| Class/ Index Number | Centre Number/ 'O' Level Index Number | Name |
|---|---|---|
| / | / | |

新加坡海星中学

**MARIS STELLA HIGH SCHOOL**
**PRELIMINARY EXAMINATION**
**SECONDARY FOUR**

**CHEMISTRY** **6092/01**
Paper 1 Multiple Choice **3 September 2025**
**1 hour**

*Additional Materials:*
Optical Test Answer Sheet (OTAS) – 1 sheet

**READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your class, index number, Centre number, O level index number and name in the spaces at the top of this page.

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

**Read the instructions on the Answer Sheet very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this question booklet.
A copy of the Periodic Table is printed on page 15.
The use of an approved scientific calculator is expected, where appropriate.

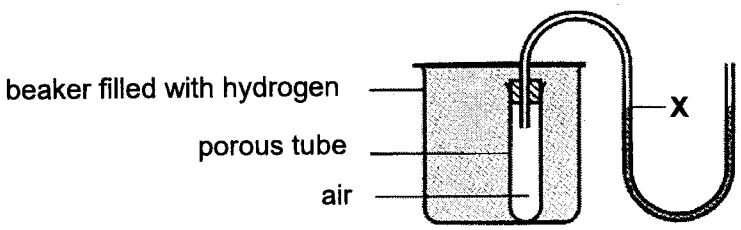
The total number of marks for this paper is 40.

At the end of the examination, hand in the following separately:
(1) Optical Test Answer Sheet (OTAS)
(2) Question Paper

This document consists of **15** printed pages.

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1 The apparatus can be used to show the diffusion of gases. Air is present in the porous tube. The beaker is filled with hydrogen.
Assume all gases are at the same temperature and pressure.




What would happen to the water level at **X** over time?

**A** The water level at **X** will remain unchanged.

**B** The water level at **X** will drop and remains there.

**C** The water level at **X** will drop and then return to its original position.

**D** The water level at **X** will rise and then return to its original position.

2 The table shows some mixtures and their constituents are obtained using suitable separation techniques.

| | mixture | constituent obtained |
|---|---|---|
| 1 | NaC*l*(aq) | $H_2O$(l) |
| 2 | $I_2$(s) and Ni(s) | $I_2$(s) |
| 3 | NaC*l*(aq) | NaC*l*(s) |

Which row gives the correct separation techniques to obtain the constituents from the mixture?

| | 1 | 2 | 3 |
|---|---|---|---|
| **A** | distillation | sublimation | evaporation |
| **B** | distillation | sublimation | filtration |
| **C** | filtration | crystallisation | evaporation |
| **D** | sublimation | crystallisation | filtration |

3 An element, **Z**, has **p** protons and **n** neutrons in its nucleus.

Which row gives a possible correct number of protons, neutrons and electrons in a negative ion of an isotope of **Z**?

| | protons | neutrons | electrons |
|---|---|---|---|
| **A** | **p** | **n+1** | **p+1** |
| **B** | **p** | **n+1** | **p–1** |
| **C** | **p+1** | **n** | **p+1** |
| **D** | **p+1** | **n** | **p–1** |

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4 The proton numbers of elements **X**, **Y** and **Z** are 6, 8 and 12 respectively.

Which row shows the correct formulae of the compounds formed between the elements?

| | compound 1 | compound 2 | compound 3 |
|---|---|---|---|
| **A** | $Z_2Y$ | XY | $ZXY_3$ |
| **B** | ZY | $XY_2$ | $ZXY_3$ |
| **C** | ZY | $XY_2$ | $ZXY_4$ |
| **D** | $Z_2Y$ | XY | $ZXY_4$ |

5 The formation of metallic oxides involves the transfer of electrons from a metal atom to oxygen atoms.

In the formation of one mole of metallic oxide, which oxide involves the transfer of more than 2 moles of electrons from metal atoms?

**A** aluminium oxide

**B** iron(II) oxide

**C** magnesium oxide

**D** sodium oxide

6 Which substance contains atoms bonded to other atoms by less than four covalent bonds?

**A** diamond

**B** poly(ethene)

**C** silicon dioxide

**D** water

7 Solid copper metal, aqueous copper(II) sulfate, solid graphite and molten magnesium chloride will conduct electricity.

Which pair of substance will conduct electricity because they both contain mobile electrons?

**A** aqueous copper(II) sulfate and molten magnesium chloride

**B** aqueous copper(II) sulfate and solid copper metal

**C** molten magnesium chloride and solid graphite

**D** solid copper metal and solid graphite

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8 Which of the statements about iron(III) oxide, $Fe_2O_3$, are correct?

1 Iron is present in $Fe_2O_3$ as an $Fe^{2+}$ ion.

2 One mole of $Fe_2O_3$ contains 112 g of iron and 48 g of oxygen.

3 The empirical formula is $Fe_2O_3$.

4 Three moles of oxygen molecules are needed to make one mole of $Fe_2O_3$.

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

9 Ammonium nitrate, $NH_4NO_3$, ($M_r$ = 80) decomposes to form dinitrogen oxide and water upon heating as shown in the equation below.

$$NH_4NO_3 \rightarrow N_2O + 2H_2O$$

When an impure sample of ammonium nitrate is heated, 27 g of water is formed.

Which expression shows the mass of ammonium nitrate in the impure sample?

**A** $66 \times \frac{27}{36}$

**B** $80 \times \frac{27}{36}$

**C** $80 \times \frac{27}{18}$

**D** $80 \times \frac{9}{36}$

10 20 $cm^3$ of propene ,$C_3H_6$, reacts with 500 $cm^3$ of oxygen according to the equation shown below.

$$2C_3H_6\,(g) + 9O_2\,(g) \rightarrow 6CO_2\,(g) + 6H_2O\,(g)$$

When cooled to room temperature, what is the total volume of gas remaining at the end of the reaction?

**A** 120 $cm^3$

**B** 410 $cm^3$

**C** 470 $cm^3$

**D** 530 $cm^3$

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**11** Which method(s) is/are suitable to distingush between 1.00 mol/dm$^3$ of aqueous hydrochloric acid and 1.00 mol/dm$^3$ of aqueous ethanoic acid?

1 using a pH meter

2 determining the volume of 1.00 mol/dm$^3$ of sodium hydroxide solution used to neutralise 25.0 cm$^3$ of the acids separately

3 measuring the total volume of hydrogen gas formed when excess magnesium is added to the acids separately

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

**12** The table shows the properties of four chlorides.

Which is copper(II) chloride?

| | **colour** | **solubility in water** | **method of preparation** |
|---|---|---|---|
| **A** | green | soluble | copper(II) oxide and hydrochloric acid |
| **B** | green | insoluble | copper metal and hydrochloric acid |
| **C** | white | insoluble | sodium chloride and copper(II) sulfate |
| **D** | green | soluble | copper(II) nitrate and hydrochloric acid |

**13** The following reactions are carried out.

| reaction | result |
|---|---|
| ethanoic acid is added to ammonium carbonate | Gas **E** is produced. |
| ammonium ethanoate is warmed with sodium hydroxide solution | Gas **F** is produced. |
| ethanoic acid is added to an aqueous solution of ammonia | Compound **G** is formed. |

What are gases **E**, **F** and compound **G**?

| | gas **E** | gas **F** | compound **G** |
|---|---|---|---|
| **A** | ammonia | ammonia | ammonium carbonate |
| **B** | ammonia | carbon dioxide | ammonium ethanoate |
| **C** | carbon dioxide | carbon dioxide | ammonium carbonate |
| **D** | carbon dioxide | ammonia | ammonium ethanoate |

**14** Which equation shows a non-redox reaction?

**A** $2H_2 + O_2 \rightarrow 2H_2O$

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

**C** $2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$

**D** $CuO + H_2 \rightarrow Cu + H_2O$

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**15** The reaction between copper and concentrated nitric acid is shown below.

$$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$$

Which statement about this reaction is correct?

