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.

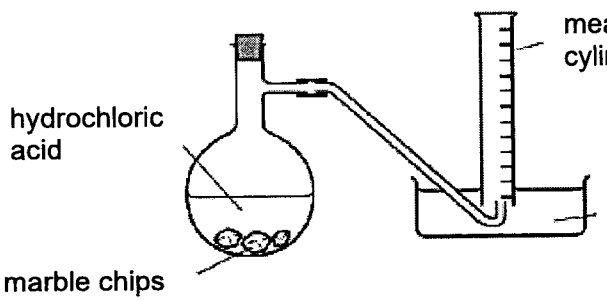
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this question paper.
A copy of the Periodic Table is printed on page **20**.
The use of an approved scientific calculator is expected, where appropriate.

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?

1



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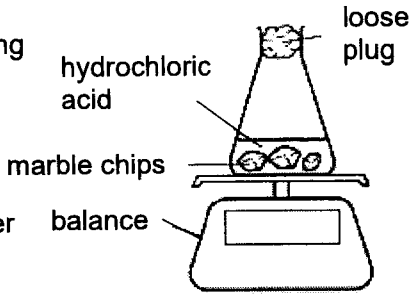
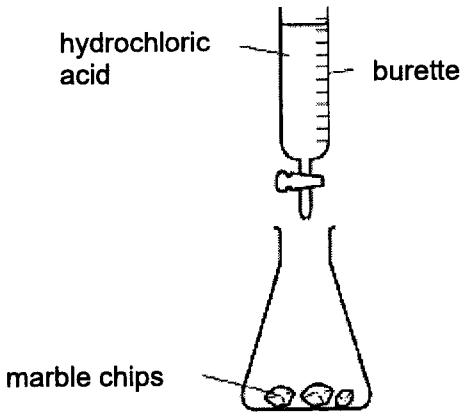


3



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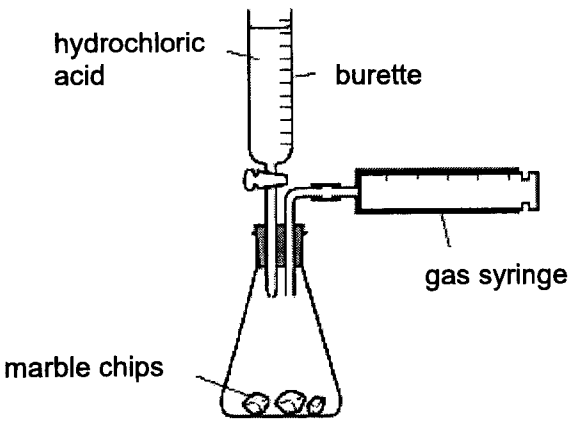


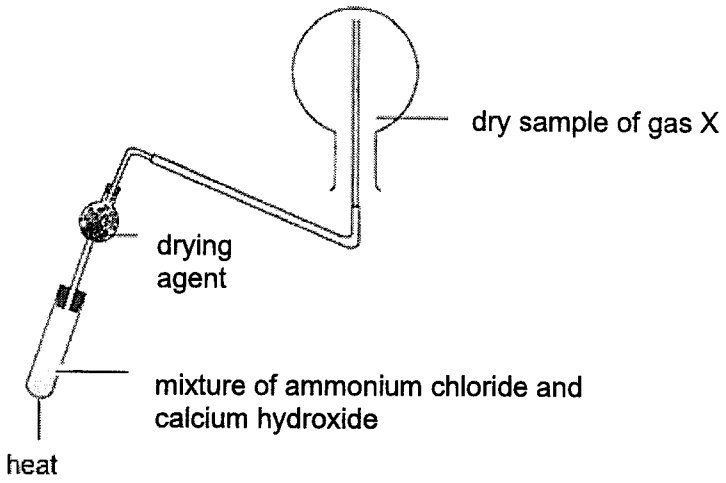
A 1 and 2 only

B 1 and 3 only

C 2 and 4 only

D 1, 2 and 4 only

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, $CaCO_3$?

