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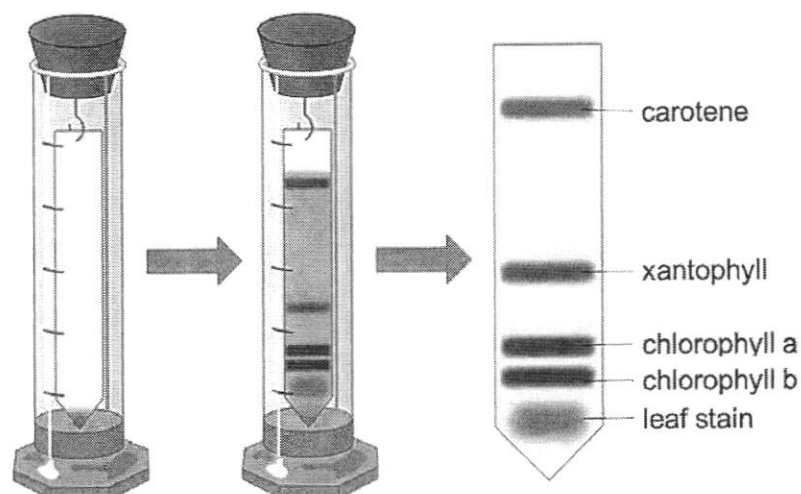


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- 1 Chromatography is used to separate the pigments present in a leaf stain as shown in the diagram.



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.

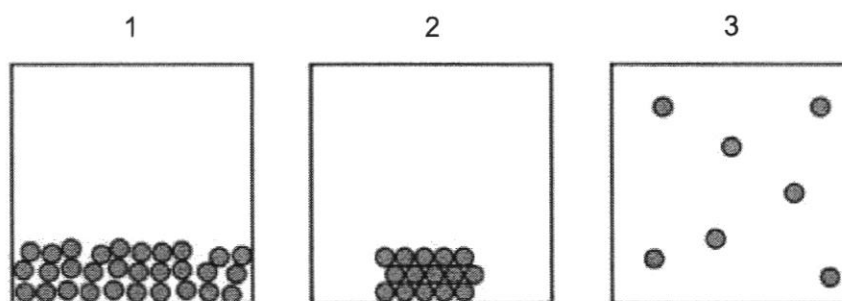
	test	result
1	Add aqueous sodium hydroxide	Light blue precipitate formed, does not dissolve in excess aqueous sodium hydroxide.
2	Add dilute nitric acid followed by aqueous silver nitrate	White precipitate is formed.

What is the salt?

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

3

- 3 The diagrams show some particles in a container.

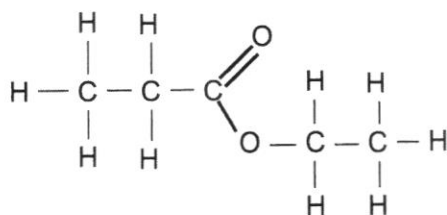


Which diagrams show the process of evaporation?

- 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.

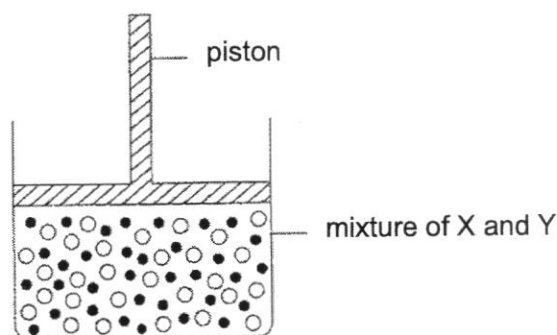
4

- 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.

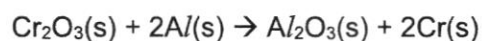


Which action will lead to an increase in the speed of reaction?