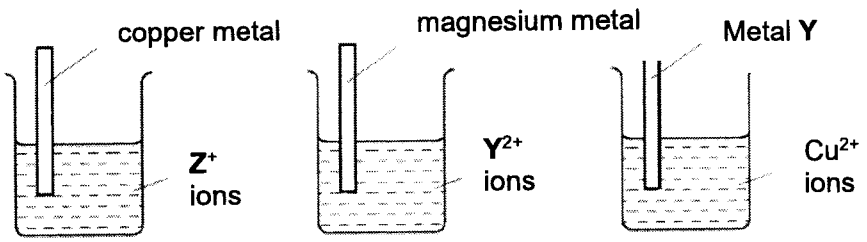
**A** $HNO_3$ is a reducing agent.

**B** The oxidation state of nitrogen in $Cu(NO_3)_2$ is -5.

**C** Cu loses electrons during the reaction.

**D** The oxidation state of oxygen has changed.

**16** A student conducted three experiments to compare the reactivities of four different metals; copper, magnesium, metal **Y** and metal **Z**.




A deposit was observed on the metal strip for each experiment.

How many metals that were investigated will be able to react with aqueous hydrochloric acid?

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

**17** Hydrogen is produced by the reaction of a metal **A** and a dilute acid.

When the same gas is passed over an oxide of metal **B**, it reduced the metallic oxide to its metal in the presence of heat.

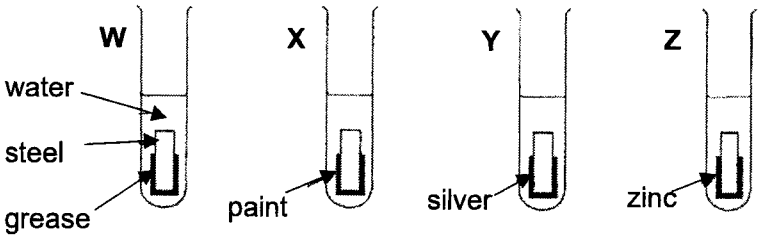
Which substances would give these results?

| | metal **A** | dilute acid | metal **B** |
|---|---|---|---|
| 1 | calcium | hydrochloric acid | lead(II) oxide |
| 2 | copper | hydrochloric acid | silver oxide |
| 3 | iron | sulfuric acid | copper(II) oxide |
| 4 | zinc | sulfuric acid | calcium oxide |

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

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**18** Four identical pieces of steel were partially coated with four different substances as shown below. The steel pieces were then left in test tubes filled with water for some days.




In which tube would the steel be least likely to rust?

**A** test tube **W**

**B** test tube **X**

**C** test test **Y**

**D** test tube **Z**

**19** A newly discovered alkali metal, **Q**, has an atomic number greater than 37.

What is the most likely property of **Q**?

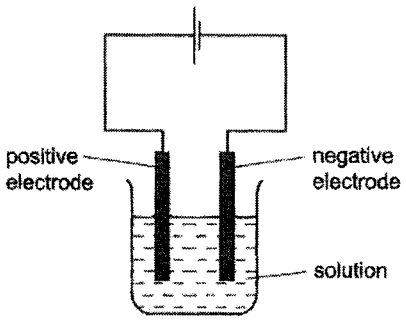
**A** **Q** floats on water.

**B** **Q** has a higher melting point than sodium.

**C** **Q** reacts with chlorine gas to form a yellow crystalline solid.

**D** **Q** reacts with water more vigorously than potassium with water.

**20** Four different solutions were electrolysed in separate experiments.




Which electrolytic set-up results in no change in the concentration of the solution during electrolysis.?

**A** aqueous sodium chloride solution with carbon electrodes

**B** copper(II) sulfate solution with copper electrodes

**C** copper(II) sulfate solution with platinum electrodes

**D** dilute sodium chloride solution with platinum electrodes

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**21** In an electrolysis, the same amount of charge deposited 54.0 g of silver and 14.9 g of tin.

The charge on the silver ion is 1+.

What was the charge of the tin ion?

**A** 1+

**B** 2+

**C** 3+

**D** 4+

**22** Which statement describes what happens when hydrogen and oxygen are used in a fuel cell?

**A** Electricity is generated due to flow of electrons from cathode to anode.

**B** Hydrogen is reduced by losing electrons at the anode.

**C** Oxygen is oxidised by gaining electrons at the cathode.

**D** Water is produced as the only product in the overall equation.

**23** Which statement about the elements in Period 3 going from left to right of the Periodic Table is correct?

**A** The metallic properties of the elements increases.

**B** The nature of the elements changes from strong reducing agents to strong oxidising agents.

**C** The nature of the oxides of the elements changes from acidic to basic.

**D** The tendency of the elements to lose electrons increases.

**24** Tellurium (Te) and sulfur belong to Group 16 of the Periodic Table.

What could be the likely formula of a compound of tellurium?

**A** $H_2Te$

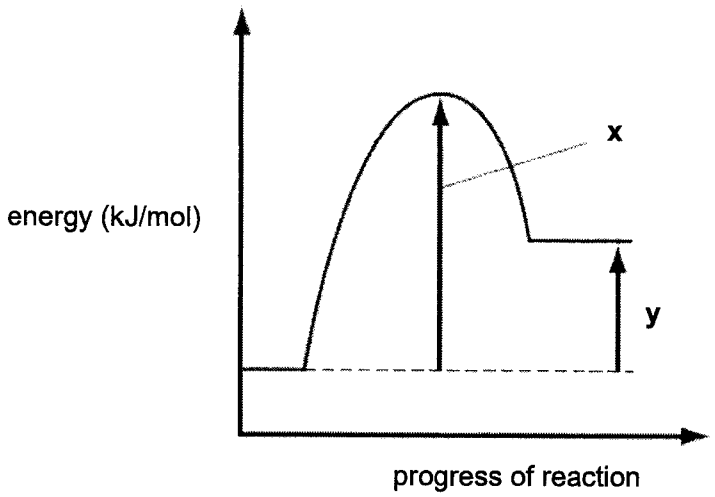
**B** $HTeO_3$

**C** TeN

**D** TeO

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**25** The energy profile diagram for a chemical reaction is shown below.




Which statement about the energy profile diagram is correct?

**A** The overall enthalpy change is equal to **x** + **y**.

**B** The reaction is exothermic.

**C** The value of **x** would decrease in the presence of a catalyst.

**D** The value of **y** would increase in the presence of a catalyst.

**26** The scheme shows four stages, 1 to 4, in the conversion of solid candlewax, $C_{30}H_{62}$, into carbon dioxide and water

1 $C_{30}H_{62}(s) \rightarrow C_{30}H_{62}(l)$

2 $C_{30}H_{62}(l) \rightarrow C_{30}H_{62}(g)$

3 $2C_{30}H_{62}(g) + 91O_2(g) \rightarrow 60CO_2(g) + 62H_2O(g)$

4 $30CO_2(g) + 31H_2O(g) \rightarrow 30CO_2(g) + 31H_2O(l)$

Which stages are exothermic?

**A** 1 and 2

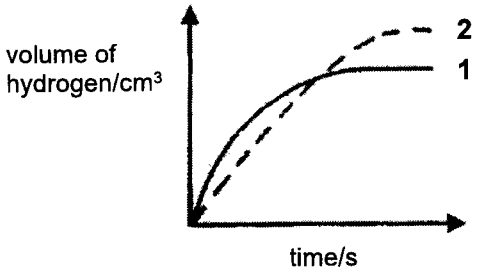
**B** 1 and 4

**C** 2 and 3

**D** 3 and 4

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27 In the graph below, curve **1** was obtained by the reaction between 50.0 $cm^3$ of 1.0 $mol/dm^3$ sulfuric acid and excess zinc granules.




Which changes would produce curve **2**?

