

Name: Register no: Class:



NGEE ANN SECONDARY SCHOOL



PRELIMINARY EXAMINATION

CHEMISTRY

6092/02

Paper 2

26 August 2026

1 h 45 min

Additional Materials: NIL

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

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

Section A

Answer **all** questions.

Write your answers in the spaces provided.

Section B

Answer **one** questions.

Write your answers in the spaces provided.

The number of marks is given in brackets [] at the end of each question or part question.

A copy of the Periodic Table is printed on page 26.

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

For Examiner's Use

Section	Marks
A	/50
B	/30
Total	/80

Checked by student: _____ Date: _____

This document consists of **25** printed pages and **1** blank pages.

Section A

Answer **all** questions.

- 1 This question is about the elements in Group 1 and Group 17 of the Periodic Table.

- (a) Elements in Group 1 and Group 17 show certain trends down the group.

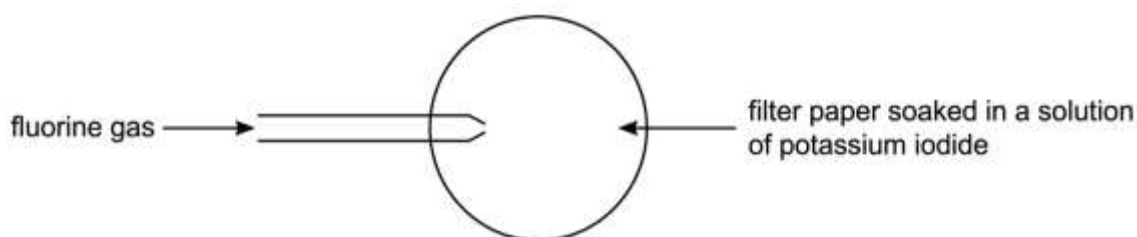
Which trends are only true for Group 1, which trends are only true for Group 17 and which trends are true for both?

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

trend down the group	only true for Group 1	only true for Group 17	true for both
The number of electron shells increases.			
The density increases.			
The reactivity increases.			
The colour intensity of the elements increases.			

[2]

- (b) A jet of fluorine gas is aimed at a filter paper soaked in a solution of potassium iodide. The solution on the filter paper quickly turns brown.



Explain why the solution turns brown.

.....

.....

.....[2]

[Total: 4]

- 2 The most common isotope of hydrogen is ${}^1_1\text{H}$.

Hydrogen has another isotope called deuterium which has the symbol ${}^2_1\text{H}$.
This isotope is given the symbol D.

- (a) (i) Explain, in terms of atomic structure, why the atoms of ${}^1_1\text{H}$ and ${}^2_1\text{H}$ are isotopes.

.....
.....
..... [1]

- (ii) Explain why the two isotopes of hydrogen have identical chemical properties.

.....
..... [1]

- (b) In Experiment 1, concentrated hydrochloric acid, $\text{HCl}(\text{aq})$ is placed at one end of a tube, and concentrated ammonia solution, $\text{NH}_3(\text{aq})$ is placed at the other end.

Gaseous HCl and NH_3 diffuse from each end. When the gases meet, they react and a white ring of solid ammonium chloride, NH_4Cl , appears, as shown in Fig. 2.1.

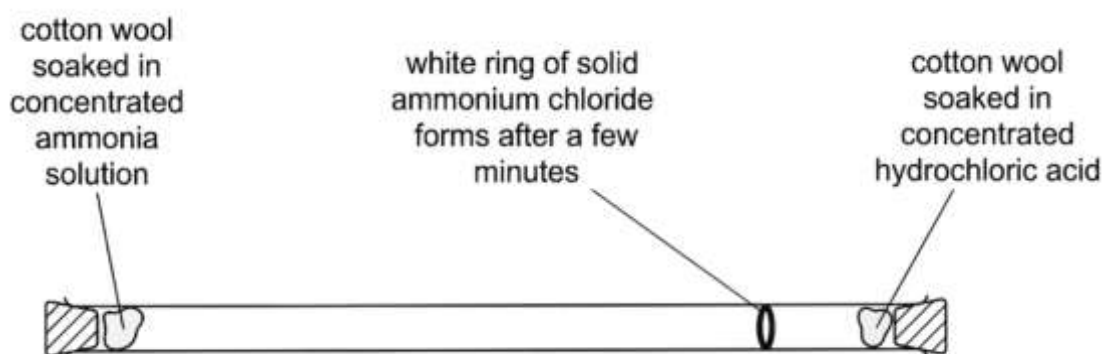


Fig. 2.1

- (i) The solid ammonium chloride obtained is dissolved in water to form a solution.

Describe how you would carry out a test to show the presence of ammonium ions in the solution.

.....
.....
..... [1]

- (ii) Fig. 2.2 shows the position of the ring of ammonium chloride formed in Experiment 1.

Experiment 2 is performed using the same tube and same temperature, with the concentrated $\text{NH}_3(\text{aq})$ being replaced with concentrated $\text{ND}_3(\text{aq})$, shown in Fig. 2.3.

Gaseous HCl and ND_3 react to form a white ring of solid, ND_4Cl .

