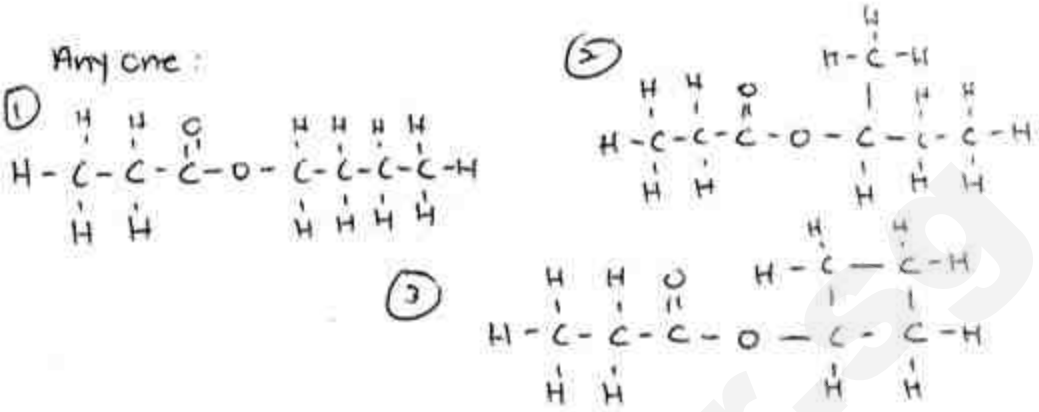
This helps to match the higher demand and lower supply for smaller chained alkanes.

(c) **(i)** Phosphoric(V) acid, 350°C, 65 atm [1]

(ii) Draw all the possible products of the addition reaction mentioned in **(c)(i)**. [3]



(iii) Using a product from (c)(ii), draw the structure of the product formed when it reacts with propanoic acid. [1]



(d) Butene requires more moles of oxygen (6 moles) than cyclobutene (5.5 moles) for complete combustion, so it will have a higher tendency to burn incompletely and produce soot, thus butene will burn with a smokier flame than butene. [1]

TEMASEK SECONDARY SCHOOL
Preliminary Examination 2017
Secondary 4 Express

CHEMISTRY **5073/01**

Paper 1 **1 hour**

Question Booklet

Additional Material: Optical Answer Sheet

READ THESE INSTRUCTIONS FIRST

Do not open the booklet until you are told to do so.

Write your name, index number and class on the Optical Answer Sheet.
Write in soft pencil.
Do not use staples, paper clips, highlighters, and glue or correction fluid.

You are not required to hand in this booklet at the end of the examination.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate answer sheet.

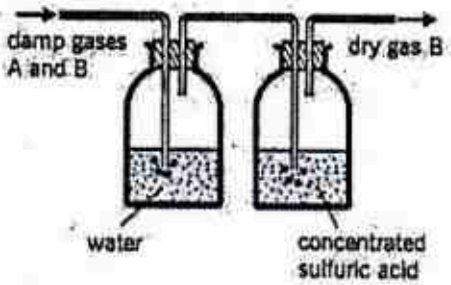
Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done on this booklet.

A copy of the Periodic Table is printed on page **21**.

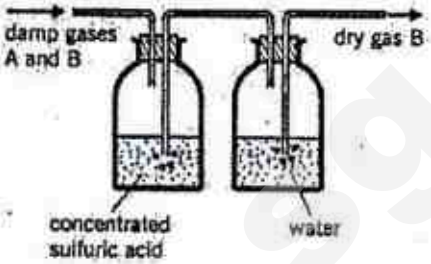
This document consists of **20** printed pages and **2** blank page.

1. Gas A is very soluble in water whereas gas B is only slightly soluble in water. Which diagram shows the correct method to obtain dry gas B from a mixture of damp gases A and B?

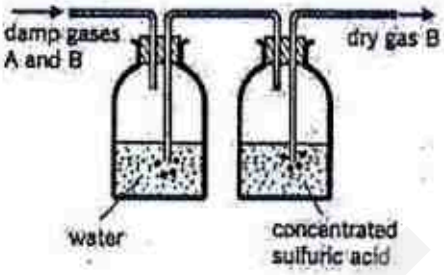
A



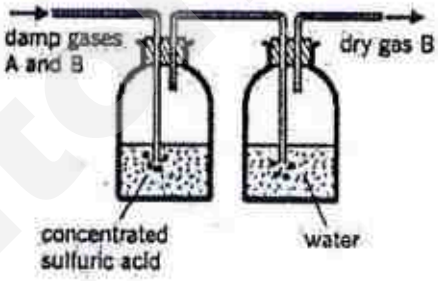
C



B



D



2. A solid sample of a compound was washed and dried. A first melting point determination of the resulting sample gave a value of 197°C. The sample was then washed and dried again. The melting point was found to be 220°C this time.

Which statement best explains the above observation?

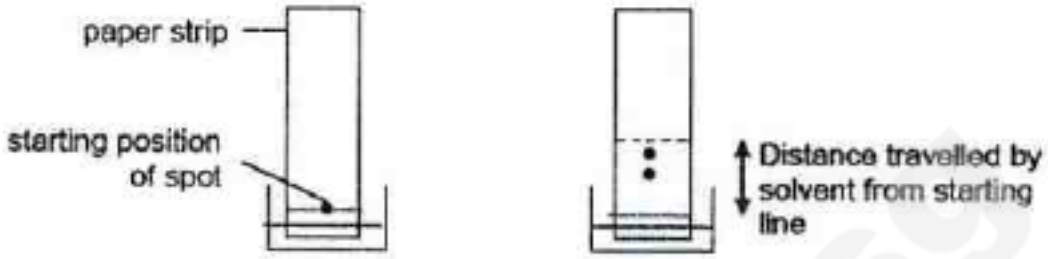
A A lower mass of the sample was used during the first melting point determination.

B The sample contained less impurities during the first melting point.

C The sample was not dried properly after the second rinsing, resulting in more impurities present.

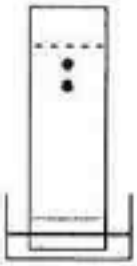
D More impurities were removed during the second rinsing, before the second melting point determination was carried out.

3. Paper chromatography was used to separate the pigments in purple ink. A chromatogram was obtained after 15 minutes as is shown opposite.



Which one of the diagrams below is most likely to indicate the appearance of the chromatogram after a further 15 minutes?

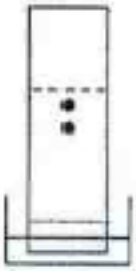
A



C

B

D



4. The rate of diffusion of gas X (M_r : 17) and gas Y (M_r : 28) was compared at 25°C and 50°C.

Which would have the highest rate of diffusion?

A gas X at 25°C

B gas X at 50°C

C gas Y at 25°C

D gas Y at 50°C

5. The table below shows the melting and boiling points of substances W to Z.

substance	melting point /°C	boiling point /°C
W	-120	-15
X	-4	42
Y	40	229
Z	413	899

Which of the following statements are true?

I.	X is a volatile liquid.
II.	Particles of Y and Z vibrate in fixed positions at room temperature
III.	Two of the above substances undergo a change in state when heated from room temperature to 80°C.

A I and II only

B I and III only

C II and III only

D All of the above

6. Which of the following options contains diatomic molecules only?

A Ammonia, carbon dioxide, water

B Carbon monoxide, hydrogen, iodine

C Methane, nitrogen, water

D Ozone, phosphorus, sulfur

7. The boiling points of some gases present in air are given in the table below.

Gas	nitrogen	oxygen	argon	xenon
Boiling point/°C	-196	-182	-186	-108

A mixture containing liquefied air at -200 °C is fractionally distilled.

Which one of the following would still remain as a liquid when the temperature is increased by 15 °C?

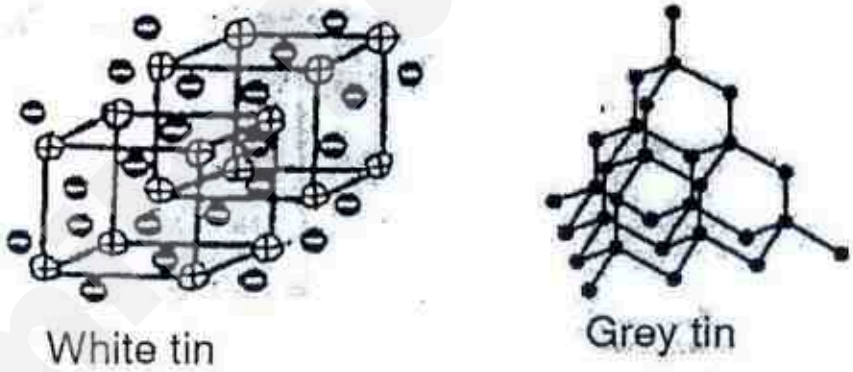
A nitrogen and argon

B oxygen and xenon

C oxygen and argon

D argon, oxygen and xenon

8. At room temperature, tin exists as white tin. Below 18°C, tin changes slowly to grey tin. The diagrams below show the structures of both types of tin.



Which one of the following best describes the two types of tin?

I.	White tin is hard while grey tin is soft.
II.	White tin is soft and malleable but grey tin is hard.
III.	Both types of tin are insoluble in organic solvents and water.
IV.	White tin can acts as a lubricant.

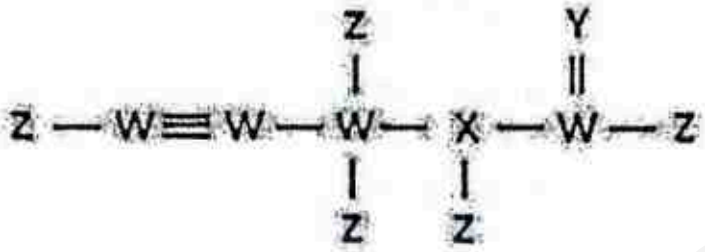
A I and II only

B I and III only

C II and III only

D II and IV only

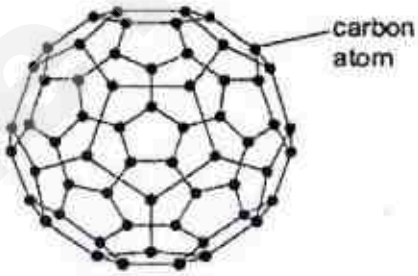
9. The structural formula of a substance is shown below.



To which group of the Periodic Table do elements W, X, Y and Z belong to?

	W	X	Y	Z
A	Group III	Group V	Group VI	Group I
B	Group V	Group VI	Group IV	Group VII
C	Group III	Group V	Group II	Group I
D	Group IV	Group V	Group VI	Group VII

10. Buckminsterfullerene has the chemical formula C_{60}.



buckminsterfullerene

Which of the following best describes buckminsterfullerene?

	structure	Ability to conduct electricity	Used as a lubricant
A	a covalent compound	no	no
B	an ionic compound	yes	no
C	simple discrete molecule	yes	no
D	macromolecule	yes	yes

11. The chemical equation for the complete combustion of methane is

$$CH_4\ (g) + 2O_2\ (g) \rightarrow CO_2\ (g) + 2H_2O\ (g)$$

25 cm^3 of methane gas is mixed with 20 cm^3 of oxygen gas in a sealed vessel and burnt.

What is the volume of the final mixture?

A 40 cm^3

B 45 cm^3

C 50 cm^3

D 80 cm^3

12. The equation for the reduction of iron ore in the blast furnace is:

$$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(l) + 3CO_2(g)$$

When 80 tonnes of the iron ore were reduced, 28 tonnes of molten iron were produced.

What is the percentage purity of the iron ore?

A 25 %

B 35 %

C 50 %

D 75 %

13. Different volumes of 2.0 mol/dm^3 potassium hydroxide solution and 2.0 mol/dm^3 sulfuric acid are mixed in a polystyrene cup.

In which combination would the temperature rise be the greatest?

	volume of KOH (aq) / cm^3	volume of H_2SO_4 (aq) / cm^3
A	20.0	40.0
B	30.0	30.0
C	40.0	20.0
D	45.0	15.0

14. 216 g of silver is deposited when an electric current is passed through a solution of silver nitrate.

What is the mass of magnesium formed when the same current is passed through molten magnesium chloride?

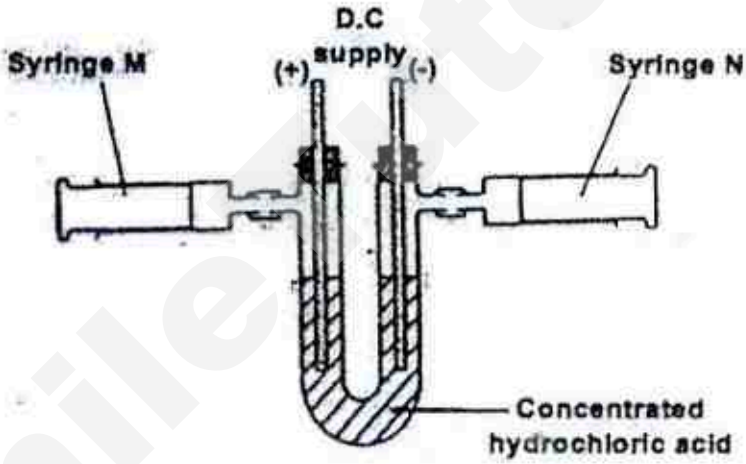
A 24 g

B 48 g

C 72 g

D 96 g

15. The apparatus shown below is used to investigate the electrolysis of concentrated hydrochloric acid. Two different gases are obtained and collected at syringes M and N.



Which statement is true about the above electrolysis?

A Copper is used as both electrodes.

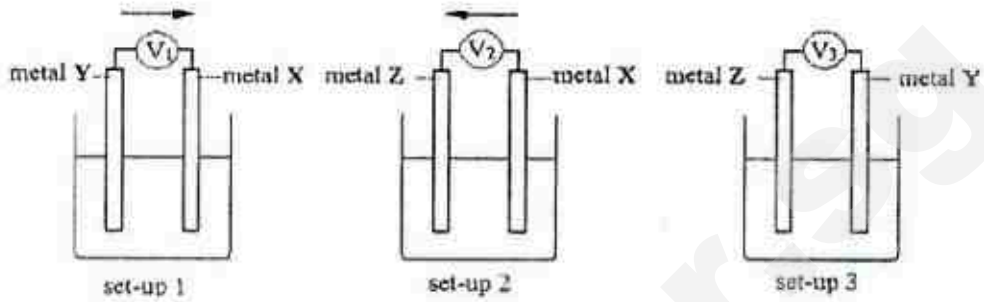
B The gas collected in syringe M is highly soluble in water.

C The gas collected in syringe N will turn moist blue litmus red, then bleaches it.

D pH of the electrolyte decreases after the electrolysis has been carried out for some time.

16. Three cells were set up as shown in the diagram. The arrows show the direction of electron flow in the external circuit.

Which of the following correctly shows the direction of electron flow and numerical value on voltmeter in set-up 3?



	direction of electron flow	numerical reading on the voltmeter V_3
A	from metal Z to Y	smaller than V1 reading
B	from metal Z to Y	between V1 and V2 readings
C	from metal Z to Y	greater than V2 reading
D	from metal Z to Y	greater than V1 and V2 readings

17. The table below compares the strengths of the bonds for reaction of the type shown below.

$$R_2 + Q_2 \rightarrow 2RQ$$

Which reaction is the most endothermic?

	Bonds in R_2	Bonds in Q_2	Bonds in RQ
A	strong	strong	strong
B	strong	strong	weak
C	weak	weak	strong
D	weak	weak	weak

18. Which of the following reactions are exothermic?

I.	$CuSO_4 + 5H_2O \rightarrow CuSO_4.5H_2O$
II.	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6$
III.	$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$
IV.	$Cl_2 \rightarrow 2Cl$

A I and II only

B I and III only

C II and IV only

D III and IV only

19. What change will decrease the speed of the following reaction?

$$CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$$

A increasing the amount of chlorine used

B using a larger reaction vessel

C increasing the temperature

D increasing the intensity of sunlight

20. Group I metals tarnish in air to form different types of oxides as shown in the table below.

Element	Oxides formed	Formula
lithium	Lithium oxide	Li_2O
sodium	sodium oxide	Na_2O
	sodium peroxide	Na_2O_2
potassium	potassium superoxide	KO_2

Which of the following shows the correct oxidation states of the metal and oxygen in each metal oxide?

	Sodium oxide, Na_2O		Sodium peroxide, Na_2O_2		Potassium superoxide, KO_2	
	formula of oxide	oxidation state of oxygen	formula of oxide	oxidation state of oxygen	formula of oxide	oxidation state of oxygen
A	O^-	-1	O^-	-1	O^-	-1
B	O^{2-}	-2	O^{2-}	-2	O^{2-}	-2
C	O^{2-}	-2	O_2^{2-}	-1	O_2^-	-0.5
D	O^{2-}	-2	O_2^{2-}	-2	O_2^-	-1

21. Which substance will dissolve in water to produce H^+ ions?

A Calcium oxide

B Carbon monoxide

C Lead(II) oxide

D Nitrogen dioxide

22. Which reactants could be used safely to prepare sodium chloride?

A Sodium and potassium chloride.

B Sodium and dilute hydrochloric acid.

C Aqueous sodium nitrate and dilute hydrochloric acid.

D Aqueous sodium carbonate and dilute hydrochloric acid.

23. Which of the following statements about the Haber process is incorrect?

A The pressure in the reaction chamber is increased to speed up the reaction.

B At the optimum conditions, the yield of ammonia is 100%.

C Nitrogen is obtained as a raw material from the fractional distillation of liquid air.

D Higher pressure produces a higher percentage yield of ammonia.

24. Which of the following are true of the Haber process?

I.	Ammonia formed is condensed and obtained as a liquid.
II.	Hydrogen is obtained from the cracking of some fractions of crude oil.
III.	Nitrogen is oxidized to form ammonia
IV.	Nitrogen and hydrogen react in the volume ratio of 3:1

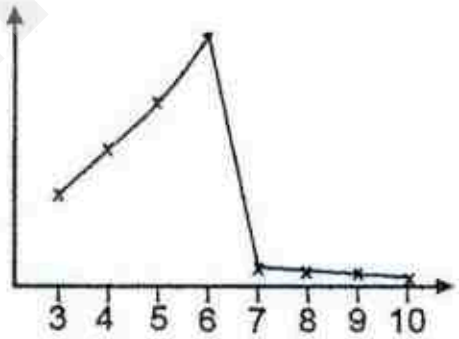
A I and II only

B I and III only

C II and IV only

D III and IV only

25. The graph below shows a trend across the elements in Period 2.



Which of the following represents this trend?

	horizontal axis	vertical axis
A	atomic mass	boiling point
B	atomic mass	solubility in water
C	number of valence electrons	atomic size
D	proton number	melting point

26. Which of the following is not true?

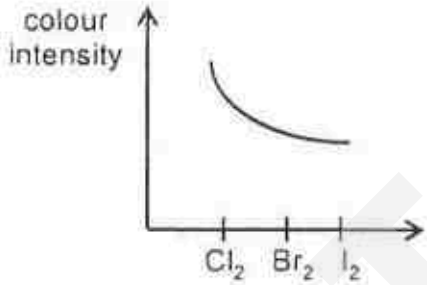
A E is a metal and F is a non-metal. E and F can be in the same group.

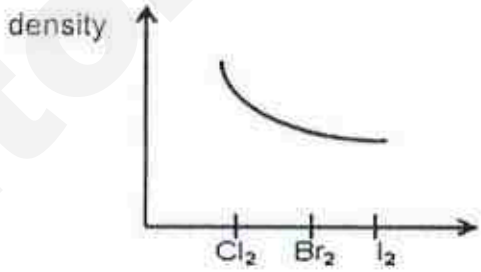
B W reacts with hydrogen to form a compound with the formula H_2W. W can be in group VI.

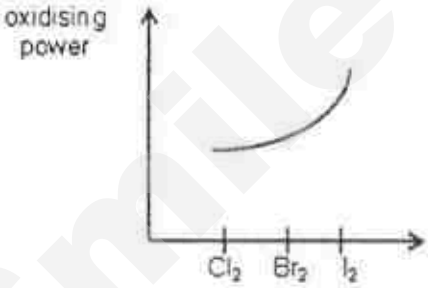
C T and U are two consecutive elements in the Periodic Table. U has a greater atomic number. The relative atomic mass of U must be higher than that of T.

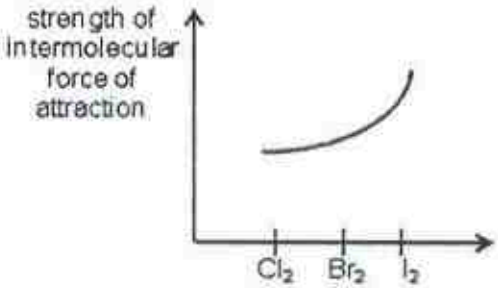
D I and J are in the same period. I and J can have the same valency.

27. Which one of the following correctly describes the trend down group VII?

A


C


B


D


28. Which one of the following statements about the elements lithium, rubidium and caesium is correct?

A They are in the same period of the Periodic Table.

B They react with cold water to form oxides and hydrogen.

C When exposed to air, they react to form a grey oxide which is insoluble in water.

D Rubidium has a higher melting point than caesium.

29. Metals can be protected against corrosion by sacrificial protection.
In the diagram shown below, metal X is being protected from corrosion by metal Y.

What are the possible identities of metal X and Metal Y?

	Metal X	Metal Y
A	Aluminum	Iron
B	Copper	Silver
C	Iron	Copper
D	Zinc	Magnesium

30. Four metals W, X, Y and Z and their compounds behaved as described.

I.	Only X, Y and Z reacted with dilute hydrochloric acid.
II.	The oxides of W, X and Y were reduced to the metal when heated with carbon powder. The oxide of Z did not react.
III.	A displacement reaction occurred when X was added to an aqueous solution of the nitrate of Y.

Arrange the metals in ascending order based on their ease of undergoing oxidation.

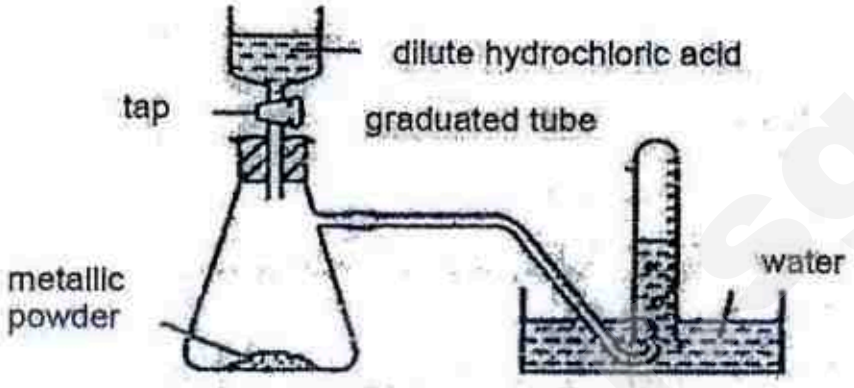
A W, X, Y, Z

B W, Y, X, Z

C Z, X, Y, W

D Z, Y, X, W

31. The diagram shows the apparatus for measuring the volume of hydrogen given off when excess dilute hydrochloric acid is added to powdered metal. The volume of gas is measured at room temperature and pressure.



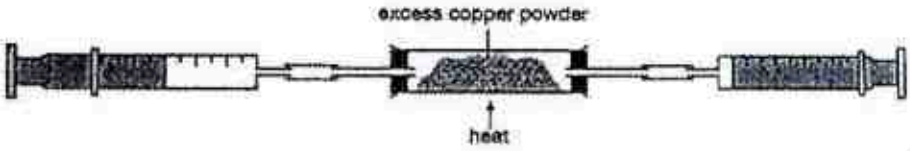
The experiment is carried out three times, using different metal powders of the same mass based on the table below.

Reaction 1	5.0 g of Magnesium
Reaction 2	5.0 g of Zinc
Reaction 3	5.0 g of Zinc and 5.0 g Magnesium

Which reaction will there be fastest rate of hydrogen production and the greatest volume of hydrogen produced?

	fastest rate of hydrogen production	greatest volume of hydrogen
A	Reaction 1	Reaction 2
B	Reaction 1	Reaction 1
C	Reaction 2	Reaction 1
D	Reaction 2	Reaction 3

32. The set-up of an experiment is shown below. At room temperature, the system initially contains 80 cm^3 of nitrogen, 60 cm^3 of oxygen and 20 cm^3 of argon.



The plungers of the gas syringes are moved to and fro until there is no further change in the system. The system is then allowed to cool to room temperature.

Which of the following statements concerning the experiment are correct?

1.	A black solid would be formed in the glass tube.
2.	The total volume of the gases in the system would decrease by 60 cm^3.
3.	The same change in total volume of gases would be observed if excess copper is replaced with excess zinc powder.

A 1 and 2

B 1 and 3

C 2 and 3

D 1, 2 and 3

33. Which one of the following is not responsible for the destruction of the ozone layer in the stratosphere?

A chlorine atoms

B fluorine atoms

C CFCs

D UV light

34. Which of the following cannot be removed from the exhaust of a petrol powered car by its catalytic converter?

A carbon monoxide

B hydrocarbons

C oxides of nitrogen

D carbon dioxide

35. Which of the following can be used to reduce atmospheric pollution by gases released from the factories which burn fossil fuels?

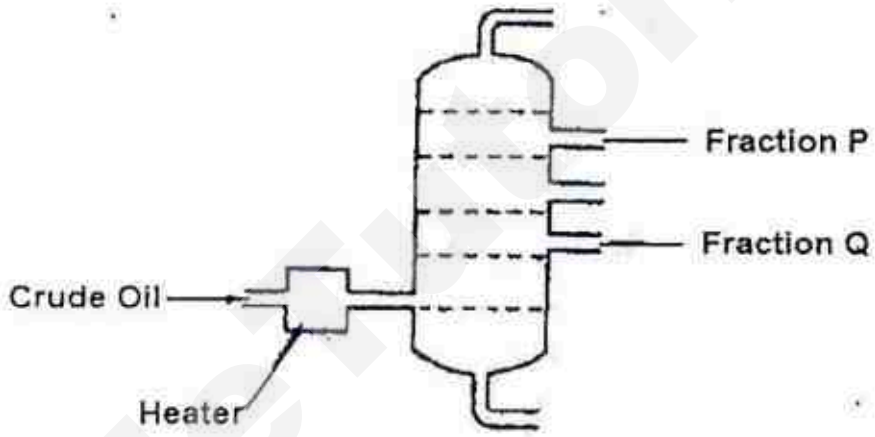
A ammonium carbonate and ammonium sulfate

B ammonium sulfate and calcium carbonate

C ammonium sulfate and calcium oxide

D calcium carbonate and calcium oxide

36. The diagram below shows two fractions, P and Q, obtained from the fractional distillation of crude oil.



What is the difference between fractions P and Q?

A Fraction P is darker than fraction Q.

B Fraction P is less viscous than fraction Q.

C Fraction P burns less readily than fraction Q.

D Fraction P has a higher boiling point than fraction Q.

37. The table below shows some of the members in the homologous series called alkanals.

Name	Chemical formula
Ethanal	CH_3CHO
Butanal	$CH_3CH_2CH_2CHO$
Hexanal	$CH_3CH_2CH_2CH_2CH_2CHO$

What is the general formula for alkanals?

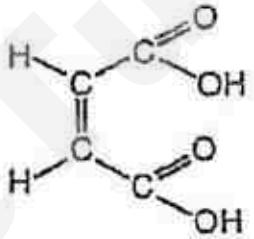
A $C_nH_{2n+1}COOH$

B $C_nH_{2n}CHO$

C $C_nH_{2n+1}CHO$

D $C_{n-1}H_{2n+1}CHO$

38. The structural formula of butenedioic acid is shown.



Which statement about butenedioic acid is not correct?

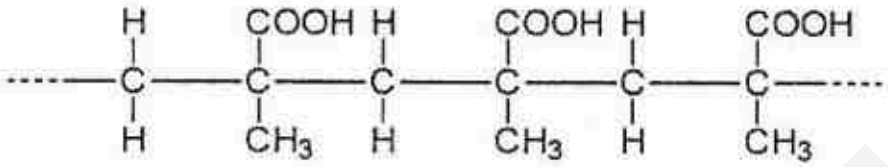
A It decolourises aqueous bromine.

B Its solution reacts with sodium carbonate.

C It decolourises cold acidified potassium manganate(VII).

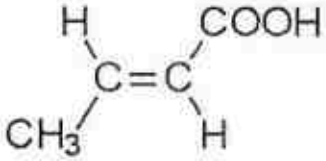
D It forms an addition polymer.

39. The structure below shows a section of a polymer.

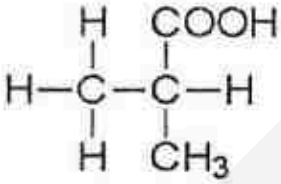


Which of the following monomers was used to make the polymer?

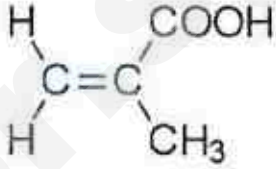
A



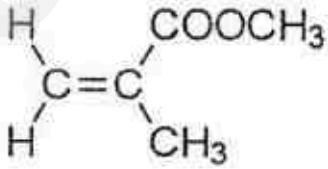
B



C



D



40. In the polymerisation of butene to poly(butene), which variable remains unchanged?

A density

B boiling point

C molecular formula

D percentage composition of elements by mass

END OF PAPER 1

TMS PURE CHEMISTRY 5073 PRELIMINARY EXAMINATION 2017
ANSWER SCHEME

1	2	3	4	5	6	7	8	9	10
A	D	C	B	D	B	B	C	D	C
11	12	13	14	15	16	17	18	19	20
B	C	C	A	B	D	B	B	B	C
21	22	23	24	25	26	27	28	29	30
D	D	B	A	D	C	D	D	D	B
31	32	33	34	35	36	37	38	39	40
B	D	B	D	D	B	C	C	C	D

Name: _____ Index Number: _____ Class: _____

TEMASEK SECONDARY SCHOOL
Preliminary Examination 2017
Secondary 4 Express

CHEMISTRY **5073/02**

Paper 2 (Section A) **Total duration for Sections A and B: 1 hour 45 minutes**

Question and Answer Booklet

READ THESE INSTRUCTIONS FIRST

Do not open the booklet until you are told to do so.

You are required to submit this booklet at the end of the paper.

Write your name, index number and class in all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.

Section A
Answer all questions in the spaces provided on the question paper.

At the end of the examination, submit **Section A and B separately**.
The number of marks is given in brackets [ ] at the end of each question or part question.
The use of an approved scientific calculator is expected, where appropriate.
A copy of the Periodic Table is printed on page **17**.

FOR EXAMINER'S USE	
Section A	/50

This document consists of **16** printed pages and **2** blank pages.

Section A

Answer all the questions in this section in the spaces provided.
The total mark for this section is 50.

A1 The table below gives some information about five substances.

substance	melting point / °C	boiling point / °C	solubility in water	electrical conductivity when molten	electrical conductivity when solid
F	-97	65	very soluble	does not conduct	does not conduct
G	1600	2230	insoluble	does not conduct	does not conduct
H	801	1413	soluble	conducts	does not conduct
I	-57	126	insoluble	does not conduct	does not conduct
J	1085	2562	insoluble	conducts	conducts

(a) Which substance in the table has ionic bonding?

..... [1]

(b) Which substance in the table has giant covalent structure?

..... [1]

(c) **(i)** Name a method which you could use to obtain substance F from a mixture of F and water.

..... [1]

(ii) State the condition which must be present for the method you named in **(c)(i)** to be successful.

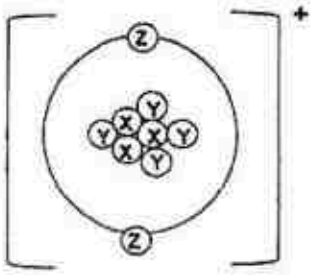
..... [1]

(d) Explain why substance J is able to conduct electricity in solid state.

.....

..... [1]

A2 An ion of element A has the following electronic arrangement.



(a) Name subatomic particles, X and Z.

..... [2]

(b) State the formula for the compound formed between A and oxygen.

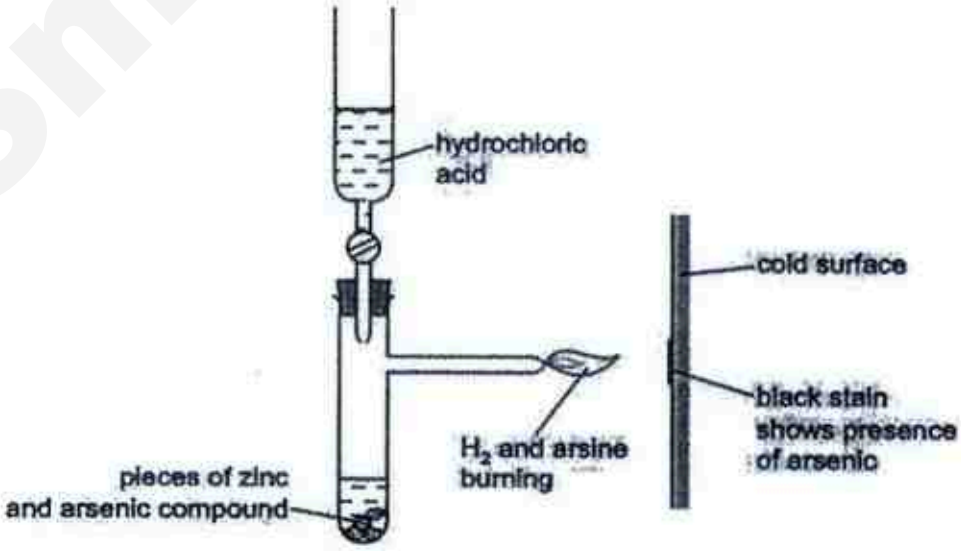
..... [1]

(c) What is the industrial method used to extract A from compound in **(b)**?

..... [1]

A3 Until recently, arsenic poisoning, either deliberate or accidental, has been a frequent cause of death. The symptoms of arsenic poisoning are identical to those of a common illness, cholera. A reliable test was needed to prove the presence of arsenic in a body.

(a) In 1840, Marsh devised a reliable test for arsenic as shown below.



Hydrogen is formed in this reaction. Any arsenic compound reacts with this hydrogen to form arsine which is arsenic hydride, AsH_3.

The mixture of hydrogen and arsine is burnt at the jet and arsenic forms as a black stain on the glass.

Write an equation for the reaction which forms hydrogen.

..... [1]

(b) Another hydride of arsenic has the composition below.

arsenic 97.4 % hydrogen 2.6 %

(i) Calculate the empirical formula of this hydride from the above data. Show your working.

[2]

(ii) The mass of one mole of this hydride is 154 g.

What is its molecular formula?

[1]

A4 (a) Manganese(IV) oxide, MnO_2, is used in the preparation of both chlorine and oxygen.

Reaction 1 $MnO_2(s) + 4HCl(aq) \rightarrow Cl_2(g) + 2H_2O(l) + MnCl_2(aq)$

Reaction 2 $2H_2O_2(aq) \rightarrow O_2(g) + 2H_2O(l)$

In reaction 2, manganese(IV) oxide acts as a catalyst.

(i) Reaction 1 is investigated using different masses of MnO_2. The results are shown in the table.

Volume of HCl / cm^3	Concentration of HCl / mol/dm^3	Mass of MnO_2 used / g	volume of Cl_2 formed at room temperature and pressure / dm^3
100	1.0	1.74	0.48
100	1.0	0.87	0.24

Explain the difference in the volume of chlorine formed.

.....

.....

.....

.....

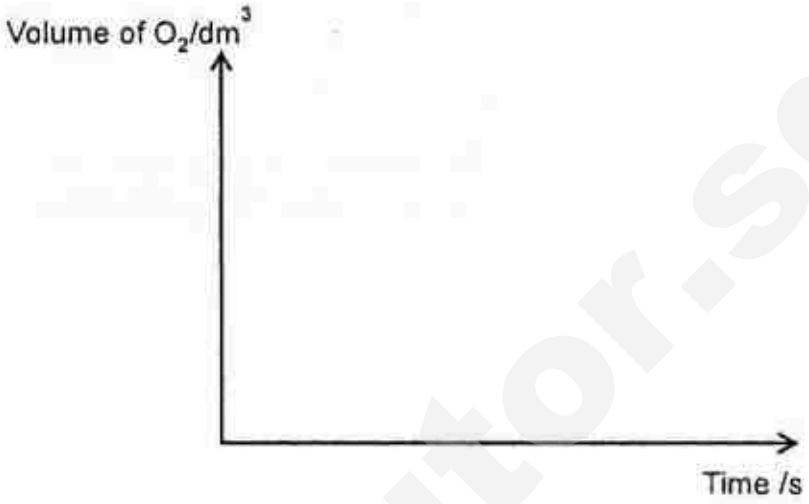
..... [2]

(ii) Reaction 2 is carried out using the following conditions. The results are shown in the table.

Volume of H_2O_2 / cm^3	Concentration of H_2O_2 / mol/dm^3	Mass of MnO_2 used / g	volume of O_2 formed at room temperature and pressure / dm^3
100	1.0	1.74	0.12

On the grid below, sketch a graph of reaction 2 and label it as Graph 2.

On the same grid, sketch how the graph would differ if 50 cm^3 of 1.5 mol/dm^3 of H_2O_2 were used instead. Label it as Graph 3.



[2]

(iii) Reaction 2 has an activation energy of 58.0 kJ/mol and 120 kJ/mol using manganese(IV) oxide and copper(II) oxide respectively as catalysts. Suggest which is a less effective catalyst.

Explain your answer and state how this would affect the rate of reaction based on the collision theory.

.....

.....

.....

.....

..... [3]

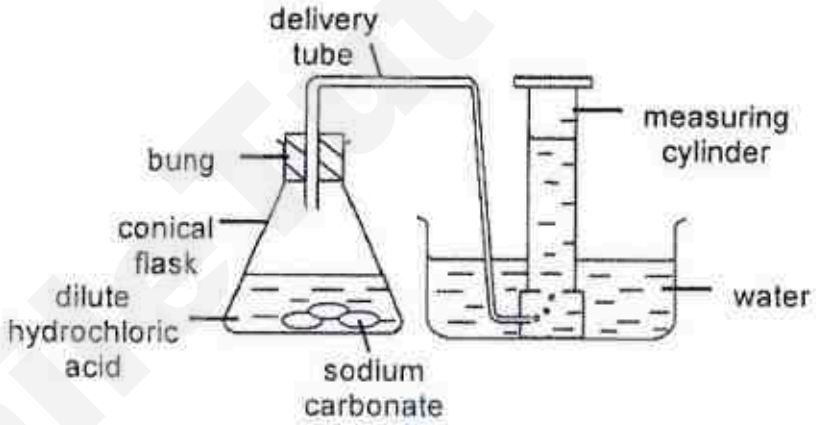
(b) Sodium carbonate reacts with dilute hydrochloric acid:

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

A student investigated the volume of carbon dioxide produced when different masses of sodium carbonate were reacted with dilute hydrochloric acid.

The following method was used:

1.	Place a known mass of sodium carbonate in a conical flask.
2.	Measure 10 cm^3 of dilute hydrochloric acid using a measuring cylinder.
3.	Add the acid into the conical flask.
4.	Place a bung in the flask and collect the gas using the set-up shown below until the reaction is complete.



The student's results are shown in the table below.

mass of sodium carbonate / g	volume of carbon dioxide gas / cm^3
0.07	16.0
0.12	27.5
0.23	52.0
0.29	12.5
0.34	77.0
0.54	95.0
0.59	95.0
0.65	95.0

(i) The result for 0.29 g of sodium carbonate is anomalous.

Suggest what may have happened to cause this result.

.....

..... [1]

(ii) What further work could the student do to be more certain about the minimum mass of sodium carbonate needed to produce 95.0 cm^3 of carbon dioxide?

.....

..... [1]

(iii) Explain how and why the expected volumes of carbon dioxide produced differ from the actual values obtained in the table shown.

.....

..... [1]

(iv) Suggest one improvement that could be made to the apparatus used that would give more accurate results.

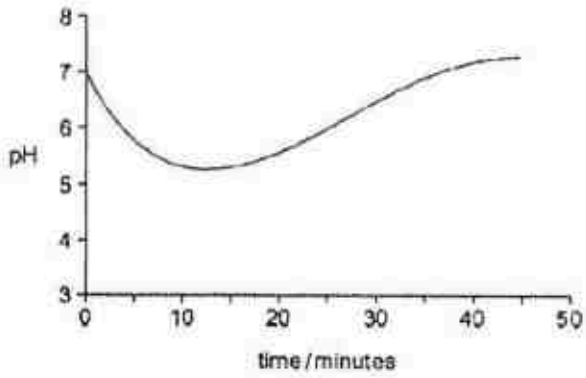
Give a reason for your answer.

.....

.....

..... [1]

A5 The diagram shows the changes in pH in a student's mouth after she has eaten an acidic sweet.



(a) Chewing an acidic sweet stimulates the formation of saliva. Saliva is slightly alkaline.

Use this information to describe and explain the shape of the graph.

.....

.....

.....

..... [2]

(b) Many sweets contain soluble calcium citrate additives.

Provide a detailed procedure as to how a pure, dry sample of the above additive can be synthesized safely in the laboratory.

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.....

..... [3]

A6 The following table summarises the reaction between 0.004 moles of various metals and 50 cm^3 (an excess) of dilute hydrochloric acid at room temperature and pressure. Use this information to answer the questions given below.

experiment	metal added	rise in temperature / °C	total volume of hydrogen given off / cm^3	observations
A	Aluminium	15	144	Reaction very slow at first. Sudden violent reaction after 20 minutes.
B	Copper turnings	0	0	No reaction.
C	Copper powder	1	0	Pink powder changes to black powder when exposed to air. Black powder reacts with acid to form blue solution.
D	Iron filings	5	96	Slow reaction at first, then fairly rapid.
E	Chromium powder	6	144	Fairly rapid reaction.
F	Zinc powder	9	96	Moderately rapid reaction

(a) Place these five metals in increasing order of reactivity putting the most reactive metal first.

..... [1]

(b) Explain the observation in

(i) experiment A.

.....

.....

..... [2]

(ii) experiment C.

.....

.....

..... [2]

(c) What is the charge on the chromium ion formed in experiment E?

Give reasons for your answer.

.....

.....

.....

..... [2]

(d) Suggest what would be observed if a magnesium strip is dipped into the blue solution formed in experiment C.

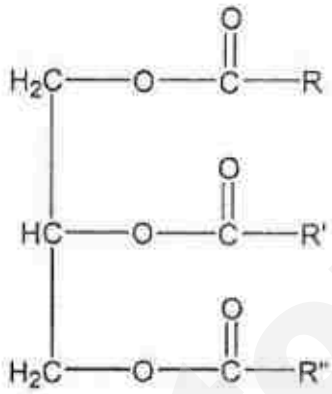
.....

.....

..... [2]

A7 Fats are solids at room temperature and pressure. They contain mainly saturated fat molecules. Oils are liquids at room temperature and pressure. They contain a larger proportion of unsaturated fat molecules.

(a) The structure of a fat or oil molecule is shown below.



(i) Identify the functional group which is present in the molecule.

..... [1]

(ii) Soap is a mixture of the sodium salts of the long-chain fatty acids produced from the hydrolysis of animal fat with aqueous sodium hydroxide.

Fat + 3NaOH → RCO_2Na + $R'CO_2Na$ + $R''CO_2Na$ + Glycerol

Draw the full structural formula of glycerol.

[1]

(b) One mole of iodine will react with one mole of carbon-carbon double bonds in oil. The degree (or amount) of unsaturation in oil can be found by reacting the oil with a known amount of iodine. The **excess** iodine is determined by titrating with sodium thiosulfate ($Na_2S_2O_3$) solution.

$I_2 + 2Na_2S_2O_3 \rightarrow Na_2S_4O_6 + 2NaI$

The number of grams of iodine that react with 100 g of oil is called the iodine number.

42.5 g of iodine was added to 35.1 g of corn oil. The **excess** iodine needed 24.2 cm^3 of 0.121 mol/dm^3 sodium thiosulfate solution for complete reaction.

(i) Calculate the number of moles of iodine that reacted with the corn oil.

[3]

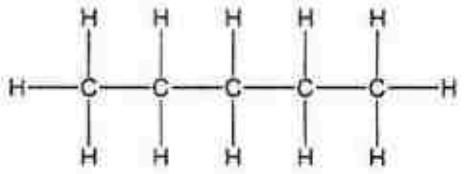
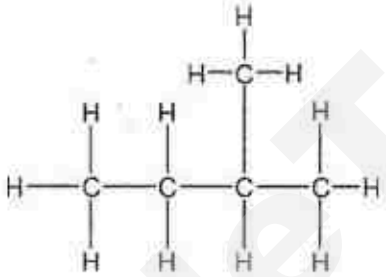
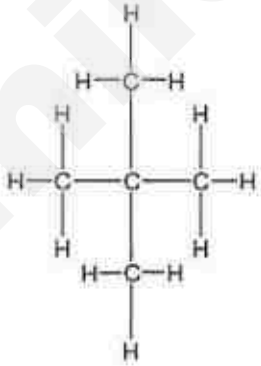
(ii) Hence, calculate the iodine number of the corn oil.

[2]

A8 The petrol that is used as fuels for car engines is a complex mixture of a hundred different hydrocarbons, which can include molecules such as pentane, octane and benzene.

The extent to which a particular type of gasoline will burn smoothly in an engine is indicated by using the octane rating. Brands of petrol are typically available with octane ratings in the range of 83 to 98.

The table below lists the octane ratings of three organic compounds which can be used as fuels.

Compound	Octane rating
	62
	92
	116

(a) Explain why the above compounds are classified as isomers.

.....

..... [1]

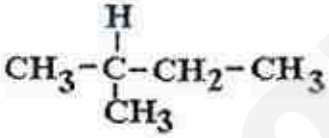
(b) Using information from the table, suggest a relationship between the structure of the compound and the octane rating.

.....

.....

..... [2]

(c) Suggest the octane number for the following hydrocarbon. Explain your answer.



.....

.....

..... [2]

END OF SECTION A

Name: _____ Index Number: _____ Class: _____

TEMASEK SECONDARY SCHOOL
Preliminary Examination 2017
Secondary 4 Express

CHEMISTRY 5073/02

Paper 2 (Section B)

Total duration for Sections A and B: 1 hour 45 minutes

Question and Answer Booklet

READ THESE INSTRUCTIONS FIRST

Do not open the booklet until you are told to do so.

You are required to submit this booklet at the end of the paper.

Write your name, index number and class in all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.

Section B
Answer **three questions** from this section.
Question **B11** is in the form of either/or and only one of the alternatives should be attempted.
Write your answers in the spaces provided.
At the end of the examination, submit **Section A and B separately**.