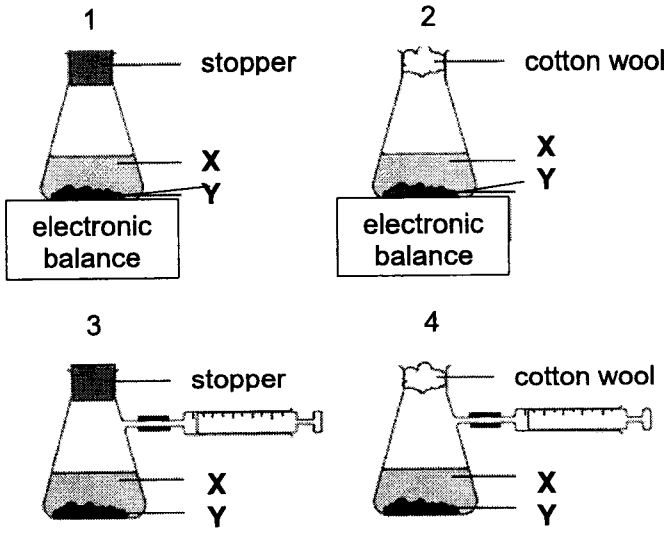
**A** Add the same mass of zinc powder instead of zinc granules.

**B** Increase the temperature by 10°C.

**C** Use 100.0 $cm^3$ of 0.75 $mol/dm^3$ sulfuric acid.

**D** Use 100.0 $cm^3$ of 1.00 $mol/dm^3$ sulfuric acid.

28 A liquid **X** reacts with solid **Y** to form a gas.




Which two diagrams show suitable methods for investigating the rate of the reaction?

**A** 1 and 3

**B** 1 and 4

**C** 2 and 3

**D** 2 and 4

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29 Ammonia is produced by the Haber process.

Which statement is **not** correct?

**A** An iron catalyst is used.

**B** Each hydrogen molecule reacts with three nitrogen molecules to form two molecules of ammonia.

**C** Hydrogen for the Haber process can be obtained by the cracking of crude oil.

**D** The reaction is reversible.

30 Which statement about the properties of ammonia is correct?

**A** It is formed upon heating solid ammonium chloride.

**B** It dissolves in water to form a solution with pH less than 7.

**C** It is formed by reacting ammonium salts with nitric acid.

**D** It reacts with alkali to form salts.

31 A sample of air is bubbled through sodium hydroxide, then passed over heated copper.

Which gases are removed by this process?

**A** carbon dioxide and oxygen

**B** carbon dioxide and water vapour

**C** hydrogen and nitrogen

**D** nitrogen and oxygen

32 Which pair of gases can cause the most damage to limestone buildings?

**A** CO and NO

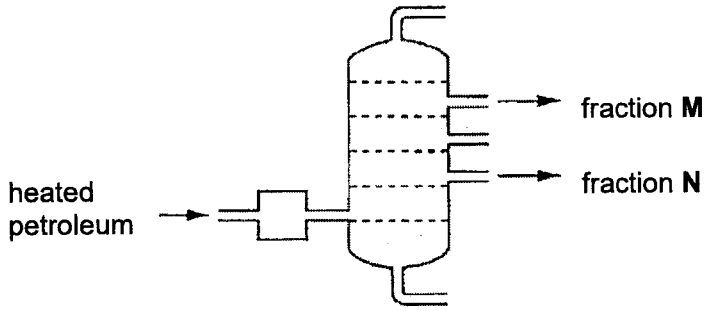
**B** NO and $CH_4$

**C** $SO_2$ and CO

**D** $SO_2$ and $NO_2$

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**33** The diagram shows the fractional distillation of petroleum.




Which row about fractions **M** and **N** are correct?

| | **M** burns more easily than **N** | **M** has a higher boiling point than **N** | **M** is more viscous than **N** |
|---|---|---|---|
| **A** | True | False | False |
| **B** | True | True | True |
| **C** | False | True | False |
| **D** | False | False | True |

**34** In the polymerisation of ethene to form poly(ethene), which property remains constant?

**A** boiling point

**B** density

**C** empirical formula

**D** molecular mass

**35** Under certain conditions, 1 mole of ethane reacts with 2 moles of chlorine in a substitution reaction.

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

**A** $C_2H_5Cl$

**B** $C_2H_4Cl_2$

**C** $C_2H_2Cl_4$

**D** $CH_2Cl_2$

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**36** Olive oil contains oleic acid. Oleic acid is an unsaturated acid which has molecular formula $C_{17}H_{31}COOH$.

How many carbon–carbon double bonds are present in one molecule of oleic acid?

**A** 1

**B** 2

**C** 3

**D** 4

**37** The following statements describe an organic compound, **L**.

1 It reacts with sodium carbonate to produce a colourless gas.

2 It decolourises bromine solution.

3 If a mixture of ethanoic acid and compound **L** is warmed with concentrated sulfuric acid, no sweet smelling substance is formed.

What could be the molecular formula of compound **L**?

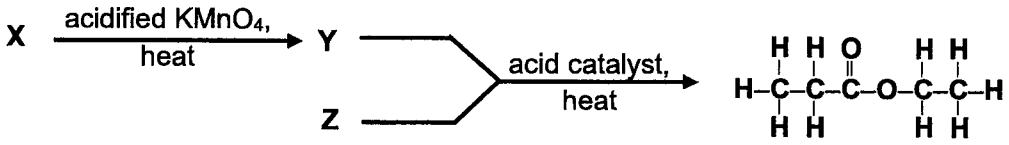
**A** CH=CHCOOH

**B** $CH_2$=CHCOOCH$_3$

**C** $CH_3CH_2CH_2OH$

**D** $CH_3CH_2CH_2Cl$

**38** The following reaction scheme shows the reactions of three substances, **X**, **Y** and **Z**.

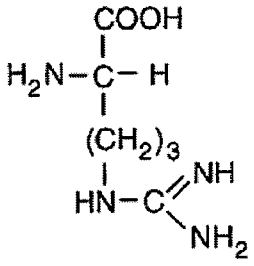



What are the molecular formulae of substances **X**, **Y** and **Z**?

| | X | Y | Z |
|---|---|---|---|
| **A** | $C_2H_6O$ | $C_3H_6O_2$ | $C_2H_6O$ |
| **B** | $C_3H_6$ | $C_3H_8O$ | $C_2H_5O_2$ |
| **C** | $C_3H_8O$ | $C_3H_6O_2$ | $C_2H_6O$ |
| **D** | $C_3H_8O$ | $C_4H_8O_2$ | $C_2H_6O$ |

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**39** The full structural formula of the amino acid, Arginine, is shown below.



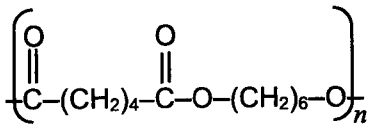
The following statements were made about the amino acid.

1 It undergoes addition polymerisation.
2 It forms a polymer with the same linkage as nylon.
3 It reacts with magnesium to form hydrogen gas.
4 It decolorises acidified potassium manganate(VII) solution readily.

Which statements are correct?

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

**40** Some polymers can undergo depolymerisation through acid hydrolysis.



Which of the following represents the monomers of the above polymer?

**A** $HO–(CH_2)_4–OH$ and $HO–(CH_2)_6–OH$
**B** $HOOC–(CH_2)_6–COOH$ and $HO–(CH_2)_4–OH$
**C** $HOOC–(CH_2)_4–OH$ and $HO–(CH_2)_6–COOH$
**D** $HOOC–(CH_2)_4–COOH$ and $HO–(CH_2)_6–OH$

**End of Paper**

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# The Periodic Table of Elements

| Group 1 | 2 | | | | | | | | | | | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 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 | 17 Cl chlorine 35.5 | 18 Ar argon 40 |
| 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 – |

**Key**

proton (atomic) number
atomic symbol
name
relative atomic mass

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lanthanoids | 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 |
| actinoids | 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 $dm^3$ at room temperature and pressure (r.t.p.).
The Avogadro constant, $L = 6.02 \times 10^{23}$ $mol^{-}$



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| Class/ Index Number | Centre Number/ 'O' Level Index Number | Name |
|---|---|---|
| / | / | |

新加坡海星中学

**MARIS STELLA HIGH SCHOOL**
**PRELIMINARY EXAMINATION**
**SECONDARY FOUR**

**CHEMISTRY** **6092/02**
Paper 2 **22 August 2025**
**1 hour 45 minutes**

Candidates answer on the Question Paper.
No additional materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your class, index number, Centre number, O level index number and name in the spaces 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** question.
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 **22.**

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

| For Examiner's Use | |
|---|---|
| Section A | 70 |
| Section B | 10 |
| Total | 80 |

This document consists of **22** printed pages.