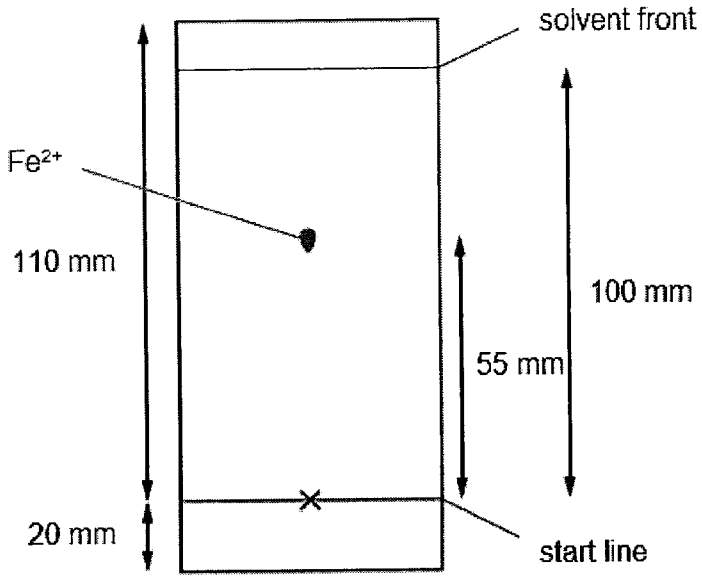
A dissolve in water → distillation → crystallisation

B dissolve in water → filtration → crystallisation

C distillation → crystallisation → heating to remove all water

D fractional distillation → filtration → heating to remove all water

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?

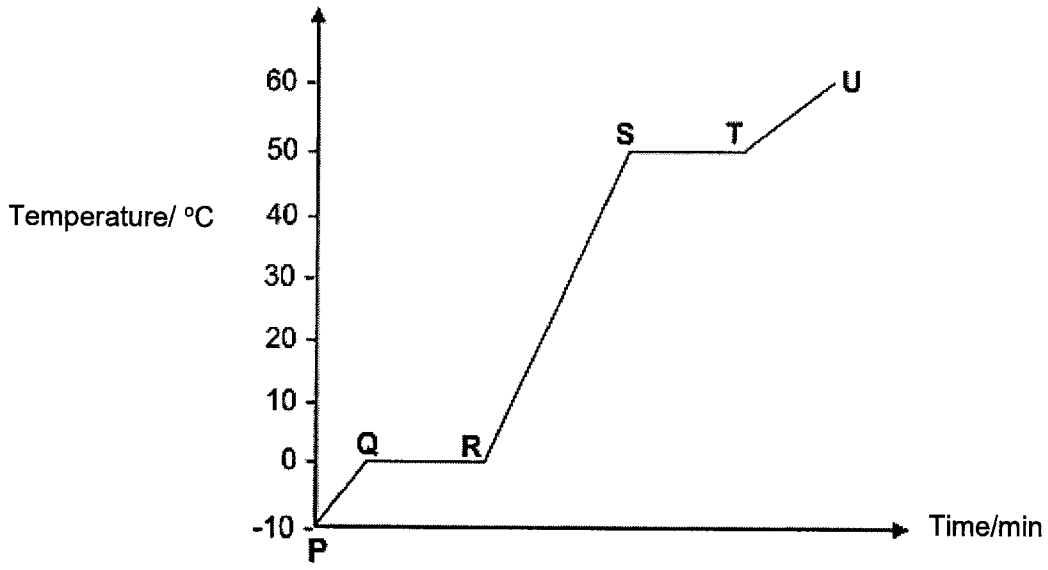
A burn it completely in oxygen

B measure its boiling point

C react with ethanoic acid

D test with litmus paper

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.

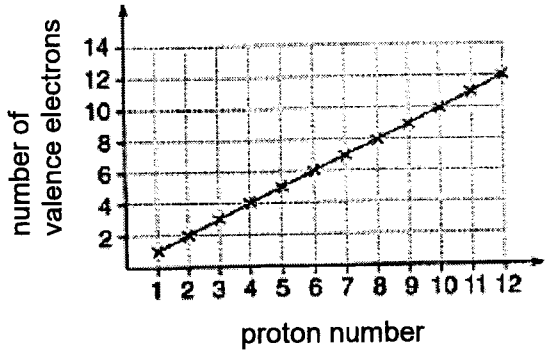
C Particles gain energy to weaken the forces of attraction from points S to T.