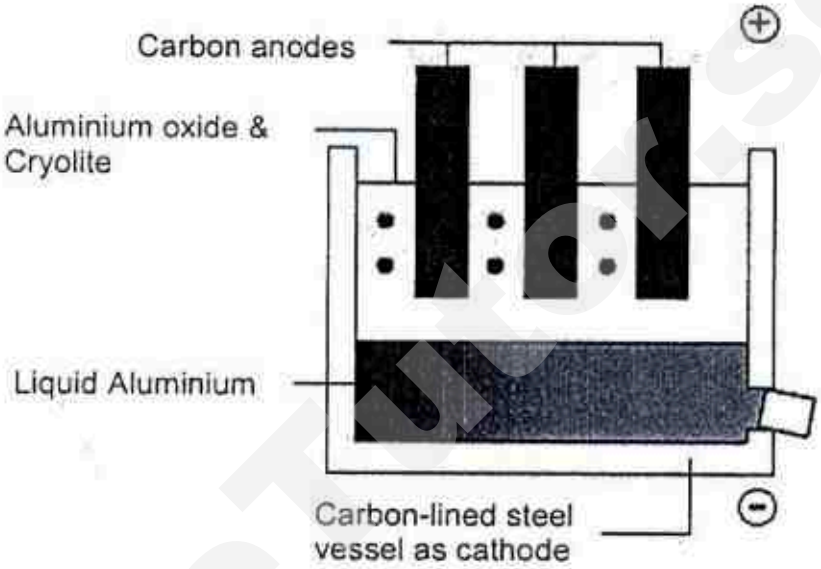
The number of marks is given in brackets [ ] at the end of each question or part question.
The use of an approved scientific calculator is expected, where appropriate.
A copy of the Periodic Table is printed on **page 17** of **Section A**.

FOR EXAMINER'S USE	
Section B	/30

This document consists of **10** printed pages.

Section B
Answer three questions from this section.
Question B11 is in the form of either/or and only one of the alternatives should be attempted.
Write your answers in the spaces provided.

B9 Aluminium is obtained by the electrolysis of molten mixture of aluminium oxide and cryolite using carbon as electrodes.



(i) Explain why the addition of cryolite is necessary for the process.

.....

..... [1]

(ii) Calculate the number of moles of electrons which are needed to produce 2.00 kg of aluminium.

[2]

(iii) During the electrolysis, the anode has to be replaced at regular intervals. Suggest a reason for doing so with the aid of balanced chemical equations.

.....

.....

..... [2]

(iv) Explain why the set up will fail to extract aluminium if the electrodes are changed to copper.

.....

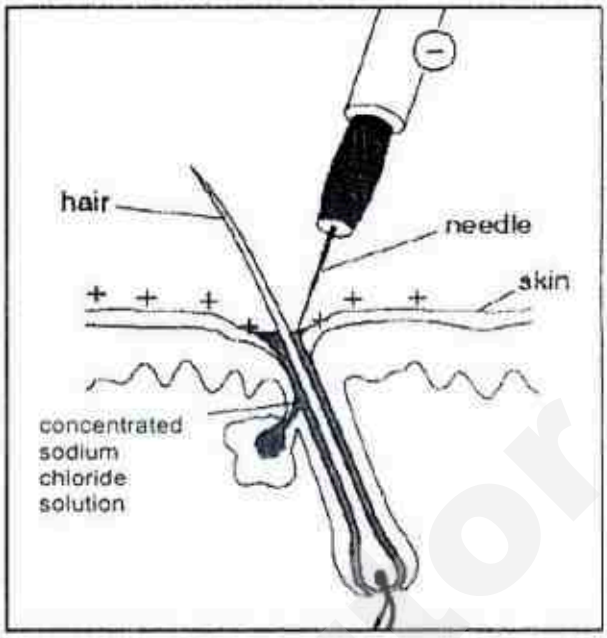
.....

.....

..... [2]

(b) Electrolysis can be used to remove unwanted hair. A needle, which serve as a negative electrode is held by the operator while the customer holds the metal bar which serve as the positive electrode.

An aqueous solution of concentrated sodium chloride is applied on the tip of the needle. The change in pH of the area around the hair leads to the removal.



Account for the removal of hair through the process above, detailing the chemistry behind it as well as the different products formed.

..... [3]

B10 The equation for the formation of ammonia in the Haber Process is shown below.

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g)$$

A series of experiments were carried out using different temperatures and catalysts to determine the percentage yield of ammonia.
The table below shows the results obtained.

experiment	catalyst	temperature / °C	Percentage yield of ammonia		
			after 3h	after 24h	after 30 days
1	none	400	2	4	23
2	none	500	3	5	17
3	aluminium	400	2	4	23
4	aluminium	500	3	5	17
5	calcium	400	3	6	23
6	calcium	500	4	7	17
7	iron	400	18	21	23
8	iron	500	7	9	17
9	osmium	400	20	23	23
10	osmium	500	8	10	17

(a) Transition metals are more effective than main group metals as catalysts. Explain how the information in the table supports this statement.

.....

.....

.....

.....

.....

.....

..... [2]

(b) A student wrote this conclusion from the results in the table:

Catalysts speed up reactions but do not affect the final yield.

Do you agree with this conclusion?
Use the results to explain your reasoning.

.....

.....

.....

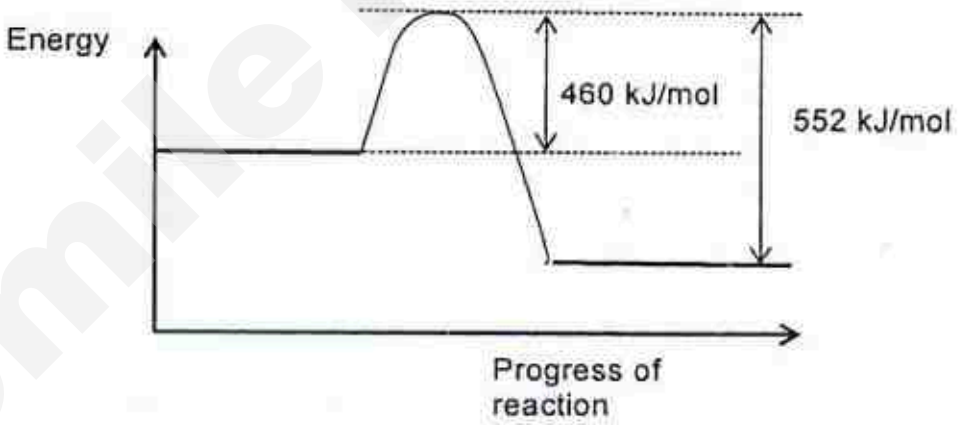
.....

.....

.....

..... [2]

(c) The energy profile diagram for the uncatalysed reaction at 400°C is shown below.



(i) Use the graph to explain whether the forward reaction is exothermic or endothermic.

.....

.....

..... [2]

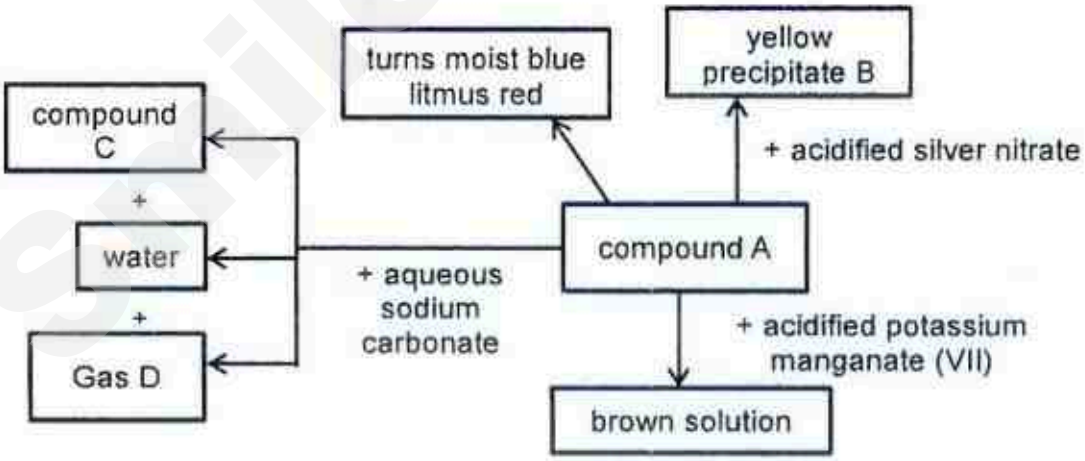
(ii) Calculate the energy change when 540 cm^3 of ammonia is formed.

[2]

(iii) In the presence of iron catalyst, the activation energy for the reverse reaction is 298 kJ/mol.
Suggest a value for the activation energy for the formation of ammonia under these conditions.

[2]

B11 EITHER
Refer to the following flow chart and answer the questions below.



(a) State the identity of A, B and C.

A : .....

B : .....

C : ..... [3]

(b) **(i)** Describe a test to identify gas D.

.....

..... [1]

(ii) Write the equation for the observation in (b)(i).

..... [1]

(c) Explain the presence of the brown solution upon adding acidified potassium manganate (VII) in terms of electron transfer.

.....

.....

..... [3]

(d) Suggest what would happen if aqueous bromine were added to a solution of compound C? Explain your answer.

.....

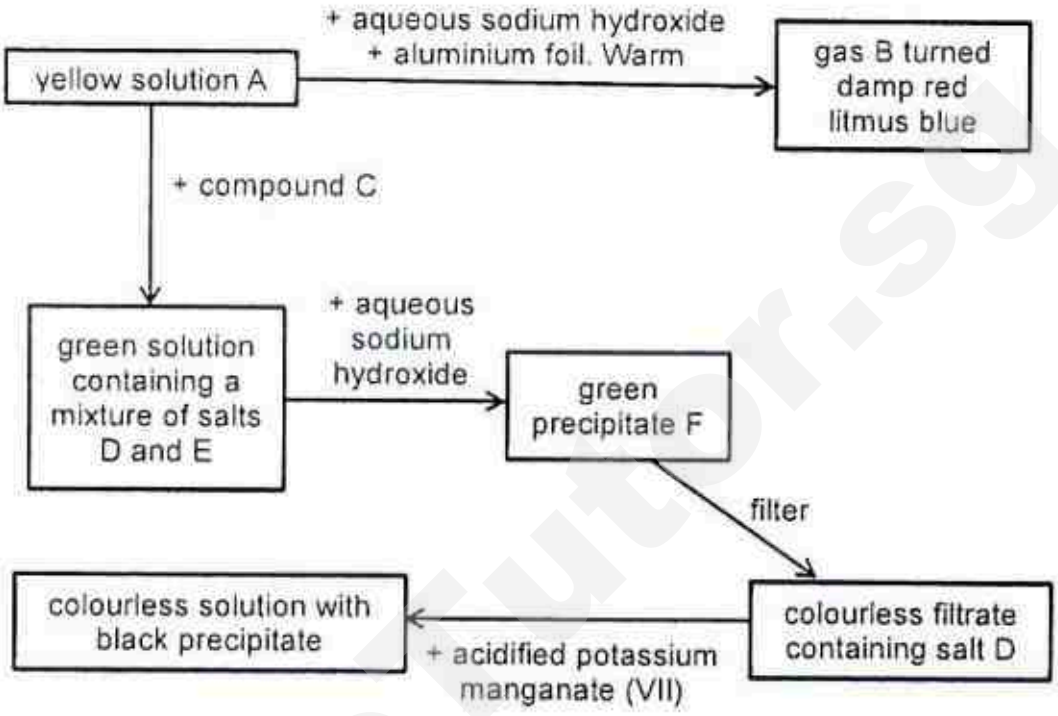
.....

.....

..... [2]

B11 OR

The flow diagram below shows a series of reaction of substance A which contains two cations and two anions.



(a) (i) Identify the cation responsible for the yellow colour in solution A.

..... [1]

(ii) Identify B and F.

B : .....

F : ..... [2]

(b) Suggest the role of compound C. Explain your answer in terms of electron transfer.

.....

.....

..... [2]

(c) Explain, in terms of oxidation state, the formation of the black precipitate upon adding acidified potassium manganate (VII) to the colourless filtrate containing salt D.

.....

.....

..... [3]

(d) Suggest a possible identity of an anion in solution A, other than the one mentioned in **(c)**.

..... [1]

(e) Gas B reacts with dilute nitric acid to form a fertilizer. State the chemical formula of the fertilizer formed.

..... [1]

END OF SECTION B

Answer Scheme for Section A

A1	(a)	H		[1]
	(b)	G		[1]
	(c)	(i)	Fractional distillation	[1]
		(ii)	F and water must have different boiling points	[1]
	(d)	J consists of a lattice of positive ions surrounded by a sea of delocalized electrons + electrons are free to move to conduct electricity		[1]

A2	(a)	X: Proton [1] Z: Electron [1]	
	(b)	A_2O [1]	
	(c)	Electrolysis of its molten compound [1]	

A3	(a)	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$		
	(b)	(i)		

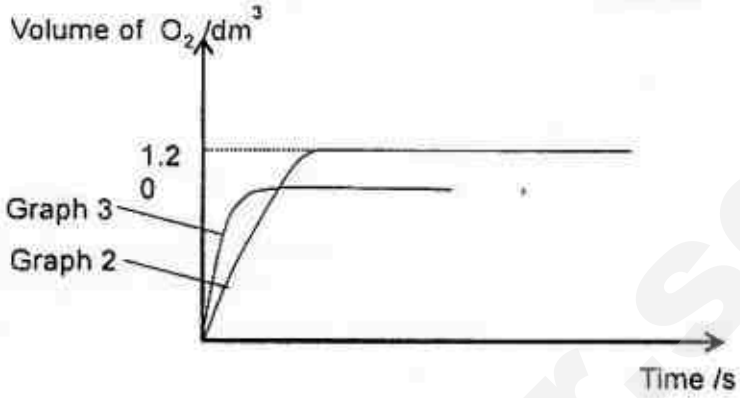
Elements	As	H
Percentage Mass (%)	97.4	2.6
No. of moles	97.4/7.5 = 1.3	2.6/1 = 2.6
Mol ratio	1	2
Empirical Forumla	AsH_2	

[1]

[1]

		(ii)	Mr of AsH_2 = 75 + 2 = 77 n = 154 / 77 = 2 molecular formula = As_2H_4 [1]	

A4	(a)	(i)	• MnO_2 is the limiting reagent [1] • Volume of Cl_2 produced is halved, from 0.48 dm^3 to 0.24 dm^3 as number of moles of MnO_2 used is halved. [1]	

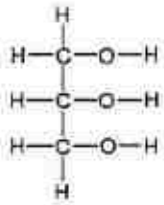
		(ii)	 [1] for correct shape for Graph 2 with volume indicated. [1] for Graph 3 with steeper gradient + smaller volume of O_2	[2]
		(iii)	• Copper(II) oxide is a less effective catalyst with a higher activation energy of 120 kJ/mol compared to manganese(IV) oxide with a lower activation energy 58.0 kJ/mol [1] • Fewer particles possess energy greater than or equal to the activation [1] • Frequency of effective collisions is lower + rate of reaction is lower [1]	
	(b)	(i)	• bung not put in firmly • gas lost before bung was placed in position • there was a leak from the delivery tube [Any one] [1]	
		(ii)	Take more readings for masses of sodium carbonate ranging from 0.34 g to 0.54 g [1]	
		(iii)	Expected volumes of carbon dioxide produced should be greater than the actual values obtained as some carbon dioxide dissolves back into the water. [1]	
		(iv)	Use a pipette/burette to measure the acid [1] as it measures volume to a higher degree of accuracy compared to the measuring cylinder [1] *OR* use a gas syringe to collect the gas [1] so it will not dissolve in water [1]	

A5	(a)	Initially pH drops sharply from 7 to 5.1/5.2/5.3 then rises gradually to 7.2/7.3 [1]	

		This is due to acidic sweet producing H+ ion to lower the pH, and the rise is due to alkali saliva neutralizing the H+ from the sweet. [1]	
	(b)	Add **excess** calcium carbonate to citric acid and stir the mixture. Filter the mixture to obtain the calcium citrate solution as the filtrate [1] Heat the filtrate until saturated, allow saturated solution to cool and crystalisation to occur. [1] Filter the mixture to obtain calcium citrate crystals as residue Wash the crystals with cold distilled water and dry between 2 pieces of filter paper [1] [Can be done using calcium oxide] [0 for calcium metal. Not safe]	

A6	(a)		Copper, Iron, Chromium, Zinc, Aluminium	1;
	(b)	(i)	The initial reaction is slow because the aluminium metal is protected by an inert and non-porous layer of aluminium oxide which prevent contact between aluminium and acid; The reaction became violet after all the aluminium oxide has reacted with the acid, exposing the aluminium metal to the acid. Aluminium reacts vigorously with acid.	1; 1;
		(ii)	Pink copper is oxidized by oxygen in air to form black copper (II) oxide; Black copper (II) oxide reacts with acid to form copper (II) chloride and water. The copper (II) chloride is soluble is water and hence forms a blue solution.	1; 1;
	(c)		+3; (zero marks for qn if charge is wrong) Chromium and aluminium gives off the same volume of hydrogen gas when reacting with the acid, hence chromium will form ions of the same charge as aluminium;	1; 1;
	(d)		Blue solution will turn colourless/ Blue solution will fade; Magnesium strip will be coated with reddish brown deposit;	1; 1;

A7	(a)	(i)	ester ALLOW: −COO−	1

		(ii)	 All covalent bonds must be shown.	1
	(b)	(i)	Number of moles of iodine added = 42.5/127x2 = 0.1673 mol Number of moles of sodium thiosulfate = 24.2/1000 x 0.121 = 2.928 x 10^{-3} mol ≈ 2.93 x 10^{-3} mol Number of moles of excess iodine = 0.5 x 2.928 x 10^{-3} mol = 1.464 x 10^{-3} mol Number of moles of iodine that reacted = 0.1673 − 1.464 x 10^{-3} = 0.1659 ≈ **0.166 mol** ALLOW: ecf.	1 1 1
		(ii)	Mass of iodine that reacted = 0.1659 x (127x2) = 42.13 g ≈ 42.1g 35.1 g of corn oil → 42.13 g of iodine 100 g of corn oil → 42.13/35.1 x 100 = 120g of iodine ∴ iodine number of corn oil is **120**. ALLOW: ecf.	1 1

A8	(a)	They are organic compounds with the same molecular formulae but different structural formulae. [all or nothing]	1
	(b)	As the amount of branching to the hydrocarbon increases, the octane number increases [1], as seen in the straight chain hydrocarbon at 62 octane number, increasing to 92 and 116 with 1 and 2 branch alkyl groups respectively. [1]	
	(c)	92 [1] It has the same structural formula as the 2nd compound in the table. [1]	

Answer Scheme for Section B

B1	(a)	(i)	Cryolite acts as an impurity which will help to lower the melting point of aluminium oxide, hence **reducing the amount of energy needed for melting.**	[1]
		(ii)	$Al^{3+} + 3e^- \rightarrow Al$ [1] No of moles of aluminium = 2000 / 27 = 74.074 = 74.07 mol No of moles of electrons = 74.074 x 3 = 222.22 = 222 mol [1]	[2]
		(iii)	$6O^{2-} \rightarrow 3O_2 + 12e^-$ $O_2 + C \rightarrow CO_2$ [1] [both eqn necessary for 1 m] The hot oxygen can react with the carbon anode to form carbon dioxide gas. [1]	
		(iv)	When copper is used as the anode, it is a reactive anode and will be oxidized to form Cu^{2+} ions. [1] These ions will be displaced by more reactive aluminium metal to form Al^{3+}, hence lowering the yield of aluminium obtained [1]	[2]
	(b)		• At the anode, Cl^- will be oxidized to form greenish yellow Cl_2 gas. • At the cathode, H^+ will be reduced to form a colourless H_2 gas. [1] • As OH^- and Na^+ remained in the electrolyte, an alkali solution of NaOH remains. [1] • This leads to an increase in pH which will cause the removal of hair. [1]	[3]

B2	(a)		• At 400°C, the percentage yield of ammonia <u>increases at a higher rate</u> [1] • of <u>18% after 3h for iron, a transition metal</u> than for <u>aluminium, a Group II metal</u> which ammonia increases at a much lower rate of <u>2% after 3h</u> [1] *OR* [1] for the correct comparison/ trend between a transition metal and a main group metals [1] for substantiating with data from the table	[2]
	(b)		• At 400°C, the percentage yield of ammonia <u>remains the same at 23% after 30 days</u> [1]	[2]

			• for both iron and osmium which are transition metals and for calcium and aluminium which are Group II and Group III metals respectively [1] *OR* • At 500°C, the percentage yield of ammonia remains the same at 17% after 30 days [1] • for both iron and osmium which are transition metals and for calcium and aluminium which are Group II and Group III metals respectively [1]	
	(c)	(i)	• Exothermic [1] • The reactants possess more energy than the products + energy lost to the surroundings. [1]	[2]
		(ii)	ΔH = - (552 -460) = - 92.0 kJ/mol [1] No of moles of ammonia = 540/1000 ÷ 24 =0.0225 moles Energy released = 0.0225 x 92.0 = 2.07 kJ [1] *(OR if student indicated ΔH with a negative sign without stating energy was released)*	[2]
		(iii)	Activation energy for catalysed formation of ammonia = 298 – 92.0 [1] = 206 kJ /mol [1]	[2]

B3	EITHER				
	(a)	A	:	HI [1]	
		B	:	AgI / silver iodide [1]	
		C	:	NaI / sodium iodide [1]	[3]

(b)	(i)	Bubble the gas through limewater + if a white ppt is formed, gas is carbon dioxide. [1]	[1]
	(ii)	$Ca(OH)_2 + CO_2 \rightarrow CaCO_3$	[1]
(c)		• I^- in compound A is oxidized by acidified potassium manganate (VII) to I_2 [1] • as I^- in A has lost electrons to form I_2 [1] • which dissolves in the solution to form brown aqueous iodine. [1]	[3]
(d)		• Bromine is more reactive than iodine [1] • It displaces iodine / iodide ions from solution C / aqueous sodium iodide to form aqueous iodine. [1]	[2]

B3 OR				
(a)	(i)	Iron(III) ion / Fe^{3+} [1]		[1]
	(ii)	B	Ammonia / NH_3 [1]	
		F	Iron(II) hydroxide / $Fe(OH)_2$ [1]	[2]
(b)		• C is a reducing agent. [1] • It reduces Fe^{3+} to Fe^{2+} as Fe^{3+} in A has gained electrons to form Fe^{2+} in E. [1]		[2]
(c)		• Acidified potassium manganate (VII) oxidizes iodide ions / I^- in D to iodine [1] as • the oxidation state of iodine increases from -1 in I^- to 0 in I_2. [1] • Iodine is only slightly soluble in water, and precipitates out as a black solid. [1]		[3]
(d)		Nitrate ion / NO_3^- [1]		[1]
(e)		NH_4NO_3		[1]

TANJONG KATONG GIRLS' SCHOOL

PRELIMINARY EXAMINATION 2017
SECONDARY FOUR

5073/01 **CHEMISTRY**

Thursday 14 September 2017 1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name and index number on the Answer Sheet in the spaces provided.

There are **forty** questions in this paper. Answer **all** questions.
For each question, there are four possible answers, **A, B, C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 2.
The use of an approved scientific calculator is expected, where appropriate.

This Question Paper consists of 22 printed pages, including this page.

DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 +															

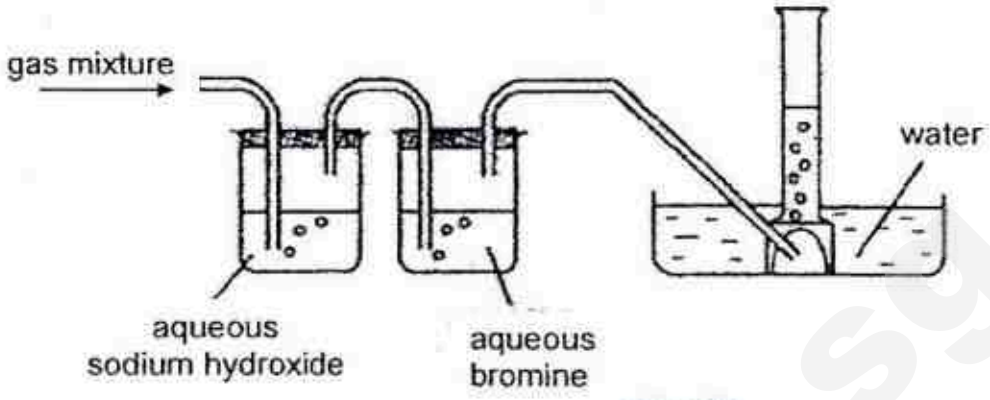
140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
+90-103 Actinoid series

Key: a X b — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

1 A gaseous mixture of ethene, oxygen and sulfur dioxide is passed through the apparatus shown. Only one of the gases is collected.



Which of the following is a property of the gas collected?

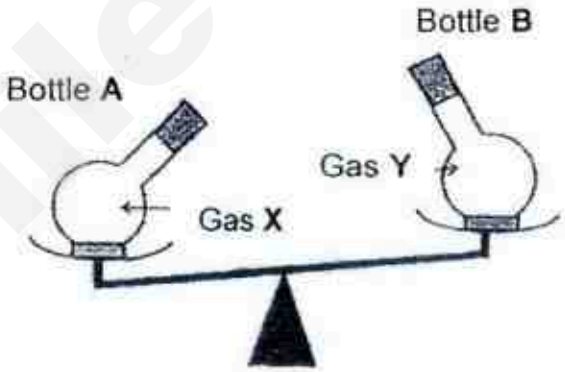
A It turns brown bromine solution colourless.

B It relights a glowing splint.

C It turns acidified potassium manganate(VII) solution colourless.

D It forms a white precipitate in limewater.

2 Two identical bottles filled with gas **X** and gas **Y** were put on a balance at room temperature and pressure. The result is shown below.



Which statement is correct?

A The number of gas particles in bottle **A** is greater than the number of gas particles in bottle **B**.

B The number of moles of gas particles in bottle **A** is greater than the number of moles of gas particles in bottle **B**.

C The molar mass of gas particles in bottle **A** is greater than the molar mass of gas particles in bottle **B**.

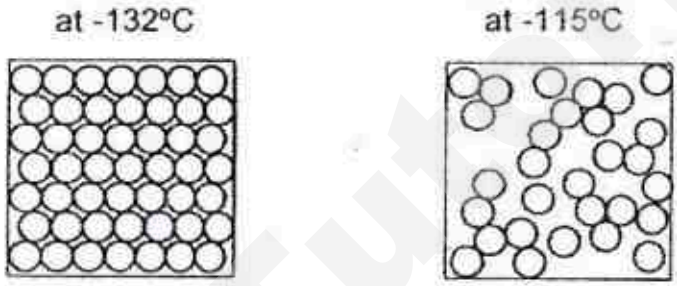
D The molar volume of gas particles in bottle **A** is greater than the molar volume of gas particles in bottle **B**.

3 Hard water contains calcium ions and hydrogencarbonate ions arising from dissolved calcium hydrogencarbonate, $Ca(HCO_3)_2$.

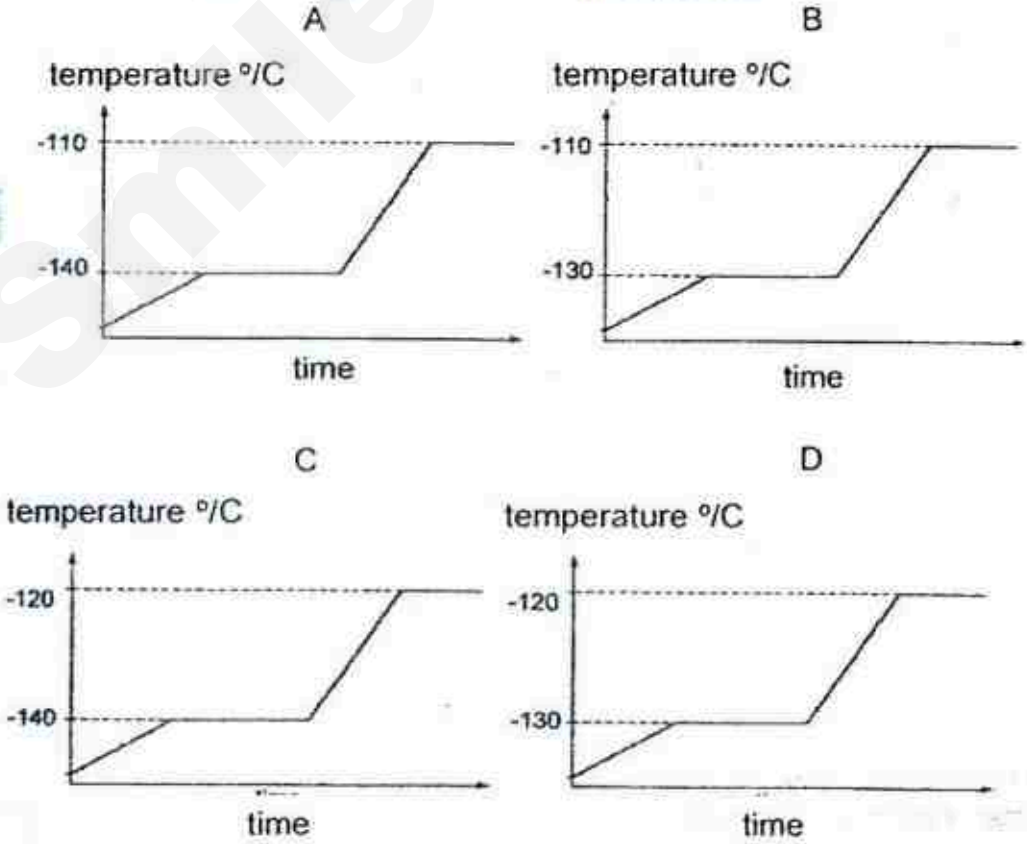
How many electrons are present in the hydrogencarbonate ion?

A 30
B 31
C 32
D 33

4 The diagrams show the spacing of particles in a substance at two different temperatures.



Which graph shows how the temperature of the substance changes with time when it is heated?



5 Titanium has five stable isotopes and shows three oxidation states, +2, +3 and +4. Below is the particle formed from the most abundant isotope.

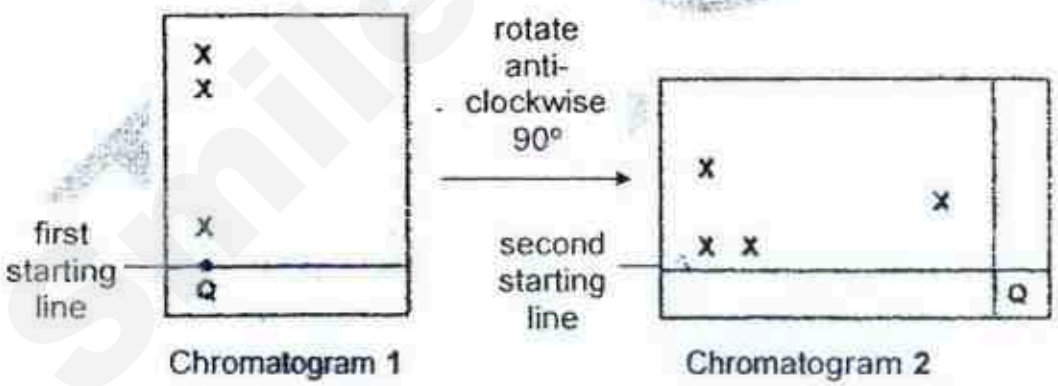
$$^{48}_{22}Ti^{4+}$$

Which of the following shows the number of protons, neutrons and electrons of the particle formed by a different isotope of titanium?

	Protons	Neutrons	Electrons
A	22	22	17
B	22	26	19
C	22	28	20
D	18	20	22

6 Chromatogram **1** below shows the separation of coloured links in mixture **Q** using solvent **A**.

Chromatogram **2** shows further separation using the same piece of paper but after it has been rotated anti-clockwise 90° in another solvent **B**.



How many different types of ink are present in mixture **Q**?

A 3

B 4

C 5

D 6

7 Which mixture can be best separated by fractional distillation?

A water and butanol

B water and butane

C seawater and paraffin

D sulfur and naphthalene

8 Oxygen consists of the isotopes ^{16}O, ^{17}O and ^{18}O. Carbon consists of the isotopes ^{12}C and ^{13}C. How many different carbon dioxide molecules can be obtained from these isotopes?

A 5

B 6

C 10

D 12

9 Elements G and J form a compound with formula G_3J. At room temperature, the particles in G_3J slide over one another in a disorderly manner. From the information given, what are the possible electronic structures of G and J?

	G	J
A	1	2.5
B	2.8.7	2.5
C	2.8.7	2.8.3
D	2.3	2.5

10 If the gas volume of argon is twice that of hydrogen at the same temperature and pressure, what is the numerical ratio of argon atoms to hydrogen atoms?

A 1 : 1

B 2 : 1

C 1 : 2

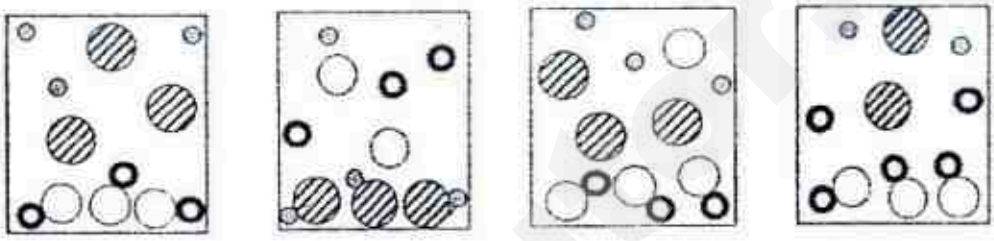
D 20 : 1

11 Solutions of 1 mol/dm^3 silver nitrate and 0.5 mol/dm^3 sodium chloride were prepared. 20 cm^3 of silver nitrate solution and 30 cm^3 of sodium chloride solution were mixed together in a beaker.

The ions in each of the initial solutions are shown below:

Which diagram best represents the particles of the contents of the beaker after the two solutions were mixed?

(water molecules are not shown)



A B C D

12 A mixture of barium chloride and barium nitrate, with a total mass of 2.00 g, is dissolved in water and treated with excess silver nitrate solution. The precipitate is dried and found to weigh 0.688 g.

What was the mass of barium chloride in the original mixture?

A 0.499 g
B 0.688 g
C 1.00 g
D 2.00 g

13 When the oxide Cl_2O_7 is added to water, a reaction takes place which is **not** a redox process.

What could the product(s) of the reaction be?

A $HClO_4$
B $HOCl$
C Cl_2 and O_2
D HCl and O_2

14 The enthalpy change when one mole of hydrogen ions is neutralised is known as the enthalpy of neutralisation.

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l) \qquad \Delta H = -57 \text{ kJ/mol}$$

How much energy is released if one mole of sulfuric acid is completely neutralised?

A 28.5 kJ

B 57 kJ

C 114 kJ

D 228 kJ

15 The table below shows some of the physical properties of four unknown substances **A, B, C** and **D**.

Unknown substance	Melting point / °C	Boiling point / °C	Electrical conductivity		Solubility in water
			Solid state	Liquid state	
A	163	440	poor	poor	insoluble
B	580	1800	poor	good	soluble
C	1823	2380	poor	poor	insoluble
D	1553	2980	good	good	insoluble

Which statement about the four substances is correct?

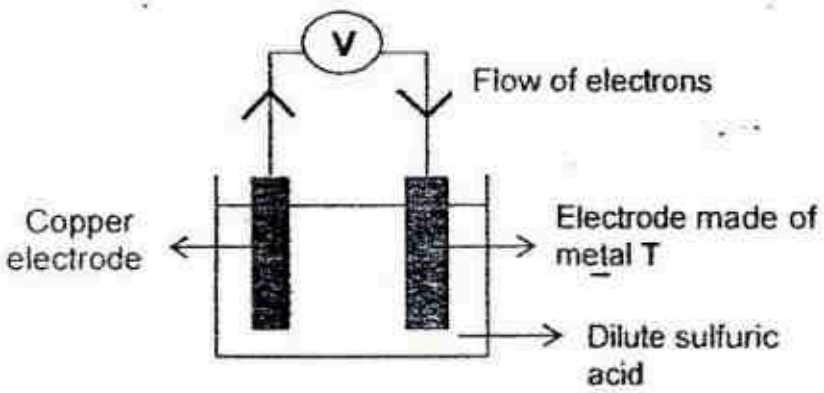
A Substance **A** is a simple molecular compound containing weak covalent bonds between molecules.

B Substance **B** is an ionic compound with mobile electrons held by strong electrostatic forces.

C Substance **C** is a giant covalent compound with mobile ions.

D Substance **D** is a giant covalent compound with mobile electrons.

16 The diagram below shows the set-up of an electric cell, making use of copper and a metal **T** as electrodes.



Which statement is correct about the above electric cell?

A The mass of copper electrode will increase.

B The electrode made of metal **T** is the negative electrode.

C Reduction takes place at the electrode made of metal **T**.

D Copper is less reactive than metal **T**.

17 **P**, **Q** and **R** are elements found in Group VII of the Periodic Table. Three experiments were carried out to determine the reactivity of **P**, **Q** and **R**. The three reactions are represented by the three equations shown below.

I	$R^-(aq)$	+	$Q_2(aq)$	→	no reaction			
II	$P^-(aq)$	+	$R_2(aq)$	→	no reaction			
III	$2Q^-(aq)$	+	$P_2(aq)$	→	$Q_2(aq)$	+	$2P^-(aq)$	

Which statement about **P**, **Q** and **R** is correct?

A P_2 is a solid at room temperature.

B R_2 is a stronger oxidising agent than Q_2.

C Aqueous **HQ** turns red litmus paper blue.

D P_2 is a reducing agent for reaction III.

18 The table shows the properties of some metal oxides, **W**, **X**, **Y** and **Z**.

Oxide	Colour of oxide	Change on heating
W	black	remains black
X	red	oxygen evolved and silvery liquid remains
Y	white	solid turns yellow when hot but becomes white again when cold
Z	brown	oxygen evolved and solid turns yellow

Which of these oxides are chemically unchanged when heated?

A **W** only
B **Y** only
C **X** and **Z** only
D **W** and **Y** only

19 The rate of reaction between a given mass of metal and an excess of hydrochloric acid is studied by collecting the hydrogen gas in a graduated syringe. The results are as shown in the table below.

Time taken / s	Volume of hydrogen gas / cm^3
0	0
20	20
40	34
60	38
80	40
100	40

How much time is required for half of the given mass of metal to react?

A 20 s
B 40 s
C 50 s
D 100 s

20 25.0 cm^3 of 0.2 mol/dm^3 of an aqueous carbonate reacts completely with 50.0 cm^3 of 0.1 mol/dm^3 of an acid. What is the charge of the anion of the acid?

A 1+

B 2+

C 1-

D 2-

21 A student mixed two aqueous solutions of ionic compounds at a time and made the following observations.

Solution A	Solution B	Observation
$Sr(ClO_3)_2$	$Mg(IO_3)_2$	a precipitate observed
$Mg(IO_3)_2$	$Ni(ClO_3)_2$	a precipitate observed
$MgCrO_4$	$Pb(ClO_3)_2$	a precipitate observed
$MgCrO_4$	$Ca(ClO_3)_2$	no visible change

Which conclusion is correct based on these observations?

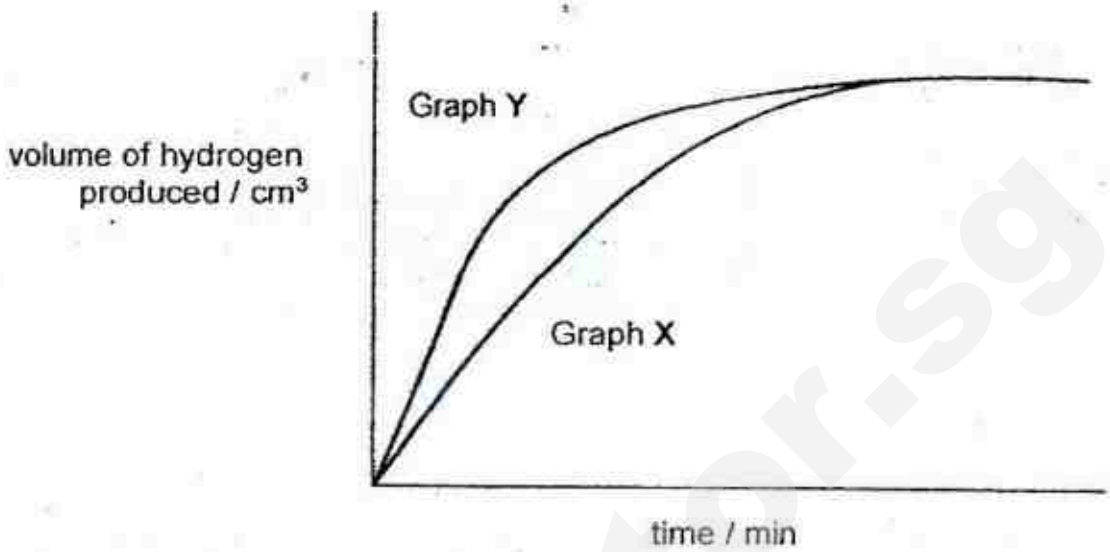
A Only $Ni(IO_3)_2$ and $Mg(ClO_3)_2$ are insoluble.

B Only $Ni(IO_3)_2$ and $PbCrO_4$ are insoluble.

C $Sr(IO_3)_2$, $Ni(IO_3)_2$ and $PbCrO_4$ are insoluble.

D $Sr(IO_3)_2$, $Ni(IO_3)_2$, $PbCrO_4$ and $CaCrO_4$ are insoluble

22 Excess zinc was added to 100 cm^3 of 1 mol/dm^3 hydrochloric acid.
Graph **X** refers to this reaction.
Another experiment was conducted and the result was represented by Graph **Y**.



Which experiment refers to graph **Y**?

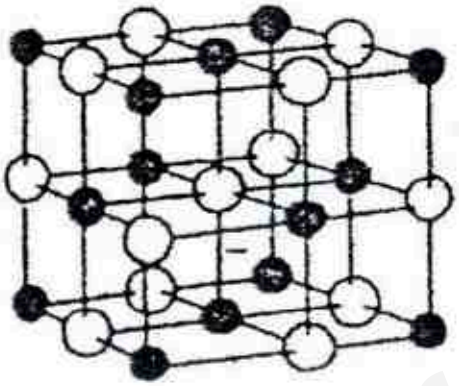
A excess zinc reacting with 100 cm^3 of 2 mol/dm^3 hydrochloric acid

B excess zinc reacting with 100 cm^3 of 1 mol/dm^3 sulfuric acid

C excess zinc reacting with 100 cm^3 of 1 mol/dm^3 ethanoic acid

D excess magnesium reacting with 100 cm^3 of 1 mol/dm^3 hydrochloric acid

23 The diagram below shows part of the structure of a solid consisting of particles of two elements (represented by ● and ○).



Which statements can be concluded from the diagram?

I The solid has a giant structure.

II Each particle in the structure is surrounded by four particles of the other type.

III There are equal numbers of each type of particle present in a crystal of the solid.

IV The arrangement of particles is like that of the sodium and chloride ions in sodium chloride.

A I and IV only

B II and IV only

C I, III and IV only

D I, II, III and IV

24 An aqueous solution contains barium iodide. Ken wants to obtain a solution that contains I^- ions (aq) but no Ba^{2+} ions (aq).

What should he add to the solution?

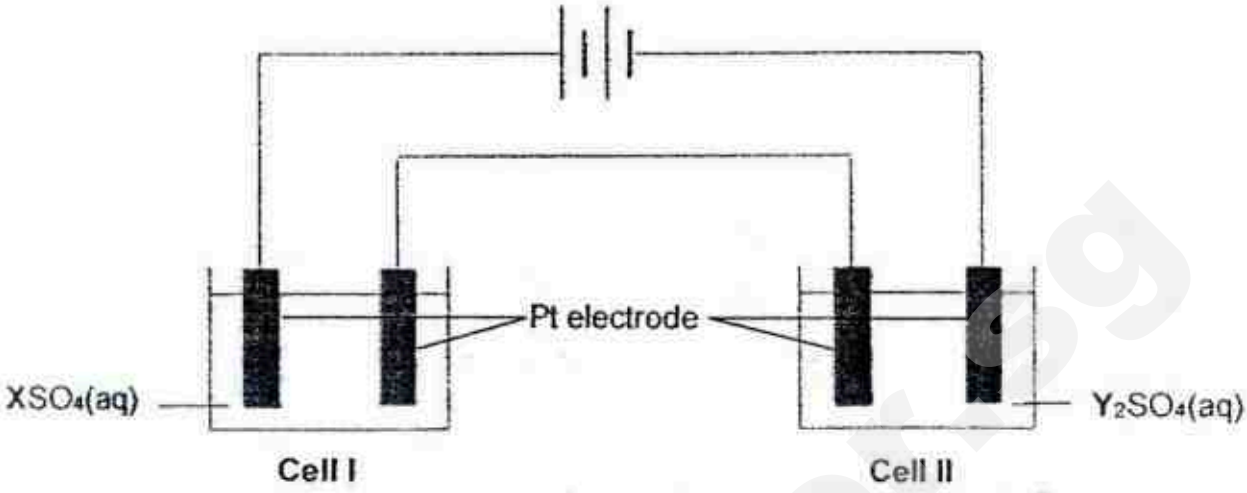
A aqueous chlorine

B hydrochloric acid

C acidified lead(II) nitrate solution

D sulfuric acid

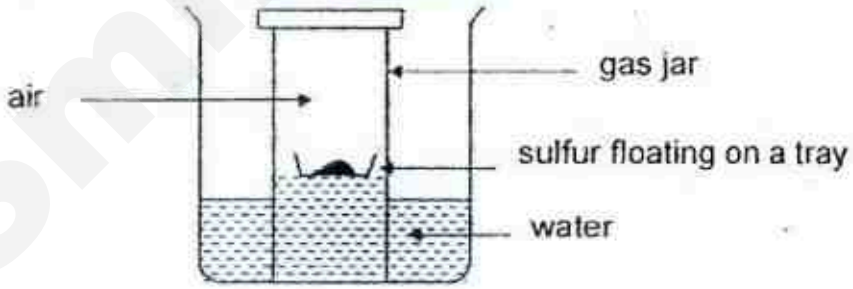
25 Two electrolytic cells were connected such that the same amount of current is passed through the two cells. Cell I contains aqueous XSO_4 and Cell II contains aqueous Y_2SO_4.



What is the ratio of the moles of **X** liberated to that of **Y** liberated?

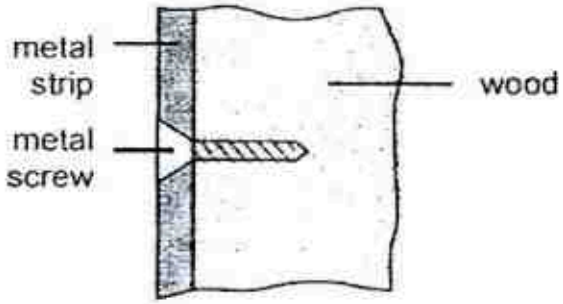
	moles of X liberated	:	moles of Y liberated
A	1	:	1
B	1	:	2
C	2	:	1
D	1	:	3

26 A lump of sulfur is burnt inside a gas jar. Some Universal Indicator solution is added to the water. Which of the following would be observed?