- 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

5

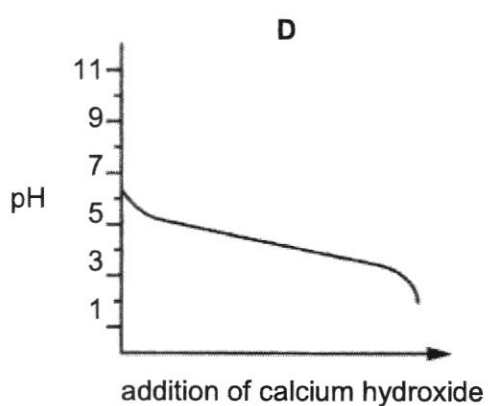
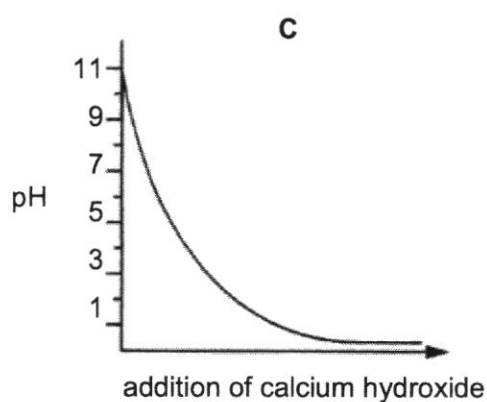
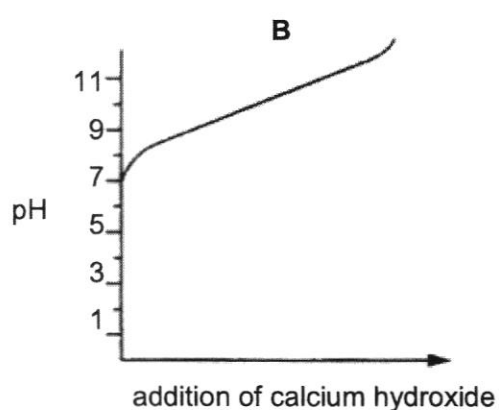
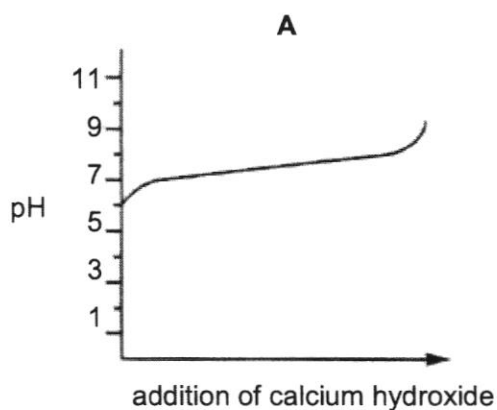
- 9 Which substance in the equation is reduced?



- 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?



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

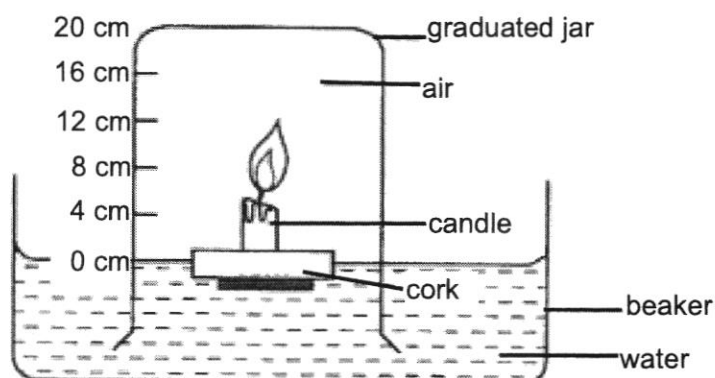
15 Which is **not** a reason for recycling copper?

- 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?

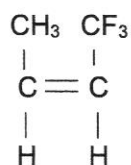
- A** to provide a fuel for aircraft engines
- B** to provide a material for road surfaces
- C** to provide lubricating oils
- D** to provide a feedstock for the petrochemical industry

19 Alkanes are a homologous series of compounds.

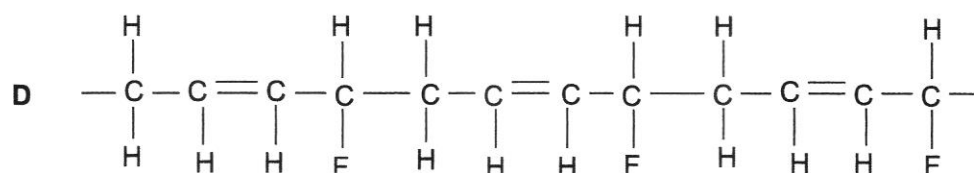
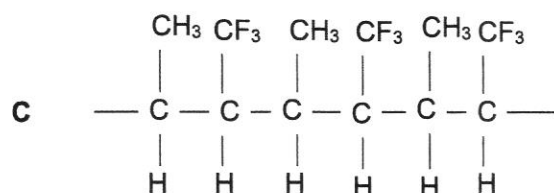
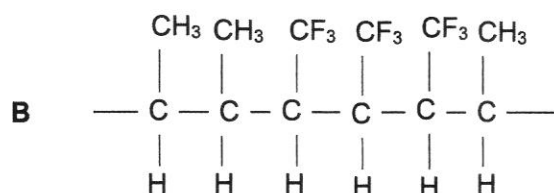
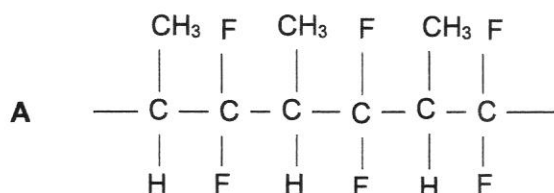
How do the physical properties of alkanes change as the size of molecules increases?

