SMILE Tutor
EFFICIENT . EFFECTIVE . EASY

2022

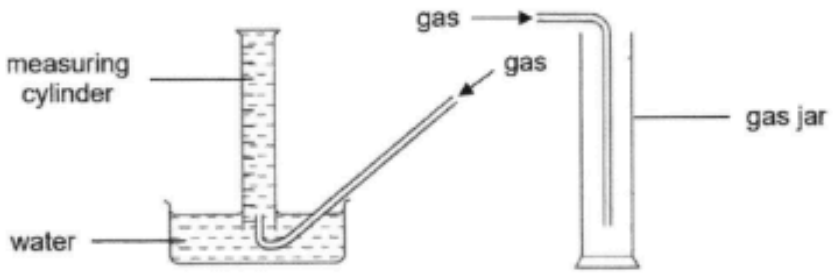
SECONDARY 4 COMBINED CHEMISTRY TEST PAPERS

SMILETutor
EFFICIENT . EFFECTIVE . EASY

Table of Contents

BEDOK GREEN SECONDARY SCHOOL PRELIM PAPER

1 The diagram below shows two methods of collecting gases.



Which row gives the properties of a gas which can be collected by both methods?

	property 1	property 2
A	soluble in water	denser than air
B	soluble in water	less dense than air
C	insoluble in water	denser than air
D	insoluble in water	less dense than air

2 The table provides information of three solids, P, Q and R.

solid	stability to heat	solubility in alcohol	solubility in water
P	yes	no	no
Q	yes	yes	no
R	no	no	yes

The following steps could be carried out to separate substance R from a mixture of these three substances.

1. filtration
2. dissolving in water
3. dissolving in alcohol
4. evaporation to dryness
5. crystallization

Which option shows the correct order of steps?

A 2, 1, 5
B 2, 3, 1, 5
C 3, 1, 4
D 3, 1, 2, 4

3 The boiling points of some gases are given in the table.

element	nitrogen	xenon	oxygen
boiling point / °C	−196	−108	−183

A mixture of the three gases was cooled to -190°C.

Which of the gases will be in liquid state?

A nitrogen only
B oxygen only
C oxygen and xenon only
D xenon only

4 The symbols for two ions are shown.

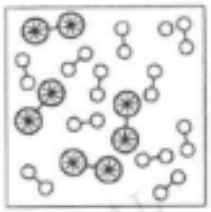
$$^{9}_{19}F^{-} \qquad ^{11}_{23}Na^{+}$$

Which statement is correct?

A Both ions contain the same number of electrons.
B Both ions contain the same number of protons.
C The fluoride ion contains more electrons than the sodium ion.
D The fluoride ion contains more neutrons than the sodium ion.

5 Which diagram best represents a mixture of elements?

A



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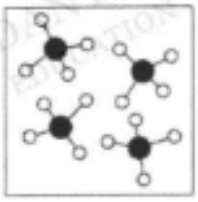

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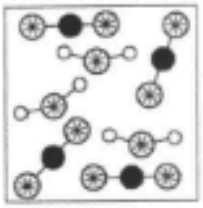
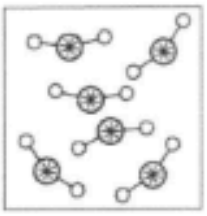


D



6 50 cm^3 of hydrogen gas was reacted with 80 cm^3 of chlorine gas to form hydrogen chloride gas.

$$H_2 + Cl_2 \rightarrow 2HCl$$

How much hydrogen chloride gas was formed from the reaction?

A 50 cm^3
B 80 cm^3
C 100 cm^3
D 160 cm^3

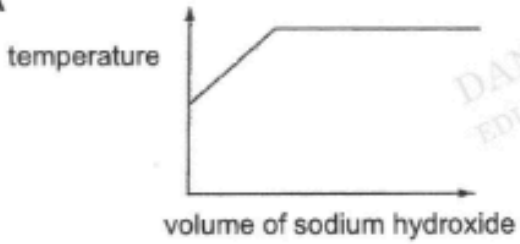
7 Which of the following compounds consists of covalent bonds only?

A silver nitrate
B carbon dioxide
C magnesium oxide
D ammonium carbonate

8 The reaction between aqueous potassium hydroxide and dilute hydrochloric acid is exothermic. Both the hydrochloric acid and potassium hydroxide are initially at room temperature.

Which graph shows how the temperature changes when aqueous potassium hydroxide is added to dilute hydrochloric acid until the alkali is present in excess?

A



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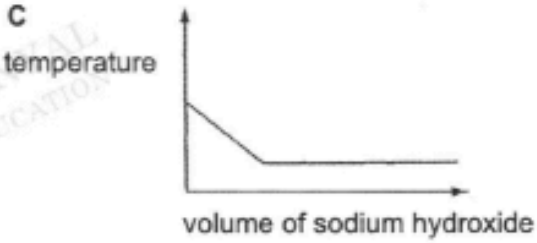
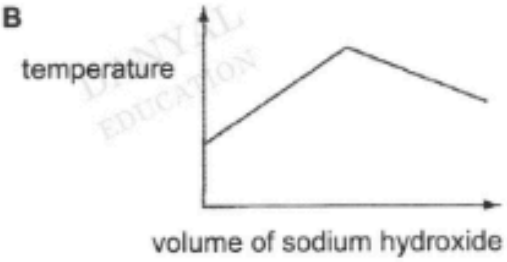


B



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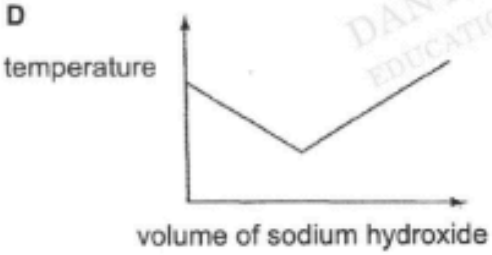


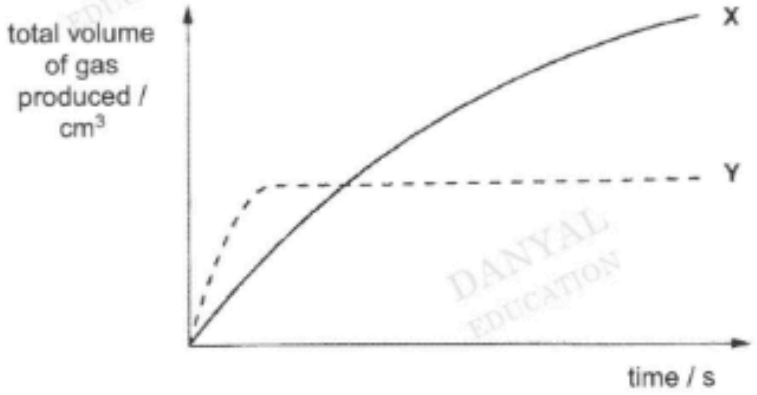
9 What are the ions present in aluminium sulfate, $Al_2(SO_4)_3$?

A Al^{2+} and SO_4^{2-}
B Al^{3+} and SO_4^{2-}
C Al^{2+} and SO_4^{3-}
D Al^{3+} and SO_4^{3-}

10 In which reaction does the oxidation state of iron remain unchanged?

A $2Fe + 3Cl_2 \rightarrow 2FeCl_3$
B $2FeCl_2 + Cl_2 \rightarrow 2FeCl_3$
C $Fe + 2FeCl_3 \rightarrow 3FeCl_2$
D $Fe_2O_3 + 6HCl \rightarrow 2FeCl_3 + 3H_2O$

11 In the graph below, curve **X** represents the results of the reaction between 1.0 g of granulated zinc and an excess of acid at 30 °C.



Which changes will produce curve **Y**?

A using 1.0 g of powdered zinc at 20 °C
B using 1.0 g of granulated zinc at 20 °C
C using 0.5 g of granulated zinc at 40 °C
D using 0.5 g of granulated zinc at 20 °C

12 The table below shows the properties of some elements W, X, Y and Z in period 3 of the Periodic Table.

	W	X	Y	Z
appearance at room temperature	yellow solid	yellowish-green gas	grey solid	grey solid
reaction with cold water	no reaction	slow reaction	fast reaction	violent reaction
nature of oxide	reacts with bases	reacts with bases	reacts with both acids and bases	reacts with acids

Which of the following shows the elements arranged in the Periodic Table in increasing proton number?

A X, W, Y, Z
B X, Y, W, Z
C Z, Y, W, X
D Z, X, Y, W

13 Steel is an alloy of iron with a very small percentage of carbon.
Which statement is correct?

A Carbon disrupts the metallic structure of iron.
B Iron atoms are the same size as carbon atoms.
C An increase in the percentage of carbon makes the steel softer.
D A decrease in the percentage of carbon makes the steel more brittle.

14 Which of the following substances will react with hydrochloric acid to form a gas and water as two of the products?

A calcium oxide
B calcium nitrate
C calcium hydroxide
D calcium carbonate

15 The elements in Group I of the Periodic Table react with water.

What is/are the product(s) formed in this reaction?

A metal oxide only
B metal hydroxide only
C metal oxide and hydrogen
D metal hydroxide and hydrogen

16 Which row shows the correct source of nitrogen dioxide and its adverse effect on the environment?

	source	effect on the environment
A	car exhausts	global warming
B	combustion of fossil fuels	global warming
C	lightning	acid rain
D	volcanoes	acid rain

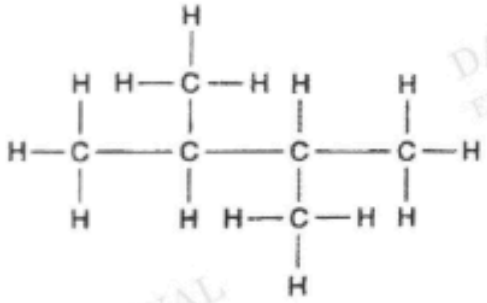
17 Which salt **cannot** be prepared by reacting a metal with dilute acid?

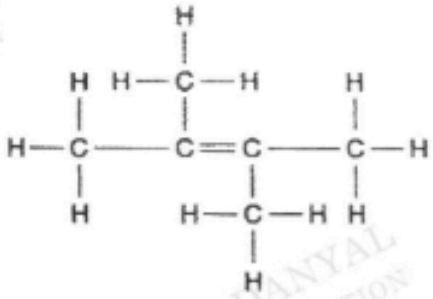
A zinc nitrate
B calcium chloride
C copper(II) sulfate
D magnesium chloride

18 In the fractional distillation of crude oil, which product has the highest boiling point?

A diesel
B kerosene
C lubricating oil
D petrol

19 The structures of two compounds are shown below.

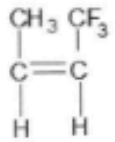




Which statement about these two compounds is correct?

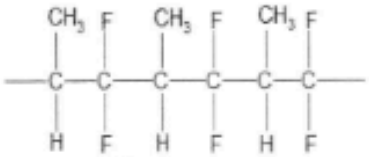
A They are both hydrocarbons.
B They are both saturated compounds.
C They have the same molecular formula.
D They are from the same homologous series.

20 The structure of a monomer is shown.



What is the structure of the polymer formed by this monomer?

A



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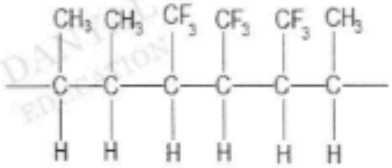

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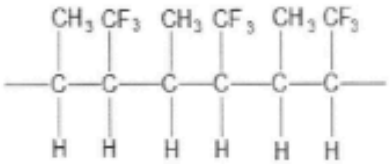

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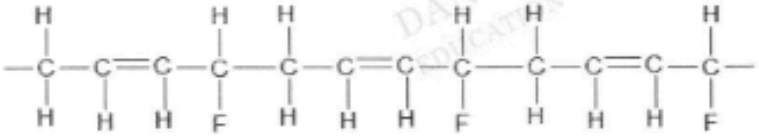
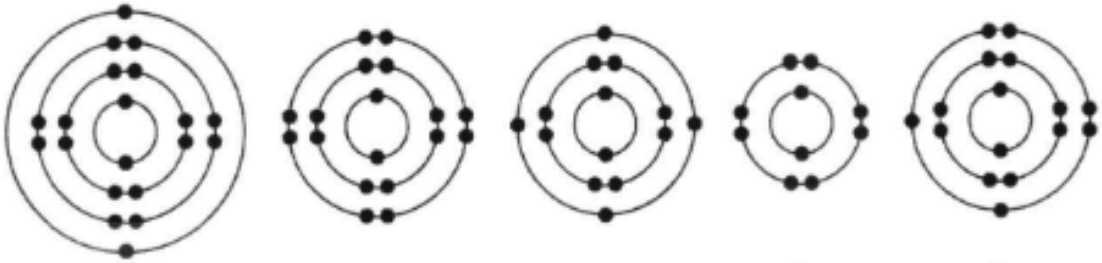


End of Paper

Section A

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

1 The electronic configurations of five atoms are shown.



Use the letters **A**, **B**, **C**, **D** and **E** to answer the questions below.
Each letter may be used once, more than once or not at all.
Which electronic configuration represents

(a) a sulfur atom?

..... [1]

(b) an atom with a proton number of 14?

..... [1]

(c) an atom of a noble gas with three electron shells?

..... [1]

(d) an atom which forms an ion with a charge of 2+?

..... [1]

2 **(a)** Table 2.1 gives information about some atoms and ions.
Complete the table.

Table 2.1

formula of atom or ion	name of particle	number of protons	number of electrons	number of neutrons
Na	sodium atom		11	12
O^{2-}		8		8
	nitride ion	7	10	7

[2]

(b) Sodium reacts with a sufficient supply of oxygen to form sodium oxide. Draw 'dot and cross' diagrams to show the arrangement of the outer shell electrons in sodium oxide.

[Proton (atomic) number: Na, 11; O, 8]

[2]

(c) Explain why sodium oxide is a solid at room temperature and pressure.

.....

.....

.....

..... [3]

3 In 2016, the International Union of Pure and Applied Chemistry (IUPAC) has confirmed the names for the four newest elements to be added in Period 7 of the Periodic Table.

One of the new elements, discovered by a team of Japanese scientists, has been named nihonium (Nh), after the Japanese name for Japan - Nihon.

Fig 3.1 shows part of the Periodic Table and the position of nihonium.

III	IV	V	VI	VII	0
					2 He helium 4
5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
113 Nh Nihonium 278					

Fig. 3.1

The element was discovered by colliding a thin layer of bismuth with zinc. The reaction produces particle **X**.

$$^{83}_{209}Bi + ^{30}_{70}Zn \rightarrow ^{113}_{278}Nh + ^{0}_{1}X$$

(a) Suggest the identity of particle **X**.

..... [1]

(b) Nihonium exists as three isotopes: nihonium-278, nihonium-282 and nihonium-285. Using the information given, compare and contrast the atomic and electronic structures of the three isotopes.
You may use Nh-278, Nh-282 and Nh-285 to represent the three isotopes.

.....

.....

.....

.....

..... [3]

(c) Another new element named tennessine (with symbol Ts) is placed close to nihonium in the Periodic Table. It has an atomic number of 117.

(i) Predict the position of tennessine on the Periodic Table and write the symbol of tennessine on Fig 3.1. [1]

(ii) A student made a few predictions about tennessine.
Which predictions about the properties of tennessine are true and which are false?

Put a tick (√) in one box in each row

	true	false
Tennessine is a good conductor of electricity.		
Tennessine is a solid at room temperature and pressure.		
Tennessine is brown in colour.		
Tennessine is the least reactive element in its group.		

[2]

4 Some magnesium powder is added to dilute sulfuric acid in a test tube.

A colourless salt solution **R** is formed and a gas is given off. When more magnesium powder is added, the reaction continues for a while and then stops, leaving some magnesium powder in the test tube.

(a) State the name of solution **R**.

.....

.....

[1]

(b) Suggest why the reaction stops and identify the limiting reactant.

.....

.....

.....

[2]

(c) Describe how you would obtain dry crystals of salt **R** from solution **R**.

.....

.....

.....

.....

[2]

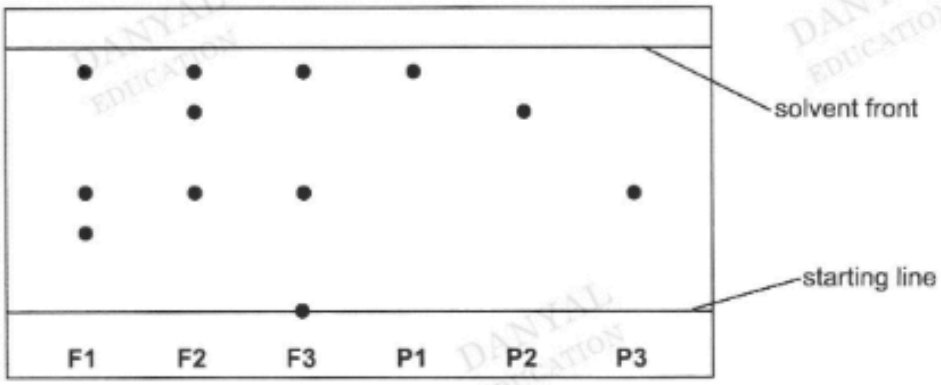
5 A student investigates the pigments found in some fruits. She obtains some coloured fruit extracts from the following:

F1 pumpkins
F2 watermelons
F3 cherries

She places a spot of each extract on chromatography paper together with spots of three pigments usually found in fruits.

P1 beta-carotene (yellow-orange pigment)
P2 lycopene (red pigment)
P3 anthocyanin (blue-purple pigment)

The diagram below shows the chromatogram at the end of the experiment.



(a) **(i)** Based on the chromatogram given above, state if each statement is true or false.
If the statement is **true**, put a **T** in the box. If the statement is **false**, put a **F** in the box.

Lycopene is not present in pumpkins, watermelons and cherries. ☐

Anthocyanin is present in cherries only. ☐

Both pumpkins and watermelons contain a pigment other than beta-carotene, lycopene and anthocyanin. ☐

[3]

(ii) Rewrite one of the false statements in part **(a)(i)** to make it correct.

.....

[1]

(b) **(i)** How many different pigments are present in pumpkins and watermelons?

..... [1]

(ii) Suggest a reason why there is a spot on the starting line in the chromatogram for cherries.

.....

..... [1]

(iii) Is the fruit extract from cherries pure? Give a reason for your answer.

.....

..... [2]

6 Metals are extracted from their ores using different methods. In the extraction of iron, haematite, coke and limestone are added to the Blast Furnace.

In the industry, iron is obtained from the ore haematite, Fe_2O_3, through a reaction with carbon monoxide.

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

Calculate the mass of iron, that can be obtained when 16 000 g of Fe_2O_3 react with excess carbon monoxide.

[Relative atomic masses: Ar: C, 12; O, 16; Fe, 56]

7 Fig. 7.1 describes some of the properties and reactions of several substances.

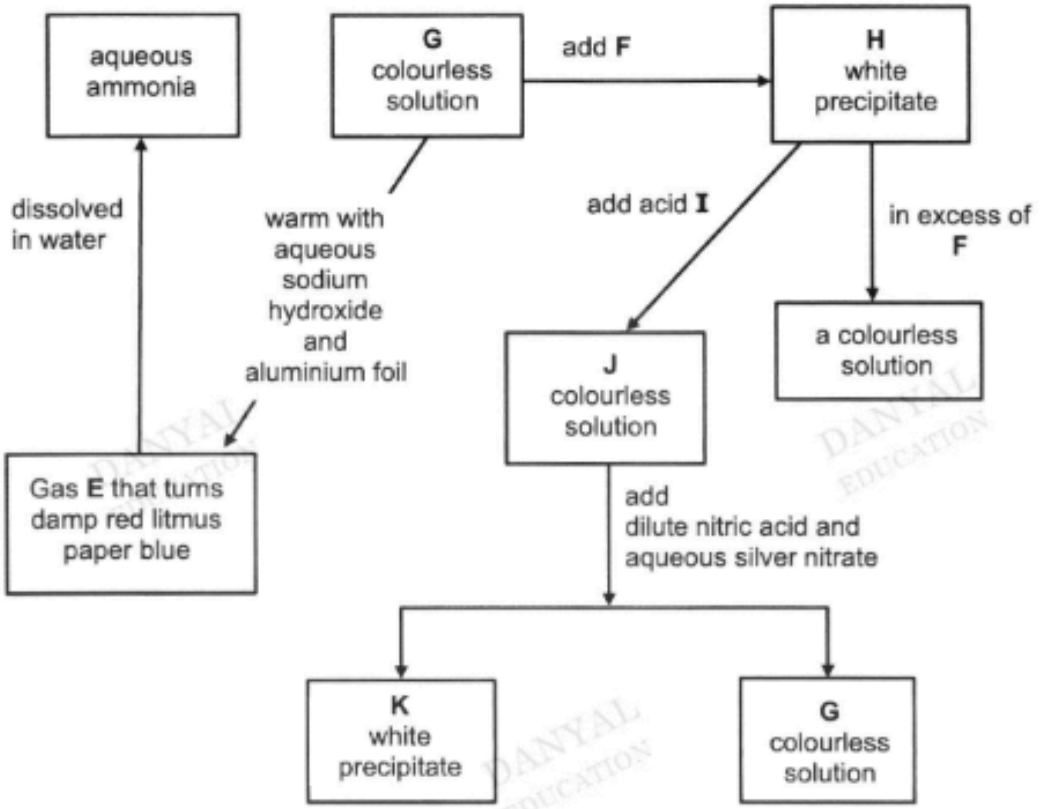


Fig. 7.1

(a) Identify each of **G**, **H**, **I**, **J** and **K**.

G .....

H .....

I .....

J .....

K ..... [5]

(b) Write a balanced chemical equation with state symbols for the reaction between compound **J** and silver nitrate.

..... [3]

(c) Instead of damp red litmus paper, dry litmus paper was used to test for gas **E**. Predict and explain if the same result will be obtained.

.....

.....

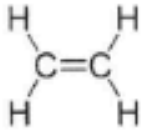
..... [3]

End of Section A

Section B

Answer any **two** questions from this section in the spaces provided.

8 The diagram shows the structure of an unsaturated molecule **A**.



(a) Name molecule **A**.

..... [1]

(b) Describe a test to show that molecule **A** is unsaturated and the observations you would expect to make.

test

.....

observation

..... [2]

(c) Molecule **A** undergoes an addition reaction with steam to form molecule **B**, CH_3OH. Molecule **B** can also be formed by a process called fermentation.

(i) Suggest the identity of molecule **B**.

..... [1]

(ii) Draw the structure of the molecule **B**.

[1]

(iii) State the conditions for the process of fermentation.

..... [1]

(d) Molecule **A** can be obtained from crude oil. The equation below shows another process where molecule **A** can be obtained from decane, $C_{10}H_{22}$.

$$C_{10}H_{22} \rightarrow 3 \text{ molecule } \mathbf{A} + \text{molecule } \mathbf{D}$$

(i) Name this process.

..... [1]

(ii) Give the molecular formula of molecule **D**.

..... [1]

(iii) Molecule **A**, like other fuels, can undergo complete combustion.
Write a balanced chemical equation for the complete combustion of molecule **A**.

..... [2]

9 **(a)** **(i)** In 20 cm^3 of aqueous solution, there is 10.6 g of sodium carbonate, Na_2CO_3.

Calculate the concentration of the solution in g /dm^3 and in mol/dm^3.

concentration: ..... g/dm^3 [1]

concentration: ..... mol/dm^3 [1]

(ii) 20 cm^3 of sodium carbonate solution from **(a)(i)** reacted with sulfuric acid of concentration 0.5 mol/dm^3. The equation below shows the reaction that occurred.

$$H_2SO_4 + Na_2CO_3 \rightarrow Na_2SO_4 + H_2O + CO_2$$

Calculate the volume of sulfuric acid required to react completely with the sodium carbonate solution.

volume: ..... dm^3 [2]

(b) Salts have many uses and can be prepared using different methods. However, a good chemist must be able to choose the best method to prepare any given salt.

To prepare two salts, **X** and **Y**, a chemist uses two different methods. The chemist prepares **X** by adding excess metal carbonate to an acid and prepares **Y** by precipitation.

Using only the information given, state one difference in physical property between **X** and **Y**.

..... [1]

(c) Sodium phosphate, Na_3PO_4, is a soluble salt, used as a water softener in washing powders.

It is made by reacting dilute phosphoric acid, H_3PO_4, with an alkali.

(i) Name the alkali which reacts with phosphoric acid to form sodium phosphate.

..... [1]

(ii) Write the ionic equation for this reaction.

..... [1]

(iii) Given the solutions of phosphoric acid and the alkali in **(c)(i)**, a suitable indicator and standard laboratory apparatus, explain how you would obtain a solution of sodium phosphate.

.....

.....

.....

.....

.....

..... [3]

10 Ore is natural rock that contains desirable minerals, typically metals, that can be extracted from it.

(a) Metal ores are generally a mixture of acidic impurities and metal oxides, metal sulfides, metal silicates, native metals or noble metals. Native metals are metals that are found pure in its metallic form in nature.

(i) Based on the metal reactivity series, state one metal that can be considered as a native metal.

..... [1]

(ii) Suggest why native metals can also be called "noble metals".

..... [1]

(c) Table 8.1 shows examples of some important ores, the chemical names of the minerals found in the ore, and their chemical formula.

Table 8.1

ore names	name of minerals found in ore	chemical formula of minerals
acanthite	silver sulfide	Ag_2S
barite	barium sulfate	$BaSO_4$
sapphire	aluminium oxide	Al_2O_3
beryl	beryllium aluminium cyclosilicate	$Be_3Al_2Si_6O_{18}$
haematite	iron(III) oxide	Fe_2O_3
scheelite	calcium tungstate	$CaWO_4$

With reference to Table 8.1,

(i) state which mineral is most likely able to react with both hydrochloric acid and sodium hydroxide,

..... [1]

(ii) deduce the formula of a tungstate ion in calcium tungstate.

..... [1]

(d) The extraction of silver is known as the cyanide process. The silver ore is crushed, concentrated and treated with sodium cyanide solution to produce sodium argento cyanide, $NaAg(CN)_2$. The product formed is reacted with zinc dust to precipitate silver.

The equations for the reactions are shown below.

Reaction 1: $Ag_2S + 4NaCN \rightarrow 2NaAg(CN)_2 + Na_2S$

Reaction 2:

..... $NaAg(CN)_2$ + ... $Zn \rightarrow$ ..... $Na_2Zn(CN)_4$ + ... Ag

(i) Complete **reaction 2** by balancing the equation. [1]

(ii) Reaction 2 is a displacement reaction.
Explain why zinc was used to precipitate silver from sodium argento cyanide.

.....

..... [1]

(iii) Explain, using Collision Theory, why zinc dust was used instead of zinc pellets.

.....

.....

..... [2]

(e) State, with reason, whether the cyanide process in part **(d)** or the smelting of haematite in the extraction of iron releases less pollutants to the atmosphere.

.....

..... [2]

End of Paper

ANSWER SHEET

PAPER 1

Question	Answer
1	C
2	A
3	C
4	A
5	A
6	C
7	B
8	B
9	B
10	D

Question	Answer
11	C
12	C
13	A
14	D
15	D
16	C
17	C
18	C
19	A
20	C

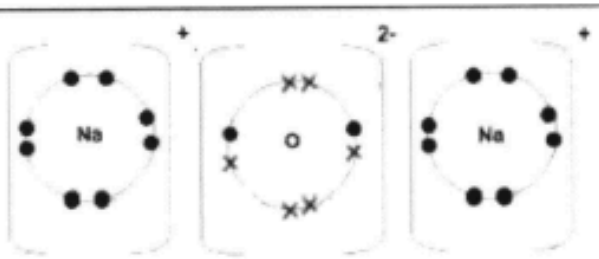
PAPER 3

1	(a) E (b) C (c) B (d) A	1 1 1 1
2(a)		2

formula of atom or ion	name of particle	number of protons	number of electrons	number of neutrons
Na	sodium atom	11	11	12
O^{2-}	oxide ion	8	10	8
N^{3-}	nitride ion	7	10	7

1 m for every 2 correct answers

2(b) — 2



2(c)

It is a solid as it has a high melting point. 1
A large amount of energy is required to overcome 1
the strong electrostatic forces of attraction between the sodium and oxide ions. 1

3(a) Neutron 1

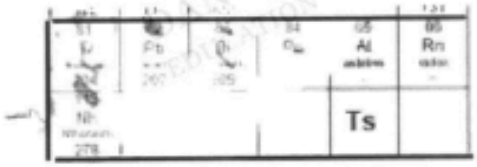
3(b)

All three isotopes have 113 protons. 1
All three isotopes have 3 valence electrons, with 7 electron shells. 1
Nh-278 has 165 neutrons, Nh-282 has 169 neutrons while Nh-285 has 172 neutrons. 1

Award the following if answers are generic.
They have the same number of neutrons, different number of protons 1
They have the same electronic configuration/same number of valence electrons/same number of electrons. 1

3(c) — 1

(i)



(ii) — 2

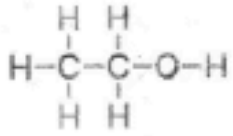
	true	false
Tennessine is a good conductor of electricity.		✓
Tennessine is a solid at room temperature and pressure.	✓	
Tennessine is brown in colour.		✓
Tennessine is the least reactive element in its group.	✓	

4 a) Magnesium sulfate 1 1

	b)	The limiting reactant is sulfuric acid. The reaction stopped as all the sulfuric acid has completely reacted.	1
	c)	heat solution R to saturation; allow the saturated solution to cool and crystallise; filter the mixture to obtain crystals of salt R; pat dry the crystals of salt R between pieces of filter paper	1 1
5(a)	(i)	Lycopene is not present in pumpkins, watermelons and cherries. **F**	1
		Anthocyanin is present in cherries only. **F**	1
		Both pumpkins and watermelons contain a pigment other than beta-carotene, lycopene and anthocyanin. **F**	1
	(ii)	Lycopene is present only in watermelons. / lycopene is not present in pumpkins and cherries. Anthocyanin is present in pumpkins, watermelons and cherries. Pumpkins, watermelons and cherries contain a pigment other than beta-carotene, lycopene and anthocyanin. **Any one of the corrected statements.**	1
5(b)	(i)	4	1
	(ii)	there is a pigment present in cherries that is insoluble in the solvent used	1
	(iii)	no; there are **three** spots of pigments present in the extract of cherries	1 1
6	No. of moles of Fe_2O_3 = 16 000 / (56 x 2 + 16 x 3) = 100 moles No. of moles of Fe = 100 x 2 = 200 moles Mass of Fe = 200 x 56 = 11200 g		3

7(a)	**G**	Zinc nitrate	5
	H	Zinc hydroxide	
	I	Hydrochloric acid	
	J	Zinc chloride	
	K	Silver chloride	
	1 m for each correct answer		
7(b)	$ZnCl_2$ (aq) + $2AgNO_3$ (aq) → $Zn(NO_3)_2$ (aq) + 2AgCl (s) **[1]** for correct formula of reactants and products **[1]** for correct balancing [1] correct state symbols		3
7(c)	The result will not be the same. There is no water present to dissolve the ammonia gas in order to dissociate into **hydroxide** ions.		1 1 1

Section B (30 marks)

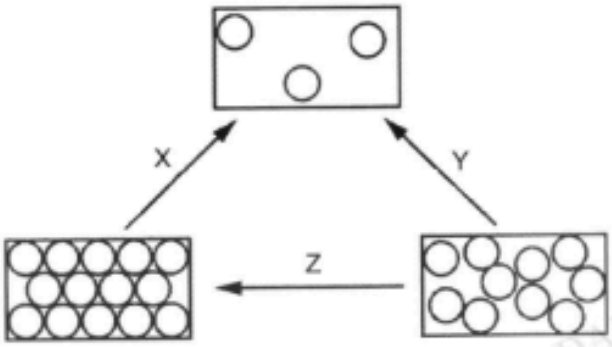
8(a)	ethene		1
8(b)	test Bubble molecule A into aqueous bromine. Observation Reddish brown aqueous bromine decolourises.		1 1
8(c)	(i)	Ethanol 	1 1
	(ii)		
	(iii)	37°C, yeast, absence of air	1
8(d)	(i)	Cracking	1
	(ii)	C_4H_{10}	1
	(iii)	$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$ 1 m – chemical equation 1m - balanced	2

9(a)	(i)	$10.6 \div 0.02 = 530$ g/dm^3 $530 \div [(23(2)+12+3(16)) = 5$ mol/dm^3	1 1
	(ii)	no of mol of sodium carbonate = 5 x 0.02 = 0.1 no of mol of acid = 0.1 ÷ volume of acid = 0.1 ÷ 0.5 = 0.2 dm^3	1 1
9(b)	Solubility of the substances in water OR X is soluble in water but Y is not soluble in water		1
9(c)	(i) (ii) (iii)	sodium hydroxide $OH^- + H^+ \rightarrow H_2O$ 1. Fill the burette with alkali and take note of the initial reading. 2. Pipette a fixed volume (25.0 cm^3) of dilute acid into the conical flask. 3. Add one or two drops of a suitable indicator (methyl orange) to the solution in the conical flask. 4. Titrate the acid with the alkali with constant swirling until the indicator turns from red to orange. Record the volume of alkali added. 5. Repeat the titration using the same volume of alkali and acid, but without the indicator to get the solution of sodium phosphate. All points: 3 m Missing 1 point: minus 1 m missing more than 3 points: 0 m	1 1 3
10(a)	Gold/silver		1
10(b)	Noble metals are unreactive / resistant to (corrosion / oxidation).		1
10(c)	(i) (ii)	aluminium oxide WO_4^{2-}	1 1
10(d)	(i) (ii) (iii)	2 $NaAg(CN)_2$ + ... Zn → ..... $Na_2Zn(CN)_4$ + 2 Ag Zinc is more reactive than silver. Therefore, it is able to displace silver from sodium argento cyanide. Zinc dust has a smaller particle size compared to zinc pellets, thus, having a larger exposed surface area. This increases the frequency of effective collision between reactants and in turn increases the speed of reaction.	1 1 1 1
10(e)	Cyanide process. It **does not produce carbon monoxide gas** or any other gaseous pollutants as a by product, unlike smelting of haematite.		1 1

BROADRICK SECONDARY SCHOOL PRELIM PAPER

1 Each diagram shows the arrangement of particles in each of the three states of matter.

X, Y and Z represent the processes needed to change from one state to another.



What are the processes X, Y and Z?

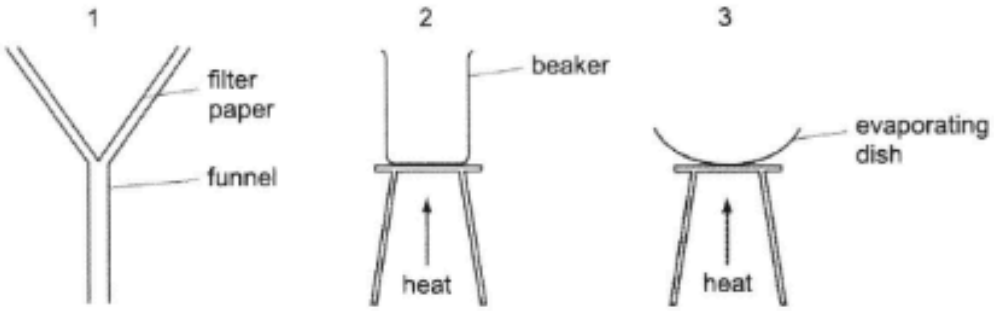
	X	Y	Z
A	evaporation	sublimation	condensation
B	evaporation	sublimation	freezing
C	sublimation	evaporation	condensation
D	sublimation	evaporation	freezing

2 A student is asked to measure the time taken for 4.00 g of magnesium carbonate to react completely with 25.0 cm^3 (an excess) of dilute hydrochloric acid.

Which pieces of apparatus does the student need?

A electronic balance, digital stopwatch, pipette
B electronic balance, digital stopwatch, thermometer
C electronic balance, pipette, thermometer
D digital stopwatch, pipette, thermometer

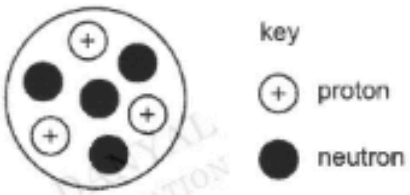
3 The diagrams show three sets of apparatus.



Which apparatus would be used to obtain separate dry samples of sand and salt from a mixture of sand and seawater?

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

4 The diagram represents a nucleus of element X.



Which of the following symbols best represent this element?

A $^{3}_{4}X$ **B** $^{4}_{3}X$ **C** $^{7}_{3}X$ **D** $^{7}_{4}X$

5 Information about some chemical elements is given below.

element	symbol	metal or non-metal	group in Periodic Table
rubidium	Rb	metal	I
indium	In	metal	III
sulfur	S	non-metal	VI
iodine	I	non-metal	VII

Which formula is **not** correct?

A In_2S_3 **B** InI_3 **C** RbI **D** RbS_2

6 Methane burns in plentiful supply of oxygen according to the following equation:

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

10 cm^3 of methane was burnt in 25 cm^3 of oxygen.

If all the volumes were measured at room temperature and pressure, what would be the total volume of gases at the end of reaction?

A 10 cm^3 **B** 15 cm^3 **C** 30 cm^3 **D** 35 cm^3

7 Ammonium sulfate and potassium sulfate are salts which can be found in fertilisers.
A sample of a fertiliser is warmed with aqueous sodium hydroxide and a gas with pH 10 is given off.

