KUO CHUAN PRESBYTERIAN SECONDARY SCHOOL

2024 PRELIMINARY EXAMINATION
Secondary 4 Express

NAME ☐

CLASS ☐ **REG. NO** ☐☐

CHEMISTRY
Paper 1 Multiple Choice

6092 / 01
28 August 2024
1 hour

Additional Materials: Multiple Choice Answer Sheet.
Setter: Ms Koh Li Eng

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and register number on the Answer Sheet in the spaces provided unless this has been done for you.

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 Answer Sheet.

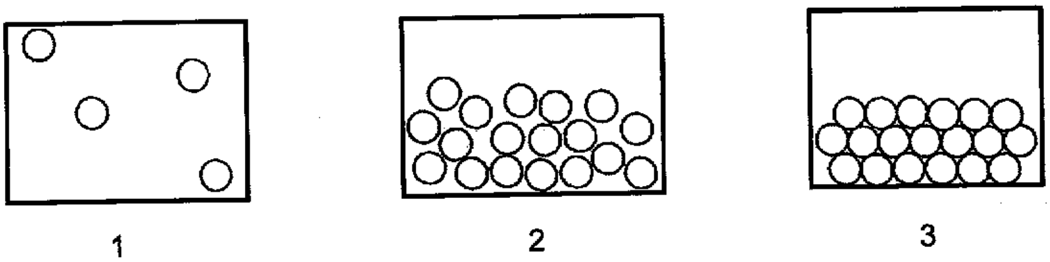
Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 22.
The use of an approved scientific calculator is expected, where appropriate.

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

[Turn Over

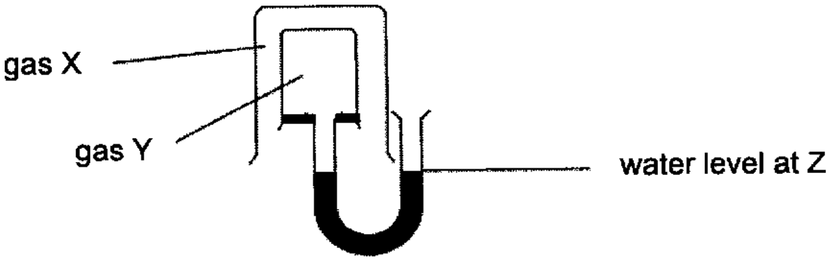
1 Diagrams 1, 2 and 3 show the particles of three substances at room temperature and pressure.



Which of these substances are correctly represented by the corresponding diagram?

	1	2	3
A	argon	mercury	dry ice
B	ethane	sodium chloride	mercury
C	ethanol	hydrogen chloride	copper
D	water	helium	zinc

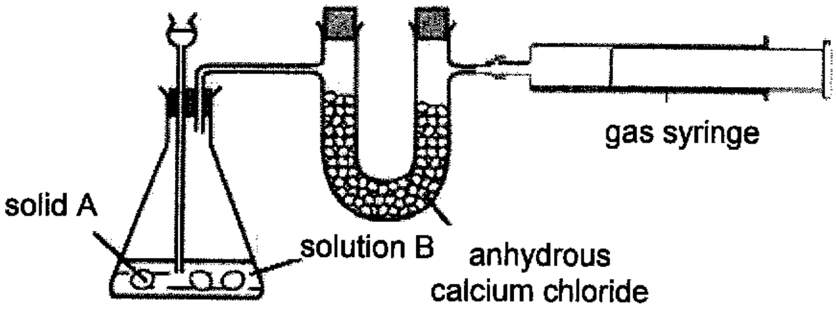
2 The set–up below shows how the relative rate of diffusion of gas X and Y can be determined.



Which pair of substances could X and Y be if the water level at Z increases?

	X	Y
A	argon	ethane
B	neon	carbon monoxide
C	oxygen	methane
D	carbon dioxide	nitrogen

3 The diagram shows a simple laboratory set-up used to prepare and collect a dry gas.



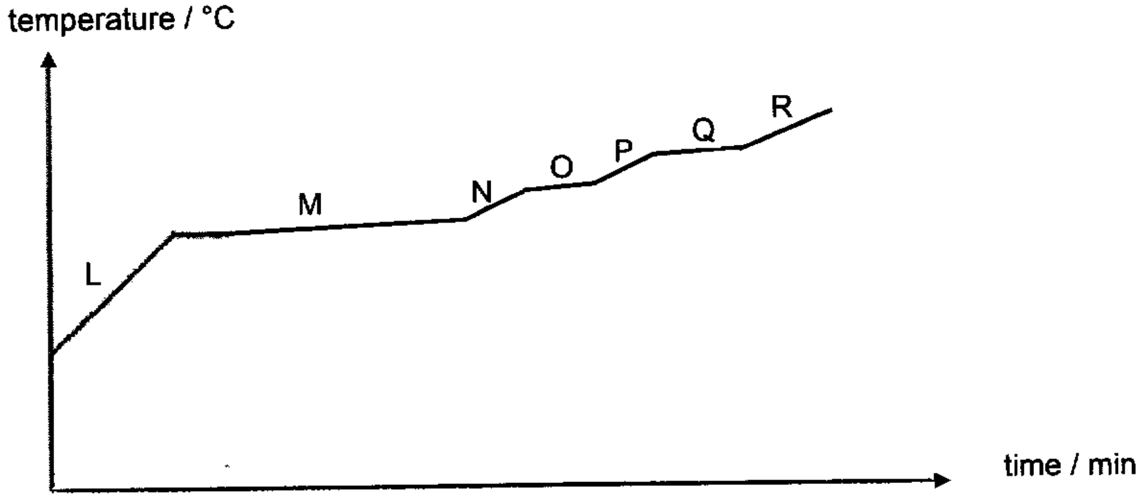
Which pair of reagents would be most suitable to prepare the gas produced using this set-up?

	solid A	solution B
A	ammonium chloride	sodium hydroxide
B	magnesium	sulfuric acid
C	potassium carbonate	aqueous ammonia
D	sodium hydroxide	hydrochloric acid

4 The three main components of liquid air are nitrogen, oxygen and argon. Their respective boiling points are:

nitrogen: –196°C
oxygen: –183°C
argon: –186°C

Liquid air can be separated into its three main components by fractional distillation. The graph shows the temperature of a liquid air mixture as it is heated.