- 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?



End of Paper

2

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.

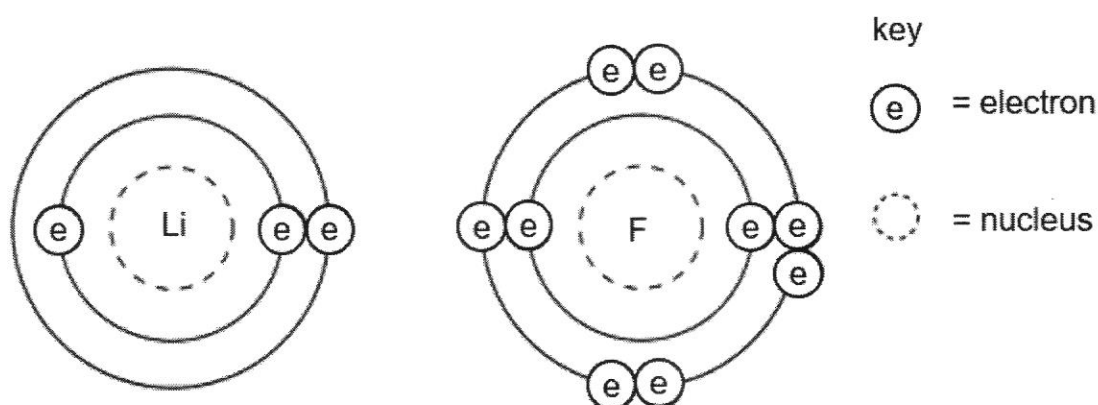


Fig. 2.1

(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.



- (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**.

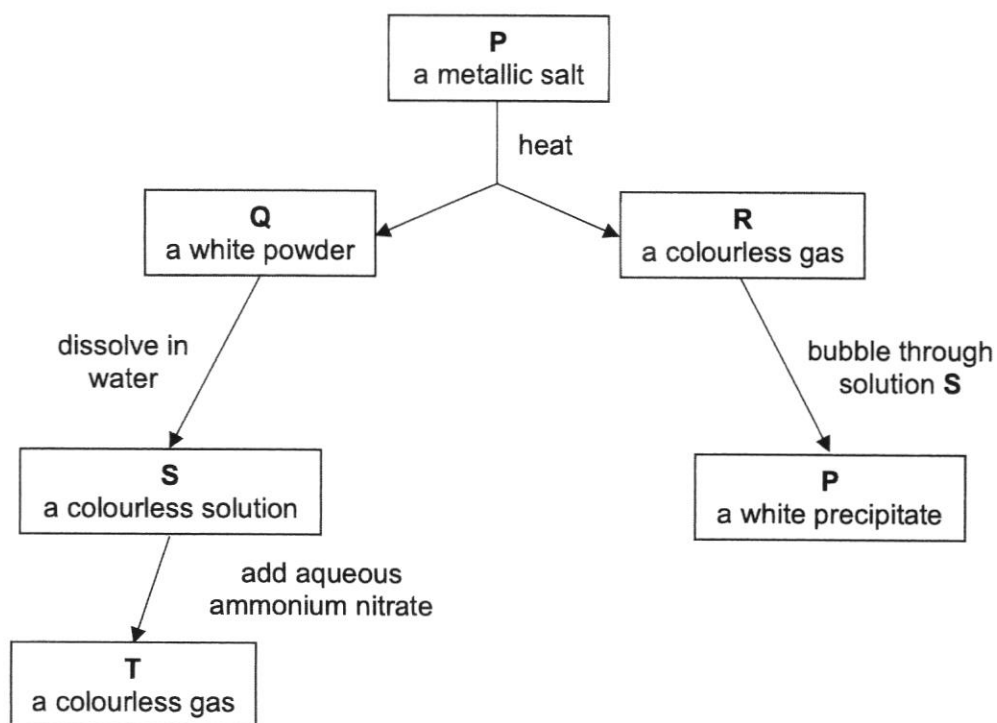


Fig. 4.1

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

P [1]