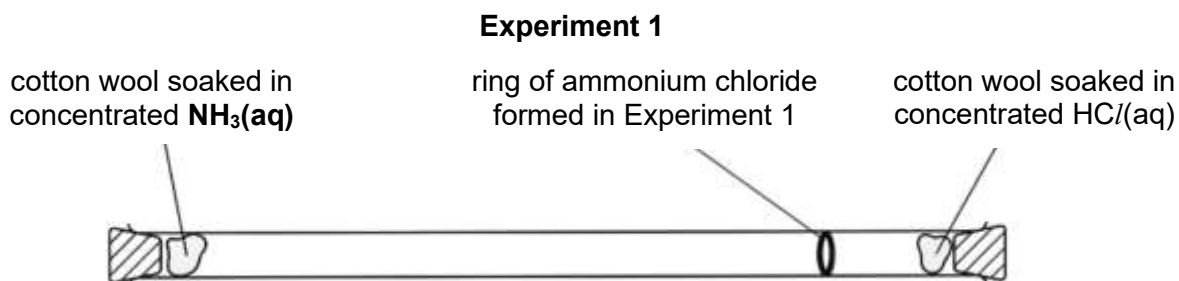


Fig. 2.2

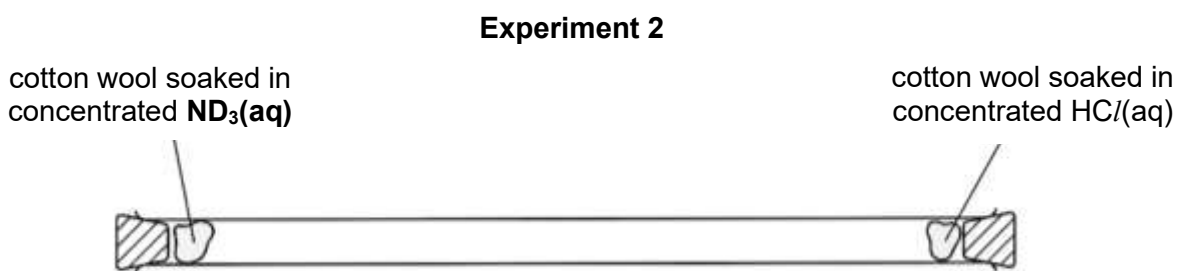


Fig. 2.3

On Fig 2.3, **draw** the likely position of the ND_4Cl formed in Experiment 2.

Explain your answer.

.....

.....

..... [2]

[Total: 5]

- 3 A student compared the action of heat on three solid metal carbonates.

She heated each carbonate using the apparatus shown in Fig. 3.1 and recorded the time taken for the limewater to form a white precipitate.

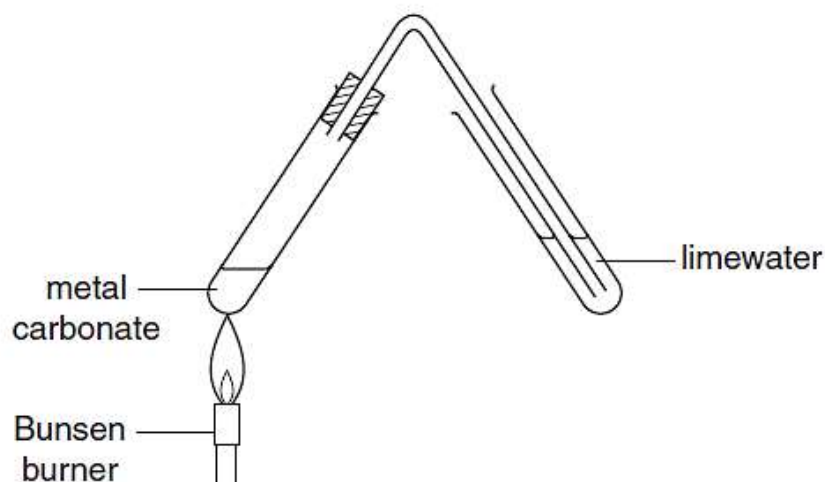


Fig. 3.1

The results for each of the carbonates are shown in Table 3.1.

Table 3.1

metal carbonate	time taken for white precipitate to form in limewater / s
copper(II) carbonate	10
magnesium carbonate	40
zinc carbonate	24

- (a) Explain the results in Table 3.1 in terms of the reactivity of copper, magnesium and zinc.

.....

.....

.....

.....

.....[2]

- (b) The student conducted another experiment with the three metal carbonates.

She heated 2.00 g samples of each of the three carbonates strongly until there was no further change in mass. Metal carbonates may decompose on heating to form a solid metal oxide and carbon dioxide gas.

Table 3.2 shows the mass of solid remaining at the end of the heating.

Table 3.2

metal carbonate	mass before heating / g	mass after heating / g
copper(II) carbonate	2.00	1.29
magnesium carbonate	2.00	0.95
zinc carbonate	2.00	1.30

- (i) Calculate the mass of carbon dioxide formed when 2.00 g of copper(II) carbonate is heated.

[1]

- (ii) The student carried out the same experiment with 2.00 g of sodium carbonate.

Predict the mass of the solid remaining at the end of heating.

.....[1]

[Total: 4]

- 4 Aldehydes are a homologous series of organic compounds. Unlike carboxylic acids, aldehydes are neutral compounds that do not ionise in water to release hydrogen ions.

