2015 Sec 4 Express
Pure Chemistry
(Paper 1 & 2 with Answers)

1.	ANGLO CHINESE SEC SCH	SA2
2.	BUKIT PANJANG GOVT HIGH SCH	SA2
3.	CATHOLIC HIGH SCH	SA2
4.	CRESCENT GIRLS' SEC SCH	SA2
5.	GAN ENG SENG SEC SCH	SA2
6.	MARIS STELLA HIGH SCH	SA2
7.	METHODIST GIRLS' SCH	SA2
8.	NAN CHIAU HIGH SCH	SA1
9.	SINGAPORE CHINESE GIRLS' SCH	SA2
10.	ST NICHOLAS GIRLS SEC SCH	SA2
11.	SWISS COTTAGE SEC SCH	SA2
12.	ZHONG HUA SEC SCH	SA2

Anglo-Chinese School

(INDEPENDENT)

THE BEST IS YET TO BE

Year 4 Express
Preliminary Examination 2015

CHEMISTRY **5073/1**

PAPER 1 Multiple Choice

Wednesday 12 August 2015 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 your 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 A bottle of solid magnesium oxide has been contaminated with sodium chloride crystals
How can a pure sample of magnesium oxide be obtained from this mixture?

A Add acid to the mixture, filter then evaporate the filtrate

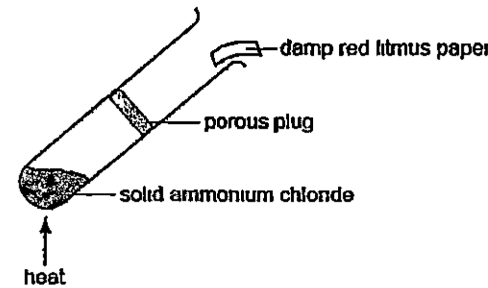
B Add acid to the mixture, filter then collect the residue

C Add water to the mixture, filter then evaporate the filtrate

D Add water to the mixture, filter then collect the residue

2 Solid ammonium chloride decomposes on heating according to the following equation

$$NH_4Cl\ (s) \rightarrow NH_3\ (g) + HCl\ (g)$$



Which change would occur to the damp red litmus paper in the experiment above?

A It remains red

B It turns blue and is then bleached

C It turns blue and remains blue

D It turns blue and then turns red

3 Which ion has the least number of occupied shells?

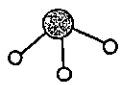
A Ca^{2+} **B** N^{3-}

C Li^{+} **D** Cl^{-}

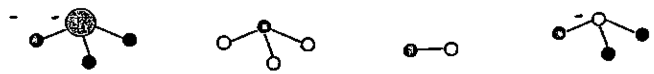
4 Which particles are responsible for conducting electricity in metals and for conducting electricity in molten ionic compounds?

	Metals	**Molten ionic compounds**
A	electrons	electrons
B	electrons	positive ions and negative ions
C	positive ions	electrons
D	positive ions and electrons	positive ions and negative ions

5 The models and formulae for some molecules are shown below

XY_3  ZX 

Which of the following is the correct model for a molecule of the compound formed between Y and Z?



A B C D

6 The electrical properties of four substances W, X, Y and Z are shown below

Substance	Electrical Property
W	Conducts electricity only in aqueous state
X	Conducts electricity when molten and in solid state
Y	Conducts electricity when molten and in aqueous state
Z	Does not conduct electricity under any conditions

What could these four substances be?

	W	X	Y	Z
A	$CaCl_2$	HCl	P	Pb
B	HCl	Pb	$CaCl_2$	P
C	P	$CaCl_2$	HCl	$CaCl_2$
D	Pb	P	Pb	HCl

7 Which solid does **not** contain covalent bonds?

A Gold

B Graphite

C Ice

D Silicon dioxide

8 Which substance contains the greatest number of molecules in 1 g?

A O_2 B NO_2

C CO D SO_2

9 Which one of the following has a mass equal to the mass of one mole of H_2O?

A One molecule of water

B 24 dm^3 of water

C Two moles of H_2 and one mole of O_2

D One mole of steam

10 20 cm^3 of oxygen reacts with 20 cm^3 of carbon monoxide to form carbon dioxide What is the volume of the gases remaining at the end of the reaction? All volume are measured at room temperature and pressure

	Oxygen / cm^3	Carbon monoxide / cm^3	Carbon dioxide / cm^3
A	10	0	20
B	10	10	20
C	0	0	20
D	0	0	40

11 Two aqueous solutions X and Y are mixed together Which of the following pairs would not give a white precipitate?

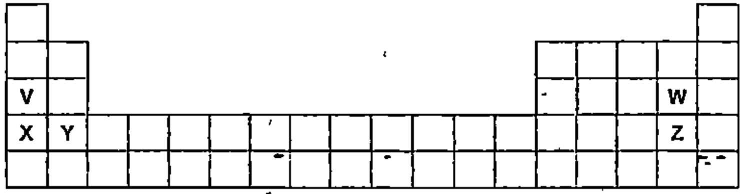
	X	Y
A	Lead(II) nitrate	Sodium sulfate
B	Zinc nitrate	Sodium carbonate
C	Silver nitrate	Sodium chloride
D	Magnesium nitrate	Sodium sulfate

12 Which one of the options below shows the best methods used to prepare the following salts?

	Titration	Precipitation	Adding excess carbonate reactants with acid
A	potassium ethanoate	silver chloride	zinc sulfate
B	ammonium nitrate	barium sulfate	sodium chloride
C	barium carbonate	calcium sulfate	magnesium chloride
D	copper(II) sulfate	ammonium chloride	iron(II) nitrate

13 Part of the Periodic Table is shown below

The letters are **not** the symbols of the elements



Which statement about the elements is correct?

A V is more reactive than X

B X has a lower melting point than V.

C Y is in the same Group as X

D Z is more reactive than W

14 The main reason farmers do not add calcium hydroxide and ammonium nitrate fertilizer to the soil at the same time is because

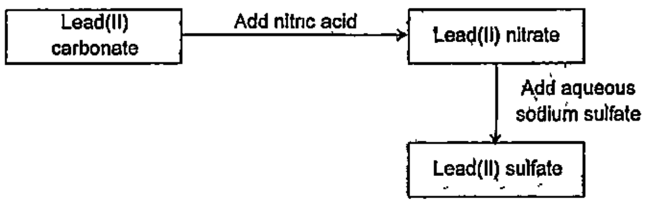
A the soil would become too alkaline

B the soil would become too acidic

C calcium hydroxide prevents the absorption of fertilizer

D the fertilizer would lose nitrogen in the form of ammonia gas

15 The diagram shows two sets of reactions used to prepare lead(II) sulfate from lead(II) carbonate



Which of the following is **not** a step in the preparation of lead(II) sulfate from lead(II) carbonate shown in the diagram?

A Add lead(II) carbonate until no more gas is produced

B Filter off unreacted lead(II) carbonate

C Evaporate the filtrate until lead(II) nitrate crystallises

D Collect lead(II) sulfate by filtration

16 Germanium(IV) oxide is an amphoteric oxide Which substance A, B, C or D in the following table could be germanium(IV) oxide?

	reaction with dilute hydrochloric acid	reaction with water	reaction with sodium hydroxide
A	dissolves	insoluble	dissolves
B	dissolves	insoluble	insoluble
C	insoluble	dissolves	insoluble
D	insoluble	insoluble	dissolves

17 In an accident at a factory, some hydrochloric acid was spilt on the floor Which substance, when added in excess would neutralise the acid **without** leaving an alkaline solution?

A Calcium carbonate

B Sodium hydroxide

C Aqueous ammonia

D Magnesium chloride

18 Which of the following salts gives only a low yield when it is made by reacting a metal oxide with dilute sulfuric acid?

A Calcium sulfate

B Iron(II) sulfate

C Copper(II) sulfate

D Zinc sulfate

19 The following sequence shows the steps in the conversion of calcium phosphate, $Ca_3(PO_4)_2$, to phosphorus acid, H_3PO_3

$$Ca_3(PO_4)_2 \rightarrow P_4 \rightarrow P_4O_6 \rightarrow H_3PO_3$$

The respective oxidation numbers of phosphorus in the above sequence are

A +5, 0, +3, +3

B +5, 0, +5, +5

C +2, +4, +4, +1

D +1, +4, +3, +1

20 Sulfur dioxide reacts with aqueous bromine according to the following equation

$$SO_2(g) + Br_2(aq) + 2H_2O(l) \rightarrow H_2SO_4(aq) + 2HBr(aq)$$

Which element has been oxidised?

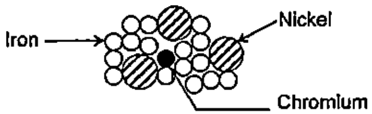
A bromine

B oxygen

C hydrogen

D sulfur

21 Stainless steel is an alloy made up of iron with other elements such as nickel and chromium The diagram below represents the particles in a certain grade of stainless steel.



Which of the following shows the composition (of the number of particles) of the stainless steel as shown in the diagram?

	Iron (%)	Nickel (%)	Chromium (%)
A	68	18	14
B	72	20	8
C	78	12	10
D	80	15	5

22 When gas Z is passed over heated copper(II) oxide, the products are copper and steam only What is gas Z?

A Ammonia B Hydrogen

C Carbon monoxide D Methane

23 Copper(II) carbonate, calcium carbonate and zinc carbonate decompose when heated The temperature at which decomposition takes place depends upon the position of the metal in the reactivity series

What is the correct order for their decomposition?

	Highest temperature	$\longrightarrow$	Lowest temperature
A	Copper(II) carbonate	Zinc carbonate	Calcium carbonate
B	Calcium carbonate	Zinc carbonate	Copper(II) carbonate
C	Calcium carbonate	Copper(II) carbonate	Zinc carbonate
D	Zinc carbonate	Calcium carbonate	Copper(II) carbonate

24 What is the effect of a catalyst on the activation energy and enthalpy change of a reaction?

	Activation energy	Enthalpy change
A	Decreases	Decreases
B	No change	Decreases
C	Decreases	No change
D	Decreases	Increases

25 A student set up three different electrochemical cells each containing two of the metals, W, Y and Z, immersed in an electrolyte The table below shows the voltage and the positive terminal of each electrochemical cell

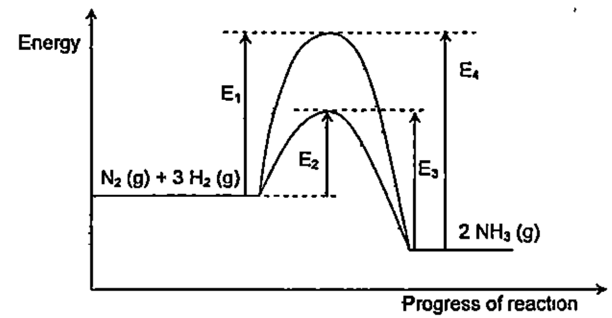
Electrochemical Cell	Metals Used	Voltage / V	Positive Terminal
1	Z and Y	+1 60	Y
2	W and Y	+1 10	W
3	W and Z	+2 70	W

Which is the order of decreasing reducing power of the metals W, Y and Z?

A Y > W > Z B Y > Z > W

C Z > Y > W D W > Z > Y

26 In the Haber process, the synthesis of ammonia from hydrogen and nitrogen is a reversible reaction The energy profile of the reaction with or without a catalyst is shown below



Which of the following statements is correct when describing the energy changes involved in the reaction?

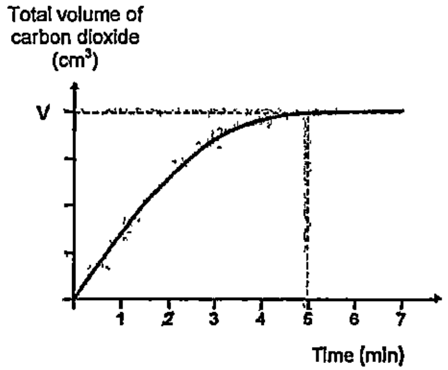
A The forward catalysed reaction is endothermic

B ($E_1 - E_2$) is the enthalpy change of the forward reaction

C E_3 is the activation energy for the backward catalysed reaction

D E_2 is the enthalpy change of the backward catalysed reaction

27 The reaction between marble chips and 200 cm^3 of 0 2 mol/dm^3 hydrochloric acid (in excess) was studied by collecting the carbon dioxide gas released in a burette The results are shown in the graph below



How would the result change if the experiment is repeated by using same mass of marble chips and 200 cm^3 of 0 4 mol/dm^3 hydrochloric acid?

	Maximum volume of CO_2 collected (cm^3)	Time at which the maximum volume is first reached (min)
A	V	More than 5 minutes
B	V	Less than 5 minutes
C	2 V	More than 5 minutes
D	2 V	Less than 5 minutes

28 Which of the following electrolytes will increase in pH when electrolysed using platinum electrodes?

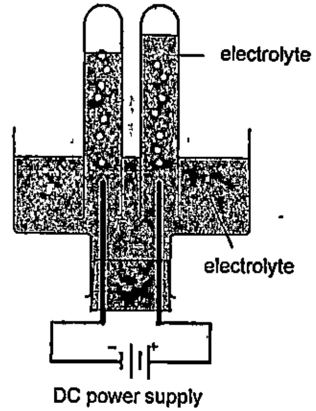
A Aqueous copper(II) sulfate

B Concentrated sodium chloride solution

C Aqueous calcium nitrate solution

D Dilute nitric acid

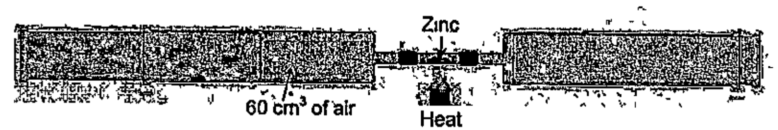
29 A student electrolysed a solution using carbon electrodes Two gases were collected as shown



Which electrolyte was used?

A Dilute sulfuric acid
B Concentrated hydrochloric acid
C Copper(II) sulfate
D Concentrated potassium iodide

30 A 60 cm^3 sample of air is trapped in a gas syringe The air is slowly passed over heated zinc in a tube until there is no further change in the volume of air



What is the final volume of air in the gas syringe?

A 40 cm^3
B 60 cm^3
C 48 cm^3
D 72 cm^3

31 Which of following reactions does **not** occur in a blast furnace in the extraction of iron?

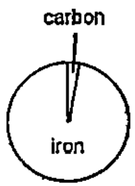
A $CaO + CO_2 \rightarrow CaCO_3$

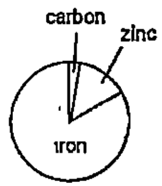
B $CaO + SiO_2 \rightarrow CaSiO_3$

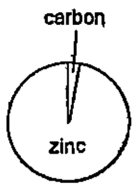
C $CO_2 + C \rightarrow 2CO$

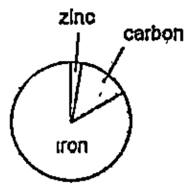
D $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

32 Which pie-chart represents the composition of a galvanised steel roof?

A


B


C


D


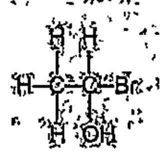
33 Useful fractions are obtained by the fractional distillation of petroleum. Which fraction is matched by its use?

	fraction	use
A	bitumen	for making roads
B	lubricating oils	aircraft fuel
C	paraffin (kerosene)	fuel in cars
D	petrol (gasolene)	for making waxes and polishes

34 Which of the following is a product formed when ethene is passed through bromine water?

A


B


C


D


35 Hydrogen gas is used in the production of margarine. The word equation for the production of margarine is shown below

vegetable oils + hydrogen gas → margarine

Which of the following options correctly lists the nature of vegetable oils, the type of reaction occurring and the catalyst used?

	Nature of vegetable oil	Type of reaction	Catalyst used
A	saturated compound	substitution reaction	iron
B	unsaturated compound	addition reaction	nickel
C	saturated compound	addition reaction	iron
D	unsaturated compound	substitution reaction	nickel

36 A compound X has all of the following properties

- It is a liquid at room temperature and atmospheric pressure
- It dissolves in water.
- It decolourises acidified potassium manganate(VII)

What could X be?

A ethane
B ethanoic acid
C ethanol
D ethene

37 Study the reaction scheme below

$$C_{10}H_{22} \xrightarrow{I} C_2H_4 \xrightarrow{II} C_2H_5OH \xleftarrow{III} C_6H_{12}O_6$$

What are reactions I, II and III?

	Reaction I	Reaction II	Reaction III
A	Fractional distillation	Addition reaction	Esterification
B	Cracking	Addition reaction	Fermentation
C	Fractional distillation	Substitution reaction	Addition reaction
D	Cracking	Addition reaction	Oxidation

38 Which of the following statements is correct?

A Complete combustion of poly(chloroethene) produces carbon dioxide and water only

B In the polymerisation of 100 g of chloroethene, 100 g of poly(chloroethene) is formed

C In the polymerisation of chloroethene to form poly(chloroethene), there is no change in the density

D Both poly(chloroethene) and chloroethene decolourise aqueous bromine rapidly.

39 The following monomer undergoes condensation polymerisation to produce a polymer

$$H-O-\square-Cl$$

Three repeat units of this polymer are shown below

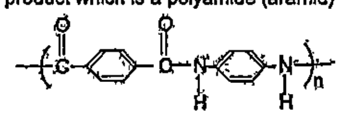
$$-O-\square-O-\square-O-\square-$$

What by-product is formed each time a monomer is added to the polymer?

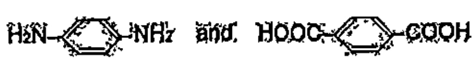
A Chlorine   B Water

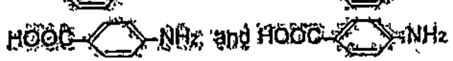
C Hydrogen   D Hydrogen chloride

40 Kelvar is a new product which is a polyamide (aramid). Its structure is

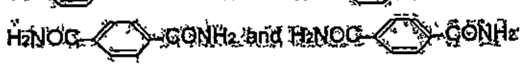


Which two molecules could be condensed to form Kelvar?

A 

B 

C 

D 

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

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

Candidate Number

Anglo-Chinese School

(INDEPENDENT)

Year 4 Express
Preliminary Examination 2015

CHEMISTRY **5073/2**

PAPER 2 Theory

Wednesday 29 July 2015 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 20.

You may use a calculator.

FOR EXAMINER'S USE	
Section A	
B7	
B8	
B9	
TOTAL	

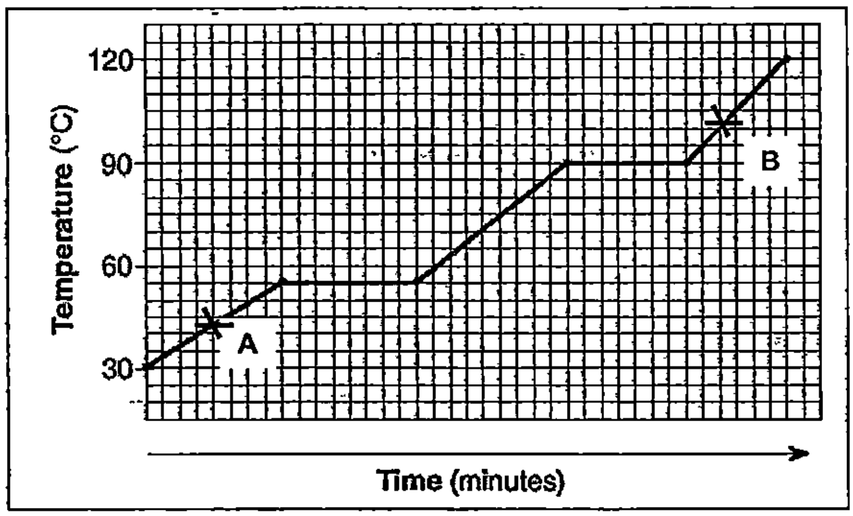
For Examiner's use

Section A

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

The total mark for this section is 50.

A1 The graph below shows the heating curve for a pure compound at room temperature and pressure.



a Explain why this compound is not water. [2]

b Draw the arrangement of particles in the compound at point **A** and **B**. [2]

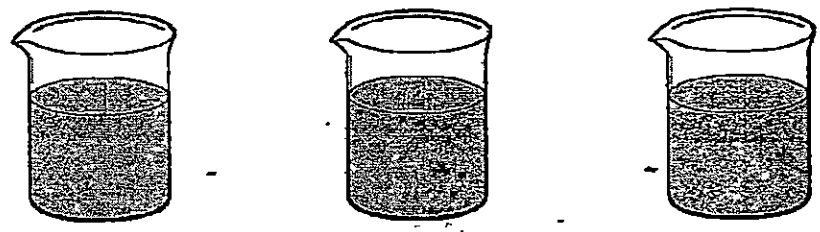
Point A	Point B

c State the type of bonding present <u>in this compound</u> and explain in terms of its structure why the melting point and boiling point are below 120°C. [3]

[Total : 7]

For Examiner's use

A2 Equal masses of magnesium carbonate were added into three beakers **P**, **Q** and **R** as shown below



After some time all the magnesium carbonate in the three beakers was reacted completely leaving behind colourless solutions.

a Write a chemical equation for the reaction between magnesium carbonate and ethanoic acid, CH_3COOH. [1]

____

b 200 cm^3 of gas was collected from beaker **P** when it is connected to a gas syringe. Would the gas collected from each of the other 2 beakers be **more than, equal to,** or **less than** 200 cm^3 when they are connected to gas syringes? [2]

i Volume of gas from beaker **Q** ______________________

ii Volume of gas from beaker **R** ______________________

c **i** Arrange the rates of reaction in ascending order for the reactions in beakers **P**, **Q** and **R**. [1]

____

ii Explain the differences in the rates of reaction in the three reactions. [3]

____

____

____

____

____

[Total : 7]

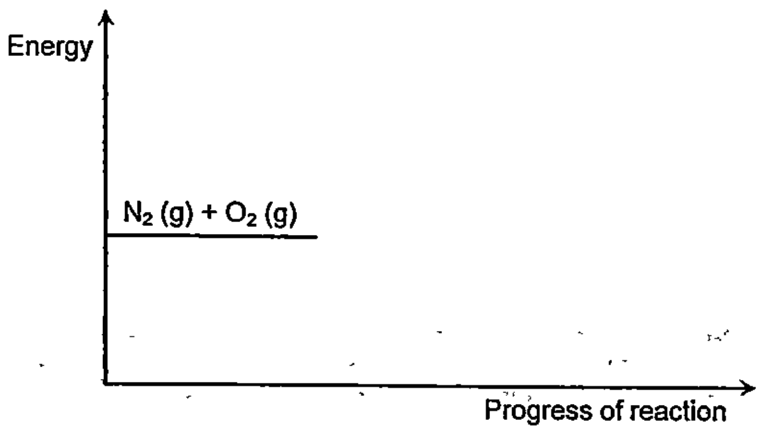
For Examiner's use

A3 In the combustion engine, nitrogen and oxygen reacts to form nitrogen monoxide as shown in the equation below:

$$N_2 (g) + O_2 (g) \rightarrow 2NO (g) \quad \Delta H = +181 \text{ kJ}$$

a Calculate the energy change when 6 dm^3 of NO is produced at room temperature and pressure. [2]

b Complete the energy profile diagram below and label clearly the products, activation energy and the enthalpy change. [2]



c Explain in terms of bond breaking and bond forming whether the reaction is exothermic or endothermic. [2]

____

____

____

d State the source of nitrogen for the above reaction? [1]

____

____

e Nitrogen monoxide can be removed in the catalytic converters installed in cars. Write an equation for the reaction of nitrogen monoxide and carbon monoxide in the catalytic converters [1]

____

f In addition to nitrogen monoxide, nitrogen dioxide is also produced in the combustion engines. Which of these two gases is directly responsible for acid rain? Explain your reasoning. [2]

____

____

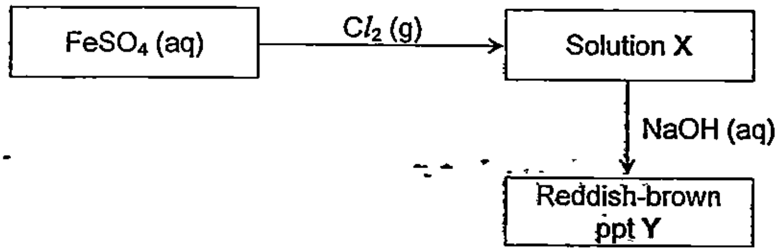
____

[Total : 10]

For Examiner's use

A4 In an experiment, chlorine gas was bubbled into aqueous iron(II) sulfate solution to form solution **X** This is followed by adding aqueous sodium hydroxide and a reddish brown precipitate **Y** is produced

The reactions are summarized in the reaction scheme below.



a i Name the precipitate Y. [1]

____

ii Write the ionic equation with state symbols for the precipitation of Y. [2]

____

b Solution **X** is thought to contain chloride ions. Describe the qualitative analysis test to show chloride ion is present. [2]

____

____

____

c The reaction between iron(II) sulfate and chlorine is a redox reaction. Explain this in terms of electron transfer. [2]

____

____

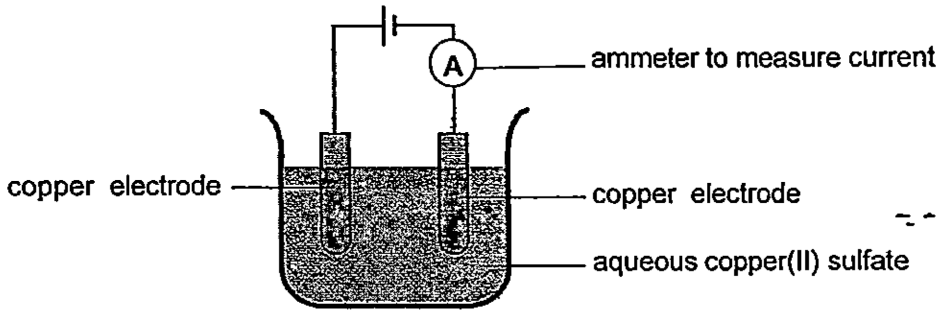
____

____

[Total : 7]

For Examiner's use

A5 A student carried out a series of electrolysis experiments using aqueous copper(II) sulfate as shown in the diagram below.



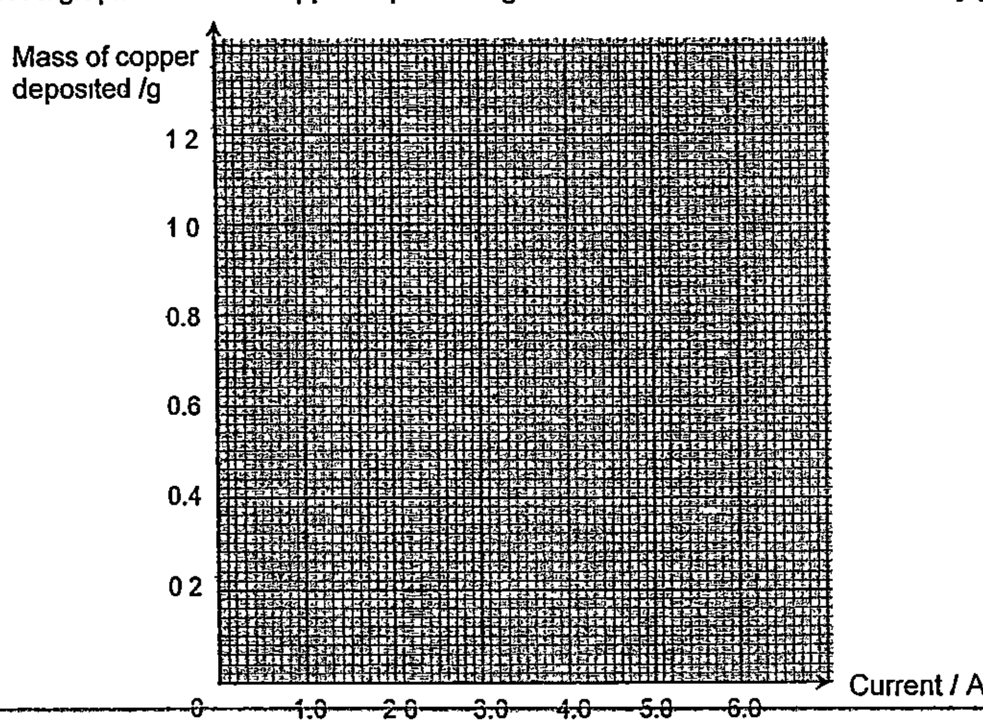
He used the same concentration of aqueous copper(II) sulfate each time, but changed the current that passed through the solution. He consistently performed each electrolysis for 10 minutes.

The student weighed the negative electrode before and after each experiment and worked out the mass of copper deposited.

The table shows the results of his experiments.

experiment	time / mins	current / A	mass of copper deposited / g
A	10	1 0	0.21
B	10	2.0	0 40
C	10	3.0	0.58
D	10	4.0	0 81
E	10	6.0	1.22

a Plot a graph of mass of copper deposited against current **[1]**



[Turn over

b Describe the relationship between the mass of the copper deposited and current as shown by your graph in **(a)**. [1]

c The student carried out another experiment by passing a current of 5.0 A through the solution of copper(II) sulfate for 5 minutes.

Use the graph from **(a)** and the information above, predict the mass of copper that would form in the experiment. [1]

d With reference to the above electrolysis, suggest the modifications made to the copper electrodes in the industrial purification of impure copper. [1]

e The student carried out another electrolysis experiment using aqueous silver nitrate and silver electrodes. His results are shown in the table below.

electrolyte	time / mins	current / A	mass of silver deposited / g
aqueous silver nitrate	10	4.0	2.7

i Write a half equation with state symbols for the reaction that occurs at the negative and positive electrodes respectively. [2]

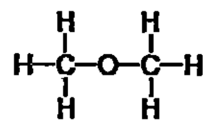
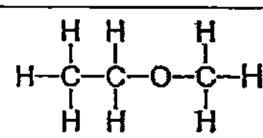
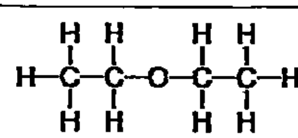
ii Calculate the number of moles of copper and the number of moles of silver that were formed when a current of 4.0 A was used for 10 minutes. [2]

iii Compare and comment on the difference between the number of moles of copper formed and the number of moles of silver formed when the same experimental conditions are used. Suggest an explanation to account for the difference. [2]

[Total : 10]

For Examiner's use

A6 The table below shows a homologous series of organic compounds called ether.

Name	Number of carbon atoms	Structural formula	Boiling point/°C
Dimethyl ether	2		-23.0
Ethylmethyl ether	3		7.0
Diethyl ether	4		34.4

a Suggest two evidences from the structural formulae to show the organic compounds belong to the same homologous series [2]

b What is the **molecular formula** of the ether molecule that contains 5 carbon atoms. [1]

c **i** Define isomers [1]

ii Draw the full structural formula of the **alcohol** which is an isomer of dimethyl ether. [1]

iii Describe a suitable chemical reaction to differentiate between the alcohol and dimethyl ether. [2]

iv The alcohol in part **(ii)** reacts with butanoic acid under suitable conditions to form a sweet smelling substance. Name and draw the full structural formula of this sweet smelling compound. [2]

[Total : 9]

Section B

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

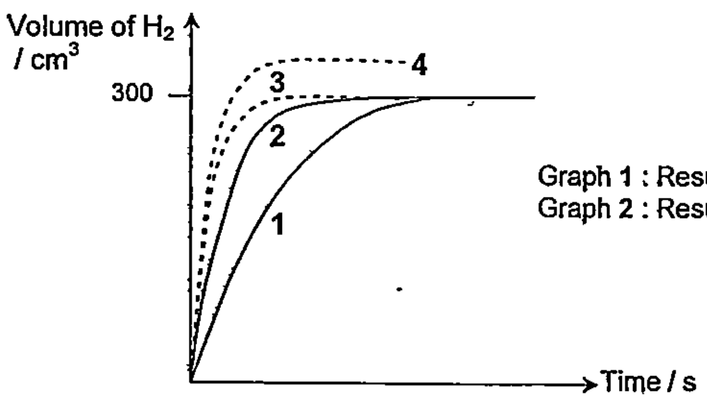
The last question is in the form **EITHER / OR** and **only one** alternative should be attempted.

Tie any extra sheets used loosely to this booklet.

B7 Metal X is found in Group II of the Periodic Table. A student placed 0.50 g of metal X into a flask containing 80 cm^3 of 1.00 mol/dm^3 HC*l* The volume of hydrogen gas was measured at regular intervals at 25°C The experiment was repeated using 0.50 g of metal X and 50 cm^3 of 2.00 mol/dm^3 HC*l*.

Experiment	Mass of Metal X	Volume and concentration of HC*l*
1	0.50 g	80 cm^3, 1.00 mol/dm^3
2	0.50 g	50 cm^3, 2.00 mol/dm^3

The results obtained are shown on the following graphs:



Graph 1 : Result from Experiment 1
Graph 2 : Result from Experiment 2

a In Experiment 1, which reagent is in excess, metal X or HC*l*? Explain your answer. [2]

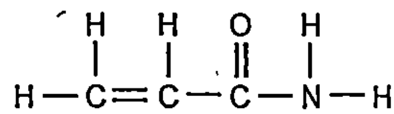
b Calculate the relative atomic mass of metal X. [3]

c Experiment 2 was repeated and an additional 0.1 g of copper was added during the reaction. The result is shown in graph 3. State and explain how copper affects the results obtained in this reaction. [2]

d Experiment 2 was carried out again but this time an additional 0.1 g of zinc was added during the reaction. The result is shown in graph 4. Explain the result. [2]

[Total : 9]

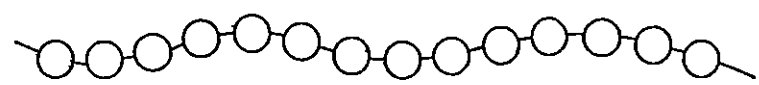
B8 **Polyacrylamide** abbreviated as PAM is a polymer formed from **acrylamide** monomer.



acrylamide, monomer

It can be synthesized as a simple **linear-chain structure** or **cross-linked.** A polymer is called a **linear polymer** (Figure 1) because it consists of a long string of carbon-carbon bonds

Figure 1

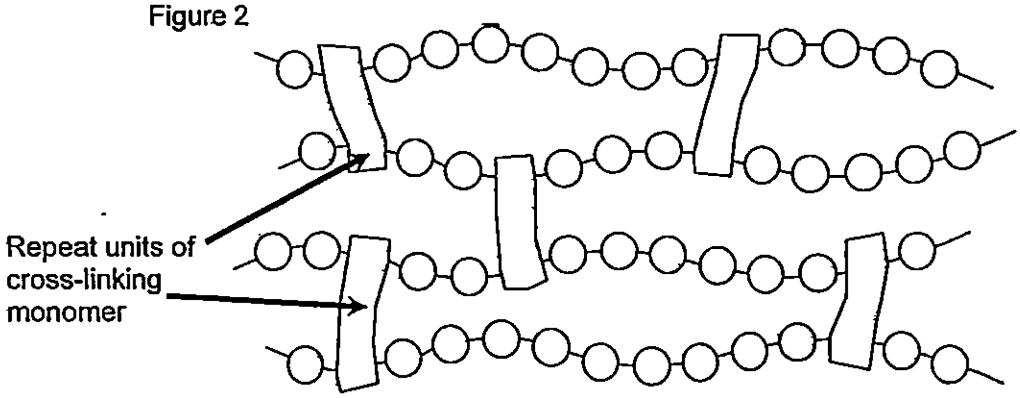


Repeat unit of acrylamide

The **cross-linked polymer** (Figure 2) uses a **cross-linking monomer** to criss-cross with the long chain polymers. Each **cross-linking monomer** has two carbon-carbon double bonds that enables it to do so.

cross-linking monomer

Figure 2



The polymers are used in the manufacture of soft contact lenses. More recently, it is used in aesthetic facial plastic surgery as filler placed beneath the skin.

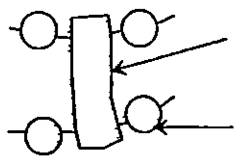
http://en wikipedia org/wiki/Polyacrylamide
http://en wikipedia.org/wiki/N,N%27-Methylenebisacrylamide
http://chemed.chem purdue.edu/genchem/topicreview/bp/1polymer/terms html

a Is the monomer **acrylamide** saturated or unsaturated? Explain with reference to its structure [2]

b Using the structural formula of the monomer given,

i draw the structure of the **linear** polyacrylamide. Your answer must show at least two repeat units. [2]

ii draw the structure of a segment of the **cross-linked** polymer. Your answer should include four **acrylamide** monomers and one **cross-linking monomer.** An outline of the required segment is shown below. [2]



c Suggest which polymer, linear or cross-linked would more likely be
(i) a fluid and
(ii) a solid.

Hence, suggest which is used to manufacture contact lenses and which is used as filler in aesthetic facial surgery? [2]

d In an addition reaction, 77 g of **cross-linking monomer** is reacted with excess iodine molecules.

Calculate the number of moles and the mass of iodine molecules required for complete addition reaction.
(relative molecular mass of **the cross-linking monomer** = 154) [3]

[Total : 11]

EITHER

B9 In the experiment to find how three gases, ammonia, carbon monoxide and sulfur dioxide, affect the rate at which metals corrode, strips of four different metals were left in contact with each gas in moist air.

After two weeks, the appearance of each metal strips was recorded as shown in the table below.

Metal	Moist air alone	Moist air polluted with		
		Ammonia	Carbon monoxide	Sulfur dioxide
Aluminium	Still shiny	Still shiny	Still shiny	Still shiny
Copper	Small patch of green solid	Coating of blue-green solid	Small patch of green solid	Coating of a black and blue solid
Iron	Coating of red-brown solid	Thin coating of red-brown solid	Coating of red-brown solid	Thin coating of red-brown solid
Lead	Still shiny	Still shiny	Still shiny	Coating of black solid

a Name the gas that gives rise to the fastest rate of corrosion and explain why this is so. [1]

b Name and explain which metal is most suitable for storing vinegar. [2]

c One more set of experiments were carried out using strips of welded iron and zinc. The welded strips were then exposed to the each of the gases in moist air.

Describe and explain the appearance of **iron** after two weeks. [3]

d Carbon monoxide and sulfur dioxide are atmospheric pollutants. Describe how they are introduced into the atmosphere. [2]

e State and explain the changes observed on red litmus paper when placed in a jar containing ammonia mixed with moist air versus a jar containing dry ammonia. [2]

[Total : 10]

OR

B9 **a** Explain the properties of the following underlined substances in terms of their bonding and structures:

i <u>Graphite</u> is a good conductor of electricity and is also used as a lubricant at high temperature. [3]

ii Particles of <u>silicon carbide</u> are laminated to paper to create sandpapers. (hint: Silicon is a group IV element just like carbon. Silicon carbide is a compound that has a structure similar to that of diamond.) [2]

b Reactions of five metals **P**, **Q**, **R**, **S** and **T** are given below.

Metals	Reactions
P	Does not react with steam but oxidizes slowly in air.
Q	Explodes in cold water.
R	Extracted industrially by reduction with coke. Reacts with steam.
S	Does not react with oxygen at room conditions
T	Sinks and reacts with water.

i Arrange the metals in descending order of reactivity. [1]

ii Identify which metal is calcium and write the equation for its reaction given in the table above. [2]

iii In an experiment, a strip of metal **R** is placed in an aqueous nitrate of **P**. Explain the reaction that would occur. [2]

[Total : 10]

ACS(Independent) Year 4 Express
2015 Final Exam

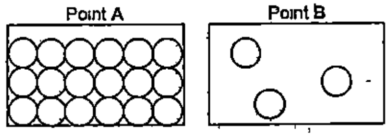
P1

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

P2

A1 a Melting point and boiling point of the compound are 55°C and 90°C respectively But melting point and boiling point of water are 0°C and 100°C respectively

b



c Covalent bonding
The compound has a simple molecular structure where the discrete molecules are held together by weak intermolecular forces These forces are easily overcome,

A2 a $MgCO_3$ (s) + 2 CH_3COOH (aq) → $(CH_3COO)_2Mg$ (aq) + H_2O (l) + CO_2 (g)

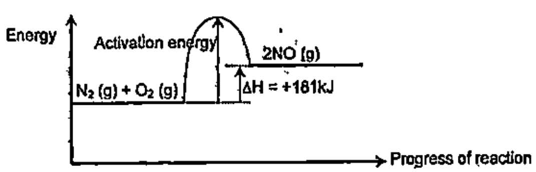
b i Volume of gas from beaker Q : Equal to 200cm³
ii Volume of gas from beaker R . Equal to 200cm³

c i Beaker R, beaker P, beaker Q

ii Ethanoic acid is a weak acid and it is only partially dissociated to give a low concentration of hydrogen ions
Dilute hydrochloric acid and dilute sulphuric acid are strong acids the dissociate completely. However, dilute sulphuric acid is a dibasic acid and it produces twice the concentration of hydrogen ions compared to dilute hydrochloric acid which is a monobasic acid

A3 a No of mol of NO = 6/24 = 0 25 mol
Energy given out = 0 25/2X181 = 22.6 kJ

b



c Endothermic.
The energy taken in to beak the bonds in 1 mole of nitrogen gas and 1 mole of oxygen gas is greater than the energy given out to form the bonds in 2 moles of nitrogen monoxide gas

d Air

e 2 NO (g) + 2 CO (g) → N_2 (g) + 2 CO_2 (g)

f Nitrogen dioxide as it is an acidic oxide and could oxidise in atmosphere and reacts with rainwater to form acid rain Nitrogen monoxide is a neutral oxide.

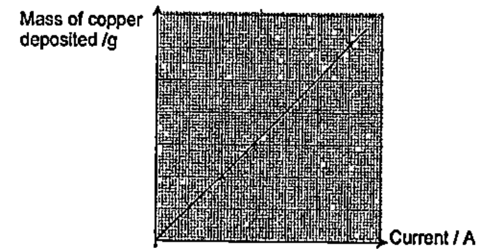
A4 a i Iron(III) hydroxide

ii Fe^{3+} (aq) + 3 OH^- (aq) → $Fe(OH)_3$ (s)

b To a sample of solution X, add dilute nitric acid followed by aqueous silver nitrate A white precipitate will be formed if chloride ion is present

c Iron(II) ion loses an electron to form iron(III) ions, this is oxidation
Chlorine gas gains electrons to form chloride ions, this is reduction

A5 a



b Mass of copper deposited is directly proportional to the current applied

c 0 508 g

d Anode impure copper, Cathode. a small piece of pure copper

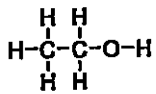
e i Negative electrode Ag^+ (aq) + e^- → Ag (s)
Positive electrode Ag (s) → Ag^+ (aq) + e^-

ii No of mole of silver = 2 7/108 = 0 025 mol
No of mole of copper = 0 81/64 = 0 0127 mol

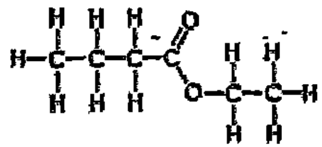
iii Number of mole of silver is twice that of copper
(number of mole of copper is half that of silver)
The charge of copper(II) ion is +2 and the charge of silver ion is +1
Given the same quantity of electrons, the number of copper(II) ions discharged is half that of silver ions

A6 a They have the same general formula, $C_nH_{2n+2}O$
The consecutive members increases by a $-CH_2-$ group of atoms

b $C_5H_{12}O$

c i Isomers are molecules that have the same molecular formula but different structural formulae ii 

iii In separate test tubes, add acidified potassium manganate(VII) to samples of ethanol and dimethyl ether and warm Ethanol decolourises the purple solution but not dimethyl ether

iv 

Ethyl butanoate

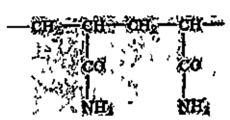
B7 a HCl is in excess
Metal X is the limiting reagent and in both experiments, the same mass of metal is used up and same volume of gas produced

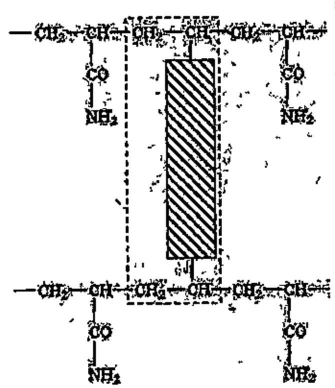
b No of mole of H_2 gas = 300/24000 = 0 0125 mol
No of mole of X = 0 0125 mol
Relative atomic mass of X = mass/mole
= 0 5/0 0125 = 40

c Copper is a catalyst
It speeds up the reaction by providing an alternative reaction pathway which has a lower activation energy

d The dilute hydrochloric acid is in excess Zinc and magnesium react concurrently to produce a higher volume of gas and faster rate than experiment 2

B8 a Unsaturated because of a carbon-carbon double bond

b i 

ii 

c Fluid is more likely to be the Linear polymer
Solid is more likely to be the Cross-linked polymer
Filler is linear polymer and contact lenses are cross-linked polymer

d No of mole of monomer = 77/154 = 0 5 mol
No of mole of iodine = 2X0 5 = 1 mole
Mass of iodine = 4X0 5X127 = 254 g

EITHER

B9 a Sulphur dioxide is an acidic oxide and dissolves in water to form acid

b Aluminium It has a protective layer of aluminium oxide

c Iron remains shiny grey Zinc provides sacrificial protection for iron Zinc is more reactive than iron and loses electrons more easily It corrodes in place of iron

d Carbon monoxide is produced from the incomplete combustion of carbon-containing substances due to the lack of oxygen
Sulphur dioxide is produced at the power station when fossil fuel is burned

e Red litmus turns blue in moist air and ammonia gas mixture but remains red in dry ammonia
Ammonia needs to dissolve in water to become an alkali and releases aqueous hydroxide ions

OR

B9 a i In the structure of graphite, each carbon bonds to other carbon atoms using three of the four valance electrons The non-bonding valance electrons of the carbon atoms form the sea of delocalised electrons that made graphite a conductor of electricity.

The carbon atoms are covalently bonded in layers consisting of hexagonal rings. Between the layers are weak forces that can be easily overcome which make the layers slide over each other easily Graphite can be used as a lubricant at high temperature due to the many strong covalent bonds between the carbon atoms

ii Silicon carbide has a giant molecular structure A large number of carbon and silicon atoms are all joined together by strong covalent bonds in a gaint three-dimensional lattice structure A lot of energy would be needed to break these bonds and the structure is hard and rigid

b i Q, T, R, P, S

ii T
$Ca\ (s) + 2\ H_2O\ (l) \rightarrow Ca(OH)_2\ (aq) + H_2\ (g)$

iii Displacement reaction
R is more reactive than P R loses electron more easily than P and it displaces P from the aqueous nitrate solution

BC YANJING

Name of Candidate ____________________ (   ) Class: ________ Index No

1. Naturally-occurring bromine has a relative atomic mass of 80 and consists entirely of two isotopes of relative atomic masses 79 and 81

What can be deduced about naturally-occurring bromine from this information only?

A Bromine contains the two isotopes in equal proportions
B Bromine has different oxidation states
C Bromine isotopes have different numbers of protons
D Bromine is a gaseous mixture of atoms and molecules at room temperature

2 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 SiC, BN and bronze are correct?

1 All are bonded covalently
2 All except silicon carbide conduct electricity when solid,
3 All have high melting points

A 1 and 2 only
B 1 and 3 only
C 2 and 3 only
D 1, 2 and 3

3 What correctly describes the molecules in very dilute sugar solution at room temperature?

	sugar molecules	water molecules
A	close together, moving at random	close together, moving at random
B	widely separated, moving at random	close together, moving at random
C	widely separated, moving at random	close together, not moving
D	widely separated, not moving	widely separated, moving at random

4. What can be deduced about two gases that have the same relative molecular mass?

A They have the same boiling point
B They have the same number of atoms in one molecule
C They have the same rate of diffusion at room temperature and pressure
D They have the same solubility in water at room temperature

5 One volume of a gaseous element X_2 combines with an equal volume of gaseous hydrogen to form two volumes of a gaseous hydride
What is the formula for the hydride of X?

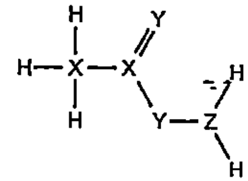
A H_2X B HX
C HX_2 D H_2X_2

6 The mass of one mole of a chloride formed by a metal Y is 74.5 g The formula of the chloride could be

A Y_3Cl C YCl

B Y_2Cl D YCl_2

7 The diagram shows the structure of a covalent compound containing the element hydrogen, H, and the unknown elements X, Y and Z.



To which groups of the Periodic Table do these three elements, X, Y and Z, belong?

	X	Y	Z
A	1	5	6
B	4	5	1
C	4	6	5
D	5	1	4

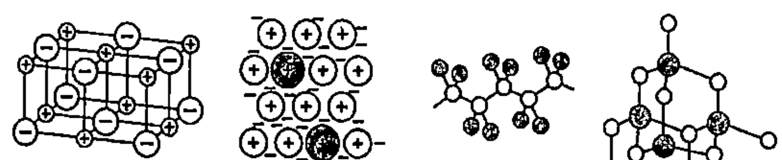
8 How could a sample of potassium be obtained from potassium chloride, KCl ?

method 1 adding zinc to a solution of KCl
method 2 electrolysing an aqueous solution of KCl
method 3 electrolysing molten KCl

A method 1 only
B methods 1 and 2
C methods 2 and 3
D method 3 only

9. Which diagram represents the structure of an alloy?

A B C D



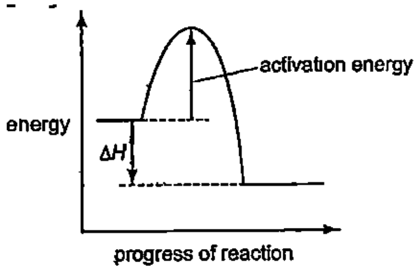
10. When a volcano erupts, which gas is produced in significant amounts?

A carbon monoxide
B chlorofluorocarbons
C methane
D sulfur dioxide

11. A concentrated aqueous solution of copper(II) chloride is electrolysed using inert electrodes. What is the product at the negative electrode?

A chlorine
B copper
C hydrogen
D oxygen

12 The energy profile for the forward direction of a reversible reaction is shown



Which row correctly shows both the sign of the activation energy and the type of the enthalpy change for the reverse reaction?

	sign of activation energy	enthalpy change
A	negative	endothermic
B	negative	exothermic
C	positive	endothermic
D	positive	exothermic

13 Which is an anion that is present in the solution formed when an excess of dilute hydrochloric acid is added to calcium carbonate?

A Ca^{2+} B Cl^- C CO^{2-} D H^+

14. Which ionic equation describes a redox reaction?

A $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$
B $2H^+(aq) + CO_3^{2-}(aq) \rightarrow CO_2(g) + H_2O(l)$
C $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
D $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$

15. Carbon and silicon are both in Group IV of the Periodic Table
Which statement is correct for both carbon dioxide and silicon dioxide?

A They are acidic oxides
B They are readily soluble in water.
C They contain ionic bonds
D They have giant molecular structures.

16 Four oxides are added separately to aqueous sodium hydroxide

1 aluminium oxide
2 carbon dioxide
3 copper(II) oxide
4 magnesium oxide

Which oxides react with aqueous sodium hydroxide?

A 1 and 2 only
B 1, 3 and 4 only
C 2 only
D 3 and 4 only

17 Which is most likely use of sulfuric acid?

A as a bleach
B in the manufacture of ammonia
C in the manufacture of fertilisers
D in the manufacture of battery acid

18 Which property is common to calcium, potassium and sodium?

A Their atoms all have one electron in the outermost shell
B Their ions all have eight electrons in their outermost shell
C The ions have are attracted to the positive electrode
D They are all deposited at the anode when their molten chloride is electrolysed

19 Which two statements indicate that metal M may have a proton number between 21 and 30?

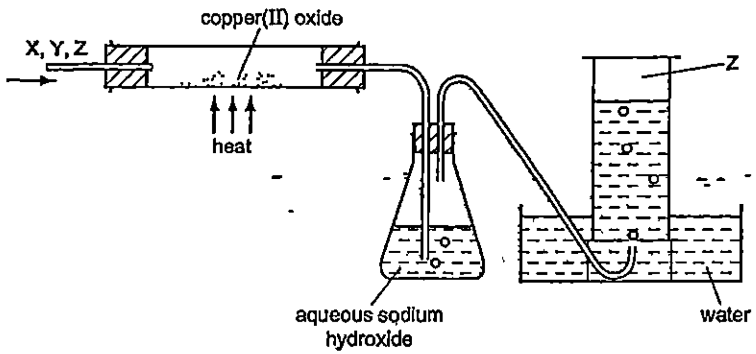
1 It conducts electricity
2 It does not react with water
3 It forms two basic oxides with formulae MO and M_2O_3
4 It forms two coloured sulfates

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

20 Which substance, in the given physical state, is found at the bottom of the blast furnace?

	substance	physical state
A	calcium carbonate	solid
B	calcium silicate	liquid
C	carbon	liquid
D	iron	solid

21 Gas Z is to be separated from a mixture of gases X, Y and Z by the apparatus shown in the diagram



For which mixture will this system work successfully?

	X	Y	Z
A	hydrogen	carbon dioxide	nitrogen
B	oxygen	hydrogen	carbon monoxide
C	nitrogen	oxygen	hydrogen
D	carbon dioxide	nitrogen	oxygen

22 Which reaction does not involve either oxidation or reduction?

A $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$
B $Cu^{2+}(aq) + Zn(s) \rightarrow Cu(s) + Zn^{2+}(aq)$
C $CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$
D $Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

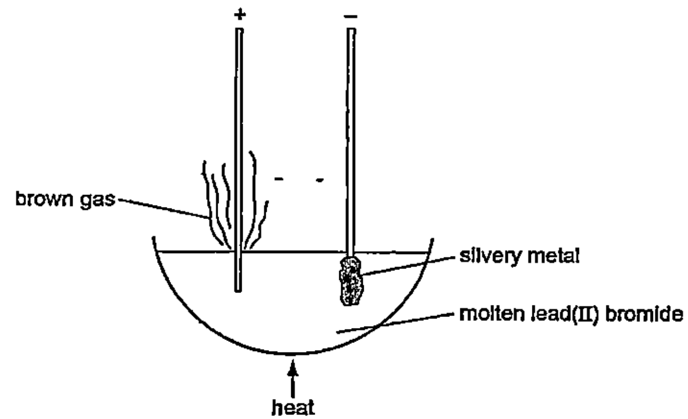
23 In the extraction of iron, carbon monoxide acts as

A an oxidising agent
B a reducing agent.
C a catalyst.
D an impurity to lower the melting point of the mixture to conserve energy

24. Magnesium can be obtained by heating magnesium oxide with which element?

A calcium
B hydrogen
C carbon monoxide
D carbon

25 The diagram shows the electrolysis of molten lead(II) bromide using inert electrodes



What happens during this electrolysis?

A Atoms change to ions
B Ions change to atoms.
C Covalent bonds are broken
D New compounds are formed

26 An alloy of copper and zinc is added to an excess of dilute hydrochloric acid The resulting mixture is then filtered Which observations are correct?

	filtrate	residue
A	colourless solution	none
B	colourless solution	red-brown
C	blue solution	grey
D	blue solution	none

27 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

28 The compounds $CO(NH_2)_2$ and NH_4NO_3 are used as fertilisers

The proportion of nitrogen by mass in $CO(NH_2)_2$ is 1 that in NH_4NO_3
The proportion of nitrogen by mole in $CO(NH_2)_2$ is 2 that in NH_4NO_3

Which words correctly complete gaps 1 and 2?

	1	2
A	equal to	equal to
B	higher than	equal to
C	higher than	higher than
D	lower than	lower than

29 Titration of an acid against a base is a method often used in the preparation of salts
Which properties of the acid, the base and the salt are required if this method is to be used?

	acid	base	salt
A	insoluble	insoluble	insoluble
B	soluble	insoluble	insoluble
C	soluble	soluble	insoluble
D	soluble	soluble	soluble

30 The oxide of an element X increases the rate of decomposition of hydrogen peroxide At the end of the reaction the oxide of X is unchanged
Which details are those of X?

	proton number	mass number
A	18	40
B	20	40
C	25	55
D	82	207

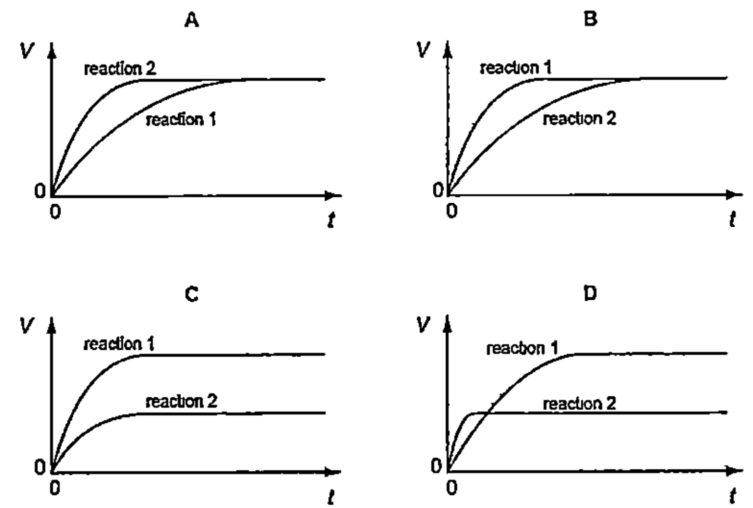
31 Scrap iron is often recycled Which reason for recycling is not correct?

A It reduces the need to collect the scrap iron
B It reduces the amount of waste taken to landfill sites
C It reduces the amount of pollution at the site of the ore extraction
D It saves natural resources

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 3 0 mol / dm^3 dilute hydrochloric acid

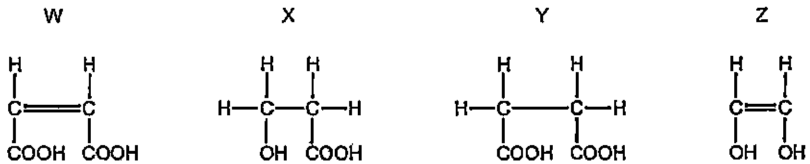
In both experiments, the volume of hydrogen produced, V, is measured against time, t, and the results plotted graphically Which set of graphs is correct?



33 Which information is correct regarding the formation of ethanol by the process of fermentation?

	substances fermented	gas evolved during fermentation
A	carbohydrates	carbon dioxide
B	carbohydrates	carbon monoxide
C	hydrocarbons	carbon dioxide
D	hydrocarbons	carbon monoxide

34 What are the reactions of compounds W, X, Y and Z?



	decolourises aqueous bromine	has a pH of less than 7	reacts with a carboxylic acid to form an ester
A	X and Y	W, X and Y	W, X , Y and Z
B	X and Y	X and Z	X and Z
C	W and Z	W, X and Y	X and Z
D	W and Z	X and Z	W, X and Y

35 Compound X has the molecular formula C_2H_6O

X can be made by a fermentation process.
X can be oxidised to Y
X can react with Y to form Z and water

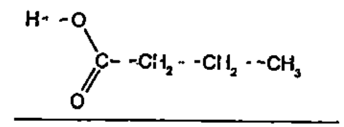
To which homologous series do X, Y and Z belong?

	X	Y	Z
A	alcohols	carboxylic acids	esters
B	alcohols	esters	carboxylic acids
C	carboxylic acids	alcohols	esters
D	carboxylic acids	esters	alcohols

36 Useful fractions are obtained by the fractional distillation of petroleum
Which fraction is matched by its use?

	fraction	use
A	bitumen	fuel in cars
B	lubricating oils	for making waxes and polishes
C	paraffin (kerosene)	for making roads
D	petrol (gasolene)	aircraft fuel

37 Which statement, about the compound shown below, is correct?



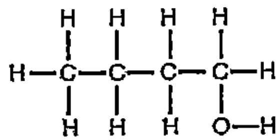
A It does not react with ammonia
B It does not react with magnesium
C It is formed by oxidation of butanol
D It is propanoic acid.

38 Compounds X and Y are both alkanes. Compound X has a higher boiling point than compound Y

What could be the formulae of compounds X and Y?

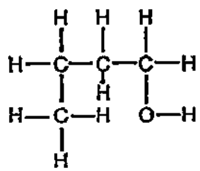
	compound X	compound Y
A	C_8H_{16}	C_9H_{18}
B	C_8H_{18}	C_9H_{20}
C	C_9H_{18}	C_8H_{16}
D	C_9H_{20}	C_8H_{18}

39 Compound Q has the structure shown.

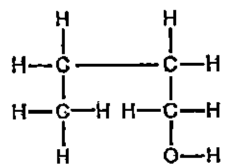


Which structure is an isomer of Q?

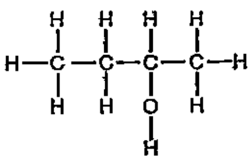
A



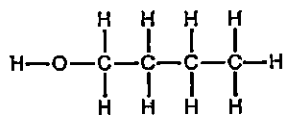
B



C

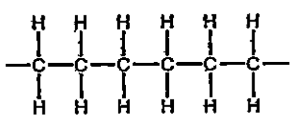


D

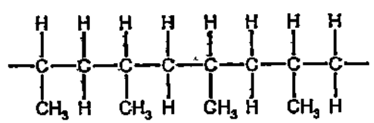


40 What is the partial structure of the polymer formed by the polymerisation of propene, $CH_3CH=CH_2$?

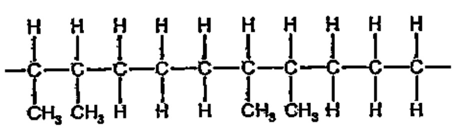
A



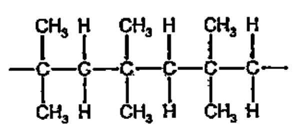
B



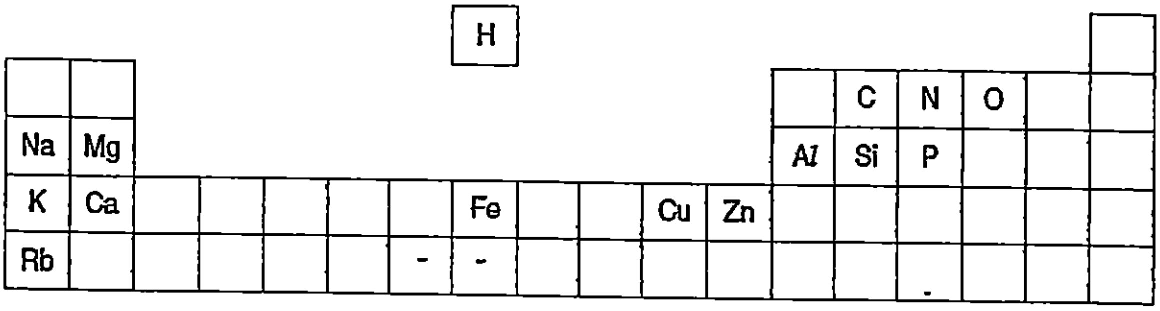
C



D



1. The diagram shows part of the Periodic Table. Only some of the elements are shown.



(a) Answer each of the following questions using only those elements shown in the diagram. Each element may be used once, more than once or not at all.

Give one element which

(i) has a giant molecular structure,

.... [1]

(ii) combines with oxygen to form a gas which contributes to acid rain,

.... [1]

(iii) forms an ion of type X^+ which has only three completely filled shells of electrons,

.... [1]

(iv) has a chloride of type XCl_2, whose aqueous solution forms a white precipitate with aqueous sodium hydroxide but insoluble in excess of NaOH.

.... [1]

(b) (i) Arsenic reacts with oxygen to form arsenic(III) oxide, As_2O_3. Construct a balanced chemical equation for this reaction.

.... [1]

(ii) Arsenic(III) oxide is slightly soluble in water. Arsenous acid, H_3AsO_3, a weak acid is formed.
When 100 cm^3 of 0.05 mol /dm^3 of both arsenous acid and hydrochloric acid is added separately to excess magnesium, will arsenous acid produce more, less or the same volume of hydrogen compared to hydrochloric acid?

.... [1]

Will the pH of arsenous acid solution be higher, lower or the same as hydrochloric acid?

.... [1]

(iii) State the chemical formula of the salt formed from the reaction between arsenous acid and magnesium.

.... [1]

2. Zinc carbonate thermally decomposes to form zinc oxide and carbon dioxide.

$$ZnCO_3(s) \rightarrow ZnO(s) + CO_2(g)$$

In an experiment, a sample of a certain mass of zinc carbonate is heated in a test-tube using a bunsen burner.
The total volume of carbon dioxide formed is measured every 10 seconds. The results are plotted on the graph below.

(a) Suggest why the volume of carbon dioxide does not increase very much when the zinc carbonate is first heated.

....

....

.... [1]

(b) Using the same flame intensity and the same particle size of lead (II) carbonate and calcium carbonate, two separate but same experiments were carried out.

Experiment (i) the **same mass** of lead (II) carbonate is heated.

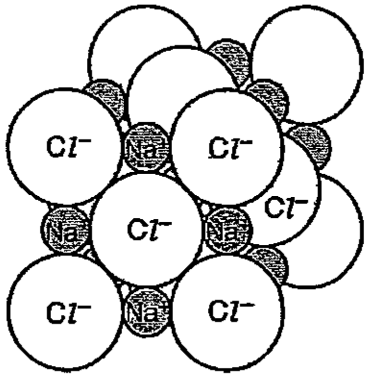
Experiment (ii) the **same number of moles** of calcium carbonate is heated.

On the axes above, draw the graphs you would expect from the results of these experiments and __label__ :-

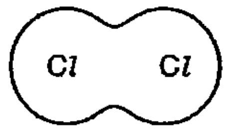
Graph (i) for experiment (i) when same mass of lead carbonate is heated, [1]

Graph (ii) for experiment (ii) when same number of moles of calcium carbonate is heated. [1]

3. The structures of sodium chloride and chlorine are shown below.



sodium chloride



chlorine

(a) The melting point of sodium chloride is 801 °C.
The melting point of chlorine is –101 °C.

(i) Explain, in terms of structure and bonding, the low melting point of chlorine

....

....

....

....[1]

(ii) Explain why hydrogen chloride can conduct electricity in the aqueous state.

....

....

....[1]

(b) State the two electrode half equations when concentrated aqueous sodium chloride is electrolyzed.

Anode reaction ....

Cathode reaction ....[2]

(c) Chlorine gas reacts with ammonia gas, NH_3, to form hydrogen chloride and nitrogen gas.

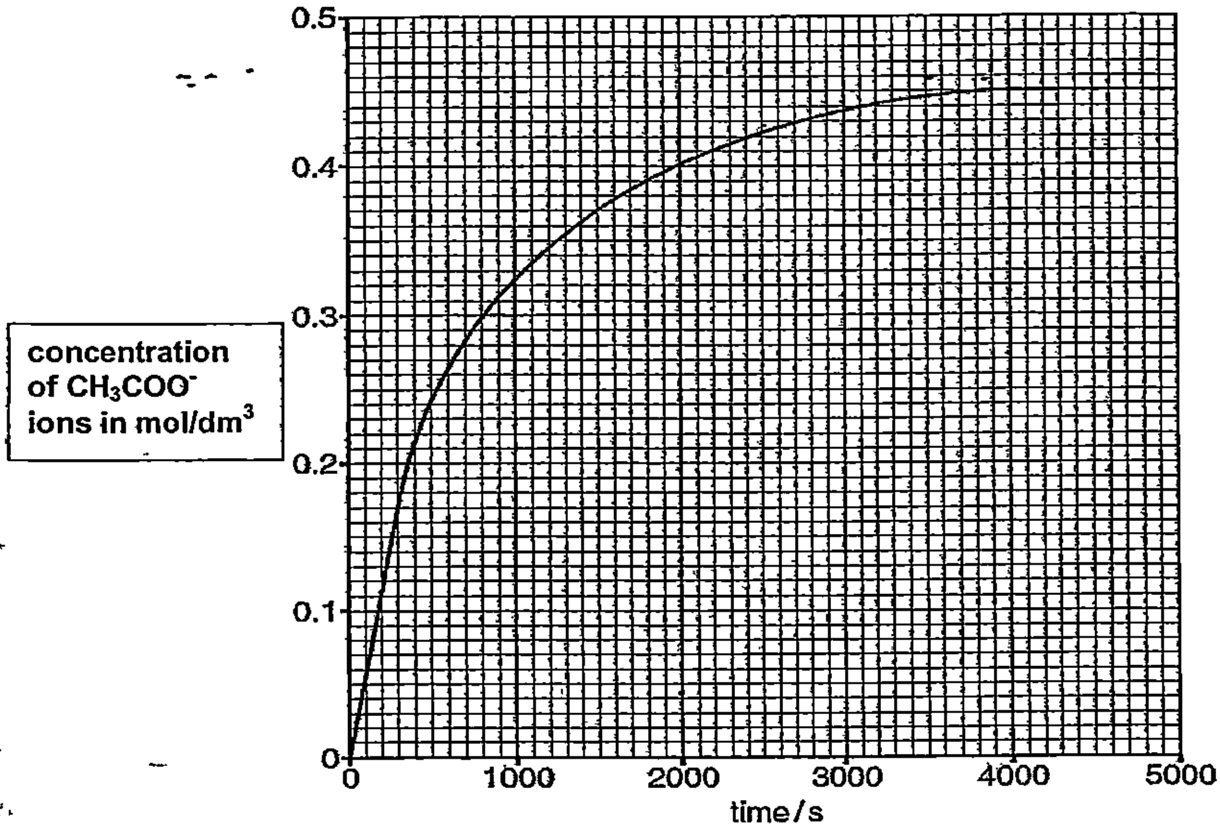
Construct a balanced chemical equation with state symbols for this reaction.

.... [2]

4. The ester, ethyl ethanoate, reacts with hydroxide ions to form ethanoate ions and ethanol, as shown in the equation below.

$CH_3COOC_2H_5$ + OH^- → CH_3COO^- + C_2H_5OH
ethyl ethanoate ethanoate ions

(a) The graph shows how the concentration of ethanoate ions, CH_3COO^-, changes as the reaction proceeds.



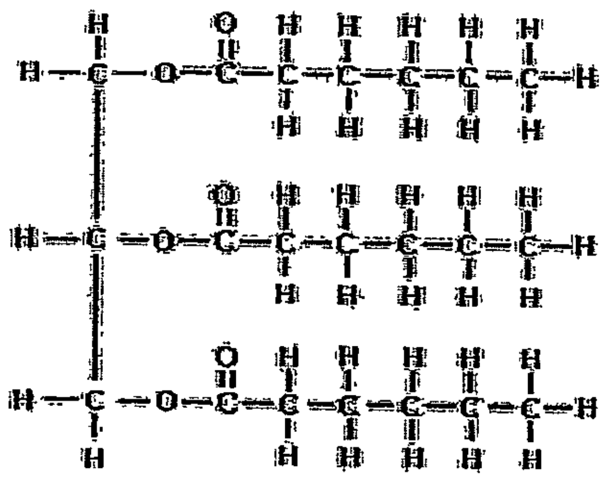
(i) Use the information in the graph to deduce the mass of ethanoate ions in 200 cm^3 of the solution when the reaction is complete.

mass = ...g [1]

(ii) Use the information in the graph to calculate the average rate of reaction, in mol/dm^3/s, during the first 300 seconds.

average rate of reaction ....mol / dm^3 / s [1]

(b) Below is a molecule of fats found in our bodies and foods are in the form of '***triglyceride***' molecule, which is a saturated fat.



Triglyceride-Saturated

Use the example given and draw the display diagram of two products when hydroxide ion, OH^-, reacts with this molecule.

[2]

5. Analysis of a yellow compound **X**, **which consists of two ions,** shows it has the following composition.

Element	Percentage by mass

hydrogen	3.40
nitrogen	12.0
oxygen	41.0
vanadium	43.6

(a) Show that X has the formula H_4NO_3V.

[1]

(b) Suggest one physical property of *compound X* caused only by the presence of vanadium in the compound.

.... [1]

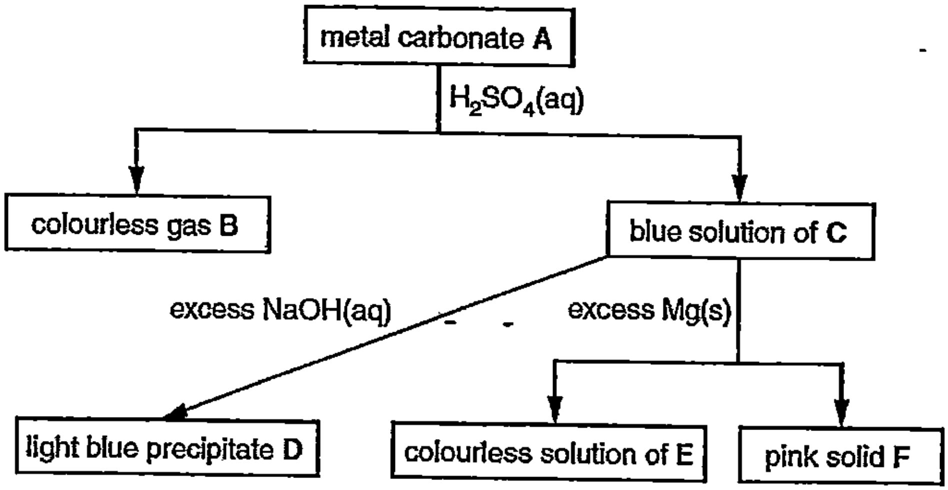
(c) Aqueous sodium hydroxide is added to solid X and the mixture is warmed.
A colourless gas that turns moist red litmus blue is evolved.
Deduce the formula of each of the two ions present in X.

positive ion .... negative ion .... [2]

(d) An acidified aqueous solution of X reacts with aqueous potassium iodide to form iodine.
State what you can deduce about the ***chemical nature*** of X.

.... [1]

6. The flow chart shows some reactions of the compounds of a metal.



Identify, by name, each of the substances.

A ....

B ....

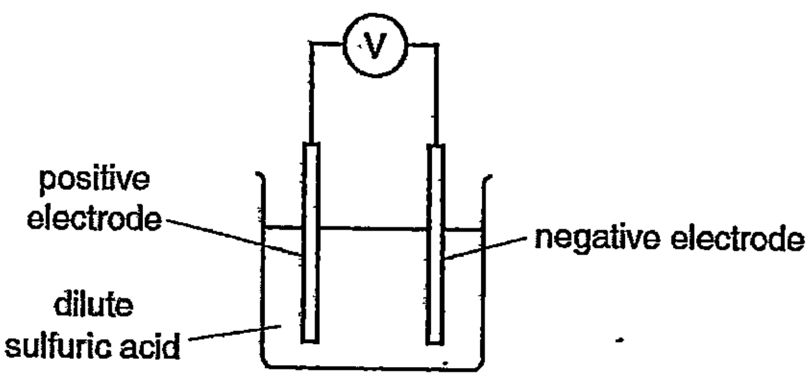
C ....

D ....

E ....

F .... [6]

7. The diagram shows a simple electrochemical cell.



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

Positive electrode	Negative electrode	Voltage / V

silver	R	+0.10
Copper	S	+0.48
Copper	T	+2.70
Copper	U	+0.78
Silver	copper	+0.46

(a) Use the information in the table to deduce the order of reactivity of the metals silver, copper, R, S, T, U

most reactive ....

↑ ....

....

....

....

least reactive .... [1]

(b) State two metals from the table that will produce the *highest voltage* when used in the electrochemical cell as shown in the diagram.

Anode .... and Cathode.................................. [1]

(c) (i) ***Briefly state*** a method, to extract aluminium and zinc from its ore, such as aluminium oxide and zinc oxide respectively.

Aluminium ....

.... [1]

Zinc ....

.... [1]

(ii) When solid copper (II) nitrate is heated, it decomposed to copper (II) oxide, nitrogen dioxide and oxygen.

Write a chemical equation to represent the thermal decomposition of copper(II) nitrate.

.... [1]

(d) Draw the cross and dot diagram of ammonium fluoride in the space below.

[2]

8. (a) (i) Explain why attaching iron with magnesium prevents iron from rusting.

....

....

.... [1]

(ii) If copper is attached to iron, will iron rust slower, or faster or no difference? Explain your answer.

....

....

.... [2]

(b) Other than cost, state one benefit of recycling of iron.

....

....

.... [1]

(c) In the manufacture of iron in the blast furnace explain the presence of nitrogen in the waste gases.

....

.... [1]

9. A student titrates 20.0 cm^3 of a metal hydroxide, $M(OH)_2$, of concentration 0.060 mol / dm^3 with a strong acid of concentration 0.050 mol / dm^3.
It requires 24.0 cm^3 of acid to neutralise the metal hydroxide.

(a) Calculate the number of moles of acid in 24.0 cm^3 of the acid.

.. .. moles [1]

(b) Calculate the number of moles of OH^- ions in 20.0 cm^3 of the metal hydroxide.

... . moles [1]

(c) Deduce whether the acid used is more likely to be hydrochloric acid or sulfuric acid.

.... [1]

(d) Explain why barium sulfate should not be prepared by adding sulfuric acid to barium oxide?

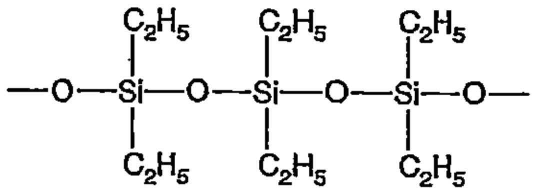
....