Which salt must be present in the fertiliser and what is the gas given off?

	salt in fertiliser	name of gas
A	ammonium sulfate	ammonia
B	ammonium sulfate	sulfur dioxide
C	potassium sulfate	ammonia
D	potassium sulfate	sulfur dioxide

8 The table gives information about three indicators.

indicator	colour at pH 1	pH at which colour changes	colour at pH 12
thymol blue	red	3	yellow
congo red	blue	5	red
phenolphthalein	colourless	10	pink

Which colours would be obtained when each indicator was added separately to pure water?

	thymol blue	congo red	phenolphthalein
A	red	blue	pink
B	yellow	blue	colourless
C	yellow	blue	pink
D	yellow	red	colourless

9 A colourless liquid in an unlabelled bottle is tested as shown.

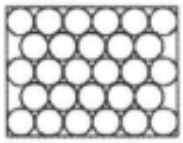
- Litmus paper turns red.
- Magnesium ribbon fizzed.
- Reaction with aqueous barium nitrate produced a white precipitate.

What is the colourless liquid?

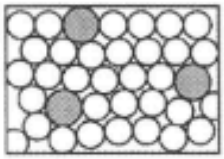
A aqueous sodium hydroxide
B aqueous sodium sulfate
C dilute hydrochloric acid
D dilute sulfuric acid

10 The diagrams show the structure of two substances used to make electrical conductors.

X



Y



Which statement correctly describes X and Y?

A X is a pure metal and Y is a compound.
B X is a pure metal and Y is an alloy.
C X is a solid and Y is a liquid.
D X is harder and stronger than Y.

11 Reactions of three metals and their oxides are listed in the table.

metal	reacts with cold water	metal oxide reacts with carbon
P	no	no
Q	no	yes
R	yes	no

What is the order of reactivity of the metals?

	least reactive	⟶	most reactive
A	P	Q	R
B	Q	P	R
C	Q	R	P
D	R	P	Q

12 The equation explains the colour change that occurs when aqueous potassium hydroxide is added to aqueous potassium dichromate(VI).

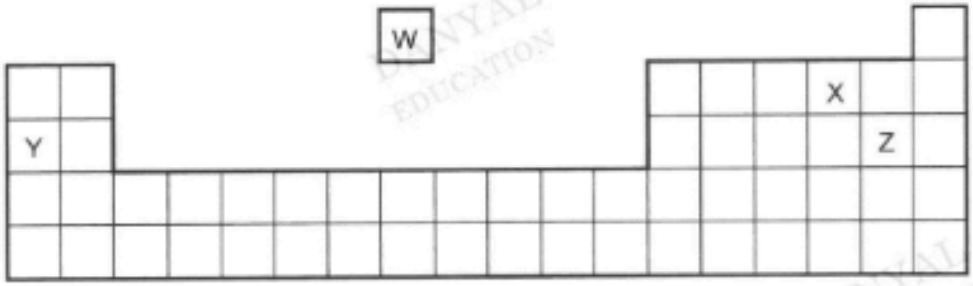
$$\underset{\text{potassium dichromate(VI)}}{K_2Cr_2O_7} + 2KOH \rightarrow \underset{\text{potassium chromate(VI)}}{2K_2CrO_4} + H_2O$$

orange → yellow

As a result of adding excess of aqueous potassium hydroxide to aqueous potassium dichromate(VI), what happens to the oxidation state of chromium and the pH of the reaction mixture?

	oxidation state of chromium	pH of the mixture
A	decreases	decreases
B	decreases	increases
C	stays the same	decreases
D	stays the same	increases

13 The diagram shows part of the Periodic Table.



Which row is correct?

	can donate or share an electron	reacts with water
A	W	X
B	W	Y
C	X	Y
D	Z	W

14 The formation of liquid water from hydrogen and oxygen may occur in three stages.

1 $2H_2(g) + O_2(g) \rightarrow 4H(g) + 2O(g)$

2 $4H(g) + 2O(g) \rightarrow 2H_2O(g)$

3 $2H_2O(g) \rightarrow 2H_2O(l)$

Which of these stages are endothermic?

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

15 Calcium carbonate was reacted with an excess of dilute hydrochloric acid at room temperature.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

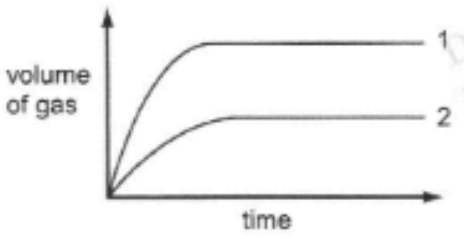
Two experiments were carried out.

Experiment 1: 10 g of calcium carbonate in large lumps

Experiment 2: 5 g of powdered calcium carbonate

Which graph is correct?

A



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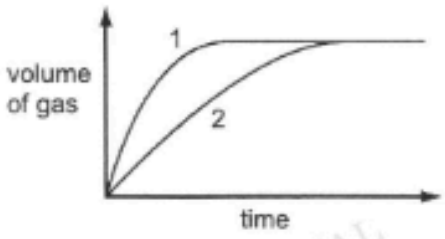

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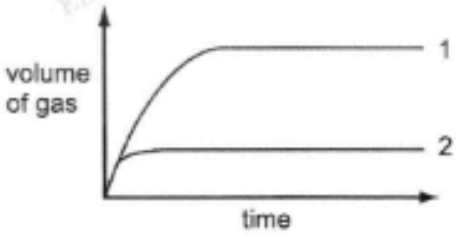
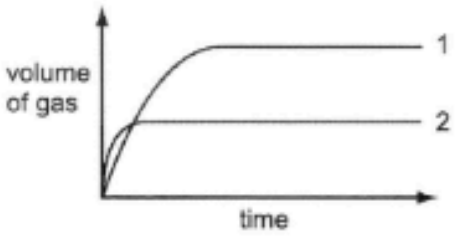


D



16 Acid rain is formed when sulfur dioxide and oxides of nitrogen dissolve in rainwater.

Which of the following is **not** caused by acid rain?

A breathing difficulties
B corrosion of statues
C dying trees
D lowered pH of lakes

17 Petroleum is separated into fractions by fractional distillation.
Separation occurs in a fractionating column.
Some properties of three of these fractions are shown.

fraction	range of boiling points / °C	number of carbon atoms in the molecules
1		5 – 10
2	320 – 350	16 – 24
3	120 – 210	

Which statement is correct?

A Fraction 1 has a higher boiling point range than fraction 2.
B Fraction 2 is removed at a higher point in the fractionating column than fraction 1.
C Molecules in fraction 3 have shorter carbon chains than those in fraction 2.
D None of the fractions are liquid at room temperature.

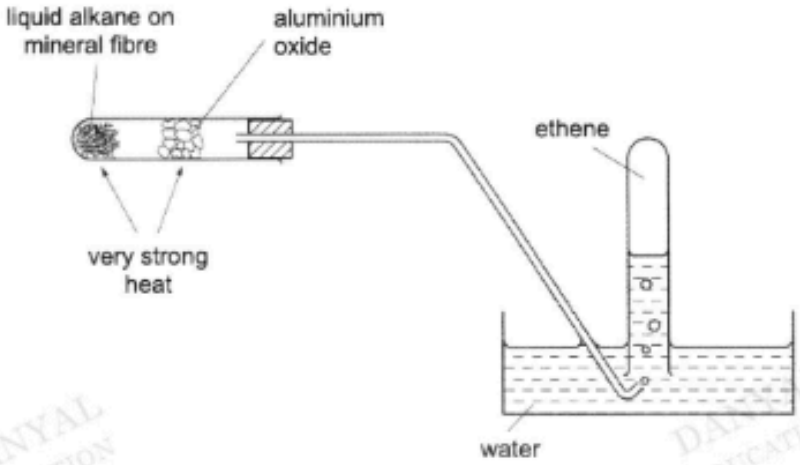
18 A student makes three statements about fat molecules.

1 Fat molecules contain only carbon atoms.
2 Fat molecules are hydrocarbons.
3 Fat molecules contain more than one carbon to carbon double bonds.

Which of these statements describe polyunsaturated fat molecules?

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

19 The following experiment is carried out.



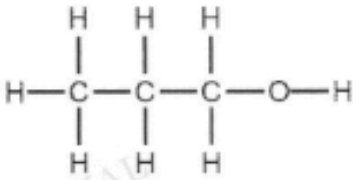
Which of the following processes takes place in the experiment shown above?

A cracking **B** distillation

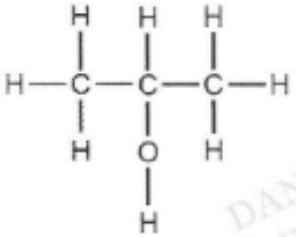
C fermentation **D** polymerisation

20 The structural formulae of some organic compounds are shown below.

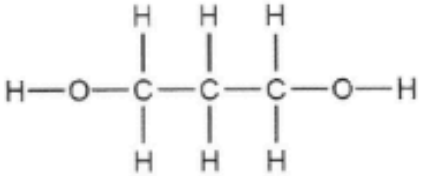
1



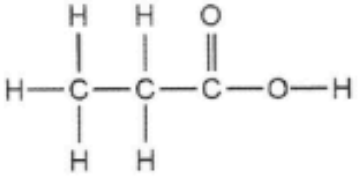
2



3



4



Which compound(s) is / are classified as alcohols?

A 1, 2, 3 and 4 **B** 1 and 2 only

C 1, 2 and 3 only **D** 4 only

Section A [45 marks]

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

For Examiners' Use

1 The following table shows the atomic structure of seven different particles P – W.

The particles are atoms or ions.

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

	P	Q	R	S	T	U	W
nucleon number	4	14	15	19	23	24	40
proton number	2	7	7	9	11	12	20
number of electrons	2	7	7	9	11	10	18

Use the letters P – W to complete the following sentences.

Each letter may be used once, more than once or **not** at all.

(a) The two particles that are ions are ..... and ..... [1]

(b) The particles in period 3 of the Periodic Table are ..... and ..... [1]

(c) The particle in Group VII of the Periodic Table is ..... [1]

(d) The particle which does **not** react with other elements is ..... [1]

(e) The two particles that are isotopes of the same element are ..... and ..... [1]

For Examiners' Use

2 **(a)** A student carried out some experiments to place four metals, W, X, Y and Z in order of reactivity. The table shows the results.

Key ✓ shows a reaction happened
× shows no reaction happened
— shows the experiment was not performed

	metal W	metal X	metal Y	metal Z
solution of W nitrate	—	✓	✓	✓
solution of X nitrate	×	—	✓	×
solution of Y nitrate	×	×	—	×
solution of Z nitrate	×	✓	✓	—

Place the metals in order of reactivity, starting with the most reactive.

..... > ..... > ..... > ..... [2]

(b) A story describes a country where metallic elements are represented by unusual code names.

The story gives the reactivity series for five of these metals, but includes the non-metals hydrogen and carbon.

decreasing order of chemical reactivity ⟶

alpha ; beta ; gamma ; carbon ; delta ; hydrogen ; epsilon

Fig. 8

Use any of the names in Fig. 8 to answer the questions that follow.

(i) Which metal will react most slowly with hydrochloric acid, forming hydrogen gas?

..... [1]

(ii) Which element will produce beta metal when heated strongly with beta oxide?

..... [1]

(iii) Which of the code names most likely represents 'copper'?

..... [1]

For Examiners' Use

3 Nitrogen can form ionic compounds with metallic elements and covalent compounds with non-metallic elements.

(a) Nitrogen reacts with lithium to form lithium nitride, Li_3N.
Draw a 'dot and cross' diagram to represent lithium nitride.
Show only the outer electrons.

[2]

(b) Nitrogen reacts with fluorine to form nitrogen fluoride, NF_3.
Draw a 'dot and cross' diagram to represent a molecule of nitrogen fluoride.
Show only the outer electrons.

[2]

(c) Lithium nitride has a high melting point of 813 °C.
Nitrogen fluoride has a low melting point of - 207 °C.

In terms of the bonding involved, explain why the melting points are different.

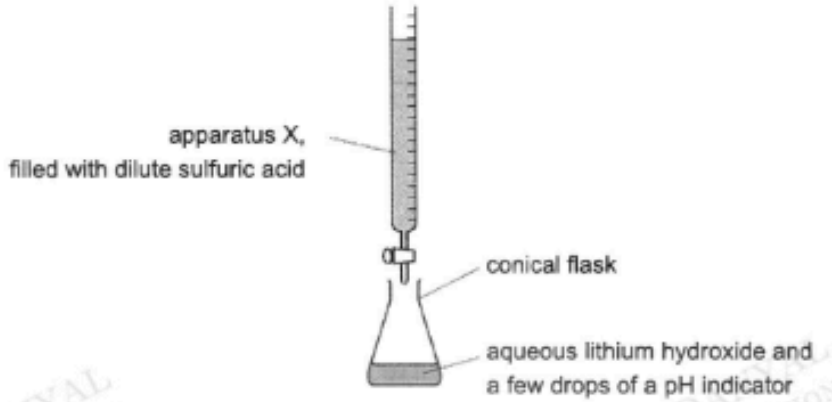
.....

.....

..... [2]

4 The soluble salt, lithium sulfate, is prepared by titration from the soluble base lithium hydroxide.

For Examiners' Use



(a) Name apparatus X. ..... [1]

(b) Provide the ionic equation for the reaction between dilute sulfuric acid and aqueous lithium hydroxide.

..... [1]

(c) The dilute sulfuric acid is added slowly from apparatus X into the conical flask, until the indicator just changes colour. The volume of dilute sulfuric acid needed to just neutralise the aqueous lithium hydroxide is noted.

Describe how you would continue the experiment to obtain pure dry crystals of lithium sulfate.

.....

.....

.....

.....

.....

..... [4]

For Examiners' Use

5 Aqueous ammonium nitrite, $NH_4NO_2(aq)$, decomposes when heated, as shown.

$$NH_4NO_2(aq) \rightarrow N_2(g) + 2H_2O(l)$$

(a) A 25.0 cm^3 sample of 0.150 mol/dm^3 of aqueous ammonium nitrite is heated.

Calculate the maximum volume of nitrogen formed, in dm^3, measured at room temperature and pressure.

volume of nitrogen ..... dm^3 [2]

(b) Another type of ammonium salt, ammonium nitrate, NH_4NO_3, is commonly used as fertiliser in farms.

The bags of ammonium nitrate fertiliser have the following warning printed on them.

Do not add fertiliser to soil that has been recently treated with any lime-containing product.

The main lime-containing product used on farms is calcium hydroxide.

(i) Why is calcium hydroxide added to soils?

..... [1]

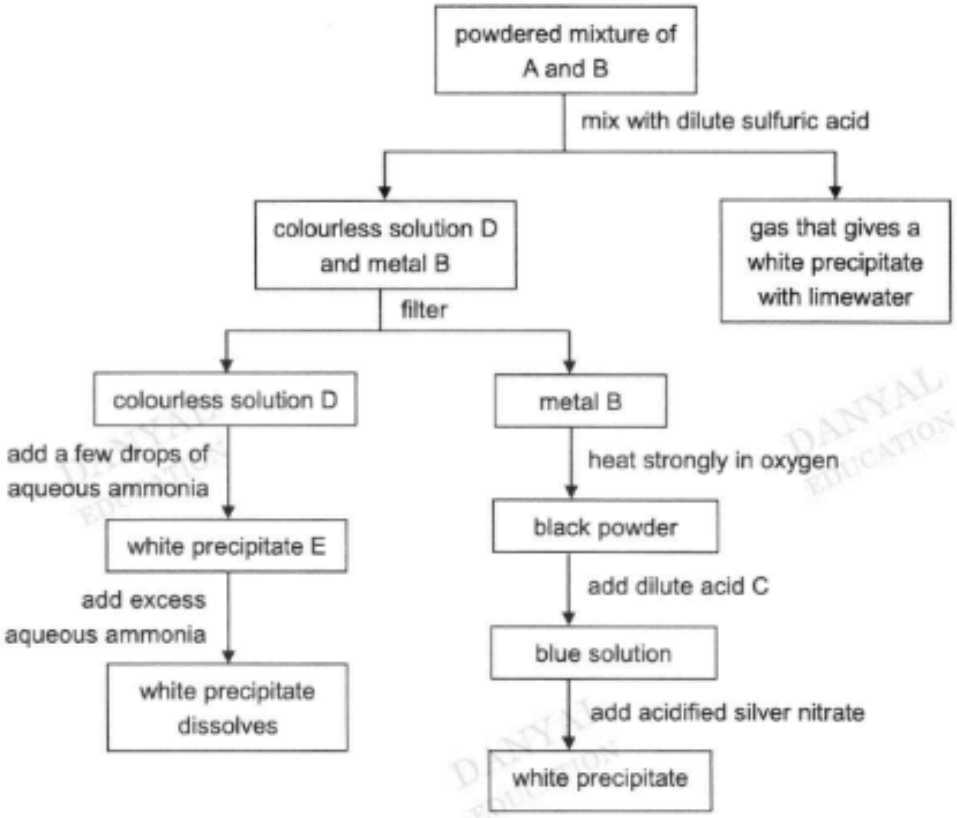
(ii) Why is it important **not** to add ammonium compounds to soils that have been treated with calcium hydroxide?

.....

..... [1]

6 The following reaction scheme describe properties of a powdered mixture of compound A and a metal B.

For Examiners' Use



(a) Name A, B, C, D and E.

(i) A .....

(ii) B .....

(iii) C .....

(iv) D .....

(v) E ..... [5]

(b) Write a balanced chemical equation, with state symbols, for any of the reactions described in the reaction scheme above.

..... [2]

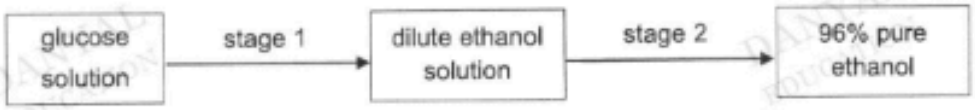
For Examiners' Use

7 In some countries, ethanol is produced from the glucose in sugar cane.

(a) Draw the full structural formula of ethanol.

[1]

(b) This flowchart summarises the production process for ethanol.



(i) Name the processes that took place in stage 1 and stage 2.

stage 1: ..... stage 2: ..... [2]

(ii) Write a balanced chemical equation, with state symbols, for the process that took place in stage 1.

..... [2]

(iii) What are the conditions required for stage 1 to take place?

..... [1]

(c) One of the uses of ethanol is fuel for cars.
An environmentalist claims that ethanol as a fuel is 'carbon neutral' because it does **not** add to the amount of carbon dioxide in the atmosphere.

Explain why this is true.

.....

..... [1]

For Examiners' Use

8 The table below shows the percentage by volume of each of the gases present in the exhaust gases from a petrol engine.

gas	percentage by volume
carbon dioxide	1.0
carbon monoxide	
hydrogen	0.2
nitrogen	77.0
nitrogen dioxide	0.3
oxygen	0.7
hydrocarbons	0.3
water vapour	5.0
	total 100.0

(a) (i) Calculate the percentage by volume of carbon monoxide in the exhaust gases.

..... % [1]

(ii) Which gas shown in the table is present in the lowest percentage by volume?

..... [1]

(iii) Where does the nitrogen in the exhaust gases come from?

..... [1]

(b) The carbon monoxide in the exhaust gases come from the incomplete combustion of hydrocarbons.

(i) What is meant by the term *hydrocarbon*?

.....

..... [1]

(ii) Describe one adverse effect of carbon monoxide on health.

.....

..... [1]

Section B [20 marks]

Answer any **two** questions in the spaces provided.

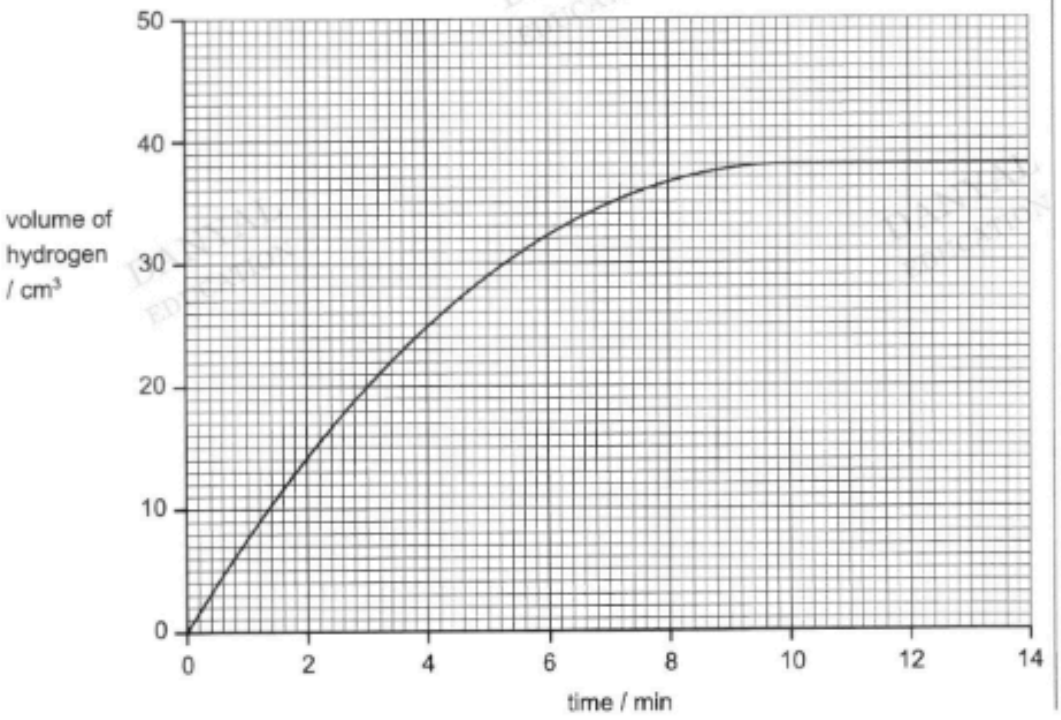
For Examiners' Use

9 A student investigated the rate of reaction between magnesium ribbon and excess dilute sulfuric acid at room temperature by measuring the volume of hydrogen gas produced.

(a) Draw a well-labelled diagram to show the experimental set-up for this investigation.

[3]

(b) The graph shows the volume of hydrogen collected as the reaction proceeds.



For Examiners' Use

(i) Explain why the volume of gas remained the same after 10 minutes.

.....

[1]

(ii) How long did it take for the first 20 cm^3 of gas to be collected?

.....

[1]

(iii) The student repeated the experiment at 40 °C.
All other conditions remained the same.

To the graph on page 12, sketch a curve to show the expected results for this experiment.

[2]

(c) The student repeated the experiment using powdered magnesium of the same mass instead of magnesium ribbon.

Use your knowledge of reacting particles, explain how the rate of reaction differs when powdered magnesium is used.

.....

.....

.....

.....

[3]

For Examiners' Use

10 Iron is one of the most important metals.
Iron can be mixed with another element to produce alloy steel.

(a) **(i)** Name the element that is added to iron in the production of steel.

.....

[1]

(ii) Describe how the addition of the element named in **(i)**, can increase the strength of iron.

.....

.....

.....

[2]

(b) Objects made of iron can rust.
Explain why coating iron with grease prevents iron from rusting.

.....

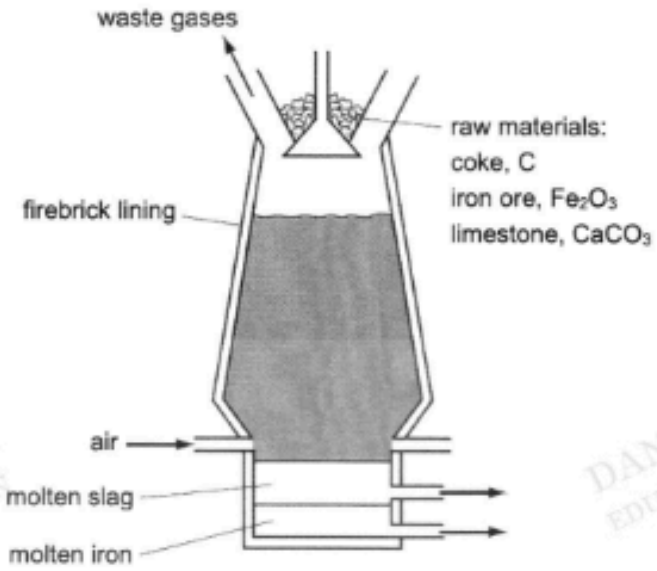
.....

.....

[2]

(c) Iron is extracted from its ore in the Blast Furnace.

For Examiner's Use



(i) Explain why the molten iron and the molten slag form two layers and why molten iron is at the lower layer.

.....

.....

..... [2]

(ii) The oxide of iron is present in iron ore and is used as a raw material for the extraction of iron in a Blast Furnace.

Include suitable chemical equations in your answer to explain how iron is extracted from the oxide of iron. There is no need to include details on how the impurities are removed from the iron ore.

.....

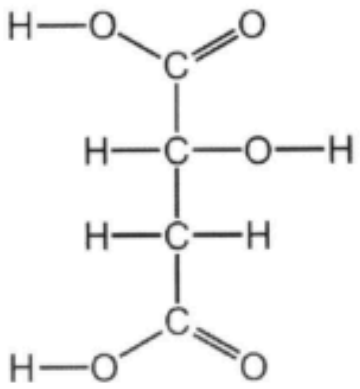
.....

.....

..... [3]

For Examiners' Use

11 The structure of malic acid is shown.

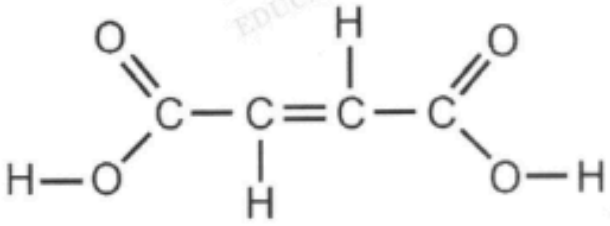


(a) **(i)** To the structure above, draw a circle around the alcohol functional group. [1]

(ii) Deduce the molecular formula of malic acid to show the number of carbon, hydrogen and oxygen atoms.

..... [1]

(b) When malic acid is heated, it forms compound F.
The structure of compound F is shown.



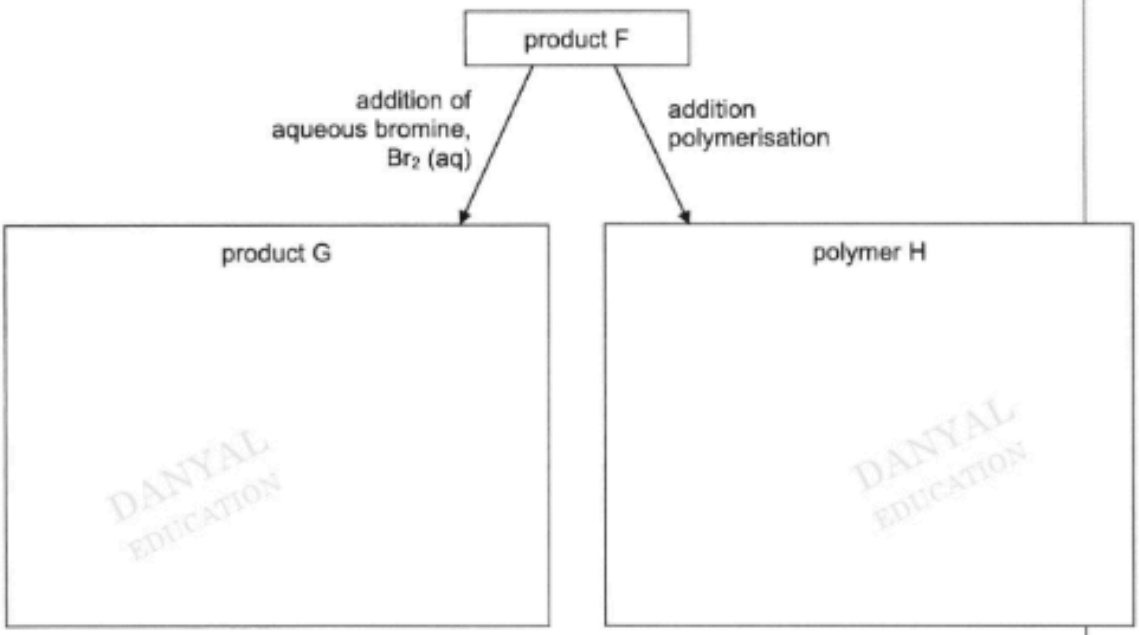
(i) Explain why compound F is described as *unsaturated*.

.....

..... [1]

(ii) Product F can undergo addition reactions as shown.

For Examiners' Use



Draw the structures of product G and polymer H in the boxes above. [3]

(c) Ethanoic acid is a carboxylic acid.

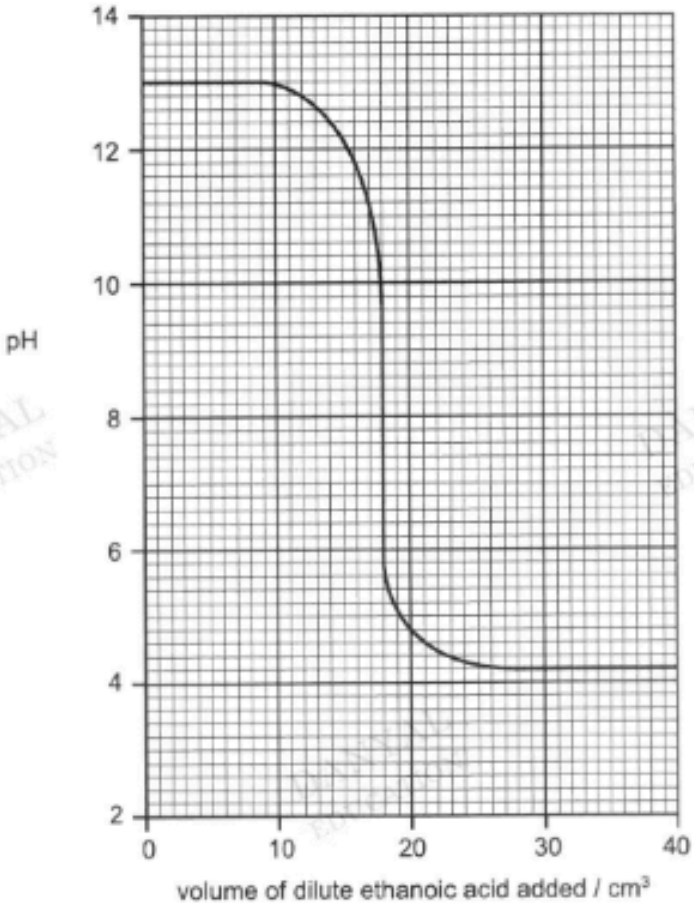
(i) Ethanol can be converted to ethanoic acid when a chemical is added to ethanol. Give the name of this reaction and the name of the chemical to be used.

reaction name .....

name of chemical used ..... [2]

(ii) The graph shows how the pH changes when dilute ethanoic acid is added slowly to aqueous sodium hydroxide.

For Examiners' Use



Deduce the pH of dilute ethanoic acid. pH = ... [1]

Deduce the volume of dilute ethanoic acid added during neutralisation.

..... cm^3 [1]

---- End of Paper 3 ----

ANSWER SHEET

Paper 1

Answer to MCQ [20 marks]

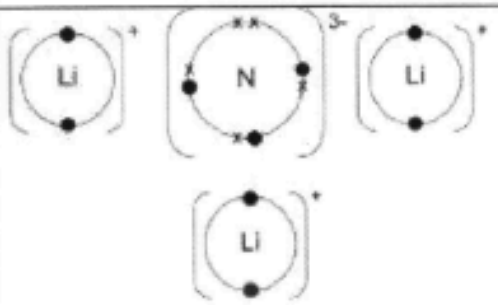
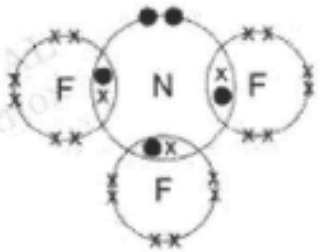
1	2	3	4	5	6	7	8	9	10
D	A	B	C	D	D	A	D	D	B

11	12	13	14	15	16	17	18	19	20
B	D	B	B	D	A	C	D	A	C

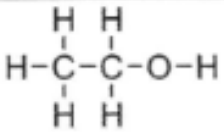
Paper 3

Answer to Section A [45 marks]

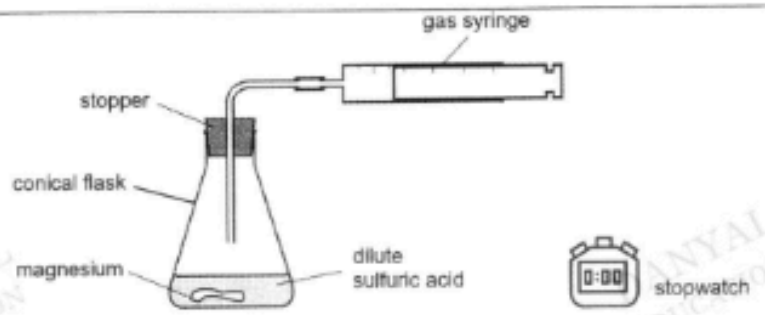
No.			Answers	Mk	Tot mk
1	a		U and W	1	5
	b		T and U	1	
	c		S	1	
	d		P	1	
	e		Q and R	1	
2	a		(most reactive) Y > X > Z > W (least reactive) Max 1m if given in reverse order Max 1m for sequencing the most and least reactive metal correctly (i.e., only X and Z are in wrong order)	2	5
	b	i	delta	1	
		ii	alpha	1	
		iii	epsilon	1	

3	a		 Legend /key: • electron of lithium x electron of nitrogen [1] correct Li^+ ion [1] correct N^{3-} ion	2	6
	b		 Legend /key: • electron of nitrogen x electron of fluorine [1] correct bond pairs [1] correct unshared electrons	2	
	c		Lithium nitride is held by strong electrostatic forces of attraction between its oppositely charged ions (Li^+ and N^{3-}) ; Nitrogen fluoride is held by weak intermolecular forces of attraction ;	2	
4	a		burette	1	6
	b		$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$	1	
	c		1 mark for each step • Repeat the titration using the same / known volumes of acid and alkali, but without indicator • Heat to evaporate / remove most of the water to obtain a saturated salt solution. • Allow the saturated salt solution to cool for crystallisation to occur ; • Filter and collect the crystals, rinse with small amount of cold distilled water and dry between filter papers ;	4	

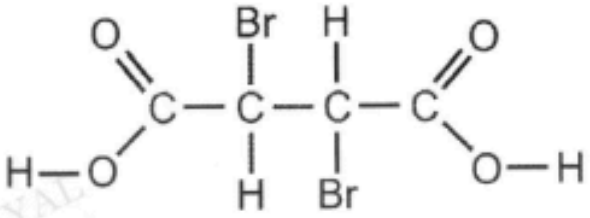
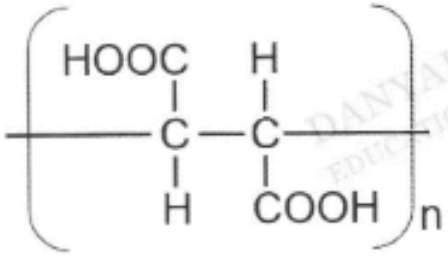
5	a		No of moles of $NH_4NO_2 = \frac{25.0}{1000} \times 0.150 = 0.00375$ mol No of moles of N_2 = 0.00375 mol ; Maximum volume of N_2 = 0.00375 x 24 = 0.09 dm^3 ; *note*: Allow ECF for (a)	2	4
	b	i	to increase the pH of acidic soils / to neutralise the acidity in soil	1	
		ii	calcium hydroxide will react with ammonium nitrate / ammonium salts / ammonium compounds to release ammonia gas, resulting a loss of nitrogen.	1	
6	a	i	A: zinc carbonate	1	7
		ii	B: copper	1	
		iii	C: (dilute) hydrochloric acid	1	
		iv	D: zinc sulfate	1	
		v	E: zinc hydroxide	1	
	b		Any of the following equation: 1m : balanced chemical equation 1m: all correct state symbols, only awarded if equation is correct • $ZnCO_3(aq) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + CO_2(g) + H_2O(l)$ • $CO_2(g) + Ca(OH)_2(aq) \rightarrow CaCO_3(s) + H_2O(l)$ • $ZnSO_4(aq) + 2NH_4OH(aq) \rightarrow Zn(OH)_2(s) + (NH_4)_2SO_4(aq)$ • $2Cu(s) + O_2(g) \rightarrow 2CuO(s)$ • $CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$ • $CuCl_2(aq) + 2AgNO_3(aq) \rightarrow 2AgCl(s) + Cu(NO_3)_2(aq)$	2	

7	a		 Reject '- OH' as qn asks for full structure	1	7
	b	i	Fermentation ; Fractional distillation ;	2	
		ii	$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$	2	
		iii	37 – 40 °C, yeast, absence of oxygen / anaerobic condition	1	
	c		The amount of carbon dioxide emitted in the combustion of ethanol is balanced by the taking in of carbon dioxide by sugar cane during photosynthesis.	1	
8	a	i	15.5 (%) working is not required	1	5
		ii	hydrogen / H_2	1	
		iii	the air / the atmosphere	1	
	b	i	compounds made up of carbon and hydrogen atoms only	1	
		ii	prevents red blood cells from transporting oxygen in the body, leading to suffocation, brain damage and eventually death	1	

Section B [20 marks]
Answer two out of three questions from this section.

