中正中学 义顺

CHUNG CHENG HIGH SCHOOL (YISHUN)

O

# 2025 Preliminary Examination
## Secondary Four Express

CANDIDATE NAME

CLASS

INDEX NUMBER

# CHEMISTRY

**6092/01**

Paper 1 Multiple Choice

**20 August 2025**

Additional Materials: OTAS

**1 hour**

**READ THESE INSTRUCTIONS FIRST**

Write your name, class and index number in the spaces at the top of this page and on the OTAS provided.

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

**Read the instructions on the OTAS very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this question paper.
A copy of the Periodic Table is printed on page **20**.
The use of an approved scientific calculator is expected, where appropriate.

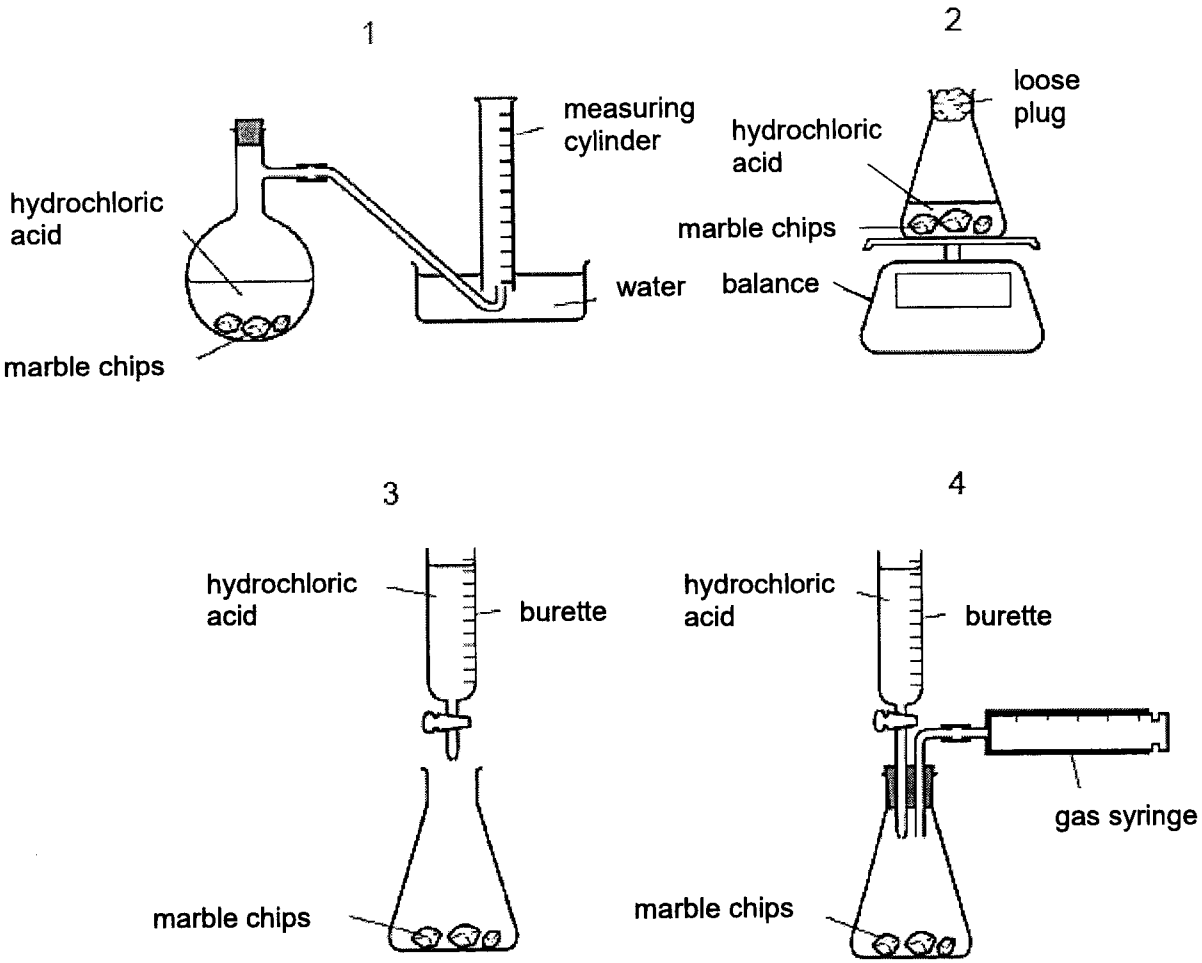


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1 A student follows the rate of reaction between marble chips, $CaCO_3$ and dilute hydrochloric acid.

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

Which set-ups show the apparatus that are suitable for this experiment?




**A** 1 and 2 only

**B** 1 and 3 only

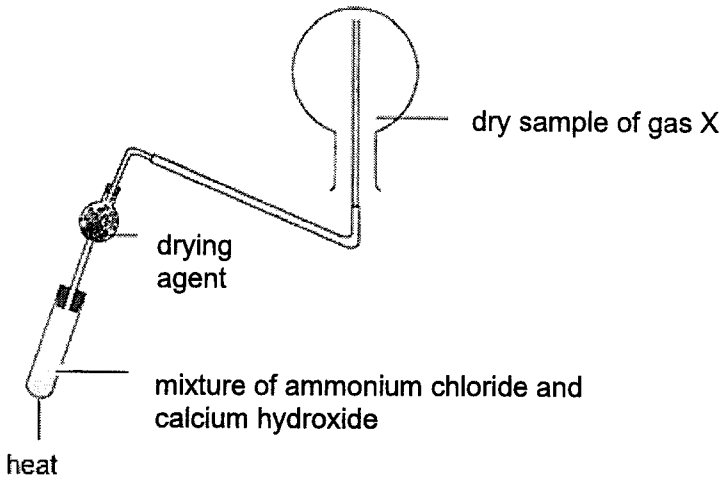
**C** 2 and 4 only

**D** 1, 2 and 4 only



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2 A student sets up the apparatus as shown below to collect a sample of clean, dry gas X.




Which row correctly gives the identity of gas X and drying agent?

| | gas X | drying agent |
|---|---|---|
| **A** | ammonia | calcium oxide |
| **B** | ammonia | concentrated sulfuric acid |
| **C** | hydrogen chloride | calcium oxide |
| **D** | hydrogen chloride | concentrated sulfuric acid |

3 Which sequence of procedures is used to separate a pure, dry sample of hydrated copper(II) sulfate, $CuSO_4.5H_2O$, from a mixture containing hydrated copper(II) sulfate and calcium carbonate, $CaCO_3$?

**A** dissolve in water → distillation → crystallisation

**B** dissolve in water → filtration → crystallisation

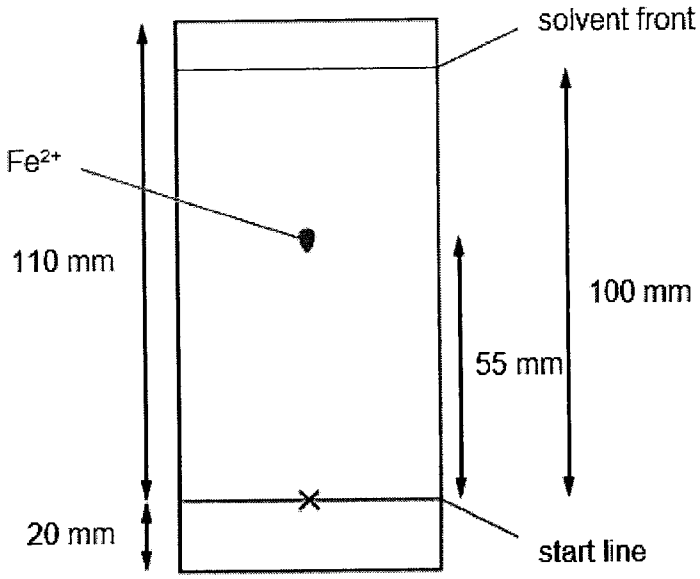
**C** distillation → crystallisation → heating to remove all water

**D** fractional distillation → filtration → heating to remove all water



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4 A paper chromatography experiment is used to find the $R_f$ value for $Fe^{2+}(aq)$. The chromatogram is shown.




To make the spot containing $Fe^{2+}(aq)$ more visible, the paper is sprayed with a locating agent that forms a precipitate of iron(III) hydroxide on the spot.

In the chromatogram, the $R_f$ of $Fe^{2+}(aq)$ is given by .....(1)..... and the colour of the precipitate is .....(2).....

| | (1) | (2) |
|---|---|---|
| **A** | 0.50 | red-brown |
| **B** | 0.50 | green |
| **C** | 0.55 | red-brown |
| **D** | 0.55 | green |

5 A liquid is suspected to be pure ethanol.

What is the best way to test its purity?