....

....

.... [1]

10. Silicone fluids are polymers. Part of the structure of a silicone fluid is shown below.



The monomer used in making this silicone fluid is a saturated compound. Deduce the structure of this monomer.

(a) Draw the structure of the repeating unit of this polymer

[1]

(b) If this is a condensation polymer, draw the monomer of this polymer.

[1]

SECTION B (30 marks)

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

11. The table below shows some properties of the Group 0 elements (noble gases).

element	density of liquid element in g/cm^3	boiling point /°C
helium	0.15	–269
neon	1.20	–246
argon	1.40	–186
krypton		–152
xenon	3.52	

(a) Describe the changes in density and boiling point of the elements in group 0 from helium to xenon.

....

.... [2]

(b) Explain why noble gases are inert and not reactive.

....

.... [1]

(c) Several compounds of the noble gases have been produced in recent years, e.g. fluorides of xenon.

(i) ***Complete the equation*** for the reaction of xenon(IV) fluoride with water.

.... XeF_4 + ... H_2O → ....Xe + ...XeO_3 + ... O_2 + ... HF [1]

(ii) Predict the pH of the solution after this reaction?

.... [1]

(d) Xenon (VI) fluoride, XeF_6, with a m.p. of 49°C and b.p. of 76°C reacts with water to form a mixture which contains *xenon, xenon(VI) oxide, XeO_3, and hydrogen fluoride, HF and oxygen gas in step 3.*

Xenon hexafluoride, XeF_6, hydrolyses to XeO_3, stepwise in 3 steps, of which only two steps is shown below.

Step 1 $XeF_6 + H_2O \rightarrow XeOF_4 + 2\ HF$
Step 2 $XeOF_4 + H_2O \rightarrow XeO_2F_2 + 2\ HF$

(i) Determine the oxidation number of the xenon in compound, XeO_2F_2, formed in step 2.

.... [1]

(ii) Using the information from reactions in step 1 and step 2, predict the balanced chemical equation for the reaction in step 3 when XeO_2F_2 hydrolyses further with water.

.... [1]

(iii) Neon is also a noble gas, state one commercial use of neon.

.... [1]

(iv) Is xenon (VI) fluoride a covalent or ionic compound? Give a reason for your answer from the information given above

....

.... [2]

12. Ammonia is manufactured by the Haber process

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(a) State what does the symbol $\rightleftharpoons$ means

.... [1]

The table below shows how the percentage yield of ammonia varies with both temperature and pressure.

pressure /atmospheres	% yield at 200°C	% yield at 300°C	% yield at 400°C	% yield at 500°C
30	68	32	11	4
100	81	51	25	10
200	86	63	36	18
300	88	69	40	24

(b) (i) Using the information above, describe how, the percentage yield of ammonia changes with temperature and pressure.

....

....

....

.... [1]

(ii) Explain how using a catalyst in the Haber process has an economic advantage.

....

....

....

.... [1]

Farmers use chemicals to improve crop yield. Ammonium phosphate, $(NH_4)_3PO_4$, is used as a fertiliser and calcium hydroxide, $Ca(OH)_2$, is used to reduce the acidity of soils.

The relative formula mass of ammonium phosphate is 149.

(c) Calculate the percentage by mass of nitrogen in ammonium phosphate.

percentage = ... % [1]

(d) A farmer adds ammonium phosphate to a field.
He then adds calcium hydroxide to the field because the soil is very acidic.

(i) Calcium hydroxide neutralises acid in soil.
Give an ionic equation for this reaction.

....[1]

(ii) Adding calcium hydroxide together with ammonium phosphate reduces the effectiveness of ammonium phosphate as a fertiliser. Explain.

....

....

....

.... [1]

(e) (i) State one man made source of oxides of nitrogen.

....

.... [1]

(ii) Use chemical equation/s, to show how the production of oxides of nitrogen can be reduced in cars.

....

....

.... [2]

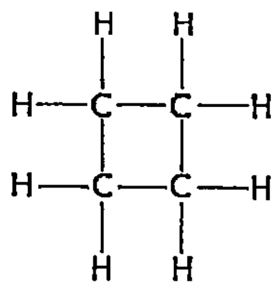
(f) State one natural source of methane.

.... [1]

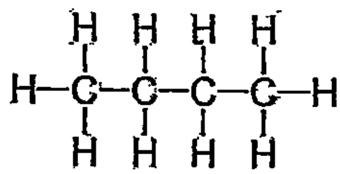
EITHER

13. The alkanes are a homologous series of hydrocarbons.

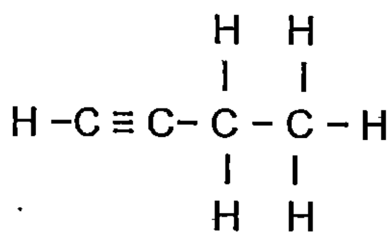
(a) Jezicar and Authoree had a discourse on the molecules below.



Molecule A



Molecule B



Molecule C

Jezicar says that both molecule A and B are in the alkane homologous series, But Authoree believes that molecule A and B are in a different homologous series because they both do not share the same general formula.

From the information above,

(i) suggest a reason, why Jezicar may be right.

....

....

.... [1]

(ii) State the condition/s for the chemical reaction between an alkane and chlorine

condition/s .... [1]

(iii) In terms of bond making and bond breaking state whether the chemical reaction between an alkane and chlorine is an exothermic or endothermic reaction?

....

....

....

.... [1]

(iv) Molecule C behaves just like an unsaturated hydrocarbon. Draw the display diagram of the product formed when excess bromine is completely reacted with molecule C.

[1]

(v) Draw a energy profile diagram for the reaction between molecule A and chlorine. Label the activation energy, enthalpy change and also label the axes.

(2)

(b) 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 another substance.

State the formula of the other substance.

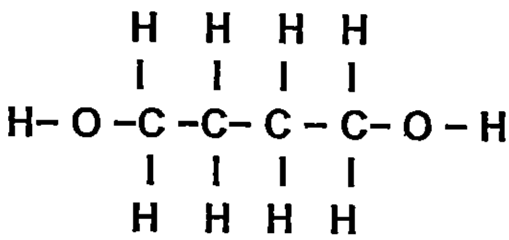
....[1]

(c) Butanoic acid, C_3H_7COOH, reacts with sodium to form a salt and a gas.
State the name and formula of the salt.

Name ....

formula .... [2]

(d) If Butan 1,4 diol , **HOCC2H4COH**, display diagram shown below

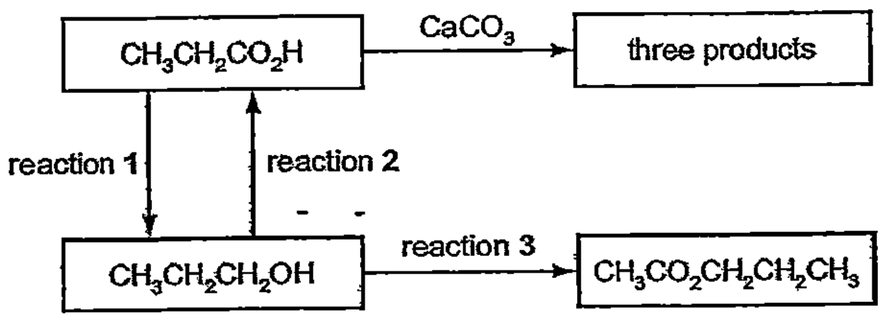


is reacted completely with excess acidified potassium manganate (VII), State the display diagram of the product form in the box below.

[1]

OR

14. A series of reactions based on propanoic acid is shown.



(a) (i) When propanoic acid reacts with calcium carbonate, there is effervescence and the solution feels warm. Write a balanced chemical equation for the reaction between propanoic acid and calcium carbonate.

.... [1]

(ii) State the name of the salt formed in reaction between CH_3CH_2COOH and calcium carbonate,

.... [1]

(iii) Draw a labelled energy profile diagram for the reaction between CH_3CH_2COOH and calcium carbonate.

[2]

(b) (i) Name the type of reaction for the conversion of $CH_3CH_2CH_2OH$ to CH_3CH_2COOH in reaction 2?

.... [1]

(ii) Suggest the name of type of reaction for the conversion of CH_3CH_2COOH to $CH_3CH_2CH_2OH$ in reaction 1.

.... [1]

(c) Suggest a suitable reagent and experimental conditions for reaction 3.

....

.... [2]

(d) State the name of an alkene and the experimental conditions to convert this alkene to $CH_3CH_2CH_2OH$.

Name of alkene ....

Conditions .... [2]

END

Bukit Panjang Government High School
Paper 1 Ans

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

Suggested Answers for BPGHS

1.

(a) (i) C/ Si

(ii) N

(iii) K

(iv) Ca/Mg

(b) (i) $4\ As + 3\ O_2 \rightarrow 2\ As_2O_3$

(ii) More, Higher

(iii) $Mg_3(AsO_3)_2$

2 (a) Zinc is a reactive metal and it forms thermally stable compounds. Hence, it takes some time for zinc carbonate to decompose

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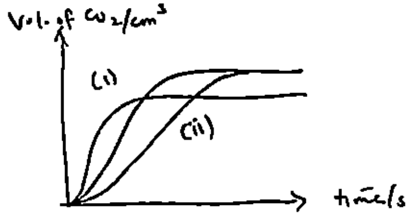
(b)



3 (a) (i) Chlorine has a simple molecular structure made up of discrete molecules. Little energy is required to overcome the weak intermolecular forces of attraction between its molecules. Hence it has low melting point.

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(a) (ii) Hydrogen chloride is soluble in water and dissociates ~~to~~to form H^+ and Cl^- mobile ions which can conduct electricity

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(b) Anode. $2\ Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$

Cathode $2H^+(aq) + 2e^- \rightarrow H_2(g)$

(c) $2NH_3(g) + 3\ Cl_2(g) \rightarrow 6\ HCl(g) + N_2(g)$

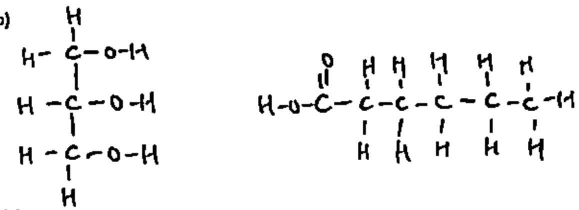
4 (a) (i) When the reaction is complete, concentration of CH_3COO^- is 0.45 mol/dm^3

No. of mol of ethanoate ions = $0.45 \times \frac{200}{1000} = 0.09$ mol

Mass of ethanoate ions = 0.09×59 = 5.31 g (3 s.f.)

(a) (ii) Rate of reaction = $\frac{0.16}{300}$ = 0.000533 mol/dm^3/s (3 s.f.)

(b)



5 (a)

	H	N	O	V
% mass	3.40	12.0	41.0	43.6
Ar	1	14	16	51
No. of moles	3.40	0.857	2.562	0.854
Ratio	4	1	3	1

Formula is H_4NO_3V (shown)

(b) It is a coloured compound (yellow)

(c) Positive ion NH_4^+

Negative ion. VO_3^-

(d) It is an oxidising agent.

6

A. Copper (II) carbonate

B. Carbon dioxide

C. Copper (II) sulfate

D. Copper (II) hydroxide

E. Magnesium sulfate

F Copper

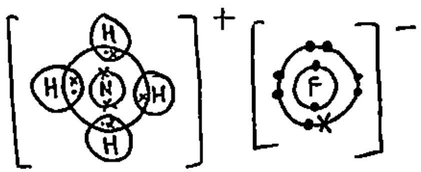
7 (a) (Most reactive) T > U > S > Copper > R > Silver (Least reactive)

(b) Anode T, Cathode Silver

(c)(i) Aluminium- Electrolysis of molten Al_2O_3, Zinc – Reduction of zinc oxide by carbon

(c)(ii) $2Cu(NO_3)_2 \rightarrow 2\,CuO + O_2 + 4\,NO_2$

(d)



8 (a)(i) Magnesium is more reactive than iron, hence it loses electrons more readily and will corrode in place of iron

(ii) Faster Iron is more reactive than copper, hence it will lose electrons more readily to Cu and will rust faster

(b) Iron is a finite resource and recycling iron will ensure the slower depletion of the non-renewable resource

(c) Air is pumped into the blast furnace, which contains 78% of nitrogen which is not used in the reaction

9 (a) No of moles of acid = $0\,050 \times \frac{24}{1000}$ = 0.0012 mol

(b) No of moles of $M(OH)_2$ = $0\,060 \times \frac{20}{1000}$ = 0 0012 mol

$M(OH)_2 \rightarrow M^{2+} + 2OH^-$

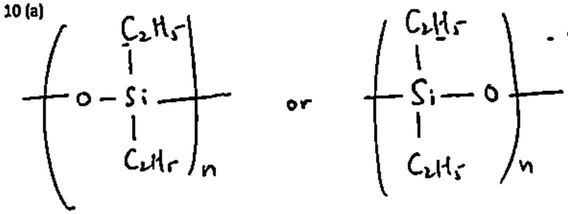
No of moles of OH ions = 0 0012 × 2 = 0.0024 mol

(c) Sulfuric acid

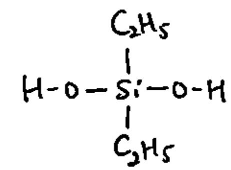
(d) $H_2SO_4\,(aq) + BaO\,(s) \rightarrow BaSO_4\,(s) + H_2O\,(l)$

The reaction produces insoluble $BaSO_4$ which will form a layer of coating around BaO, preventing further reacting with H_2SO_4 Reaction will not go to completion

10 (a)



10 (b)



11 a) Both density and boiling point increase from He to Ar

(b) Noble gases have a fully filled outermost shell, hence they have no tendency to lose or gain electrons

(b) (i) $4\,XeF_4 + 8\,H_2O \rightarrow 2Xe + 2XeO_3 + O_2 + 16\,HF$

(ii) pH ~~1 – 2~~3 – 4 (HF is a weak acid)

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(c) (i) +6

(ii) $XeO_2F_2 + H_2O \rightarrow XeO_3 + 2HF$

(iii) Fill the bulbs of neon lamps

(iv) Simple covalent compound It has a low melting (49°C) and boiling point (76°C)

12 (a) Reversible reaction

(b)(i) As pressure increases from 30 to 300 atm, percentage yield of ammonia increases As temperature increases from 200°C to 500°C, the percentage yield of ammonia decreases

(ii) Catalyst provides an alternative pathway with lower activation energy which results in more particles having energy greater than activation energy, thus increasing the frequency of effective collisions and the rate of reaction Thus lesser energy will be required and thus less cost spent on electricity

(c) % by mass = $\frac{3(14)}{149} \times 100\%$ = 28 2% (3 s f)

(d) (i) $H^+ (aq) + OH^- (aq) \rightarrow H_2O (l)$

(ii) Adding calcium hydroxide to ammonium phosphate will result in a reaction where ammonia gas will be liberated Nitrogen essential for healthy plant growth will be lost in the form of ammonia gas

(e)(i) Exhaust of car engines/ Burning of fossil fuels in car engines

(ii) $2 NO + 2 CO \rightarrow N_2 + 2CO_2$

(f) Decay of plants/dead matter

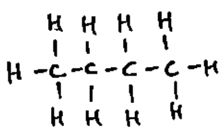
13 Either

(a) (i) Molecule A and B are saturated hydrocarbons

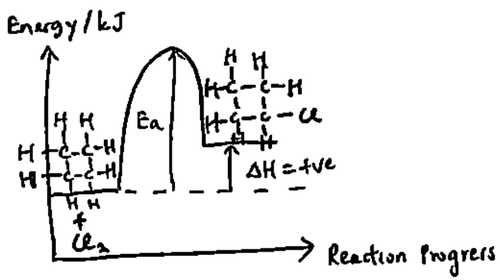
(a) (ii) UV light

(a) (iii) Energy absorbed for the bond breaking of bonds in alkane and chlorine is more than the energy released for the bond forming of bonds in chlorine-substituted alkane, hence it is a endothermic reaction

(a) (iv)



(a) (v)



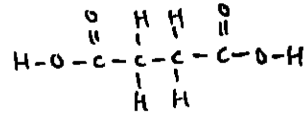
Either

13 (b) C_6H_{14}

(c) Name Sodium butanoate

Formula C_3H_7COONa

(d)

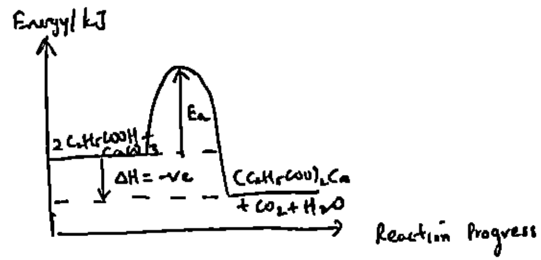


OR

14 (a) (i) $2C_2H_5COOH + CaCO_3 \rightarrow (C_2H_5COO)_2Ca + CO_2 + H_2O$

(ii) Calcium propanoate

(iii)



(b) (i) Oxidation

(ii) Reduction

(c) Reagent CH_3COOH, concentrated sulfuric acid

Conditions. Heat under reflux

(d) (i) Propene

(ii) H_2O (g), 300°C, 60 atm, H_3PO_4 (aq)

Name.		Index Number		Class	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4

CHEMISTRY **5073/1**

Paper 1 **18 September 2015**

1 hour

Additional Materials Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the Multiple Choice Answer Sheet 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 most appropriate **one** and record your choice in soft pencil on the Multiple Choice Answer Sheet provided

A copy of the Periodic Table is given on page **24**

You may use a calculator.

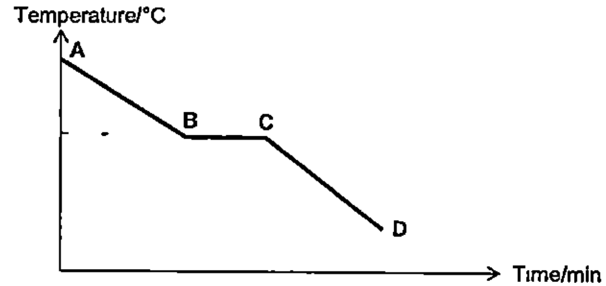
For examiner's use only

Paper 1	/ 40
Total	**/ 40**

This document consists of **24** printed pages, including this cover page
Page **23** is a blank page.

Paper 1: Multiple Choice Questions [40 marks]

1 A sample of nitrogen dioxide gas is cooled and the temperature is measured every minute The following graph is obtained



Which describes the arrangement and movement of the particles in the region **C – D**?

	Arrangement of particles	Movement of particles
A	Closely packed in orderly arrangement	Vibrate about fixed positions
B	Closely packed in disorderly arrangement	Moving at high speeds
C	Closely packed in disorderly arrangement	Moving freely over each other
D	Mixture of particles closely packed in orderly and disorderly arrangement	Some particles are vibrating about fixed positions while some are moving freely over each other

2 At -200°C, a mixture of liquid oxygen, nitrogen and xenon is heated up by 15°C. The boiling points of some gases are given in the table below.

Gases	Boiling point / °C
Nitrogen	-196
Xenon	-108
Oxygen	-183

Which of the substances will be in the liquid state at this higher temperature?

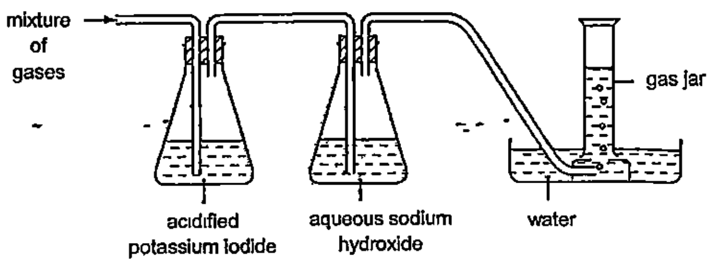
A nitrogen only

B xenon only

C a mixture of nitrogen and oxygen

D a mixture of xenon and oxygen

3 A gaseous mixture of ammonia, oxygen, carbon dioxide and chlorine was passed through the set-up shown in the diagram below. Only one gas was collected in the gas jar.



Which statement describes a property of the gas collected in the gas jar?

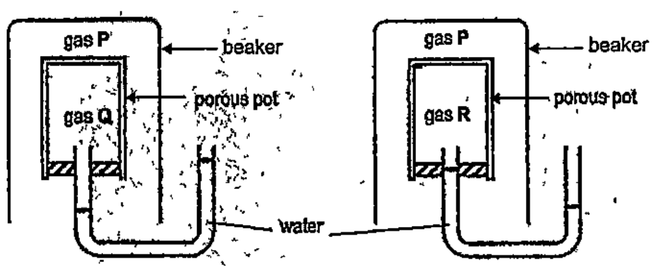
A It bleaches moist blue litmus paper

B It forms a white precipitate when bubbled into limewater

C It relights a glowing splint.

D It turns moist red litmus paper blue

4 The apparatus can be used to show the diffusion of gases. Two beakers containing gas **P** were placed over two porous pots containing gases **Q** and **R** respectively. The results are shown below.



What is the correct order of the relative molecular mass of gases **P**, **Q** and **R**?

	Lowest M_r	$\longrightarrow$	Highest M_r
A	R	P	Q
B	R	Q	P
C	Q	P	R
D	P	Q	R

5 Solid samples of ammonium chloride, lead(II) chloride and sodium chloride were accidentally mixed together. Which of the following sequences outlines the best method to obtain the pure dry sample for each substance?

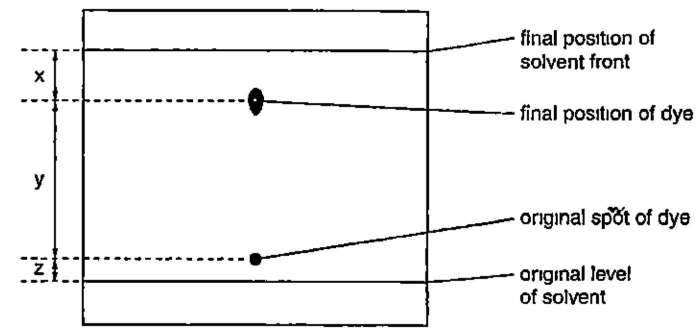
A dissolving, filtration, sublimation, crystallisation

B dissolving, fractional distillation, filtration, evaporation

C sublimation, dissolving, filtration, evaporation

D sublimation, filtration, evaporation, crystallisation

6 The diagram shows the chromatogram obtained by analysis of a single dye. Three measurements are shown.



Which expression shows the R_f value of the dye?

A $\dfrac{x}{x+y}$

B $\dfrac{y}{x+y}$

C $\dfrac{x}{x+y+z}$

D $\dfrac{y}{x+y+z}$

7 When a saturated solution of copper(II) sulfate is allowed to cool from 80˚C to room temperature, crystals separate out from the solution

The following statements were made about crystallisation

1 The concentration of the solution remains the same
2 The mass of the dissolved copper(II) sulfate in the solution changes
3 The mass of the solvent in the solution remains the same.
4 The solubility of copper(II) sulfate decreases as the temperature falls

Which statement(s) is/are correct?

A 1 and 2 only

B 1 and 3 only

C 2, 3 and 4

D 4 only

8 Which of the following substances contain delocalised mobile electrons?

I Copper
II Graphite
III Molten copper(II) chloride
IV Solid copper(II) chloride

A I and II

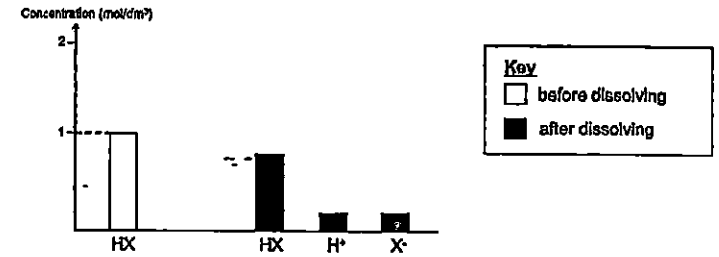
B I and III

C II only

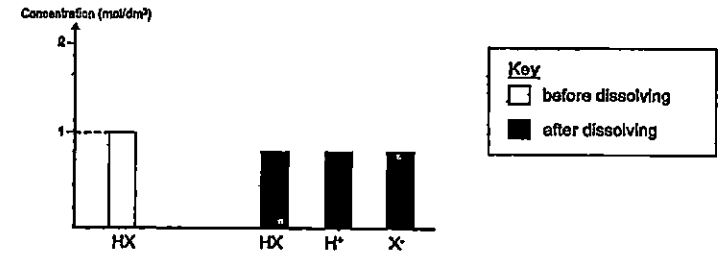
D II, III and IV

9 Which graph shows the solution formed when one mole of a **weak acid**, HX is dissolved in 1 dm^3 of water?

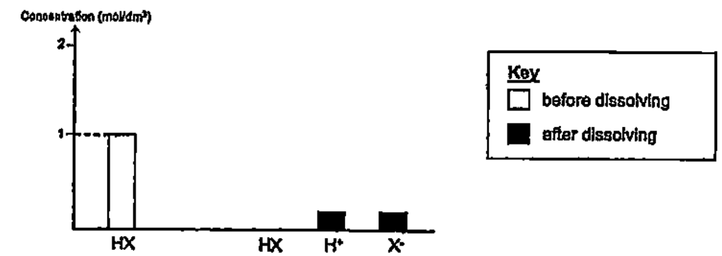
A



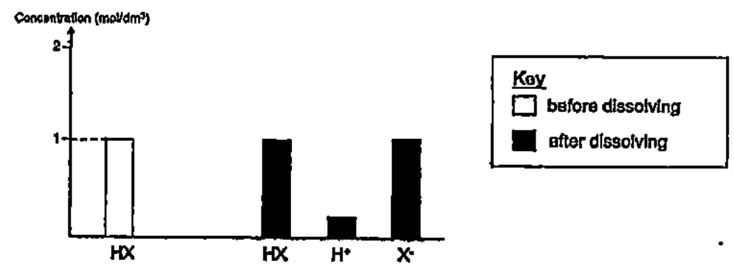
B



C



D



10 Phosphine has the formula PH_3. It has similar properties to ammonia. What are the ions produced when phosphine dissolves in water?

A PH_3^+, H^+

B PH_4^+, H^+

C PH_3^+, OH^-

D PH_4^+, OH^-

11 A new indicator has just been produced in the laboratory. It changes colours according to the table below.

pH	Colour
0 - 3	Red
4 - 7	Green
8 - 14	Dark blue

This indicator would be suitable to distinguish between

A aqueous ammonia and sodium hydroxide

B aqueous sodium chloride and water

C aqueous sodium nitrate and sodium hydroxide

D dilute hydrochloric acid and dilute sulfuric acid

12 When excess calcium carbonate pieces are added to dilute hydrochloric acid, the reaction gradually becomes slower and finally stops.

Which statement best explains why the rate of reaction becomes slower?

A An insoluble layer of calcium chloride is formed on calcium carbonate

B The concentration of hydrochloric acid gradually reduces to zero

C The mass of calcium carbonate decreases throughout the reaction

D The pieces of calcium carbonate gradually become smaller

13 Three substances were added separately to aqueous potassium sulfate and aqueous potassium carbonate. The three substances were

I aqueous ammonia

II barium nitrate solution

III dilute hydrochloric acid

Which substance(s) would give different observations when added separately to aqueous potassium sulfate and aqueous potassium carbonate?

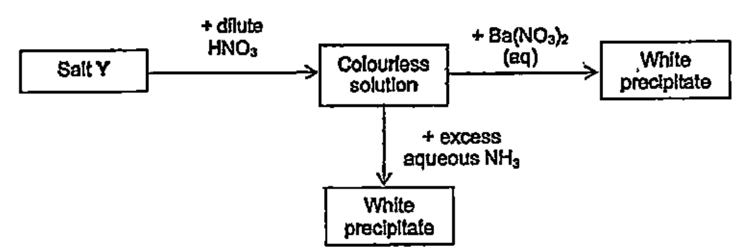
A I only

B I and II

C II and III

D III only

14 The scheme below shows some reactions of salt Y.



What is salt Y?

A aluminium sulfate

B calcium chloride

C lead(II) chloride

D zinc sulfate

15 When a mixture of iron(II) sulfate, potassium hydroxide and barium chloride is stirred with some water, a mixture of green and white solids is formed

What are the identities of the solids?

	Green solid	White solid
A	iron(II) chloride	barium hydroxide
B	iron(II) hydroxide	barium sulfate
C	barium sulfate	iron(II) chloride
D	potassium chloride	barium sulfate

16 A textbook writes 'Nitric acid, HNO_3, is a strong oxidising agent'

Which of the following **cannot** be a product of nitric acid in its reaction with a reducing agent?

A N_2

B N_2O_5

C NO

D NO_2

17 Zinc oxide is produced by heating zinc carbonate

$$ZnCO_3 \rightarrow ZnO + CO_2$$

What is the percentage yield of zinc oxide if 125 g zinc carbonate produces 75 g of zinc oxide when heated?

A $\frac{75}{81} \times 100$

B $\frac{81}{75} \times 100$

C $125 \times \frac{81}{75} \times 100$

D $125 \times \frac{75}{81} \times 100$

18 A pure compound contains 24 g of carbon, 4 g of hydrogen and 32 g of oxygen What is the empirical formula of the compound?

A CHO

B CH_2O

C CH_4O

D C_2H_2O

19 5.0 dm^3 of sulfur dioxide is reacted with 3.0 dm^3 of oxygen at room temperature and pressure The equation for the reaction is given below.

$$2SO_2\,(g) + O_2\,(g) \rightarrow 2SO_3\,(g)$$

What is the total volume of gas(es) at the end of the reaction?
(Assume that the reaction goes to completion)

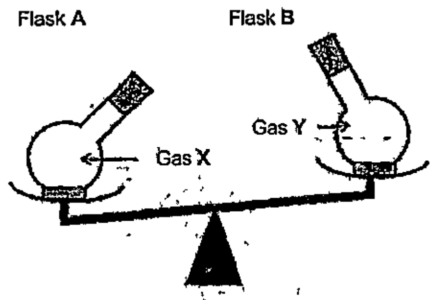
A 4.0 dm^3

B 5.0 dm^3

C 5.5 dm^3

D 6.0 dm^3

20 Two identical flasks, A and B, have been filled up with gases X and Y and they are placed on a balance at room temperature and pressure. The results are shown below



Which of the following statements can be deduced from the results?

A The molar mass of gas particles in flask A is greater than the molar mass of gas particles in flask B

B The molar volume of gas particles in flask A is greater than the molar volume of gas particles in flask B.

C The number of gas particles in flask A is greater than the number of gas particles in flask B

D The number of moles of gas particles in flask A is greater than the number of moles of gas particles in flask B

21 The scheme shows four stages I to IV in the conversion of solid candlewax $C_{30}H_{62}$ into carbon dioxide and water

$$C_{30}H_{62}(s) \xrightarrow{\text{I}} C_{30}H_{62}(l) \xrightarrow{\text{II}} C_{30}H_{62}(g) \xrightarrow{\text{III}} \begin{array}{c}30CO_2(g)\\+31H_2O(g)\end{array} \xrightarrow{\text{IV}} \begin{array}{c}30CO_2(g)\\+31H_2O(l)\end{array}$$

Which of the following stages are exothermic?

A I and II

B I, II and III

C I and IV

D III and IV

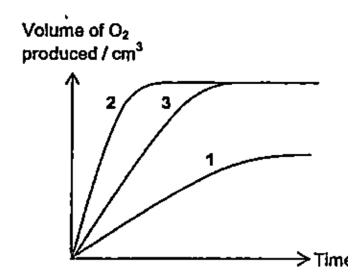
22 The decomposition of hydrogen peroxide is carried out under different conditions in three experiments at room temperature and pressure. A common catalyst used for decomposition reaction is manganese(IV) oxide (MnO_2). An equation for the reaction is given below

$$2\,H_2O_2(aq) \xrightarrow{MnO_2} 2\,H_2O(l) + O_2(g)$$

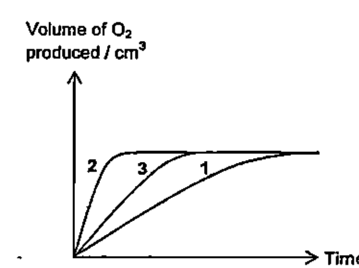
Experiment	Conditions
1	Absence of catalyst
2	Presence of MnO_2 powder
3	Presence of MnO_2 lumps

Which graph shows how the volume of oxygen gas produced varies with time in each experiment?

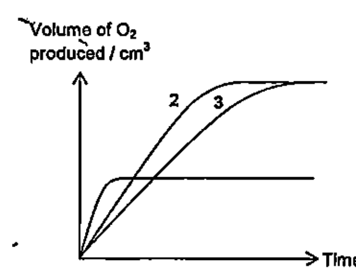
A



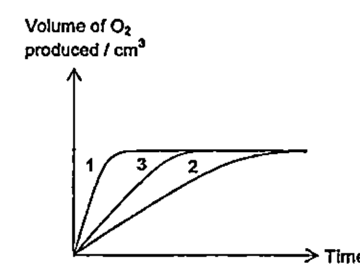
B



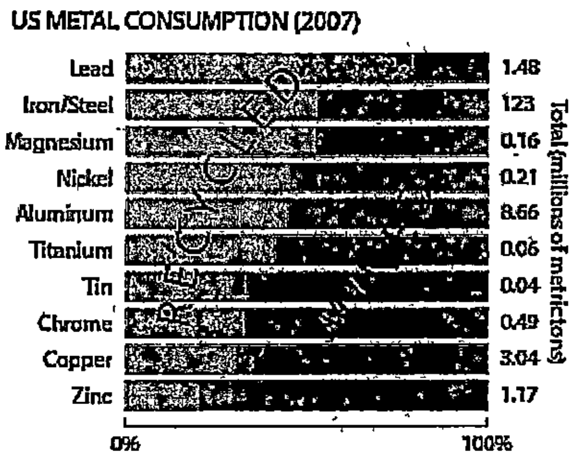
C



D



23 The graph shows the consumption of different metals in United States in 2007 It also shows the percentage of metals recycled and mined in order to meet the consumption levels



Which of the following statements may be true?

A Demand for nickel is higher than for copper

B Less pollution is generated when lead is recycled compared to when it is mined

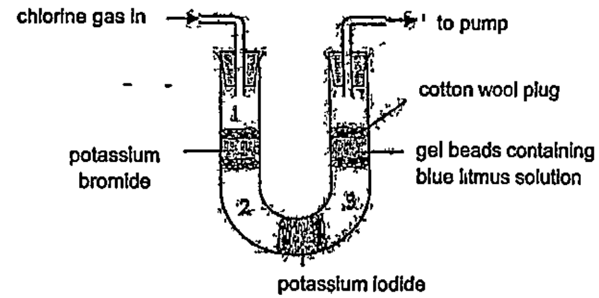
C Recycling zinc is cheaper than extracting zinc from its ore.

D The mass of magnesium mined is approximately equal to the mass of iron mined.

24 Equal masses of iron(II) oxide were heated separately in oxygen and hydrogen What changes (if any) would you expect in the masses of the iron(II) oxide after heating?

	Mass after heating in oxygen	Mass after heating in hydrogen
A	decrease	increase
B	increase	decrease
C	increase	increase
D	unchanged	decrease

25 Gaseous chlorine was passed through the following apparatus The apparatus was continuously heated and the observations were recorded below



Which of the following observations would be made at regions 1, 2 and 3?

	Region 1	*Region 2*	*Region 3*
A	red-brown gas	black solid	violet gas
B	red-brown gas	violet gas	black solid
C	yellow-green gas	red-brown gas	violet gas
D	yellow-green gas	violet gas	brown gas

26 Rubidium is an element in Group I of the Periodic Table The following statements were made about rubidium

1 Rubidium conducts electricity only when it is in solid state
2 Rubidium is soft and can be cut easily with a knife
3 Rubidium reacts with chlorine to form a white compound rubidium chloride.
4 Rubidium reacts explosively with water to form an acidic solution

Which statements about rubidium are true?

A 1 and 2 only

B 1, 2 and 3 only

C 2 and 3 only

D 2, 3 and 4 only

27 Which statement about groups in the Periodic Table is correct?

- **A** All groups contain both metals and non-metals
- **B** Atoms of elements in the same group have the same number of electron shells
- **C** In Group I, reactivity decreases with increasing proton (atomic) number.
- **D** In Group VII, the melting point of the elements increases with increasing proton (atomic) number

28 Which one of the following properties is true for all metals?

- **A** All metals are good electrical conductors.
- **B** All metals form coloured compounds
- **C** All metals react with dilute acids to produce hydrogen
- **D** All metals show variable oxidation states

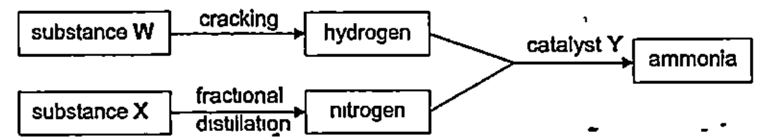
29 The table below shows some properties of four metals and their compounds

Metal	Action of dilute sulfuric acid on metal	Effect of hydrogen on heated metal oxide	Action of metal on a solution of the sulfate of J
G	hydrogen evolved	reduced	no reaction
H	no reaction	reduced	no reaction
I	hydrogen evolved	no reaction	J formed
J	hydrogen evolved	no reaction	no reaction

Which of the following shows a **descending** order of the thermal stability of the metal carbonates?

	Most stable →			Least stable
A	H	G	J	I
B	H	J	G	I
C	I	J	G	H
D	I	H	G	J

30 The diagram shows the processes that take place during the production of ammonia



What are substances W, X and Y?

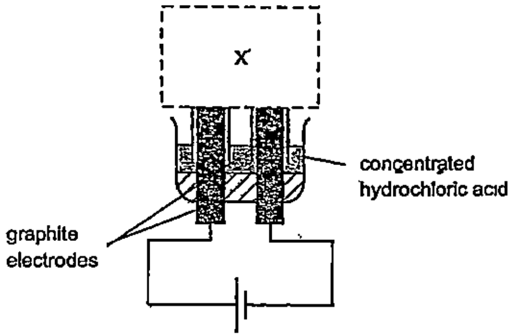
	W	X	Y
A	air	oil	iron
B	air	oil	nickel
C	oil	air	iron
D	oil	air	nickel

31 Methane, sulfur dioxide and carbon dioxide are gases which affect the atmosphere and the environment

In what ways do these gases affect the environment?

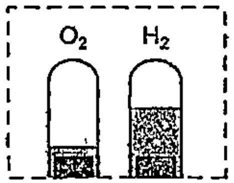
	Methane	Sulfur dioxide	Chlorofluorocarbons
A	Global warming	Acid rain	Ozone layer depletion
B	Global warming	Ozone layer depletion	Acid rain
C	Ozone layer depletion	Acid rain	Global warming
D	Photochemical smog	Global warming	Acid rain

32 The diagram shown is not complete



What would be shown at X after the solution has been electrolysed for some time?

A



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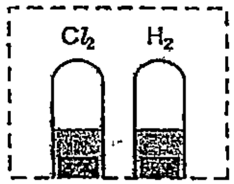
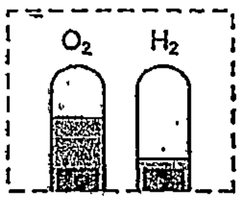
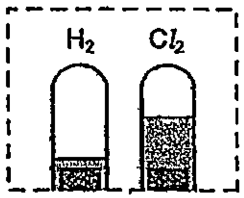


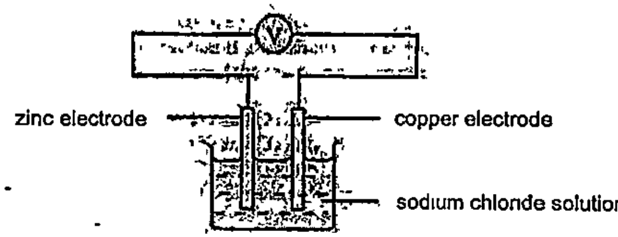
C



D



33 Consider the following chemical cell.



Which of the following changes would lead to an increase in the voltage of the cell?

I The copper electrode is replaced with an iron electrode
II The sodium chloride solution is replaced with a sugar solution
III The zinc electrode is replaced with a magnesium electrode

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

34 In an electrolysis experiment, the same amount of charge deposited 54 0 g of silver and 14 9 g of tin

What was the charge on the tin ion?

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

35 Which row correctly describes the electrodes and electrolyte used during the electroplating of a chromium bracelet with silver?

	Anode	Cathode	Electrolyte
A	bracelet	silver	chromium nitrate
B	bracelet	silver	silver nitrate
C	silver	bracelet	chromium nitrate
D	silver	bracelet	silver nitrate

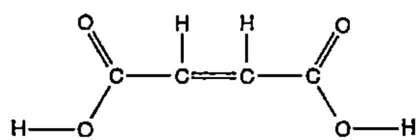
36 Four alkanes, H, I, J and K were extracted from a sample of crude oil.
Some properties of the alkanes are listed below

- K is more viscous compared to I
- J burns with a less sooty flame compared to I and K
- H is less flammable than K.

What is the order in which the alkanes were collected from the fractional distillation?

	Alkane collected first	→		Alkane collected last
A	H	K	I	J
B	J	H	K	I
C	J	I	K	H
D	K	H	J	I

37 The structure of an organic compound is shown below



Which one of the following statements is **not** correct?

A Its aqueous solution reacts with sodium carbonate

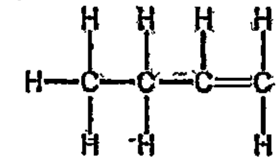
B It decolourises an aqueous solution of bromine.

C It turns acidified potassium dichromate(VI) from orange to green

D It is an unsaturated compound

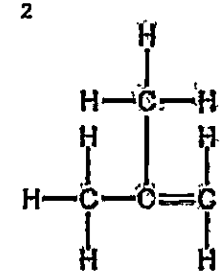
38 Compound 1 has a structure shown below.

1

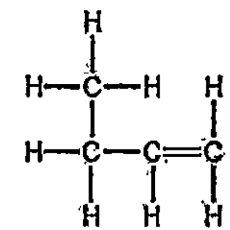


Which of the compounds below are isomers of structure 1?

2



3



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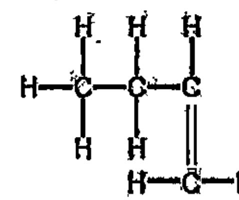

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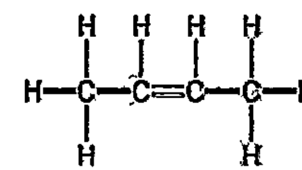
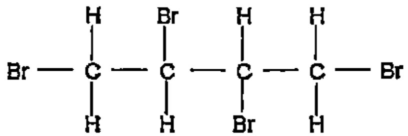
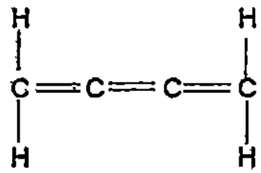


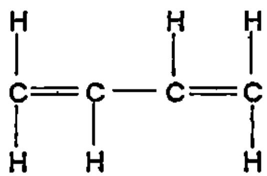
A 2 and 3 B 2 and 5 C 3 and 4 D 4 and 5

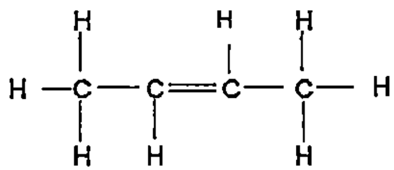
39 When an alkene reacts with two moles of bromine, the product formed is

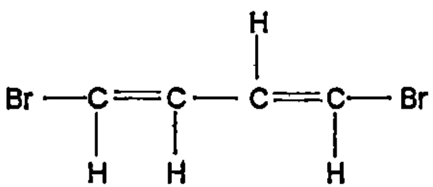


This implies that the original structure of the alkene is

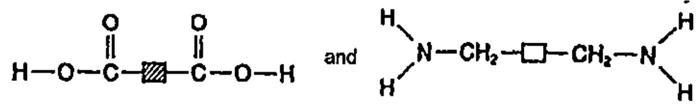
A 

B 

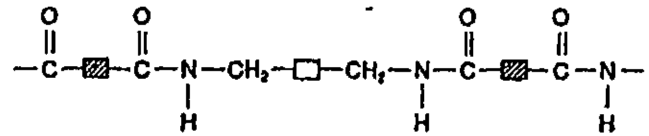
C 

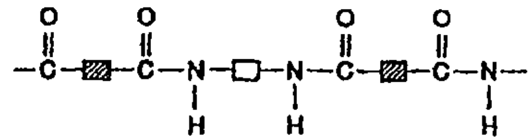
D 

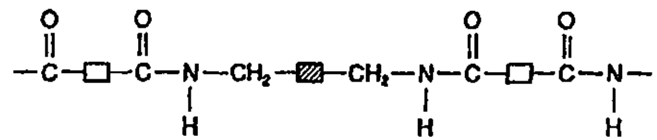
40 A condensation polymer is made from the two monomers below

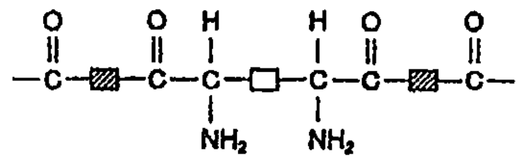


Which diagram shows part of the structure of the polymer formed?

A 

B 

C 

D 

- End of Paper 1 -

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The Periodic Table of the Elements

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

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

Answers for Paper 1

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

Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4

CHEMISTRY

5073/2

Paper 2

16 September 2015
1 hour 45 minutes

Additional Materials: NIL

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.
You may use a soft pencil for any rough working. You may use a calculator.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO NOT WRITE ON THE MARGINS.
A copy of the Periodic Table is printed on page 11.

Section A
Answer all questions in the spaces provided.

For examiner's use only: **Section A** **/ 50**

At the end of the examination, fasten all your work for each section securely together.
Hand in each section separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of 11 printed pages, **including** this cover page.
Page **12** has been intentionally left blank.

[Turn over]

Section A (50 marks)

Answer all questions in the spaces provided.

A1 The data in the table below describe two properties of some substances.

The letters are **not** the actual symbols of the elements in the Periodic Table.

Element / Compound	**Appearance at room temperature and pressure**	**Products of burning in oxygen**
A	Black solid	Carbon dioxide
B	Colourless gas	Water
C	Colourless gas	(Does not burn in oxygen)
D	Yellow solid	Sulfur Dioxide
E	Colourless liquid	Carbon Dioxide and water

You may use the letter once, more than once or none at all to answer the questions below.

(a) **(i)** Which substance is mostly likely to be hydrogen? .... **[1]**

(ii) Which substance is most likely to be a compound? ... . **[1]**

(b) Carbon monoxide is an atmospheric pollutant that may be produced when substance **A** burn in oxygen.
What harmful effect does carbon monoxide have on human health? **[2]**

. ...

....

....

(c) (i) Gas **C** is an element that does not burn in oxygen. Suggest the name of this substance **C**. **[1]**

....

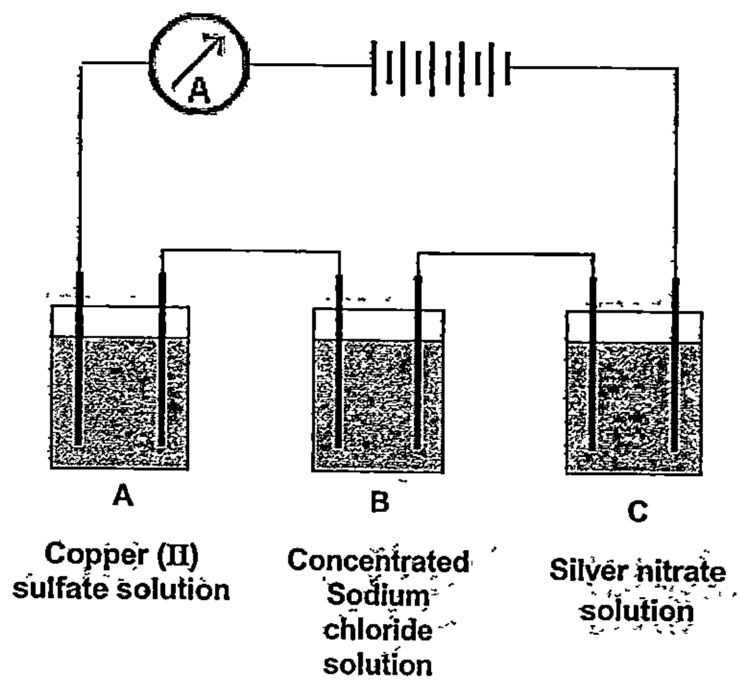
(ii) Explain your answer in (c)(i). **[1]**

....

....

[Total marks: 6]

A2 The diagram shows the electrolysis of three different solutions using inert electrodes.



(a) (i) Write equations for the reactions that happen at each electrode in Cell **B** during electrolysis. Include state symbols. **[2]**

....

....

(ii) Describe two observations that take place in Cell **B**. Explain your observations. [4]

....

....

....

....

....

(b) If 6.0 dm^3 of oxygen is liberated from Cell **A** at room temperature pressure,

(i) Calculate the increase in mass of the cathodes in Cell **A** and Cell **C** [3]

(ii) What is another observation in Cell **A**? Explain your observation. [2]

....

....

....

(c) The experiment is repeated and the electrodes in Cell **C** have been changed to silver electrodes. How would you expect the results for this experiment to differ from the first experiment? Explain your answer. [2]

....

....

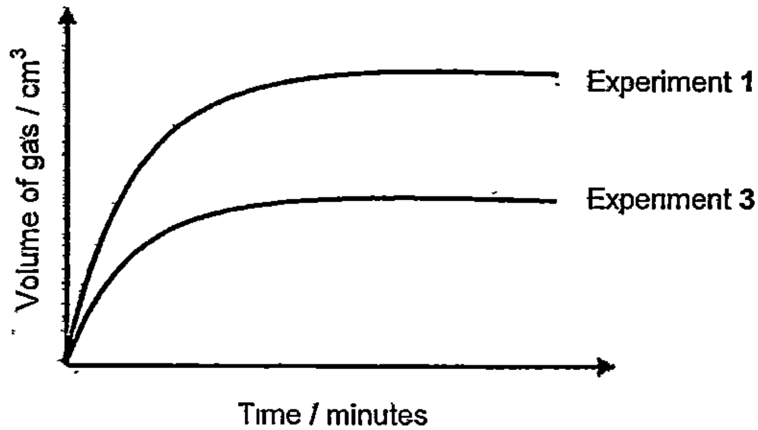
....

[Total marks: 13]

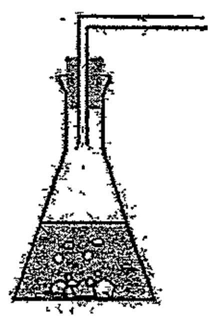
A3 A student carried out a series of experiments to determine the rate of reaction between zinc and dilute hydrochloric acid (HCl) by measuring the volume of gas produced per unit time.
In Experiment 1 (conducted at 25 °C), he used 5 g of zinc granules and 30 cm^3 of 0.5 mol/dm^3 dilute hydrochloric acid.
The experiments were repeated two more times, with different variables.

Experiment 2: 5 g of zinc powder and 30 cm^3 of 0 5 mol/dm^3 of HCl, 25 °C
Experiment 3: 5 g of zinc granules and **y** cm^3 of **z** mol/dm^3 of HCl, 25 °C

The graph below shows the volume of gas produced over time.



(a) Complete the diagram below with the appropriate apparatus used in the experiment. **[1]**



(b) Write a balance equation for the reaction between zinc and dilute hydrochloric acid. **[1]**

....

(c) On the graph above, sketch and label the graph for Experiment 2. **[1]**

(d) Taking reference from the graph above, suggest appropriate values for y and z. **[2]**

y = ... cm^3

z = ... mol/dm^3

(e) The student repeated the experiment at 50 °C. Explain in terms of energy and particle collisions how an increase in temperature increases the rate of a reaction. **[3]**

....

....

... ...

.. ..

[Total marks: 8]

A4 The table below shows the results of some of the chemical reactions of <u>four</u> unknown metals.

Metals	Thermal decomposition of metal carbonates	Reaction of metal with cold water
A	Greenish-blue solid turns black. White precipitate formed when gas produced is being passed through limewater	No reaction
B	White solid remains. No gas was produced.	Very vigorous reaction
C	White solid turns yellow, turns back to white after when cooled. White precipitate formed when gas produced is being passed through limewater	No reaction
D	White solid remains white. White precipitate formed when gas produced is being passed through limewater	Little bubbles formed on the surface of the metal

(a) Arrange the metals in ascending order of their chemical reactivity. **[1]**

....

(b) Metal **A** and **D** are placed into two separate beakers of iron(III) sulfate solution. Describe the observations you will see in each beaker. **[3]**

....

....

....

....

(c) Pure iron can be extracted using the Blast furnace in the presence of carbon monoxide.

(i) State the three raw materials needed for the extraction of pure iron using the Blast furnace. [2]

....

(ii) Write a balanced equation, with state symbols, for the reaction mentioned in (c). [2]

....

(d) Iron oxidises to form iron(III) oxide, which is also known as rust.

(i) State the conditions needed for rusting to take place. [1]

....

(ii) Using your knowledge of the reactivity series of metals, describe and explain how rusting can be prevented. [2]

....

....

....

[Total marks: 11]

A5 Hydrazine, N_2H_4, is used as rocket fuel. The equation for the combustion of hydrazine is as follows:

$$N_2H_4\,(g) + O_2\,(g) \rightarrow 2H_2O\,(g) + N_2\,(g) \qquad \Delta H = -622\ \text{kJ/mol}$$

(a) Explain, in terms of bond breaking and bond forming, why the above reaction is an exothermic reaction. [3]

....

....

....

....

(b) Draw the energy profile diagram, for the reaction between hydrazine and oxygen. Label clearly, the **[3]**

- ΔH of reaction,
- activation energy, E_a,
- reactants and products.

(c) Hydrazine also undergoes another reaction with fluorine

$$N_2H_4\,(g) + 2\,F_2\,(g) \rightarrow 4\,HF\,(g) + N_2\,(g)$$

Use the following data to answer the question that follows:

Bond	Bond Energy (kJ/mol)
N – N	163
N – H	390
F – F	158
H – F	565
N ≡ N	945

Calculate the ΔH for the reaction between hydrazine and fluorine. **[3]**

(d) Hydrogen fluoride is a highly dangerous gas, forming corrosive and penetrating hydrofluoric acid upon contact with living tissue. The gas can also cause blindness by rapid destruction of the corneas.

(i) Hydrofluonc acid is a strong acid. Define the term strong acid. [1]

....

....

(ii) A student claims that hydrofluoric acid conducts electricity, therefore hydrogen fluoride is an ionic compound. Do you agree with the student? Explain your reasoning. [2]

....

....

[Total marks: 12]

- End of Section A -

The Periodic Table of the Elements

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

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

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Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4

B

CHEMISTRY **5073/2**

Paper 2

16 September 2015
1 hour 45 minutes

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.
You may use a soft pencil for any rough working. You may use a calculator.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE ON THE MARGINS

Section B
Answer all questions in the foolscap paper provided.

For examiner's use only: **Section B** **/ 30**

At the end of the examination, fasten all your work for each section securely together.
Hand in each section separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **11** printed pages, **including** this cover page.
Page 12 has been intentionally left blank.

[Turn over]

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.

B6 Mass spectrometry is an important technique which can identify the amount and type of chemicals present in a sample by using a machine called a mass spectrometer. In general, the two quantities that can be measured are the **mass/charge ratio (m/z)** and the **relative abundance** of particles in the sample.

Mass/charge (m/z) ratio: this is calculated by dividing the mass of an ion by its charge. E.g. a sodium-23 ion, $^{23}Na^{+}$, would have a **m/z** value of 23. Hence, the **m/z** of an ion with a charge of 1+ is effectively its relative mass.

Relative abundance: this refers to the percentage of a particular isotope which occurs in nature. E.g. in a sample of chlorine, the relative abundance of chlorine-35 is 75% and chlorine-37 is 25%.

The steps below show how mass spectrometry is done:

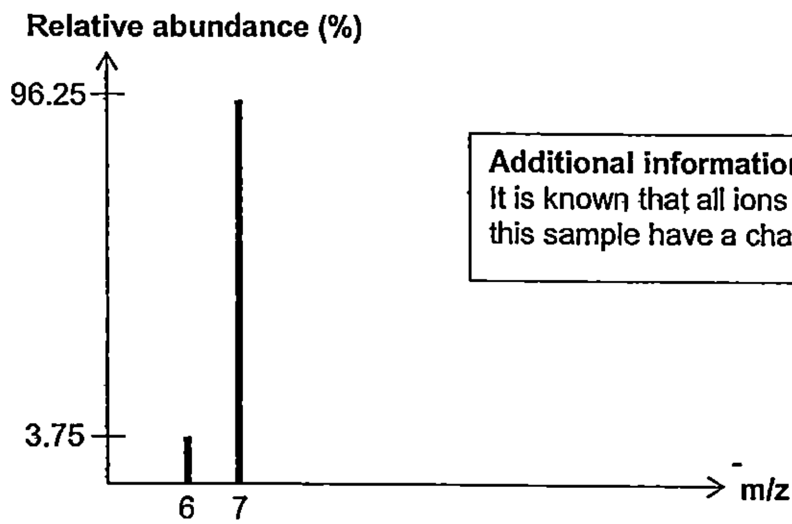
Step 1: Ionisation – the sample is vapourised. Energy is then used to knock off one or more electrons from atoms or molecules in the sample, changing them into positive ions. If enough energy is supplied, some bonds of molecules are broken and smaller positive ions are formed.

Step 2: Acceleration – the ions formed from Step 1 are accelerated through the spectrometer by the use of negatively-charged plates.

Step 3: Deflection and detection – the ions are deflected by a magnetic field and are detected electrically.

Step 4: Mass spectrum – the mass spectrometer records the **m/z** and **relative abundance** of all ions in the form of a histogram, called a mass spectrum.

Figure 1 below shows the mass spectrum of a pure sample of **lithium**:



Additional information
It is known that all ions analysed in this sample have a charge of **1+**.

Figure 1: Mass spectrum of a pure sample of ***lithium***

Figure 2 below shows the mass spectrum of a pure sample of **chlorine:**

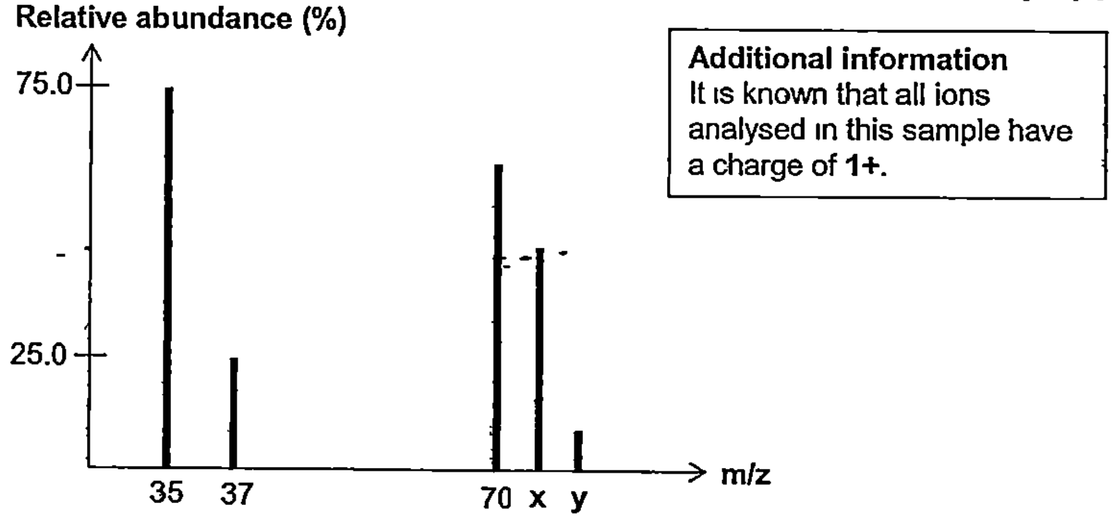


Figure 2: Mass spectrum of a pure sample of ***chlorine***

Figure 3 below shows the mass spectrum of a pure sample of **an unknown hydrocarbon:**

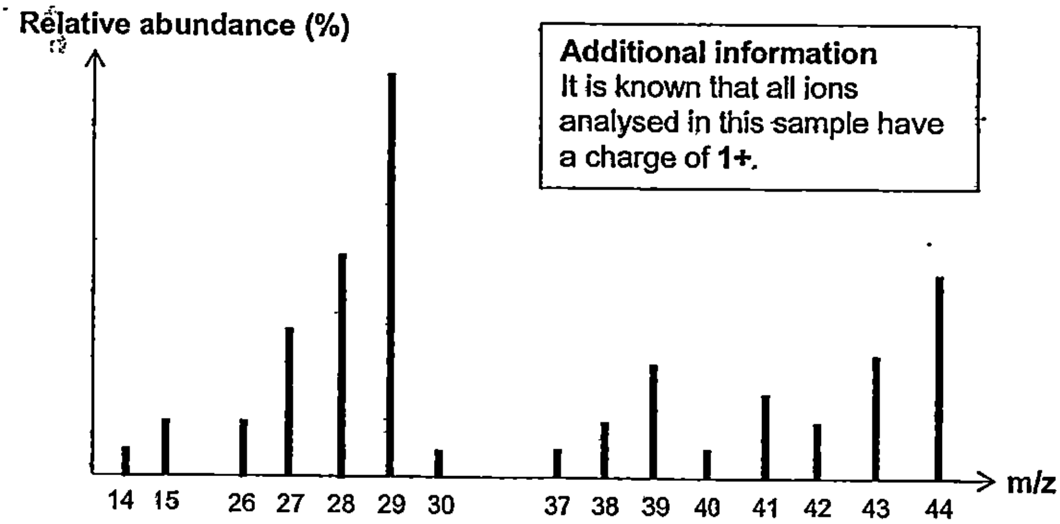


Figure 3: Mass spectrum of a pure sample of ***an unknown hydrocarbon***

Figure 1

(a) (i) Explain how the data in **Figure 1** shows that there are two isotopes of lithium. [2]

....

....

....

(ii) Show that the average relative atomic mass of lithium is 6.96 rounded off to 3 significant figures. Show your working clearly. [1]

Figure 2

(b) (i) State the values of **x** and **y**. .... [2]

(ii) There are only two known isotopes of chlorine, **C*l*-35** and **C*l*-37**. Use the data in **Figure 2** to suggest why there are 3 additional peaks of **70, x** and **y** on the mass spectrum of chlorine [2]

....

....

....

Figure 3

(c) (i) A student comments that the unknown hydrocarbon is propane Explain how the data in **Figure 3** shows that this is true. [2]

....

....

....

(ii) Suggest the formula of the ion which has a **m/z** value of 14. [1]

....

(iii) Another mass spectrometry analysis was carried out on a sample of butane. Suggest how the results of the mass spectrum of butane would differ from that of propane. [2]

....

....

....

[Total marks: 12]

B7 The table below provides some information on four organic compounds:

Compound	Molecular formula	Decolourises brown aqueous bromine?	Turns moist blue litmus paper red?
A	C_2F_4	Yes	No
B	$C_3H_6O_2$	No	Yes
C	$C_3H_6O_2$	Yes	No
D	$HO_2C-C_2H_4-CO_2H$	No	Yes

(a) (i) Compound **A** can be polymerised to make polytetrafluoroethylene, also known as **PTFE**. **[1]**
Draw the structure of **PTFE**.

(ii) There are high and low grades of **PTFE**. **[1]**
Molecules of high-grade **PTFE** typically have a relative molecular mass of 1.2×10^6.
Calculate how many repeat units there are in a typical molecule of high-grade **PTFE**. Show your working clearly.

(iii) Low-grade **PTFE** molecules typically have a relative molecular mass of 1.4×10^4. **[1]**
Explain why low-grade **PTFE** has a lower melting point than high-grade **PTFE**.

....

....

(iv) Describe and explain a pollution problem caused by getting rid of substances made of **PTFE**. **[2]**

....

....

(b) Compound **B** can react with another organic compound to form ethyl propanoate.

(i) Draw the structure of the organic compound which can react with **B** to form ethyl propanoate. [1]

(ii) Draw the structure of ethyl propanoate. [1]

(c) Compound **C** can be polymerised with Compound **D**. [1]
During this polymerisation process, small molecules of water are eliminated.
Draw the structure of the polymer formed when **C** is polymerised with **D**, showing 2 repeat units.

[Total marks: 8]

EITHER

B8 This question concerns the chemistry of carbon and silicon, elements from Group IV of the Periodic Table.
The table below provides some information on two different forms of carbon (allotropes) and silicon:

Substance	Melting point / °C	Electrical conductivity	Uses
Carbon allotrope **A**	Above 3000	Poor	Cutting tools, drill bits
Carbon allotrope **B**	Above 3000	Good	Lubricant
Silicon	1414	Good	Semiconductors in electronics

Table 1: Some information on carbon and silicon

(a) Carbon tends to form covalent compounds. **[3]**
By drawing the dot-and-cross diagram of a carbon compound of your choice, describe how a covalent bond is formed. You only need to show valence electrons.

....

....

....

(b) Explain, in terms of bonding, why carbon allotrope **A** can be used as a drill bit while carbon allotrope B can be used as a lubricant. **[2]**

....

....

....

....

(c) Carbon is commonly used as a reducing agent. For example, it can reduce zinc oxide to form zinc. **[1]**
Explain, using oxidation states, how carbon is acting as a reducing agent in the reduction of zinc oxide.

....

....

(d) Silicon has the structure has shown below: **[2]**

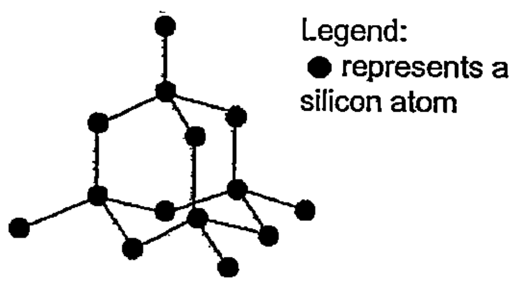


Figure 4: Structure of silicon

This structure of silicon in **Figure 4** above alone is <u>unable</u> to account for one of its physical properties stated in **Table 1.**
State this physical property and explain why.

....

....

....

(e) Silicon reacts with oxygen to form silicon dioxide. **[2]**
Describe one **similarity** and one **difference** between the **structures** of silicon and silicon dioxide.

....

....

....

[Total marks: 10]

OR

B8 This question concerns the chemistry of some elements in Group II of the Periodic Table.

(a) Magnesium is in Group II of the Periodic Table. It tends to form ionic compounds. **[3]**
By drawing the dot-and-cross diagram of a magnesium compound of your choice, describe how an ionic bond is formed. You only need to show valence electrons.

....

....

....

(b) Magnesium reacts with oxygen to form magnesium oxide.

(i) In terms of bonding, "strong electrostatic forces of attraction" exist in both solid magnesium and solid magnesium oxide, but different kinds of particles are involved. **[2]**
State these particles.

....

....

(ii) Both solid magnesium and molten magnesium oxide conduct electricity differently. **[1]**
Explain how solid magnesium conducts electricity differently from molten magnesium oxide.

....

....

....

(c) Both magnesium and calcium metals are reducing agents. [1]
Some chemical reactions show that calcium is a stronger reducing agent than magnesium.
Write a single, chemical equation to represent one such reaction.

....

(d) The table below provides some information on some salts of Group II elements: [3]

Name of salt	Solubility (maximum grams dissolved in 100 cm^3 of water at r.t.p)
Magnesium sulfate	35.1
Calcium sulfate	0 21
Barium sulfate	2.45×10^{-4}
Radium sulfate	?

From the information give in the table above, suggest how you would prepare a pure, dry sample of radium sulfate. Name the starting reagents in your answer.

....

....

....

....

[Total marks: 10]

- End of Section B -

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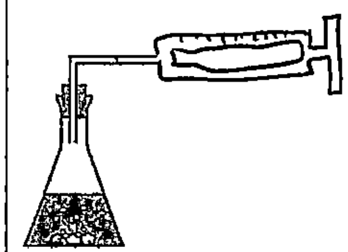
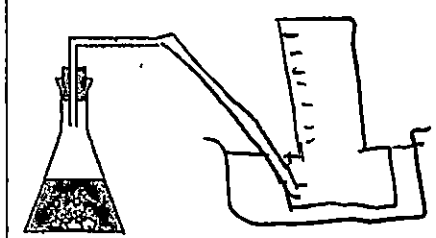
2015 Prelim Answers

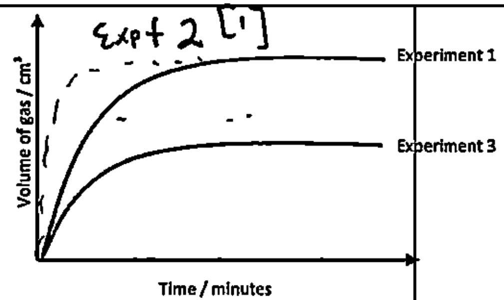
Paper 1

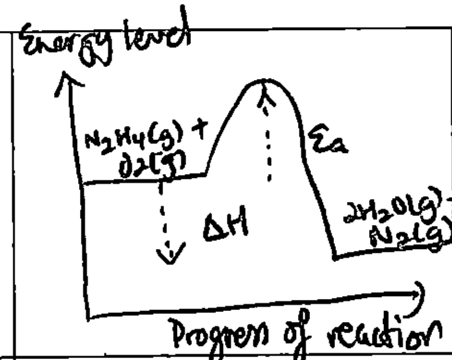
1 C	2 D	3 C	4 A	5 C	6 B	7 C	8 A	9 A	10 C
11 C	12 C	13 D	14 D	15 B	16 B	17 A	18 B	19 A	20 A
21 D	22 B	23 C	24 B	25 C	26 C	27 D	28 A	29 C	30 C
31 A	32 B	33 D	34 D	35 D	36 C	37 B	38 B	39 C	40 A

Paper 2 Section A

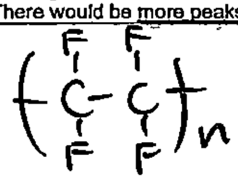
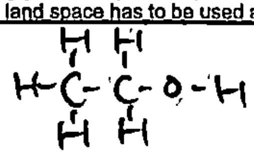
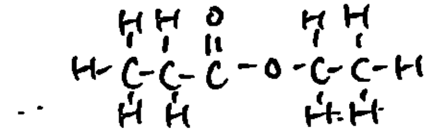
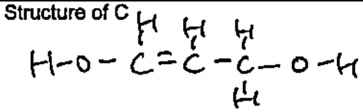
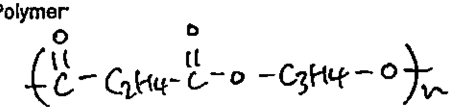
	Marking scheme	Remarks
A1ai	B	
ii	E	
b	Carbon monoxide **binds irreversibly with haemoglobin** [1] to form carboxyhaemoblobin which prevents **transportation of oxygen to the whole body**, causing **respiratory difficulty** [1]	Reject breathing difficulty
C i	Any noble gas	
ii	Noble gases is unreactive/full valence shell/octet or duplet structure [1]	
A2ai	Cathode: $2H^+(aq) + 2e^- \rightarrow H_2(g)$ Anode $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$	-1 mark if no state symbols
ii	**Effervescence** of a **colourless gas** produced at **cathode**. [1] **Hydrogen** is **less reactive** than **sodium** in the reactivity series, therefore, **H^+ ions** is **preferentially discharged** [1] **Effervescence** of a **greenish yellow gas** produced at **anode.** [1] **Cl^- ions** are preferentially discharged because it is a **concentrated** solution [1]	Reject chlorine ions/chloride atoms. Reject hydrogen is preferentially discharged
(b)(i)	No. of mol of Cl_2 $= \frac{6.0}{24} = 0.25$ mol [1] No. of mol of $e^- = 0.50$ mol [1] $Cu^{2+} + 2e^- \rightarrow Cu$ Mass of Cu $= \frac{0.50}{2} \times 64$ $= 16.0$ g [1]	ECF from A2ai ECF from within question.

	$Ag^+ + e^- \rightarrow Ag$ Mass of Ag $= 0.50 \times 108$ $= 54.0$ g [1]	
ii	Solution will turn from **blue to colourless** [1] **Copper ions** are **preferentially discharged** from the solution [1]	
(c)	**Silver anode** will **dissolve** compared to seeing **effervescence** seen at the anode [1] Silver anode is a **reactive electrode** compared to **inert carbon electrode** [1]	Comparison must be made
A3a	 	Markings must be shown
(b)	$2HCl(aq) + Zn(s) \rightarrow ZnCl_2(aq) + H_2(g)$	-1 mark for no state symbol No marks for wrongly balanced equation

(c)		
(d)	Y = 30.0 cm^3 Z = 0.25 mol/dm^3 Or Y = 60 0 cm^3 Z = 0 125 mol/dm^3	
(e)	Increase in temperature, <u>increases the kinetic energy of the particles [1]</u>, <u>more particles have energy greater or equal to the activation energy [1]</u>, <u>higher frequency of effective collision</u>,[1] increase speed of reaction	
A4a	A,C,D,B	
b	Metal A. No visible observation [1] Metal D: Metal D dissolves/brown solution becomes colourless/Grey solid produced (Any 2 for 2 marks)	
(c)(i)	Coke, Haematite and Limestone	
(ii)	$Fe_2O_3(s) + 3CO(g) \rightarrow 3CO_2(g) + 2Fe(l)$	-1 mark if no state symbols
(d)(i)	Oxygen and water	Reject air
(ii)	Sacrificial Protection A <u>more reactive metal</u> like magnesium or zinc can be <u>placed beside iron</u> [1] It will <u>corrode in place of iron</u> [1]	
A5a	<u>Bond energy absorbed to break the bonds of N_2H_4 and O_2</u> [1] is <u>lesser</u> [1] than the <u>energy released for the bond formation</u> of <u>H_2O and N_2</u> [1]	

(b)		1m - Shape of the graph 2m – For enthalpy change, activation energy and correct reactants and products. (-1 m if one or two is missing) Arrow wrong = wrong
(c)	Energy absorbed = 163 + 390(4) + 158(2) = 2039 kJ [1] Energy released = 565(4) + 945 = 3205 kJ [1] ΔH = 2039 – 3205 = – 1166 kJ/mol [1]	
(d)(i)	A strong acid is an acid that <u>dissociates completely in water to produce H^+ ions</u>	
(ii)	The statement is false. Hydrogen fluoride is made up of <u>non-metals</u> [1] therefore it is a <u>covalent compound</u> [1]	

Paper 2 Section B

	Marking scheme	Remarks
B6ai)	Isotopes have the same number of protons but different number of neutrons In Figure 1, there are <u>2 ions</u> detected which have different m/z values of <u>6 and 7</u> [1] This indicates that these 2 ions have <u>different numbers of neutrons</u> [1]	ACCEPT "particles" in place of ions REJECT different "mass numbers"
aii)	3.75/100 x 6 + 96.25/100 x 7 = 6.96 (3sf)	No marks if no working is shown
bi)	x = 72 [1], y = 74 [1]	
bii)	Chlorine exists as <u>diatomic molecules</u> [1] There are 3 possible combinations 2 atoms of Cl-35 1 atom of Cl-35 and 1 atom of Cl-37 2 atoms of Cl-37 [1]	OWTTE
ci)	The largest m/z value is 44, which belongs to the ion formed by the <u>largest molecule</u>. This molecule would be that of the unknown hydrocarbon as it is <u>unbroken</u> [1] <u>Propane has a relative molecular mass of 44</u> [1]	OWTTE
cii)	CH_2^+	
ciii)	The highest m/z value recorded would be <u>58</u> [1] There would be <u>more peaks</u> [1]	
B7ai)		ACCEPT 2 or more repeat units
aii)	M_r of one repeat unit = 12 x 2 + 19 x 4 = 100 No. of repeat units = (1.2 x 10^6) / 100 = 12000	
aiii)	Low-grade PTFE molecules are smaller, and hence there are fewer electrons. There are <u>weaker intermolecular forces</u> in low-grade PTFE which <u>require less heat to overcome</u> [1]	
aiv)	Substances made of PTFE are <u>non-biodegradable</u> [1]. If they are disposed by <u>burning, toxic gases are released</u> [1] OR if they are disposed by <u>burying, valuable land space has to be used as landfills</u> [1]	
bi)		
bii)		
c)	Structure of C  Polymer 	ACCEPT 2 or more repeat units
EITHER 8a)	Any appropriate compound 1 mark for correct number of electrons on carbon atom 1 mark for correct number of electrons on the other atom(s) Explanation. the carbon atom and X atom <u>share a pair of electrons to attain a noble gas electronic configuration</u> [1]	0 marks for ionic compound
b)	In allotrope A, <u>every carbon atom is bonded to 4 other carbon atoms by strong covalent bonds</u>. This makes the whole structure very hard. In allotrope B, <u>every carbon atom is bonded to 3 other carbon atoms in hexagonal layers</u>. Little force is needed to overcome these <u>weak intermolecular forces of attraction between layers</u>, making B <u>slippery</u>.	To discuss mark allocation
c)	Carbon causes the <u>oxidation state of zinc to decrease from +2 in ZnO to 0 in Zn</u>, hence reducing zinc oxide	
d)	Good electrical conductivity [1] Every carbon atom is bonded to 4 other carbon atoms, all valence electrons are used in bonding and there appears to be no mobile delocalised electrons or ions	
e)	Similarity. both silicon and silicon dioxide have giant covalent <u>tetrahedral</u> [1] structures Difference: the structure of silicon <u>only involves silicon atoms while there are silicon and oxygen atoms present in silicon dioxide</u> [1].	