	Water level in the gas jar	Solution shows
A	remains unchanged	an acidic solution
B	drops	an alkaline solution
C	rises	an acidic solution
D	rises	an alkaline solution

27 An old garden gate is being restored. A metal strip was secured on the exterior of the wooden gate using screws. After a few weeks of being exposed to the atmosphere, the screws are heavily corroded but the strips are not.



Which two metals below would give this result?

	Screws	Strip
A	copper	steel
B	steel	zinc
C	copper	zinc
D	zinc	copper

28 Pain is often felt when a piece of aluminium foil touches a tin amalgam filing in a tooth. An electric current momentarily flows.

Which statement about what happens is **not** correct?

A Electrons flow from aluminium to tin amalgam.

B Oxidation state of aluminium increases.

C Aluminium acts as an oxidising agent.

D The current flow is smaller if a piece of zinc foil touches the tin amalgam.

29 What ion can be identified using a reduction process?

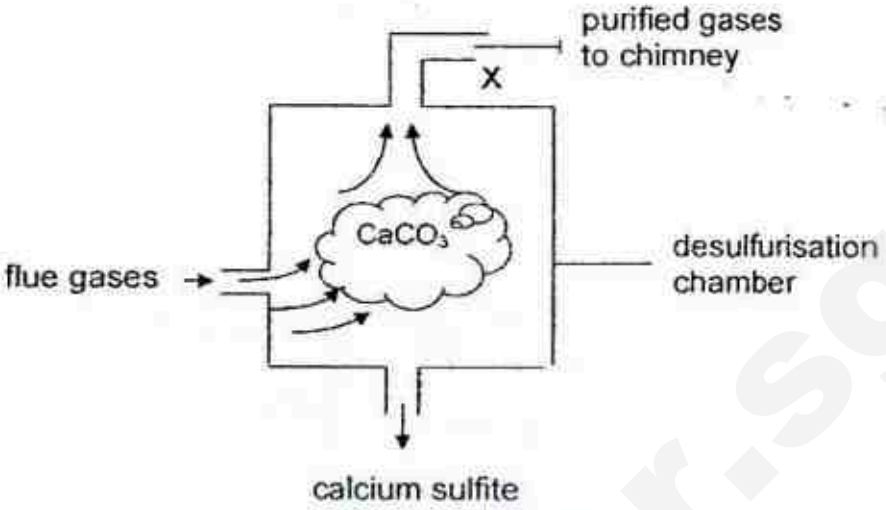
A ammonium

B chloride

C nitrate

D sulfate

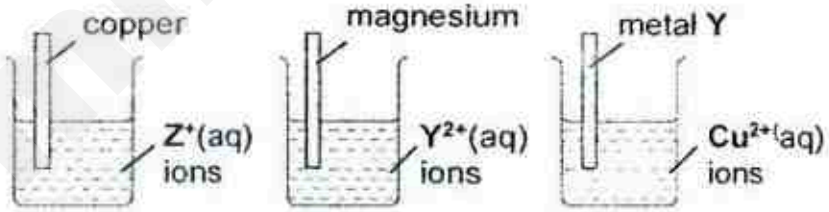
30 The following diagram shows a simplified process of desulfurisation.



Which observation at the outlet **X** best describes the nature of the gases to chimney?

A Gases turned red litmus blue.
B Gases turned acidified potassium manganate (VII) purple.
C Gases turned acidified potassium iodide brown.
D Gases formed white precipitate with lime water.

31 A student conducted three experiments to compare the reactivities of four different metals – copper, magnesium, metal **Y** and metal **Z**.



A deposit was observed on the metal strip for each experiment.

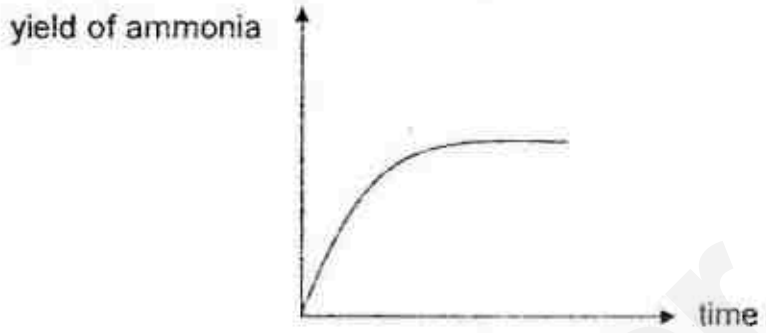
How many of these metals that were investigated will be able to react with acid?

A 1
B 2
C 3
D 4

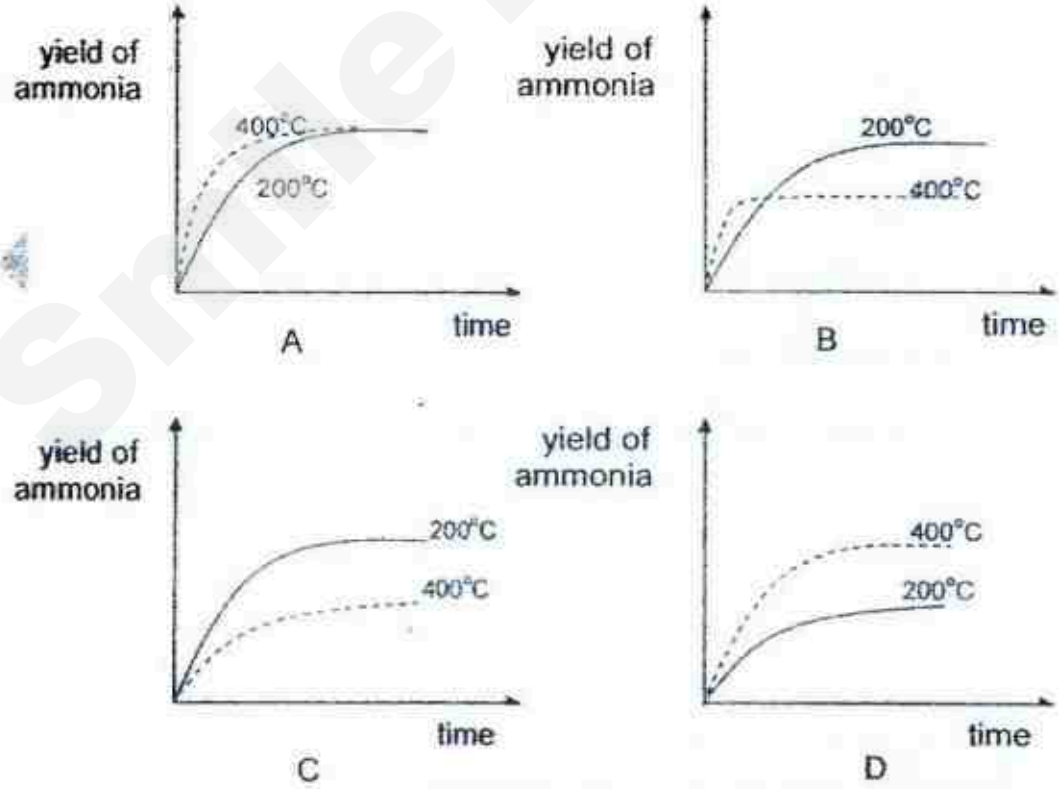
32 Ammonia is produced from hydrogen and nitrogen, according to the equation:

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

The graph shows the yield of ammonia at 200°C and 1 atm.



Which graph below shows a correct comparison of the yield of ammonia produced at temperature of 400°C with the yield at 200°C, keeping the pressure at 1 atm?



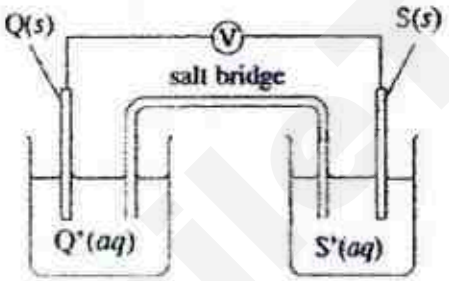
33 Some reactions of the metals **Q**, **R** and **S** are given below.

Metal	Reaction in air	Reaction with water	Reaction with dilute hydrochloric acid
Q	burns to form metallic oxide	reacts with steam to form hydrogen	hydrogen formed
R	reacts slowly to form metallic oxide	does not react	does not react
S	reacts to form metallic oxide	does not react	hydrogen formed

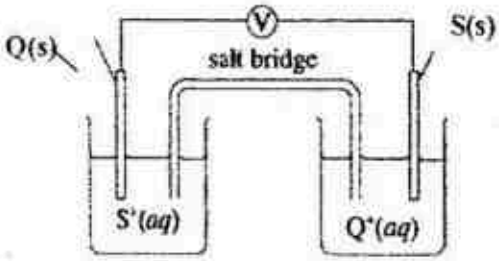
In the galvanic cell, Q^+, R^+ and S^+ would represent cations of these three metals.

Which simple cell will produce the greatest voltage?

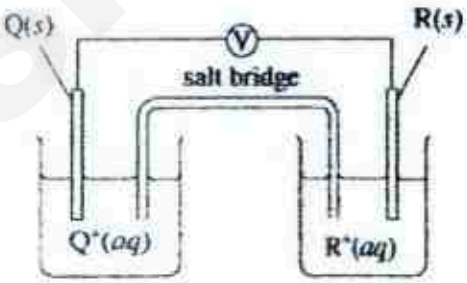
A



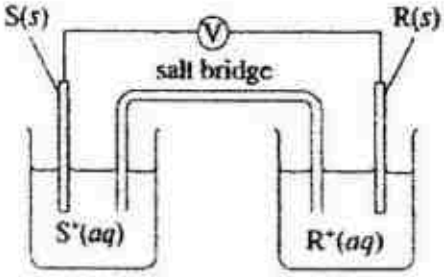
B



C



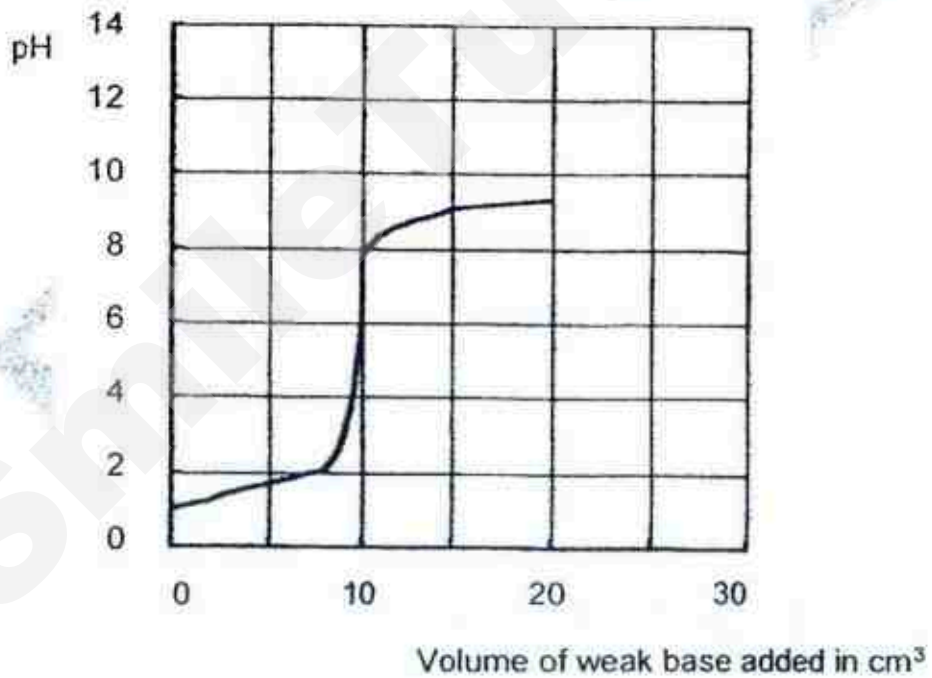
D



34 Different indicators change colour over different pH ranges and it is important to choose the correct indicator to obtain an accurate result in a titration.

Indicator	pH range for the colour change	Colour	
		lower pH	higher pH
Indigo carmine	11.6 to 14.0	blue	yellow
Methyl red	4.2 to 6.3	red	yellow
Methyl violet	0.3 to 3.0	yellow	violet
Phenolphthalein	8.2 to 10.0	colourless	pink

If a certain weak base is added to a strong acid, the following curve is obtained showing the variation of pH with the volume of weak base added.



Which indicator would be the best choice to use in the titration?

A Indigo carmine

B Methyl red

C Methyl violet

D Phenolphthalein

35 The table below shows the results of a series of electrolysis experiments.

Electrolyte	Anode (+ve)	Cathode (-ve)	Observation at anode	Observation at cathode
X	platinum	carbon	oxygen gas	hydrogen gas
aqueous copper(II) nitrate	Y	Y	anode dissolves in the solution	pink copper deposit
concentrated aqueous magnesium chloride	carbon	platinum	chlorine gas	Z

Which could **X**, **Y** and **Z** be?

	X	Y	Z
A	nitric acid	copper	hydrogen gas
B	aqueous sodium chloride	copper	grey magnesium deposit
C	nitric acid	carbon	grey magnesium deposit
D	aqueous sodium chloride	platinum	hydrogen gas

36 A compound X_2Y was decomposed as follows:

$$X_2Y(g) \rightarrow X_2(g) + Y(g) \qquad \Delta H = \text{positive}$$

What difference would there be if the same amount of X_2Y were decomposed in the presence of a catalyst?

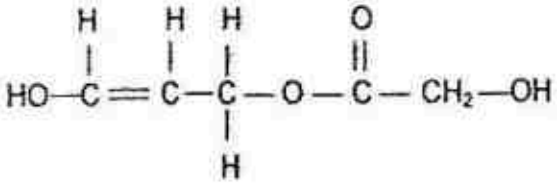
A More X_2 would be present at the end of the reaction.

B Less heat would be absorbed during the reaction.

C ΔH would become negative.

D Time taken to decompose X_2Y would be shorter.

37 An organic compound has the following structure.



Which observation is correct when the organic compound is tested with zinc, aqueous bromine and acidified potassium manganate(VII) solution?

	With solid zinc	With aqueous bromine	Warmed with acidified potassium manganate(VII) solution
A	effervescence	turned colourless	turned colourless
B	effervescence	no reaction	remained purple
C	no reaction	turned colourless	turned colourless
D	no reaction	no reaction	remained purple

38 When iodine, I_2, reacts with an unsaturated compound, one molecule of iodine adds across each double bond.

Unsaturated fatty acids react similarly with iodine. 0.150 mol of a particular fatty acid reacts with exactly 0.300 mol of I_2.

What could the fatty acid be?

A lauric acid : $CH_3(CH_2)_{10}CO_2H$

B linoleic acid: $CH_3(CH_2CH{=}CH)_2(CH_2)_{10}CO_2H$

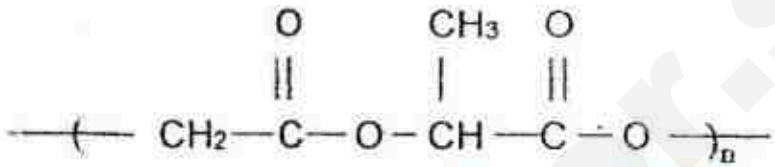
C palmitoleic acid: $CH_3(CH_2)_5CH{=}CH(CH_2)_7CO_2H$

D arachidonic acid: $CH_3(CH_2CH{=}CH)_4(CH_2)_6CO_2H$

39 The reaction between a carboxylic acid, $C_xH_yCO_2H$ and an alcohol, $C_nH_{2n+1}OH$, produces an ester. How many hydrogen atoms does one molecule of the ester contain?

A y+2n
B y+2n+1
C y+2n+2
D y+2n+3

40 Cuts and wounds are often stitched using a biodegradable polymer with the formula shown below.



It is made from a condensation polymerisation reaction between lactic acid, $HOCH(CH_3)COOH$, and glycolic acid.

What is the formula of glycolic acid?

A $HOCH_2COOH$
B $HOCH_2CH_2OH$
C $HOOCCH_2COOH$
D $HOOCCH_2CH_2OH$

Answers

1	B	11	C	21	C	31	B
2	C	12	A	22	D	32	B
3	C	13	A	23	C	33	C
4	B	14	C	24	D	34	B
5	C	15	D	25	B	35	A
6	B	16	C	26	C	36	D
7	A	17	B	27	D	37	C
8	D	18	D	28	C	38	B
9	B	19	A	29	C	39	B
10	A	20	D	30	D	40	A

Class Register No.

Candidate's Name : _____

TANJONG KATONG GIRLS' SCHOOL

PRELIMINARY EXAMINATION 2017
SECONDARY FOUR

5073/02 **CHEMISTRY**
Paper 2

Tuesday 12 September 2017 1 h 45 min

INSTRUCTIONS TO CANDIDATES

Write your name, class and register number at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use papers clips, glue or correction fluid.

Section A
Answer **all** questions in the space provided.

Section B
Answer **all** the questions in the space provided, the last question is in the form of either/ or.

The number of marks is given in brackets [ ] at the end of each question or part question.

INFORMATION FOR CANDIDATES

A copy of the Periodic Table is printed on page 23.
The use of an approved scientific calculator is expected, where appropriate.

The total marks for this paper is 80.

This Question Paper consists of 23 printed pages, including this page

SECTION A

Answer **all** the questions in this section in the spaces provided.
The total marks for this section is 50.

A1 Suggest suitable chemical reagents to prepare the following salts:

In choosing the chemical reagents, you should take into consideration the need to achieve optimal yield as well as safety.

(a) (i) copper(II) sulfate

.....and .....

(ii) copper(II) carbonate

..... and .....

(iii) sodium nitrate

..... and ..... [3]

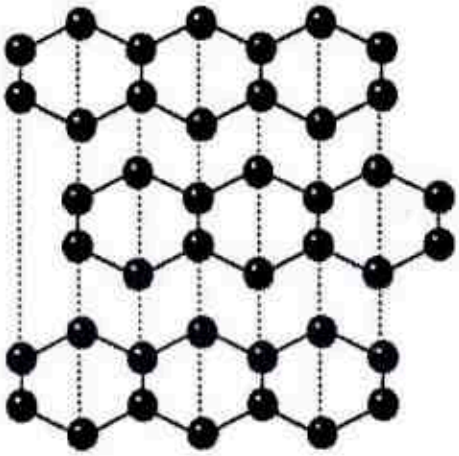
(b) Name a reagent that would react with ammonium carbonate to produce

(i) ammonia gas .....

(ii) carbon dioxide gas .....

[2]
[total:5]

A2 In 2010, the Nobel Prize for Physics was awarded to two researchers, Andre Geim and Konstantin Novoselov, from Manchester University for their work on preparing graphene from graphite. The structures of graphite and graphene are shown.



graphite

graphene

(a) Describe the structure of graphite.

.....

.....[1]

(b) State one common physical property that you would expect from graphite and graphene.

.....

.....[1]

(c) Graphene can be prepared from graphite by using sticky tape. Use your knowledge of the bonding in graphite to explain why it is possible to create graphene by this method.

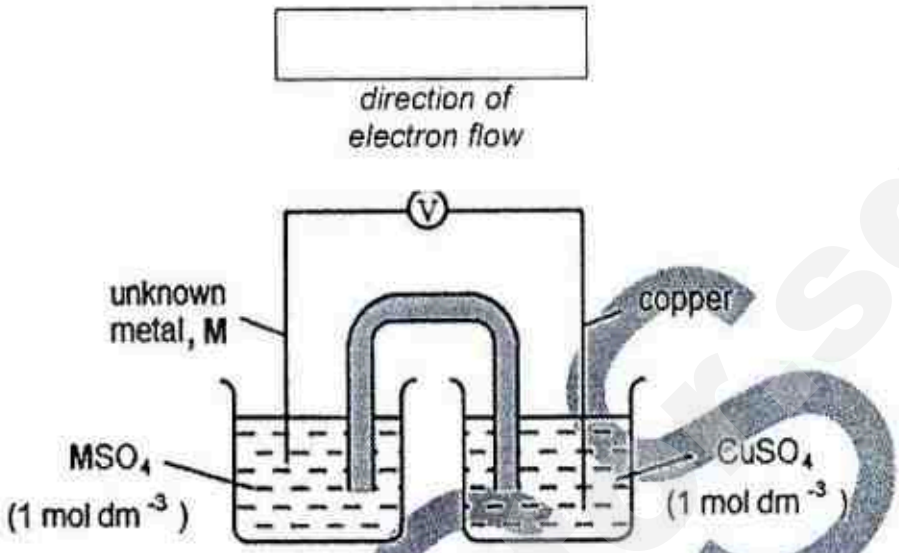
.....

.....[1]

[total:3]

A3

(a) A student sets up a simple cell between a copper electrode and an unknown metal **M** electrode shown below. The copper electrode is found to be the positive electrode.



(i) In the box over the voltmeter symbol, draw an arrow to show the direction of the electron flow through the voltmeter. [1]

(ii) The student made the following conclusion:

M is more reactive than copper.

Do you agree with his conclusion? Explain your answer.

.....

.....

.....

.....[2]

(iii) Describe what might be observed if a rod of metal **M** is dipped into a 1 mol dm^{-3} $CuSO_4$ solution. Write ionic equation(s) for any reactions that occur.

.....

.....

.....

.....[2]

(iv) The student was told that **M** could either be silver, zinc or lead. He added powdered sample of **M** to dilute sulfuric acid and observed that **M** dissolved with rapid effervescence to form a colourless solution. Deduce which metal **M** could be. Explain your answer.

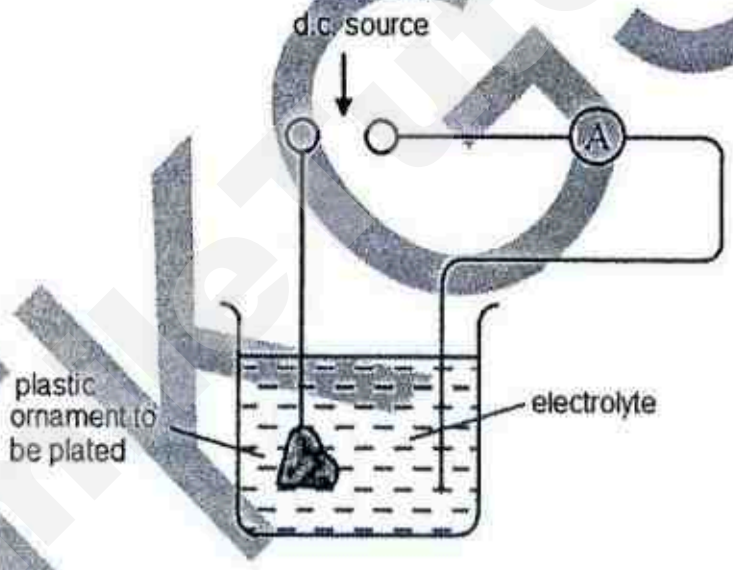
.....

.....

.....

.....[3]

(b) To enhance the appearance of a plastic ornament that the student plans to give away as a gift, he silver-plates it as a cheaper alternative to using solid silver metal. The diagram below shows the apparatus for the silver-plating process.



(i) Indicate clearly on the diagram, the polarity (+ / -) of the power source. [1]

(ii) Suggest a suitable electrolyte. [1]

electrolyte:.....

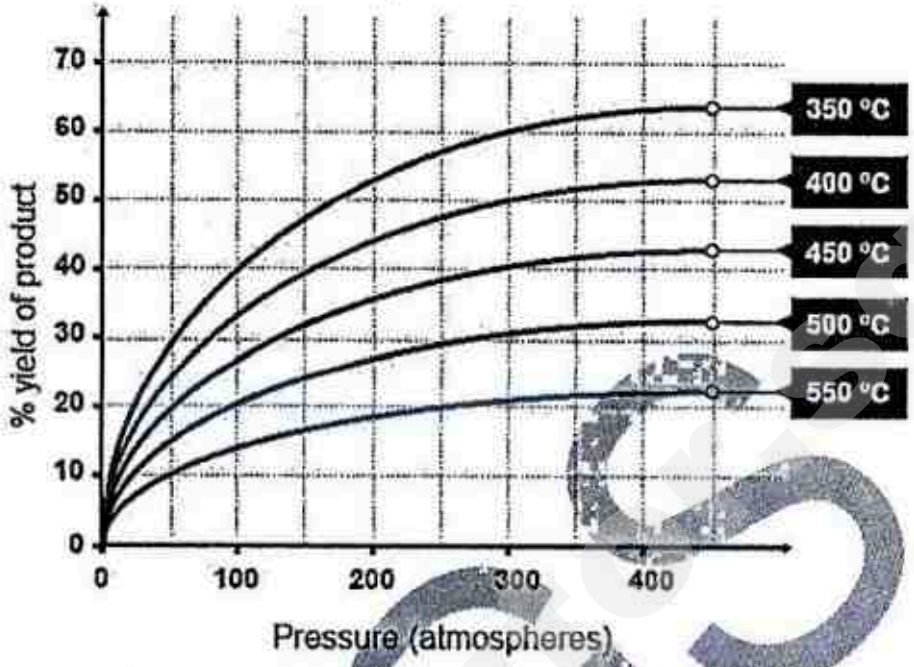
(iii) For the ornament to be silver-plated, it has to be first coated with a thin layer of graphite. Why is the ornament first coated with graphite?

.....

.....[1]

[total:11]

A4 The percentage yield of the product in a gas-phase reversible reaction varies with changes in temperature and pressure as shown below.



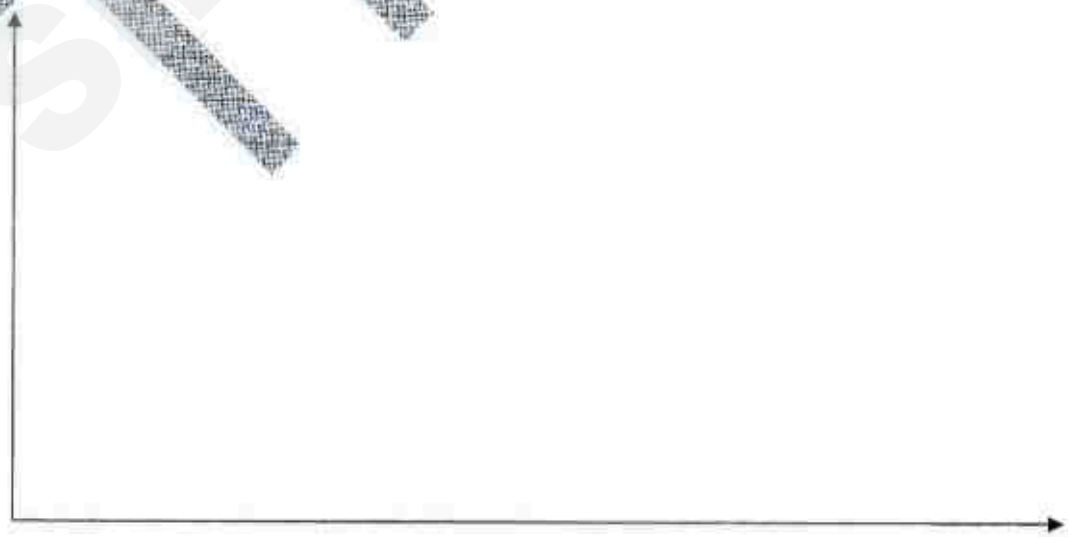
(a) Use the information given above to deduce whether the forward reaction is exothermic or endothermic. Explain your answer.

.....

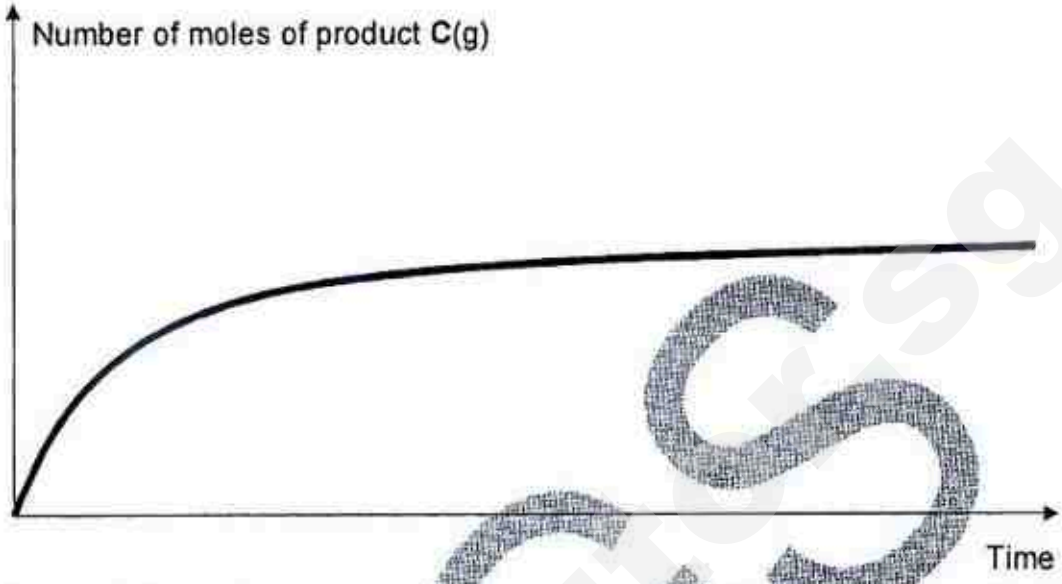
.....

.....[2]

(b) Sketch a labelled energy profile diagram of the forward reaction. You may use **A**(g) + **B**(g) to represent the reactants and **C**(g) to represent the product. [2]



(c) The graph below shows how the number of moles of the product, **C**(g) of the gas-phase reaction changes during the course of the reaction under certain conditions.



Use the information on **page 6**, sketch a graph on the same axes to illustrate what happens when the reaction is carried out at a higher pressure – label this as **graph I**. [1]

(d) With reference to collision theory, explain the shape of **graph I**.

.....

.....

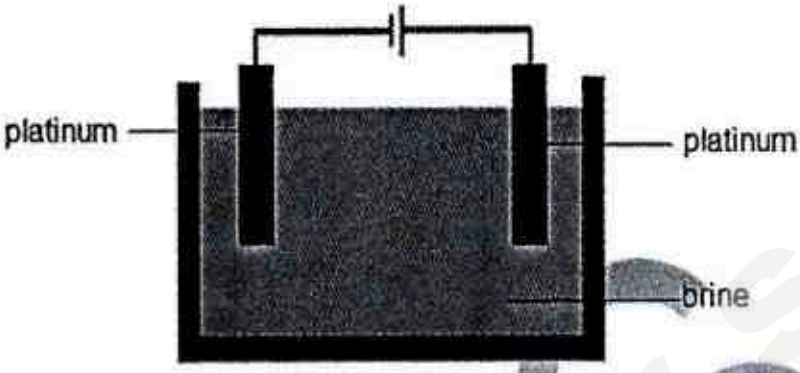
.....

.....

.....[3]

[total:8]

A5 Many compounds of chlorine are manufactured from brine, NaC*l*(aq). The electrolysis of brine produces chlorine and sodium hydroxide. The diagram below shows the set-up of the electrolysis of brine using platinum electrodes.



(a) (i) Write the equations of the reactions taking place at the cathode and anode.

cathode:.....

anode:.....[2]

(ii) Suggest how sodium hydroxide is formed.

.....[1]

(b) In some industrial electrolytic cells, the products, chlorine and sodium hydroxide, are allowed to react further. Different compounds are formed when chlorine and sodium hydroxide react under different conditions.

With cold, dilute sodium hydroxide,

$$C\ell_2 + 2NaOH \rightarrow NaC\ell O + NaC\ell + H_2O$$

With hot, concentrated sodium hydroxide,

$$3C\ell_2 + 6NaOH \rightarrow NaC\ell O_3 + 5NaC\ell + 3H_2O$$

Explain with reasons, whether you agree with the following statements:

(i) With hot concentrated sodium hydroxide, chlorine is oxidised.

.....

.....[1]

(ii) Chlorine is oxidised to a larger extent when reacted with hot, concentrated sodium hydroxide than when reacted with cold, dilute sodium hydroxide.

.....

.....

.....

.....[2]

[total:6]

A6 This question is about reactions of Group VII elements.

(a) Interhalogen compounds are formed between atoms of different elements in Group VII such as chlorine, bromine and fluorine.

Chlorine and fluorine react vigorously to form chlorine trifluoride, ClF_3. When gaseous ClF_3 is added to water, three gases are formed. The following observations are made when the gases are tested:

- Damp blue litmus turned red and bleached.
- Glowing splint rekindled.

The third gas is hydrogen fluoride.

Write a balanced equation, including state symbols, for the reaction between chlorine trifluroide and water.

.....[2]

(b) Astatine is an element found below iodine in Group VII of the Periodic Table. Suggest with reason what you would observe when aqueous chlorine is added to aqueous sodium astatide. Support your answer with relevant equation(s).

.....

.....

..... [3]

(c) Labels of test tubes containing liquids hexene, C_6H_{12} and hexane, C_6H_{14} have fallen off. Suggest a chemical test to distinguish between the two liquids.

.....

.....

.....

.....[2]

[total:7]

A7 In recent years, there has been worldwide interest in the possible extraction of 'shale gas' (a form of natural gas) as an important energy source.

(a) One of the problems associated with using shale gas is its variable composition. **Table 1** shows the percentage composition of shale gas from three different sources **J**, **K** and **L**.

source	CH_4	C_2H_x	C_3H_y	CO_2	N_2
J	80.3	8.1	2.3	1.4	7.9
K	82.1	14.0	3.5	0.1	0.3
L	77.5	4.0	0.9	3.3	14.3

In the formulae above, *x* and *y* are variables.

Table 1

(i) Which source of shale gas, **J**, **K** or **L**, will provide the most energy when burned? Explain your answer.

.....

.....[1]

(ii) Suggest a method by which carbon dioxide can be removed from shale gas.

.....

.....[1]

(iii) Draw a 'dot and cross' diagram to show the arrangement of electrons in a molecule of carbon dioxide.

You only need to show outer shell electrons. [2]

(b) **Table 2** shows a comparison of the relative amounts of pollutants produced when shale gas, fuel oil and coal are burned to produce the **same amount of energy**.

air pollutant	shale gas	fuel oil	coal
CO_2	117	164	208
CO	0.040	0.033	0.208
NO_2	0.092	0.548	0.457
SO_2	0.001	1.12	2.59
particulates	0.007	0.84	2.74

Table 2

(i) Suggest why shale gas produces the smallest amount of CO_2.

.....

.....[1]

(ii) Explain which of the three fuels, shale gas, fuel oil or coal, is the largest contributor to 'acid rain'.

fuel.....

.....

.....[1]

(iii) Suggest a reason why fuel oil and coal produce more NO_2 than shale gas.

.....

.....[1]

(iv) Explain why carbon monoxide causes breathing problems.

.....

.....[1]

(c) Butane is used as fuel for a common lighter or butane torch.

A 30 cm^3 sample of butane, C_4H_{10}, was completely reacted in a limited supply of oxygen to produce 60 cm^3 of carbon dioxide and 60 cm^3 of carbon monoxide.

Calculate the volume of oxygen used. (All volumes were measured at room temperature and pressure.)

[2]
[total:10]

Section B

Answer all **three** questions in this section.

The last question is in the form of either/or and only one of the alternatives should be attempted.

The total marks for this section is 30.

B8 Sodium chloride, sodium bromide, sodium iodide and magnesium oxide are ionic compounds.

An estimate of the strength of the bonds in an ionic compound can be obtained by measuring the **lattice energy** of the compound, which is the energy evolved when oppositely charged ions in the gas phase come together to form a solid.

For example, the lattice energy of NaCl is the energy evolved when Na^+ and Cl^- ions in the gas phase come together to form the lattice of alternating Na^+ and Cl^- ions in the NaCl crystal.

$$Na^+(g) + Cl^-(g) \rightarrow NaCl(s)$$

The magnitude of the lattice energy is 781 $kJ\,mol^{-1}$.

The magnitude of lattice energy is directly proportional to the charges on the ions (q_1 and q_2) and inversely proportional to distance between the ions (r^2). The greater the ionic radius, the greater the distance between the ions.

$$\text{Lattice Energy} \propto \frac{q_1 \times q_2}{r^2}$$

(a) Describe the bonding and structure of NaCl.

.....

.....

.....[2]

(b) (i) Suggest with reason whether you expect the value of the lattice energy to be negative or positive.

.....

.....[1]

(ii) Hence, complete the energy **level** diagram below for the reaction:

$$Na^+(g) + Cl^-(g) \rightarrow NaCl\,(s)$$

[1]

(c) (i) Explain why the magnitude of lattice energies of the sodium halides decreases from NaCl to NaI.

.....

.....

.....

.....[2]

(ii) The table shows the ionic radius of some ions.

Ion	Mg^{2+}	Na^+	O^{2-}	Cl^-
Ionic radius (pm)	72	102	140	184

Using the information above and the data from the table, suggest how you would expect the magnitude of the lattice energy of MgO to be compared to that of NaCl. Explain your answer.

.....

.....

.....

.....[2]

(iii) Hence, suggest with reason how you would expect the melting point of MgO to be compared to NaC*l*.

.....

.....

.....

.....[2]

[total:10]

B9 Amines belong to a homologous series which has a general formula of $C_nH_{2n+1}NH_2$, when n is the number of carbon atoms per molecule.

Amines and their salts have chemical properties similar to those of ammonia and ammonium salts.

For example, methylamine dissociates in water to form an alkali.

$$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^-$$

(a) Would you expect the solution formed by amines to be a weak or strong alkali? Explain your answer.

.....

.....

.....[2]

(b) Methylamine reacts with acids to form salts.

$$CH_3NH_2 + HCl \rightarrow CH_3NH_3Cl$$

methylammonium chloride

(i) Write a balanced chemical reaction between sulfuric acid and methylamine. Name the salt formed.

Equation .....

Name of salt .....[2]

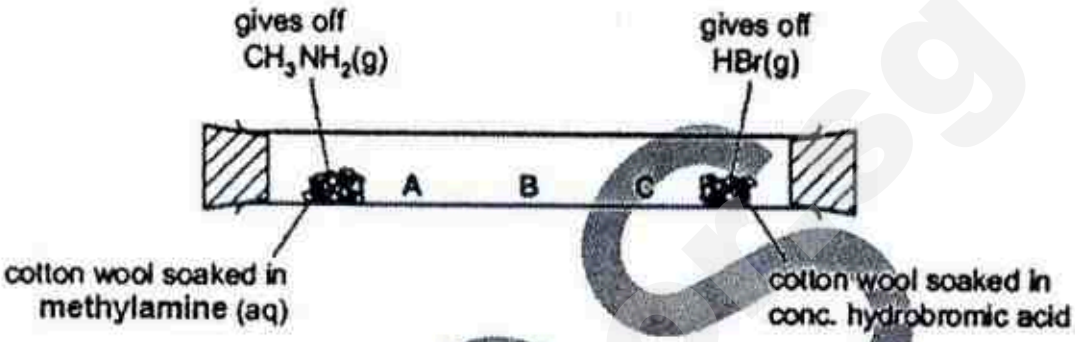
(ii) Suggest a reagent that could be used to displace methylamine, from its salt methylammonium chloride.

.....[1]

(iii) When the colourless gases hydrogen bromide and methylamine come into contact, a white solid is formed.

$$CH_3NH_2(g) + HBr(g) \rightarrow \underset{\text{white solid}}{CH_3NH_3Br(s)}$$

The following apparatus can be used to compare the rates of diffusion of the two gases methylamine and hydrogen bromide.



Predict at which position, **A**, **B** or **C**, the white solid will form. Explain your choice.

.....

.....

.....[2]

(c) Under different conditions, amines can react with carboxylic acids to form a product that has the same linkage as nylon.

(i) Draw the full structural formula of the organic product formed from the reaction between methylamine and ethanoic acid. Name the functional group of the organic product.

functional group:..... [2]

(ii) Another homologous series called diamine has a general formula of $H_2NC_nH_{2n}NH_2$.

Draw the full structural formula of the organic product from the reaction between $H_2NCH_2NH_2$ and the dicarboxylic acid, $HOOC(CH_2)COOH$.

[1]
[total:10]

B10 EITHER

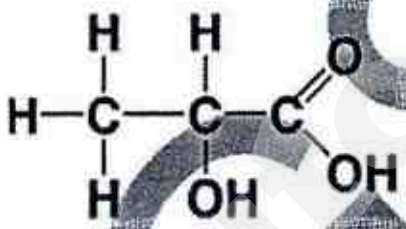
As there are millions of different organic compounds, it is useful to classify and group these organic compounds into families called homologous series. An example of a homologous series is carboxylic acids.

(a) Define the term *homologous series*.

.....

.....[1]

(b) Lactic acid is present in certain plant juices as well as in the blood and muscles of animals.



Lactic acid

(i) Dehydration of lactic acid removes a water molecule. This produces CH_2=CHCOOH.

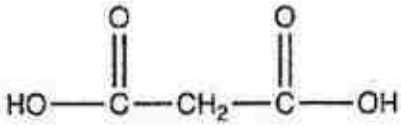
Draw the structural formula of the **repeat unit** for the polymer formed by addition polymerisation of CH_2=CHCOOH. [1]

(ii) Under suitable conditions, lactic acid may react with ethanol to form a sweet-smelling compound.

Write a chemical equation, using structural formula to show this reaction. State the reagent and conditions required to form the sweet-smelling compound.

reagent and conditions:.....[3]

(iii) **W** is an isomer of lactic acid. Under suitable conditions, **W** undergoes oxidation to form malonic acid.



malonic acid

Write the structural formula of **W** and suggest the reagent and conditions for **W** to form malonic acid.

structural formula of **W**:

reagent and conditions:.....[2]

(iv) 1.97 g of an impure sample of malonic acid was dissolved in water and the resulting solution titrated with 1.00 mol dm^{-3} NaOH. 27.5 cm^3 of 1.00 mol dm^{-3} NaOH was required for complete neutralisation.

Use these data to calculate the percentage purity of malonic acid. [3]

[total:10]

B10 OR

Long chain alkanes such as octane, C_8H_{18} can be 'cracked' to produce shorter chain hydrocarbons which could then be separated by fractional distillation.

octane →	**B**	+ a mixture of **C**, **D** and **E**
C_8H_{18}	C_3H_6	(isomers of C_5H_{12})

(a) State the conditions necessary for this reaction to take place.

.....[1]

(b) Write the structural formula of **B**.

[1]

(c) Outline how the mixture may be separated by fractional distillation in the laboratory. [3]

.....

.....

.....

.....

.....

.....

.....

(d) **C**, **D** and **E** exhibit structural isomerism. They are isomers of pentane, C_5H_{12}.

(i) Define the term *isomerism*.

.....

.....[1]

(ii) Complete the table to show all possible isomers for pentane.

C	**D**	**E**

[2]

(e) In a separate experiment, one of the alkanes **C**, **D** or **E** reacted with bromine under ultraviolet light and produced **only one** bromoalkane compound **F**, with the formula, $C_5H_{11}Br$.

Suggest the structure of **F** and the alkane it was produced from.

F	Alkane (C_5H_{12})

[2]

[total:10]

The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

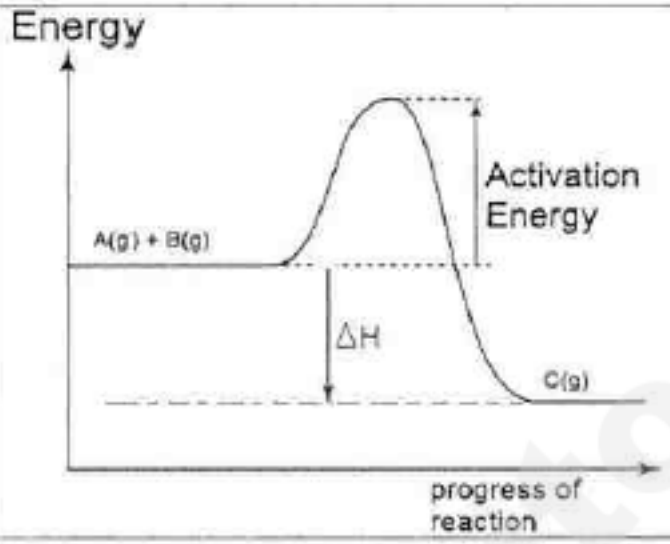
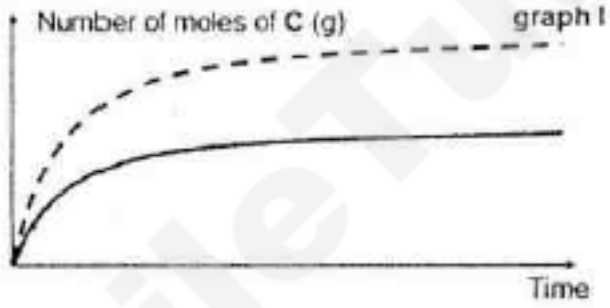
Key: a X b
a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

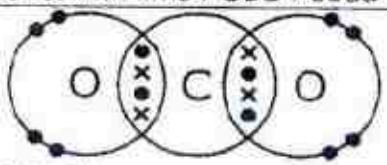
The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

SUGGESTED SOLUTIONS

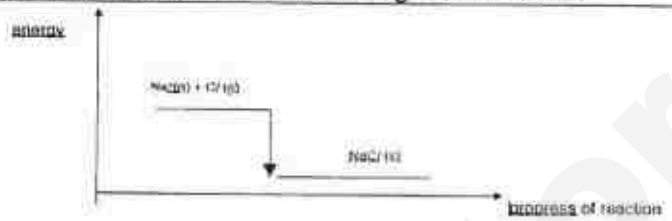
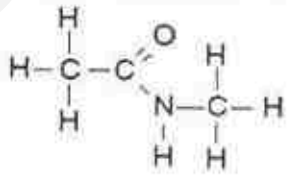
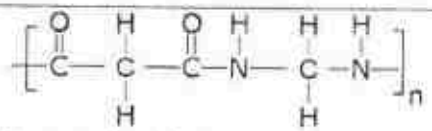
Paper 2
Section A (50 marks)

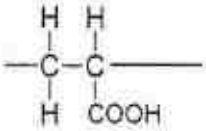
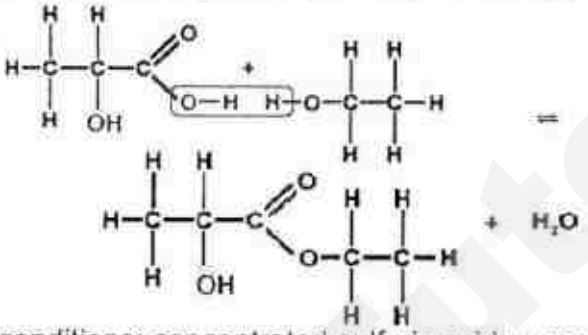
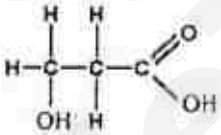
Q No.	Answer
A1	
(a)(i)	copper(II) oxide/copper(II) carbonate and sulfuric acid
(ii)	any soluble copper(II) salt and any soluble carbonate
(iii)	sodium hydroxide (not sodium metal) and nitric acid
(b)(i)	any alkalis
(ii)	any acids
A2	
(a)	Graphite exists as a giant molecular structure made up of layers of carbon atoms held together by strong covalent bonds in hexagonal rings.
(b)	High electrical conductivity; High melting point
(c)	The Van der Waals forces holding together the layers of carbon atoms are weak. Hence, they are easily overcome by physical force.
A3	
(a)(i)	→
(ii)	Agree (no marks) **M** is the negative electrode suggests that **M** has undergone oxidation as **M** loses electrons. Therefore **M** must have a higher tendency to form M^{2+} as compared to Cu.
(iii)	Pink solid of Cu deposited. Blue solution decolourises. $M(s) + Cu^{2+}(aq) \rightarrow M^{2+}(aq) + Cu(s)$
(iv)	**M** is Zn as Zn will react with sulfuric acid to form a colourless solution with effervescence of H_2. **M** cannot be Ag as **M** is more reactive than Cu or the charge of M^{2+} is +2 while the charge of Ag^+ is +1. **M** cannot be Pb as Pb will react with sulfuric acid and form a precipitate of $PbSO_4$
(b)(i)	Ornament is connected to the negative electrode;
(ii)	Electrolyte: silver nitrate
(iii)	The ornament is plastic which does not conduct electricity. It has to be coated with graphite for it to conduct electricity before it can be silver-plated.
A4	
(a)	The forward reaction is exothermic as % yield decreases when temperature increases.