No.			Answers	Mk	Tot mk
9	a		 [1] correct drawing of gas syringe + label [1] correct drawing of stoppered conical flask with contents + label [1] correct drawing of stopwatch + label Max 2 marks for correct drawing of the full set-up but w/o labels	3	10
	b	i	all magnesium has reacted / reaction has completed	1	
		ii	3 min / 180 s (units required)	1	
		iii	Curve sketched • has steeper initial gradient and starts at (0,0) ; • ends at the same volume of gas collected and reaches this volume earlier ;	2	
	c		rate of reaction will be faster ; powdered magnsium has a greater total surface area / higher surface area to volume ratio when compared with magnesium ribbon ; hence resulting in increased frequency of effective collision ;	3	

10	a	i	carbon	1	10
		ii	different atomic size of carbon disrupts the regular arrangement of the main iron atom layers ; hence preventing the iron atom layers from sliding past one another ;	2	
	b		grease acts as a barrier to prevent contact between iron with oxygen and water / water vapour / moisture.	2	
	c	i	molten iron has a higher density / is denser than molten slag [2] 'different density' – 1 mark awarded	2	
		ii	• Carbon dioxide is formed when coke undergoes combustion in hot air: $C(s) + O_2(g) \rightarrow CO_2(g)$ [1] • Further reaction takes place between coke and carbon dioxide to form carbon monoxide. $C(s) + CO_2(g) \rightarrow 2CO(g)$ [1] • Iron metal is formed when haematite is reduced by carbon monoxide. $Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(l) + 3CO_2(g)$ [1] 1 mark awarded for each balanced chemical equation, state symbols are not required	3	

11	a	i	circle drawn at the hydroxyl (-OH) group	1	10
		ii	$C_4H_6O_5$	1	
	b	i	It has a C=C double bond / carbon-carbon double bond.	1	
		ii	product G: 	1	
			polymer H [1] correct repeat unit [1] bracket and 'n' indicated 	2	
	c	i	oxidation acidified potassium manganate (VII)	1 1	
		ii	1. (pH) 4.2 2. 18 (cm^3)	1 1	

CHRIST CHURCH SECONDARY SCHOOL PRELIM PAPER

21 Which information correctly describes the movement of particles in the three physical states?

	solid	liquid	gas
A	stationary	move freely throughout the liquid	move about rapidly in any direction
B	stationary	move about rapidly in any direction	vibrating about fixed position
C	vibrating about fixed position	move freely throughout the liquid	move about rapidly in any direction
D	vibrating about fixed position	stationary	move freely throughout the liquid

22 A student intends to measure the speed of reaction between a fixed mass of marble chips and fixed volume of dilute hydrochloric acid.

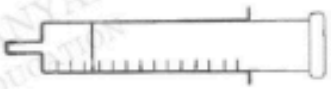
$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

Which piece of apparatus is **not** required?

A

B

C



D

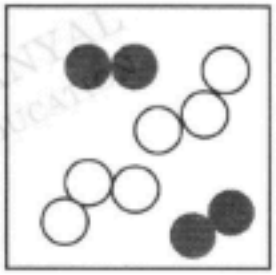
23 Ethanol and water are miscible liquids.

Which method could be used to separate a mixture of ethanol and water and how is the purity of separated ethanol checked?

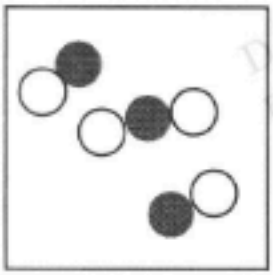
	method of separation	purity check
A	filtration	add aqueous bromine
B	filtration	find the boiling point
C	fractional distillation	add aqueous bromine
D	fractional distillation	find the boiling point

24 Which diagram represents a mixture of two compounds?

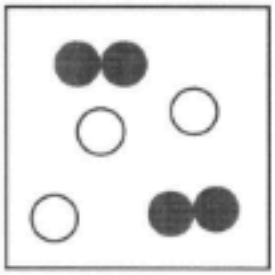
A



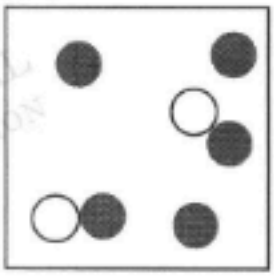
B



C



D



25 The nucleus of an atom has neutrons and protons.

Which statement about an atom is correct?

A The nucleus has a negative charge.

B The nucleus and electrons repel each other.

C Neutrons and protons have different relative mass.

D The nucleus contains most of the mass of the atom.

26 Which statement about covalent compounds is **incorrect**?

A They are formed by the sharing of electrons between the atoms.

B They conduct electricity as they have free-moving electrons.

C They do not dissolve in water but are soluble in organic solvent.

D They have low melting and boiling points due to the weak intermolecular forces between the molecules.

27 Element Q has an electronic structure 2,4.

Element R has an electronic structure 2,8,6.

What would be the formula of the compound formed between Q and R?

A QR_2 **B** Q_2R **C** QR_3 **D** Q_2R_3

28 An equation is shown.

$$wC_2H_4 + xO_2 \rightarrow yCO_2 + zH_2O$$

Which numbers will correctly balance this equation?

	w	x	y	z
A	1	3	2	2
B	1	2	3	3
C	2	3	4	3
D	2	1	2	3

29 25 cm^3 of aqueous 0.5 mol/dm^3 hydrochloric acid exactly neutralises 20 cm^3 of aqueous sodium hydroxide.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

What is the concentration of the sodium hydroxide solution?

A 0.3 mol/dm^3

B 0.5 mol/dm^3

C 0.625 mol/dm^3

D 1.25 mol/dm^3

12

30 Which pair of reagents can be used to produce an aqueous solution containing copper(II) sulfate salt?

A copper and dilute sulfuric acid
B copper(II) carbonate and dilute hydrochloric acid
C copper(II) hydroxide and sodium sulfate
D copper(II) oxide and dilute sulfuric acid

31 The table below shows the observations when oxides of three elements, Q, R and S are added to water.

	observations in water
Q oxide	Dissolved to form a solution with pH 2
R oxide	Dissolved to form a solution with pH 7
S oxide	Dissolved to form a solution of pH 10

What are elements Q, R and S?

	Q	R	S
A	sulfur	calcium	nitrogen
B	sulfur	nitrogen	calcium
C	calcium	nitrogen	sulfur
D	nitrogen	sulfur	calcium

32 Which three salts can be prepared by titration?

A sodium sulfate, potassium chloride, ammonium nitrate
B barium sulfate, potassium chloride, lead(II) sulfate
C zinc sulfate, silver chloride, sodium nitrate
D barium sulfate, lead(II) chloride, ammonium nitrate

33 Which reaction is **not** an example of a redox reaction?

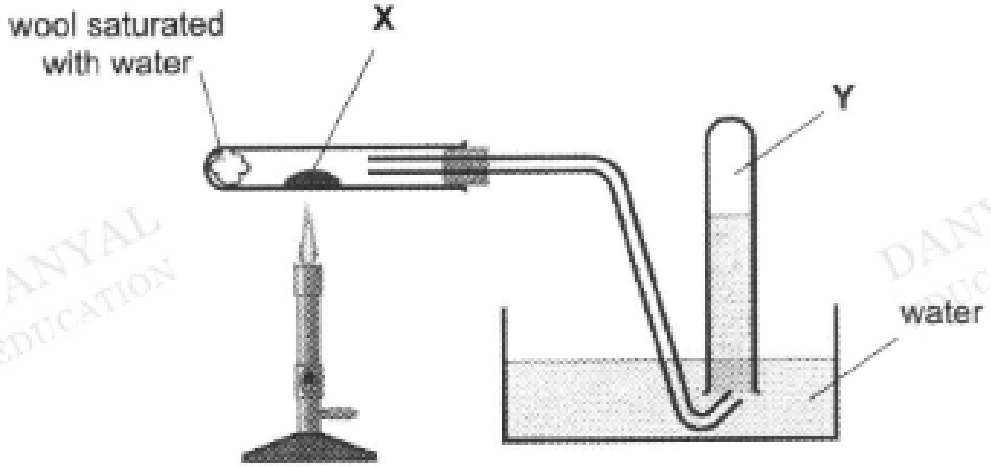
A $Fe^{2+} \rightarrow Fe^{3+} + e^-$

B $CuO + H_2 \rightarrow Cu + H_2O$

C $2Al + 3CuO \rightarrow Al_2O_3 + 3Cu$

D $KOH + HCl \rightarrow KCl + H_2O$

34 Steam is passed over a heated solid X. Gas Y is collected.



What are substances **X** and **Y**?

	X	Y
A	silver	hydrogen
B	lead	oxygen
C	copper	oxygen
D	zinc	hydrogen

35 Experiments are carried out for metals P, Q and R. The table shows the results.

experiment	P	Q	R
Can the metal be extracted by reducing its oxide with carbon?	no	yes	yes
Does the metal displace zinc from zinc chloride?	yes	no	yes

What is the order of reactivity of the metals?

	most reactive ⟶		least reactive
A	P	R	Q
B	Q	P	R
C	Q	R	P
D	R	Q	P

36 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 $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

D $FeO + CO \rightarrow Fe + CO_2$

37 Which statements about alkali metals is correct?

A Their reactivities decrease down Group I.

B They form oxides on reacting with water.

C Their melting points decrease down Group I.

D They form covalent bonds with the halogens.

38 An energy change takes place as ammonium nitrate is dissolved in water at 30°C. The temperature changes by 4.5°C.

What is the final temperature?

A 25.5°C

B 30.0°C

C 34.5°C

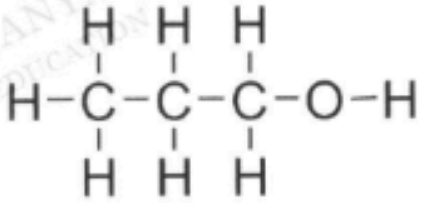
D 37.0°C

39 Methane, the first member of the alkane homologous series, has a boiling point of -161°C.

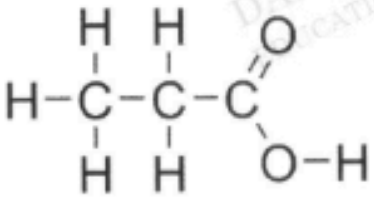
Which molecular formula and boiling point could be correct for another alkane member in the series?

	molecular formula	boiling point/°C
A	C_2H_4	-88
B	C_2H_6	-89
C	C_3H_6	-69
D	C_3H_8	-200

40 Compound X can be oxidised to compound Y.



compound X



compound Y

What are compounds X and Y?

	X	Y
A	butanol	propanoic acid
B	ethanol	propanol
C	propanol	propanoic acid
D	ethanol	ethanoic acid

Section A

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

1 Table 1.1 shows some information about four different substances.

Table 1.1

substance	chemical formula	solubility in water
lead(II) nitrate	$Pb(NO_3)_2$	
lead(II) sulfate	$PbSO_4$	insoluble
sodium carbonate		soluble
barium carbonate	$BaCO_3$	insoluble

(a) Complete the table by filling in the blank boxes. [2]

(b) A white precipitate of lead(II) carbonate is formed when two substances in the table are mixed together.

(i) Name these two substances.

..... [1]

(ii) Describe how you would obtain a pure sample of lead(II) carbonate from the result of this mixing.

.....

.....

.....

.....

..... [3]

2 Magnesium, copper and iron are metals.

(a) State two physical properties of metals.

.....

.....

..... [2]

(b) **(i)** Table 2.1 shows the reactions of the three metals with dilute hydrochloric acid and cold water. Put a tick (√) if a reaction will take place and a cross (X) if a reaction will not take place.

Table 2.1

metal	reaction with cold water	reaction with dilute hydrochloric acid
magnesium		
copper		
iron		

[3]

(ii) Place the three metals in order of chemical reactivity, with the most reactive first.

most reactive .....

.....

least reactive .....

[2]

(c) Iron rusts under certain conditions.

(i) State the conditions required for iron to rust.

.....

..... [2]

(ii) State one way to prevent iron from rusting.

.....

..... [1]

3 Fig. 3.1 describes some of the reactions of a metal salt **R**.

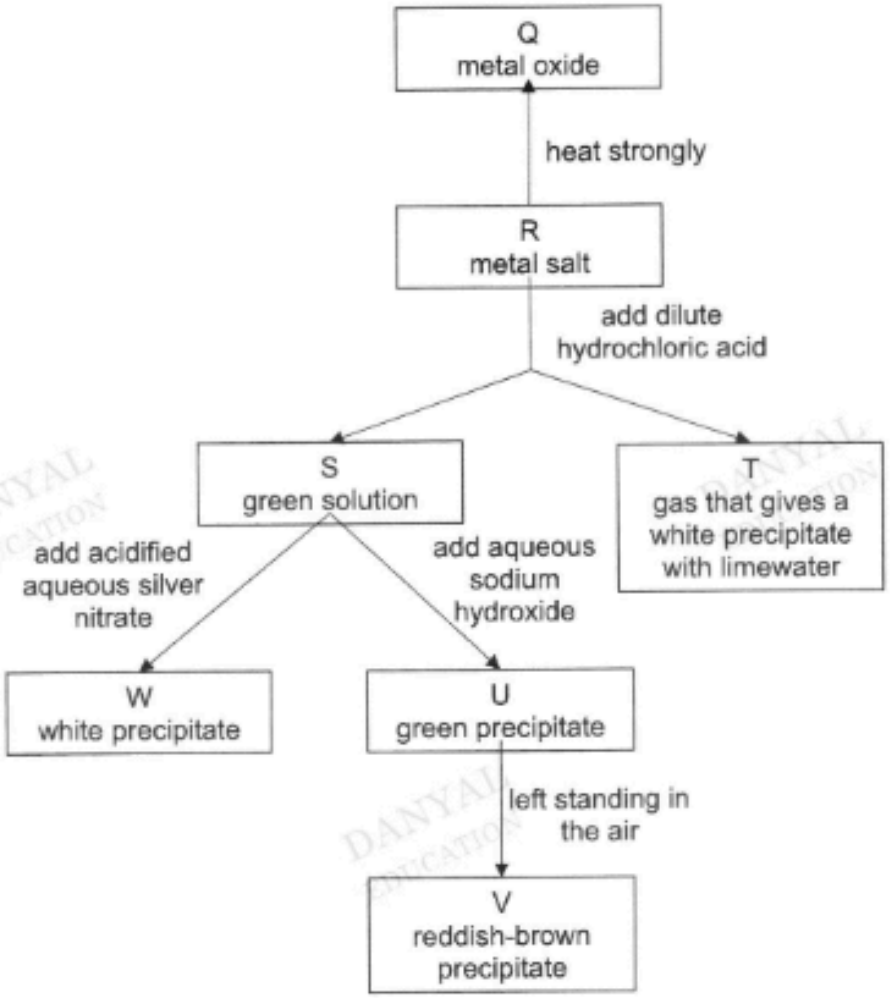


Fig. 3.1

Name **Q**, **R**, **S**, **T**, **U**, **V**, and **W**.

Q .....

R .....

S .....

T .....

U .....

V .....

W .....

4 Methane and propane are organic compounds in the same homologous series.

(a) Draw the full structural formula of methane and propane.

methane	propane

[2]

(b) **(i)** Name the homologous series that consists of methane and propane.

..... [1]

(ii) State the general formula for the homologous series named in part **(b)(i)**.

..... [1]

(c) State two general properties of a homologous series.

.....

.....

..... [2]

(d) Describe a chemical reaction of methane. State the products and conditions clearly.

.....

.....

.....

..... [3]

5 Nitrogen, N_2, and hydrogen, H_2, combined on a large scale to form ammonia, NH_3 as shown in the equation below.

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

(a) (i) Define relative molecular mass.

.....

.....

..... [1]

(ii) Calculate the relative molecular mass of ammonia.

[Relative atomic masses: Ar: H, 1; N, 14]

[1]

(b) (i) Calculate the volume of ammonia produced when 240 dm^3 of nitrogen reacts in excess hydrogen. All volumes are measured at room temperature and pressure.

[3]

(ii) Calculate the mass of this volume of ammonia.

[Relative atomic masses: Ar: H, 1; N, 14]

[1]

6 Indigestion is caused by having too much hydrochloric acid in the stomach. Antacid tablets containing calcium hydroxide are commonly used to treat indigestion.

(a) **(i)** Calcium hydroxide is an alkali. State the symbol for the ion that causes this alkalinity.

..... [1]

(ii) State two properties of calcium hydroxide.

.....

.....

..... [2]

(b) **(i)** Write the balanced chemical equation to show the reaction between hydrochloric acid and calcium hydroxide. State symbols are **not** required.

..... [2]

(ii) What name is given to this type of reaction?

..... [1]

(iii) Write an ionic equation to represent this reaction.

..... [1]

Section B

Answer any **two** questions in this section.
Write your answers in the spaces provided.

7 Fluorine and chlorine are halogens found in Group VII of the Periodic Table.

(a) Using the electronic structures of these two elements, explain why both elements appear in the same group of the Periodic Table.

.....

.....

..... [2]

(b) For these two elements, suggest **two** similarities in their physical properties and **two** trends in their physical properties.

Similarities: .....

.....

.....

Trends:.....

.....

..... [4]

(c) Chlorine reacts with calcium to form a compound named calcium chloride.

(i) Draw a diagram to show the electronic structure of calcium chloride.

[2]

(ii) Using the structure, explain why calcium chloride has a very high melting point.

.....

.....

..... [2]

8 Fig 8.1 shows some reactions of ethene.

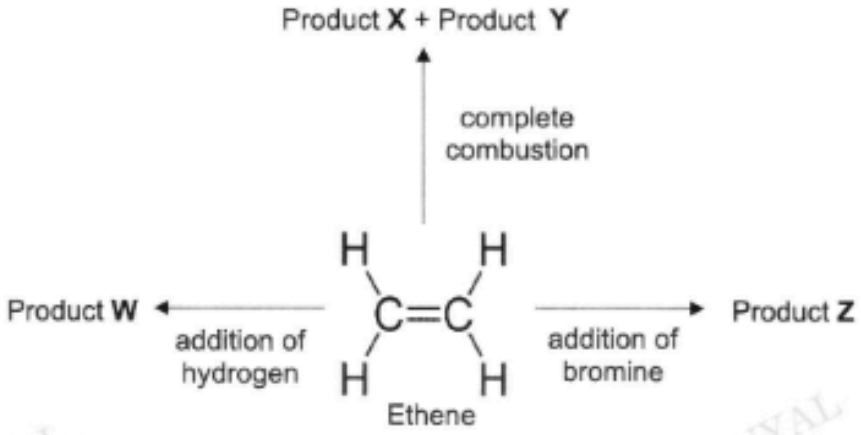


Fig 8.1

(a) Draw the full structural formulae for products **W**, **X**, **Y** and **Z**.

Product **W**

Products **X** and **Y**

Product **Z**

[4]

(b) Describe a chemical test and the observation that allow you to distinguish between ethene and product **W**.

test .....

.....

results .....

.....

..... [3]

(c) Ethene undergoes addition polymerisation to form poly(ethene). Poly(ethene) is a type of plastic that is used to make items such as plastic bags, toys and clingfilm.

(i) Briefly explain how poly(ethene) can be formed by addition polymerisation. State the conditions clearly.

.....

.....

..... [2]

(ii) Write an equation for the addition polymerisation of ethene.
State symbols are **not** required.

[1]

9 **(a)** 5.0 g of calcium carbonate lumps reacted with 50 cm^3 of 0.5 mol/dm^3 nitric acid to produce carbon dioxide gas.

State and explain two ways to increase the speed of this reaction.

.....

.....

.....

.....

.....

.....

..... [4]

(b) The speed of reaction can be determined by measuring the volume of carbon dioxide gas produced.

Describe, with the aid of a labelled diagram, an experiment to measure the speed of this reaction.

Diagram

.....

.....

.....

.....

..... [4]

(c) Fig 9.1 shows the graph of the volume of carbon dioxide produced against time when 5.0 g of calcium carbonate lumps reacted with 50 cm^3 of 0.5 mol/dm^3 nitric acid.

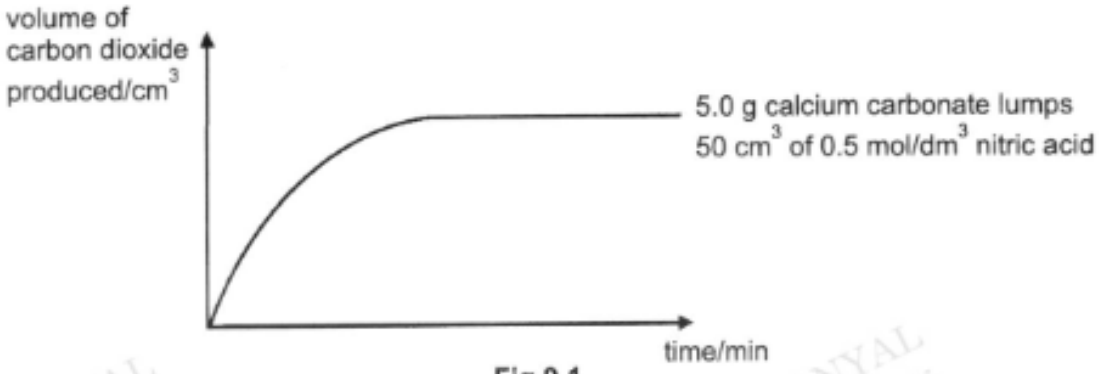


Fig 9.1

On Fig 9.1,

(i) sketch the graph you would expect when the experiment is repeated using 50 cm^3 of 0.1 mol/dm^3 nitric acid. Label this graph as **(i)**. [1]

(ii) sketch the graph you would expect when the experiment is repeated using 5.0 g of powdered calcium carbonate. Label this graph as **(ii)**. [1]

ANSWER SHEET

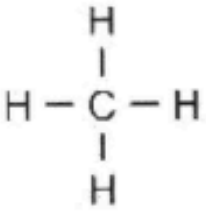
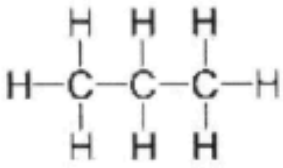
Paper 1

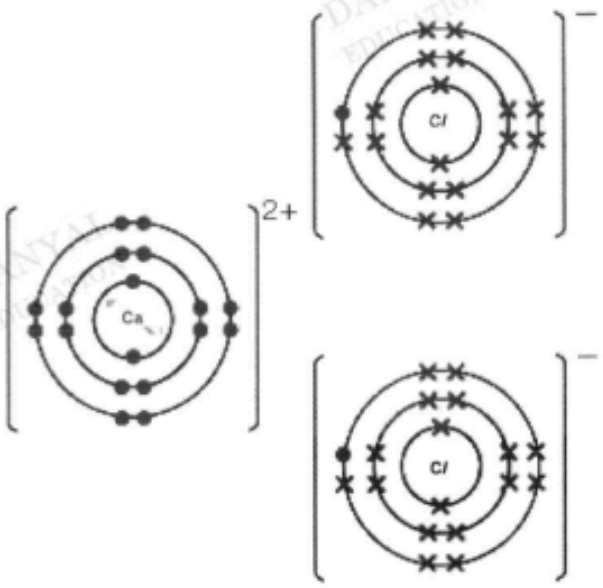
21	22	23	24	25	26	27	28	29	30
C	B	D	B	D	B	A	A	C	D

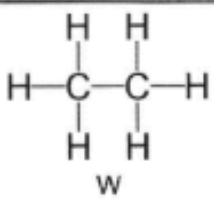
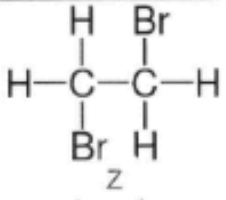
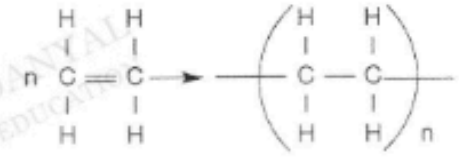
31	32	33	34	35	36	37	38	39	40
B	A	D	D	A	B	C	A	B	C

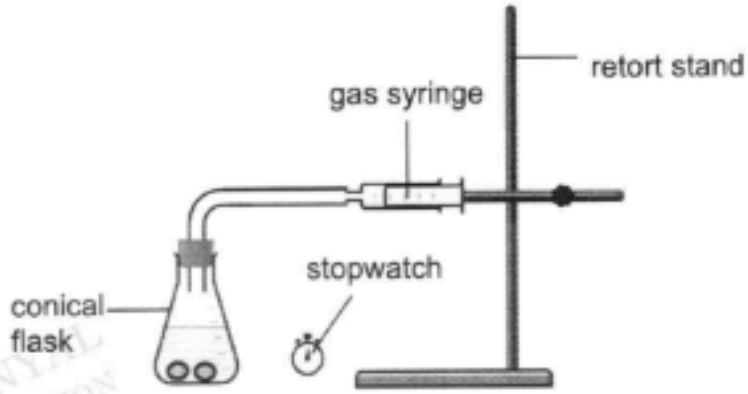
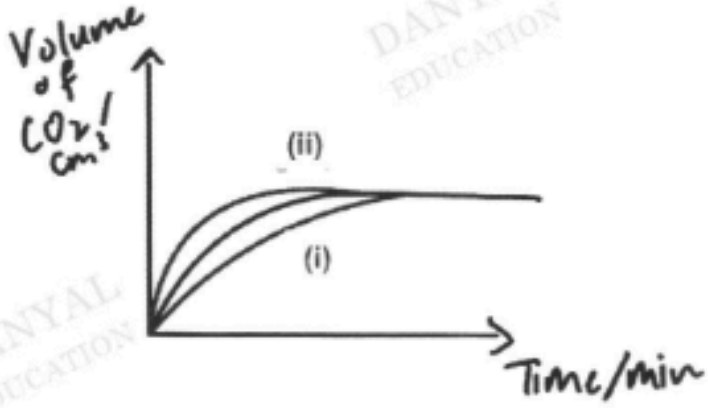
Paper 3
Section A

Qn	Answer	Marks/ Remarks
1a	substance / chemical formula / solubility in water lead(II) nitrate / $Pb(NO_3)_2$ / soluble lead(II) sulfate / H_2SO_4 / soluble sodium carbonate / Na_2CO_3 / soluble barium carbonate / $BaCO_3$ / insoluble	1 m per blank 2 m
1bi	Lead(II) nitrate and sodium carbonate	1 m
1bii	Filter the mixture through a filter funnel with filter paper [1] Wash the residue with distilled water [1] Dry the residue between two filter paper [1] *R: Wash and dry*	3 m
2a	Good conductor of heat Good conductor of electricity High densities High melting and boiling points Malleable and ductile *Any 2 points above or reasonable answers*	2 m
2bi	metal / reaction with cold water / reaction with dilute hydrochloric acid magnesium / √ / √ copper / X / X iron / X / √	6 pt – 3 m 4-5 pt – 2 m 2-3 pt – 1 m 0-1 pt – 0 m
2bii	Magnesium (most reactive) > Iron > Copper (least reactive)	3 pt – 2 m 2 pt – 1 m 0 – 1 pt – 0 m
2ci	Oxygen in air [1] Water [1]	2 m
2cii	Coat the iron with a layer of paint/grease; Cover the iron with a plastic; Electroplating; *Any one point above*	1 m
3	Q – iron(II) oxide R – iron(II) carbonate S – iron(II) chloride T – carbon dioxide U – iron(III) hydroxide V – iron(III) hydroxide W – silver chloride	7 m

Qn	Answer	Marks/ Remarks
4a	 methane  propane	1 m for each correct structure (All bonds must be drawn) 2 m
4bi	alkane	1 m
4bii	C_nH_{2n+2}	1 m
4c	same functional group; similar chemical properties; gradual change in their physical properties as we go down the series from one member to the next; *Any 2 points above*	2 m
4d	Combustion [1] Methane burn readily in excess oxygen/air [1] to produce carbon dioxide and water [1] Incomplete combustion [1] Methane burn in limited oxygen/air [1] to produce carbon monoxide, carbon and water [1] Substitution reactions [1] Methane react with halogens/chlorine/bromine in presence of UV light [1] to form chloromethane and hydrogen chloride [1] *Any one reaction above*	3 m
5ai	Relative molecular mass is the average mass of one molecule of that element/compound compared to 1/12 of the mass of one carbon-12 atom	1 m
5aii	Relative molecular mass = 14 + 3 = 17 No mark awarded if unit is written	1 m
5bi	mole of nitrogen = 240 / 24 = 10 mol [1] $N_2 : NH_3 = 1 : 2$ Mole of ammonia = 10 X 2 = 20 mol [1] Volume of ammonia = 20 X 24 = 480 dm^3 [1]	3 m
5bii	Mass of ammonia = 20 mol X 17 = 340 g [1]	1 m
6ai	OH^- ion	1 m
6aii	taste bitter and feels soapy conduct electricity in aqueous state turns red litmus paper blue pH value more than 7 reacts with acid to form salt and water	2 m

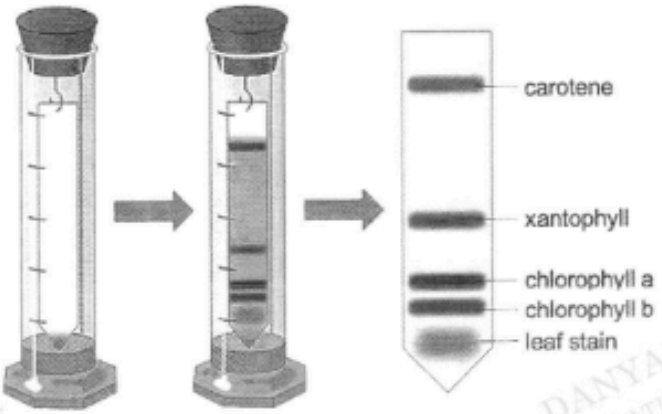
Qn	Answer	Marks/ Remarks
	reacts with ammonia salt to form salt, ammonia gas and water Any 2 points above	
6bi	$Ca(OH)_2 + 2\ HCl \rightarrow CaCl_2 + 2\ H_2O$	1 m – chemical formula 1 m – balanced equation
6bii	Neutralisation reaction	1 m
6biii	$H^+ (aq) + OH^- (aq) \rightarrow H_2O (l)$ No mark awarded without state symbols	1 m
7a	Fluorine: (2,7) and Chlorine: (2,8,7) [1] The elements are in the same group as they have 7 valence electrons [1] *No mark awarded if student state valence electrons*	2 m
7b	Similarities: Low melting and boiling points [1] Coloured elements [1] Trends: Melting and boiling points increase down the group [1] Colour intensity increases/gets darker down the group [1]	4 m
7ci	 [1] – correct cation [1] – correct anion	2 m

Qn	Answer	Marks/ Remarks
	Deduct overall 1 m if student did not draw all electrons	
7cii	Calcium chloride has a <u>giant lattice structure</u> [1] Large amount of energy is required to overcome the <u>strong electrostatic forces between the oppositely-charged ions</u> [1]	2 m
8a	 W  Z *accept any isomers*	4 m
	Products X and Y	
8b	test: add butane and butene to the <u>bromine solution</u> [1] Observation: 1) product W <u>will not decolourise bromine solution</u> / butane will not cause the bromine solution to turn from reddish brown to colourless [1] 2) <u>ethene will decolourise bromine solution</u> / butene will cause the bromine solution to turn from reddish brown to colourless [1]	3 m
8ci	Under <u>high temperature and pressure and presence of a catalyst</u> [1], Poly(ethene) can be formed by addition polymerisation of ethene monomers [1]	2 m
8cii	 ethene poly(ethene)	1 m
9a	Increase the concentration of nitric acid [1] At a higher concentration, there are <u>more reactant particles</u> to collide and the <u>frequency of effective collisions increase</u> [1] Use powdered calcium carbonate [1] Powdered calcium carbonate has a <u>higher exposed surface area</u> for collision and the <u>frequency of effective collisions increase</u> [1] Increase the temperature of nitric acid [1]	4 m

Qn	Answer	Marks/ Remarks
	At higher temperature, more reactant particles possess energy equal to or greater than the activation energy and frequency of effective collisions increase [1] Any 2 points above	
9b	 [1] – all apparatus correctly drawn [1] – all apparatus clearly labelled Set up the apparatus as shown above. Record the volume of gas produced in the gas syringe at regular intervals [1] Plot a graph of volume of gas against time [1]	4 m
9ci/9cii		2 m

CHUA CHU KANG SECONDARY SCHOOL PRELIM PAPER

1 Chromatography is used to separate the pigments present in a leaf stain as shown in the diagram.



Which pigment is the most soluble in the solvent?

A carotene

B xanthophyll

C chlorophyll a

D chlorophyll b

2 The results of separate tests on a salt solution are shown in the table.

	test	result
1	Add aqueous sodium hydroxide	Light blue precipitate formed, does not dissolve in excess aqueous sodium hydroxide.
2	Add dilute nitric acid followed by aqueous silver nitrate	White precipitate is formed.

What is the salt?

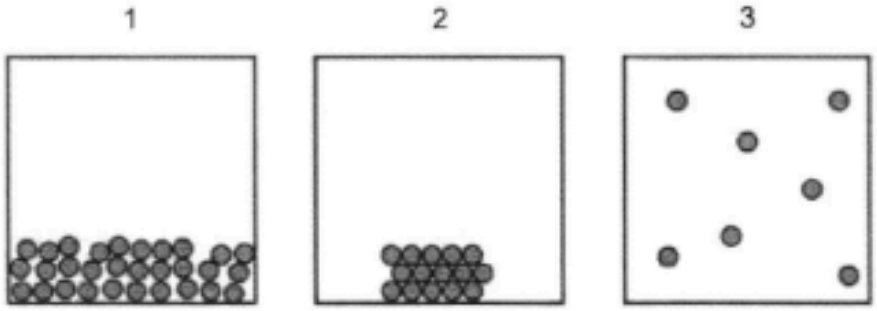
A copper(II) sulfate

B copper(II) chloride

C iron(III) sulfate

D iron(III) chloride

3 The diagrams show some particles in a container.



Which diagrams show the process of evaporation?

A 1 → 2

B 1 → 3

C 2 → 3

D 3 → 1

4 Which of the following ions does **not** have the electronic configuration of an argon atom?

A Ca^{2+}

B Cl^-

C K^+

D O^{2-}

5 Which statement about isotopes is correct?

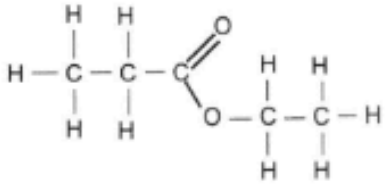
A They have different numbers of electrons but the same number of protons.

B They have different numbers of electrons shells but the same number of neutrons.

C They have different numbers of neutrons but the same number of electron shells.

D They have different numbers of protons but the same number of electrons.

6 The diagram shows the molecule ethyl propanoate.



How many bonding pairs of electrons are there in the molecule?

A 7

B 13

C 16

D 17

7 Which process is exothermic?

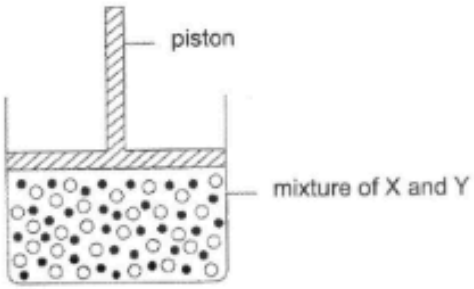
A burning petrol in a car engine

B cracking of petroleum fractions

C fractional distillation of petroleum

D melting bitumen for roads

8 Gases X and Y can undergo a chemical reaction when mixed together.
The two gases are mixed together in a container at room temperature as shown in the diagram.



Which action will lead to an increase in the speed of reaction?

A keep the container in a dark room

B lower the piston

C place the container in an ice bath

D release some of the gases from the container

9 Which substance in the equation is reduced?

$$Cr_2O_3(s) + 2Al(s) \rightarrow Al_2O_3(s) + 2Cr(s)$$

A Cr_2O_3

B Al

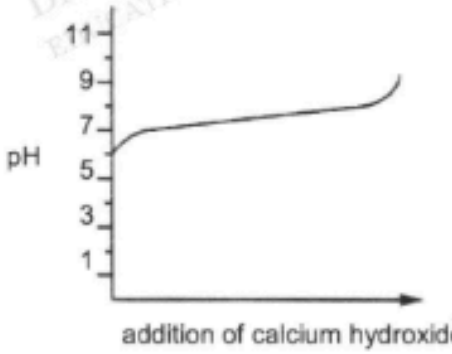
C Al_2O_3

D Cr

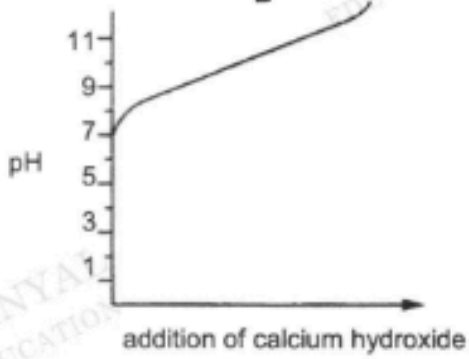
10 Calcium hydroxide is added slowly to acidic soil to reduce the acidity.
The pH of the soil samples are measured using pH meter.

Which graph shows the change in pH as calcium hydroxide is added to the soil?

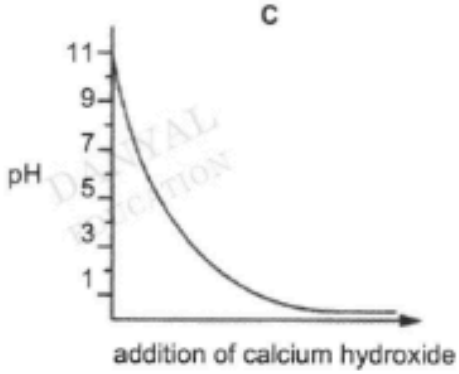
A



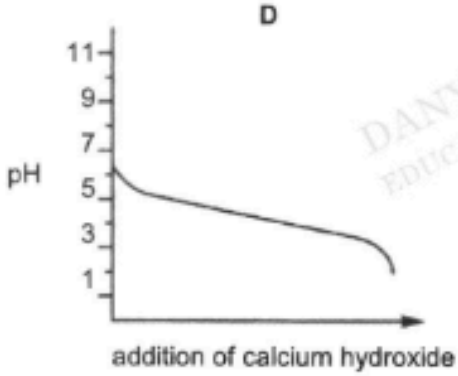
B



C



D



11 Which row describes a basic oxide?

	reacts with sulfuric acid	reacts with calcium hydroxide
A	no	no
B	no	yes
C	yes	no
D	yes	yes

12 Calcium sulfate is an insoluble salt.

Which method is **most** suitable for preparing calcium sulfate?