OR B8		
a)	Any appropriate compound 1 mark for correct number of electrons and charge on magnesium ion 1 mark for correct number of electrons and charge on the other ion(s) Explanation the magnesium atom transfers 2 valence electrons to X atom Both ions attain noble gas electronic configurations [1]	
bi)	In solid magnesium, strong electrostatic forces of attraction exist between positive and negative ions [1] In solid magnesium oxide, strong electrostatic forces of attraction exist between positive ions and "sea" of mobile, delocalised electrons [1]	
bii)	Solid magnesium conducts electricity because of the "sea" of mobile, delocalised electrons Molten magnesium oxide conducts electricity because of mobile ions	
c)	Any appropriate reaction, e g displacement reaction involving calcium and magnesium	
d)	Add any soluble radium salt, e g aqueous radium nitrate to any soluble sulfate salt, e.g. aqueous sodium sulfate [1] Filter the mixture and keep the residue [1] Wash residue with distilled water and press dry between sheets of filter paper [1]	

Class.	Register No	Name.

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION 2015

CHEMISTRY

Paper 1 Multiple Choice

5073/01
31 August 2015
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 17 printed pages, including the cover page

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 †															

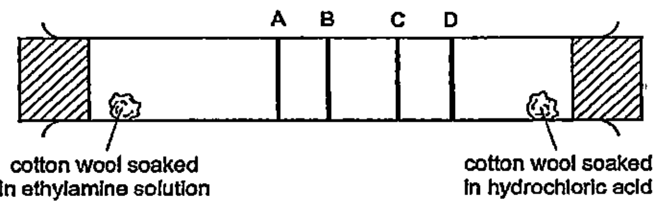
*58-71 Lanthanoid series
†90-103 Actinoid series

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

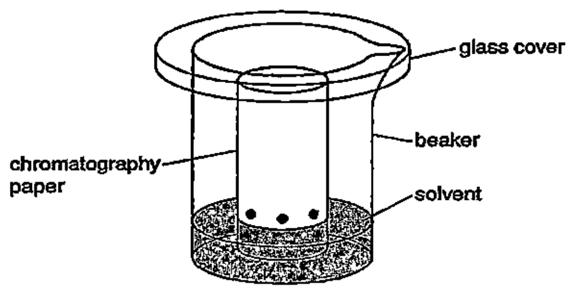
Key: a X b — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

1 Ethylamine gas, $C_2H_5NH_2$, and hydrogen chloride gas, HCl, react together to form a white solid, ethylamine hydrochloride.

At which position in the tube would a ring of solid white ethylamine hydrochloride form?



2 Amino acids are colourless and can be separated and identified by chromatography as shown



What additional apparatus and/or chemical is/are required to calculate the R_f value of the amino acids present in a mixture?

A a ruler

B a locating agent

C a ruler and a locating agent

D neither a ruler nor a locating agent

3 In which pair do neither of the gases change the colour of moist blue litmus paper?

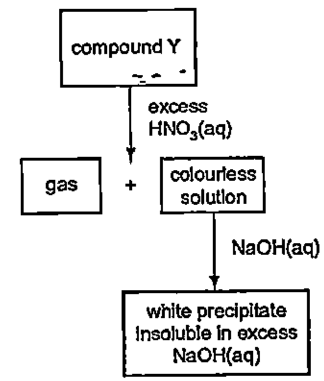
A ammonia and hydrogen

B ammonia and hydrogen chloride

C carbon dioxide and chlorine

D carbon dioxide and sulfur dioxide

4 The scheme shows a sequence of reactions starting from compound Y



What could compound Y be?

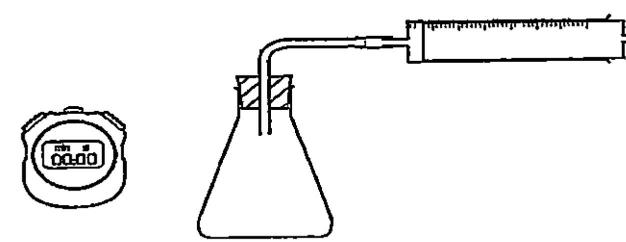
A aluminium hydrogencarbonate

B calcium carbonate

C copper(II) carbonate

D zinc carbonate

5 The apparatus shown can be used to find the rate of some chemical reactions



The rate of which reaction can be followed using this apparatus?

A $Mg + HCl$

B $AgNO_3 + KI$

C $NaOH + HCl$

D $NaOH + CuSO_4$

6 Naturally-occuring bromine has a relative atomic mass of 80 and consists entirely of two isotopes of relative atomic masses 79 and 81

What can be deduced about naturally-occuring bromine from this information only?

A Bromine is radioactive

B Bromine has different oxidation states

C Bromine isotopes have different number of protons

D Bromine contains the two isotopes in equal proportions.

7 An ion X^{2-} has **m** nucleons and **n** electrons

What does the nucleus of an atom X contain?

	number of protons	number of neutrons
A	n – 2	m – n
B	n – 2	m – (n – 2)
C	n + 2	m – (n – 2)
D	n + 2	m – (n + 2)

8 Both magnesium oxide, MgO, and aluminium oxide, Al_2O_3, are solids at room temperature of 25 °C

The table below shows their melting and boiling points

	melting point (°C)	boiling point (°C)
MgO	2852	3600
Al_2O_3	2072	2880

Over which temperature range will both pure compounds conduct electricity?

A 25 °C to 2852 °C

B 2072 °C to 2852 °C

C 2852 °C to 2880 °C

D 2880 °C to 3600 °C

9 The structure of metals consists of positive ions in a 'sea of electrons'.

Which statement correctly describes what happens to the particles in the metallic heating element of an electric kettle when the kettle is switched on?

A Electrons move in both directions in the element.

B Electrons move in one direction only in the element.

C Positive ions move in one direction only in the element.

D Electrons move in one direction and positive ions move in the opposite direction in the element.

10 In the lattice structure of ionic compounds, coordination number is the number of nearest neighbour ions of opposite charge For instance, in sodium chloride, each Na^+ ion is surrounded by 6 Cl^- ions and each Cl^- ion is surrounded by 6 Na^+ ions Therefore, coordination number of Na^+ and Cl^- ions is 6.

The table below shows the ions present and the coordination number of the ions in some ionic compounds

compound	ions present		coordination number of		formula
	cation	anion	cation	anion	
sodium chloride	Na^+	Cl^-	6	6	NaCl
titanium(IV) oxide	Ti^{4+}	O^{2-}	6	3	TiO_2
P	Q	R	4	8	?

What is the formula of compound P?

A QR_2

B Q_2R

C QR_4

D Q_4R

11 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 SiC, BN and bronze are correct?

1 All are bonded covalently.

2 All have high melting and boiling point.

3 All except bronze are soluble in organic solvent.

4 All except silicon carbide conduct electricity when solid

A 1 and 2

B 2 and 3

C 2 and 4

D 3 and 4

12 One volume of gaseous element X_2 reacts with an equal volume of gaseous hydrogen to form two volume of a gaseous hydride

What is the formula for the hydride of X?

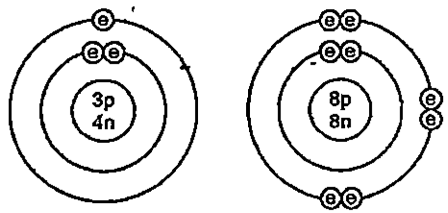
A HX

B HX_2

C H_2X_2

D H_2X

13 The diagram shows the stuctures of the atoms of elements Y and Z.



p = proton
n = neutron
e = electron

Y Z

Elements Y and Z react to form a compound

What is the mass of one mole of this compound?

A 11 g B 12 g
C 23 g D 30 g

14 An equal number of moles of two chemical compounds, R and S, are given

The chemical formulae of these two substances, R and S, are shown below

R $NaAlSi_3O_8$

S $CaAl_2Si_2O_8$

Which statements are incorrect?

1 R and S contain the same number of moles of oxygen
2 Both R and S have the same percentage by mass of oxygen.
3 The percentage by mass of aluminium in S is twice the percentage by mass of aluminium in R

A 1 and 2 B 1 and 3
C 2 and 3 D 1, 2 and 3

15 Four students prepared hydrated copper(II) sulfate by adding an excess of dilute sulfuric acid to copper(II) oxide Each student used a different mass of copper(II) oxide

$$\underset{Mr = 80}{CuO} \xrightarrow{\text{dilute sulfuric acid}} \underset{Mr = 250}{CuSO_4\,5H_2O}$$

After the copper(II) sulfate had crystallised, the students dried and weighed the crystals

It is known that 1 mole of copper(II) oxide produces 1 mole of hydrated copper(II) sulfate from the reaction

Which student produced the highest percentage yield of hydrated copper(II) sulfate?

	mass of copper(II) oxide used / g	mass of crystal produced / g
A	4 0	11 5
B	8 0	23 5
C	12 0	35 0
D	16 0	46 5

16 20 cm^3 of propyne, C_3H_4, is reacted with 500 cm^3 of oxygen.

The equation for the reaction is shown below.

$$C_3H_4 + 4O_2 \rightarrow 3CO_2 + 2H_2O$$

What is the total volume of gas remaining at the end of the reaction?

(all volumes are measured at room temperature and pressure)

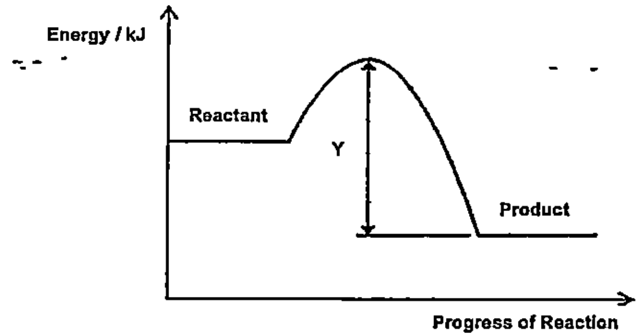
A 60 cm^3 B 100 cm^3
C 480 cm^3 D 520 cm^3

17 Which processes are endothermic?

1 $Cl_2 \rightarrow 2Cl$
2 burning a fossil fuel
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

18 The change in energy during a reaction is represented in the following energy profile diagram



What does Y represent?

A the enthalpy change for the forward reaction

B the activation energy of the forward reaction

C the activation energy for the reverse reaction

D the energy released to form the bonds in the products for the reverse reaction

19 Solutions of hydrochloric acid, HCl and ethanoic acid, CH_3COOH, of the same concentration react completely with 5 0 g of calcium carbonate, $CaCO_3$, in separate containers

Which statement is correct?

A CH_3COOH reacts slower because it has a lower pH than HCl

B A smaller volume of CO_2 is produced with CH_3COOH than with HCl

C A greater volume of CO_2 is produced with CH_3COOH than with HCl

D The same volume of CO_2 is produced with both CH_3COOH and HCl

20 In which reaction does a single nitrogen atom have the greatest change in oxidation number?

A $2NO + O_2 \rightarrow 2NO_2$

B $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

C $4NH_3 + 6NO \rightarrow 5N_2 + 6H_2O$

D $3NO_2 + H_2O \rightarrow 2HNO_3 + NO$

21 Three electrolytic cells are set up Each cell uses inert electrodes

The electrolytes used for each cell are shown in the table below

cell 1	concentrated silver chloride solution
cell 2	molten sodium iodide
cell 3	dilute nitric acid solution

In which of these cells is a gas formed at both electrodes?

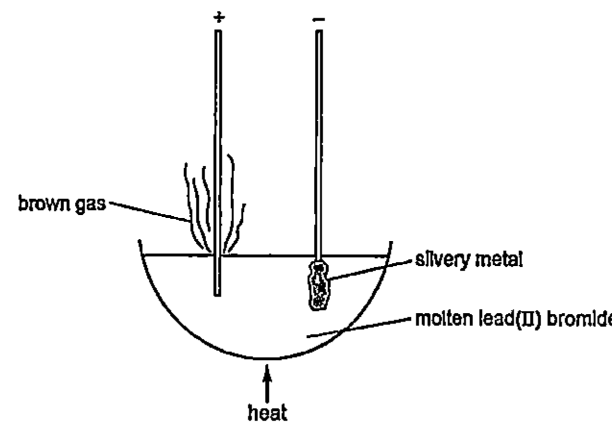
A 1 and 2

B 1 and 3

C 2 only

D 3 only

22 The diagram shows the electrolysis of molten lead(II) bromide using inert electrodes



What happens during this electrolysis?

A Ions change to atoms

B Atoms change to ions

C Covalent bonds are broken

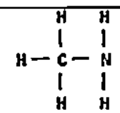
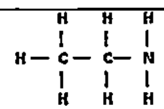
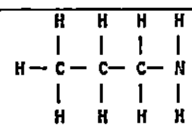
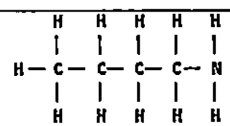
D New compounds are formed

23 The dissociation constant (K_b) for a base indicates the extent to which it dissocates into ions in water The higher the dissociation constant (K_b), the higher the strength of the base

Generally, compounds from amine homologous series form weak bases when dissolved in water For instance, when methylamine is-added to water, it ionises partially into methylammonium ion and hydroxide ion as shown in the equation below

$$CH_3NH_2\ (aq) + H_2O\ (l) \leftrightharpoons CH_3NH_3^+\ (aq) + OH^-\ (aq)$$

The dissociation constant (K_b) and full structural formula for the first four members of the amine homologous series are given in the table below

amine	full structural formula	dissociation constant (K_b)
methylamine		4.6×10^{-4}
ethylamine		4.5×10^{-4}
propylamine		3.5×10^{-4}
butylamine		4.0×10^{-4}

Based on the data above, which statement is correct?

A Aqueous methylamine turns Universal Indicator from green to yellow

B Increasing the length of carbon chain increases the strength of the base

C There are more undissociated molecules in a solution of butylamine than that in ethylamine of same concentration.

D Given that the K_b of ammonia = 1.8×10^{-5}, there is a higher concentration of OH^- ions in ammonia solution than that in propylamine of the same concetration

24 Three oxides are added separately to aqueous barium hydroxide

1 lead(II) oxide

2 nitrogen monoxide

3 silicon dioxide

Which oxide(s) react(s) with aqueous barium hydroxide?

A 1 and 2 **B** 1 and 3

C 2 and 3 **D** 1 only

25 A colourless solution contains three different ions, Ag^+, Ba^{2+} and an unknown anion, Y

What is Y?

A Cl^- **B** CO_3^{2-}

C NO_3^- **D** SO_4^{2-}

26 Which two statements indicate metal M may have a proton number between 21 to 30?

1 It conducts electricity

2 It forms two coloured sulfates

3 It forms two basic oxides with formulae MO and M_2O_3.

4 It reacts with steam to form a metal oxide with formula M_3O_4

A 1 and 2 **B** 1 and 4

C 2 and 3 **D** 3 and 4

27 Which property would all the hydrogen compounds of the Group VII elements possess?

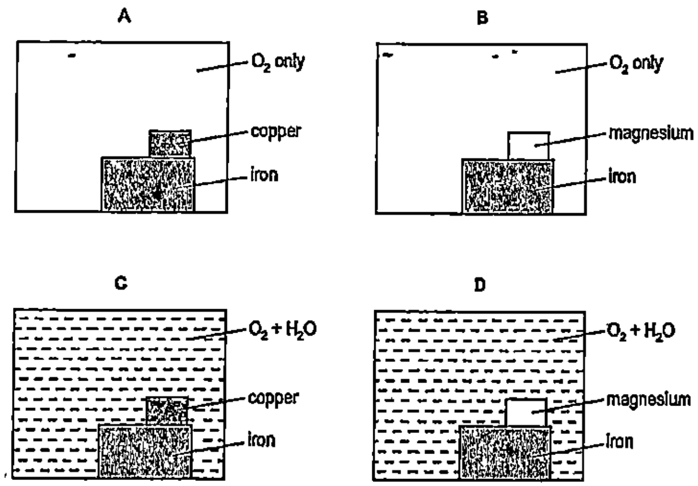
A They are covalent.

B They are solids at room temperature

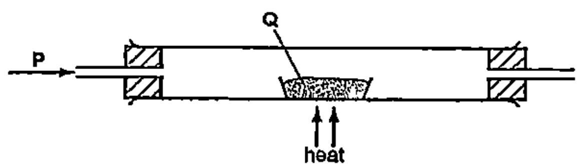
C They conduct electricity when molten

D They form alkaline aqueous solutions

28 Which diagram correctly illustrates how iron is prevented from rusting by sacrificial protection?



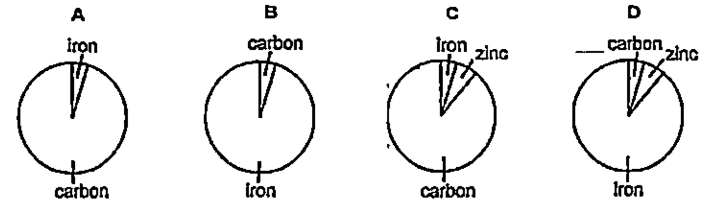
29 In the apparatus shown, gas P is passed over solid Q. No visible reaction occurs.



Identify gas P and solid Q.

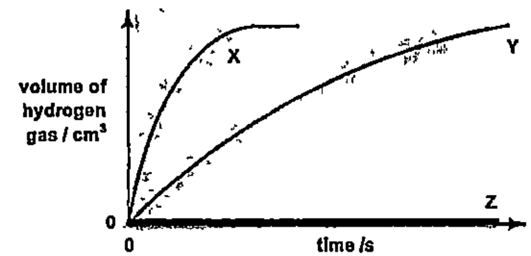
	P	Q
A	hydrogen	zinc oxide
B	hydrogen	iron(II) oxide
C	oxygen	sulfur
D	oxygen	carbon

30 Which chart could represent the composition of a galvanised roof?



31 Three different metals, X, Y and Z, are each added to an excess of dilute hydrochloric acid.

The graph shows how rapidly hydrogen gas is given off.



Identify metal X, Y and Z.

	X	Y	Z
A	Fe	Cu	Ca
B	Ca	Fe	Cu
C	Mg	Pb	Ag
D	Mg	Ag	Pb

32 Which pollutant gas is produced by the decomposition of vegetation?

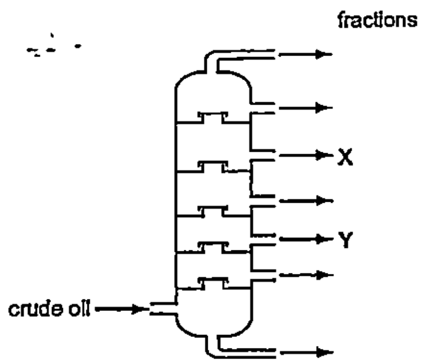
A CH_4

B CO

C NO

D SO_2

33 Crude oil is fractionally distilled in a fractionating column The positions at which fractions X and Y are collected are shown



Which statement is correct?

A X has a higher boiling point than Y.

B X has a longer chain molecules than Y

C The temperature increases up the column

D X condenses at a lower temperature than Y.

34 Which organic compound requires the least oxygen for the complete combustion of one mole of the compound?

A C_3H_8 B C_4H_8

C C_3H_7OH D C_3H_7COOH

35 Which bonds is/are **not** present in methanoic acid?

1 C–C

2 C=C

3 C–O

A 1 and 2 B 2 and 3

C 1 only D 2 only

36 With the presence of UV light, 1 mole of propane reacts with 3 moles of chlorine in a substitution reaction

What is the formula of the organic product in this reaction?

A $C_3H_2Cl_6$ B $C_3H_3Cl_5$

C $C_3H_4Cl_4$ D $C_3H_5Cl_3$

37 Arachidonic acid is one of the most abundant polyunsaturated fatty acids in the brain.

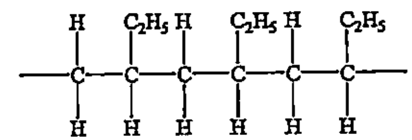
It has a molecular formula of $C_{19}H_{31}COOH$

How many C=C double bonds are present in 1 molecule of arachidonic acid

A 1 B 2

C 3 D 4

38 The diagram shows a section of a polymer



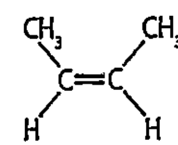
Which statement about this polymer is correct?

A It is a condensation polymer.

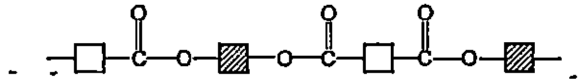
B It decolourises aqueous bromine

C Both the polymer and its monomers have the same empirical formula.

D The structural formula of its monomer is



39 The diagram shows the partial structure of Terylene



From which pair of monomers is it made?

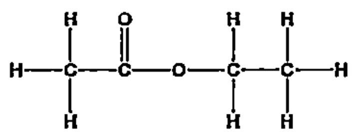
A 

B 

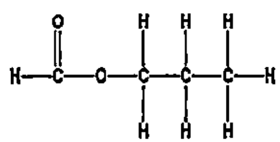
C 

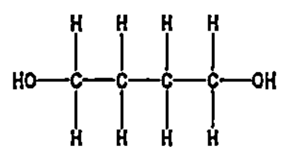
D 

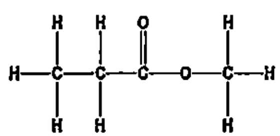
40 The diagram shows the structure of ethyl ethanoate

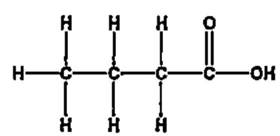


Which structure is not an isomer of ethyl ethanoate?

A 

B 

C 

D 

Crescent Girls' School
Secondary Four
Preliminary Examinations 2015
Chemistry Paper 1 – Worked Solutions

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

CLASS:	REGISTER NO.:	NAME:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION 2015

CHEMISTRY **5073/2**
Paper 2
20th August 2015
1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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.
You may use a pencil for any diagrams or graphs.
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 17.

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

For Examiner's Use	
Section A	
B6	
B7	
B8 EITHER/OR	
Total	80

This paper consists of 17 printed pages, including the cover page.

Section A

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

A1 The following information is given for the oxides of some elements in Period 3.
The elements are labelled as **W**, **X**, **Y** and **Z**.

Element	Formula of oxide	Melting point/°C	Boiling point/°C	Behaviour of oxide with water	Reaction of oxide with hydrochloric acid
W	WO_2	-72	-10	Dissolves in water to form a solution that turns blue litmus paper red	No reaction
X	XO	2852	3600	Insoluble in water	Reacts with acid
Y	Y_2O	1132	1950	Dissolves in water to form a solution that turns red litmus paper blue	Reacts with acid
Z	Z_2O_3	2072	2977	Insoluble in water	Reacts with acid

Use the information from the table to answer the following questions.

(a) Which element has the highest tendency to gain electrons? Explain your answer. [2]

____

____

(b) (i) Draw a 'dot and cross' diagram to show the bonding in Y_2O. [2]

Show the valence electrons only.

A1 (b) (ii) Predict the electrical conductivity of Y_2O in the solid state. Explain your answer. [2]

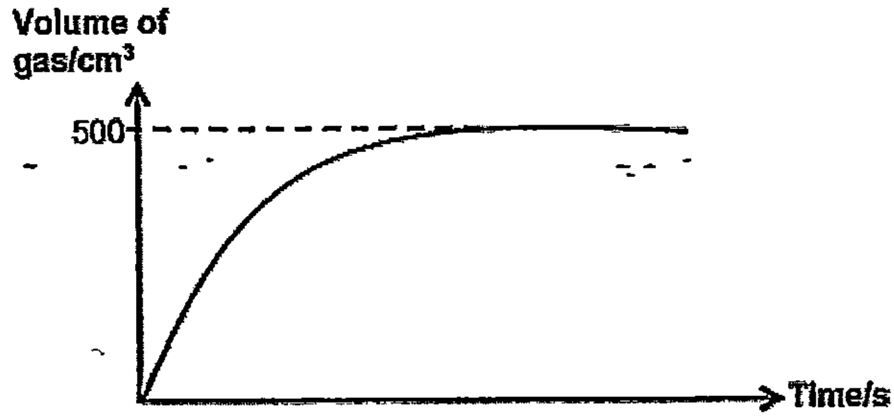
(c) Arrange the elements **W, X, Y, Z** in order of increasing proton numbers [2]

[Total: 8 marks]

A2 (a) During a chemistry experiment, a student added 1.00 g of calcium metal to 25.0 cm^3 of 1.50 mol/dm^3 of nitric acid. The gas evolved from the reaction was collected and measured over fixed intervals until the reaction is completed. [3]

Calculate the total volume of gas expected to be collected at the end of the reaction.

A2 (b) At the end of the experiment, a graph of volume of gas collected against time was plotted and shown below.



Suggest a reason for the difference between the actual volume of gas obtained and the theoretical volume calculated in **(a)**. [1]

___

___

(c) The student intends to repeat the experiment using sulfuric acid. Other than mass, suggest one other important factor regarding the metal reagent that needs to be kept constant in order to ensure that a fair second experiment was conducted. [2]

Explain your answer.

___

___

___

(d) Given that the volume and concentration of acid and mass of calcium metal used for the second experiment is kept the same as the first experiment, sketch the expected graph on the same axes and label the graph as **(d)**. [2]

(e) Explain the shape of your graph in **(d)**. [3]

___

___

___

___

[Total: 11 marks]

A3 The Ostwald Process is a chemical process for manufacturing nitric acid, HNO_3. It is done via two stages.

The chemical equation below illustrates the redox reaction that occurs in Stage One.

Stage One: $4NH_3\ (g) + 5O_2\ (g) \rightarrow 4NO\ (g) + 6H_2O\ (g)$ $\Delta H = -905.2$ kJ

(a) Draw an energy profile diagram for the reaction above, indicating the enthalpy change and activation energy clearly. [3]

(b) In terms of oxidation states, explain why the reaction in Stage One is a redox reaction. [2]

____

____

____

Stage Two consists of two steps.

Step 1: $2\ NO\ (g) + O_2\ (g) \rightarrow 2\ NO_2\ (g)$

In **Step 2**, NO_2 produced in **Step 1** is absorbed by water readily to form dilute nitric acid as well as nitrogen monoxide, which is recycled to be used in **Step 1**.

(c) (i) Write a balanced chemical equation to show the reaction in **Step 2**. [1]

____

(ii) Name a physical process that can be carried out to increase the concentration of the dilute nitric acid that is obtained at the end of Stage 2. [1]

____

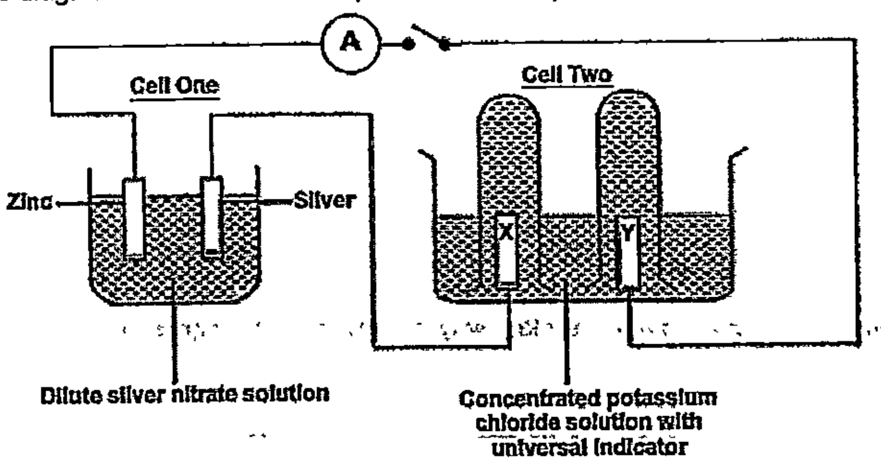
A3 (c) (iii) Explain why it is important that the product in **Step 1** of Stage Two does not escape into the atmosphere. [2]

____

____

Total: [9 marks]

A4 The diagram below shows an experimental set-up of two electrochemical cells



Both electrodes **X** and **Y** are made of graphite.

(a) Identify the **positive terminals** of both electrochemical cells and write the equations to illustrate the reactions happening at the electrodes. Include state symbols. [3]

	Positive Terminal	Half-equation
Cell One		
Cell Two		

(b) (i) What is the expected ratio of the volume of the gases obtained at electrodes X and Y? [2]

Explain your answer with appropriate equation(s). Include state symbols.

____

____

____

A4 (b) (ii) Suggest a possible reason why the ratio of the volume of the gases may not be the same as what was expected in **(b)(i)** **[1]**

___

___

(c) What is the colour observed in the electrolyte of **Cell Two** when the circuit has been switched on for a period of time? **[2]**

Explain your answer.

___

___

___

[Total: 8 marks]

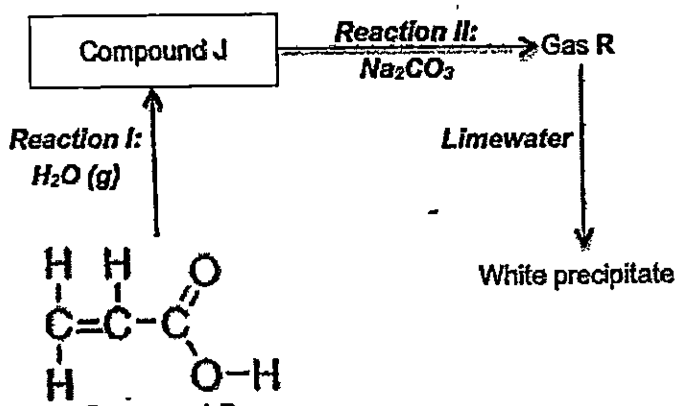
A5 (a) (i) An organic compound **J** contains 40.0% of carbon, 53.3% of oxygen and 6.7% of hydrogen. **[3]**

Calculate the empirical formula of the compound.

(ii) The relative molecular mass of the compound is 90. **[2]**

What is the molecular formula of the compound J?

A5 (b) The diagram below shows some information related to compound **J**.



Compound G

(i) **Reaction I** is known as a ***hydration*** reaction. State the conditions required for the reaction to take place. **[1]**

____

(ii) Identify Gas **R** and the functional group present in compound **J** that allows **Reaction II** to occur. **[2]**

____

____

(iii) Compound **J** has an isomer. **[2]**

Using the information in **(a)** and the diagram above, deduce and draw the **full** structural formulae of compound **J** and its isomer

Compound J	**Isomer of Compound J**

A5 (c) (i) One of the isomers of compound **J** can undergo ***condensation polymerisation***. [1]

Define the term '***condensation polymerisation***'.

____

(ii) Draw the structure of the polymer formed when compound **J** undergoes condensation polymerisation. Show at least **two** repeating units. [1]

(d) (i) What type of polymerisation can compound **G** undergo? [1]

____

(ii) Draw the structure of the polymer of compound **G**. Show at least **two** repeating units. [1]

[Total:14 marks]

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

B6 Read the information below about titanium and answer the questions.

Titanium is a metal that is higher than carbon in the reactivity series. However, it is not extracted by electrolysis. It is extracted from rutile, which contains 50% titanium(IV) oxide Although titanium is the 10th most common occurring element in the Earth's crust, it is a very expensive metal.

The flowchart below shows the extraction of titanium.

Step 1: Titanium(IV) oxide (TiO_2) is reacted with chlorine and coke at 1000 °C to produce titanium(IV) chloride ($TiCl_4$) and carbon monoxide Titanium(IV) chloride is cooled and collected.

↓

Step 2: Titanium(IV) chloride from **Step 1** is reacted with magnesium at a temperature of 1100°C in a sealed reactor for 3 days to obtain titanium. The sealed reactor contains an atmosphere of argon.

↓

Step 3: The reactor is allowed to cool.
The reactor is opened and the titanium is separated from the other product, magnesium chloride.

(a) Titanium(IV) chloride that is produced in **Step 1** exists as a colourless liquid at room temperature and pressure and boils at 136°C.

(i) Based on the information given, deduce the structure and bonding present in titanium(IV) chloride. Explain your answer. **[2]**

(a) (ii) What is unusual about the bonding present in titanium(IV) chloride? Briefly explain your answer. **[1]**

B6 **(a)** **(iii)** Hence, suggest a possible reason why electrolysis of titanium(IV) chloride is not used as a method to extract titanium. **[2]**

(b) **(i)** Write a balanced chemical equation to show the reaction that took place in **Step 1** to convert titanium(IV) oxide to titanium(IV) chloride. **[1]**

(ii) State an health effect of the product(s) produced in this reaction. **[1]**

(c) **(i)** Write a balanced chemical equation to show the reaction that took place in **Step 2.** **[1]**

(ii) Name the type of reaction that has occurred. **[1]**

(iii) Suggest a reason why an argon atmosphere is necessary in this process **[1]**

(iv) Based on the information given above, deduce why titanium is expensive despite its abundance in the Earth's crust. **[2]**

[Total: 12 marks]

B7 **(a)** You are given two 1 0 mol/dm^3 of strong acids **A** and **B**, which have different basicity. One is monobasic while the other is dibasic

(i) Give an example of a monobasic acid and dibasic acid. [1]

Monobasic acid	
Dibasic acid	

(ii) Using your answer in (a)(i) as example, state and explain the difference in electrical conductivity, if any, between monobasic and dibasic acids [2]

(iii) Using your answer in (a)(i) as example, briefly describe and explain an experiment to distinguish two given samples of a monobasic and dibasic acid using a solution of 1.0 mol/dm^3 of aqueous NaOH. [3]

(b) Aqueous solutions of chlorine and iodine are added separately to two test tubes each containing a solution of iron(II) ions. Aqueous sodium hydroxide is then added to each test tube The results are given in the table below.

	Addition of aqueous Cl_2	**Addition of I_2**
Aqueous iron(II) ions	Green solution turns yellow	Green solution remains green
After addition of 3 drops of aqueous NaOH	Reddish brown precipitate is formed	Dirty green precipitate is formed

(i) Name the reddish brown precipitate formed. [1]

B7 (b) (ii) State what is observed when excess aqueous NaOH is added to the brown precipitate. [1]

(iii) Based on the table of results above, compare the oxidising powers of chlorine and iodine. [2]

Include appropriate ionic equation(s), with state symbols, in your explanation.

[Total: 10 marks]

EITHER

B8 Crude oil is a raw material which is processed in an oil refinery. Two of the processes involved in the refinery process are fractional distillation and cracking.

The table below shows the percentage by mass of different fractions in crude oil and the demand for each fraction expressed as a percentage.

Fraction	Number of carbon atoms per molecule	Percentage in crude oil (%)	Percentage needed by the oil refinery to supply demand (%)
Petroleum gases	1 – 4	4	11
Petrol	5 – 9	11	22
Kerosene	10 – 14	12	20
Diesel oil	14 – 20	18	15
Naptha & bitumen	Over 20	23	4

(a) State the physical property that is used to separate crude oil by fractional distillation [1]

(b) (i) Define the term 'cracking'. [1]

EITHER

B8 (b) (ii) Using the information from the table, explain how cracking helps an oil refinery match the supply of petrol with the demand of petrol. [2]

(c) The hydrocarbon $C_{15}H_{32}$ can be cracked to form 2 moles of ethene, 2 moles of propene and one other hydrocarbon. [1]

Write a balanced chemical equation for this reaction.

(d) Ethene can be reacted with hydrogen to give a saturated compound M.

(i) Draw the structural formula of saturated compound M formed. [1]

(ii) Describe a chemical test that can be used to distinguish between ethene and compound M. [2]

[Total: 8 marks]

OR

B8 (a) The table shows some information about a homologous series of carbon compounds called alkynes

Name	Condensed formula	Molecular formula	Enthalpy change of combustion (kJ/ mol)
Ethyne	$HC\equiv CH$	C_2H_2	- 1390
Propyne	$HC\equiv C-CH_3$	C_3H_4	- 1466
Butyne	$HC\equiv CH_2CH_3$	C_4H_6	- 1952
Pentyne	$HC\equiv C-CH_2CH_2CH_3$	C_5H_8	- 2438

(a) Using the information given, deduce the general formula of alkynes [1]

____

(b) How will the boiling points of alkynes vary down the homologous series? Explain your answer. [2]

____

____

____

(c) What general trend can be observed in the enthalpy changes of combustion of alkynes? Explain your answer. [2]

____

____

____

OR

B8 **(d)** Researchers have been investigating the use of propyne for replacing hydrogen as a liquid fuel for space craft intended for low Earth orbit. Its major advantage is that, unlike hydrogen, propyne can be used as a liquid fuel without the need for storage at extremely low temperatures.

(i) Given that the enthalpy change of combustion of hydrogen is –118 kJ/g, which fuel, hydrogen or propyne, gives a greater energy output per gram of fuel used? Show your workings clearly. **[2]**

(ii) Suggest a reason why it is necessary for the space craft to store and use a fuel in its liquid state instead of its gaseous form. **[1]**

____

____

[Total: 8 marks]

☺ 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

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
2015 PRELIMINARY EXAMINATION
CHEMISTRY PAPER 2 – ANSWER SCHEME

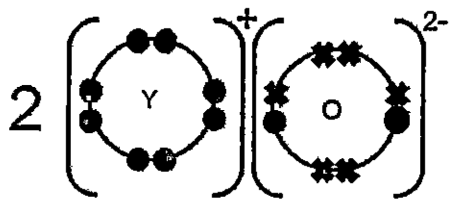
A1 (a) Element W

W forms an **acidic oxide** and W is a **non-metal** which tends to gain electrons

OR

WO_2 has a **low melting point and boiling point** indicating it is a **simple covalent compound** which is usually formed by non-metals

(b) (i)



(ii) **Poor/non-conductor** of electricity
In solid state, the **ions are held in fixed positions**
No mobile ions or **mobile electrons** to conduct electricity

(c) Y, X, Z, W

A2 (a) $Ca + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2$

No. of moles of acid $= \frac{25.0}{1000} \times 1.5 = 0.0375$ moles

No of moles of Ca $= \frac{1.0}{40} = 0.025$ moles

0.025 moles of Ca requires 0.05 moles of acid

Hence acid is the limiting reagent.

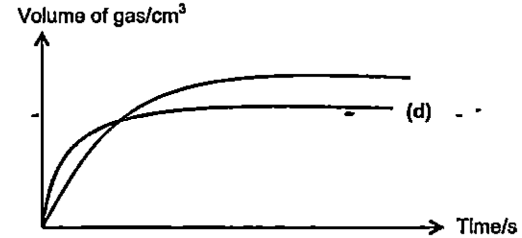
Number of moles of $H_2 = \frac{0.0375}{2} = 0.01875$ moles

Volume of $H_2 = 0.01875 \times 24 = 0.45\ dm^3$ or $450\ cm^3$

(b) Calcium is a **reactive metal** and hence it can **react with water** as well to form aqueous calcium hydroxide and hydrogen gas

(c) **Particle size/ surface area** of M must be the same as the surface area affects the speed of reaction
The larger the surface area, the larger the area of contact between reactant particles and hence faster the reaction

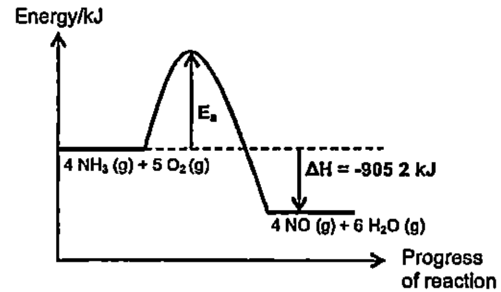
(d)



(e) The reaction will be faster initially as sulfuric acid is a **dibasic acid** and hence the **concentration of H+ ions will be twice/higher** than nitric acid, leading to **higher frequency of effective collisions**

However, calcium reacts with sulfuric acid to form an **insoluble coating of calcium sulfate** around calcium and hence the volume of gas formed will not be maximum

A3 (a)



(b) The oxidation state of N of NH_3 increases from -3 to +2 in NO
The oxidation state of O in O_2 decreases from 0 to -2 in NO

(c) (i) $3NO_2 + H_2O \rightarrow 2HNO_3 + NO$

(ii) Distillation

(iii) NO_2 is an acidic oxide and dissolves in water readily to form **acid rain** which **corrodes metal structures and limestone buildings/ damages crops due to low pH of soil**

A4 (a)

	Positive Terminal	Half-equation
Cell One	Silver ✓	$Ag^+ (aq) + e \rightarrow Ag(s)$ ✓
Cell Two	X✓	$2Cl^- (aq) \rightarrow Cl_2 (g) + 2e$ ✓

(b) (i) Equation 1: $2Cl^- (aq) \rightarrow Cl_2 (g) + 2e$
Equation 2: $2H^+ (aq) + 2e \rightarrow H_2 (g)$
OR
$2Cl^- (aq) + 2H^+ (aq) \rightarrow H_2 (g) + Cl_2 (g)$

From the equations, $1Cl_2 \equiv 2e$; $1H_2 \equiv 2e$. Hence, when 1 mole of Cl_2 is formed, 2 mole of electrons is lost and accepted by H^+ ions to form one mole of H_2
Hence, the expected ratio of H_2 to Cl_2 formed is 1:1

(ii) This is because chlorine is more soluble in water than hydrogen/ chlorine is very soluble in water while hydrogen gas is insoluble in water. The volume of Cl_2 collected may be lower than expected, resulting in a different ratio

(c) Violet/Purple solution obtained because when H^+ and Cl^- ions are discharged, the OH- ions left behind are at a high concentration/ the OH ions form a strong alkali with K^+ ions

OR

The solution turned colourless dye to the bleaching by the Cl_2 gas dissolved in the solution

A5 (a) (i)

Element	C	H	O
% by mass	40 0	6 7	53 3
No. of moles	$\frac{40.0}{12} = 3.333$	$\frac{6.7}{1} = 6.7$	$\frac{53.3}{16} = 3.331$
Ratio	1	2	1

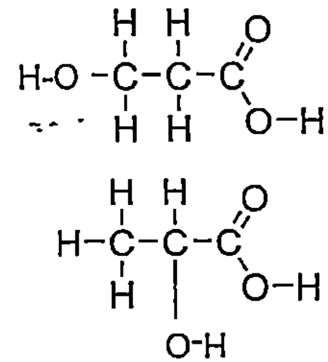
The empirical formula is CH_2O

(ii) Molar mass of $CH_2O = 12 + 2 + 16 = 30$ g/mol
$n(CH_2O) = 90$
$n = 3$
Molecular formula – $C_3H_6O_3$

(b) (i) 300 °C, 60 atm; Phosphoric acid (H_3PO_4)

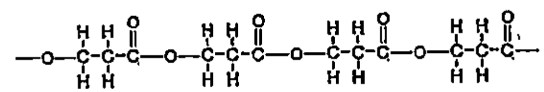
(ii) CO_2 gas
Carboxyl / -COOH functional group

(iii)



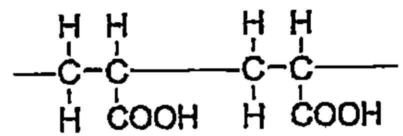
(c) (i) Condensation polymerisation occurs when monomers combine to form a polymer with the removal of small molecules such as water

(ii)



(d) (i) Addition polymerisaton

(ii)



Section B

B6 (a) (i) As titanium(IV) chloride exists as a liquid at room temperature and pressure and boils at 136°C, it has a low melting and boiling point. Hence, it should exist as a simple covalent compound, with weak intermolecular forces between its moelcules

(ii) No. Titanium is a metal and hence usually forms ionic compound with chlorine (a non-metal) but titanium(IV) chloride is a covalent compound

(iii) Since titanium(IV) chloride is a covalent compound, thus it cannot conduct electricity at any state since it

does not have any mobile ions or free moving electrons

(b) (i) $TiO_2 + 2Cl_2 + 2C \rightarrow TiCl_4 + 2CO$

(ii) CO is a poisonous gas as it combines with haemoglobin to form a compound which prevents oxygen gas from being transported to the rest of the body/ causes respiratory difficulties

(c) (i) $TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$

(ii) Metal displacement/ redox reaction

(iii) To provide an inert atmosphere to

prevent magnesium from reacting with air since it is a reactive metal

(iv) The extraction of titanium requires the use of magnesium which is a reactive metal and requires electrolysis to be extracted

Alternative answer accepted:

The process requires the use of argon which is obtained from fractional distillation of liquid air and large amount of fossil fuels is required in order to maintain the high temperature required.

B7 (a) (i) Monobasic – Hydrochloric acid/Nitric acid

Dibasic – Sulfuric acid

(ii) The electrical conductivity of the *(dibasic acid)* will be higher than the *(monobasic acid)* because

1 mole of *(monobasic acid)* dissociates to give 2 moles of mobile ions *($1H^+$ and $1X^-$)* while

1 mole of dibasic acid dissociates to give 3 moles of mobile ions *($2H^+$ and Y^{2-})*

Hence, there is higher number of mobile ions present in the dibasic acid when it dissociates

(iii) Titrate and

measure the volume of NaOH required to completely neutralise 25.0 cm^3 (fixed volume) of acid A and B

Since both acids have the same concentration,

the volume of the NaOH required for complete neutralization of dibasic acid will be twice than that of the monobasic acid as the

mole ratio between NaOH : HCl = 1:1 while mole ratio of NaOH : H_2SO_4 = 2:1

(b) (i) Iron(III) hydroxide

(ii) The precipitate is insoluble in excess aqueous NaOH

(iii) Aqueous chlorine was able to oxidise Fe^{2+} solution to Fe^{3+} solution while iodine was unable to do so

Chlorine is a stronger oxidising agent than iodine

$Cl_2\,(aq) + 2Fe^{2+}\,(aq) \rightarrow 2Fe^{3+}\,(aq) + 2Cl^-\,(aq)$

B8 EITHER

(a) Differences in boiling point

(b) (i) Process of breaking down longer hydrocarbons into smaller hydrocarbons.

(ii) Cracking helps to break down bigger hydrocarbon fractions like naptha and bitumen which are

lower in demand (4%) but

exists in higher proportion in crude oil (11%) into smaller fractions like petrol and kerosene which are

higher in demand (23%) but

exists in lower proportion in crude oil (4%)

(c) $C_{15}H_{32} \rightarrow 2C_2H_4 + 2C_3H_6 + C_5H_{12}$

(d) (i) CH_3CH_3

(ii) When aqueous bromine is added separately to both compound M and ethene in the absence of light,

ethene will decolourise brown aqueous bromine while compound M will not.

B8 OR

(a) C_nH_{2n-2}

(b) The boiling points increase down the homologous series
As the molecules get bigger,
the van der waals' forces of attraction between molecules get stronger/ intermolecular forces get stronger
Larger amount of energy required to overcome them and hence boiling points increase.

(c) The enthalpy change of combustion becomes more negative/ increases as the carbon chain increases down the homologous series

As the carbon chain increases, greater amount of energy is released to form the greater no of moles of products (CO_2 and H_2O) formed

(d) (i) 1 mol of propyne releases 1466 kJ of energy
1 mol of propyne -> 40 g

i e 40 g of propyne releases 1466 kJ of energy
amount of energy released by 1 g of propyne = $\frac{1466}{40} = 36\ 7\ kJ$
Hence, hydrogen has a greater energy output

(ii) As particles in the liquid state are closely packed together, more molecules of the fuel can be stored in the same volume of space when transported in liquid state as compared to gaseous state

OR

Fuel in the gaseous form is more explosive than when it is in its liquid form as gaseous particles contains more kinetic energy than liquid particles

O

GAN ENG SENG SCHOOL
Preliminary 2 Examination 2015

CANDIDATE NAME

CLASS

INDEX NUMBER

CHEMISTRY

5073/01
31 August 2015
1 hour

Secondary 4 Express

Paper 1 Multiple Choice

Additional Materials: OTAS

Calculators are allowed in the examination

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid
Write your name, class and index number on the OTAS

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 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 in this booklet

A copy of the Periodic Table is on page 14

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

Total Marks

40

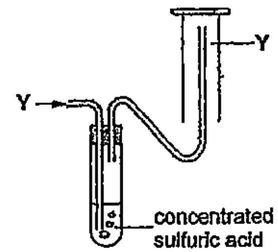
This paper consists of 14 printed pages including the cover page.

1 There are two unlabelled bottles, one of which is hydrochloric acid and the other is sulfuric acid. To distinguish the two acids, a student adds aqueous sodium hydroxide to each of the acids.

Given that the concentration of the solutions used are the same, which of the following apparatus would **not** be necessary in this investigation?

A beaker
B measuring cylinder
C stop watch
D thermometer

2 The following diagram shows a method to collect a sample of gas Y



Which of the following information can be deduced about gas Y?

1 Y is alkaline.
2 Y is very soluble in water
3 Y is less dense than air

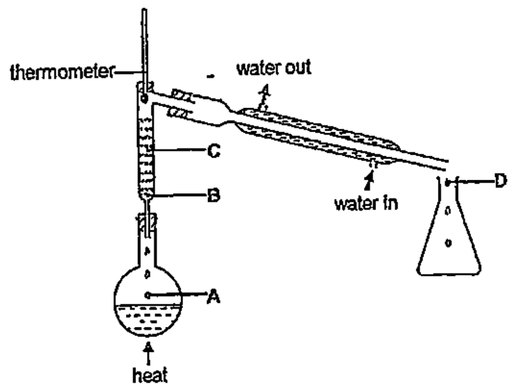
A 1, 2 and 3
B 1 and 2
C 3 only
D None of the above

3 Which set of results is correct when the reagent is added to a solution containing both iron(II) sulfate and sodium nitrate?

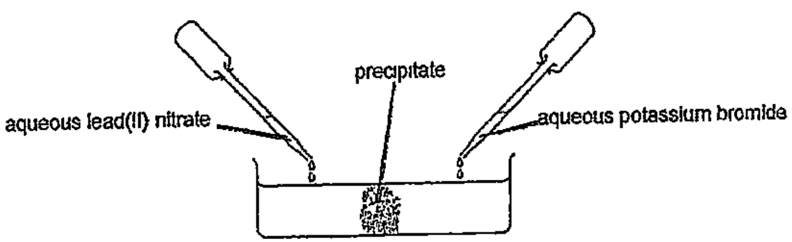
	reagent	result
A	aqueous barium chloride	green precipitate seen settled at the bottom of the test tube
B	aqueous barium chloride	white precipitate seen
C	aqueous sodium hydroxide	gas turned moist red litmus blue when warmed
D	aqueous sodium hydroxide	dark green solution seen in excess reagent

4 A mixture containing equal volumes of two liquids is placed in the apparatus shown and heated until the thermometer first shows a constant reading

At which position will there be the highest proportion of the liquid with the higher boiling point?



5 Aqueous lead(II) nitrate and aqueous potassium bromide are added to a dish containing water, as shown



A precipitate forms after a few minutes

Which of the following statements explains the phenomenon?

A Particles collide, diffuse and then react.
B Particles collide, react and then diffuse
C Particles diffuse, collide and then react.
D Particles diffuse, react and then collide.

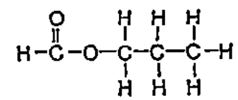
6 The isotope cobalt-60 is used to destroy cancer cells in the human body.

Which of the following statements about an atom of cobalt-60 are correct?

1 It contains 33 neutrons.
2 Its nucleus has 27 positive charges
3 It has a different number of neutrons from some atoms of cobalt.

A 1 and 2 B 1 and 3
C 2 and 3 D All of the above

7 The diagram shows the molecule propyl methanoate



What is the total number of electrons that are not involved in the bonding in the molecule?

A 8 B 12
C 20 D 28

8 Which of the following solid has both ionic and covalent bonds?

A ammonium sulfate
B iodine
C silicon dioxide
D steel

9 The two statements are about chlorine The statements may or may not be correct. They may or may not be linked

statement 1 Chlorine has weak covalent bonds in its simple molecular structure

statement 2 Chlorine is soluble in water

What is correct about these two statements?

A Both statements are correct and statement 1 explains statement 2.
B Both statements are correct but statement 1 does not explain statement 2
C Statement 2 is correct but statement 1 is incorrect.
D Both statements are incorrect.

10 On collision, airbags in cars inflate rapidly due to the production of nitrogen. The nitrogen is formed in two steps as shown below

Step 1: $2NaN_3 \rightarrow 2Na + 3N_2$
Step 2: $10Na + 2KNO_3 \rightarrow K_2O + 5Na_2O + N_2$

How many moles of nitrogen gas are produced from 1 mole of sodium azide, NaN_3?

A 1.5 moles B 1.6 moles
C 2.0 moles D 4.0 moles

11 Dinitrogen tetraoxide, N_2O_4, is a poisonous gas. It can be disposed of safely by reaction with sodium hydroxide

$$N_2O_4(g) + 2NaOH(aq) \rightarrow NaNO_3(aq) + NaNO_2(aq) + H_2O(l)$$

What is the minimum volume of 0.5 mol/dm^3 sodium hydroxide needed to dispose of 1.84 g of dinitrogen tetraoxide?

A 40 cm^3 B 80 cm^3
C 12500 cm^3 D 50000 cm^3

12 Brine is a saturated solution of sodium chloride. In the electrolysis of brine, the products are chlorine, hydrogen and sodium hydroxide

What is the maximum yield of each of these products when 58.5 kg of sodium chloride are electrolysed as brine?

	yield of chlorine / kg	yield of hydrogen / kg	yield of sodium hydroxide / kg
A	35.5	1	40
B	35.5	0.5	80
C	17.75	1	40
D	17.75	0.5	80

13 Consider the following reaction for which the heat of reaction is given

$$2N_2O_5\,(s) \rightarrow 4N_2\,(g) + 5O_2\,(g) \qquad \Delta H = -23\ \text{kJ/mol}$$

Which of the following statements about the reaction is not correct?

A For each mole of N_2O_5 (s) reacted, 11.5 kJ of heat is released.
B For 2 moles of N_2 (g) produced, 11.5 kJ of heat is released
C The energy of N_2O_5 is less than that of the products.
D The energy involved in bond forming is greater than that of bond breaking

14 The two statements are about electrolysis of concentrated aqueous potassium nitrate using graphite electrodes. The statements may or may not be correct. They may or may not be linked

statement 1 The solution around anode turned litmus red during electrolysis

statement 2 Hydroxide ions are discharged at the anode during electrolysis

Which is correct about the two statements?

A Both statements are correct and statement 1 explains statement 2
B Both statements are correct but statement 2 does not explain statement 1
C Statement 2 is correct but statement 1 is incorrect.
D Both statements are incorrect.

15 In the extraction of aluminium by electrolysis using graphite electrodes, molten aluminium oxide is dissolved in molten cryolite which is a sodium salt.

statement 1 Aluminium is deposited at the negative electrode

statement 2 Aluminium ion is less reactive than sodium ion

The statements may or may not be correct. They may or may not be linked

Which is correct about the two statements?

A Both statements are correct and statement 1 explains statement 2.
B Both statements are correct but statement 2 does not explain statement 1
C Statement 1 is correct but statement 2 is incorrect.
D Both statements are incorrect.

16 When a hot glass rod is placed in a gas jar of hydrogen iodide, the hydrogen iodide decomposes immediately

Which of the following statements about this reaction are correct?

1 Hydrogen iodide has reacted with oxygen in the air
2 The hot rod provides the activation energy
3 One of the products is a dark purple vapour.

A 1 and 2 B 1 and 3
C 2 and 3 D All of the above

17 Which of the following processes is/are described correctly?

1 Burning of coke requires energy to start the reaction and hence is endothermic.
2 Freezing of water is endothermic as the temperature of the surroundings is cold
3 Reaction between sodium and water releases heat to the surroundings and hence is exothermic.

A 2 only
B 1 and 3
C 2 and 3
D 1, 2 and 3

18 Yeast is an enzyme which catalyses the fermentation of sugar to ethanol

Which of the following statements is true for this reaction?

A The amount at yeast present is unchanged in the reaction
B The presence of yeast increases the final amount of ethanol produced
C Yeast changes the energy of the reactants and products
D Yeast operates effectively at extreme low temperatures

19 A piece of magnesium strip dissolved completely in 20 cm^3 of a dilute sulfuric acid solution and the volume of hydrogen evolved was recorded at regular time intervals. Another piece of magnesium strip 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 the second experiment differ from those in the first experiment?

	initial rate of reaction	*total volume of hydrogen evolved*
A	increase	increase
B	increase	no change
C	no change	no change
D	no change	increase

20 A household bleach contains sodium chlorate(I), NaClO, as its active ingredient. When sodium chlorate(I) is stirred into excess aqueous hydrogen peroxide, the reaction that occurs is represented by the following equation

$$NaClO(aq) + H_2O_2(aq) \rightarrow NaCl(aq) + O_2(g) + H_2O(l)$$

Which of the following can be deduced from the reaction?

1 Hydrogen peroxide acts as a reducing agent in this reaction
2 The final solution gives a precipitate with acidified silver nitrate
3 The final solution bleaches litmus.

A 1 only
B 3 only
C 1 and 2
D all of the above

21 Which reagent, when mixed and heated with ammonium sulfate, liberates ammonia?

A aqueous bromine
B acidified potassium manganate(VII)
C concentrated sulfuric acid
D limewater

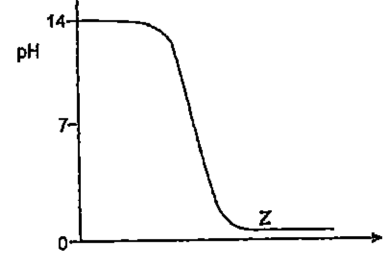
22 The equation explains the colour change that occurs when aqueous potassium hydroxide is added to aqueous potassium dichromate(VI) until no further change is seen

$$\underset{\text{orange}}{K_2Cr_2O_7} + 2KOH \rightarrow \underset{\text{yellow}}{2K_2CrO_4} + H_2O$$

What happens to the oxidation state of the chromium and the pH of the reaction mixture?

	oxidation state of chromium	pH of mixture
A	decreases	decreases
B	decreases	increases
C	remains the same	decreases
D	remains the same	increases

23 The graph shows how the pH changes in a reaction between an acid and an alkali



1 Acid is added to a fixed amount of alkali.
2 Only salt and water are present at Z part of the graph.
3 Neutralisation occurs at about pH 7

Which of the above statements could be deduced from the graph?

A 1 and 2
B 1 and 3
C 2 and 3
D All of the above

24 Some reactions of a substance, R, are shown in the diagram

substance R $\xrightarrow{\text{reacts with}}$
- 1 zinc → effervescence
- 2 sodium carbonate → effervescence
- 3. iron(II) oxide → pale green solution

What is substance R?

A	aqueous ammonia	B	ethanoic acid
C	potassium dichromate(VI)	D	steam

25 A mixture of the oxides of two elements of the third period is dissolved in water The solution is approximately neutral

What could be the constituents of the mixture?

A Al_2O_3 and MgO
B CO_2 and SO_3
C Na_2O and MgO
D Na_2O and SO_3

26 Which two processes are involved in the preparation of zinc sulfate crystals from dilute sulfuric acid and zinc oxide?

A neutralisation and filtration
B neutralisation and oxidation
C precipitation and filtration
D precipitation and oxidation

27 Aqueous ethylamine has similar properties as aqueous ammonia. Which of the following is true about aqueous ethylamine?

A It forms a gas with dilute sulfuric acid.
B It forms white fumes with hydrogen chloride
C It forms a colourless solution when added to aqueous aluminium nitrate.
D It forms blue precipitate with aqueous copper(II) chloride when added in excess

28 Which information about an element can be used to predict its chemical properties?

A colour of its compound
B density
C melting point
D position in the Periodic Table

29 Which of the following substances would produce effervescence when added to aqueous magnesium chloride?

A copper
B iodine
C sodium
D zinc

30 An element M is a grey solid at room temperature and pressure It form an oxide of formula, MO_2 (melts at 1630°C and boils at 1800°C) It also forms a chloride of formula, MCl_4 (melts at –37°C and boils at 114°C)

These suggest that this element M is a .. .1 and its chloride is .. 2

Which words correctly fill in the blanks 1 and 2?

	1	2
A	metal	covalent
B	metal	ionic
C	non-metal	covalent
D	non-metal	ionic

31 Group II nitrates undergo thermal decomposition according to the following equation.

$$2X(NO_3)_2 \rightarrow 2XO + 4NO_2 + O_2$$

Which Group II nitrate requires the highest temperature to bring about its thermal decomposition?

A barium nitrate
B calcium nitrate
C magnesium nitrate
D strontium nitrate

32 Dilute sulfuric acid is added to a mixture of excess copper, magnesium and lead in a beaker The beaker is left for about 10 minutes and its contents are then filtered.

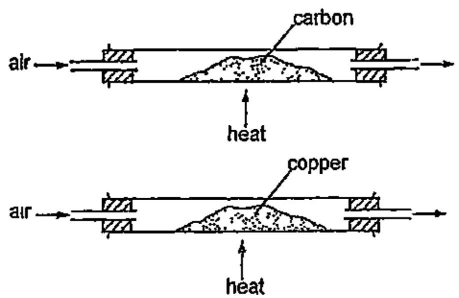
What does the filtrate contain?

A copper(II) sulfate, lead(II) sulfate, magnesium sulfate,
B copper(II) sulfate, magnesium sulfate
C lead(II) sulfate, magnesium sulfate
D magnesium sulfate

33 In which industrial process is the presence of water not essential?

A electrolytic purification of copper
B manufacture of ethanol from ethene
C manufacture of ethanol by fermentation
D manufacture of iron in the Blast Furnace

34 Powdered carbon and powdered copper are separately heated as shown.



What observations would be seen when each of the substances is heated over a period of time?

	carbon	copper
A	less black solid formed	more black solid formed
B	more black solid formed	more reddish-brown solid formed
C	less black solid remained	more black solid formed
D	more black solid remained	more reddish-brown solid formed

35 Which gas is present in the exhaust fumes of a car engine in a much greater amount than any other gas?

A carbon dioxide
B carbon monoxide
C nitrogen
D water vapour

36 The hydrocarbon $C_{17}H_{36}$ can be cracked.
Which compound is the least likely to be produced in this reaction?

A C_3H_8
B C_4H_{10}
C $C_{10}H_{20}$
D $C_{16}H_{34}$

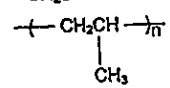
37 The following substances are some organic compounds

1 ethanol
2 ethanoic acid
3 methyl methanoate

Which of the above substances has / have the same empirical formula CH_2O?

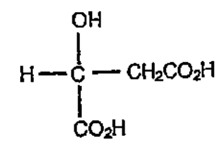
A 1, 2 and 3
B 1 and 3
C 2 and 3
D 2 only

38 Which of the following compounds can be obtained from propene in a single reaction?

1 $CH_2BrCHBrCH_3$
2 
3 $CH_3CH_2CH_2OH$

A 1 and 2
B 1 and 3
C 2 and 3
D All of the above

39 Malic acid occurs in apples.



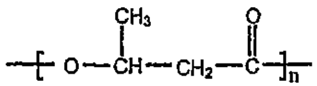
malic acid

Which of the following substances could react with malic acid?

1 acidified aqueous potassium iodide
2 copper(II) carbonate
3 aqueous sodium hydroxide

A 1 and 2
B 1 and 3
C 2 and 3
D All of the above

40 PHB (polyhydroxybutyric acid) is a natural polymer produced by a range of micro-organisms. The structure of this polymer is as shown below.



PHB (polyhydroxybutyric acid)

Which of the following statements are true about PHB?

1 PHB is a condensation polymer
2 PHB molecule contains many ester groups
3 PHB is made from two different types of unsaturated monomers

A 1 and 2
B 1 and 3
C 2 and 3
D All of the above

- END OF PAPER -

The Periodic Table of the Elements

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	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.).

Answers

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

O

GAN ENG SENG SCHOOL
Preliminary 2 Examination 2015

CANDIDATE NAME

CLASS

INDEX NUMBER

CHEMISTRY
5073/02

Paper 2

28 August 2015
1 hour 45 minutes

Secondary 4 Express

Candidates answer on the Question Paper.
Calculators are allowed in the examination

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 soft pencil for any diagrams or graphs.
Do not use staples, paper clips, 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 on page 17.

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

	For Examiner's Use
Section A	....
Section B B9	....
B10 B11 *Either / OR *Circle where appropriate	....
Total	80

Section A (50 marks)

Answer all the questions in the spaces provided.

A1 The diagram shows part of the Periodic Table.

				He
C	N	O	F	Ne
		S	Cl	Ar
			Br	Kr

Answer the following questions using **only** the elements shown in the diagram.
Each element may be used once, more than once or not at all.

(a) Which element has 2 electrons only? ____________________ [1]

(b) Which element has a giant covalent structure? ____________________ [1]

(c) Which element(s) form(s) oxides that often result in acid rain? ____________________ [1]

(d) Which element has diatomic molecules? ____________________ [1]

(e) Which element gains electrons most readily? ____________________ [1]

(f) Which element has one oxidation number only? ____________________ [1]

(g) Which element can form a compound of formula MgX? ____________________ [1]

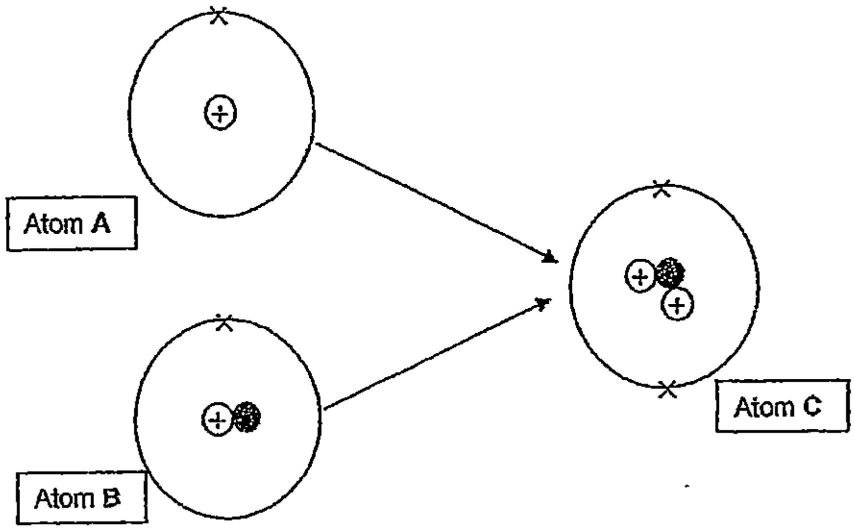
[Total: 7]

A2 Nuclear fusion involves two atoms joining to make a heavier atom which releases a lot of energy in the process.

The Sun and other stars use nuclear fusion to release energy. The elements that make up the Sun and the stars are mainly:

- those that undergo nuclear fusion and
- those that are made from nuclear fusion

The sequence of nuclear fusion reactions in a star is complex. Below is one nuclear fusion reaction that could take place in the Sun and the stars.



(a) From the above diagram, what are the two elements mainly present in the Sun and the stars? Explain your answer.

....

....

....

.... [3]

(b) What is the name given for atoms A and B?

.... [1]

(c) Explain why atom C is heavier than atom A.

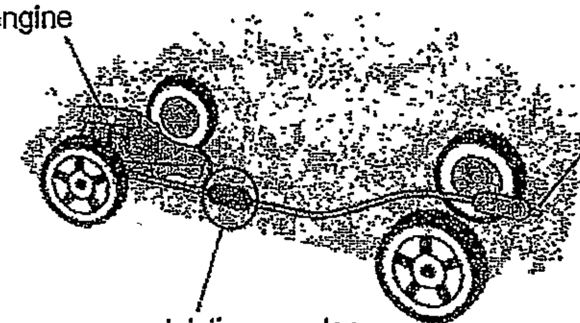
....

....

.... [2]

[Total: 6]

A3 Since 1975, the cars have been installed with catalytic converters to convert harmful pollutants into less harmful emissions before leaving the car exhaust pipe. Most of the cars are powered by burning petrol which is a mixture of hydrocarbons in the car engine. As a result, the pollutants are mainly carbon monoxide, oxides of nitrogen and unburnt hydrocarbons.



(a) Which pollutant is least likely to be produced when the petrol is just ignited in a ***cold*** car engine? Explain your answer.

____

____

____

____ [2]

(b) Recent innovation in the automobile industry includes the use of gold to ***improve the efficiency*** of oxidation process in catalytic converters.

(i) Why does the use of gold improve the efficiency of the catalytic converter?

____

____ [1]

(ii) The catalytic converter contains a very small amount of gold.
Do you expect the amount of gold to change after the catalytic converter is used for a few years?
Explain your answer.

____

____

____ [1]

[Total: 4]

A4 John Newlands was one of the first chemists who attempted to classify elements in a systematic way based on atomic weight. In 1866 he suggested that there was a repeating pattern of elements with similar properties every eighth element.
Part of Newlands' Periodic Table using his symbols is shown below.

H	F	Cl	Co/Ni
Li	Na	K	Cu
Gl	Mg	Ca	Zn
Bo	Al	Cr	Y
C	Si	Ti	In
N	P	Mn	As
O	S	Fe	Se

(a) Describe a trend that is observed in both Newlands's Periodic Table and the Modern Periodic Table that we use today.

____

____ [1]

(b) The symbols **Gl** and **Bo** have been changed in the Modern Periodic Table. State the current symbols used for Gl and Bo.

Gl ______________________

Bo ______________________ [2]

(c) Describe one similarity and two differences between the Newland's Periodic Table and the Modern Periodic Table.

____

____

____

____

____

____

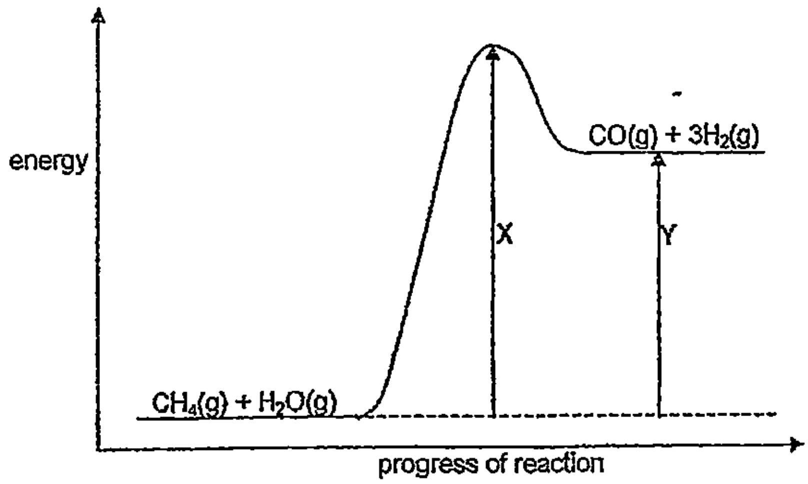
____ [3]

[Total: 6]

A5 Hydrogen has many industrial uses. One possible way to manufacture hydrogen involves the reaction between methane and steam.

$$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$$

The diagram shows the energy profile diagram for this reaction.



(a) What is one industrial use of hydrogen?

____ [1]

(b) What do the arrows, X and Y, represent in the diagram?

____

____ [2]

(c) A student wrote the following statement:

In the reaction between methane and steam, the energy for bond forming is smaller than the energy for bond breaking.

Do you agree with the student? Explain your answer.

____

____

____

____

____

____ [3]

[Total: 6]

A6 Hydrogen peroxide is a colourless liquid. An aqueous solution of hydrogen peroxide reacts with the iodide ions in acidified potassium iodide to form water and iodine.

$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \rightarrow 2H_2O(l) + I_2(aq)$$

(a) (i) Which substance is the reducing agent in this reaction? Explain your answer.

....

....

.... [2]

(ii) Describe the observation when this reaction is complete.

.... [1]

(b). An investigation on the effect of concentration of potassium iodide and dilute sulfuric acid on the speed of reaction occurring between hydrogen peroxide and acidified potassium iodide is carried out.
The table shows how the speed of this reaction changes when different concentrations of same volume of potassium iodide and dilute sulfuric acid are used.

experiment	concentration of potassium iodide in mol/dm^3	concentration of dilute sulfuric acid in mol/dm^3	speed of reaction in mol/dm^3/s
1	0.1	0.1	0.00017
2	0.2	0.1	0.00034
3	0.1	0.2	0.00017
4	0.3	0.1	0.00051
5	0.1	0.3	0.00017

(i) Describe the measurement that has to be taken during the investigation in order to calculate the speed of reaction.

....

.... [1]

(ii) State **two** key conditions, other than no catalyst is used, that have to be held constant during the investigation.

....

.... [2]

(iii) Using the information in the table, describe how concentration of the following reagents affects the speed of reaction.

potassium iodide

....

[1]

sulfuric acid

____

____ [1]

[Total: 8]

A7 Both strontium and sulfur form chlorides of the formula XCl_2. The table below compares some of their properties.

	strontium chloride	sulfur dichloride
appearance	white crystals	red liquid
melting point / °C	874	–120
boiling point / °C	1250	59
conductivity of liquid	good	poor
solubility in water	dissolves to form a neutral solution	reacts with water and form the following: • two different sulfur-containing substances • one acidic compound that ionises in water according to the following equation: $HA(aq) \rightarrow H^+(aq) + A^-(aq)$

(a) Explain why sulfur dichloride is likely to be a liquid at room temperature.

____ [1]

(b) Strontium is a metal and sulfur is a non-metal. Explain why both form chlorides of the formula XCl_2.

____

____

____ [2]

(c) Deduce the name of the acidic solution formed when sulfur dichloride reacts with water.

____ [1]

(d) Explain the difference in electrical conductivity of liquid strontium chloride and liquid sulfur dichloride in terms of bonding and structure.

____

____

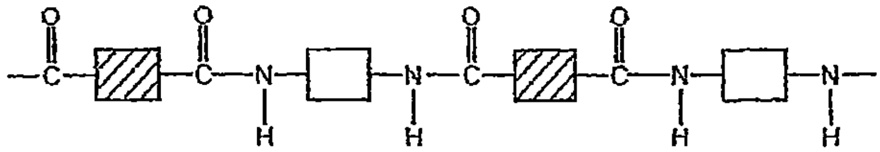
____

____ [4]

[Total: 8]

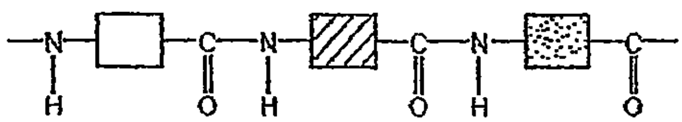
A8 Nylon and protein are macromolecules with amide linkages.

Nylon, a synthetic polymer, has the following structure.



Nylon

Protein, a natural macromolecule, has the following structure



Protein

(a) Describe two differences between nylon and protein.

____

____

____

____

____ [2]

(b) (i) Draw one repeating unit of nylon.

Repeating unit of nylon

[1]

(ii) Draw two monomers of protein.

Monomers of protein

[2]

[Total: 5]

Section B (30 marks)

Answer all **three** questions. The last question is in the form **either/or**.
Write your answers in the spaces provided.

B9 Iron is produced in the blast furnace using the ore haematite, iron(III) oxide (melting point 1566°C), as one of the raw materials.
Titanium is produced from the ore rutile, titanium dioxide (melting point 1843°C), which cannot be reduced by coke and hence requires a different method of extraction.

Iron

Haematite is reacted with coke at 1500°C in a furnace to produce molten cast iron.
Cast iron contains iron, about 4% carbon and some impurities such as silicon and phosphorus.

↓

Oxygen is blown into molten cast iron and molten recycled iron at 1500°C in a furnace to produce low-carbon steel.
Low-carbon steel contains iron and about 0.1% carbon.

Titanium

Rutile is reacted with chlorine at 1000°C to produce titanium(IV) chloride.
Titanium(IV) chloride is cooled and collected.

↓

Titanium(IV) chloride is reacted with magnesium at 1100°C in a sealed reactor for 3 days.
The sealed reactor contains an ***atmosphere of argon***.

↓

The reactor is allowed to cool.
The reactor is opened and the titanium is separated from the other product, magnesium chloride.

Titanium reactors produce about 1 tonne of the metal per day.
Iron blast furnaces produce about 20 000 tonnes of the metal per hour.

(a) Explain why the production of low-carbon steel uses oxygen but the production of titanium requires ***'an atmosphere of argon'***.

____

____

____

____

____ [3]

(b) The melting point of iron(III) oxide is higher than the temperature in the blast furnace. Explain why iron(III) oxide could remain in molten state in the blast furnace.

____

____ [1]

(c) Other than blowing oxygen into molten cast iron, lime (calcium oxide) is also added in the same furnace during the production of low-carbon steel.

Explain the purpose of the addition of lime in the furnace.

____

____ [1]

(d) There is less titanium than iron in the Earth's crust.
Other than titanium's scarcity, explain why titanium costs much more than iron.

____

____

____

____

____

____ [3]

(e) Explain why water is used to wash titanium at the last stage.

____

____ [1]

(f) Suggest the position of titanium in the Reactivity Series of Metals.
Explain your answer.