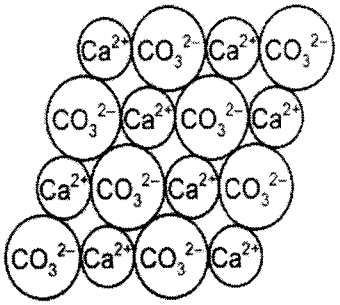
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## Section A

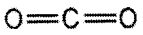
Answer **all** questions in this section in the spaces provided.

**1** The structures of some carbon-containing substances, **A**, **B**, **C**, **D**, **E** and **F** are shown in Fig 1.1.

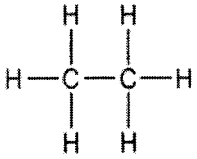
**A**



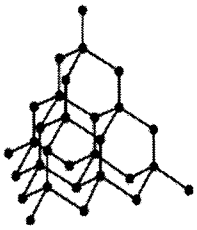

**B**



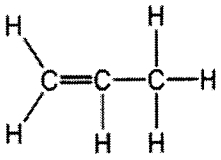

**C**



**D**



**E**



**F**

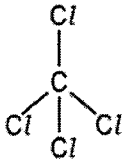


**Fig. 1.1**

**(a)** Use the letters **A**, **B**, **C**, **D**, **E** and **F** to answer the following questions.

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

**(i)** Which substance is a saturated hydrocarbon?

.....[1]

**(ii)** Which substance has a giant molecular structure?

.....[1]

**(iii)** Which substance is a product of respiration?

.....[1]

**(iv)** Which substance is in the same homologous series as ethene?

.....[1]

**(v)** Which substance is found in limestone?

.....[1]

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**(b)** Explain why substance **B** in the atmosphere is increasing and why planting more trees is not a long-term solution to the increase in the amount of **B**.

.....

.....

.....[2]

[Total: 7]

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2 Lithium is a metal and lithium chloride is a compound. The structure and properties of these substances are very different.

**(a)** Explain using ideas about bonding and structure, how the particles in lithium and lithium chloride are held together.

.....

.....

.....

.....[2]

**(b)** Table 2.1 below shows the melting and boiling points of lithium and lithium chloride.

**Table 2.1**

| | melting point / °C | boiling point / °C |
|---|---|---|
| lithium | 180.5 | 1342 |
| lithium chloride | 605.0 | 1382 |

Using the information from Table 2.1, explain what can be deduced about the forces of attraction holding the particles together in lithium and lithium chloride.

.....

.....

.....

.....[2]

**(c)** Two students, **A** and **B**, are comparing the properties of lithium and lithium chloride at room temperature. Student **A** states that both lithium and lithium chloride can conduct electricity, but Student **B** states that **only** lithium can conduct electricity.

State whether Student **A**, Student **B**, or neither student is correct. Explain your answer.

.....

.....

.....

.....

.....[3]

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**(d)** Students **A** and **B** then went on to discuss the bonding in another substance, calcium fluoride. Explain, in terms of electrons, how the bonds in calcium fluoride are formed.

.....

.....

.....

.....[2]

[Total: 9]

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3 Chlorine dioxide, $ClO_2$, was the first oxide of chlorine to be discovered. Although unstable as a liquid or gas, it is now produced on a very large scale for the bleaching of wood pulp and water treatment.

Chlorine dioxide has a complex bonding structure. The chlorine atom in the molecule has an unpaired electron, which is not involved in bonding, contributing to its reactivity.

The structure of a chlorine dioxide molecule can be represented as shown.

$$O = Cl = O$$

**(a)** Draw a 'dot & cross' diagram to show the bonding in a chlorine dioxide molecule. Show outer shell electrons only.

[2]

**(b)** Chlorine dioxide was first obtained by scientist and inventor, Humphry Davy. It was formed by the hazardous disproportionation reaction of chloric acid, $HClO_3$.

$$3HClO_3 \rightarrow 2ClO_2 + HClO_4 + H_2O$$

Disproportionation is a type of redox reaction in which the same element is both oxidised and reduced.

Which element in the reaction has undergone disproportionation? Explain your answer using oxidation states.

.....

.....

.....[2]

**(c)** Chlorine dioxide can also be produced by reacting sodium chlorate(III), $NaClO_2$ with chlorine. The other product is sodium chloride.

**(i)** Write an equation for the reaction.

.....[1]

**(ii)** Which is the oxidising agent? Explain your answer.

.....

.....[2]

[Total: 7]

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**4** Sulfuric acid and malonic acid are both dibasic acids.

Malonic acid is a white crystalline solid which is soluble in water. It melts at 135 °C. The structural formula of malonic acid is given below.

$$HOOC–CH_2–COOH$$

**(a)** **(i)** Write the molecular formula of malonic acid.

.....[1]

**(ii)** When malonic acid is thermally decomposed, carbon dioxide and a simpler carboxylic acid are formed. Deduce the name and formula of this acid.

.....[2]

**(iii)** Name the product when the carboxylic acid in **(a)(ii)** is mixed with ethanol and heated in the presence of concentrated sulfuric acid.

.....[1]

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

[1]

**(b)** Suggest why a solution of malonic acid, of concentration 0.2 mol/dm$^3$, has a higher pH than sulfuric acid of the same concentration.

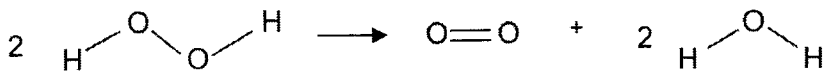
.....[1]

[Total: 6]

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**5** Aqueous hydrogen peroxide is often used in households as a bleaching agent as well as a disinfectant among other uses.

At room temperature, aqueous hydrogen peroxide decomposes very slowly to form water and oxygen. The decomposition of hydrogen peroxide can be represented by the equation below.



**(a)** Explain in terms of bond making and bond breaking why this reaction is exothermic.

.....

.....[2]

**(b)** The decomposition of hydrogen peroxide is speeded up by adding powdered manganese(IV) oxide.

An experiment was carried out with three samples of hydrogen peroxide placed in conical flasks labelled **P**, **Q** and **R**. An equal mass of powdered manganese(IV) oxide was added to each conical flask. The mass of the conical flasks and their contents were measured at regular time intervals, and a graph of mass was plotted against time.

The results are shown in Fig. 5.1.

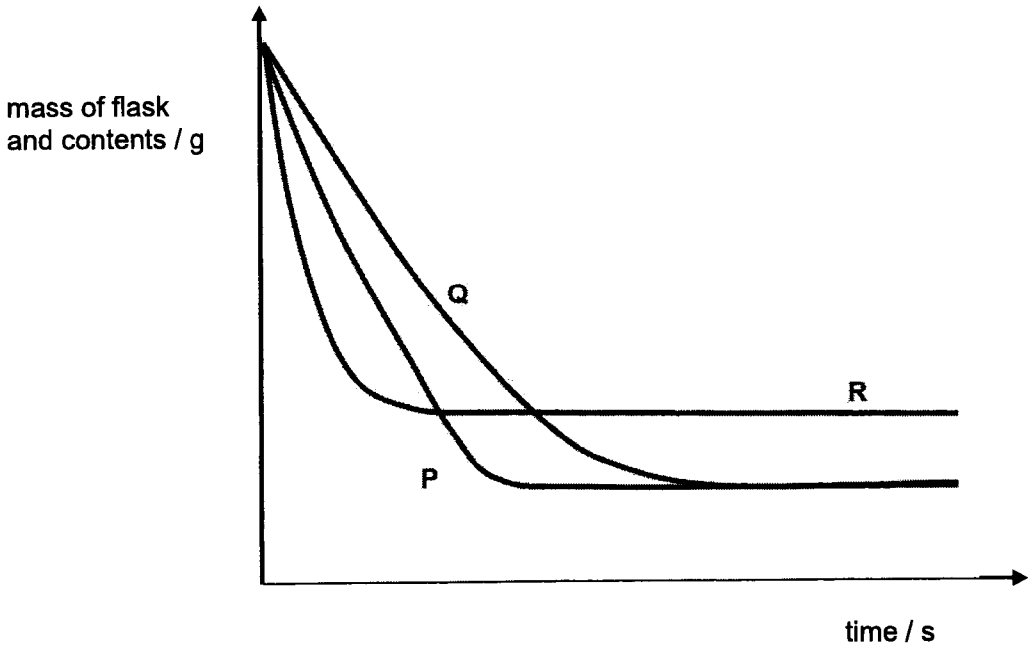



**Fig. 5.1**

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(i) Given that conical flask **P** contained 50 $cm^3$ of 2.0 $mol/dm^3$ of hydrogen peroxide and conical flask **Q** contained 80 $cm^3$ of hydrogen peroxide, calculate the concentration of hydrogen peroxide in conical flask **Q**.