A adding calcium metal to dilute sulfuric acid

B adding aqueous calcium nitrate to dilute sulfuric acid

C titrating calcium hydroxide solution with dilute sulfuric acid

D warming solid calcium carbonate with dilute sulfuric acid

13 Which pair of elements reacts together most violently?

A fluorine and lithium

B fluorine and potassium

C iodine and lithium

D iodine and potassium

14 A blast furnace is used to extract iron from iron ore.

Why is limestone added to the blast furnace?

A to cause the furnace to heat up

B to change the ore into iron

C to convert impurities in the ore into slag

D to produce oxygen for the coke to burn

15 Which is **not** a reason for recycling copper?

A to conserve copper ore

B less energy is needed in recycling than extraction

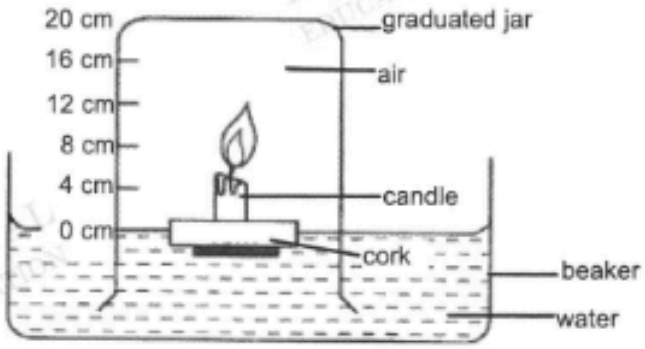
C to reduce damage made to the environment by mining

D copper made by recycling is less pure than that made by extraction

16 Which row shows the correct source of nitrogen dioxide and its adverse effect on the environment?

	source	effect on the environment
A	car exhausts	global warming
B	combustion of fossil fuels	global warming
C	lightning	acid rain
D	volcanoes	acid rain

17 A wax candle was fixed to a weighted piece of cork and floated on water. The candle was then lit and covered with a graduated jar.



What will the water level be when the flame extinguishes?

A 4 cm

B 8 cm

C 12 cm

D 16 cm

18 Naphtha is one fraction obtained from the fractional distillation of petroleum.

What is the main use of naphtha?

A to provide a fuel for aircraft engines

B to provide a material for road surfaces

C to provide lubricating oils

D to provide a feedstock for the petrochemical industry

19 Alkanes are a homologous series of compounds.

How do the physical properties of alkanes change as the size of molecules increases?

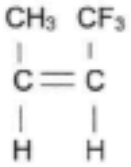
A The boiling point increases and the flammability increases.

B The flammability decreases and the viscosity increases.

C The flammability increases and the melting point increases.

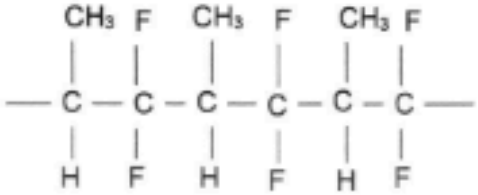
D The viscosity increases and the boiling point decreases.

20 The structure of a monomer is shown.

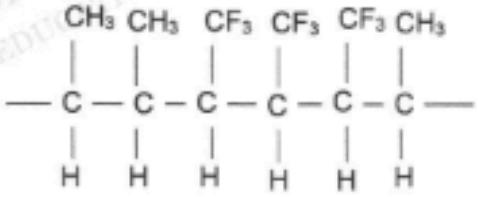


What is the structure of the polymer formed by this monomer?

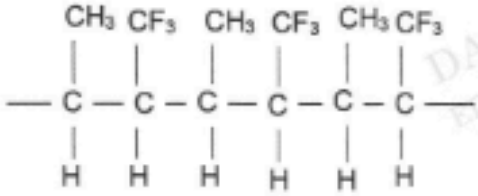
A



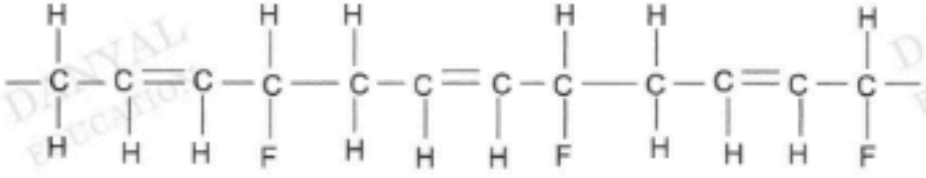
B



C



D



End of Paper

Section A

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

1 For each of the following, give the name of the substance that matches the description.

magnesium	copper	sulfuric acid	carbon dioxide
aluminium	helium	sodium	carbon monoxide

(a) A monoatomic gas.

..... [1]

(b) A compound that reduces iron oxide to iron in a blast furnace.

..... [1]

(c) A metal that is soft and easily cut.

..... [1]

(d) A poisonous gas that is odourless and produced by incomplete combustion.

..... [1]

(e) A compound with polyatomic ions.

..... [1]

[Total: 5]

2 Fig. 2.1 shows the electronic structures of lithium and fluorine atoms.

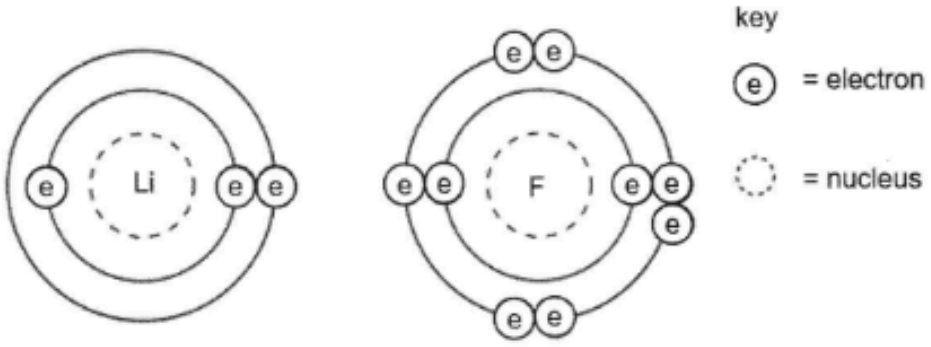


Fig. 2.1

(a) Fluorine reacts with lithium to form solid lithium fluoride.

Draw a 'dot and cross' diagram to show the bonding in lithium fluoride.

Show only the outer shell electrons.

[2]

(b) Fluorine also reacts with oxygen to form solid compound **Q**.

Explain in terms of structure and bonding, why

(i) both solid lithium fluoride and solid **Q** do **not** conduct electricity.

solid lithium fluoride: .....

.....

..... [2]

solid **Q**: .....

..... [1]

(ii) molten lithium fluoride will conduct electricity.

.....

..... [1]

[Total: 6]

3 Hydrogen peroxide can be thermally decomposed to produce water and oxygen gas. The equation for this reaction is shown below.

$$2H_2O_2\ (l) \rightarrow 2H_2O\ (l) + O_2\ (g)$$

(a) A student measured the temperature change when some hydrogen peroxide was decomposed. The table shows her results.

temperature at start /°C	28
temperature at end /°C	25

(i) Calculate the temperature change.

..... [1]

(ii) Explain if hydrogen peroxide decomposition reaction is endothermic or exothermic.

.....

..... [1]

(b) Calculate the relative molecular mass of hydrogen peroxide.
[Relative atomic masses: A_r: H,1; O,16]

relative molecular mass of hydrogen peroxide = ... [1]

(c) What is the mass of water produced when 68 g of hydrogen peroxide reacts?

[Relative molecular masses: M_r: H_2O, 18]

mass of water produced = ...g [2]

(d) What is the volume of oxygen gas produced when 68 g of hydrogen peroxide reacts?

[The volume of one mole of any gas is 24 dm^3 at room temperature and pressure.]

volume of oxygen gas produced = ...dm^3 [2]

[Total: 7]

4 Fig. 4.1 describes some of the substances that result from the chemical reactions of metallic salt **P**.

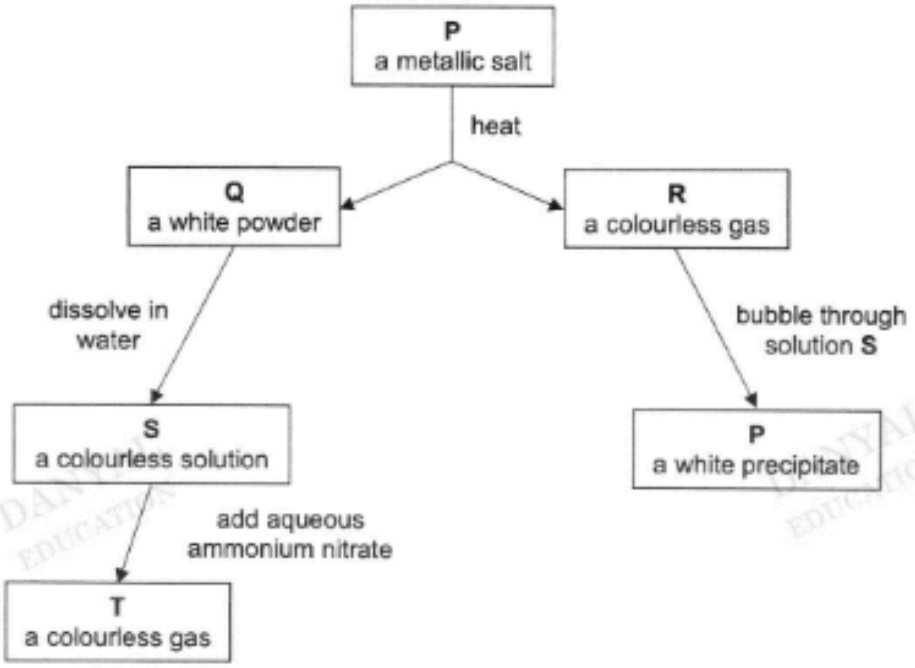


Fig. 4.1

(a) Identify **P**, **Q**, **R**, and **S**.

P ..... [1]

Q ..... [1]

R ..... [1]

S ..... [1]

(b) Write a balanced chemical reaction for the formation of colourless gas **T**.

..... [2]

[Total: 6]

5 Stainless steel alloy is used to make some bicycle parts.

(a) Give the meaning of the term *alloy*.

.....

..... [1]

(b) Alloys are generally preferred over pure metals as they are harder and stronger. With the aid of a diagram, explain why this is so.

.....

.....

..... [3]

(c) Explain how the oil, the paint and the plastic coating slows down rusting.

.....

..... [1]

[Total: 5]

6 **(a)** Fig. 6.1 shows what is observed when a piece of sodium reacts in a container of chlorine gas to form sodium chloride.

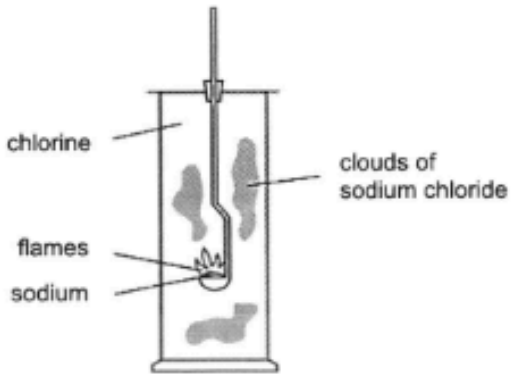


Fig. 6.1

(i) Describe in terms of electrons why sodium was oxidised in this reaction.

.....

..... [1]

(ii) Suggest why this experiment should **not** be carried out with potassium.

.....

.....

..... [2]

(b) Sodium chloride can also be made by reacting an alkali with an acid.

(i) Name the type of chemical reaction that occurs between an acid and an alkali.

..... [1]

(ii) Name the acid and the alkali that react to produce sodium chloride solution.

acid .....

alkali ..... [2]

(iii) Suggest how the solution of sodium chloride could be tested to ensure that it does not contain excess acid or alkali.

.....

.....

..... [2]

(iv) Describe briefly how a sample of dry sodium chloride crystals can be obtained from sodium chloride solution.

.....

.....

.....

..... [1]

[Total: 9]

7 A student carried out some experiments to place four metals, **W, X, Y** and **Z** in order of reactivity. Table 7.1 shows the results.

Table 7.1

	metal **W**	metal **X**	metal **Y**	metal **Z**
solution of **W** nitrate	–	X	X	X
solution of **X** nitrate	✓	–	✓	✓
solution of **Y** nitrate	✓	X	–	✓
solution of **Z** nitrate	✓	X	X	–

✓ shows a reaction happened
X shows no reaction happened
– shows the experiment was not performed

(a) Place the metals in decreasing order of reactivity, starting with the most reactive.

....., ..., ..., ...
most reactive least reactive [1]

(b) Another metal **M** belongs to Group II and reacts with hydrochloric acid.

What would you **observe** when metal **M** reacts with hydrochloric acid?
Write a balanced equation to show the chemical reaction. Include state symbols in your answer.

.....

.....

..... [3]

(c) The student carried out further experiments to place metal **M** in the list from part **(a)**.
She used dilute hydrochloric acid and samples of the metals from part **(a)**.
She found out that metal **M** is the fourth most reactive metal.

Describe the experiments that the student carried out.
Your answer should include

- the experiments that she carried out using dilute hydrochloric acid and samples of the metals,
- the measurements that she made,
- apparatus and instruments used,
- how the results showed that metal **M** is the fourth most reactive metal.

.....

.....

.....

.....

.....

..... [3]

[Total: 7]

Section B

Answer any **two** questions from this section.

Write your answers in the spaces provided.

8 Group VII contains halogens such as fluorine, chlorine, bromine and iodine.

(a) Table 8.1 shows the number of electrons, neutrons and protons in two halogen particles.

Complete Table 8.1.

Table 8.1

	number of electrons	number of neutrons	number of protons
$^{35}_{17}Cl$	17		
$^{79}_{35}Br^-$		44	

[3]

(b) Three unknown halogens, X_2, Y_2 and Z_2, were given in an experiment.

To identify the three given halogens, some tests were carried out.

(i) Table 8.2 shows data about the melting and boiling points of one of the halogens, Z_2.

Table 8.2

halogen	melting point / °C	boiling point / °C
Z_2	–7.2	58.8

State the physical state of Z_2 at room temperature.

..... [1]

(ii) Displacement reactions were further carried out to identify the halogens.

Table 8.3 shows the results of the displacement reactions for three halogens, X_2, Y_2 and Z_2.

Table 8.3

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	–

It was also given that the halogens were chlorine, bromine and iodine.

Use the results from Table 8.3 to identify the halogens X_2 and Y_2.
Explain your answer.

X_2: .....

explanation:.....

.....

Y_2: .....

explanation:.....

..... [4]

(iii) Write the balanced ionic equation for any one of the displacement reactions.

..... [2]

[Total: 10]

9 Four experiments were carried out to measure the rate of reaction between excess powdered calcium carbonate and dilute hydrochloric acid. The reaction produces a gas.

The conditions of the different experiments are shown in Table 9.1.

Table 9.1

experiment	concentration of acid/ mol/dm^3	volume of acid /cm^3	temperature of reaction/ °C
1	2.0	40	50
2	1.0	40	50
3	2.0	20	50
4	1.0	40	30

The rate of reaction was followed by measuring the volume of gas produced at regular time intervals.

(a) In experiment 1, 40 cm^3 of 2.0 mol/dm^3 hydrochloric acid was used.

Give the name and formula of the salt that forms in the reaction.

name : .....

formula : ..... [1]

(b) The results of experiment 1 and experiment 2 are shown in Fig. 9.2.

On the same axes provided, sketch the curve obtained for the 3rd and 4th experiment and label them as experiment 3 and experiment 4 respectively.

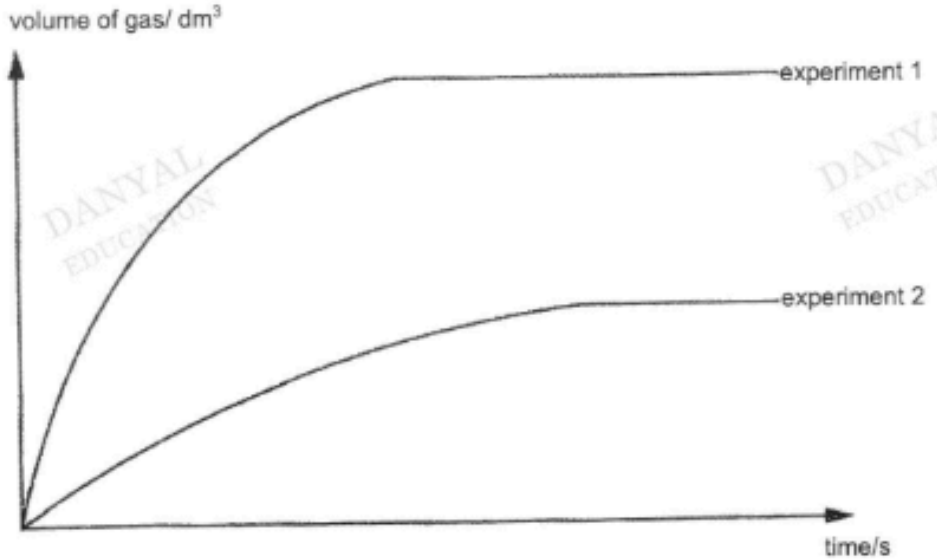


Fig. 9.2

[2]

(c) Use your knowledge on collisions between reacting particles to explain why the rate of reaction between two substances changes with increasing concentration.

.....

.....

..... [2]

(d) Draw a labelled diagram of the experimental set-up for the reaction, showing how the volume of carbon dioxide gas is measured.

[2]

(e) In a different solution, 500 cm^3 of a solution contains 80 g of hydrochloric acid, HCl.

(i) Calculate the concentration of the solution in mol/dm^3.

[Relative atomic masses: A_r: H, 1; Cl, 35.5]

concentration = ... mol/dm^3 [2]

(ii) If 100 cm^3 of the solution in part **(e)(i)** is added to a conical flask, and water is added to make up to 1 dm^3, what will be the new concentration of the solution in mol/dm^3?

concentration = ... mol/dm^3 [1]

[Total: 10]

10 Alcohols are commonly used as a medicinal drug, a solvent and as material to make detergents.

(a) Ethanol is a type of alcohol made in the laboratory using yeast.

(i) Name the process and list the substance(s) needed to make ethanol at room temperature in the laboratory.

name of process: .....

substance(s) needed: ..... [2]

(ii) Explain why the temperature of the reaction mixture must be kept below 45 °C.

.....

..... [1]

(b) Propanol is a member of the homologous series of alcohols.

(i) Draw the full structural formula of propanol.

[1]

(ii) Describe the observation when propanol is heated with purple acidified potassium manganate(VII).

.....

..... [1]

(iii) Give the chemical formula of the product(s) formed in the reaction in **(b)(ii)**.

..... [2]

(iv) Determine if propanol has been oxidised or reduced in **(b)(ii)**.
Explain your answer.

.....

..... [1]

(c) Acrylic (prop-2-enoic) acid belongs to the homologous series of carboxylic acids.

The structure of acrylic acid is shown in Fig. 10.1

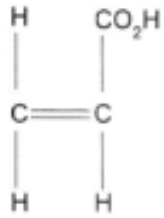


Fig. 10.1

(i) Which part of the structure shows that acrylic acid is unsaturated?

..... [1]

(ii) State the observation when acrylic acid is added to a solution of sodium carbonate.

.....

..... [1]

[Total: 10]

END OF PAPER 3

ANSWER SHEET

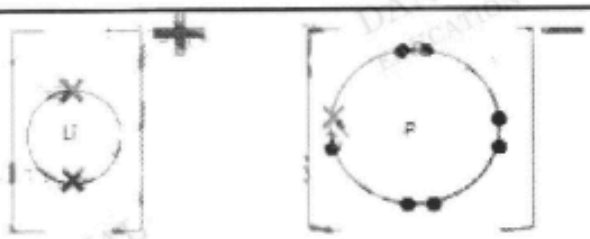
Paper 1 (20 marks)

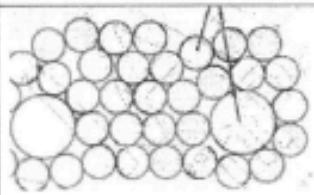
1	A	**11**	C
2	B	**12**	B
3	B	**13**	B
4	D	**14**	C
5	C	**15**	D
6	D	**16**	C
7	A	**17**	A
8	B	**18**	D
9	A	**19**	B
10	A	**20**	C

A – 6, B – 5 , C – 5 , D – 4

Paper 3

Section A (45 marks)

1	**(a)** Helium **(b)** Carbon monoxide **(c)** Sodium **(d)** Carbon monoxide **(e)** Sulfuric acid	1 1
		Total: 5
2(a)	 Correct charges and number of ions – 1 Correct number of dot and cross – 1	2
(b)(i)	Lithium fluoride • the ions are held in fixed position. • There are no mobile ions to conduct electricity. Solid Q • exist as molecules there are no free mobile electrons or charged ions to conduct electricity.	1 1 1
(b)(ii)	In molten lithium fluoride, the ions are able slide over one another / move about freely to conduct electricity.	1
		Total: 6

3(a)(i)	− 3°C (Accept 3°C)	1
(a)(ii)	Endothermic Energy is taken in from the surrounding. *Alternative:* Temperature of the surrounding decreases.	 1
(b)	Mr of hydrogen peroxide = 2(1) + 2(16) = 34	1
(c)	Mole of hydrogen peroxide = 68/34 = 2 mol Mole ratio of H_2O_2 : H_2O = 1: 1 Mass of water produced = 2 X 18 = 36 g	1 1
(d)	Mole ratio of H_2O_2 : O_2 = 2: 1 Volume of oxygen produced = 1 X 24 = 24 dm^3	1- mole of oxygen 1
		Total: 7
4(a)	P – calcium carbonate / $CaCO_3$ Q – calcium oxide / CaO R – carbon dioxide / CO_2 S – limewater / $Ca(OH)_2$	1 each
(b)	$Ca(OH)_2 + 2NH_4NO_3 \rightarrow Ca(NO_3) + 2NH_3 + 2H_2O$ Correct formula – 1 Correct balancing – 1	2
		Total: 6
5(a)	Alloys are mixture of metals with another element.	1
(b)	 Drawing -1 mark Alloys have atoms of different sizes, which disrupt the regular arrangement of atoms in pure metal. Hence preventing atoms from sliding over each other, when force is applied.	1 1 1
(c)	They prevent exposure of iron to water and oxygen, hence reducing rusting.	1
		Total: 5

6(a)(i)	Sodium loses an electron.	1
(a)(ii)	Potassium is more reactive than sodium. The reaction with potassium would be explosive.	1 1
(b)(i)	Neutralisation	1
(b)(ii)	acid – hydrochloric acid alkali – sodium hydroxide	1 1
(b)(iii)	Add universal indicator to the solution and it will remain green / Use blue and red litmus paper and no visible change observed	1- test 1- observation
(b)(iv)	Heat the solution to dryness to collect a sample of dry salt.	1
		Total: 9
7(a)	W, Z, Y, X	1
(b)	Bubbles of gas produced. $M(s) + 2HCl(aq) \rightarrow MCl_2(aq) + H_2(g)$ All formula correct -1 mark Balancing and/or state symbol correct – 1 mark	1 2
(c)	1. Measure time taken for the reaction to end OR measure volume gas produced in fixed period of time when acid and each metal reacted. 2. gas syringe and stopwatch 3. M produced less gas than W,Z,Y but more gas than X. **OR** M took more time than W, Z, Y but less time than X. 4. In a fixed time, M produced the 4th most volume of gas. OR M finished the reaction the fourth.	3 (Any 3)
		Total: 7

Section B (10 marks)

8(a)

	number of electrons	number of neutrons	number of protons
$^{35}_{17}Cl$	17	18	17
$^{79}_{35}Br^-$	36	44	35

1-2 correct [1m]; 3 correct [2 m]; 4 correct [3m] — 3

(b)(i) liquid — 1

(b)(ii) Y_2 is iodine — 1

- unreactive/least reactive as it is not able to displace any of the halogen — 1

X_2 is chlorine as — 1

- the most reactive as it is able to displace all the halogen. — 1

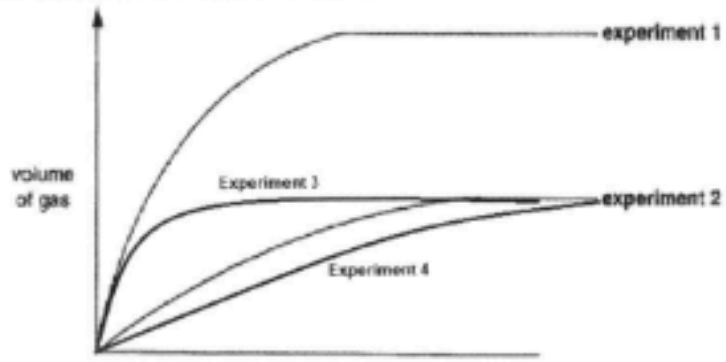
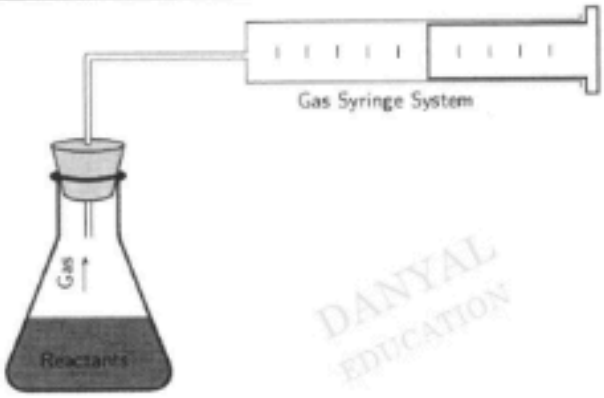
(b)(iii)

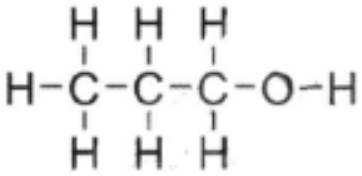
$Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$
$Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$
$Br_2 + 2I^- \rightarrow I_2 + 2Cl^-$

Correct formula – 1
Correct balancing – 1

Ignore state symbol — 2

Total: 10

9(a)	Calcium chloride $CaCl_2$	1
(b)		Exp 3-1m Exp 4 – 1m
(c)	When concentration increases, the number of particles per unit volume increases. Resulting in higher frequency of effective collisions and higher speed of reaction.	1 1
(d)	 Conical flask with reactant 1 m Gas syringe 1 m	2
(e)(i)	Mole in 80 g – 80 / 36.5 = 2.1918 mol Concentration = 2.1918 mol / 0.5 dm^3 = 4.38 mol/dm^3	1 1
(ii)	ECF from part (i) Moles in 100 cm^3 = 4.38 x (100/1000) = 0.438 mol Concentration = 0.438 mol/dm^3	1
		Total: 10

10(a)(i)	fermentation glucose	1 1
(ii)	The yeast (microbes) would denature/ stop working/ be destroyed/die.	1
(b)(i)		1
(ii)	Purple potassium manganate(VII) solution turned colourless/ decolourised.	1
(iii)	C_2H_5COOH / $C_3H_6O_2$ H_2O	1 1
(iv)	Oxidised Propanol gained an oxygen.	 1
(c)(i)	C=C	1
(ii)	effervescence/bubbles observed.	1
		Total: 10

COMPASSVALE SECONDARY SCHOOL PRELIM PAPER

1 Which apparatus is most suitable for collecting 25.0 cm^3 of fluorine at room temperature?

A burette
B gas syringe
C measuring cylinder
D pipette

2 The melting and boiling points of two substances X and Y are shown.
Substances X and Y are miscible liquids.

substance	melting point / °C	boiling point / °C
X	5.5	80
Y	–95	110

Which method is most suitable to separate substances X and Y?

A crystallisation
B filtration
C fractional distillation
D simple distillation

3 Which statements about the Kinetic Particle Theory are correct?

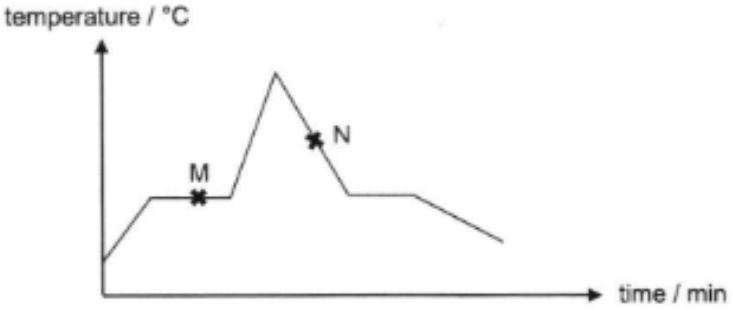
1 In gaseous state, particles are far apart and moving in random directions.

2 Particles in solid state have lower kinetic energy than particles in liquid state.

3 During boiling, particles gain energy and break free from their fixed positions.

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

4 A solid substance is heated to melt and cooled as shown in the diagram.



What are the physical states of the substance at M and N?

	M	N
A	liquid	liquid + solid
B	liquid + solid	liquid
C	liquid + solid	solid
D	solid	liquid + solid

5 A solution of lead(II) nitrate is tested with different reagents.

Which row gives the correct observation?

	test	observation
A	aqueous ammonia added	white precipitate formed, soluble in excess
B	aqueous sodium hydroxide added	white precipitate formed, soluble in excess
C	aqueous sodium hydroxide added	effervescence observed
D	dilute nitric acid added	effervescence observed

6 An element X forms an ion X^{2-}.

Which group of the Periodic Table is this element found in?

A Group I
B Group II
C Group VI
D Group VII

7 The chemical formula of the compound formed by P and Q is PQ_2.

Both P and Q are non-metals.

What is the correct electronic configuration of P and Q?

	P	Q
A	2.2	2.7
B	2.4	2.6
C	2.8.1	2.6
D	2.8.6	2.1

8 Potassium chlorate has the formula $KClO_3$.

What is the chemical formula of copper(II) chlorate?

A $CuClO_3$
B Cu_2ClO_3
C $Cu_3(ClO_3)_2$
D $Cu(ClO_3)_2$

9 A solution of nitric acid is made by dissolving 31.5 g of HNO_3 in 200 cm^3 of water.

What is the concentration, in mol/dm^3, of this solution?

A 0.0025 mol/dm^3
B 0.1575 mol/dm^3
C 2.5 mol/dm^3
D 157.5 mol/dm^3

10 A student adds an aqueous solution of sodium hydroxide to a solution of dilute hydrochloric acid. The reaction is exothermic.

Which row shows the direction of heat flow and the change in temperature for this reaction?

	temperature change	direction of heat flow
A	fall	from surroundings
B	fall	to surroundings
C	rise	from surroundings
D	rise	to surroundings

11 Copper(II) oxide is added to excess dilute nitric acid.

The equation for the reaction is shown.

$$CuO(s) + 2HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + H_2O(l)$$

Which change in the conditions will increase the speed of reaction?

A decrease the concentration of nitric acid
B decrease the volume of nitric acid
C increase the particle size of copper(II) oxide
D increase the temperature

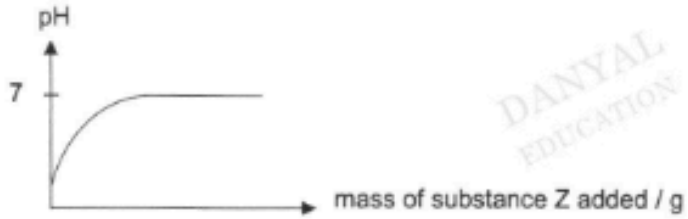
12 Part of some chemical reactions are shown.

Which reaction represents reduction?

A $2Cl^- \rightarrow Cl_2 + 2e^-$
B $H^+ + OH^- \rightarrow H_2O$
C $Na^+ + Cl^- \rightarrow NaCl$
D $Fe^{3+} + e^- \rightarrow Fe^{2+}$

13 Substance Z is an insoluble solid. Excess substance Z is added into a beaker of dilute hydrochloric acid.

The pH of the reaction mixture is measured and shown.



What is substance Z?

A calcium hydroxide
B magnesium carbonate
C potassium oxide
D silver chloride

14 Some information about oxides of T and U are given.

	reacts with acid to form salt and water	reacts with base to form salt and water
oxide of T	✓	×
oxide of U	×	×

What type of oxides are oxides of T and U?

	T	U
A	acidic	amphoteric
B	amphoteric	acidic
C	basic	neutral
D	neutral	basic

15 Which salt requires pipette and burette in its preparation?

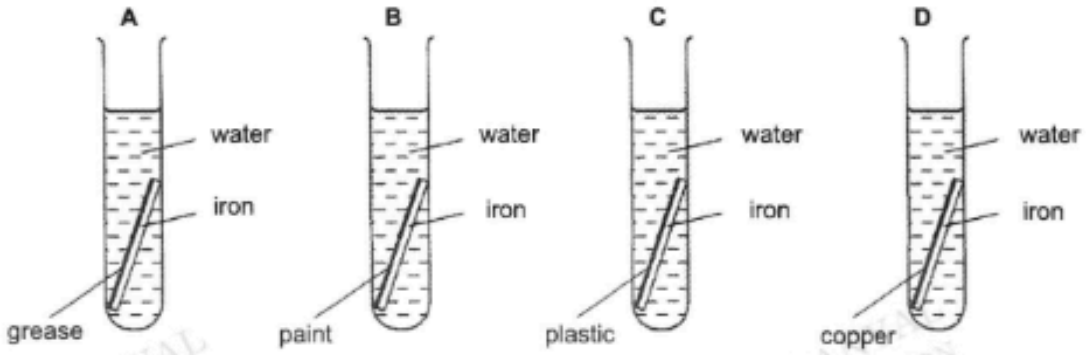
A ammonium chloride
B barium sulfate
C lead(II) chloride
D zinc nitrate

16 Which row about bromine is correct?

	state at room temperature	colour	displacement reactions
A	liquid	red-brown	displaces chlorine from chlorides
B	liquid	red-brown	displaces iodine from iodides
C	solid	brown	displaces chlorine from chlorides
D	solid	brown	displaces iodine from iodides

17 Identical pieces of iron are placed in four different test-tubes.

In which test-tube will the iron rust?



18 Two statements were made about acid rain.

Statement 1: The burning of fossil fuels containing sulfur is a cause of 'acid rain'.

Statement 2: Acid rain is formed from sulfur dioxide which is produced when sulfur compounds burn.

Which of the following is true?

A Both statements are correct and statement 2 explains statement 1.
B Both statements are correct but statement 2 does not explain statement 1.
C Statement 1 is correct but statement 2 is incorrect.
D Statement 2 is correct but statement 1 is incorrect.

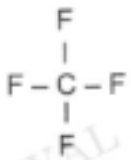
19 Which petroleum fraction is used as a material for road surfaces?

A bitumen
B diesel
C lubricating oil
D naphtha

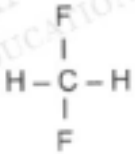
20 The diagram shows part of the structure of an addition polymer.

Which monomer is used to make this polymer?

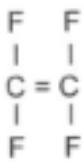
A



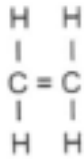
B



C



D



Section A

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

1 Write on the line above the arrow a suitable description of the change. The first has been completed for you as an example.

example	ethene	***polymerisation*** ⟶	poly(ethene) production
(a)	bromine atom	⟶	bromide ion
(b)	carbon	⟶	carbon dioxide
(c)	dissolving ammonium chloride in water	⟶	drop in temperature
(d)	sea water	⟶	pure water
(e)	sodium chloride crystals	⟶	molten sodium chloride

[5]

2 Use the Periodic Table to help you answer the following questions.

(a) State the order by which the elements are arranged in the Periodic Table.

..... [1]

(b) Which group contains only

(i) relatively soft, low density metals, ... [1]

(ii) monatomic non-metals? ..... [1]

(c) Name an element which is

(i) found in Group VI, period 3, ... [1]

(ii) in the same period as beryllium but has a more metallic character.

..... [1]

3 Paper chromatography was used to find out the type of food colourings used in Brand **X** Jelly. Five commonly used food colourings, **A**, **B**, **C**, **D** and **E** were spotted on the chromatogram.

Fig 3.1 shows the chromatogram.

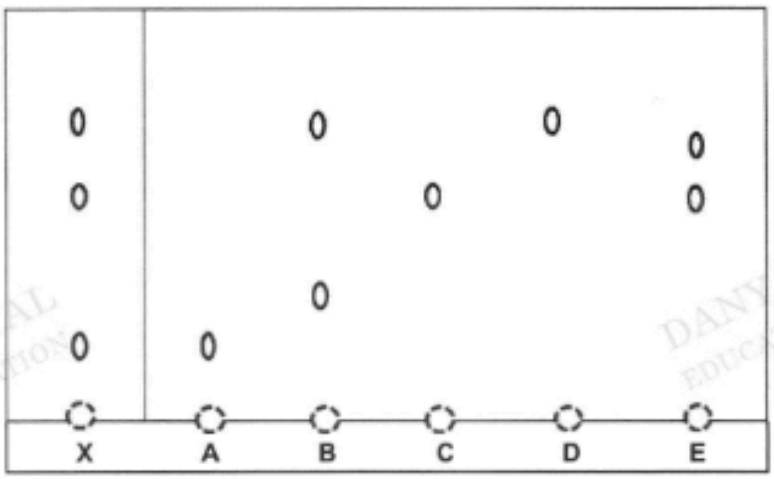


Fig. 3.1

(a) State which food colourings Brand **X** Jelly contain.

..... [1]

(b) From the chromatogram, state and explain one difference in physical property between food colourings **C** and **D**.