**A** burn it completely in oxygen

**B** measure its boiling point

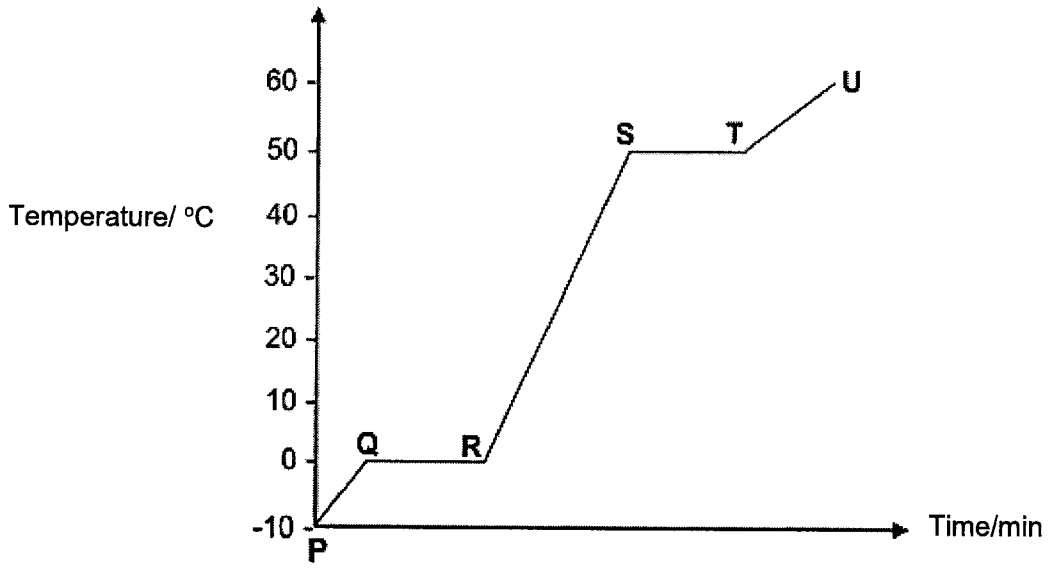
**C** react with ethanoic acid

**D** test with litmus paper



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6 The graph shows the change in the temperature of a substance with time when it is heated from -10°C to 60°C.




Which statement describes the change taking place between the points?

**A** Energy is released from points P to Q.

**B** Kinetic energy of the particles remains constant from points P to U.

**C** Particles gain energy to weaken the forces of attraction from points S to T.

**D** There is a large increase in the volume of the substances from points R to S.

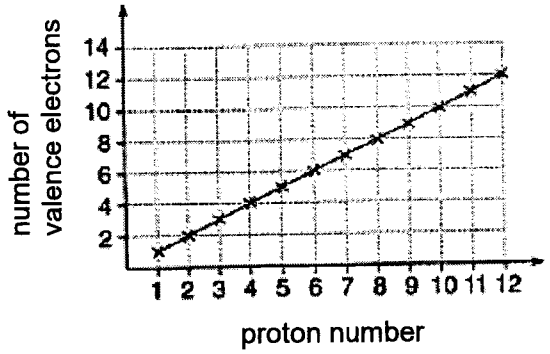


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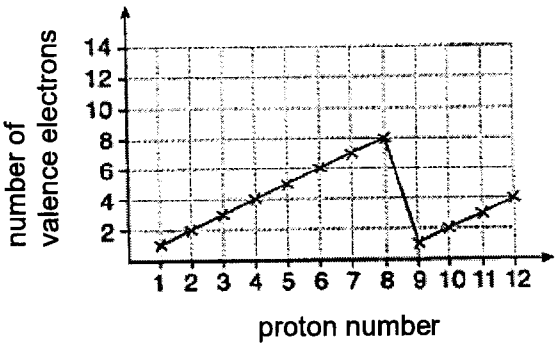
7 The number of valence electrons for elements hydrogen to magnesium was plotted against the proton number of the element.

Which graph was obtained?

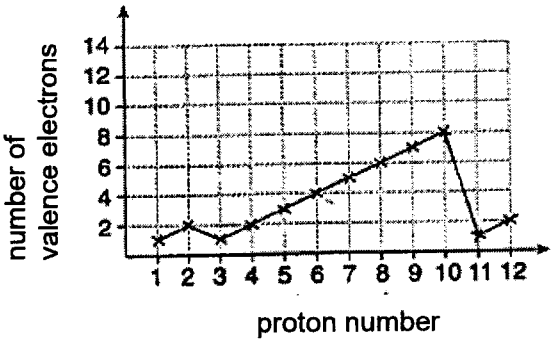
A



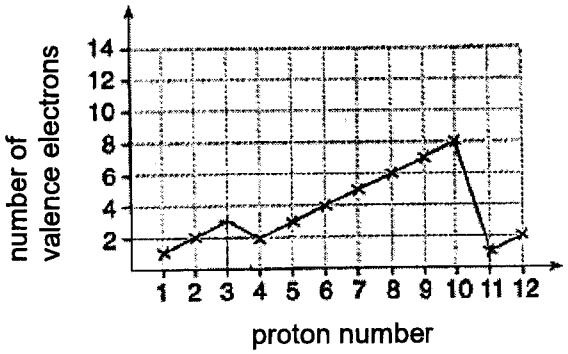

B




C



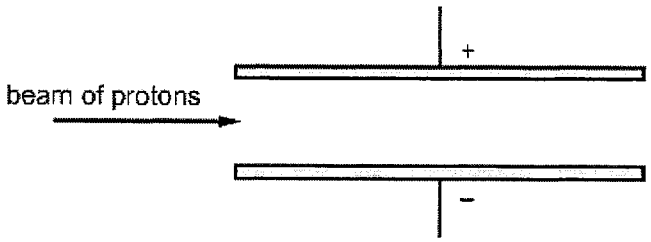

D






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8 A beam of protons was passed through an electrostatic field between two charged plates. The electrostatic field deflected the beam of protons towards the negatively charged plates. The lower the relative mass of the particle, the larger the deflection.




The experiment was repeated using a beam of electrons in place of the beam of protons.

Which row correctly shows the extent of deflection and the direction of the beam of electrons?

| | extent of deflection of beam of electrons | direction of deflection of beam of electrons |
|---|---|---|
| **A** | deflected less than beam of protons | opposite direction to beam of protons |
| **B** | deflected less than beam of protons | same direction as beam of protons |
| **C** | deflected more than beam of protons | opposite direction to beam of protons |
| **D** | deflected more than beam of protons | same direction as beam of protons |

9 An atom of element X is represented by ${}^{9}_{4}X$.

Which statement about an atom of X is correct?

**A** It is in Group 14 of the Periodic Table.

**B** It is in Period 4 of the Periodic Table.

**C** It forms an ion with a 2+ charge.

**D** The total number of protons and neutrons is 13.



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

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

**A** Bromine contains the two isotopes in equal proportions.

**B** Bromine has different number of electrons.

**C** Bromine isotopes have different number of protons.

**D** Bromine is radioactive.

**11** Which substance contains both ionic and covalent bonds?

**A** ammonium chloride

**B** hydrogen chloride

**C** lithium oxide

**D** silicon dioxide

**12** A substance Y

- has a high melting point;
- is a good conductor of electricity;
- is malleable.

What could Y be?

**A** graphite

**B** iron

**C** potassium chloride

**D** silicon dioxide



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**13** Some properties of substances P, Q and R are given in the table below.

| substance | percentage composition by mass | electrical conductivity when solid | effect of heat |
|---|---|---|---|
| P | constant | yes | solid burns in air to form an oxide |
| Q | varies | no | liquid burns to form carbon dioxide and water |
| R | constant | no | solid decomposes to form two products |

Which row shows the correct classification of the substances as an element, a mixture or a compound?

| | compound | element | mixture |
|---|---|---|---|
| **A** | P | Q | R |
| **B** | P | R | Q |
| **C** | Q | P | R |
| **D** | R | P | Q |

**14** 0.24 g of an element, X, is reacted with 240 $cm^3$ $Cl_2$ to form a chloride with the formula $XCl_2$ at r.t.p.

What is element X?

**A** carbon

**B** calcium

**C** magnesium

**D** titanium



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**15** The manufacture of nitric acid, $HNO_3$, involves 2 steps.

Step 1: $2NO + O_2 \rightarrow 2NO_2$
Step 2: $4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$

What is the maximum number of moles of nitric acid that could be formed from 0.50 moles of nitrogen monoxide, NO?

**A** 0.125 **B** 0.25 **C** 0.50 **D** 1.00

**16** Which hydrocarbon has the highest percentage of hydrogen by mass?

**A** $CH_4$ **B** $C_3H_8$ **C** $C_4H_{10}$ **D** $C_5H_{12}$

**17** On heating, ammonium nitrate, $NH_4NO_3$, decomposes to form dinitrogen oxide and water.

$$NH_4NO_3 \rightarrow N_2O + 2H_2O$$

When 100 g of an impure sample of ammonium nitrate is heated, 30 g of water is formed.