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

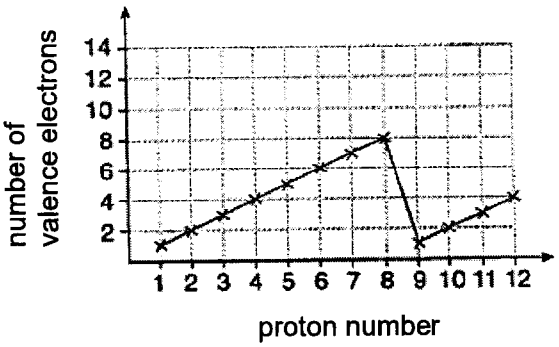
7 The number of valence electrons for elements hydrogen to magnesium was plotted against the proton number of the element.

Which graph was obtained?

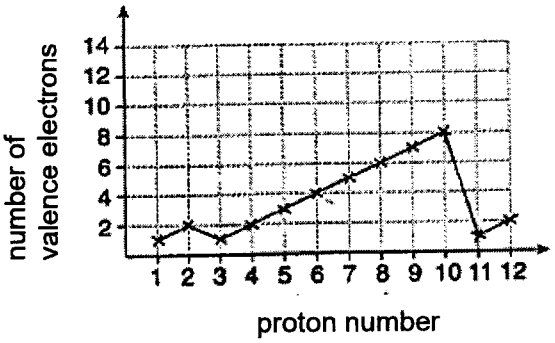
A



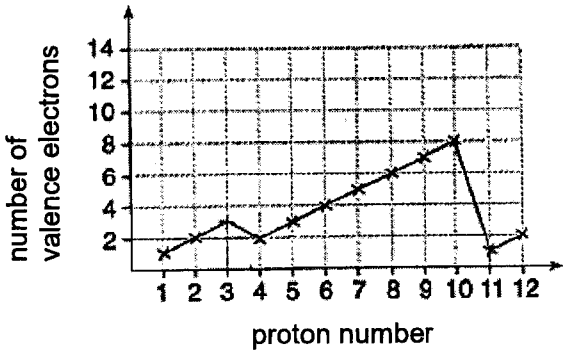
B



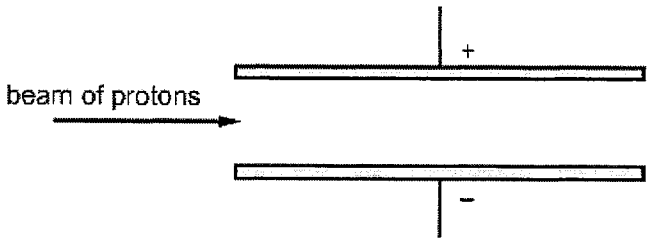
C



D



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.

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

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

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

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.

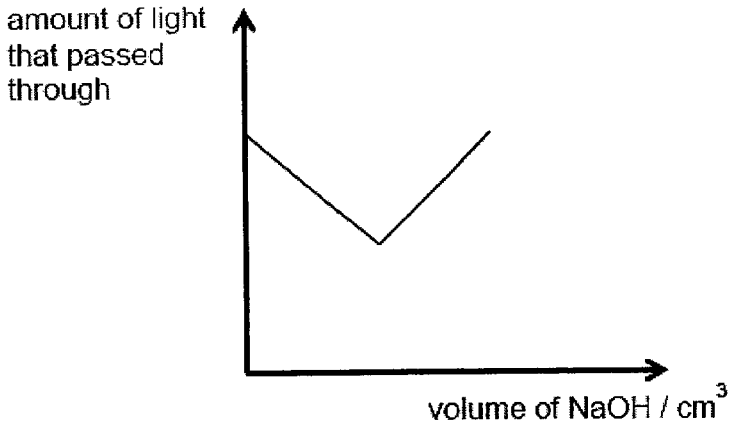
B The reaction is endothermic, hence a temperature of 450°C is used.

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.