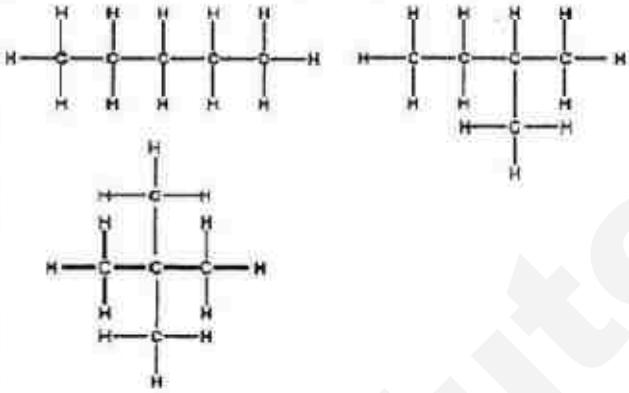
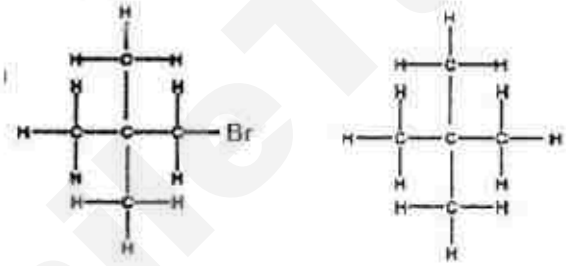
Q No.	Answer
(b)	
(c)	
(d)	As pressure increases, the gas particles are closer together and there is increase in the frequency of collisions between the gas particles. As a result, the frequency of the effective collision increases, rate of reaction increases, steeper gradient for graph I. At a higher pressure, the yield also increases.
A5 (a)(i)	cathode: $2H^+(aq) + 2e \rightarrow H_2(g)$ anode: $2Cl^-(g) \rightarrow Cl_2(g) + 2e$
(ii)	Sodium hydroxide is formed as H^+ and Cl^- are discharged at the electrodes leaving behind Na^+ and OH^- in the solution.
(b)(i)	Disagree With hot NaOH(aq), chlorine is oxidised to NaClO and reduced to NaCl.
(ii)	Agree With cold dilute NaOH(aq), the oxidation state of chlorine increased from 0 to +1. With hot concentrated NaOH(aq), the oxidation state of chlorine increased to a greater extent compared to cold dilute sodium hydroxide from 0 to +5.
A6 (a)	$4ClF_3(g) + 6H_2O(l) \rightarrow 2Cl_2(g) + 3O_2(g) + 12HF(g)$
(b)	The more reactive chlorine displaces the less reactive astatine from its salt. Black solid of At_2 formed.

Q No.	Answer
	$C/_2 + 2NaAt \rightarrow 2NaC/ + At_2$
(c)	Add bromine to the test tubes in the absence of UV light. Hexene will decolourise the reddish-brown bromine. Hexane will not decolourise the reddish-brown bromine.
A7 (a)(i)	K since it has the greatest % of hydrocarbons / carbon-containing compounds or 99.6 % of it is burnt for energy or greatest % of CH_4
(ii)	React with lime / CaO / soda lime / $Ca(OH)_2$ / KOH / NaOH /limewater
(iii)	 Legend : x – electrons of carbon • - electrons of oxygen
(b)(i)	'Shale' gas have a shorter carbon / hydrocarbon chain or shorter hydrocarbon or fewer carbon atoms in its chain or have high H / C ratio or majority of CH_4 present in shale gas
(ii)	Coal produces the largest amount of SO_2 or largest combined amount of SO_2 and NO_2
(iii)	They burn at higher temperatures
(iv)	CO combines with haemoglobin in the red blood cells, causing the red blood cells to be unable to transport oxygen to the rest of the body.
(c)	$2C_4H_{10} + 11O_2 \rightarrow 4CO_2 + 4CO + 10H_2O$ Number of moles of O_2 = 60/4 x 11 = 165 cm^3

Section B (30 marks)

Q No.	Answer
B8 (a)	Sodium chloride exists as giant ionic structure made up of oppositely charged ions held together by strong electrostatic forces of attraction (or ionic bonds)
(b)(i)	The value of lattice energy is negative as energy is given out when ionic bonds are formed between the gaseous ions.
(ii)	
(c)(i)	The ionic radius increases from Cl^- to I^- due to increasing number of electron shells. Based on the equation,
(ii)	The magnitude of the lattice energy of MgO is larger than that of the lattice energy of NaCl. (no marks) The charges of Mg^{2+} and O^{2-} are higher than Na^+ and Cl^-; while the ionic radii of Mg^{2+} and O^{2-} are smaller than that of Na^+ and Cl^-.
(iii)	The melting point of MgO is higher than that of NaCl as more energy is required to overcome the stronger forces of attraction.
B9 (a)	Amines are weak alkalis. Amines dissociate partially in aqueous solutions to form hydroxide ions.
(b)(i)	$2CH_3NH_2 + H_2SO_4 \rightarrow (CH_3NH_3)_2SO_4$ methylammonium sulfate
(b)(ii)	NaOH or $Ca(OH)_2$ or sodium hydroxide or calcium hydroxide
(b)(iii)	**C** Methylamine or CH_3NH_2 has a lower relative molecular mass (31) than hydrogen bromide or HBr (81); methylamine diffuses faster.
(c)(i)	 name of functional group: amide
(c)(ii)	 where n is a large number

Q No.	Answer
B10 Either (a)	A homologous series is a family of organic compounds with the same functional group and similar chemical properties.
(b)(i)	
(ii)	 conditions: concentrated sulfuric acid; warm
(iii)	W:  acidified potassium manganate (VII), heat
(iv)	As there are two –COOH in malonic acid, 1 mole of malonic acid requires 2 moles of NaOH. no. of mol of NaOH = 27.5/1000 x 1.00 = 0.0275 mol no of mol of malonic acid = 0.0275/2 = 0.01375 mol mass of pure malonic acid = 0.01375 x 104 = 1.43 g % purity of malonic acid = 1.43/1.97 x 100% = 72.6%
B10 or (a)	aluminium oxide/silicon dioxide and high temperature/600°C
(b)	$CH_2=CHCH_3$
(c)	During fractional distillation, the liquid with the lowest boiling point will vaporise first and distil over as the first fraction (or distillate). Vapours of liquids with higher boiling points condense along the fractionating column and fall back into the round-bottomed flask.

Q No.	Answer
	After all of the liquid with the lowest boiling point is distilled, the temperature of the mixture increases again to the next lowest boiling point where it will vaporise and be collected as the second fraction
(d)(i)	Isomerism is the existence of two or more compounds with the same molecular formula but with different structural formulae.
(ii)	
(e)	F: 

Name	Class	Register Number

5073/01 (with SPA)

17/4P2/5073/1

CHEMISTRY
PAPER 1

Thursday **3 August 2017** **1 hour**

VICTORIA SCHOOL

PRELIMINARY EXAMINATION TWO
(SECONDARY FOUR)

Additional materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Write your name, class and index number on all the work you hand in.
Do not use staples, paper clips, glue or correction fluid.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C** and **D**.
Choose the one that you consider correct and record your choice **in soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

A copy of Periodic Table is printed on **page 13**.

This question paper consists of 13 printed pages (including this cover page)

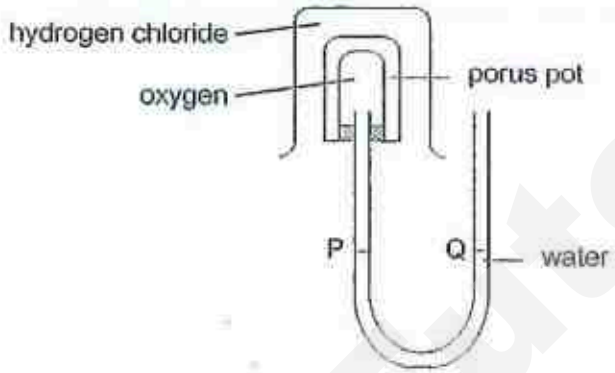
[Turn Over]

1 An unknown white solid, M, melts between 171 °C and 174 °C. When chromatography is performed with water as the solvent, M produces only one spot on the chromatogram.

Which statement must be true about M?

A M can sublime.
B M is an ionic compound.
C M is impure as it melts over a range of temperatures.
D M is pure as it produces only 1 spot on the chromatogram.

2 A beaker containing hydrogen chloride gas was placed over a porous pot containing oxygen as shown below.



How would the water levels at P and Q change after a few minutes and three hours?

	after a few minutes	after three hours
A	higher at P than Q	higher at P than Q
B	higher at P than Q	same at P and Q
C	higher at Q than P	higher at Q than P
D	higher at Q than P	same at Q and P

3 Paper chromatography is performed on a substance. However, it was observed that the sample had failed to move up from the start line.

What is the best explanation for this observation?

A The sample is insoluble in the solvent.
B The solvent level was above the start line.
C The start line was drawn in pen.
D The test tube was not stoppered.

4 Which of the following pairs of substances can be separated by sublimation?

A copper(II) chloride and copper(II) oxide
B ethanol and ethene
C silver chloride and aluminium oxide
D sodium chloride and ammonium chloride

5 Which statement about an atom is correct?

A Each element has only one nucleon number.
B The nucleon number can be less than the atomic number.
C The nucleon number can be equal to the atomic number.
D The number of neutrons is never equal to the number of electrons.

For questions **6**, **7** and **8**, use the table below which shows the electronic configuration of elements P to T.

elements	electronic configuration
P	2.8.1
Q	2.8.8.1
R	2.8
S	2.4
T	2.8.6

6 Which two elements are from the same group?

A P and Q
B P and T
C R and S
D S and T

7 How many protons are present when element T forms an ion?

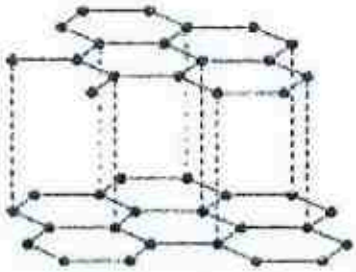
A 6
B 14
C 16
D 18

8 Which elements will react to form a ionic compound with formula X_2Y?

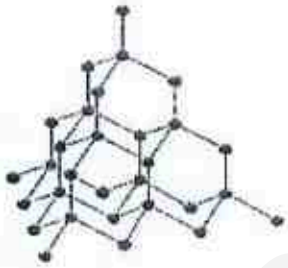
A P and R
B P and T
C R and S
D S and T

9 The diagrams below show the structures of a solid element in two forms, P and Q.

P



Q



What are the uses of P and Q based on their structures as shown above?

	P	Q
A	drilling	drilling
B	drilling	lubricating
C	lubricating	drilling
D	lubricating	lubricating

10 Ammonium perchlorate has a formula of NH_4ClO_4.

What is the formula of iron(III) perchlorate?

A $FeClO_4$ B $Fe(ClO_4)_3$ C Fe_3ClO_4 D $FeH_4(ClO_4)_3$

11 Which reagent can be used to demonstrate that zinc oxide is amphoteric?

A hydrochloric acid
B sodium hydroxide
C universal indicator
D water

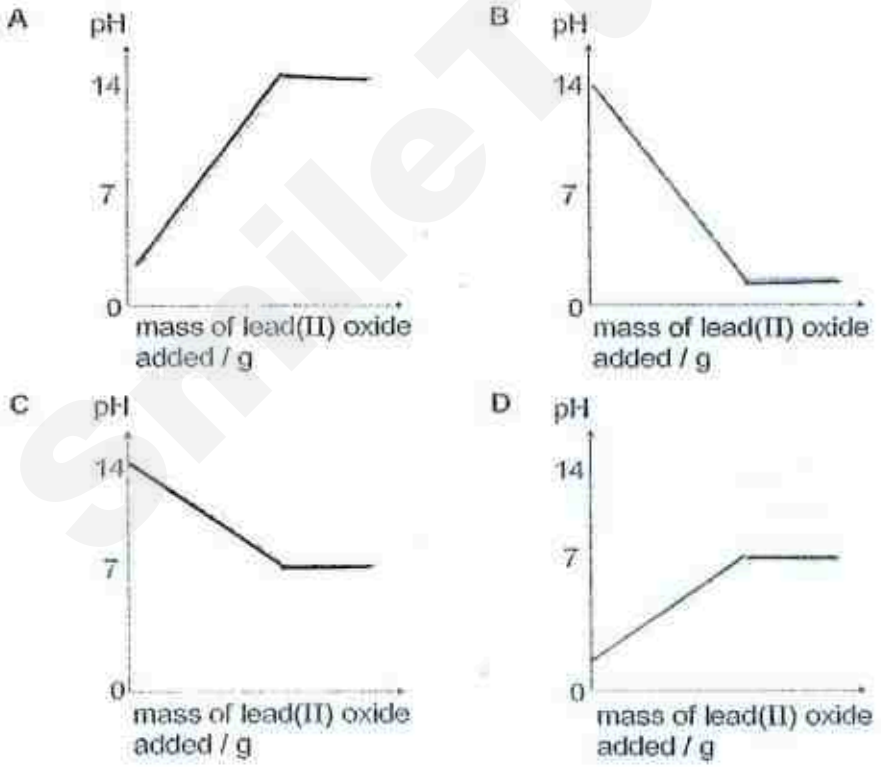
12 Which reaction does not produce a salt?

A $CH_3COOH + CH_3OH \rightarrow CH_3COOCH_3 + H_2O$
B $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$
C $2CH_3COOH + Mg \rightarrow (CH_3COO)_2Mg + H_2$
D $2CH_3COOH + CaCO_3 \rightarrow (CH_3COO)_2Ca + H_2O + CO_2$

13 Which statements correctly describe the rate of reaction and volume of hydrogen gas produced when 100 cm^3 of 1.00 mol dm^{-3} sulfuric acid and 100 cm^3 of 1.00 mol dm^{-3} nitric acid are reacted separately with excess magnesium?

	rate of reaction	volume of H_2 obtained
A	both reactions would proceed at the same rate	the same volume of H_2 would be obtained for both acids
B	both reactions would proceed at the same rate	twice the volume of H_2 would be obtained when sulfuric acid is used
C	the reaction with sulfuric acid would proceed at a faster rate	the same volume of H_2 would be obtained for both acids
D	the reaction with sulfuric acid would proceed at a faster rate	twice the volume of H_2 would be obtained when sulfuric acid is used

14 Which pH curve best represents excess lead(II) oxide being added to 1.00 mol dm^{-3} nitric acid?



15 What is the best method to produce iron(II) hydroxide?

A react aqueous iron(II) nitrate with aqueous sodium hydroxide
B react aqueous iron(II) nitrate with copper(II) hydroxide
C react excess iron metal with aqueous sodium hydroxide
D react excess iron metal with dilute hydrochloric acid

16 A student tried unsuccessfully to prepare silver chloride by reacting silver metal with dilute hydrochloric acid.

Which statement below explains what the student did wrong?

A An insoluble and impervious layer of silver chloride prevents further reaction.
B Silver is an unreactive metal and does not react with dilute hydrochloric acid.
C The silver metal was not powdered to speed up rate of reaction.
D The student did not catalyse the reaction.

17 20.0 cm^3 of 0.100 mol dm^{-3} sulfuric acid was titrated against 25.0 cm^3 of 0.100 mol dm^{-3} aqueous potassium hydroxide.

Which statement is true for the titration?

A Effervescence of colourless gas will be observed.
B Sulfuric acid is the limiting reagent.
C The final pH of the solution will be 2.
D Universal indicator is a suitable indicator for the titration.

18 Three unlabelled bottles are known to contain aqueous solutions of lead(II) nitrate, aluminium nitrate and zinc nitrate.

Which pair of reagents can be used to identify the contents of the three bottles?

A excess aqueous ammonia and aqueous potassium iodide
B excess aqueous ammonia and dilute nitric acid
C excess aqueous sodium hydroxide and aqueous potassium iodide
D excess aqueous sodium hydroxide and dilute nitric acid

19 Oxide X is a gas at room temperature. It turns moist blue litmus paper red and can change the colour of acidified potassium dichromate(VI).

What is the most likely identity of oxide X?

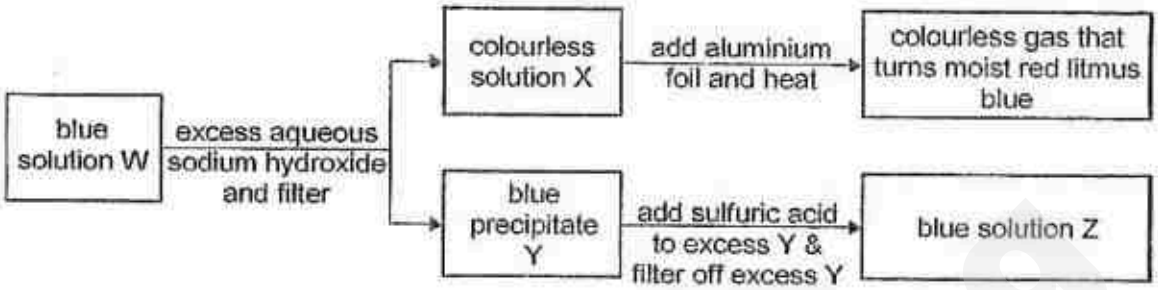
A carbon monoxide
B carbon dioxide
C sodium oxide
D sulfur dioxide

20 Vanadium and chlorine can react to form a red substance that is liquid at room temperature.

Why is this unusual?

A Vanadium and chlorine should form an ionic compound and thus is likely to be a solid.
B Vanadium and chlorine should form a simple molecule and thus is likely to be a gas.
C Vanadium and chlorine should form a macromolecule and thus is likely to be a solid.
D Vanadium has a fully filled valence electron shell and thus is unlikely to react.

21 The flow chart below shows some reactions that blue solution W undergoes.



What are the identities of W, X, Y and Z?

	W	X	Y	Z
A	$Cu(NO_3)_2$	$NaNO_3$	$Cu(OH)_2$	$CuSO_4$
B	$CuSO_4$	Na_2SO_4	$Cu(OH)_2$	$CuSO_4$
C	$Fe(NO_3)_2$	$NaNO_3$	$Fe(OH)_2$	$FeSO_4$
D	$(NH_4)_2SO_4$	NH_4OH	$Cu(OH)_2$	$CuSO_4$

Read the passage below about the Hunter process and answer questions **22**, **23** and **24**.

The Hunter process was the first industrial process to produce pure ductile metallic titanium. It was invented in 1910 by Matthew A. Hunter, a New Zealand born chemist.

The process involves reacting titanium tetrachloride with sodium in a batch reactor with an inert atmosphere at a temperature of 1000 °C. Dilute hydrochloric acid is then used to leach the salt from the product.

$$TiCl_4 + 4Na \rightarrow 4NaCl + Ti$$

22 1 ton (1000 kg) of titanium tetrachloride is reacted in the reactor.

If the percentage yield is 96.0 %, what is the mass of Ti formed?

A 0.121 ton B 0.243 ton C 0.960 ton D 1.00 ton

23 What is the reducing agent in the Hunter process?

A Na B $NaCl$ C Ti D $TiCl_4$

24 Which gas is suitable to be used in the batch reactor?

A carbon monoxide
B chlorine
C neon
D oxygen

25 The table below shows the reactions of manganese with different substances and their observations.

reaction with	products formed
dilute acid	hydrogen gas evolved
cold water	-
steam	hydrogen gas evolved

Which of the following gives the correct arrangement of the metals in ascending order of reactivity?

A calcium, manganese, lead
B lead, calcium, manganese
C lead, manganese, calcium
D manganese, calcium, lead

26 In which substances do nitrogen have an oxidation state of -3?

1 $Ca(NO_3)_2$
2 N_2
3 NH_3
4 $(NH_4)_2CO_3$

A 1 only
B 4 only
C 2 and 3 only
D 3 and 4 only

27 Electron affinity is defined as the amount of energy released when an electron is added to a neutral atom to form a negative ion.

What are the trends in the following properties of elements down Group VII?

	colour intensity	electron affinity
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

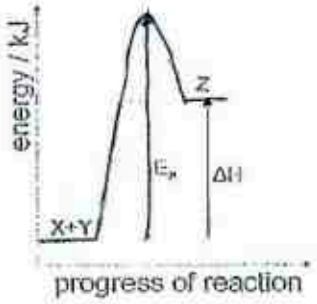
28 During the thermite reaction, iron(III) oxide reacts with aluminium to produce extremely high temperatures.

Why does the reaction produce such high temperatures?

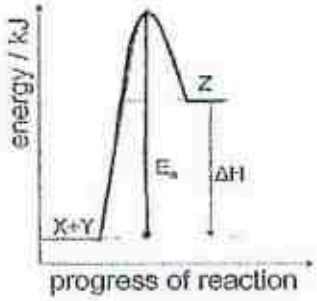
A The thermite reaction absorbs heat from the surroundings.
B The thermite reaction gives out heat to the surroundings.
C The thermite reaction undergoes combustion.
D The thermite reaction undergoes decomposition.

29 Which graph shows the correct activation energy and energy change for the reaction X+ Y → Z?

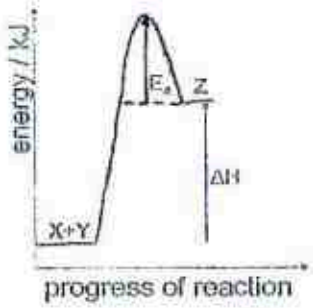
A



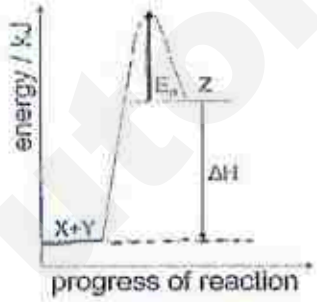
B



C



D



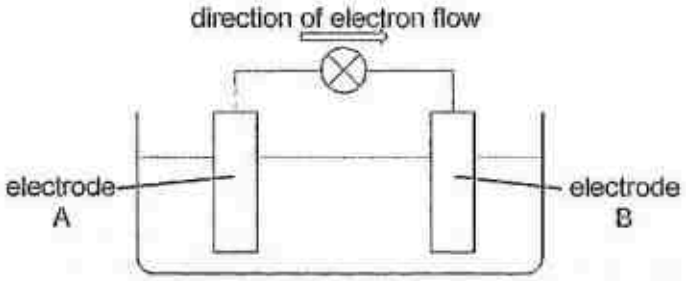
30 What are the products formed at the anode and cathode when concentrated copper(II) sulfate solution undergoes electrolysis using copper electrodes?

	anode	cathode
A	copper(II) ions	copper metal
B	copper(II) ions	hydrogen gas
C	oxygen gas	copper metal
D	oxygen gas	hydrogen gas

31 What is a suitable electrolyte to electroplate an aluminium trophy with silver?

A aqueous aluminium nitrate
B aqueous silver nitrate
C molten silver nitrate
D molten silver

32 Which pair of metal electrodes will make the electrons flow clockwise around the circuit as shown in the diagram?



	electrode A	electrode B
A	carbon	silver
B	copper	magnesium
C	iron	calcium
D	zinc	iron

33 When starting a campfire, kindling, which is usually comprised of fine shavings of wood and shredded paper is used to ignite the large pieces of wood.

Why is it necessary that pieces of kindling be as fine as possible?

A to decrease the activation energy of the kindling
B to decrease the mass of kindling needed to start the fire
C to increase the average kinetic energy of the kindling particles
D to increase the total exposed surface area of the kindling

34 Three strips of the same metal were dipped into three different aqueous solutions containing $CuSO_4$, $MgSO_4$ and $Fe(NO_3)_2$ respectively.

A metallic deposit was observed on the metallic strips dipped into the $CuSO_4$ and $Fe(NO_3)_2$ solutions.

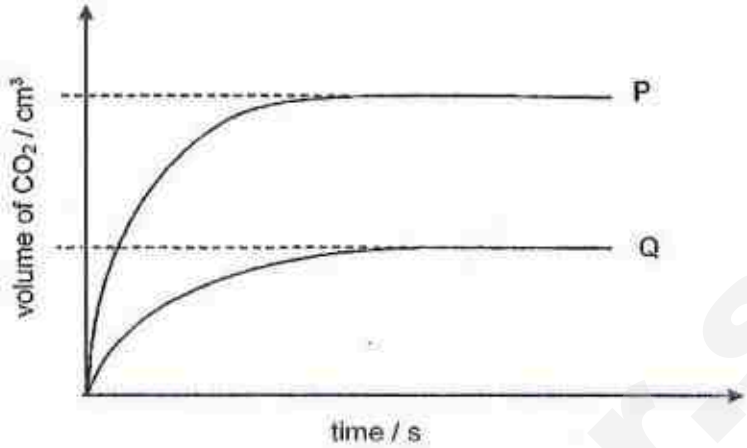
What could the metal be?

A Pb B Ca C Fe D Zn

35 What are the correct reaction conditions and catalyst for the Haber process?

	temperature / °C	pressure / atm	catalyst
A	250	250	nickel
B	250	450	iron
C	450	250	iron
D	450	450	nickel

36 Excess calcium carbonate is added to two different dilute acids. The graphs show the volume of carbon dioxide being produced at regular intervals.



If graph P corresponds to 100 cm^3 of 2.0 mol dm^{-3} dilute hydrochloric acid, which acid will graph Q correspond to?

A 50 cm^3 of 2.0 mol dm^{-3} dilute ethanoic acid

B 100 cm^3 of 2.0 mol dm^{-3} dilute ethanoic acid

C 50 cm^3 of 1.0 mol dm^{-3} dilute sulfuric acid

D 100 cm^3 of 2.0 mol dm^{-3} dilute sulfuric acid

37 Which of the following reactions is not an addition reaction?

A combustion of ethene

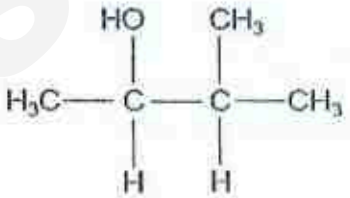
B formation of pentanol from pentene

C manufacture of margarine

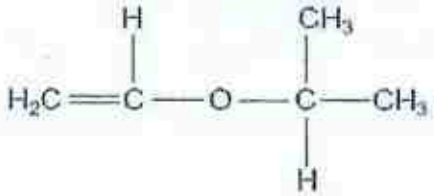
D propene decolourising aqueous bromine

38 Which of the following is not an isomer of the other three?

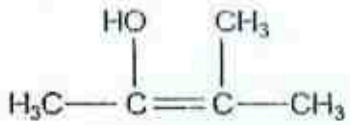
A



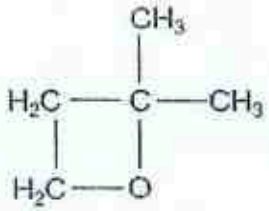
B



C

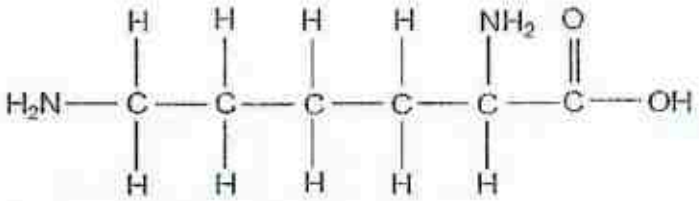


D



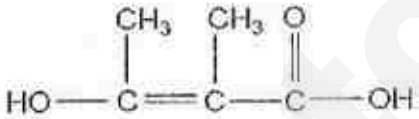
39 The molecule below is lysine.

How many different functional groups are there in this molecule?



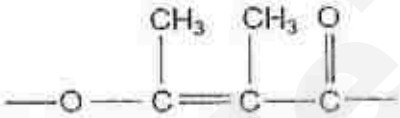
A 2 B 3 C 4 D 5

40 What is the repeating unit of the polymer formed when molecule R undergoes polymerisation with the loss of water?

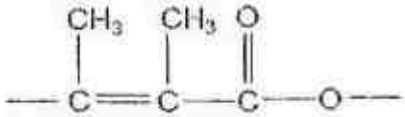


molecule R

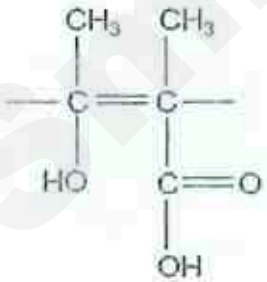
A



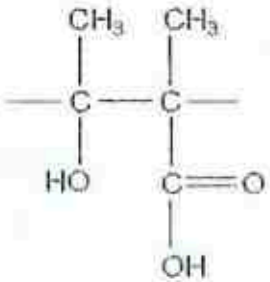
B



C



D



- End of Paper -

Victoria School
2017 Sec 4 Chemistry Prelim 2 Answer Scheme

Paper 1

1	2	3	4	5	6	7	8	9	10
C	B	A	D	C	A	C	B	C	B
11	12	13	14	15	16	17	18	19	20
B	A	D	D	A	B	C	A	D	A
21	22	23	24	25	26	27	28	29	30
A	B	A	C	C	D	C	B	A	A
31	32	33	34	35	36	37	38	39	40
B	D	D	D	C	A	A	A	A	A

Name	Class	Register Number

5073/02 (with SPA)

17/4P2/5073/2

CHEMISTRY
PAPER 2

Thursday 3 August 2017 1 hour 45 minutes

VICTORIA SCHOOL VICTORIA SCHOOL VICTORIA SCHOOL VICTORIA SCHOOL VICTORIA SCHOOL VICTORIA SCHOOL VICTORIA SCHOOL VICTORIA SCHOOL VICTORIA
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VICTORIA SCHOOL

PRELIMINARY EXAMINATION TWO
(SECONDARY FOUR)

INSTRUCTIONS TO CANDIDATES

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer all questions in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form either/or.
Answer **all** questions in the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.

The use of an approved scientific calculator is expected, where appropriate.

A copy of Periodic Table is printed on **page 20**.

Section A	/ 50
Section B	/ 30
Total	/ 80

Deductions	
Presentation	
Significant Figures	
Units	

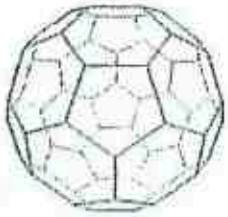
This question paper consists of 20 printed pages (including this cover page)

[Turn Over]

Section A (50 marks)

Answer all the questions in this section in the spaces provided.

A1 In 1985, fullerenes were discovered. They are solid forms of the element carbon. The structure of the C_{60} fullerene is given below.



(a) Explain, in terms of structure and bonding, why fullerenes sublime at a relatively low temperature of 600 °C.

.....

.....

.....[2]

(b) Another fullerene has a relative molecular mass of 840.

How many carbon atoms are there in one molecule of this fullerene?

.....[1]

(c) Fullerenes are soluble in liquid hydrocarbons such as octane. The other solid forms of carbon are insoluble.

Describe how you could obtain crystals of fullerenes from soot which is a mixture of fullerenes and other solid forms of carbon.

.....

.....

.....

.....[2]

(d) A mixture of fullerene and potassium is a good conductor of electricity.

(i) Which other form of solid carbon is a good conductor of electricity?

.....[1]

(ii) Explain, in terms of structure, why a mixture of a fullerene and potassium, is a good conductor of electricity.

.....

.....

.....[2]

(iii) The mixture of fullerene and potassium has to be stored out of contact with air as there are substances in unpolluted air which will react with potassium.

Name two potassium compounds which can be formed when potassium is exposed to air.

.....[1]

[Total: 9]

A2 The iron produced from the blast furnace is impure. It contains about 5 % of impurities, mainly carbon, sulfur, silicon and phosphorus, which have to be removed before iron is converted into steel.

(a) Explain how the addition of oxygen and calcium oxide can remove these impurities.

.....

.....[2]

(b) High carbon steel contains 2 % of carbon. It is less malleable and much harder than mild steel.

(i) Give a use of

mild steel .....

high carbon steel .....[2]

(ii) Suggest an explanation why high carbon steel is less malleable than mild steel.

.....

.....

.....

.....[2]

(c) Samples of iron were placed in aqueous solutions having different pH values.

The table shows how the speed of rusting of iron varies with the pH of the solutions.

speed of rusting / cm per year	0.043	0.029	0.012	0.010	0.010	0.010	0.009	0.006
pH	2	3	4	5	6	8	10	12

Describe how pH affects the speed of rusting of iron.

.....

.....

.....[2]

[Total: 8]

A3 Hydrazine, N_2H_4, is a liquid that is used as a rocket fuel. It reacts with oxygen as shown in the equation below.

$$N_2H_4 + O_2 \rightarrow N_2 + 2H_2O \qquad \Delta H = -622.2 \text{ kJ/mol}$$

(a) Suggest why the combustion of hydrazine has very little negative environmental impact.

.....

.....[1]

(b) Explain, in terms of the energy changes which occur during bond breaking and bond forming, why the combustion of hydrazine is exothermic.

.....

.....

.....

.....[2]

(c) **(i)** Calculate the energy released when 100 kg of hydrazine is burnt.

[2]

(ii) A rocket burns hydrazine in an oxygen atmosphere. Both hydrazine and oxygen are stored in the rocket as liquids.

Suggest why oxygen is stored as a liquid rather than as a gas.

.....

.....[1]

(d) Hydrazine, N_2H_4, has similar chemical properties to ammonia.

(i) Hydrazine reacts with hydrochloric acid.

Suggest the formula of the product of this reaction.

.....[1]

(ii) Given two aqueous solutions of hydrazine and sodium hydroxide, describe how you could conduct a 'fair' experiment to identify the pH of the two solutions.

.....

.....

.....

.....

.....[2]

(iii) Draw a 'dot-and-cross' diagram to represent the bonding in hydrazine. Show only the valence electrons.

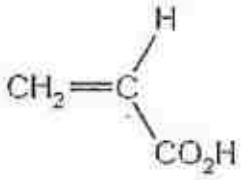
[2]

[Total: 11]

A4 Super-absorbent polymers have the ability to absorb 200 to 300 times their own mass of water.

They are classified as hydrogels and they are widely used in personal disposable hygiene products such as babies' diapers.

These addition polymers are commonly made by the polymerisation of compound K, acrylic acid, mixed with sodium hydroxide in the presence of an initiator.



compound K

(a) **(i)** Explain what is meant by the term 'polymerisation'.

.....

.....[1]

(ii) Describe the changes in chemical bonding that occur during the polymerisation of K.

.....

.....[1]

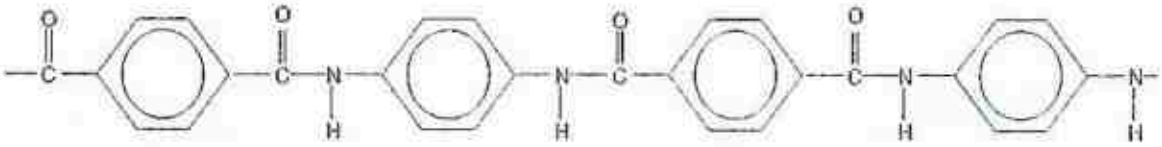
(b) **(i)** Draw the structure of the product when K is mixed with aqueous sodium hydroxide.

[1]

(ii) Draw the full structure of at least two repeating units of the polymer formed by the product in **(b)(i)**.

[1]

(c) Another polymer Kevlar® is known for its variety of applications such as in bicycle tyres and bullet proof vests. The structure of Kevlar® is shown below.

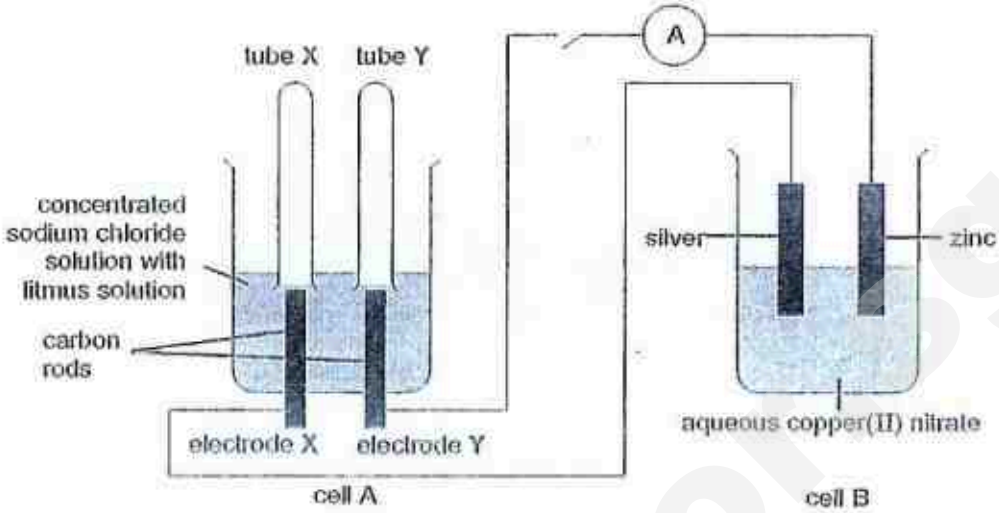


If the formation of Kevlar® releases hydrogen chloride as a by-product, draw the structural formula of the two monomers that make up Kevlar® which one of the monomer contains an amine functional group.

[2]

[Total: 6]

A5 The diagram below shows an experimental set-up of an electrolytic cell (cell A) connected to a simple cell (cell B).



(a) Show the direction of electron flow on the diagram above. [1]

(b) (i) Give the ionic equations with state symbols for the reactions occurring at the silver and zinc plates in cell B.

	ionic equations
zinc	
silver	

[3]

(ii) What are the observations for the electrolyte in cell B after electrolysis has taken place for some time?

.....[1]

(c) (i) Mark on the diagram above to show the relative volumes of gases collected in tubes X and Y.

Label clearly the identity of the gases collected. [2]

(ii) Explain why the solution in cell A turns blue.

.....

.....

.....[2]

[Total: 9]

A6 Nickel carbonyl, $Ni(CO)_4$, reacts with hydrogen iodide.

$$Ni(CO)_4(l) + 2HI(g) \rightarrow NiI_2(s) + H_2(g) + 4CO(g)$$

(a) Explain how hydrogen iodide acts as an oxidising agent in terms of electron transfer.

.....

.....[1]

(b) The proton numbers and accurate relative atomic masses of cobalt and nickel are shown in the table.

element	cobalt	nickel
proton number	27	28
relative atomic mass	58.9	58.7

(i) Suggest why cobalt has a higher relative atomic mass than nickel.

.....

.....[1]

(ii) State a property of these two transition metals.

.....

.....[1]

(c) Hydrogen iodide is a colourless gas at room temperature. It can dissolve in water to form an aqueous solution.

(i) Describe the changes in the arrangement and movement of the particles when hydrogen iodide dissolves in water.

.....

.....

.....[2]

(ii) Chlorine gas is bubbled into a beaker of aqueous solution of hydrogen iodide.

Describe and explain the observations.

.....

.....

.....[2]

[Total: 7]

Section B (30 marks)

Answer all three questions in this section.

The last question is in the form of an either / or and only one of the alternatives should be attempted.

B7 Copper and aluminium are two important metals in the industry. The global production of copper peaked at 19.4 million tonnes while aluminium at 59 million tonnes in 2016.

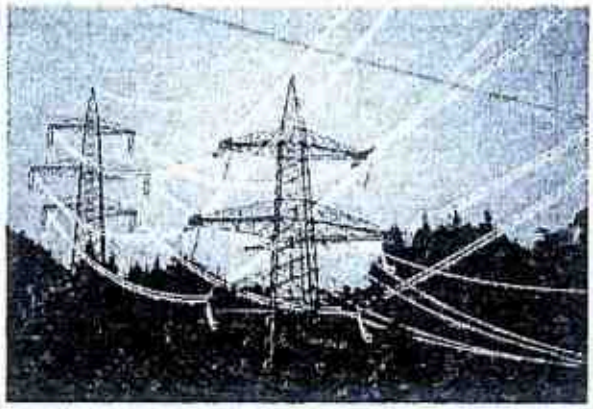
The table below lists some information on the extraction of copper and aluminium from their metal ores.

metal	copper	aluminium
metal ore	chalcocite, containing 17 % by mass of Cu_2S	bauxite, containing 25 % by mass of Al_2O_3
extraction	1 The ore is concentrated by froth flotation to obtain high grade Cu_2S. 2 The Cu_2S is roasted in air to obtain Cu_2O. 3 Copper is extracted from Cu_2O in a furnace by heating with carbon. 4 Copper is purified by electrolysis.	1 Impurities in ore are removed by filtration after dissolving Al_2O_3 in aqueous sodium hydroxide. 2 Water is added to the solution to precipitate out aluminium hydroxide. 3 The aluminium hydroxide is then roasted in air to obtain Al_2O_3. 4 Aluminium is extracted from Al_2O_3 by electrolysis.
cost of metal	S$8200 per tonne	S$2700 per tonne

Both copper and aluminium are widely used in wiring and electrical devices. However, one metal is sometimes favoured over the other in some applications. The table below compares some physical properties of copper and aluminium.

metal	copper	aluminium
tensile strength / kg cm^{-2}	3867	1758
density / g cm^{-3}	8.96	2.70
electrical conductivity / S m^{-1}	5.85×10^7	3.69×10^7
other information	• higher electrical conductivity allows smaller conductor to be used • expand 35 % lesser than aluminium	• oxidised easily causing resistance of wire to increase. Overheating in wire can melt insulation and trigger a fire

* The tensile strength is a measurement of the amount of force required to pull something to the point where it breaks.



Transmission lines are widely used to transmit TV signals, radio signals, phone signals and power. The cables used in overhead transmission lines can either be made of copper or aluminium. They can run from 50 km to 150 km depending on the voltages they carry. These lines always hang loosely instead of stretched tightly due to the tension caused by their own weights. Thermal contraction and expansion due to climatic changes also have a part to play in the sagging cables.

(a) Show by calculation that the mass of copper obtained from 1 tonne of chalcocite is larger than the mass of aluminium from 1 tonne of bauxite.
(1 tonne = 1 000 000 g)

[2]

(b) (i) What property of Al_2O_3 allows it to dissolve in aqueous sodium hydroxide?

.....[1]

(ii) Write the ionic equation for the precipitation of aluminium hydroxide in step 2 in the extraction of aluminium from its ore.

[1]

(c) Suggest one problem that the extraction of copper from chalcocite has on the environment.

.....

.....[1]

(d) Aluminium wires which are exposed pose the risk of electrocution.

Explain why these wires are also fire hazards.

.....

.....[1]

(e) (i) State the advantages of using copper instead of aluminium in making the cables for transmission lines.

.....

.....

.....[2]

(ii) State the disadvantages of using copper instead of aluminium in making the cables for transmission lines.

.....

.....

.....[2]

(f) (i) Copper can be extracted from its oxide by heating it with aluminium.

Explain why this is possible.

.....

.....[1]

(ii) Suggest why this method is not employed in the mass extraction of copper from its oxide?

.....

.....[1]

[Total: 12]

B8 (a) Describe a chemical reaction which occurs very slowly.

.....

.....[1]

(b) The reaction between potassium hypochlorite and potassium iodide in the presence of OH^- catalyst is represented by the following ionic equation.

$$OCl^-(aq) + I^-(aq) \xrightarrow{OH^-} OI^-(aq) + Cl^-(aq)$$

30.0 cm^3 each of aqueous OCl^- and aqueous I^- are reacted with 1.0 cm^3 of aqueous OH^-. The table below shows the results of each experiment when different concentrations of each reactant are used.

experiment	concentration / mol dm^{-3}			rate / mol dm^{-3} s^{-1}
	OCl^-	I^-	OH^-	
1	0.0040	0.0020	1.00	4.8×10^{-4}
2	0.0020	0.0040	1.00	5.0×10^{-4}
3	0.0020	0.0020	1.00	2.4×10^{-4}
4	0.0020	0.0020	0.50	4.6×10^{-4}
5	0.0020	0.0020	0.25	9.4×10^{-4}

(i) Using information from the table, describe how the concentrations of OCl^-, I^- and OH^- affect the rate of the reaction.

.....

.....

.....

.....

.....

.....[3]

(ii) Explain how OH^- helps to catalyse the reaction between OCl^- and I^-.

.....

.....

.....[2]

(iii) Another experiment was conducted with the following concentrations of the reactants.

concentration / mol dm^{-3}		
OCl^-	I^-	OH^-
0.0010	0.0020	1.00

Predict what will be the rate of the reaction.

.....[1]

(iv) In experiment 5, a small volume of reaction mixture was extracted and placed in a test-tube.

A few drops of aqueous silver nitrate were then added.

Explain why this method allows one to determine whether the reaction has completed.

.....

.....[1]

[Total: 8]

EITHER

B9 Palm wine is an alcoholic beverage created from the sap of various species of palm trees.

The palm sap is extracted and left to ferment. Within two hours, fermentation yields an aromatic wine of up to 4 % alcohol content, mildly intoxicating and sweet.

The wine may be allowed to ferment longer, up to a day, to yield a stronger, sourer taste, which some people prefer.

Fermentation longer than a day produces vinegar instead of stronger wine.

(a) **(i)** Write a balanced equation for the fermentation reaction, indicating the conditions required.

[2]

(ii) The article says 'Fermentation longer than a day produces vinegar instead of stronger wine.'

Do you agree with this statement? Explain your reasoning.

.....

.....