What is the percentage purity of ammonium nitrate in the sample?

**A** 33.3% **B** 66.7% **C** 75% **D** 88.3%

**18** A student titrates 25.00 $cm^3$ of 0.100 $mol/dm^3$ of sulfuric acid with 0.250 $mol/dm^3$ of sodium hydroxide using a methyl orange indicator.

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

She records the volume of sodium hydroxide used to be 24.00 $cm^3$.

Which statement(s) is/are correct?

1 The colour of the solution at the end of the titration is yellow.
2 The colour of the solution at the end of the titration is orange.
3 She has exceeded the end-point of the titration.
4 She has just reached the end-point of the titration.

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



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**19** Which of the following oxides can react with aqueous potassium hydroxide?

**A** $CO_2$ and BaO

**B** $CO_2$ and $H_2O$

**C** $CO_2$ and PbO

**D** $CO_2$ only

**20** When an excess of lead(II) carbonate reacts with dilute sulfuric acid, the reaction stops after only a small amount of gas has been given off.

Which statement best explain why this happens?

**A** An insoluble layer of lead(II) sulfate is formed on lead(II) carbonate.

**B** The concentration of acid decreases rapidly.

**C** The lead(II) carbonate is unreactive.

**D** The lead(II) carbonate is impure.

**21** Which method of preparation is suitable for making these salts?

| | titration | metal + acid | metal carbonate + acid | precipitation |
|---|---|---|---|---|
| **A** | potassium nitrate | silver chloride | copper(II) sulfate | zinc sulfate |
| **B** | potassium nitrate | zinc sulfate | copper(II) sulfate | silver chloride |
| **C** | zinc sulfate | sodium nitrate | silver chloride | copper(II) sulfate |
| **D** | zinc sulfate | copper(II) sulfate | potassium nitrate | silver chloride |

**22** Industrial ammonia is obtained by the Haber process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92 \text{ kJ / mol}$$

Which statement is **incorrect** about the process?

**A** The industrial catalyst used is finely divided iron.

**B** The reaction is endothermic, hence a temperature of 450°C is used.

**C** The hydrogen needed is obtained mainly by cracking of petroleum oil.

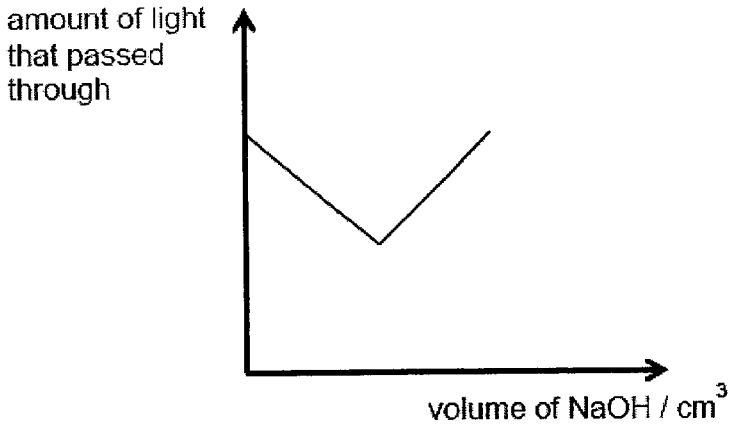
**D** 250 atm favours the production of ammonia but is difficult to maintain.



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**23** An aqueous solution of a salt, X, is placed in a test-tube and sodium hydroxide is gradually added. A light meter is used to measure the amount of light passing through the test-tube.

The amount of light that passes through the test-tube was plotted against the volume of sodium hydroxide solution added.




What is X?

**A** ammonium chloride

**B** calcium nitrate

**C** copper(II) nitrate

**D** zinc chloride

**24** Disproportionation is a reaction in which the same element is oxidised and reduced simultaneously.

Which reaction is an example of disproportionation?

**A** $3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$

**B** $2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$

**C** $2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$

**D** $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$



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**25** A student is presented with two gases, X and Y. He bubbles both gases in different solutions and makes the following observations.

| gas | observations |
|---|---|
| X | colourless solution of potassium iodide turns brown |
| Y | purple acidified potassium manganate(VII) turns colourless |

Which row correctly gives the identity of gas X and gas Y?

| | gas X | gas Y |
|---|---|---|
| **A** | oxidising agent | oxidising agent |
| **B** | oxidising agent | reducing agent |
| **C** | reducing agent | oxidising agent |
| **D** | reducing agent | reducing agent |

**26** The table gives statements about the properties between an electrolytic cell and a simple cell.

In which row are both statements correct?

| | electrolytic cell | simple cell |
|---|---|---|
| **A** | converts chemical energy to electrical energy | converts electrical energy to chemical energy |
| **B** | movement of positive and negative ions across electrolyte | flow of electrons from reactive metal to less reactive metal |
| **C** | reduction takes place at positive electrode | oxidation takes place at positive electrode |
| **D** | electrolyte decomposes to form new substances | positive electrode dissolves |



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**27** In an electrolysis experiment, the same amount of charge deposited 38.4 g of copper and 14.4 g of titanium. The charge on the copper ion is 2+ and titanium has a relative atomic mass of 48.

What was the charge on the titanium ion?

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

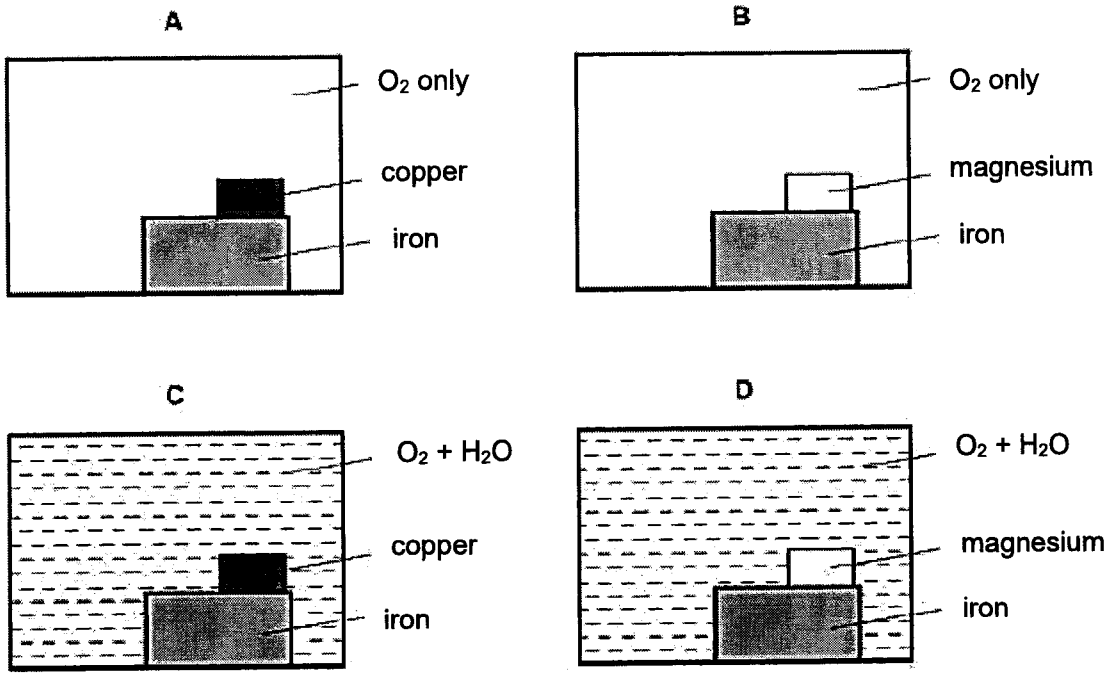
**28** Four elements identified only as W, X, Y and Z are all found in the third period of the Periodic Table. W, X, Y and Z are not the actual chemical symbols of the elements.

1 W does not lose, gain or share electrons with other elements.
2 X forms an alkaline solution when reacted with cold water.
3 Y is diatomic.
4 X and Z forms ions which are smaller than their atoms.

Using the information provided, what is the most likely order of arrangement of these elements from left to right in the third period?

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

**29** Which diagram correctly shows the conditions necessary for the rusting of iron and also the metal that can be used to prevent rusting by sacrificial protection?






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**30** Which metal carbonate is most likely to melt but not decompose upon heating?