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

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

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+

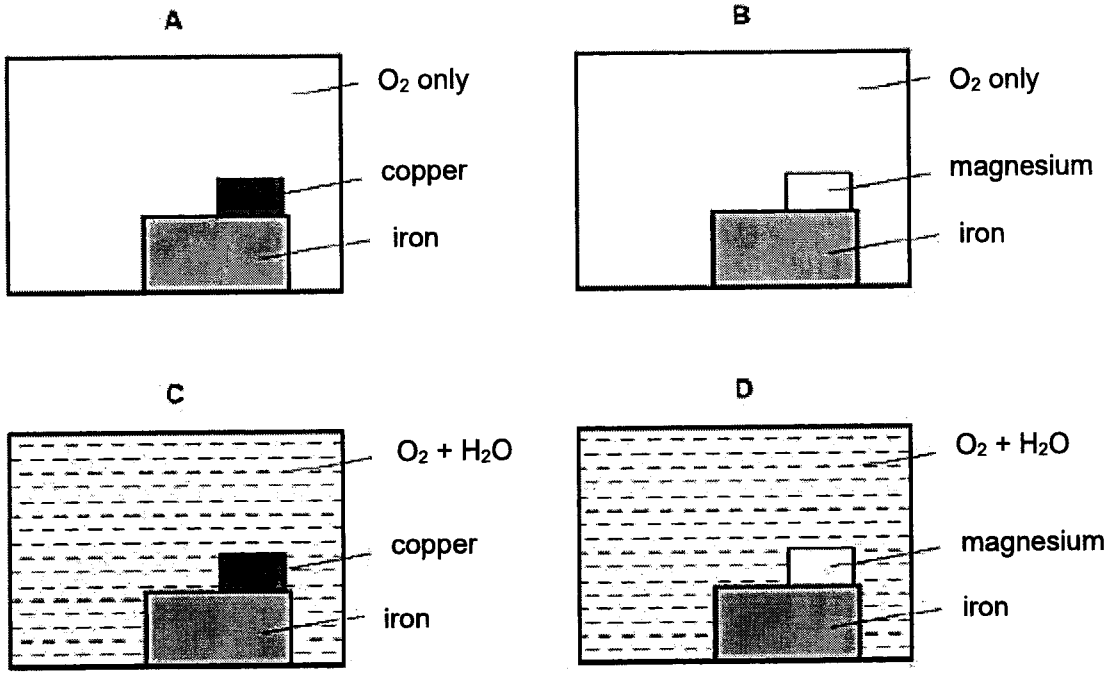
28 Four elements identified only as W, X, Y and Z are all found in the third period of the Periodic Table. W, X, Y and Z are not the actual chemical symbols of the elements.

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?



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

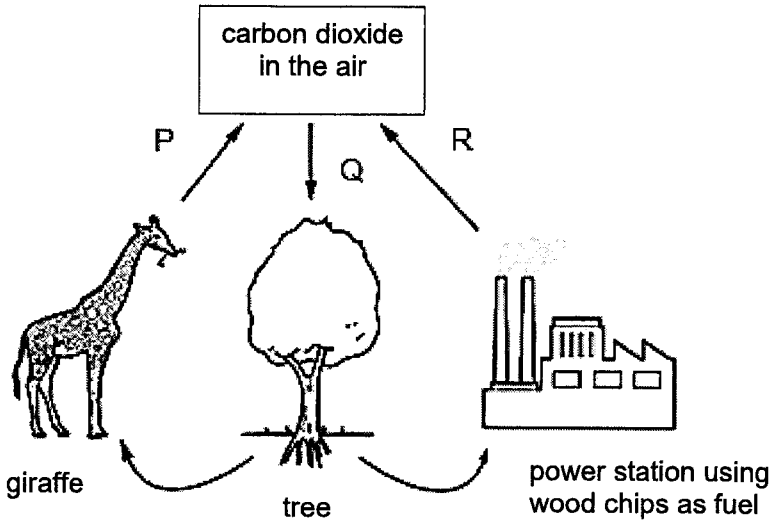
A copper(II) carbonate

B iron(III) carbonate

C lead(II) carbonate

D potassium carbonate

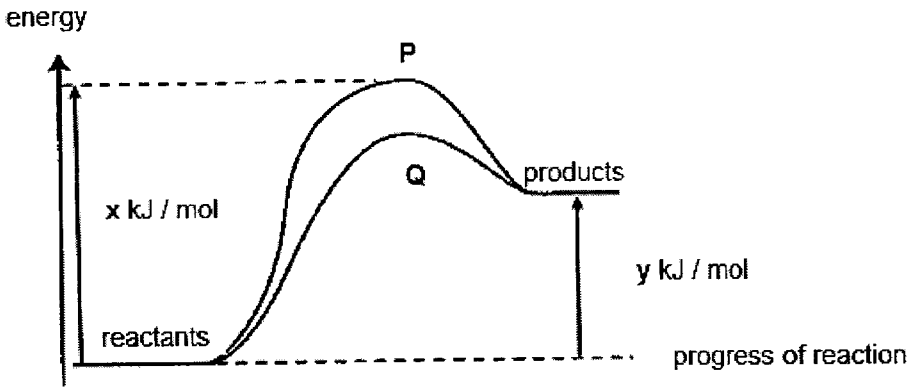
31 The diagram shows part of the carbon cycle. P, Q and R refer to specific processes of the carbon cycle.