.....

..... [2]

(c) What would you say about the boiling point of food colouring **B**? Use Fig 3.1 to explain your reason.

.....

..... [2]

4 A photochromic glass is a type of glass that darkens on exposure to UV light.

In photochromic lenses, silver chloride and copper(I) chloride crystals are added during the manufacturing of the glass.

In the presence of UV light, silver particles produced darken the glass.

$$AgCl(s) + CuCl(s) \rightarrow Ag(s) + CuCl_2(s)$$

(a) Determine the oxidation states of copper and silver in this reaction.

element	oxidation state in reactants	oxidation state in products
copper		
silver		

[2]

(b) Using your answer in **(a)**, identify and explain which element is oxidised in the reaction.

.....

..... [1]

5 When sodium hydrogen carbonate, $NaHCO_3$, is heated, it decomposes to form sodium carbonate, Na_2CO_3, water vapour and carbon dioxide as shown in the equation:

$$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$$

16.8 g of sodium hydrogen carbonate is heated and decomposed.

(a) Calculate the relative formula mass of sodium hydrogen carbonate, $NaHCO_3$.

relative formula mass = ... [1]

(b) Calculate the mass of sodium carbonate, Na_2CO_3 produced.

mass of sodium carbonate = ... g [2]

(c) Calculate the total volume of gas produced.

volume of gas = ... dm^3 [2]

6 Fig. 6.1 describes some of the reactions of an aqueous salt solution, **A**.

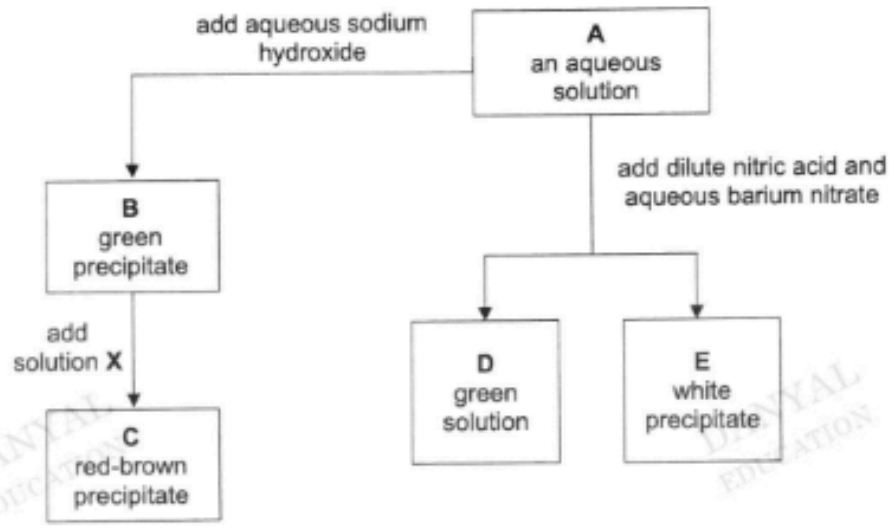


Fig. 6.1

(a) Identify **A**, **B**, **C**, **D** and **E**.

A .....

B .....

C .....

D .....

E ..... [5]

(b) Write a balanced chemical equation for any of the reactions included in Fig. 6.1.

..... [2]

(c) Suggest the identity of solution **X** and state the role it plays in the reaction.

.....

..... [2]

7 A student investigated the reactivity of three metals – magnesium, nickel and zinc.

(a) In the first experiment, the student investigated the temperature change when he added different metals to dilute hydrochloric acid.

Table 7.1 shows the results.

Table 7.1

metal added	initial temperature / °C	final temperature / °C
magnesium	25.0	42.5
nickel	25.0	27.0
zinc	25.0	32.5

(i) State **two** variables that needs to be kept constant to ensure a fair experiment.

.....

..... [2]

(ii) Using the information in Table 7.1, place the metals in order of their reactivity.

most reactive .....

.....

least reactive ..... [1]

(b) In the second experiment, the student then added the same three metals – magnesium, nickel and zinc, to different metal sulfate solutions.

Predict if there would be a reaction occurring and complete Table 7.2.

You should:

- use a tick (✓) to show where a reaction will occur
- use a cross (✗) to show where no reaction will occur

Table 7.2

	magnesium sulfate	nickel sulfate	zinc sulfate
magnesium			
nickel			
zinc			

[2]

8 Table 8.1 shows the proton and nucleon numbers of some particles.

Table 8.1

particle	proton number	nucleon number
V	8	17
W	8	18
X	9	18
Y	12	25
Z	17	35

(a) Particles **Y** and **Z** react together to form a compound.

(i) Draw a 'dot-and-cross' diagram to show the arrangement of electrons in this compound. Only the outer shells of electrons need to be shown.

[2]

(ii) Describe **two** physical properties of this compound.

.....

.....

..... [2]

(b) **(i)** Which two particles have the same chemical properties but different masses?

..... [1]

(ii) Explain why this is so, using information from Table 8.1.

.....

.....

..... [3]

Section B

Answer any **two** questions in this section.

Write your answers in the spaces provided.

9 A student investigates how the speed of a reaction changes over time.

(a) Excess zinc granules are added to dilute sulfuric acid in a flask and placed on an electronic balance. The mass of the flask and its contents are measured regularly until the reaction is completed.

(i) Sketch the graph that the student will obtain from the data collected. Label both axes.

[2]

(ii) Explain how the graph shows that the speed of reaction changes over time.

.....

.....

.....

..... [2]

(b) The student then investigated how the concentration of acid and the particle size of zinc affect the speed of reaction.

The student varied the concentration and particle size as shown in Table 9.1.

Table 9.1

experiment	concentration of H_2SO_4 / mol/dm^3	particle size of Zn
1	0.5	granules
2	1.0	powder
3		

(i) Fill in the conditions for Experiment 3 in Table 9.1 for the student to be able to determine how concentration and particle size affect the speed of reaction. [1]

(ii) State how the concentration of acid and the particle size of zinc affect the speed of reaction.

Use your knowledge of reacting particles to explain your answer.

.....

.....

.....

.....

.....

.....

..... [5]

10 Most metals exist in the form of ores. An ore is a compound of the metal mixed with large amounts of earth and rock.

(a) The position of a metal in the reactivity series affects the ease of extraction of the metal from its ore.

Both magnesium and iron are found in the reactivity series.

(i) State the methods of extraction for magnesium and iron.

magnesium .....

iron ..... [2]

(ii) Explain the difference in the ease of extraction of magnesium and iron from their ores.

.....

.....

..... [2]

(b) Name one metal that occurs freely in nature as an uncombined metal.

..... [1]

(c) Many metal ores contain carbonates of a metal. The amount of carbonate can be determined by reacting the ore with an acid.

You are provided with two metal ores, **P** and **Q**.

Describe a laboratory investigation that can be used to decide which metal ore, **P** or **Q** contains more carbonate. Include all the measurements you would make.

You may draw a diagram to help you.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(d) Instead of extracting metals from their ores, we are encouraged to recycle metals.

State an advantage of recycling metals.

.....

..... [1]

11 Alkanes and alkenes are two homologous series of hydrocarbons. One property of a homologous series is that the members have the same general formula.

(a) State the general formulas of alkane and alkene homologous series.

alkane .....

alkene ..... [2]

(b) State **two** other properties of a homologous series.

.....

.....

..... [2]

(c) The cracking of nonane, C_9H_{20}, produces methane and ethene.

(i) Write a balanced chemical equation for this reaction.

..... [2]

(ii) Describe a test to distinguish between methane and ethene.

.....

.....

..... [2]

(iii) Describe what is a cracking process and explain why cracking is important in the chemical industry.

.....

.....

..... [2]

ANSWER SHEET

Paper 1

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
B	C	A	B	B	C	B	D	C	D
Q11	**Q12**	**Q13**	**Q14**	**Q15**	**Q16**	**Q17**	**Q18**	**Q19**	**Q20**
D	D	B	C	A	B	D	A	A	C

Paper 3

Section A

1 (a) reduction [1]

(b) combustion/oxidation [1]

(c) endothermic [1]

(d) simple distillation [1]

(e) melting [1]

2 (a) increasing proton number [1]

(b) (i) Group I [1]
(ii) Group 0 [1]

(c) (i) sulfur [1]
(ii) lithium [1]

3 (a) A, C, D

(b) Food colouring C is less soluble than D [1]
as its spot travels a smaller/shorter distance from the starting line / spot is nearer to starting line [1]

(c) Food colouring B will boil over a range of temperatures. [1]
as it is a mixture of 2 components/substances [1]

4 **(a)**

element	oxidation state in reactants	oxidation state in products
copper	+1	+2
silver	+1	0

any 2 [1]

(b) Copper is oxidised as its oxidation state increases from +1 in CuCl to +2 in $CuCl_2$. [1]

5 **(a)** relative formula mass = 23 + 1 + 12 + 3(16) = 84 [1]

(b) Number of moles of $NaHCO_3$ = 16.8 / 84 [1]
= 0.2

By mole ratio,

$NaHCO_3 : Na_2CO_3$
2 : 1
0.2 : 0.1

mass of Na_2CO_3= 0.1 x [2(23) + 12 + 3(16)] = 10.6g [1]

(c) By mole ratio,

$NaHCO_3 : H_2O : CO_2$
2 : 1 : 1 [1]
0.2 : 0.1 : 0.1

volume of gas = (0.1 + 0.1) x 24 = $4.8dm^3$ [1]

6 **(a)** A: iron(II) sulfate / $FeSO_4$ [1]
B: iron(II) hydroxide / $Fe(OH)_2$ [1]
C: iron(III) hydroxide / $Fe(OH)_3$ [1]
D: iron(II) nitrate / $Fe(NO_3)_2$ [1]
E: barium sulfate / $BaSO_4$ [1]

(b) $FeSO_4 + 2NaOH \rightarrow Fe(OH)_2 + Na_2SO_4$ [2]

OR

$FeSO_4 + Ba(NO_3)_2 \rightarrow Fe(NO_3)_2 + BaSO_4$

1m for correct formulas; 1m for balanced chemical equation

(c) acidified potassium manganate(VII) / $KMnO_4$ or acidified potassium dichromate(VI) [1]
oxidising agent [1]

7 (a) (i) same size/mass of metal [1]
same concentration/volume of acid [1]

(ii) most reactive **magnesium** [1]

zinc

least reactive **nickel**

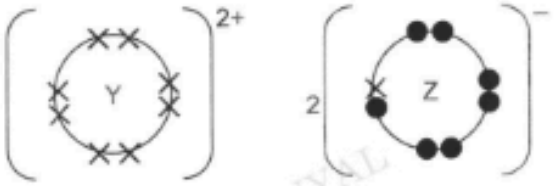
(b)

	magnesium sulfate	nickel sulfate	zinc sulfate
magnesium		✓	✓
nickel	×		×
zinc	×	✓	

any 3 – 1m [2]

8 (a) (i)

[2]



1m for correct charge and ratio; 1m for correct electronic structure
minus 1m for drawing inner shell electrons

(ii) soluble in water, not soluble in organic solvent [2]
high melting and boiling point
good conductor of electricity in molten and aqueous state

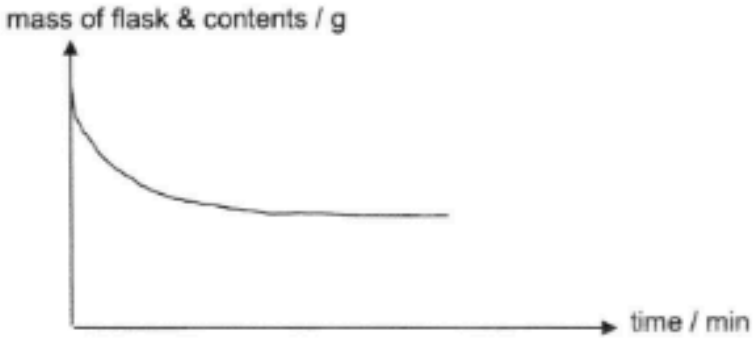
any 2

(b) (i) V and W [1]

(ii) They are isotopes of the same element. [1]
They have the same number of valence electrons, 6, hence same chemical properties [1]
They have different number of neutrons, V has 9 and W has 10 hence different masses. [1]

Section B

9 **(a)** **(i)** [2]



label – 1m
shape of graph – 1m

(ii) Gradient is steepest at the start; speed of reaction is the fastest [1]
Gradient decreases with time until gradient is zero; speed of reaction decreases with time until reaction stops. [1]

(b) **(i)** 0.5 and powder [1]
or
1.0 and granules

(ii) Speed of reaction increases with higher frequency of effective collisions between reacting particles of H_2SO_4 and Zn. [1]

When the concentration of acid increases, speed of reaction increase. [1]
As there are more H^+ ions per unit volume. [1]

When particle size of Zn decrease, speed of reaction increase. [1]
Smaller particle size provides a larger total surface area for collision. [1]

10 **(a)** **(i)** magnesium: electrolysis [1]
iron: reduction using carbon [1]

(ii) Magnesium is more reactive than iron [1]
hence more energy is needed to break the bond in the compound to extract magnesium than iron. [1]

(b) gold/platinum [1]

(c) Experimental set-up with gas syringe *(draw or describe)* [1]

Add the same mass of P and Q in the same volume and concentration of hydrochloric acid, separately in each conical flask. [1]

Measure the volume of carbon dioxide gas collected until the reaction has stopped / volume of gas collected remains constant / over a period of time e.g. 5min [1]

[1]

The ore that produces more volume of carbon dioxide gas contains more carbonate.

(d) It conserves finite resources [1]
It requires less energy to recycle than to extract from its ore.

any 1

11 (a) alkane: C_nH_{2n+2} [1]
alkene: C_nH_{2n} [1]

(b) They have similar chemical properties [1]
They show a gradation in physical properties [1]
members in the homologous series differ by $-CH_2-$

(c) (i) $C_9H_{20} \rightarrow CH_4 + 4C_2H_4$ [2]

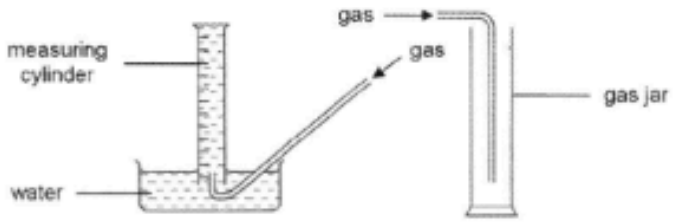
correct formula of methane and ethene – 1m
balanced chemical equation – 1m

(ii) Test: Bubble methane and ethene separately into aqueous bromine. [1]
Observation: Red-brown aqueous bromine turns colourless when ethene is added, remains red-brown when methane is added. [1]

(iii) Cracking is a chemical reaction which breaks up large and long-chain alkane molecules into smaller and more useful hydrocarbons molecules, and/or hydrogen. [1]
it converts long-chain alkanes into smaller and more useful hydrocarbon molecules, which are in greater demand. [1]

PING YI SECONDARY SCHOOL PRELIM PAPER

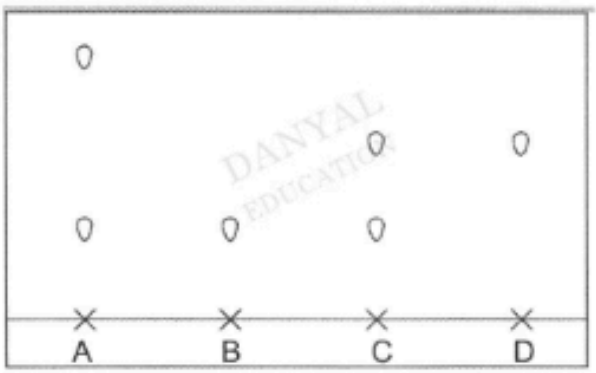
1. The diagram below shows two methods of collecting gases.



Which row gives the properties of a gas which can be collected by both methods?

	property 1	property 2
A	soluble in water	denser than air
B	soluble in water	less dense than air
C	insoluble in water	denser than air
D	insoluble in water	less dense than air

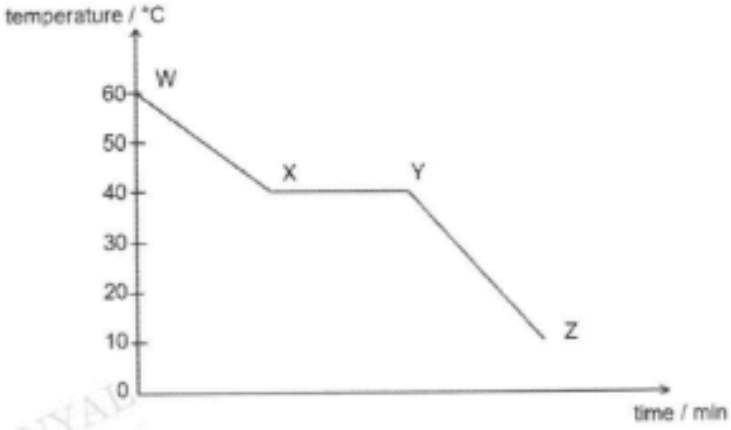
2. The diagram shows paper chromatograms of four substances A, B, C and D.



Which of the following statements is true?

A Substance A is a pure substance.
B Substance B has a variable melting point.
C Substance C is found in substance B.
D Substance D is found in substance C.

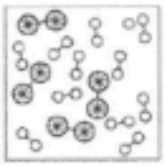
3. The curve below shows the temperature changes as liquid Q was cooled from 60 °C to 10 °C.

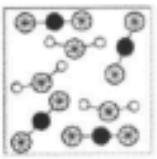


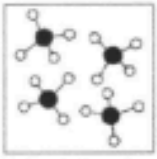
Which statement correctly describes the particles of liquid Q at various regions of the curve?

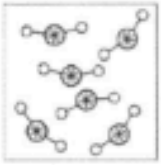
A Heat energy is gained by the particles at region XY to overcome the forces of attraction.
B The particles exist as a mixture of gas and liquid at region XY.
C The particles are vibrating about fixed positions at region YZ.
D The particles are arranged far apart and in a disorderly manner at region WX.

4. Which diagram best represents a mixture of elements?

A 

C 

B 

D 

5. Which information is correct for the subatomic particles?

	subatomic particle	position in the atom	relative charge	relative mass
A	proton	inside nucleus	-1	0
B	neutron	outside nucleus	0	1
C	electron	outside nucleus	+1	1
D	proton	inside nucleus	+1	1

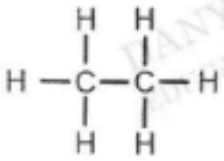
6. The table shows the number of neutrons and electrons in four particles of elements.

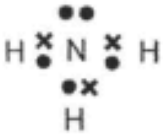
particles	number of neutrons	number of electrons
E	8	8
J	8	10
M^{2+}	12	10
X^{2-}	10	10

Which of the two elements are isotopes?

A E and X
B E and J
C E and M
D M and X

7. Ethane, C_2H_6 and ammonia, NH_3 are covalent compounds. The electronic structure of these compounds and statements about them are given below.



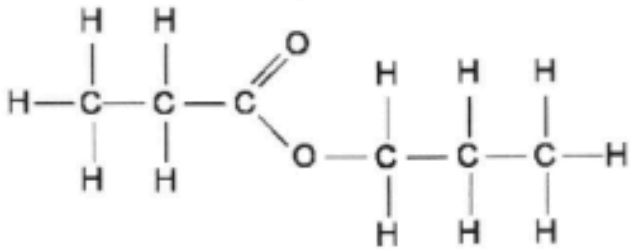


1. A molecule of ethane contains double the number of hydrogen atoms as a molecule of ammonia.
2. A molecule of ammonia contains 2 electrons that are not involved in bonding.
3. In an ethane molecule, the bond between the carbon atoms is formed by sharing 2 electrons, one from each carbon atom.

Which statements are correct?

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

8. The diagram shows the molecule ethyl propanoate.



How many bonding pairs of electrons are there in the molecule?

A 10 B 15 C 17 D 20

9. Ethane, C_2H_6, burns completely in oxygen to produce carbon dioxide and water.

$$2\ C_2H_6 + 7\ O_2 \rightarrow 4\ CO_2 + 6\ H_2O$$

What is the total volume of gaseous products obtained at room temperature and pressure when 0.5 moles of ethane is burnt completely?

A 6 dm^3 B 12 dm^3 C 24 dm^3 D 60 dm^3

10. 0.1 mol of sodium chloride was dissolved in 100 cm^3 of water to form solution X. What can Cassandra do to obtain a 2 mol/dm^3 solution of sodium chloride?

A add 100 cm^3 of water to solution X
B evaporate 50 cm^3 of water from solution X
C dissolve 1 mol of sodium chloride in solution X
D prepare another 100 cm^3 of solution X and mix the solution together

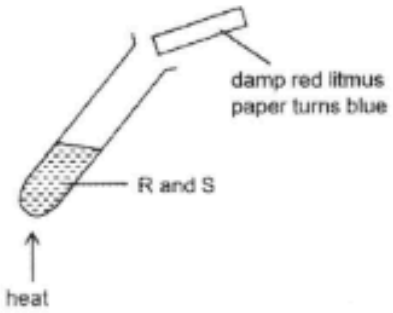
11. Aqueous solution of an unknown salt gives the following observations when added to the following reagents.

reagent used	result
acidified aqueous barium chloride	white precipitate
aqueous sodium hydroxide	green precipitate that turns brown slowly

Which compound could have been present in the water?

A iron(II) sulfate B copper(II) sulfate
C iron(III) chloride D zinc chloride

12. The diagram shows two substances, R and S, being heated together.



Which row identifies R and S?

	substance R	substance S
A	aluminium	aqueous sodium nitrate
B	aluminium	hydrochloric acid
C	ammonium sulfate	aqueous sodium hydroxide
D	ammonium sulfate	hydrochloric acid

13. Four different solids, W, X, Y and Z, are dissolved in equal volumes of water at 20 ^{0}C. The table shows the change in temperature when each solid dissolves in water.

	W	X	Y	Z
change in temperature /^{0}C	+10	-6	-5	+15

Which row correctly describes the energy changes when each solid is dissolved in water?

	solid	energy change	solid	energy change
A	W	endothermic	Y	exothermic
B	X	exothermic	W	endothermic
C	X	endothermic	Z	exothermic
D	Y	exothermic	Z	endothermic

14. The table below shows the reactions of three oxides X, Y and Z.

oxide	reacts with acid	reacts with alkali
X	no	no
Y	yes	yes
Z	no	yes

Which of the following correctly describes the oxides?

	X	Y	Z
A	amphoteric	neutral	acidic
B	amphoteric	neutral	basic
C	neutral	amphoteric	acidic
D	neutral	amphoteric	basic

15. In an experiment to determine the reactivity of metals Q, R and S, the reactions of the metals with cold water and dilute hydrochloric acid were recorded in the table below. A shaded box indicates that the reaction is not carried out.

metal	reaction with cold water	reaction with dilute hydrochloric acid	displacement reaction
Q		no reaction	
R	no reaction	readily	
S	slow		can displace metal Q from its salt solution

What is the order of reactivity of the metals from the most reactive to least reactive?

A S → R → Q
B S → Q → R
C Q → R → S
D R → S → Q

16. Which air pollutant is **not** correctly matched to its source?

	air pollutant	source
A	carbon monoxide	complete combustion of carbon-containing fuels
B	oxides of nitrogen	lightning activity
C	sulfur dioxide	volcanic eruption
D	unburnt hydrocarbon	incomplete combustion of carbon-containing fuels

17. Which statement about trends in the Periodic Table is **not** correct?

A Elements in the same period have the same number of electron shells.
B The elements change from metals to non-metals from left to right.
C The number of protons in an atom of an element increases from left to right.
D The oxides of the elements change from acidic to basic from left to right.

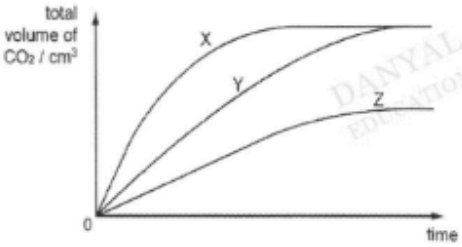
18. Which of the following is a redox reaction?

A $AgNO_3 + HCl \rightarrow AgCl + HNO_3$
B $N_2 + 3H_2 \rightarrow 2NH_3$
C $LiOH + HNO_3 \rightarrow LiNO_3 + H_2O$
D $NH_4^+ + OH^- \rightarrow NH_4OH$

19. In experiment 1, an excess of finely powdered marble is added to 20 cm^3 of dilute hydrochloric acid.

In experiment 2, an excess of large marble chips is added to 20 cm^3 of dilute hydrochloric acid of the same concentration.

The total volume of carbon dioxide given off are determined at regular time intervals and plotted in the following graph.



Which part of curves is obtained in the two experiments?

	experiment 1	experiment 2
A	X	Z
B	X	Y
C	Y	Z
D	Y	X

20. A student investigated the reaction of vegetable oils with hydrogen. 100 cm^3 of hydrogen was bubbled through 1 g sample of four different vegetable oils containing a suitable catalyst.

The volume of hydrogen remaining after each experiment was recorded.

vegetable oil	volume of hydrogen remaining /cm^3
P	100
Q	87
R	63
S	0

Which vegetable oil(s) is/are unsaturated?

A P, Q and R
B Q and R only
C Q, R and S
D S only

END OF PAPER

Section A

Answer **all** the questions.

Write your answers in the spaces provided on the question paper.

1. The following are terms used to describe chemical reactions.

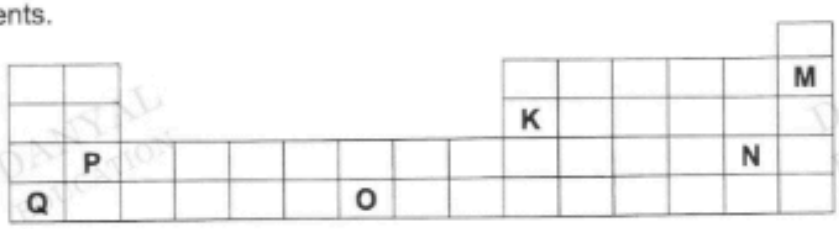
addition	rusting	redox
decomposition	neutralisation	substitution

Using the terms above, identify the type of reaction that each chemical equation represents. [4]

Each term can be used once, more than once or not at all.

	description of reaction	chemical reaction
(a)	$C_3H_6 + H_2 \rightarrow C_3H_8$	
(b)	$ZnCO_3 \rightarrow ZnO + CO_2$	
(c)	$H_2 + F_2 \rightarrow 2HF$	
(d)	$C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$	

2 The diagram below represents part of the Periodic Table. The code letters **K** to **Q** represent elements.



Using the code letters, identify the following element(s) in **(a)** to **(d)**.
[You may use any code letter once, more than once or not at all.]

Write down the symbol for an element which

(a) does not react with any other element,

..... [1]

2 **(b)** forms an oxide that reacts only with acid,

..... [1]

(c) has variable oxidation state number,

..... [1]

(d) forms oxide and is added to decrease the acidity of the soil.

..... [1]

3 Table 3.1 contains details of seven different particles. The letters are not the chemical symbols.

	D	E	F	G	H	I	J
nucleon number	3	10	11	14	19	23	35
proton number	2	5	5	7	10	11	17
total number of electrons	2	5	5	7	10	11	18

Table 3.1

Use the table to state which of the particles, **D, E, F, G, H, I** and **J**

(a) has a single neutron, ... [1]

(b) will form an ionic compound with chlorine, XCl_3, ... [1]

(c) is soft and shiny. ..... [1]

4 Most substances can be placed into only one of the five groups listed in Table 4.1.

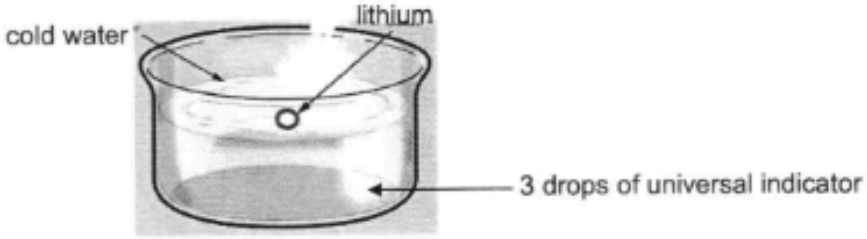
group	letter
element	**A**
compound	**B**
mixture of elements	**C**
mixture of compounds	**D**
mixture of elements and compounds	**E**

Table 4.1

Which of the groups, **A, B, C, D** or **E** in Table 4.1, best describes each of the following substances? [2]

	substances	group
(a)	air	
(b)	hydrogen	
(c)	brass	
(d)	sodium carbonate	

5 7 g of lithium reacts with 50 cm^3 cold water as shown below.



(a) Write the chemical equation for this reaction. Include state symbols in your equation.

..... [2]

(b) Describe what is observed (apart from release of hydrogen gas) when lithium reacts with cold water.

.....

..... [1]

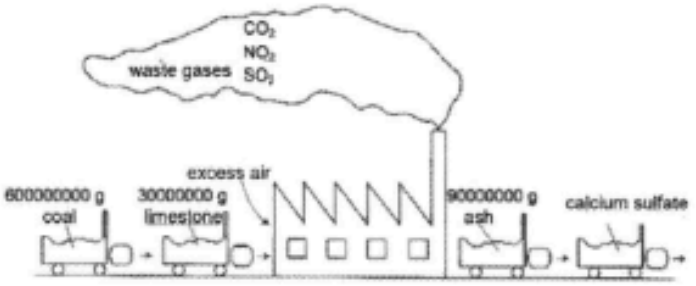
(c) Calculate the number of moles of lithium used. [1]

no of moles of lithium= ..... mol

(d) Calculate the concentration of lithium hydroxide formed. [2]
[Relative atomic masses: A_r: H, 1; O, 16; Li, 7]

concentration of lithium hydroxide = ... mol/dm^3

6 Some power stations use coal as fuel. Coal contains sulfur impurities. On c
sulfur is oxidized to sulfur dioxide. The melting and boiling points of sulfur c
–73 °C and –10 °C respectively. Before the waste gases are released into the atmosphere, the sulfur dioxide is removed by limestone. The diagram shows the amount of substances used and produced by a coal-fired power station in a day.



(a) Draw a 'dot and cross' diagram for one of the waste gas, carbon dioxide. Show only the valence electron. [2]

(b) State one harmful effect of sulfur dioxide.

.....

..... [1]

(c) Using Kinetic Particle Theory, describe the changes in arrangement and movement of sulfur dioxide from –63°C to 0°C.

arrangement: .....

.....

.....

movement: .....

.....

..... [2]

6 **(d)** Limestone removes sulfur dioxide from the waste gases, as shown in the equation below.

$$CaCO_3\ (s) + SO_2\ (g) \rightarrow CaSO_3\ (s) + CO_2\ (g)$$

Calculate the maximum volume of carbon dioxide produced from 30000000 g (30 tonnes) of limestone at room temperature and pressure. [3]
[Relative atomic masses: A_r: Ca, 40; O, 16; C, 12; S, 32;]

volume of carbon dioxide gas = ...dm^3

(e) When the limestone was first used in the power stations, some scientists claimed they 'solved all pollution problems at the power stations'. Explain why this is not true.

.....

.....

..... [1]

7 5 g of magnesium ribbon was added to 100 cm^3 of 1.0 mol/dm^3 of excess hydrochloric acid. Volume of hydrogen is collected and recorded every 30 seconds.

Fig. 7.1 shows the results obtained for the experiment.

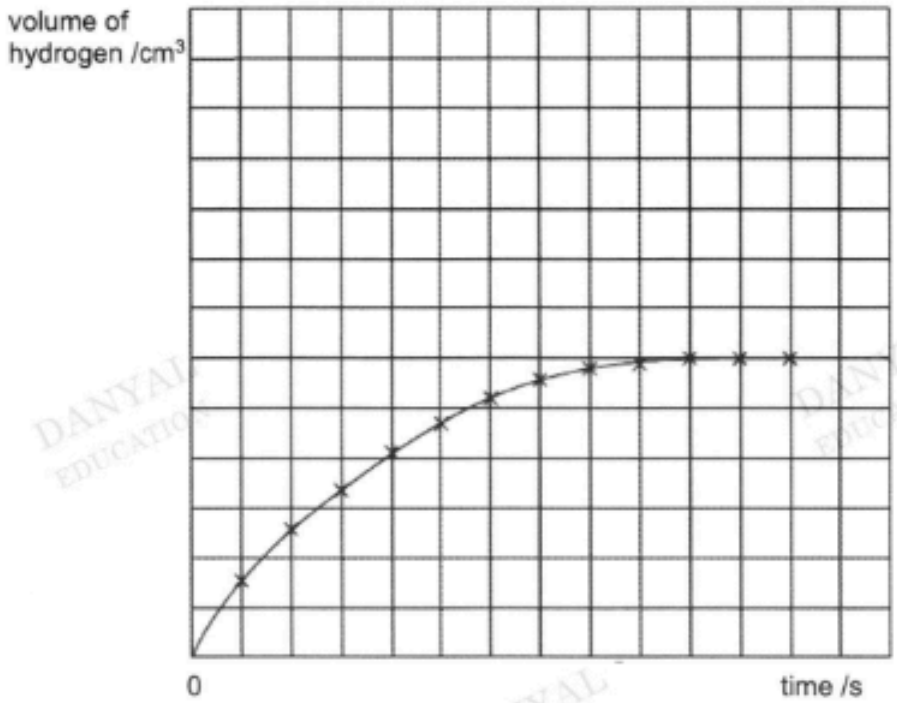


Fig. 7.1

(a) The experiment is repeated with 5 g of magnesium ribbon and 100 cm^3 of 0.5 mol/dm^3 excess hydrochloric acid. Sketch the graph that you would obtain from the results of this experiment on the same grid in Fig. 7.1. Label the graph X. [1]

(b) The experiment is repeated with 2.5 g of magnesium ribbon and 100 cm^3 of 1.0 mol/dm^3 excess sulfuric acid. Sketch the graph that you would obtain from the results of this experiment on the same grid in Fig. 7.1. Label the graph Y. [1]

8 (a) Sodium chloride and lead(II) chloride are two different salts which require two different methods of preparation. Complete Table 8.1 below to name the possible reactants used to prepare these two different salts. [2]

salt	reactant 1	reactant 2
sodium chloride		
lead(II) chloride		

Table 8.1

(b) Nicholas wrote his Chemistry notes by hand while preparing for his Chemistry examination. The following is an extract taken from his notes illustrating the following instructions for preparing magnesium nitrate crystals.

> Place 100 cm^3 of dilute sulfuric acid in a beaker. Heat the acid until it is almost boiling. Add magnesium powder until no more can dissolve. Filter the mixture. Place the residue in an evaporating dish. Place the evaporating dish on a tripod and heat it until the liquid has been reduced to about one-third of its volume. Set aside the mixture and allow it to cool. Filter off the crystals from the cooled solution. Wash with large quantities of tap water and dry them between pieces of filter paper.

(i) State the purpose of the underlined instructions in Table 8.2. [2]

instruction	purpose
until no more can dissolve	
about one-third of its volume	

Table 8.2

(ii) Nicholas has made several mistakes in his notes. Complete Table 8.3 to list one of the mistakes and correction to the mistake. [2]

mistake	correction to mistake

Table 8.3

9 Aldehydes are a homologous series of organic compounds like alkanes and alkenes. Table 9.1 shows the names and formulae of some aldehydes.

name	formula
methanal	HCHO
ethanal	CH_3CHO
propanal	C_2H_5CHO
pentanal	C_4H_9CHO

Table 9.1

(a) Using the information in Table 9.1, give two pieces of evidence that suggest aldehydes are a homologous series.

.....

.....

..... [2]

(b) Predict the chemical formula of the next member (after pentanal) in the aldehydes homologous series. [1]

Chemical formula: .....

10 Study the series of chemical reactions shown in Fig. 10.1.

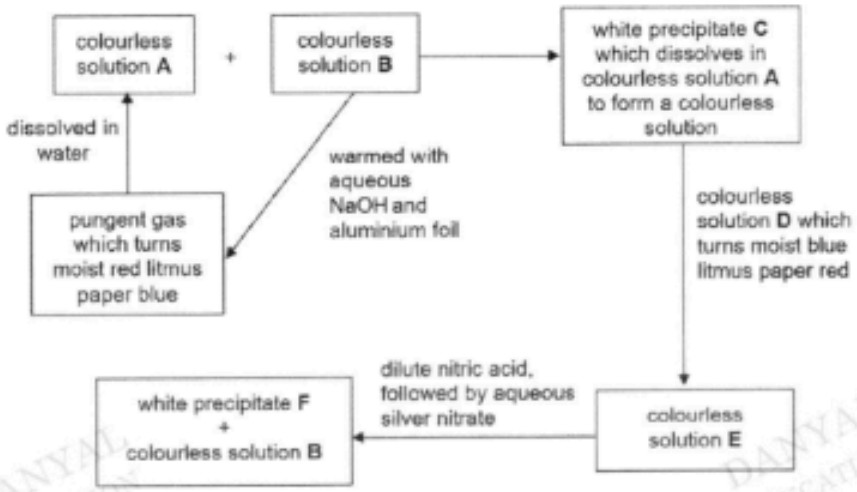


Fig. 10.1

(a) Identify the following substances.

substance	identity of substance
A	
B	
D	
E	
F	

[5]

(b) Write the ionic equation for the formation of white precipitate **C**.

..... [1]

Section B (20 marks)

Answer any **two** questions from this section.

Write your answers in the spaces provided.

11 Group VII elements exists as diatomic molecules and are strong oxidising agents. Chlorine is an example of a group VII element that is highly reactive.

(a) Chlorine gas reacts readily with Group II metals to form a chloride salt.

(i) Name a Group II metal. Write a balanced chemical equation to show the reaction of chlorine with the metal.

.....