In section P of the graph, the mixture remaining consists of

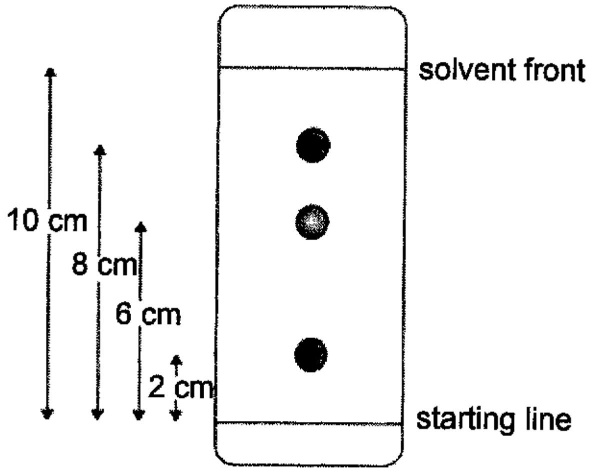
A liquid nitrogen and argon only.

B liquid nitrogen only.

C liquid oxygen and argon only.

D liquid oxygen only.

5 The diagram shows the chromatogram obtained from the analysis of a dye mixture. Four measurements are shown in the diagram below.



What is the R_f value of the most soluble dye?

A 0.20

B 0.80

C 1.25

D 5.00

6 The solubilities of three solids in water and tetrachloromethane are given in the table below.

solid	solubility in water	solubility in tetrachloromethane
sand	not soluble	not soluble
sodium chloride	good	not soluble
sulfur	not soluble	good

Which of the experimental procedures would be suitable for obtaining pure sand from a mixture of sand, sodium chloride and sulfur?

A Add tetrachloromethane and stir, then filter to collect residue.

B Add tetrachloromethane and stir, then filter. Add the residue to water and stir, then filter to collect residue.

C Add water and stir, then filter. Add tetrachloromethane to filtrate and stir, then evaporate to dryness.

D Add water and stir, then filter. Evaporate the filtrate to dryness.

7 Which pair of statement correctly describes the properties of the compound iron(II) sulfide, FeS, and a mixture of iron and sulfur?

	iron(II) sulfide	mixture of iron and sulfur
1	The ratio of iron to sulfur is always 2 : 1.	The ratio of iron to sulfur can vary.
2	Iron(II) sulfide has the same properties as iron and sulfur.	The mixtures do not have the same properties as iron and sulfur.
3	Iron and sulfur react when heated to form iron(II) sulfide.	Iron and sulfur mix together with no energy change.

A 1 and 2

B 1 and 3

C 3 only

D All the above

8 An ion of formula X^{2-} contains 10 electrons.

If the relative atomic mass of X is 16, what is present in the nucleus of the ion?

A 8 protons and 8 neutrons
B 10 protons and 6 neutrons
C 10 protons and 10 neutrons
D 12 protons and 8 electrons

9 Which compound contains both ionic and covalent bonds?

A ammonia

B barium chloride

C methyl propanoate

D potassium sulfate

10 Which substance has metallic bonding?

substance	electrical conductivity		property of product formed from the reaction between substance and oxygen
	in solid state	in molten state	
A	X	X	reacts with alkali
B	X	✓	no reaction with acid or alkali
C	✓	✓	reacts with alkali
D	✓	✓	reacts with both acid and alkali

11 An investigation of the properties of the chlorides of Period 3 elements shows that the boiling points of sodium chloride and silicon tetrachloride are 1465°C and 57°C respectively.

This difference in boiling points is a result of

A covalent bonds being weaker than ionic bonds.
B metallic character decreasing across the period.
C silicon forming weaker bonds with chlorine as compared to sodium.
D silicon tetrachloride having weak intermolecular forces of attraction.

12 Two comments about hydrogen chloride are made below.

Comment 1: Hydrogen chloride has strong covalent bonds in its simple molecular structure.

Comment 2: Hydrogen chloride is soluble in water.

Which statement is correct?

A Both comments are correct and comment 1 explains comment 2.
B Both comments are correct but comment 1 does not explain comment 2.
C Both comments are incorrect.
D Comment 2 is correct but comment 1 is incorrect.

13 Bismuth is in the same group as nitrogen in the Periodic Table.

What is the chemical formula of lithium bismuthide?

A Li_3Bi

B $LiBiO_3$

C $LiBi_3$

D Li_3BiO

14 Which substance contains the greatest number of atoms in 1g?

A CO_2

B NO

C O_3

D SO_3

15 200 cm^3 of ammonia burns in 100 cm^3 of oxygen according to the following equation:

$$4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$$

What volume of gas will be collected at the end of the reaction when cooled to room temperature?

A 66.7 cm^3 **B** 100.0 cm^3

C 133.3 cm^3 **D** 333.3 cm^3

16 Magnesium oxide is produced by heating magnesium carbonate.

$$MgCO_3 \rightarrow MgO + CO_2$$

When 84 g of magnesium carbonate is heated, 34 g of magnesium oxide is produced.
What is the percentage yield of magnesium oxide?
[M_r: $MgCO_3$, 84; MgO, 40]

A $\frac{34}{40} \times 100$

B $\frac{34}{84} \times 100$

C $\frac{40}{34} \times 100$

D $84 \times \frac{34}{40} \times 100$

17 20.0 cm³ of 0.500 mol/dm³ hydrochloric acid were added to 0.7 g of a sample of sodium carbonate containing some sodium chloride as impurity. The excess acid was neutralised by 10.0 cm³ of 0.400 mol/dm³ of sodium hydroxide solution.

What is the percentage purity of the sodium carbonate in the sample?
[M_r: HC*l*, 36.5; Na_2CO_3, 106; NaOH, 40]

A 31.8% **B** 45.4%

C 63.6% **D** 90.9%

18 Arsine (AsH_3) is a gas that behaves like ammonia.

Which of the following particles are found in the solution when Arsine dissolves in water?