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

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



Which conclusion can be made based on the diagram?

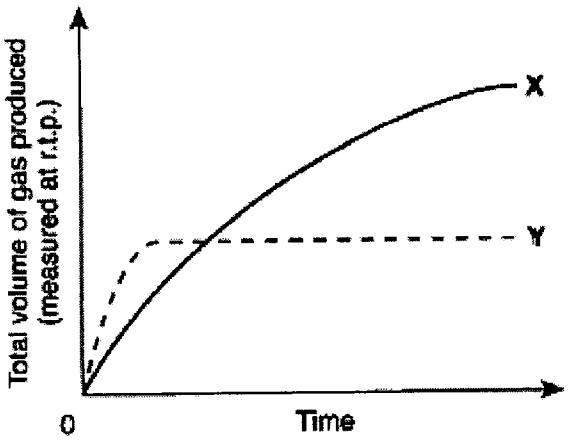
A Enthalpy change of the reaction equals (x-y) kJ/mol.

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?

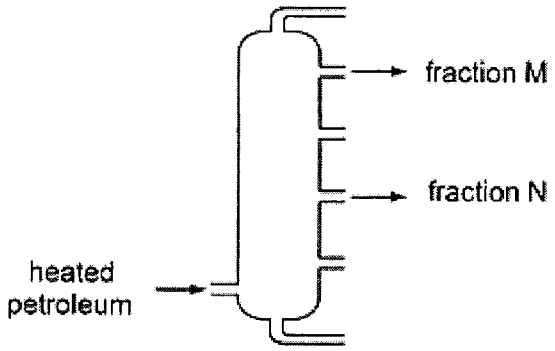
A using 2 g of zinc granules at 30°C

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

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.

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?

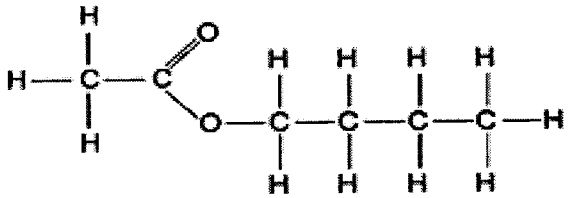
A CH_3OH

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

38 What are formed when glucose is fermented?

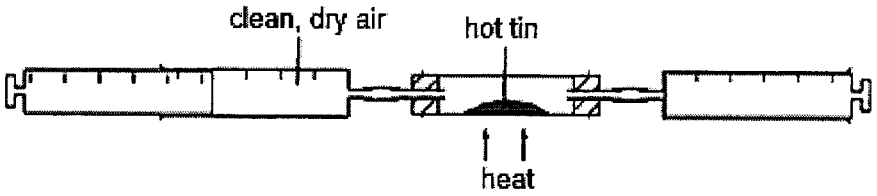
A ethanol and carbon dioxide

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.

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

中正中学 义顺

CHUNG CHENG HIGH SCHOOL (YISHUN)

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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]

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]

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

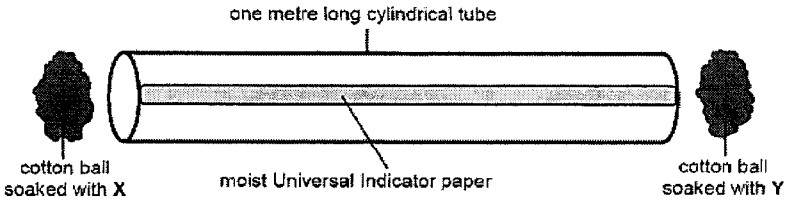


Fig. 3.1

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.