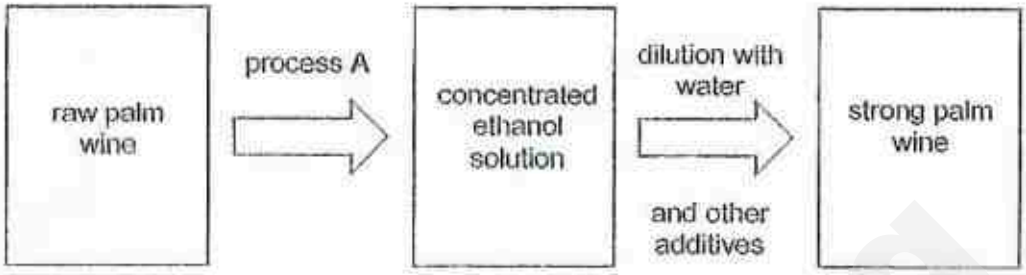
.....[2]

(iii) Explain why aluminium cans cannot be used to contain the vinegar produced.

.....

.....[1]

(b) Stronger wine can instead be made through the following steps.



(i) What is the name of process A?

.....[1]

(ii) 500 cm^3 of a concentrated ethanol solution has a concentration of 4.00 mol/dm^3 of ethanol.

Calculate the volume of water that must be added to obtain a strong palm wine with concentration of 2.50 mol/dm^3 of ethanol.

[2]

(c) Ethanol can be combined with carboxylic acids to form esters.

(i) Draw the full structural formula of the ester that is formed when ethanol reacts with propanoic acid.

[1]

(ii) Name the ester formed in **(c)(i)**.

.....[1]

[Total: 10]

OR

B9 Hydrocarbon **B** has a percentage by mass of 85.7% carbon and 14.3% hydrogen. It has a relative molecular mass of 84.

(a) **(i)** Determine the empirical formula of the hydrocarbon **B**.

[2]

(ii) Hence determine the molecular formula of hydrocarbon **B**.

[1]

(b) Another hydrocarbon butene can be formed when butanol undergoes dehydration in the presence of concentrated sulfuric acid.

(i) Explain how you could use acidified aqueous potassium manganate(VII) to confirm that all of the butanol has undergone dehydration.

.....

.....

.....[2]

(ii) Both butene and butanol can be used as fuels.

Which is a cleaner fuel? Explain your choice.

.....

.....

.....[2]

(iii) Write a balanced equation for the incomplete combustion of butene, showing the organic compounds as displayed formulae.

Explain an environmental problem this will cause.

.....

.....

.....[3]

[Total: 10]

- End of paper -

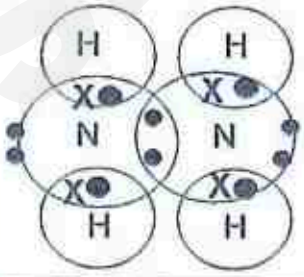
Victoria School
2017 Sec 4 Chemistry Prelim 2 Answer Scheme

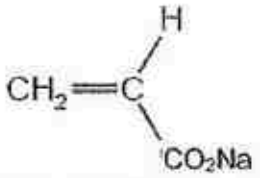
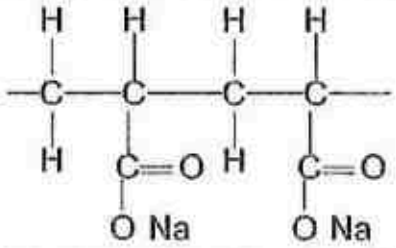
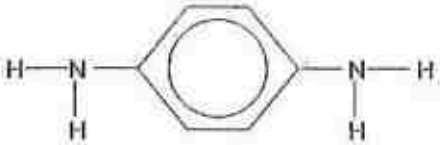
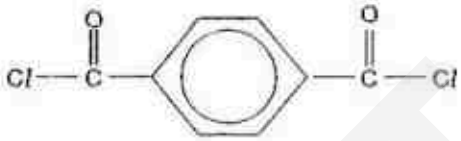
Paper 1

1	2	3	4	5	6	7	8	9	10
C	B	A	D	C	A	C	B	C	B
11	12	13	14	15	16	17	18	19	20
B	A	D	D	A	B	C	A	D	A
21	22	23	24	25	26	27	28	29	30
A	B	A	C	C	D	C	B	A	A
31	32	33	34	35	36	37	38	39	40
B	D	D	D	C	A	A	A	A	A

Paper 2 Section A

Qn	Suggested answers	Mark
1a	• simple molecular structure • small amount of energy needed to overcome • weak intermolecular forces of attraction	2pts -1 3pts -2
b	70	1
c	Add octane (or other liquid hydrocarbon) to **dissolve** the fullerenes and filter (to remove insoluble forms of carbon); evaporate/heat/warm till saturated and filter and rinse with distilled water to collect the crystals. Or leave in sun to get crystals of fullerene	1 1
di	Graphite	1
ii	Fullerene: 1 carbon atom covalently bonded to 3 other carbon atoms, leaving free **unbonded** electrons to **move** to conduct Potassium: free delocalised **electrons move** to conduct	1 1
iii	potassium oxide, potassium hydroxide, potassium carbonate, potassium hydrogencarbonate (bicarbonate)	Any two -1
	Total	9
2a	Form **acidic oxides** with oxygen; Calcium oxide, a **basic oxide**, neutralise them away	1 1
bi	Mild steel: car bodies/nuts & bolts /pipes /chains/ bridges High carbon steel: cutting tools /drills /chisels /knives	1 1
ii	In low carbon steel alloy: carbon atoms of **different atomic radii** **disrupt the regular arrangement** of the atoms; **layers** of iron atoms **cannot slide over each other easily when force is applied;** In high carbon steel alloy: **more carbon atoms** causes **more disruptions** in the **regular arrangement** of iron atoms	1 1

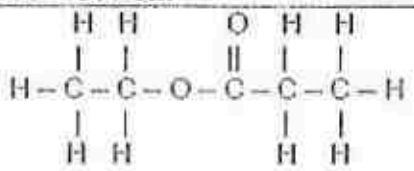
Qn	Suggested answers	Mark
c	the higher the pH the slower the speed of rusting/the lower the pH the faster the speed of rusting; between pH 5 and 8 there is no difference in speed of rusting; Note: reject answer that states the more acidic/alkaline the solution, the faster/slower the speed of rusting. answer must make specific reference to pH rather than acid, acidic, alkali or alkaline	1 1
	Total	**8**
3a	non-polluting/harmless gases/products (nitrogen and water) formed NOT: nitrogen and water less harmful / nitrogen and water are formed (without qualification)/ environmentally friendly products	1
b	bond breaking reaction absorbs energy, hence its endothermic AND bond making reaction releases energy, hence its exothermic; more energy is released than absorbed	1 1
ci	No. of moles of hydrazine = 100 000/32 = **3125 mol** Energy released = 3125 x 622.2 = 1944375 kJ = **1.94 x 10^6 kJ** or 1940 000 kJ (3 s.f.)	1 1
ii	able to store more in liquid form / gaseous volume too high / maximum storage capacity / liquid occupies smaller volume IGNORE: less easily spread out/no gas can escape / less possibility of an explosion / to prevent reaction with other substances	1
di	N_2H_5Cl REJECT: N_2H_5Cl in equation if more than one product given $N_2H_4 + HCl \rightarrow N_2H_5Cl$	1
ii	• Place a pH meter into the 2 solutions: pH of hydrazine, pH range of 9-12 is lower than pH of NaOH, pH range of 13-14 Or • Adding a few drops of Universal Indicator into the 2 solutions and compare with pH chart: Hydrazine – blue, pH range of 9-12, NaOH – violet, pH range of 13-14	1 1
iii		1 – bonded 1 - unbonded
	Total	**11**
4ai	Process of joining together **many small molecules**(monomers) by **covalent bonding** to form **a large molecule**	1
ii	C=C bond is broken and new C-C single bonds are formed	1

Qn	Suggested answers	Mark
bi		1
ii		1
c	 	1 1
	Total	**6**
5a	Electrons out from zinc, enter into silver	1
bi	Zinc: $Zn(s) \rightarrow Zn^{2+}(aq) + 2e$ Silver: $Cu^{2+}(aq) + 2e \rightarrow Cu(s)$	1 1 1 -ss
ii	Cell B: **blue** solution fades/turns colourless **gradually**	1
ci	 [1] for vol; [1] for labelling (ecf from bii)	2
ii	• Hydrogen ions are (preferentially) discharged to form hydrogen gas (at the cathode); • Concentration of hydroxide ions is higher	1 1
	Total	**9**
6a	hydrogen ions gain (two) electrons to form hydrogen, hence is reduced.	1
bi	cobalt has greater proportion of heavier isotopes than nickel /nickel has lower proportion of lighter isotopes than cobalt	1
ii	• Its compounds exist as variable oxidation states • Form coloured compounds • High melting and boiling points • Used as catalyst	Any 1 - 1

Qn	Suggested answers	Mark
ci	Arrangement: very far apart and disorderly arranged to closely packed and disorderly arranged. Movement: moving rapidly randomly/in all directions to sliding over each other.	1 1
ii	Colourless solution turns brown; Chlorine is more reactive than iodine, displaces iodine from hydrogen iodide to form aqueous iodine;	1 1
	Total	7

Paper 2 Section B

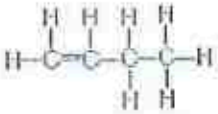
Qn	Suggested answers	Mark
7a	mass of Cu = 0.17 x (128/160) x 1 = 0.136 tonne mass of Al = 0.25 x (54/102) x 1 = 0.132 tonne	1 1
bi	It is amphoteric.	1
ii	$Al^{3+} + 3OH^- \rightarrow Al(OH)_3$	1
c	Roasting Cu_2S in air produces SO_2 which can cause acid rain. Accept CO_2 and CO Reject: CO oxidised to CO_2 by O_2 in air	1
d	The aluminium will be oxidised causing the resistance of wire to increase. Overheating in the wire can melt the insulation and cause a fire.	1
ei	high tensile strength and does not break easily / higher conductivity **OR** thinner wires can be used / does not oxidise easily when exposed [any 2]	2
ii	expensive / heavy due to high density	2
fi	Aluminium is more reactive than copper and hence able to displace copper from oxides of copper	1
ii	Aluminium is expensive.	1
	Total	12
8a	any slow chemical reactions (e.g. ageing, fruit ripening, rusting)	1
bi	Using expt 3, 4 & 5, when concentrations of OCl^- and I^- are constant, decreasing concentration of OH^- will cause rate of reaction to increase. Using expt 2 & 3, when concentrations of OCl^- and OH^- are constant, decreasing concentration of I^- will cause rate of reaction to decrease. Using expt 1 & 3, when concentrations of I^- and OH^- are constant, decreasing concentration of OCl^- will cause rate of reaction to decrease.	1 1 1
ii	by providing an alternative pathway of lower activation energy so that ions/particles of lower energy can also overcome the energy barrier and undergo effective collision for reaction.	1 1
iii	1.2×10^{-4} mol dm^{-3} s^{-1}	1
iv	As long as yellow precipitate is formed, the reaction has not completed.	1
	Total	8

Either B9ai	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ Yeast, 37°C, absence of oxygen(anaerobic)	1 1
aii	• Yes • ethanol is oxidised by oxygen (in the presence of bacteria) in the air to form ethanoic acid • yeast dies when concentration of alcohol is more than 15%	2pts -1 3pts -2
aiii	Aluminium can react with the ethanoic acid to form soluble salts/ corrode the cans.	1
bi	Fractional distillation	1
bii	$c_1v_1 = c_2v_2$ $4.00 \times 500 = 2.5 \times v_2$ $v_2 =$ **800 cm³** Volume of water to be added' 800-500 = **300 cm³**	 1 1
ci		1
cii	ethyl propanoate	1
	Total	**10**
OR B9ai		

	C	H
mass/g	85.7	14.3
no of moles/mol	85.7/12 = **7.141**	14.3/1 = **14.3**
molar ratio	7.141 / 7.141 =1	14.3/7.141 = 2
simplest ratio	1	2
Empirical formula: **CH_2**		

1

1

ii	Relative molecular mass: 84 Empirical formula mass: 14 84 = n(14) n = 6 molecular formula: **C_6H_{12}**	 1
bi	acidified aqueous potassium manganate(VII) react with/oxidise butanol to butanoic acid from **purple to colourless**; If all the butanol has been dehydrated to butane, there will be **no colour change** when acidified aqueous potassium manganate(VII) is added.	1 1
bii	**butanol** is a cleaner fuel as it has a **lower percentage by mass of carbon**; Less chances of incomplete combustion	1 1
biii	 $+ 4O_2 \rightarrow 4CO + 4H_2O$ Carbon monoxide bonds readily and irreversibly with haemoglobin(RBC), forming carboxyhaemoglobin/stable compound. This reduces oxygen intake around the body, leading to dizziness and then death.	1 1 1
	Total	**10**

Anglo-Chinese School

(INDEPENDENT)

THE BEST IS YET TO BE

Year 4 Express
Preliminary Examination 2017

CHEMISTRY **5073/1**

PAPER 1 Multiple Choice

Wednesday 16 August 2017 1 hour

Additional materials:
- Calculator
- Multiple Choice answer sheet
- Soft clean eraser
- Soft pencil (type 2B recommended)

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.
Write and shade Candidate number on the answer sheet in the spaces provided.

There are **forty** questions in this paper. Answer **all** questions. For each question there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in **soft pencil** on the separate answer sheet.

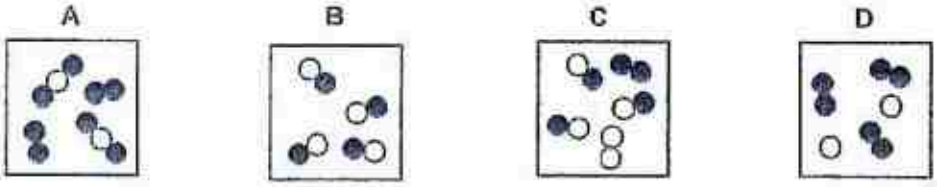
Read very carefully the instructions on the answer sheet.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
You may use a calculator.
A copy of the Periodic Table is printed on page 14.

This question paper consists of 14 printed pages.

1 Which of the following diagrams represents a reaction between two elements which is **not yet** completed?



2 The following table shows the melting points and boiling points of some substances.

Substance	Melting point / °C	Boiling point / °C
P	5	78
Q	780	1413
R	– 5	102
S	– 186	– 185

From the data given above, which of the following statements is **incorrect**?

A P is a liquid at 100°C.

B S is a gas at room temperature.

C R is a liquid at room temperature.

D Q is a solid at 100°C.

3 Trichloroethane is a solvent used to remove grease from clothing during the dry cleaning process. How is the solvent separated from the grease after the process?

A Chromatography

B Crystallization

C Distillation

D Filtration

4 You are given a mixture of silver and silver oxide. Which of the following sequences would enable you to obtain a pure dry sample of silver?

A Add aqueous sodium chloride, filter, crystallize.

B Add aqueous sodium chloride, stir, filter.

C Add dilute hydrochloric acid, stir, filter.

D Add dilute nitric acid, stir, filter.

5 Which one of the following statements is **incorrect**?

A A cation has more protons than electrons.

B Every atom has at least one neutron in its nucleus.

C Isotopes of the same element have the same number of protons.

D An anion of a non-metal has more electrons than its atom.

6 Which of the following has the highest electrical conductivity?

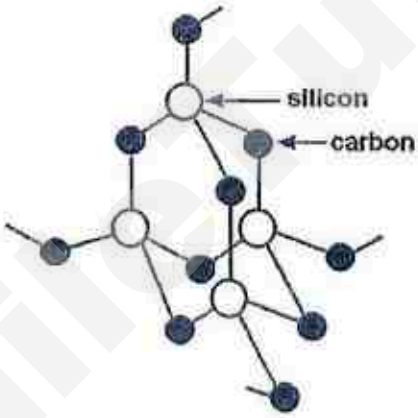
A Aqueous sugar solution

B Pure water

C Solid sodium chloride

D Solid graphite

7 The diagram shows part of the structure of the compound **silicon carbide**.



A sample of silicon carbide underwent complete combustion in oxygen to form a **gaseous oxide** and a **solid oxide**. Which of the following are the structures of **silicon carbide**, the **gaseous oxide** and the **solid oxide**?

	Silicon carbide	The gaseous oxide	The solid oxide
A	Giant molecular structure	Simple molecular structure	Giant molecular structure
B	Ionic structure	Ionic structure	Giant molecular structure
C	Giant molecular structure	Simple molecular structure	Simple molecular structure
D	Ionic structure	Giant molecular structure	Ionic structure

8 Which solid does **not** contain covalent bonds?

A Gold
B Graphite
C Ice
D Calcium carbonate

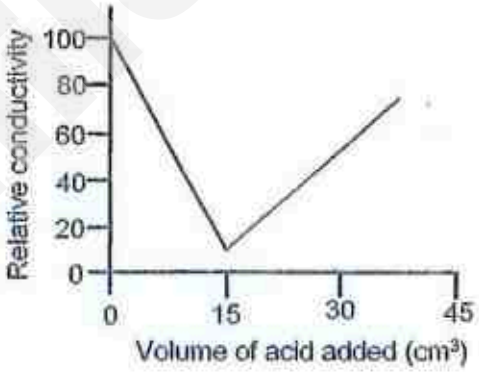
9 In Group VII, chlorine exists as a gas while iodine exists as a solid at room temperature. This is due to

A greater number of neutrons present in the iodine atoms.
B more covalent bonds present in the iodine molecules.
C stronger covalent bonds present in the iodine molecules.
D stronger forces of attraction present between iodine molecules.

10 The mass of a diamond is expressed in a unit called the carat. One carat is equivalent to a mass of 0.200 g. Which of the following is closest to the number of atoms in a 0.500 carat diamond?
(1 mole = 6×10^{23} particles)

A 2.50×10^{21}
B 5.00×10^{21}
C 1.00×10^{22}
D 2.00×10^{22}

11 20.0 cm^3 of $Ba(OH)_2$ solution was titrated with 0.200 mol/dm^3 H_2SO_4 solution in a conductivity cell. The data obtained were plotted to give the graph shown below.



The equation for the reaction is shown below

$$Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2\,H_2O$$

What is the concentration of the $Ba(OH)_2$ solution?

A 0.300 mol/dm^3
B 0.150 mol/dm^3
C 0.120 mol/dm^3
D 0.075 mol/dm^3

12 0.2 mol of $CuSO_4$ and 0.1 mol of Na_2SO_4 were dissolved in water and the solution made up to 500 cm^3. Which is the correct statement?

A The solution contained 0.1 mol of sodium ions.

B The solution contained equal number of positive and negative ions.

C The concentration of copper(II) ions in the solution is 0.4 mol/dm^3.

D The concentration of sulfate ions in the solution is 0.8 mol/dm^3.

13 Phosphine, PH_3, is a gas which has similar properties as ammonia. Which ions would be produced when phosphine dissolves in water?

A PH_3^+, H^-

B PH_4^+, H^+

C PH_3^+, OH^-

D PH_4^+, OH^-

14 When dry hydrogen chloride dissolves in methylbenzene, the solution formed

A contains hydrogen chloride molecules.

B conducts electricity.

C is greenish yellow in colour due to the chlorine gas evolved.

D contains high concentration of hydrogen ions.

15 Which of the following substances would react with copper?

I Dilute hydrochloric acid

II Oxygen

III Aqueous silver nitrate

IV Cold water

A I and II only

B II and III only

C III and IV only

D All of the above

16 A precipitate of lead(II) hydroxide dissolves in aqueous sodium hydroxide to form a colourless solution. Which property of lead(II) hydroxide can be deduced from the reaction?

A Lead(II) hydroxide is a reducing agent.

B Lead(II) hydroxide is basic.

C Lead(II) hydroxide is soluble in water.

D Lead(II) hydroxide is amphoteric.

17 When solid Y was added to a dilute sulfuric acid, effervescence was observed and a colourless solution was obtained. When solid Y was warmed with aqueous sodium hydroxide and potassium nitrate, a pungent gas which turned damp red litmus paper blue was evolved. What could Y be?

A Lead
B Copper
C Aluminium
D Iron

18 Which of the following is a redox reaction?

A $NaOH + HCl \rightarrow NaCl + H_2O$
B $FeCl_3 + 3\ NaOH \rightarrow Fe(OH)_3 + 3\ NaCl$
C $2\ Na_2CrO_4 + 2\ HCl \rightarrow Na_2Cr_2O_7 + 2\ NaCl + H_2O$
D $2\ SO_2 + O_2 \rightarrow 2\ SO_3$

19 The following are four reactions that can occur in the industrial conversion of ammonia into nitric acid. Which one of these reactions shows the greatest change in the oxidation number of nitrogen?

A $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$
B $3\ NO_2 + H_2O \rightarrow 2\ HNO_3 + NO$
C $2\ NO + O_2 \rightarrow 2\ NO_2$
D $4\ NH_3 + 6\ NO \rightarrow 5\ N_2 + 6\ H_2O$

20 Why does an aqueous solution of potassium iodide turn brown with black solid particles when chlorine gas is bubbled into it?

A A compound is formed between chlorine and iodine.
B The chlorine oxidizes iodide ions to iodine.
C A solution of potassium chloride is formed.
D The solution of potassium iodide is reduced.

21 Hydrazine reacts with fluorine as shown in the equation below:

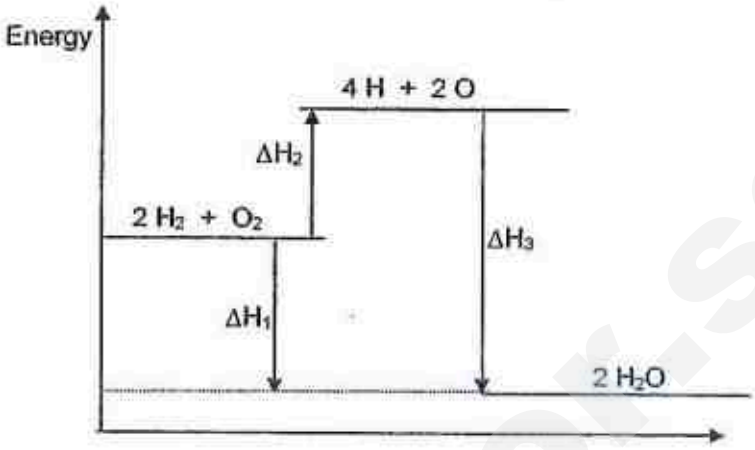
$$N_2H_4\ (g) + 2\ F_2\ (g) \rightarrow N_2\ (g) + 4\ HF(g) \qquad \Delta H = +\ 500kJ$$

If 1 mole of hydrazine and 1 mole of fluorine are used, what is the energy absorbed?

A 125 kJ
B 250 kJ
C 500 kJ
D 1000 kJ

22 The following energy level diagram represents the reaction between hydrogen and oxygen to form steam.

$$2\,H_2\,(g) + O_2\,(g) \rightarrow 2\,H_2O\,(g)$$



Which of the following represents the energy required for bond breaking and the energy released when new bonds are formed?

	energy required for bond breaking	energy released for bond formation
A	ΔH_2	ΔH_3
B	ΔH_2	ΔH_1
C	ΔH_1	ΔH_2
D	ΔH_1	ΔH_3

23 The rate of a chemical reaction can sometimes be determined by measuring the change in mass of the reaction flask and its content with time. For which of the following reactions would this technique be most successful?

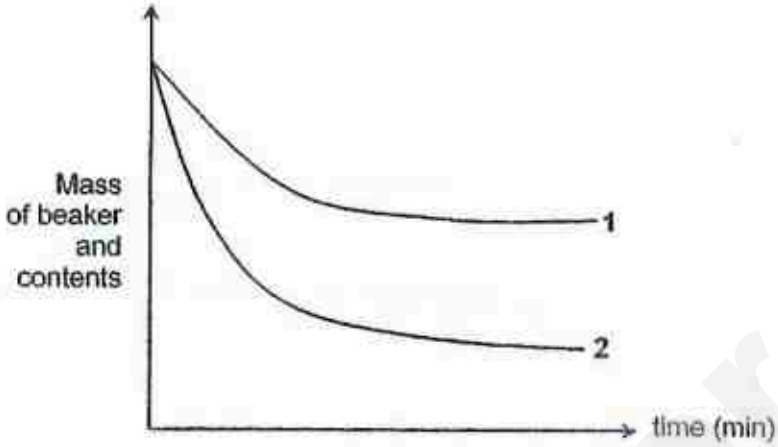
A Copper(II) oxide and dilute sulfuric acid.

B Aqueous sodium chloride and aqueous silver nitrate.

C Magnesium carbonate and dilute hydrochloric acid.

D Zinc and aqueous copper(II) sulfate.

24 Excess magnesium was added to a beaker of dilute hydrochloric acid on a electronic balance.
A graph of the mass of the beaker and contents was plotted against time (curve 1).



What change in the experiment could give curve 2?

I The same mass of magnesium but in smaller pieces.
II The same volume of a more concentrated solution of hydrochloric acid.
III A lower temperature.

A I only.
B II only.
C I and II only.
D II and III only.

25 A current is passed through each of the following electrolytes using inert electrodes. Which one will produce an alkaline solution at the end of the electrolysis?

A Aqueous sodium sulfate
B Concentrated potassium chloride solution
C Dilute sulfuric acid
D Aqueous copper(II) nitrate solution

26 Which of the following could be formed at the electrodes during the electrolysis of aqueous sodium hydroxide using carbon electrodes?

	Cathode	Anode
A	Hydrogen	Oxygen
B	Oxygen	Hydrogen
C	Sodium	Oxygen
D	Sodium	Hydrogen

27 Francium is the last element of Group I in the Periodic Table. Which of the following properties will francium be likely to exhibit?

A Francium has a high melting point.

B Francium will form an acidic oxide.

C Francium conducts electricity.

D Francium reacts less explosively with cold water than caesium.

28 A solid X has the following properties.

- It does not react with cold water.
- Its hydroxide is insoluble in water.
- It can be obtained by heating the oxide of X with carbon.

What is X?

A Sodium

B Calcium

C Iron

D Magnesium

29 Pure iron is obtained from a blast furnace that is filled with the respective raw materials. Which of the following reactions do **not** occur in the blast furnace?

A $CO_2 + C \rightarrow 2\ CO$

B $C + O_2 \rightarrow CO_2$

C $CaO + SiO_2 \rightarrow CaSiO_3$

D $2\ CaCO_3 \rightarrow 2\ CaO + 2\ CO + O_2$

30 Molecules present in car exhaust fumes include carbon dioxide, carbon monoxide, nitrogen, nitrogen dioxide, unburned hydrocarbons and water. Which of these molecules are **not** treated after passing through the catalytic converter of the car?

A Nitrogen dioxide and carbon monoxide only.

B Nitrogen and water only.

C Nitrogen, carbon dioxide, unburned hydrocarbons and water only.

D Nitrogen, carbon dioxide and water only.

31 Which gas is produced in the atmosphere by lightning activities?

A Nitrogen monoxide

B Carbon dioxide

C Methane

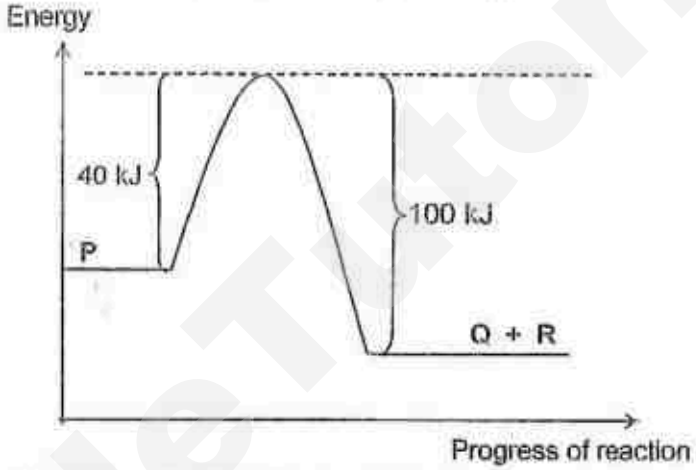
D Ozone

32 Which of the following conditions are normally used in the manufacture of ammonia in Haber Process?

	Temperature /°C	Pressure /atm	Catalyst
A	450	1	Iron
B	450	200	Iron
C	450	1	Iron (II) oxide
D	450	200	Iron(III) oxide

33 The energy profile diagram for the following reversible reaction is given below:

$$P \rightleftharpoons Q + R$$



What is the activation energy for the following reaction?

$$Q + R \rightleftharpoons P$$

A 40 kJ
B 60 kJ
C 100 kJ
D 140 kJ

34 As the number of carbon atoms in the homologous series of alkane molecules increases, which property of the alkanes decreases?

A Density
B Boiling point
C Flammability
D Number of isomers

35 Which of the following is not a product of cracking?

A H_2
B C_7H_{16}
C C_2H_4
D C_2H_5OH

36 Useful fractions are obtained by the fractional distillation of petroleum oil. Which fraction and use are correct?

	Fraction	Use
A	Bitumen	Fuel in cars
B	Petrol (gasoline)	Aircraft fuel
C	Paraffin (kerosene)	For making roads
D	Lubricating fraction	For making waxes and polishes

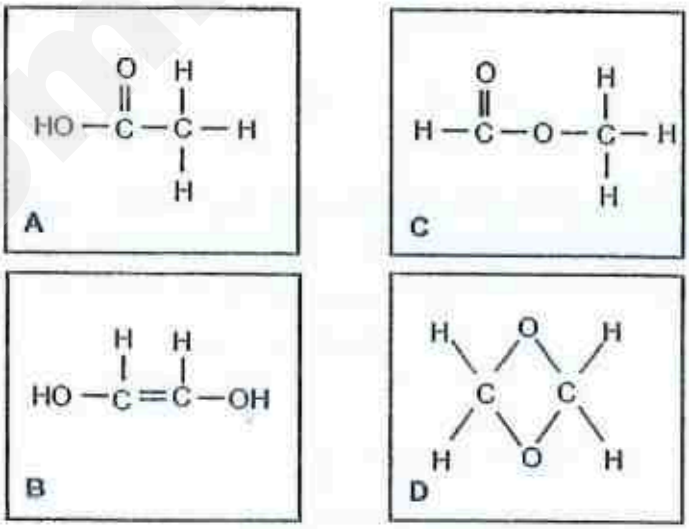
37 A molecule of hydrocarbon, $C_{20}H_{42}$, undergoes cracking to produce a molecule of butane and the rest are ethene molecules. How many ethene molecules are produced?

A 2
B 4
C 8
D 16

38 Which of the following substances will hinder the fermentation of sugars?

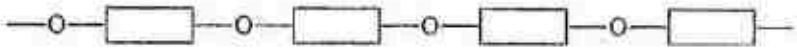
A Yeast
B Oxygen
C Water
D A temperature of 37°C

39 A compound with molecular formula $C_2H_4O_2$ dissolves readily in water to form an aqueous solution. When this aqueous solution reacts with magnesium and limestone respectively, bubbles of colourless gas are observed. What is the structural formula of this compound?

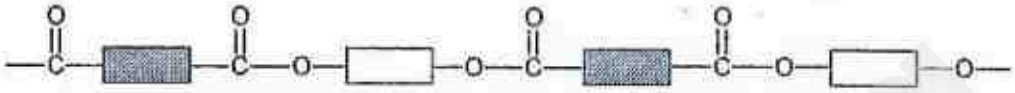


40 Which of the following structures represents nylon?

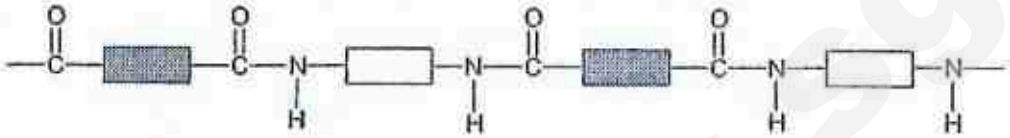
A



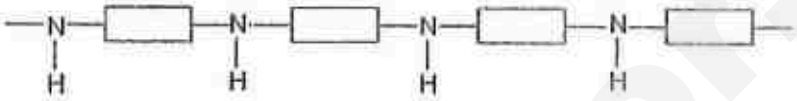
B



C



D



ACS(Independent) Year 4 Express
2017 Prelim Exam

P1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
C	A	C	D	B	D	A	A	D	B	B	C	D	A	B	D	C	D	A	B
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
B	A	C	B	B	A	C	C	D	D	A	B	C	C	D	D	C	B	A	C

NAME: _____ ( ) CLASS: _____

ST JOSEPH'S INSTITUTION

PRELIMINARY EXAMINATION 2017
SECONDARY 4 ('O' Level Programme)

CHEMISTRY 5073 / 01

Paper 1 Multiple Choice

23 August 2017

1 hour

1045 – 1145 h

Additional materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers **A, B, C and D.**
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in the question paper.
The use of an approved scientific calculator is expected, where appropriate.
A copy of the Periodic Table is printed on page 2.

This question paper consists of **24 printed pages** including the Cover Sheet.

[Turn over]

DATA SHEET
The Periodic Table of the Elements

Group

I	II											III	IV	V	VI	VII	0
							H										He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac															

*58-71 Lanthanoid series
190-103 Actinoid series

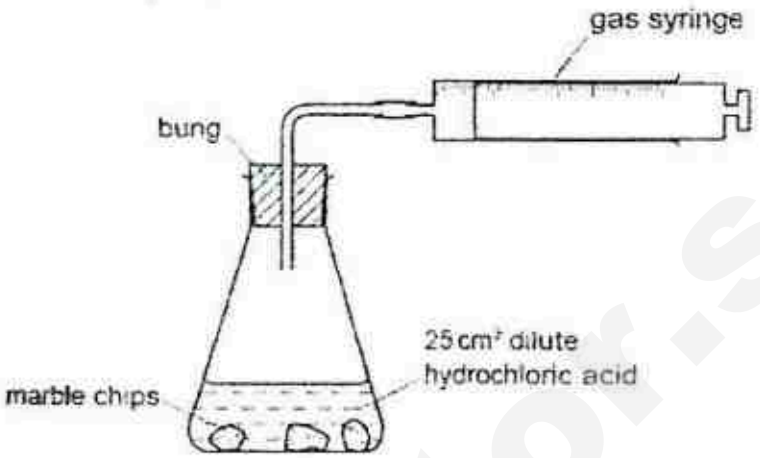
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Key

a X b	a = relative atomic mass X = atomic symbol b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

1 The apparatus shown in the diagram below was set up by Peter to measure the volume of carbon dioxide gas made when different masses of marble chips were added to 25 cm^3 of dilute hydrochloric acid.



Which other apparatus did he use for his experiment?

A Filter funnel and mass balance

B Filter funnel and stopwatch

C Measuring cylinder and mass balance

D Measuring cylinder and stopwatch

2 The table gives data about four substances.
In which substance are the particles closely packed and arranged randomly at room temperature?

Substance	Melting point / °C	Boiling point / °C
A	15	145
B	40	1407
C	-114	-30
D	-20	10

3 The nucleon number and number of electrons of an atom of **X** and an atom of **Y** are shown.

Atom	X	Y
Nucleon number	51	51
Number of electrons	23	27

Which statement about **X** and **Y** is **incorrect**?

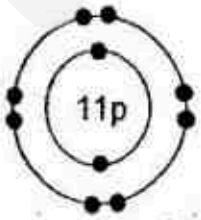
A An atom of **X** has fewer protons than an atom of **Y**.

B An atom of **Y** has fewer neutrons than an atom of **X**.

C **X** is above **Y** in the same group of the Periodic Table.

D **X** is in the same period in the Periodic Table as **Y**.

4 Which of the following statements describes a particle with the following electronic structure?



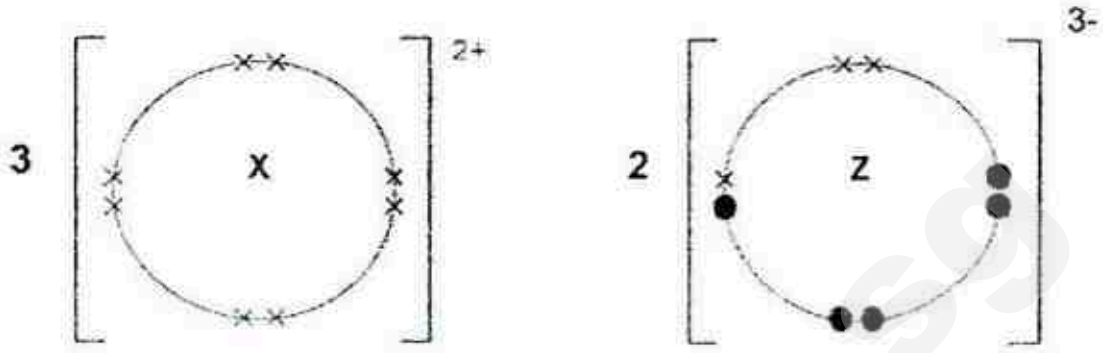
A an anion with an oxidation state of –1

B a cation with an oxidation state of +1

C an atom in the second period

D an inert gas atom

5 The dot-cross diagram (with only the outer electrons) of the compound formed between element **X** and **Z** is shown.



Which of the following is the correct set of formula of the chloride of **X** and **Z**?

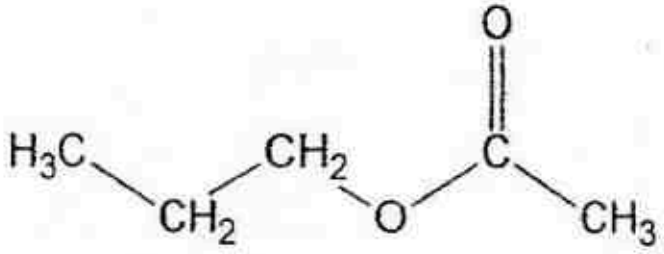
A XCl, Z_3Cl

B XCl, ZCl_3

C XCl_2, Z_3Cl

D XCl_2, ZCl_3

6 The diagram shows the molecule propyl ethanoate.



How many pairs of electrons are used in bonding in the molecule?

A 1

B 7

C 14

D 17

7 The table below shows the physical properties of substances **P**, **Q**, **R** and **S**.

Substance	Melting point /°C	Electrical Conductivity	
		in solid state	in molten state
P	High	Poor	Good
Q	High	Good	Good
R	High	Poor	Poor
S	Low	Poor	Poor

Using the information from the table, which statement is true about substances **P**, **Q**, **R** and **S**?

A Substance **R** consists of weak bonds between the atoms.

B Substance **S** exists in a simple molecular structure.

C Substance **P** contains mobile electrons to conduct electricity when in molten state.

D Substance **Q** consists of strong electrostatic attractions between oppositely charged particles.

8 Chlorine gas is a severe irritant to the eyes and respiratory system. The maximum safe toleration level of chlorine gas in air is 0.005 mg dm^{-3}.

How many molecules of chlorine gas are present in 1 dm^3 of air at the toleration level? (*Note: 1g =1000 mg*)

A $\frac{0.005}{6\times10^{23}}\times71$

B $\frac{0.005}{71}\times6\times10^{23}$

C $\frac{0.005}{1000}\times\frac{1}{71}\times6\times10^{23}$

D $\frac{0.005}{1000}\times71\times6\times10^{23}$

9 Dinitrogen tetroxide, N_2O_4 is a poisonous gas. It can be disposed of safely by reaction with sodium hydroxide. In the experiment, the concentration of aqueous sodium hydroxide used is 1.5 mol/dm^3.

N_2O_4 (g) + 2NaOH (aq) → $NaNO_3$ (aq) + $NaNO_2$ (aq) + H_2O (l)

Which of the following is the least volume of aqueous sodium hydroxide required to dispose of 300 cm^3 of N_2O_4 at room temperature and pressure?

A 10 cm^3

B 20 cm^3

C 200 cm^3

D 600 cm^3

10 Sulfuric acid and nitric acid are both strong acids.
Ethanoic acid is a weak acid.

20.00 cm^3 solutions of 0.10 mol/dm^3 concentration of each of these three acids were separately titrated with a 0.10 mol/dm^3 solution of sodium hydroxide.

In order to react completely

A all three acids would require the same volume of sodium hydroxide solution.

B ethanoic acid and nitric acid would require the same volume of sodium hydroxide solution but sulfuric acid would require more.

C nitric acid would require more sodium hydroxide solution than ethanoic acid but less than sulfuric acid.

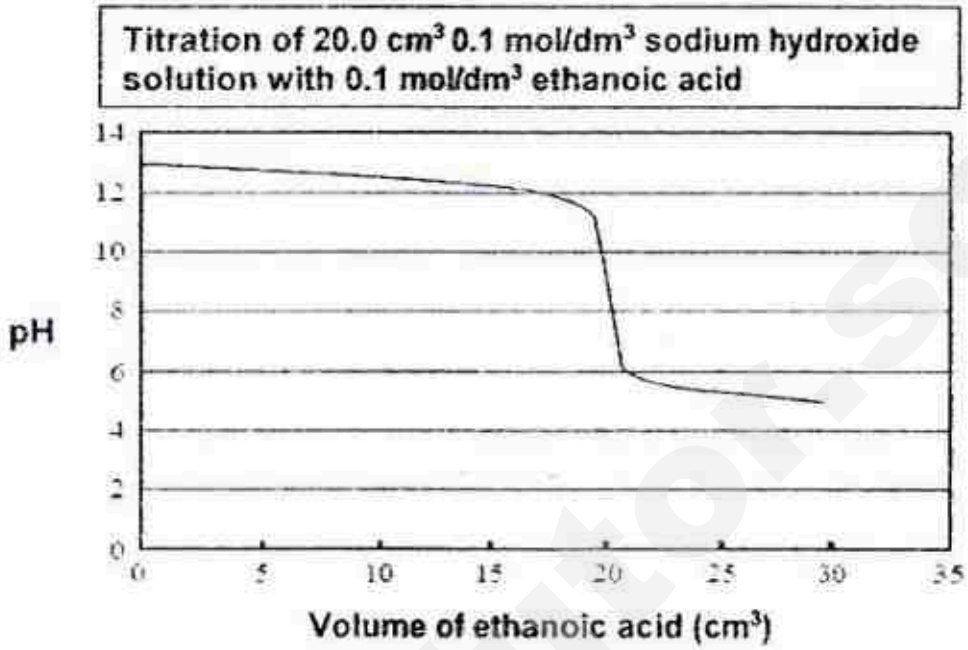
D sulfuric acid and nitric acid would require the same volume of sodium hydroxide solution but ethanoic acid would require less.

11 Solution X and solid Y are mixed in a beaker. After mixing, the final mass of the substances and the beaker is lesser than the initial mass.

What could solution X and solid Y be?

	solution X	solid Y
A	hydrochloric acid	iron(III) hydroxide
B	nitric acid	magnesium oxide
C	potassium hydroxide	ammonium carbonate
D	sulfuric acid	copper

12 The graph below shows the change in pH of a reaction solution during a titration of 0.10 mol/dm^3 sodium hydroxide solution with 0.10 mol/dm^3 ethanoic acid.



Below are the approximate pH changes for a few indicators.

Indicator	Approximate pH range for colour change
Methyl orange	3.2-4.4
Phenolphthalein	8.2-10
Litmus solution	5.5-8.2
Bromocresol green	3.8-5.4

Which indicator is the ***most suitable*** to identify the end point of this titration?

A Bromocresol green

B Litmus solution

C Methyl orange

D Phenolphthalein

13 An excess of sodium hydroxide is added to an aqueous solution of salt L and boiled. Ammonia gas is only given off after aluminium foil is added to the hot solution. What could be salt L?

A Ammonium chloride

B Ammonium nitrate

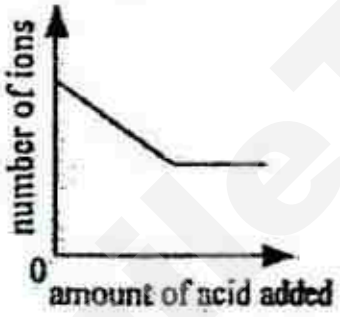
C Sodium chloride

D Sodium nitrate

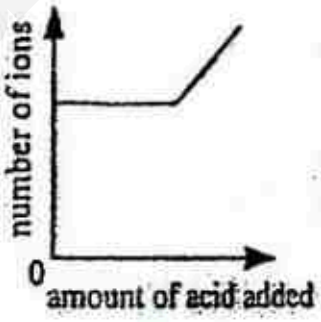
14 Excess dilute sulfuric acid was added to a fixed volume of aqueous barium hydroxide.

Which graph best represents the variation in the total number of mobile ions present in the solution?

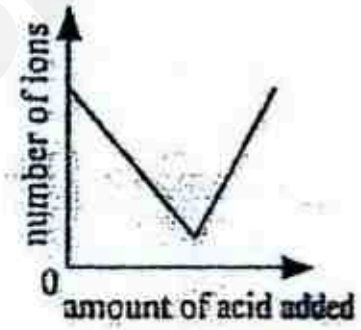
A



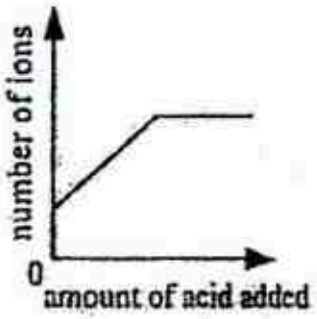
B



C



D



15 Elements **Q**, **X**, **Y** and **Z** are found in consecutive groups of the Periodic Table starting from group IV. They also belong to the same period.
In which molecule are all the outer electrons of the atoms involved in bonding?

A QH_4

B XH_3

C YH_2

D ZH

16 **X** is a Group I element while **Y** is a transition element.
Which of the following states the correct similarity and difference in their properties?

	Similarity	Difference
A	**X** and **Y** have high melting point.	**Y** has higher density than **X**.
B	**X** and **Y** have high melting point.	**Y** is harder than **X**.
C	**X** and **Y** conduct electricity.	**X** is soluble in water while **Y** is insoluble in water.
D	**X** and **Y** form coloured compounds.	**X** does not conduct electricity while **Y** conducts electricity.

17 Adrian carried out four experiments to arrange metals **X**, **Y** and **Z** in order of decreasing reactivity.

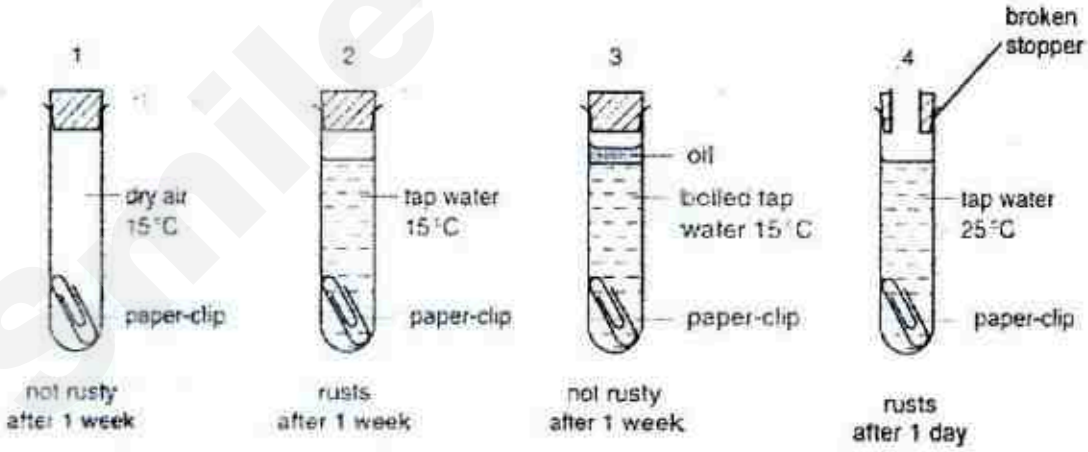
The table shows the results of his experiments:

Experiment	X	Y	Z
Does the metal react with dilute hydrochloric acid?	yes	no	yes
Is the oxide of the metal reduced by heating with carbon?	yes	yes	no

What is the order of reactivity of the metals?