A As^+ and OH^-

B AsH_3, As^+ and OH^-

C AsH_4^+ and OH^-

D AsH_3, AsH_4^+ and OH^-

19 Which method(s) is/are suitable to test the strengths of acids and alkalis?

1 titration
2 using a pH meter
3 measuring their electrical conductivity

A 1 only

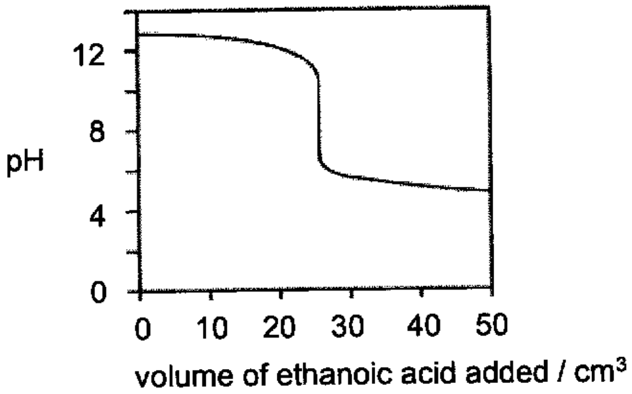
B 1 and 2

C 2 and 3

D all of the above

20 Different indicators change colour over different pH ranges and it is important to choose the correct indicator to obtain an accurate result in a titration.

The graph below shows the change of pH when ethanoic acid is added to a fixed volume of aqueous sodium hydroxide in a titration.



Which would be the most suitable indicator to use in this titration?

indicator	pH range for the colour change	colour	
		lower pH	higher pH
A	0.3 – 3.0	yellow	violet
B	4.2 – 6.3	red	yellow
C	8.2 – 10.0	colourless	pink
D	11.6 – 14.0	blue	yellow

21 In the Haber process,

1 the hydrogen used is obtained from the cracking of petroleum
2 the reaction is pressurised to increase the yield
3 the ammonia formed is collected by distillation

Which of the statement(s) is/are true?

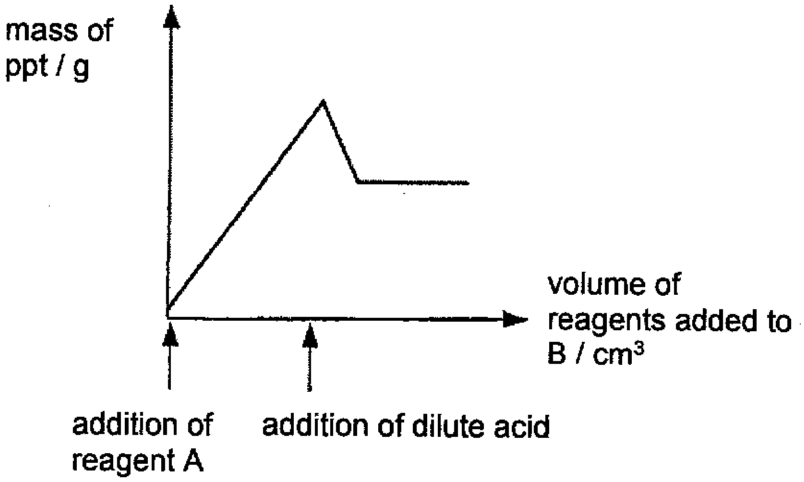
A 1 only

B 1 and 2

C 2 and 3

D all of the above

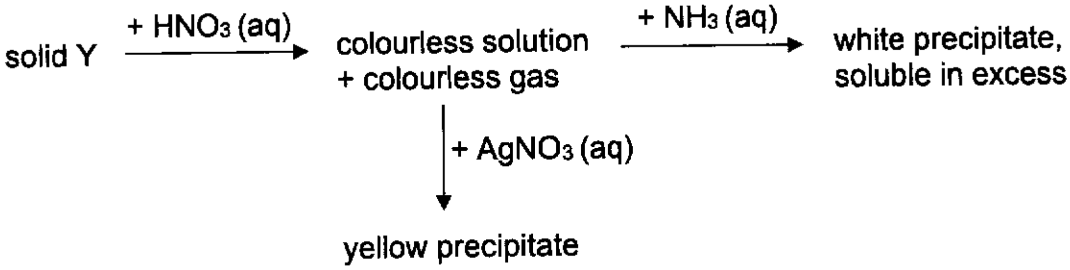
22 In a quantitative analysis, reagent A is gradually added to a salt solution B (that contains either 1 or 2 different anions), followed by the addition of a dilute acid. The graph below shows how the mass of precipitate formed changes with the reagents added.



Which of the following combinations would produce the graph above?

	anions in salt solution B	reagents (A and acid) added
A	Cl^-	$AgNO_3$ and HNO_3
B	CO_3^{2-}, Cl^-	$Ba(NO_3)_2$ and HNO_3
C	CO_3^{2-}, SO_4^{2-}	$AgNO_3$ and HCl
D	CO_3^{2-}, SO_4^{2-}	$Ba(NO_3)_2$ and HCl

23 Solid Y contains a mixture of two salts. The scheme below shows some reactions of solid Y.



Which of the following could be the two salts present in solid Y?

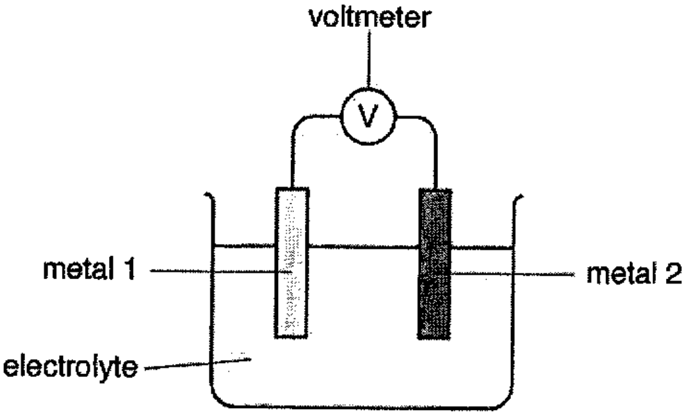
A aluminium carbonate and ammonium chloride

B calcium chloride and zinc carbonate

C copper(II) carbonate and sodium iodide

D zinc iodide and calcium carbonate

24 The table shows the voltage produced by some cells when different metals are used together with copper.



metal 1	metal 2	voltage / V
silver	copper	–0.46
magnesium	copper	+2.69

What would be the likely voltage obtained when silver is used as metal 1 and magnesium is used as metal 2?