[2]

(ii) Suggest a suitable volume and concentration of hydrogen peroxide in conical flask **R**.

Volume of hydrogen peroxide .....

Concentration of hydrogen peroxide .....[2]

(iii) Suggest another way to speed up the decomposition further, without the use of a catalyst or varying the concentration. Explain your answer in terms of collision theory.

.....

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.....[3]

[Total: 9]

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6 Fig. 6.1 shows the electrolysis of a concentrated solution of sodium chloride in the laboratory.

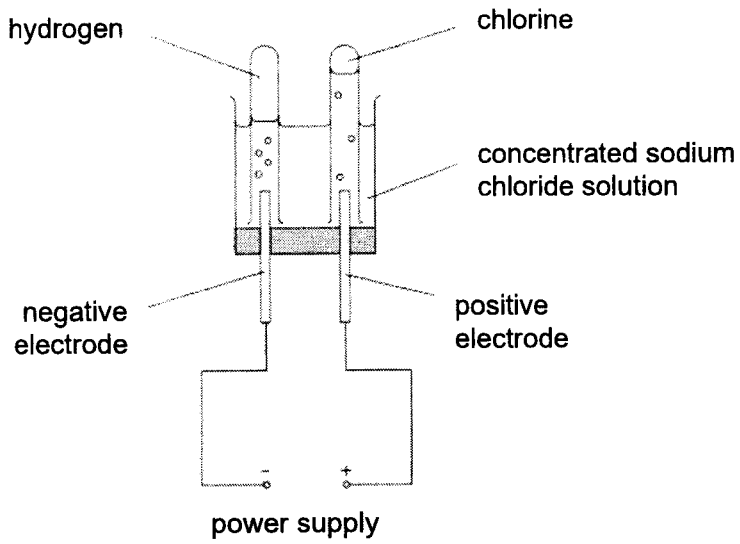



**Fig. 6.1**

**(a)** **(i)** Explain, with the use of ionic equations, why the volume of chlorine collected should be the same as the volume of hydrogen collected.

.....

.....

.....

.....[2]

**(ii)** Suggest why the volume of chlorine collected is always less than the volume of hydrogen collected.

.....[1]

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**(b)** In the chemical industry, chlorine can be produced by the electrolysis of molten sodium chloride. The overall equation for this reaction is shown below.

$$2NaCl(l) \rightarrow 2Na(l) + Cl_2(g)$$

Calculate the maximum volume, in $dm^3$, of chlorine gas that can be obtained from 23.4 tonnes of molten sodium chloride.

(1 tonne = 1000 kg)

[3]

**(c)** Nuclear submarines can stay underwater for months without needing to come to the surface.

Oxygen for the crew to breathe is produced using an equipment called an automated electrolytic oxygen generator.

Many people assume that seawater is used directly and electrolysed to produce oxygen.

Explain why the assumption is incorrect and potentially hazardous, and how seawater can be processed to obtain oxygen.

.....

.....

.....

.....

.....

.....[3]

[Total : 9]

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7 Ethanol can be manufactured by two different methods. Table 7.1 gives some information about the two methods.

**Table 7.1**

| | hydration of ethene | fermentation of glucose |
|---|---|---|
| raw material | crude oil | sugar cane |
| rate of reaction | fast | slow |
| purity of ethanol | pure | impure |
| operating temperature | 300 °C | 30 °C |
| operating pressure | 60 – 70 atmospheres | 1 atmospheres |
| catalyst | phosphoric acid | enzymes in yeast |

Use the information given in Table 7.1 to discuss the advantages and disadvantages of these two methods.

.....

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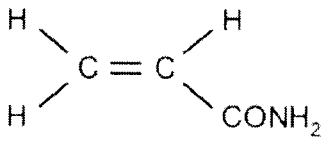
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[Total: 4]

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8 **(a)** Researchers have found the presence of acrylamide in certain foods that were heated to temperature above 120 °C. Potato chips and french fries were found to contain high levels of acrylamide.

Acrylamide is thought to be harmful to human health and has the following structure.




**(i)** Acrylamide readily polymerises to form poly(acrylamide). Draw the structure of poly(acrylamide).

[1]

**(ii)** Acrylamide reacts with water to form acrylic acid and ammonium ions. Describe the test for ammonium ion.

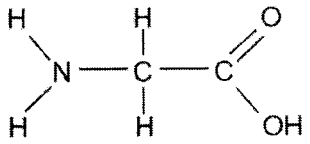
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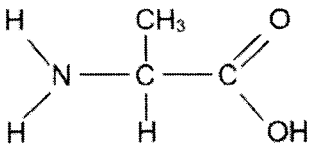
.....[2]

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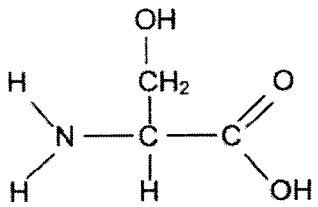
**(b)** A silk protein is made of many identical protein chains, which are made mainly from equal number of three amino acid monomers, glycine, alanine and serine.



glycine



alanine



serine

One possible structure of the silk protein is shown below.




**(i)** Name the type of polymerisation when the amino acid monomers polymerise.

.....[1]

**(ii)** Draw the structural formula of the repeat unit for the silk protein, containing the three amino acids.

[1]

**(c)** Outline two differences between the polymerisation of acrylamide in **(a)(i)** and the amino acid monomers in **(b)(i)**.

.....

.....

.....

.....[2]

[Total: 7]

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## 9 Principles of Chromatography

Chromatography makes use of the principle that components in a mixture when dissolved in a liquid or gas (mobile phase), will flow through another substance (stationary phase) at varying rates.

The rate of separation depends on how the components in the mixture interact with the stationary phase (their retention) and how soluble they are in the mobile phase.

### Gas-Liquid Chromatography

Gas-liquid chromatography is used for analysing gases, volatile liquids and solids in their vapour form. This method uses a column with a non-volatile liquid as a stationary phase. An inert carrier gas such as helium or nitrogen moves the sample molecules through the stationary phase.

The sample is injected into the column and the vapour formed is carried through the stationary phase using the inert-gas mobile phase.

Retention time is the time taken for a component to travel through the column and it is recorded on a chromatogram. The position of the peaks shows the retention time of each component in the analysed sample.

The relative sizes of the peaks are related to how much each component is present in the mixture.