____

____

____

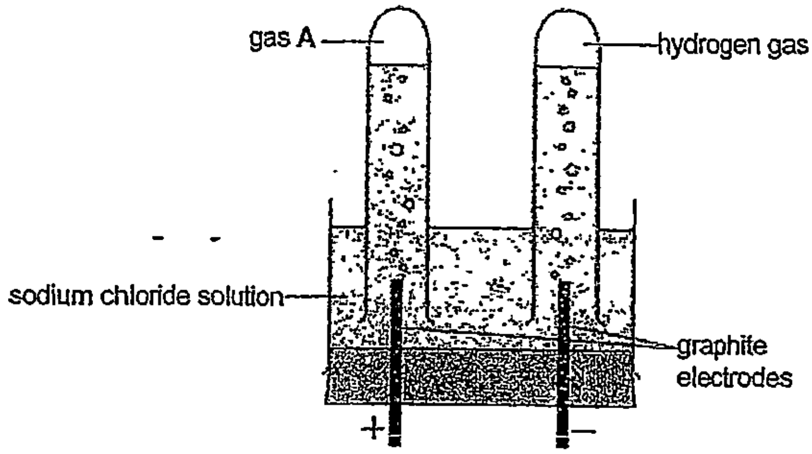
____

____

____ [3]

[Total: 12]

B10 A student investigated the electrolysis of sodium chloride solution.
The diagram below shows the results of the electrolysis.



(a) Explain why hydrogen gas is produced at the negative electrode.

____

____

____ [2]

(b) Explain why gas A cannot be oxygen. Support your answer with relevant equations.

____

____

____

____

____

____

____

____ [4]

(c) Describe a test to verify the identity of gas A.

____

____ [2]

[Total: 8]

EITHER

B11 Alcohols are a homologous series of organic compounds.
This homologous series of compounds typically undergoes oxidation.

Using propanol as an example, the reaction scheme of oxidation of alcohol is shown in the box below.

$$\underset{\text{propanol}}{CH_3CH_2CH_2OH} \xrightarrow{\text{partially oxidised}} \underset{\text{propanal}}{CH_3CH_2CHO} \longrightarrow \text{final product}$$

The propanol is first partially oxidised to an intermediate, propanal, which is then quickly oxidised to the final product.

(a) Such oxidation of alcohol can be achieved by reacting the alcohol using one chemical in the laboratory.

(i) Name the chemical that can be used to oxdise propanol as shown in the above reaction scheme.

.... [1]

(ii) Describe how the chemical in **(a)(i)** would be used to indicate whether the reaction is complete.

....

....

....

.... [3]

(b) Name the final product in the above reaction scheme.

.... [1]

(c) Butanol undergoes similar oxidation process as propanol.

Name and draw the full structural formula of the ***intermediate*** formed when butanol is ***partially oxidised.***

[2]

(d) The table shows the formulae and names of two compounds.

Compound	Formula	Name
1	CH_3CH_2CHO	propanal
2	CH_3COCH_3	propanone

A student said:

> *"I think compound 1 and 2 are from the same homologous series because their relative molecular mass is the same."*

Comment on the student's statement.

____

____

____

____

____ [3]

[Total: 10]

OR

B11 Cooking oils contain polyunsaturated fats, which are healthier than polysaturated fats.

A scientist wanted to find the amount of polyunsaturated fats in cooking oils.

The scientist tested four cooking oils, V, W, X, Y and Z. The volume of oil and the concentration of bromine water used are the same for each test.

The results are shown below.

Cooking oil	Number of drops of bromine water reacted		
	Test 1	Test 2	Test 3
V	12	13	15
W	28	18	29
X	18	19	18
Y	4	5	3
Z	15	14	16

(a) What is meant by the term *'polyunsaturated'*?

____ [1]

(b) What type of reaction has occurred between polyunsaturated fats and bromine water?

____ [1]

(c) Describe how bromine water is used to obtain the results in the table.

____

____

____

____ [3]

(d) Which one of the results in the table should be tested again? Explain your answer.

____

____

____ [2]

(e) The cooking oil **V** is claimed to have more polyunsaturated fats than other cooking oils.

Do you agree with the claim? Explain your answer.

____

____

____

____

____

____ [3]

[Total: 10]

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	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

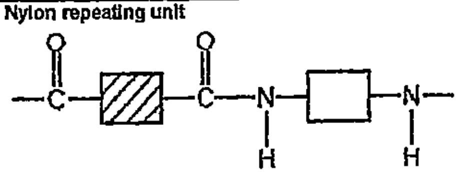
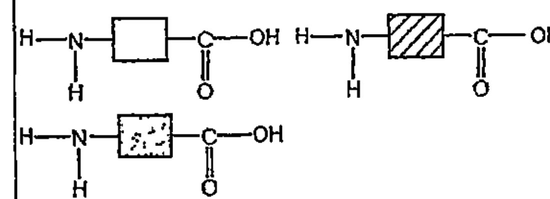
The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

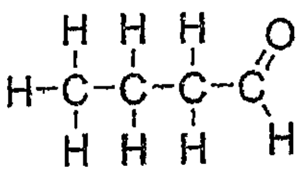
Gan Eng Seng

5073 Chemistry Prelim 2 2015 Mark Scheme

Paper 2

Qn	Answer	Marks	Remarks
A1a	He [Accept name of the element]	1	
b	C [Accept name of the element]	1	
c	S and N [Accept name of the element]	1	Ignore O / oxygen
d	F / Cl / Br / O / N [Accept name of the element, molecular formula]	1	
e	F [Accept name of the element, molecular formula]	1	Reject spelling error
f	Any one of the noble gases e g Ne [Accept name of the element]	1	Many students do not understand the meaning of 'element has only one oxidation state'
g	O / S [Accept name of the element]	1	
A2a	Hydrogen and Helium [1 mark each] Atoms A AND B have 1 proton while atom C has 2 protons.	2 1	Some students have difficulty understanding the context and apply their atomic structure knowledge to it.
b	Isotopes	1	Students thought it's to name the element rather than referring to the particles which are atoms.
c	Atom C has 2 protons and 1 neutron while atom A has only 1 proton The mass of electrons is negligible / electrons are too light to contribute significantly to the mass of an atom	1 1	Many students did not think of negligible mass of electrons which shows they could not interpret the context given.
A3a	Oxides of nitrogen The temperature is low and hence nitrogen and oxygen in the air are less likely/unlikely to combine/react and form oxides of nitrogen	1 1	Many thought CO and unburnt hydrocarbons which are not accepted because these would more likely to be produced rather less.
bi	Gold is a better catalyst than other metals in speeding up the reaction/oxidation in the catalytic converter	1	Students need to understand the meaning of *improve* efficiency of oxidation which implies that there are catalysts in the catalytic converter already but are more efficient with gold
bii	No, catalyst / gold remains chemically unchanged / is not used up at the end of the reaction.	1	
A4a	• Elements are arranged in order of increasing atomic / proton number	1	
b	Gl – Be Bo – B	1 1	
c	Similarity • Some elements such as F and Cl with the same number of valence/outer electrons are grouped together [Accept: a correct link between any two named elements and same group/column] Differences: • Metals and non-metals are in the same period / row in Newland's Periodic Table but metals are placed in separate groups such as Transition Metals from non-metals in the Modern Periodic Table • Elements with the same number of valence electrons such as F and Cl are arranged in horizontal rows in Newland's Periodic Table instead of vertical columns in the Modern Periodic Table • No noble gases / only group I to VII elements and transition metals	1 2	
A5a	To manufacture ammonia [Accept: use in Haber Process] Accept: conversion of vegetable oils to margarine	1	Industrial is defined as large scale as well as common in daily life. Hence fuel cell is not accepted
b	X: activation energy / minimum energy to start the reaction Y: enthalpy change / energy change	1 1	
c	[No marks for response to agree / partially agree / partially disagree / disagree with the statement] From the diagram, energy of the reactants are lower than energy of the products / energy of products are higher than energy of the reactants / energy change is positive Therefore reaction is endothermic. Less energy given out for bond forming than energy taken in for bond breaking / More energy taken in for bond breaking than energy given out for bond forming	 1 1 1	Some students still confuse with direction of energy change for bond breaking and bond forming
A6ai	I^- / iodide ion / acidified potassium iodide / acidified KI H_2O_2 is reduced as the oxidation number of O in H_2O_2 decreases from –1 in H_2O_2 to –2 in H_2O OR H_2O_2 is reduced as it loses oxygen and form H_2O	1 1	Many tend to explain a reducing agent as one that oxidises itself rather than one that reduces others
aii	Solution turned (from colourless to) brown	1	
bi	Record the time taken at the instant when the solution just turned brown / for a cross to be obscured	1	Many simply described time taken for complete reaction without describing how one could see reaction is really complete

bii	• same temperature • aqueous hydrogen peroxide / H_2O_2 has to be in excess / same number of moles	1 1	
biii	From experiment 1, 2 and 4, as the concentration of potassium iodide increases, the speed of reaction increases From experiment 1, 3 and 5, as the concentration of sulfuric acid increases, the speed of reaction remains constant / the speed of reaction is not affected by (concentration of) sulfuric acid	1 1	Many did not use the information by citing the experiments that enable them to make the conclusion for the impact of each solution
A7a	The melting point of sulfur chloride is below / lower than room temperature AND boiling point is above / higher than room temperature.	1	
b	Strontium has 2 valence electrons and hence loses two valence electrons to chlorine. Sulfur has 6 valence electrons and hence shares two valence electrons with chlorine [1] mark awarded if students only mention strontium loses 2 electrons and sulfur shares/gains 2 electrons	1 1	
c	Hydrochloric acid	1	
d	Liquid/molten strontium chloride is an ionic compound which has a giant ionic crystal lattice that has been broken down / electrostatic attraction is overcome and hence there are [1] into mobile ions [1]. Liquid sulfur chloride has a simple molecular structure [1] consists of only molecules [1]	4	
A8a	1. Nylon has only two monomers but protein has 3 monomers / at least 3 monomers / many monomers 2. In nylon, one monomer has two COOH and the other monomer has two NH_2 but in protein, each monomer has one COOH and one NH_2 OR In nylon, one monomer is a dicarboxylic acid and the other is a diamine but in protein, all monomers are amino acids	1 1	
bi	Nylon repeating unit 	1	
bii	Protein monomers – Any two of the following 	2	Many drew the monomers with eliminated atoms
B9a	Oxygen is needed to react with / oxidised carbon to reduce carbon content and produce low-carbon steel. (To produce titanium), argon is used to create an unreactive / inert atmosphere as any oxygen would react with / air would oxidise magnesium / titanium.	1 1 1	Students need to be taught how to read in between the lines of the question. In this case, there are 3 questions explain why use O_2 in low C steel, explain why use argon in Ti, explain why cannot use O_2 in Ti
b	The presence of impurities such as silicon dioxide / sand lower the melting point of iron(III) oxide and hence iron(III) oxide could melt at lower temperatures Accept: impurities such as silicon and phosphorus OR The energy released from the combustion of carbon/coke results in more heat / higher temperature in the blast furnace for the iron(III) oxide to melt.	1	Many did not refer to the context and cite the impurities.
c	To react with acidic impurities such as silicon dioxide and remove them as molten slag	1	Many did not describe acidic which has to be emphasized as CaO can only remove such impurities and not any other types
d	There are more stages to manufacture titanium less efficient / more energy are needed In one day, blast furnace could produce (24 x 20000 =) 480000 tonnes of metal while the reactors could only produce 1 tonne of metal and hence the rate of production is slower. [student must extract the data on the quantities of metal produced to support the production rate is slower] Blast furnace uses coke/carbon which is abundant and cheaper than magnesium / Magnesium used in reactor is more expensive than coke/carbon because it is extracted by electrolysis	1 1 1	Students must pick out the relevant data that best support why Ti is more expensive
e	To remove soluble magnesium chloride from titanium	1	
f	Titanium is below magnesium AND above zinc in the reactivity series Magnesium could displace titanium from titanium(IV)	1	Many students cannot see why Ti must be above Zn and not just Fe

	chloride and hence magnesium is more reactive than titanium Titanium dioxide cannot be reduced by coke but iron(III) oxide can be reduced by coke. Therefore, titanium is more reactive as it forms more stable compound than iron.	1 1	
B10	Both hydrogen ions / H^+ AND sodium ions / Na^+ in sodium chloride solution are attracted / migrate to the negative electrode / are in the solution. Hydrogen ions / H^+ are more preferentially discharged / reduced than sodium ions / Na^+ and hence hydrogen gas is produced at the negative electrode.	1 1	
b	At anode / positive electrode $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$ The volume gas A is the same as the volume of hydrogen The concentration of chloride ions / Cl^- is higher than hydroxide ions / OH^-. Therefore chloride ions / Cl^- are discharged / oxidised instead of hydroxide ions / OH^- at the anode	1 1 1 1	This question cannot be just merely proving why the gas is not oxygen because based on the context given, one can infer the identity of the gas instead of just proving it is not
c	Gas A would turn moist blue litmus red and then bleach it / bleach moist red litmus paper And hence it is chlorine.	1 1	Reject the whole answer if the test and observation are wrong as this would contradict with the identity of the gas
Either B11ai	Acidified aqueous potassium dichromate(VI) / potassium manganate(VII)	1	
aii	Add acidified aqueous potassium dichromate(VI) / potassium manganate(VII) dropwise / drop by drop to propanol. If potassium dichromate(VI) turn from orange to green / potassium managnate(VII) turn from purple to colourless with every drop, reaction is not complete. If potassium dichromate(VI) remains orange / potassium managnate(VII) remains purple / not decolourised, reaction is complete.	1 1 1	This question is meant to test student's procedural knowledge rather than content knowledge Many students explained instead of describing the steps taken to obtain results which show lack of understanding in question stem
b	propanoic acid	1	
c	Butanal 	1 1	

d	Compound 1 and 2 are isomers They have the same molecular formula / same type and number of each atom and hence relative molecular mass is the same. However, their functional groups are not the same and hence they do not come from the same homologous series	1 1 1	
OR B11a	A polymer / macromolecule with many C=C / carbon-carbon double (covalent) bonds	1	
b	Addition Reject: Addition polymerisation	1	
c	Add bromine (water) dropwise / drop by drop to the fats Count the number of drops Until bromine (water) remain reddish brown	1 1 1	
d	Test 2 for oil W both need to be correct [Allow Ws, 18] Result is not consistent with test 1 and 3 / is anomalous [Reject: *does not fit pattern/trend*]	1 1	Reject answer that says 'W' only as it implies all three tests of W have to be tested again instead of one test
e	No [No marks] The greater the number of drops of bromine (water) used, the more polyunsaturated / unsaturated fats in the cooking oil. W and X have more polyunsaturated / unsaturated fats than V [Accept: W has the most unsaturated fats] [Ignore Z has more unsaturated fats] V has much more polyunsaturated / unsaturated fats than Y only	 1 1 1	Many students simply concluded V does not have more polyunsaturated fats than other cooking oils which is rejected as it implies that V has less polyunsaturated fats than Y

Class	Index Number	Name

新加坡海星中学

MARIS STELLA HIGH SCHOOL

PRELIMINARY EXAMINATION 2

SECONDARY FOUR

CHEMISTRY **5073/01**

Paper 1 **31 August 2015**

1 hour

Additional Material.

OTAS

READ THESE INSTRUCTIONS FIRST

Write in soft pencil

Write your name, class and index number on the Answer Sheet

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

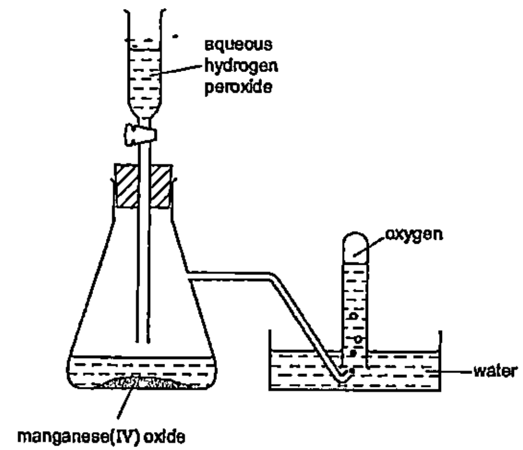
At the end of the examination, hand in the following separately :

(1) Optical Test Answer Sheet (OTAS)

(2) Question Paper

1 Oxygen was prepared from hydrogen peroxide and collected as shown in the diagram

$$2H_2O_2 \rightarrow 2H_2O + O_2$$



The first few tubes of gas were rejected because the gas was contaminated by

A hydrogen

B hydrogen peroxide.

C nitrogen.

D water vapour

2 Which of the following is the best method of obtaining pure water from ink?

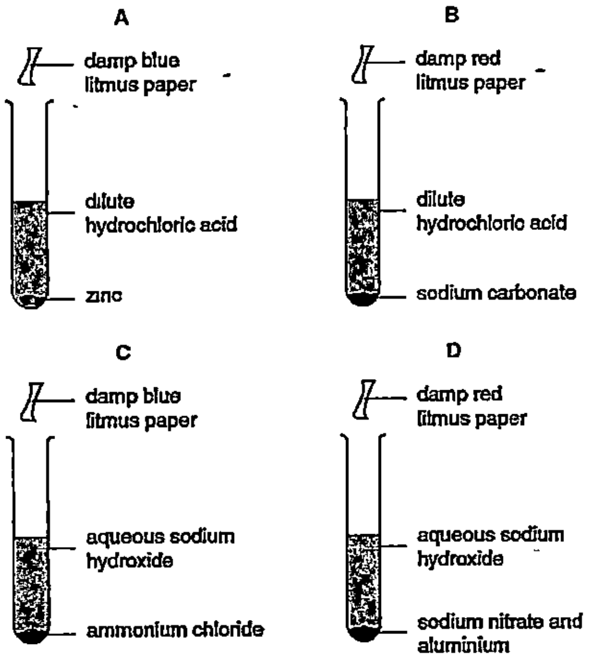
A chromatography

B distillation

C filtration

D freezing

3 The diagrams show mixtures of chemicals that react to produce gases
In which reaction will the litmus paper change colour?



4 Which statement about the numbers of particles in atoms is correct?
Apart from hydrogen, most atoms contain

A more electrons than protons.

B more neutrons than protons.

C more protons than electrons

D more protons than neutrons.

5 In one molecule of carbon dioxide, CO_2, what is the total number of electrons present and how many are involved in bonding between the carbon and oxygen atoms?

	total number of electrons	electrons involved in bonding
A	16	4
B	16	8
C	22	4
D	22	8

6 The symbols and electronic structures for some elements are shown below.
silicon, Si (2,8,4) oxygen, O (2,6) hydrogen, H (1)
fluorine, F (2,7) nitrogen, N (2,5)

Which formula is correct for a compound containing silicon?

A Si_4F B SiH_4 C SiN_5 D Si_2O

7 The formula of an oxide of uranium is UO_2.
What is the formula of the corresponding chloride?

A UCl_2 B UCl_4 C U_2Cl D U_4Cl

8 Elements X and Y combine to form the gas XY_2
What are X and Y?

	X	Y
A	calcium	chlorine
B	carbon	hydrogen
C	carbon	oxygen
D	hydrogen	oxygen

9 An 8 g sample of oxygen atoms contains the same number of atoms as 16 g of element X.
What is the relative atomic mass, A_r, of X?

A 4 B 8 C 16 D 32

10 Which of the samples below has the greatest mass?

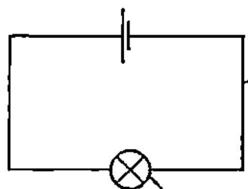
A 6.0×10^{25} molecules of hydrogen

B 5.0 mol of neon atoms

C 1.2×10^{24} atoms of silver

D 1.7×10^{2} g of iron

11 An electrical circuit is set up using copper wire



Which process takes place in the copper wire?

A Electrons move along the wire to the negative terminal, positive ions stay in position

B Electrons move along the wire to the positive terminal, positive ions move to the negative terminal

C Electrons move along the wire to the positive terminal, positive ions stay in position

D Negative ions move along the wire to the positive terminal, positive ions move to the negative terminal.

12 A substance Q conducts electricity both when solid and molten
What is Q?

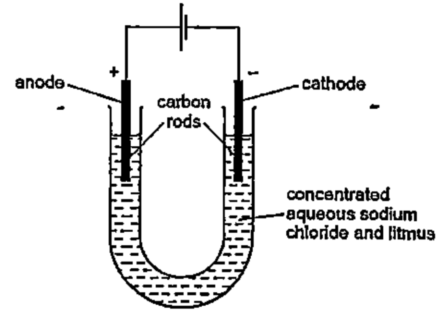
A an alloy

B a hydrocarbon

C a metal oxide

D a salt

13 The diagram shows the electrolysis of concentrated aqueous sodium chloride.



What is the colour of the litmus at each electrode after five minutes?

	colour at anode	colour at cathode
A	blue	red
B	red	blue
C	red	colourless
D	colourless	blue

14 In which of the following reaction is sulfur dioxide acting as an oxidizing agent ?

A $SO_2 + 2H_2O + Cl_2 \rightarrow H_2SO_4 + 2HCl$

B $SO_2 + 2NaOH \rightarrow Na_2SO_3 + H_2O$

C $2SO_2 + O_2 \rightarrow 2SO_3$

D $SO_2 + 2H_2S \rightarrow 2H_2O + 3S$

15 Substance X liberates iodine from aqueous potassium iodide and decolourises acidified aqueous potassium manganate(VII).
How is the behaviour of X described?

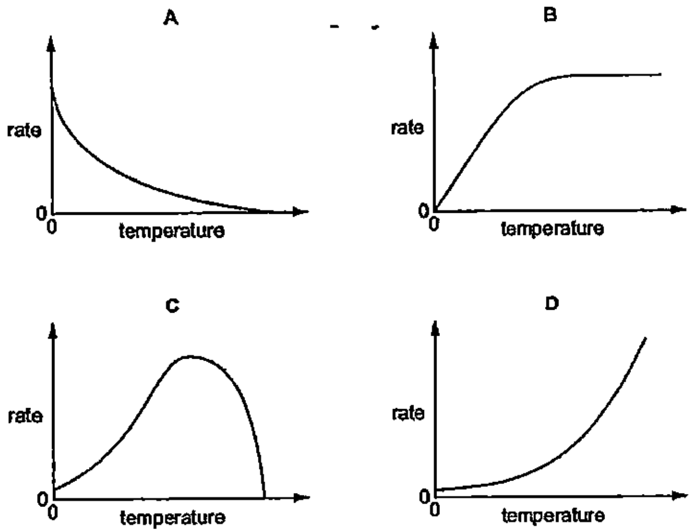
A as an oxidising agent only

B as a reducing agent only

C as an oxidising agent and a reducing agent

D as neither an oxidising agent nor a reducing agent

16 Which graph shows the effect of increasing temperature on the rate of reaction of calcium carbonate with dilute hydrochloric acid?



17 Sulfuric acid (H_2SO_4) and nitric acid (HNO_3) are both strong acids.
Ethanoic acid (CH_3COOH) is a weak acid

20 00 cm^3 solutions of 0.10 M concentration of each of these three acids were separately titrated with a 0.10 M solution of sodium hydroxide (NaOH)
In order to react completely

A all three acids would require the same volume of NaOH

B CH_3COOH and HNO_3 would require the same volume of NaOH but H_2SO_4 would require more.

C HNO_3 would require more NaOH than CH_3COOH but less than H_2SO_4.

D H_2SO_4 and HNO_3 would require the same volume of NaOH but CH_3COOH would require less

18 A 25 cm^3 sample of dilute sulfuric acid contains 0 025 moles of the acid
What is the concentration of hydrogen ions in the solution?

A 2 00 mol / dm^3

B 1 00 mol / dm^3

C 0 50 mol / dm^3

D 0 25 mol / dm^3

19 Titration of an acid against a base is a method often used in the preparation of salts
Which properties of the acid, the base and the salt are required if this method is to be used?

	acid	base	salt
A	insoluble	insoluble	insoluble
B	soluble	insoluble	insoluble
C	soluble	soluble	insoluble
D	soluble	soluble	soluble

20 One mole of compound X gives three moles of ions in aqueous solution
X reacts with ammonium carbonate to give an acidic gas
What is compound X?

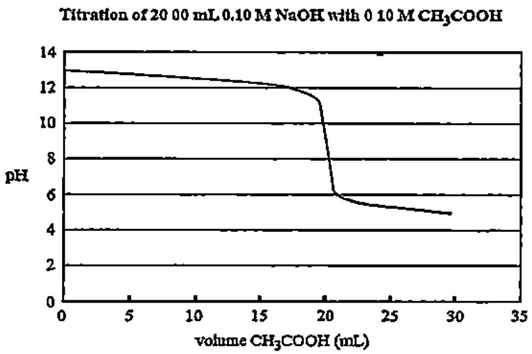
A calcium hydroxide

B ethanoic acid

C sodium hydroxide

D sulfuric acid

21 The graph below shows the change in pH of a reaction solution during a titration of 0.10 M NaOH with 0 10 M CH_3COOH



A suitable indicator for the titration and the colour change observed is

	indicator	colour change observed
A	methyl orange	red to yellow
B	methyl orange	yellow to red
C	phenolphthalein	colourless to pink
D	phenolphthalein	pink to colourless

22 Which statement about the Periodic Table is correct?

A The colour of the elements becomes darker down Group VII

B The melting point of the elements increases down Group I

C The reactivity of the elements increases down Group VII

D The reactivity of the elements decreases down Group I

23 Element **X** is a solid at room temperature
It needs one electron per atom to gain the electronic structure of a noble gas
It is the least reactive element in its group
What is the element **X**?

A At B Cs C F D Li

24 The results of three halogen displacement experiments are shown.
The table shows the results

experiment	halogen added	halide solution		
		X^-	Y^-	Z^-
1	X_2	–	Y_2 displaced	Z_2 displaced
2	Y_2	no reaction	–	no reaction
3	Z_2	no reaction	Y_2 displaced	–

What are halogens X, Y and Z?

	X	Y	Z
A	Br	Cl	I
B	Br	I	Cl
C	Cl	Br	I
D	Cl	I	Br

25 Rubidium is in Group I of the Periodic Table.
What are properties of rubidium chloride?

	formula	approximate melting point/°C	solubility in water
A	RbCl	70	insoluble
B	RbCl	700	soluble
C	$RbCl_2$	70	soluble
D	$RbCl_2$	700	insoluble

26 The carbonate of metal **X** is a white solid It decomposes when heated.
Carbon dioxide and a yellow solid oxide are formed
What is metal **X**?

A copper

B iron

C lead

D sodium

27 Iron pipes corrode rapidly when exposed to sea water
Which metal, when attached to the iron, would ***not*** offer protection against corrosion?

A aluminium

B copper

C magnesium

D zinc

28 Three types of steel have different properties
steel 1 easily shaped
steel 2 brittle
steel 3 resistant to corrosion
What are the names of these three types of steel?

	steel 1	steel 2	steel 3
A	high carbon	mild	stainless
B	high carbon	stainless	mild
C	mild	high carbon	stainless
D	mild	stainless	high carbon

29 Which oxide is most readily reduced to the metal by heating in a stream of hydrogen?

A calcium oxide

B lead(II) oxide

C sodium oxide

D zinc oxide

30 Which method can be used to obtain ammonia from ammonium sulfate?

A Heating it with an acid

B Heating it with an alkali

C Heating it with an oxidising agent

D Heating it with a reducing agent

31 Vegetable matter is biodegradable
Which gas is released into the atmosphere when vegetable matter biodegrades?

A carbon monoxide

B methane

C nitrogen dioxide

D sulfur dioxide

32 Samples of four different substances are added to separate volumes of water
The temperature changes are measured.
For which substance does an exothermic reaction occur?

	substance added	temperature change
A	ammonium chloride	decrease
B	ethanol	none
C	ice	decrease
D	sodium	increase

33 A student investigated the reaction of different vegetable oils with hydrogen
100 cm^3 of hydrogen was passed through 1 g samples of vegetable oils containing a suitable catalyst.
The volume of hydrogen remaining after each reaction was recorded

vegetable oil	volume of hydrogen remaining / cm^3
P	100
Q	87
R	63
S	0

Which vegetable oils are unsaturated?

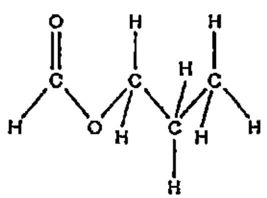
A P only

B Q and R only

C Q, R and S only

D S only

34 A compound associated with the smell or flavour of raspberries has the structure



To synthesise this compound in the laboratory you would react

A butanol and methanoic acid.

B methanol and butanoic acid.

C methanol and propanoic acid.

D propanol and methanoic acid

35 A large polyethene molecule is found to have a relative molecular mass of $4\,0 \times 10^4$.
The number of carbon atoms in this molecule would be closest to

A 1500

B 2900

C 3300

D $1\,8 \times 10^{27}$

36 Methane, CH_4, the first member of the alkane homologous series, has a boiling point of $-161\,^\circ C$
Which molecular formula and boiling point could be correct for another alkane?

	molecular formula	boiling point / °C
A	C_2H_4	−88
B	C_2H_6	−185
C	C_3H_6	−69
D	C_3H_8	−42

37 A factory manufactures poly(ethene)
Which raw material will the factory need?

A bitumen

B methane

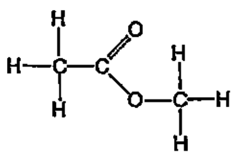
C methanol

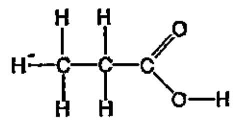
D naphtha

38 Under certain conditions 1 mole of ethane reacts with 2 moles of chlorine in a substitution reaction
What is the formula of the organic product in this reaction?

A C_2H_5Cl **B** $C_2H_4Cl_2$ **C** $C_2H_2Cl_4$ **D** CH_2Cl_2

39 The displayed formulae of two compounds are shown

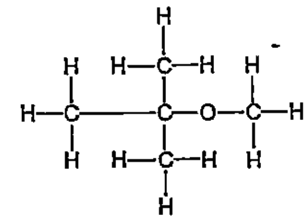




What are the similarities and differences between the two compounds?

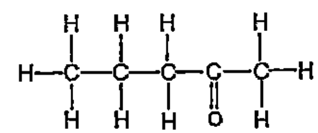
	similarities	differences
A	molecular formulae	reactions
B	molecular formulae	relative molecular masses
C	structures	molecular formulae
D	structures	relative molecular masses

40 A compound known in industry as 'MTBE' is used as an additive in 'lead-free' petrol.
The structural formula of MTBE is shown

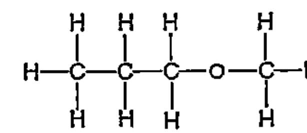


Which compound is an isomer of 'MTBE'?

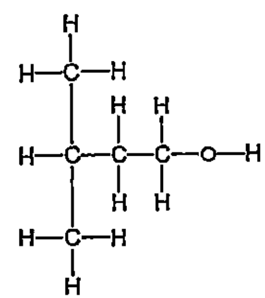
A



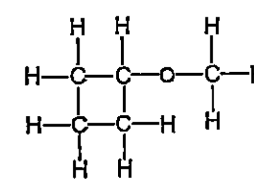
B



C



D



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.)

Class	Index Number	Name

新加坡海星中学

MARIS STELLA HIGH SCHOOL

PRELIMINARY EXAMINATION 2

SECONDARY FOUR

CHEMISTRY
Paper 2

5073/02
21 August 2015
1 hour 45 minutes

Additional Material:Nil

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 on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

This is Section A of the paper

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

The number of marks is given in brackets [ ] at the end of question or part question.
A copy of the Periodic Table is printed on page 13 of Section B.
The use of an approved scientific calculator is expected, where appropriate.

At the end of the examination, hand in the following separately :
(1) Section A
(2) Section B

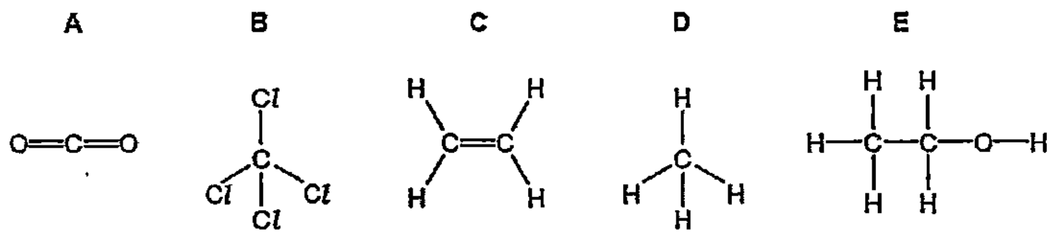
FOR EXAMINER'S USE	
Section A	/50
Section B	/30
Total	/80

Section A

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

For Examiner's Use

A1 The diagram shows the structures of five compounds, **A**, **B**, **C**, **D** and **E**, containing carbon.



Answer these questions using the letters **A, B, C, D** or **E**.
Each compound can be used once, more than once or not at all.

Which one of these compounds

(a) can change the colour of aqueous bromine ________ [1]

(b) is a product of respiration ________ [1]

(c) is the main constituent of natural gas ________ [1]

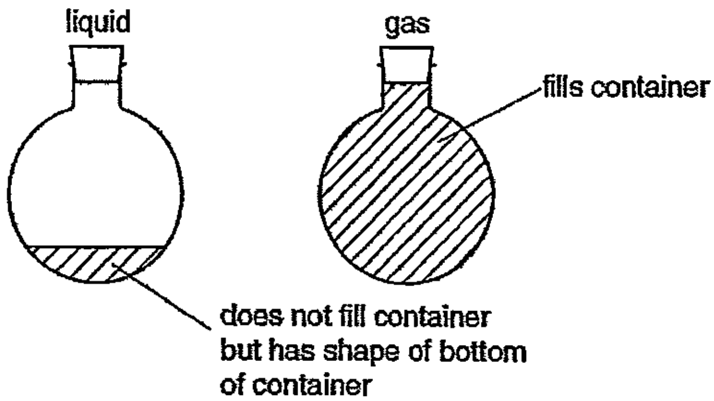
(d) is a product of substitution reaction ________ [1]

(e) is a liquid at room temperature and pressure ________ [1]

[Total : 5]

For Examiner's Use

A2 **(a)** The Kinetic Theory explains the properties of solids, liquids and gases in terms of the movement of particles.
Liquids and gases both take up the shape of the container but a gas always fills the container. Explain this, using the ideas of the Kinetic Theory.



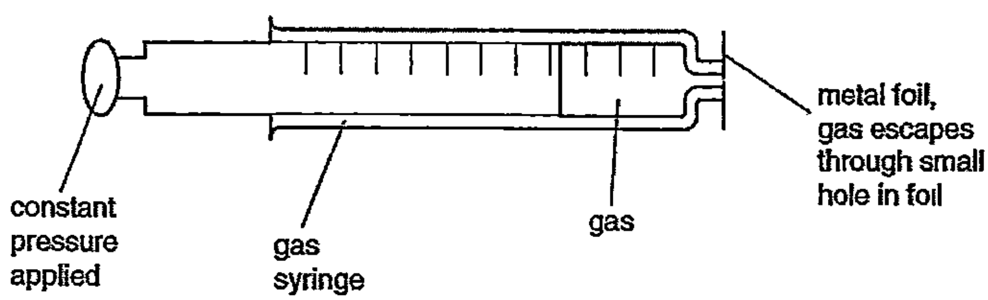
____

____

____

____ [3]

(b) The following apparatus can be used to measure the rate of diffusion of a gas.



(i) What measurements would need to be taken to calculate the rate of diffusion of a gas?

____

____

____ [2]

For Examiner's Use

A2 **(ii)** Which gas, carbon dioxide or sulfur dioxide, would diffuse faster? Explain your choice.

____

____

____ [2]

(c) A 20 cm^3 sample of butyne, C_4H_6, is burnt in 150 cm^3 of oxygen.

$$2C_4H_6(g) + 11O_2(g) \longrightarrow 8CO_2(g) + 6H_2O(l)$$

What is the total volume of gases left at the end of the reaction? [3]

[Total : 10]

For Examiner's Use

A3 Insoluble salts are made by precipitation.

(a) A preparation of the insoluble salt calcium fluoride is described below.
To 15 cm^3 of aqueous calcium chloride, 30 cm^3 of aqueous sodium fluoride is added.
The concentration of both solutions is 1.00 mol/dm^3. The mixture is filtered and the precipitate washed with distilled water. Finally, the precipitate is heated in an oven.

(i) Write the ionic equation (including state symbols) for the reaction.

____ [2]

(ii) Why is the volume of sodium fluoride solution double that of the calcium chloride solution?

____

____ [1]

(iii) Why is the precipitate washed with distilled water?

____

____ [1]

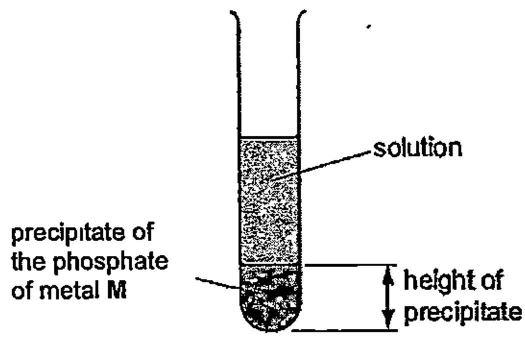
(iv) Why is the solid heated?

____

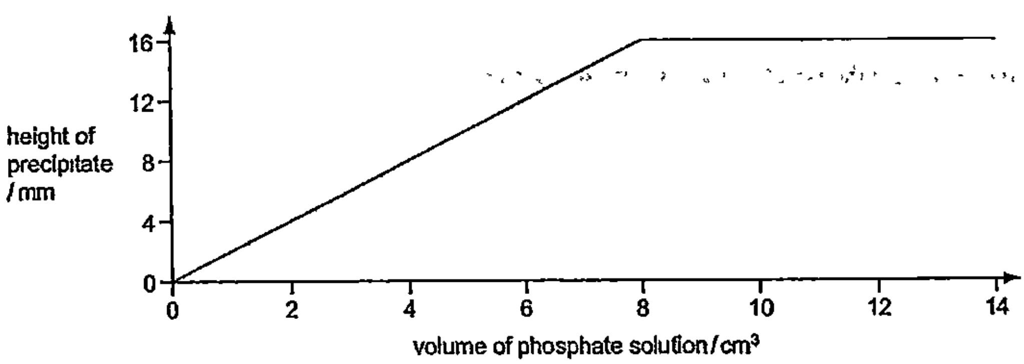
____ [1]

For Examiner's Use

A3 **(b)** The formulae of insoluble compounds can be found by precipitation reactions.
2.0 cm^3 of aqueous sodium phosphate, Na_3PO_4 was added to 12.0 cm^3 of an aqueous solution of the nitrate of metal **M**.
The concentration of both solutions was 1.00 mol/dm^3.
When the precipitate had settled, its height was measured.



The experiment was repeated using different volumes of the phosphate solution. The results are shown on the following graph.



What is the formula of the phosphate of metal **M**? Explain your reasoning.

____

____

____

____

______________________________ [3]

[Total : 8]

For Examiner's Use

A4 Ethylamine, $CH_3-CH_2-NH_2$, is a base which has similar properties to ammonia.

(a) In aqueous ethylamine, there is the following reaction :

$$CH_3-CH_2-NH_2 + H_2O \rightleftharpoons CH_3-CH_2-NH_3^+ + OH^-$$

Given aqueous solutions of ethylamine and sodium hydroxide, describe how you could show that ethylamine is a weak base like ammonia and not a strong base like sodium hydroxide.

____

____

____

____

____ [3]

(b) Ethylamine, like ammonia, reacts with acids to form salts.

$$CH_3-CH_2-NH_2 + HCl \rightarrow \underset{\text{ethylammonium chloride}}{CH_3-CH_2-NH_3Cl}$$

Suggest how you could displace ethylamine from the salt, ethylammonium chloride.

____

____ [1]

(c) Explain the chemistry of the following reaction:
When aqueous ethylamine is added to aqueous iron(III) chloride, a red-brown precipitate is formed.

____

____

____ [2]

[Total : 6]

A5 The reactivity series shows the metals in order of reactivity.

For Examiner's Use

(a) The reactivity series can be established using displacement reactions.
A piece of zinc is added to aqueous lead(II) nitrate. The zinc becomes coated with a black deposit of lead.

$$Zn + Pb^{2+} \rightarrow Zn^{2+} + Pb$$

Zinc is more reactive than lead.
The reactivity series can be written as a list of ionic equations.

$$Zn \rightarrow Zn^{2+} + 2e^-$$
$$Fe \rightarrow Fe^{2+} + 2e^-$$
$$Pb \rightarrow Pb^{2+} + 2e^-$$
$$Cu \rightarrow Cu^{2+} + 2e^-$$
$$Ag \rightarrow Ag^+ + e^-$$

(i) Explain why the positive ions are likely to be oxidants (oxidising agents).

____ [1]

(ii) Deduce which ion in the list above is the best oxidant (oxidising agent).

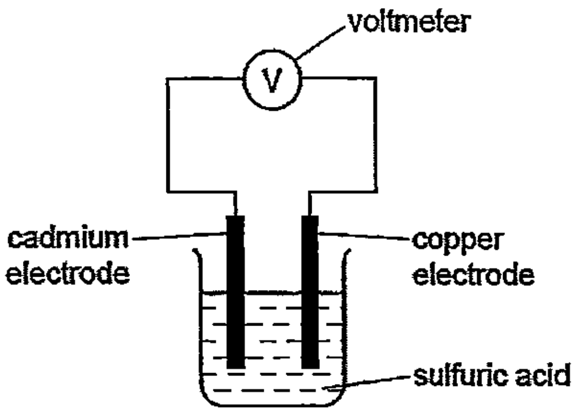
____ [1]

(iii) Which ion(s) in the list can oxidise lead metal?

____ [1]

For Examiner's Use

A5 **(b)** A reactivity series can also be established by measuring the voltage of simple cells. The diagram shows a simple cell.



Results from cells using the metals tin, cadmium, zinc and copper are given in the table below.

cell	electrode 1 positive electrode	electrode 2 negative electrode	voltage / volts
1	copper	cadmium	0.74
2	copper	tin	0.48
3	copper	zinc	1.10

Write the four metals in order of increasing reactivity and explain how you used the data in the table to determine this order.

____

____

____

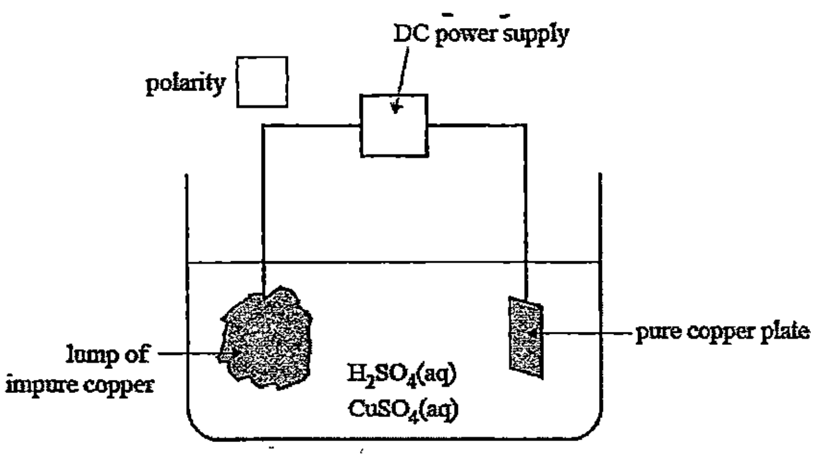
____

____ [3]

[Total : 6]

For Examiner's Use

A6 An electrolytic process known as electro-refining is the final stage in producing highly purified copper. In a small-scale trial, a lump of impure copper is used as one electrode and a small plate of pure copper is used as the other electrode. The electrolyte is a mixture of aqueous sulfuric acid and copper(II) sulfate.



(a) Indicate in the box labelled 'polarity' on the diagram above, the polarity of the impure copper electrode by putting either + or -. [1]

In a trial experiment, the electrodes were weighed before and after electrolysis.
The results are provided in the following table.

	Mass of lump of impure copper	Mass of pure copper
Before electrolysis	10.30 kg	1.55 kg
After electrolysis	0.855 kg	9.80 kg

(b) On the basis of these results

(i) calculate the percentage purity of the lump of impure copper; [3]

For Examiner's Use

A6 (ii) state **one** factor that may affect the accuracy of these results.

____

____ [1]

(c) Lumps of impure copper typically contain impunties such as silver, gold, cobalt, nickel and zinc. Cobalt, nickel and zinc are oxidised from the copper lump and exist as ions in the electrolyte. Silver and gold are not oxidised and form part of an insoluble sludge at the base of the cell.
Why is it important that silver and gold are not present as cations in the electrolyte?

____

____ [1]

[Total : 6]

For Examiner's Use

A7 There are two types of polymerisation - addition and condensation.

(a) Describe the difference between them.

____

____

____

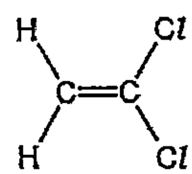
____

____

____

____ [2]

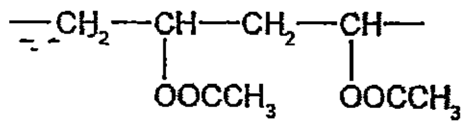
(b) Poly(dichloroethene) is used to package food.
The structural formula of dichloroethene is shown below.



Draw the structure of poly(dichloroethene) showing two repeat units. [2]

For Examiner's Use

A7 **(c)** The polymer known as PVA is used in paints and adhesives.
Its structure is shown below.



Deduce the structural formula of its monomer. [1]

(d) A condensation polymer can be made from the following monomers.

$HOOC(CH_2)_4COOH$ and $H_2N(CH_2)_6NH_2$

(i) Draw the structure of this polymer showing two repeat units. [2]

(ii) Describe the pollution problems caused by non-biodegradable polymers.

____

____

____

____

____ [2]

[Total : 9]

Class	Index Number	Name

新加坡海星中学

MARIS STELLA HIGH SCHOOL

PRELIMINARY EXAMINATION 2

SECONDARY FOUR

CHEMISTRY
Paper 2

5073/02
21 August 2015
1 hour 45 minutes

Additional Material:Nil

INSTRUCTIONS TO CANDIDATES

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

This is Section B of the paper

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 question or part question.
A copy of the Periodic Table is printed on page 13.
The use of an approved scientific calculator is expected, where appropriate.

FOR EXAMINER'S USE	
B8	/10
B9	/10
B10	/10
Total	/30

This document consists of 12 printed pages and 1 blank page.

2

BLANK PAGE

Section B

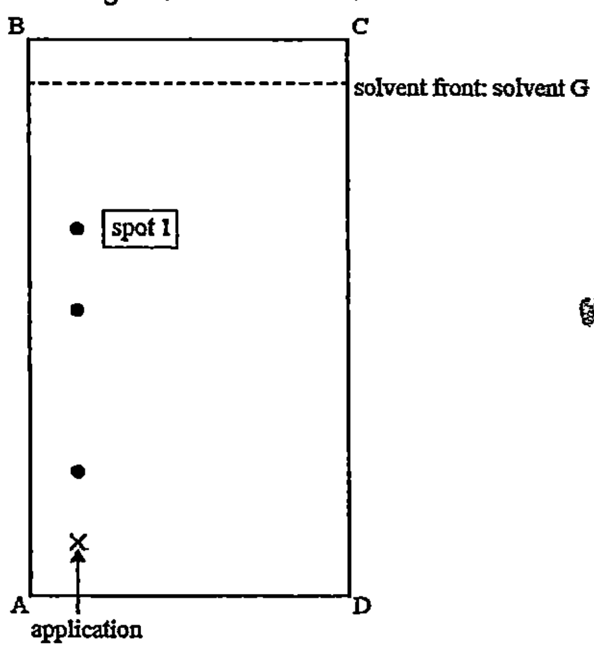
Answer the questions in this section in the spaces provided.
Answer **three** questions from this section.

For Examiner's Use

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

The total mark for this section is 30.

B8 **(a)** Enzymes are biological catalysts. They are used both in research laboratories and in industry. Enzymes called proteases can hydrolyse proteins to amino acids. The amino acids can be separated and identified by chromatography. A drop that contains a mixture of four amino acids was applied to a thin layer chromatography plate. The plate was placed in solvent **G** and the following chromatogram was obtained.



The R_f values for each of the amino acids in solvent **G** are provided in table below.

amino acid	R_f (solvent **G**)
alanine	0.51
arginine	0.16
threonine	0.51
tyrosine	0.68

For Examiner's Use

B8 **(i)** Name the amino acid that corresponds to spot 1.

____ [1]

(ii) What factor determines the different R_f values of the different amino acids?

____ [1]

(iii) Explain why the chromatogram must be exposed to a locating agent before R_f values can be measured.

____

____ [1]

(iv) Measuring R_f values on a chromatogram is one way of identifying amino acids. Suggest another.

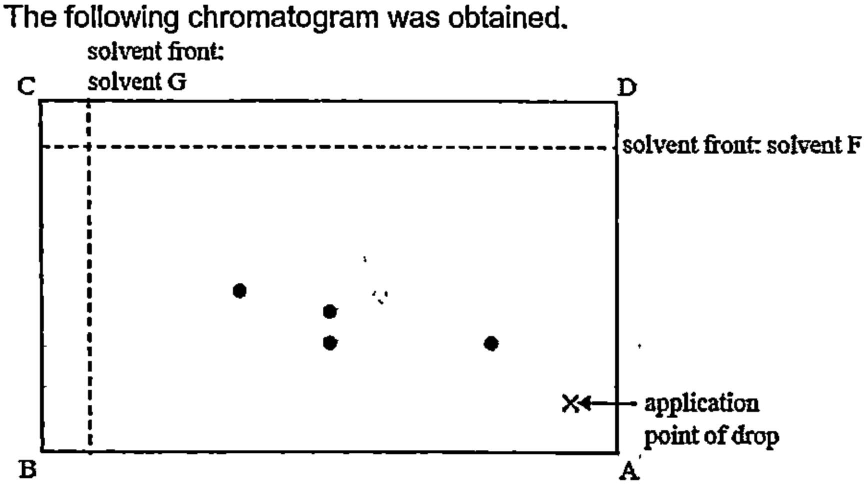
____ [1]

(v) The plate was dried, rotated through 90^0 in an anticlockwise direction and then placed in solvent **F**.

The R_f values for each of the amino acids in solvent **F** are provided in table below.

amino acid	R_f (solvent **F**)
alanine	0.21
arginine	0.21
threonine	0.34
tyrosine	0.43

The following chromatogram was obtained.



chromatogram II

For Examiner's Use

B8 Circle the spot on chromatogram II that represents alanine. [1]

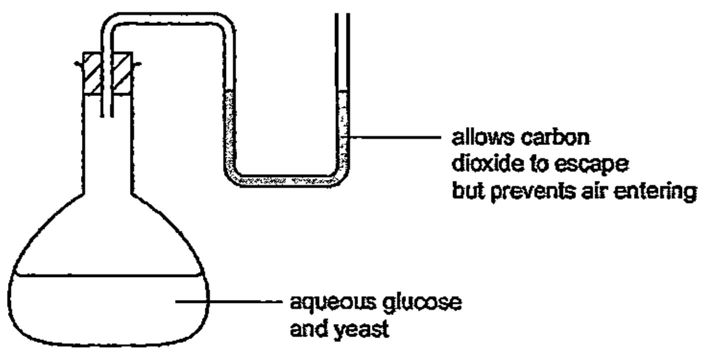
Explain, in terms of the data provided, why only three spots are present in chromatogram I while four spots are present in chromatogram II.

____

____

____ [2]

(b) The enzyme called zymase catalyses the anaerobic respiration of glucose during fermentation which can be carried out in the apparatus drawn below. After a few days the reaction stops. It has produced a 12% aqueous solution of ethanol.



(i) Complete the equation.

$C_6H_{12}O_6 \rightarrow$ ____________________ + ______________ [1]

(ii) Suggest a reason why the reaction stops after a few days.

____ [1]

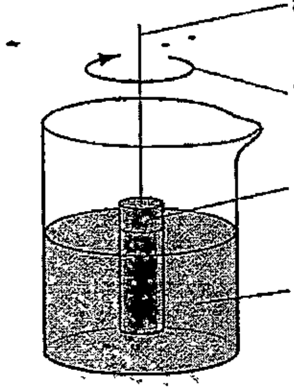
(iii) Why is it essential that there is no oxygen in the flask?

____ [1]

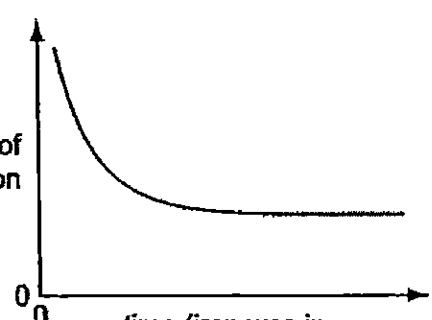
[Total : 10]

For Examiner's Use

B9 **(a)** The rate of the reaction between iron and aqueous bromine can be investigated using the apparatus shown below.



A piece of iron was weighed and placed in the apparatus. It was removed at regular intervals and the clock was paused. The piece of iron was washed, dried, weighed and replaced. The clock was restarted.
This was continued until the solution was colourless.
The mass of iron was plotted against time. The graph shows the results obtained.



(i) Suggest an explanation for the shape of the graph.

____

____

____

____

____ [2]

For Examiner's Use

B9 **(ii)** Predict the shape of the graph if a similar piece of iron (same mass) with a much rougher surface had been used. Explain your answer.

____

____

____

____________________ [2]

(iii) Describe how you could find out if the rate of this reaction depended on the speed of stirring.

____

____

____

____

____

____________________ [3]

(b) Iron is extracted from its ore (haematite) in a blast furnace.
Using chemical equations, describe the essential reactions taking place in the blast furnace which results in the production of iron.

____

____

____

____

____

____

____________________ [3]

[Total : 10]

For Examiner's Use

EITHER

B10 **(a)** A 'QwikCure' 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.
The change of energy that occurs can be used to treat an injury.

$NH_4NO_3\ (s) \rightarrow NH_4NO_3\ (aq) \qquad \Delta H = +25\ kJ/mol$

(i) State and explain if the dissolving process is exothermic or endothermic.

____

____

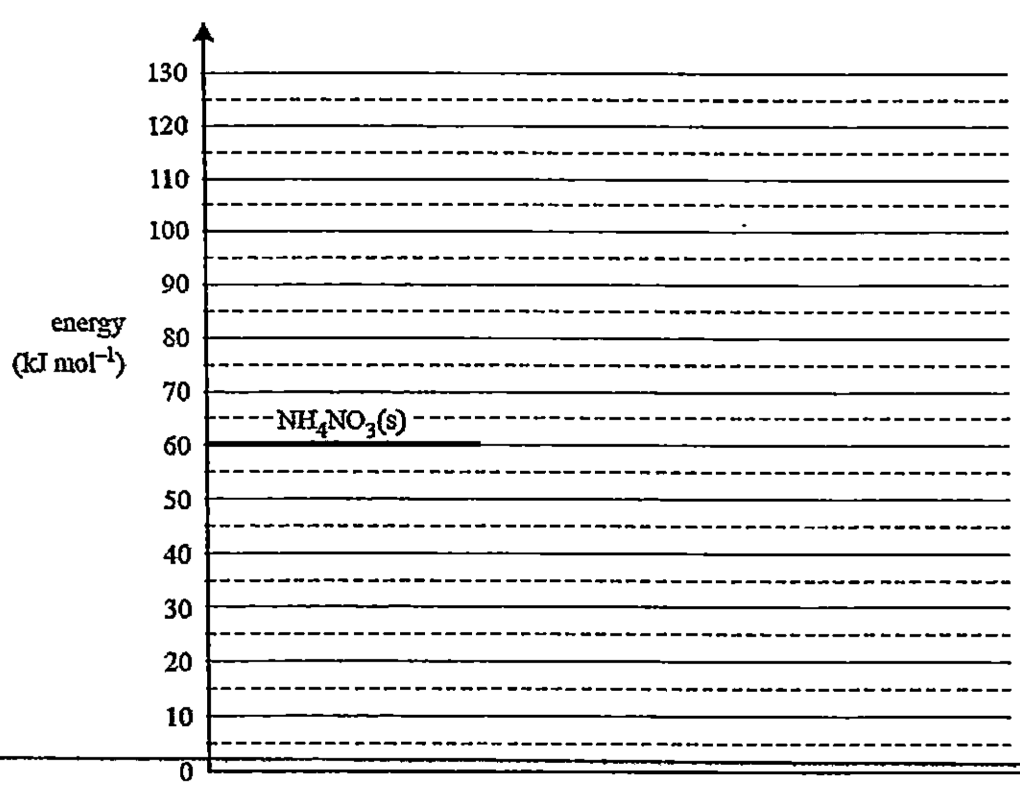
____ [2]

(ii) Suppose the activation energy of the reverse change is 35 kJ/mol.
Explain the meaning of the term 'activation energy'.

____

____ [1]

(iii) On the graph below, sketch an energy profile diagram showing the changes that occur in chemical energy as the NH_4NO_3 powder dissolves. [3]



For Examiner's Use

EITHER

B10 **(b)** Sodium reacts with nitrogen to form a compound called sodium nitride.
The chemical formula of sodium nitride is Na_xN.

A sample of sodium in a porcelain boat was heated in a combustion tube while nitrogen gas was passed over it.
The following masses were recorded.

Mass of porcelain boat when empty = 14.84 g
Mass of porcelain boat + sodium = 15.13 g
Mass of porcelain boat + sodium nitride = 15.19 g

(i) Determine the empirical formula of sodium nitride. [3]

(ii) Write an equation for the formation of sodium nitride.

____ [1]

[Total : 10]

For Examiner's Use

OR

B10 **(a)** In 1894, the scientist W. Ramsay, carried out the following experiments starting with 100 cm^3 of air.

The 100 cm^3 of air were passed through solution **X** to remove traces of acidic gases. Then the air was bubbled through concentrated sulfuric acid to remove water vapour. The remaining gases were treated with excess of hot copper and the volume decreased from almost 100 cm^3 to 80 cm^3. The gases that did not react with hot copper were heated with magnesium. 1 cm^3 of gas **Y** remained and a white solid **Z** was formed. Solid **Z** reacted with water to form only magnesium hydroxide and ammonia.

(i) Name the ion, in solution **X**, which reacts with the acidic gases.

____ [1]

(ii) Give the formula of solid **Z**.

____ [1]

(iii) Gas **Y** has a density of 1.66 g/dm^3 at r.t.p.
Calculate the mass of 1 mole of gas **Y** and hence identify the gas.

[1]

(iv) Most gases are identified by a chemical test.
Why must gas **Y** be identified using a physical property?

____ [1]

For Examiner's Use

OR

B10 (b) The table shows some properties of gases in dry air.

Gas in dry air	Density in kg/m^3	Melting point in °C	Boiling point in °C	Percentage (%) in air
Nitrogen	1.2506	–210	–196	78.08
Oxygen	1.4290	–219	–183	20.95
Carbon dioxide	1.977	–57	–57	0.033
Helium	0.1785	–272	–269	0.00052
Neon	0.8999	–249	–246	0.0019
Argon	1.7837	–189	–186	0.934
Krypton	3.74	–157	–153	0.00011
Xenon	5.86	–112	–108	0.0000087

In 1895, Lord Rayleigh isolated nitrogen from dry air by removing the other known gases, oxygen and carbon dioxide.
He then discovered that nitrogen from dry air had a different density to pure nitrogen produced from chemical reactions.
He concluded that nitrogen extracted from dry air was mixed with another gas.
The density of nitrogen extracted from dry air was higher than the density of pure nitrogen.

Use the information above to explain why.

____

____

____ [2]

For Examiner's Use

OR

B10 **(c)** Minimising air pollution is essential for health and for the environment.

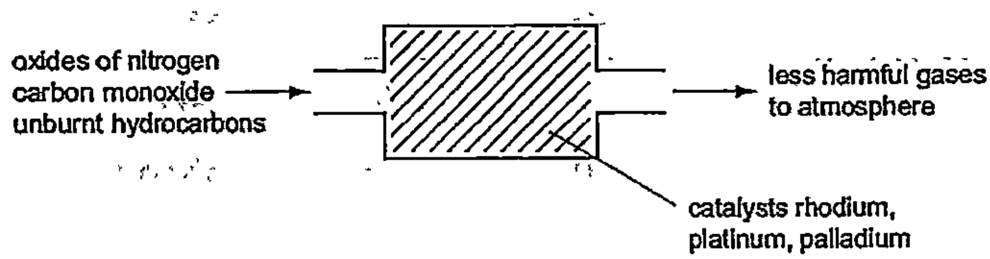
(i) Low sulfur fuels are being introduced. Ordinary diesel contains 500 ppm of sulfur but low sulfur diesel contains less than 50 ppm.
Why is this an advantage to the environment?

____

____

____ [2]

(ii) Catalytic converters reduce pollution from motor vehicles, as shown in the following diagram.



Rhodium catalyses the decomposition of the oxides of nitrogen.
$2NO \rightarrow N_2 + O_2$
Two other pollutants are carbon monoxide and unburnt hydrocarbons.

How are they converted into less harmful substances?

____

____

____ [2]

[Total : 10]

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 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.)

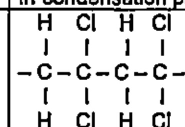
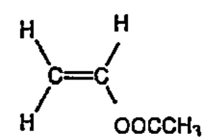
MSHS 2015 Chemistry Prelim II Answer Key

Paper 1

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

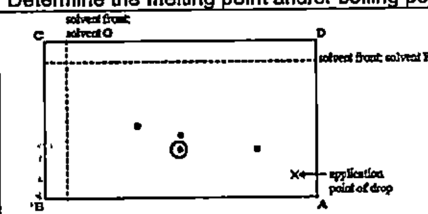
Paper 2 Section A

Q no	Answer
1	(a) C (b) A (c) D (d) B (e) E
2(a)	In liquid, the particles are close together; the strong forces of attraction between the particles do not allow them to move apart. They can move in the volume of the liquid to take up the shape of the container. In gas, the forces are much weaker and the particles can move in all directions / freely to fill the container
(b)(i)	Measure the volume of gas left in the gas syringe (or volume of gas that escapes) at regular intervals of time
(ii)	Carbon dioxide, It has lower relative molecular mass / molar mass / mass
(c)	From the equation, 2 moles of C_4H_6 react with 11 moles of O_2 Since both are gases at rtp, applying Avogadro's Law, 2 volumes of C_4H_6 react with 11 volumes of O_2 to form 8 volumes of CO_2 Thus 20 cm^3 of C_4H_6 react with 110 cm^3 of O_2 to form 80 cm^3 of CO_2 Volume of gases left = 40 cm^3 of excess O_2 + 80 cm^3 of carbon dioxide = 120 cm^3
3(a)(i)	$Ca^{2+}(aq) + 2F^-(aq) \rightarrow CaF_2(s)$
(ii)	Mole ratio of F^- (or NaF) : Ca^{2+} (or $CaCl_2$) is 2 1 Or 2 moles of NaF react with 1 mole of $CaCl_2$
(iii)	To remove sodium chloride or sodium fluoride or calcium chloride solution
(iv)	To dry (precipitate) or to remove water or to evaporate water
(b)	$M_3(PO_4)_2$; From the graph, 8 cm^3 of sodium phosphate totally react with 12 cm^3 of nitrate of M Since both solutions have same concentration, 2 moles of sodium phosphate react totally with 3 moles of nitrate of M
4(a)	Using equal volume and concentration of both solutions, add a few drops of Universal indicator /pH sensor/ pH meter; indicator in ethylamine shows blue/indigo while that in sodium hydroxide shows violet / ethylamine has a lower pH or Using equal volume and concentration of both solutions,

	measure electrical conductivity using circuit with battery and bulb/ammeter; bulb is less bright/ammeter shows lower reading for ethylamine
(b)	Add aqueous sodium/potassium/calcium hydroxide, warm
(c)	Aqueous ethylamine has hydroxide ions which react with aqueous iron(III) ions to form insoluble iron(III) hydroxide
-	-
5(a)(i)	They can accept or gain electrons (from another substance) to form atoms
(ii)	silver ion (Ag^+)
(iii)	silver ion and copper(II) ion (Ag^+ and Cu^{2+})
(b)	copper, tin, cadmium, zinc, copper is the least reactive metal as it is always the positive electrode, zinc is the most reactive since the voltage is the highest, followed by cadmium, then tin or the bigger the difference in reactivity between the metals, the bigger the voltage
6(a)	+
(b)(i)	Decrease in mass of impure electrode = 10 30 kg – 0 855 kg = 9.445 kg Increase in mass of pure electrode = mass of pure copper = 9 80 kg – 1.55 kg = 8.25 kg % purity = (8 25/9 445) x 100 = 87.3 (to 3 sig fig)
(ii)	electrodes not properly dried before weighing / not all the copper produced at the pure copper plate sticks to the copper plate
(c)	Silver and gold ions (when present in higher concentration than copper(II) ions) could be selectively charged to form silver and gold which is deposited at the pure copper plate
7(a)	Any TWO Addition polymerisation produces only one product, the polymer, but condensation polymerisation produces the polymer and a by product such as water The total mass of the monomers is the same as that of the addition polymer while the total mass of the monomers is greater than that of the condensation polymer as the process eliminates a simple molecule such as water. In addition polymerisation, each monomer has a carbon-carbon double bond while in condensation polymerisation, each monomer has a functional group at each end.
(b)	
(c)	

(d)(i)	$-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-\overset{H}{\overset{\mid}{N}}-(CH_2)_6-\overset{H}{\overset{\mid}{N}}-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-\overset{H}{\overset{\mid}{N}}-(CH_2)_6-\overset{H}{\overset{\mid}{N}}-$
(ii)	Any TWO from. -causes litter / land pollution if not properly disposed -incomplete combustion produces poisonous carbon monoxide -complete combustion produces carbon dioxide a greenhouse gas -combustion produces other named poisonous gas

Paper 2 Section B

Q no	Answer
8(a)(i)	tyrosine
(ii)	Difference in solubility of the amino acids in the solvent used
(iii)	The spots are colourless, locating agent reacts with the spots to form coloured substances
(iv)	Determine the melting point and/or boiling point
(v)	 In chromatogram I, which used solvent G, alanine and threonine appeared at the same spot/were not separated since both had the same R_f value (0 51) which means they have the same solubility in solvent G In chromatogram II, which used solvent F, alanine and threonine had different R_f values and were thus separated.
(b)(i)	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$
(ii)	yeast is 'killed'/'poisoned' /enzyme is denatured by ethanol
(iii)	Oxygen will oxidise ethanol to ethanoic acid or oxygen is absent to ensure anaerobic respiration of glucose occurs so as to form ethanol
9(a)(i)	Rate at which mass of iron decreases becomes lower / gradient decreases because concentration of aqueous bromine decreases; Mass of iron stops decreasing / gradient becomes zero because all the aqueous bromine is used up
(ii)	The initial rate / gradient is greater because of bigger surface area /more iron particles exposed; final mass of iron is the same because the same mass of iron is reacted with aqueous bromine
(iii)	Repeat the experiment using same mass of iron and same volume and concentration of aqueous bromine but by increasing/decreasing the speed of stirring/not stirring the iron piece; measure the mass of iron piece at regular time intervals; calculate the rate of reaction / gradient and compare
(b)	Coke is heated in air to form carbon dioxide; $C + O_2 \rightarrow CO_2$

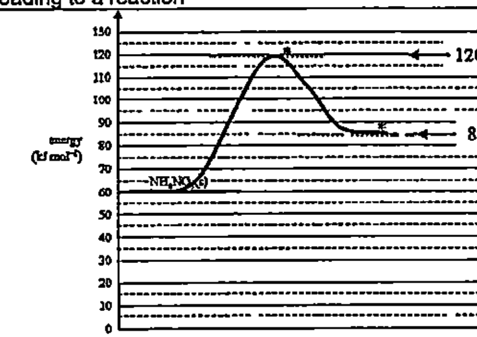
	Carbon dioxide reacts with more coke to form carbon monoxide; $CO_2 + C \rightarrow 2CO$ Carbon monoxide reduces [iron(III) oxide in] haematite to iron; $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
10 Either (a)(i)	Endothermic, The enthalpy change is positive which means heat is absorbed from the surrounding during the process
(ii)	The minimum energy that particles must possess in order to collide effectively leading to a reaction
(iii)	
(b)(i)	(table below) The empirical formula is Na_3N
(ii)	$6Na + N_2 \rightarrow 2Na_3N$
10 OR (a)(i)	Hydroxide (ion)
(ii)	Mg_3N_2
(iii)	Molar mass = 1.66g x 24 = 39 84g or 39 8g (to 3 sig fig) Gas Y is argon/ Ar
(iv)	Argon is a noble gas/has completely filled valence shells and is chemically unreactive or inert
(b)	Nitrogen from dry air contained argon/krypton/xenon; argon/krypton/xenon have density higher than that of nitrogen
(c)(i)	Combustion of low sulfur diesel would release less sulfur dioxide into the atmosphere, less acid rain would be formed which means less corrosion to limestone buildings and/or metal structures
(ii)	Carbon monoxide would be converted into carbon dioxide; unburnt hydrocarbons (reacted with oxygen) are converted to carbon dioxide and water (vapour)

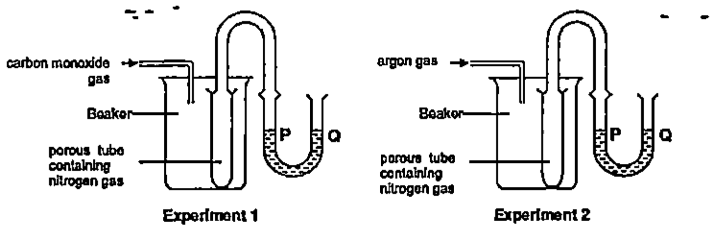
Table for 10 Either (b)(i):

	Sodium (Na)	Nitrogen (N)
Mass (g)	15 13-14 84 = 0 29	15 19-15 13 = 0.06
Molar mass (g)	23	14
No of mole	0 29/23 = 0 0126	0 06/14 = 0 00429
Mole ratio	3	1

MGS - P1

1 Two experimental set-ups used to demonstrate diffusion of gases are shown in the diagram below The gas in each porous tube is nitrogen (M_r is 28)

In experiment 1, the gas introduced into the beaker is carbon monoxide (M_r is 28) while in experiment 2, the gas is argon (A_r is 40)



What changes, if any, to the water levels at P and Q would you expect to see in both experiments?

	Experiment 1	Experiment 2
A	P and Q remain at the same level	P is at a higher level than Q
B	P and Q remain at the same level	Q is at a higher level than P
C	P is at a higher level than Q	P is at a higher level than Q
D	P is at a higher level than Q	Q is at a higher level than P

2 Three separations are listed below

1 Obtaining ethanol from alcoholic drink.
2 Obtaining ammonium chloride from a mixture of ammonium chloride and sodium chloride.
3 Obtaining solid copper(II) sulfate from aqueous copper(II) sulfate.

Which techniques would be involved in separation 1, 2 and 3 respectively?

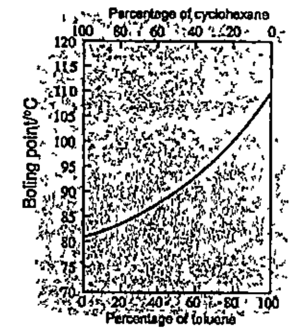
	1	2	3
A	fractional distillation	sublimation	crystallisation
B	fractional distillation	sublimation	filtration
C	distillation	crystallisation	evaporation
D	distillation	crystallisation	filtration

3 Which quantity is the same for 1 mole of ethane and 1 mole of ethene?

A mass
B number of molecules
C number of atoms
D number of ions

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

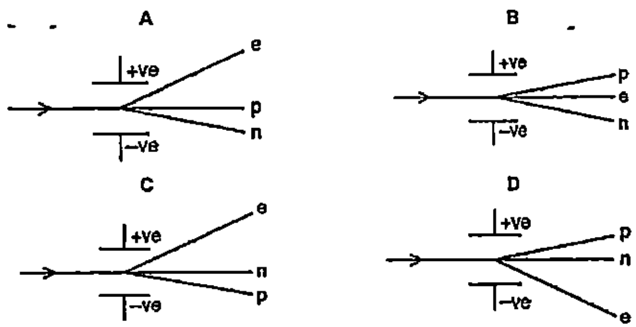


Which of the following best describes the boiling point of any mixture of toluene and cyclohexane as shown by the graph?

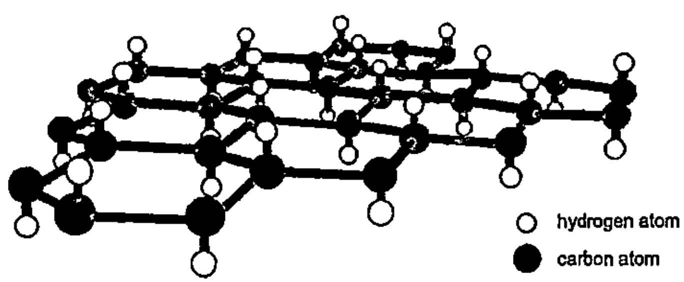
A The boiling point is below that of toluene.
B The boiling point is higher than that of cyclohexane
C The boiling point is below that of both toluene and cyclohexane.
D The boiling point is between that of toluene and cyclohexane.

5 A beam of particles contains neutrons, n, protons, p, and electrons, e The beam is passed between charged plates

Which diagram shows how the particles are affected by the plates?



6 Graphane, an allotrope of carbon has a similar structure to graphite, except that, it has one hydrogen atom attached to each carbon as shown in the diagram



Which set of properties will graphane have?

1 It is hard.
2 It has a giant molecular structure
3 It conducts electricity in the solid state.

A 1 and 2
B 1 and 3
C 2 and 3
D 1, 2 and 3

7 The formulae of the ions of some elements are shown below

P^{3-} O^{2-} Cl^{-} Na^{+} Ca^{2+}

Which of the following statements about these ions is correct?

A All have full outer shell
B All have the same number of electron shells
C All have the same number of neutrons in their nuclei
D All have more electrons than protons

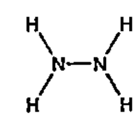
8 Four substances have the following electrical properties

Substance	Property
W	Does not conduct under any conditions
X	Conducts only in aqueous solution
Y	Conducts in both the molten and solid states
Z	Conducts in both molten and aqueous states

What are these four substances?

	W	X	Y	Z
A	HCl	S	KCl	Zn
B	Zn	HCl	KCl	S
C	S	HCl	Zn	KCl
D	S	KCl	HCl	Zn

9 The diagram shows the structural formula of the covalent molecule hydrazine, N_2H_4



Consider all the electrons in a molecule of hydrazine

Which statement is true of the number of electrons in the molecule?

	Total number of electrons involved in bonding	Total number of electrons not involved in bonding
A	5	4
B	5	8
C	10	4
D	10	8

10 Compound X consists of a lattice of positive ions of metal Y and negative ions of non-metal Z.

Each positive ion is surrounded by eight negative ions and each negative ion is surrounded by four positive ions

Which of the following shows the formulae of the ions present and compound X?

	Ions present	Formula
A	Y^{+}, Z^{2-}	Y_2Z
B	Y^{2+}, Z^{-}	YZ_2
C	Z^{+}, Y^{2-}	Z_2Y
D	Z^{2+}, Y^{-}	ZY_2

11 Which reaction takes place in the blast furnace?

A $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$
B $SiO_2 + CaO \rightarrow CaSiO_3$
C $SiO_2 + 2NaOH \rightarrow Na_2SiO_3 + H_2O$
D $FeCr_2O_4 + 4C \rightarrow Fe + 2Cr + 4CO$

12 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.

$$N_2O_4\,(g) + 2NaOH\,(aq) \rightarrow NaNO_3\,(aq) + NaNO_2\,(aq) + H_2O\,(l)$$

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 120 cm^3
D 240 cm^3

13 The dissociation constant for an acid indicates the extent to which it dissociates into ions The higher the dissociation constant, the stronger the acid

The dissociation constant for some acids are given below along with two possibly correct statements

Acid	Dissociation Constant
Methanoic acid, HCO_2H	$1\ 80 \times 10^{-4}$
Ethanoic acid, CH_3CO_2H	$1\ 75 \times 10^{-5}$
Propanoic acid, $CH_3CH_2CO_2H$	$1\ 34 \times 10^{-5}$
Chloroethanoic acid, $Cl\,CH_2CO_2H$	$1\ 40 \times 10^{-3}$

Statement 1	Increasing the length of the carbon chain makes the acid stronger
Statement 2	Replacing a hydrogen by a chlorine in ethanoic acid makes the acid stronger

Based on the data above, which of the above two statements are correct?

A Statement 1 and 2
B Statement 1 only
C Statement 2 only
D Neither statement

14 Which pair of reagents is most suitable in preparing the following salts?

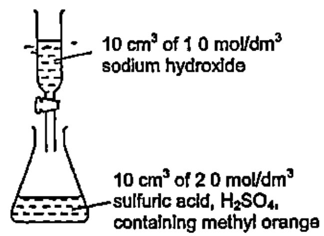
	Salt	Reagents
A	magnesium sulfate	magnesium nitrate + sodium sulfate
B	ammonium nitrate	aqueous ammonia + nitric acid
C	lead (II) chloride	lead (II) oxide + hydrochloric acid
D	sodium chloride	sodium + hydrochloric acid

15 A student performed a number of tests on an aqueous solution of lead(II) nitrate.

Which test must be repeated because the student's observation was **incorrect**?