A –2.23 V

B –3.15 V

C 2.23 V

D 3.15 V

25 Which of the following reactions takes place in a hydrogen fuel cell?

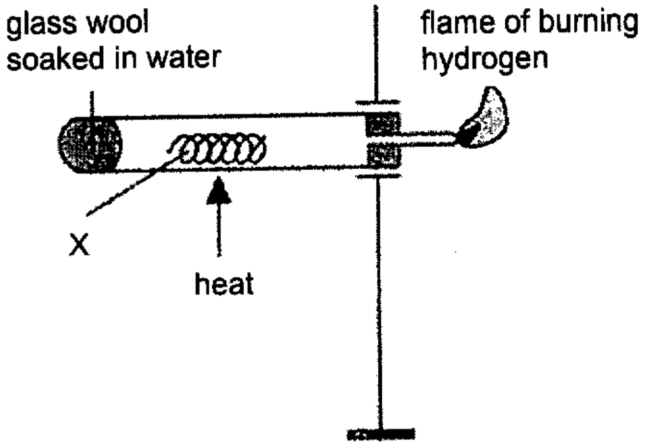
A Hydrogen ions are oxidised at the anode.

B Hydrogen ions are reduced at the cathode.

C Hydrogen loses electrons to form H^+ ions at the anode.

D Oxygen gains electrons to form O^{2-} at the cathode.

26 The set-up below shows the reaction of substance X.



What is the possible identity of X?

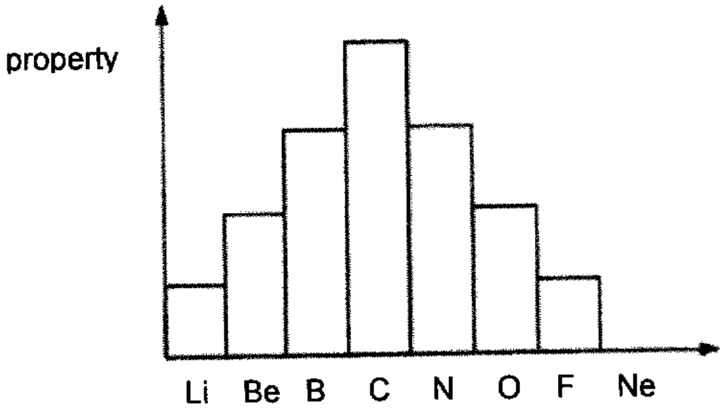
A X is a metal above hydrogen in the reactivity series.

B X is a metal below hydrogen in the reactivity series.

C X is an oxide of a metal that is above hydrogen in the reactivity series.

D X is an oxide of a metal that is below hydrogen in the reactivity series.

27 The bar chart shows the variation of a specific property of elements in Period 2 from lithium to neon.



Which property of these elements is shown in the chart?

A atomic radius

B melting point

C number of electrons used in bonding

D number of shells holding electrons

28 The elements in a group of Periodic Table shows the following trends.

- The element with the lowest proton number has the lowest reactivity.
- The melting point of the elements decreases down the group.
- The density of the elements increases down the group

Which group can the elements be found in?

A 1
B 17
C 18
D transition

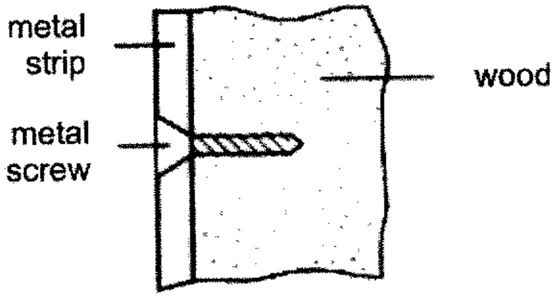
29 The following observations were made when nickel and iron were placed separately into salt solutions of metals S, T and U.

	salt solution of S	salt solution of T	salt solution of U
nickel	solid deposit formed	no visible change	no visible change
iron	solid deposit formed	solid deposit formed	no visible change

What is the correct order in decreasing reactivity of the five metals?

A S > Ni > Fe > T > U
B S > Ni > T > Fe > U
C U > Fe > T > Ni > S
D U > T > Fe > Ni > S

30 An old railway carriage is being restored by having metal strips secured to the outside of the wooden carriage by means of screws.



After a few weeks of being exposed to wind and rain, the screws are heavily corroded but the metal strips are not.

Which two metals would give this result?

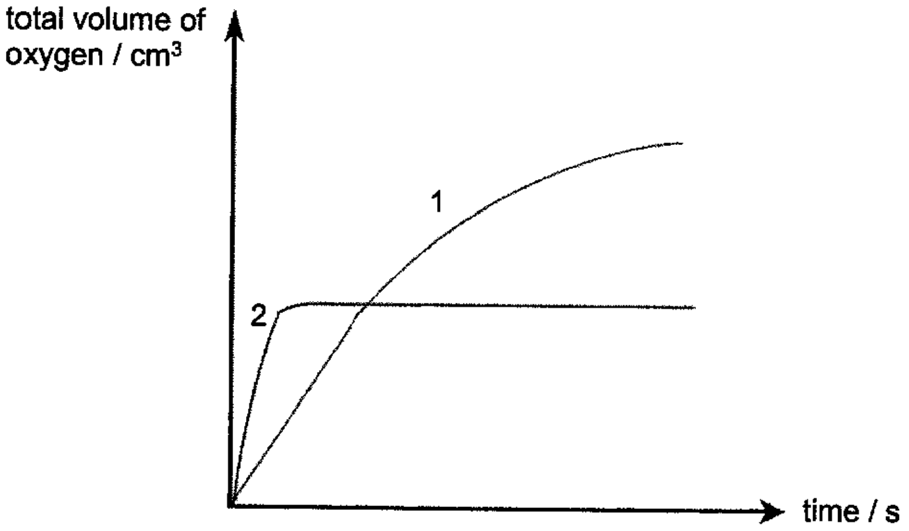
	screw	strip
A	copper	iron
B	copper	zinc
C	iron	copper
D	iron	magnesium

31 For which process is the enthalpy change always positive?

A boiling
B combustion
C dissolving of acids in water
D respiration

32 Manganese(IV) oxide catalyses the decomposition of aqueous hydrogen peroxide into water and oxygen.

In order to follow the rates of this reaction for two different solutions of hydrogen peroxide, the total volumes of oxygen evolved were recorded at regular time intervals and the results were plotted. In each experiment, the same mass of catalysts were used and the temperature was kept constant.



If curve 1 corresponds to 25.0 cm^3 of 4.0 mol/dm^3 of solution, curve 2 would correspond to

A 7.5 cm^3 of 8.0 mol/dm^3 solution.