Fig. 9.1 shows the chromatogram of mixture **X**, with four components, **A, B, C and D.**

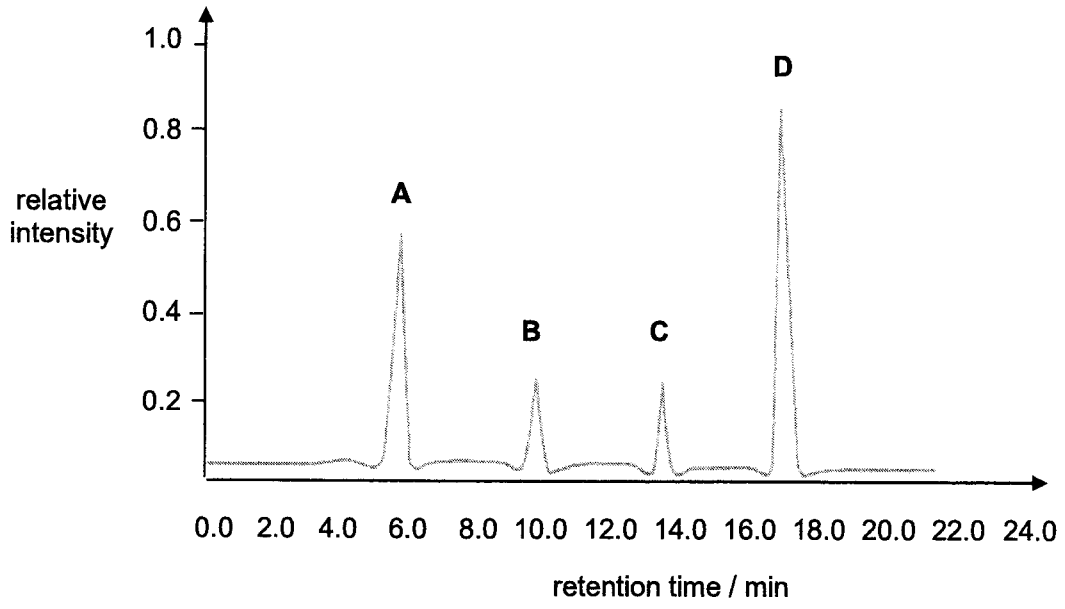



**Fig. 9.1**

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Gas-liquid chromatography is often carried out with mass spectrometry to analyse each component as it exits the chromatography column. The molecular mass of each component in the mixture can be determined and matched with the time it took for the sample to move through the column.

**Mass Spectrometry**

Mass spectrometry is an analytical technique used to identify particles of different relative mass. It involves vaporising atoms or molecules and bombarding the vapourised particles with electrons to generate a beam of positive ions.

The number of different positive ion particles produced are then separated and counted. The resulting data from the detector is called a mass spectrum. It provides accurate data on the relative masses as well as the relative abundance of all the positive ions generated from individual atoms, molecules and fragments of molecules.

Each peak in the mass spectrum corresponds to a certain fragment with a particular mass to charge ratio (m/z) value. The peak with the highest m/z value is the molecular ion which corresponds to the molecular mass of the component. The molecular ion is the entire molecule that has lost one electron when bombarded with a beam of electrons.

Gas chromatography is carried out on an organic mixture. Two of the compounds in the mixture are hydrocarbons with similar retention times.

The mass spectra of the two compounds reveals that they have the same molecular formula but with subtle differences, indicating they are isomers. Both isomers are tested with aqueous bromine, which remains orange.

The mass spectrum of one of the isomers, **Y** is shown in Fig. 9.2.

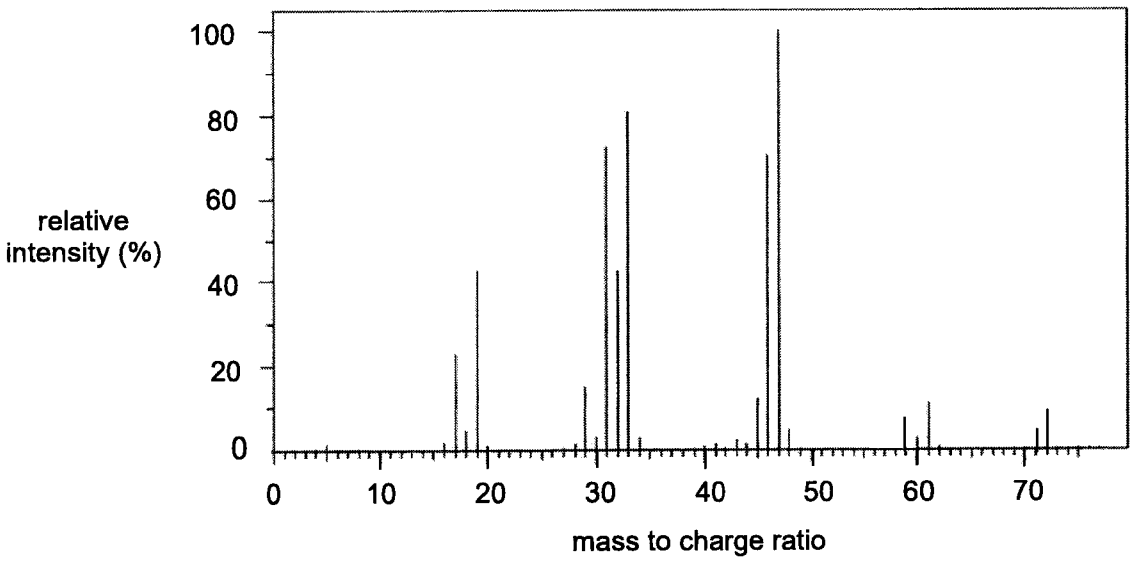



**Fig. 9.2**

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**(a)** Complete Table 9.1 to show the stationary and mobile phase of paper chromatography.

**Table 9.1**

| chromatography technique | stationary phase | mobile phase |
|---|---|---|
| gas-liquid chromatography | column with liquid | inert carrier gas |
| paper chromatography | | |

[2]

**(b)** **(i)** Which component in **X** is present in the greatest quantiy?

.....[1]

**(ii)** Which components in **X** were present in equal amounts?

.....[1]

**(iii)** Which component in **X** has the strongest interaction with the stationary phase?

.....[1]

**(c)** **(i)** What is the molecular mass of isomer **Y**?

.....[1]

**(ii)** Deduce the molecular formula of **Y**. Explain your answer.

.....

.....[2]

**(iii)** Write a balanced equation for the reaction of **Y** with excess oxygen.

.....[2]

**(iv)** Draw the full structural formula of two isomers of **Y**.

[2]

[Total: 12]

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## Section B

Answer **one** question from this section.

**10** A student conducted three experiments to investigate the chemical properties of four different metals, **J**, **K**, **L** and **M**. The results of the three experiments are recorded as shown in Table 10.1.

**Table 10.1**

| no | experiment | J | K | L | M |
|---|---|---|---|---|---|
| 1 | passing steam through the metal | a colourless gas is evolved | a colourless gas is evolved | no observable change | reacts very vigorously and a colourless gas is evolved |
| 2 | placing metal in silver nitrate | shiny silver crystals form on the surface of the metal | shiny silver crystals form on the surface of the metal | shiny silver crystals form on the surface of the metal | reacts very vigorously and a colourless gas is evolved |
| 3 | heating metal oxide with carbon at 1500°C | no observable change | formation of a silvery solid and a colourless gas is evolved | formation of a red-brown solid and a colourless gas is evolved | no observable change |

**(a)** **(i)** Write down the order of increasing reactivity of **J**, **K**, **L** and **M**.

.....[1]

**(ii)** Explain the formation of the colourless gas when **M** is placed in the silver nitrate solution.

.....[1]

**(iii)** Suggest the identity of **L**.
Write an ionic equation with state symbols for the reaction between **L** and silver nitrate solution.

.....

.....[2]

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**(b)** The student conducted a fourth experiment to determine the position of hydrogen in the list of metals **J**, **K**, **L** and **M** in their order of reactivity.

Dry hydrogen gas was passed over heated oxides of the metals separately. The results are shown in Table 10.2.

**Table 10.2**

| metal oxide | observation |
|---|---|
| oxide of metal **J** | remains white |
| oxide of metal **K** | white to yellow when hot, turns back to white when cold |
| oxide of metal **L** | colour turns from black to red-brown |
| oxide of metal **M** | remains white |

**(i)** Use the experimental results in Table 10.2 to explain the position of hydrogen.

.....

.....

.....

.....

.....[3]

**(ii)** Which one of the four metals **J**, **K**, **L** and **M**, will cause iron to corrode faster when iron is in contact with it?
Explain your answer.

.....

.....

.....

.....