	Test	Observation
A	Add aqueous zinc sulfate	A white precipitate was formed
B	Add aqueous barium chloride	No precipitate was formed
C	Add aqueous sodium hydroxide	A white precipitate was formed
D	Add aqueous sodium hydroxide and aluminium foil, then heat	A gas was evolved that turned moist red litmus paper blue

16 During an experiment, 10 cm^3 of 1 0 mol/dm^3 sodium hydroxide, NaOH, is gradually added to 10 cm^3 of 2 0 mol/dm^3 sulfuric acid, H_2SO_4, containing methyl orange indicator



Which change occurs in the mixture?

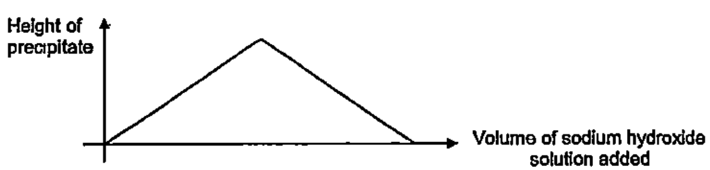
A The concentration of the OH^- ions increases
B The methyl orange changes colour
C A precipitate is formed
D More water molecules are formed

17 To reduce atmospheric pollution, the waste gases from a coal-burning power station are passed through a wet suspension of powdered calcium carbonate

Which waste gas will **NOT** be removed by powdered calcium carbonate?

A carbon monoxide, CO
B nitrogen dioxide, NO_2
C sulfur dioxide, SO_2
D phosphorus(V) oxide, P_2O_5

18 An aqueous solution of a salt, **X**, is placed in a test-tube and sodium hydroxide solution is gradually added The height of the precipitate in the test-tube is plotted against the volume of sodium hydroxide added



Which cation is found in **X**?

A aluminium ion
B ammonium ion
C copper(II) ion
D iron(II) ion

19 Equations for reactions of iron and iron compounds are shown

1 $Fe + 2HCl \rightarrow FeCl_2 + H_2$
2 $2FeCl_2 + Cl_2 \rightarrow 2FeCl_3$
3 $FeSO_4 + Mg \rightarrow Fe + MgSO_4$
4 $FeSO_4 + 2NaOH \rightarrow Fe(OH)_2 + Na_2SO_4$

How many of these are redox reactions?

A 1
B 2
C 3
D 4

20 Waste gases from a car engine are passed through a catalytic converter to remove the pollutant gases

One of pollutant gases is nitrogen monoxide The equation below shows how it is removed

$$2CO + 2NO \rightarrow N_2 + 2CO_2$$

Which statement about the reaction is **incorrect**?

A The oxidation state of carbon changes from +2 to +4
B The oxidation state of nitrogen changes from +2 to 0
C The oxidation state of oxygen is unchanged
D The oxidation state of oxygen changes from -2 to -4

21 The table shows the reactions of each of the metals **A**, **B**, **C** and **D** with separate solutions containing ions of the other metals

Which metal forms an oxide that is most easily reduced by heating with carbon?

Metal	Solution of			
	A nitrate	B nitrate	C nitrate	D nitrate
A		reaction	no reaction	no reaction
B	no reaction		no reaction	no reaction
C	reaction	reaction		reaction
D	reaction	reaction	no reaction	

22 The following gases can be found in the blast furnace that used to extract iron

1 Carbon monoxide
2 Carbon dioxide
3 Nitrogen

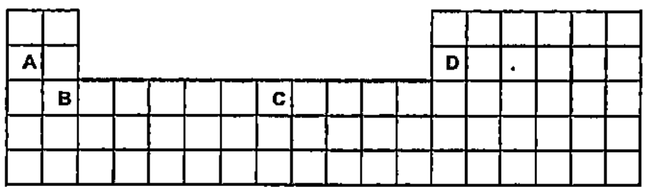
Which of the above gases can be both a reactant and a waste gas?

A 1 only
B 1 and 2 only
C 1 and 3 only
D 1, 2 and 3

23 The positions of four elements 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 forms chlorides XCl_2 and XCl_3

Which element is X?



24 W, X, Y and Z are metals When various mixtures of one of the metals is heated with a metal oxide, the following results were obtained

(i) oxide of Z + W → oxide of W + Z
(ii) oxide of X + W → no reaction
(iii) oxide of Z + Y → oxide of Y + Z
(iv) oxide of W + Y → no reaction

Which of the following arrangements shows the metals W, X, Y and Z in order of increasing reactivity?

A X Y W Z
B Y X W Z
C W X Y Z
D Z Y W X

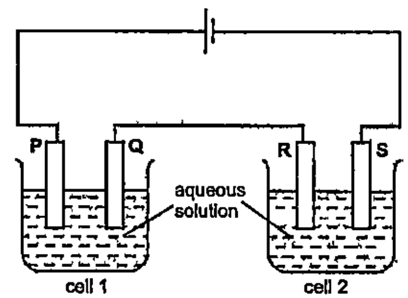
25 Metal M forms a chloride MCl_2 M is between copper and silver in the reactivity series

If a concentrated aqueous solution of MCl_2 is electrolysed, which reactions will occur at the cathode and the anode?

	Cathode(negative electrode)	Anode(positive electrode)
A	$M^{2+} + 2e^- \rightarrow M$	$2Cl^- \rightarrow Cl_2 + 2e^-$
B	$M^{2+} + 2e^- \rightarrow M$	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$
C	$2H^+ + 2e^- \rightarrow H_2$	$2Cl^- \rightarrow Cl_2 + 2e^-$
D	$2H^+ + 2e^- \rightarrow H_2$	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$

26 In the diagram, each cell contains an aqueous solution of a single salt and all four electrodes are platinum

Electrodes Q and S increase in mass during the electrolysis but no gas is given off at Q or S



If the increase in mass of Q is greater than the increase in mass of S in the same duration of time, which statement must be true?

A The loss of mass of electrode P is less than the loss of mass of electrode R.
B The current passing through cell 1 is greater than the current passing through cell 2
C The cation of the solution in cell 1 is different from the cation of the solution in cell 2
D The cation in cell 1 is the same as in cell 2 but the solution in cell 1 is more concentrated than in cell 2

27 Gaseous phosphorus pentachloride, PCl_5, can be decomposed into gaseous phosphorus trichloride and chlorine by heating

$$PCl_5\,(g) \rightarrow PCl_3\,(g) + Cl_2\,(g)$$

The table below gives the bond energies

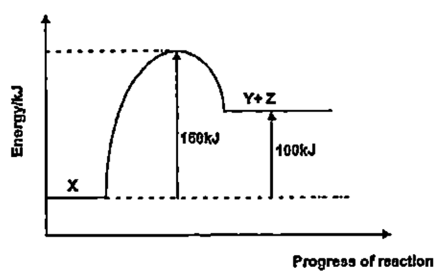
Bond	Bond energy (kJ/mol)
P–Cl (in both chlorides)	330
Cl–Cl	240

What is the enthalpy change of the decomposition of phosphorus pentachloride?

A +90 kJ
B -90 kJ
C +420 kJ
D -420 kJ

28 The diagram shows the energy profile for the decomposition of X to form products, Y and Z.

$$X \rightarrow Y + Z$$



Which statement is correct?

A The overall enthalpy change is +60kJ
B The reaction is exothermic
C The value of 160kJ would decrease in the presence of a catalyst.
D The value of 100kJ would decrease in the presence of a catalyst.

29 Cracking of hydrocarbons is done to obtain smaller molecules

Which of the following cracking reactions carried out at the same temperature and pressure will produce the largest volumes of products from one mole of hydrocarbon?

A $C_6H_{14}\,(g) \rightarrow 3C_2H_4\,(g) + H_2\,(g)$
B $C_8H_{18}\,(g) \rightarrow 2C_3H_8\,(g) + C_2H_2\,(g)$
C $C_{10}H_{22}\,(g) \rightarrow C_8H_{18}\,(g) + C_2H_4\,(g)$

D $C_{12}H_{26}\,(g) \rightarrow C_8H_{18}\,(g) + 2C_2H_4\,(g)$

30 In each of three experiments, a halogen was added to separate solutions containing ions of one of the other two halogens The table shows the results

Experiment	Halogen added	Solution of halide		
		U	V	W
1	U_2		No reaction	Reaction occurs
2	V_2	Reaction occurs		Reaction occurs
3	W_2	No reaction	No reaction	

What were the halogens U, V and W?

	U	V	W
A	Br_2	Cl_2	I_2
B	Br_2	I_2	Cl_2
C	Cl_2	Br_2	I_2
D	Cl_2	I_2	Br_2

31 Petrol and diesel are two common fuels used by cars and buses respectively The combustion of these fuels produces air pollutants

The following table shows the mass of pollutants found in the exhaust fume when 1 kg of each fuel is burnt

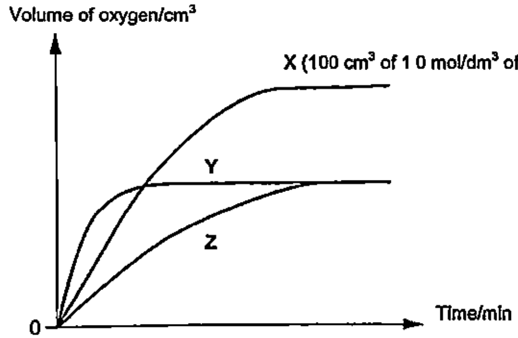
Pollutant	Petrol/g	Diesel/g
carbon monoxide	14	10
oxides of nitrogen	30	60
sulfur dioxide	1	4
unburnt hydrocarbons	15	20

Which of the following statements can be inferred using the data in the table?

A Petrol contributes more towards the formation of acid rain
B The temperature in petrol engine is lower than that in diesel engine
C All the pollutants listed in the table can be removed by installing a catalytic converter
D Unburnt hydrocarbons are produced by complete combustion of the fuels

32 The volume of oxygen produced as hydrogen peroxide decomposes was measured over time

In the first experiment, 100 cm^3 of 1 0 mol/dm^3 of hydrogen peroxide was used A graph, labelled X, was obtained, as shown in the diagram below



The experiment was repeated twice with changes in the conditions and graphs Y and Z were obtained.

Which of the following set of changes could possibly produce the results illustrated by graphs Y and Z?

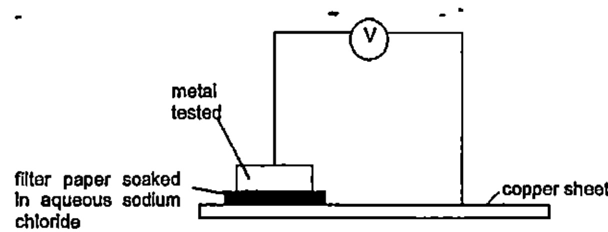
	Graph Y	Graph Z
A	50 cm^3 of 1 5 mol/dm^3 of H_2O_2	150 cm^3 of 0 5 mol/dm^3 of H_2O_2
B	100 cm^3 of 1.5 mol/dm^3 of H_2O_2	50 cm^3 of 0 5 mol/dm^3 of H_2O_2
C	50 cm^3 of 2 0 mol/dm^3 of H_2O_2	100 cm^3 of 0.1 mol/dm^3 of H_2O_2
D	100 cm^3 of 2 0 mol/dm^3 of H_2O_2	50 cm^3 of 0 5 mol/dm^3 of H_2O_2

33 Which change would increase the speed of the reaction between 1 mol of two gases?

- A A decrease in surface area of the catalyst
- B A decrease in temperature
- C A decrease in the volume of the reaction flask
- D A decrease in the pressure of the gases

34 The reactivity of Group II metals follows a similar trend to that of Group I metals

Four Group II metals, P, Q, R and S were tested in an electric cell as shown in the diagram below



The voltage produced is recorded and shown in the following table

Metal	Voltage/V
P	0 2
Q	0 8
R	0 6
S	0 4

The four metals tested were magnesium, calcium, strontium and barium

What is a possible identity of metal R?

- A magnesium
- B calcium
- C strontium
- D barium

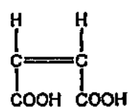
35 Which statements are true about alkenes?

1 Their general formula is C_nH_{2n}
2 They are saturated
3 They react with halogens

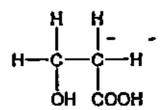
- A 1 and 2 only
- B 1 and 3 only
- C 2 and 3 only
- D 1, 2 and 3

36 What are the reactions of compounds W, X, Y and Z?

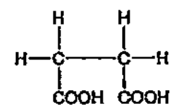
W



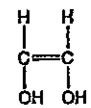
X



Y



Z



	decolourises aqueous bromine	has a pH of less than 7	condensation polymerisation
A	X and Y	W and Y	W, X, Y and Z
B	X and Y	W and Y	X, Y and Z
C	W and Z	W, X and Y	X, Y and Z
D	W and Z	W, X and Y	W, X, Y and Z

37 Engine oil is used to lubricate the car engine Certain polymers are added to engine oil to improve its viscosity

A portion of the chain of one such polymer is shown below

$$-CH_2CH(CH_2CH_2CH_3)CH_2CH(CH_2CH_2CH_3)CH_2CH(CH_2CH_2CH_3)-$$

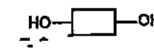
A molecule of this polymer contains 40 carbon atoms

How many molecules of monomer are required to form one molecule of this polymer?

A 4
B 5
C 8
D 10

38 The structures of five monomers are shown below

1



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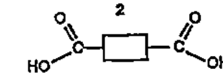

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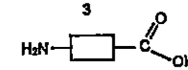

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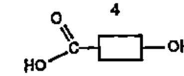

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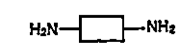
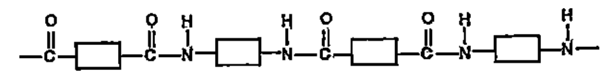


Which pair of monomers will form a polyamide with the following structure?



A 1 and 2
B 2 and 3
C 2 and 5
D 4 and 5

39 The table shows the composition of four different brands of crude oil namely Arabian Heavy, Arabian Light, Iranian Heavy and North Sea

When each brand of crude oil undergoes fractional distillation, the percentage of each fraction collected is listed in the table below

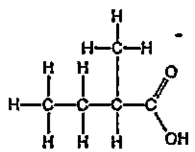
Crude oil / Fraction	Arabian Heavy /%	Arabian Light /%	Iranian Heavy /%	North Sea /%
petrol	18	21	21	23
kerosene	11 5	13	13	15
diesel	18	20	20	24
naphtha	52.5	46	46	38

Which type of crude oil is best for the use in motor vehicle industry?

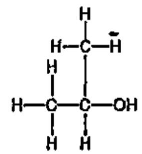
A Arabian Heavy
B Arabian Light
C Iranian Heavy
D North Sea

40 Esters are formed when an alcohol reacts with a carboxylic acid

Which ester would be formed using the carboxylic acid and alcohol shown?

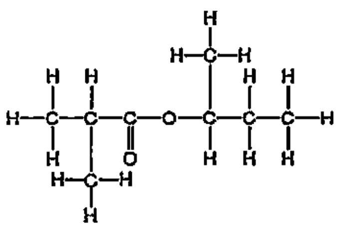


carboxylic acid

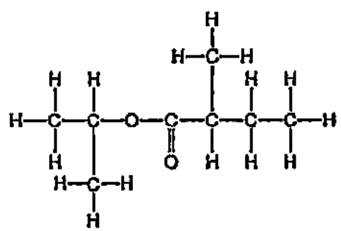


alcohol

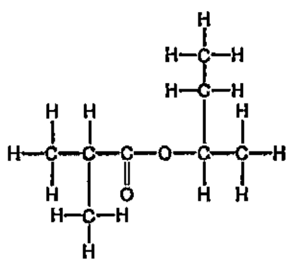
A



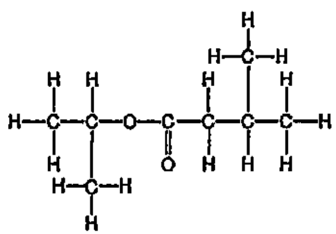
B



C



D



MGS- P2

Section A (50 marks)

Answer all the questions in the spaces provided.

A1 Choose from the following compounds to answer the questions below.

$BaSO_4$

$FeCl_2$

CO_2

$CuCO_3$

$CaCO_3$

CF_3Cl

$MgSO_4$

NaCl

$ZnSO_4$

Each compound can be used once, more than once or not at all.

State the compound which

(a) is responsible for ozone depletion,

.... [1]

(b) is prepared by titration method,

.... [1]

(c) is an insoluble green solid,

.... [1]

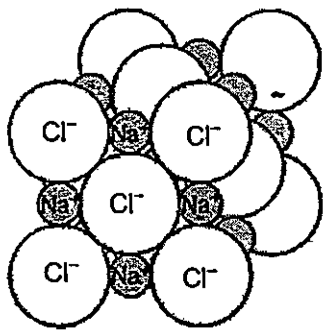
(d) is a product of fermentation,

.... [1]

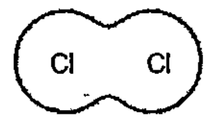
(e) in aqueous state will react with aqueous barium chloride to give a white precipitate.

.... [1]

A2 The structures of sodium chloride and chlorine are shown below.



sodium chloride



chlorine

(a) The melting point of sodium chloride is 801°C.
The melting point of chlorine is –101°C.

Explain in terms of bonding and structure, why the melting point of chlorine is so low.

....

....

....

....

.... [2]

(b) Explain why molten sodium chloride conducts electricity but solid sodium chloride does not.

....

....

.... [1]

(c) The reactions occurring at the electrodes when molten sodium chloride is electrolysed are shown below.

Negative electrode $Na^+ + e^- \rightarrow Na$
Positive electrode $2Cl^- \rightarrow Cl_2 + 2e^-$

With reference to both equations, explain why this electrolysis involves both oxidation and reduction.

....

....

.... [2]

A3 Zinc can be extracted from zinc blende, ZnS, or from calamine, $ZnCO_3$, in a two-stage process

Extraction from zinc blende	Extraction from calamine
Stage 1: $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$	$ZnCO_3 \rightarrow ZnO + CO_2$

Stage 2: $ZnO + C \rightarrow Zn + CO$

(a) Explain why the gas from stage 2 must be removed for the safety of the workers.

....

....

.... [1]

(b) Explain why the reactions in the two-stage process cannot be used to extract sodium from sodium carbonate, Na_2CO_3.

....

....

....

....

.... [2]

(c) Industrial processes release large amounts of sulfur dioxide and carbon dioxide into the atmosphere.

(i) State a **natural** source of sulfur dioxide.

.... [1]

(ii) Carbon dioxide contributes to global warming.

Describe one environmental consequence of an increase in global warming.

....

....

....

....

.... [1]

(d) The zinc obtained in stage 2 has to be purified further for more useful purposes.

One of the most common uses for zinc is as an anti-corrosion agent.

Explain why zinc is able to act as an anti-corrosion agent in galvanized **steel lamp posts.**

....

....

....

.... [2]

(e) The most abundant and stable zinc isotope is ^{65}Zn
State the number of protons and neutrons in this isotope of zinc.

Number of protons ....

Number or neutrons .... [1]

A4 Sulfamic acid, SO_3NH_3, is a weak acid used to remove limescale, deposited calcium carbonate, from kettles

(a) Explain the meaning of the term *weak acid*.

....

.... [1]

(b) The pH of an aqueous solution of sulfamic acid can be determined using a pH meter.

Describe another way of estimating the pH of a solution of sulfamic acid.

....

....

....

.... [1]

(c) A 0.105 g sample of sulfamic acid is dissolved in some water. This sulfamic acid solution requires 10.8 cm^3 of 0.100 mol/dm^3 potassium hydroxide for complete neutralisation.

Calculate the number of moles of sulfamic acid that react with one mole of potassium hydroxide

[3]

(d) Aqueous sulfamic acid reacts with magnesium to form magnesium sulfamate, $Mg(SO_3NH_2)_2$.

(i) Write an equation for this reaction.

.... [1]

(ii) Limescale contains calcium carbonate.

Describe, with the aid of an equation, what is observed when aqueous sulfamic acid reacts with calcium carbonate.

....

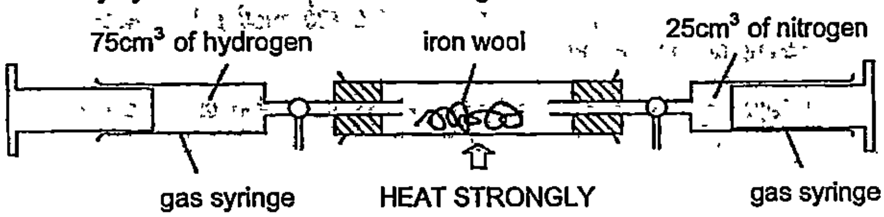
....

.... [2]

A5 Ammonia is a compound of hydrogen and nitrogen with a formula of NH_3. It is a colourless gas with a pungent smell. The formation of ammonia is made by reacting nitrogen and hydrogen in a reversible reaction as shown in the equation below.

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

(a) The reaction to produce ammonia can be demonstrated in the science laboratory by the method shown in the diagram below:



The mixture of nitrogen and hydrogen is passed backwards and forwards over the hot iron wool until there is no further reaction.

(i) Explain why air must not be present in the above reaction.

....

.... [1]

(ii) Assuming only 15% of the nitrogen and hydrogen react to produce ammonia, calculate the volume of ammonia produced at room temperature and pressure.

[2]

(b) In industries, ammonia is manufactured in the Haber Process The table below shows the percentage yield of ammonia at different temperature and pressures.

Temperature/°C	Percentage yield of ammonia at equilibrium		
	200 atm	300 atm	400 atm
350	24	40	48
450	20	23	30
550	10	12	15

(i) State how the increase in pressure affects the percentage yield of ammonia at equilibrium.

....

.... [1]

(ii) Suggest one advantage and one disadvantage of using 450°C rather than 350°C as the working temperature

....

....

....

....

.... [2]

(iii) Explain why the use of expensive metals as catalyst does not increase the cost of production of ammonia in the Haber Process.

....

.... [1]

A6 Hydrogen peroxide, H_2O_2, is a covalent compound. Hydrogen peroxide decomposes to form water and oxygen according to the equation:

$$2H_2O_2\,(l) \rightarrow 2H_2O\,(l) + O_2\,(g)$$

(a) The decomposition of hydrogen peroxide involves a change from the liquid state to the gaseous state

Describe the difference in both the movement and arrangement of particles in a liquid and in a gas.

Movement: ....

....

....

....

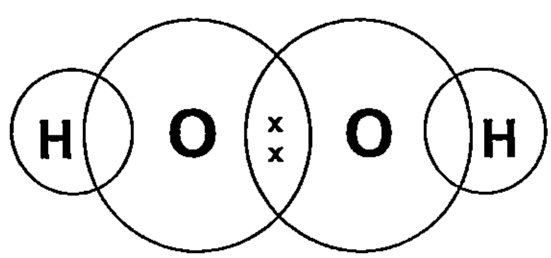
Arrangement: ....

....

....

.... [2]

(b) Complete the 'dot and cross' diagram to show the bonding present in hydrogen peroxide, H_2O_2, using the legend stated.



Key

x : electrons of oxygen atoms

●: electrons of hydrogen atoms

[2]

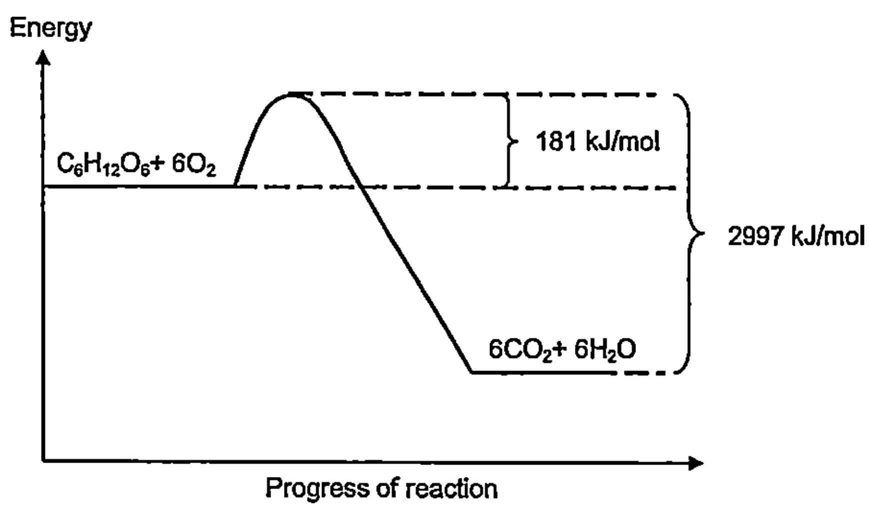
(c) Hydrogen peroxide can act as an oxidising agent or a reducing agent.

Deduce the nature of hydrogen peroxide in each test described.

Test	Observation	Nature of hydrogen peroxide
hydrogen peroxide is added to iron(II) sulfate	light green solution turns yellow	
hydrogen peroxide is added to acidified potassium manganate (VII)	purple solution turns colourless	

[2]

A7 The following energy profile diagram shows the differences in amount of energy associated with the combustion of glucose, $C_6H_{12}O_6$, during cellular respiration to produce carbon dioxide and water.



(a) Calculate the enthalpy change, ΔH, of the reaction.

[1]

(b) Explain whether this reaction is endothermic or exothermic in terms of bond breaking and bond forming.

....

....

....

....

.... [2]

(c) Calculate the energy released per gram of glucose.

[2]

A8 Crude oil is a raw material which is processed in an oil refinery. Two of the processes used are fractional distillation and cracking.

The table below shows the percentage of the supply and demand of each fraction in crude oil.

Fraction	Number of carbon atoms per molecule	Percentage of supply in crude oil	Percentage of demand in crude oil
Petroleum gases	1 - 4	4%	11%
Petrol (gasoline)	5 - 9	11%	22%
Kerosene	10 - 14	12%	20%
Diesel oil	14 - 20	18%	15%
Waxes and bitumen	Over 20	23%	4%

(a) State the physical property which is used to separate crude oil by fractional distillation.

.... [1]

(b) Use the information from the table to

(i) identify the fractions that would undergo cracking to meet the demand for petrol.

.... [1]

(ii) explain your choice in (i)

....

....

.... [1]

(c) Heptane, an alkane with 7 carbon atoms, can be cracked into smaller molecules under high temperatures and a catalyst.

A large volume of heptane was subjected to cracking and the main product was methane. Gas **B** which has a relative molecular mass of 28 was also isolated in the product mixture and was found to be unsaturated.

(i) Write an equation to show the cracking process.

....

.... [1]

(ii) Describe a chemical test that can be used to distinguish between methane and gas **B**

....

....

....

.... [2]

Section B (30 marks)

Answer all **three** questions in this section.
The last question is in the form of EITHER/OR and only one alternative should be attempted.

B9 Aqueous chlorine dioxide, a yellow solution, reacts with an alkali according to the following equation:

$$\underset{\text{yellow}}{2ClO_2\,(aq)} + 2OH^-\,(aq) \rightarrow \underset{\text{colourless}}{ClO_3^-\,(aq) + ClO_2^-\,(aq)} + H_2O\,(l)$$

A student carried out different experiments to investigate the rate of reaction using different concentrations of aqueous chlorine dioxide and alkali. In each experiment, she measured how quickly the colour of aqueous chlorine dioxide disappeared.

The table showed the results obtained with differing concentrations of aqueous chlorine dioxide and alkali used in each experiment.

Experiment	Concentration of ClO_2 / mol/dm^3	Concentration of OH^- / mol/dm^3	Rate of disappearance of ClO_2 / mol/dm^{3}s
1	0.020	0.030	0.00276
2	0.040	0.030	0.01104
3	0.020	0.060	0.00552
4	0.040	0.060	0.02208
5	0.040	0.090	0.03312
6	0.120	0.030	0.09936

The reaction of aqueous chlorine dioxide with alkali is interesting because it is an example of a disproportionation reaction. Disproportionation happens when the oxidation state of the same element both increases and decreases in the reaction.

(a) Describe the trend in the rate of reaction with respect to the concentration of the reagents used.

Explain and justify your answer using the results in the table, stating clearly the experiment number you are using for **each** reagent.

....

....

....

....

....

....

....

.... [3]

(b) Using Collisions Theory, explain the trend stated in **(a)**.

....

....

....

.... [2]

(c) Two students have different opinion about the data.

Student 1: I think that the rate of reaction depends on the concentration of aqueous chlorine dioxide to a greater extent.

Student 2: I think that the rate of reaction depends on the concentration of alkali to a greater extent.

Who do you agree with? Explain your answer using results from the table. State which experiment number you are using, and show clearly how you arrived at your answer.

....

....

....

....

....

....

....

....

.... [2]

(d) Predict the rate of the disappearance of ClO_2 if the experiment was conducted using 0.040 mol/dm^3 of ClO_2 and 0.120 mol/dm^3 of OH^-.

.... [1]

(e) Use the idea about oxidation state to explain why the reaction of chlorine dioxide with an alkali is a disproportionation reaction.

....

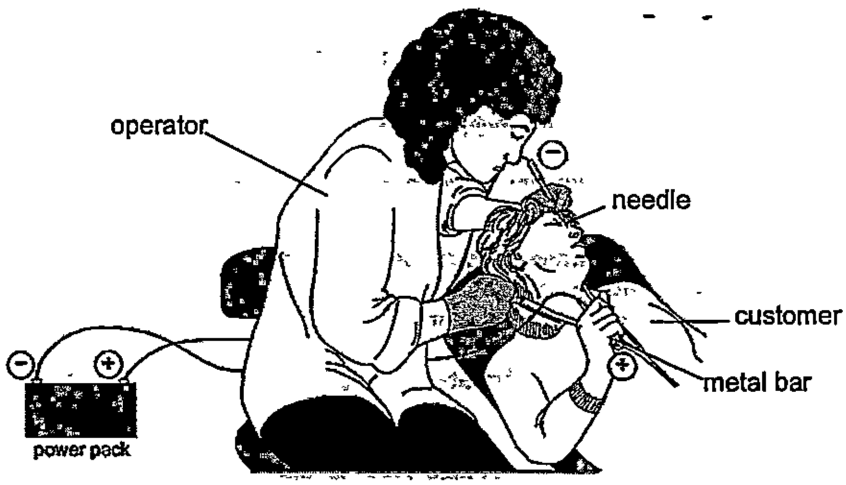
....

....

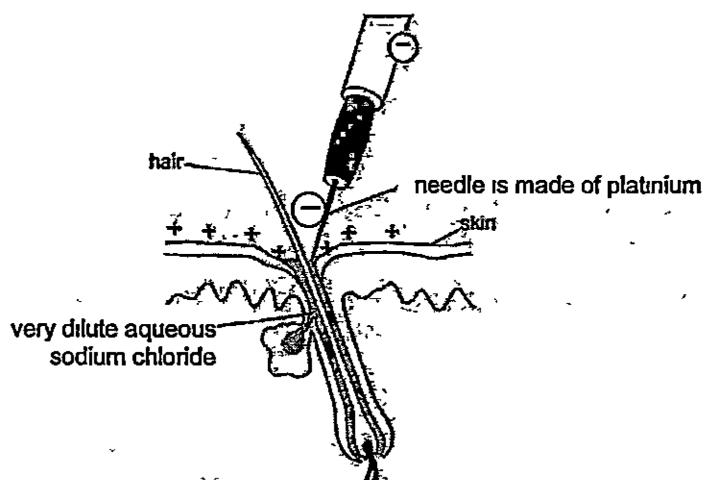
.... [2]

[Total: 10]

B10 Electrolysis can be used to remove unwanted hair. The customer holds a metal bar which acts as a positive electrode. A needle, which acts as the negative electrode, is held by the operator.



(a) The solution around the tip of the needle is very dilute aqueous sodium chloride.



(i) Explain why very dilute aqueous sodium chloride is used instead of pure water.

....

.... [1]

(ii) Give the formulae of all the ions present in very dilute aqueous sodium chloride during this electrolysis.

.... [1]

(iii) During electrolysis, a small amount of gas is formed at the surface of the skin.

Name the gas formed and write a half equation for the formation of gas.

....

.... [2]

(iv) During electrolysis, hydrogen gas is also formed at the tip of the negatively charged needle. The formation of gas caused the pH of the remaining solution to change.

Explain why the formation of the gas caused the pH of the remaining solution to change.

....

....

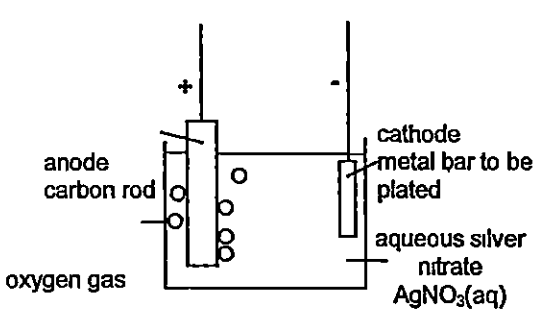
....

....

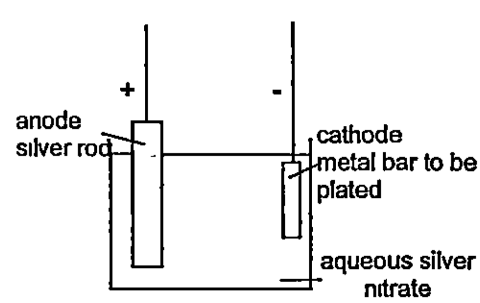
.... [2]

(b) During the hair removal by electrolysis, the metal bar held by the customer acts as an electrode.

Two different experiments are set up by a student to electroplate the metal bar used with silver to improve its appearance.



Experiment 1



Experiment 2

At the beginning of each experiment, a sample of the electrolyte, aqueous silver nitrate, is removed and placed in a test-tube. A few drops of aqueous sodium chloride are then added to the sample of electrolyte.

(i) Describe what the student sees in the test tube.

.... [1]

(ii) After some time, it is observed that when no more silver is being deposited on the metal bar in experiment 1, more silver is still being deposited on the metal bar in experiment 2.

Suggest a reason for this observation. Predict what the student will see if aqueous sodium chloride is added to the electrolyte in experiment 1.

....

....

....

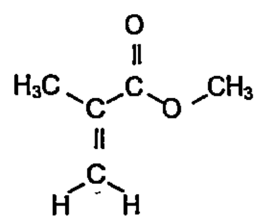
....

.... [3]

[Total: 10]

EITHER

B11 (a) **PMMA** is a member of a family of polymers known as acrylics It is a clear plastic and is often used as a shatterproof replacement for glass. It is formed from a single monomer, **methyl methacrylate,** that has the following structure:



(i) State the actual name of **PMMA**.

.... [1]

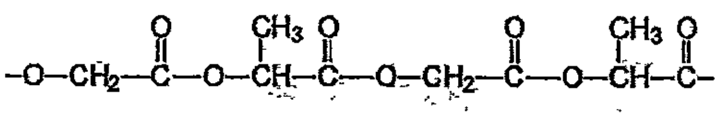
(ii) Draw the structure of **PMMA** with 3 repeat units.

[2]

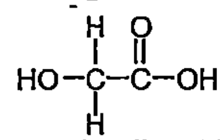
(iii) Name the reaction that is used to form **PMMA**.

.... [1]

(b) **PLGA** is another polymer which is used in manufacturing staples for closing surgical wounds. **PLGA** is synthesized by means of polymerisation of two different monomers, lactic acid and glycolic acid. Lactic acid and glycolic acid can be found in food.



PLGA



glycolic acid

(i) State the type of polymer the **PLGA** is classified as.

.... [1]

(ii) State the functional groups in the monomers that react to form **PLGA**.

.... [1]

(iii) Draw the full structural formula of lactic acid.

[1]

(iv) **Name** the reaction and **draw** the **full structural formula** of the molecule formed when glycolic acid is left in the air for a long period of time.

....

Full structural formula

[2]

(v) Name one advantage of using **PLGA**.

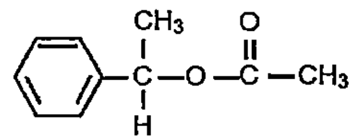
.... [1]

[Total: 10]

OR

B11 Perfumes usually contain three groups of compounds called the top note, the middle note and the end note

(a) Top notes consist of small, light molecules that evaporate quickly. An example of a top note compound is styrallyl acetate as shown below:



top note

(i) With reference to the structure of the compound, explain why it is likely to have a pleasant smell.

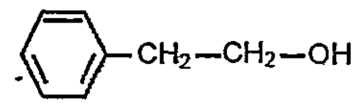
....

.... [1]

(ii) Draw the structural formula of the alcohol and carboxylic acid used to make styrallyl acetate.

[2]

(b) The middle note compounds form vapours less rapidly than the top note compounds. A typical compound of the middle note is 2-phenylethanol. The structure of 2-phenylethanol is shown below:



middle note

(i) Describe a chemical test which would distinguish between the top note and the middle note compounds

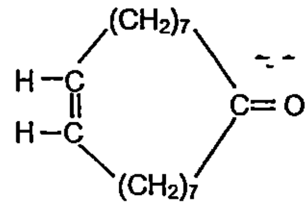
[2]

(ii) **Name** and **draw** the **full structural formula** of the molecule formed in the positive test in **(i)**.

Full structural formula

[2]

(c) The end note compound of a perfume has a long lasting odour which stays with the user. An example of an end note compound is shown below.



end note

(i) Explain why the end note compound is described as unsaturated.

....

.... [1]

(ii) The end note compound undergoes hydrogenation reaction.

State the conditions that are essential for the hydrogenation reaction.

....

.... [1]

(iii) Iodine reacts with unsaturated compounds. The iodine value is a measure of how unsaturated a compound is. It is based on the mass, in g, of iodine that reacts with 100 g of the compound.

The relative molecular mass of the end note compound is 250.

Calculate the iodine value for the end note compound.

[1]

[Total: 10]

MGIS

Answer for 2015 Chemistry Prelim Paper 1

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

METHODIST GIRLS' SCHOOL
SECONDARY FOUR PRELIM EXAMINATION (2015)

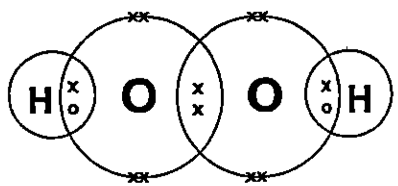
Answer Scheme

Section A

1	(a)	CF_3Cl	1
	(b)	NaCl	1
	(c)	$CuCO_3$	1
	(d)	CO_2	1
	(e)	$ZnSO_4$ / $MgSO_4$	1
2	(a)	Chlorine has a simple molecular structure/ exists as molecules There are weak intermolecular forces of attraction between the chlorine molecules hence little energy is needed to overcome these forces, thus the melting point of chlorine is low.	1 1
	(b)	Molten sodium chloride has mobile ions but the ions in solid sodium chloride are held in fixed positions, hence it cannot move to conduct electricity	1
	(c)	Sodium ions gain electrons to form sodium It is reduced Chloride ions lose electrons to form chlorine, it is oxidised Or The oxidation state of sodium increases from +1 in sodium to 0 in sodium The oxidation state of chlorine decreases from -1 in chloride ion to 0 in chlorine	1 1
3	(a)	CO is poisonous as it combines with the haemoglobin in the red blood cells to form carboxyhaemoglobin which prevents transport of oxygen to other parts of the body	1
	(b)	Stage 1. Sodium carbonate cannot be decomposed by heat as it is a very stable compound Stage 2: Sodium oxide cannot be reduced to by carbon Electricity is needed to break the strong ionic bonds between sodium ions and oxide ions OR Carbon is not reactive enough to break the strong ionic bonds in sodium oxide	1 1
	(c)(i)	Volcanic eruptions	1
	(c)(ii)	Flooding of low-lying areas as sea level rise due to melting ice caps OR Extreme changes in global climate The rise in temperature will cause more land areas to be infertile deserts, resulting in decrease in crop yields/food shortages/drought.	1 1
	(d)	Zinc is more reactive than iron in the steel Zinc loses electrons more easily than iron, thus it will corrode preferentially and protect iron	1 1
	(e)	Number of protons = 30 Number of neutrons = 35	1
4	(a)	A weak acid is a substance that when dissolves in water ionises partially to give hydrogen ions	1
	(b)	Use universal indicator Idea that the different colours indicate different pH values / match colour against a colour chart (Allow this mark even for an incorrect indicator)	1 1
	(c)	No of moles of sulfamic acid =0 105/97 = 0 001082 No of moles of KOH = 10 8/1000 x 0 1 = 0 00108 Thus, 1 mole of sulfamic acid reacts with 1 mole of KOH	1 1 1
	(d)(i)	$Mg + 2SO_3NH_3 \rightarrow Mg(SO_3NH_2)_2 + H_2$	1
	(d)(ii)	$CaCO_3 + 2SO_3NH_3 \rightarrow Ca(SO_3NH_2)_2 + H_2O + CO_2$ Bubbles of gas formed when sulfamic acid reacts with calcium carbonate	1 1
5	(a)(i)	Hydrogen burns in air to release a lot of heat energy/ Oxygen in the air will react with the heated iron to form iron oxide	1
	(a)(ii)	Volume of NH_3 formed if 100% conversion = 25 x 2 = 50cm^3 If only 15% converted, volume of NH_3 formed = 50 x 15/100 = 7 5cm^3	1 1
	(b)(i)	As pressure increases, the % yield of ammonia increases	1
	(b)(ii)	Advantage higher temperature, the rate of reaction will increase/faster Disadvantage: lower % yield of ammonia.	1 1
	(b)(iii)	Only a small amount is needed / can be recycled/ catalyst remained unchanged at the end of the reaction, hence can be recovered if used as catalyst.	1

6 (a) Movement: The particles in the liquid move and slide in and throughout each other while the particles in the gas move randomly and at high speed in all direction 1

Arrangement: The particles in the liquid are closely packed but arranged in a disorderly manner / irregular arrangement. The particles in the gas are far apart. 1



1

1

1m for correct covalent bond between H and O
1m for correct correctly shown valence electron in O

(c)

Test	Observation	Nature of hydrogen peroxide	
hydrogen peroxide is added to iron(II) sulfate	light green solution turns yellow	Oxidising agent	1
hydrogen peroxide is added to acidified potassium manganate (VII)	purple solution turns colourless	Reducing agent	1

7 (a) Enthalpy change of reaction = 2997 – 181 = – 2816 kJ/mol 1

Students need to give the negative sign, to be awarded the 1m

(b) Exothermic. 1
More energy is released to make the bonds in water and carbon dioxide than energy taken in to break the bonds in glucose and oxygen 1

(c) 1 mole contains 180g of glucose (which contains 2816 kJ energy) 1
1 g of glucose contains (2816/180) = 15.6kJ of energy 1

8 (a) Boiling point. 1

(b)(i) diesel oil, waxes and bitumen 1

(b)(ii) Lower in demand compared to percentage of supply. Hence the excess can be used for cracking to form petrol 1

(c)(i) $C_7H_{16} \rightarrow CH_4 + 3C_2H_4$ 1

(ii) Bubble the gases separately into aqueous bromine / bromine solution 1
Gas B turns reddish-brown aqueous bromine colourless whereas aqueous bromine remained reddish-brown when methane was bubbled into it. 1

Answer Scheme for Section B

B9 (a) As the concentration of the reagent increases, the rate of reaction also increases

Comparing experiment 2, 4 and 5, while keeping the concentration of aqueous chlorine dioxide the same, as the concentration of aqueous sodium hydroxide//hydroxide ion increases, the rate of disappearance of aqueous chlorine dioxide also increases.

Comparing experiment 1, 2 and 6, while keeping the concentration of aqueous sodium hydroxide /hydroxide ion the same, as the concentration of aqueous chlorine dioxide increases, the rate of disappearance of aqueous chlorine dioxide also increases

1m for stating the general trend
1m for comparing the correct experiment
1m for mention that keeping concentration of the other reagent the same

(b) When the concentration of aqueous chlorine dioxide or hydroxide ions increases, the number of aqueous chlorine dioxide particles or hydroxide ions per unit volume increases or the number of moles of aqueous chlorine dioxide particles or hydroxide ions per unit volume increases. — 1
This causes an increase in the frequency of effective collisions, hence, the rate of reaction also increases. — 1

(c) Comparing experiment 1 and 2, when the concentration of aqueous chlorine dioxide is doubled/twice, rate of disappearance increased by 4 times.

Comparing experiment 2 and 4 or (1 and 3), when the concentration of aqueous sodium hydroxide /hydroxide ion is doubled/twice, rate of disappearance increased by 2 times/ is doubled/twice.
Hence, I agreed with student 1
OR
Comparing experiment 2 and 5, when the concentration of aqueous chlorine dioxide is thrice, rate of disappearance increased by 9 times

Comparing experiment 2 and 6, when the concentration of aqueous sodium hydroxide /hydroxide ion is thrice, rate of disappearance increased by 3 times
Hence, I agreed with student 1.

1m for stating 2 pairs of experiment number.
1m for the working

(d) Rate of disappearance
= using expt 4 (0 040 mol/dm^3 of ClO_2 and 0.060 mol/dm^3 of OH^-)
multiply by 2
= 0 02208 x 2
=0 04416 mol/ dm^3 s — 1

(e) The oxidation state of chlorine increased from +4 in ClO_2 to +5 in ClO_3^-. — 1

The oxidation state of chlorine decreased from +4 in ClO_2 to +3 in ClO_2^-. — 1

[Total.10]

B10 (a) (i) Dilute aqueous sodium chloride contain mobile ions OR Pure water does not contain mobile charged particles. — 1

(ii) H^+, OH^-, Na^+, Cl^- — 1
(all correct: award 1 mark)

(iii) The gas is oxygen. — 1

$4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$ — 1

(iv) As more and more hydrogen ions are preferentially discharged to form hydrogen gas, concentration of hydrogen ions decreases — 1
OR
the remaining solution is sodium hydroxide
Hence, the pH of the solution will increase. — 1

(b) (i) White precipitate is observed — 1

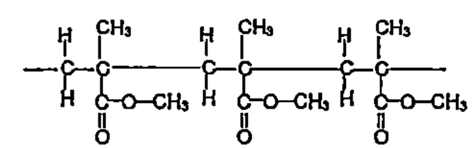
(ii) In experiment 1, all the silver ions in the electrolyte are completely discharged. — 1 In experiment 2, the silver in the anode will continue to oxidise and form silver ions which go into the solution. The silver ions will continue to be discharged at the cathode — 1
No white precipitate formed/ No visible change when aqueous sodium chloride is added — 1
OR
Silver in the anode in experiment 2 will oxidise to form silver ions which go into the solution (1m)
In experiment 1, the silver ions that discharged on the metal bar come from the silver nitrate solution only In experiment 2, while 1 mole of silver ions is discharged, 1 mole of silver ions will be replenished in the solution (1m)
No white precipitate formed/ No visible change when aqueous sodium chloride is added (1m)

[Total:10]

EITHER

B11 (a) (i) Polymethylmethacrylate — 1

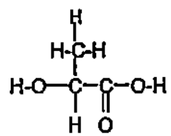
(ii) — 2



(iii) Addition polymerisation — 1

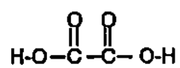
(b) (i) PLGA is a condensation polymer. — 1

(ii) ~~The monomers must have carboxyl and hydroxyl functional~~ groups (Both correct: award 1 m) — 1

(iii)  1

(iv) oxidation 1

1



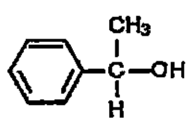
(v) PLGA is biodegrable 1

[Total 10]

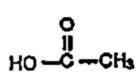
OR

B11 (a) (i) The compound consists of a functional group named ester 1

(ii) Alcohol

 1

Carboxylic acid

 1

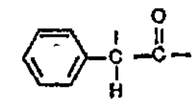
(b) (i) Add acidified potassium manganate(VII) solution to each sample of top note compound and middle note compound 1

If the acidified potassium manganate(VII) solution turned from purple to colourless, the sample is middle note. 1
If the acidified potassium manganate(VII) solution remained purple, the sample is top note.

OR
Add acidified potassium dichromate(VI) solution to each sample, if the solution turned from orange to green, the sample is middle note or if the solution remained green, the sample is top note.
1m for test, 1 m for the observation

~~(ii) 2-phenylethanoic acid 1~~

H

 1

(c) (i) The end note consists of carbon-carbon double bond 1

(ii) Temperature of 200°C and the catalyst used is nickel 1

(iii) 1 mol of end note reacts with 1 mol of iodine
No of mole of end note
$= \frac{100}{250}$
$= 0.4$
No of mole of iodine = 0.4
Mass of iodine
$= 0.4 \times 2 \times 127$
$= 102$
Iodine value is 102. 1

[Total 10]

Name Register Number: Class

For Marker's Use

南僑中學

NAN CHIAU HIGH SCHOOL

PRELIMINARY EXAMINATION 3 2015
SECONDARY FOUR EXPRESS

CHEMISTRY **5073/01**

Paper 1 Multiple Choice **16 Sep 2015, Wednesday**

1 hour

Candidates answer on the OTAS

INSTRUCTIONS TO CANDIDATES
Write your name, register number and class on the OTAS in the spaces provided and also in this question booklet.

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 OTAS

Read very carefully the instructions on the OTAS.

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 on the question paper

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

A copy of the Periodic Table is printed on page 13.

Setter: Mr Tien Chee Wai

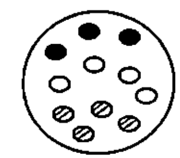
This paper consists of 13 printed pages including the coverpage.

1 The table below shows a list of elements and the symbols for their atoms.

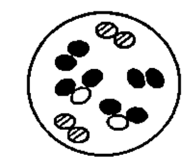
element	symbol for atom
hydrogen	●
oxygen	○
krypton	⊘

Which diagram best shows the arrangement of a mixture of hydrogen, steam and krypton gas in a balloon?

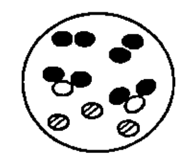
A



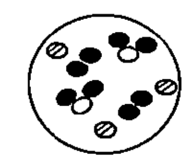
C



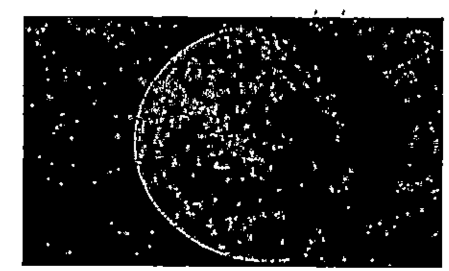
B



D

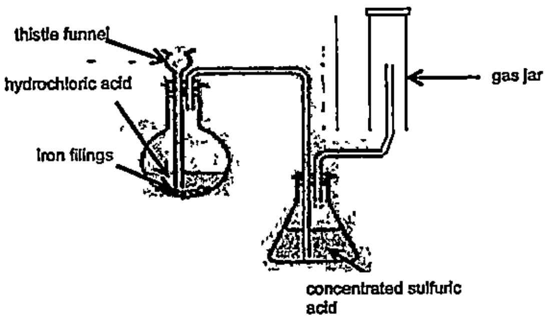


2 The sun-lit side of the planet Mercury has a temperature of 427°C. The dark or night side of the planet has a temperature of -180°C. Which substance may be found on one side of Mercury as a liquid and on the other side as a solid?



	substance	melting point/°C	boiling point/°C
A	oxygen	-219	-183
B	phosphorus	44	280
C	ethane	-183	-87
D	sulfur	115	445

3 The experimental set-up shown below is used to collect the gaseous product of the reaction between iron filings and dilute hydrochloric acid



Which of the following statements about the experimental set-up is incorrect?

A Concentrated sulfuric acid acts as the drying agent.
B The gas jar is inverted to collect a gas that is of low density.
C The iron filings can be replaced with magnesium to produce the same gas.
D It is not necessary to ensure that the end of the thistle funnel is immersed in the hydrochloric acid

4 Which of the following mixtures would be best separated using fractional distillation?

A butane and water
B butanol and water
C ethyl ethanoate and water
D barium carbonate and water

5 You are asked to separate a suspension of silver chloride in a solution of potassium chloride and ammonium chloride so as to obtain all three substances To do this, the following processes can be used: evaporation, filtration and sublimation. In which order should you carry out these processes?

A sublimation, filtration, evaporation
B sublimation, evaporation, filtration
C filtration, evaporation, sublimation
D filtration, sublimation, evaporation

6 The formulas of two substances are given as $Co(NO_3)_2$ and $Co(NO_3)_3$ Which statement is true?

A The two substances are mixtures of cobalt, nitrogen and oxygen.
B The elements are different in the two substances
C Both substances are compounds
D The percentage of cobalt is the same in both substances

7 In an experiment, a solid X is found to melt at 121^{0}C, the same temperature as the melting point of benzoic acid To check the identity of the solid, some of it is mixed with pure solid benzoic acid. The melting point of the mixture is found to be 115^{0}C. From this, it can be deduced that X is

A a mixture.
B a pure compound
C not benzoic acid.
D impure benzoic acid

8 An ion of element X has 22 electrons and a 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

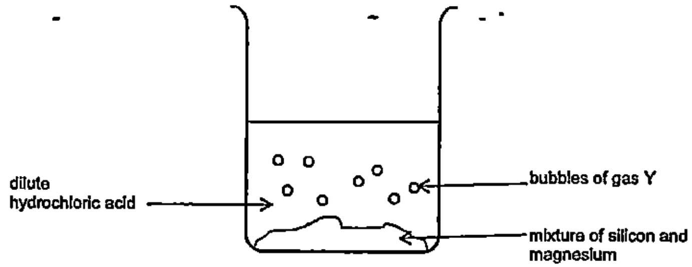
9 Selenium is a chemical element with symbol $^{79}_{34}Se$. It was discovered in 1817 and has an electronic configuration 2 8 18.6 What is the electronic configuration of the selenide ion?

A 2 8
B 2 8.18
C 2 8.18 8
D 2 8 18 2

10 Which one of the following is a compound consisting of small molecules?

A natural gas
B lithium
C heptane
D diamond

11 A mixture of silicon and magnesium was added to a beaker of excess dilute hydrochloric acid as shown in the diagram below At the end of the reaction, the mixture was filtered to obtain the silicon as residue.



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

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

12 The electronic structures of elements X and Y are
X: 2 8 18.18.8 2
Y. 2 8 6
What are the likely formula and type of bonds in the compound of X and Y?

	formula	bonds
A	XY_2	ionic
B	XY	covalent
C	XY	ionic
D	XY_2	covalent

13 How many oxygen atoms does 62 5g of hydrated copper(II) sulfate, $CuSO_4\ 5H_2O$, contain?

A 6 00 X 10^{23}
B 7 50 X 10^{23}
C 1.35 X 10^{24}
D 5 40 X 10^{24}

14 Tritium is an isotope of hydrogen with the symbol ${}^3_1T$ It reacts with oxygen to form a liquid called tritiated water, T_2O
What is the mass of tritiated water produced when 3g of tritium reacts with 16g of oxygen?

A 9g
B 11g
C 22g
D 44g

15 7 15g of hydrated sodium carbonate ($Na_2CO_3\ nH_2O$) were treated with excess nitric acid to produce 600 cm^3 of carbon dioxide measured at room conditions Calculate the value of n

A 4
B 6
C 8
D 10

16 If 24g of sulfur trioxide (SO_3) contains x atoms, how many atoms (in terms of x) are there in 2.4dm^3 of carbon dioxide (CO_2), measured at r t.p.?

A 0.25x
B 0 33x
C 0.50x
D 1 00x

17 There are two acids, hydrochloric acid and ethanoic acid, of the same concentration (both 1 00mol/dm^3) Which of the following is/are suitable methods to test their strength?

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

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

18 Which oxide can react with hydrochloric acid as well as with lithium hydroxide?

A calcium oxide
B iron(III) oxide
C lead(II) oxide
D sulfur dioxide

19 A mixture of magnesium bromide and magnesium sulfite is known to contain 3 moles of magnesium ions and 4 moles of bromide ions How many moles of sulfite ions are present?

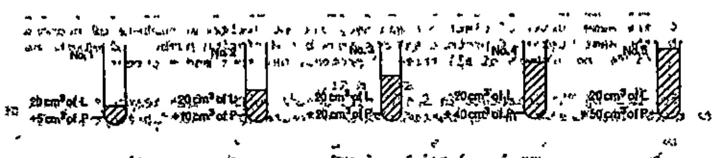
A 1
B 2
C 3
D 4

20 Tartaric acid is a dibasic acid and its salts are used in food The molecular formula of tartaric acid is $H_6C_4O_6$
What are the possible formulas of the salts formed by tartaric acid?

A $K_2H_4C_4O_6$ and $Al(H_3C_4O_6)_3$
B $FeH_3C_4O_6$ and $Li_2H_4C_4O_6$
C $BaH_4C_4O_6$ and $LiH_5C_4O_6$
D $NaH_5C_4O_6$ and $Na_2H_5C_4O_6$

21 When solutions of lead(II) nitrate and potassium iodide are mixed, lead(II) iodide is precipitated The equation for the reaction is as follows

$$Pb(NO_3)_2 + 2KI \longrightarrow PbI_2 + 2KNO_3$$



Different volumes of 1.0 mol/dm^3 aqueous potassium iodide (P) are added to the same volume of 0.5 mol/dm^3 aqueous lead(II) nitrate (L) in each of five test-tubes as shown above. When the precipitate settles, it is found that the amount of precipitate

A are the same in all five test-tubes
B increase stepwise from tube 1 to tube 5
C increase from tube 1 to tube 2, but are the same in tubes 2 to 5.
D increase from tube 1 to tube 3, but are the same in tubes 3 to 5

22 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	$H_2C_2O_4 \longrightarrow H_2O + CO + CO_2$
B	chlorine	$3ClO^- \longrightarrow ClO_3^- + 2Cl^-$
C	nitrogen	$H_2O + 2NO_2 \longrightarrow HNO_3 + HNO_2$
D	sulfur	$2FeSO_4 \longrightarrow Fe_2O_3 + SO_2 + SO_3$

23 In which of the following reactions does $Fe^{2+}(aq)$ act as a reducing agent?

A $Fe^{2+}(aq) + Mg(s) \longrightarrow Fe(s) + Mg^{2+}(aq)$
B $4Fe^{2+}(aq) + SO_3^{2-}(aq) + 6H^+(aq) \longrightarrow 4Fe^{3+}(aq) + S(s) + 3H_2O(l)$
C $Fe^{2+}(aq) + 2OH^-(aq) \longrightarrow Fe(OH)_2(s)$
D $Fe(s) + 2H^+(aq) \longrightarrow Fe^{2+}(aq) + H_2(g)$

24 Metal X is placed between zinc and iron in the reactivity series Which prediction can be made about metal X?

A Metal X displaces magnesium from an aqueous solution of a magnesium salt.
B Metal X reacts with dilute hydrochloric acid to produce oxygen
C Metal X forms a hydroxide which is insoluble in water.
D Metal X is extracted from its ores by electrolysis.

25 The table shows the results of adding weighed 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

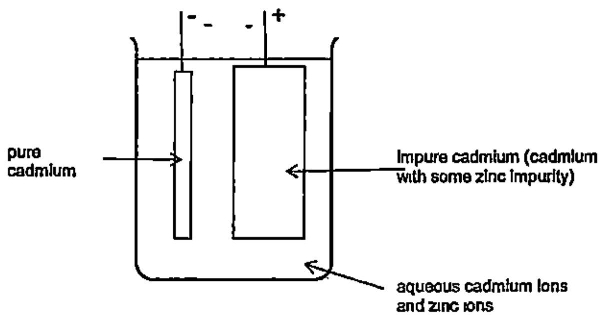
Which of the following shows the correct arrangement of metals in decreasing reactivity?

A P, R, zinc, Q
B R, P, zinc, Q
C Q, zinc, P, R
D Q, zinc, R, P

26 In an experiment, 6 moles of magnesium ions were discharged in the electrolysis of molten magnesium chloride Which amount of metal would be discharged by the same amount of electricity in the following experiments?

A 3 moles of copper(II) ions in the electrolysis of aqueous copper(II) sulfate
B 6 moles of zinc ions in the electrolysis of aqueous zinc chloride.
C 12 moles of calcium ions in the electrolysis of molten calcium fluoride.
D 12 moles of lithium ions in the electrolysis of molten lithium bromide

27 Cadmium is a metal used to make rechargeable batteries. The purification of cadmium by electrolysis is shown below. Cadmium and zinc form ions with the same electric charge



The following results were obtained from an investigation of this process

	mass of pure cadmium electrode/g	mass of impure cadmium electrode/g
at start of electrolysis	140	860
at end of electrolysis	700	260

The percentage of zinc in the impure cadmium is ________________

A 6 67%
B 16 3%
C 23 3%
D 93 3%

28 Carbon and silicon are in the same group of the Periodic Table Which of the following formulas is **incorrect**?

A $CaSiO_2$
B SiH_4
C $SiCl_4$
D $HSiCl_3$

29 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 is a coloured liquid at room temperature
B is the halogen with the weakest oxidizing power
C has the lowest melting point.
D is the most reactive halogen

30 Study the following equation·
$C_8H_{18} \longrightarrow C_5H_{12} + C_3H_6 \quad \Delta H = +110kJ$

Which of the following statements is correct?

A It is a substitution reaction
B The heat of combustion is 110kJ per mole of octane
C The cracking process takes in heat energy.
D The bond breaking process is exothermic

31 Methane reacts very slowly with air at room temperature But if a transition metal T is added to the methane-air mixture, the methane ignites The addition of T

I reduces the activation energy.
II increases the ΔH.
III increases the rate of reaction
IV reduces the energy of the reactants

A I and II only
B II and III only
C I and III only
D all of the above

32 Which of the following conditions will cause the highest rate of reaction between the dilute acids and zinc?

A 10g of zinc lumps and 50 cm^3 of 1mol/dm^3 HCl
B 10g of zinc powder and 50 cm^3 of 1mol/dm^3 HCl
C 10g of zinc lumps and 50 cm^3 of 0 5mol/dm^3 H_2SO_4
D 10g of zinc powder and 25 cm^3 of 1mol/dm^3 H_2SO_4

33 Potassium chlorate solution decomposes according to the equation shown:
$2KClO_3(aq) \longrightarrow 2KCl(aq) + 3O_2(g)$

If 50cm^3 of water is added to the potassium chlorate solution before the reaction begins, what effect will it have on the rate of the reaction and the volume of oxygen produced?

A Both the rate of reaction and the volume of oxygen produced will decrease.
B The rate of reaction will increase but the volume of oxygen produced will decrease
C The rate of reaction will decrease but the volume of oxygen produced will remain unchanged
D The rate of reaction will remain unchanged but the volume of oxygen produced will decrease.

34 Which fertilizer provides the most nitrogen per kg?

A NH_4NO_3
B $NaNO_3$
C $(NH_4)_3PO_4$
D $(NH_4)_2SO_4$

35 Air samples collected from the Central Expressway tunnels were analysed Which of the following substances are likely to be present in the air samples?

I CO
II C_8H_{18}
III NO_x
IV C_2H_4

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

36 When a mixture X consisting of C_5H_{12}, C_7H_{16}, $C_{10}H_{22}$ and $C_{16}H_{34}$ undergoes fractional distillation, the fraction that is collected at the highest in the column is richer in

A C_5H_{12}
B C_7H_{16}.
C $C_{10}H_{22}$
D $C_{16}H_{34}$.

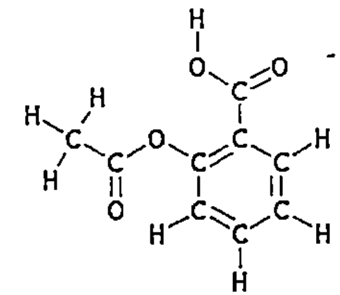
37 What is the total number of straight chain and branched chain isomers for the organic molecule pentene?

A 3
B 4
C 5
D 6

38 Which of the following statements about the alkyne series of hydrocarbons, C_nH_{2n-2} ($n\geq2$) is true?

A The hydrocarbons are saturated.
B The relative molecular masses of successive members in the series differ by 12.
C The boiling point of alkyne decreases as n increases
D Alkynes decolourise aqueous bromine rapidly.

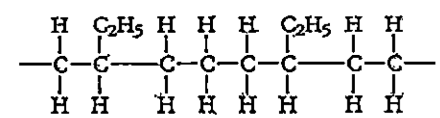
39 Aspirin is one of the most widely used pain relievers in the world It has the structure as shown



From the structure, we can deduce that aspinn

A will turn phenolphthalein pink.
B reacts with ethanoic acid to form an ester
C will produce carbon dioxide when reacted with a carbonate.
D is an unsaturated hydrocarbon

40 Part of a polymer is shown below Which pair of alkenes was used as monomers?



A ethene and propene
B propene and but-1-ene
C ethene and but-1-ene
D propene and but-2-ene

DATA SHEET

The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							H Hydrogen										He Helium
Li Lithium	Be Beryllium											B Boron	C Carbon	N Nitrogen	O Oxygen	F Fluorine	Ne Neon
Na Sodium	Mg Magnesium											Al Aluminium	Si Silicon	P Phosphorus	S Sulphur	Cl Chlorine	Ar Argon
K Potassium	Ca Calcium	Sc Scandium	Ti Titanium	V Vanadium	Cr Chromium	Mn Manganese	Fe Iron	Co Cobalt	Ni Nickel	Cu Copper	Zn Zinc	Ga Gallium	Ge Germanium	As Arsenic	Se Selenium	Br Bromine	Kr Krypton
Rb Rubidium	Sr Strontium	Y Yttrium	Zr Zirconium	Nb Niobium	Mo Molybdenum	Tc Technetium	Ru Ruthenium	Rh Rhodium	Pd Palladium	Ag Silver	Cd Cadmium	In Indium	Sn Tin	Sb Antimony	Te Tellurium	I Iodine	Xe Xenon
Cs Caesium	Ba Barium	La Lanthanum	Hf Hafnium	Ta Tantalum	W Tungsten	Re Rhenium	Os Osmium	Ir Iridium	Pt Platinum	Au Gold	Hg Mercury	Tl Thallium	Pb Lead	Bi Bismuth	Po Polonium	At Astatine	Rn Radon
Fr Francium	Ra Radium	Ac Actinium															

*58-71 Lanthanoid series

†90-103 Actinoid series

Ce Cerium	Pr Praseodymium	Nd Neodymium	Pm Promethium	Sm Samarium	Eu Europium	Gd Gadolinium	Tb Terbium	Dy Dysprosium	Ho Holmium	Er Erbium	Tm Thulium	Yb Ytterbium	Lu Lutetium
Th Thorium	Pa Protactinium	U Uranium	Np Neptunium	Pu Plutonium	Am Americium	Cm Curium	Bk Berkelium	Cf Californium	Es Einsteinium	Fm Fermium	Md Mendelevium	No Nobelium	Lr Lawrencium

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.)

Name: Register Number: Class:

For Marker's Use

南僑中學

NAN CHIAU HIGH SCHOOL

PRELIMINARY EXAMINATION 3 2015
SECONDARY FOUR EXPRESS

CHEMISTRY **5073/02**

PAPER 2 **14 Sep 2015, Monday**

1 hour 45 minutes

Additional Materials: Answer paper (4 sheets)

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number 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, glue or correction fluid.
The use of an approved scientific calculator is expected, where appropriate

Section A: Structured Questions [50 marks]
Answer all questions. Write your answers in the spaces provided on the question paper. All working 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. Start each question on a fresh piece of paper. Fasten your answers securely together.

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 periodic table is provided on page 14.

Setter: Mr J. Chua
Vetters: Mr Tien CW & Mrs Hay MH

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

Section A: Structured Questions [50m]
Answer all questions in this section in the spaces provided.

A1 Carbon has fifteen known isotopes ranging from carbon-8 to carbon-22.

a) Explain what is meant by isotopes. [1]

____

____

b) Complete the table below with the correct number of subatomic particles. [6]

Isotope	Number of protons	Number of electrons	Number of neutrons
${}^{8}_{6}C$			
${}^{12}_{6}C$			
${}^{14}_{6}C$			

c) Carbon-14 is formed in the upper layers of the atmosphere where a free moving nitrogen atom collides with a very energetic neutron in the reaction below, giving off a particle from its nucleus.

$${}^{14}N + n \longrightarrow {}^{14}C + \text{Particle } \mathbf{X}$$

i) Name particle **X**. [1]

____

ii) Name another particle that is formed in the upper layers of the atmosphere which is responsible for the destruction of the ozone layer. [1]

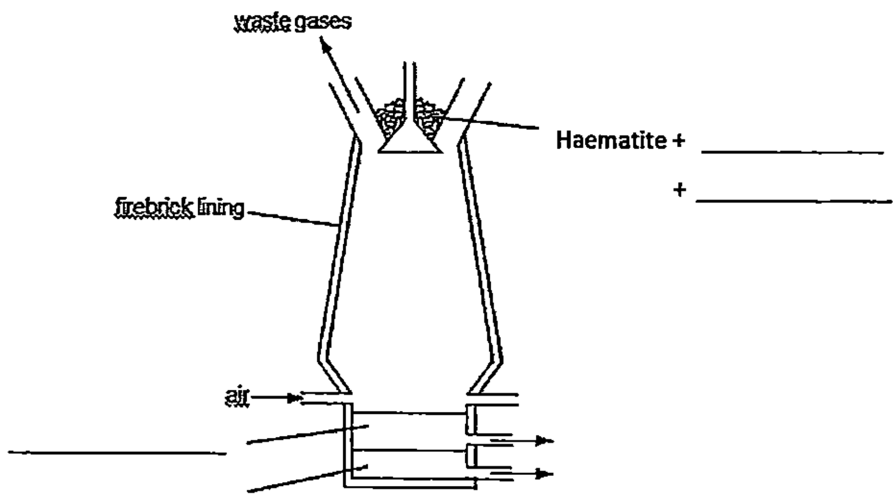
____

d) Due to carbon's special electronic configuration, it is able to form a wide variety of compounds, both organic and inorganic, with many other elements.

i) When carbon reacts with oxygen, an inorganic compound, carbon dioxide is formed. Draw a dot-and-cross diagram for carbon dioxide, showing only the valence electrons. [2]

ii) When methane undergoes substitution reaction with chlorine, dichloromethane is formed as one of the organic products. Draw a dot-and-cross diagram for dichloromethane, showing only the valence electrons. [2]

A2 Iron is extracted from haematite ore industrially in a blast furnace as shown below.



a) Fill in the blanks in the diagram above [4]

b) Write a balanced chemical equation with state symbols for the reduction of haematite by the gases in the blast furnace. [2]

____

c) Assuming a yield of 65%, calculate the mass of iron that can be extracted from 10 tonnes of haematite ore. [1 tonne = 1000 kg] [2]

d) Due to contamination of the ore with sulfur, sulfur dioxide is often formed and released into the atmosphere with the waste gases

i) Suggest one harmful effect on the environment by releasing large amount of sulfur dioxide into the atmosphere. [1]

____

____

ii) Name a process that can remove sulfur dioxide from the waste gases and write the chemical equation for the reaction. [2]

____

____

iii) Name one other possible air pollutant that can be present in the waste gases. [1]

____

e) Vibranium is a fictional metal that is used to make Captain America's shield. An excerpt below explains how vibranium makes the shield almost indestructible.

"Vibranium has the unique property to absorb all vibrations as well as kinetic energy directed at it. ***The energy absorbed is stored within the bonds between the molecules that make up the substance*** *.. Using the shield made of vibranium alloy, Captain America is able to cut through other metals ."*

i) State the wrong concept from the bolded sentence in the excerpt above and explain why it is incorrect. [2]

____

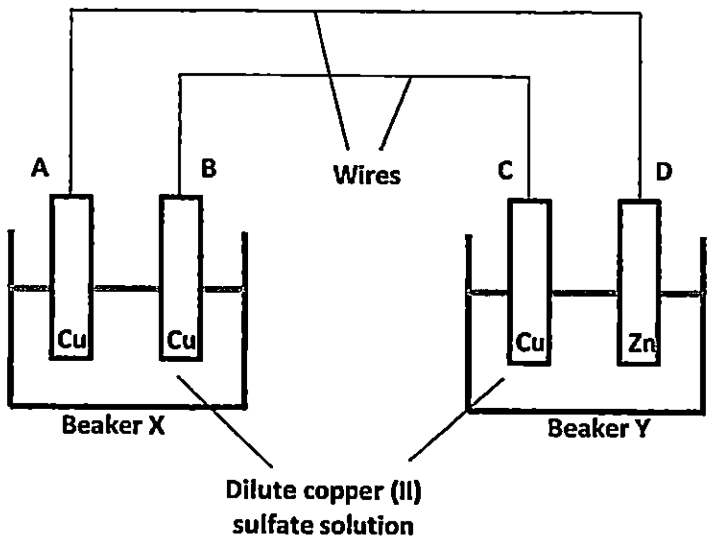
____

____

ii) Draw a well-labelled diagram of the likely structure of Vibranium. [3]

iii) Name an alloy that can also be used for the same function as Vibranium as mentioned in the excerpt. [1]

A3 Beaverina sets up the following circuit using different metals as electrodes in an investigation.



a) Suggest which beaker is functioning as the simple cell in the set-up above. [1]

---

b) Draw arrows on both wires to show the flow of electrons in the circuit above. [1]

c) Complete the table below to predict the observations made. [4]

Location	Observations
Electrode A	
Electrode B	
Electrolyte in X	
Electrolyte in Y	

d) Write the equation for the reaction occurring at electrode **B**. [1]

---

e) Predict one change to the observation made at electrode **A**, if any, when the zinc electrode is replaced by a magnesium electrode. [1]

A4 Sodium sulfite (Na_2SO_3) is often added to preserve food. The amount of sodium sulfite in a piece of meat can be determined through a series of tests shown below.

Step 1: Boil the meat with hydrochloric acid to form sodium chloride, water and sulfur dioxide.

Step 2: Collect gas produced and bubble it through 100 cm³ of water to dissolve sulfur dioxide.

Step 3: Titrate the solution obtained against iodine according to the following reaction.

$$SO_2\,(aq) + 2H_2O\,(l) + I_2\,(aq) \longrightarrow 4H^+\,(aq) + SO_4^{2-}\,(aq) + 2I^-\,(aq)$$

a) Write a balanced chemical equation for the reaction in Step 1. [1]

____

b) Describe a chemical test to determine if there is any sulfur dioxide present after the gas has been bubbled through water in Step 2. [2]

____

____

____

c) It was noted that 12.00 cm³ of 0.0250 mol/dm³ of iodine was required for complete reaction in the titration.

i) Calculate the volume of SO_2 produced in Step 2. [2]

ii) Explain, using oxidation states, why the titration in Step 3 involves a redox reaction. [2]

____

____

____

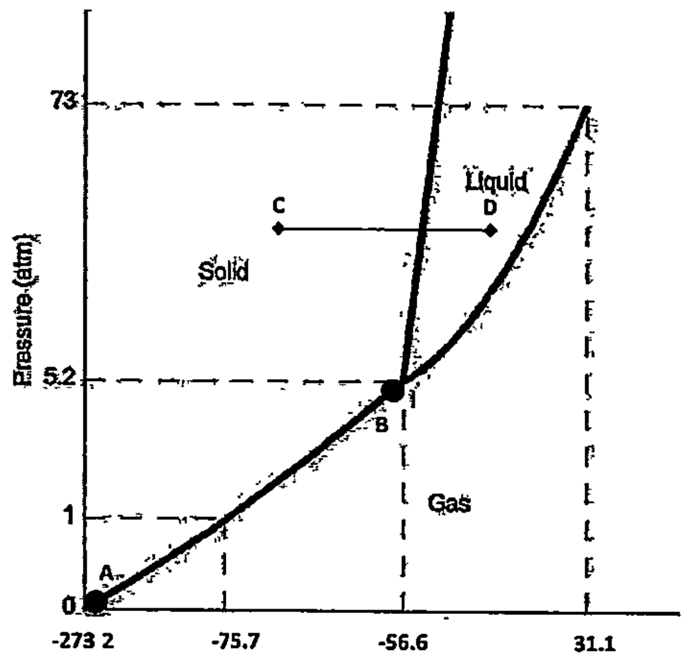
____

____

____

A5 Phase diagram is a chart which shows the physical states of a substance at various temperature and pressure. The chart is divided into regions where the substance exists as a solid, liquid or gas.

The bolded lines in the diagram that separate the regions are known as phase boundaries, where the substance changes from one state to another. Shown below is a phase diagram of carbon dioxide and some of its physical states at various pressure and temperature.



Pressure /atm	Temperature /°C	Physical state
1.0	30.0	Gas
5.0	-70.0	Solid
70	0.0	Liquid

a) Carbon dioxide is being stored under a pressure of 1 atm. Suggest the temperature that it should be kept at such that it is in a solid state. [1]

____

b) Name the physical process that occurs along the phase boundary from point **A** to point **B**. [1]

____

c) Using the idea of kinetic particle theory, state what happens to the arrangement and movement of the particles of carbon dioxide when it is heated from point **C** to **D** under constant pressure [2]

Section B: Essay Question [30m]
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.
*Begin each question on a **fresh page** with its question number clearly written.*

B6) Although solids of ionic compounds are generally known to be soluble in water, some ionic solids such as calcium hydroxide or silver sulfate are only sparingly soluble (soluble to a small extent) in water.

The solubility of ionic compounds depends on two factors.
- The forces of attraction between the water molecules and the ions of the solid.
- The forces of attraction between the cations and anions of the solid.