..... [2]

(ii) Draw a 'dot and cross' diagram to show the bonding of the metal chloride salt formed. Show only valence electrons. [2]

(iii) Predict the electrical conductivity of the chloride salt at room temperature and pressure. Explain your answer.

.....

.....

..... [2]

11 (b) Aqueous chlorine is added to aqueous potassium bromide. The equation for the reaction is:

$$Cl_2\,(aq) + 2KBr\,(aq) \rightarrow 2KCl\,(aq) + Br_2\,(aq)$$

(i) Explain, in terms of oxidation states, why aqueous chlorine is a strong oxidizing agent.

.....

.....

..... [2]

(ii) Describe and explain the observation made for the reaction.

.....

.....

..... [2]

12 Four metals, **W**, **X**, **Y** and **Z** are tested with cold water, steam and dilute hydrochloric acid separately.

Table 12.1 below shows the results of the experiment.

metal	reaction with			
	cold water	steam	dilute hydrochloric acid	aqueous copper(II) sulfate
W	x	√	√	
X	√	√	√	
Y	x	x	x	
Z	x	x	√	

Table 12.1

key:
√: reaction occurred
x: no visible reaction

(a) Arrange the four metals, **W**, **X**, **Y** and **Z** in increasing order of reactivity.

..... [1]

(b) Predict the reaction of the four metals with aqueous copper(II) sulfate by filling in the blanks with '√' or 'x' in the table above. [2]

(c) Metal **W** is often mixed with carbon to form an alloy, steel, in industries. Explain why steel is preferably used in industries as compared to metal **W**.

.....

.....

..... [2]

12 (d) Outline a laboratory investigation that can be used to decide the reactivity of metals, namely zinc, iron and copper.

You are provided with the metals and their aqueous solutions.

- zinc nitrate
- iron (II) nitrate
- copper (II) nitrate

You may include equations in your answer.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

13 Ethanol is a member of the alcohol homologous series.

(a) Draw the full structural formula of ethanol. [1]

(b) Ethanol is manufactured by the fermentation of glucose. Briefly describe this process. Include in your answer the conditions needed for fermentation and how ethanol is purified.

.....

.....

.....

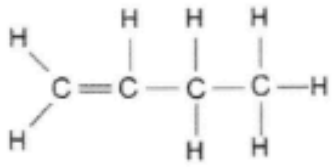
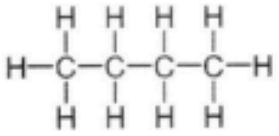
.....

.....

..... [3]

(c) Ethanol is oxidized by oxygen in the air to form ethanoic acid. Draw the full structural formula of ethanoic acid. [1]

13 (d) Some organic compounds are given below.

A	B
	

(i) Describe a chemical test to differentiate between compounds **A** and **B**.

.....

.....

.....

..... [2]

(ii) Compound **A** undergoes polymerization. Draw the monomer and polymer with 2 repeating units for compound **A**. [2]

monomer of compound **A**	polymer with 2 repeating units for compound **A**

(iii) Compound **B** undergoes a chemical reaction to produce smaller chains hydrocarbons. Name the chemical reaction.

..... [1]

END OF PAPER

ANSWER SHEET

P1 [20 marks]

5076 /01 [Chem section only]

21	C	31	A
22	D	32	C
23	C	33	C
24	A	34	C
25	D	35	A
26	A	36	A
27	B	37	D
28	D	38	B
29	C	39	B
30	B	40	C

5078 /01 [Chem section only]

1	C	11	A
2	D	12	C
3	C	13	C
4	A	14	C
5	D	15	A
6	A	16	A
7	B	17	D
8	D	18	B
9	C	19	B
10	B	20	C

1

	description of reaction	chemical reaction
(a)	$C_3H_6 + H_2 \rightarrow C_3H_8$	addition
(b)	$ZnCO_3 \rightarrow ZnO + CO_2$	decomposition
(c)	$H_2 + F_2 \rightarrow 2HF$	redox
(d)	$C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$	substitution

**every 1 correct, 1 mark* — 4

2

(a)	M	1
(b)	Q or P	1
(c)	O	1
(d)	P	1

3

(a)	D	1
(b)	E or F	1
(c)	I	1

4

	substances	group
(a)	air	E
(b)	hydrogen	A
(c)	brass	C
(d)	sodium carbonate	B

**every 2 correct, 1 mark* — 2

5

(a) $2\ Li\ (s) + 2\ H_2O\ (l) \rightarrow 2\ LiOH\ (aq) + H_2\ (g)$ — 2

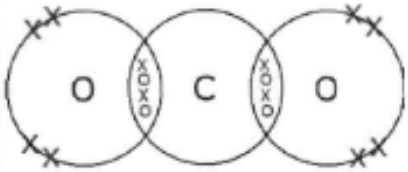
**1m for balancing equation, 1m for state symbols*

(b) Lithium *darts/reacts moderately* on the surface of the water. — 1

(c) No of mole of Lithium = 7/7 = 1 mol — 1

(d) From the equation, mole ratio H_2O: Li — 1
2:2
1:1

Concentration of LiOH = 1/(50/1000) — 1
= 20 mol/dm^3

6	(a)	 *1m for equal sharing of electrons between carbon and oxygen 1m for valence electrons of oxygen	2
	(b)	Sulfur dioxide dissolves in rainwater to form acid rain which corrodes building and harm aquatic life.	1
	(c)	Change from *liquid → gas* *arrangement*: At -63^{0}C, particles are arranged closely packed in a disorderly manner. At ^{0}0C, particles are spaced far apart in a disorderly manner. *movement*: At -63^{0}C, particles are sliding past each other. At ^{0}0C, particles are moving rapidly in any direction.	 1 1
	(d)	No of mole of $CaCO_3$ = 30000000/(40+12+48) = 300000 mole From the equation, mole ratio of $CaCO_3$: CO_2 1:1 300000:300000 Volume of CO_2 = 300000 x 24 = 7200000 dm^3	1 1 1
	(e)	While limestone helps to remove the waste gas SO_2, it has resulted in the reléase of CO_2. CO_2 is a greenhouse gas that *contributes to global warming, raising earth's temperature and causing floods in low lying áreas.*	 1
7	(a)	Graph X • *gradient is lower than original graph / time taken is more than original time* • *final volume is same*	1
	(b)	Graph Y • *gradient is steeper than original graph* • *final volume is half of the original volume*	1
8	(a)	salt: sodium chloride — reactant 1: sodium hydroxide / sodium oxide / sodium carbonate — reactant 2: hydrochloric acid salt: lead (II) chloride — reactant 1: lead(II) nitrate solution **need the word solution or aqueous* — reactant 2: sodium chloride solution or group I chloride salts **need the word solution or aqueous*	2

*1m for each correct reagents

(b) (i)

instruction	purpose
until no more can dissolve	To ensure that all acid is used.
about one-third of its volume	To obtain a saturated solution for crystallization to take place

*1m for each purpose — 2

(ii)

mistake	correction to mistake
Place 100 cm^3 of dilute sulfuric acid	Place 100cm^3 of dilute *nitric acid*
Place the residue in the evaporating dish	Place the *filtrate* in the evaporating dish
Wash with large quantities of tap water	*Rinse* with *distilled water*

*1m each for each mistake and correction. The mistake needs to tally with the correction accordingly. — 2

9 (a) Each member has a functional group of CHO
Each member name ends with -al
Each successive member differ in chemical formula from the next member by a $-CH_2$ group
*any 2 marks for 2 of the points — 2

(b) $C_5H_{11}CHO$ — 1

10 (a)

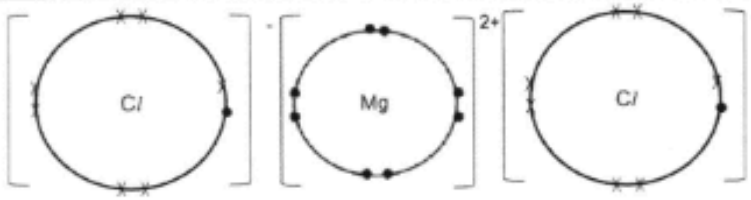
substance	identity of substance
A	aqueous ammonia/ ammonia/ NH_3;
B	zinc nitrate/ $Zn(NO_3)_2$;
D	hydrochloric acid/ HCl;
E	zinc chloride/ $ZnCl_2$;
F	silver chloride/ AgCl;

— 5

(b) $Zn^{2+}(aq) + 2OH^-(aq) \rightarrow Zn(OH)_2(s)$
*mindful that the state symbol for Zinc hydroxide is solid — 1

Structured Questions Section B

11	**(a)**	**(i)**	magnesium	1

			$Mg + Cl_2 \rightarrow MgCl_2$ [Accept any other Group II metals.]	1
		(ii)	 [1m for correct number of charges; 1m for correct number of valence electrons] [Deduct 1m if students do not show alternate arrangement of ions]	2
		(iii)	It *does not* conduct electricity at solid state. It *does not have free moving ions* to carry charges as they are held in fixed position in the giant lattice structure.	1 1
	(b)	(i)	Aqueous chlorine / Cl_2 *oxidises* KBr to form Br_2. The oxidation state of Br increases from -1 in KBr to 0 in Br_2.	1 1
		(ii)	Colourless solution turns reddish-brown. Chlorine, being more reactive, displaces bromine from potassium bromide to form aqueous bromine.	1 1
12	(a)		**Y**, **Z**, **W** and **X**	1
	(b)		<table><tr><th rowspan="2">metal</th><th colspan="4">reaction with</th></tr><tr><th>cold water</th><th>steam</th><th>dilute hydrochloric acid</th><th>aqueous copper(II) sulfate</th></tr><tr><td>**W**</td><td>x</td><td>√</td><td>√</td><td>√</td></tr><tr><td>**X**</td><td>√</td><td>√</td><td>√</td><td>√</td></tr><tr><td>**Y**</td><td>x</td><td>x</td><td>x</td><td>x</td></tr><tr><td>**Z**</td><td>x</td><td>x</td><td>√</td><td>√</td></tr></table>[Any 2 correct answers 1m; All 4 correct answers 2m]	2
	(c)		Steel is *stronger / harder* than metal **W**. The *atoms* of different elements have *different sizes* that *disrupt the orderly arrangement* of layers of metal atoms in pure metals. This *prevents the layers of atoms from sliding over one another* when a *force is applied*.	1 1
	(d)		Displacement reaction Add zinc into iron (II) nitrate and copper (II) nitrate solutions and observe. $Zn + Fe(NO_3)_2 \rightarrow Zn(NO_3)_2 + Fe$	 1

$Zn + Cu(NO_3)_2 \rightarrow Zn(NO_3)_2 + Cu$
Iron (II) nitrate changes from green to colourless while
Copper (II) nitrate changes from blue to colourless

Add iron into zinc nitrate and copper (II) nitrate solutions and observe. 1
$Fe + Zn(NO_3)_2 \rightarrow$ no reaction
$Fe + Cu(NO_3)_2 \rightarrow Fe(NO_3)_2 + Cu$
Copper (II) nitrate changes from blue to green while
zinc nitrate remains colourless

Add copper into zinc nitrate and iron (II) nitrate solutions and observe. 1
No visible observations is seen in both experiments

Zinc is more reactive than iron and copper *since displacement reactions occurred.* Iron is more reactive than copper but less reactive than zinc as only a displacement reaction is observed when iron is added to copper (II) nitrate. 1

Hence, Zn>Fe>Cu 1

OR

Place a clean strip of zinc into each of the solution. 1
Observe what happens. Repeat the experiment with clean strips of iron and copper using fresh metal sulfate solution. Record the observations in the table below.

metal	$ZnSO_4$	$FeSO_4$	$CuSO_4$
zinc		$Zn + FeSO_4 \rightarrow ZnSO_4 + Fe$ *Solution changes from green to colourless*	$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$ *Solution changes from blue to colourless*
iron	*No visible reaction*		$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$ *Solution changes from blue to green*
copper	*No visible reaction*	*No visible reaction*	

2

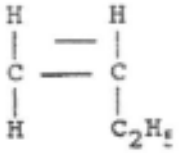
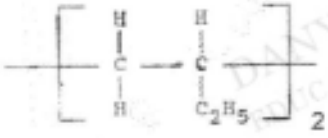
Since *zinc can displace both iron and copper from aqueous solution, it is the most reactive metal.* Since *copper cannot displace any metal from aqueous solution, it is the least reactive metal.* 1

Order of reactivity from least to most reactive is copper< iron<zinc 1

13 **(a)** 1

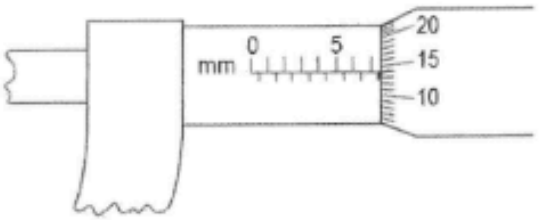
(b) Yeast acts on glucose to produce ethanol and carbon dioxide. 1

Conditions: absence of oxygen and 37^0C 1

		Pure ethanol can be obtained vai fractional distillation.		1
	(c)			1
	(d)	(i)	Add *aqueous bromine* to compound **A** and compound **B** separately. Compound **A** would rapidly decolourise aqueous bromine from *reddish brown to colourless.* Compound **B** *remains reddish brown.*	1 1
		(ii)	monomer of compound **A**:  polymer with 2 repeating units for compound **A**: 	2
		(iii)	Catalytic cracking	1

SENG KANG SECONDARY SCHOOL PRELIM PAPER

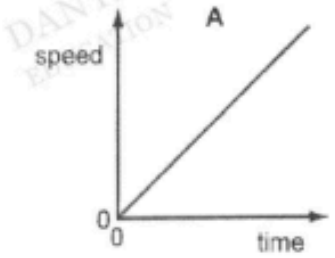
1 The diagram shows a micrometer scale.

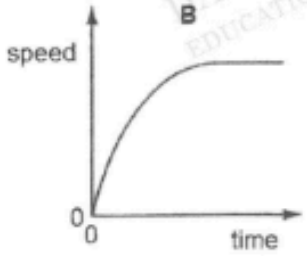


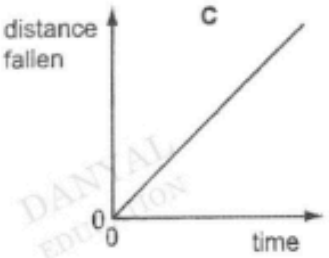
Which reading is shown?

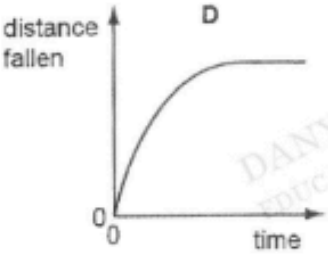
A 5.64 mm **B** 7.14 mm **C** 7.16 mm **D** 7.64mm

2 Which graph shows the motion of a heavy, steel ball falling from a height of 2 m?

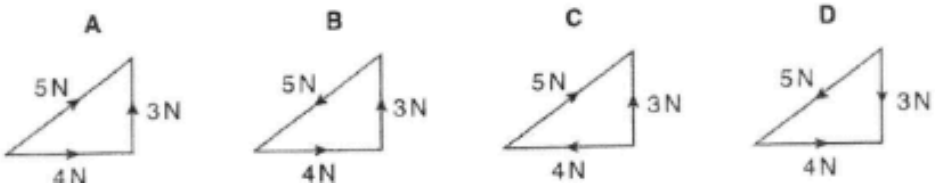








3 Which diagram correctly shows the addition of a 4 N and a 3 N force?



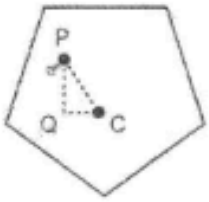
4 An object that has a mass of 15 kg on the Earth is taken to the Moon. The gravitational field strength on the Earth is 10 N/kg and on the Moon is 1.6 N/kg.

What are the mass and the weight of the object on the Moon?

	mass / kg	weight / N
A	15	24
B	15	150
C	24	15
D	150	24

5 A plane lamina is freely suspended from point P.
The weight of the lamina is 2.0 N and the centre of gravity is at C.

PC = 0.50 m
PQ = 0.40 m
QC = 0.30 m



lamina

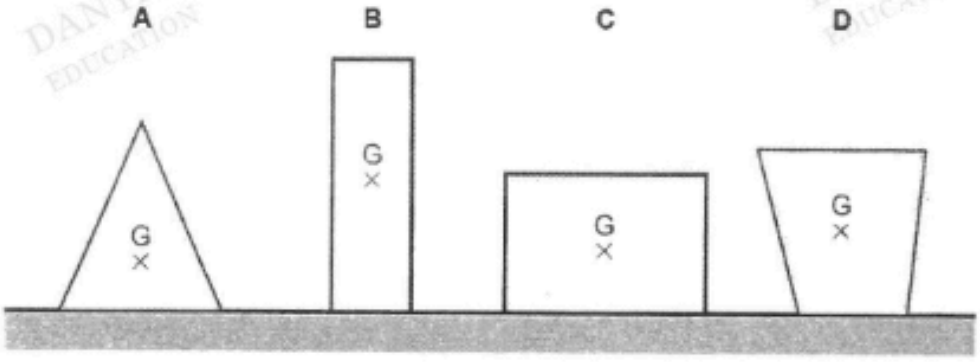
The lamina is displaced to the position shown.

What is the moment that will cause the lamina to swing?

A 0.60 N m clockwise
B 0.80 N m anticlockwise
C 1.0 N m clockwise
D 1.0 N m anticlockwise

6 Four objects of equal mass rest on a table.
The centre of gravity of each object is labelled G.

Which object is the least stable?



7 Four students exercised in a gym.

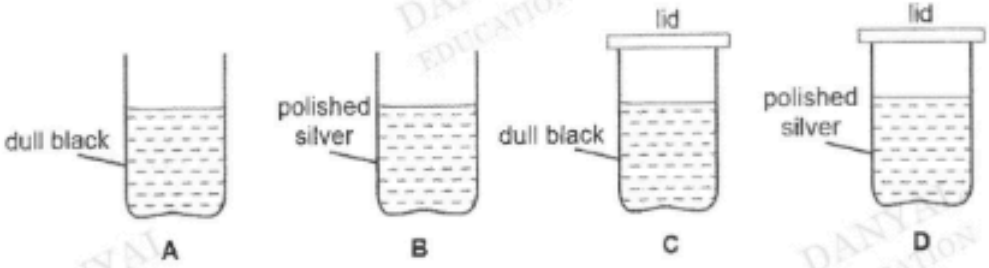
Which student did the most work?

	exercise time / s	power developed / W
A	50	250
B	100	150
C	200	200
D	250	30

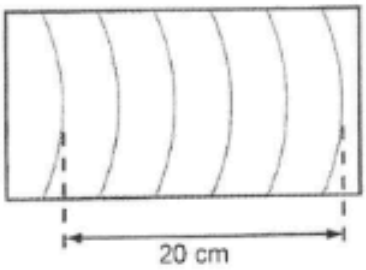
8 Assuming the temperature remains constant, which combination correctly describes the volume and the shape of a gas or liquid?

	gas or liquid	volume	shape
A	gas	fixed	not fixed
B	gas	not fixed	not fixed
C	liquid	fixed	fixed
D	liquid	not fixed	fixed

9 The diagram shows four similar cans. Each can contains the same volume of water initially at 80 °C. After five minutes, which can will contain the coolest water?



10 The dipper in a ripple tank vibrates at a frequency of 4.0 Hz and the resulting wave pattern is photographed. The distance between the two crests shown is 20 cm.



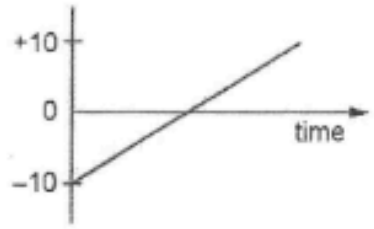
What is the speed of the wave?

A 4 cm/s B 5 cm/s C 16 cm/s D 20 cm/s

11 Ice at –10 °C is heated at a constant rate until it is water at +10 °C.

Which graph shows how the temperature changes with time?

A



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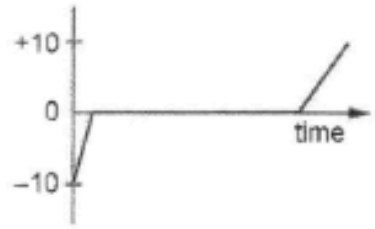

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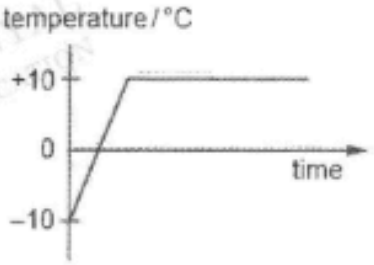

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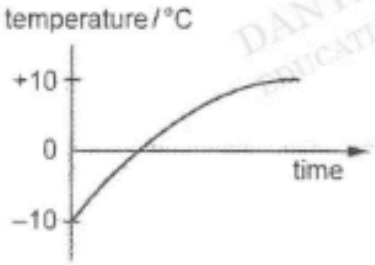


12 The human eye has a converging lens system that produces an image at the back of the eye.

If the eye views a distant object, which type of image is produced?

A real, erect, same size

B real, inverted, diminished

C virtual, erect, diminished

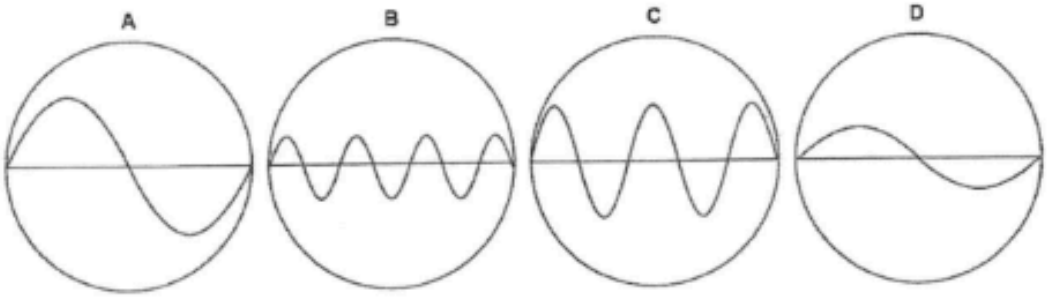
D virtual, inverted, magnified

13 Radio waves, visible light and X-rays are all part of the electromagnetic spectrum.

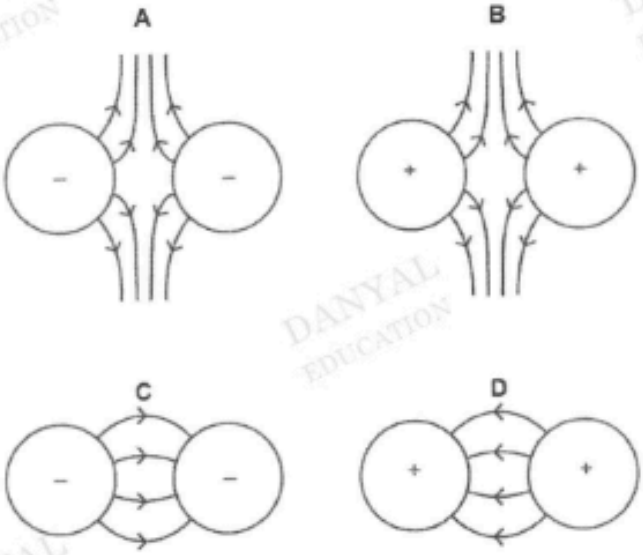
What is the correct order of increasing wavelength?

	shortest ——————————> *longest*		
A	radio waves	visible light	X-rays
B	radio waves	X-rays	visible light
C	X-rays	radio waves	visible light
D	X-rays	visible light	radio waves

14 The diagrams represent sound waves displayed on an oscilloscope.
Assuming the controls of the oscilloscope remain the same for each sound, which diagram represents the quietest sound with the highest frequency?



15 Which diagram correctly shows the electric field between two charged spheres?



16 An electrical quantity is defined as 'the energy converted by a source in driving a unit charge round a complete circuit.'

What is this quantity called?

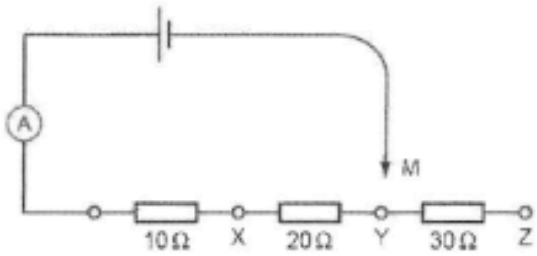
A current
B electromotive force
C potential difference
D power

17 A combined bathroom unit of a heater and a lamp is controlled by one switch. The unit contains a 2 kW heater and a 100 W lamp. In one week, the lamp uses 1 kW h of electrical energy.

How much electrical energy is used by the heater alone?

A 2 kW h **B** 4 kW h **C** 10 kW h **D** 20 kW h

18 The diagram shows a cell connected in series with an ammeter and three resistors (10 Ω, 20 Ω, 30 Ω). The circuit can be completed by a moveable contact M.



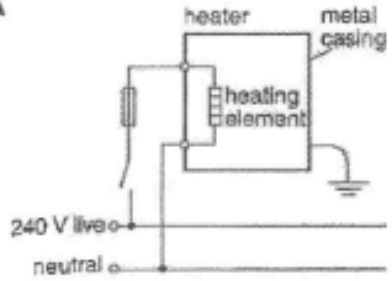
When M is connected to X, the ammeter reads 0.6 A.

What is the ammeter reading when M is connected to Y?

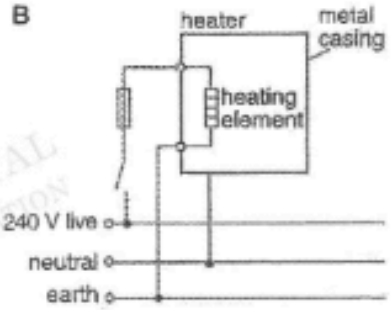
A 0.1 A **B** 0.2 A **C** 0.3 A **D** 0.6 A

19 Which of the following correctly shows how a water heater should be connected to the mains?

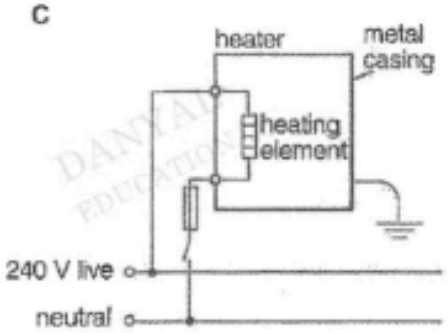
A



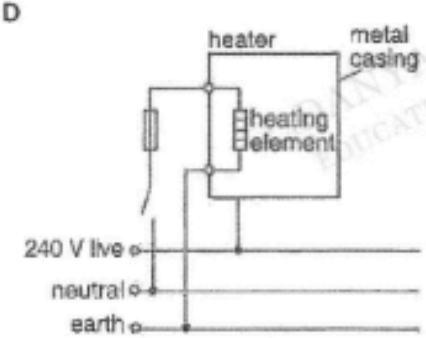
B



C

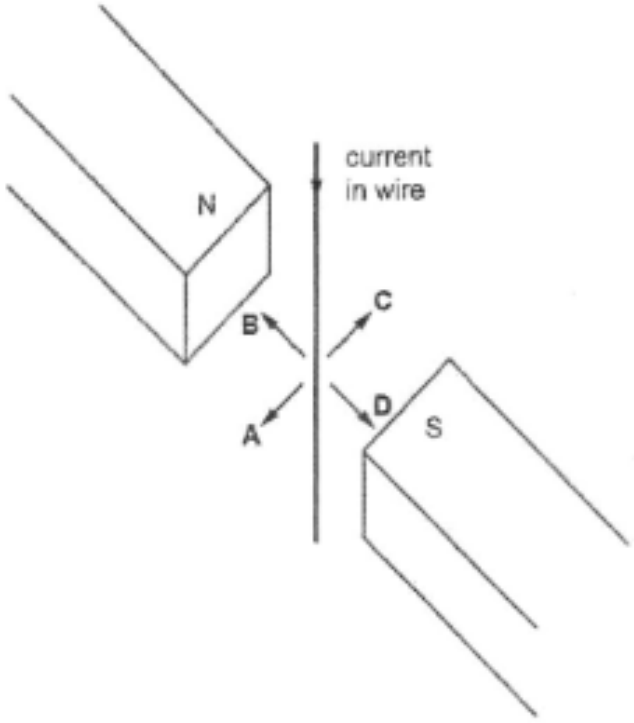


D



20 A wire hangs between the poles of a magnet.

When there is a current in the wire, in which direction does the wire move?



21 A student carried out an experiment to study the rate of reaction when a piece of magnesium was added to some dilute hydrochloric acid.

Which piece of apparatus is **not** required for this experiment?

A Bunsen burner
B conical flask
C gas syringe
D stop-watch

22 An aqueous solution of zinc chloride is tested by adding reagents.

Which observation is correct?

	reagent	observations
A	acidified aqueous barium nitrate	white precipitate
B	aqueous ammonia	white precipitate, soluble in excess
C	aqueous sodium hydroxide	white precipitate, insoluble in excess
D	powdered copper	grey precipitate

23 The particles in substance Z are widely spaced and able to move freely.
Z changes to a state in which the particles are in contact but are still able to move freely.

What is this change called?

A condensation
B evaporation
C freezing
D melting

24 Four atoms are shown.

$^{14}_{6}C$ $^{15}_{7}N$ $^{16}_{8}O$ $^{17}_{9}F$

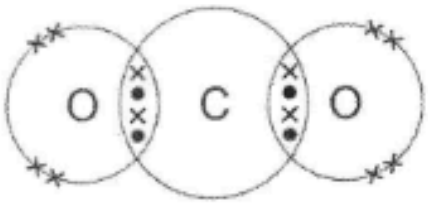
Which statement about all four atoms is correct?

A They have the same number of electrons.
B They have the same number of neutrons.
C They have the same number of nucleons.
D They have the same number of protons.

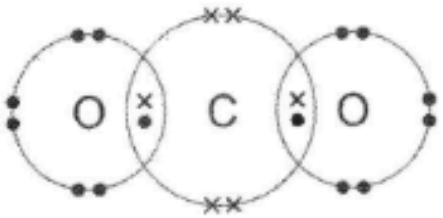
25 The bonding in a molecule of carbon dioxide can be represented by a 'dot-and-cross' diagram.

Which diagram is correct?

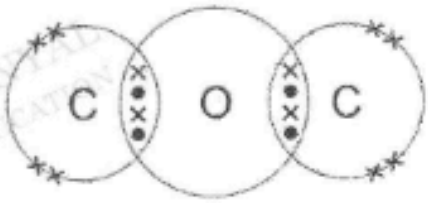
A



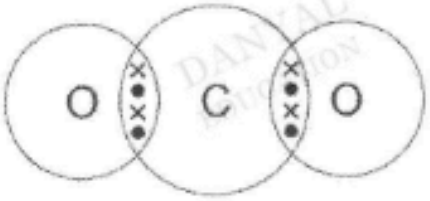
B



C



D



26 The relative atomic mass of chlorine is 35.5.

What is the mass of 2 moles of chlorine gas?

A 17.75 g
B 35.5 g
C 71 g
D 142 g

27 Methane burns in oxygen.

$$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$$

10 cm^3 of methane reacted with 25 cm^3 of oxygen.

What is the total volume of gas that would be measured after the reaction?

Assume all volumes of gases are measured at room temperature and pressure.

A 10 cm^3
B 15 cm^3
C 30 cm^3
D 35 cm^3

28 Solutions of two chemicals are mixed in a beaker.

A reaction occurs and a decrease in temperature is observed.

Which statement is correct?

A An endothermic reaction occurs and the reacting chemicals gain energy.
B An endothermic reaction occurs and the reacting chemicals lose energy.
C An exothermic reaction occurs and the reacting chemicals gain energy.
D An exothermic reaction occurs and the reacting chemicals lose energy.

29 Magnesium oxide reacts with sulfuric acid.

Which change increases the rate of reaction by increasing the movement of the particles?

A increase in concentration of sulfuric acid
B increase in surface area of magnesium oxide
C increase in temperature of sulfuric acid
D using a catalyst

30 Which statements about oxidation and reduction are correct?

1 Reduction can involve the loss of oxygen.
2 Oxidation can involve the loss of hydrogen.
3 Reduction can involve the loss of electrons.

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

31 In a neutralisation reaction, which change in particles occurs?

A atoms $\longrightarrow$ ions
B atoms $\longrightarrow$ molecules
C ions $\longrightarrow$ atoms
D ions $\longrightarrow$ molecules

32 Flowers of a hydrangea bush are blue when grown in acidic soil and pink when the soil is alkaline.

Which substance is added to the soil of a hydrangea with blue flowers so that it produces pink flowers?

A calcium hydroxide
B citric acid
C copper(II) sulfate
D sodium chloride

33 Which statement about elements in the Periodic Table is correct?

A Elements at the left-hand side of the Periodic Table are more metallic than those, in the same period, near the right-hand side.
B Elements at the top of a group lose electrons more readily than those, in the same group, that are lower in the Periodic Table.
C Elements in the same group of the Periodic Table have the same number of shells of electrons.
D Elements in the same period of the Periodic Table have the same number of electrons in the outer shell.

34 Which statement about the properties of the elements in Group 0 of the Periodic Table, helium to xenon, is correct?

A Argon reacts with iron to form a compound.
B Helium is less dense than air.
C The elements change from gas to solid down the group.
D The elements exist as covalent molecules.

35 Steel is often galvanised.

Which statements about galvanising are correct?

1 Galvanising makes a steel alloy.
2 Galvanising provides a sacrificial protection against rusting.
3 Galvanising coats a layer of zinc onto steel.

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

36 Which pair of substances act as reducing agents in the blast furnace?

A carbon and carbon monoxide
B carbon and oxygen
C carbon dioxide and oxygen
D carbon monoxide and carbon dioxide

37 Which pollutant gas is produced by both lightning activity and internal combustion engines?

A carbon monoxide
B nitrogen dioxide
C ozone
D sulfur dioxide

38 Which statement about alkanes is correct?

A Alkanes are described as being saturated because they are insoluble in water.
B Alkanes react with chlorine in an addition reaction.
C The alkane containing 10 carbon atoms in each molecule has a higher viscosity than the alkane containing 20 carbon atoms.
D The formula of an alkane with 35 carbon atoms in each molecule is $C_{35}H_{72}$.

39 Which petroleum fraction is used as a fuel for aircraft engines?

A bitumen
B diesel
C paraffin
D petrol

40 An organic compound E reacts with acidified potassium manganate(VII) solution causing a colour change.

What is E?

A ethane
B ethanoic acid
C ethanol
D poly(ethene)

END OF PAPER

Section A

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

1 Choose from the following oxides to answer the questions.

aluminium oxide
calcium oxide
carbon monoxide
copper(II) oxide
magnesium oxide
sodium oxide
sulfur dioxide

Each oxide may be used once, more than once or not at all.

Identify an oxide which:

(a) is amphoteric

..... [1]

(b) contains ions with a 1+ charge

..... [1]

(c) is formed from the incomplete combustion of carbon-containing fuel

..... [1]

(d) contributes to acid rain

..... [1]

(e) is a product of the thermal decomposition of calcium carbonate

..... [1]

(f) is a black solid.

..... [1]

2 (a) Group I and Group VII elements show different trends in their properties.

Group I	Group VII
Li	F
Na	Cl
K	Br
Rb	I

(i) Describe the trend in melting point down each group.

.....

..... [1]

(ii) Describe the trend in reactivity down each group.

.....

..... [1]

(b) Table 2.1 shows the **most common** oxidation states of four elements, **A**, **B**, **C** and **D** in their compounds.

Table 2.1

element	most common oxidation state	metal or non-metal?
A	−2	
B	+1	non-metal
C	+3	
D	−1	

(i) Complete Table 2.1 by filling in the last column to show which elements are **metals** or **non-metals**. [1]

(ii) Use the letters **A**, **B**, **C** and **D** to answer the following questions.

(a) Which element is most likely to be hydrogen?

..... [1]

(b) Which element is most likely to be in Group VI?

..... [1]

(c) No elements from Group 0 appear in Table 2.1.
Explain why this statement is true.

.....

..... [2]

3 Simple alcohols form a homologous series. Butanol is an example of an alcohol and has the following structure as shown in Fig. 3.1.

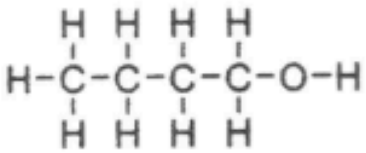


Fig. 3.1

(a) Give the general formula for the homologous series of alcohols.

..... [1]

(b) **(i)** Name and give the chemical formula for the second member of the homologous series.

name .....

chemical formula ..... [2]

(ii) When left exposed to air, this alcohol is slowly oxidised.

Give the name and draw the full structural formula of the product of this oxidation.

name .....

full structural formula

[3]

4 Metals are extracted from their oxides by reduction.
Table 4.1 shows the minimum temperature that is needed for the reduction of some metal oxides by reaction with carbon.

Table 4.1

metal oxide	minimum temperature needed for reduction /°C
calcium oxide	2100
zinc oxide	900
copper(II) oxide	100
magnesium oxide	1600
lead(II) oxide	400

(a) (i) How does the temperature needed for reduction relate to the reactivity of the metal?

.....

..... [1]

(ii) Predict the minimum temperature needed for the reduction of iron oxide by reaction with carbon.

Explain your reasoning.

temperature .....°C

reason .....

..... [2]

(b) (i) Zinc metal can react with steam.

Give the names of the **two** products of this reaction.

..... and ..... [1]

(ii) Construct a chemical reaction, with state symbols, for the reaction of zinc and steam.

..... [2]

5 Salts can be prepared by different methods.

(a) State the type of reaction that occurs when an acid reacts with an alkali to form a salt and water.