B 12.5 cm^3 of 4.0 mol/dm^3 solution.

C 25.0 cm^3 of 2.0 mol/dm^3 solution.

D 25.0 cm^3 of 8.0 mol/dm^3 solution.

33 Which statement about the fractional distillation of crude oil is correct?

A At each level of the fractionating column, only one compound is collected.

B The fraction at the top of the column is the least flammable.

C The fraction collected at the bottom of the column has the highest viscosity.

D The higher up the fractionating column, the higher the temperature.

34 Banana releases a gas that is able to make other fruit ripen. When this gas is bubbled into aqueous bromine, the reddish-brown solution decolourises.

What could be the identity of this gas?

A ethane

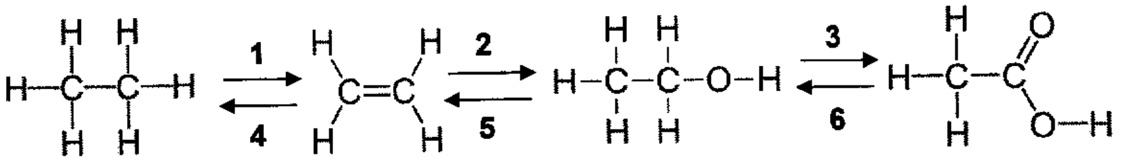
B ethene

C iodine

D sulfur dioxide

Answer questions 35 and 36 based on the following information.

The reaction pathways of the conversions between the 4 organic chemistry homologous series are as shown below.



35 How many of the above reactions are redox reactions?

A 0

B 2

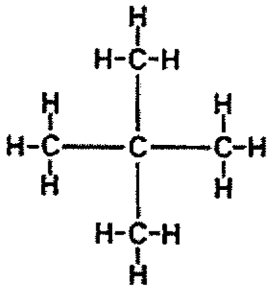
C 4

D 6

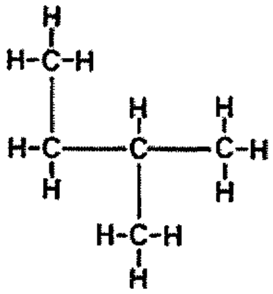
36 Which of the following shows the correct reactant and conditions for reaction pathway 1?

	reactant	conditions
A	hydrogen	150 °C, Ni catalyst
B	hydrogen	UV light
C	none	600 °C, Al_2O_3 and SiO_2 as catalysts
D	none	37 °C, yeast, absence of oxygen

37 Five structural formulae are shown below.



1



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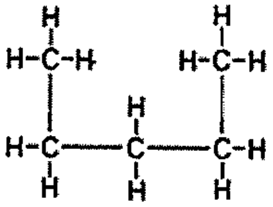

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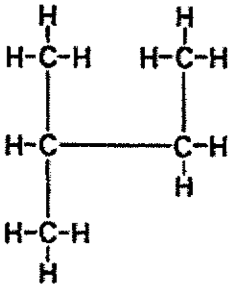

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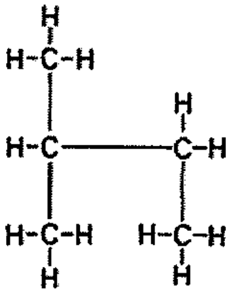


5

How many of the structures represent isomers of one another?

A	2	**B**	3
C	4	**D**	5

38 A student investigated the reaction of different vegetable oils and margarines with hydrogen.

100 cm^3 of hydrogen was passed through 1 g samples containing a catalyst. The volume of hydrogen gas remaining in each reaction was recorded in the table below.

sample	volume of hydrogen remaining / cm^3
P	0
Q	87
R	100

Which sample(s) is/are unsaturated vegetable oils?

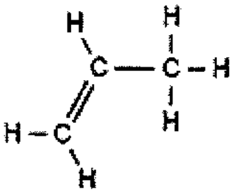
A P only
B P, Q and R
C P and Q
D R only

39 In which reaction is water **not** a product?

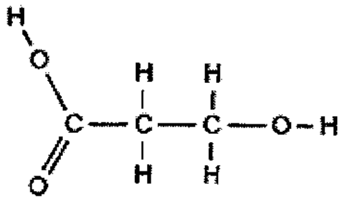
A combustion of petroleum gases
B esterification between propanoic acid and butanol
C fermentation of glucose
D neutralization between dilute nitric acid and aqueous ammonia

40 Which of the following monomer(s) would undergo polymerisation on their own?

1



2



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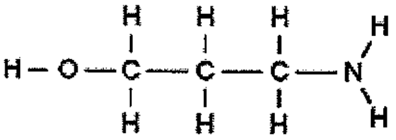

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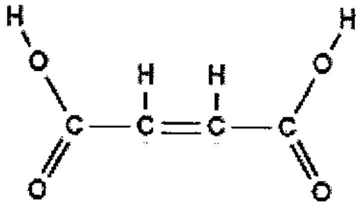

A 1 and 2 only

B 1, 2 and 4

C 2 and 4

D all of the above

End of Paper

The Periodic Table of Elements

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

Group

1	2	3	4	5	6	7	8	9	10	11	12	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											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 –

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

KUO CHUAN PRESBYTERIAN SECONDARY SCHOOL

2024 PRELIMINARY EXAMINATION
Secondary 4 Express

NAME	

CLASS ☐ **REG. NO** ☐☐

CHEMISTRY
Paper 2
Setter: Ms Koh Li Eng

6092 / 02
22 August 2024
1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use a 2B pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 24.

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

FOR EXAMINER'S USE	
Section **A**	/ **70**
Section **B**	/ **10**
Total	/ **80**

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Section A

Answer **all** questions.