	Most reactive →		Least reactive
A	X	Z	Y
B	Y	X	Z
C	Z	X	Y
D	Z	Y	X

18 Joseph performed four experiments on rusting as shown below.



Which two of these experiments can Joseph use to show that air is needed for iron to rust?

A 1 and 2

B 1 and 3

C 2 and 3

D 2 and 4

19 Which of the following is a redox reaction?

A $NH_3 + H^+ \longrightarrow NH_4^+$

B $N_2 + 3H_2 \longrightarrow 2NH_3$

C $NH_4^+ + Cl^- \longrightarrow NH_4Cl$

D $NH_4^+ + OH^- \longrightarrow NH_4OH$

20 A piece of clean copper wire is suspended in a beaker of aqueous silver nitrate. Crystals of silver are deposited on the copper wire and the solution in the beaker gradually turns blue.

Which deduction is **not** correct?

A Copper is oxidised.

B Silver nitrate is reduced.

C The total number of negative ions in the solution is unchanged.

D The total number of positive ions in the solution is unchanged.

21 Aqueous potassium iodide and acidified potassium manganate (VII) were added to separate samples of hydrogen peroxide.

The observations are summarised in the table.

Reagent added to hydrogen peroxide	Observations
Aqueous potassium iodide	Aqueous potassium iodide turns from colourless to brown
Acidified potassium manganate (VII)	Acidified potassium manganate (VII) turns from purple to colourless.

Which of the following set of properties is correct for the above observations?

	Aqueous potassium iodide	Acidified potassium manganate(VII)
A	Oxidising agent	Reducing agent
B	Oxidising agent	Oxidising agent
C	Reducing agent	Oxidising agent
D	Reducing agent	Reducing agent

22 In the electrolysis of molten aluminium oxide, 4 moles of aluminium ions (Al^{3+}) were discharged at the cathode.

Which one of the following would be discharged by the same amount of electricity?

A 4 moles copper(II) ions (Cu^{2+}) in the electrolysis of aqueous copper (II) sulfate

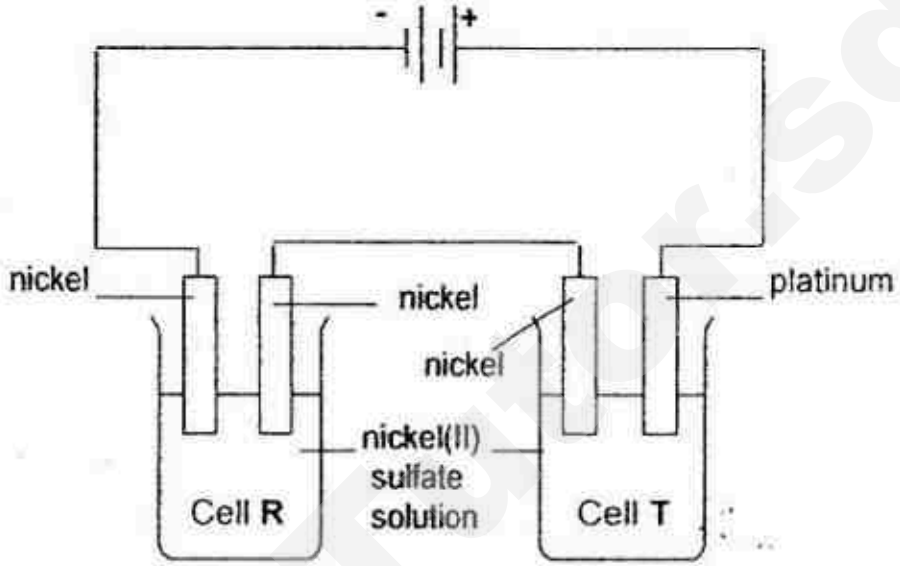
B 6 moles of lead ions (Pb^{2+}) in the electrolysis of molten lead(II) bromide

C 6 moles of silver ions (Ag^{+}) in the electrolysis of aqueous silver nitrate

D 12 moles of zinc ions (Zn^{2+}) in the electrolysis of molten zinc sulfate

23 A current is passed through two electrolytic cells, **R** and **T**, for some time. The electrolyte in both cells is green nickel(II) sulfate solution of the same concentration. Cell **R** has two nickel electrodes, while Cell **T** has a nickel and a platinum electrode.

The results are summarised in the table below.



Cell	Cathode	Anode
R	4.0 g of nickel is deposited.	Nickel dissolves.
T	Nickel is deposited.	Oxygen evolved.

Which statement about the reactions above is **not** true?

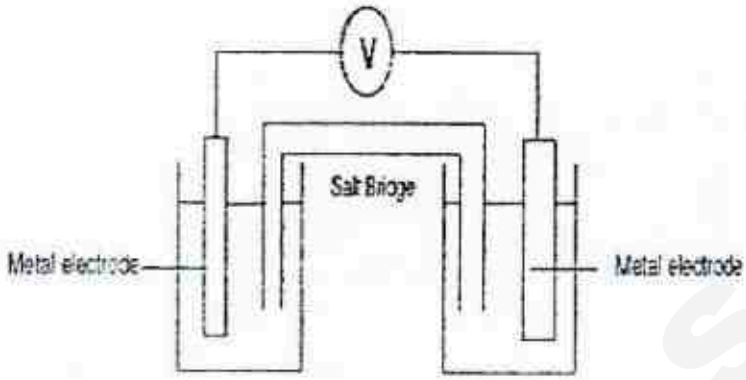
A The oxygen evolved at the anode of Cell **T** burns the platinum.

B The cathode in Cell **R** increases in mass by 4.0 g.

C The concentration of the nickel(II) sulfate solution in Cell **R** remains the same.

D The green colour of the nickel(II) sulfate solution in Cell **T** fades slowly and eventually disappears.

24 Four metals tin, *x*, *y* and *z* were connected in pairs and the voltages were recorded.



The results obtained are shown in the table below:

negative terminal	positive terminal	Voltage (V)
tin	*y*	+ 1.10
x	tin	+ 0.90
z	tin	+ 2.50

What is the order of reactivity of the four metals with the most reactive first?

A *x*, tin, *y*, *z*

B *y*, tin, *x*, *z*

C *z*, tin, *y*, *x*

D *z*, *x*, tin, *y*

25 The table below shows the differences in the composition of the mixtures of exhaust gases from two cars, one fitted with a catalytic converter and one ithout.

	% by volume of nitrogen monoxide	% by volume of carbon dioxide	% by volume of water vapour
Car without catalytic convertor	67.60	12.00	11.00
Car with catalytic convertor	23.60	32.25	41.10

Which statement does **not** explain the differences in the data above?

A The percentage of nitrogen monoxide decreases as it is oxidised to form nitrogen in the catalytic converter.

B The percentage of nitrogen monoxide decreases as it is reduced to form nitrogen in the catalytic converter.

C The percentage of carbon dioxide increases as unburnt hydrocarbons undergo complete combustion in the catalytic converter.

D The percentage of water vapour increases as unburnt hydrocarbons undergo complete combustion in the catalytic converter.

26 To reduce atmospheric pollution, the following waste gases from a coal burning power station are passed through wet powdered calcium carbonate.

How many of the following waste gases will **not** be removed by the wet powdered calcium carbonate?

carbon monoxide	carbon dioxide
nitrogen monoxide	nitrogen dioxide
sulfur dioxide	phosphorus(V) oxide

A 1

B 2

C 3

D 4

27 The enthalpy of vaporization, (ΔH_{vap}) is the amount of energy absorbed to convert one mole of a liquid substance into a gas. The ΔH_{vap} for water is +40.7 kJ/ mol at 100°C and 1 atm.
Which of the following statements is true?

A The ΔH_{vap} for water is positive as energy is absorbed to break O-H bonds.

B 226 kJ of heat is absorbed to convert 100g of water into steam at 100°C and 1 atm

C Less than 226 kJ of heat is absorbed to convert 100g of water at 25°C into steam at 1 atm.

D Energy is absorbed to transform water molecules vibrating in fixed positions into molecules moving randomly at high speeds.

28 Which of the following processes are exothermic in nature?

I. Rusting of iron metal
II. Neutralisation of butanoic acid with alkali
III. Thermal decomposition of calcium carbonates
IV. Breaking down of hydrogen chloride into its constituent atoms
V. Combustion of sulfur to form an acidic gas

A I,II and III

B I, II and V

C I, II, III, IV

D All of the above

29 A piece of zinc foil dissolved completely in 20 cm^3 of a dilute sulfuric acid solution, and the volume of hydrogen evolved was noted at equal, short time intervals.

Another piece of zinc foil of the same surface area and mass was added to 40 cm^3 of the same solution of dilute sulfuric acid.

How will the initial rate of reaction and the total volume of hydrogen evolved in this second experiment compare to the first experiment?

	initial rate of reaction	total volume of hydrogen evolved
A	no change	Increase
B	no change	no change
C	increase	no change
D	increase	increase

30 When sodium thiosulfate reacts with dilute hydrochloric acid, a fine suspension of sulfur is formed.

An experiment was carried out at various temperatures and the time taken for the suspension to appear was recorded in the table below.

Temperature / °C	Time taken / s
30	97
35	52
40	42
50	24

Which one of the following conclusions about the experiment can be drawn from the above table?

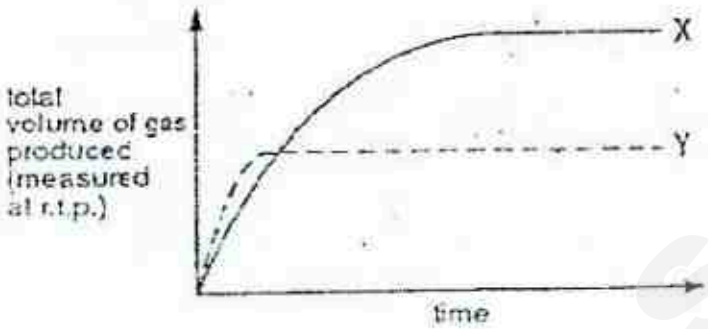
A The shorter the time taken, the higher the temperature rise of the reaction.

B The longer the time taken, the lower the temperature rise of the reaction.

C The higher the temperature, the lower the rate of formation of sulfur.

D The higher the temperature, the higher the rate of formation of sulfur.

31 In the graph shown below, curve **X** represents the result of the reaction between 2.5g of magnesium ribbon and 50 cm^3 of 1 mol/dm^3 sulfuric acid at 50°C.



Which reaction could produce curve **Y**?

A 2.5g of magnesium powder at 50°C

B 2.5g of magnesium ribbon at 60°C

C 12.5 cm^3 of 2 mol/dm^3 sulfuric acid at 60°C

D 25 cm^3 of 2 mol/dm^3 sulfuric acid at 50°C

32 Which statement about speed of reaction is correct?

A Increasing the concentration of a reactant increases the speed because there are more rapidly moving particles.

B Increasing the size of particles of a solid increases the speed because there are more particles.

C Increasing temperature increases the speed because it increases the number of particles.

D Increasing temperature increases the speed because there are more collisions.

33 Why is it wasteful to add ammonium nitrate fertiliser to soil which has recently been treated with slaked lime?

A Ammonium nitrate can be easily decomposed.

B Ammonium nitrate will react with slaked lime and ammonia is released into the air.

C Slaked lime has made the soil too basic for ammonium nitrate to be useful.

D The percentage by mass of nitrogen in ammonium nitrate is low.

34 Which of the following statements about alkanes and alkenes is true?

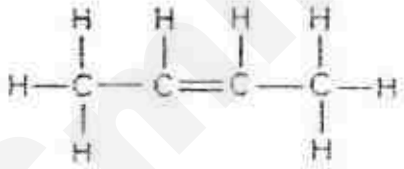
A Alkanes are unsaturated but alkenes are saturated.

B Alkanes undergo substitution while alkenes undergo addition.

C Alkanes and alkenes belong to the same homologous series.

D Alkanes have a higher percentage composition of carbon than the corresponding alkene.

35 The structure of but-2-ene is as shown. But-2-ene undergoes an addition reaction with hydrobromic acid, HBr in a similar way that it reacts with bromine.



Which of the following statements is true about the reaction between but-2-ene and HBr?

A The product is a mixture of two structural isomers

B Both the reactants and products are unsaturated.

C The product has a higher boiling point than the reactant.

D The product can undergo addition reaction with hydrogen.

36 An open can of beer is left exposed to the air for several days and was found to acquire a sour taste. Which of the following statements best explains this phenomenon?

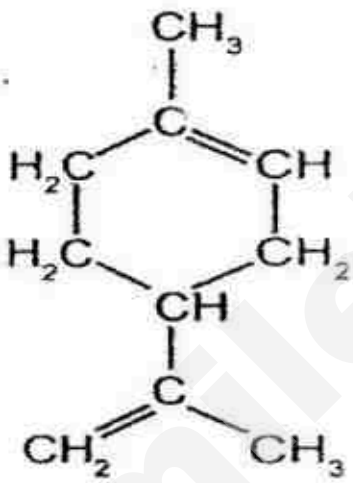
A The fermentation of glucose takes place in the can of beer.

B The oxidation of ethanol occurs to form ethanoic acid.

C The decomposition of carbohydrates in the beer occurs to form ethanoic acid.

D Carbon dioxide from the fermentation reacts with water to form carbonic acid.

37 The smell in citrus fruits is due to an organic compound, limonene, found in them. Which of the following statements apply to limonene?



I. Limonene undergoes addition polymerisation.
II. Limonene decolourises brown bromine water.
III. Limonene is saturated hydrocarbon.
IV. Limonene reacts with excess hydrogen gas to form a saturated product.
V. Limonene reacts with steam under suitable conditions to form an acid.

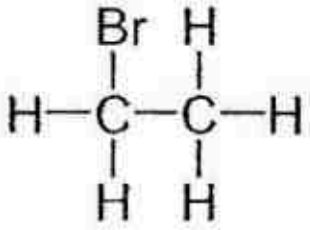
A I, II, IV

B II,IV, V

C I,II, III, V

D All of the above.

38 Ethane undergoes substitution reaction with bromine gas under certain conditions to form bromoethane.



Which of the following statements about the above reaction is true?

A The reaction should be carried out at room temperature in darkness.

B The side product of this reaction is hydrogen bromide, HBr.

C There are two possible isomers of bromoethane.

D A suitable solvent for the reactant mixture is water.

39 Which of the following physical property of the alcohols increases when the number of carbon atoms increases?

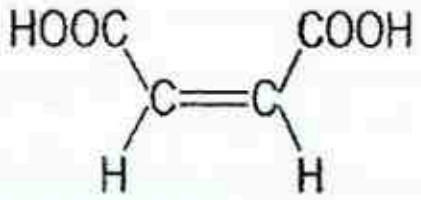
A Boiling Point

B Fluidity

C Flammability

D Water solubility

40 The structure shown below is maleic acid. It can be used as a monomer to make polymers. Which of the following statements is true?



A It can undergo addition polymerisation with $HN_2CH_2CH_2NH_2$.

B It can undergo condensation polymerisation with $HOCH_2CH_2OH$.

C When maleic acid undergoes addition polymerisation, it loses water molecules.

D When maleic acid undergoes condensation polymerisation, polymaleic acid is formed.

SJI Chemistry 5073 2017
Marking Scheme:
Paper 1:

1	C	21	C
2	A	22	B
3	C	23	A
4	B	24	D
5	D	25	A
6	D	26	B
7	B	27	B
8	C	28	B
9	B	29	B
10	B	30	D
11	C	31	C
12	D	32	D
13	D	33	B
14	C	34	B
15	A	35	C
16	C	36	B
17	C	37	A
18	C	38	B
19	B	39	A
20	D	40	B

南 华 中 学

NAN HUA HIGH SCHOOL

2017 PRELIMINARY EXAMINATIONS

Name: _____ ( )

Subject	:	**Chemistry**
Paper	:	**5073/02**
Level	:	**Secondary Four Express**
Date	:	**14 September 2017**
Duration	:	**1 hour 45 minutes**

INSTRUCTIONS TO CANDIDATES

Write your name, class and index number on the cover page.

Write in dark blue or black pen on both sides of the paper.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

SECTION A
Answer all questions in the spaces provided.

SECTION B
Answer all three questions, the last question is in the form either/or.

Answer all questions in the spaces provided.

INFORMATION FOR CANDIDATES

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 26.
The total of the marks for this paper is 80.

For Examiner's Use	
Section A	
B11	
B12	
B13	
Total	

This paper consists of 26 printed pages.

Section A

Answer **all** the questions in this section in the spaces provided.
The total mark for this section is 50.

A1 P, Q, R, S and T are elements. [5]

- P is a halogen which is a black solid at room temperature.
- Q is an alkali metal which displaces sodium from its salt solution.
- R is a transition metal that forms an anion of the type RO_4^-.
- S is a non-metal that conducts electricity.
- T is a non-metal that has a maximum oxidation state of +7.

Give the chemical symbols of P, Q, R, S and T.

P: _____

Q: _____

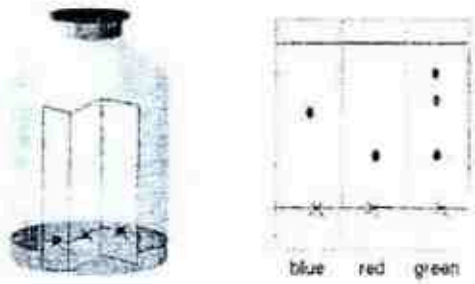
R: _____

S: _____

T: _____

[Total: 5]

A2 Paper chromatography was used to separate 3 food colourings which are very soluble in ethanol, but only slightly soluble in water. The experiment was allowed to run for 10 minutes with water as a solvent, and the result obtained is shown below.



a) What is the purpose of the plastic cover on the bottle? [1]

_____

b) Describe the effect on the R_f value of the dyes if

i) the paper used for the experiment was twice the length. [1]

_____

ii) the solvent was changed to ethanol. [1]

_____

c) The blue dye in the chromatogram has the formula $KFe[Fe(CN)_6]$, which consists of potassium ions, iron ions and $Fe(CN)_6^{3-}$ ions (which are slightly yellow in colour).

When a moist chromatogram containing the blue dye is electrolysed, a faint spot migrates to each electrode as seen in the diagram below.

i) State the charge of iron ions found in the blue dye. [1]

_____

ii) Is the blue dye a mixture or a compound? Justify your answer using information from the paper chromatography and electrolysis experiments. [2]

_____

_____

_____

[Total: 6]

A3 A series of experiments was carried out on an element **T**. It is found that **T** can conduct electricity in the solid state, under room conditions. It dissolves very readily in water to form alkaline solutions.

a) Draw a diagram to represent the structure of **T**. [2]

b) Draw a "dot-and-cross" diagram of the sulfide of **T**. [2]

[Total: 4]

A4 a) ^{16}O and ^{18}O are isotopes of oxygen. Complete the table below. [2]

Formula	Number of protons	Number of neutrons	Number of electrons
^{16}O	8		8
$^{18}O^{2-}$		10	
$^{18}O_2$		20	16

bi) To study the reaction between carboxylic acids and alcohols, ethanol was added to propanoic acid and heated with concentrated sulfuric acid. The oxygen atoms in ethanol are made of the heavy oxygen isotope, i.e. ^{18}O. [2]

Draw the organic product formed during this reaction, and mark the heavy oxygen atom with a '*'.

ii) The ethanol used in (i) can be made by fermentation of glucose. Explain why fermentation alone is not used to produce most of the ethanol used in industry. [1]

_____

_____

[Total: 5]

A5 Propane and methane are sometimes transported in the liquid state.

Substance	Melting point/°C	Boiling point/°C	Where transported as a liquid
Propane	-188	-42	In ships
Methane	-182	-162	In road tankers and ships

Propane is transported as a liquid at room temperature by keeping it under pressure. It is not practical to keep methane liquid in a tanker by the same method.

a) Suggest how methane is kept as a liquid in a tanker. [1]

_____

_____

b) In terms of arrangement and movement of particles, describe the changes when methane turns from gas to liquid. [2]

_____

_____

_____

[Total: 3]

A6a) If concentrated acid is spilled onto the skin of someone on the streets, it must be washed as quickly as possible by lots of running water. Give 1 reason why water is used in this case, instead of a solution of potassium hydroxide. [2]

b) Outline the procedure involved in disposing of concentrated acid spilled on the street without leaving excess alkaline solution. Describe how total acid removed is ensured. [2]

ci) State whether the following statement is true or false and explain your answer: [1]
*"Given same concentration of acid **X** and **Y**, if **X** is a stronger acid than **Y**, then the pH of an aqueous solution of **X** must be lower than that of **Y**."*

ii) Describe a simple test to differentiate between **X** and **Y**. [1]

[Total: 6]

A7 This question is about making salts. For each salt, suggest the name of the missing reagent and briefly describe how to obtain the solid product from the reaction mixture. [4]

a) Salt to be made: caesium chloride.

Reagent 1: dilute hydrochloric acid

Reagent 2: _____

I could obtain solid caesium chloride by:

_____

_____

b) Salt to be made: iron(II) sulfate crystals.

Reagent 1: dilute sulfuric acid

Reagent 2: _____

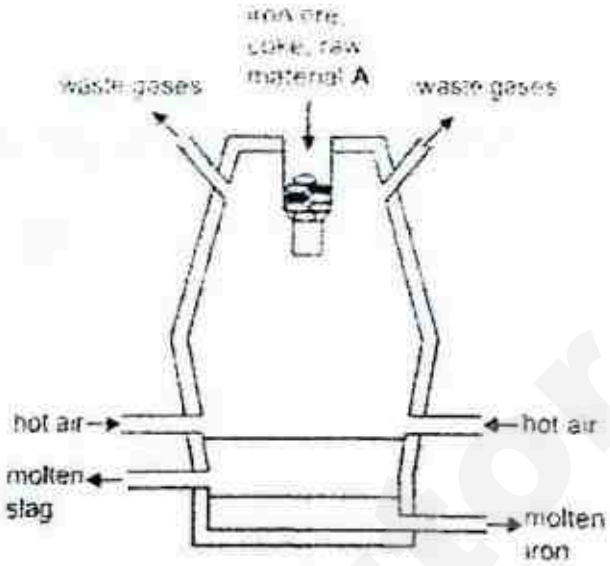
I could obtain iron(II) sulfate crystals by:

_____

_____

[Total: 4]

A8 The diagram below shows the Blast Furnace.



a) Identify raw material A and explain why it is added to the blast furnace. [2]

_____

_____

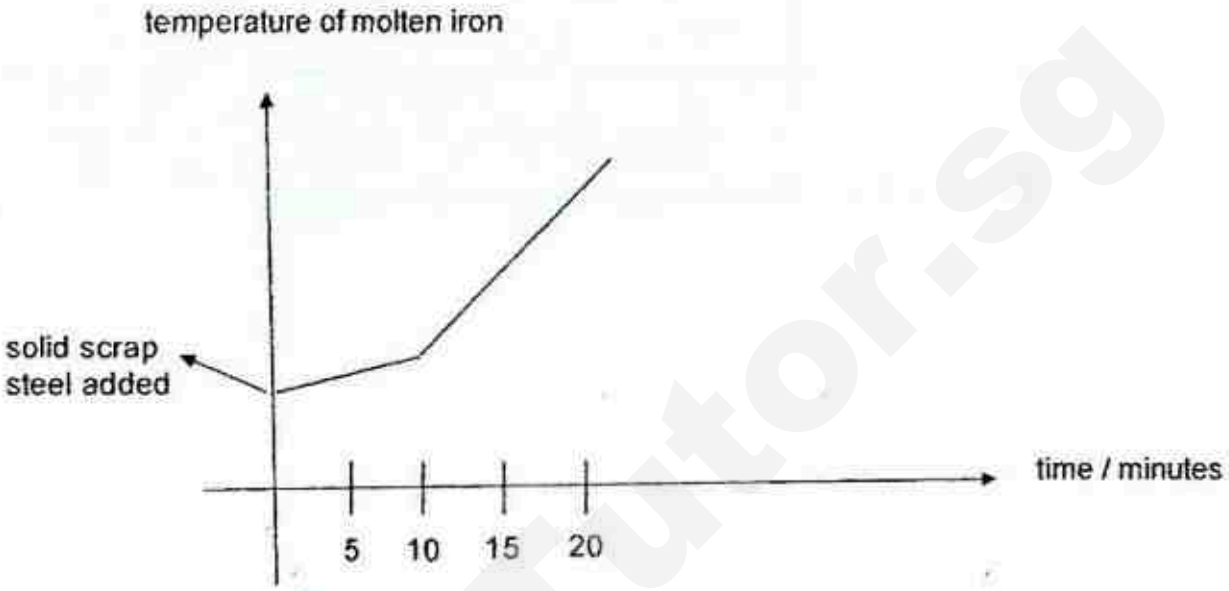
b) Iron produced from the blast furnace is impure as it contains carbon as impurities. In order to get rid of the carbon, oxygen is blown on the molten iron. Carbon dioxide is then produced. [1]

As the oxygen is blown into it, the temperature of the molten iron rises. Explain this observation.

_____

_____

c) To recycle iron, scrap steel is added to the molten iron produced from the blast furnace. The graph below shows the changes in temperature of the molten iron during the oxygen blow. [2]



Describe how the temperature of the molten iron changes during the oxygen blow. Suggest a reason for the change.

_____

_____

d) Silicon can be added to iron to make electrical steel. The table below shows the types of electrical steel and their composition.

Steel type	Composition
1	1.1% Si
2	2.3% Si

Sketch diagrams to illustrate the arrangement of atoms in: [3]

i) Steel Type 1.

ii) Steel Type 2

[Total: 8]

A9 Titanium can be manufactured by heating titanium(IV) chloride with magnesium.

a) Construct the equation for this reaction. [1]

_____

b) Explain why this reaction involves both oxidation and reduction. [2]

_____

_____

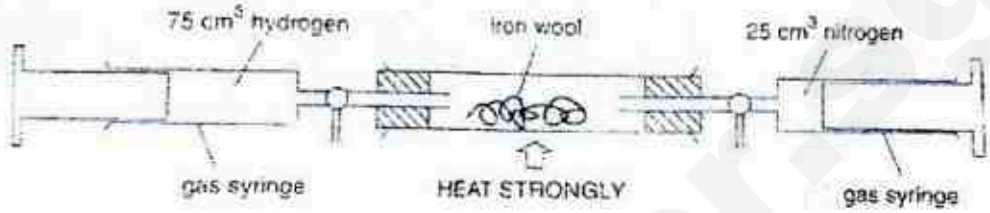
c) What mass of titanium can be made from 125g of titanium(IV) chloride? [2]

[Total: 5]

A10 Ammonia is manufactured by reacting a mixture of nitrogen and hydrogen together in the Haber Process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The reaction can be demonstrated in the laboratory by the method shown in the diagram.



The mixture of nitrogen and hydrogen is passed backwards and forwards over the hot iron wool until there is no further reaction. The iron wool is heated to the same temperature as the iron used in the industrial process.

a) State a source of hydrogen. [1]

_____

_____

b) Suggest why it is important that no air is to be present in the apparatus when the iron is heated. [1]

_____

ci) In the industrial process, a yield of 15% is obtained. If the same percentage conversion takes place in the laboratory demonstrations, what volume of ammonia (measured at r.t.p.) would be produced? [1]

cii) How would you expect the actual volume of ammonia produced in the laboratory demonstration to compare with the calculated volume in c(i)? Explain your answer. [1]

_____

_____

[Total: 4]

Section B

Answer all **three** questions from this section.
The last question is in the form of either/or and only one of the alternatives should be attempted.

B11 The Green Vehicle Trend

All-electric car

Electricity has been explored as an alternative power source to replace or complement the internal combustion engine for decades. There are two types of electrically powered vehicles, including, hybrid cars and electric cars.

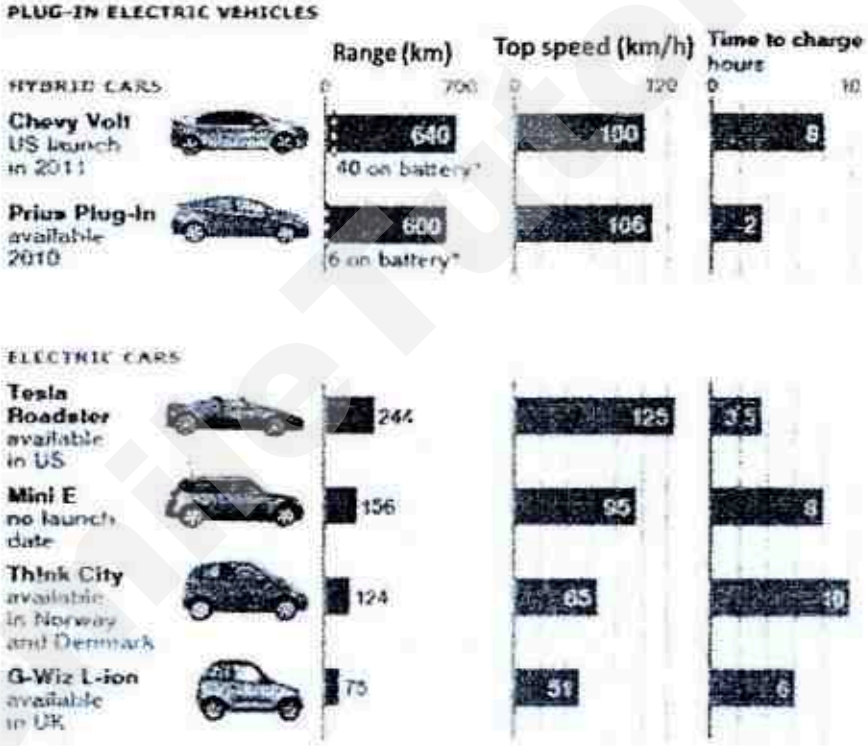


Figure 1: The performances of new electric vehicles (Source: Madslien, 2009)

Fuel Consumption Reduction

Hybrid systems can reduce fuel consumption and CO_2 emissions by up to 35%, equivalent to more than a 50% increase in fuel economy.

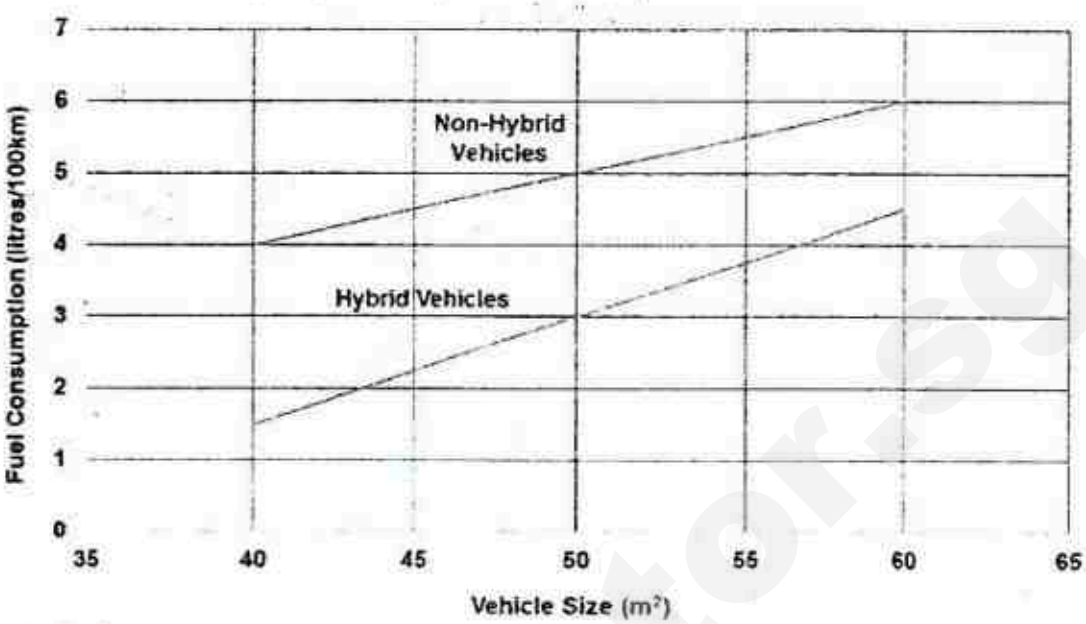


Figure 2: A graph of fuel consumption against vehicle size (footprint) for current hybrid and non-hybrid models (Source: U.S. EPA's 2014 Fuel Economy Trends Report, 2014)

Nickel Metal Hydride (NiMH) Battery in Electric Cars

The principles in which NiMH cells operate are based on their ability to absorb, release, and transport (move) hydrogen between the electrodes within the cell. The following sections will discuss the chemical reactions occurring within the cell when charged and discharged.

Charging Chemical Reaction

An aqueous solution of potassium hydroxide is the major component of the electrolyte of a nickel metal hydride battery. When a NiMH cell is charged, the positive electrode releases hydrogen into the electrolyte. The hydrogen in turn is absorbed and stored in the negative electrode. The reaction begins when solid nickel hydroxide ($Ni(OH)_2$) in the positive electrode and hydroxide (OH^-) from the electrolyte combine. This produces solid nickel oxyhydroxide (NiOOH) within the positive electrode, water (H_2O) in the electrolyte, and one free electron (e^-). At the negative electrode the metal alloy (M) in the negative electrode, water (H_2O) from the electrolyte, and an electron (e^-) react to produce aqueous metal hydride (MH) in the negative electrode and hydroxide (OH^-) in the electrolyte.

Because heat is generated as a part of the overall chemical reaction during the charge of a NiMH cell, the charging reaction described above is exothermic.

Discharge Chemical Reaction

When a NiMH cell is discharged, the chemical reactions are the reverse of what occurs when charged. Hydrogen stored in the metal alloy of the negative electrode is released into the electrolyte to form water. This water then releases a hydrogen ion that is absorbed into the positive electrode to form nickel hydroxide.

For NiMH cells, the process of moving or transporting hydrogen from the negative electrode to the positive electrode absorbs heat and is therefore endothermic.

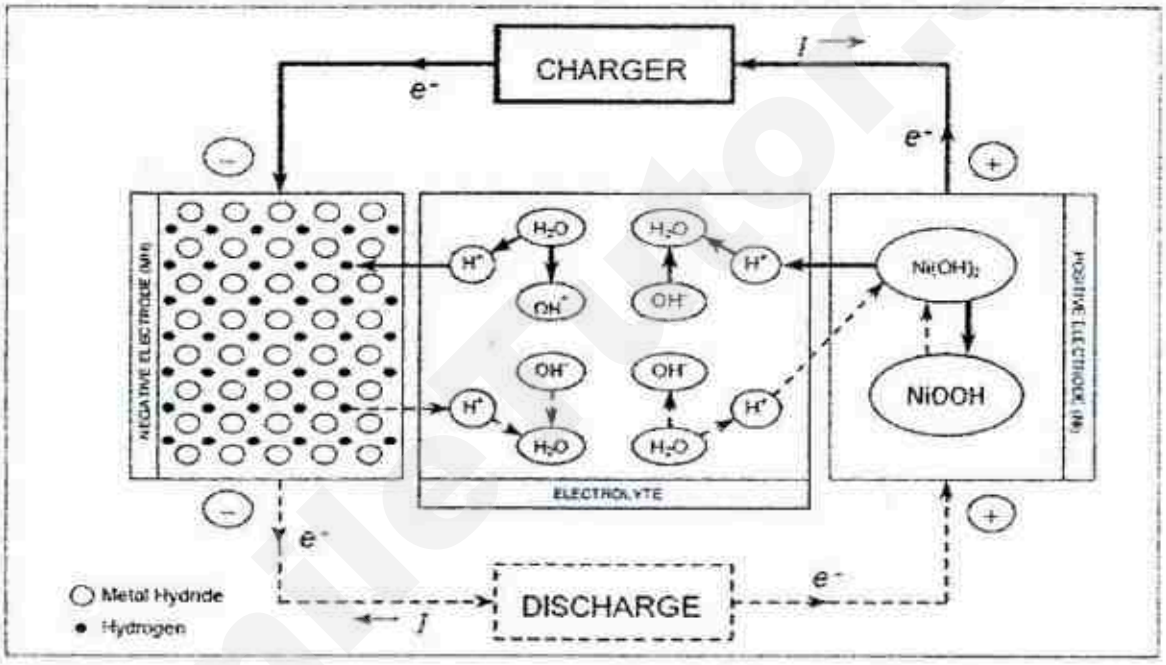


Figure 3: Transport Diagram

a) State the name of the electric car that covers the least distance per hour of charging. [1]

_____

bi) Deduce the relationship between fuel consumption and the size of a vehicle. [1]

_____

_____

ii) Do hybrid cars or non-hybrid cars consume more fuel for the same vehicle size? Use information to support your answer. [2]

_____

_____

_____

c) The electrolyte used in the Nickel Metal Hydride (NiMH) batteries is an aqueous solution of potassium hydroxide. [2]

Briefly explain why aqueous potassium hydroxide is used as the electrolyte and not pure water.

_____

_____

_____

di) Write ionic equations for the reactions at the positive and negative electrodes when the NiMH cell is charging. [2]

At the positive electrode:

_____

At the negative electrode:

_____

ii) Hence, construct the overall equation for the charging process. [1]

_____

iii) What happens to the concentration of nickel hydroxide during the charging process? Explain your reasoning. [1]

_____

_____

e) State one difference between a NiMH cell and an electrolytic cell. [1]

_____

_____

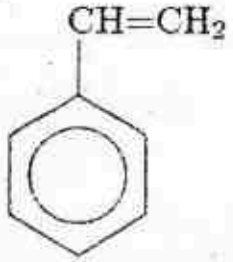
f) Explain why it is not advisable to overcharge NiMH cells. [1]

_____

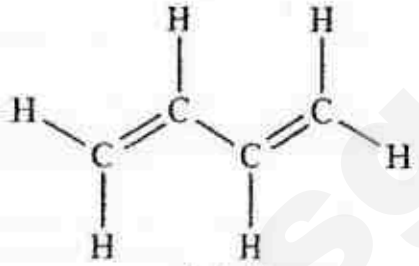
_____

[Total: 12]

B12a) Styrene-butadiene rubber is a synthetic rubber. It is produced by polymerising a mixture of the monomers styrene and butadiene.



Styrene (C_8H_8)



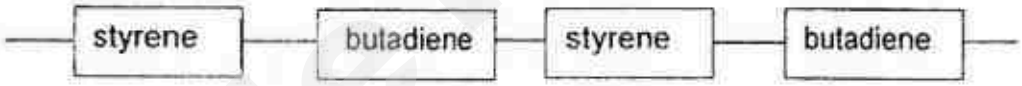
Butadiene

a) Butadiene is said to be a polyunsaturated compound. Explain what is meant by 'polyunsaturated'. [1]

_____

_____

b) One possible structure for the polymer is shown below.



i) Give the structural formula of 1 repeating unit in this polymer. [2]

ii) During the manufacturing process, the chain length of the polymer is controlled so that the polymer molecules have an average relative molecular mass in the range 13000 to 20000. What is the range of the average number of repeating units in the polymer? [2]

Show your working.

iii) When the mixture of styrene and butadiene polymerises, the polymer is unlikely to contain only this regular, repeating pattern. Explain why this is impossible. [1]

_____

_____

c) Butadiene can be made by cracking butane in a cracking tower. Butane cracks to form butadiene and one other product. Write an equation for this reaction. [1]

_____

d) Hydrogen was added to a sample of styrene at 200°C with nickel catalyst. Draw a product that can be formed in this reaction. [1]

[Total: 8]

B13 **EITHER**

a) A student performed an experiment to investigate the rate of reaction between zinc and an acid. 5 g of zinc granules was added to a conical flask containing 100 cm^3 of 2 mol/dm^3 hydrochloric acid at 25 °C. Calculate the mass of zinc chloride formed in this reaction. [2]

b) A standard solution was prepared by dissolving 2.12g of anhydrous sodium carbonate in distilled water and making up to a total of 250 cm^3. [3]

A 25.0 cm^3 portion of this solution was titrated against hydrochloric acid solution, using methyl orange as indicator. This indicator changes colour when sodium carbonate has been completely converted into sodium chloride.

20 cm^3 of the acid were required for neutralization. What is the concentration of the acid?

ci) Three beakers containing the following acid solutions were prepared.

Beaker **A** : 50 cm^3 of 1.0 mol/dm^3 hydrochloric acid
Beaker **B** : 50 cm^3 of 1.0 mol/dm^3 sulfuric acid
Beaker **C** : 50 cm^3 of 1.0 mol/dm^3 ethanoic acid

0.48 g of magnesium was added to each beaker. Arrange the beakers in order of decreasing rate of reaction and explain why the rate of reaction differs in each beaker. [3]

_____

_____

_____

_____

ii) A student mentioned: [2]

"*Sulfuric acid produced greater mass of gaseous products than the other 2 acids when reacted with 0.48 g of magnesium*".

Do you agree with this statement? Explain why you agree or disagree with the help of balanced chemical equations and working(s).

[Total: 10]

B13 **OR**

a) The volume of sulfur dioxide in air can be determined by bubbling a sample of the air through sodium hydroxide solution, where it reacts according to the equation below.

$$SO_2\ (g) + 2NaOH\ (aq) \rightarrow Na_2SO_3\ (aq) + H_2O\ (l)$$

The concentration of the unreacted sodium hydroxide can be determined by titration against a standard solution of hydrochloric acid.

1000 dm^3 of air were bubbled through 200 cm^3 of 1 mol/dm^3 solution of sodium hydroxide. The resulting solution was diluted to 1000 cm^3 with water and 25.0 cm^3 of this solution was neutralized by 20.0 cm^3 of a 0.1 mol/dm^3 solution of hydrochloric acid.

i) Calculate the total number of moles of unreacted sodium hydroxide. [1]

ii) Find the number of moles of sulfur dioxide in 1000 dm^3 of air. [2]

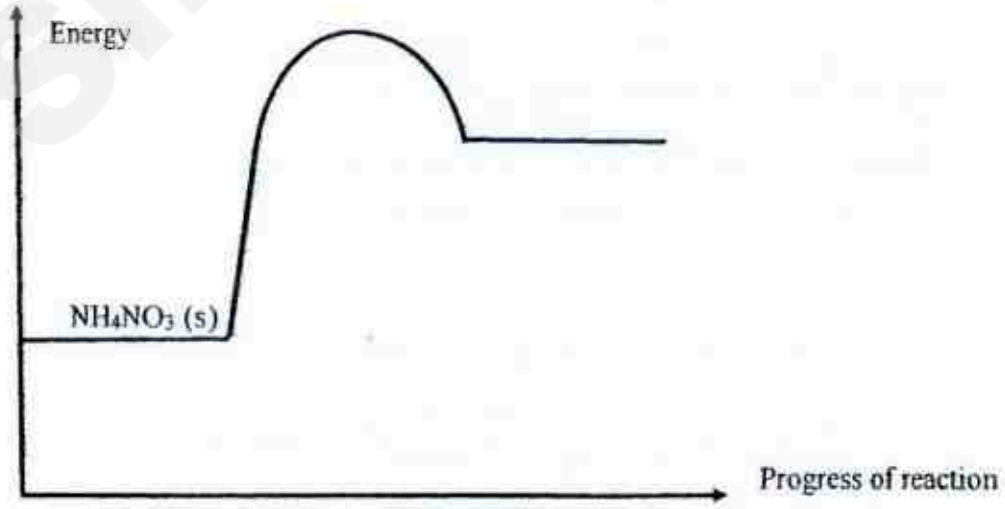
iii) Calculate the percentage by volume of sulfur dioxide in the air at room temperature and pressure. [2]

b) A typical cold-pack consists of ammonium nitrate and water. They are stored in separate compartments. To make the cold-pack work, we need to twist the pack so that the inner membrane breaks. [2]

i) If a cold pack consists of 0.1 kg of ammonium nitrate, the maximum amount of heat that it can absorb during activation is 31.9 kJ. Calculate the enthalpy change in dissolving 1 mole of ammonium nitrate.

ii) Draw the energy profile diagram when 1 mole of ammonium nitrate is dissolved in water. Your diagram should show and label the following: [3]

- product
- activation energy of reaction
- enthalpy change of reaction.