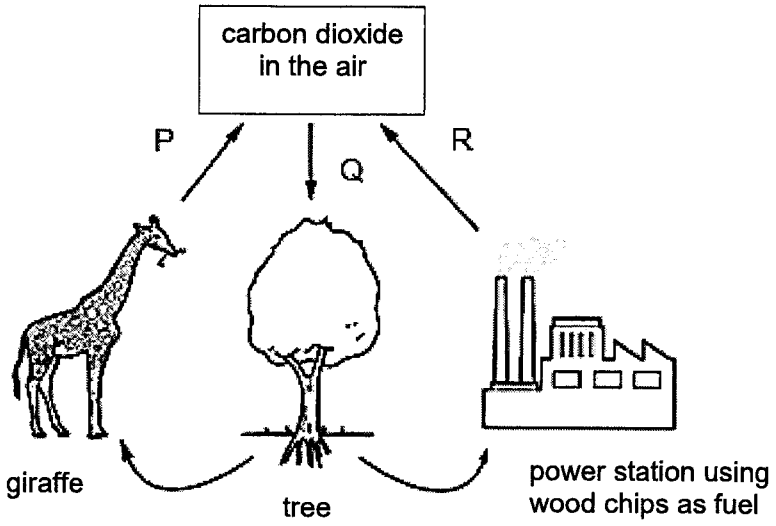
**A** copper(II) carbonate

**B** iron(III) carbonate

**C** lead(II) carbonate

**D** potassium carbonate

**31** The diagram shows part of the carbon cycle. P, Q and R refer to specific processes of the carbon cycle.



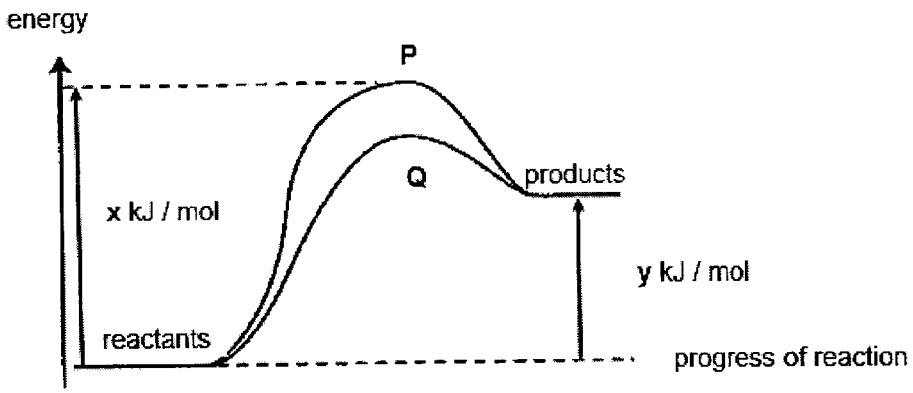

Which row correctly describe the energy changes of these processes?

| | P | Q | R |
|---|---|---|---|
| **A** | endothermic | exothermic | endothermic |
| **B** | endothermic | exothermic | exothermic |
| **C** | exothermic | endothermic | endothermic |
| **D** | exothermic | endothermic | exothermic |



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**32** The energy profile diagram shows two different paths, P and Q.




Which conclusion can be made based on the diagram?

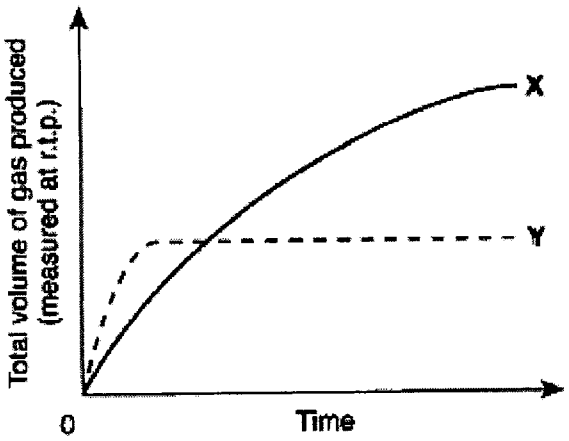
**A** Enthalpy change of the reaction equals (x-y) kJ/mol.

**B** The path Q is achieved by using a catalyst.

**C** The temperature of the surrounding increases when the products are formed.

**D** More products are formed through path Q than through path P.

**33** In the graph shown below, curve X represents the results of the reaction between 2 g of zinc granules and an acid in excess at 25°C.




Which change will produce curve Y?

**A** using 2 g of zinc granules at 30°C

**B** using 1 g of zinc granules at 15°C

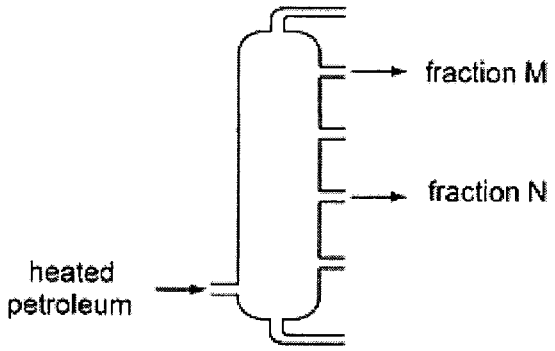
**C** using 1 g of zinc granules at 30°C

**D** using 2 g of zinc powder at 15°C



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




Which row about fraction M and N is 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 | false |
| **C** | false | true | true |
| **D** | false | false | true |

**35** Which statement is correct about vegetable oil and the margarine made from it?

**A** Both are liquids at room temperature and pressure.

**B** Both occur naturally.

**C** Margarine has a higher melting point.

**D** Vegetable oil has fewer carbon-carbon double bonds than margarine.



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**36** An alcohol X was fully oxidised to a carboxylic acid. Neutralisation of the acid with calcium carbonate gave a salt of formula $(CH_3CO_2)_2Ca$.

What was alcohol X?

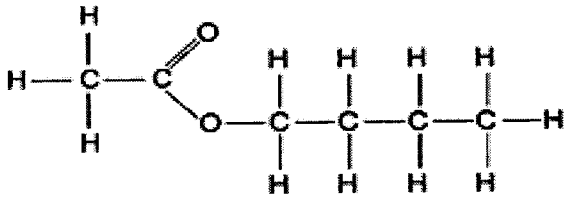
**A** $CH_3OH$

**B** $C_2H_5OH$

**C** $C_3H_7OH$

**D** $C_4H_9OH$

**37** A food chemist wants to create the odour of pineapples using the organic compound shown below.



Which row correctly shows the pair of reactants that would react to form this compound and the name of the compound?

| | reactant 1 | reactant 2 | name of compound |
|---|---|---|---|
| **A** | $CH_3CH_2OH$ | $CH_3CH_2CH_2CH_2OH$ | ethyl butanoate |
| **B** | $CH_3CH_2OH$ | $CH_3CH_2CH_2COOH$ | ethyl butanoate |
| **C** | $CH_3COOH$ | $CH_3CH_2CH_2CH_2OH$ | butyl ethanoate |
| **D** | $CH_3CH_2CH_2COOH$ | $CH_3COOH$ | butyl ethanoate |



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**38** What are formed when glucose is fermented?

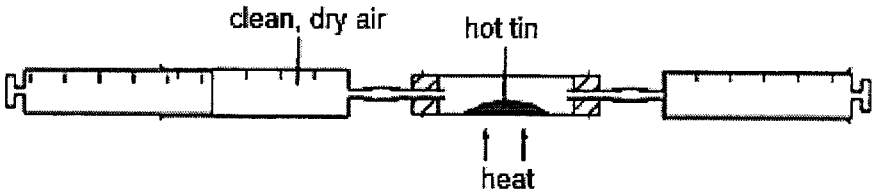
**A** ethanol and carbon dioxide

**B** ethanol and oxygen

**C** ethene and carbon dioxide

**D** ethene and oxygen

**39** A sample of clean, dry air is passed over hot tin until all the oxygen in the air has reacted with tin.




The volume of air decreases by 30 $cm^3$.

What was the estimated original volume of the sample of air?

**A** 6 $cm^3$ **B** 40 $cm^3$ **C** 120 $cm^3$ **D** 145 $cm^3$

**40** Which statement is true about atmospheric pollutants?

**A** Carbon monoxide is oxidised by oxygen and dissolves in rainwater to form acid rain.

**B** Hydrocarbons react with fluorine to produce a gas that depletes the ozone layer.

**C** Ozone at low altitudes in the atmosphere helps to block off ultraviolet rays.

**D** Sulfur dioxide can be removed from flue gases by passing over calcium carbonate.



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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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中正中学 义顺

CHUNG CHENG HIGH SCHOOL (YISHUN)

O

# 2025 Preliminary Examination
## Secondary Four Express

CANDIDATE NAME

CLASS

INDEX NUMBER

# CHEMISTRY

**6092/02**

Paper 2

**19 August 2025**

Candidates answer on the Question Paper.
Additional Materials: NIL

**1 hour 45 minutes**

**READ THESE INSTRUCTIONS FIRST**

Write your name, class and index number in the spaces at the top of this page.
Write in dark blue or black pen.
You are to use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, glue, correction fluid or correction tape.

**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 | |
| Section B | |
| Total | |



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## Section A

Answer **all** questions.