1 Fig. 1.1 shows part of the Periodic Table with some elements.

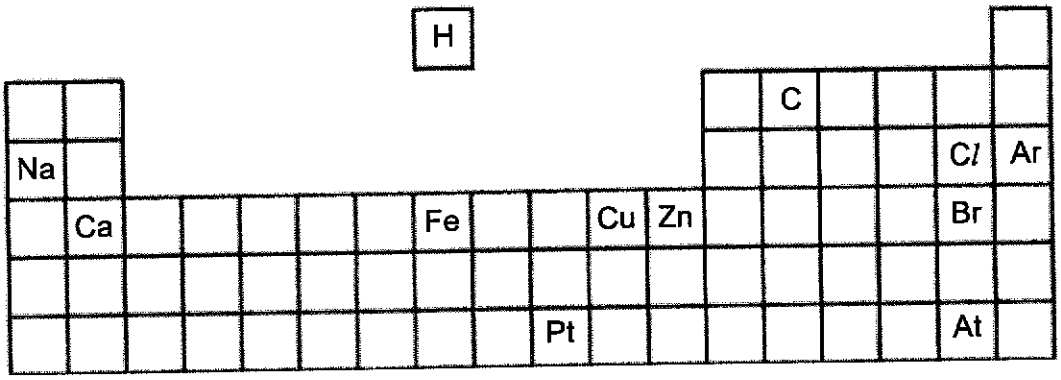


Fig. 1.1

Use the symbols of the elements from Fig. 1.1 to answer the questions.

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

(a) Which element is inert?

.... [1]

(b) Which elements have an atomic mass of 40?

.... [1]

(c) Which elements exist as a black solid?

.... [1]

(d) Which element forms a carbonate that is the most thermally stable?

.... [1]

(e) Which elements are used to make brass?

.... [1]

(f) Which elements can be used as electrodes in the electrolysis of water?

.... [1]

[Total: 6]

2 Complete the table to name the most appropriate separation technique that can be used to obtain the substance underlined in the mixture.

mixture	**separation technique**
<u>ammonium chloride</u> + sodium chloride	
water + <u>lead(II) sulfate</u>	
<u>methanol</u> + glucose solution	

[3]

[Total: 3]

3 An experiment was carried out to investigate the rate of reaction between magnesium and dilute nitric acid using the apparatus shown in Fig. 3.1.

$$Mg\ (s) + 2HNO_3\ (aq) \rightarrow Mg(NO_3)_2\ (aq) + H_2\ (g)$$

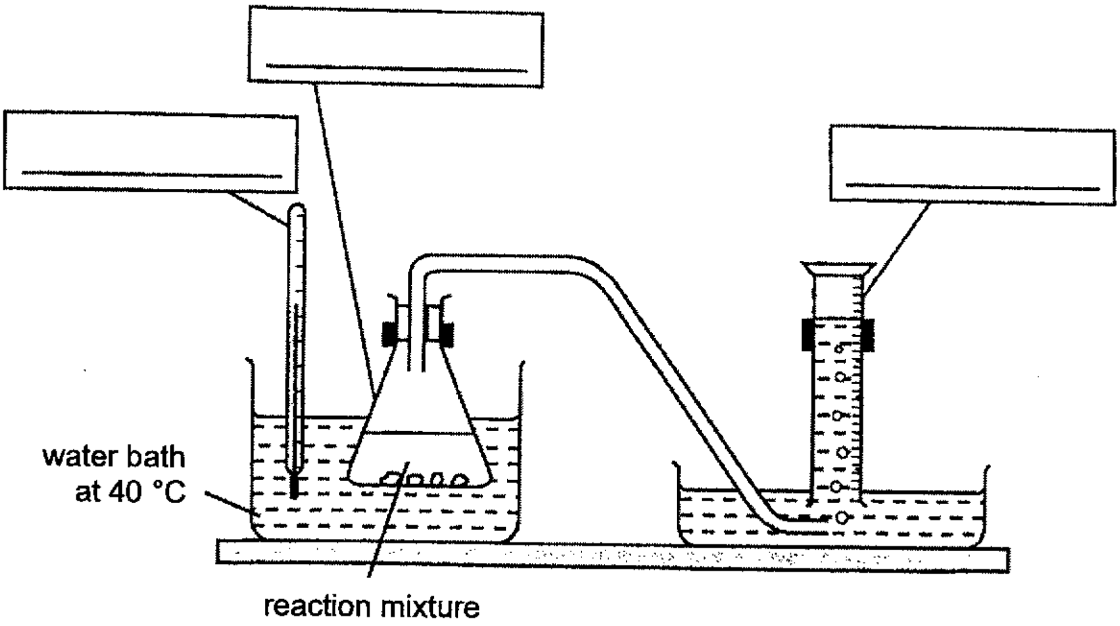


Fig. 3.1

(a) Complete Fig. 3.1 by filling in the empty boxes to identify the apparatus. [2]

(b) 2.0 g of magnesium was added to 100 cm^3 of 1.5 mol/dm^3 of dilute nitric acid.

Show that magnesium is used in excess in this reaction.

[3]

[Total: 5]

4 The relative abundance of isotopes can be determined experimentally using a technique called mass spectrometry. Fig. 4.1 shows the mass spectrum of copper isotopes and their respective natural abundance.

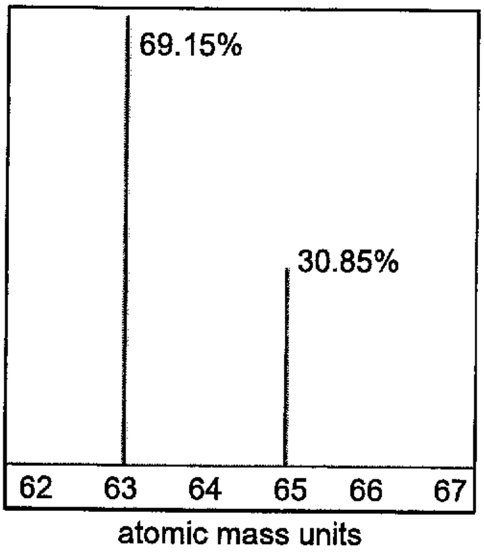


Fig. 4.1

(a) Based on the information, calculate the relative atomic mass of copper. Show your workings clearly and give your answer to the nearest whole number.

[2]

(b) Copper is a typical transition element with many of its compounds having colours. An example is copper(II) chloride solution, $CuCl_2$, which is green-blue in colour.

(i) Complete Fig. 4.2 with the expected observations when $CuCl_2$ undergoes the different reactions.