.....[3]

[Total: 10]

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**11** Zamak is an alloy of zinc with magnesium, aluminium and copper. It is widely used to make die-cast toys. Magnesium and aluminium are adjacent elements in the third Period of the Periodic Table. Zinc and copper are next to each other in the first set of transition elements.

Table 11.1 shows the densities of the four metals present in Zamak.

**Table 11.1**

| metal | metal 1 | metal 2 | metal 3 | metal 4 |
|---|---|---|---|---|
| density ($g/cm^3$) | 1.74 | 2.70 | 7.13 | 8.96 |

**(a)** Suggest the identities of metals 3 and 4 present in Zamak.

.....[1]

**(b)** **(i)** When finely powdered Zamak is shaken with cold dilute hydrochloric acid, three of the metals dissolved and one remains as a solid residue. Name the solid residue.

.....[1]

**(ii)** Explain, in terms of collision theory, why finely powdered Zamak is used in the reaction.

.....

.....

.....

.....[2]

**(c)** Using ideas of arrangement of atoms in Zamak alloy, explain why Zamak is harder than pure zinc.

.....

.....

.....[2]

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**(d)** Mobile phones are made from many different substances. Table 11.2 shows the composition of substances used to make a typical mobile phone.

**Table 11.2**

| substance | percentage by mass in a typical mobile phone (%) |
|---|---|
| plastics | 56 |
| ceramics | 16 |
| copper | 15 |
| iron | 3 |
| other materials | 10 |

**(i)** Plastic is a non-biodegradable material.

Explain why being non-biodegradable is both an advantage and a disadvantage.

.....

.....

.....[2]

**(ii)** The iron used in a mobile phone must not rust.

Suggest one way to prevent the iron from rusting and explain how this method of rust prevention works.

.....

.....

.....[2]

[Total: 10]

**END OF PAPER**

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# The Periodic Table of Elements

| Group 1 | 2 | | | | | | | | | | | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 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 | 17 Cl chlorine 35.5 | 18 Ar argon 40 |
| 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 – |

**Key**

proton (atomic) number
atomic symbol
name
relative atomic mass

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lanthanoids | 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 |
| actinoids | 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 $dm^3$ at room temperature and pressure (r.t.p.).
The Avogadro constant, $L = 6.02 \times 10^{23}\ mol^{-1}$



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# 2025 MSHS S4 Chemistry Prelim Paper 1 Answer

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

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**Secondary Four Chemistry**
**Preliminary Examination 2025**
**Mark Scheme**

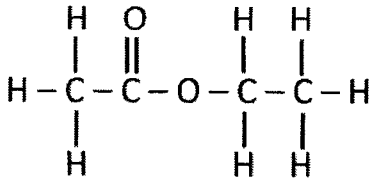
**Paper 2**

**Section A**

| Qn No. | Answer | Mark |
|---|---|---|
| 1ai | C | 1 |
| li | D | 1 |
| iii | B | 1 |
| iv | E | 1 |
| v | A | 1 |
| b | The amount of B/carbon dioxide is increasing due to the **complete combustion of fossil fuels** in vehicles and industries.<br>It takes years for trees to grow, so the **absorption of carbon dioxide through photosynthesis is much slower** than the release of carbon dioxide by complete combustion of fossil fuels. | 1<br>1 |
| | **Total** | **7** |
| | | |
| 2a | The ions in lithium are held together by **electrostatic forces of attraction** between **positive lithium ions** and the **sea of delocalised electrons.**<br>The ions in lithium chloride are held together by the **electrostatic forces of attraction** between **positively charged lithium ions and negative charged chloride ions**. | 1<br>1 |
| b | The melting and boiling points of lithium chloride are **higher** than that of lithium.<br>The electrostatic forces of attraction between oppositely charged ions in lithium chloride is **stronger** than the electrostatic forces of attraction between lithium ions and the delocalised electrons in lithium metal. | 1<br>1 |
| (c) | Both Student **A** and Student **B** are incorrect **OR**<br>Student **B** is incorrect and Student **A** is partly correct.<br>Lithium can conduct electricity in all states because of the **mobile electrons.**<br>Lithium chloride can conduct electricity when **molten / dissolved in water** because **the ions are mobile**, but **not in the solid state** because the ions are held in fixed positions and are **not mobile**.. | 1<br>1<br>1 |



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| Qn No. | Answer | Mark |
|---|---|---|
| d | One calcium atom (2, 8, 2) **loses two electrons** to two fluorine atoms, to form **positively charged calcium ion** (2, 8).<br>Each fluorine atom (2, 7) **gains one electron** to form **negatively charged fluoride ions** (2,8). | 1<br>1 |
| | **Total** | **9** |
| | | |
| 3a | 2 oxygen atoms and 1 chlorine with 4 shared pair of electrons<br>chlorine atom with 1 lone pair and 1 unshared electrons | 1<br>1 |
| b | Chlorine has undergone disproportionation.<br>Chlorine is oxidised because its oxidation state has increased from +5 in $HClO_3$ to +7 in $HClO_4$.<br>Chlorine is also reduced because its oxidation state has decreased from +5 $HClO_3$ to +4 in $ClO_2$. | 1<br>1 |
| ci | $2NaClO_2 + Cl_2 \rightarrow 2ClO_2 + 2NaCl$ | 1 |
| ii | Chlorine is the oxidising agent.<br>It oxidises sodium chlorate to chlorine dioxide / it causes the oxidation state of chlorine to increase from +3 in sodium chlorate to +4 in chlorine dioxide. | 1<br>1 |
| | **Total** | **7** |
| | | |
| 4ai | $C_3H_4O_4$ | 1 |
| ii | $C_2H_4O_2$ / $CH_3COOH$<br>Ethanoic acid | 1<br>1 |
| iii | Ethyl ethanoate | 1 |
| iv |  | 1 |
| bi | Malonic has a higher pH because it is a weak acid. | 1 |
| | **Total** | **6** |
| | | |
| | | |



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| Qn No. | Answer | Mark |
|---|---|---|
| 5a | **More energy is released/given out** in **bond forming** of **2 moles of water and 1 mole of oxygen** than the energy absorbed/taken in **bond breaking of 2 moles of hydrogen peroxide**. | 1<br>1 |
| bi | Number of moles of $H_2O_2$ in **P** = 50÷1000 x 2 = 0.1<br>Number of moles of $H_2O_2$ in **Q** = 0.1<br>Concentration of Q = 0.1÷ 0.08<br>= 1.25 mol/dm$^3$<br><br>Or Concentration of Q = (50÷80) x 2<br>= 1.25 mol/dm$^3$ | 1<br><br><br>1 |
| ii | From graph,<br>**Loss in mass** for conical flask **R** is **less** than that for conical flask **P** and **Q**.<br>Hence **number of moles of $H_2O_2$** in **R** should be **less than 0.1 mole**.<br>**Speed of reaction** for conical flask **R** is **greater** than that for conical flask **P** and **Q**.<br>Hence concentration of $H_2O_2$ in **R** shoud be greater than 2.0 mol/dm$^3$.<br><br>Any volume that gives number of moles less than 0.1 for the suggested concentration. e.g. 30 cm$^3$<br>Any concentration greater than 2.0 mol/dm$^3$ e.g. 2.5 mol/dm$^3$<br><br>No. of moles = $\frac{30}{1000}$ x 2.5 = 0.75 mol | <br><br><br><br><br><br>1<br>1 |
| iii | Increase the temperature of $H_2O_2$ solution.<br>When the **temperature raised**, particles **gain more energy and move faster**. **More particles have the minimum activation energy** to react when they collide/more particles **possess energy greater than or equal to activation energy.**<br>Hence, **frequency of effective collisions increases** and hence rate of reaction increases. | <br>1<br>1<br><br>1 |
| | **Total** | **9** |
| | | |
| 6ai | $2H^+(aq) + 2e^- \rightarrow H_2(g)$<br>$2\,Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$<br><br>For **2 moles of electrons** that passed through the circuit, **1 mole of hydrogen and 1 mole of chlorine** are formed.<br>Equal **number of moles of gases occupy equal volumes** at r.t.p., 1 volume of hydrogen and 1 volume of chlorine are formed. | 1<br><br><br>1 |