Table 4.1 shows the names, formulae and boiling points of some aldehydes.

Table 4.1

name	molecular formula	structural formula	boiling point / °C
methanal	CH ₂ O	$\begin{array}{c} \text{O} \\ \parallel \\ \text{H}-\text{C} \\ \\ \text{H} \end{array}$	-19
ethanal	C ₂ H ₄ O	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{C} \\ \quad \parallel \\ \text{H} \quad \text{O} \\ \quad \\ \quad \text{H} \end{array}$	20
propanal	C ₃ H ₆ O	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{C} \\ \quad \quad \parallel \\ \text{H} \quad \text{H} \quad \text{O} \\ \quad \quad \\ \quad \quad \text{H} \end{array}$	49
butanal	C ₄ H ₈ O	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C} \\ \quad \quad \quad \parallel \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{O} \\ \quad \quad \\ \quad \quad \text{H} \end{array}$	75

- (a) Using the information in Table 4.1, state two characteristics of a homologous series.

.....

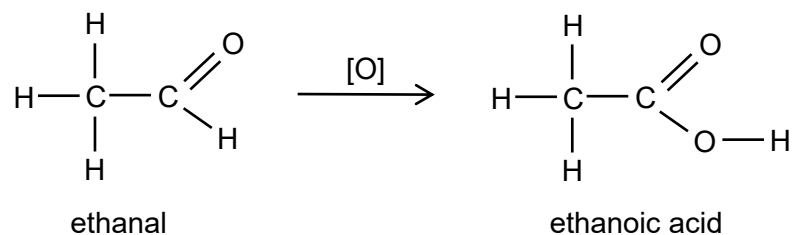
[2]

- (b) Describe and explain the trend in boiling point of the aldehydes from methanal to butanal.

.....

[2]

(c) Ethanal can be oxidised to form ethanoic acid.



(i) Name a reagent available in the laboratory that can oxidise ethanal to ethanoic acid.

.....[1]

(ii) Describe an observation when the reagent stated in (c)(i) is added to ethanal and the mixture is warmed.

.....[1]

(d) Ethanal reacts with a reagent, 2,4-dinitrophenylhydrazine to form an orange precipitate as shown in Fig. 4.1.

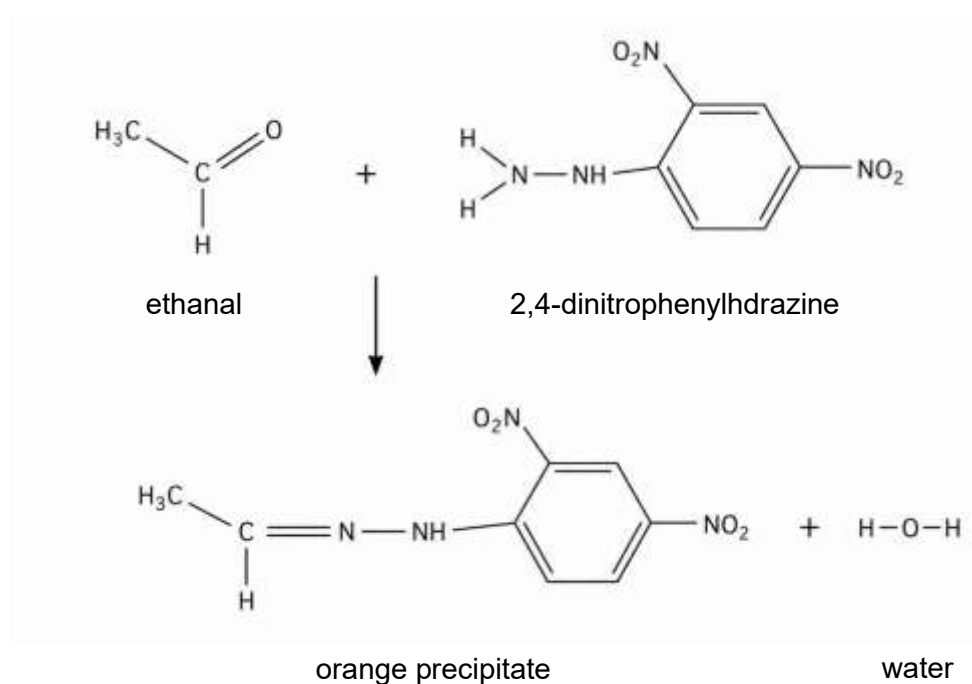
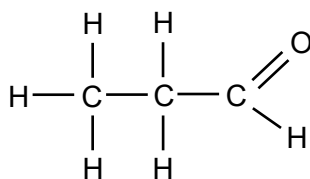


Fig. 4.1

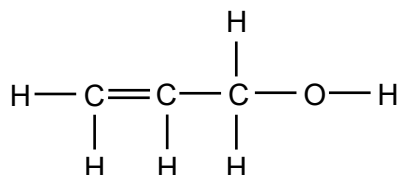
State the type of reaction that occurs when ethanal reacts with 2,4-dinitrophenylhydrazine.

.....[1]

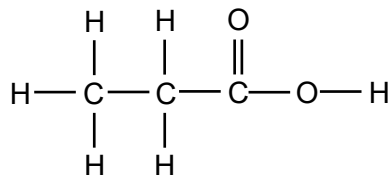
- (e) The diagrams show the structures of propanal and two other compounds.



propanal



compound 1



compound 2

- (i) Two of the compounds are isomers.