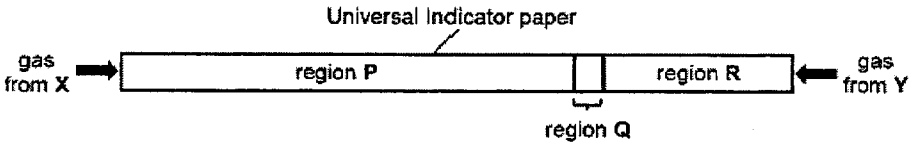


Fig. 3.2

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]

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]

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]

(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]

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]

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

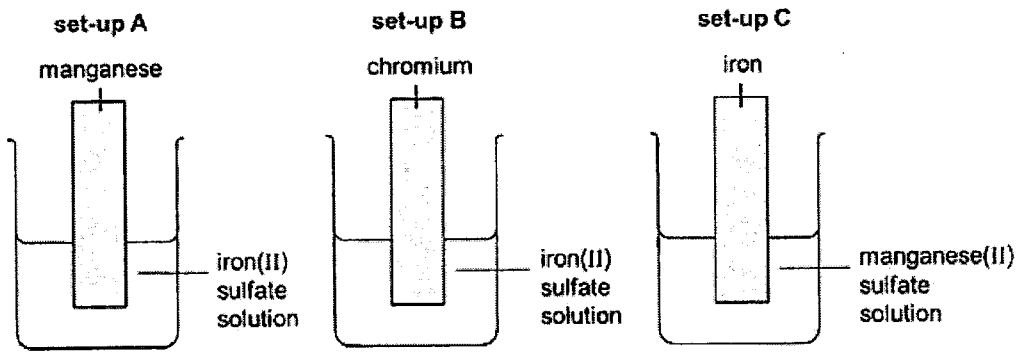


Fig. 6.1

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]

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]

(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.

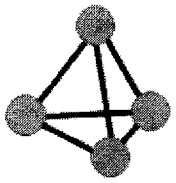
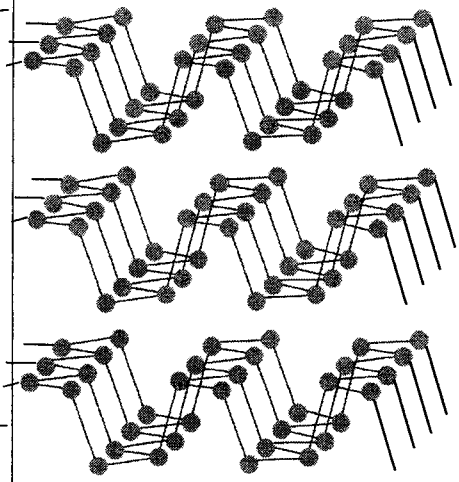
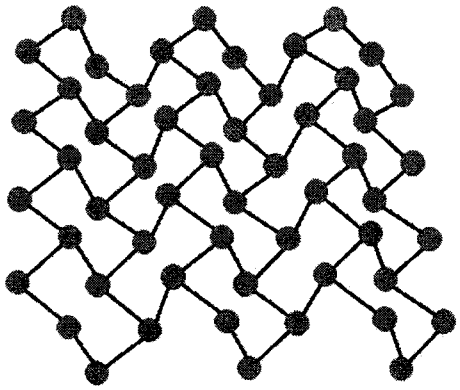
Calculate the concentration of sodium hydroxide in g/dm^3.

[4]

[Total: 10]

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):  part of the structure of one single layer (top view): 	610

(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]

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.