**1** Fig. 1.1 shows part of the Periodic Table.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Li | | | | | | | | | | | | | C | N | O |
| | | | | | | | | | | | | Al | | | |
| | Ca | | | | | | Fe | | | Cu | Zn | | | | |

**Fig. 1.1**

Select elements from Fig. 1.1 to answer the following questions. You may use each element once, more than once or not at all.

Write down the symbol for an element which

**(a)** forms a stable ion by losing three electrons,

.....[1]

**(b)** exists as diatomic molecules,

.....[1]

**(c)** forms an ion which gives a red-brown precipitate on additon of aqueous ammonia,

.....[1]

**(d)** has chemical properties similar to those of magnesium,

.....[1]

**(e)** has a giant covalent structure,

.....[1]

**(f)** reacts with sodium to form an ionic compound with Mr less than 70.

.....[1]

[Total: 6]



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**2** Fig. 2.1 shows the label on a bottled mineral water.

| ions present | mol/dm$^3$ |
|---|---|
| $Ca^{2+}$ | 20 |
| $K^+$ | 30 |
| $Na^+$ | 145 |
| $H^+$ | 185 |
| $OH^-$ | 225 |
| $HCO_3^-$ | 289 |
| $SO_4^{2-}$ | 410 |

| | |
|---|---|
| dry residue at 180°C | 210 mol/dm$^3$ |

**Fig. 2.1**

**(a)** Suggest whether the bottled mineral water is acidic, alkaline or neutral.

Explain your reasoning.

.....

.....[2]

**(b)** State the name and formulae of two salts that could be present in the bottled mineral water.

| | name of salt | formula of salt |
|---|---|---|
| salt 1 | | |
| salt 2 | | |

[2]

**(c)** Describe how the dry residue is obtained from the bottled mineral water.

.....[1]

[Total: 5]



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3 Fig. 3.1 shows a strip of moist Universal Indicator paper pasted in a hollow cylindrical tube.

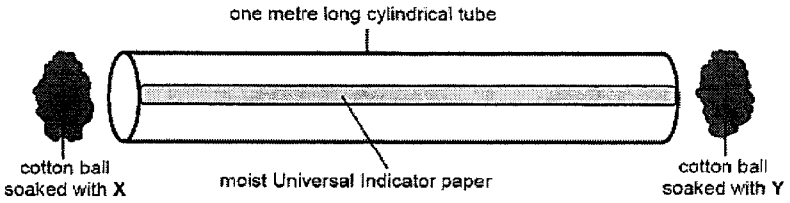



**Fig. 3.1**

One cotton ball is soaked with concentrated hydrochloric acid which will produce hydrogen chloride gas. The other cotton ball is soaked with concentrated aqueous ammonia which will produce ammonia gas.

Both cotton balls are inserted at both ends of the cylindrical tube simultaneously.

When no more changes are observed on the Universal Indicator paper, the cotton balls are removed, and the Universal Indicator paper is taken out.

The results are shown in Fig. 3.2.

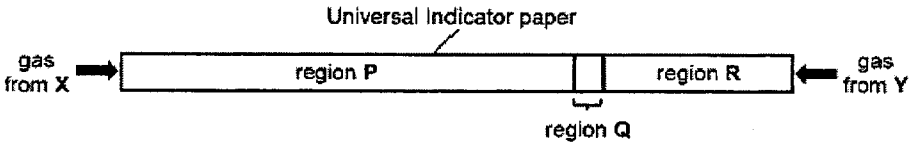



**Fig. 3.2**

Region **P** is uniformly of one colour and region **R** of another colour.

**(a)** Suggest identity of **X** and **Y**.

Explain your answer.

.....

.....

.....

.....[3]

**(b)** State the colours of region **P** and region **R**.

Region **P**: ..... Region **R**: ..... [2]

**(c)** Region **Q** remains green throughout the experiment. Explain why.

.....

.....[1]

[Total: 6]



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4 Table 4.1 shows information about the atomic radii and ionic radii of some Group 1 and Group 17 elements.

**Table 4.1**

| element | atomic radius/pm | ionic radius/pm |
|---|---|---|
| lithium | 152 | 68 |
| sodium | 185 | 98 |
| chlorine | 99 | 181 |
| bromine | 115 | 196 |

**(a)** Describe, in terms of electron loss and gain, how and why a lithium atom reacts with a chlorine atom.

.....

.....

.....

.....[2]

**(b)** Describe and explain, in terms of electron shells, the change in radius when a lithium atom forms a lithium ion.

.....

.....

.....

.....[2]

**(c)** What would you observe when aqueous bromine is added to lithium chloride solution?

Explain your answer.

.....

.....

.....

.....[2]

[Total: 6]



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**5** Climate change is become increasingly severe, leading to more frequent weather events.

To reduce the amount of pollutants in the air, countries around the world has made it compulsory for catalytic converters to be installed in vehicles and encouraged the planting of more trees.

**(a)** Within a catalytic converter, the following reactions take place.

$$2CO + 2NO \rightarrow 2CO_2 + N_2$$

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$

**(i)** Explain how catalytic converter reduces the amount of pollutants released in the air.

.....

.....[1]

**(ii)** Explain why the catalytic converter does **not** solve all the environmental problems caused by the pollutant gases in the exhaust emissions from cars.

.....

.....[1]

**(b)** Suggest **two** reasons why planting more trees does **not** solve the problem of global warming caused by the use of vehicles.

.....

.....

.....[2]



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**(c)** Ethanol can also be used as a car fuel. In some countries, it is produced from the sugars in the sugar cane.

An environmentalist claims that ethanol as a fuel is 'carbon neutral' because using it does **not** add to the amount of carbon dioxide in the atmosphere.

Explain why this is true.

.....

.....

.....

.....

.....

.....[3]

[Total: 7]



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6 Three experiments are conducted using iron, manganese and chromium and the observations from each experiment are recorded.

Experiment 1: The metals are added separately into flasks of dilute sulfuric acid.
Experiment 2: The metals are heated strongly in air.
Experiment 3: Strips of the metals are added into flasks of metal salt solutions.

The results for Experiments 1 and 2 are shown in Table 6.1.

**Table 6.1**

| metal | experiment 1 | experiment 2 |
|---|---|---|
| iron | metal dissolves slowly with effervescence, a pale green iron(II) sulfate solution is formed | burns in air to form a dark brown iron(III) oxide solid |
| manganese | metal dissolves very quickly with effervescence, a pale pink manganese(II) sulfate solution is formed | burns in air with an intense white light forming a red solid mixture of manganese(II) oxide and manganese(III) oxide |
| chromium | metal dissolves readily with effervescence, a violet chromium(II) sulfate solution is formed | burns in air to form green chromium(III) oxide |

**(a)** Using information from Table 6.1, give reasons why iron, manganese and chromium can be identified as transition metals.

.....

.....

.....[2]

**(b)** **(i)** Write an ionic equation, with state symbols, for the reaction of chromium metal with dilute sulfuric acid.

.....[2]

**(ii)** In terms of electron transfer, explain why the reaction in **(b)(i)** is a redox reaction.

.....

.....

.....[2]



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**(c)** Fig. 6.1 illustrates the different set-ups in experiment 3.

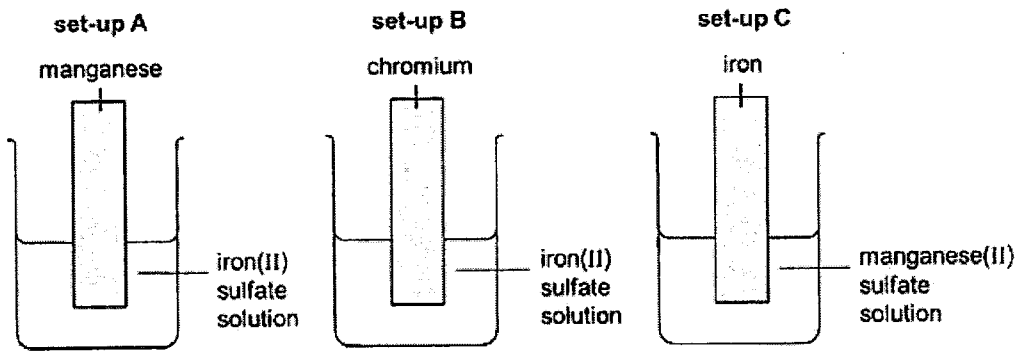



**Fig. 6.1**

List the three metals in order of increasing reactivity. Hence, describe the observations you would see for set-ups **A**, **B** and **C**.

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 10]



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7 Table 7.1 compares the time taken for excess alloy to react with ethanoic acid, hydrochloric acid and phosphoric acid, each at three different concentrations.

The time taken for the alloy to decrease in mass by 1.0 g was measured. Hydrogen gas was collected as the alloy reacts with the acid. All other conditions are kept the same.