Identify the two compounds. Explain your answer.

.....and are isomers.

explanation

.....[2]

- (ii) Propanal, compound 1 and compound 2 are colourless liquids.

By naming suitable reagents, describe chemical tests to distinguish between the three compounds.

.....

.....

.....

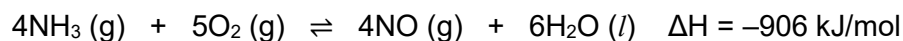
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.....[3]

[Total: 12]

- 5 The first stage in the manufacture of nitric acid is the reaction of ammonia and oxygen to form nitrogen monoxide, NO, and water.



Modern industrial plants carry out this reaction with an operating temperature of 900 °C, a pressure of 2 atm, with powdered platinum catalyst.

- (a) With reference to collision of particles, explain how the use of powdered platinum catalyst increases the rate of reaction.

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.....[3]

- (b) A graph of the percentage yield of nitrogen monoxide at different temperatures and pressures is shown in Fig. 5.1.

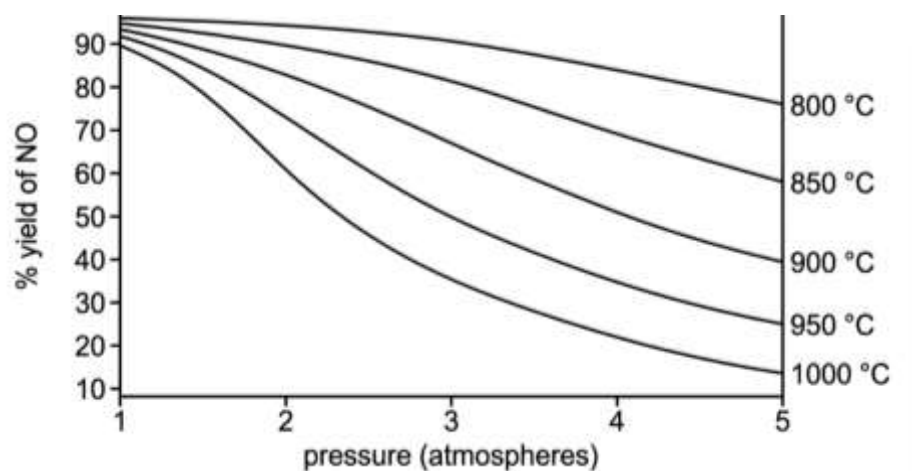


Fig. 5.1

The operating temperature of 900 °C is chosen to carry out this reaction in industrial plants.

Considering the percentage yield and rate of reaction, explain why an operating temperature of 900 °C is chosen instead of a temperature of 800 °C.

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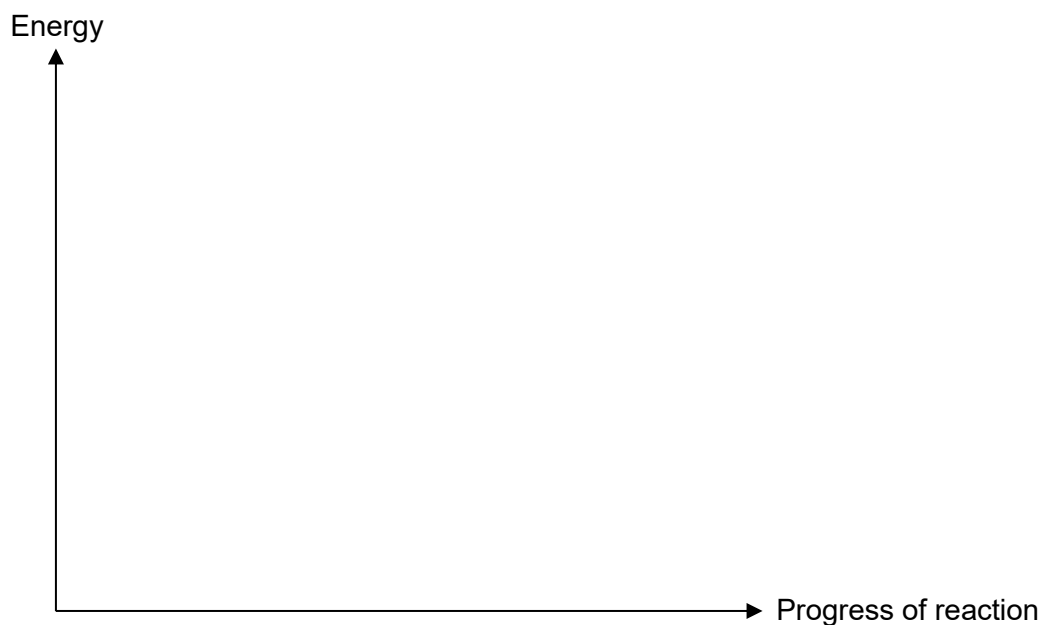
.....

.....[2]

- (c) Draw an energy profile diagram to represent the reaction of ammonia and oxygen to form nitrogen monoxide and water.

Your diagram should include:

- the reactants and products of the reaction
- labels to show the enthalpy change, ΔH and activation energy, E_a



[2]

- (d) Nitrogen monoxide is an atmospheric pollutant and should not be released into the atmosphere. Explain why.