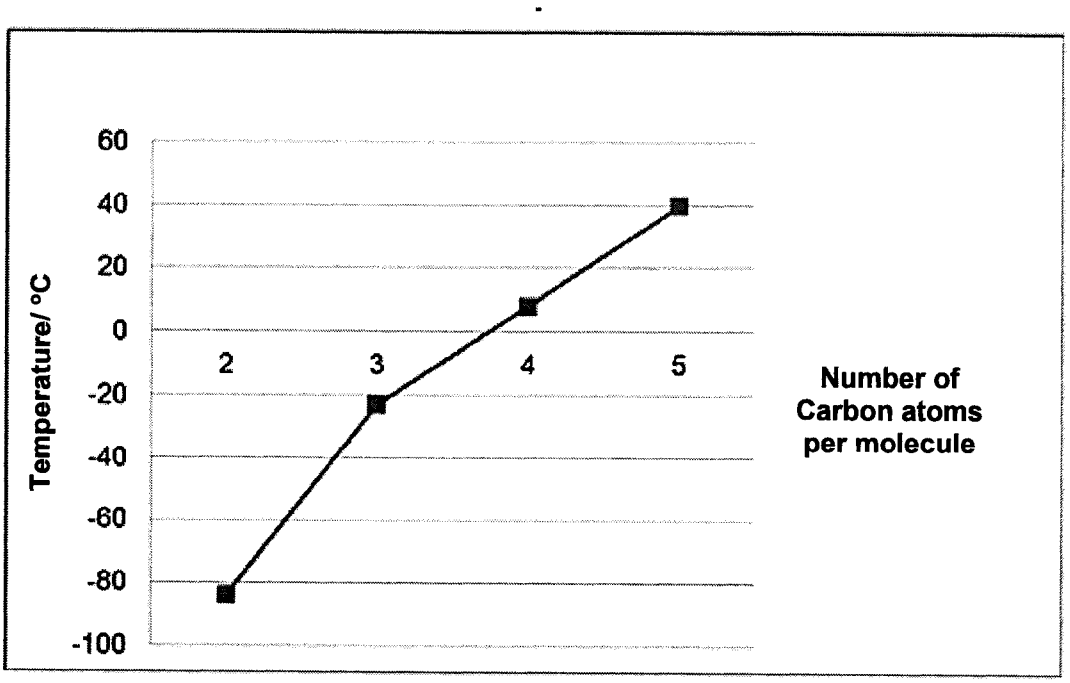


Fig. 9.1

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]

(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.

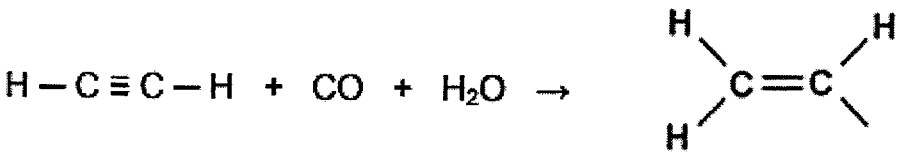
.....

.....

.....[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]

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**.

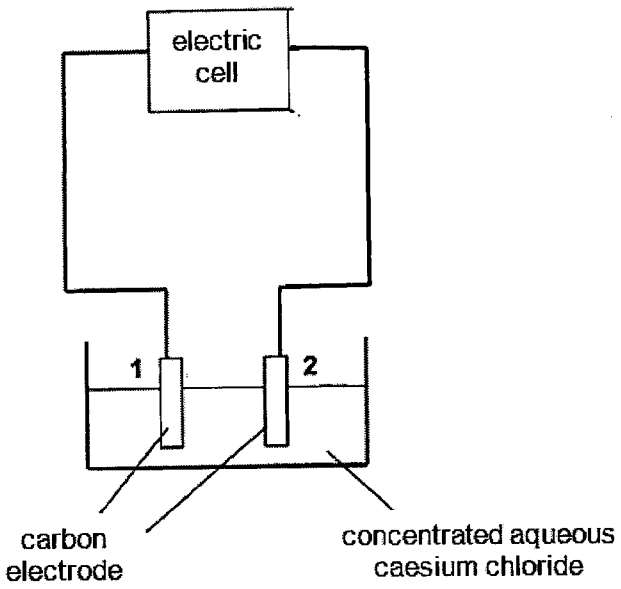


Fig. 10.1

(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]

(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.