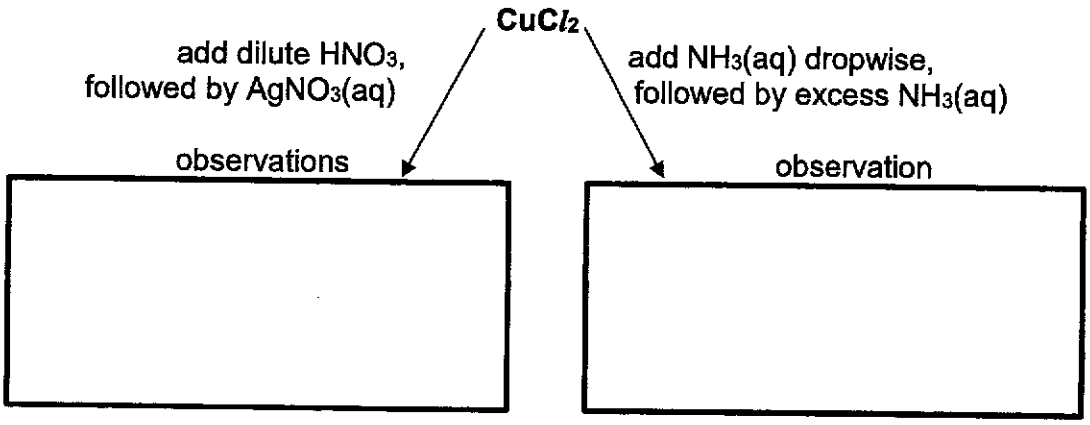


Fig. 4.2

[3]

(ii) Name the type of reaction that occurred between $CuCl_2$ and $AgNO_3$.

.... [1]

(iii) Under suitable conditions, $CuCl_2$ can be converted into a compound **X** which is pale green in colour. The composition of **X** by mass is Cu, 21.5%, F, 38.7%, K, 39.8%.

Use the information to work out the empirical formula of compound **X**. Show your working clearly.

[3]

[Total: 9]

5 Fig. 5.1 shows two set–ups that a student used to investigate the difference in the reactions between an electrolytic cell and a simple cell.

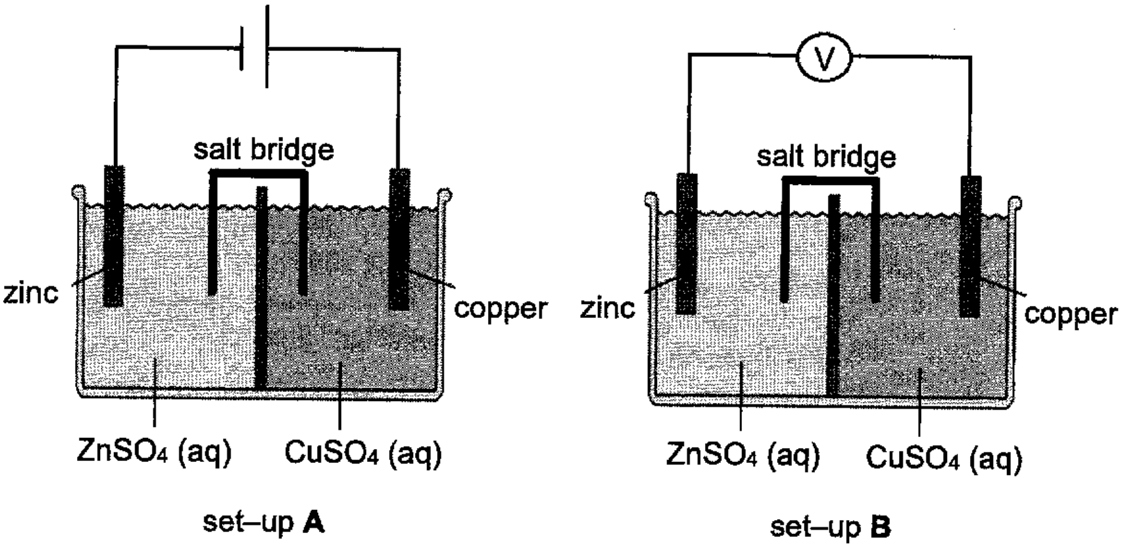


Fig. 5.1

(a) Draw arrows in Fig. 5.1 to show the flow of electrons on both set-ups clearly. [1]

(b) It was observed that the zinc electrodes of both set-ups change in size.

(i) State and explain the expected changes in sizes of the zinc electrodes in both set-ups.

Your answer should:

- describe the expected change in size in each set-up
- explain why each change occurs
- give half-equations for each change.

....

....

....

....

....

....

....

.... [5]

(ii) Describe two differences, other than the change in size of the zinc electrode, in the observations between the two set-ups.

....

....

....

.... [2]

(c) The student would like to prepare more zinc sulfate and copper(II) sulfate for the experiments.

Complete the table below to identify the starting reagents needed.
Include state symbols.

salt	formulae of starting reagents used
$ZnSO_4$ (s)	**(1)** .... **(2)** H_2SO_4 (aq)
$CuSO_4$ (s)	**(1)** .... **(2)** H_2SO_4 (aq)

[2]

[Total: 10]

6 In the Haber process, nitrogen and hydrogen are reacted together to form ammonia.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(a) Describe the arrangement and movement of ammonia particles at room temperature and pressure.

....

.... [1]

Table 6.1 shows some bond energies of the covalent bonds of nitrogen and hydrogen atoms.

Table 6.1

bond	bond energy in kJ/mol
N–N	160
N=N	418
N≡N	941
N–H	391
H–H	436

(b) Based on information given in Table 6.1, describe and explain the trend of bond energy between nitrogen atoms.

....

....

....

....

.... [2]

(c) **(i)** Using the data given in Table 6.1, calculate the overall enthalpy change for the forward reaction of the Haber process.

Show your working.

[3]

(ii) Hence, state the energy change for the backward reaction where 2 moles of ammonia decomposes.

.... [1]

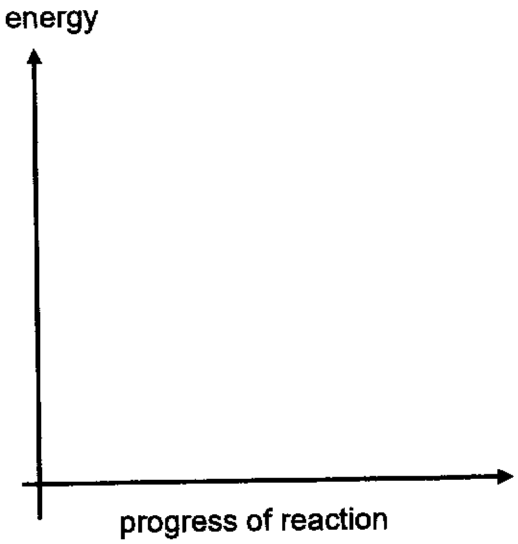
[Total: 7]

7 A study has been done on the cracking of poly(propene), $(C_3H_6)_n$, as a possible alternative to solving plastic waste. It is an endothermic reaction which requires nano materials as catalyst. The products are mainly $C_7 - C_{10}$ hydrocarbons.