..... [1]

(b) Construct an ionic equation, with state symbols, for the reaction in **(a)**.

..... [2]

(c) Sodium sulfate is soluble in water. To prepare crystals of this salt, a neutral and colourless solution of sodium sulfate must be prepared.

Describe how you would prepare this sodium sulfate solution from sodium hydroxide solution, a suitable indicator and an acid.

.....

.....

.....

..... [3]

(d) Aqueous sodium sulfate is used to prepare barium sulfate according to the following equation.

$$Ba^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow BaSO_4(s)$$

(i) Name the method that is used to prepare barium sulfate.

..... [1]

(ii) State the colour of the barium sulfate that is formed.

..... [1]

(iii) In another experiment 20.0 cm^3 of 0.550 mol/dm^3 of barium nitrate is added to an excess of sodium sulfate as follow.

$$Ba(NO_3)_2(aq) + Na_2SO_4(aq) \longrightarrow BaSO_4(s) + 2NaNO_3(aq)$$

Showing your working clearly, calculate the maximum mass of barium sulfate that could be made in the reaction. Give your answer correct to **three** significant figures.

maximum mass of barium sulfate = ... g [2]

6 (a) Calcium reacts with water to form aqueous calcium hydroxide, which is commonly referred to as limewater. A solution of calcium hydroxide has an approximate pH of 8.

Some reactions of calcium and calcium hydroxide are shown in Fig. 6.1.

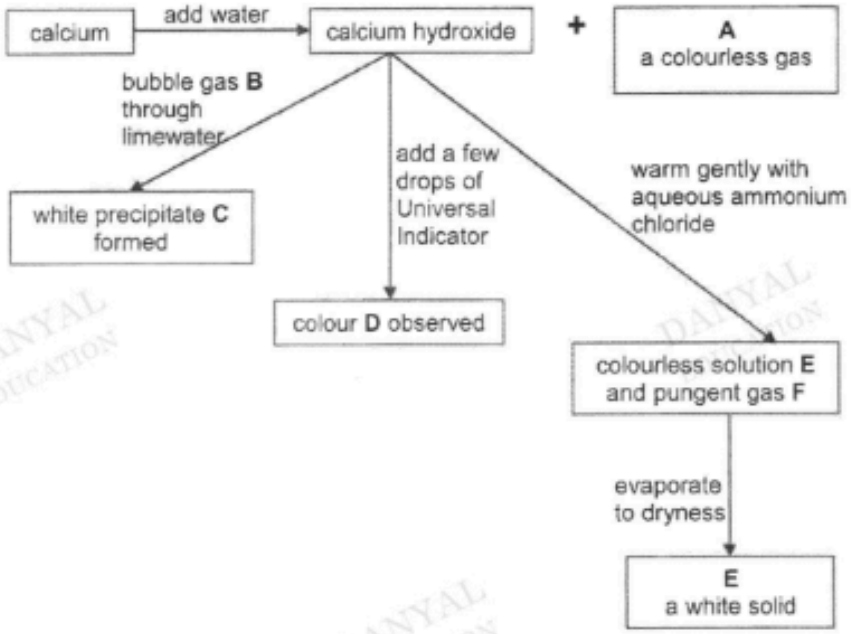


Fig. 6.1

Identify

A .....

B .....

C .....

colour D .....

E .....

F ..... [6]

(b) Describe how you would carry out a test to confirm the identity of gas **A**. Include the observation you would expect.

chemical test: .....

observation: .....

..... [1]

(c) Solid **E** has a melting point of 772°C.

(i) Deduce the type of bonding that is present in solid **E**.

..... [1]

(ii) Explain, in terms of structure and bonding, why solid **E** has such a high melting point.

.....

.....

.....

.....

..... [2]

Section B

Answer any **two** questions from this section.

Write your answers in the spaces provided.

7 Iron(II) carbonate powder reacts with dilute sulfuric acid.

$$FeCO_3(s) + H_2SO_4(aq) \longrightarrow FeSO_4(aq) + CO_2(g) + H_2O(l)$$

(a) The graph in Fig. 7.1 shows the volume of carbon dioxide that is produced at 20°C as the reaction proceeds.

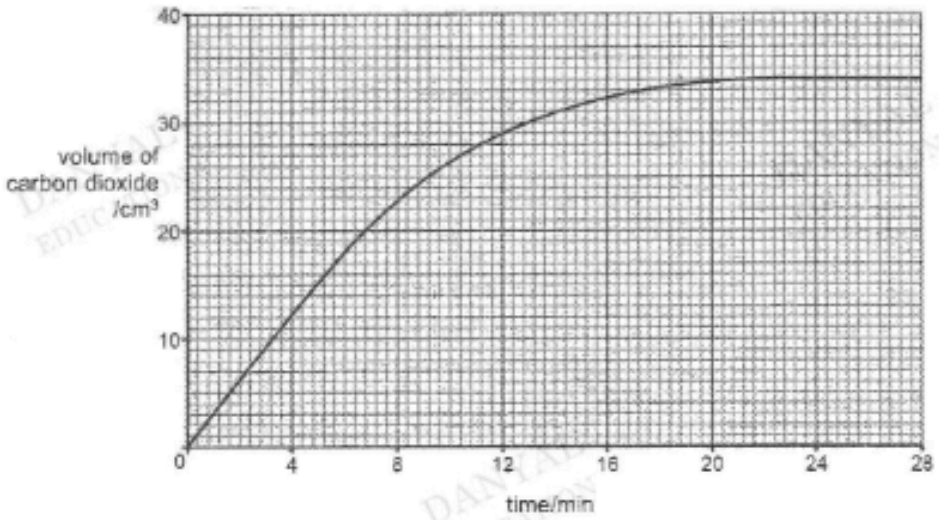


Fig. 7.1

(i) State how long it takes from the start of the experiment to collect 18 cm^3 of carbon dioxide gas.

.....

[1]

(ii) The experiment is repeated at 30°C. All other conditions remain the same.

On the same grid in Fig. 7.1, draw the graph to show how the volume of carbon dioxide gas produced changes with time when the reaction is carried out at 30°C. [2]

(b) **(i)** Explain, in terms of collisions between reacting particles, why a higher temperature affects the rate of reaction. All other conditions remain the same.

.....

.....

.....

[2]

(b) (ii) When the reaction between iron(II) carbonate and dilute sulfuric acid is complete, describe how you would carry out a test to show the presence of iron(II) ions in the resulting solution.

Include the observation you would expect.

chemical test: .....

.....

observation: .....

..... [2]

(c) Showing your working clearly, calculate the maximum volume, in dm^3, of carbon dioxide produced when 6.96 g of iron(II) carbonate react with excess dilute sulfuric acid at room temperature and pressure.

maximum volume of carbon dioxide = ... dm^3 [3]

8 Alkenes are a homologous series of hydrocarbons.

(a) (i) How does the boiling point of an alkene with three carbon atoms in each molecule compare with the boiling point of an alkene with two carbon atoms?

.....

..... [1]

(ii) Suggest a possible explanation for this difference in **(a)(i)**.

.....

..... [1]

(b) (i) Which **two** compounds are formed when an alkene burns in excess air?

..... and ..... [1]

(ii) Write the balanced chemical equation for burning, in excess air, the alkene with two carbon atoms in each molecule.

..... [2]

(c) Margarine is manufactured from vegetable oils using a nickel catalyst.

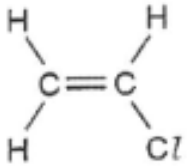
(i) Name the other reactant used in this reaction.

..... [1]

(ii) State the type of chemical reaction which occurs when margarine is manufactured from vegetable oils.

..... [1]

(d) The structure of chloroethene is shown.



Chloroethene is the monomer used to make poly(chloroethene).
Poly(chloroethene) is commonly known as poly(vinyl chloride) (PVC) and is used in the construction industry, for example, in electrical cables and water pipes.
Poly(chloroethene) is non-biodegradable.

(i) Draw the full structural formula of two repeating units of poly(chloroethene). Show all the bonds in your answers.

[2]

(ii) Describe **one** environmental problem caused by the disposal of non-biodegradable plastics.

.....

..... [1]

9 **(a)** Not all of the atoms of bromine are identical. Examples of bromine atoms that occur naturally are ^{79}Br and ^{81}Br.

(i) What name is given to atoms such as ^{79}Br and ^{81}Br?

.....

[1]

(ii) Explain why different atoms of bromine can have different masses but have the same chemical properties.

.....

.....

[2]

(b) Phosphorus, a non-metal, reacts with bromine to form phosphorus tribromide, PBr_3, according to the following equation.

$$2P + 3Br_2 \longrightarrow 2PBr_3$$

PBr_3 is a colourless liquid. It has to be handled and stored carefully because it is very toxic, and it reacts very vigorously with water.

(i) Draw 'dot-and-cross' diagram to show the bonding in PBr_3.

Show outer electrons only.

[3]

(ii) Deduce the colour change that will be observed when phosphorus reacts with bromine to form phosphorus tribromide.

.....

[1]

(iii) The reaction of phosphorus with bromine to form phosphorus tribromide is also a redox reaction.

Use ideas about oxidation states to explain your answer.

.....

.....

.....

..... [2]

(iv) When phosphorus tribromide reacts with water, it forms phosphorus acid, H_3PO_3, and hydrogen bromide, HBr.

Construct a balanced chemical equation for this reaction.

..... [1]

END OF PAPER

ANSWER SHEET

Paper 1

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

Paper 3

1 (a) aluminium oxide 1

(b) sodium oxide 1

(c) carbon monoxide 1

(d) sulfur dioxide 1

(e) calcium oxide 1

(f) copper(II) oxide 1

2 (a) (i) Melting point decreases down Group I, and increases down Group VII 1

(ii) Reactivity increases down Group I, and decreases down Group VII 1

(b) (i)

element	most common oxidation state	metal or non-metal?
A	–2	non-metal
B	+1	non-metal
C	+3	metal
D	–1	non-metal

All correct - 1

(ii) (a) B (b) A 1, 1

(c) The following answers are acceptable:

Group 0 elements have a full valence shell / completely-filled outer shell / electronically stable, 1

exist as elements and will not form ions 1

OR

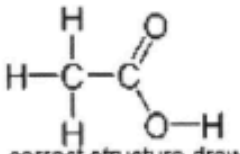
They will not form compounds / will exist as elements 1

Hence, oxidation state is zero and no elements in Table 2.1 have oxidation states of zero. 1

3 (a) $C_nH_{2n+1}OH$ 1

(b) (i) name: ethanol chemical formula: C_2H_5OH 1, 1

(ii) ethanoic acid 1



correct structure drawn, no need to slant bonds; ALL bonds are drawn 1 ,1

4 (a) (i) The more reactive the metal, the higher the temperature. 1
[Accept converse reasoning]

(ii) Any number greater than 400 and less than 900 1

Reason: iron is more reactive than lead, but less reactive than zinc 1

[NO marks if students mention position of metals in reactivity series]

(b) (i) zinc oxide and hydrogen 1

(ii) $Zn(s) + H_2O(g) \rightarrow ZnO(s) + H_2(g)$

All correct formulae and correctly balanced (accept correct multiples) 1

All state symbols are correct *1

*state symbol mark can only be awarded when all the formulae are correct

5 (a) neutralisation

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

All correct formulae and correctly balanced (accept correct multiples) 1

All state symbols are correct *1

*state symbol mark can only be awarded when all the formulae are correct

[NOTE: NO mark if chemical equation is written]

(c) Titrate sodium hydroxide against sulfuric acid with appropriate indicator eg methyl orange (accept screened methyl orange) 1

Brief description of how a neutral sodium sulfate solution is obtained by the change of appropriate colours in indicator used 1

Brief description of appropriate volume of sulfuric acid needed for neutralisation and repeat experiment without the indicator 1

(d) (i) precipitation [NO mark: method 3 ; wrong spelling] 1

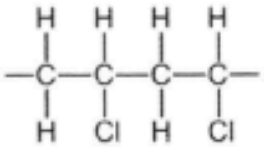
(ii) white 1

(iii) no. of moles of $Ba(NO_3)_2$ = 0.550 x (20.0/1000) = **0.0110 moles** (0.011✓) 1

max mass of $BaSO_4$ = 0.0110 x [137+32+4(16)] = 2.563 ≈ **2.56 g (3sf)** 1

[NO mark if there is NO working!]

6	(a)	A	hydrogen / H_2	1
		B	carbon dioxide / CO_2	1
		C	calcium carbonate / $CaCO_3$	1
		D	blue	1
		E	calcium chloride / $CaCl_2$	1
		F	ammonia / NH_3	1
	(b)		lighted splint "pop" sound with lighted splint / extinguished with "pop" sound	1
	(c)	(i)	ionic bonding	1
		(ii)	much energy required to overcome the strong electrostatic attraction between the oppositely-charged ions	1 1
7	(a)	(i)	6 min [**NO marks** if no unit or wrong unit]	1
		(ii)	initial gradient steeper and starting from origin	1
			horizontal line portion of curve levels off at 34 cm^3 gas	1
	(b)	(i)	rate of reaction increases and	
			① particles move faster / particles have more kinetic energy / more particles obtain minimum activation energy	1
			② more frequent effective collisions	1
			[NOTE: rate of reaction increases alone = NO mark]	
		(ii)	chemical test: add sodium hydroxide / aqueous ammonia till in excess	1
			observation: green ppt insoluble in excess	1
	(c)		No. of moles of $FeCO_3$ = 6.96 / [56 + 12 + 3(16)] = 0.06 mol	1
			Max vol. of CO_2 = 0.06 x 24 [allow ecf]	1
			= 1.44 dm^3	1
			[NOTE: NO mark awarded for numbers without working]	
8	(a)	(i)	higher boiling point	1
		(ii)	more energy is required to overcome the greater number of intermolecular forces in alkene with three carbon atoms	1
	(b)	(i)	carbon dioxide and water vapour (accept water)	1
		(ii)	$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$	
			all formulae are correct	1
			correctly balanced (accept correct multiples)	1
			State symbols are **NOT** required, if state symbols are written and are wrong, to **award maximum of 1 mark**	

	(c)	(i)	hydrogen	1
		(ii)	addition	1
			[NO mark if hydrogenation is written]	
	(d)	(i)	 2 repeat units shown extension bonds at both ends	1 1
		(ii)	Any one of the following - release of toxic gases upon incineration - take up space in landfills - endanger marine animals when thrown into sea	1
9	(a)	(i)	Isotopes	1
		(ii)	different number of neutrons give rise to different masses	1
			same number of valence electrons → same chemical properties	1
	(b)	(i)	3 pairs of bonding electrons between each Br and P 6 unpaired electrons on each bromine & 2 unpaired electrons on P atoms are labelled with P and Br appropriately	1 1 1
		(ii)	from red-brown to colourless	1
		(iii)	P is oxidised, increase in oxidation states from 0 to +3	1
			Br_2 is reduced, decrease in oxidation states from 0 to –1	1
			[NOTE: just stating oxidised or reduced alone will not be awarded marks]	
		(iv)	$PBr_3 + 3H_2O \rightarrow H_3PO_3 + 3HBr$	1

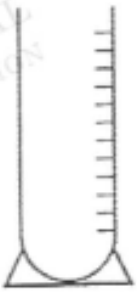
SERANGOON SECONDARY SCHOOL PRELIM PAPER

1 Which piece of apparatus is used to measure exactly 25.0 ml of acid?

A

B

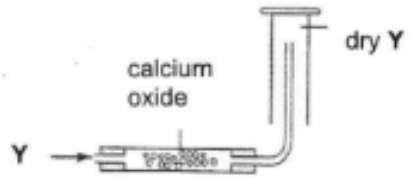
C



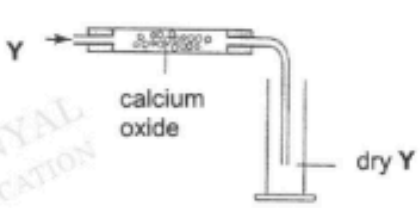
D

2 A gas **Y**, is less dense than air, very soluble in water and is alkaline in nature. Calcium oxide and sulfuric acid are drying agents used to dry this gas. Which method is used to collect a dry sample of the gas?

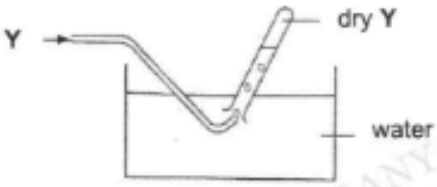
A



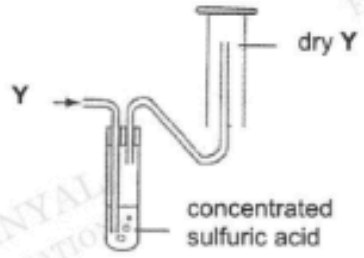
B



C



D



3 Which substance would show a change of state if cooled from room temperature to 0 °C?

substance	melting point / °C	boiling point / °C
A	−305	−42
B	−28	34
C	−18	2
D	−85	127

4 ^{85}Z and ^{87}Z are isotopes of element Z.

How is the ion formed by ^{85}Z different from the ion formed by ^{87}Z?

A it has two less neutrons and two less electrons
B it has two less neutrons but no less electrons
C it has two less protons and two less electrons
D it has two less protons but no less electrons

5 The symbol for an atom of boron is $^{11}_{5}B$.
What does the number 11 represent for an atom of boron?

A the number of protons
B its position in the Periodic Table
C the total number of protons, neutrons, and electrons
D the nucleon number

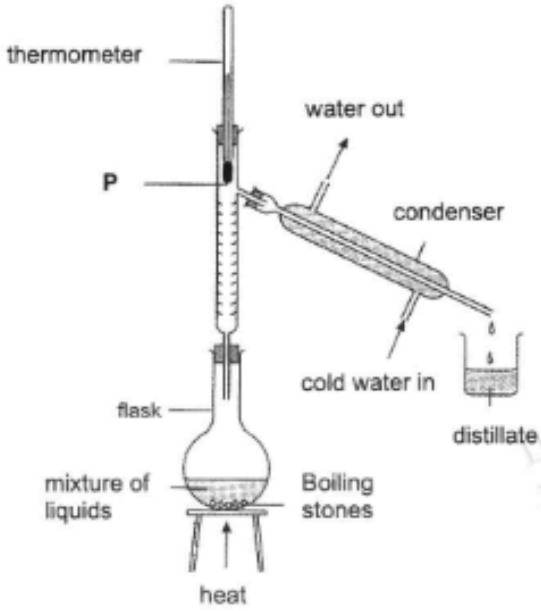
6 Element Y has the electronic configuration 2, 2.

Element Z has the electronic configuration 2, 8, 7.

What is the formula of the compound formed between Y and Z?

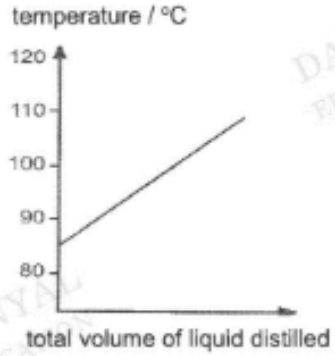
A YZ
B YZ_2
C Y_2Z
D Y_3Z_2

7 The diagram below shows the apparatus used to separate a mixture of two liquids with boiling points 85 °C and 110 °C.

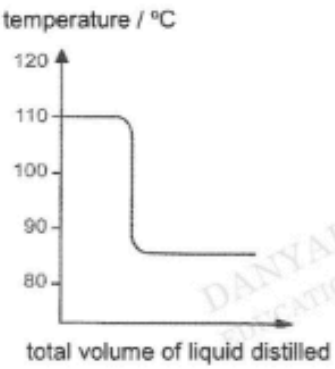


Which graph would be obtained if the temperature at Point **P** was plotted against the total volume of distillate produced?

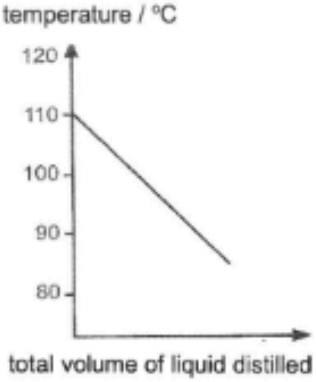
A



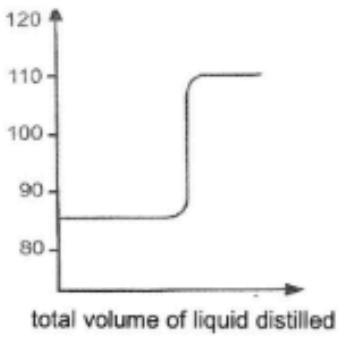
B



C

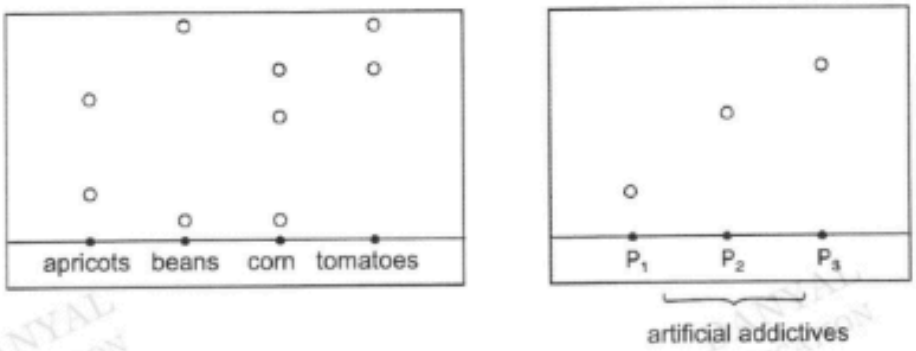


D



8 Samples of canned apricots, beans, corn and tomatoes were tested for additives by chromatography. The chromatograms were compared with those of three artificial additives, P_1, P_2 and P_3.

The results were as follows.



Which canned food does **not** contain any artificial additives?

A apricots
B beans
C corn
D tomatoes

9 What is the total number of elements present in one unit of wolframite, $(FeMn)WO_4$?

A 3
B 4
C 7
D 9

10 Two indicators, bromophenol blue and Congo red, show the following colours in acidic solutions and in alkaline solutions.

indicator	acid	alkali
bromophenol blue	yellow	blue
Congo red	violet	red

A few drops of each indicator are added to separate samples of a solution of pH 2.

What are the colours of the indicators in this solution?

	colour of indicator in a solution of pH 2	
	bromophenol blue	Congo red
A	blue	red
B	blue	violet
C	yellow	red
D	yellow	violet

11 Which statement about the elements in the Periodic Table is correct?

A Group 0 elements are unreactive metals.
B Group I elements form covalent chlorides.
C Group VII elements form ions when combined with other elements.
D The elements become more metallic from right to left across a period.

12 An unknown element has the following properties.

1. It floats on water.
2. It is able to conduct electricity
3. It tarnishes easily when exposed to air.
4. When reacted with water, it forms an alkaline solution.

Which group in the Periodic Table does it belong to?

A Group I
B Group II
C Group IV
D Group VII

13 What is the mole ratio between 71 g of chlorine to 2 g of hydrogen?

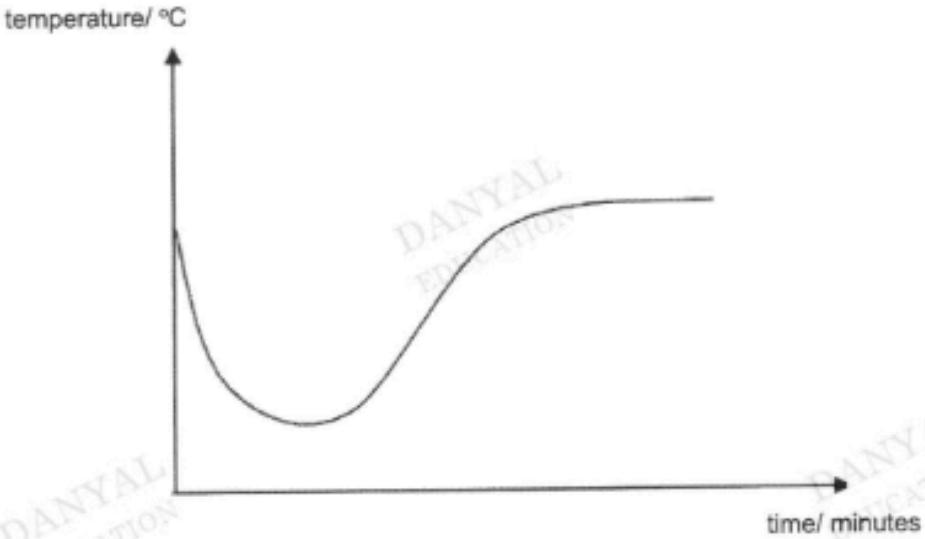
A	1:1	**B**	2:1
C	71:1	**D**	71:2

14 Which volume of oxygen (at room temperature and pressure) is needed when 194 g of zinc sulfide is heated in air?

$$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$$

A	24 dm^3	**B**	48 dm^3
C	72 dm^3	**D**	96 dm^3

15 The change in temperature when ammonium nitrate is added into water is shown below.



Which of the following can be derived from the graph?

A A salt and water are formed.

B It is an endothermic process.

C It is an exothermic process.

D The temperature of the water rises.

16 The table below shows some reactions of metals **P** to **S**.

metal	action of hydrochloric acid on metal	action of carbon on heated metal oxide	action of hydrogen gas on heated metal oxide
P	a lot of effervescence seen immediately	reduced	not reduced
Q	a lot of effervescence seen immediately	not reduced	not reduced
R	some effervescence after a long time	reduced	reduced
S	no reaction	reduced	reduced

What is the order of reactivity of the metals in increasing reactivity?

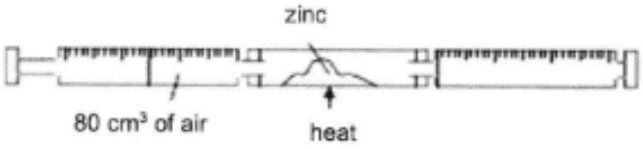
A **P, Q, R, S**
B **Q, P, R, S**
C **S, R, P, Q**
D **S, R, Q, P**

17 Stainless steel is used to make cutlery. Aluminium is used to make food containers.

Which property do **both** stainless steel and aluminium have that makes them suitable for these uses?

A They are good conductors of electricity.
B They are good conductors of heat.
C They are resistant to corrosion.
D They are ductile.

18 A 80 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.



On cooling to room temperature, what is the final volume of air in the gas syringe?

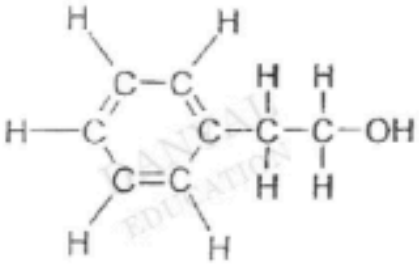
A 16 cm^3
B 21 cm^3
C 32 cm^3
D 63 cm^3

19 Useful fractions are obtained by the fractional distillation of petroleum oil.

Which fraction and its use is correct?

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

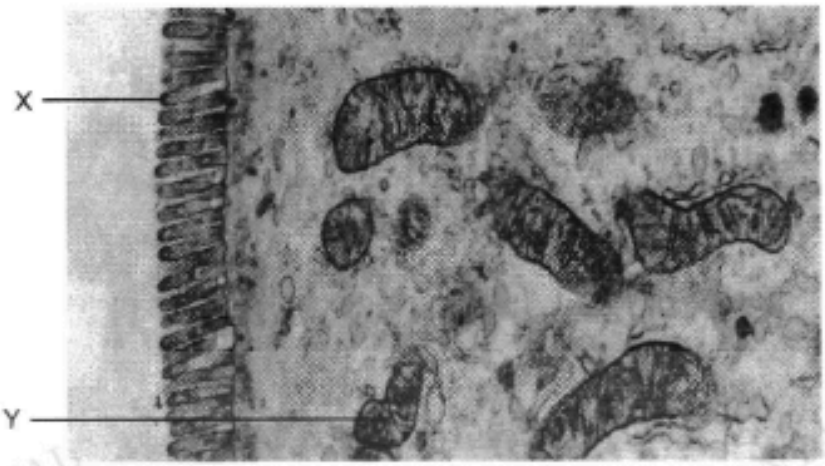
20 The diagram below shows the structure of a substance responsible for the fragrance of roses.



Which of the following statements about this molecule is correct?

A It is a saturated molecule.
B It can be oxidised by acidified potassium manganate(VII).
C It does not decolourise bromine water under any conditions.
D It can react with reactive metal to form salt.

Refer to the electron micrograph of a section of a small intestine below to answer question **21** and **22**.



21 What is the structure labelled Y?

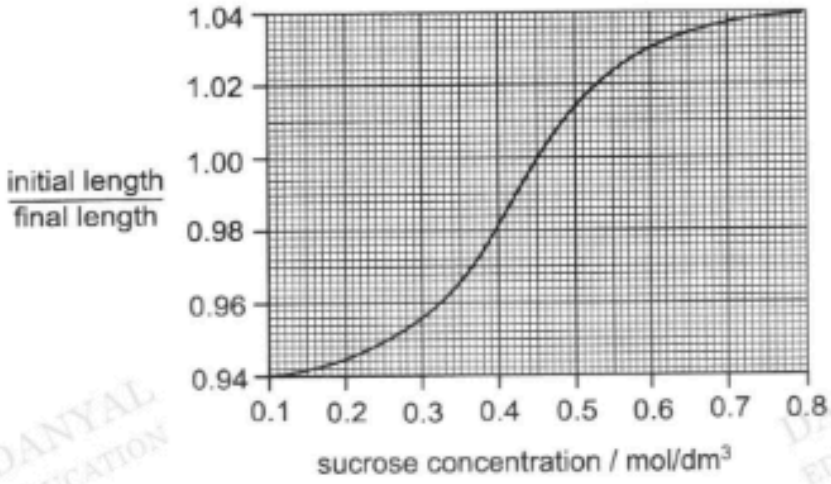
A chloroplast
B mitochondrion
C ribosome
D vacuole

22 What is the likely function of structure X?

A to slow down movement of food substances by obstructing flow
B to increase surface area to volume ratio to enhance absorption of nutrients
C to increase surface area to volume ratio to enhance secretion of digestive enzymes
D to provide sweeping action to move the food substances down the small intestine

23 Strips of plant tissue were soaked in a range of sucrose solutions of different concentrations. Their length was measured before soaking and after 30 minutes in the different solutions.

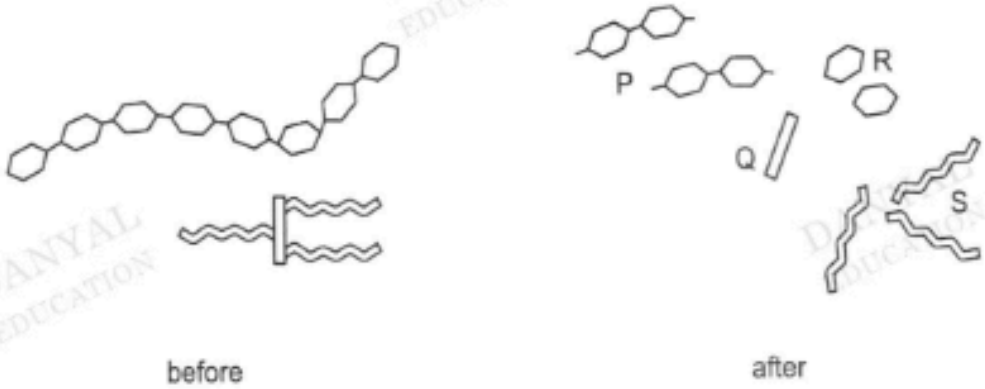
The graph shows the ratio of initial length to final length.



Which concentration of sucrose solution, in mol/dm^3, has the same water potential as the cell sap before immersion?

A 0.10 **B** 0.25 **C** 0.45 **D** 0.80

24 The diagram shows two food molecules before and after they have been digested by enzymes.



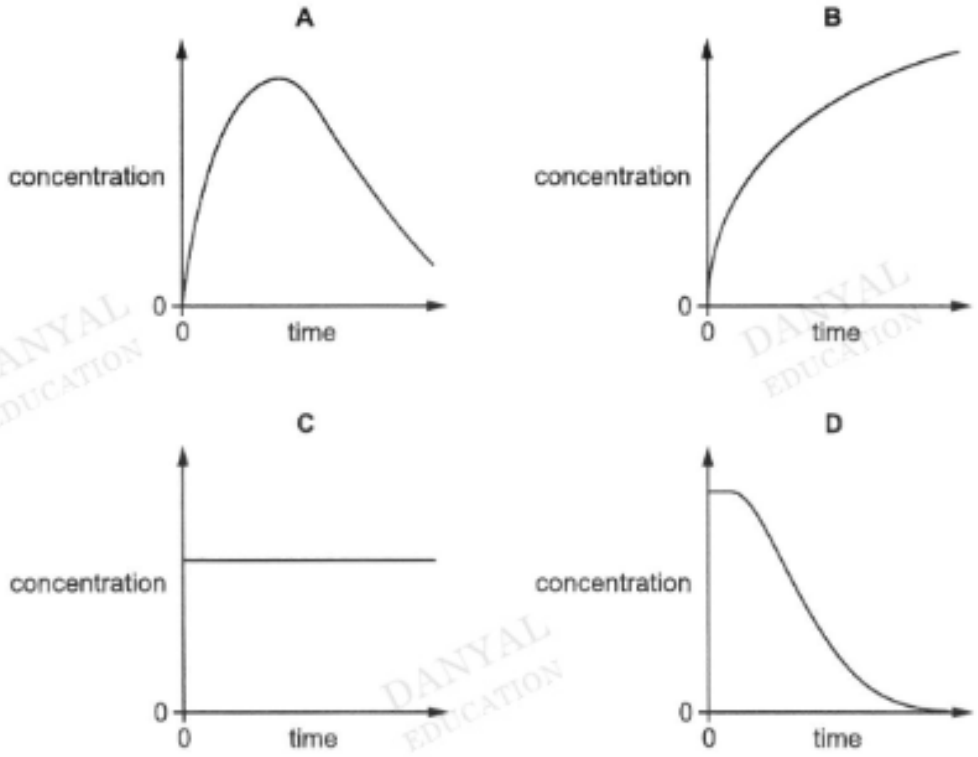
Which are the products of fat digestion?

A P and R **B** P and S **C** Q and R **D** Q and S

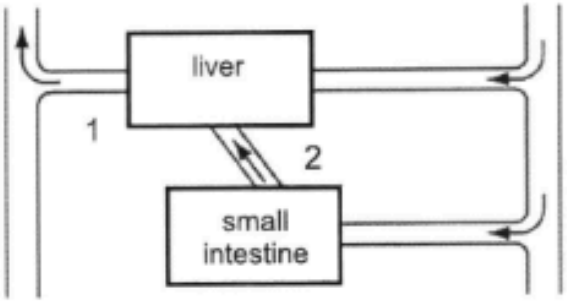
25 An enzyme was added to an excess of its substrate. All variables were kept constant.

A student was asked to sketch a graph to show how the concentration of enzyme-substrate complex changes over time.

Which graph shows this correctly?



26 The diagram represents some human organs and their associated blood vessels?



A man has consumed an alcoholic drink.

Which statement about the concentration of alcohol in his blood vessels 1 and 2 is true?

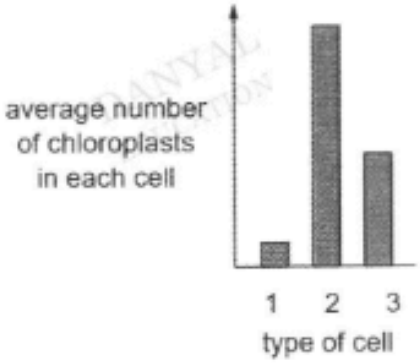
A There is no alcohol in both blood vessels.

B The concentration of alcohol is higher in 1 than 2.

C The concentration of alcohol is lower in 1 than 2.

D The concentration of alcohol is equal in both blood vessels.

27 The bar chart shows the average number of chloroplasts in each of three different cells.



What are the three types of cell?

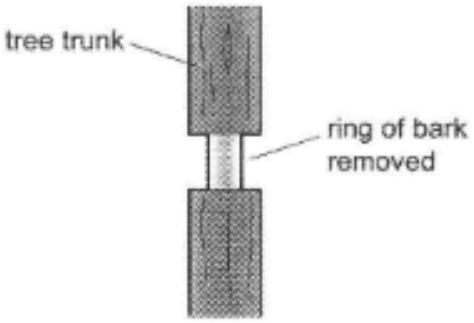
	1	2	3
A	guard cell	palisade mesophyll cell	spongy mesophyll cell
B	palisade mesophyll cell	spongy mesophyll cell	guard cell
C	spongy mesophyll cell	guard cell	palisade mesophyll cell
D	spongy mesophyll cell	palisade mesophyll cell	guard cell

28 The roots of plants take up nitrates from the soil. Nitrates contain the element nitrogen.

Which nutrient is produced from the nitrates in plants?

A fats
B glucose
C protein
D starch

29 The diagram shows a part of a tree trunk. A ring of bark including the phloem has been removed.



The tree will eventually die because removing the bark stops the transport of

A mineral salts to the leaves.
B nutrients to the roots.
C oxygen to the roots.
D water to the leaves.

30 Some functions of the blood are listed below:

1. antibody production
2. dissolve and transport nutrients
3. conversion of fibrinogen into fibrin threads
4. phagocytosis

Which of the functions listed are functions of white blood cells?

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

31 Which statement explains why a lot of dust and micro-organisms are found in the lungs of a heavy smoker?

A He is addicted to nicotine.
B His arteries are blocked with tar.
C The surface area of his lungs is reduced.
D The cilia in his trachea have been damaged.