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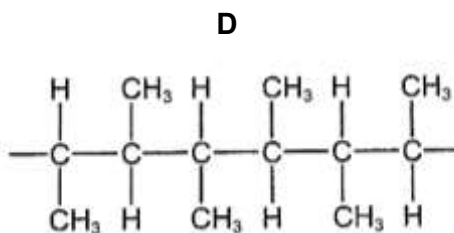
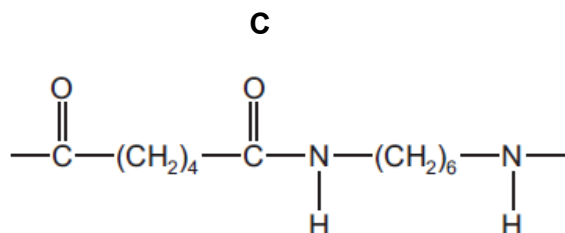
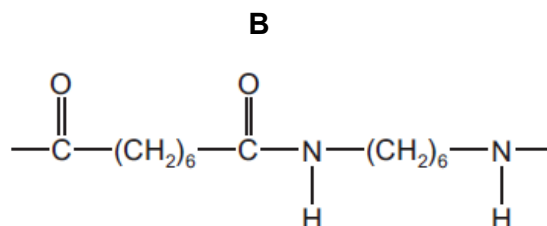
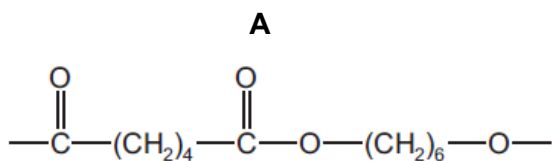
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.....[2]

[Total: 9]

6 Many plastics contain polymers.

The partial structures of four polymers, **A**, **B**, **C** and **D** are shown below.



- (a) Which polymer represents the structure of *Terylene*?

.....[1]

- (b) Which polymer is a polyamide made up of monomers with 6 carbon atoms each?

.....[1]

- (c) Draw the structure of the monomer used to make polymer **D**.
Name the monomer.

name

[2]

- (d) Plastics can be recycled in waste treatment plants through different chemical reactions.

Briefly describe **two** chemical methods to recycle plastics.

.....

.....

.....

.....

.....[2]

[Total: 6]

- 7 Information of Group 14 elements, carbon and tin, is shown in Table 7.1.

Table 7.1

physical property	C (graphite)	C (diamond)	Sn (tin)
state and appearance at room temperature and pressure	black solid	colourless solid	silvery solid
electrical conductivity	good	non-conductor	good
hardness	soft and slippery	extremely hard	malleable
melting point / °C	3730 (sublimes)	3550	232

- (a) The arrangement of particles in solid tin is shown in Fig. 7.1.

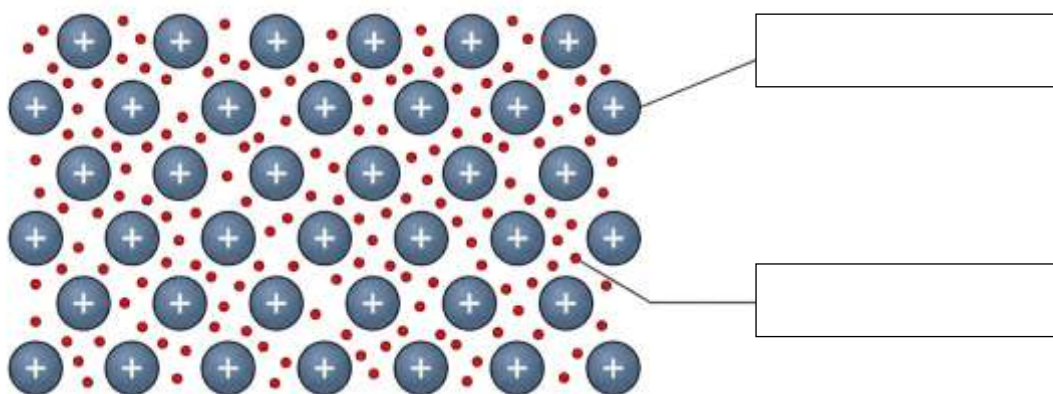


Fig. 7.1

Complete the diagram by labelling the particles in Fig. 7.1.

[1]

(b) Tin is rarely used in its pure form. It is often mixed with other metals to form alloys.

(i) Solder is an alloy consisting of 60% tin and 40% lead.

Suggest how the hardness and melting point of solder will differ from pure tin.

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

(ii) Tin forms an amphoteric oxide, tin(IV) oxide, SnO_2 .

Write a balanced chemical equation for the reaction when SnO_2 reacts with dilute sulfuric acid.

.....[1]

(iii) Tin is often used to coat steel food cans.

Explain how the tin coating prevents the iron in steel from rusting.

.....
.....[1]

(c) Diamond and graphite both have a giant molecular structure of carbon atoms.

Explain, using ideas of bonding, why the two forms of carbon have different electrical conductivity and hardness.