**Table 7.1**

| concentration of acid, mol/dm$^3$ | time taken for alloy to decrease in mass by 1.0 g/min | | |
|---|---|---|---|
| | ethanoic acid | hydrochloric acid | phosphoric acid |
| 0.04 | 92 | 2 | 19 |
| 0.02 | 190 | 6 | 39 |
| 0.01 | 410 | 18 | 80 |

**(a)** Using ideas of colliding particles, explain how the concentration of acid affects the rate of reaction.

.....

.....

.....

.....[3]

**(b)** Estimate the time taken for the mass of alloy to decrease by 1.0 g if 0.01 mol/dm$^3$ sulfuric acid reacts with the excess alloy.

.....[1]

**(c)** A student makes the following statement:

"The final volume of hydrogen gas collected for the concentration of 0.02 mol/dm$^3$ of hydrochloric acid and 0.02 mol/dm$^3$ ethanoic acid would be different."

Is this statement correct?

Explain your reasoning.

.....

.....

.....[2]



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**(d)** 20.0 $cm^3$ of sodium hydroxide is transferred to a conical flask. A few drops of an indicator are added into the flask and titrated against 0.5 $mol/dm^3$ hydrochloric acid. 20.0 $cm^3$ of the sodium hydroxide requires 18.50 $cm^3$ of acid for the colour of indicator to change.

Calculate the concentration of sodium hydroxide in $g/dm^3$.

[4]

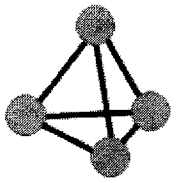
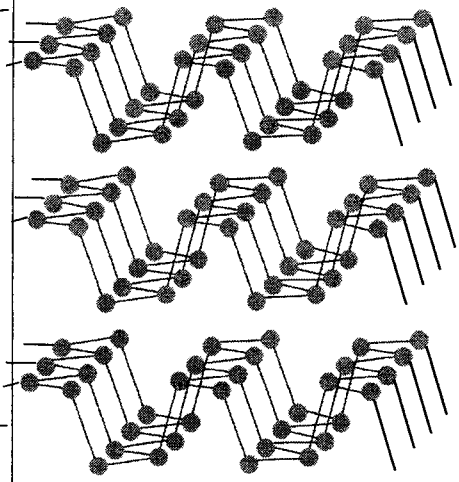
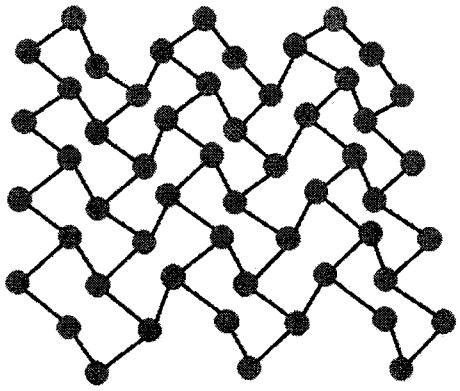
[Total: 10]



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**8** Phosphorus can exist as different allotropes where the same element can be arranged differently. The structures and melting points of two such allotropes, white phosphorus and black phosphorus, are shown in Table 8.1

**Table 8.1**

| allotrope | structure | melting point/ °C |
|---|---|---|
| white phosphorus |  | 44 |
| black phosphorus | part of the structure (side view):  layers of atoms<br>part of the structure of one single layer (top view):  | 610 |



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**(a)** State the chemical formula of white phosphorus.

.....[1]

**(b)** Identify the structure of each allotrope of phosphorus.

white phosphorus .....

black phosphorus .....[2]

**(c)** Explain, in terms of bonding, the difference in the melting points of the two allotropes of phosphorus.

.....

.....

.....

.....

.....[3]

**(d)** State another physical property of white phosphorus.

.....[1]

**(e)** A single layer of black phosphorus can be obtained by using the adhesive tape delamination method. This method involves the use of an adhesive tape to peel off a single layer.

Suggest why a single layer of black phosphorus can be easily peeled off using a adhesive tape.

.....

.....[1]

[Total: 8]



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## 9 Properties of Alkynes

The alkynes are a homologous series of hydrocarbons. All alkynes contain a carbon to carbon triple bond (C ≡ C). Table 9.1 gives the structural formula of some alkynes.

**Table 9.1**

| name of alkyne | structural formula | molecular formula | Mr |
|---|---|---|---|
| ethyne | H — C ≡ C — H | $C_2H_2$ | 26 |
| propyne | H — C ≡ C — $CH_3$ | $C_3H_4$ | 40 |
| butyne | H — C ≡ C — $CH_2$ — $CH_3$ | $C_4H_6$ | 54 |
| pent-1-yne | H — C ≡ C — $CH_2$ — $CH_2$ — $CH_3$ | $C_5H_8$ | 68 |

Fig. 9.1 shows the graph of boiling points of some alkynes plotted against the number of carbon atoms in each alkyne molecule.

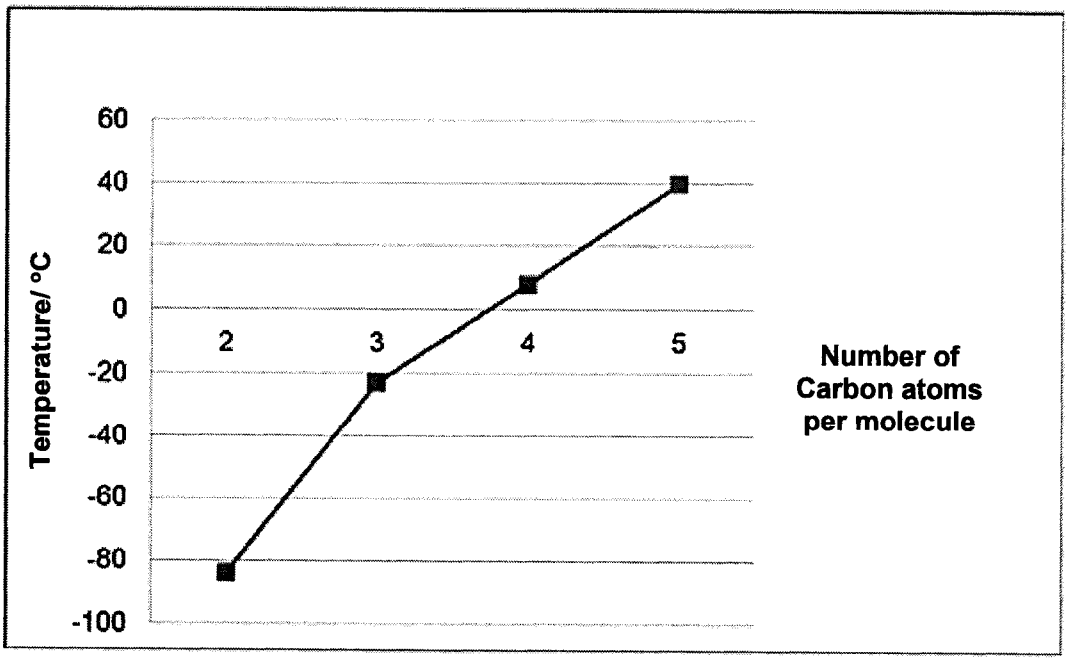



**Fig. 9.1**



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**Manufacture of Ethyne**

For the past 50 years, ethyne was produced by the reaction of calcium carbide with water according to the equation below.

$$CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$$

A modern method for producing a good yield of ethyne is by heating ethene above 1150 °C. The reaction is represented by the equation shown below.

$$CH_2{=}CH_2\ (g) \rightarrow H-C{\equiv}C-H + H_2\ (g)$$

**Reaction of Alkynes**

Alkynes are unsaturated compounds that react similarly to alkenes in many chemical reactions such as addition reactions.

For example, like alkenes, alkynes undergo addition reaction with bromine water. However, unlike alkenes, alkynes react more slowly with bromine water.

**(a)** Describe and explain the trends show shown in the data in **Table 9.1** and **Fig. 9.1**.

.....

.....

.....[2]

**(b)** Draw a 'dot and cross' diagram to show the bonding in ethyne.
Show outer electrons only.

[2]

**(c)** **(i)** Deduce the general formula of the homologous series of alkynes.

.....[1]

**(ii)** Write the chemical formula of hex-1-yne, a six carbon alkyne.

.....[1]

**(iii)** Predict the boiling point of hex-1-yne.

.....[1]



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**(d)** Calculate the volume of ethyne that will be obtained at room temperature and pressure from 500 g of calcium carbide.

volume of ethyne: .....[2]

**(e)** Describe a test to distinguish an alkyne from an alkene. Include appropriate apparatus and chemicals used in the test.

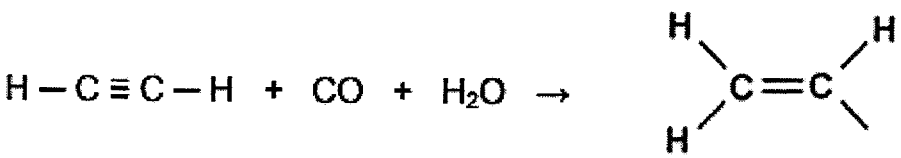
.....