Q [1]

R [1]

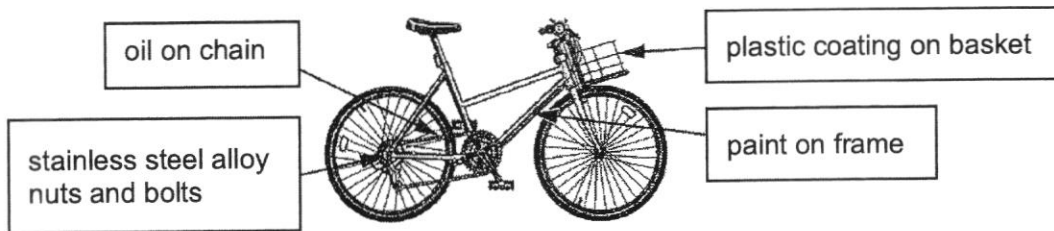
S [1]

- (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.

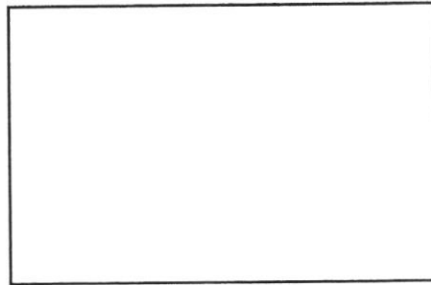


- (a) Give the meaning of the term *alloy*.

.....

..... [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.

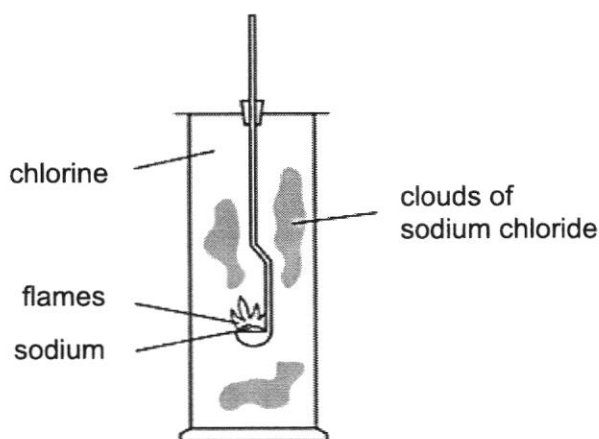


Fig. 6.1

- (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
$^{35}_{17}\text{Cl}$	17		
$^{79}_{35}\text{Br}^{-}$		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/ $^{\circ}\text{C}$
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.