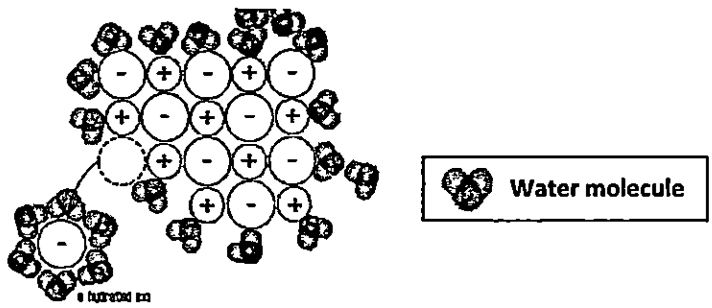


Fig 1: Dissolving of ionic compound in water

The solubility of sparingly soluble ionic compounds can be estimated from its solubility product, K_{sp}, which is a constant value that is only affected by temperature. The higher the K_{sp} value, the more soluble the compound will be.

The table below shows the K_{sp} values of some common ionic compounds.

Compound	Chemical Formula	K_{sp} (mol^2/dm^6) at 25°C
Barium sulfate	$BaSO_4$	1.0×10^{-10}
Calcium carbonate	$CaCO_3$	5.0×10^{-9}
Calcium sulfate	$CaSO_4$	2.0×10^{-5}
Silver chloride	$AgCl$	2.0×10^{-10}

Table 1

Predicting precipitation

The K_{sp} value can be used to predict whether precipitation of a certain compound will occur when two solutions are mixed together. The ionic product of the concentration of cations and anions present in the mixed solution is compared to the K_{sp} value. For instance,

$$BaSO_4 \rightleftharpoons Ba^{2+} + SO_4^{2-}$$

Ionic product = (Concentration of Ba^{2+} ions in solution) x (Concentration of SO_4^{2-} in solution)

Scenario	Outcome
Ionic product = K_{sp}	No precipitation. Solution is just saturated.
Ionic product < K_{sp}	No precipitation. Solution is not saturated.
Ionic product > K_{sp}	Precipitation is observed. Solution is already saturated.

Table 2

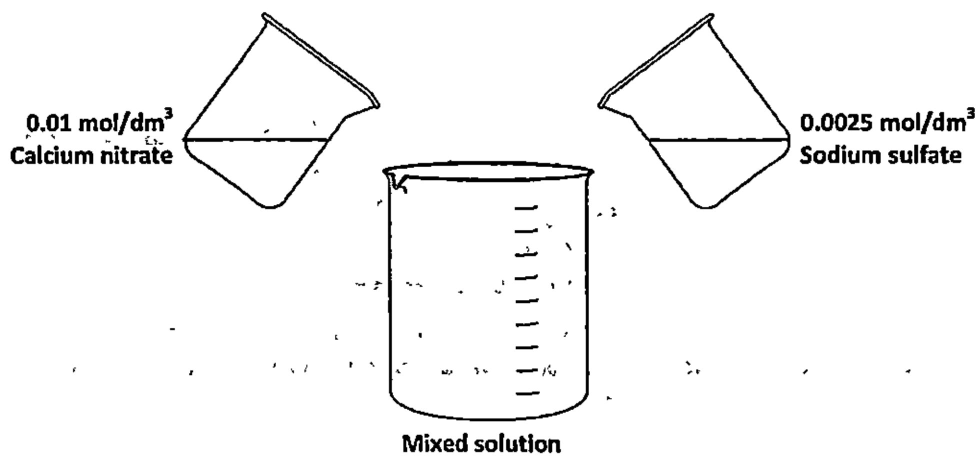
a) Using information from above, explain why sodium chloride is very soluble in water while silver chloride is only sparingly soluble. [2]

b) Predict the relationship between temperature and K_{sp} value of an ionic compound. [1]

c) State the least soluble compound found in **table 1**. [1]

d) Suggest the name of another ionic compound not present in **table 1** that has a very low K_{sp} value [1]

e) Michelle plans to add equal volume of 0.01 mol/dm^3 of calcium nitrate solution to 0.0025 mol/dm^3 of sodium sulfate solution to precipitate out calcium sulfate salt as shown in the diagram below.

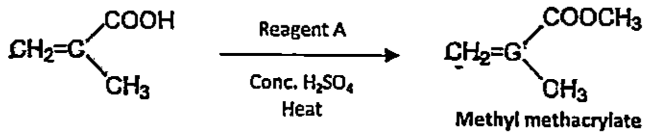


Determine, by calculation of ionic product in the mixed solution, and with reference to **table 1** and **2**, if precipitation of any compound will occur. [3]

f) Without further addition of any reagent, suggest two ways of increasing the amount of solid precipitated out from a saturated solution. [2]

B7) Perspex, also known as acrylic, is a transparent thermoplastic that is made from the polymerisation of a monomer, methyl methacrylate.

The process below shows part of the production process of methyl methacrylate.



a) Name reagent A. [1]

b) State the type of polymerisation that methyl methacrylate undergoes and the chemical name of perspex. [2]

c) Draw two repeating units in the polymer perspex. [2]

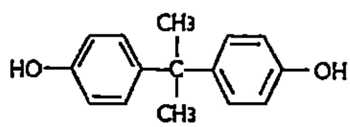
d) Aqueous bromine solution is added to perspex.

i) State the observation made. [1]

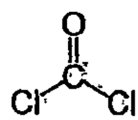
ii) State one conclusion, based on the observation in part di), about perspex. [2]

e) Another type of transparent thermoplastic, polycarbonates, is used to make spectacle lens due to its high strength and ability to block UV light.

Polycarbonate is formed by condensation polymerisation where small molecules of HCl are removed as the polymerisation takes place. The two monomers of polycarbonates are shown below.



BPA



Phosgene

Draw the structure of polycarbonate. [2]

f) State one difference between the polymerisation process of perspex and polycarbonate other than the elimination of small molecules in polycarbonate. [1]

EITHER

B8) The table shows the arrangement of elements made by John Newlands in 1886.

ROW						
1	H	F	Cl	Co, Ni	Br	___
2	Li	Na	K	Cu	Rb	___
3	Be	Mg	Ca	Zn	Sr	___
4	B	Al	Cr	Y		
5	C	Si	Ti	In		
6	N	P	Mn	As		
7	O	S	Fe	Sc		

a) The elements are arranged in vertical column according to their relative atomic masses. State how the elements are arranged in the modern Periodic Table. [1]

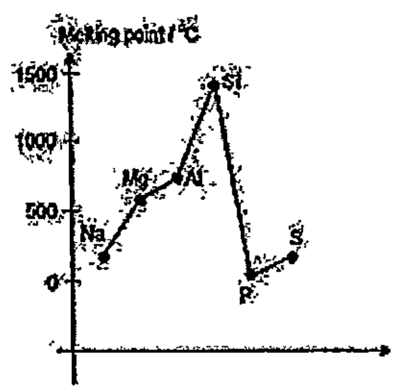
b) Based on the arrangement, determine the first three elements in the last column. List the elements in the order from the top to the bottom. [1]

c) With reference to the elements in the second horizontal row,

i) State which element is wrongly placed and what the new classification of that element in modern Periodic Table? [1]

ii) Explain your answer in part ci) using the chemical reaction of the elements with water. Write a suitable chemical equation to support your answer. [3]

d) The graph below shows the melting point of the elements in the second column of Newlands table with the exclusion of fluorine.

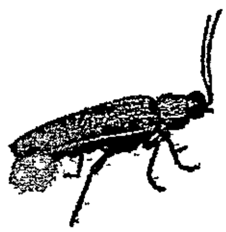


i) Explain why melting point increases from sodium to aluminium in the graph. [2]

ii) Even though silicon, phosphorus and sulfur are all covalent substances, silicon's melting point is far apart from that of phosphorus and sulfur. Explain why this is so. [2]

OR

B8) In the past 60 years, scientists have discovered that a chemical reaction between a naturally occurring chemical called luciferin, together with oxygen, calcium or magnesium, is responsible for the glowing of fireflies. The structural formula of a molecule of luciferin is shown below.



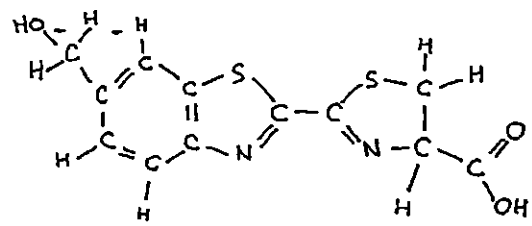


Fig 2: Structural formula of Luciferin

a) State the molecular formula of Luciferin. [1]

b) Calculate the percentage by mass of sulfur in a molecule of Luciferin. [1]

c) A series of chemical tests are performed on a sample of Luciferin.
(i) Suggest the observations for each of the test.
Test 1: Addition of acidified potassium dichromate (VI).
Test 2. Addition of aqueous sodium hydrogen carbonate. [2]
(ii) Draw the full structural formula of the organic product formed in test 1. [1]

d) It is often thought that the production of light by fireflies occurs via the following pathway catalysed by an enzyme luciferase.

$$\text{Luciferin} + O_2 \xrightarrow{\textit{Luciferase}} \text{Oxyluciferin} + CO_2 + \text{Light}$$

(i) State, with reasons, whether the oxidation of Luciferin is an exothermic or endothermic reaction. [1]
(ii) Define what is meant by an enzyme. [1]
(iii) Draw a well-labelled energy profile diagram for the oxidation of Luciferin, clearly showing the pathways for the catalysed and non-catalysed reactions. [3]

~~End of paper~~

☺ What in the world isn't Chemistry? ☺

The Periodic Table of the Elements

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

NCHS
Sec 4 Preliminary Examinations 3, 2015

Section A: MCQ (40 marks)

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

ANSWERS

Section A: Structured Questions [50m]
Answer all questions in this section in the spaces provided

A1

a) Isotopes are <u>atoms</u> of the <u>same element</u> with <u>different number of neutrons</u> but same number of protons [1]

b)

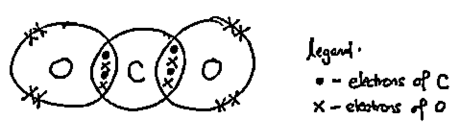
Isotope	Number of protons	Number of electrons	Number of neutrons
$^{8}_{6}C$	6	6	2
$^{12}_{6}C$	6	6	6
$^{14}_{6}C$	6	6	8

[2] for each isotope if all correct.
[1] if at least one correct

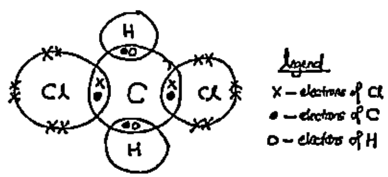
c)
i) Proton [1]

ii) Chlorine <u>atom/free radical</u> [1]

d)
i)

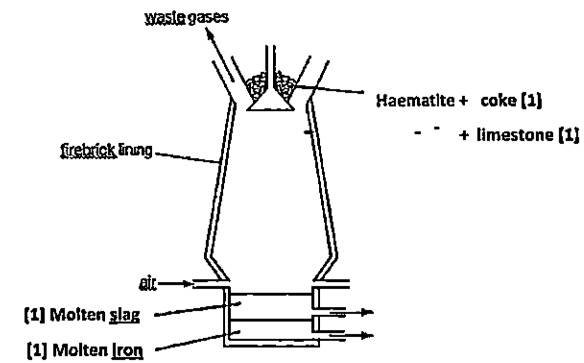


ii)



[1] for correct bonding electrons, [1] for correct non-bonding electrons

A2 a)



b) $Fe_2O_3\ (s) + 3\ CO\ (g) \rightarrow 2Fe\ (l) + 3\ CO_2\ (g)$
[1] for correct balanced equation
[1] for correct ss (not given if equation is wrong)

c) Mass of iron in 10 tonnes of haematite = 2 (56) / (2(56) + 3(16)) x 10
= 7.00 tonne [1]

Mass of iron extracted = 65/100 x 7.00
= 4.55 tonne (3sf) [1]

d)
i) Sulfur dioxide reacts with water vapour in the air to <u>form acid rain</u> [1]

ii) Flue gas desulfurization [1]

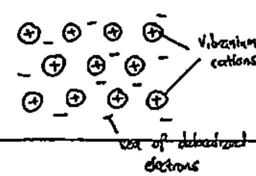
$SO_2 + CaCO_3 \rightarrow CaSO_3 + CO_2$ [1]
and/or
$SO_2 + CaO \rightarrow CaSO_3$

iii) Carbon monoxide / Nitrogen oxides [1]

e) i) Metals are <u>not made up of molecules</u> [1]

They are made up of <u>positive metal cations surrounded by a sea of free and mobile electrons</u>. [1]

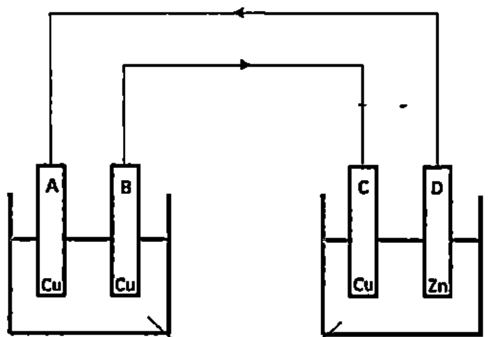
ii)



[1] for correct arrangement
[1] for balanced charges
[1] for labels

iv) High carbon steel / Manganese steel [1]

A3



a) Beaker Y [1]

b) Draw arrows on both wires to show the flow of electrons in the circuit above. [1]

c)

Location	Observations
Electrode A	The electrode grows larger in size [1]
Electrode B	The electrode grows smaller in size [1]
Electrolyte in X	The blue solution remains unchanged. / no change is observed. [1]
Electrolyte in Y	The blue solution fades to a lighter colour. [1]

d) $Cu \rightarrow Cu^{2+} + 2e^-$ [1]

e) Electrode A grows larger in size at a faster rate [1]

A4 a) $Na_2SO_3 + 2HCl \rightarrow 2NaCl + H_2O + SO_2$ [1]

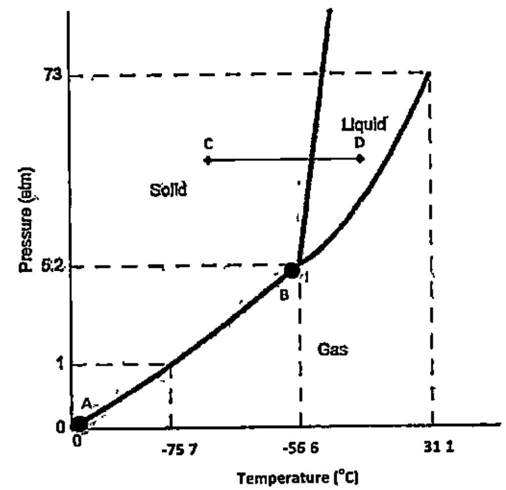
a) Test the remaining gas with a filter paper soaked in acidified $KMnO_4$. [1]

If purple $KMnO_4$ turns colourless, SO_2 is still present. If $KMnO_4$ remains purple, SO_2 is not present. [1]

c) i)
Mole of iodine reacted = 12/1000 x 0.0250 = 0.000300 mol [1]
Mole of SO_2 formed from step 2 = 0 000300 mol
Vol of SO_2 produced = 0 000300 x 24 = 0 00720 dm^3 [1]

ii) SO_2 is oxidized to SO_4^{2-} as the oxidation state of S increases from +4 to +6. [1]
I_2 is reduced to I^- as the oxidation state of I decreases from 0 to -1 [1]
Thus, this is a redox reaction

A5



b) Below -75 7°C. [1]

b) Sublimation/condensation/deposition. [1]

c) The particles of carbon dioxide are initially arranged very closely in an orderly manner, vibrating about fixed positions at point C. [1]

When it is heated to point D, the particles are now spaced slightly further apart in a disorderly manner, sliding past one another randomly. [1]

Section B Essay Question [30m]

B7) a) Water molecules attract the Na^+ and Cl^- ions much stronger than the attraction between the both ions. Hence, it is very soluble in water. [1]

However, the attraction between the Ag^+ and Cl ions are much stronger than the attraction between water molecules and the ions Hence, it is only sparingly soluble. [1]

b) The higher the temperature, the higher the K_{sp} values or vice versa [1]

c) Barium sulfate [1]

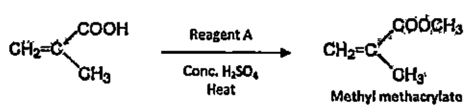
d) Lead (II) chloride/sulfate / All carbonates except SPA. [1]

e) Ionic product = $[Ca^{2+}]$ $[SO_4^{2-}]$ = (0 01/2) (0 0025/2) [1]
= $6\ 25 \times 10^{-6}$ mol^2/dm^6 [1]

Since ionic product is lesser than K_{sp}, there will be no precipitation. [1]

f) Evaporating the solvent to increase concentration of the ions present [1]
Lower temperature to lower K_{sp}. [1]

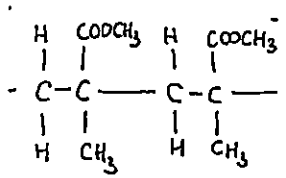
B8) Perspex, also known as acrylic, is a transparent thermoplastic that is made from the polymerisation of a monomer, methyl methacrylate
The process below shows part of the production process of methyl methacrylate



a) Methanol [1]

b) Addition polymerisation. [1]
Poly(methyl methacrylate) [1]

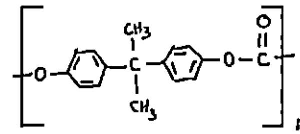
c)



[1] for correct structure
[1] for 2 repeating units

d) The red brown solution remains unchanged [1]
Perspex is a saturated organic molecule. [1]
(Hydrocarbon not accepted)

e)



[1] for correct structure
[1] for bracket and n

f) There is no mass loss in the polymerisation of Perspex while polycarbonate has a larger mass than the monomers used in the polymerisation. [1]
or
The types of monomers used in both polymerisation are different
or
The linkages formed between the monomers are different.

EITHER

B9) a) The elements are arranged according to the proton number / atomic number [1]

b) I, Cs, Ba. [1]

c) i) Cu. It is classified as a transition metal in the modern Periodic Table. [1]

ii) Cu does not react with cold water [1] while the rest of the elements in the row will react vigorously with cold water. [1]

2 Li + $2H_2O \rightarrow$ 2 LiOH + H_2 (Na, K or Rb all accepted) [1]

d)

i) The melting points increase from Na to Al as the charge of the metal cations increases [1] from +1 to +3,

causing the metallic bonds to be stronger, therefore requiring increasing amount of energy to overcome [1]

ii) Even though, they are all covalent substances, Si has a very high melting point due to strong covalent bonds between the Si atoms in the giant molecular structure, hence requiring large amount of energy required to overcome them [1]

The melting point drops sharply for P and S as they both have simple molecular structure where lesser amount of energy is required to overcome the weak van der Waal's forces between the molecules. [1]

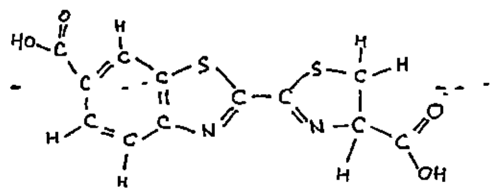
OR

B9) a) $C_{12}H_{10}N_2S_2O_3$ [1]

b) % mass of S = 2(32) / (144 + 10 + 28 + 64 + 48) x 100 = 21 8% (3sf) [1]

c) (i) Test 1: Acidified $K_2Cr_2O_7$ turns from orange to green. [1]
Test 2: Effervescence is observed. [1]

(ii)



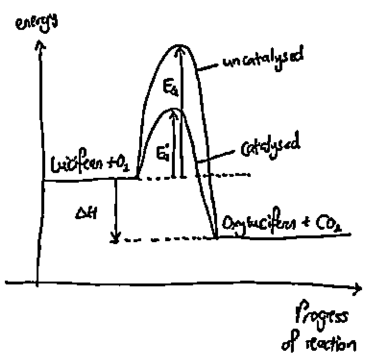
[1] for correct structure

d)

(i) The oxidation of Luciferin is an exothermic reaction Energy in the form of light is given off. [1]

(ii) An enzyme is a biological catalyst [1]

(iii)

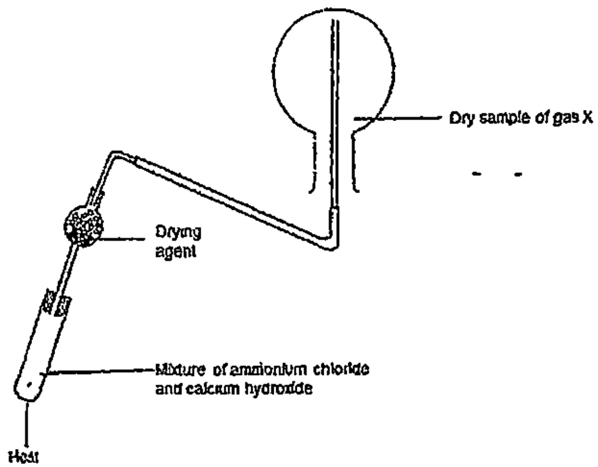


[1] for correct shape of graph (exo)
[1] for correct labels of axes, reactants and products
[1] for correct label of ΔH and E_a and E_a'

St. Nicholas Girls School

2015 Prelim ; Pure Chemistry 5073

1) A student set up the apparatus as shown below to collect a sample of clean, dry gas X. Predict the identity of gas X and identify a suitable drying agent to be used.



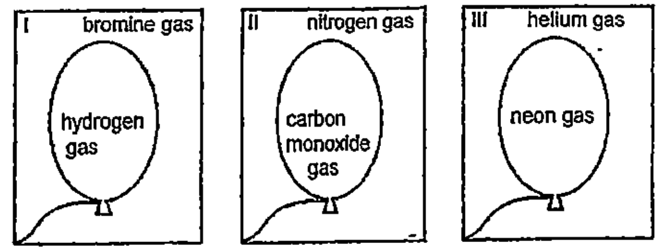
	Gas X	Drying agent
A)	Ammonia	Calcium oxide
B)	Ammonia	Concentrated sulfuric acid
C)	Hydrogen chloride	Calcium oxide
D)	Hydrogen chloride	Concentrated sulfuric acid

2) Compound X is soluble in hot water, but not in cold water while Compound Y is soluble in both hot and cold water Compound X has a boiling point of 2670 °C while compound Y has a boiling point of 1430 °C

Which is the most suitable method in obtaining a pure, dry sample of Compound X crystals from a hot solution of Compound X and Y?

A) Cool the mixture, filter, rinse and collect the residue.
B) Cool the mixture, filter and evaporate the filtrate.
C) Simple distillation of the mixture.
D) Heat the mixture to dryness.

5) The following diagram shows three similar set-ups where a balloon is trapped inside each plastic container



Which of the following shows the correct description of the balloon in each set-up after a short while?

	I	II	III
A)	deflates	remains the same	grows bigger
B)	grows bigger	remains the same	deflates
C)	remains the same	deflates	remains the same
D)	remains the same	grows bigger	remains the same

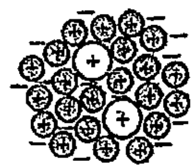
8) Some isotopes are unstable and decompose naturally. In one type of decomposition, a neutron in the nucleus decomposes to form a proton, which is retained in the nucleus, and an electron, which is expelled from the nucleus. Which change describes this type of decomposition?

A) $^{13}_{6}C \rightarrow ^{12}_{7}N$
B) $^{23}_{12}Mg \rightarrow ^{23}_{11}Na$
C) $^{81}_{36}Kr \rightarrow ^{80}_{36}Kr$
D) $^{131}_{53}I \rightarrow ^{131}_{54}Xe$

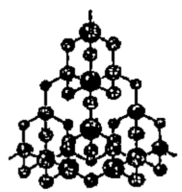
9) Which of the following shows the structure of bronze?

A)

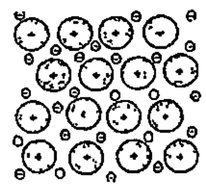
B)



C)



D)



10) Silicon carbide is a shiny, hard, chemically inert material with a very high melting point. It can be used to sharpen knives and make crucibles. Which type of structure explains these properties?

A) a giant structure with covalent bonds between carbon and silicon atoms
B) a giant structure containing metallic bonds
C) a giant structure with covalent bonds between atoms and van der Waals' forces between the layers of atoms
D) a simple molecular structure with covalent bonds between the carbon and silicon atoms

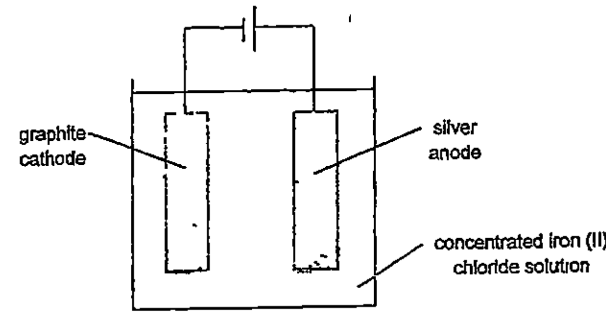
13) All of the following substances produce carbon dioxide upon complete combustion. Which one will produce 24.0 dm^3 of carbon dioxide gas when cooled to room temperature?

A) 11.5 g of ethanol (M_r = 46)
B) 15.0 g of ethane (M_r = 30)
C) 44.0 g of propane (M_r = 44)
D) 18.0 g of graphite (A_r = 12)

14) When 250 cm^3 of 3.00 mol/dm^3 dilute hydrochloric acid is added to 350 cm^3 of 2.00 mol/dm^3 dilute hydrochloric acid, what is the concentration of the resulting solution?

A) 1.45 mol/dm^3
B) 2.42 mol/dm^3
C) 2.50 mol/dm^3
D) 8.33 mol/dm^3

15) The diagram below shows the electrolysis of concentrated iron (II) chloride solution using a graphite cathode and a silver anode.



Which of the following statements about the electrolysis setup shown above are correct?

I A white precipitate was formed around the anode.
II Red litmus paper is bleached when it was dipped into the electrolyte beside the anode after some time.
III A gas was formed at both electrodes.
IV A dirty green precipitate may be formed after some time.

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

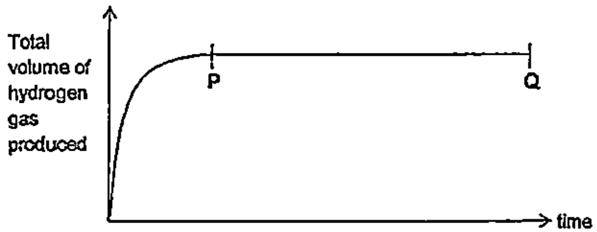
19) The scheme below shows how hexane is utilized as a fuel

$$C_6H_{14}(s) \xrightarrow{I} C_6H_{14}(l) \xrightarrow{II} C_6H_{14}(g) \xrightarrow{III} 6CO_2(g) + 7H_2O(g) \xrightarrow{IV} 6CO_2(g) + 7H_2O(l)$$

Which stages are exothermic?

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

20) The graph below shows how the total volume of hydrogen produced by the reaction between dilute nitric acid and an excess of calcium, varies with time.



Which of the following statements about section PQ of the curve is correct?

A) The reaction is continuing at a constant rate
B) The rate of production of hydrogen is at a maximum
C) All the calcium has reacted.
D) All dilute nitric acid has reacted.

24) Which statements about the reaction between 25 0 cm^3 of 0 1 mol/dm^3 hydrochloric acid and 50 0 cm^3 of 0 05 mol/dm^3 sodium hydroxide are true?

I The ionic equation of reaction is. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
II The temperature of the solution increases as hydrochloric acid is added.
III There is no change in the total mass of the reactants and products.
IV Pure dry sodium chloride crystals can be obtained by heating the mixture to dryness

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

25) What will be observed when a beaker of pure ethanoic acid dissolved in pure butanol is mixed with magnesium metal?

A) The mass of the set-up decrease slowly with effervescence observed The magnesium metal becomes smaller
B) The mass of the set-up decrease rapidly with effervescence observed. The magnesium metal disappears
C) The mass of the set-up increase slowly with white precipitate observed
D) The mass of the set-up remains the same with no visible reaction.

26) Which of the following mixtures below will result in the ionic equation shown?

$$Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4$$

A) aqueous lead(II) nitrate is added to dilute sulfuric acid
B) lead(II) chloride is added to aqueous sodium sulfate
C) lead(II) oxide is added to dilute sulfuric acid
D) lead(II) sulfate is added to water

29) A part of the Periodic Table is shown below

				Group				
	I	II	III	IV	V	VI	VII	0
Period 1								R
2	S			T			U	
3							V	

Which of the following statements is correct?

A) The valence shell of an atom of R has an octet structure
B) The metallic character of the Period 2 elements increases from S to U
C) T forms an ionic compound with U
D) U is a stronger oxidising agent than V.

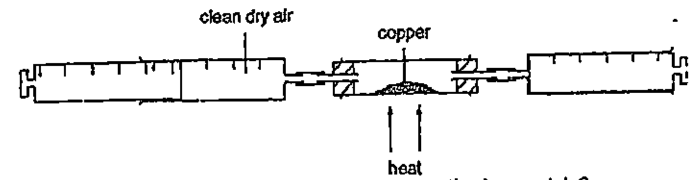
30) A metal is between magnesium and aluminium in the reactivity series How can the metal be extracted?

A) Reduction of its oxide using carbon.
B) Electrolysis of its salt solution
C) Reduction of its oxide using aluminium.
D) Electrolysis of its molten compound

31) Which of the following reaction takes place in the blast furnace for the extraction of iron from haematite?

A) $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$
B) $SiO_2 + CaO \rightarrow CaSiO_3$
C) $2CO + FeSiO_4 \rightarrow 2Fe + SiO_2 + 2CO_2$
D) $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$

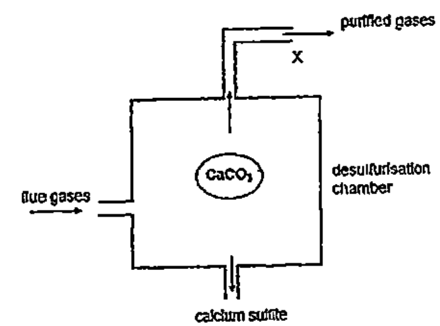
34) A 240 cm^3 sample of clean, dry air is passed over hot excess copper at room temperature and pressure until there is no further change in volume. The pink copper metal turns black.



What is the mass of the black solid formed when the reaction is complete?

A) 0.16 g
B) 0.32 g
C) 0.80 g
D) 1.60 g

35) The diagram below shows a simplified process of desulfurisation



Which of the observation at outlet X best describes the nature of the gases exiting?

A) The gases turned moist red litmus paper blue
B) The gases turned acidified potassium manganate(VII) purple.
C) The gases turned acidified potassium iodide brown
D) The gases formed a white precipitate in limewater.

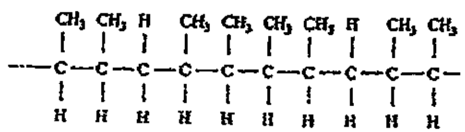
39) The reaction between a hydrocarbon C_xH_{10} and chlorine can be represented as follows

$$C_xH_{10}\,(g) + 2Cl_2\,(g) \rightarrow C_xH_8Cl_2\,(g) + 2HCl\,(g)$$

Which of the following is a correct statement?

A) It is an addition reaction
B) The molecular formula of the hydrocarbon is C_5H_{10}
C) Ultraviolet light is an essential condition for the reaction to take place
D) High temperature, high pressure and a catalyst are required in the reaction

40) When two different types of monomers are joined in the same polymer chain, a copolymer can be formed Part of a copolymer is shown below



What are the two monomers used to produce the copolymer?

A) pent-2-ene and but-1-ene
B) pent-2-ene and but-2-ene
C) propene and but-1-ene
D) propene and but-2-ene

~ End of Paper ~

St. Nicholas Girls Sch Paper-2

Section A

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

The total mark for this section is 50.

A1 The following table shows the properties of pure substances *Q* to *T*.

Substance	Melting point / °C	Boiling point / °C	Solubility in water
Q	–114	78	Very soluble
R	801	1413	Very soluble
S	–74	99	Insoluble
T	Changes from solid to gas at 114°C		Slightly soluble

(a) Name the most suitable method that can be used to obtain

(i) water from an aqueous solution of *R*. [1]

....

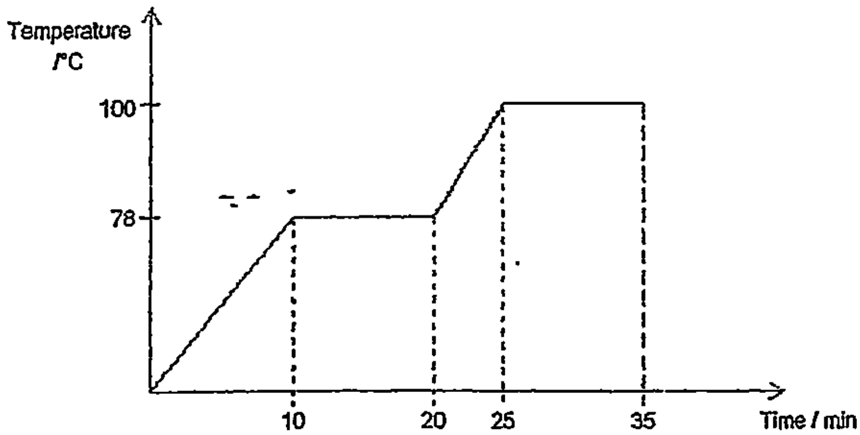
(ii) *S* from a mixture of water and *S*. [1]

....

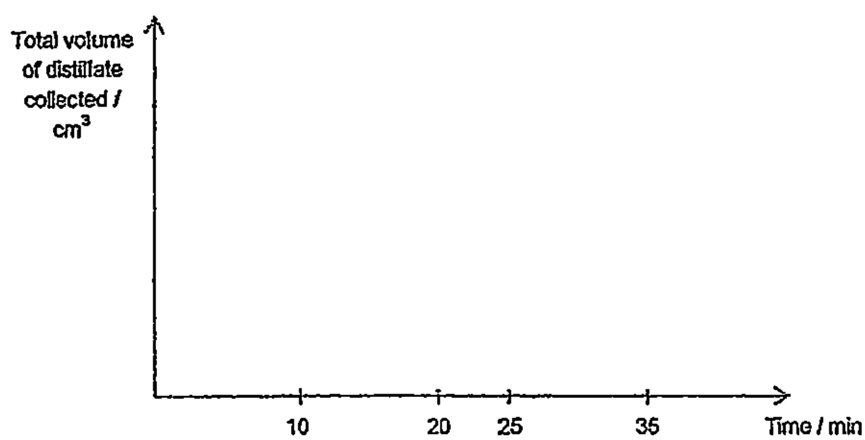
(iii) solid *T* from a mixture of solid *R* and solid *T*. [1]

....

(b) 100 cm^3 of a mixture containing 60% by volume of water and 40% by volume of Q is separated by fractional distillation. The graph below shows the temperature change during the process of separation. [2]



In the axes below, sketch a graph to show how the total volume of distillate collected changes over time Indicate clearly the volume of water and Q that could be obtained.



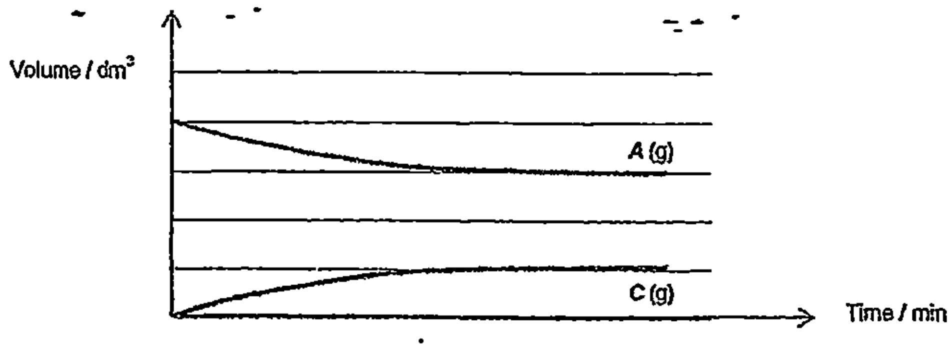
[Total: 5 marks]

A2 The reaction between substances *A* and *B* produces substances *C* and *D* according to the following equation.

$$A\ (g) + 2B\ (g) \rightarrow C\ (g) + 3D\ (g) \qquad \Delta H = +x \text{ kJ/mol}$$

Some *A* and *B* are placed in a closed container and allowed to react at a fixed temperature

The following graph shows how the volumes of *A* and *C* change as the reaction progresses.



(a) (i) On the graph above, sketch a line to show how the volume of *C* changes as the reaction progresses if a catalyst was added. Label this line "(ai)". [1]

(ii) Explain, in terms of collision of particles, your answer in part (ai). [2]

....

....

....

....

(iii) State what happens to the value of the enthalpy change of the reaction if a catalyst was added. [1]

....

(iv) On the graph above, sketch a line to show how the volume of *D* changes as the reaction progresses. Label this line "(aiv)". [1]

(b) (i) Explain, in terms of bond breaking and bond forming, why the enthalpy change for the above reaction is positive. [3]

....

....

....

....

(ii) In the space below, sketch a fully labelled energy profile diagram for the above reaction. [3]

[Total: 11 marks]

A3 A car manufacturer wants to fit the most environmentally friendly engine into their new car model. They considered two different types of engines, one normal and one known as a "lean burn" engine which has a lower working temperature. They also made modifications to both types of engines, thus coming up with four different types of engines and tested all four of them out. The table below shows the percentage composition of exhaust gases emitted from cars fitted with the four different engines.

	Normal engine	Normal engine with "modification"	"Lean burn" engine	"Lean burn" engine with "modification"
Carbon dioxide	14	15	16	18
Oxygen	0.7	0	0 5	0
Carbon monoxide	4.5	0.3	0.2	0.03
Nitrogen oxides	0.3	0.04	0.05	0.01
Hydrocarbons	0.12	0.03	0.09	0.01

(a) Name the major component of the exhaust gases that is not listed in the table above. [1]

....

(b) Using the data given, suggest what "modification" has been made to both the normal and "lean burn" engines. [1]

....

(c) Suggest why there is a drop in the percentages of nitrogen oxides from the normal engine to the "lean burn" engine. [1]

....

....

(d) Explain why carbon monoxide is produced in the car engines. [1]

....

....

(e) Write the balanced chemical equation of a reaction that takes place in the engine with "modification" that leads to a lower emission of both carbon monoxide and nitrogen oxides. [1]

....

(f) Nitrogen monoxide can easily be oxidised to nitrogen dioxide. State an effect on the environment if nitrogen dioxide is allowed to escape into the atmosphere. [2]

....

....

....

[Total: 7 marks]

A4 Ozone is usually made by passing oxygen gas through a tube between two highly charged electrical plates.

$$3O_2 (g) \rightarrow 2O_3 (g)$$

The reaction is stopped before it can go to completion, so a mixture of the two gases results.

The concentration of O_3 in the mixture can be determined by its reaction with aqueous KI.

$$O_3 + 2KI + H_2O \rightarrow I_2 + O_2 + 2KOH$$

The iodine formed can be estimated by its reaction with sodium thiosulfate.

$$2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$$

When 192 cm^3 of a mixture of oxygen and ozone gas at r.t.p was passed into an excess of aqueous KI, iodine was formed. The iodine formed was titrated with 80 cm^3 of 0.1 mol/dm^3 $Na_2S_2O_3$.

(a) (i) Calculate the number of moles of iodine produced from the reaction with aqueous potassium iodide. [2]

(ii) Calculate the volume of ozone present in the 192 cm^3 mixture [1]

(iii) Hence, calculate the volume of unreacted oxygen. [1]

(b) Using the oxidation state of sulfur, explain whether sodium thiosulfate is [2]
reduced or oxidised.

....

....

....

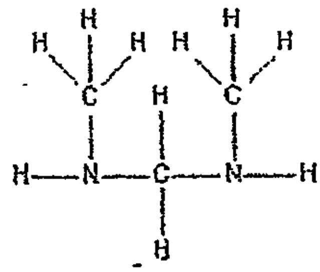
[Total: 6 marks]

A5 This question is about the condensation reactions of some organic substances

(a) (i) Substance **A** contains 40.7% by mass of carbon, 5.1% by mass of hydrogen and 54.2% by mass of oxygen. Find the empirical formula of substance **A**. [2]

(ii) When completely combusted, 1 mole of substance **A** forms 4 moles of carbon dioxide. From this information and your answer in **part (ai)**, find the molecular formula of substance A. [1]

(iii) 1 mole of substance A reacts completely with 1 mole of sodium carbonate to produce carbon dioxide gas. Substance A also reacts with N,N'-dimethylmethanediamine to form a condensation polymer. [2]

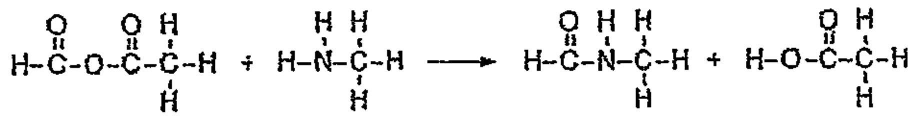


N,N'-dimethylmethanediamine

From this information and your answer in **part (aii)**, draw the full structural formula of substance A.

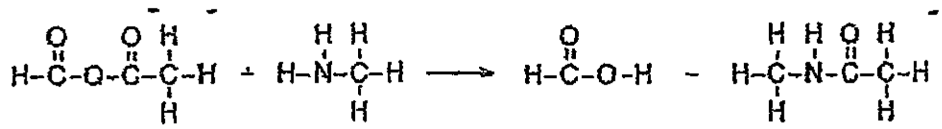
Draw 1 repeating unit of the condensation polymer formed between substance A and N,N'-dimethylmethanediamine.

(b) Acid anhydrides can also react with amines to form amides. The reaction between an acid anhydride and an amine gives all the 4 products as shown below. [2]



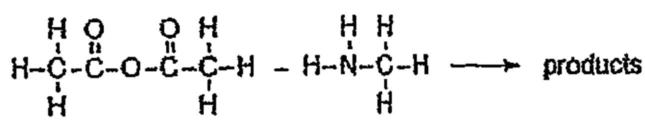
acid anhydride *amine*

AND

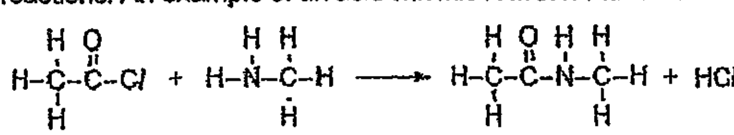


acid anhydride *amine*

Draw the full structural formula of all the possible products for the reaction below.



(c) Lastly, acid chlorides can also react with amines to form amides via condensation reactions. An example of an acid chloride reaction with an amine is shown below. [2]



The products are dissolved in dichloromethane, an organic solvent. A student decided to add dry blue litmus paper to the mixture obtained. Predict the observation that the student should see and explain your answer.

....

....

....

[Total: 9 marks]

A6 A student wants to conduct tests to identify some unknown samples but some chemicals are missing from the laboratory.

(a) The student has three samples containing calcium, zinc and lead(II) ions. However, she does not have any alkalis to test for the ions. Describe how the student can differentiate between the three samples, including any observations that she is expected to see [4]

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(b) (i) The student decides to address the lack of alkalis in the laboratory by synthesising calcium oxide in two steps, which can subsequently be added to water to form calcium hydroxide. In the first step, describe how the student can synthesise a pure dry sample of calcium carbonate starting from sodium carbonate and calcium chloride. [3]

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(ii) In the second step, describe how the student can obtain a pure sample of calcium oxide from the calcium carbonate obtained in part (bi). [1]

....

....

(iii) Give a reason why the student cannot form sodium oxide using a similar method in **part (bii)**. Explain your answer. [2]

....

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....

(iv) After forming the calcium oxide in **part (bii)**, the student added water to form calcium hydroxide. Since potassium manganate(VII) is also missing from the laboratory, the student decided to use calcium hydroxde to test for sulfur dioxde. Write the chemical equation for this reaction. [1]

....

(v) State the type of reaction that is occurring in **part (biv)**. [1]

....

[Total: 12 marks]

Section B

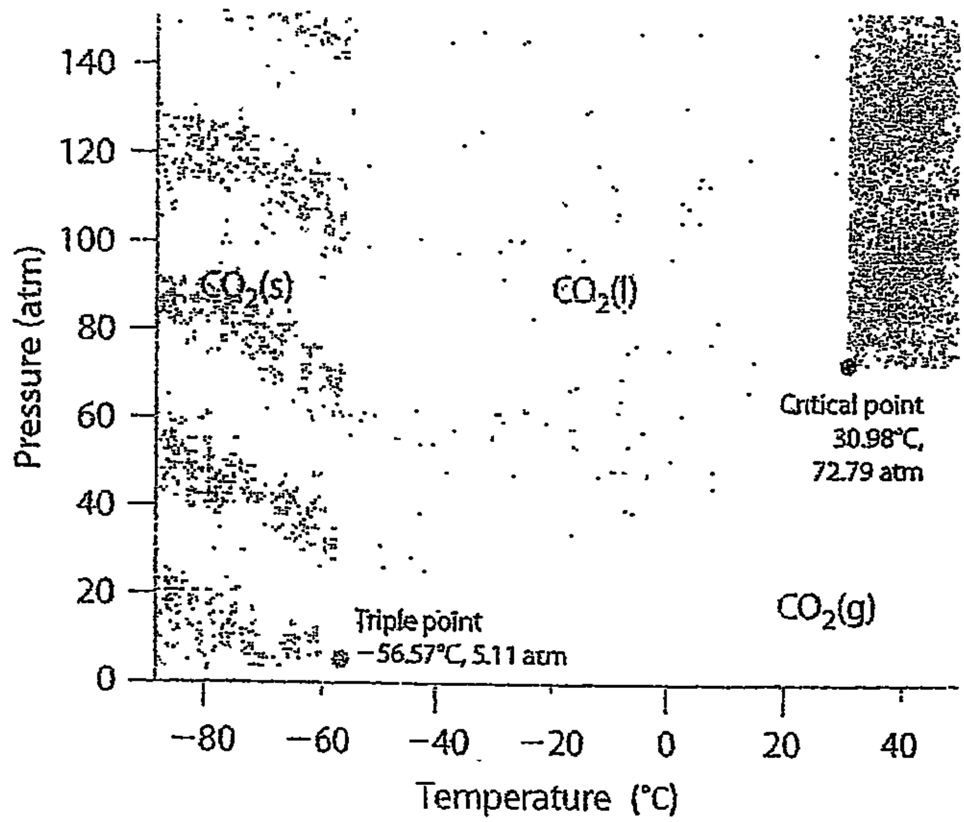
Answer all three questions from this section

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

Write your answers in the spaces provided.

The total mark for this section is 30.

B7 A phase diagram is a graphical representation of the physical states of a substance under different temperatures and pressures. The curves represent the temperature and pressure at which 2 states of the substance can coexist. As we cross the curves on the phase diagram, a change in state occurs. The triple point represents the temperature and pressure at which all 3 states of the substance coexist. The phase diagram of carbon dioxide is shown below.



(a) (i) Estimate the temperature at which liquid carbon dioxide changes to a gas at a pressure of 40 atm. [1]

....

(ii) Estimate the melting point of solid carbon dioxide on a planet *X* where the pressure is 80 atm. [1]

....

(iii) Describe how the arrangement and movement of the carbon dioxide molecules change as its pressure increases from 1 atm to 20 atm at – 60°C. [2]

....

....

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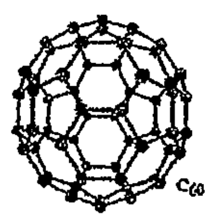
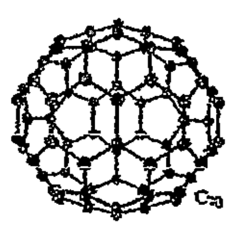
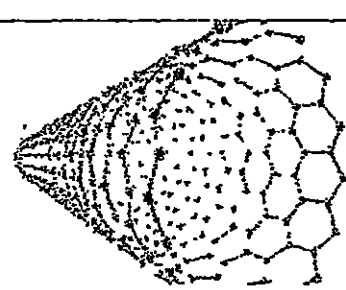
....

(iv) Canisters of carbon dioxide are to be stored and transported in the liquid state at 20°C. Estimate the minimum pressure it has to be stored at. [1]

....

(b) Carbon is an element found in Group IV of the Periodic Table, and can exist in different forms such as graphite or diamond. Other forms of carbon include C_{60}, C_{70} and the carbon nanotube. The structures and melting points of these three other forms of carbon are shown below.

	Structure	Melting point / °C
C_{60}		280
C_{70}		?
Carbon nanotube		3652 – 3697

(i) Based on the information given on the previous page, predict the type of structure that C_{60} has. Explain your answer in terms of bonding and structure. [2]

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(ii) Will C_{70} have a higher, lower or the same melting point as C_{60}? Explain your answer in terms of bonding and structure [2]

....

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(iii) State and explain, in terms of bonding and structure, the electrical conductivity of the carbon nanotube. [3]

....

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[Total: 12 marks]

B8 A mixture of molten sodium bromide and sodium iodide is electrolysed.

(a) (i) Describe what you will expect to see at the anode initially and after the electrolysis is carried out for a long time. [2]

....

....

(ii) Explain your answer in part (ai). [2]

....

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....

(b) Write a half ionic equation, with state symbols, for the reaction occurring at the cathode. [2]

....

(c) Describe the observations that you expect if the metal formed from the electrolysis is added to water. [2]

....

....

[Total: 8 marks]

B9 EITHER

Ethene is a useful molecule that can be used to synthesise many other compounds in the chemical industry.

(a) State the reaction by which ethene can be formed from a long-chain hydrocarbon [1]

....

(b) Propyl ethanoate is a molecule that can be formed from ethene. Describe the formation of propyl ethanoate from ethene, stating the reactants and conditions as well as the products formed in each step. You may show your answer in the form of a diagram. [5]

(c) Ethene can also be polymerised to formed poly(ethene). Describe how ethene can be distinguished from poly(ethene) [2]

....

....

(d) "Poly(propene) will always have a higher melting point than poly(ethene) as the relative molecular mass of the monomer in poly(propene) is larger." [2]
Do you agree with the above statement? Explain your answer.

....

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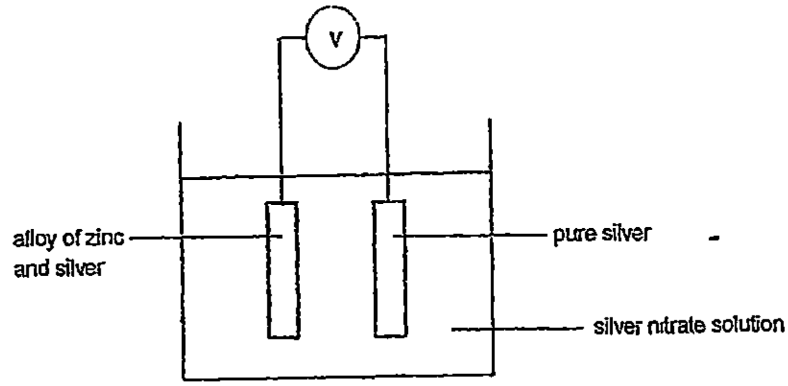
....

[Total: 10 marks]

B9 OR

A student wants to find out mass of zinc in an alloy of zinc and silver. The set-up is shown below.



(a) (i) Write half ionic equations for the reactions occurring at the anode and cathode. [2]

(ii) The experiment is carried out until the current in the circuit stops. If the mass of the pure silver electrode increases by 0.10 g when the current stops, calculate the mass of zinc in the alloy. [2]

(iii) Explain clearly why the mass of zinc calculated is lower than expected. [2]

(b) Suggest another method, other than the setup shown in part (a) above, the student could use to find out the mass of zinc in the alloy. Name the reagent(s) used, state all important steps that should be taken, and write balanced equations for any chemical reactions that take place. [4]

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[Total: 10 marks]

~ End of Paper ~

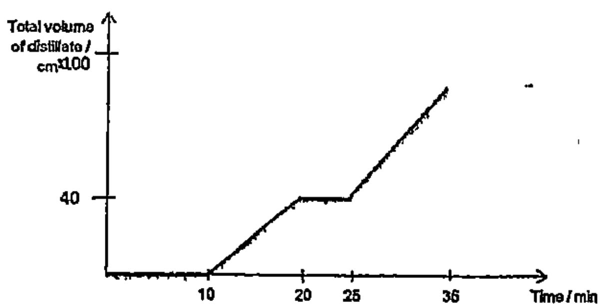
St. Nicholas Girls' Sch

2015 Sec 4 Chemistry Prelim Paper

Paper 1

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

Paper 2

A1	a	(i) simple distillation	[1]
		(ii) separating funnel	[1]
		(iii) sublimation	[1]
	b		[2]
A2	a	(i) faster than original graph but same volume formed	[1]
		(ii) A catalyst provides an alternative pathway with lower activation energy More particles have energy higher than or equal to Ea Higher frequency/ of effective collisions Faster rate	[2]

		(iii) remains the same	[1]
		(iv) faster than original graph C and three times as much formed and ends at same time as C	[1]
	b	(i) Energy absorbed to break bonds in 1 mole of A and 2 moles of B is More than Energy released to form bonds in 1 mole of C and 3 moles of D	[3]
		(ii) x-axis: progress of reaction and y-axis: energy Endothermic curve Reactants and products labelled Ea labelled with arrow pointing up ΔH labelled with arrow pointing up	[3]
A3	a	Nitrogen	[1]
	b	Catalytic converter added	[1]
	c	Temperature in "lean burn" engines lower	[1]
	d	Incomplete combustion of petrol	[1]
	e	$2CO + 2NO \rightarrow 2CO_2 + N_2$ Or $4CO + 2NO_2 \rightarrow 4CO_2 + N_2$	[1]
	f	It forms acid rain Which corrodes buildings made of metals and limestone	[2]
A4	a	(i) Moles of sodium thiosulfate = 80/1000 x 0.1 = 0.008 moles Moles of iodine = 0.008/2 = 0.004 moles	[2]

(ii) Moles of ozone produced = moles of iodine = 0.004 moles
Volume of ozone = 0.004 x 24000 = 96 cm^3 [1]

(iii) Volume of oxygen that did not react = 192 – 96 = 96 cm^3 [1]

b Oxidation state of sulfur increased
From +2 in $Na_2S_2O_3$
To +2.5 in $Na_2S_4O_6$
$Na_2S_2O_3$ is oxidised [2]

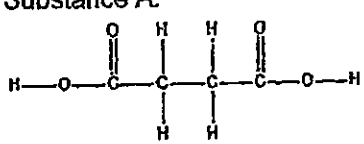
A5 a (i) [2]

	C	H	O
% by mass	40.7	5.1	54.2
Ar	12	1	16
No of moles	3.3916	5.1	3.3875
Mole ratio	1.00	1.51	1
Nearest whole number	2	3	2

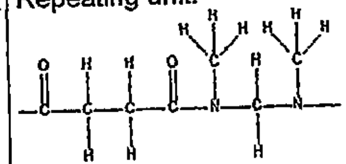
Empirical formula: $C_2H_3O_2$

(ii) Since 1 mole of substance A forms 4 moles of CO_2,
1 mole of substance A has 4 moles of C
Therefore molecular formula is $C_4H_6O_4$ [1]

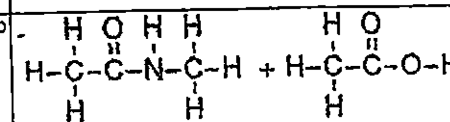
(iii) [2]
Substance A:



Repeating unit:



b [2]



c There is no observable change/blue litmus paper remain blue
Since water is not present
Hydrogen chloride does not dissociate/ionise to form Hydrogen ions [2]

A6 a Add aqueous sodium chloride/any soluble chlorides or soluble iodide
White precipitate or bright yellow precipitate if lead(II) ions are present
Add aqueous sodium sulfate/any soluble sulfates to remaining 2 solutions
White precipitate formed if calcium ions are present [4]

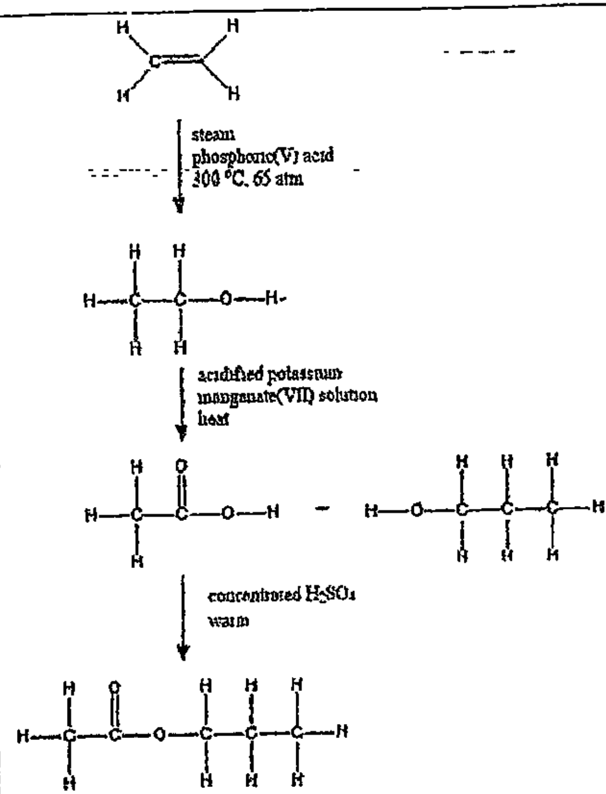
b i Mix aqueous sodium carbonate and aqueous calcium chloride
White precipitate formed
Filter mixture and retain residue
Wash residue with distilled water
Dry residue with filter paper [3]

ii Heat calcium carbonate
until there is no further decrease in mass [1]

iii Sodium will form a very stable carbonate
That cannot be thermally decomposed [2]

		iv	$Ca(OH)_2 + SO_2 \rightarrow CaSO_3 + H_2O$	[1]
		v	Neutralisation	[1]
B7	a	i	2 to 8 °C	[1]
		ii	–53 to –56 °C	[1]
		iii	From far apart and random To closely packed and regular arrangement. From moving at high speeds to vibrating in fixed positions	[2]
		iv	57 to 59 atm	[1]
	b	i	simple molecular structure Simple discrete molecules Held together by weak intermolecular forces Very little energy to overcome	[2]
		ii	Higher melting point Higher relative molecular mass Stronger intermolecular forces More energy needed to overcome	[2]
		iii	good conductor of electricity Only 3 out of 4 valence electrons used for bonding/1 atom bonded to 3 other atoms/only 1 valence electron not used for bonding Many Valence electrons mobile/free to move	[3]
B8	a	i	A purple/violet gas will be evolved After some time, a reddish brown gas will be evolved	[2]

		ii	Iodide ions loses electrons more readily/oxidised more easily/selectively discharged/preferentially discharged Concentration of iodide ions decreases/lesser than bromide concentration/iodide ions used up	[2]
	b		$Na^+ (l) + e \rightarrow Na (l)$	[2]
	c		Effervescence Of a colourless odourless gas Sodium darts around on the surface of the water	[2]
B9 E	a		Catalytic cracking	[1]

	b			[6]
	(c)		Ethene will turn reddish brown aqueous bromine Colourless spontaneously Aqueous bromine will remain reddish brown when added to poly(ethene)	[2]
	(d)		Polyethene may have greater number of monomers/repeating units/polymer length Larger molecular mass	[2]
B9 Or	a	i	Anode: $Zn \rightarrow Zn^{2+} + 2e$ Cathode. $Ag^{+} + e \rightarrow Ag$	[2]

		ii	moles of Ag = $0.1 \div 108 = 9.259 \times 10^{-4}$ mol (4sf) moles of electrons = 9.259×10^{-4} mol moles of Zn = $(9.259 \times 10^{-4}) \div 2 = 4.629 \times 10^{-4}$ mol (4sf) mass of Zn = $4.629 \times 10^{-4} \times 65 = 0.0301$ g (3sf)	[2]
		iii	Zinc displaces silver from silver nitrate/displacement occurs at zinc/displacement occurs at anode Lesser silver formed at cathode	[2]
	b		React weighed sample with excess dilute hydrochloric acid / dilute sulfuric acid $Zn + 2HCl \rightarrow ZnCl_2 + H_2$ / $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$ Filter mixture Rinse residue (silver metal) with distilled water Dry completely Weigh residue Mass/percentage of zinc is difference between mass/percentage of sample and mass/percentage of residue	[4]

SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination
Secondary Four

CANDIDATE NAME			
CLASS	4	REGISTER NUMBER	
CENTRE NUMBER		INDEX NUMBER	

Chemistry **5073/01**

Paper 1 Multiple Choice

Tuesday **11 August 2015** **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, class and index number on the Question Paper and 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**, **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 14
The use of an approved scientific calculator is expected, where appropriate

This question paper consists of 14 printed pages

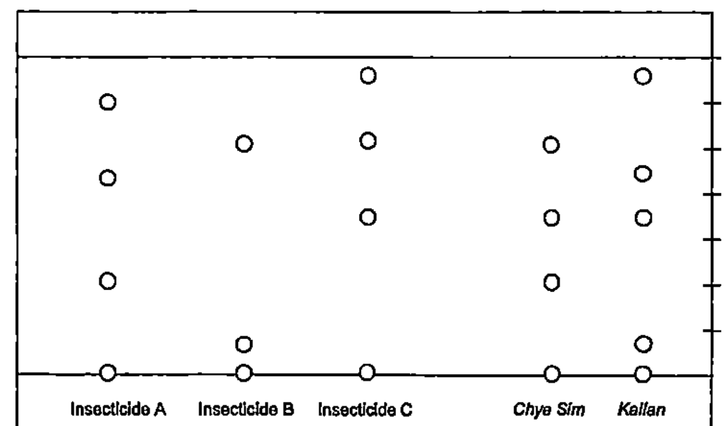
1 A student weighs out a fixed mass of copper and sulfur separately She heats the copper and sulfur together in a closed container to produce copper(II) sulfide After the reaction is complete, the unreacted sulfur is removed (all the copper has reacted) and the copper(II) sulfide formed is weighed The table shows the results of the investigation

Mass of copper before reaction	x g
Mass of sulfur before reaction	y g
Mass of copper(II) sulfide formed	z g
Mass of unreacted sulfur	p g

What is the value of p in terms of x, y and z?

A z - y
B y + z - x
C y - z
D x + y - z

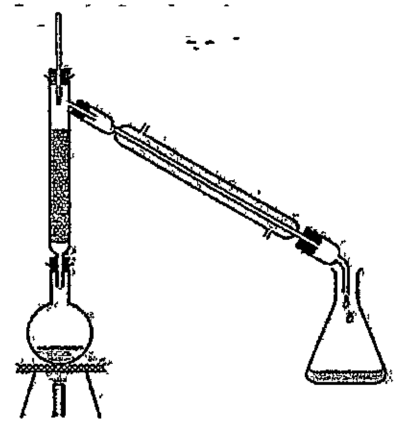
2 Samples of *Chye Sim* and *Kailan* vegetables were tested to determine if the poisonous insecticides A, B and C were present in them. The diagram below shows the results of the tests



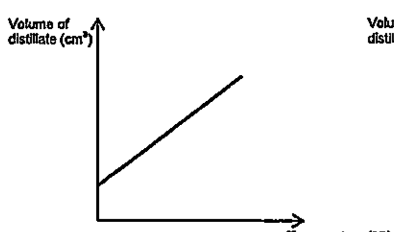
Which of the following statements is true based on the chromatogram above?

A Only *Chye Sim* contains at least one of the insecticides, A, B and C
B Only *Kailan* contains at least one of the insecticides, A, B and C.
C Both *Chye Sim* and *Kailan* contain at least one of the insecticides A, B and C
D Both *Chye Sim* and *Kailan* do not contain any of the insecticides A, B and C

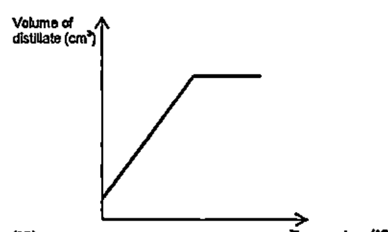
3 The following apparatus was used to separate 2 miscible liquids S (boiling point 60°C) and T (boiling point 90°C)



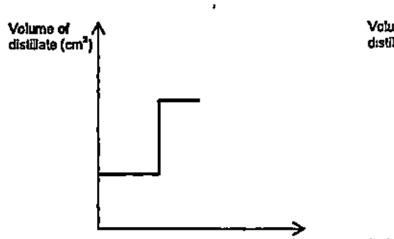
What is the graph obtained when the volume of distillate is plotted against temperature?



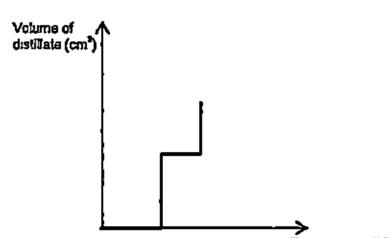
A



B



C



D

4 Study the following statements in a student's notebook

I In a solid, the particles are stationary and held in fixed positions due to strong forces of attraction
II When a solid is heated, the particles expand and become larger.
III At the melting point, the particles are able to slide and roll over one another
IV When the boiling point is reached, evaporation and boiling start to take place and the gas is formed

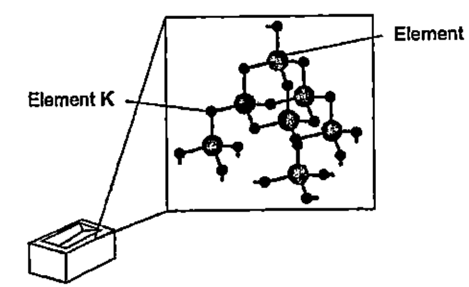
Which of the above statement(s) is(are) true?

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

5 In gold jewellery, the metal gold is usually mixed with copper and silver Which of the following changes in physical properties does not happen when the alloy is formed?

A Density decreases
B Hardness increases
C Colour changes
D Malleability increases

6 A major component of bricks is a compound consisting of elements K and L chemically combined together



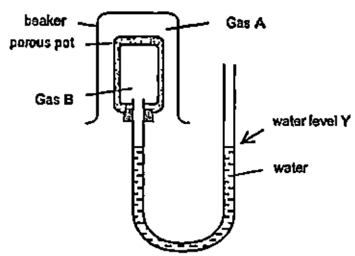
What are elements K and L?

	Element K	Element L
A	Carbon	Silicon
B	Silicon	Carbon
C	Oxygen	Silicon
D	Silicon	Oxygen

7 The atomic number of beryllium is 4
What is the electronic configuration of the beryllium ion?

A 2
B 2 2
C 2 7
D 2 8

8 A student uses the following apparatus to carry out a series of experiments to compare the rate of diffusion between different gases K, L, M and N



The table below summarises the observations made

Experiment	Gas A	Gas B	Observations after 5 mins
1	K	L	Water level Y rises
2	M	N	Water level Y falls
3	L	N	Water level Y rises

Which of the following correctly lists the gases in order of increasing relative molecular mass?

A K, L, M, N
B K, L, N, M
C M, N, L, K
D M, L, N, K

9 4 g of hydrogen is mixed with 16 g of oxygen and the mixture is ignited. Which of the following correctly describes the mixture at the end of the reaction?

	Mass of Hydrogen Left	Mass of Oxygen Left	Mass of Water Formed
A	0 g	0 g	20 g
B	0 g	8 g	12 g
C	2 g	8 g	20 g
D	2 g	0 g	18 g

10 The percentage composition by mass of a compound containing carbon, fluorine and chlorine is as follows

Carbon 18 05% Fluorine 28 50% Chlorine 53 45%

Which of the following could be the molecular formula of this compound?

A CF_3Cl
B CF_2Cl_2
C $C_2F_2Cl_2$
D C_2F_2Cl

11 Which one of the samples contains the most atoms?

A 1 5 mol of CO_2
B 0 5 mol of C_2H_6
C 3 0 mol of He
D 1 0 mole of SO_3

12 A sample of 2.50 g fertilizer was analysed for its sulfate content. After a series of procedures, 2 33 grams of barium sulfate were precipitated from the fertiliser What is the percentage composition by mass of sulfate in the fertiliser?

A 38 4%
B 41 2%
C 61 6%
D 93 2%

13 Three electrochemical cells are set up using copper metal and three unknown metals, U, V and W as electrodes, immersed in dilute sulfuric acid of the same concentration
The voltage produced in each cell is given in the table below

Cell	Metals used	Voltage
1	Copper and U	0 45
2	Copper and V	1 11
3	Copper and W	2 71

Which of the following correctly list the metals U, V and W in the order of increasing ease of oxidation?

A U, V, Copper, W
B W, V, Copper, U
C Copper, U, V, W
D Copper, W, V, U

14 What happens to the positive ions at the cathode during electrolysis?

A Nothing happens to the ions
B The ions lose electrons to form positive ions
C The ions lose electrons to form neutral atoms
D The ions gain electrons to form neutral atoms

15 Concentrated aqueous potassium chloride is electrolysed using carbon electrodes
What happens to the electrolyte?

A It becomes more acidic.
B It becomes more alkaline
C It becomes more dilute
D It becomes more concentrated

16 Which of the following correctly describes what takes place in a hydrogen-oxygen fuel cell?

A Hydrogen ions are reduced at the positive electrode to form hydrogen
B Hydrogen ions are oxidized at the positive electrode to form hydrogen
C Hydrogen gas is reduced at the negative electrode to form water
D Hydrogen gas is oxidized at the negative electrode to form water

17 Which of the following statements is true for an endothermic reaction?

A Energy is absorbed from the surroundings and temperature increases
B Energy is released to the surroundings and the temperature increases
C Energy is absorbed from the surroundings and temperature decreases
D Energy is released to the surroundings and temperature decreases

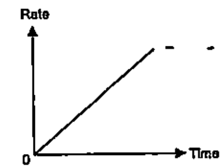
18 The equation for the reaction between magnesium and hydrochloric acid is given below

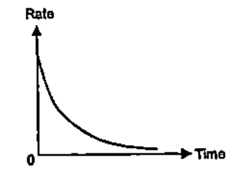
$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g) \qquad \Delta H = \text{negative}$$

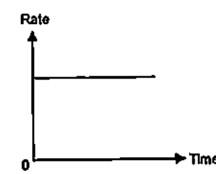
Which statement about this reaction is incorrect?

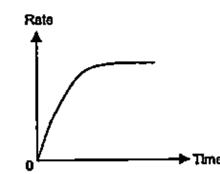
A The products possess less energy than the reactants
B The bonds of the reactants are stronger than the bonds of the products
C The total energy change in bond formation is more than that in bond breaking
D The magnesium has been oxidised.

19 Which of the following graphs represents how the rate of reaction varies with time when an excess of zinc reacts with dilute hydrochloric acid?

A


C


B


D


20 Which of the following is the strongest reducing agent?

A chlorine gas
B chloride ion
C bromine gas
D bromide ion

21 In which reaction is the underlined substance not reduced?

A $K\underline{Br}O_3 + 5KBr + 6HNO_3 \rightarrow 6KNO_3 + 3Br_2 + 3H_2O$
B $3CH_3OH + 4\underline{Mn}O_4^- \rightarrow 3HCOOH + 4MnO_2$
C $\underline{Ag_2}CO_3 + 2NaOH \rightarrow Ag_2O + Na_2CO_3 + H_2O$
D $\underline{Pb}O_2 + 4HCl \rightarrow PbCl_2 + Cl_2 + 2H_2O$

22 A sample of air polluted with sulfur dioxide was passed through aqueous potassium iodide and acidified aqueous potassium permanganate Which pair of colour changes are both correct?

	Aqueous potassium iodide	Acidified aqueous potassium permanganate
A	No change	Purple to colourless
B	Colourless to brown	Colourless to purple
C	No change	Colourless to purple
D	Brown to colourless	Purple to colourless

23 What is the ionic equation for the reaction that occurs when propanoic acid, C_2H_5COOH, and potassium hydroxide solutions are mixed?

A $H^+ + OH^- \rightarrow H_2O$
B $H^+ + KOH \rightarrow K^+ + H_2O$
C $C_2H_5COOH + KOH \rightarrow C_2H_5COOK + H_2O$
D $C_2H_5COO^- + K^+ \rightarrow C_2H_5COOK$

24 Which of the following are uses of sulfuric acid?

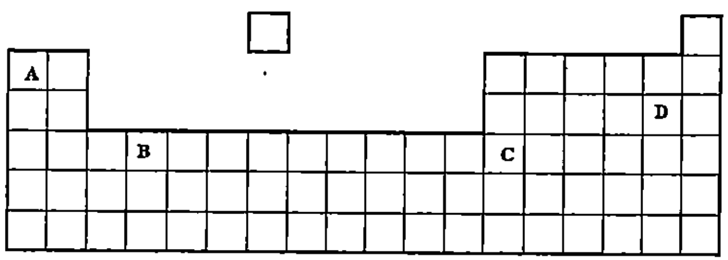
I Making fertilizers
II Sterilising water
III Making detergents
IV Used in car batteries

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

25 The sulfate of element F is green Which other properties is element F likely to have?

	density	melting point
A	high	high
B	high	low
C	low	low
D	low	high

26 The positions of four elements in the Periodic Table are shown Which element is most likely to form an amphoteric oxide?



27 Which statements explain why aluminium is preferred to iron for making drink cans?

I Aluminium is lighter than iron
II Aluminium corrodes less easily than iron
III Aluminium is a better conductor of heat than iron

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

28 Which of the following explains why recycling ensures that metals will be available in the future?

A Dumping of metals in landfill sites is unsightly
B Recycling avoids the environmental damage caused by mining for metals
C Recycling costs less than obtaining metals from their ores
D There are only limited amounts of metals in the Earth's surface

29 Which reaction produces most of the carbon monoxide used to extract iron in the blast furnace?

A Burning coke in air
B Reacting coke with carbon dioxide
C Reacting iron(III) oxide with coke
D Decomposition of limestone

30 Metal **U** displaces metal **V** from an aqueous solution of the nitrate of **V**
Metal **W** reacts with cold water to give hydrogen, but metal **U** gives hydrogen only when reacted with steam
Metal **U** can be extracted from its oxide by reaction with carbon but not with hydrogen
What could elements **U**, **V** and **W** be?

	U	V	W
A	Magnesium	Lead	Sodium
B	Zinc	Copper	Calcium
C	Iron	Silver	Calcium
D	Copper	Iron	Magnesium

31 Which of the following gases cannot be removed from the exhaust gases of a petrol powered car by its catalytic convertor?

A Carbon dioxide
B Carbon monoxide
C Nitrogen dioxide
D Hydrocarbons

32 The table below gives the relative concentrations of polluting gases in the air in four different industrialised cities In which city, A, B, C or D, are limestone buildings most threatened by pollution?

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

33 Which of the following is NOT a problem associated with plastics?

A Burning plastics gives off toxic gases
B Disposal of plastics by burying can cause shortage of landfill sites
C Plastics made from plants are biodegradable.
D Manufacture of plastics leads to exhaustion of non-renewable energy resources

34 What process/reaction is occurring when ethene and octane are obtained from decane, $C_{10}H_{22}$?

A Cracking
B Polymerisation
C Fractional Distillation
D Combustion

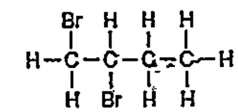
35 Nonane is an alkane present in petrol. What are the products formed when nonane is completely burnt in air?

A carbon dioxide and hydrogen
B carbon monoxide and water
C carbon dioxide and water
D carbon dioxide, carbon monoxide and water

36 Which of the following compounds can turn orange acidified potassium dichromate(VI) green?

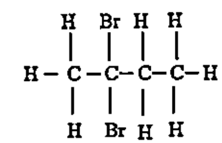
A CH_3CH_3
B CH_3CH_2OH
C CH_3COOH
D CH_3COOCH_3

37 One possible structure of $C_4H_8Br_2$ is

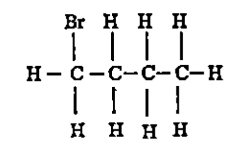


Which of the following are isomers of this organic compound?

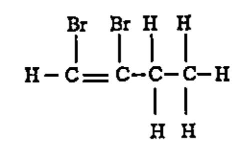
I



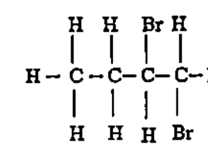
II



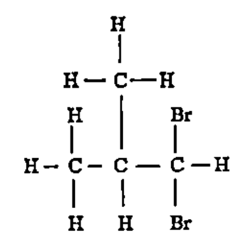
III



IV



V

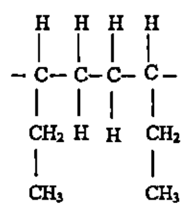


A I and V only
B II and III only
C III, IV and V only
D I, IV and V only

38 What is the molecular formula of the ester formed when propanol is reacted with butanoic acid?

A $C_2H_5CO_2C_4H_9$
B $C_3H_7CO_2C_3H_7$
C $C_3H_7CO_2C_4H_9$
D $C_4H_9CO_2C_3H_7$

39 A polymer has the following structure



Its monomer is

A propene
B butene
C propane
D butane

40 The diagram shows a repeat unit of a polymer
Which of the following statements about the polymer and the monomers it is made from is/are true?

$$-\overset{\displaystyle O}{\overset{\|}{C}}-(CH_2)_4-\overset{\displaystyle O}{\overset{\|}{C}}-NH-(CH_2)_6-NH-$$

I The polymer is made from the joining of many unsaturated monomers
II One of its monomers can react with sodium hydroxide
III The polymer is a polyester
IV If the total mass of the monomers reacted together to form the polymer is 1000kg, the maximum mass of polymer formed will also be 1000kg

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

DATA SHEET
The Periodic Table of the Elements

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 †															

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

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

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

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.)

SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination
Secondary Four

CANDIDATE NAME

CLASS 4

REGISTER NUMBER

CENTRE NUMBER

INDEX NUMBER

Chemistry 5073/02

Paper 2 Theory

Tuesday **28 July 2015** **1 hour 45 minutes**

Candidates answer on the Question Paper.
No Additional materials are required.
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 soft 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** 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 22

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

For Examiner's Use	
Section A	50
B8	12
B9	8
B10	10
Total	80

This question paper consists of **22** printed pages.

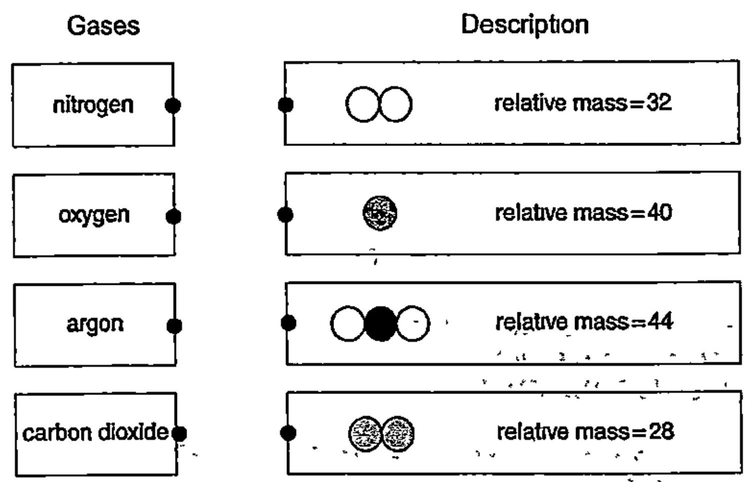
For Examiner's Use

Section A

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

A1 Four of the gases found in air are nitrogen, oxygen, argon and carbon dioxide

(a) Draw straight lines which correctly match the gases and the descriptions shown on the right.



[2]

(b) Study the 6 statements below. Put a tick (✓) in the box if the statement is true.

Air is a mixture. ☐

All gases in air are elements. ☐

The components in air are only made up of non-metals. ☐

There are weak attractions between the molecules in air. ☐

The gases in air have high melting and boiling points. ☐

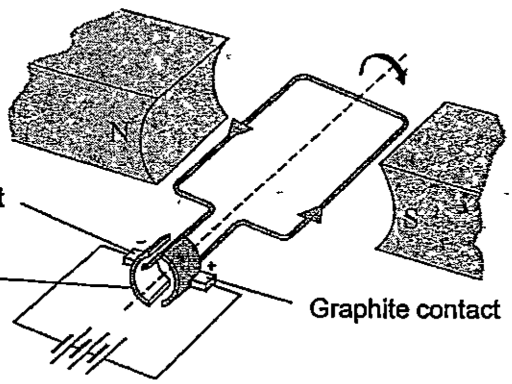
Liquid air does not have a fixed boiling point. ☐

[2]

[Total: 4]

For Examiner's Use

A2 The diagram below shows the main parts of an electric motor.



Graphite contacts are used to conduct electricity to the copper ring. When electricity passes through the wires, the copper ring rotates rapidly, turning the motor which is connected to the drill bit. The ring does not get stuck or become worn out.

(a) Explain, in terms of structure and bonding, why copper and graphite are able to conduct electricity.

(i) copper

....

....

.... [2]

(ii) graphite

....

....

....

.... [2]

(b) Explain why the copper ring does not become worn out easily though it is in constant contact with the graphite during rotation.

....

....

.... [2]

[Total: 6]

A3 A student carries out some tests on an unknown solution **P** which is known to contain 2 metallic cations and 1 anion. She recorded her observations and deductions in the table shown below.

Expt No.	Procedure	Observations	Deductions
1a	To a solution of **P**, add sodium hydroxide solution.	*White ppt formed*	*Pb^{2+}, Zn^{2+}, Ca^{2+} or Fe^{2+} could be present*
1b	Add excess sodium hydroxide solution into the test tube	*Ppt decreased by approximately half. Remaining ppt is insoluble in excess sodium hydroxide*	*Ca^{2+} is present*
2	Add Devarda's alloy to the mixture in expt 1b. Warm the mixture	*Gas evolved turns moist red litmus blue*	*Cl^- is present*
3a	To new sample of solution P, add aqueous ammonia.	*White ppt formed*	*Al^{3+}, Pb^{2+} or Zn^{2+} could be present*
3b	Add excess aqueous ammonia solution into the test tube.	*White ppt insoluble in excess aqueous ammonia*	*Al^{3+} or Pb^{2+} could be present*

(a) The student made **3** mistakes in her deductions. In the table below, state the experiment number in which the mistakes were made. **Briefly** explain your answer.

	Expt No.	Explanation
Mistake 1		
Mistake 2		
Mistake 3		

[3]

(b) Describe a simple test to differentiate between aluminium ions (Al^{3+}) and lead(II) ions (Pb^{2+}).

....

....

....

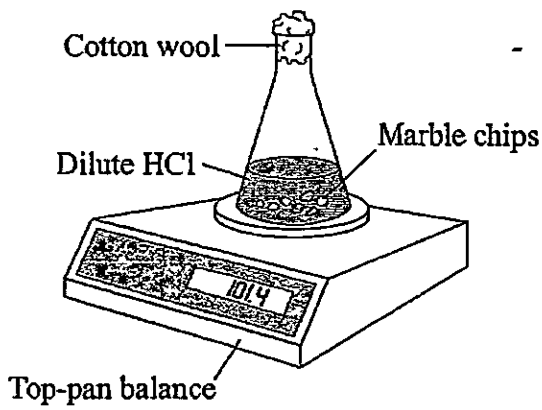
....

.... [2]

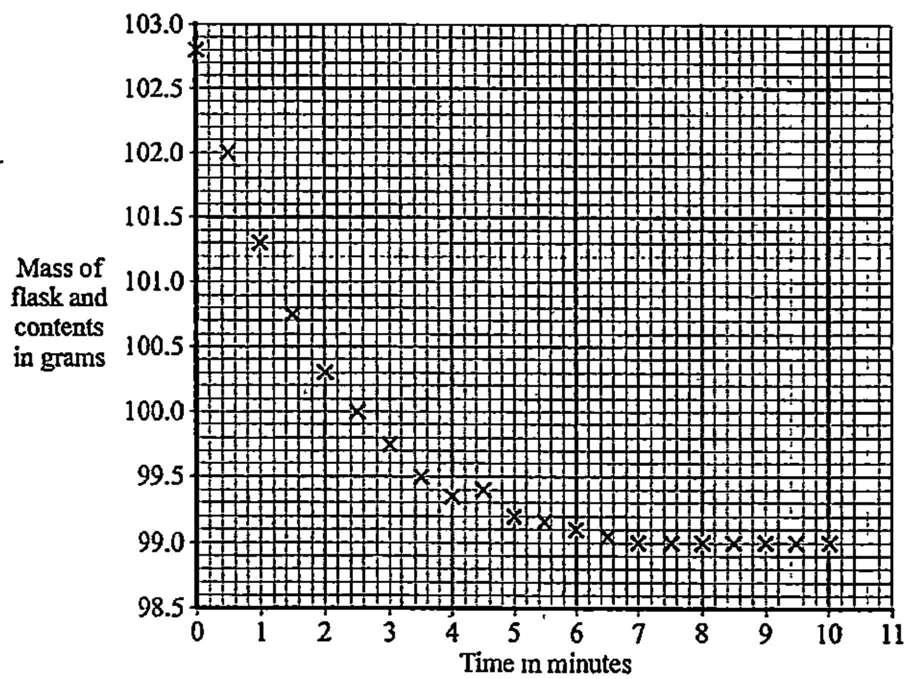
[Total: 5]

For Examiner's Use

A4 The rate of reaction between hydrochloric acid and excess marble chips (calcium carbonate) was investigated at a temperature of 40°C using the apparatus shown in the diagram below.



The mass of the flask and contents was measured every half minute for ten minutes. The data obtained was plotted on a graph shown in the grid below.



(a) Complete the graph by drawing a line of best fit. [1]

(b) Explain why the mass of the flask and contents decreased with time.

....

.... [1]

For Examiner's Use

(c) State the time taken for the reaction to complete.

.... [1]

(d) A student repeated the experiment but forgot to place the cotton wool at the neck of the conical flask. State how his results would be different and explain your answer.

....

....

.... [2]

(e) Given that 40 cm^3 of hydrochloric acid were used in the reaction, calculate the concentration of this acid in mol/dm^3.

[3]

Another student repeated the first experiment at a temperature of 50°C. All other variables were kept the same.

(f) On the same grid on page 5, draw the graph she can expect to obtain for this experiment. Label this graph **T**. [1]

(g) Explain, in terms of the collision theory, how an increase in temperature affects the rate of reaction.

....

....

....

....

....

....

....

.... [3]

[Total: 12]

For Examiner's Use

A5 One method of manufacturing hydrogen is to pass methane and steam over heated nickel catalyst, a process called steam reforming.

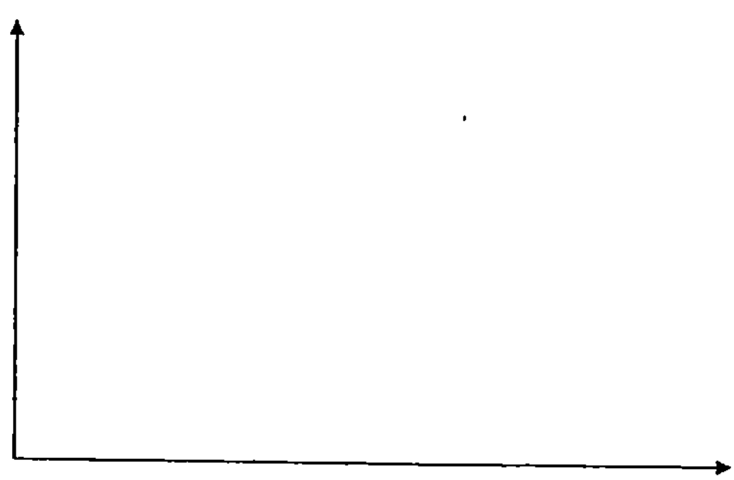
$$CH_4\,(g) + H_2O\,(g) \rightarrow CO\,(g) + 3H_2\,(g)$$

(a) Using the bond energies listed in the table below, calculate the enthalpy change (ΔH) of this reaction.

Bond	**Bond energy (kJ/mol)**
H – H	436
C – H	410
O – H	460
C – C	350
C ≡ O	1046

[3]

(b) Using your answer to part (a), draw the energy profile diagram using the axes given below, showing the activation energy and the enthalpy change clearly.



[3]

For Examiner's Use

(c) State whether this is an endothermic or exothermic reaction. Explain your answer in terms of bond breaking and bond forming.

....

....

....

....

.... [2]

[Total: 8]

A6 The diagram below shows a food label describing the nutritional content of a packet of crackers.

Nutrition Facts

Serving Size 5 Crackers (16g)
Servings Per Container About 14

Amount Per Serving	
Calories 80	Calories from Fat 35
	% Daily Value*
Total Fat 4g	**6%**
Saturated Fat 0.5g	**3%**
Trans Fat 0g	
Polyunsaturated Fat 2g	
Monounsaturated Fat 1g	
Cholesterol 0mg	**0%**
Sodium 150mg	**6%**
Total Carbohydrate 10g	**3%**

From the food label, it can be seen that the cracker contains both saturated and unsaturated fat.

(a) Describe a simple chemical test to differentiate between saturated fat and unsaturated fat.

....

....

....

.... [2]

(b) Describe the main difference in structure between monounsaturated fat and polyunsaturated fat.

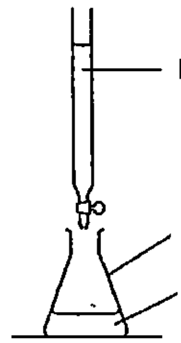
....

....

.... [1]

Saturated fats are linked to heart problems. In order to be able to claim that their crackers are healthy, the manufacturer decides to use a vegetable oil which has a higher unsaturated fat content. In a test to determine what kind of vegetable oil is healthier, a laboratory investigation was carried out.

20 cm^3 of different vegetable oils were titrated with bromine solution of concentration 0.50 mol/dm^3. The results are shown in the table on page 10.



Vegetable oil	Initial burette reading (cm^3)	Final burette reading (cm^3)	Volume of bromine solution used (cm^3)
Palm	0.2	13.7	
Peanut	0.2	12 6	
Soya	0.1	14.4	
Sunflower	0.5	18.9	

(c) Complete the table above. [1]

(d) What colour change in the conical flask would be observed at the end point of the titration?

From .... to .... [1]

(e) Which is the healthiest vegetable oil to use to manufacture the crackers? Explain your answer.

Healthiest vegetable oil : ....

Reason ....

....

....

.... [2]

(f) Unsaturated vegetable oils can be hardened to make margarine. Describe how this process is carried out.

....

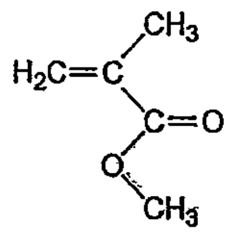
....

.... [2]

[Total: 9]

For Examiner's Use

A7 The diagram below shows the structure of an ester molecule **M**.



(a) Circle clearly on the above diagram the group of atoms which makes this molecule an ester. [1]

When **M** is reacted with water under reflux in the presence of a catalyst, an alcohol and a carboxylic acid are formed.

(b) Draw the structures of the 2 products formed.

Product 1 Product 2 [2]

When **M** undergoes polymerization, a polymer called Perspex is formed.

(c) What type of polymer is Perspex? Give a reason for your answer.

Type of polymer : ....

Reason : ....

.... [2]

(d) Draw the structure of Perspex, showing **two** repeat units.

[1]

[Total: 6]

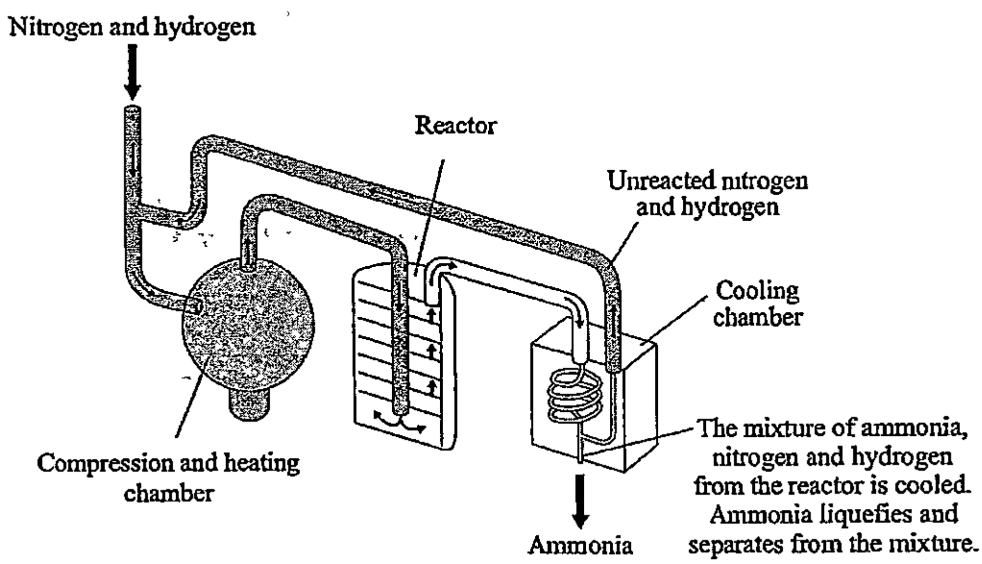
Section B

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 Haber process, also called the Haber–Bosch process, is an artificial nitrogen fixation process and is the main industrial procedure for the production of ammonia today. It converts atmospheric nitrogen to ammonia by reacting it with hydrogen Named after its inventors, German chemists Fritz Haber and Carl Bosch, who developed it in the first half of the twentieth century, the Haber process provided Germany with a source of ammonia for the production of explosives during World War I. Today, the ammonia is mainly used to produce fertilisers.

The diagram below shows how a modern ammonia manufacturing plant looks like.



The yield of ammonia can vary, depending on the temperature and pressure. The table below shows the percentage yield under different conditions.

Pressure (atm)	Temperature (°C)					
	100	200	300	400	500	600
10	-	50.7	14.7	3 9	1.2	0.2
25	91.7	63.6	27.4	8.7	2 9	-
50	94.5	74.0	39 5	15.3	5 6	1.1
100	96.7	81.7	52.5	25 2	10.6	2.2
200	98.4	89.0	66.7	38.8	18.3	-
400	99.4	94.6	79.7	55 4	31.9	-
1000	-	98.3	92.6	79.8	57.5	12.9

(a) Write the equation (including state symbols) for the reaction between nitrogen and hydrogen in the Haber Process.

.... [1]

(b) State the main source of nitrogen and the process by which it is obtained.

.... [1]

(c) Suggest why air is not used in the Haber process although 78% of air is nitrogen.

....

.... [1]

(d) The reactant gases are passed through a substance in the reactor. Name this substance and state its function.

Substance : .... [1]

Function : .... [1]

(e) From the information in the table, describe how temperature and pressure affects the yield of ammonia

....

....

....

....

.... [2]

(f) A particular ammonia plant uses a temperature of 400°C and pressure of 200 atm. Using the information in the table, calculate the mass of ammonia formed when 210 tonnes of nitrogen are reacted.

[2]

(g) The gases that leave the reactor still contain nitrogen One reason for this is that nitrogen is a relatively inert gas. Explain this property of nitrogen in terms of its bonding.

....

....

....

....

.... [2]

(h) The boiling points of nitrogen, hydrogen and ammonia are as follows :

Gas	Boiling point
nitrogen	-196°C
hydrogen	-253°C
ammonia	-33°C

Suggest a suitable temperature that the cooling chamber must have to be able to function effectively.

Temperature of cooling chamber : .... [1]

[Total: 12]

B9 The vertical columns in the Periodic Table are called Groups.

(a) Lithium is the first element in Group I.
Describe what you will observe when a piece of lithium is put into water.

....

....

....

....

.... [2]

(b) Fluorine is the first element in Group VII.
Describe and explain what you will observe when fluorine is bubbled in aqueous sodium iodide.

....

....

....

....

.... [2]

(c) Lithium reacts with fluorine to form lithium fluoride which melts at 845°C.

(i) Draw the 'dot and cross' diagram to show the bonding in lithium fluoride.

[2]

(ii) Explain why lithium fluoride has a high melting point

....

....

....

....

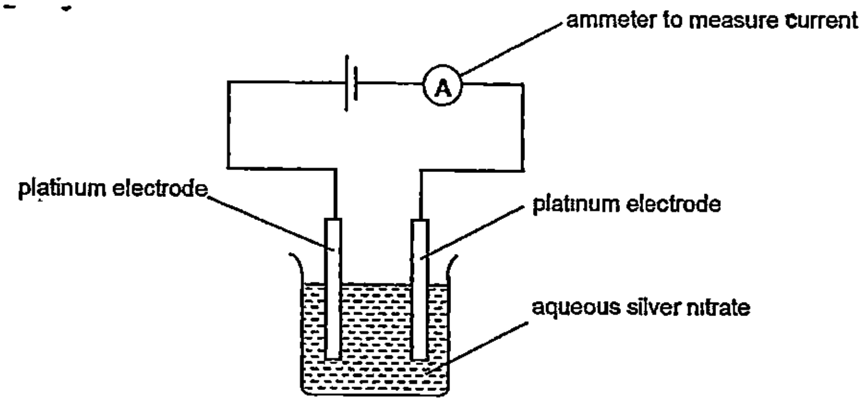
....

.... [2]

[Total: 8]

EITHER

B10 A student carried out the electrolysis of two equal volumes of silver nitrate solutions of the same concentration using platinum electrodes as shown in the diagram below.



In Experiment 1, a current of 1 0 ampere was used and the mass of one of the electrodes was weighed every 5 minutes to determine the mass of the silver deposited. This was done for 60 minutes. The results in the following table are plotted on the grid on page 18.

Time (min)	0	5	10	15	20	25	30	35	40	45	50
Mass of silver deposited (g)	0	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.80	2.80

In Experiment 2, the student repeated the procedure using the same volume of aqueous silver nitrate solution but he increased the current to 1.5 amperes instead The results are shown in the following table.

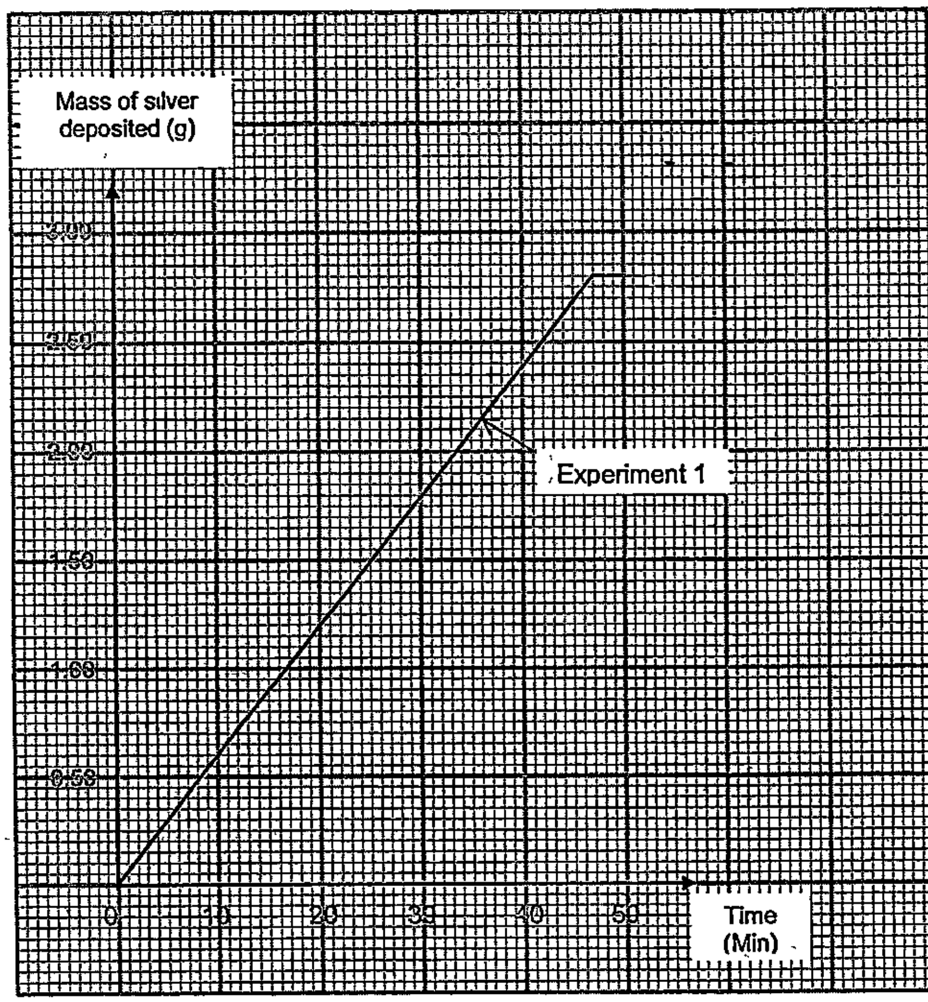
Time (min)	0	5	10	15	20	25	30	35	40	45	50
Mass of silver deposited (g)	0	0.45	0.90	1.35	1.80	2.25	2 70	?	2 80	2.80	2.80

(a) Name the electrode that was weighed in the experiment. Write the equation for the reaction which takes place at this electrode

Electrode : ....

Equation .... [2]

(b) Plot the graph of mass of silver deposited against time for Experiment 2 on the same grid on page 18. Label the graph "Experiment 2" clearly.



[1]

(c) Determine the mass of silver deposited after 35 minutes for the second experiment

.... [1]

(d) State two conclusions from the results of the experiments.

....

....

....

....

.... [2]

(e) State a change in the electrolyte at the end of the electrolysis of the two silver nitrate solutions.

.... [1]

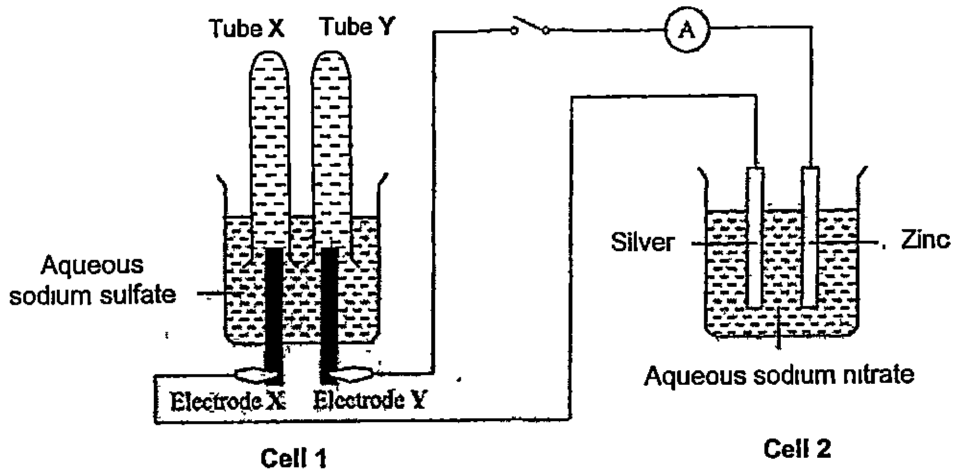
(f) If the electrolyte were replaced by copper(II) sulfate solution and the same current of 1 ampere was passed through, calculate the mass of copper deposited at the end of 40 minutes.

[3]

[Total: 10]

OR

B10 The diagram below shows an experimental set-up of a simple cell and an electrolytic cell Both electrodes **X** and **Y** are made of graphite. The switch is then closed and reactions take place in both cells



(a) Which is the simple cell? Explain your answer.

Simple Cell : Cell .... [1]

Explanation : ....

....

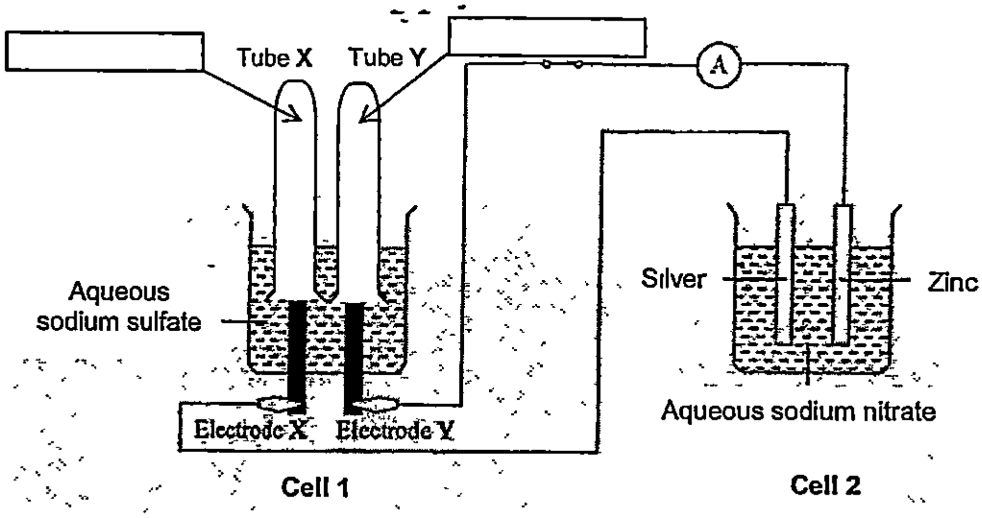
.... [1]

(b) Write the ionic equations for the reactions which take place at the electrodes of **Cell 1.**

Electrode **X** : .... [1]

Electrode **Y** : .... [1]

(c) Complete the diagram below to show the new levels of the aqueous sodium sulfate solution after the switch is closed for a while and hence the relative volumes of gases collected in tube **X** and tube **Y**. Label clearly the gases collected in each tube [2]



(d) Electrode **X** is then replaced by a copper rod. State an observation and explain your answer.

Observation : .... [1]

Explanation : ....

....

.... [1]

(e) State and explain an observation that can be made in **Cell 2** during the experiment.

Observation : .... [1]

Explanation : ....

....

.... [1]

[Total: 10]

DATA SHEET
The Periodic Table of the Elements

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	226 Ra Radium 88	227 Ac Actinium 89 †															

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

Answers for SCGS Preliminary Examination Chemistry P1 2015

1-5	D	D	D	A	D
6-10	C	A	B	D	C
11-15	A	A	C	D	B
16-20	D	C	B	C	D
21-25	C	A	A	C	A
26-30	C	A	D	B	B
31-35	A	C	C	A	C
36-40	B	A	B	B	A

SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination
Secondary Four

CANDIDATE NAME			
CLASS	4	REGISTER NUMBER	
CENTRE NUMBER		INDEX NUMBER	

Chemistry 5073/02

Paper 2 Theory

Tuesday **28 July 2015** **1 hour 45 minutes**

Candidates answer on the Question Paper
No Additional materials are required
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 soft 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 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 22

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

Answers

For Examiner's Use	
Section A	50
B8	12
B9	8
B10	10
Total	80

For Examiner's Use

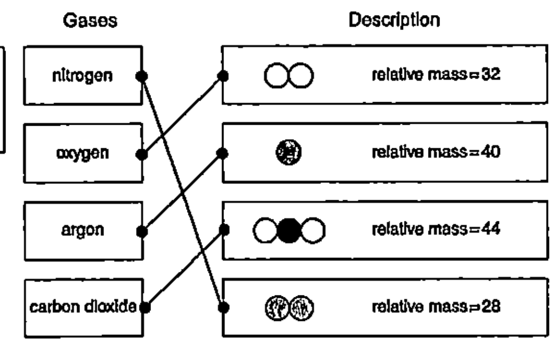
Section A

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

A1 Four of the gases found in the air are nitrogen, oxygen, argon and carbon dioxide

(a) Draw straight lines which correctly match the gases and the descriptions shown on the right.

1 correct – 0m
2 correct – 1m
3 correct – 1m
4 correct – 2m



[2]

(b) Study the 6 statements below Put a tick (✓) in the box if the statement is true

Air is a mixture.	✓
All gases in air are elements.	
The components in air are only made up of non-metals	✓
There are weak attractions between the molecules in air	✓
The gases in air have high melting and boiling points	
Liquid air does not have a fixed boiling point.	✓

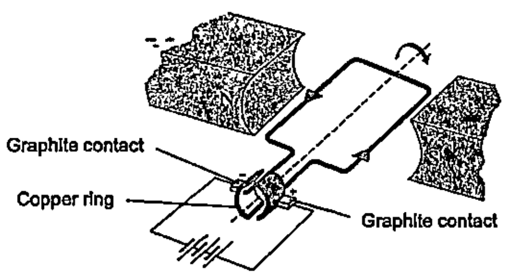
[2]

If 4 ticks or less, ignore wrong ticks
1 correct – 0m
2 correct – 1m
3 correct – 1m
4 correct – 2m
If 5 ticks or more, 1m

[Total 4]

For Examiner's Use

A2 The diagram below shows the main parts of an electric motor



Graphite contacts are used to conduct electricity to the copper ring When electricity passes through the wires, the copper ring rotates rapidly, turning the motor which is connected to the drill bit. The ring does not get stuck or become worn out

(a) Explain, in terms of structure and bonding, why copper and graphite are able to conduct electricity

(i) copper

Outer/valence electrons of copper atoms are delocalized, **1m**

Electrons are mobile and able to move freely within metal lattice **1m**

[2]

(ai) NOT Accepted.
Copper is surrounded by a sea of electrons;
Copper has charged particles,
Protons in a sea of electrons.

(ii) graphite

1 valence electron from each carbon atom are not used for covalent bonding with other atoms; **1m**

these delocalized electrons can move freely along the hexagonal layers **1m**

[2]

(b) Explain why the copper ring does not become worn out easily though it is in constant contact with the graphite during rotation.

Graphite is soft and slippery; **1m**

very little friction between the copper ring and graphite contacts, **1m**

[2]

[Total: 6]

(aii) NOT Accepted.
Graphite has 3 valence out of 4 valence electrons involved in bonding (per atom not mentioned);
Electrons bonded to each other; One carbon bonded to 3 electrons, 3 out of 4 carbon atoms bonded, leaving one free to conduct electricity; 3 out of 4

(b) NOT Accepted
Graphite is soft (no mention of slippery), Copper is hard;
Copper layers cannot slide

For Examiner's Use

A3 A student carries out some tests on an unknown solution P which is known to contain 2 metallic cations and 1 anion She recorded her observations and deductions in the table shown below.

Expt No	Procedure	Observations	Deductions
1a	To a solution of P, add sodium hydroxide solution	*White ppt formed*	*Pb^{2+}, Zn^{2+}, Ca^{2+} or Fe^{2+} could be present*
1b	Add excess sodium hydroxide solution into the test tube	*Ppt decreased by approximately half Remaining ppt is insoluble in excess sodium hydroxide*	*Ca^{2+} is present*
2	Add Devarda's alloy to the mixture in expt 1b Warm the mixture.	*Gas evolved turns moist red litmus blue*	*Cl^- is present*
3a	To new sample of solution P, add aqueous ammonia	*White ppt formed*	*Al^{3+}, Pb^{2+} or Zn^{2+} could be present*
3b	Add excess aqueous ammonia solution into the test tube	*White ppt insoluble in excess aqueous ammonia*	*Al^{3+} or Pb^{2+} could be present*

(a) The student made 3 mistakes in her deductions In the table below, state the experiment number in which the mistakes were made Briefly explain your answer

	Expt No.	Explanation
Mistake 1	1a	Fe^{2+} ions cannot be present as it forms green ppt, **1m**
Mistake 2	1a	Aluminium ion (Al^{3+}) should also be a possible ion present as it forms white ppt with aqueous sodium hydroxide **1m**
Mistake 3	2	Nitrate ion (NO_3^-) should be present, not chloride **1m**

[3]

(b) Describe a simple test to differentiate between aluminium ions (Al^{3+}) and lead(II) ions (Pb^{2+})

Add aqueous potassium iodide, **1m**, only lead(II) ions will give yellow ppt **1m**

OR Add any solution containing chloride or sulfate ions (except of barium), **1m**,

only lead(II) ions will give white ppt **1m**

[2]

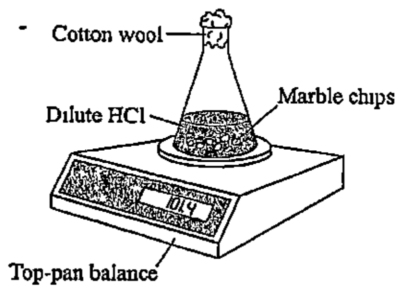
[Total 5]

a) Mistake 3 - NOT Accepted:
Cl^- turns blue litmus red, then bleaches it;
Gas evolved is not chlorine (Chlorine gas is NOT mentioned; only chloride ion)
Gas is NH_4^+ which turns red litmus blue,
Ion should be NH_4^+, NH_3^-, NO_3^+

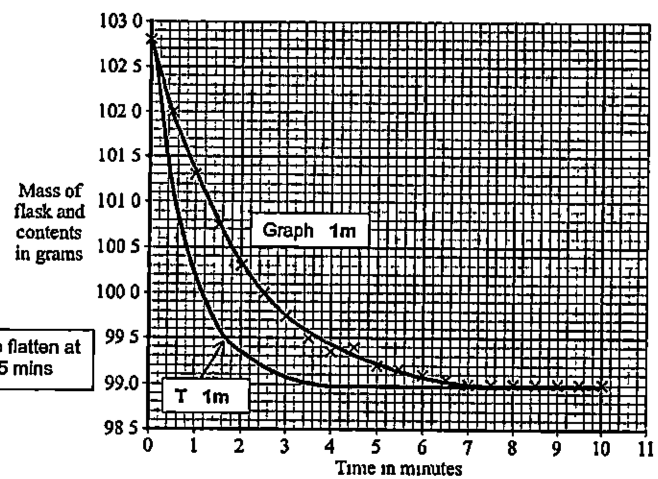
a) accept Expt 1 b
This means that Al^{3+} or Pb^{2+} may be present together with Ca^2
b) Displacement method, partial mark if explained correctly; Not accepted – use of barium chloride solution

For Examiner's Use

A4 The rate of reaction between hydrochloric acid and excess marble chips (calcium carbonate) was investigated at a temperature of 40°C using the apparatus shown in the diagram below



The mass of the flask and contents was measured every half minute for ten minutes The data obtained was plotted on a graph shown in the grid below



Graph to flatten at about 3 5 mins

(a) Complete the graph by drawing a line of best fit. [1]

(b) Explain why the mass of the flask and contents decreased with time.

Carbon dioxide gas produced during the reaction escapes 1m

b) Explanation must convey loss of carbon dioxide gas from flask to the surroundings [1]

For Examiner's Use

(c) State the time taken for the reaction to complete

7 minutes 1m | Reject all other answers [1]

(d) A student repeated the experiment but forgot to place the cotton wool at the neck of the conical flask State how his results would be different and explain your answer

Only answered 1st part correctly (no explanation) 1m, Correct answer but wrong/absurd reasoning 1m

Mass readings will be lower than the actual mass. 1m

Without the cotton wool, some acid will be lost as acid spray 1m [2]

(e) Given that 40 cm^3 of hydrochloric acid were used in the reaction, calculate the concentration of this acid in mol/dm^3

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

ECF Max mark 1/3

Mass of carbon dioxide produced = 102 8 g – 99 0 g = 3 8 g

No of moles of carbon dioxide produced = $\frac{3.8}{44}$ moles = 0 086364 mole 1m

2 moles of hydrochloric acid produces 1 mole of carbon dioxide

Hence, no of moles of hydrochloric acid present = 2 x 0 086364moles = 0.17273 moles 1m

Hence, concentration of hydrochloric acid = $\frac{0\ 17273}{0.04}$ = 4 32 mol/dm^3 1m

[3]

Another student repeated the first experiment at a temperature of 50°C All other variables were kept the same

(f) On the same grid on page 5, draw the graph she can expect to obtain for this experiment. Label this graph T [1]

(g) Explain, in terms of the collision theory, how an increase in temperature affects the rate of reaction

Particles gain kinetic energy and move faster or

More particles possess energy equal or greater than the activation energy. 1m

Frequency of collisions increases, number of effective collisions increases per unit time. 1m

rate of reaction increases 1m

[3]

[Total 12]

For Examiner's Use

A5 One method of manufacturing hydrogen is to pass methane and steam over heated nickel catalyst, a process called steam reforming

$$CH_4 (g) + H_2O (g) \rightarrow CO (g) + 3H_2 (g)$$

(a) Using the bond energies listed in the table below, calculate the enthalpy change (ΔH) of this reaction

No statements and wrong answer – 0m, minus 1m for no units or sign
If statements/concepts correct but calculation wrong, max 1m

Bond	Bond energy (kJ/mol)
H – H	436
C – H	410
O – H	460
C – C	350
C ≡ O	1046

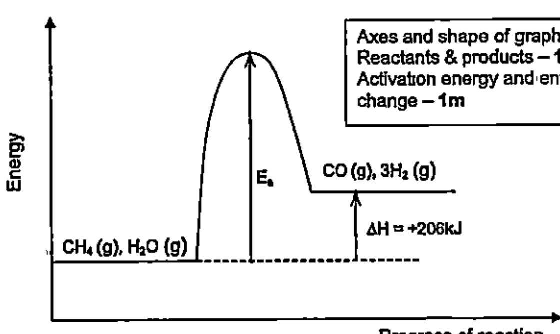
Energy taken in to break bonds in reactants
4 C – H bonds in methane = 4 x +410 = +1640 kJ
2 O – H bonds in water = 2 x +460 = +920 kJ
Total energy taken in = + 1840 + 920 = +2560 kJ **1m**
Energy released when bonds are formed in products .
1 C≡O bond = 1 x -1046 = -1046 kJ
3 H – H = 3 x -436 = -1308 kJ
Total energy released = -1046 -1308 = -2354 kJ **1m**

Hence, ΔH for reaction = +2560–2354 = +206 kJ **1m**

[3]

(b) Using your answer to part (a), draw the energy profile diagram using the axes given below, showing the activation energy and the enthalpy change clearly

ECF If Part a ΔH wrong but all parts correct in part b, max 3m
Reject terms such as energy needed, required for both bond-making/breaking processes



Axes and shape of graph – **1m**
Reactants & products – **1m**
Activation energy and enthalpy change – **1m**

[3]

For Examiner's Use

(c) State whether this is an endothermic or exothermic reaction Explain your answer in terms of bond breaking and bond forming

Energy taken in to break the bonds in methane and steam is greater than energy released when bonds are formed in carbon monoxide and hydrogen.

(or vice versa) hence it is an endothermic reaction

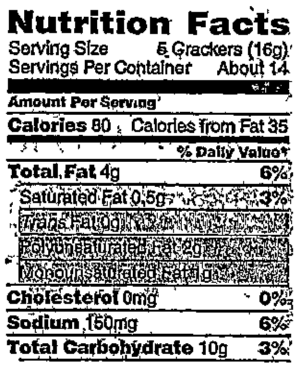
Energy taken in to break the bonds in reactants and energy released when bonds are formed in products – **1m**
Greater/lesser and endothermic reaction – **1m**

[2]

[Total 8]

For Examiner's Use

A6 The diagram below shows a food label describing the nutritional content of a packet of crackers



From the food label, it can be seen that the cracker contains both saturated and unsaturated fat.

(a) Describe a simple chemical test to differentiate between saturated fat and unsaturated fat.

Add aqueous bromine into the sample of fat and shake, **1m**

Unsaturated fat will decolourise the reddish brown bromine, no visible change with saturated fat (Bromine remains brown) **1m**

[2]

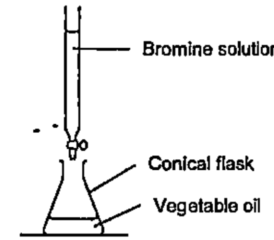
(b) Describe the main difference in structure between monounsaturated fat and polyunsaturated fat.

Monounsaturated fat has one carbon-carbon double bond per molecule compared to polyunsaturated which has many carbon-carbon double bonds in the molecules (or vice versa) **1m** [1]

Saturated fats are linked to heart problems In order to be able to claim that their crackers are healthy, the manufacturer decides to use a vegetable oil which has a higher unsaturated fat content. In a test to determine what kind of vegetable oil is healthier, a laboratory investigation was carried out.

20 cm^3 of different vegetable oils were titrated with bromine solution of concentration 0 50 mol/dm^3. The results are shown in the table on page 10

For Examiner's Use



Vegetable oil	Initial burette reading (cm^3)	Final burette reading (cm^3)	Volume of bromine solution used (cm^3)
Palm	0 2	13 7	13 5
Peanut	0 2	12 6	12 4
Soya	0 1	14 4	14 3
Sunflower	0 5	18 9	18 4

(c) Complete the table above $\boxed{\text{All values correct – 1m}}$ [1]

(d) What colour change in the conical flask would be observed at the end point of the titration?

From pale yellow/colourless to light brown (Both colours correct **1m**) [1]

(e) Which is the healthiest vegetable oil to use to manufacture the crackers? Explain your answer

Healthiest vegetable oil . Sunflower oil **1m**

Reason Sunflower oil needs the highest volume of bromine solution to react with it completely, suggesting that sunflower oil is most unsaturated (has the largest number of carbon-carbon double bonds **1m**

[2]

(f) Unsaturated vegetable oils can be hardened to make margarine Describe how this process is carried out.

Carry out hydrogenation (or react vegetable oil with hydrogen), **1m**

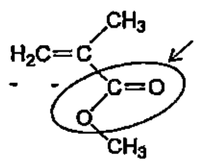
at temperature of 200°C and nickel catalyst **1m**

[2]

[Total 9]

For Examiner's Use

A7 The diagram below shows the structure of an ester molecule M

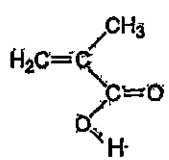


1m

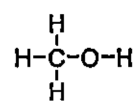
(a) Circle clearly on the above diagram the group of atoms which makes this molecule an ester. [1]

When M is reacted with water under reflux in the presence of a catalyst, an alcohol and a carboxylic acid are formed

(b) Draw the structures of the 2 products formed



1m



1m

Product 1

Product 2

[2]

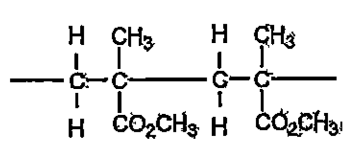
When M undergoes polymerization, a polymer called Perspex is formed

(c) What type of polymer is Perspex? Give a reason for your answer.

Type of polymer : Addition polymer 1m

Reason . M has a carbon-carbon double bond which allows addition polymerization to take place 1m [2]

(d) Draw the structure of Perspex, showing two repeat units



1m

[1]

[Total 6]

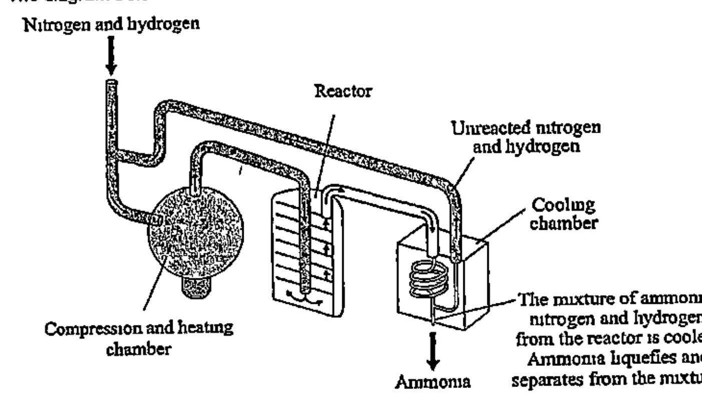
Section B

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 Haber process, also called the Haber–Bosch process, is an artificial nitrogen fixation process and is the main industrial procedure for the production of ammonia today. It converts atmospheric nitrogen to ammonia by reacting it with hydrogen Named after its inventors, German chemists Fritz Haber and Carl Bosch, who developed it in the first half of the twentieth century, the Haber process provided Germany with a source of ammonia for the production of explosives during World War I Today, the ammonia is mainly used to produce fertilisers

The diagram below shows how a modern ammonia manufacturing plant looks like



The yield of ammonia can vary, depending on the temperature and pressure The table below shows the percentage yield under different conditions

Pressure (atm)	Temperature (°C)					
	100	200	300	400	500	600
10	-	50 7	14 7	3 9	1 2	0 2
25	91 7	63 6	27.4	8 7	2 9	-
50	94 5	74 0	39 5	15 3	5 6	1 1
100	96 7	81 7	52 5	25 2	10 6	2 2
200	98 4	89 0	66 7	38 8	18 3	-
400	99 4	94 6	79 7	55 4	31 9	-
1000	-	98 3	92 6	79 8	57 5	12 9

(a) Write the equation (including state symbols) for the reaction between nitrogen and hydrogen in the Haber Process

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ 1m

(b) State the main source of nitrogen and the process by which it is obtained

Fractional distillation of liquid air 1m [1]

(c) Suggest why air is not used in the Haber process although 78% of air is nitrogen

Oxygen in the air will react with the hydrogen at high temperature and lower the yield of ammonia 1m [1]

(d) The reactant gases are passed through a substance in the reactor Name this substance and state its function

Substance Finely divided iron 1m [1]

Function Catalyst to speed up reaction 1m [1]

(e) From the information in the table, describe how temperature and pressure affects the yield of ammonia

The higher the temperature, the lower the yield 1m

The higher the pressure the higher the yield 1m

[2]

(f) A particular ammonia plant uses a temperature of 400°C and pressure of 200 atm Using the information in the table, calculate the mass of ammonia formed when 210 tonnes of nitrogen are reacted

From mass ratio of equation, 28 units of nitrogen yields 34 units of ammonia

Hence, 210 tonnes of nitrogen yield = $\frac{34}{28} \times 210 = 255$ tonnes of ammonia 1m

From table, the yield at 400°C and 200 atm is 38 8%

Hence, the mass of ammonia formed = $\frac{38.8}{100} \times 255 = 98\ 94$ tonnes of ammonia
= 98 9 tonnes (3 s f) 1m

[2]

(g) The gases that leave the reactor still contain nitrogen One reason for this is that nitrogen is a relatively inert gas Explain this property of nitrogen in terms of its bonding

Nitrogen is a very inert/unreactive gas,

Each nitrogen molecule has 3 covalent bonds joining 2 nitrogen atoms, 1m

a lot of energy is required to break these bonds 1m

[2]

(h) The boiling points of nitrogen, hydrogen and ammonia are as follows

Gas	Boiling point
nitrogen	-196°C
hydrogen	-253°C
ammonia	-33°C

Suggest a suitable temperature that the cooling chamber must have to be able to function effectively

Temperature of cooling chamber Any temp between -34°C and -196°C 1m [1]

[Total 12]

B9 The vertical columns in the Periodic Table are called Groups

(a) Lithium is the first element in Group I
Describe what you will observe when a piece of lithium is put into water

Lithium darts on the surface, **1m** | Reject skip or jump

sizzling sound, **1m**

sparks **1m** **(Any 2 points, 2m)**

[2]

(b) Fluorine is the first element in Group VII
Describe and explain what you will observe when fluorine is bubbled in aqueous sodium iodide

Iodine is not reddish brown! Water present so iodine formed in aqueous state not as a purple gas! NOT fluorine is more reactive than iodide ; NOT iodide ion not iodine ion!

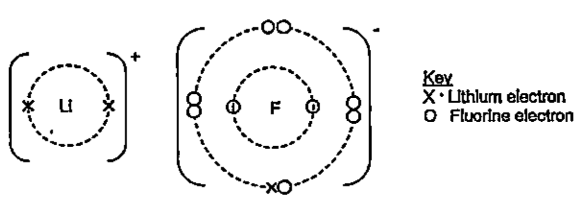
Colourless solution turns brown / black precipitate will be seen, **1m**

Fluorine is more reactive than iodine and displaces the iodide ions to form brown aqueous iodine **1m**

[2]

(c) Lithium reacts with fluorine to form lithium fluoride which melts at 845°C

(i) Draw the 'dot and cross' diagram to show the bonding in lithium fluoride



1m **1m**

[2]

(ii) Explain why lithium fluoride has a high melting point.

Lithium fluoride has giant crystal/ionic lattice structure, **1m**

Strong electrostatic force of attraction between lithium and fluoide ions,

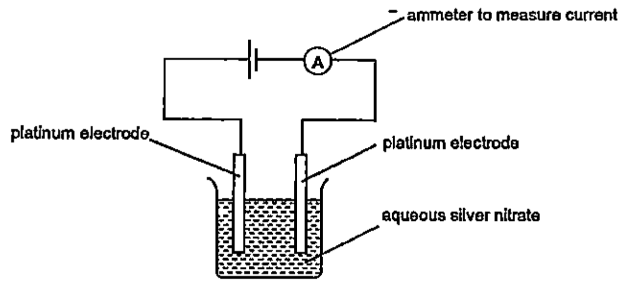
a lot of energy is required to break force of attraction, hence high m p **1m**

[2]

[Total 8]

EITHER

B10 A student carried out the electrolysis of 2 equal volumes of silver nitrate solutions of the same concentration using platinum electrodes as shown in the diagram below



In Experiment 1, a current of 1 0 ampere was used and the mass of one of the electrodes was weighed every 5 minutes to determine the mass of the silver deposited. This was done for 60 minutes The results in the following table are plotted on the grid on page 18

Time (min)	0	5	10	15	20	25	30	35	40	45	50
Mass of silver deposited (g)	0	0 30	0 60	0 90	1 20	1 50	1 80	2 10	2.40	2 80	2 80

In Experiment 2, the student repeated the procedure using the same volume of aqueous silver nitrate solution but he increased the current to 1 5 amperes instead The results are shown in the following table

Time (min)	0	5	10	15	20	25	30	35	40	45	50
Mass of silver deposited (g)	0	0.45	0.90	1.35	1 80	2 25	2.70	?	2.80	2.80	2.80

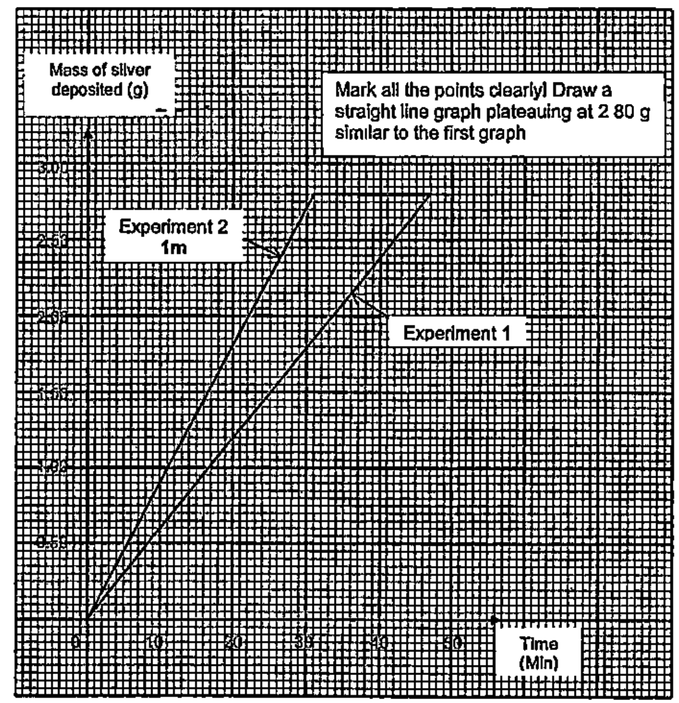
(a) Name the electrode that was weighed in the experiment. Write the equation for the reaction which takes place at this electrode

Electrode <u>Cathode</u> **1m**

Equation . <u>$Ag^+(aq)$ + e → Ag (s)</u> 1m [2]

(b) Plot the graph of mass of silver deposited against time for Experiment 2 on the same grid on page 18 Label the graph "Experiment 2" clearly

Remark , The tables show an increase in mass of the electrode so this must be the cathode Silver ions are preferentially discharged to form silver solid on the cathode



[1]

(c) Determine the mass of silver deposited after 35 minutes for the second experiment

<u>2.80 g</u> **1m** [1]

(d) State two conclusions from the results of the experiments

<u>Mass of silver deposited is directly proportional to time,</u> **1m**

The <u>larger the current, the faster the rate of the silver</u> deposited **1m OR**

An <u>increase in current</u> from 1 ampere to 1 5 amperes has <u>no effect on the final mass of silver deposited</u> [2]

The two experiments involve mass of silver deposited, time and current so conclusions should be specific to these factors and their relationships

Rejected
The final mass of silver for both experiments in 2 80 g (not a conclusion based on experiments but a fact)
An increase in current increases the rate of reaction/ rate of electrolysis (not specific enough)

When the same volume and concentration of solution is used, the mass of silver deposited will be the same (True but not based on experiments, we did not vary volume/concentration to investigate this)

(e) State a change in the electrolyte at the end of the electrolysis of the two silver nitrate solutions

The electrolyte becomes more acidic or pH decreases **1m OR** [1]

Concentration of silver ions decreases **1m**

(f) If the electrolyte were replaced by copper(II) sulfate solution and the same current of 1 ampere was passed through, calculate the mass of copper deposited at the end of 40 minutes

Number of moles of silver deposited = $\frac{2.4}{108}$ mole = 0 022222 mole **1m**

$Ag^{+}(aq) + e \rightarrow Ag(s)$

1 mole of silver ions takes in 1 mole of electrons to form 1 mole of silver

Hence, 0 022222 mole of silver has combined with 0 022222 mole of electrons

$Cu^{2+}(aq) + 2e \rightarrow Cu(s)$

Cu^{2+} ions takes in twice the number of electrons to form 1 mole of copper

Hence, number of moles of copper deposited by 0 022222 mole of electrons

= 0 5 x 0 022222 = 0 011111 mole **1m**

Mass of copper deposited = 0 011111 x 64 = 0.711 g (3 s f) **1m**

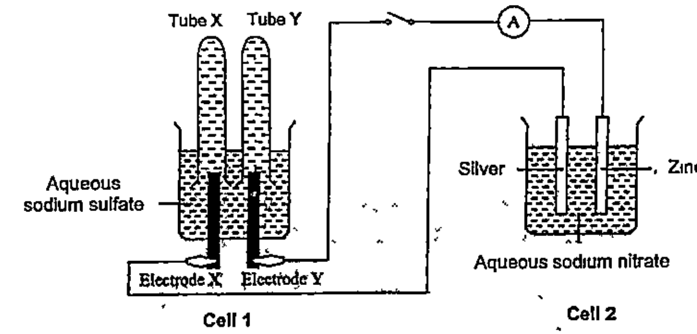
Rejected.
Mass of copper deposited = 2.40/ 2 = 1 20 g (Ratio of masses ≠ ratio of moles)

[3]

[Total 10]

OR

B10 The diagram below shows an experimental set-up of a simple cell and an electrolytic cell Both electrodes **X** and **Y** are made of graphite The switch is then closed and reactions take place in both cells



(a) Which is the simple cell? Explain your answer

Simple Cell Cell 2 **1m** [1]

Explanation · simple cell consists of 2 different metals dipped in electrolyte

and not connected to external power supply Both points **1m**

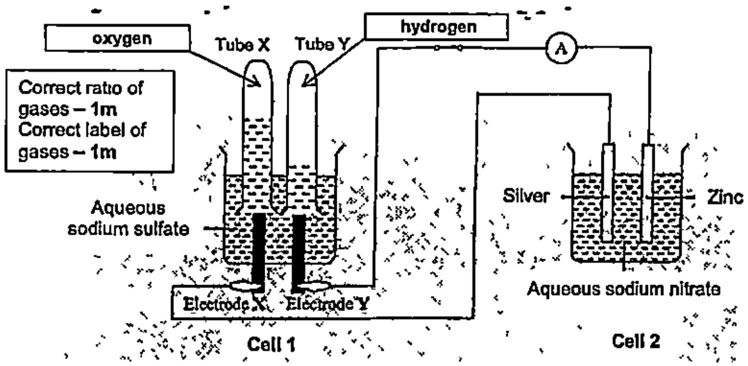
[1]

(b) Write the ionic equations for the reactions which take place at the electrodes of **Cell 1.**

Electrode X $4OH^{-}(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e$ **1m** [1]

Electrode Y $2H^{+}(aq) + 2e \rightarrow H_2(g)$ **1m** [1]

(c) Complete the diagram below to show the new levels of the aqueous sodium sulfate solution after the switch is closed for a while and hence the relative volumes of gases collected in tube **X** and tube **Y**. Label clearly the gases collected in each tube [2]



(d) Electrode **X** is then replaced by a copper rod. State an observation and explain your answer.

Observation <u>electrolyte will turn blue</u> OR <u>size of copper decreases</u> 1m [1]

Explanation : <u>Copper electrode (the anode) ionizes to form copper(II) ions which is blue</u>, hence <u>electrolyte turns blue</u> OR <u>copper electrode becomes smaller</u> as copper ionizes 1m [1]

(e) State and explain an observation that can be made in **Cell 2** during the experiment.

Observation : <u>Size of zinc decreases</u> OR <u>bubbles seen at silver electrode</u> 1m [1]

Explanation : <u>zinc, the more reactive metal, ionizes to form zinc ions</u> OR <u>Hydrogen ions accept electrons to form hydrogen gas</u> 1m

[1]

[Total 10]

Rejected
Reddish brown solid deposited on electrode Y (this does not happen immediately, at the beginning effervescence is seen as hydrogen ions are preferentially discharged)

DATA SHEET
The Periodic Table of the Elements

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
†90-103 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 = 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.).

SWISS COTTAGE SECONDARY SCHOOL
SECONDARY FOUR EXPRESS
PRELIMINARY EXAMINATIONS

Name ______________________ ( ) Class 4E

CHEMISTRY 5073/01

Monday 24 August 2015

Additional Materials. Multiple Choice Answer Sheet 1 hour

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 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 18
The use of an approved scientific calculator is expected, where appropriate

This document consists of 18 printed pages

Setter Mr Goh Weibin
Vetters Mr Hoon Yongwei & Mdm Tan Pui San

[Turn over

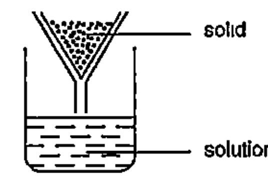
1 A crystal of iodine produces a coloured vapour when gently heated

Which pair of statements correctly describes this process?

	type of bond broken	formula of coloured species
A	intermolecular	I
B	intermolecular	I_2
C	intramolecular	I
D	intramolecular	I_2

2 A mixture of copper, magnesium and zinc is added to an excess of dilute sulfuric acid

The resulting mixture is then filtered



What is the colour of the filtrate?

A blue

B colourless

C grey

D pink

3 Which of these pairs of aqueous ions both react with dilute sulfuric acid to give a visible result?

A Ba^{2+} and Cl^-

B Ba^{2+} and CO_3^{2-}

C NH_4^+ and Cl^-

D NH_4^+ and CO_3^{2-}

4 Which atom has twice as many neutrons as protons?

A $^{1}_{1}H$ B $^{2}_{1}H$ C $^{3}_{1}H$ D $^{4}_{1}H$

5 The ^{68}Ge isotope is medically useful because it undergoes a natural radioactive process to give a gallium isotope, ^{68}Ga, which can be used to detect tumours This transformation of ^{68}Ge occurs when an electron enters the nucleus, changing a proton into a neutron

Which statement about the composition of an atom of the ^{68}Ga isotope is correct?

A It has 3 shells

B It has 5 electrons in its outer shell

C It has 37 neutrons

D Its proton number is 32

6 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

7 Boron is a non-metallic element which is placed above aluminium in Group III of the Periodic Table It forms a compound with nitrogen known as boron nitride which has a structure similar to graphite.

Which of the following conclusions can be drawn from this information?

1 The empirical formula of boron nitride is BN

2 The boron and nitrogen atoms are likely to be arranged alternately in a hexagonal pattern.

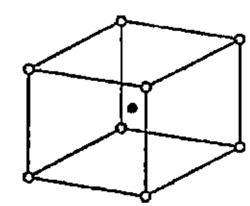
3 Boron nitride has a layer structure with intermolecular forces of attraction between the layers

A 1 only B 1 and 2 only C 2 and 3 only D 1, 2 and 3

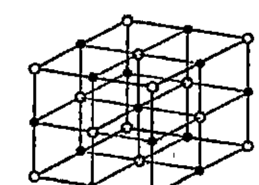
8 The table gives the radii, in pm, of some ions [1 pm = 10^{-12} m]

ion	radii
Na^+	102
Mg^{2+}	72
Cs^+	167
Cl^-	181
O^{2-}	140

Caesium chloride, CsCl, has a different lattice structure from both sodium chloride, NaCl, and magnesium oxide, MgO



CsCl lattice



NaCl and MgO lattice

Which factor appears to determine the type of lattice for these three compounds?

A the charge on the cation

B the ratio of the ionic charges

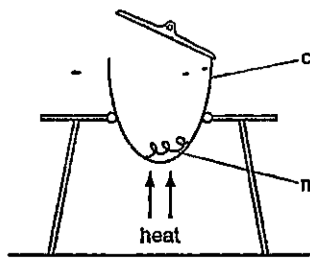
C the ratio of the ionic radii

D the sum of the ionic charges

9 Which relative molecular mass, Mr, is **not** correct for the molecule given?

	molecule	M_r
A	ammonia	17
B	carbon dioxide	44
C	methane	16
D	oxygen	16

10 The diagram shows an experiment to find the formula of magnesium oxide



Which piece of apparatus would be needed in addition to those shown?

A a balance

B a measuring cylinder

C a stopwatch

D a thermometer

11 Nickel makes up 20 % of the total mass of a coin The coin has a mass of 10 0 g.

How many nickel atoms are there in the coin?

A $2\ 03 \times 10^{22}$ B 4.29×10^{22} C $2\ 14 \times 10^{23}$ D $1\ 20 \times 10^{24}$

12 On collision, airbags in cars can inflate rapidly due to the production of nitrogen

The nitrogen is formed according to the following equations.

$$2NaN_3 \rightarrow 2Na + 3N_2$$

$$10Na + 2KNO_3 \rightarrow K_2O + 5Na_2O + N_2$$

How many moles of nitrogen gas are produced from 1 mol of sodium azide, NaN_3?

A 1 5 B 1.6 C 3 2 D 4.0

13 Which oxide, when mixed with water, will produce the solution with the lowest pH?

A CO B Na_2O C P_4O_{10} D SiO_2

14 A sample of soil has a nitrogenous fertiliser in the form of an ammonium salt added to it The ammonium salt dissolved in the water in the soil

When tested a week later, the water in the soil contained 15 3 % of dissolved nitrogen and had a pH of 4 6

Calcium hydroxide was added to the soil and then the water in the soil was tested the next day, both for nitrogen content and pH

What would be the most likely result of the final test?

	% of nitrogen	pH
A	11 4	4 6
B	12.7	6.9
C	15 3	4 6
D	15 3	6 9

15 The table gives the concentrations and pH values of the aqueous solutions of two compounds X and Y Either compound could be an acid or base

	X	Y
concentration	2 mol/dm^3	2 mol/dm^3
pH	6	10

Student P concluded that X is a weak base

Student Q concluded that the extent of dissociation is lower in X(aq) than in Y(aq)

Which of the students are correct?

A both P and Q

b neither P and Q

C P only

D Q only

16 A student puts 10 cm^3 of 0.100 mol/dm^3 nitric acid into one test-tube and 10 cm^3 of 0.100 mol/dm^3 ethanoic acid into another test-tube. He then adds 1.0 g (an excess) of magnesium ribbon to each test-tube and takes suitable measurements. Both acids have the same starting temperature.

Neither reaction is complete after 2 minutes, but both are complete after 20 minutes.

Which statements are correct?

1 After 2 minutes, the nitric acid is at a higher temperature than the ethanoic acid.

2 After 2 minutes, the nitric acid has produced more gas than the ethanoic acid.

3 After 20 minutes, the nitric acid has produced more gas than the ethanoic acid.

A 1 only **B** 1 and 2 only **C** 2 and 3 only **D** 1, 2 and 3

17 Rat poison needs to be insoluble in rain water but soluble at the low pH of stomach contents.

What is a suitable barium compound to use for rat poison?

A barium carbonate

B barium hydroxide

C barium nitrate

D barium sulfate

18 In which equation is the underlined substance acting as a reducing agent?

A $3\underline{CO} + Fe_2O_3 \rightarrow 2Fe + 3CO_2$

B $\underline{CO_2} + C \rightarrow 2CO$

C $\underline{CuO} + H_2 \rightarrow Cu + H_2O$

D $\underline{CaO} + H_2O \rightarrow Ca(OH)_2$

19 Sulfur dioxide, SO_2, is added to wines to prevent oxidation of ethanol by air. To determine the amount of SO_2, a sample of wine is titrated with iodine, I_2. In this reaction, one mole of SO_2 is oxidised by one mole of I_2.

What is the change in oxidation number of sulfur in this reaction?

A $+2 \rightarrow +4$ **B** $+4 \rightarrow +6$ **C** $+6 \rightarrow +4$ **D** $+4 \rightarrow +2$

20 A metal has the following properties.

- It does not react with cold water.
- It reacts with dilute hydrochloric acid.
- It cannot be extracted from it oxide using carbon.

Between which two metals in the reactivity series should it be placed?

A calcium and magnesium

B iron and copper

C magnesium and zinc

D zinc and iron

21 Which of the following carbonates shows the least change in mass after strong heating?

A calcium carbonate

B copper(II) carbonate

C sodium carbonate

D silver carbonate

22 Some calcium carbonate and hydrochloric acid start to react

Water is then added to the reaction mixture

What happens to the speed of the reaction?

A It decreases

B It increases

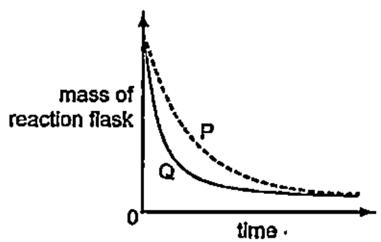
C It stays the same.

D It stops

23 A student investigates the rate of reaction between marble chips and hydrochloric acid

The loss in mass of the reaction flask is measured.

The graph shows the results of two experiments, P and Q



Which change explains the difference between P and Q?

A A catalyst is added in P.

B A higher temperature is used in P

C A higher pressure is used in Q

D Powdered marble chips are used in Q

24 The following report appeared in a newspaper

> Drums of bromine broke open after a vehicle crash on the motorway Traffic was diverted as purple gaseous bromine drifted over the road (it is denser than air), causing irritation to drivers' eyes Fireman sprayed water over the scene of the accident, dissolving the bromine and washing it away

What is **wrong** with the report?

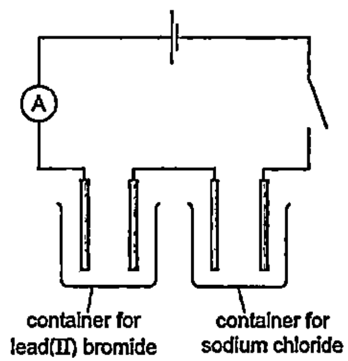
A Bromine does not dissolve in water

B Bromine does not vapourise readily

C Bromine is less dense than air.

D Bromine is not purple

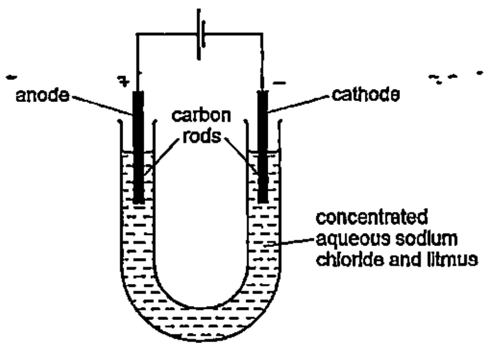
25 The diagram shows the circuit for electrolysing lead(II) bromide and sodium chloride to liberate the metal.



In which form are these salts electrolysed for liberating the metal?

	lead(II) bromide	sodium chloride
A	concentrated solution	concentrated solution
B	concentrated solution	molten
C	molten	concentrated solution
D	molten	molten

26 The diagram shows the electrolysis of concentrated aqueous sodium chloride



What is the colour of the litmus at each electrode after five minutes?

	colour at anode	colour at cathode
A	blue	green
B	red	green
C	colourless	green
D	colourless	blue

27 The ability of an atom in a covalent bond to attract electrons to itself is called its electronegativity

The greater the difference between the electronegativities of the two atoms in the bond, the more polar is the bond.

Which pair will form the **most** polar covalent bond between the atoms?

A chlorine and bromine

B chlorine and iodine

C fluorine and chlorine

D fluorine and iodine

28 Which substance does **not** produce a poisonous gas when burnt in a limited amount of air?

A hydrogen B methane C propene D sulfur

29 Which gas is present in the exhaust fumes of a car engine in a much greater amount than any other gas?

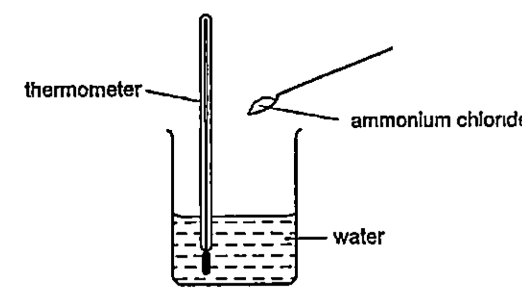
A carbon dioxide

B carbon monoxide

C nitrogen

D water vapour

30 When solid ammonium chloride is added to water, a solution is formed



Which row correctly shows the temperature change and the type of reaction taking place?

	temperature change	type of reaction
A	decreases	endothermic
B	decreases	exothermic
C	increases	endothermic
D	increases	exothermic

31 Some bond energy values are listed below.

bond	bond energy / $kJ mol^{-1}$
C–H	410
C–C*l*	340
C*l*–C*l*	244
Br–Br	193

These bond energy values relate to the following four reactions

P $Br_2 \rightarrow 2Br$

Q $2Cl \rightarrow Cl_2$

R $CH_3 + Cl \rightarrow CH_3Cl$

S $CH_4 \rightarrow CH_3 + H$

What is the order of enthalpy changes of these reactions from most negative to most positive?

A P → Q → R → S

B Q → R → S → P

C R → Q → P → S

D S → P → Q → R

32 Ethanol is a fuel used in cars It can be made from petroleum.

$$C_4H_{10} \rightarrow C_2H_4 + C_2H_6$$

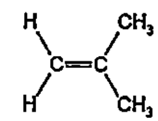
$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

Compounds of how many homologous series appear in these equations?

A 1 B 2 C 3 D 4

33 The compound 2-methylpropene, C_4H_8, is a monomer used in the production of synthetic rubber



In addition to 2-methylpropene there are x other isomers of C_4H_8 which contain a double bond.

What is the value of x?

A 1 B 2 C 3 D 4

34 One of the reactions taking place in a catalytic converter in a car exhaust system is between nitrogen oxide and octane (unburned petrol). The products of this reaction are non-toxic

Which is the correct equation for the reaction?

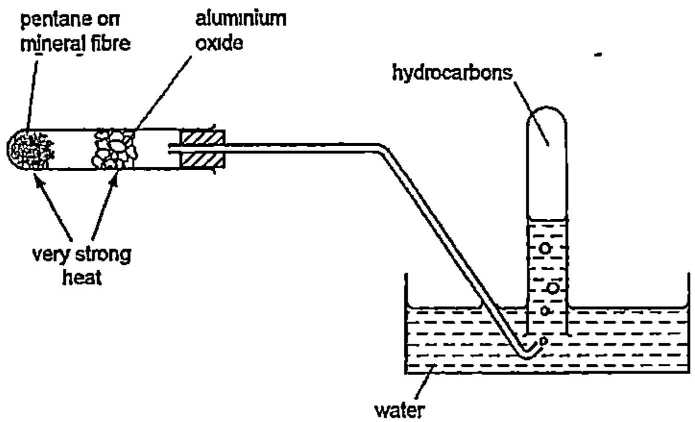
A $C_8H_{16} + 16NO \rightarrow 8CO + 8N_2 + 8H_2O$

B $C_8H_{16} + 24NO \rightarrow 8CO_2 + 12N_2 + 8H_2O$

C $C_8H_{18} + 17NO \rightarrow 8CO + 8\frac{1}{2}N_2 + 9H_2O$

D $C_8H_{18} + 25NO \rightarrow 8CO_2 + 12\frac{1}{2}N_2 + 9H_2O$

35 Which hydrocarbon would **not** be collected in the inverted tube by heating pentane, $CH_3(CH_2)_3CH_3$, in the apparatus shown?



A CH_4

B CH_3CH_3

C $CH_3CH_2CH{=}CH_2$

D $CH_3(CH_2)_8CH_3$

36 A pure hydrocarbon is used in bottled gas for cooking and heating.

Exactly 50 cm^3 of oxygen is needed for complete combustion of 10 cm^3 of the hydrocarbon.

30 cm^3 of carbon dioxide is produced

All gaseous volumes were measured at room temperature and pressure.

What is the formula of the hydrocarbon?

A C_2H_6 **B** C_3H_6 **C** C_3H_8 **D** C_4H_{10}

37 The solubility of the carboxylic acids in water decreases as the size of the carboxylic acid molecules increases

Which carboxylic acid is the least soluble in water?

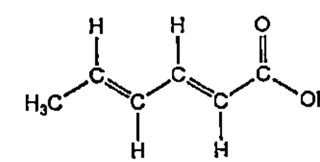
A butanoic acid

B ethanoic acid

C methanoic acid

D propanoic acid

38 Sorbic acid is used as a food preservative because it kills fungi and moulds.



sorbic acid

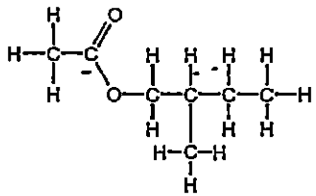
Sorbic acid will react with

- hydrogen in the presence of a nickel catalyst,
- bromine in an organic solvent

How many moles of hydrogen and of bromine will be incorporated into one mole of sorbic acid by these reactions?

	moles of hydrogen	moles of bromine
A	2	2
B	2	2½
C	3	2
D	3	2½

39 Bees use 2-methylbutyl ethanoate as an 'alarm' pheromone to alert other bees



2-methylbutyl ethanoate

Which starting materials would be required to synthesise 2-methylbutyl ethanoate?

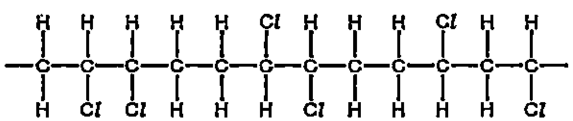
A CH_3CH_2OH and $CH_3CH_2CH(CH_3)CO_2H$

B CH_3CO_2H and $CH_3CH_2CH(CH_3)CH_2OH$

C CH_3CH_2OH and $CH_3CH_2CH(CH_3)CH_2CO_2H$

D CH_3CO_2H and $CH_3CH_2CH(CH_3)CH_2CO_2H$

40 A molecule of a polymer contained the sequence shown



Which monomer could produce this polymer by addition polymerisation?