.....

.....[2]

**(f)** When ethyne reacts with carbon monoxide and water, in the presence of a catalyst, propenoic acid is formed.

Complete the structure of the propenoic acid in the equation shown below.



[1]

[Total: 12]



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## Section B

Answer **one** question from this section.

**10** Fig. 10.1 shows the electrolysis of concentrated aqueous caesium chloride.

A few drops of Universal Indicator are added to the caesium chloride solution before the start of the experiment.

As the experiment proceeds, a coloured gas is observed at electrode **2**.

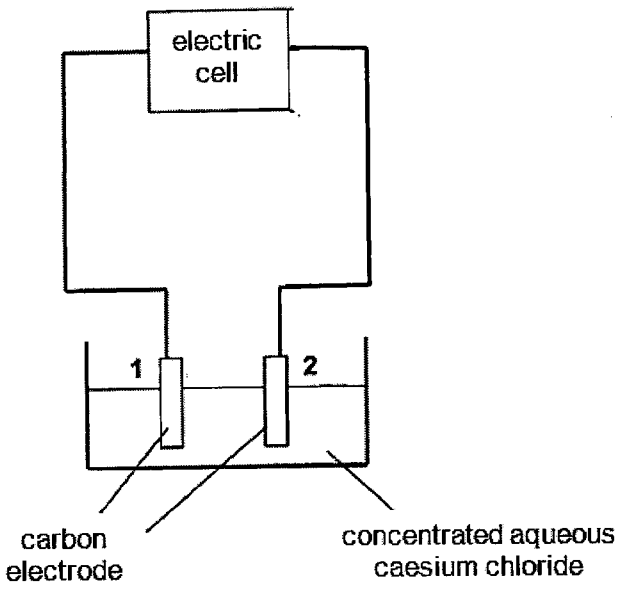



**Fig. 10.1**

**(a)** Determine whether electrode **2** is the positive electrode or negative electrode.

Write the half-equation for the reaction that occurs at this electrode.

.....

.....

..... [2]

**(b)** Describe and explain the observations at electrode **1**.

.....

.....

..... [2]



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**(c)** State and explain the observations made on the electrolyte as the experiment proceeds.

.....

.....

.....

.....[2]

**(d)** Fig. 10.2 shows the actual electric cell used. The electrolyte used is aqueous copper(II) sulfate.

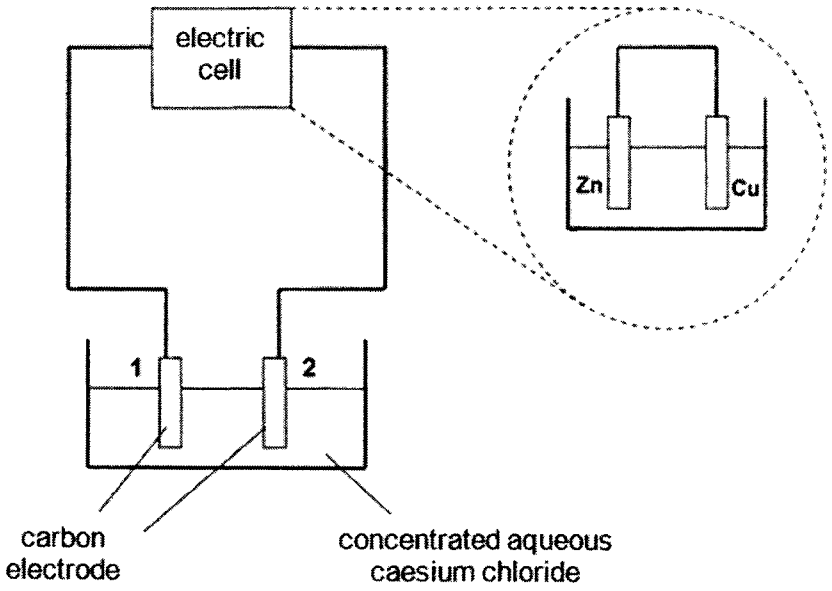



**Fig. 10.2**

**(i)** State the direction of flow of electrons.

.....[1]

**(ii)** Write the half-equation for the reaction at the copper metal.

.....[1]

**(iii)** State the element that is reduced during the experiment. Explain your reasoning using oxidation state.

.....

.....

.....[2]

[Total: 10]



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**11** **(a)** Proteins are large biomolecules, or macromolecules, consisting of one or more long chains of amino acid monomers. **Fig. 11.1** shows the repeat unit of the protein.

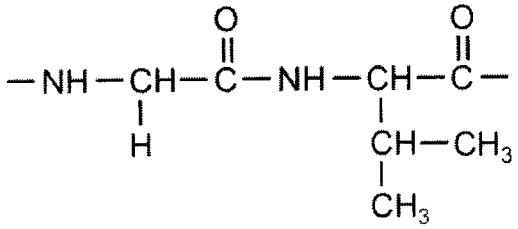


**Fig. 11.1**

Draw the full structural formula of the monomers that make up this section of the protein.

[2]

**(b)** When a surgeon repairs a wound, a mesh can be inserted to minimise the wound from opening. Poly(propene) is the recommended material for the mesh.

**(i)** Draw a section of poly(propene) showing 2 repeat units.

[1]

**(ii)** Describe **two** differences between the type of polymerisation for poly(propene) and the protein in **(a)**.

.....

.....

.....

.....[2]



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**(iii)** A polymer of propene was manufactured and have an average relative molecular mass in the range of 5000 to 10 200.

Calculate the minimum number of repeating units in the polymer.

[2]

**(iv)** Suggest one reason why poly(propene) is used rather than a natural fibre such as cotton.

.....

.....[1]

**(v)** Propene is obtained from the cracking of long chain hydrocarbons such as hexadecane, $C_{16}H_{34}$, which is less useful.

When 1 mole of hexadecane is cracked, it produces 4 moles of propene and one other product.

Write the chemical equation and state the condition for this cracking process.

equation: .....

conditions: .....

.....[2]

[Total: 10]



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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 CCHY Chem Prelim P1**
**Suggested Answers**

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

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**2025 CCHY S4 Chemistry Preliminary Examination P2 Marking Scheme**

| Qn | Marking point | Marks |
|---|---|---|
| 1(a) | Al or Fe | 1 |
| (b) | N or O | 1 |
| (c) | Fe | 1 |
| (d) | Ca | 1 |
| (e) | C | 1 |
| (f) | O or N | 1 |
| | **Total** | **6** |
| 2(a) | Alkaline | 1 |
| | Concentration of hydroxide ions is **higher** than concentration of hydrogen ions<br><br>*Reject amount* | 1 |
| (b) | Sodium sulfate; $Na_2SO_4$ | 2 |
| | Sodium bicarbonate, $NaHCO_3$ | |
| | Potassium sulfate, $K_2SO_4$ | |
| | Potassium bicarbonate, $KHCO_3$ | |
| | Magnesium sulfate, $MgSO_4$ | |
| | Magnesium bicarbonate, $Mg(HCO_3)_2$ | |
| | Calcium sulfate, $CaSO_4$ | |
| | Calcium bicarbonate, $Ca(HCO_3)_2$<br><br>*Any two of the above* | |
| (c) | **Heating** to remove **all** the water/ evaporate to dryness<br><br>*Reject heating/ crystallisation* | 1 |
| | **Total** | **5** |
| 3(a) | X: concentrated ammonia<br><br>Y: concentrated hydrochloric acid | 1 |
| | Mr of ammonia= **17**<br><br>Mr of HCl= **36.5**<br><br>Relative molecular mass of ammonia is **lower** than hydrogen chloride | 1 |
| | Ammonia (gas from X) will **diffuse faster and travel a longer distance**<br><br>[answer can be of gas from Y] | 1 |
| (b) | Region P: **blue** | 1 |
| | Region R: **red** | 1 |