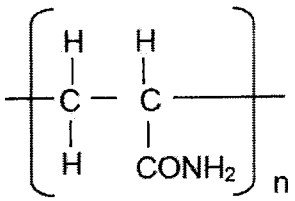
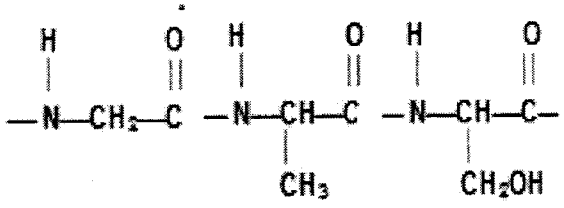


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| Qn No. | Answer | Mark |
|---|---|---|
| ii | Chlorine dissolves / soluble in acid / solution | 1 |
| b | Mr of NaCl = 23 + 35.5<br>= 58.5<br>From eqn<br>2 moles NaCl produce 1 mole $Cl_2$<br>2(58.5 g) NaCl produce 71 g $Cl_2$<br>117 g NaCl produce 71 g $Cl_2$<br>117 tonnes NaCl produce 71 tonnes $Cl_2$<br>23.4 tonnes NaCl produce (23.4 ÷ 117) x 71 tonnes $Cl_2$<br>= 14.2 tonnes<br>No. of mole of $Cl_2$ = 142 000 000 mol ÷ 71 g/mol<br>= 200 000<br>Volume of $Cl_2$ = 200 000 x 24 $dm^3$<br>= 4.80 x $10^6$ $dm^3$ | 1<br>1<br>1 |
| c | Seawater is a concentrated sodium chloride solution.<br>Electrolysis of concentrated sodium chloride solution produces chlorine which is toxic.<br>Add water to dilute the seawater. Electrolysis dilute sodium chloride solution produces hydrogen and oxygen. | 1<br>1 |
| | **Total** | **9** |
| | | |



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| Qn No. | Answer | Mark |
|---|---|---|
| 7 | **Advantages of fermentation / disadvantages of hydration:**<br>• Sugar cane can be re-grown/is renewable but crude oil is non-renewable/finite/cannot be replaced.<br>• Fermentation of glucose uses a lower temperature (30 °C) than hydration of ethene (300 °C), so energy cost is lower than that for hydration of ethene.<br>• Fermentation of glucose uses a lower pressure (1 atm) than hydration of ethene (60–70 atm) so energy cost/cost of equipment to maintain the pressure is lower than that for hydration of ethene.<br>• Yeast is a natural substance and not harmful whereas phosphoric acid is corrosive.<br>**Advantages of hydration / disadvantages of fermentation:**<br>• Hydration of ethene is a faster process whereas fermentation is a slower process.<br>• Hydration of ethene produces pure ethanol whereas fermentation produces impure ethanol.<br>Any four of the above points | 4 |
| | **Total** | **4** |
| 8ai |  | 1 |
| ii | Add aqueous sodium hydroxide to a solution containing ammonium ions. Warm the mixture gently.<br>If the gas turns damp red litmus paper blue (ammonia), then ammonium ions are present. | 1<br>1 |
| bi | Condensation polymerisation | 1 |
| ii |  | 1 |

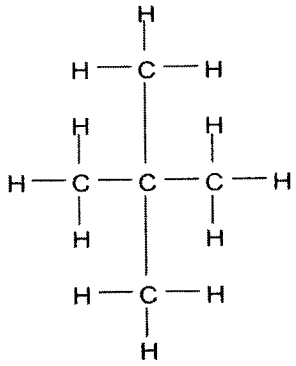
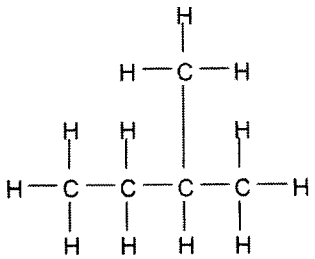


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<table>
<tr><th>Qn No.</th><th>Answer</th><th>Mark</th></tr>
<tr><td>c</td><td>Addition polymerisation of acrylamide in (a) produces only <u>one</u> product, the <u>polymer</u> whereas the condensation polymerisation in (b) produces the polymer and water as a <u>by-product</u>.<br><br>The mass of the polymer in (a) is the <u>same</u> as the mass of all the monomers added together whereas the mass of the polymer in (b) is <u>less</u> than that of all the monomers.<br><br>For addition polymerisation of in (a), the monomer has a carbon-carbon <u>double</u> bond. For the condensation polymerisation in (b), the monomers has a <u>functional</u> group at each end of the molecule.<br><br>Any two of the above differences.</td><td>2</td></tr>
<tr><td></td><td>Total</td><td>7</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>9a</td><td><table><tr><td>chromatography technique</td><td>stationary phase</td><td>mobile phase</td></tr><tr><td>paper chromatography</td><td>chromatography paper</td><td>ethanol</td></tr></table></td><td>2</td></tr>
<tr><td>bi</td><td>Component D</td><td>1</td></tr>
<tr><td>ii</td><td>Components B and C</td><td>1</td></tr>
<tr><td>iii</td><td>Component D</td><td>1</td></tr>
<tr><td>ci</td><td>72</td><td>1</td></tr>
<tr><td>ii</td><td>$C_5H_{12}$<br>It is a saturated hydrocarbon since it does not decolourise aqueous bromine.</td><td>1<br>1</td></tr>
<tr><td>iii</td><td>$C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$<br>reactants and products<br>balanced equation</td><td><br>1<br>1</td></tr>
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| Qn No. | Answer | Mark |
|---|---|---|
| iv |   | 2 |
| | **Total** | **12** |
| | | |



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## Section B

| Qn No. | Answer | Mark |
|---|---|---|
| **10ai** | (least) **L**, hydrogen, **K**, **J** and **M** (most) | 1 |
| **ii** | M is a reactive metal which **reacts with water** (present in silver nitrate solution) to **form hydrogen gas**. | 1 |
| **iii** | Copper<br>$Cu(s) + 2Ag^{+}(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$ | 1<br>1 |
| **bi** | Oxide of metal **L** turns from black to red-brown as it is **reduced by hydrogen** to form metal **L** (red-brown). This shows that **hydrogen is more reactive** than metal **L** (copper).<br><br>Oxides of metals **K, J** and **M** remain white as they are **not reduced by hydrogen**. This shows that **hydrogen is less reactive** than metals **K, J** and M, it cannot reduce oxides of metal **K**, J and M. | 1<br><br>1<br>1 |
| **ii** | Metal **L** (or Copper).<br>Iron is **more reactive** than metal **L**.<br>Iron **loses electrons more readily** than metal **L**, the electrons will move to metal **L**. Hence corrosion of iron becomes faster. | 1<br>1<br>1 |
| | **Total** | **10** |
| | | |
| **11a** | Copper and zinc | 1 |
| **bi** | Copper | 1 |
| **ii** | Powdered Zamak has smaller particle size with greater surface area exposed to the acid for reaction.<br><br>Thus, the frequency of effective collisions increases and rate of reaction is higher. | 1<br><br>1 |
| **c** | Atoms in pure zinc are of the **same size** and arranged in an **orderly manner**. Layers of atoms can slide over one another.<br><br>**Different sizes of atoms** (aluminium, copper & magnesium) in the alloy **disrupts the orderly arrangement**, making it difficult for the **layers of atoms** to slide over one another. | 1<br><br>1 |
| **di** | Non-biodegradable materials are not easily decomposed by bacteria in the soil and hence they have a longer life span.<br><br>However, disposal of non-biodegradable materials result in accumulation of waste in landfill, causing environmental pollution. | 1<br><br>1 |



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| Qn No. | Answer | Mark |
|---|---|---|
| ii | Sacrificial protection.<br>Metal in sacrificial metal loses electrons more easily than iron / sacrificial metal oxidised in preference to iron / sacrificial metal more reactive (magnesium) than iron.<br><br>OR<br><br>Covering the iron with plastic prevents iron from coming into contact with oxygen and/or water. | 1<br>1 |
| | **Total** | **10** |



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