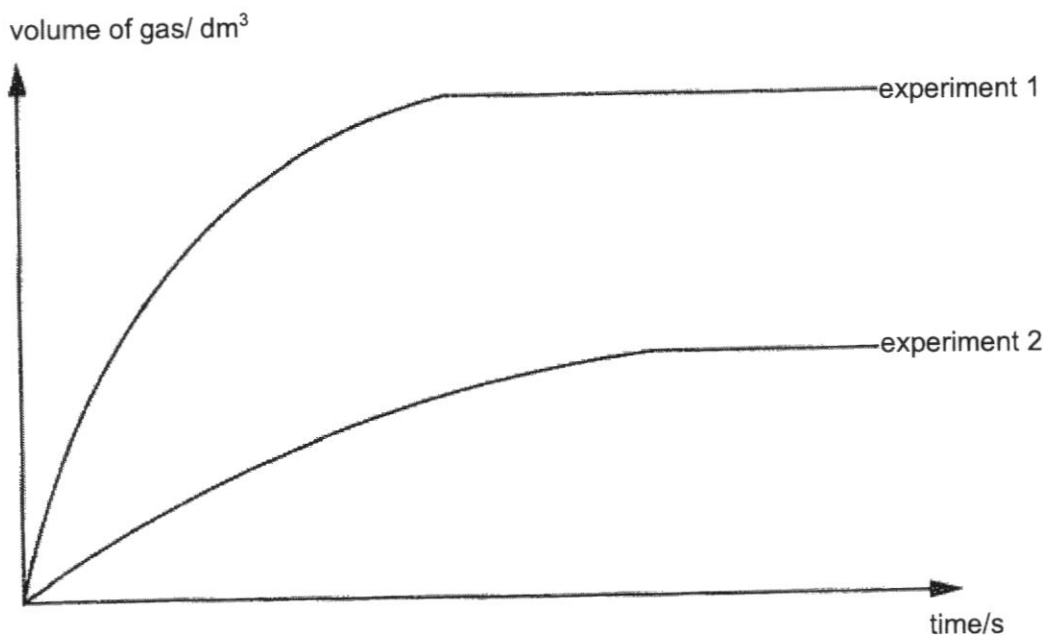


Fig. 9.2

[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 cm³ of a solution contains 80 g of hydrochloric acid, HCl.

- (i) Calculate the concentration of the solution in mol/dm³.

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

concentration = mol/dm³ [2]

- (ii) If 100 cm³ of the solution in part (e)(i) is added to a conical flask, and water is added to make up to 1 dm³, what will be the new concentration of the solution in mol/dm³?

concentration = mol/dm³ [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

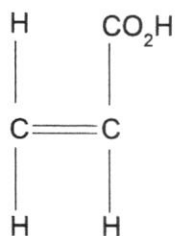


Fig. 10.1

- (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



**Secondary 4E5N
Science (Chemistry)
Preliminary Examination 2022**

Mark Scheme

Paper 1 (20 marks)

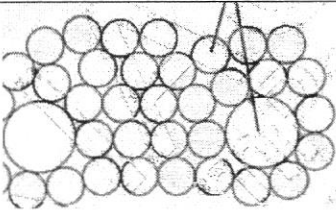
1	A	11	C
2	B	12	B
3	B	13	B
4	D	14	C
5	C	15	D
6	D	16	C
7	A	17	A
8	B	18	D
9	A	19	B
10	A	20	C

A – 6, B – 5, C – 5, D – 4

Paper 3

Section A (45 marks)

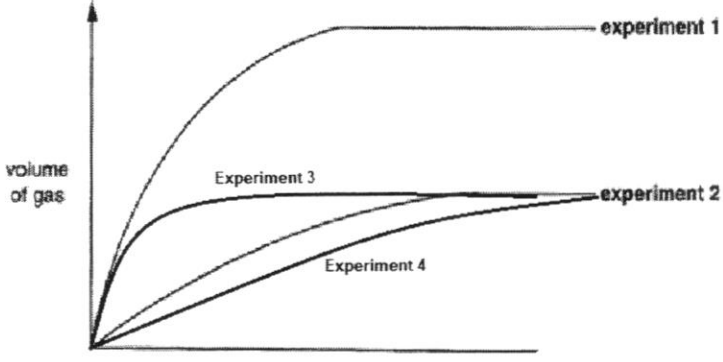
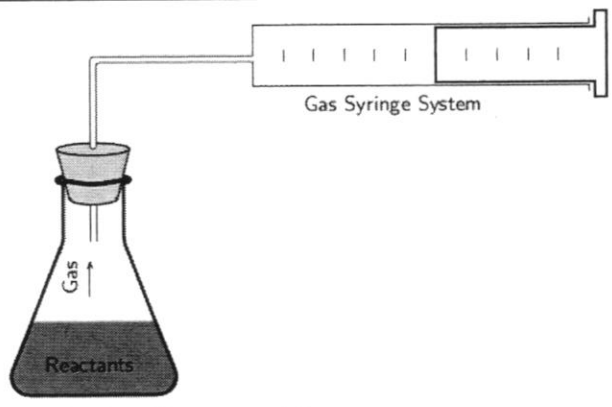
1	(a) Helium (b) Carbon monoxide (c) Sodium (d) Carbon monoxide (e) Sulfuric acid	1 1 1 1 1
Total: 5		
2(a)	Correct charges and number of ions = 1 Correct number of dot and cross = 1	2
(b)(i)	Lithium fluoride: - the ions are held in fixed position. - There are <u>no mobile ions</u> to conduct electricity. Solid Q - exist as molecules there are <u>no free mobile electrons or charged ions</u> to conduct electricity.	1 1 1
(b)(ii)	In molten lithium fluoride, the <u>ions are able slide over one another / move about freely</u> 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. <i>Alternative:</i> Temperature of the surrounding decreases.	1
(b)	Mr of hydrogen peroxide = $2(1) + 2(16) = 34$	1
(c)	Mole of hydrogen peroxide = $68/34 = 2 \text{ mol}$ Mole ratio of $\text{H}_2\text{O}_2 : \text{H}_2\text{O} = 1:1$ Mass of water produced = $2 \times 18 = 36 \text{ g}$	1 1
(d)	Mole ratio of $\text{H}_2\text{O}_2 : \text{O}_2 = 2:1$ Volume of oxygen produced = $1 \times 24 = 24 \text{ dm}^3$	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)	$\text{Ca(OH)}_2 + 2\text{NH}_4\text{NO}_3 \rightarrow \text{Ca(NO}_3)_2 + 2\text{NH}_3 + 2\text{H}_2\text{O}$ Correct formula – 1 Correct balancing – 1	2
		Total: 6
5(a)	Alloys are <u>mixture of metals</u> with another element.	1
(b)	 Drawing -1 mark Alloys have atoms of <u>different sizes</u> , which <u>disrupt the regular arrangement of atoms</u> in pure metal. Hence <u>preventing atoms from sliding over each other</u> , when force is applied.	1 1 1
(c)	They <u>prevent exposure of iron to water and oxygen</u> , hence reducing rusting.	1
		Total: 5