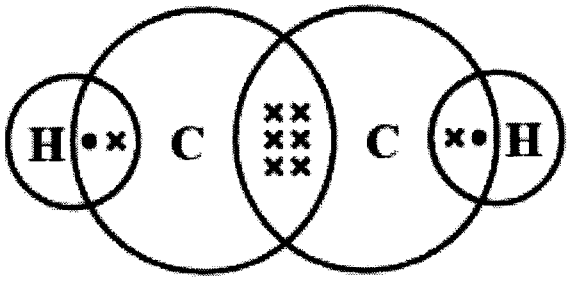
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| Qn | Marking point | Marks |
|---|---|---|
| (c) | A **neutral salt** formed | 1 |
| | **Total** | **6** |
| 4(a) | How: lithium atom **loses 1 valence electron** to form a **positively charged ion** | 1 |
| | How: chlorine atom **gains 1 valence electron** to form a **negatively charged ion** | 1 |
| | Why: to **achieve the full valence shell** of a noble gas | 1 |
| (b) | Describe: radius of lithium atom **decreases** when it forms an ion | 1 |
| | Explain: Lithium atom **loses 1 electron shell** when it forms an ion | 1 |
| (c) | Observation: **no visible change/ no observable change/ solution remains reddish brown** | 1 |
| | Explain: bromine is **less reactive** than chlorine thus **no displacement reaction takes place** | 1 |
| | **Total** | **6** |
| 5(a)(i) | Catalytic converter converted the **harmful pollutants, CO, NO and unburnt hydrocarbons into harmless $CO_2$ and $H_2O$** | 1 |
| (ii) | The **excess** $CO_2$ produced will **lead to global warming** and thus will lead to extreme weather events | 1 |
| (b) | The **rate of photosynthesis to absorb $CO_2$ cannot catch up** | 1 |
| | with the **rate of $CO_2$ being released** during the combustion of fossil fuels and animals respiration | 1 |
| (c) | The **amount of $CO_2$ absorbed** by the sugar cane during **photosynthesis** | 1 |
| | is **equal** to | 1 |
| | the **amount of $CO_2$ released** when ethanol **burned as fuel** | 1 |
| | Thus there is net zero change in atmospheric $CO_2$ | |
| | **Total** | **7** |
| 6(a) | They formed **coloured** compounds | 1 |
| | They form compounds with **variable oxidation state** | 1 |
| (b)(i) | $2Cr\ (s) + 6H^+\ (aq) \rightarrow 2Cr^{3+}\ (aq) + 3H_2\ (g)$ | 1: correct balance eqn |

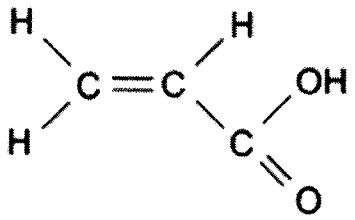
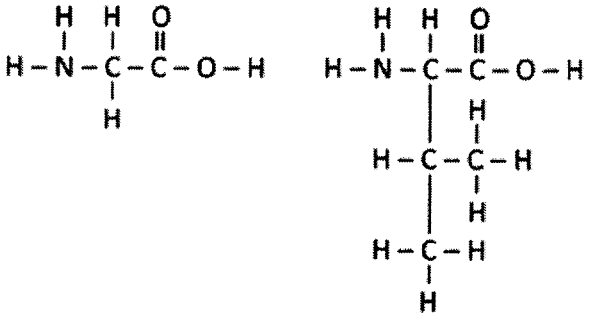
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| Qn | Marking point | Marks |
|---|---|---|
| | | 1: correct state symbol |
| (ii) | **Cr** was **oxidized** as it **lost electrons** to form **$Cr^{3+}/Cr_2(SO_4)_3$.** | 1 |
| | **$H^+$ / Hydrogen ion / $H_2SO_4$** was **reduced** as $H^+$ **gained the elections** to form **$H_2$** | 1 |
| (c) | Order of metal in increasing reactivity: **Iron, Chromium, Manganese** | 1 |
| | Observation in set up A: **Green solution turns pink, grey/silvery solid forms** | 1 |
| | Observation in set up B: **Green solution turns violet, grey/silvery solid forms.** | 1 |
| | Observation in set up C: **No visible / observable change / pale pink solution remains pink** | 1 |
| | **Total** | **10** |
| 7(a) | Rate of reaction **increases with increasing** concentration of acid | 1 |
| | as there is **more reacting particles per unit volume** | 1 |
| | and there is an **increase in frequency of effective collision** between the reacting particles | 1 |
| (b) | 6 min/ 9 min | 1 |
| (c) | No | |
| | Both are **monobasic acids and no of moles of acids used are the same** | 1 |
| | thus final volume of gas produced will be the **same** | 1 |
| (d) | No of moles of HCl = 0.5 x 18.50/ 1000 = 0.00925 mol | 1 |
| | No of moles of NaOH= 0.00925 mol | 1 |
| | Concentration of NaOH = 0.00925/ [20.0/ 1000] = 0.4625 $mol/dm^3$ | 1 |
| | Concentration of NaOH = 0.4625 x (23 + 16 + 1) = 18.5 $g/dm^3$ | 1 |
| | **Total** | **10** |
| 8(a) | $P_4$ | 1 |
| (b) | White phosphorus: simple molecular | 1 |

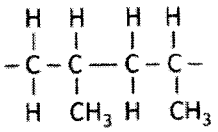
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| Qn | Marking point | Marks |
|---|---|---|
| | Black phosphorus: giant covalent | |
| (c) | White phosphorus has a **lower melting point** than black phosphorus | 1 |
| | as **little** energy is absorbed to overcome the **weak forces of attraction between the molecules** | 1 |
| | And in black phosphorus, **a lot** of energy is absorbed to overcome the **strong covalent bond between the P atoms** | 1 |
| (d) | It cannot conduct electricity in any state | |
| (e) | Layers of atoms can be peeled easily as it has **weak forces of attraction between the layers of atoms** | 1 |
| | **Total** | **8** |
| 9(a) | **Boiling point increases** as **number of carbon atoms increases** | 1 |
| | **Strength** of the intermolecular forces of attraction **increases** as the **molecules become larger/ molecular mass increases** | 1 |
| | Thus **more energy absorbed** to overcome the forces of attraction | 1 |
| (b) |   | 1: correct no of shared electrons 1: correct no of atoms |
| (c)(i) | $C_nH_{2n-2}$ | 1 |
| (ii) | $C_6H_{10}$ | 1 |
| (iii) | 81 °C ( accept any temp equal to or greater than 70 °C) | 1 |
| (d) | No of moles of calcium carbide= 500/ [40 + 2(12)]= 7.8125 mol<br><br>No of moles of ethyne= 7.8125 mol | 1 |
| | Volume of ethyne= 7.8125 x 24 = 187.5 $dm^3$ | 1 |
| (e) | Add **aqueous bromine/ bromine solution/ bromine** water to both sample | 1 |
| | Sample which turns from reddish brown to colurless/ decolourises **slower** contains alkyne | 1 |

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| Qn | Marking point | Marks |
|---|---|---|
| | | |
| (f) |  | 1 |
| | **Total** | **12** |
| 10(a) | Positive terminal | 1 |
| | $2Cl^- \rightarrow Cl_2 + 2e^-$ | 1 |
| (b) | Describe: **Bubbles of gas/ efferevescence** | 1 |
| | Explain: **$H^+$ will be preferentially discharged** at electrode 1 to produce **hydrogen gas** | 1 |
| (c) | State: Electrolyte will change from green to purple/ blue | 1 |
| | Explain: **Caesium hydroxide** will be left behind in the electrolyte and it is an **alkali** | 1 |
| (d)(i) | From Zinc to Copper | 1 |
| (ii) | $Cu^{2+} + 2e^- \rightarrow Cu$ | 1 |
| (iii) | State: Copper | 1 |
| | Explain: copper is reduced as oxidation state **decreases from +2** in Cu2+ **to 0** in Cu | 1 |
| | **Total** | **10** |
| 11(a) |  | 2 |

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<table>
<tr><th>Qn</th><th>Marking point</th><th>Marks</th></tr>
<tr><td>(b)(i)</td><td></td><td>1</td></tr>
<tr><td>(ii)</td><td>
<table>
<tr><td>Addition polymers<br><br>Poly(propene)</td><td>Condensation polymers<br><br>Protein</td></tr>
<tr><td>Monomers are linked to form one large molecule, poly(propene) with no loss of atoms.</td><td>Monomers are linked to form one large molecule, protein with the elimination of a small molecule, water.</td></tr>
<tr><td>Poly(propene) is formed from monomers that are unsaturated.</td><td>Protein is formed from monomers that contain the amine and carboxyl functional group.</td></tr>
<tr><td>Poly(propene) contain monomers are linked together with C-C bond.</td><td>Proteins contains monomers that are joined with the amide linkage.</td></tr>
</table>
Any 2 differences</td><td>2</td></tr>
<tr><td>(iii)</td><td>Mr of propene= 12(3) + 6(1)= 42</td><td>1</td></tr>
<tr><td></td><td>Number of repeating units= 5000/ 42 = 119.0476<br><br>Minimum no= 120</td><td>1</td></tr>
<tr><td>(iv)</td><td>Durable/ Tough/ Does not tear easily<br><br>Any reasonable answers</td><td>1</td></tr>
<tr><td>(v)</td><td>Equation: $C_{16}H_{34} \rightarrow 4C_3H_6 + C_4H_{10}$</td><td>1</td></tr>
<tr><td></td><td>Condition: High temperature of 600°C<br>Catalysts – Aluminium oxide and/or Silicon dioxide</td><td>1</td></tr>
<tr><td></td><td>Total</td><td>10</td></tr>
</table>

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