5073 CHEMISTRY GCE ORDINARY LEVEL (2017)

The Periodic Table of the Elements

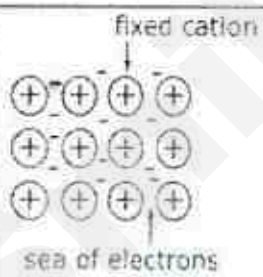
Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

NHHS 2017 Secondary Four Chemistry Prelim 2 Paper 2

Qn	Answer	Mark
A1	P: At / I or At_2 / I_2 Q: K / Fr / Cs / Rb R: Mn S: C / Si T: Cl / Br / I / At	1m each
		Total: [5]
A2a)	To keep atmosphere in jar saturated (with solvent vapour) allow: To **reduce / prevent solvent/water evaporation**	[1]
bi)	R_f values would **remain the same** / no change / no effect	[1]
ii)	R_f values would **increase** (because the dyes are readily soluble in ethanol)	[1]
ci)	2+ or (+2)	[1]
ii)	The blue dye is a **compound**. It **cannot be separated by paper chromatography / has only 1 spot on chromatogram**. (1m) Its components **can be separated by electrolysis / to give two substances/spots**. (1m) -1m for "dot"	[2]
		Total: [6]
A3 (a)	 Regular closely packed cations in sea of electrons (some e^- drawn must be in between cations) – 1m Balance charges – 1m -1m for wrong labelling	[2]
(b)	1m – correct number of electrons transferred & total number of electrons 1m – correct charge on ions & correct number of ions (accept: all Group I, Ca, Sr, Ba, Ra for T)	[2]
		Total: [4]

A4a)		[2]

Formula	Number of protons	Number of neutrons	Number of electrons
^{16}O	8	8	8
$^{16}O^{2-}$	8	10	10
$^{16}O_2$	16	20	16

1 correct is 0m

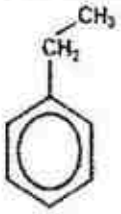
2 or 3 correct is 1m

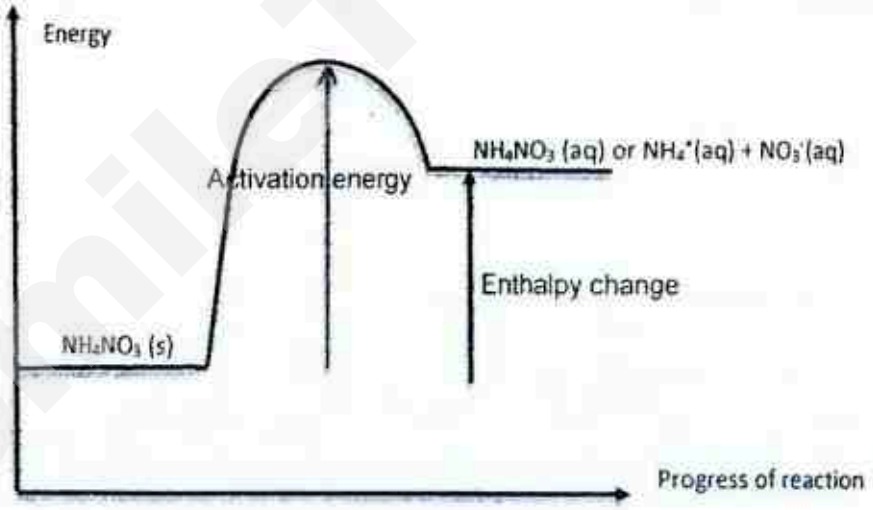
bi)		[2]
ii)	When the **concentration of ethanol exceeds 15% / high concentration of ethanol**, the **yeast dies/stop working/denatured** and fermentation stops. Or Because the **ethanol** produced is **too dilute/cannot meet the demand**, hence **require fractional distillation** instead of just fermentation alone Or Fermentation alone **cannot meet the demand** in the industry, therefore **hydration of ethene** is also used to produce ethanol.	[1]
		Total: [5]
A5a)	By cooling it **below -162°C** (and above -182°C), where it is in the liquid state.	[1]
b)	Arrangement: Particles are closer together/very far apart to more closely packed in a disorderly/irregular/random manner. [1] Movement: The particles move rapidly in any direction to move freely throughout the liquid or slide over each other / particles move slower [1]	[2]
		Total: [3]
A6a)	(Any one) • KOH can be used to neutralise the acid but much heat will be generated/produced during the neutralisation reaction(1m) and this heat can damage the skin. Heat is also generated during the process of dilution but if large volume of water are used, most of this heat is absorbed by the water (1m). *Accept similar phrasing* or • KOH can be used to neutralise the acid but excess of KOH is corrosive/alkaline (1m) to the skin and it would be hard to estimate when	[2]

	one has used just enough for the task. There is no problem with using excess of water, as water is not corrosive/is neutral(1m).	
b)	• Add $CaCO_3$/ any **insoluble** carbonate/ CaO/ any **insoluble** base(1m) powders to soak up the spilled liquid and thus prevent it from spreading (unlike liquid bases). • Also, when reagent is added in excess OR continuously until effervescence stops/solid does not decrease in size anymore (due to the formation of CO_2 with the acid), this indicated that neutralisation is complete (1m) and total acid removal is ensured.	[2]
ci)	True. "**X** is stronger than **Y**" only means the degree of ionisation of X is higher than that of Y. pH of an acid solution depends on the degree of ionisation/dissociation(1m) or X dissociates **more** completely in water than Y to produce H^+, or X has a higher concentration of H^+ than Y.	[1]
ii)	Use universal indicator. If UI turns from green solution to yellow/orange, the acid is Y. If UI turns from green solution to red, the acid is X. Accept pH meter (pH of Y>pH of X)	[1]
	Total: [6]	
A7a) b)	(Aqueous) caesium hydroxide/ caesium carbonate (solution) (1m) Evaporate/heat the caesium chloride solution until it is saturated. Allow the saturated solution to cool so that the salt can crystallise. (1m) Iron(II) oxide/ iron(II) hydroxide/ iron(II) carbonate/ iron (1m) Filter to remove the excess iron(II) oxide/ carbonate/ hydroxide/ iron, collect the filtrate/aqueous iron(II) sulfate. Heat the solution/filtrate until it is saturated and leave it to cool and crystallise.(1m) Wrong reagent 0m	[4]
	Total: [4]	
A8a)	Limestone/calcium carbonate/$CaCO_3$. [1] When heated, it produces calcium oxide, which is basic and removes acidic impurities/sand/SiO_2. [1]	2
b)	Oxidation of carbon is exothermic/heat is produced. Penalise for "Combustion of C"	1
c)	From t=0 to t = 10minutes, the temperature of molten iron increases slowly. From t=10 minutes onwards, the temperature of molten iron **increase** was **faster**. [1] Heat used to melt scrap steel but after 10min, **all the scrap steel had melted**. [1]	2
d)	1m - disruption 1m - size of atoms (Iron is bigger than silicon) + closely packed	3

	1m – di) minimum ratio 1:10 dii) minimum ratio 1:5 Penalise 1m for missing/incorrect label	
		Total: [8]
A9a)	$TiCl_4 + 2Mg \rightarrow 2MgCl_2 + Ti$	1
b)	Reduction because Ti^{4+} ions gain electrons to form Ti. Oxidation since Mg loses electrons to form Mg^{2+}. **OR** Oxidation state of Ti decreases from +4 in $TiCl_4$ to 0 in Ti, reduction Oxidation state of Mg increases from 0 in Mg to +2 in $MgCl_2$ oxidation Penalise 1m for use of 'change'.	2
c)	No. of moles of $TiCl_4$ = 125/190 = 0.65789 mol (1m) Mole ratio -> $TiCl_4$: Ti -> 1:1 Mass of Ti = 0.65789 x 48 = **31.6g** (1m)	2
		Total: [5]
A10a)	• Cracking of (long-chain) alkane/ hydrocarbons/crude oil/ petroleum in the presence of Al_2O_3 / SiO_2 at 600°C • Electrolysis of water • Steam reforming (Any one)	1
b)	The hydrogen/iron would **react** with the **oxygen** in the air/ **oxidised**.	1
ci)	Volume of ammonia produced = 2 x 25 x 15/100 = 7.5cm³	1
cii)	It will be **less** than 7.5cm³. The **pressure** used is **lower** than the 200 / 250 atmospheres used in industry.	1
		Total: [4]
B11a)	Think City	[1]
(bi)	Fuel consumption increases as the vehicle size increase. [1]	[1]
(bii)	**Non-hybrid cars** consume more fuel for the same vehicle size. [1] From Figure 2, for hybrid cars of vehicle size 40m² consumes 1.5 litres/100km, while non-hybrid cars of the same vehicle size consumes 4 litres/100km. [1] Accepts other information when vehicle size is 50m², 60m² only.	[2]
(c)	Pure water **does not conduct electricity**. Water exists as **molecules** / does	[2]

	not contain any mobile electrons or ions [1]. Aqueous potassium hydroxide **conducts electricity**. It contains **mobile** potassium **ions** and hydroxide ions [1].	
(di)	At the positive electrode: $Ni(OH)_2(s) + OH^-(aq) \rightarrow NiOOH(s) + H_2O(l) + e^-$ At the negative electrode: $M(s) + H_2O(l) + e^- \rightarrow MH(aq) + OH^-(aq)$	[2]
(dii)	$Ni(OH)_2(s) + M(s) \rightarrow NiOOH(s) + MH(aq)$	[1]
(diii)	The concentration of nickel hydroxide will **decrease** as it will be **oxidised/react** to form nickel oxyhydroxide. [1]	[1]
(e)	• Electrolytic cells rely upon **external power sources** instead of **stored chemical reactants** in NiMH cells. • NiHM cells are rechargeable/can be reused while electrolytic cells will stop functioning once the reactants are used up. • Electrical energy is produced in NiHM cells while electrical energy is consumed in electrolytic cells. • In NiMH cells, the redox reactions are spontaneous. In electrolytic cells, the redox reactions are non-spontaneous and take place only when energy is supplied. [Any 1 point]	[1]
(f)	Extreme **elevated temperatures/too much heat/overheating** will be experienced when NiHM cells are overcharged. [1] Reject: exothermic/explosion	[1]
		Total: [12]
B12a)	**More than one carbon-carbon double bond** or C=C double bond Reject: C-C double bond	[1]
bi)	1m – for each "monomer" drawn correctly Penalise 1m if no side bonds drawn	[2]
ii)	13000 / 158 = 82.28 20000/158 = 126.58 **1m – if both above workings are correct** Hence the range is 83 to 126. [1]	[2]
iii)	It is because the **same type of monomer** may **join to each other**, instead of only having the styrene and butadiene joining to each other in alternate positions.	[1]
c)	$C_4H_{10} \rightarrow C_4H_6 + 2H_2$	[1]

d)		[1]
		Total: [8]
Either B13a)	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$ No. of moles of Zn = 5g/65 = 0.076923 mol No. of moles of HCl = 2 x 0.1 = 0.2 mol (1m) Zn is the limiting reagent. No. of moles of Zn = No. of moles of $ZnCl_2$ = 0.076923 mol Mass of $ZnCl_2$ = 0.076923 x (65+71) = 10.461 = <u>10.5 g</u> (1m)	[2]
b)	Molar mass of Na_2CO_3 = 106g Concentration of standard solution = mol of Na_2CO_3 ÷ volume = (2.12 / 106) ÷ (250/1000) = 0.08 mol/dm^3 (1m) Since $Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$ No.of moles of Na_2CO_3 = (25/1000) x 0.08 mol = 0.002 mol No. of moles of HCl = 2 x 0.002 = 0.004 mol (1m) Concentration of acid = 0.004 mol ÷ 0.02 dm^3 = 0.200 mol/dm^3 (1m)	[3]
ci)	B,A,C [1] Ethanoic acid is a <u>weak</u> acid while hydrochloric acid and sulfuric acid are <u>strong</u>. [1] Sulfuric acid is dibasic while hydrochloric acid is monobasic, hence <u>concentration of H^+ ions in sulfuric acid</u> is <u>double/more</u> that <u>of hydrochloric acid</u>. [1]	[3]
ii)	Disagree. $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$ $Mg + 2HCl \rightarrow MgCl_2 + H_2$ $Mg + 2CH_3COOH \rightarrow (CH_3COO)_2Mg + H_2$ [1m-for 3 balanced equations] [1m-for working + stating Mg is LR] E.g. No. of mole of Mg = 0.48 / 24 = 0.02 mol No. of mole of HCl / H_2SO_4 / CH_3COOH = 0.05 x 1 = 0.05 mol Hence, <u>Mg is the limiting reactant</u> in the 3 experiments.	[2]
		Total: [10]

B13 OR ai)	$NaOH + HCl \rightarrow NaCl + H_2O$ No. of moles of NaOH unreacted in 25 cm^3 = no. of moles of HCl used in titration = 0.1 x 0.02 = 0.002 mol No. of moles of NaOH unreated = 0.002 x 1000/25= 0.08 mol (1m)	1
ii)	No. of moles of NaOH = 0.2 x 1 = 0.2 mol No. of moles of NaOH reacted = 0.2 - 0.08 = 0.12 (1m) From the equation: SO_2 (g) + 2NaOH (aq) → Na_2SO_3 (aq) + H_2O (l) No. of moles of SO_2 = ½ no. of moles of NaOH used up = ½ x o.12 = 0.06 mol (1m)	2
iii)	Volume of SO_2 = 0.06 x 24 = 1.44 dm^3 (1m) % by volume = (1.44/1000) x 100% = 0.144 % (1m)	2
bi)	Enthalpy change in dissolving NH_4NO_3 = kJ/g x g/mol = (+31.9/100) x 80 (1m) = + 25.52 kJ/mol <u>or</u> + 25.5 kJ/mol (1m) Accept kJ	2
ii)	 1m – activation energy (single-headed arrow) 1m – enthalpy change (single-headed arrow) with correct shape 1m – NH_4NO_3 (aq) Penalise max 1m if label E_a	3
		Total: [10]

Candidate Name _____ Class _____ Index No_____

BUKIT PANJANG GOVERNMENT HIGH SCHOOL
Preliminary Examination 2017
Secondary 4 Express

Chemistry (SPA)
Paper 1

5073/1
Date: 17 August, 2017
Duration: 1 hour
Time: 09 30 – 10 30 h

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C**, and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 14.
The use of an approved scientific calculator is expected, where appropriate.

[Please Turn over]

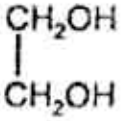
This document consists of 14 printed pages.

1 A particle contains 52 protons, 76 neutrons and 54 electrons. Which is the correct symbol for this particle?

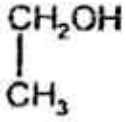
A $^{76}_{52}Te$ B $^{76}_{52}Te^{2+}$ C $^{128}_{52}Te^{2+}$ D $^{128}_{52}Te^{2-}$

2 Which compound contains only eight covalent bonds?

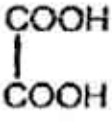
A



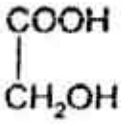
B



C



D



3 Which of the following pairs of substances can be separated by heating?

A ammonium chloride and potassium iodide

B copper (II) nitrate and potassium iodide

C ammonium chloride and iodine

D sodium chloride and copper (II) nitrate

4 Which substance has metallic bonding?

Substance	State of product formed on reacting with oxygen	Conducts electricity when solid?	Conducts electricity when liquid?
A	gas	yes	yes
B	No reaction	no	yes
C	solid	no	no
D	solid	yes	yes

5 Element X has proton number n and is virtually unreactive under most conditions. Another element Y has proton number (n + 2). What is the likely formula of the phosphide of Y?

A Y_3P_2

B Y_2P_3

C YP

D Y_5P

6 The table below shows the properties of four substances A, B, C and D. Which one of the following could be silver iodide?

Substance	Melting point/°C	Boiling point/°C	Conducts electricity when molten?	Conducts electricity when placed in water?
A	-31	66	no	no
B	502	953	yes	no
C	920	1400	yes	yes
D	3252	4938	no	no

7 In an experiment, 5 cm^3 of a gaseous hydrocarbon reacted with excess oxygen to form 30 cm^3 of carbon dioxide and 15 cm^3 of steam. Assuming all volumes of gases were measured at the same temperature and pressure, what is the formula of the hydrocarbon?

A CH_4

B C_2H_4

C C_2H_6

D C_6H_6

8 The reaction between sodium carbonate and nitric acid is as shown below:

$$Na_2CO_3 + 2HNO_3 \rightarrow 2NaNO_3 + H_2O + CO_2$$

Given that 0.8 g of hydrated sodium carbonate ($Na_2CO_3.nH_2O$) requires 10 cm^3 of 1 mol/dm^3 of dilute nitric acid for the above reaction, what is the value of n?

A 3 B 5 C 7 D 10

9 In an experiment to determine the concentration of hydrochloric acid, 20 cm^3 hydrochloric acid in a conical flask was titrated with 0.1 mol/dm^3 aqueous sodium hydroxide. Which of the steps would cause the calculated concentration of hydrochloric acid to be lower than its true value?

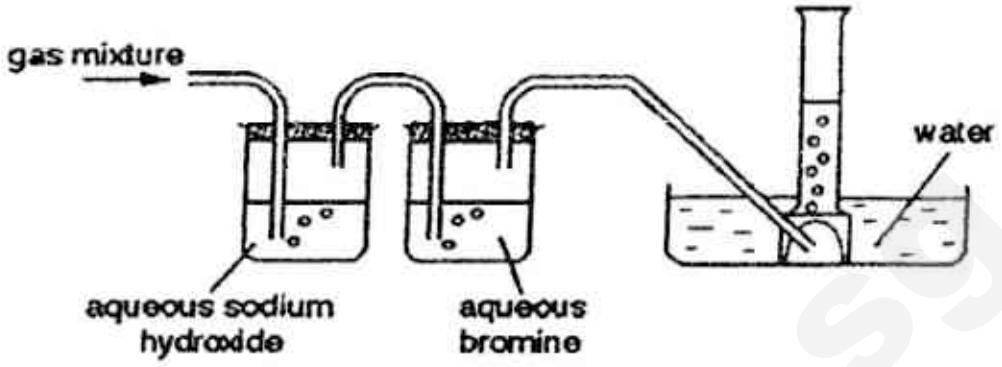
A The burette was rinsed with distilled water followed by 0.1 mol/dm^3 aqueous sodium hydroxide.

B The conical flask was rinsed with distilled water followed by aqueous sodium hydroxide before the hydrochloric acid is pipetted into the flask.

C There is an air bubble in the burette jet.

D The titration reading was taken at the end point.

10 A gaseous mixture of ethene, oxygen and sulfur dioxide is passed through the apparatus shown. Only one of the gases is collected.



What is a property of the gas collected?

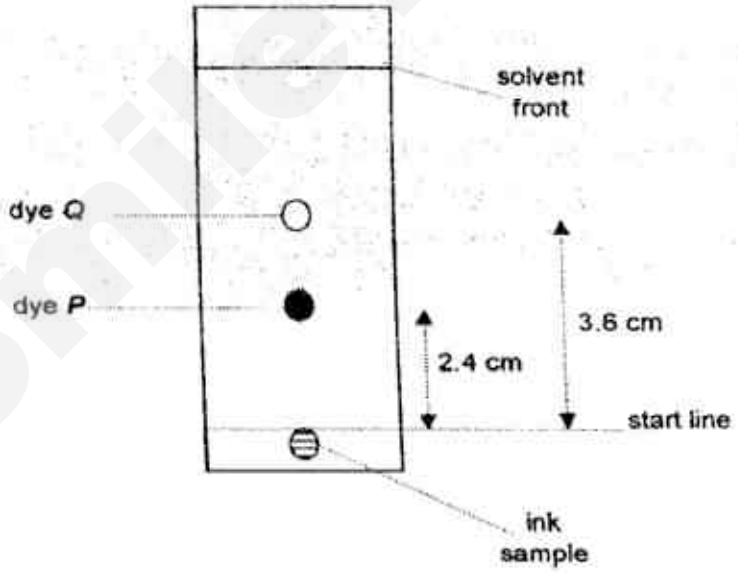
A burns with a yellow flame

B relights a glowing splint

C turns limewater chalky

D turns acidified potassium dichromate (VI) solution green

11 The results of a paper chromatography experiment shown below were obtained.



Given that the R_f values of dye **P** is 0.40, determine the R_f value of dye **Q**.

A 0.5

B 0.6

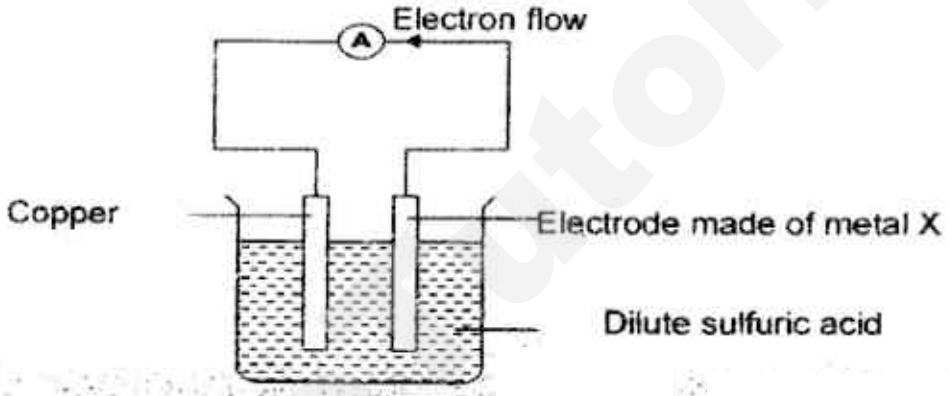
C 0.7

D 0.8

12 Aqueous copper (II) sulfate is electrolysed using a copper cathode and a platinum anode. Which observation will be made?

	at anode	at cathode	the electrolyte
A	anode dissolves	pink solid forms	no change
B	anode dissolves	pink solid forms	blue colour fades
C	colourless gas forms	colourless gas forms	no change
D	colourless gas forms	pink solid forms	blue colour fades

13 With reference to the diagram below, which of the following statements is correct?



A Copper electrode is the negative electrode.

B Metal X is below copper in the reactivity series.

C The mass of the copper electrode decreases.

D The mass of the X electrode decreases.

14 It was found that the heat required to boil 7.4 g of ethoxyethane $(C_2H_5)_2O$ was 2.6 kJ while that required to boil 4.6 g of ethanol was 3.9 kJ. From this evidence, which of the following would you judge to be the most correct conclusion? [M_r of $(C_2H_5)_2O$ = 74; C_2H_5OH = 46]

A The atoms in ethanol molecules are more difficult to break apart than those in ethoxyethane molecules.

B The molecules of ethanol are bound together more strongly than those of ethoxyethane

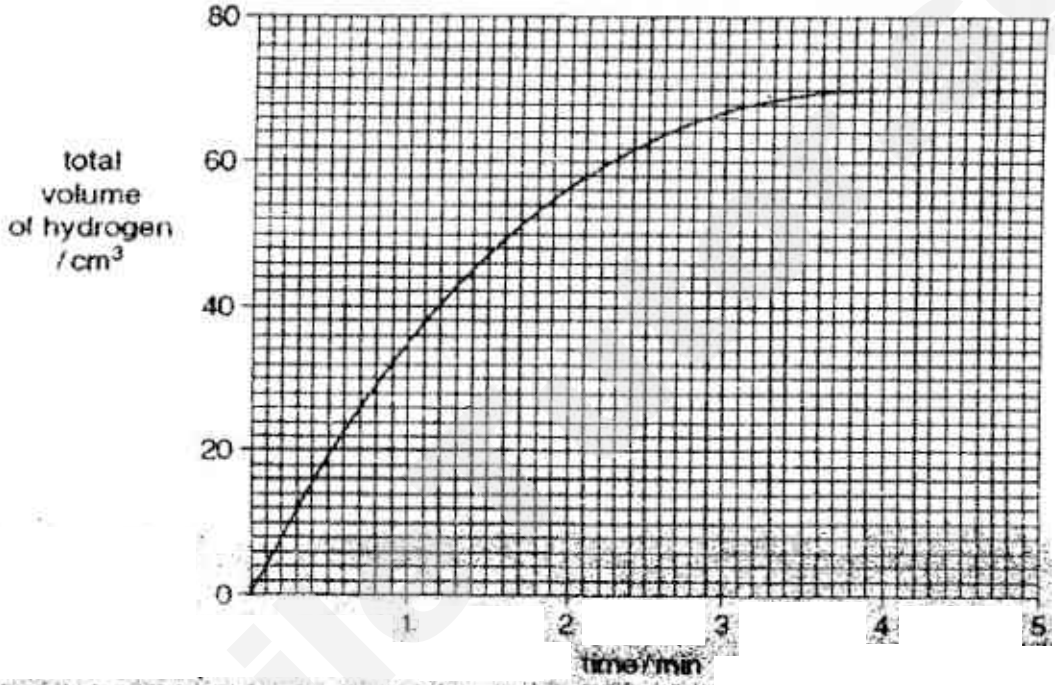
C The molecules of ethoxyethane are bound together more strongly than those of ethanol

D The more carbon atoms there are in a molecule, the easier it is to evaporate the substance

15 When 1 g of methane is burnt, 56 kJ of energy is released. How much heat is released when 1 mole of methane is burnt?

A	28 kJ/mol	B	224 kJ/mol
C	504 kJ/mol	D	896 kJ/mol.

16 A student measured the rate of reaction between a given mass of zinc and an excess of hydrochloric acid by recording the volume of hydrogen produced. The results are shown in the graph below.



How long did it take for half of the zinc to react?

A 1.0 min

B 1.5 min

C 2.0 min

D 2.5 min

17 In which of the following pairs of compounds do the two elements underlined have the same oxidation state?

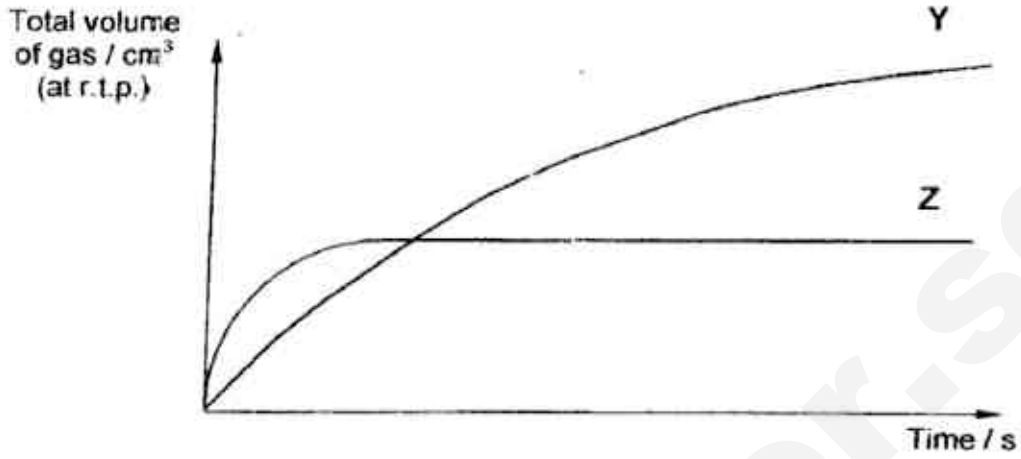
A $\underline{Cr}O_3$ and $K\underline{Cl}O_3$

B $\underline{Cu}Cl_2$ and $\underline{Na}_2CO_3$

C $K\underline{Mn}O_4$ and $K_2\underline{Cr}_2O_7$

D $\underline{Mn}SO_4$ and $\underline{Fe}SO_4$

18 In the graph, curve Y represents the results of reacting 1.0 g of magnesium granules with an excess of acid at 40°C.



Which changes could produce curve Z?

A using 1.0 g of magnesium granules and an excess of acid at 30°C

B using 1.0 g of magnesium powder and an excess of acid at 30°C

C using 0.5 g of magnesium granules and an excess of acid at 50°C

D using 0.5 g of magnesium granules and an excess of acid at 30°C

19 When acidified potassium dichromate (VI) is added to ethanol and warmed, the mixture changes colour from orange to green. This shows that ethanol is

A a catalyst

B a neutralising agent

C an oxidising agent

D a reducing agent

20 Which of the following mixtures gives the best yield of zinc carbonate?

A Aqueous zinc chloride and aqueous sodium carbonate

B Powdered zinc and powdered calcium carbonate

C Powdered zinc chloride and aqueous sodium carbonate

D Powdered zinc oxide and aqueous potassium carbonate

21 In which reaction is dilute hydrochloric acid **not** behaving as an acid?

A $HCl\,(aq) + NaOH\,(aq) \rightarrow NaCl\,(aq) + H_2O\,(l)$

B $HCl\,(aq) + AgNO_3\,(aq) \rightarrow AgCl\,(s) + HNO_3\,(aq)$

C $2HCl\,(aq) + CuO\,(s) \rightarrow CuCl_2\,(aq) + H_2O\,(l)$

D $2HCl\,(aq) + Mg\,(s) \rightarrow MgCl_2\,(aq) + H_2\,(g)$

22 Manganese dioxide acts as a catalyst in the following reaction:

Hydrogen peroxide (H_2O_2) → water + oxygen

Several experiments were carried out using the same mass of manganese dioxide and the same volume of hydrogen peroxide solution.

Experiment	Concentration of H_2O_2 (mol/dm^3)	Temperature / °C	Form of catalyst
1	0.5	20	powder
2	1.0	30	lump
3	1.5	20	lump
4	1.5	30	powder
5	0.5	20	lump
6	2.0	20	powder

Which two experiments should be compared to show the effect of particle size on the speed of reaction?

A Experiments 1 and 3

B Experiments 1 and 5

C Experiments 2 and 4

D Experiments 3 and 6

23 Which pair of gases **do not** damage limestone buildings?

A nitrogen and carbon monoxide

B nitrogen dioxide and carbon monoxide

C nitrogen dioxide and carbon dioxide

D sulfur dioxide and carbon dioxide

24 In the Haber process, the yield of ammonia can be increased by _____.

A increasing the pressure to 300 atmospheres

B increasing the temperature to 1500 °C

C using a mixture containing three parts of nitrogen to one part of hydrogen

D using platinum as a catalyst

25 Which of the following statements correctly describes a trend in the properties of the elements, going from left to right of Period 2 of the Periodic Table?

A The ability of the elements to conduct electricity increases.

B The melting point of the elements increases.

C The number of neutrons in the atoms decreases.

D The ability to form positive ions decreases.

26 Excess bromine was shaken with a mixture of potassium chloride and potassium iodide solution. The final solution will contain _____.

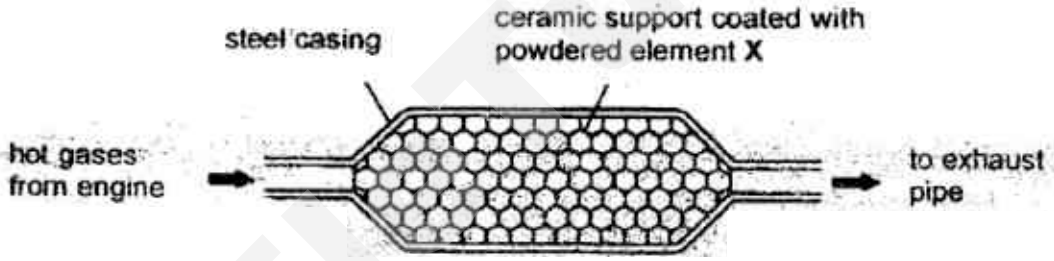
A potassium chloride, potassium bromide, bromine and iodine

B potassium bromide, bromine and iodine

C potassium iodide, potassium bromide, bromine and chlorine

D potassium bromide, iodine, bromine and chlorine

27 The diagram below shows the structure of a catalytic converter.



Which part of the Periodic Table is element X most likely to be found?

A The period lithium to neon

B Group I

C The transition metals

D Group VII

28 The following data refer to copper as a typical transition element and to sodium, a Group I element. For which property are they under the correct element?

	Property	Copper	Sodium
A	Density / g cm^{-3}	8.92	0.97
B	Colour	blue	white
C	Melting point / °C	810	1083
D	Nature of oxide	amphoteric	basic

29 Metal M is placed between zinc and iron in the reactivity series. Which of the following statement is a correct assumption of the metal M?

A Metal M has to be extracted by electrolysis.

B Metal M reacts with water at room temperature to produce hydrogen.

C Metal M forms an oxide that can be reduced by coke.

D Its oxide decomposes to give the metal on heating.

30 Which pair of substances act as reducing agents in the blast furnace?

A carbon and oxygen

B carbon monoxide and carbon dioxide

C carbon and carbon monoxide

D carbon dioxide and oxygen

31 Scrap iron is often recycled. Which reason for recycling is **not** correct?

A It reduces the amount of pollution at the site of the ore extraction.

B It reduces the amount of waste taken to landfill sites.

C It reduces the need to collect the scrap iron.

D It saves natural resources.

32 Which of the following best describes the properties of the three types of steel?

	High carbon steel	Mild steel	Stainless steel
A	corrosion resistant	soft and easily shaped	strong and brittle
B	strong and brittle	soft and easily shaped	corrosion resistant
C	corrosion resistant	strong and brittle	soft and easily shaped
D	soft and easily shaped	strong and brittle	corrosion resistant

33 Which of the following statements about homologous series is **not** true?

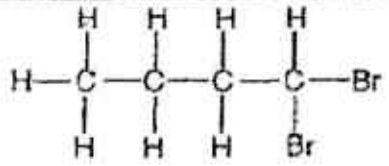
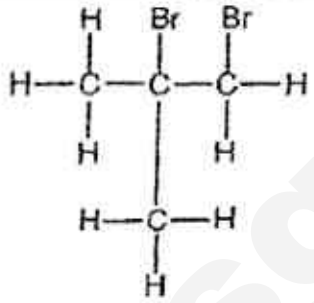
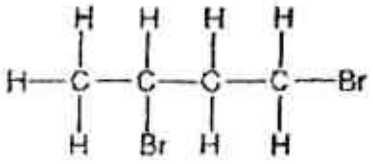
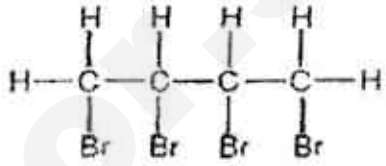
A The members have similar chemical properties.

B The boiling points increase with increasing relative molecular mass.

C The relative molecular masses of consecutive members differ by 14.

D They can be represented by the same empirical formula.

34 Which of the following compounds could be formed by the action of bromine on an alkene of formula C_4H_8?

A		B	
C		D	

35 What happens when one mole of methane is mixed in the dark at room temperature with four moles of chlorine (Cl_2)?

A 1 mole of CCl_4 and 4 moles of HCl are formed.

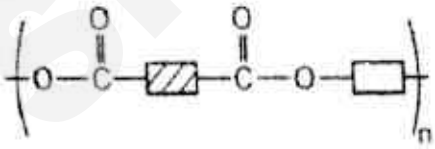
B 4 moles of CH_3Cl and HCl are formed.

C 1 mole of CH_3Cl and HCl are formed.

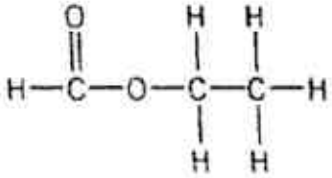
D There is no reaction.

36 Which of the following has **not** been prepared by reacting a carboxylic acid with an alcohol?

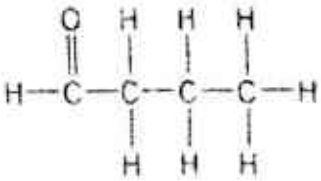
A



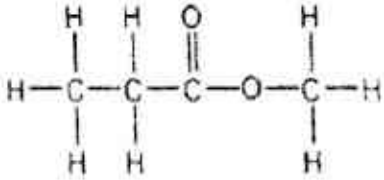
B



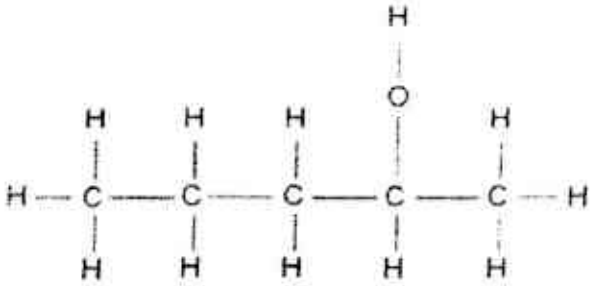
C



D

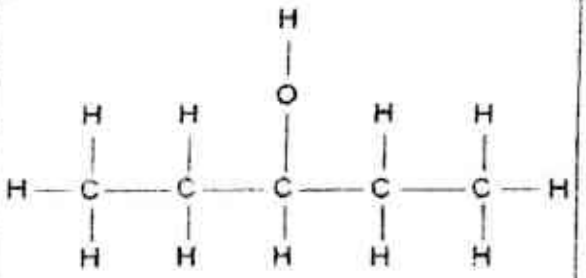


37 The structure of pentan-2-ol is shown.

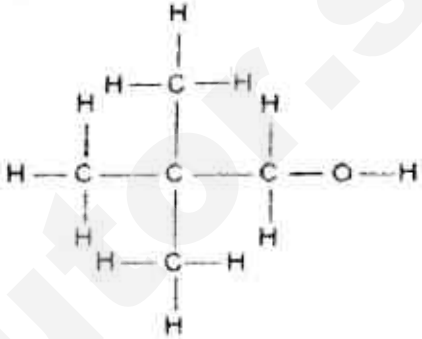


Which structure(s) is/are isomer(s) of pentan-2-ol?

I

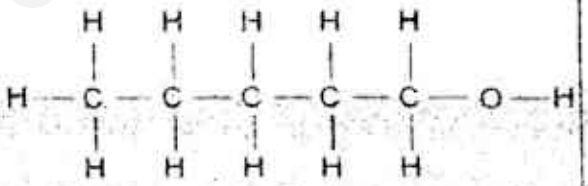


II



III

IV



A None of the above

B II and III only

C I and IV only

D All of the above

38 Which of these polymers is a nylon?

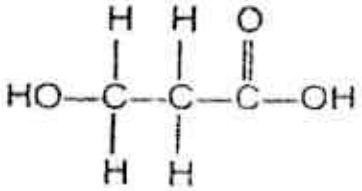
A $(C_2H_3Cl)_n$

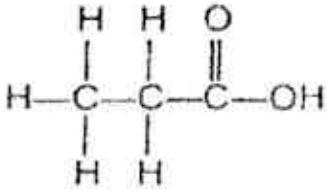
B $(C_5H_8O_2)_n$

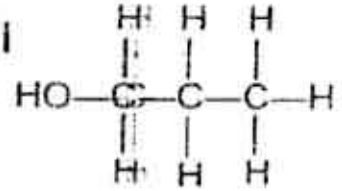
C $(C_6H_{10}O_5)_n$

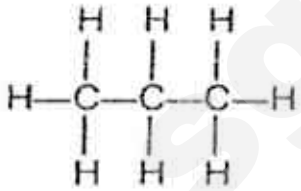
D $(C_2H_3NO)_n$

39 Which organic compound(s) can react with sodium carbonate to form a compound?

I 

II 

III 

IV 

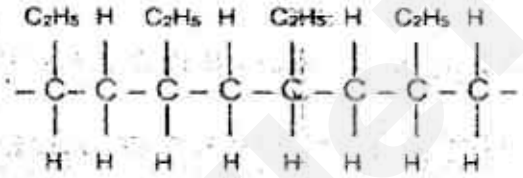
A I and II only

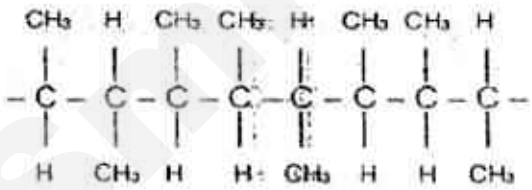
B I and III only

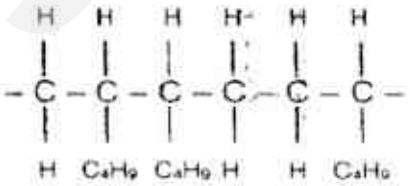
C I, II and III only

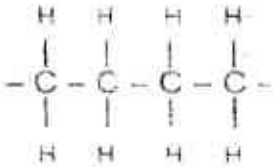
D All of the above

40 Which formula shows the polymer made from but-2-ene?

A 

B 

C 

D 

Sec 4 Express Chemistry Prelim Examination 2017 – Marking Scheme

Paper 1 (40 marks)

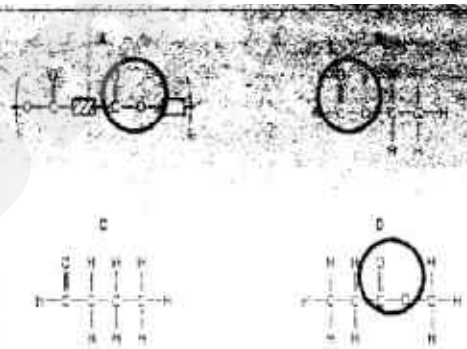
No.	Ans	Explanation	Key concept
1	D	An atom has equal number of protons and electrons. Since there are 2 more electrons, particle would have gained two extra negative charge since electrons have a charge of -1. Mass number would be 128 since it is the total sum of number of protons (52) and neutrons (76). Proton number would be 52.	Atomic Structure
2	B	Draw out full structural formula to see clearly. A – Contains 9 covalent bonds B – Contains 8 covalent bonds C – Contains 9 covalent bonds D – Contains 9 covalent bonds	Covalent Bonding
3	A	A – Ammonium chloride can sublime but not potassium iodide which will remain behind. B – Both cannot sublime. C – Both can sublime. D – Both cannot sublime.	Separation Techniques
4	D	Metals form solid oxides at room temperature and can conduct electricity in solid and liquid state.	Metallic Bonding
5	A	X is a noble gas found in Group 0. Y must be in Group II. Since Y is Y^{2+} and phosphide is P^{3-}, the formula is Y_3P_2.	Periodic Table
6	B	Silver iodide is an ionic compound and is insoluble in water (hence, will not conduct electricity when placed in water since the ions cannot dissociate to move and carry charge). It will conduct only when molten as there are mobile oppositely charged ions that can move and carry charge.	QA
7	D	Hydrocarbon CO_2 H_2O 5:30:15 1:6:3 Equation will be $\underline{1}C_6H_6 + \frac{15}{2}O_2 \rightarrow \underline{6}CO_2 + \underline{3}H_2O$	Stoichiometry
8	A	No. of moles of HNO_3 = (10/1000) x 1 = 0.01 mol Since hydrated sodium carbonate:nitric acid = 1:2 No. of moles of hydrated sodium carbonate = 0.01 / 2 = 0.005 mol Mass = moles x Mr 0.8 = 0.005 x Mr Mr = 160 Mr of hydrated sodium carbonate = 2 x 23 + 12 + 3 x 16 + n (2 + 16)	Stoichiometry

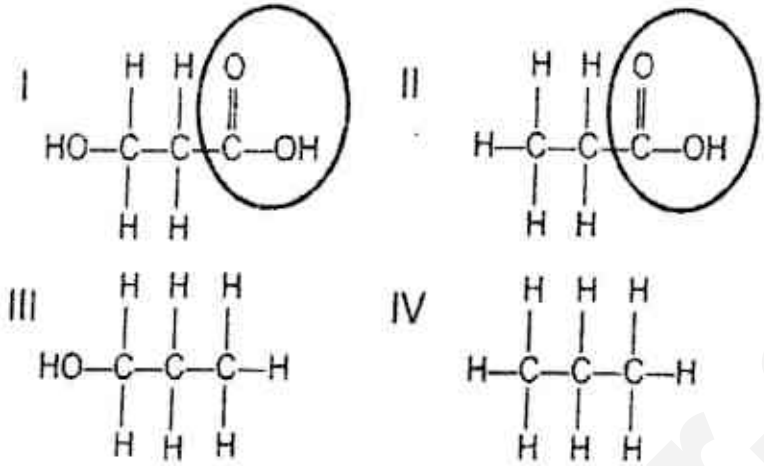
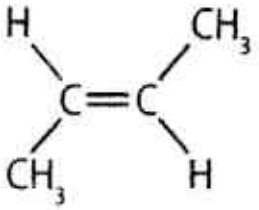
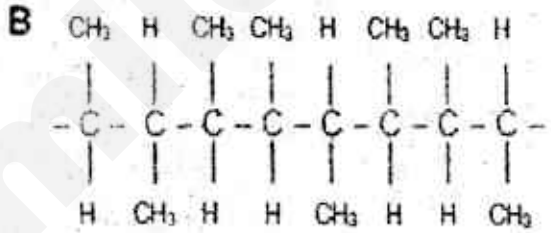
		160 = 106 + 18n n = 3	
9	B	A – This is the correct step to prepare the burette for titration since sodium hydroxide was the titrant that is supposed to go into the burette. B – Incorrect step. It should only be rinsed with distilled water if necessary. Rinsing with sodium hydroxide would cause some of the hydrochloric acid that is added next to react with droplets of sodium hydroxide left behind, even before the titrant was added from the burette. There would then be less HCl to react with the titrant, causing the volume of titrant used to be less. C – This would cause more sodium hydroxide to be added as there is an air bubble occupying the space where sodium hydroxide is supposed to be. D – This is the correct step.	Acids & Bases
10	B	Sodium hydroxide (Alkali) will react with sulfur dioxide (acidic oxide). Bromine will react with ethane. This leaves behind oxygen which will relight a glowing splint	Acids & Bases
11	B	$Rf = \frac{distance\ travelled\ by\ substance}{distance\ travelled\ by\ solvent}$ $0.4 = \frac{2.4}{x}$ x = 6 cm Rf of Q = $\frac{3.6}{6}$ = 0.6	Separation Techniques
12	D	Anode: Hydroxide ions will be preferentially discharged at anode as sulfate ions are not discharged. Since hydroxide ions are discharged to give oxygen gas, colourless gas is observed. Cathode: Copper(II) ions will be preferentially discharged at cathode instead of hydrogen ion as copper is below hydrogen in the metal reactivity series. Electrolyte: Since copper(II) ions are being discharged and leaving the electrolyte, the blue colour will fade.	Electrolysis
13	D	A – The more reactive metal is the anode, which the negative electrode Terminal for simple cell is opposite of electrolytic cell. B – X is more reactive then copper and will be above it. C – Copper is not dissolving. Metal X is dissolving as it is the more reactive metal and is the anode. D - Electrons flow from the more reactive metal to the less reactive metal since more reactive metals have a higher tendency to lose electrons. $X \rightarrow X^{+} + e^{-}$ Since electrons are lost, metal X is being oxidised and will decrease in mass.	Electrolysis
14	B	Number of moles of ethanol and ethoxyethane are calculated to be 0.1 mol. Since more energy was taken in to overcome the attractive forces in	Energy

		ethanol, answer must be B. A – The strong covalent bonds are not overcome in the process of boiling, only the weak intermolecular forces of attraction are overcome. D – Since covalent bonds are not overcome, student cannot discuss the presence of more carbon atoms which will have covalent bonds within the molecule.	Changes
15	D	No. of moles of methane = mass / Mr = 1 / 16 = 0.0625 mol 0.0625 mol → 56 kJ 1 mol → 896 kJ/mol	Energy Changes
16	A	Total volume of hydrogen = 70 cm^3 Half of hydrogen volume = 35 cm^3 At 35 cm^3, the time taken is 1 min.	Rate of reaction
17	D	A – Oxidation state (O. S.) of Cr = +6, O.S. of Cl = +5 B – O.S. of Cu = +2, O.S. of Na = +1 C – O.S. of Mn = +7, O.S. of Cr = +6 D – O.S. of Mn = +2, O.S. of Fe = +2	Redox
18	C	A – Z will have a less steep gradient only. B – Z may be steeper or less steep as there are 2 factors that are varied here that affects gradient. C – Using half the mass will give half the yield as per curve Z. Using higher temperature will give steeper gradient as per curve Z. D – Using half the mass will give half the yield. Using lower temperature will give less steep gradient.	Rate of reaction
19	D	Potassium dichromate (VI) is an oxidising agent so ethanol must be a reducing agent. Ethanol will be oxidised to be ethanoic acid while potassium dichromate (VI) will be reduced to Cr^{3+} ions.	Redox
20	A	Zinc carbonate is an insoluble substance which must be prepared by precipitation which is the mixing of 2 aqueous substances. Only option A is viable.	Salts Preparation
21	B	A – Acid + alkali → Salt + water B – Precipitation reaction C – Acid + Base → Salt + water D – Acid + metal → Salt + hydrogen	Acids & Bases
22	B	A – Concentration and particle size were varied. B – Only particle size was varied while concentration and temperature were kept constant. C – Concentration and temperature were varied. D – Concentration and particle size were varied.	Rate of reaction
23	A	Limestone contains calcium carbonate. Find substances that are neutral	Air and

		and will not react with it. A – Nitrogen and carbon monoxide are both neutral. B – Nitrogen dioxide is acidic while carbon monoxide is neutral. C – Both are acidic. D – Both are acidic.	Atmosphere
24	A	A – Increase pressure will increase yield. B – Increase temperature will decrease yield. C – Since $3H_2 + N_2 \leftrightarrow 2NH_3$, the reacting ratio should be three parts hydrogen to one part nitrogen, not vice versa. D – The catalyst is finely divided iron, not platinum.	Ammonia
25	D	A – From left to right, elements change from metal to non-metal, so ability to conduct electricity decreases. B – Metals will have a higher melting point than non-metals so melting point should decrease as elements change from metal to non-metal. C – Number of neutrons may sometimes remain the same for two different elements from left to right. D - From left to right, elements change from metal to non-metal. Only metals have a tendency to form positive ions while non metals have a tendency to form negative ions. This statement is true.	Periodic Table
26	A	There will be leftover bromine since excess bromine was used. Bromine cannot displace chlorine from KCl so KCl will also remain. Bromine can displace iodine from KI so there will be iodine and KBr. Hence, there will be bromine, KCl, iodine and KBr.	Periodic Table (Group VII)
27	C	There are catalysts in a catalytic converter, namely palladium, rhodium, platinum. These are transition metals. Transition metals make good catalysts.	Air and Atmosphere
28	A	A – Transition metals will have high density while Group I metals have low density. B – Copper is reddish brown/pink in colour while sodium is silvery grey. C – Transition metals have high melting point while Group I metals have low melting point. D – Copper forms CuO (basic oxide). Sodium forms NaO (basic oxide). Only zinc oxide, aluminium oxide and lead (II) oxide are amphoteric.	Periodic Table (Group I and Transition)
29	C	A – Only ores of Potassium, sodium, calcium, Magnesium and aluminium are extracted via electrolysis. B – Metal M cannot react with water, only steam since magnesium, zinc and iron react with steam. Only potassium, sodium, calcium and magnesium react with water. C – Since zinc ore and iron ore can undergo reduction with carbon or	Metals (Extraction)

		heating with carbon, so can metal M. D – Only metals that are below copper will give the metal when its compounds decompose on heating.	
30	C	A: $C + O_2 \rightarrow CO_2$ In this reaction, carbon has reduced oxygen to CO_2 so carbon is a reducing agent. Oxidation state (O.S.) of oxygen decreased from 0 to -2. However, oxygen has oxidised carbon to CO so oxygen is an oxidising agent. O.S. of carbon increased from 0 to +4. B: $Fe_2O_3 + 3CO \rightarrow 2Fe + 3\ CO_2$ CO is a reducing agent as it reduced iron from Fe_2O_3 to Fe. O.S. of Fe decreased from +3 to 0. $CO_2 + C \rightarrow 2\ CO$ However, CO_2 is an oxidising agent as it oxidised carbon into CO. C: $C + O_2 \rightarrow CO_2$ In this reaction, carbon has reduced oxygen to CO_2 so carbon is a reducing agent. Oxidation state (O.S.) of oxygen decreased from 0 to -2. $Fe_2O_3 + 3CO \rightarrow 2Fe + 3\ CO_2$ CO is a reducing agent as it reduced iron from Fe_2O_3 to Fe. O.S. of Fe decreased from +3 to 0. D: $CO_2 + C \rightarrow 2\ CO$ CO_2 is an oxidising agent as it oxidised carbon into CO. $C + O_2 \rightarrow CO_2$ Oxygen has oxidised carbon to CO so oxygen is an oxidising agent. O.S. of carbon increased from 0 to +4.	Metals (Extraction of iron from haematite)
31	C	A – True. Mining and extraction by heating with carbon need not be carried out which will reduce emission of gases which are released during burning of fossil fuels to supply heat energy in extraction in blast furnaces. There will also be reduced air pollution as gases like CO_2 (greenhouse gas) will also not be released when there is less extraction of iron being carried out. B – True. Less scrap metal will be disposed off to occupy space in landfill as the metal is being recycled instead. C – False. It increases the need to collect scrap iron if they are recycled. D – True. We conserve fossil fuels as they do not need to be burnt to supply energy for extraction of iron in blast furnace.	Metals (Recycling)
32	B	High carbon steel will be hard and strong as there are more carbon atoms	Metals (Steel)

		to disrupt the orderly and regular arrangement of layers of atoms, making it hard for the layers to slide over one another. Mild steel contains less carbon atoms so there will be less carbon atoms to disrupt the orderly and regular arrangement of layers of atoms, making it easier for the layers to slide over one another. Stainless steel contains chromium which has an oxide layer that is insoluble, impermeable and non-porous making it hard for the stainless steel to corrode.	
33	D	A – True. They will behave the same way in chemical reactions to give similar products. B – True. The larger the molecule, the more and stronger the intermolecular forces of attraction which require more heat energy to overcome, thus increasing the boiling points. C – True. They each differ by a $-CH_2-$ unit which has an Mr of 14. D – False. Take methane and ethane (2 members of the same homologous series) for example. Empirical formula of Methane is CH_4 while empirical formula of ethane is CH_3 (simplify C_2H_6 to CH_3).	Organic Chemistry
34	B	A – Can only obtain this from substitution reaction under UV light of an alkane where the formula is C_4H_{10}. B – The Br atoms will add across 2 different carbon atoms which are right next to each other as the original carbon-carbon double bond will be between two adjacent carbon atoms. C – Cannot obtain this as this does not show the carbon-carbon double bond was between two carbon atoms that are right next to each other. D – This would imply there were two double bonds. However, C_4H_8 only has one double bond.	Alkenes
35	D	Without UV light, substitution reaction cannot even begin.	Alkanes
36	C	 All of the above have the circled ester functional group (-COO-) except option C.	Ester
37	D	All have different structures where the there are 5 carbon atoms, 12 hydrogen atoms and 1 oxygen atom.	Alcohols
38	D	Look out for a –CONH – group. Only option D has it, as given away by the nitrogen atom.	Condensation Polymer

39	A	Look out for carboxylic acid functional groups that can react with the sodium carbonate. Only I and II have them.  	Carboxylic Acids
40	B	But-2-ene:  Hence after converting the double bond into single bonds, the polymer looks like option B:  	Addition Polymer

CHRIST CHURCH SECONDARY SCHOOL
2017 PRELIMINARY EXAMINATION
FOUR EXPRESS

CANDIDATE NAME		CLASS	
CENTRE NUMBER	S	INDEX NUMBER	

CHEMISTRY **5073/01**
Paper 1 **23 August 2017**
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number, name and class on all the work you hand in.
Write in soft pencil on the Multiple Choice Answer Sheet
Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **forty** questions on this paper. Answer all questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Multiple Choice Answer Sheet.