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.....
.....[5]

[Total: 10]

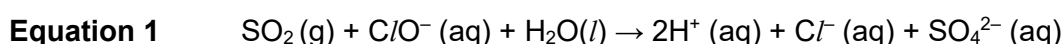
8 Stain removal

Stains on clothes are difficult to remove. Bleaching agents are chemicals used to remove colour from the stains.

Chlorine-based bleaching agents

Traditionally, the most common bleaching agents are chlorine-based. These bleaches contain the chlorate(I) oxyanion, ClO^- , which acts as a powerful oxidising agent to break down coloured molecules.

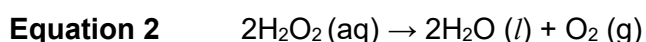
However, manufacture of chlorine-based bleaches results in industrial wastewater containing residual chlorine, in the form of the chlorate(I) oxyanion, which is highly toxic to aquatic life. To reduce environmental impact, sulfur dioxide is used as a dechlorination agent to remove residual chlorine from wastewater before it is discharged. The reaction for the dechlorination process using sulfur dioxide is shown in Equation 1.



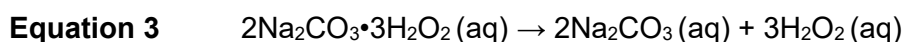
Oxygen-based bleaching agents

In recent years, the industry has shifted towards using hydrogen peroxide as a bleaching agent as it is considered environmentally friendly.

Hydrogen peroxide also acts as an oxidising agent, which reduces itself to oxygen and water, as shown in Equation 2.



Another widely used oxygen-based bleach is sodium percarbonate, a solid with a formula $2\text{Na}_2\text{CO}_3 \cdot 3\text{H}_2\text{O}_2$. When dissolved in water, it releases hydrogen peroxide and sodium carbonate as shown in Equation 3.



Sodium percarbonate is also preferred as it provides an alkaline environment which causes a faster breakdown of hydrogen peroxide.

Table 8.1 summarises the information about the various bleaching agents.

Table 8.1

bleaching agent	physical state	active species	pH of solution formed when bleaching agent dissolves in water
chlorine-based	liquid	ClO^-	11.0
hydrogen peroxide	liquid	H_2O_2	4.5
sodium percarbonate	solid	H_2O_2	10.5

Greasy Stains

Many food and grease stains consist of fats. Chemically, these fats are esters — large organic molecules formed from the reaction between glycerol (an alcohol) and long-chain carboxylic acids, known as fatty acids. These large fat molecules are insoluble in water, making them difficult to wash away.

To remove these stains, cleaning agents that are alkaline in nature are used to trigger a process called saponification. In saponification, the hydroxide ions in the alkaline solution hydrolyse the ester bonds in the fat molecules. This breaks them down into glycerol and fatty acid salts, which can be rinsed away easily by water.

Fig. 8.1 shows the products of saponification when one mole of fat molecule, tripalmitin, is heated with 3 moles of aqueous sodium hydroxide.