6(a)(i)	Sodium <u>loses</u> an <u>electron</u> .	1
(a)(ii)	Potassium is <u>more reactive</u> than sodium. The reaction with potassium would be <u>explosive</u> .	1 1
(b)(i)	Neutralisation	1
(b)(ii)	acid – hydrochloric acid alkali – sodium hydroxide	1 1
(b)(iii)	Add <u>universal indicator</u> to the solution and it will remain <u>green</u> / Use <u>blue and red litmus paper</u> and <u>no visible change</u> observed	1- test 1- observation
(b)(iv)	<u>Heat</u> the solution to <u>dryness</u> 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. <u>Measure time taken for the reaction to end</u> OR <u>measure volume gas produced in fixed period of time</u> 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 4 th most volume of gas. OR M finished the reaction the fourth.	3 (Any 3)
		Total: 7

Section B (10 marks)

8(a)				3	
		number of electrons	number of neutrons		number of protons
	$^{35}_{17}\text{Cl}$	17	18		17
	$^{79}_{35}\text{Br}^-$	36	44		35
	1-2 correct [1m]; 3 correct [2 m]; 4 correct [3m]				
(b)(i)	liquid			1	
(b)(ii)	Y_2 is <u>iodine</u>			1	
	<u>unreactive/least reactive</u> as it is <u>not able to displace any</u> of the halogen			1	
	X_2 is <u>chlorine</u> as			1	
	the <u>most reactive</u> as it is <u>able to displace all</u> the halogen.			1	
(b)(iii)	$\text{Cl}_2 + 2\text{Br}^- \rightarrow \text{Br}_2 + 2\text{Cl}^-$ $\text{Cl}_2 + 2\text{I}^- \rightarrow \text{I}_2 + 2\text{Cl}^-$ $\text{Br}_2 + 2\text{I}^- \rightarrow \text{I}_2 + 2\text{Br}^-$		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 <u>number of particles per unit volume increases</u> . Resulting in <u>higher frequency of effective collisions</u> 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 – $80 / 36.5 = 2.1918 \text{ mol}$ Concentration = $2.1918 \text{ mol} / 0.5 \text{ dm}^3 = 4.38 \text{ mol/dm}^3$	1 1
(ii)	ECF from part (i) Moles in $100 \text{ cm}^3 = 4.38 \times (100/1000) = 0.438 \text{ mol}$ 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)	$ \begin{array}{ccccccc} & \text{H} & & \text{H} & & \text{H} & \\ & & & & & & \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - \text{O} - \text{H} \\ & & & & & & \\ & \text{H} & & \text{H} & & \text{H} & \end{array} $	1
(ii)	Purple potassium manganate(VII) solution turned <u>colourless/</u> <u>decolourised.</u>	1
(iii)	$\text{C}_2\text{H}_5\text{COOH}$ / $\text{C}_3\text{H}_6\text{O}_2$ H_2O	1 1
(iv)	Oxidised Propanol gained an oxygen.	1
(c)(i)	$\text{C}=\text{C}$	1
(ii)	effervescence/bubbles observed.	1
		Total: 10