Read the instructions on the answer sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 15.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **15** printed pages.

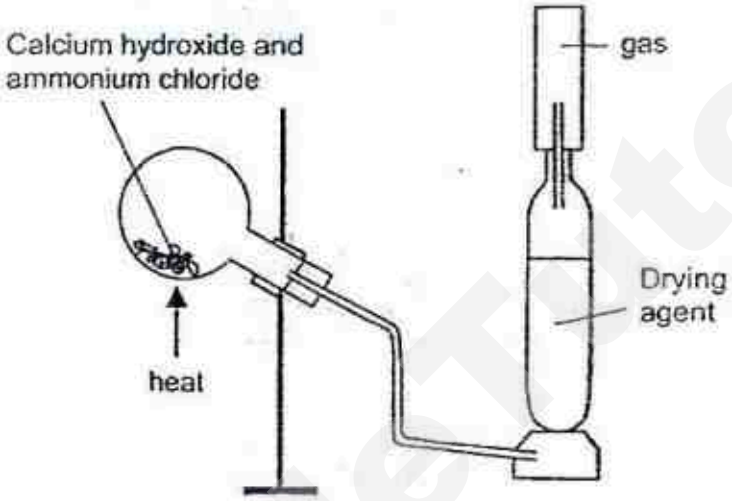
[Turn over

1 Which of the following gases diffuses the fastest?

It is given that the relative molecular mass of gas A and gas B is 14 and 32 respectively.

A gas A at 10°C
B gas B at 10°C
C gas A at 15°C
D gas B at 15°C

2 The set up below shows one way to collect a dry sample of the gas produced from the reaction of calcium hydroxide and ammonium chloride.



Which of the following best suggest the possible identity of the gas and the drying agent?

	gas	drying agent
A	ammonia	calcium oxide
B	ammonia	concentrated sulfuric acid
C	hydrogen chloride	calcium oxide
D	hydrogen chloride	concentrated sulfuric acid

3 Solid samples of three chlorides, ammonium chloride, lead(II) chloride and sodium chloride, were accidentally mixed together.

Which of the following outlines the best method to obtain the pure and dry sample for each substance?

A sublimation, dissolving, filtration, evaporation
B dissolving, filtration, sublimation, crystallisation
C sublimation, filtration, evaporation, crystallisation
D dissolving, fractional distillation, filtration, evaporation

4 Sterling silver is an alloy that is commonly used in jewelleries and ornaments. It consists 90% silver and 10% copper.

Which of the following statements is likely to be true about the properties of sterling silver as compared to pure silver?

A Sterling silver does not react with acids.
B Sterling silver is more malleable than pure silver.
C Sterling silver is stronger but more brittle than pure silver.
D Sterling silver has a higher melting point as compared to pure silver.

5 The atmosphere of a newly discovered planet contains mainly oxygen, argon and nitrogen. The melting and boiling points of these gases are shown in the table below.

gas	melting point/ °C	boiling point/ °C
oxygen	– 219	– 183
argon	– 189	– 186
nitrogen	– 210	– 196

Out of the three gases, only oxygen exists in the liquid state on the planet. What is most likely the temperature at the surface of the planet?

A – 182°C
B – 184°C
C – 187°C
D – 198°C

6 75% of chlorine exists naturally as chlorine-35 and 25% of chlorine exists naturally as chlorine-37. Which of the following properties describes the two forms of chlorine correctly?

I Chlorine-35 contains less neutrons as compared to chlorine-37
II Chlorine-37 has a stronger odour than chlorine-35.
III They can both react with ethane in the presence of UV light.

A I only
B I and III
C II and III
D All of the above

7 What is the atomic structure of X^{2-} given that X has an atomic number of 8 and a mass number of 18?

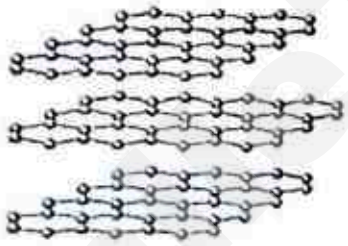
	electrons	protons	neutrons
A	8	8	10
B	10	8	8
C	6	8	10
D	10	8	10

8 Lead(IV) chloride, $PbCl_4$, is a yellow, oily liquid and has a melting point of – 15 °C and boiling point of 50 °C.

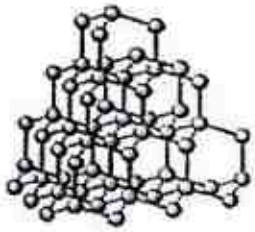
Which of the following statements is incorrect?

A It is formed by reacting lead with chlorine.
B It does not conduct electricity under any conditions.
C It is formed by the transfer of electrons from lead to chlorine atoms.
D It is a simple covalent molecule with strong covalent bonds between the atoms.

9 The following structures show four different allotropes of carbon.

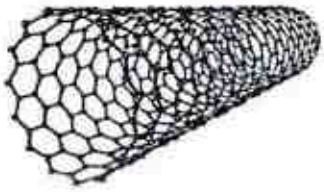


graphite



diamond

C_{60} fullerene



fullerene nanotube

Which allotrope(s) conducts electricity?

A graphite
B C_{60} fullerene, graphite
C C_{60} fullerene, graphite, fullerene nanotube
D All of the above

10 Which one of the following represents the structural formula of disulfur dichloride, S_2Cl_2?

A Cl-S-S-Cl
B S-Cl-Cl-S
C S-Cl-S-Cl
D Cl=S-S=Cl

11 If the formula of sodium thiosulfate is $Na_2S_2O_3$ and the formula of niobium oxide is NbO, then the formula of niobium thiosulfate is

A NbS_2O_3
B $Nb_2S_2O_3$
C $Nb(S_2O_3)_2$
D $Nb_2(S_2O_3)_2$

12 Element X exists as gaseous molecules with the molecular formula X_2 at room temperature and pressure.

50 cm^3 of element X combines with 100 cm^3 of hydrogen gas to form 100 cm^3 of the gaseous hydride of X.

What is the molecular formula of the hydride of X formed?

A HX
B HX_2
C H_2X
D H_2X_2

13 When a sample of unknown green solid was added to a beaker of dilute hydrochloric acid, effervescence was observed. Which of the following is most likely this unknown solid?

A iron(III) oxide
B copper(II) oxide
C iron(III) carbonate
D copper(II) carbonate

14 Element Y is a good conductor of electricity and forms a halide which dissolves readily in water. In addition, Y hydroxide reacts with both acids and alkalis. Hence, the identity of Y is most likely

A lead
B sodium
C magnesium
D aluminium

15 Which of the following method(s) is/are suitable to differentiate between two monobasic acids of the same concentration but of different strength?

I Using a pH meter.
II Titration using aqueous sodium hydroxide of known concentration.
III Measuring the total amount of hydrogen gas produced when excess magnesium metal is added to the acids respectively.

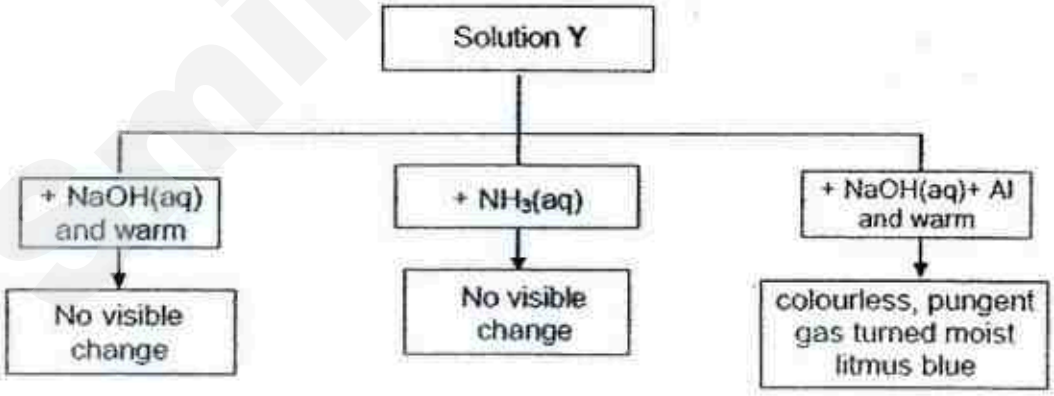
A I only
B I and II only
C II and III only
D All of the above

16 A student performed four tests on an aqueous solution of potassium carbonate and recorded the results as shown below.

Which one of the tests should be repeated as the observation made is inaccurate?

	test conducted	observation
A	addition of hydrochloric acid	effervescence observed
B	addition of barium nitrate	no visible reaction
C	addition of sodium hydroxide solution	no visible reaction
D	addition of zinc chloride solution	white precipitate

17 The flow chart below shows the reactions of a salt solution Y with three reagents:



What is a possible identity of salt solution Y?

A sodium nitrate
B sodium sulfate
C ammonium nitrate
D ammonium sulfate

18 Which of the following gases has the lowest density at r.t.p.?

A neon
B nitrogen
C sulfur dioxide
D carbon monoxide

19 What is the concentration of sulfate ions in 0.01 mol/dm^3 sulfuric acid?

A 0.01 g/dm^3
B 0.02 g/dm^3
C 0.96 g/dm^3
D 1.92 g/dm^3

20 A solution containing one mole of aqueous ammonia is added to a solution containing one mole of aluminium sulfate.

The equation for this reaction is shown below.

$$Al_2(SO_4)_3 + 6NH_4OH \rightarrow 2Al(OH)_3 + 3(NH_4)_2SO_4$$

What is the number of moles of aluminium hydroxide formed?

A 0.333
B 0.500
C 1.000
D 2.000

21 Aspirin, $C_9H_8O_4$, is commonly used to treat mild to moderate pain and also to reduce fever or inflammation.

Aspirin is made from salicylic acid, $C_7H_6O_3$, as shown by the equation given below.

$$C_7H_6O_3 + C_4H_6O_3 \rightarrow C_9H_8O_4 + CH_3COOH$$

Assuming that aspirin is always produced with a percentage yield of 70%, calculate the mass of salicylic acid required to make an aspirin tablet of 325 mg.

A 174 mg
B 249 mg
C 356 mg
D 424 mg

22 What is the oxidation state of nitrogen in NO_2 and NH_4^+?

	oxidation state of nitrogen in	
	NO_2	NH_4^+
A	+3	–3
B	+3	–5
C	+4	–3
D	+4	–5

23 Which of the following is not a redox reaction?

A $Mg + 2HF \rightarrow MgF_2 + H_2$
B $LiOH + HNO_3 \rightarrow LiNO_3 + H_2O$
C $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$
D $Cu + 2H_2SO_4 \rightarrow CuSO_4 + 2H_2O + SO_2$

24 Which of the following statements about the properties of a catalyst is inaccurate?

A A catalyst increases the average kinetic energy of the reactants.
B A catalyst increases the rate of both the forward and reverse reaction.
C A catalyst has no effect on the enthalpy change of the reaction.
D A catalyst is more effective in the powdered than granular form.

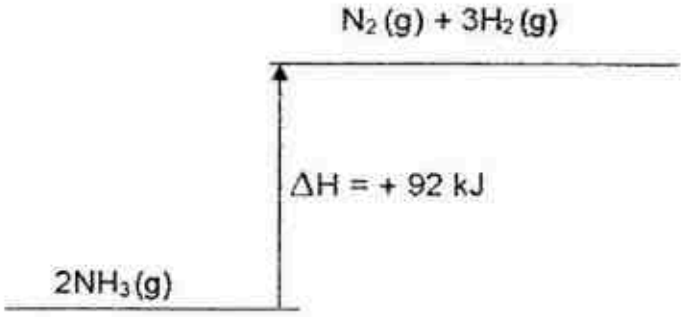
25 The table compares the strengths of the bonds for reaction of the type below.

$$X_2 + Y_2 \rightarrow 2XY$$

Which reaction is most likely to be exothermic?

	X-X bond	Y-Y bond	X-Y bond
A	Strong	Strong	Strong
B	Strong	Strong	Weak
C	Weak	Weak	Strong
D	Weak	Weak	Weak

26 The diagram below is the energy level diagram for the reverse reaction of the Haber process.



Which of the following may be deduced from the energy level diagram?

I The reaction is exothermic.
II A catalyst was used to speed up the reaction.
III 92 kJ of heat energy has to be absorbed to decompose one mole of ammonia.

A I and II
B II and III
C All of the above
D None of the above

27 Which property is displayed by all metals?

A They are extracted from their ores by heating with carbon.
B They conduct electricity in all states.
C They either form acidic oxides or basic oxides.
D They react with hydrochloric acid to form hydrogen.

28 An experiment was conducted to test the reactivity of some metals. Different metals were placed into different metal salt solutions and the observations were recorded in the table given below.

metal	metal salt solution	observation
nickel (Ni)	Cr^{3+} solution	no observation
chromium (Cr)	Cu^{2+} solution	pink solid formed
platinum (Pt)	Cu^{2+} solution	no observation
copper (Cu)	Ni^{2+} solution	no observation

Based on the observation, arrange the reactivity of the metals the in order of decreasing reactivity.

A Ni, Cr, Cu, Pt
B Cr, Ni, Cu, Pt
C Ni, Cu, Pt, Cr
D Cr, Ni, Pt, Cu

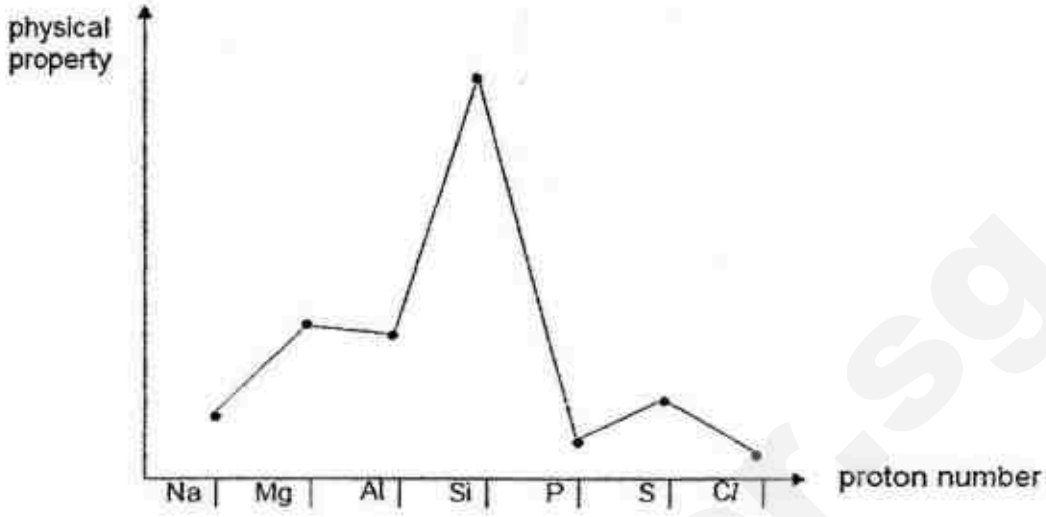
29 In which of the following process is the presence of water not essential?

A the rusting of iron
B the electrolytic purification of copper
C the production of ethanol from ethene
D the extraction of iron in the Blast Furnace

30 Which statement about the extraction of iron in the blast furnace is correct?

A Iron(III) oxide is reduced by carbon monoxide.
B Coke is added to the furnace to remove acidic impurities.
C Limestone reacts with silicon dioxide to form calcium silicate.
D Pure molten iron floats on top of molten slag at the bottom of the furnace.

31 The graph below shows the variation of a physical property with the proton number for the elements from sodium to chlorine in the Periodic Table.



Which of the following is a possible physical property as described above?

A atomic radius
B electrical conductivity
C valency
D melting point

32 A catalytic converter in a car exhaust system changes pollutants into less harmful products. Which of the following change does not occur in a catalytic converter?

A carbon dioxide → carbon
B nitrogen oxides → nitrogen
C carbon monoxide → carbon dioxide
D unburnt hydrocarbons → carbon dioxide and water

33 Polyvinyl chloride, commonly known as PVC, is the world's third most widely produced synthetic plastic polymer. PVC products are often burnt in incinerators for disposal purpose.

Which gases produced would contribute to the formation of acid rain?

I hydrogen chloride
II carbon dioxide
III carbon monoxide

A I only
B I and II only
C II and III only
D All of the above

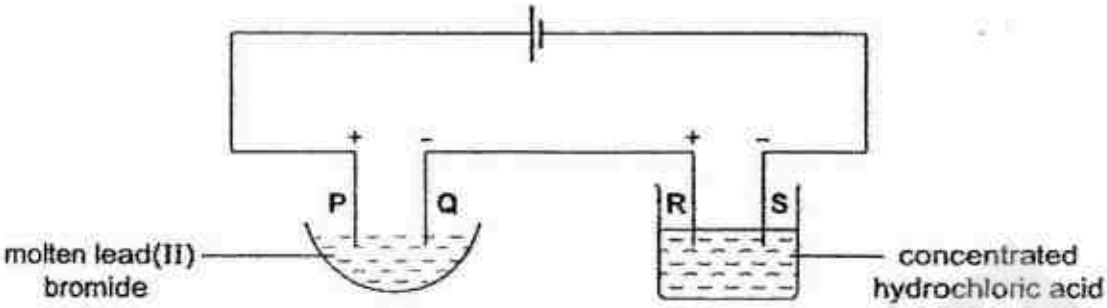
34 A metal can be extracted by the electrolysis of its molten chloride. The table shows properties of the metal and its chloride.

substance	melting point/ °C	boiling point/ °C	density/ gcm^{-3} (at temperature of electrolysis)
metal	328	1750	11
metal chloride	534	950	4.5

In what state will the metal be formed in the electrolysis?

A As a solid below the molten chloride.
B As a liquid below the molten chloride.
C As a solid on the surface of the molten chloride.
D As a liquid on the surface of the molten chloride.

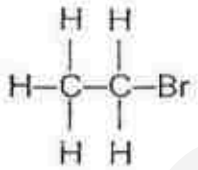
35 The following electrolysis circuit is set up, using inert electrodes P, Q, R and S.

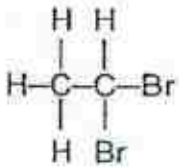


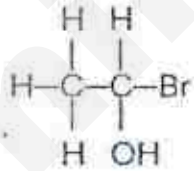
At which electrodes is a Group VII element produced?

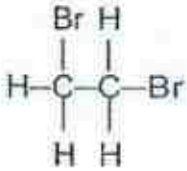
A P only
B P and R
C Q only
D Q and S

36 Which of the following is most likely the product when ethene is bubbled into bromine water?


A


B


C


D

37 A food chemist wants to create the smell of pineapples using an organic compound with the chemical formula, $CH_3COOCH_2CH_2CH_2CH_3$.

Which of the following pair of reactants, with a suitable catalyst, would produce this compound?

A CH_3CH_2OH and $CH_3CH_2CH_2CH_2OH$
B CH_3CH_2OH and $CH_3CH_2CH_2COOH$
C CH_3COOH and $CH_3CH_2CH_2CH_2OH$
D $CH_3CH_2CH_2COOH$ and CH_3COOH

38 Two unlabelled bottles containing benzoic acid and nonanol respectively were mixed up. The best method to distinguish between the two organic compounds is by using

A aqueous bromine
B sodium carbonate
C dilute sulfuric acid
D sodium hydroxide solution

39 Oleic acid is an unsaturated acid found commonly in olive oil which has a molecular formula of $C_{17}H_{31}COOH$. How many carbon-carbon double bond(s) is/are present in one molecule of oleic acid?

A 1
B 2
C 3
D 4

40 Which of the following statements about the fractional distillation of petroleum is correct?

A The molecules collected at the bottom of the column are the most flammable.
B The molecules reaching the top of the column have the lowest viscosity.
C The molecules reaching the bottom of the column are usually the least intensely coloured.
D The molecules collected at the top of the column possess the highest boiling point.

End of Paper

4E Chemistry 2017 Prelim
Marking Scheme

Paper 1 5073/01

1	C	**2**	A	**3**	A	**4**	C	**5**	B
6	B	**7**	D	**8**	C	**9**	C	**10**	A
11	A	**12**	C	**13**	D	**14**	D	**15**	A
16	B	**17**	A	**18**	A	**19**	C	**20**	A
21	C	**22**	C	**23**	B	**24**	A	**25**	C
26	D	**27**	B	**28**	B	**29**	D	**30**	A
31	D	**32**	A	**33**	B	**34**	B	**35**	B
36	D	**37**	C	**38**	B	**39**	B	**40**	B

Name: ..... Register no: ..... Class: .....

NGEE ANN SECONDARY SCHOOL

E

SECONDARY 4 PRELIMINARY EXAMINATION

CHEMISTRY **5073**

Paper 1 **3 August 2017**

1 h

Additional Materials: Optical Answer Sheet (OAS)

Instructions to Candidates

Write your name, register number and class at the top of this page.

Write in dark blue or black pen.

You may use pencil for any diagrams, graphs, tables or rough working.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.

Choose the one you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

A copy of the Periodic Table is printed on page 2.

The use of an approved scientific calculator is expected, where appropriate.

Checked by student: _____ Date: _____

This document consists of 13 printed pages and 1 blank page.

1 Methylbenzene is an organic compound which is insoluble in water and it is found to boil at 111 °C.

Given a mixture of methylbenzene and dilute aqueous copper(II) sulfate, which two methods would need to be carried out in order to obtain samples of methylbenzene and copper(II) sulfate crystals?

	method 1	method 2
A	fractional distillation	crystallisation
B	simple distillation	evaporation
C	using of a separating funnel	crystallisation
D	using of a separating funnel	evaporation

2 A piece of zinc metal does not react when placed in a solution of hydrogen chloride which is dissolved in toluene. Which of the following changes will cause a reaction?

A Add water and stir well.
B Bubble more hydrogen chloride gas into the solution to increase its concentration.
C Remove the layer of oxide on the zinc metal before placing it in the solution.
D Use zinc powder instead of zinc metal as rate of reaction will increase.

3 Which of the following salts is best prepared using precipitation?

A barium nitrate
B potassium carbonate
C silver chloride
D zinc sulfate

4 Which of the following reagents, when mixed and heated with ammonium sulfate, liberates a gas that turns a moist red litmus paper blue?

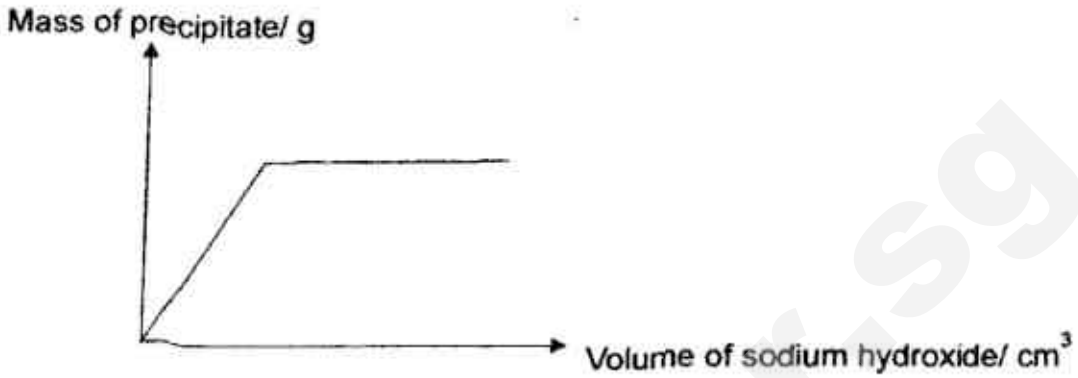
A acidified potassium dichromate(VI)
B aqueous bromine
C dilute hydrochloric acid
D limewater

5 When testing for a sulfate ion using barium nitrate, the solution must be acidified with nitric acid.

What is the purpose of the nitric acid?

A to act as a catalyst
B to adjust the pH such that it is suitable for the reaction to occur
C to prevent precipitation of barium carbonate
D to reduce the sulfate ion

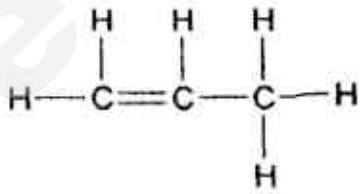
6 An aqueous solution, of a salt was placed in a test tube and aqueous sodium hydroxide was gradually added from the burette. The mass of the precipitate was obtained when various volumes of aqueous sodium hydroxide was added and a graph was obtained as shown.



Which of the following is likely to be the aqueous solution?

A aluminium phosphate
B copper(II) chloride
C lead(II) nitrate
D zinc sulfate

7 An organic molecule has the structural shown.



How many of the electrons is/are not involved in bonding?

A 3 B 4
C 6 D 8

8 Which of the compounds does not contain covalent bonds?

A calcium carbonate B magnesium oxide
C potassium phosphate D sodium hydroxide

9 The element X has three electrons in its outer shell.

What is the formula of the oxide of element X?

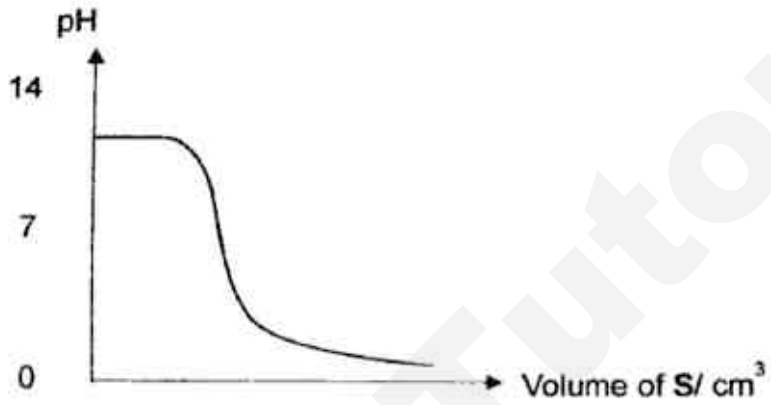
A a covalent compound X_3O
B an ionic compound X_3O
C a covalent compound X_2O_3
D an ionic compound X_2O_3

10 A solid, **R**, has a melting point of 734 °C. It can only conduct electricity when molten or in aqueous solution. It is soluble in water but not in organic solvent.

Which of the following is likely to be **R**?

A diamond
B graphite
C potassium bromide
D zinc

11 Aqueous solution **S** is added to aqueous solution **R**. The changes pH is shown in the graph.



Which of the following solutions best represents **R** and **S**?

	R	S
A	aqueous ammonia	ethanoic acid
B	aqueous ammonia	hydrochloric acid
C	aqueous sodium hydroxide	ethanoic acid
D	aqueous sodium hydroxide	hydrochloric acid

12 Which row correctly shows the order of rates of diffusion of the gases carbon dioxide, nitrogen and oxygen?

	slowest	→	fastest
A	CO_2	N_2	O_2
B	CO_2	O_2	N_2
C	O_2	CO_2	N_2
D	N_2	O_2	CO_2

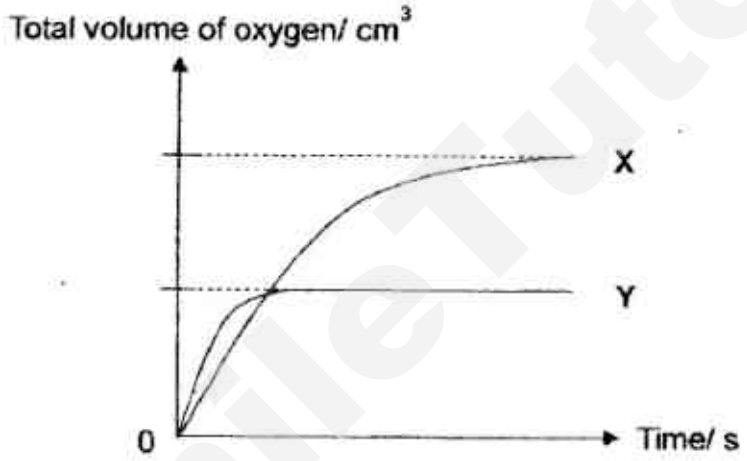
13 The table shows details of the particles present in the following 4 atoms or ions.

atoms/ ions	number of neutrons	number of electrons
W^-	17	18
X	16	16
Y^{2+}	20	18
Z	20	17

Which of the following atoms is an isotope of W?

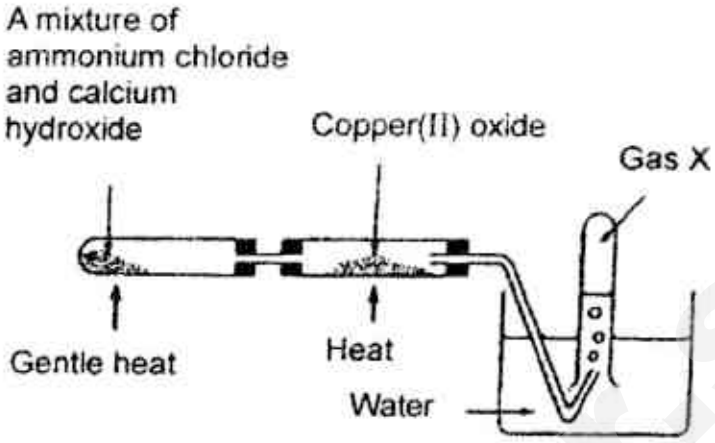
A X
B Y
C Z
D None of the above

14 The graph represents the results of two experiments, X and Y, demonstrating the catalytic decomposition of hydrogen peroxide to form water and oxygen. Assuming that all other conditions are kept constant, which one of the following is a correct explanation of the different results?



	X	Y
A	The catalyst was in lumps.	The catalyst was finely divided.
B	1.0 g of manganese(IV) oxide was used	0.50 g of manganese(IV) oxide was used
C	The reaction was carried out at 60 °C.	The reaction was carried out at 30 °C.
D	50 cm^3 of 1.0 mol/dm^3 hydrogen peroxide were used	12.5 cm^3 of 2.0 mol/dm^3 hydrogen peroxide were used

15 Copper(II) oxide reacts with ammonia at high temperature to form a solid and two gases.



The gas X

A relights a glowing splint.
B has no effect on the colour of moist litmus paper.
C turns a moist blue litmus paper red then bleaches.
D turns anhydrous copper(II) sulfate blue.

16 Which statement describes the changes in the elements from left to right across a period of the Periodic Table?

A The ability to conduct electricity increases.
B The element changes from metals to non-metals.
C The melting and boiling point increases.
D The number of neutrons in an atom decreases.

17 What volume of air is required to ensure the complete combustion of 24 cm^3 of propane at room temperature and pressure?

A 24 cm^3 **B** 120 cm^3
C 114 cm^3 **D** 571 cm^3

18 Tin is extracted from SnO_2 (M_r = 151) by reducing it with coal in a furnace according to the chemical equation.

$$SnO_2 + 2C \rightarrow Sn + 2CO$$

What is the percentage purity of tin ore if 600 g of SnO_2 on reduction produces 82 g of tin?

A 17.3% **B** 34.6%
C 41.3% **D** 82.6%

19 Which of the following has 7.2×10^{23} atoms?

A 0.2 mol of magnesium metal
B 0.3 mol of ammonia gas
C 3.0 mol of carbon dioxide gas
D 4.0 mol of hydrogen chloride

20 Copper reacts with hot concentrated sulfuric acid in a redox reaction.

$$Cu + H_2SO_4 \rightarrow CuSO_4 + SO_2 + H_2O$$

Which statement about this reaction is correct?

During the reaction

A copper changes from oxidation state 0 to oxidation state +2.
B hydrogen changes from oxidation state +1 to –1.
C sulfuric acid is acting as a reducing agent.
D sulfur remains in oxidation state +4.

21 Photochemical smog appears as a brownish haze over many industrialised cities. Which of the following is not responsible for its formation?

A nitrogen dioxide
B ozone
C propane
D sulfur dioxide

22 A sample of air along the Tampines Expressway (TPE) is collected and its composition is examined.

Which of the following is least likely to be one of the components in the sample of air?

A carbon monoxide
B nitrogen dioxide
C nitrogen monoxide
D sulfur dioxide

23 The following observations were made when nickel, Ni, and iron, Fe, were put separately into salt solutions of three metals P, Q and R.

metals	salt solution, P	salt solution, Q	salt solution, R
Ni	not displaced	yes, displaced	not displaced
Fe	yes, displaced	yes, displaced	not displaced
R	yes, displaced	yes, displaced	-

What is the correct order in increasing reactivity of the five metals?

A P, R, Fe, Ni, Q
B P, Fe, R, Q, Ni
C Q, Ni, Fe, R, P
D Q, Ni, P, Fe, R

24 A metal **X** is place between zinc and tin in the reactivity series. Which method can be used to extract **X**?

A electrolysis of an aqueous solution of a chloride of **X**
B heating of a carbonate of **X**
C reduction of an oxide of **X** by hydrogen
D reduction of an oxide of **X** by carbon

25 Element **X**

- density is 19.25 g/cm^3.
- forms XO_2 and XO_3.
- has the ability to conduct electricity in solid state.

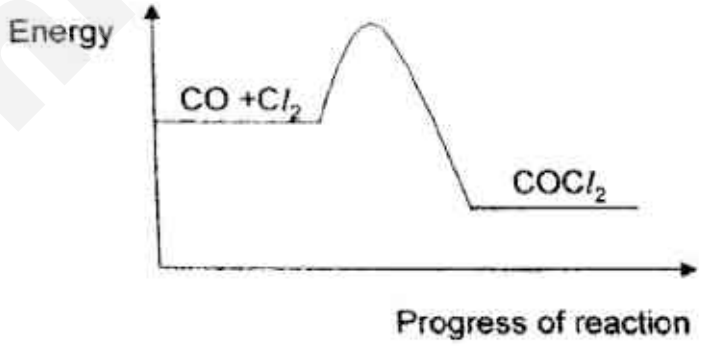
Wh at is the possible identity of element **X**?

A lithium
B sulfur
C tungsten
D zinc

26 Which statement describes what happens when hydrogen and oxygen are used in a fuel cell?

A Electricity is generated directly.
B Electricity is used to produce water.
C Hydrogen is burned to form steam.
D Hydrogen reacts to form a hydrocarbon fuel.

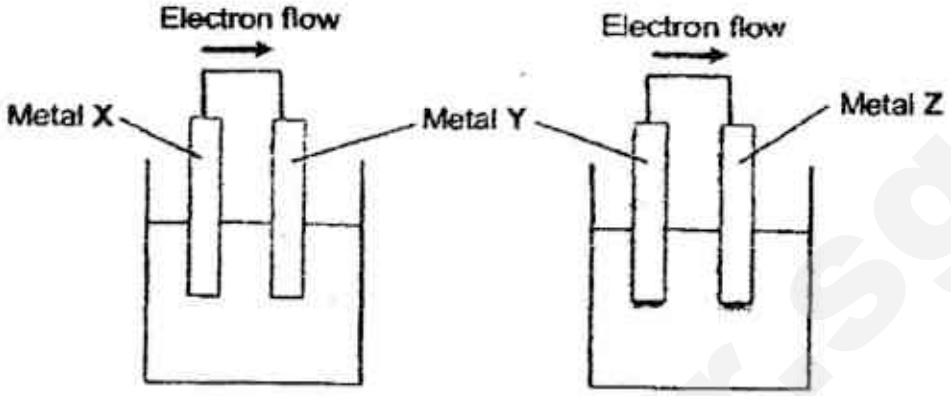
27 The energy profile diagram for the reaction between carbon monoxide and chlorine gases to form carbonyl dichloride is shown below.



From the diagram, which statement about this reaction is correct?

A The energy change when breaking the bonds in carbon monoxide and chlorine is greater than the energy change when forming the bonds in carbonyl dichloride.
B The presence of catalyst lowers the activation energy of the reaction.
C The reaction is exothermic as heat energy is given out.
D The volume of the reactants is equal to the volume of products

28 Two cells were set up as shown in the diagram. The arrow indicates the direction of the electron flow in the circuit.



Which set of metals would give the electron flow in the direction shown above?

	metal X	metal Y	metal Z
A	Ag	Mg	Zn
B	Mg	Zn	Ag
C	Mg	Ag	Zn
D	Zn	Mg	Ag

29 Carbon electrodes are used in the electrolysis of an aqueous solution containing both copper(II) nitrate and sodium sulfate.

What will be produced at the positive electrode?

A copper
B hydrogen
C nitrogen
D oxygen

30 During electrolysis, an electrolyte contains two different anions each present at the same concentration.

Which of the statements is correct?

A Both are discharged at the anode at the same time.
B Both are discharged at the cathode at the same time.
C The stronger reducing agent is discharged at the anode.
D The stronger reducing agent is discharged at the cathode.

31 Ammonia is produced by the Haber process.

Which of the statements is true?

1 Each hydrogen molecule reacts with three nitrogen molecules to form two molecules of ammonia.
2 Hydrogen can be obtained by the cracking of long chain hydrocarbons.
3 The formation of ammonia is a reversible process.

A 1 and 2 only
B 1 and 3 only
C 2 and 3 only
D 1, 2 and 3

32 Which of the following does not take place in the catalytic converter?

A carbon monoxide is oxidised to carbon dioxide
B oxides of nitrogen are reduced to nitrogen
C unburnt hydrocarbons are oxidised to carbon dioxide and water
D water vapour is reduced to hydrogen

33 Which two compounds are commonly used as fuels for cooking?

A diesel and naptha
B kerosene and petroleum gas
C kerosene and diesel
D petroleum gas and naptha

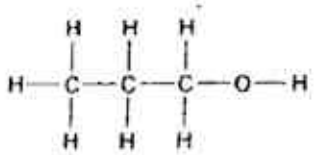
34 Which of the following statements is true about butane and butene?

1 They can react with chlorine in the dark.
2 Butene burns with a smokier flame than butane.
3 Butene is more reactive than butane.

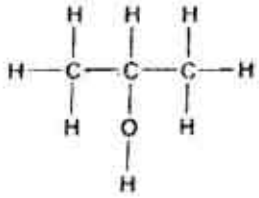
A 1 only
B 1 and 2 only
C 2 and 3 only
D 1, 2 and 3

35 The structural formulae of three compounds, **X**, **Y** and **Z** are as shown.

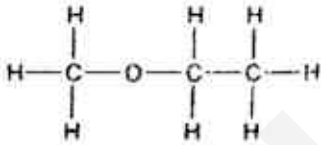
X



Y



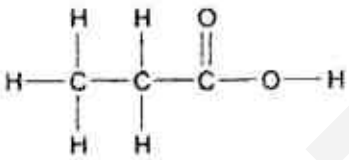
Z

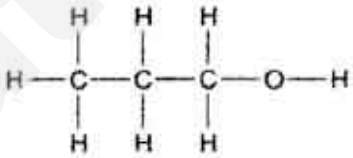


Which compounds are isomers?

A X and Y only
B X and Z only
C Y and Z only
D X, Y and Z

36 The structural formulae of two compounds are as shown.





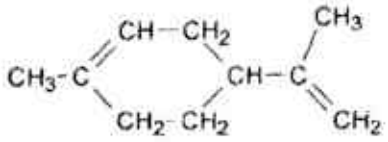
Which of the following is the best method to distinguish between these two compounds?

A using bromine water
B using dilute hydrochloric acid
C using sodium carbonate
D using sodium hydroxide

37 Which compound is obtained by hydration of propene?

A C_3H_8
B C_3H_7OH
C C_3H_5COOH
D C_4H_9OH

38 Limonene is found in orange oil. The structure of limonene is as shown.



Which statements are true about limonene?

1 It reacts with chlorine.
2 It is flammable.
3 It can react with hydrogen gas to form a saturated hydrocarbon.

A 1 and 2 only
B 1 and 3 only
C 2 and 3 only
D 1, 2 and 3

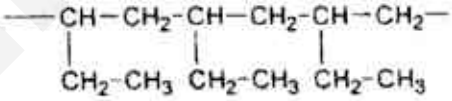
39 An alcohol **X** can react with acid **Y** to form an ester with the formula $C_8H_{16}O_2$.

Alcohol **X** can be oxidised to acid **Y** by heating with acidified aqueous potassium manganate(VII).

What is the structural formula of the ester?

A $C_3H_7COOC_5H_{11}$
B $C_3H_7COOC_4H_9$
C $C_4H_9COOC_4H_9$
D $C_5H_{11}COOC_2H_5$

40 The structure of a polymer is shown below.



What is the molecular formula of the monomer?

A C_2H_4
B C_3H_8
C C_4H_8
D C_4H_{10}

— End of Paper —

2017 Secondary 4 Chemistry (5073) Prelim Paper

Suggested Answers

Paper 1

1	C	11	B	21	D	31	C
2	A	12	B	22	D	32	D
3	C	13	C	23	D	33	B
4	D	14	D	24	D	34	C
5	C	15	B	25	C	35	D
6	B	16	B	26	A	36	C
7	C	17	D	27	C	37	B
8	B	18	A	28	B	38	D
9	D	19	B	29	D	39	B
10	C	20	A	30	C	40	C