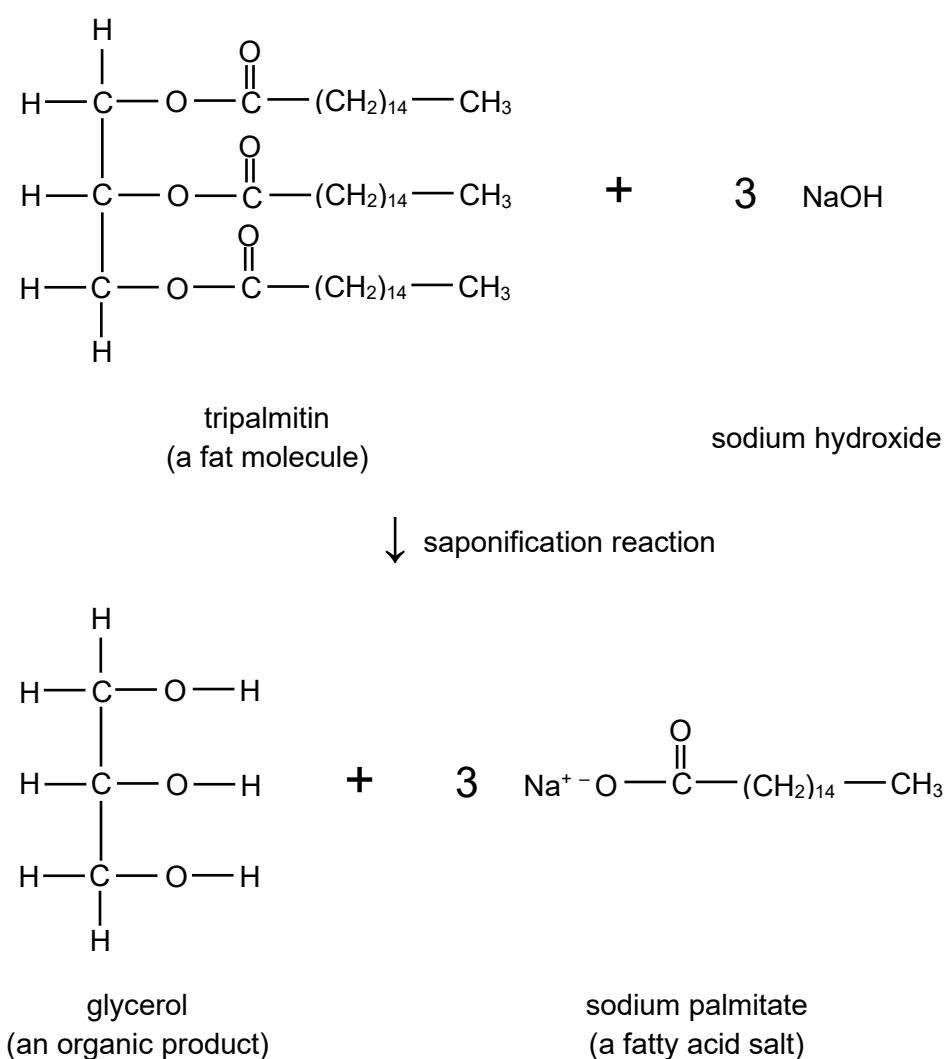


Fig. 8.1

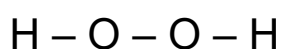
- (a) In Equation 1, sulfur dioxide is used as a dechlorination agent.

Use changes in oxidation states to explain why Equation 1 involves both oxidation and reduction.

.....

[3]

- (b) Hydrogen peroxide has the following structure.



- (i) Draw a 'dot-and-cross' diagram to show the arrangement of outer shell electrons in a molecule of hydrogen peroxide.

[2]

- (ii) Explain why hydrogen peroxide does not cause environmental harm when used as a bleaching agent.

.....
[1]

- (c) (i) A student wants to remove a grease stain and chooses sodium percarbonate as the bleaching agent instead of hydrogen peroxide.

Using the information provided, explain the **key** reason for the student's choice.

.....

[1]

- (ii) In one washing machine cycle, a packet of solid sodium percarbonate releases hydrogen peroxide and 5.30 g of sodium carbonate, Na_2CO_3 . The hydrogen peroxide subsequently decomposes to release oxygen gas as shown in Equation 2.

Calculate the volume of oxygen gas, measured at room temperature and pressure, released in one washing machine cycle.

[3]

- (d) Propyl ethanoate, $\text{CH}_3\text{COOC}_3\text{H}_7$, contains the same ester functional group as fats.

When propyl ethanoate is heated in a solution of aqueous sodium hydroxide, saponification occurs and two products are formed.

Draw the **displayed** formula of the two products formed in the appropriate spaces below.

organic product	fatty acid salt

[2]

[Total: 12]

- 9 A student investigates the amount of copper that forms on the negative electrode during electrolysis of aqueous copper(II) sulfate.

The apparatus used is shown in Fig. 9.1

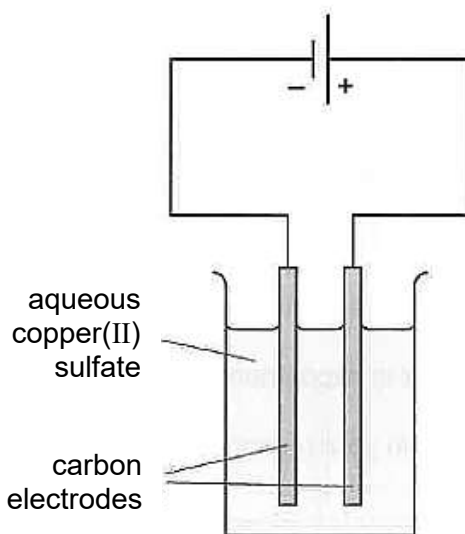


Fig. 9.1

- (a) Construct the ionic half-equations for the reactions that happen at each carbon electrode during the electrolysis. Include state symbols.

at the positive electrode

at the negative electrode

[2]

- (b) State **one** expected observation during the electrolysis.

.....[1]

- (c) The student measures the mass of the negative electrode at the start.

He allows the electrolysis to continue for 10 minutes. He dries the electrode, reweighs it and then replaces the electrode to allow the electrolysis to continue for a further 10 minutes.

He repeats the process until the mass of the electrode does not change.

Table 9.1 shows his results.

Table 9.1

total time / min	mass of negative electrode / g
0	3.50
10	3.90
20	4.33
30	4.56
40	5.16
50	5.57
60	6.00
70	6.00

- (i) The student made an error in recording one of the mass readings in Table 9.1
Which result is most likely to be an error?

.....[1]

- (ii) Suggest why the mass of electrode does not change after 60 minutes.

.....
.....[1]

- (iii) The student also tested the electrolyte solution with blue and red litmus paper at the start and end of the experiment.

Predict the changes in the colour of the litmus paper, if any.

.....
.....

Explain your reasoning.

.....
.....
.....
.....[3]

[Total: 8]

Section B

Answer **one** question in this section.

- 10 (a) The structure of oxalic acid, a dicarboxylic acid, is shown in Fig. 10.1.

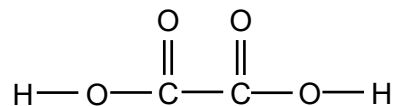


Fig. 10.1

- (i) Determine the molecular formula and the empirical formula of oxalic acid.

molecular formula

empirical formula

[1]

- (ii) A 0.45 g sample of oxalic acid is dissolved in water and made up to 25.0 cm³ in volume.

Determine the amount of oxalic acid, in moles, present in 25.0 cm³ of solution.

[1]

- (iii) Oxalic acid and sulfuric acid are both dibasic acids.