32 Three directions in which nerve impulses can travel in the nervous system are listed.

1. away from the central nervous system
2. towards the central nervous system
3. within the central nervous system

Which correctly identifies the direction of the nerve impulse in motor and relay neurone?

	motor neurone	relay neurone
A	1	2
B	1	3
C	2	1
D	2	3

33 Which describes pupil reflex in bright light?

A ciliary muscle contract, radial muscles relax, lens become rounder

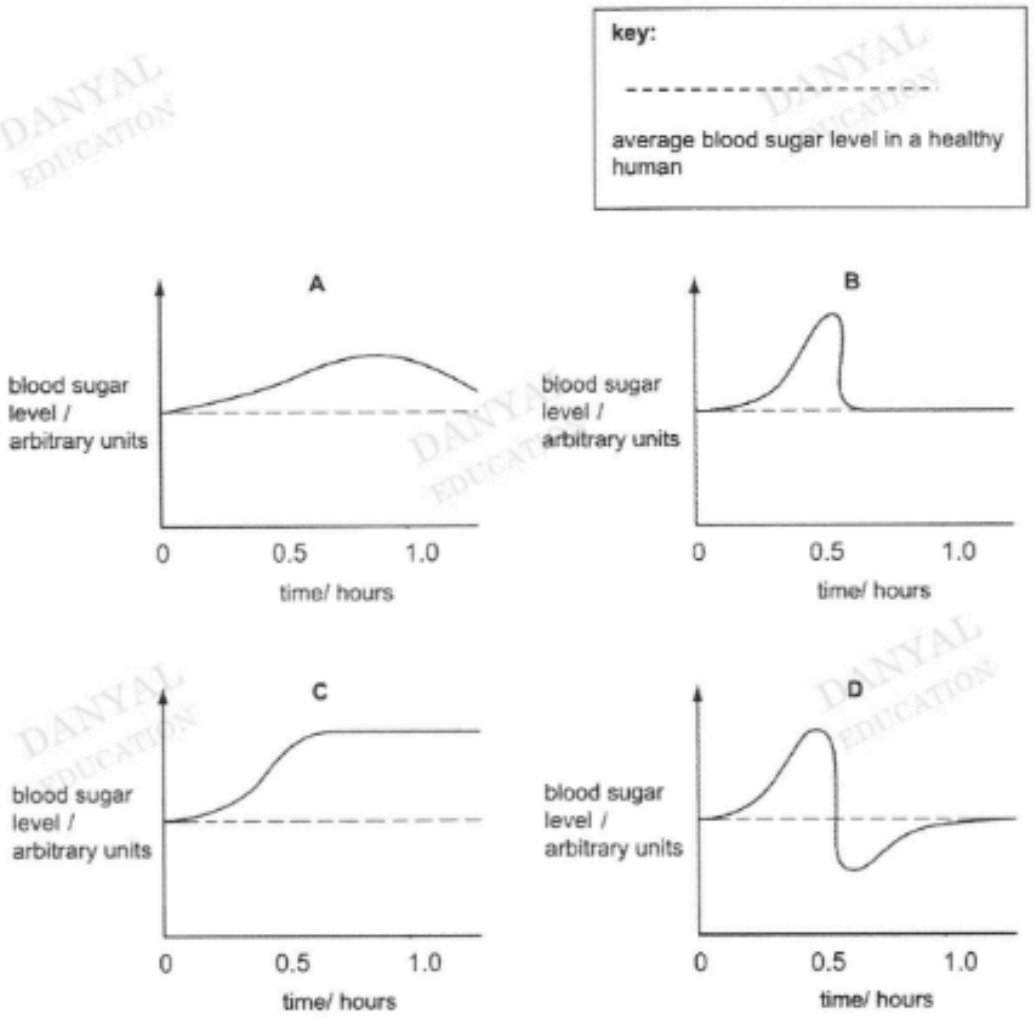
B ciliary muscle relax, radial muscle contract, lens become flatter

C circular muscles contract, radial muscles relax, pupil constricts

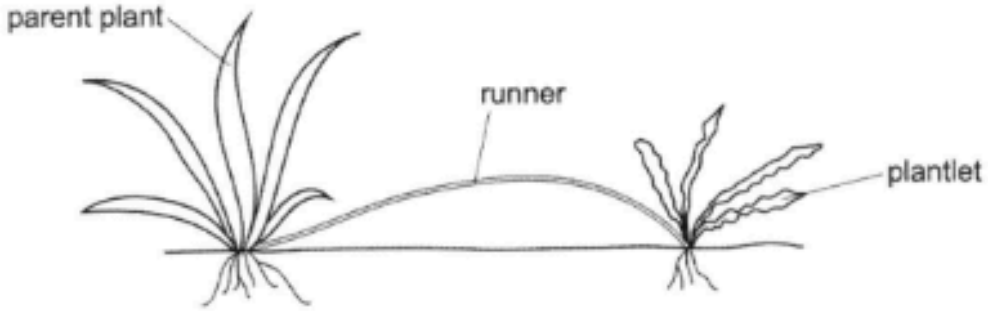
D circular muscles relax, radial muscles contract, pupil dilates

34 The graphs show changes in the amount of sugar in the blood after a person has eaten a sugary meal at time 0.

Which graph shows changes in the amount of blood sugar of a person with untreated diabetes?



35 The diagram shows a plant reproducing asexually by growing a plantlet from a runner. The leaves of the plantlet appear different to the leaves of the parent plant.



Which statement explains the difference in the leaf shape of the plantlet?

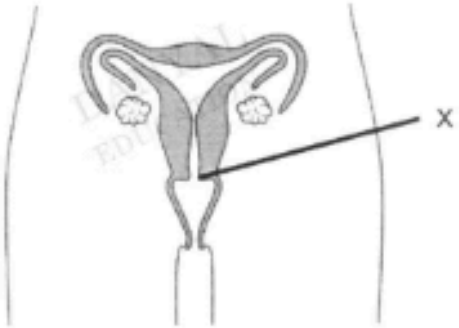
A The plantlet inherited the genes from the parent plant.

B The plantlet showed a recessive phenotype.

C The plantlet was exposed to a chemical mutagen.

D The plantlet was produced by the fusion of gametes.

36 The diagram shows a human female's reproductive organs.



What is structure X?

A cervix

B ovary

C oviduct

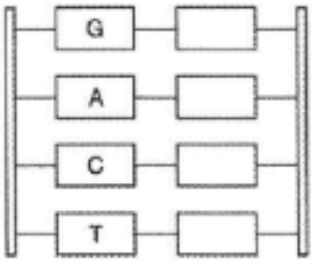
D ovule

37 A man has three daughters.

What is the chance of the fourth child being a daughter?

A 25% **B** 50% **C** 75% **D** 100%

38 The diagram shows a section of DNA, with four bases identified on one strand.



Which shows the correct sequence of bases, from top to bottom?

A AGTC

B CTGA

C GATC

D TCAG

39 It is often suggested that the most energy efficient method to sustain the human population is for humans to consume more cereals and grains rather than fish and meat.

Why might this be the case?

A A greater proportion of energy in the ecosystem would be available to humans.

B A shorter food chain would be less efficient.

C Cereals and grains are digested a lot more efficiently.

D Crop plants would provide more suitable nutrients for humans.

40 Which statements describe why conservation is necessary?

1. to ensure that our food supplies will not run out in future
2. to maintain the biodiversity on Earth
3. to increase the amount of carbon dioxide in the air
4. to prevent disruption of natural cycles such as the water cycle

A 1 and 3 only

B 2 and 4 only

C 1, 2 and 3 only

D 1, 2 and 4 only

Section A [45 marks]

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

1 Choose from the following oxides to answer the questions below.

Al_2O_3	CaO	CO	CuO
SO_2	SO_3	NO	SiO_2

Each oxide can be used once, more than once or not at all.

Identify an oxide which

(a) is formed during the incomplete combustion of propene. ..... [1]

(b) reacts with sulfuric acid to give a blue solution. ..... [1]

(c) removes acidic impurities in the extraction of iron. ..... [1]

(d) can react with either sodium hydroxide or hydrochloric acid. ..... [1]

(e) is used as catalyst for cracking of large alkanes. ..... [1]

2 In Fig. 2.1, **A** to **F** represent the particles of different substances at room temperature.

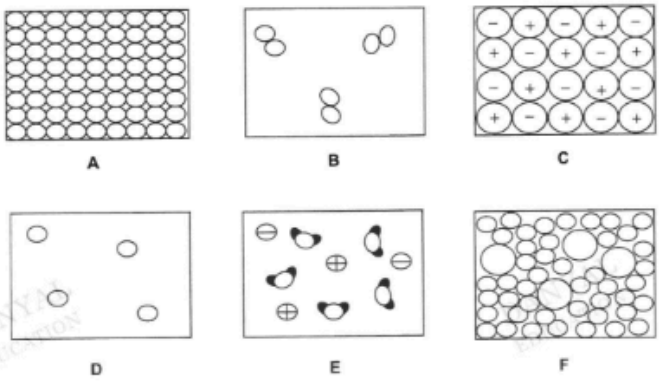


Fig. 2.1

Write the letter of the diagram which best represents each of the following substances below. Each letter may be used once, more than once, or not at all.

(a) solid sodium chloride ..... [1]

(b) brass ..... [1]

(c) magnesium ribbon ..... [1]

(d) neon gas ..... [1]

3 Carbon disulfide, CS_2, is a simple covalent compound used in manufacturing polymers and fibres.

(a) Draw a 'dot and cross' diagram to show the bonding in carbon disulfide.
Show the outer shell electrons only.

[2]

(b) Using your understanding of bonding and structure, which of these statements would you predict to be true and which would you predict to be false?

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

	true	false
Carbon disulfide has a low boiling point.		
Carbon disulfide has good electrical conductivity when molten.		
Carbon disulfide is very soluble in water.		
Carbon disulfide is a crystalline solid at room temperature.		

[2]

4 Fluorine, chlorine and bromine are elements in Group VII of the Periodic Table.
Group VII elements are also known as halogens.

(a) Use your knowledge on electronic structures to explain why chlorine is placed below fluorine in the Periodic Table.

.....

.....

..... [2]

(b) Table 4.1 shows different halogens react with hydrogen under different conditions.

Table 4.1

element	observations for reaction with hydrogen
fluorine	explosively
chlorine	vigorous
bromine	-
iodine	little reaction

Suggest the observations for the reaction of bromine with hydrogen. Explain your answer.

.....

.....

..... [2]

5 (a) Fig. 5.1 shows three beakers containing different metal solutions.
Tin metal was dipped into each metal solutions.

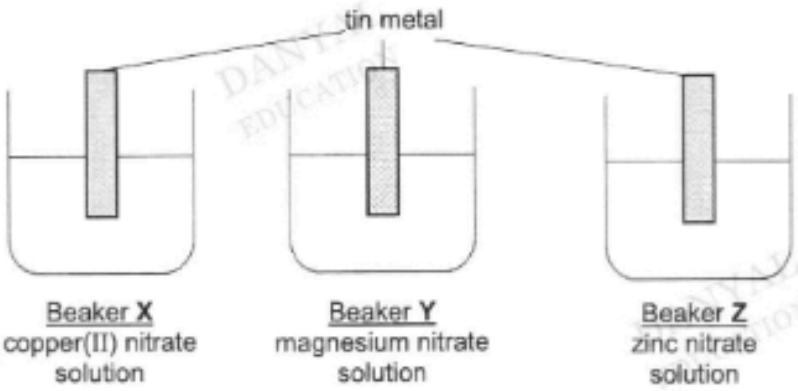


Fig. 5.1

A few minutes later, it was observed that only Beaker **X** showed a change.

(i) What can you conclude about the relative positions of tin, copper, magnesium and zinc in the metal reactivity series?

.....

..... [1]

(ii) State the change observed in Beaker **X**. Explain.

.....

.....

..... [2]

(b) Two separate blocks of iron were each coated with a layer of metal as shown in Fig. 5.2. One was coated with copper and the other was coated with zinc. A small portion of the layer was scratched off.

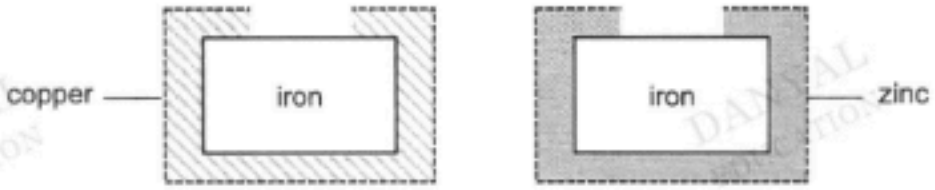


Fig. 5.2

It was found that only the iron block coated with copper rusted while the one coated with zinc did not rust. Explain the difference in the observations.

.....

.....

.....

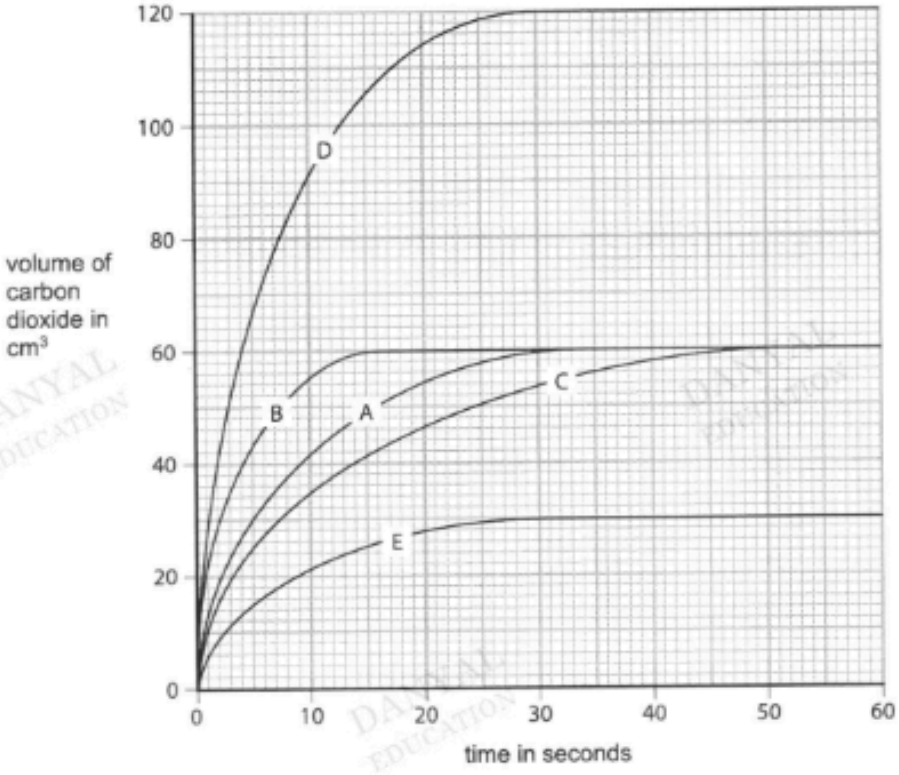
..... [3]

(c) State one disadvantage of extracting metals from their ores instead of recycling them.

.....

..... [1]

6 The graph shows the volumes of carbon dioxide given off when lumps of magnesium carbonate were added to sulfuric acid in five different experiments, **A** to **E**.



Curve **A** shows the volume of carbon dioxide collected when 5.0 g of magnesium carbonate lumps were added to an excess of 1.0 mol/dm³ sulfuric acid at room temperature and pressure. The experiment was then repeated four more times, each time with a different condition modified.

(a) Calculate the average speed for experiment **A** in cm³/s for the first 20s.

average speed: ..... cm³/s [1]

(b) The experiment is repeated using 5 g of powdered magnesium carbonate. Identify the curve, **B** to **E**, that corresponds to the modification and explain your choice in terms of collisions between reacting particles.

.....

.....

.....

..... [3]

(c) State the condition for the experiment that will produce curve **C**.

.....

..... [1]

7 The neutralisation reaction between sulfuric acid and sodium hydroxide is represented by the chemical equation below.

$$H_2SO_4\ (aq) + 2NaOH\ (aq) \rightarrow Na_2SO_4\ (aq) + 2H_2O\ (l)$$

In the experimental setup, 25.0 cm^3 of 0.1 mol/dm^3 sulfuric acid was used to neutralise 20.0 cm^3 of sodium hydroxide exactly.

(a) Calculate, in mol/dm^3, the concentration of sodium hydroxide used in the reaction.

concentration: ..... mol/dm^3 [3]

(b) Determine the mass of sodium sulfate produced.

mass: ..... g [2]

8 Fig. 8.1 below describes some of the properties and reactions of several substances.

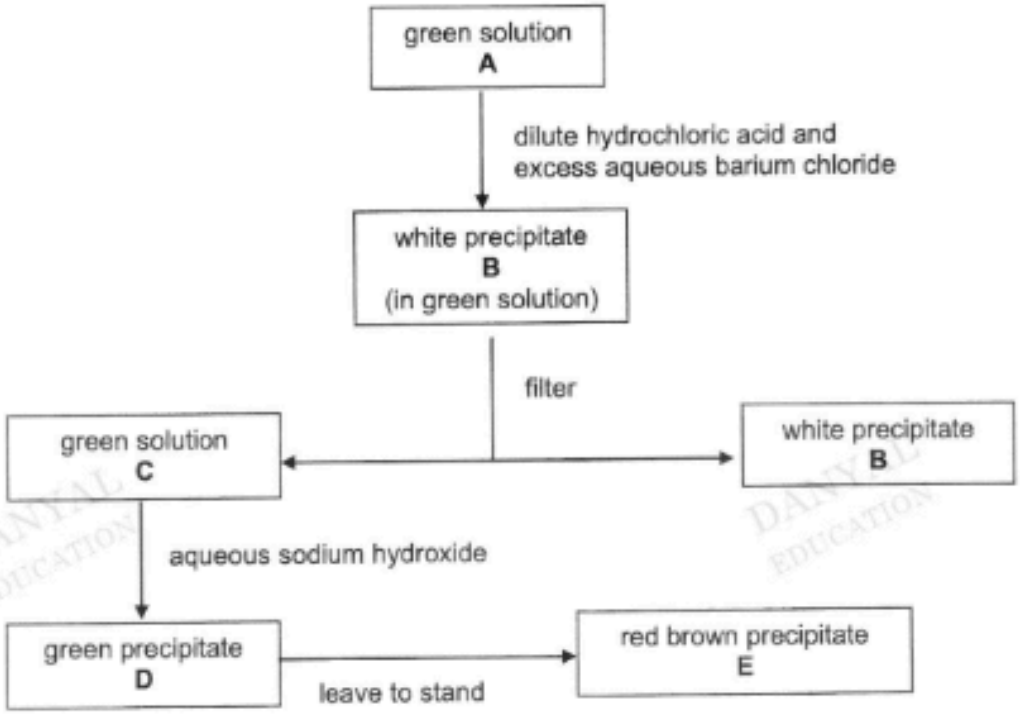


Fig. 8.1

(a) Suggest the identity of the following substances:

A .....

B .....

C .....

D .....

E ..... [5]

(b) Write a chemical equation for the formation of green precipitate **D**.

..... [2]

9 (a) Fig. 9.1 shows an addition polymer **X**.

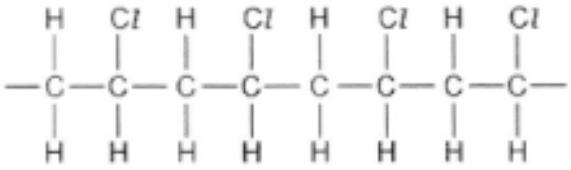


Fig. 9.1

(i) Draw the structure of the monomer from which polymer **X** is formed.

[1]

(ii) Polymer **X** is non-biodegradable. Explain the term 'non-biodegradable'.

.....

..... [1]

(b) Linalool, ($C_{10}H_{17}OH$) an alcohol, is an essential oil used in perfume making. It gives a sweet, lavender-like smell.

The structural formula of linalool is shown in Fig. 9.2.

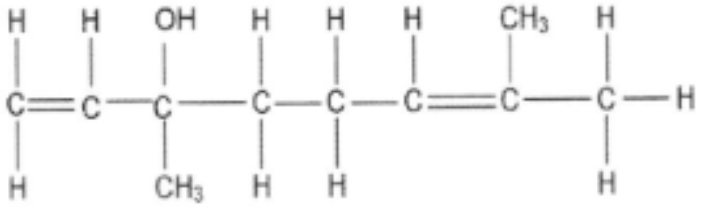


Fig. 9.2

(i) Describe what would be observed when aqueous bromine is added to linalool.

.....

..... [1]

(ii) Draw the product formed when linalool reacts with excess aqueous bromine.

Section B [20 marks]

Answer **any two** questions in this section.

Write your answers in the spaces provided.

10 **(a)** State **one** physical property of acids.

..... [1]

(b) Briefly describe **three** characteristic reactions of acids.

.....

.....

..... [3]

(c) **(i)** Describe a way to prepare a pure sample of lead(II) chloride, $PbCl_2$, from lead(II) carbonate, $PbCO_3$.

Use the following information to help you.

- both lead(II) chloride and lead(II) carbonate are insoluble in water.
- all nitrates are soluble in water.

.....

.....

.....

.....

..... [4]

(ii) Write a balanced equation for the reaction to produce $PbCl_2$ in **(c)** **(i)**. State symbols are **not** required.

..... [2]

11 The chloroalkanes are a homologous series of organic compounds. Some properties of the chloroalkanes are given in Table 11.1 below.

name of chloroalkane	chemical formula	boiling point/°C
chloromethane	CH_3Cl	−24
chloroethane	C_2H_5Cl	8
chloropropane	C_3H_7Cl	
chlorobutane	C_4H_9Cl	78
chloropentane	$C_5H_{11}Cl$	110

Table 11.1

(a) State the general formula of the chloroalkanes.

.....[1]

(b) **(i)** State the reagent(s) and condition(s) required to produce chloromethane from methane.

.....[2]

(ii) Name the type of reaction described in **(b) (i)**.

.....[1]

(c) **(i)** State the product(s) formed when alkanes undergo complete combustion.

.....[1]

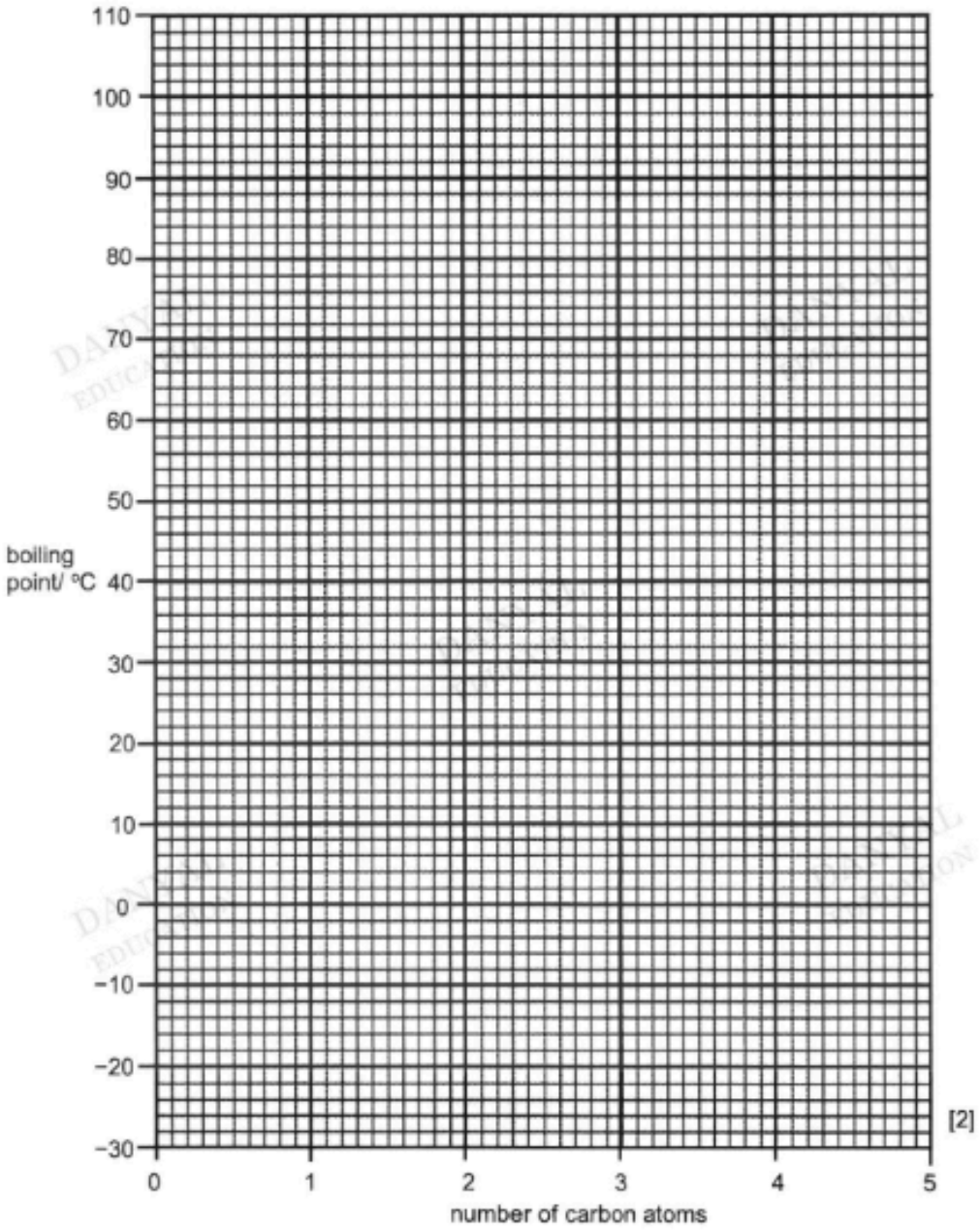
(ii) Would you expect the same product(s) as in **(c) (i)** to be formed when chloroalkanes undergo complete combustion? Explain your answer.

.....

.....[2]

(d) (i) In the grid below, plot the boiling point against the number of carbon atoms for the chloroalkanes, marking each point with a cross (x).

Draw a line of best fit taking into account all your plotted points.



[2]

(ii) Use your graph to predict the boiling point of chloropropane.

..... [1]

12 Fig 12.1 below shows how the carbon monoxide concentration in the air in a city changes across different times in the same day.

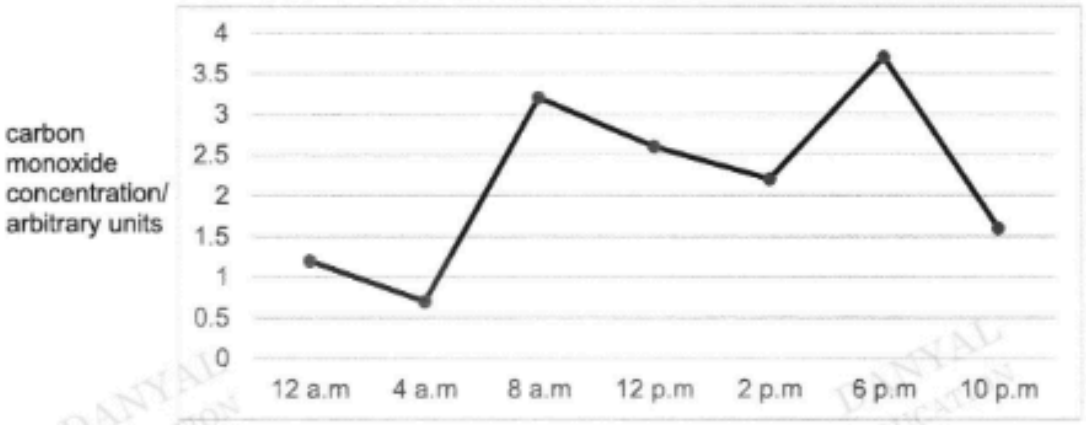


Fig 12.1

(a) **(i)** State the time of the day at which the carbon monoxide concentration in air is the lowest and suggest a reason for this observation.

.....

.....

..... [1]

(ii) Explain why carbon monoxide is harmful to human health.

.....

..... [1]

(iii) Besides carbon monoxide, name another common air pollutant and state **one** source of its production.

.....

.....

..... [2]

The carbon monoxide concentration in a sample of polluted air can be determined by passing the polluted air over solid iodine pentoxide, I_2O_5.

The carbon monoxide present will react with iodine pentoxide according to the following equation:

$$I_2O_5\ (s) + 5CO\ (g) \rightarrow I_2\ (s) + 5CO_2\ (g)$$

(b) With reference to the equation given above, state and explain, in terms of oxidation state, the substance that has been reduced.

.....

.....

..... [2]

In an experiment, 1500 cm^3 of polluted air, which contains carbon monoxide, was passed over excess iodine pentoxide. It was found that 0.046 g of iodine pentoxide was required to react with all the carbon monoxide present in the sample of polluted air.

(c) **(i)** Calculate the number of moles of iodine pentoxide present in 0.046 g.

number of moles of iodine pentoxide = ... mol [1]

(ii) Using your answer to **(c)** **(i)**, calculate the volume of carbon monoxide, measured at room temperature and pressure, which reacts with 0.046 g of iodine pentoxide.

volume of carbon monoxide = ... cm^3 [2]

(ii) Hence, calculate the percentage of carbon monoxide in the sample of polluted air.

percentage of carbon monoxide = ... % [1]

-END OF PAPER-

ANSWER SHEET

Paper 1

1	D	6	B	11	D	16	C
2	A	7	D	12	A	17	C
3	C	8	B	13	A	18	D
4	B	9	B	14	C	19	B
5	D	10	D	15	B	20	B

Paper 3

Section A

1	a		CO	[1]
	b		CuO	[1]
	c		CaO	[1]
	d		Al_2O_3	[1]
	e		Al_2O_3	[1]

2	a		C	[1]
	b		F	[1]
	c		A	[1]
	d		D	[1]

3	a		 C: 8 outer electrons (1m) O: 8 outer electrons (1m)	[2]

	b			true	false
			Carbon disulfide has a low boiling point.	√	
			Carbon disulfide has good electrical conductivity when molten.		√
			Carbon disulfide is very soluble in water.		√
			Carbon disulfide is a crystalline solid at room temperature.		√

[2]

			4 \ : 2; 3 \ : 1: 2 \ : 1; 1 \ : D	

4	a		The electronic structures of chlorine and fluorine are 2.8.7 and 2.7 respectively. [1] Having one more electron shell [1] in an atom of chlorine. it is placed one period below fluorine.	[2]
	b		Bromine is less reactive than chlorine [1] would probably react in slowly with hydrogen. [1]	[2]

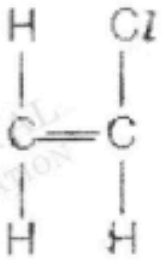
5	a	i	Tin lies below magnesium and zinc metal but above copper metal in the reactivity series. (accept: reactivity in increasing/decreasing order)	[1]
	a	ii	Blue solution turns colourless OR Reddish-brown deposit seen. ['] Tin is more reactive than copper and displaces copper from copper(II) nitrate solution. [1]	[2]
	b		When the layers of metal are scratched, the iron is exposed to corrosion by oxygen and moisture in air. [1] Zinc is more reactive than iron and will corrode in place of iron. Hence, the iron block will not rust. ['] Copper is less reactive than iron and will not corrode in place of iron. Hence, the iron block will rust. [1]	[3]
	c		Extracting metals is more expensive and uses more energy than recycling. Extracting metals from their ores uses up our earth's finite resources of metals. Extracting metals from their ores uses up the limited resource of fossil fuels. Any one.	[1]

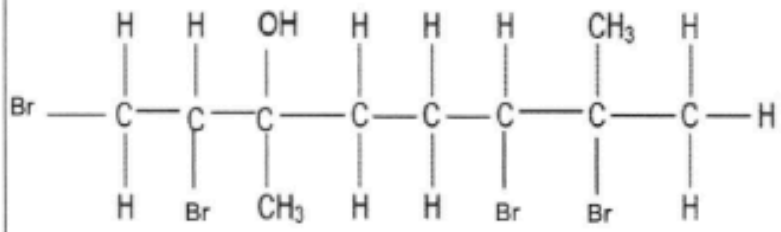
6	a		Vol of CO_2 produced = 54 cm^3 Average speed = 54 / 20 = 2.70cm^3/s	[1]
	b		B. [1] For powedered form, the surface area increases which leads to higher frequency of effective collisions between particles.[1] Hence the rate of reaction increases which is shown by steeper gradient. [1] *To give mark for explanation even if graph used is wrong*	[3]

	c		Lower temperature/ lower concentration of acid	[1]

7	a		H_2SO_4 (aq) + 2NaOH (aq) → Na_2SO_4 (aq) + $2H_2O$ (l) no. of mol of H_2SO_4 = 0.1 x 25.0/1000 = 0.0025 mol [1] no. of mol of NaOH = 2 x 0.0025 mol = 0.005 mol [1] concentration of NaOH in mol/dm^3 = 0.005/(20.0 + 1000) = 0.25 mol/dm^3 [1]	[3]
	b		no. of mol of Na_2SO_4 = 0.0025 mol [1] mass of Na_2SO_4 = 0.0025 x (46 + 32 +64) = 0.355 g [1]	[2]

8	a		**A** iron(II) sulfate **B** barium sulfate **C** Iron(II) chloride **D** iron(II) hydroxide **E** iron (III) hydroxide	[5]
	b		$FeCl_2$ + 2NaOH → 2NaCl + $Fe(OH)_2$	[2]

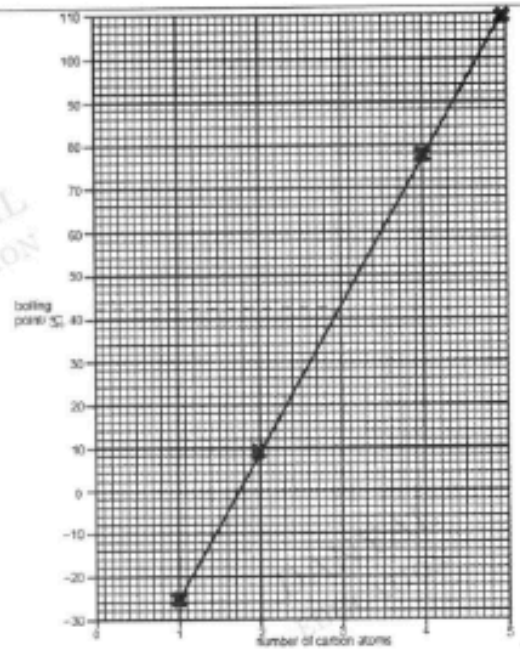
9	a	i		[1]
	a	ii	It does not decompose easily by bacteria/ or other living organisms./ Cannot be broken down naturally by bacteria.	[1]
	b	i	Reddish-brown aqueous bromine will be decolourised. *Reject: if student merely writes the final colour.*	[1]

	b	ii		[1]

Section B

10	a		Sour taste/turn blue litmus red/pH less than 7	[1]
	b		Reactive metals react with acids to form salts and hydrogen gas. [1] Metal carbonates react with acids to form salts, carbon dioxide and water. [1] Bases react with acids to form salt and water [1] accept if students give metal oxides or metal hydroxides instead of bases	[3]
	c		• Add **excess $PbCO_3$** to warm dilute nitric acid [1] • Filter the mixture, **collect the filtrate** (aqueous $Pb(NO_3)_2$) [1] • Add **aqueous sodium chloride/potassium chloride/hydrochloric acid** (any soluble chloride) to the filtrate [1] • Filter the mixture, **collect the residue** [1] • Wash the residue with distilled water and tap dry.	[4]
	d		Magnesium and sulfuric acid react to form magnesium sulfate & hydrogen. $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$ 1M – correct formulae 1M – balancing Metal must be above H in the Reactivity Series (reject if students use Cu or Ag)	[2]

11	a		$C_nH_{2n+1}Cl$	[1]
	b	i	**chlorine gas/Cl_2** [1] presence of **UV light/sunlight** [1]	[2]
		ii	**substitution** reaction	[1]

	c	i	carbon dioxide, water both products correct for 1M	[1]
		ii	No [1] Chloroalkanes **contain chlorine atoms in addition to carbon and hydrogen**. (Thus, chlorine-containing products will be formed as well) [1]	[1]
	d	i	 All 4 points plotted correctly – 1M Straight line of best fit through all 4 points – 1M	[2]
		ii	42°C (accept 40°C – 44°C)	[1]

12	a	i	4 a.m. There is the **least amount of traffic** on the roads at 4 a.m. Both must be correct for 1M.	[1]
		ii	It prevents **red blood cells from binding to and transporting oxygen**, leading to **breathlessness, suffocation and death**. Students must mention: • Mode of action of CO At least one effect (either breathlessness, suffocation or death)	[1]
		iii	Sulfur dioxide OR nitrogen oxides [1]	[2]

			Sulfur dioxide: combustion of fossil fuels OR volcanic activity [1] Nitrogen oxides: reaction of nitrogen and oxygen in the air due to high temperatures, in car engines OR due to lightning activity.	
	b		**Iodine pentoxide** is reduced [1] as it **lost oxygen** to form iodine. [1]	**[2]**
	c	i	number of moles of $I_2O_5 = \frac{mass}{M_r} = \frac{0.046}{2 \times 127 + 5 \times 16}$ $= 0.000138$ mol (1.38×10^{-4} mol) – 3 s.f.	**[1]**
		ii	Mole ratio: I_2O_5 : CO = 1:5 ∴ number of moles of CO = $1.38 \times 10^{-4} \times 5 = 6.9 \times 10^{-4}$ mol [1] Volume of CO = $6.9 \times 10^{-4} \times 24000$ = **16.56** cm^3 [1] Accept if students round off to 3 s.f. = 16.6 cm^3	**[2]**
		iii	% of CO in the sample = $\frac{16.56}{1500} \times 100\%$ = **1.10**% - 3 s.f. [1] Note: if students used 16.6 cm^3, same answer of 1.10% should be obtained.	**[1]**