A $CHCl{=}CHCl$

B $CH_2{=}CHCl$

C $CH_3CCl{=}CHCl$

D $CH_3CCl{=}CH_2$

DATA SHEET
The Periodic Table of the Elements

I	II											III	IV	V	VI	VII	0
							1 H 1										4 He 2
7 Li 3	9 Be 4											11 B 5	12 C 6	14 N 7	16 O 8	19 F 9	20 Ne 10
23 Na 11	24 Mg 12											27 Al 13	28 Si 14	31 P 15	32 S 16	35.5 Cl 17	40 Ar 18
39 K 19	40 Ca 20	45 Sc 21	48 Ti 22	51 V 23	52 Cr 24	55 Mn 25	56 Fe 26	59 Co 27	59 Ni 28	64 Cu 29	65 Zn 30	70 Ga 31	73 Ge 32	75 As 33	79 Se 34	80 Br 35	84 Kr 36
85 Rb 37	88 Sr 38	89 Y 39	91 Zr 40	93 Nb 41	96 Mo 42	Tc 43	101 Ru 44	103 Rh 45	106 Pd 46	108 Ag 47	112 Cd 48	115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
133 Cs 55	137 Ba 56	139 La 57 *	178 Hf 72	181 Ta 73	184 W 74	186 Re 75	190 Os 76	192 Ir 77	195 Pt 78	197 Au 79	201 Hg 80	204 Tl 81	207 Pb 82	209 Bi 83	Po 84	At 85	Rn 86
Fr 87	226 Ra 88	227 Ac 89 †															

140 Ce 58	141 Pr 59	144 Nd 60	Pm 61	150 Sm 62	152 Eu 63	157 Gd 64	159 Tb 65	162 Dy 66	165 Ho 67	167 Er 68	169 Tm 69	173 Yb 70	175 Lu 71
232 Th 90	Pa 91	238 U 92	Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100	Md 101	No 102	Lr 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.)

SWISS COTTAGE SECONDARY SCHOOL
SECONDARY FOUR EXPRESS
PRELIMINARY EXAMINATIONS

Name: ______________________( )   Class: Sec 4E ______

CHEMISTRY
Paper 2

5073/02
Thursday 20 Aug 2015
1 hour 45 min

Additional materials: Nil

READ THESE INSTRUCTIONS FIRST

Write in blue or black ink. You may use a calculator.

Section A
Answer all the questions in the spaces provided

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

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

This question paper consists of 20 printed pages.

Setter: Mr Hoon Yeng Wei
Vetter: Mr Goh Weibin and Mdm Tan Pui San

[Turn over

*We Nurture Students to **Think, Care** and **Lead** with **P.R.I.D.E.***

Section A (50 Marks)

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

A1 The diagram shows the structures of various compounds.

substance	melting point / °C	boiling point / °C	electrical conductivity as a solid	electrical conductivity as a liquid
A	839	1484	good	good
B	-188	-42	poor	poor
C	776	1497	poor	good
D	-117	78	poor	poor
E	1607	2227	poor	poor
F	-5	102	poor	good

Use the letters **A** to **F** to answer the following questions.
Each compound may be used once, more than once or not at all.

(a) Which substance could be a metal?

....[1]

(b) State all the substances that are liquid at room temperature?

....[1]

(c) Which substance could have a macromolecular structure similar to that of silicon(IV) oxide?

....[1]

(d) Which substance could be propane?

.... [1]

(e) Which substance could be sodium chloride?

....[1]

A2 The table shows some properties of the Group I metals.

metal	density in g / dm^3	melting point / °C	boiling point / °C
lithium	0.53	181	1342
sodium	0.97	98	883
potassium	0.86	63	
rubidium	1.53	39	686
caesium	1.88	29	669

(a) **(i)** Describe the general trend in the density of the Group I metals.

....[1]

(ii) Predict the boiling point of potassium.

....[1]

(iii) What is the physical state of caesium at 35 °C? Explain your answer.

....

....[1]

(b) **(i)** Describe the trend in reactivity of the Group I metals with water.

....[1]

(ii) Construct the equation for the reaction of rubidium with water.

....[1]

(iii) The reaction of rubidium with water is exothermic.
What is meant by the term *exothermic*?

....[1]

(c) Sodium and calcium form ionic hydrides containing the hydride ion, H^-.
Sodium and calcium hydrides react with water to form the hydroxide and hydrogen.

$$NaH + H_2O \rightarrow NaOH + H_2$$

$$CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$$

Deduce the general ionic equation for these reactions.

....[1]

(d) Sodium is a soft metal with little catalytic activity.
Nickel is a hard metal which is often used as a catalyst.

(i) Describe two **other** differences in the physical properties of sodium and nickel.

1 ....

....

2 ....

....
[2]

(ii) State one industrial use of nickel as a catalyst.

....[1]

(iii) Explain why an alloy of nickel and copper is less malleable than copper alone.

....

....

....

....

.... [2]

A3 The melting point of sodium chloride is 801 °C.
The melting point of chlorine is −101 °C.

(a) Explain, in terms of structure and bonding, the difference between the melting points of these two substances.

....

....

....

....

....

....

....[3]

(b) Explain why molten sodium chloride conducts electricity but solid sodium chloride does not.

....

....

....

....

....

....

....[2]

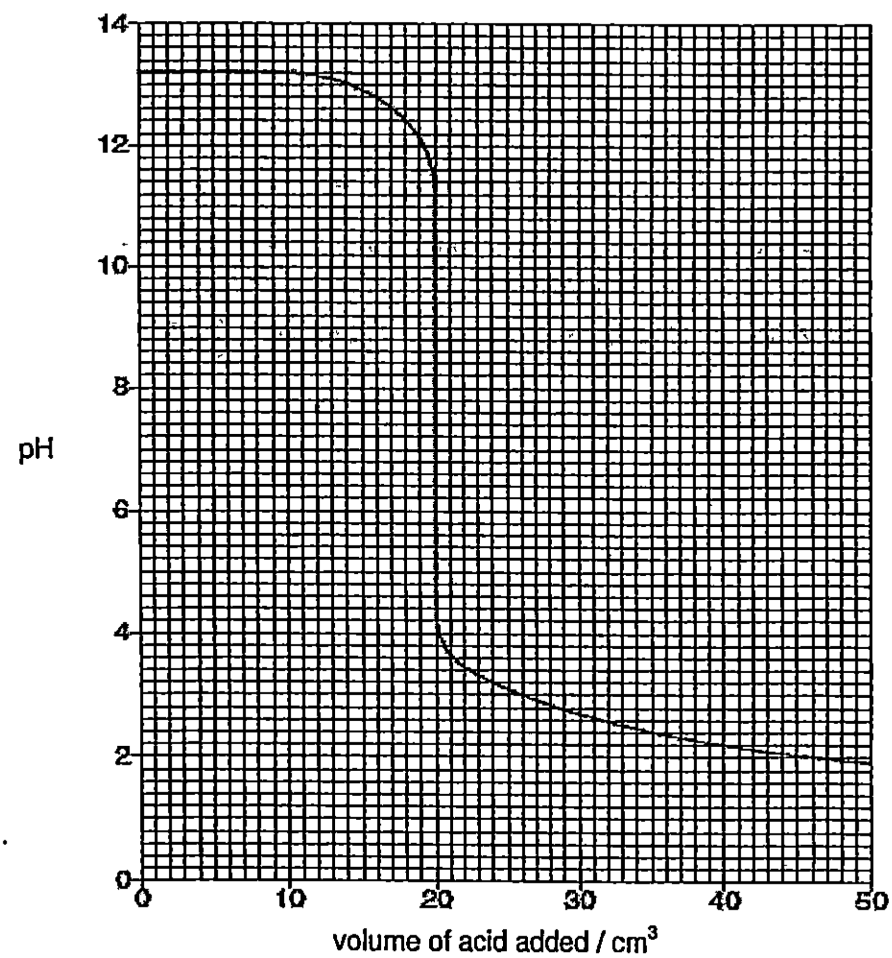
A4 Sulfuric acid reacts with the alkali sodium hydroxide.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

(a) Write the ionic equation for this reaction.

....[1]

(b) The graph below shows how the pH changes when aqueous sulfuric acid is added slowly to 45.0 cm^3 of 0.150 mol / dm^3 sodium hydroxide until the acid is in excess.



(i) What volume of acid has been added when the pH is 7?

....[1]

(ii) Use your answer to part (i) to calculate the concentration, in mol / dm^3, of the sulfuric acid.

[3]

(c) The experiment was repeated using ethanoic acid of the same concentration as the sulfuric acid The same volume and concentration of aqueous sodium hydroxide was used.

(i) The volume of ethanoic acid required to neutralise the aqueous sodium hydroxide was twice as great compared with the volume of sulfuric acid.

Explain why.

....

....[2]

(ii) Suggest the value of the pH after excess ethanoic acid has been added.

....

....[1]

(d) Sulfuric acid is one of the acids present in acid rain.

(i) Suggest how sulfuric acid is formed in the atmosphere.

....

....

....[2]

(ii) State one effect of acid rain on human health.

....

.... [1]

A5 Chromium is a transition element.

(a) (i) State two differences in the physical properties of chromium and sodium.

....

....

....

....[2]

(ii) State two differences in the chemical properties of chromium and sodium.

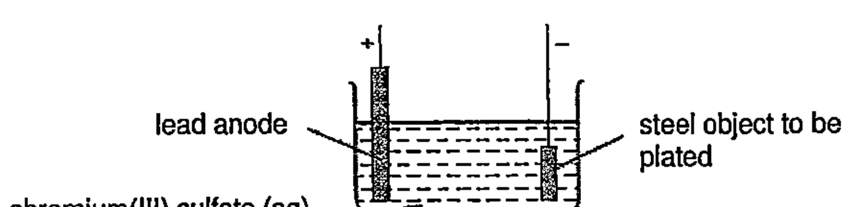
....

....

....

....[2]

(b) Chromium is used in minute amounts in producing stainless steel. Chromium is also used to electroplate steel objects. The diagram shows how this could be done.



(i) Suggest **two** reasons why steel objects are plated with chromium.

....

....[2]

(ii) Write the ionic half-equation for the reaction at the negative electrode.

....[1]

(iii) During the electroplating process, a colourless gas is formed at the positive electrode. Suggest the name for this gas and describe the test for it.

....

....

....

....[2]

(iv) During electroplating, it is necessary to add more chromium(III) sulfate but during copper plating using a copper anode, it is not necessary to add more copper(II) sulfate. Explain this difference.

....

....

....

....

....

....[2]

A7 Iodine reacts with chlorine to form dark brown iodine monochloride.

$$I_2 + Cl_2 \rightarrow 2ICl$$

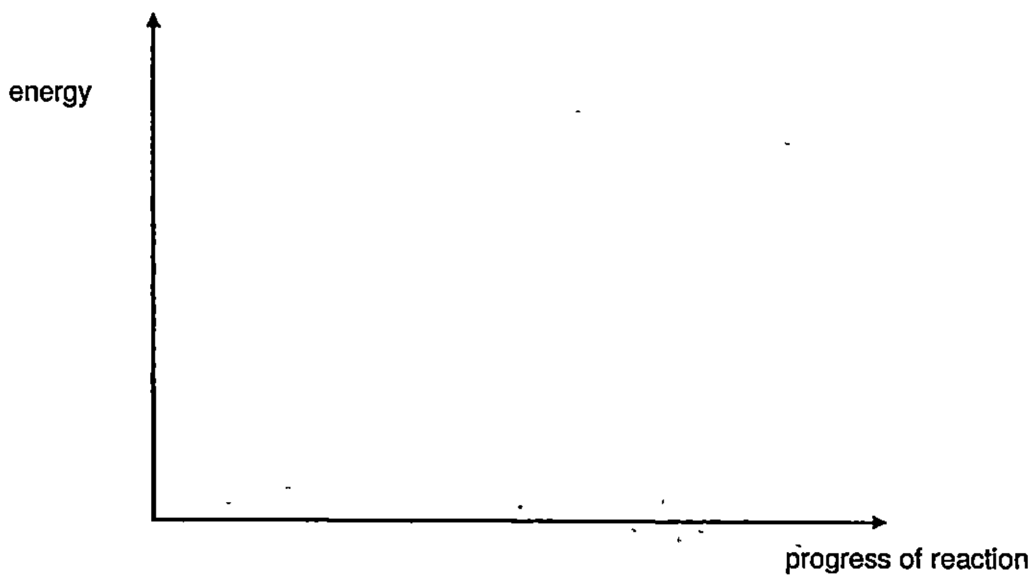
(a) Calculate the overall energy change for the reaction between iodine and chlorine using the bond energy values shown.

bond	energy / kJ per mol
I - I	151
Cl - Cl	242
I - Cl	208

Show your working.

[3]

(b) Draw a labelled energy level diagram for the reaction between iodine and chlorine using the information in **(a)**. Label **'activation energy** and **'ΔH'**.



[3]

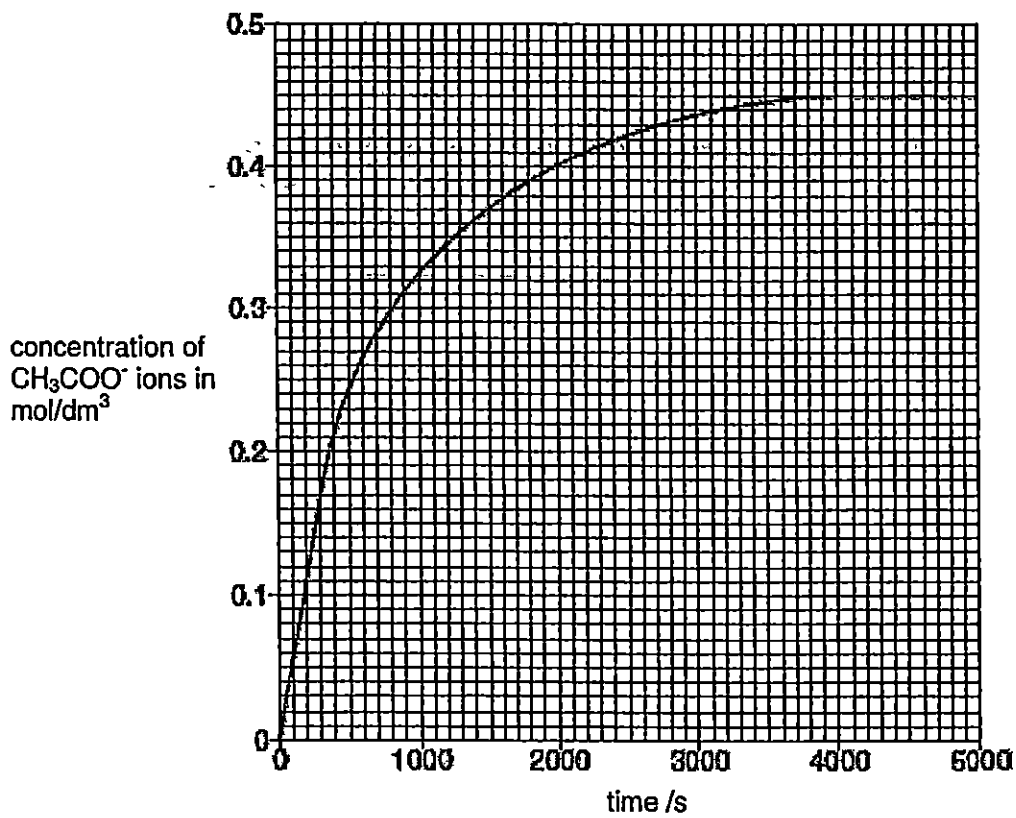
Name:____________________________ (   )   Class:____

Section B

Answer all **three** questions from this section.
The last question is in the form either/or and only **one** of the alternatives should be attempted.
The total mark for this section is 30

B8 The ester, ethyl ethanoate, reacts with hydroxide ions to form ethanoate ions and ethanol.

The graph shows how the concentration of ethanoate ions, CH_3COO^-, changes as the reaction proceeds at 25 °C.



(a) Write a balanced chemical equation for the reaction.

....[1]

(b) Describe and explain, using the kinetic particle theory, the change in the rate of reaction with time in the above graph.

....

....

....

....

....[3]

(c) Use the information in the graph to deduce the mass of ethanoate ions in 200 cm^3 of solution when the reaction is complete.

[2]

(d) Use the information in the graph to calculate the average rate of reaction, in mol / dm^3 / s, during the first 300 seconds.

[1]

(e) Describe how, and explain why, the rate of reaction changes with increase in concentration of hydroxide ions.

....

....

....

....[2]

(f) Sketch on graph, the curve you would expect if the reaction is done at 40 °C. Label this curve **H**.

[1]

B9 There are two types of polymerisation, addition and condensation.

(a) Explain the difference between these two types of polymerisation.

....

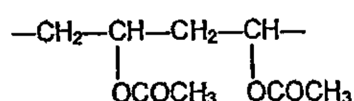
.... [1]

(b) Some plastics, formed by polymerisation, are non-biodegradable.
Describe two pollution problems that are caused by non-biodegradable plastics.

....

....[2]

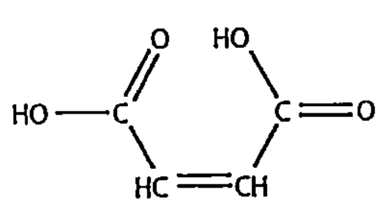
(c) The polymer known as PVA is used in paints and adhesives. Its structural formula is shown below.



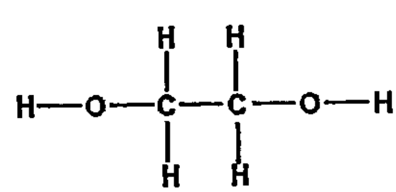
Deduce the structural formula of its monomer.

[1]

(d) The structural formulae of butenediol acid and ethane-1,2-diol are shown.



butenediol acid



ethane-1,2-diol

Describe the visible observations when butenediol acid or ethane-1,2-diol reacts with

(i) aqueous bromine

....

....[1]

(ii) aqueous sodium carbonate

....

....[1]

(iii) acidified potassium(VII) manganate

....

....[1]

(e) Butenediol acid and ethane-1,2-diol can undergo condensation polymerisation under the right conditions to form a polymer **W**.

Draw the structural formula of a repeat unit of the polymer **W** and circle the group that links the monomers together.

[2]

(f) Butenediol acid can undergo self-polymerisation under the right conditions to form a polymer **X**.

Draw the structural formula of two repeat units of the polymer **X**.

[1]

Either

B10

'Tin cans' are often used as containers for food. In fact, a 'tin can' is made from a steel alloy with a thin coating of tin on it

To recover the tin from used cans, they crushed and then warmed with chlorine. The tin forms tin(IV) chloride, boiling point 114 °C, which distils from the mixture.

On stronger heating, the tin(IV) chloride decomposes into molten tin and chlorine, which is re-used.

(a) Suggest why the steel alloy is coated with tin for use in food containers.

....

....[1]

(b) Draw the 'dot-and-cross' diagram to show the bonding in tin(IV) chloride. Show outer electrons only.

[2]

(c) Is the bonding in this compound ionic or covalent? Give an explanation for your answer.

....

....[2]

(d) Construct the balanced chemical equation for the decomposition of tin(IV) chloride. Explain why this decomposition is an example of a redox.

....

....

....[2]

(e) Calculate the mass volume of chlorine gas produced from the decomposition of 30 g of tin(IV) chloride.

[3]

Or

B10

A 6.30 g sample of hydrated ethanedioic acid, $H_2C_2O_4.xH_2O$, was dissolved in water and the solution made up to 250 cm^3.

A 25.0 cm^3 sample of this solution was acidified and titrated with 0.100 mol / dm^3 potassium manganate(VII) solution. 20.0 cm^3 of this potassium manganate(VII) solution was required to react fully with the ethanedioate ions, $C_2O_4^{2-}$, present in the sample.

(a) The MnO_4^- ions in the potassium manganate(VII) *oxidise* the ethanedioate ions.

(i) How does the oxidation state of Mn change during the reaction?

....

....[1]

(ii) Complete and balance the ionic equation for the reaction between the manganate(VII) ions and the ethanedioate ions.

$2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + ...H^+(aq) \rightarrow ....Mn^{2+}(aq) + 10CO_2(aq) + ...H_2O(l)$

[1]

(b) **(i)** Calculate the number of moles of manganate(VII) used in the titration.

[1]

(ii) Calculate the relative formula mass of $H_2C_2O_4.xH_2O$.

[3]

(ii) The relative formula mass of anhydrous ethanedioic acid, $H_2C_2O_4$, is 90. Calculate the value of x in $H_2C_2O_4.xH_2O$.

[1]

(c) (i) Suggest and draw the full structural formula of anhydrous ethanedioic acid, $H_2C_2O_4$.

[1]

(ii) Draw the 'dot-and-cross' diagram to show the bonding in anhydrous ethanedioic acid, $H_2C_2O_4$.

[2]

~ End of paper ~

DATA SHEET
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 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.).

Swiss Cottage Secondary
2015 4E Prelim Examinations
Mark Scheme

Section A

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

Paper 2 Section A

Qn		Mark Scheme	M	Markers Comments
A1	a	A	1m	
	b	D and F	1m	
	c	E	1m	
	d	B	1m	
	e	C	1m	

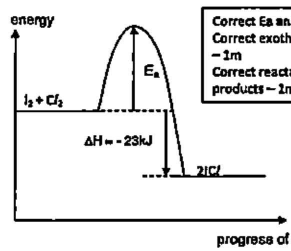
A2	ai	Density generally increases down the group	1m	
	aii	760 °C (Allow between 710 – 860 °C)	1m	
	aiii	The physical state is liquid and melting point is below 35 °C and boiling point is above 35 °C.	1m for both correct	
	bi	Metals in Group I are generally more reactive down the group	1m	
	b ii	$2Rb + 2H_2O \rightarrow 2RbOH + H_2$	1m	
	b iii	Exothermic is a reaction which releases heat / releases energy to the surroundings	1m	
	c	$H^- + H_2O \rightarrow OH^- + H_2$	1m	
	d i	Any two of the following • sodium has low density but nickel has high density • sodium has low melting and boiling point but nickel has high melting and boiling point	1m each [2m]	
	dii	Any two from the following • sodium is more reactive than nickel, • nickel has more than one oxidation state, sodium has one, • nickel forms coloured compounds, sodium compounds are white; • sodium reacts with cold water, nickel does not, • nickel has catalytic properties, sodium does not	1 m for each point [2]	

	d iii	Use in the manufacture of margarine / hydrogenation of alkenes	1m	
	d iv	Different sized nickel atoms are added to disrupt the orderly arrangement of copper atoms [1] Thus the layers of copper atoms cannot slide past one another as easily as before addition of nickel making it less malleable [1]	1m each [2m]	
A3	a	Cl_2 is a covalent substance/ molecule with a simple molecular structure [0.5] There is weak intermolecular force of attraction between molecules [0 5] Thus little heat energy is required to overcome these weak forces of attraction [0 5] Thus, Cl_2 has a low melting and boiling point. On the other hand, NaCl is an ionic compound with a giant ionic structure. [0.5] There is strong electrostatic force of attraction between oppositely charge ions [0 5] Thus high heat energy is required to overcome these strong forces of attraction.[0.5] Thus, NaCl has a high melting and boiling point.	0.5m for each point [3]	
	b	Molten sodium chloride does conduct electricity as it has mobile ions to act as charge carriers. [1] On the other hand, the ions in solid sodium chloride are held in fixed positions thus are not mobile to act as charge carriers. [1]	1 m for each point [2]	

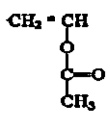
A4	a	$H^+ + OH^- \rightarrow H_2O$	1m	
	b i	20 cm^3 or 0 02 dm^3	1m	
	b ii	No of moles of NaOH = 0 15 × 0.045 = 0 00675 mol [1] Comparing mole ratio, H_2SO_4 / NaOH = 1 / 2 No of moles of H_2SO_4 = 1 / 2 x 0 00675 = 0 003375 mol [1] concentration = 0 003375 ÷ 0 02 = 0 169 mol/dm^3 [1]	1 m for each point [3]	
	c i	The volume of ethanoic acid used will be doubled / 40 cm^3. [1] 1 mole of ethanoic acid dissociates in water to produce 1 mol of H^+ whereas 1 mole of H_2SO_4 produces 2 per mol of H^+. [1] Thus for the same concentration, the volume required for ethanoic acid to neutralise sulphuric acid is twice as much	1 m for each point [2] Reject definition of 'strong' and 'weak' acid	
	c ii	Any pH value between 3 and 6 9 inclusive	1 m	

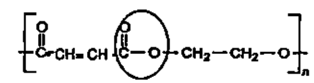
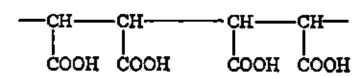
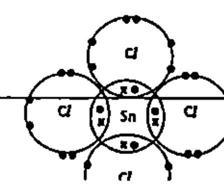
	d i	Sulfur dioxide from volcanic activity / combustion of fossil fuels[1] reacts with water in the atmosphere to produce sulfurous acid which is slowly oxidised to form sulfuric acid. [1]	1 m for each point [2]	
	d ii	Any one of the following • corrode buildings • irritates skin • irritates eyes • leaching of nutrients • harm to marine life	1 m	
A5	a	$Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$	1 m for equation 1 m for correct state symbols [2]	
	b	$4OH^- \Rightarrow 2H_2O + O_2 + 4e$ [1] Oxygen gas is produced Place a glowing splint [1] near the electrode, the glowing should relight / rekindle [1]	1 m for each point [3]	
	c	Chromium(III) sulfate is added to replace the chromium(III) ions that were used to plate steel [1] However, during copper plating using a copper anode, the copper(II) ions are replaced from the oxidation of the copper anode [1]	1 m for each point [2]	

A6	a	Energy absorbed in bond breaking = 1(I - I) + 1 (Cl - Cl) = +151 + 242 = 393 kJ [1m] Energy released in bond making = 2 (I - Cl) = 2(-208) = 416 kJ [1m] Energy change = + 393+ (-416) = - 23 kJ [1m][3]	Minus 1 for each of the following no units/sign (only for final step) allow ECF in final step	
	b	The reaction is exothermic. The heat energy absorbed for bond breaking in 1 mole of iodine and 1 mole of chlorine[1] is less than the heat energy released in the bond forming of 2 moles of iodine monochloride [1]	1m for each point [2]	

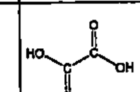
	c	 Correct Ea and ΔH – 1m Correct exothermic plot – 1m Correct reactants and products – 1m	Minus 1 mark for each of the following • Arrow points in opposite direction/double head arrow/arrow too long or too short. If exothermic plot given, ECF for Ea and ΔH, and reactants and products [3]	
B 7	a	$CH_3COOC_2H_5 + OH^- \rightarrow CH_3COO^- + C_2H_5OH$ A $CH_3COOC_2H_5 + NaOH \rightarrow CH_3COONa + C_2H_5OH$ A $CH_3COOC_2H_5 + H_2O \rightarrow CH_3COOH + C_2H_5OH$	[1]	•
	b	1 The rate of reaction decreases with time / reaction slows down [1] 2 As concentration/number of mole of ethyl ethanoate and hydroxide ions or reactant per unit volume decreases [1], 3 frequency of effective collision decreases. [1]	[3] No mark if candidates discussed with respect to temperature and SA, even if point 2 and 3 were mentioned	•

	c	Concentration of ethanoate = 0 45 mol / dm^3 No of moles of ethanoate ions = 0 45 x 200/100 = 0 09 mol [1] mass = 0 09 × 59 = 5.31 g [1]	[2] No mark for missing unit	•
	d	Average rate = 0 16/0 17 ÷ 300 = 5.33/5 67 × 10^{-4} mol/dm^3 s^{-1}[1]	[1] No mark for missing/incorrect unit or incorrect sig fig	
	e	1 The concentration of ethanoate ions will double/increase [1] 2 as the ethanol is oxidized by atmospheric oxygen to form ethanoic acid which will dissociate to form ethanoate ions [1]	[2]	•
	f	Steeper initial gradient only [1]	[1]	
B8	a	(any one) 1 Addition polymerization is where there is only one product involves unsaturated monomers with carbon – carbon double bonds Condensation polymerization involves monomers with functional group such as carboxyl group, hydroxyl group and amino group 2 Addition polymerization produces addition polymers which are made up of repeating units bonded together by carbon to carbon single covalent bond Condensation polymerization produces condensation polymers which are made up of	[1]	•

		repeating units bonded together by ester or amide linkages 3 In addition polymerization, monomers are joined together to form an addition polymer without the removal of small molecules Condensation polymerization monomers are joined together to form a condensation polymer with the removal of small molecules.		
	b	(any two) 1 Burning of plastics releases poisonous gases. 2 It causes land pollution as they take up space in landfills 3 Marine animals may mistake plastic bags for food and choke on them 4 Plastics may clog up rivers and drains, which might become breeding grounds for mosquitoes	[2]	
	c		[1]	
	di	With butenediol acid, reddish brown aqueous bromine is decolourised but remains reddish brown with ethane-1,2-diol	[1]	
	dii	With butenediol acid, bubbles of colourless odourless gas will be observed but no visible change with ethane-1,2-diol.	[1]	
	diii	With ethane-1,2-diol, purple acidified $KMnO_4$ is	[1]	

		decolourised but remains purple with butenediol acid.		
	ei		1m for correct circle 1m for correct structure [2]	
	eii		[1]	
B 1 0	a	The tin acts as a protective layer and prevents the iron in steel from rusting/coming into contacts with oxygen and moisture in the air	[1]	
	b	The bonding is covalent [1] This is because $SnCl_4$ has a relatively low boiling point. [1]	[2]	
	c		1m for correct bonding 1m for all correct valence electrons	

			[2] No deduction of marks for wrong size.	
	d	$SnCl_4 \rightarrow Sn + 2Cl_2$ [1] The oxidation states of tin in $SnCl_4$ has decreased from +4 to 0 in tin and $SnCl_4$ is reduced Chlorine in $SnCl_4$ has increased from -1 to 0 in Cl_2 and $SnCl_4$ is oxidised [1] Thus the reaction is a redox reaction.	[2]	•
	e	No of moles of $SnCl_4$ = 30 / 261 = 0 11494 mol [1] Compare mole ratio, Cl_2 / $SnCl_4$ = 2 / 1 No of moles of sulfur = 2 x 0 11494 = 0.22988 mol } [1] Volume of chlorine gas produced = 0 22988 x 24 = 5.52 dm^3 (3sf) [1]	[3]	•
B 9	ai	$2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + 16H^+(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_2(aq) + 8H_2O(l)$	[1]	

	aii	The oxidation state of Mn in MnO_4 decrease from +7 to +2 in Mn^{2+}	[1]	
	bi	No of moles of MnO_4^- = 0 02 × 0 100 = 2 × 10^{-3} mol	[1]	
	bii	Comparing mole ratio, $C_2O_4^{2-}$ / MnO_4^- = 5 / 2 No of moles of $C_2O_4^{2-}$ = 5 / 2 x 2 × 10^{-3} = 5× 10^{-3} mol } 1m No of moles of $C_2O_4^{2-}$ in 6.3 g = 5 × 10^{-3} x 250/25 = 0 05 mol [1m] Relative molecular mass of $H_2C_2O_4.xH_2O$ = 6.3 / 0 05 = 126 [1m]	[3]	•
	biii	Value of x = (126 – 90) / 18 = 2	[1]	
	ci		[1]	•
	cii	*Students need to refer to c(i) and draw the representative 'dot and cross' diagram	1m for correct bonding	

			1m for all correct valence electrons [2] No deduction of marks for wrong size.	

ZHONGHUA SECONDARY SCHOOL
Preliminary Examination 2015

CANDIDATE NAME ( )

CLASS

CHEMISTRY **5073/01**

Paper 1 Multiple Choice **14 September, 2015**

Secondary 4 Express **1 hr**

Set by: Ms Ong Lay Hong

Vetted by: Mrs Maybne Ang and Mr Ong Kai Kun

READ THESE INSTRUCTIONS FIRST

Write in soft pencil

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

Write your name, index number and class on the OTAS 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**

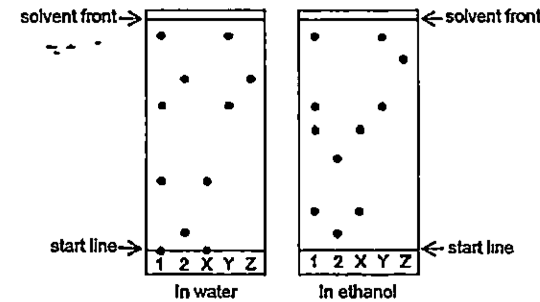
Choose the one you consider correct and record your choice in soft pencil on the separate OTAS Answer Sheet.

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

1 Food dyes, 1 and 2 are known to contain one or more of 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 There is a component in Sample 1 that is insoluble in water but soluble in ethanol
II The component in Z is more soluble in water than in ethanol
III Substance Z is likely to be pure

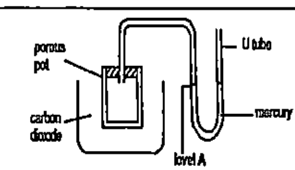
A I only **B** II only

C I and III only **D** II and III only

2 In a porous pot experiment, the porous pot was placed in a beaker of carbon dioxide The porous pot was joined to a U tube filled with mercury as shown

Which of the gases, I to IV when used to fill the porous pot would cause level A to move up?

I chlorine
II hydrogen
III ammonia
IV nitrogen



A I only **B** I and III only

C II and III only **D** II, III and IV only

3 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.

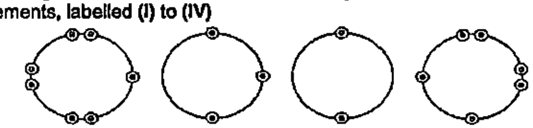
4 A giant molecule is made up of a large amount of carbon, mainly isotopes ^{12}C and ^{13}C. It was found that the average relative atomic mass of carbon in the molecule is 12.2

What is the ratio by mass of ^{12}C to ^{13}C?

A 4 : 1 B 1 : 4

C 3 : 4 D 3 : 1

5 The diagram below show the electron arrangement in the outer shells of four elements, labelled (I) to (IV)



(I) (II) (III) (IV)

Which two elements will form an ionic compound with formula of the type YZ_2?

A I and III B III and IV

C II and III D II and IV

6 Carbon monoxide is an air pollutant which is included in our PSI index and is generated by incomplete combustion of carbon containing fuels.
Which is the electronic structure, showing the outermost electrons of carbon monoxide?

A 

B 

C 

D 

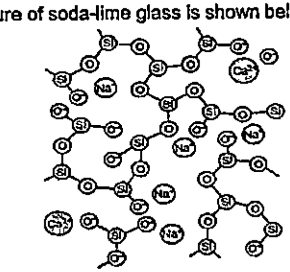
7 Silicon carbide has a similar structure to diamond.
Which one of the following are advantages of using a silicon carbide ceramic compound instead of steel?

I Silicon carbide has a higher melting point.
II Silicon carbide is more resistant to oxidation
III Silicon carbide is less likely to deform under compression

A I, II and III B I and II only

C II and III only D II only

8 A flame cauldron is specially designed and created for every Olympic games. One of the materials commonly used is soda-lime glass as it can withstand high temperatures of over 2000°C when the cauldron is lit during each opening ceremony.
The structure of soda-lime glass is shown below



Soda-lime glass is prepared by melting calcium carbonate, sodium carbonate and silicon dioxide in a furnace.

What bond(s) is/are present in soda-lime glass?

A covalent only B covalent and ionic only

C ionic and metallic only D metallic and covalent only

9 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 this toleration level? (*Note 1g =1000 mg*)

A $0.005 / 6 \times 10^{23} \times 71$

B $0.005/71 \times 6 \times 10^{23}$

C $0.005/1000 \times 1/71 \times 6 \times 10^{23}$

D $0.005/1000 \times 71 \times 6 \times 10^{23}$

10 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 pressure?

A 10 cm^3 B 15 cm^3

C 20 cm^3 D 30 cm^3

11 In a pathology laboratory, a sample of urine containing 0 120 g of urea, NH_2CONH_2 (Mr = 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 this 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

12 A cheap carbon monoxide detector for a gas heater consists of a patch containing palladium chloride crystals When carbon monoxide is present, the crystals turn from orange to black as the following reaction takes place.

$CO(g) + PdCl_2(s) + H_2O(l) \rightarrow CO_2(g) + Pd(s) + 2HCl(aq)$

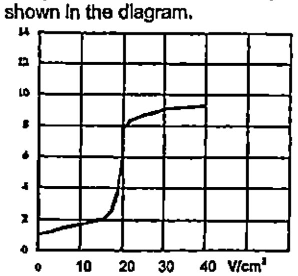
Which is the element whose oxidation number decreases in this reaction?

A carbon B chloride
C hydrogen D palladium

13 Which of the following is an example of a redox reaction?

A $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$
B $Mg + 2HCl \rightarrow MgCl_2 + H_2$
C $ZnCl_2 + 2NaOH \rightarrow Zn(OH)_2 + 2NaCl$
D $CaO + SiO_2 \rightarrow CaSiO_3$

14 In an acid – base titration, a 0 10 mol/dm^3 solution of a base is added to 20 cm^3 of a 0.10 mol/dm^3 solution of an acid
The pH value of the solution is plotted against the volume of base, *V*, added as shown in the diagram.



This diagram could represent a titration between

A CH_3COOH (aq) and NH_3 (aq) B CH_3COOH(aq) and KOH (aq)
~~C HCl (aq) and KOH (aq)~~ ~~D HCl (aq) and NH_3(aq)~~

15 The table below refers to four metals and some of their compounds

metal	action of dilute sulfuric acid on metal	effect of hydrogen on heated oxide	action of metal on a solution of the sulfate of J
G	hydrogen evolved	reduced	no reaction
H	no reaction	reduced	no reaction
I	hydrogen evolved	no reaction	J formed
J	hydrogen evolved	no reaction	no reaction

Which one of the following is the order of *thermal stability* of their carbonate towards heating?

more stable towards heating → less stable towards heating

A	H	G	J	I
B	H	J	G	I
C	I	J	G	H
D	I	H	G	J

16 The equation shows the reaction between a halogen and aqueous bromide ions.

$X_2 + 2Br^-(aq) \rightarrow 2X^-(aq) + Br_2(aq)$

Which of the following sets is true for the above reaction?

	identity of X_2	colour change observed	explanation
A	chlorine	reddish brown to colourless	X_2 is an oxidising agent.
B	chlorine	colourless to reddish brown	Br^- is oxidized.
C	iodine	brown to colourless	X_2 is reduced
D	chlorine	colourless to brown	Br^- is a reducing agent.

17 Solid X has the following properties

I It is soluble in water
II When warmed with sodium hydroxide solution, a gas is given off.
III It gives off a gas when added to dilute sulfuric acid

Which of the following is X?

A ammonium carbonate B sodium nitrate
C calcium chloride D magnesium sulfate

18 Many properties of an element and its compounds can be predicted from the position of the element in the Periodic Table What property could not be predicted in this way?

A the acidic or basic nature of its oxide
B the formula of its oxide
C the number of isotopes it has
~~D its metallic or non-metallic properties~~

19 Which of the following statements are true about the elements in Group I of the Periodic Table?

1 They are reducing agents
2 The ionic radius increases down the group
3 Their reactivities decrease on descending down the group

A 1, 2 and 3 B 1 and 2 only

C 2 and 3 only D 1 only

20 In an experiment 4 0 cm^3 of 1.0 mol/dm^3 of copper(II) sulfate solution are mixed with 8.0 cm^3 of 1 0 mol/dm^3 potassium carbonate solution

What does the reaction vessel now contain?

A a green precipitate and a blue solution

B a colourless solution only

C a white precipitate and a colourless solution

D a green precipitate and a colourless solution

21 Approximately 40% of all iron and steel is produced by recycling
Which statements 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, 2 and 3 B 1 and 2 only

C 1 and 3 only D 2 and 3 only

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

A Carbon burning in air to produce carbon dioxide

B Carbon reacting with carbon dioxide to produce carbon monoxide

C Iron (III) oxide reacting with carbon monoxide to form iron

D Iron reacting with limestone to produce slag

23 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 mol of ammonia are formed

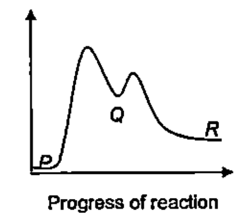
B Iron catalyst has the same effect on both forward and backward reaction

C The process is carried out at a high pressure of 250 atmospheres

D When 2 mol of N_2 and 6 mol of H_2 are used, 4 mol of NH_3 are collected

24 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?



step 1: P → Q
step 2 Q → R

A Both steps are endothermic

B The overall reaction to convert P to R is exothermic

C Step 2 involves breaking of stronger bonds than step 1 because Q is at higher energy level.

D Step 1 is harder to take place than step 2 because more energy is needed for bond breaking

25 Dilute hydrochloric acid reacts with an aqueous solution of sodium thiosulfate, $Na_2S_2O_3$,
according to the chemical equation below

$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl\,(aq) + H_2O(l) + S(s) + SO_2(g)$

10 0 cm^3 portions of 2 00 mol/dm^3 dilute hydrochloric acid were added to four separate
conical flasks. Each flask contains 90 0 cm^3 sodium thiosulfate solution which was prepared by dilution with different volumes of water as shown in the table.

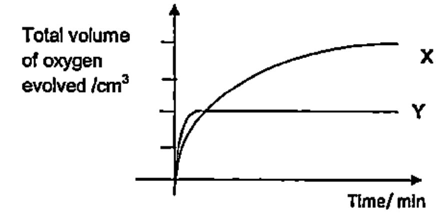
conical flask	sodium thiosulfate solution		volume of water added/cm^3
	initial concentration/ mol/dm^3	volume/cm^3	
W	1 00	80 0	10 0
X	1 50	60 0	30 0
Y	2 50	30 0	60 0
Z	3 00	20 0	70 0

In which one of the above conical flasks would the reaction proceed at the fastest rate?

A W B X

C Y D Z

26 The result of an experiment involving the decomposition of 20 0 cm^3 of hydrogen peroxide of 1.5 mol/dm^3 is represented by graph X below



Which one of the following produces graph Y?

	volume of hydrogen peroxide used (cm^3)	concentration of hydrogen peroxide used (mol/dm^3)
A	10 0	1 5
B	5 0	2 5
C	20 0	0 75
D	7.5	2 0

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

How many 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

28 In the past, CFC (chlorofluorocarbon eg CF_3CH_2Cl) compounds were used as aerosol propellants
Which element in the compound can cause a depletion of ozone?

A carbon B fluorine C chlorine D hydrogen

29 Element X is extracted by the electrolysis of a molten compound of elements X and Y The electrode reactions are shown below

cathode · $X^{2+} + 2e^- \rightarrow X$

anode $2Y^{2-} \rightarrow Y_2 + 4e$

Which of the following could be the compound?

A aluminium oxide B calcium chloride

C magnesium oxide D potassium chloride

30 Three electrolytic cells are set up with inert electrodes
The electrolytes used are listed below

cell 1 concentrated aqueous rubidium chloride
cell 2 dilute nitric 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

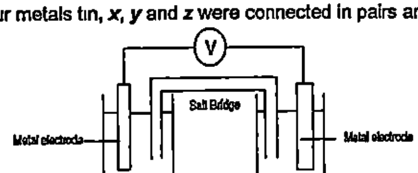
C 1 and 2 only D 1 and 3 only

31 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

32 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 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*

33 The compound C_8H_{10} is a member of a hydrocarbon homologous series
Which of the following can be the first possible member of this series?

A C_2H_6 B C_2H_4

C C_2H_3 D C_2H_2

34 Metal X reacts rapidly with hydrochloric acid It can be used for the sacrificial protection of underwater pipes

Metal Y does not corrode easily It can be used for 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

35 Which ester contains five carbon atoms in one molecule of the ester?

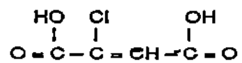
A butyl propanoate

B ethyl ethanoate

C ethyl propanoate

D propyl methanoate

36 The diagram shows the structural formula of chloromaleic acid



Which of the following statements is **incorrect?**

Chloromaleic acid

A will turn acidified potassium dichromate (VI) from orange to green

B decolourises aqueous bromine rapidly

C can undergo addition polymerisation

D will react with zinc carbonate to produce a gas

37 Which statement about fractional distillation of petroleum is correct?

A At each level in the column, only one compound is collected

B The higher up the column, the greater the temperature

C The molecules collected at the bottom of the column are the most flammable

D The molecules reaching the top of the column have the smallest relative molecular mass

38 The formulae of four covalent molecules are shown

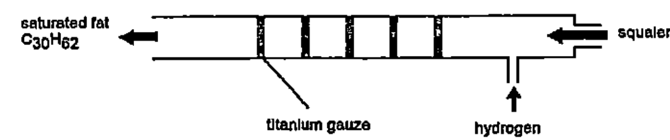
1 CO_2
2 H_2O
3 C_2H_5OH
4 C_2H_5COOH

In which pair of molecules does oxygen atom form at least one double bond in both molecules?

A 1 and 2 B 1 and 4

C 2 and 3 D 3 and 4

39 The diagram below shows how pure titanium can be used to catalyse the reduction of unsaturated oils to saturated fats Squalene is naturally occurring unsaturated oil present in sharks

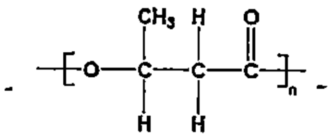


A 0 100 mol sample of squalene reacted with 14 4 dm^3 of hydrogen at room temperature and pressure to form a saturated hydrocarbon $C_{30}H_{62}$
What is the molecular formula of squalene?

A $C_{30}H_{50}$ B $C_{30}H_{52}$

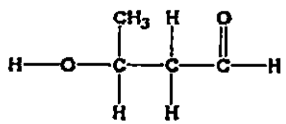
C $C_{30}H_{54}$ D $C_{30}H_{58}$

40 Polyhydroxyalkanoates are biodegradable plastics The structure of one type of these plastics is shown below

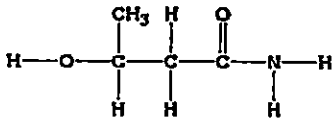


Which of the following molecules could be its monomer?

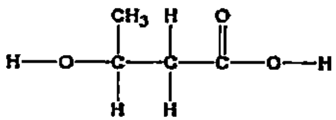
A



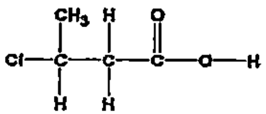
B



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

The volume of one mole of any gas is 24 dm^3 at room temperature and

ZHONGHUA SECONDARY SCHOOL
Preliminary Examination 2015

CANDIDATE NAME		( )

CLASS	4	E	

CHEMISTRY **5073/02**

Paper 2 Theory **31 August, 2015**

Secondary 4 Express **1 hour 45 minutes**

Set by: **Mrs Elizabeth Lim**

Vetted by: **Ms Ong Lay Hong and Mr Ong Kai Kun**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces at the top of this page and on all separate answer paper used.
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.

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

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

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, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question
All essential working must be shown clearly.
A copy of the Periodic Table is printed on page 21.

For Examiner's Use	
Section A	
B 7	
B 8	
B 9	
Total	

Section A

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

A1 Table 1 1 shows information about six substances

Table 1.1

substances	state at room temperature	pH in water
A	gas	1
B	gas	4
C	gas	11
D	gas	No reaction
E	liquid	7
F	solid	14
G	solid	No reaction

Use the letters **A, B, C, D, E, F** and **G** to answer the following questions.

(a) Which substance, whose solution when added to the solid G, produces an effervescence?

.... [1]

(b) Which substance, whose solution, when added to aluminum nitrate solution produces a precipitate soluble in excess?

.... [1]

(c) Which substance can be found in fizzy drinks?

.... [1]

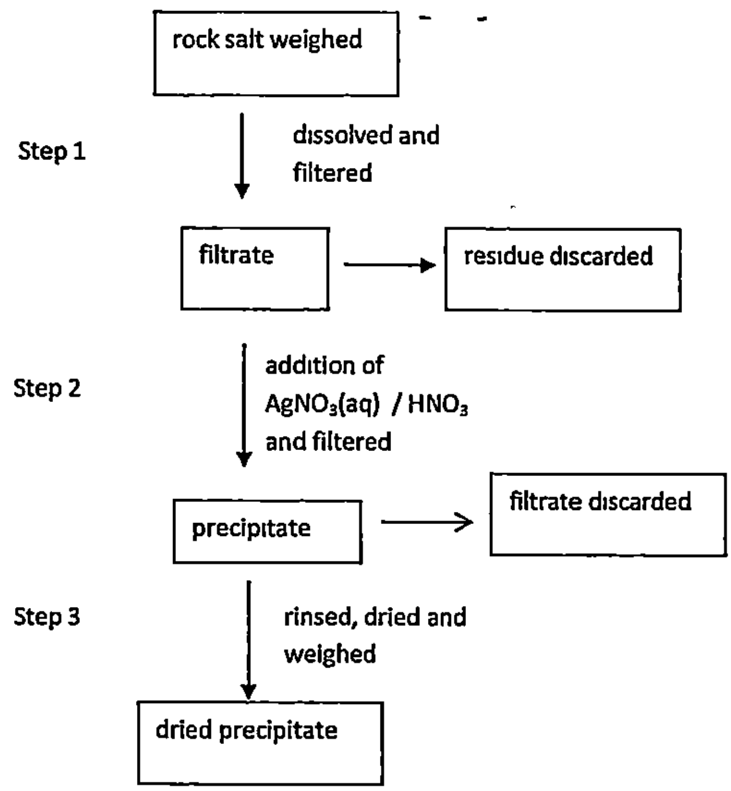
(d) Which two substances when reacted together produced a fertilizer that is used in the agriculture industry?

.... [1]

(e) Which substance is formed when there is incomplete combustion of fuel?

.... [1]

A2 Rock salt (NaCl) is an ionic compound that occurs naturally as white crystals. It is extracted from the mineral form halite or evaporation of seawater. The flowchart outlines the steps used to determine the percentage of sodium chloride present in a sample of rock salt of mass 2.5 g.



(a) Give the ionic equation for the formation of the precipitate formed in Step 2.

.... [1]

(b) Explain what precautions must be taken in steps 2 and 3 to ensure accuracy of results.

....

....

....

....

.... [2]

(c) At the end of the experiment the mass of the precipitate was found to be 5.74 g. Calculate the percentage of sodium chloride in the rock salt sample.

[3]

(d) Suggest another test to show that the rock salt is impure.

____

____

____ [2]

A3 A student performed three experiments using the metals iron, manganese and chromium.
In the first experiment he added the metals separately into dilute sulfuric acid.
In the second experiment he heated the metals in air and in the last experiment he put strips of the metals in metal salt solutions.

Table 3.1 below shows the results of the first two experiments.

Table 3 1

metal	reaction with sulfuric acid	reaction with air
iron	metal dissolves slowly with effervescence, a pale green solution is formed	burns in air to form dark brown iron (III) oxide
manganese	metal dissolves quickly with effervescence, a pale pink solution, manganese (II) sulfate, is formed	burns in air with an intense white light forming a red solid, manganese(II,III) oxide, Mn_3O_4
chromium	metal dissolves readily with effervescence, a violet solution, chromium (III) sulfate, is formed	burns in air to form green chromium(III) oxide, Cr_2O_3

(a) From the information above, state two properties of iron, manganese and chromium that show them to be transition metals.

____

____

____ [2]

(b) Write a balanced equation for the reaction of manganese with dilute sulfuric acid

____ [1]

(c) Figure 3.1 below shows strips of manganese and chromium in iron(II) sulfate and manganese(II) sulfate solutions.

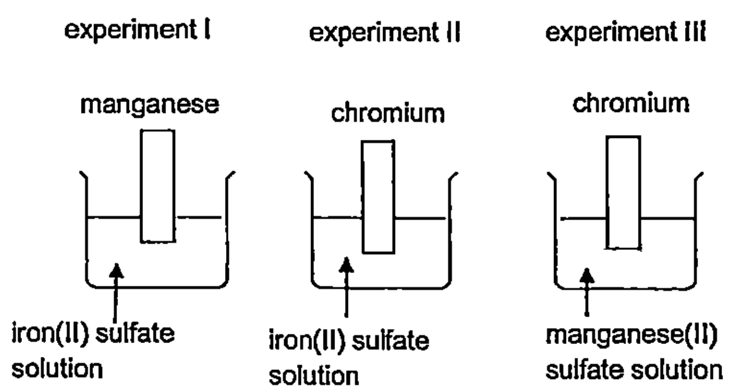


Fig 3.1

State the observations you would expect in Table 3 2 below.

Table 3.2

experiment I	experiment II	experiment III

[3]

(d) Decomposition temperature of a substance is the temperature at which the substance chemically decomposed. Carbonate of iron, manganese and chromium decompose to give the metal oxide and carbon dioxide.

$$MCO_3 \longrightarrow MO + CO_2$$

(i) Explain which of the three carbonates has a higher decomposition temperature?

____

____

____ [2]

(ii) When 2 3 g of a metal carbonate is decomposed completely by heating, 480 cm^3 of carbon dioxide is produced at room temperature and pressure. Calculate the relative formula mass of the metal carbonate and hence identify the metal.

[3]

A4 Figure 4.1 represents the electrolysis of aqueous silver nitrate using graphite electrodes.

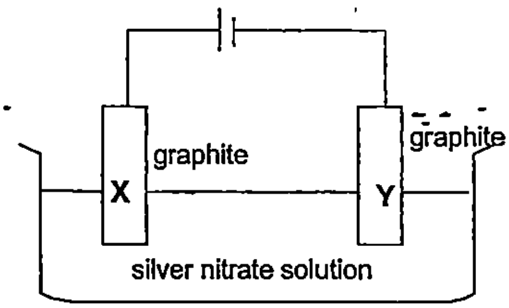


Fig 4.1

(a) (i) What would you observe at each electrode and write the ionic half equation for the reaction that occurred at each electrode

electrode **X**

observation ....

ionic equation: .... [2]

electrode **Y**

observation. ....

ionic equation: .... [2]

(ii) Explain what happened to the electrolyte after some time.

____

____

____

____ [2]

(b) Rust and corrosion are costing the industry billions of dollars a year. In fact, rust has almost become part of our everyday life - with many industries resigned to accepting rust as being inevitable and costly.

(i) Write the ionic half equation when iron rust.

[1]

____

(ii) Figure 4.2 illustrates one method of protectng an underground steel pipe.

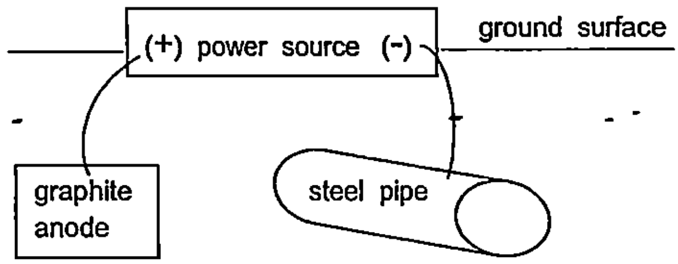


Fig 4 2

1. Indicate on the diagram the flow of electrons. [1]

2. Explain how this method works.

....

.... [1]

(iii) Suggest an alternative way the underground pipe can be protected
With the help of ionic half equation, explain your answer.

....

....

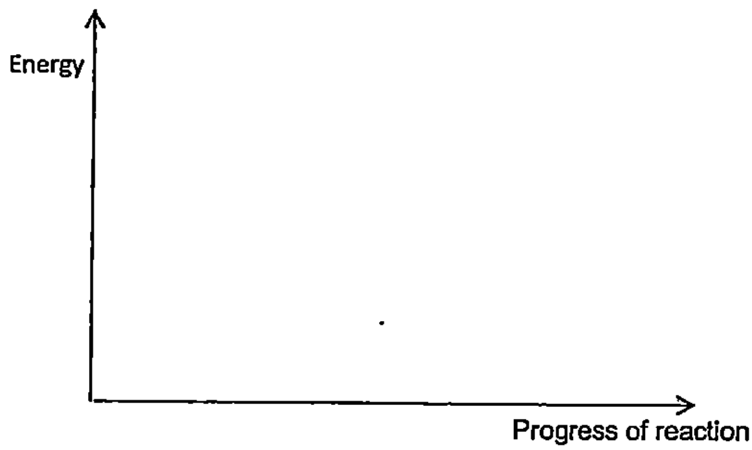
.... [2]

A5 Fossil fuels are a major source of energy. To generate electricity, heat produced by the burning of liquefied petroleum gas (LPG) is used to convert water to steam which then drives a turbine that generates electricity. LPG contains mainly propane. The equation for the combustion of propane is shown below.

$$C_3H_8\,(g) + 5O_2\,(g) \longrightarrow 3CO_2\,(g) + 4H_2O\,(g) \quad \Delta H = -2220\ \text{kJ/mol}$$

(a) Draw an energy profile diagram for the combustion of propane.
Your diagram should show and label

- reactants and products,
- the activation energy for the reaction,
- the enthalpy change of the reaction.



[2]

(b) Sketch on the energy profile diagram you have drawn in **(a)** for the burning of liquid propane. [1]

(c) A propane – oxygen fuel cell uses oxygen and propane to produce electricity. The followings are the two half equations for the reactions.

Equation 1: $C_3H_8(g) + 6H_2O\,(l) \longrightarrow 3CO_2(g) + 20H^+(aq) + 20e^-$

Equation 2: $5O_2(g) + 20H^+(aq) + 20e^- \longrightarrow 10\,H_2O(l)$

(i) Which reaction takes place at the anode and which at the cathode?

anode: ....

cathode: .... [1]

(ii) What is the overall equation for the propane – oxygen fuel cell? [1]

....

(iii) Suggest with reasons which is a more efficient way of producing electricity, propane – oxygen fuel cell or the burning of LPG to drive the turbine in the generator

....

.... [1]

(d) Liquefied petroleum gas (LPG) and paraffin (kerosene) are used as household fuel. Paraffin is safer than LPG. Suggest a reason why.

____

____ [1]

A6 (a) Group IV elements show a trend from non-metallic to metallic behaviour with increasing atomic number. This is shown by the acid base properties of carbon dioxide, silicon dioxide and lead(II) oxide.

group IV elements	formula of oxide	acidic / basic / amphoteric
C	CO_2	
Si	SiO_2	
Pb	PbO	

(i) Complete the table by filling in the empty boxes. [1]

(ii) Support your answer with equations where possible to explain the acidic, basic or amphoteric behaviour of CO_2, SiO_2 and PbO.

....

....

....

....

....

....

....

.... [4]

(b) PbO and PbO_2 differ strikingly in their properties. Both oxides react with acid as given in the equations below.

equation 1: $PbO + 2HCl \longrightarrow PbCl_2 + 2H_2O$

equation 2: $PbO_2 + 4HCl \longrightarrow PbCl_2 + Cl_2 + 2H_2O$

What is the role of lead oxide in each of the reaction with hydrochloric acid? Explain your answer.

PbO:

____

____

____ [1]

PbO_2:

....

....

....

.... [2]

Section B

Answer **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 (a) The ionization energy of an atom describes the minimum amount of energy required to remove an electron (to infinity) from an atom.
The data below shows a plot of ionisation energy against the number of the electron removed for sodium.

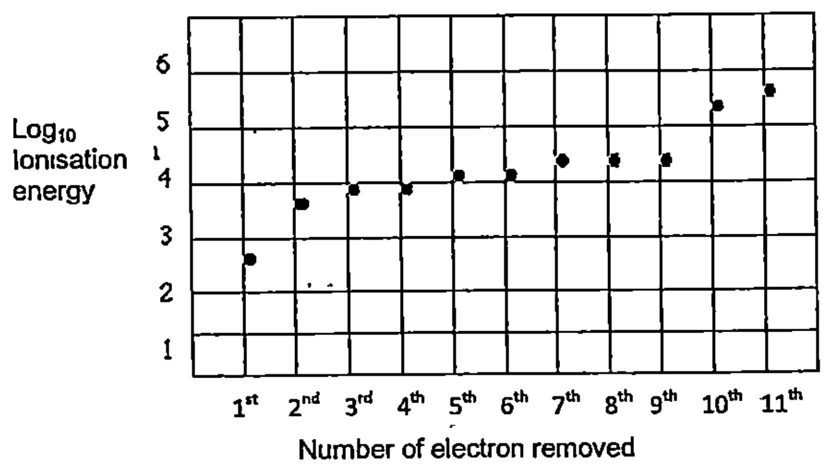


Fig 7.1

Use the information above to explain the trend in ionisation energy for sodium with reference to its electronic structure.

____

____

____

____

____

____

____ [3]

(b) Table 7.1 shows the first ionization energy (energy required to remove the first electron from the atom) of elements in Period 3.

Table 7.1

element	Na	Mg	Al	Si	P	S	Cl	Ar
first ionisation energy / kJ /mol	496	738	577	786	1060	1000	1256	1520
formula of the hydride of the element	NaH	MgH_2	AlH_3			H_2S	HCl	

(i) Complete the table by filling in the formulae of the hydrides. [1]

(ii) Explain why there is a great difference in the first ionization energy of sodium and argon.

____

____

____

____ [2]

(iii) Draw a 'dot and cross' diagram to show the bonding in sodium hydride. [2]
You need to show all the electrons.

(iv) Suggest one similarity and one difference in physical property between sodium hydride and hydrogen chloride.

similarity: ....

....

difference: .... [2]

....

B8 A student carried out an experiment to investigate the relationship between the mass of zinc used in a reaction and the volume hydrogen gas liberated.
In the experiment he added pieces of zinc to 50 cm^3 of hydrochloric acid and recorded the volume of the gas collected. Table 3.1 shows the student's results.

Table 3.1

mass of zinc /g	volume of hydrogen collected / cm^3
0.1	33
0 2	66
0.3	99
0.4	132
0.5	165
0.6	198
0.7	225
0 8	225

The reaction of zinc and hydrochloric acid is

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

(a) (i) Calculate the volume of hydrogen liberated when 0.5 g of zinc was used.

[2]

(ii) Using information from Table 3.1 suggest why the answer in a (i) is different from the one obtained in the experiment.

....

.... [1]

(b) Suggest why the volume of the hydrogen collected is different for 0.1 g to 0.6 g of zinc but remains the same for 0.7 g and 0.8 g.

....

....

....

....

.... [2]

(c) Using information from the Table 3.1 calculate the concentration of the acid used in this experiment.

[3]

(d) The experiment was repeated using hydrochloric acid which was warmed to 60°C. Using the collision theory explain why a shorter time was observed to collect the hydrogen gas.

....

....

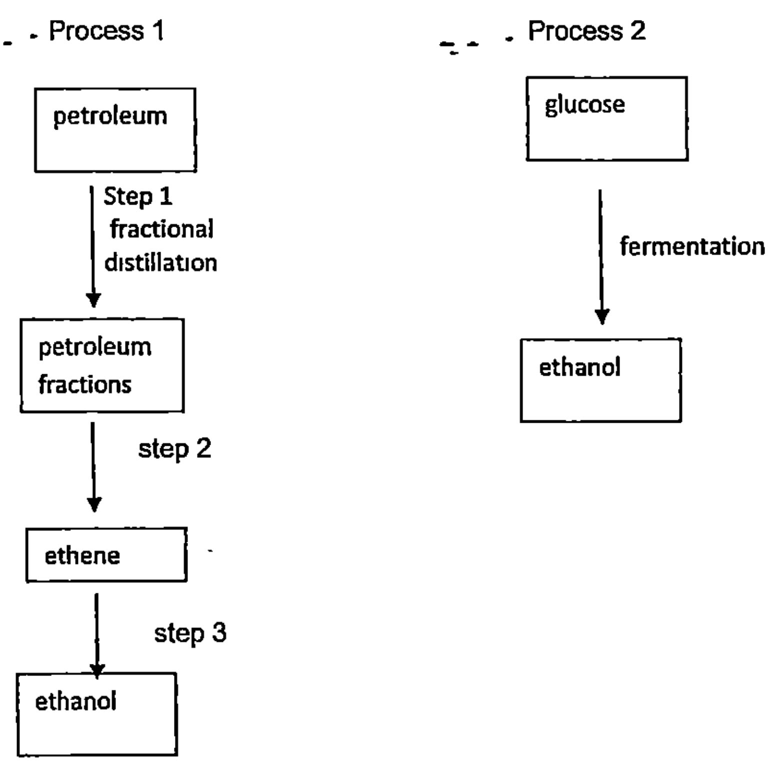
....

....

.... [2]

Either

B9 **(a)** Ethanol can be manufactured by two processes. The flowcharts outline the sequence of steps for producing ethanol



(i) Name the process in step 2

____ [1]

(ii) State the conditions for step 3.

____ [1]

(iii) Briefly explain which process 1 or 2 is sustainable in the production of ethanol in the industry

____

____ [1]

(iv) Suggest two reasons to show that Process 2 is more environmentally friendly than Process 1.

____

____

____ [2]

(b) (i) Ethyl ethanoate, a sweet smelling compound, has many uses It can be used in perfumes or as flavouring.
Outline with the help of condensed or full structural formula equations, how a sample of ethyl ethanoate can be prepared in the laboratory. You can only use ethanol as the starting material. Other inorganic reagents where appropriate can be used in the preparation.

____

____

____

____

____

____

____ [4]

(ii) Draw the full structural formula of an isomer of ethyl ethanoate which belongs to the same homologous series.

[1]

Or

B9 Today, a significant number of personal care products such as scrubs and toothpastes are known to contain thousands of minuscule balls of plastic called microplastics, or more specifically, microbeads. Over the years, microbeads have replaced traditional, alternatives such as ground nut shells, and salt crystals.

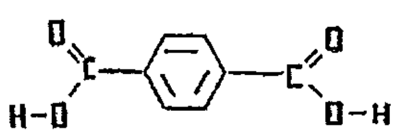
The microbeads used in personal care products are almost always smaller than 1 mm, the width of a pencil tip. They are mainly made **of polyethene (PE)**, but can be also be made of **polypropene (PP), polyethylene terephthalate (PET), polymethyl methacrylate (PMMA)** and **nylon.**

Microbeads are washed down the drain after use and flow through sewer systems around the world before making their way into rivers and canals and ultimately, straight into the seas and oceans. Now, fish have a gut full of them. Researchers around the world have detected them in marine mussels and shore crabs. Their synthetic molecules bind to chemicals to become "a pathway for pollutants to enter the food chain".

(a) Draw the full structural formula of **polypropene** showing **two** repeat units.

[1]

(b) Polyethylene terephthalate (PET) is made from two monomers, **terephthalic acid** and **ethane-1,2-diol (HO CH_2CH_2OH).**
The structural formula of **terephthalic acid** is:



Draw the repeat unit of PET.

[1]

(c) **Methyl methacrylate (MMA)** is an organic compound with the formula $CH_2{=}C(CH_3)COOCH_3$ This colourless liquid, **(MMA)**, is the methyl ester of **methacrylic acid.**
MMA is a monomer produced on a large scale for the production of **polymethyl methacrylate (PMMA).**

(i) Draw the full structural formula of **methacrylic acid.** [1]

(ii) Draw the structure of **polymethyl methacrylate (PMMA)** showing **two** repeat units.

[1]

(iii) The common name for **polymethyl methacrylate (PMMA)** is perspex and has the appearance of glass. It is used in aeroplane windows.
Suggest one advantage of perspex over the use of glass.

____

____ [1]

(d) (i) Microbeads are cheap. Give one reason why they might become expensive in the future.

____

____ [1]

(ii) Suggest a reason why the traditional use of ground nut shells is better than the use of microbeads.

____

____ [1]

(e) Polypropene can be disposed of by combustion.

(i) Using its empirical formula construct an equaton for the complete combustion of polypropene.

____ [1]

(ii) Calculate the volume of carbon dioxide produced when 1 tonne of polypropene is burned

[2]

☺☺☺ END ☺☺☺

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 = 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.)

Zhonghua Secondary School

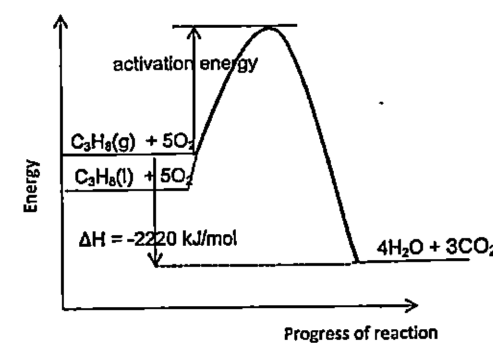
2015 Prelim Chemistry

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

2015 Preliminary 2 Chemistry
Marking Scheme

A1	(a)	A or B	[1]
	(b)	F	[1]
	(c)	B	[1]
	(d)	A / B and C	[1]
	(e)	D	[1]
A2	(a)	$Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$	[1]
	(b)	In step 2 there must be excess of silver nitrate solution and nitric acid to ensure all chloride ions are precipitated	[1]
		In step 3 the precipitate must be dried and weighed a number of time until a constant weight is obtained to ensure all water has evaporated from silver chloride	[1]
	(c)	Moles of AgCl $= \dfrac{5.74}{143.5} = 0.04$	[1]
		Mass of NaCl $= 0.04 \times 58.5 = 2.34$ g	[1]
		% of NaCl $= \dfrac{2.34}{2.5} \times 100 = 93.6$	[1]
	(d)	Carry out chromatography on the rock sample. If there is one spot it is pure. More than one spot it is impure. Or Check the melting point of the rock sample. If it melts at a fixed temperature it is pure. If it melts over a range of temperature it is impure	[2]
A3	(a)	They form coloured compounds	[1]
		They have variable oxidation states	[1]
	(b)	$Mn + H_2SO_4 \longrightarrow MnSO_4 + H_2$	[1]
	(c)	(see table below)	[3]
	(d)	(i) $MnCO_3$ has the highest decomposition temperature	[1]
		Mn is the most reactive metal among the three metals, its compounds are the most stable and need more energy to decompose	[1]
		(ii) Moles of $CO_2 = \dfrac{480}{24000} = 0.02$	[1]

Experiment I	Experiment II	Experiment III
pale green solution turns pale pink a grey deposit is formed	pale green solution turns violet a grey deposit is formed	no reaction

		Relative Formula mass $= \dfrac{2.3}{0.02} = 115$	[1]
		Relative atomic mass of M = 55 The metal is manganese	[1]
A4	(a)	(i) Electrode X. effervescence	[1]
		$4OH^-(aq) \longrightarrow 2H_2O(l) + O_2(g) + 4e$	[1]
		Electrode Y. a silvery grey deposit	[1]
		$Ag^+(aq) + e \longrightarrow Ag(s)$	[1]
		(ii) $AgNO_3$ solution slowly turns into acidic HNO_3 solution as OH^- ions are being discharged from the solution leaving behind H^+ ions.	[1] [1]
	(b)	(i) $Fe \longrightarrow Fe^{3+} + 3e$	[1]
		(ii) 1 The electrons from the power source (-) travels to the steel pipe	[1]
		2. Excess electrons on the steel pipe prevents the oxidation of iron	[1]
		(iii) Attached a block of Mg to the steel pipe	[1]
		Mg being more reactive than iron will corrode instead of iron $Mg \longrightarrow Mg^{2+} + 2e$	[1]
A5	(a)		[2]
		Correct diagram with labelling [2] (b) Correct position of liquid propane [1]	[1]
	(c)	(i) Anode Equation 1 Cathode Equation 2	[1]
		(ii) $C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(g)$	[1]
		(iii) Fuel cell is a more efficient way. Using the generator a lot of heat is lost to the surroundings when fuel is burnt to generate steam to turn the turbine	[1]
	(d)	Paraffin is safer to use as it is a liquid and has a higher boiling point and is not as flammable as LPG	[1]
A6	(a)	(i) CO_2 - acidic, SiO_2 - acidic, PbO - amphoteric	[1]

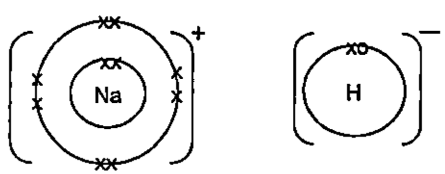
		(ii) CO_2 is acidic dissolves in water to form H_2CO_3 SiO_2 is acidic. It reacts with CaO (a base) to form a salt,calcium silicate $SiO_2 + CaO \longrightarrow CaSiO_3$ PbO is amphoteric It reacts with acid to form a salt and water $PbO + 2HCl \longrightarrow PbCl_2 + H_2O$ PbO reacts with NaOH to from a salt, sodium plumbate, and water	[1] [1] [1] [1]
	(b)	Equation1 PbO is acting as a base It reacts with acid to form salt and water Equation 2 PbO_2 is an oxidising agent. PbO_2 oxidises Cl^- in HCl to Cl_2 There is an increase in oxidation state od chlorine from -1 to 0	[1] [1] [1]
B7	(a)	The first ionisation energy is removing one electron from the third shell which is furthest away from the nucleus hence lowest energy required. There is only a slight increase from the 2^{nd} to 9^{th} ionisation energy as this involves the removal of 8 electrons from the same second shell 10^{th} and 11^{th} ionisation energy are the highest as it involves removal from the first shell closest to the nucleus.	[1] [1] [1]
	(b)	(i) First ionisation energy of Na and Ar both involves removal of one electron from the third shell However the comletely-filled shell of Ar has extra stability It is more difficult to remove electron from this stable configuration and hence the ionisation energy is very high	[1] [1]

(ii)

Formula of the hydride of the element				SiH_4	PH_3			—

If all correct [1] — [1]

(iii)

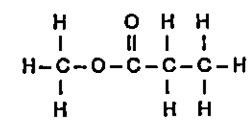


sodium hydride — [2]

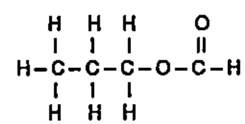
		(iv) Similarity: NaH and HCl are both soluble in water Difference NaH has high melting point and boiling point. HCl has low melting and boiling point	[1] [1]
B8	(a)	(i) Moles of 0 5 g of zinc = $\frac{0\ 5}{65}$ = 0 007692 Moles of H_2 = 0 007692 Volume of H_2 = 0 007692 x 24000 = 184 6 cm^3	[1] [1]

		(ii) The zinc samples are impure	[1]
	(b)	In the experiments when 0 1 g to 0 6 g of zinc were used , zinc is the limiting reagent. In excess of 0 7 g of zinc, HCl is the limiting reagent	[1] [1]
	(c)	Moles of H_2 = $\frac{225}{24000}$ = 0 009375 Moles of HCl = 0 009167 x 2 = 0 01875 Concentration of HCl = $\frac{1000}{50}$ x 0 01875 = 0 375 mol/dm^3	[1] [1] [1]
	(d)	At a higher temperature the particles gain energy and move faster There are more particles that possess the minimum activation energy hence increase in effective collisions, increase in rate of reaction	[1] [1]
Either B9	(a)	(i) cracking (ii) heat, 60 atmospheric pressure and phosphoric (V) acid (iii) Process 2 is more viable as the source of glucose which comes from plants is renewable whereas petroleum in Process 1 is non-renewable (iv) Process 1 involves processes that require energy and at the same time produce a lot of waste products like CO_2 In Process 2 the carbon footprint is zero as the CO_2 produced during fermentation is absorbed by plants during photosynthesis	[1] [1] [1] [1] [1]
	(b)	(i) Ethanol is oxidized to ethanoic acid using acidified $K_2Cr_2O_7$ or $KMnO_4$ and heat $CH_3CH_2OH + O_2 \longrightarrow CH_3COOH + H_2O$ Ethanol is then heated with ethnoic acid in the presence of concentrated H_2SO_4 to produce ethyl ethanoate $CH_3COOH + CH_3CH_2OH \longrightarrow CH_3COOCH_2CH_3 + H_2O$	[1] [1] [1] [1]

(ii)

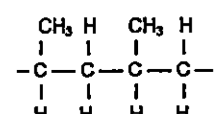


Or

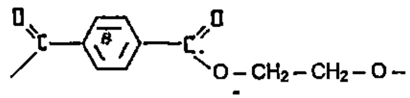
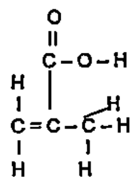
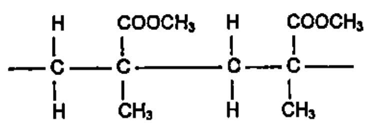


[1]

OR B9 (a)



[1]

	(b)		[1]
	(c)	(i) 	[1]
		(ii) 	[1]
		(iii) Perspex does not break as easily as glass / Perspex when shattered does not injure as seriously as glass	[1]
	(d)	(i) The raw material of microbeads is crude oil and in future, oil will be very expensive as it is running low	[1]
		(ii) Ground nut shells occur naturally hence it is biodegradable and environmental friendly.	[1]
	(e)	(i) $2CH_2 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$	[1]
		(ii) 1 tonne CH_2 = $\frac{1}{14} \times 10^6$ moles Moles of CO_2 = $0\ 07142 \times 10^6$ Volume of CO_2 = $0\ 07142 \times 10^6 \times 24\ dm^3$ = $1\ 71 \times 10^6\ dm^3$	[1] [1]
		OR $2C_3H_8 + 9O_2 \longrightarrow 6CO_2 + 6H_2O$ 1 tonne C_3H_8 = $\frac{1}{42} \times 10^6$ moles = $0\ 023809 \times 10^6$ Moles of CO_2 = $0\ 023809 \times 10^6 \times 3$ Volume of CO_2 = $0\ 07142 \times 10^6 \times 24\ dm^3$ = $1\ 71 \times 10^6\ dm^3$	