The pH of the two acids of the same concentration is measured. The pH of oxalic acid is 3.2, while the pH of sulfuric acid is 0.90.

Why are the pH values different?

.....

[2]

- (iv) Oxalic acid burns in an excess of oxygen to form two products.
 Name the products formed.

.....[1]

- (b) A student conducted an experiment involving some acids. He titrated 25.0 cm^3 of each acid against aqueous sodium hydroxide. The volume of aqueous sodium hydroxide required for complete neutralisation of each acid is recorded in Table 10.1.

Table 10.1

acid (0.40 mol/dm^3)	volume of aqueous sodium hydroxide required for complete neutralisation / cm^3
hydrochloric acid	16.70
ethanoic acid	16.70
sulfuric acid	33.40

- (i) Explain the similarities and differences between the volumes of aqueous sodium hydroxide required for complete neutralisation of the three acids.

.....

.....

.....

.....

.....

.....[3]

- (ii) The acids have a concentration of 0.40 mol/dm^3 . Determine the amount of hydrogen ions, in moles, present in 25.0 cm^3 of hydrochloric acid.

[1]

- (iii) The student then titrated 25.0 cm^3 solution of the oxalic acid in (a)(ii) against aqueous sodium hydroxide of the same concentration.

Predict the volume of aqueous sodium hydroxide required for complete neutralisation.

.....[1]

[Total: 10]

- 11** Barium is a Group 2 element that forms several compounds.
The properties of some barium compounds are shown in Table 11.1.

Table 11.1

compound	solubility in water	uses
barium carbonate	insoluble	rat poison (toxic due to barium ions)
barium chloride	soluble	heat treatment of steel tools
barium hydroxide	soluble	used in acid-base titrations
barium sulfate	insoluble	used as 'contrast agent' for X-rays

- (a)** To prepare a pure and dry sample of barium chloride salt, an excess of barium carbonate is added to hydrochloric acid.

Describe the subsequent steps required to obtain a pure and dry sample of barium chloride.

.....

[3]

- (b)** While solid barium sulfate is safely ingested in our bodies as a 'contrast agent' for X-rays, solid barium carbonate is highly toxic upon entering the stomach.

Suggest why barium carbonate is toxic upon entering the stomach.

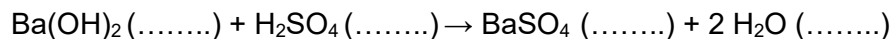
.....
[1]

- (c)** Hydrated barium chloride has the formula $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ where one formula unit of barium chloride, BaCl_2 , combines with 2 molecules of water.

Calculate the mass of barium chloride in a 4.88 g sample of hydrated barium chloride.

[2]

- (d) The reaction between aqueous barium hydroxide and dilute sulfuric acid is investigated.



Aqueous barium hydroxide was added from a burette, 1.00 cm³ each time, to dilute sulfuric acid in the beaker. After each addition, the electrical conductivity of the mixture in the beaker was recorded using a data-logger.

Fig. 11.1 shows how the electrical conductivity of the mixture in the beaker changes as aqueous barium hydroxide was added.

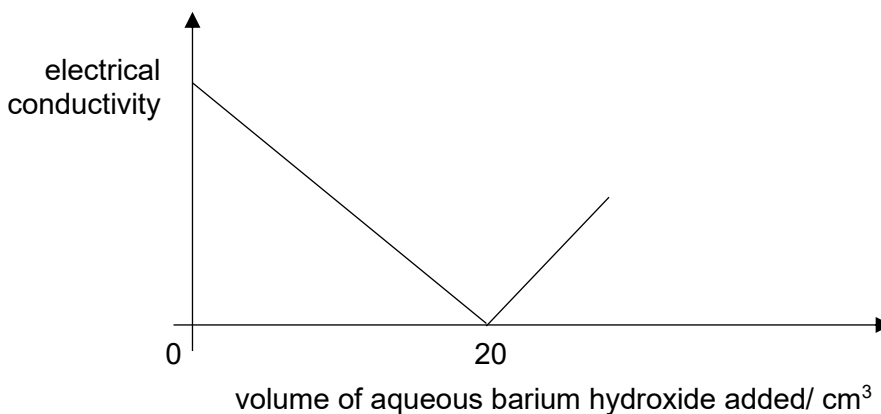


Fig. 11.1

- (i) Complete the equation for the reaction by filling in the missing state symbols. [1]
- (ii) Hence, state what is observed in the beaker as aqueous barium hydroxide is added. [1]
-
- (iii) When 20.00 cm³ of aqueous barium hydroxide was added to dilute sulfuric acid, the electrical conductivity of the mixture in the beaker was zero.

Explain why.

.....

.....

.....

.....[2]

[Total: 10]

– End of Paper –

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The Periodic Table of Elements

Group																						
1	2											13	14	15	16	17	18					
Key proton (atomic) number atomic symbol name relative atomic mass							1 H hydrogen 1										2 He helium 4					
							3 Li lithium 7	4 Be beryllium 9									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
							11 Na sodium 23	12 Mg magnesium 24	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84					
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131					
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —					
87 Fr francium —	88 Ra radium —	89–103 actinoids	104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganesson —					

26

lanthanoids

actinoids

57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.)

The Avogadro constant, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$.