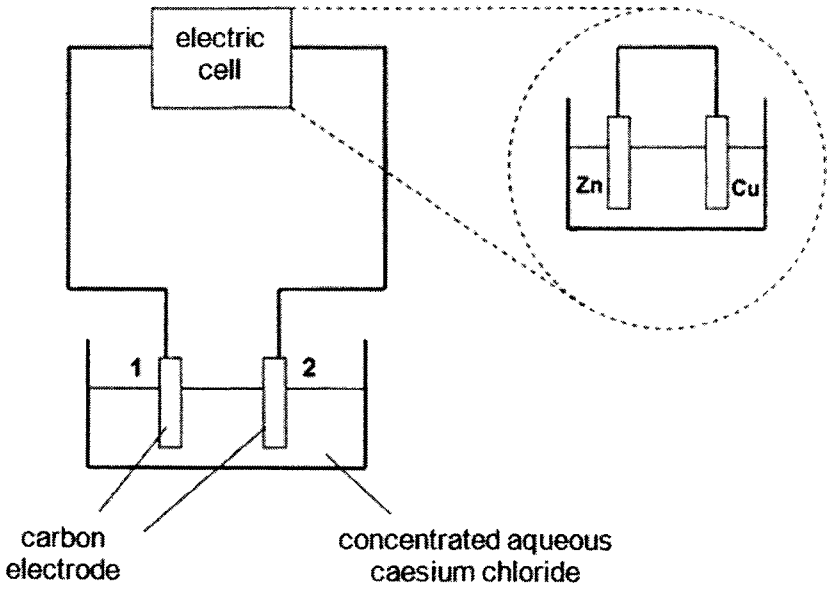


Fig. 10.2

(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]

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.

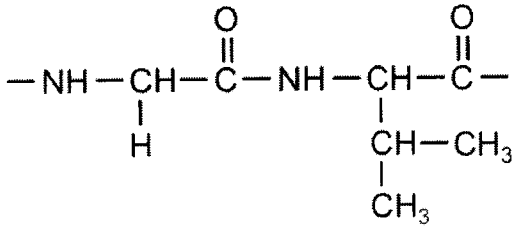


Fig. 11.1

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]

(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]

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

2025 CCHY Chem Prelim P1
Suggested Answers

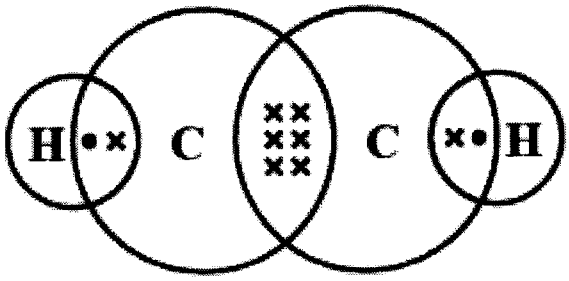
1	A	**21**	B
2	A	**22**	B
3	B	**23**	D
4	C	**24**	C
5	B	**25**	B
6	C	**26**	B
7	C	**27**	D
8	C	**28**	C
9	C	**29**	D
10	A	**30**	D
11	A	**31**	D
12	B	**32**	B
13	D	**33**	C
14	C	**34**	A
15	C	**35**	C
16	A	**36**	B
17	B	**37**	C
18	A	**38**	A
19	C	**39**	D
20	A	**40**	D

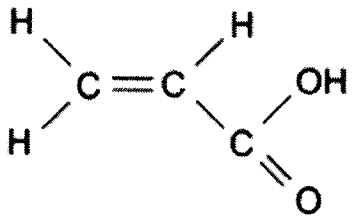
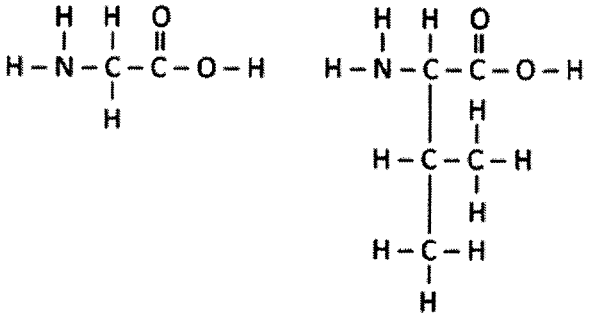
2025 CCHY S4 Chemistry Preliminary Examination P2 Marking Scheme

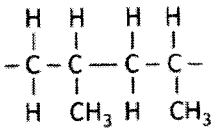
Qn	Marking point	Marks
1(a)	Al or Fe	1
(b)	N or O	1
(c)	Fe	1
(d)	Ca	1
(e)	C	1
(f)	O or N	1
	Total	**6**
2(a)	Alkaline	1
	Concentration of hydroxide ions is **higher** than concentration of hydrogen ions *Reject amount*	1
(b)	Sodium sulfate; Na_2SO_4	2
	Sodium bicarbonate, $NaHCO_3$	
	Potassium sulfate,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

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

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

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 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

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

<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

Poly(propene)</td><td>Condensation polymers

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

Minimum no= 120</td><td>1</td></tr>
<tr><td>(iv)</td><td>Durable/ Tough/ Does not tear easily

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
Catalysts – Aluminium oxide and/or Silicon dioxide</td><td>1</td></tr>
<tr><td></td><td>Total</td><td>10</td></tr>
</table>