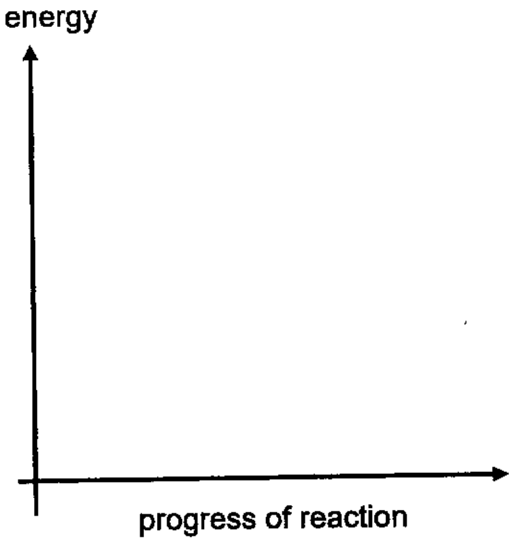
(a) Draw the energy profile diagrams to show the effect of the catalyst on the energy changes in the cracking of poly(propene).

Your diagrams should show:

- the reactants and products of the reaction
- the activation energy of the reaction
- the enthalpy change of the reaction, △H



reaction without catalyst



reaction with catalyst

[3]

(b) **(i)** Draw the structure of the repeating unit of poly(propene) and give the empirical formula of poly(propene).

[2]

(ii) Using its empirical formula from (b)(i), construct a balanced chemical equation for the complete combustion of poly(propene).

.... [1]

(iii) Hence, calculate the volume of carbon dioxide produced when 5 kg of poly(propene) is completely burned in air.

[2]

(c) Poly(propene) is a main form of plastic waste because of its wide variety of applications such as water pipes.

Suggest an advantage and a disadvantage of using poly(propene) instead of iron to make water pipes.

....

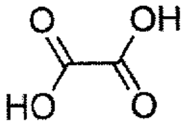
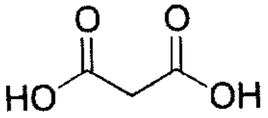
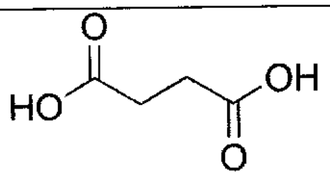
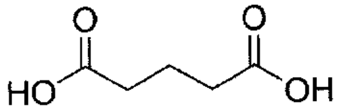
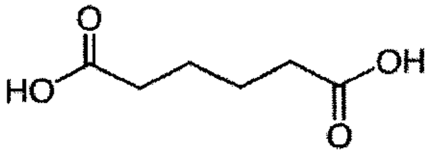
....

....

.... [2]

[Total: 10]

8 The table shows some information of the homologous series of a class of organic compounds called dicarboxylic acids.

name	**condensed formula**	***skeletal formula**
ethanedioic acid	HOOCCOOH	
propanedioic acid	$HOOCCH_2COOH$	
		
pentanedioic acid	$HOOC(CH_2)_3COOH$	
hexanedioic acid	$HOOC(CH_2)_4COOH$	

**In skeletal formulae, the carbon atoms are implied to be located at the corners and ends of line segment rather than being indicated by the atomic symbol C. Hydrogen atoms attached are also not indicated but understood to be present accordingly.*

(a) **(i)** Fill in the table to show the name and condensed formula of the dicarboxylic acid missing in the homologous series. [1]

(ii) What is the general formula of the members in this homologous series?

.... [1]

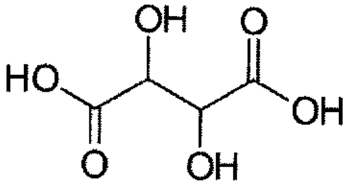
(b) A student claims that dicarboxylic acids are able to undergo condensation polymerisation on its own to form polyesters.

Explain whether you agree with claim.

....

.... [1]

(c) Tartaric acid is a substituted dicarboxylic acid which is found in unripe grapes, making it taste sour. It is a weak, dibasic acid and undergoes neutralisation with potassium hydroxide. The skeletal formula of tartartic acid is shown below.



(i) Explain the term weak acid and circle the acidic hydrogens on the skeletal formula of tartaric acid.

....

....

.... [2]

(ii) State another physical and chemical property that tartaric acid will exhibit.

physical property: ....

....

chemical property: ....

.... [2]

(iii) Suggest two differences in the structural formula between tartaric acid and butanoic acid, C_3H_7COOH.

....

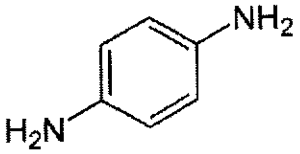
....

....

.... [2]

(iv) Tartaric acid can undergo condensation polymerisation reaction with 1, 4-phenylene-diamine to form a polyamide.

The skeletal formula of 1, 4-phenylene-diamine is shown below.



Draw the structure of the polyamide, showing one repeat unit.

[1]

[Total: 10]

9 A student investigated the rate of reaction in a series of experiments for the following reaction.

$$2ClO_2\,(aq) + 2OH^-\,(aq) \rightarrow ClO_3^-\,(aq) + ClO_2^-\,(aq) + H_2O\,(l)$$

The initial rate of this reaction was determined using different concentrations of the reactants as shown in the following experiments. Table 9.1 shows his results.

Table 9.1

experiment	concentration of ClO_2 (mol/dm^3)	concentration of OH^- (mol/dm^3)	initial rate of reaction (mol/dm^3 s)
1	0.02	0.03	0.00276
2	0.02	0.06	0.00552
3	0.04	0.03	0.01104
4	0.04	0.03	0.00552
5	0.04	0.06	0.02208

From the data in Table 9.1, changes in the concentration of each reactant affect the rate of reaction differently. Knowing how the rate is affected by the concentration of each reactant will allow us to predict the rate of reaction.

We can classify the reactions into the following two types as shown in Table 9.2.

Table 9.2

type of reaction	characteristic	example
First order reaction with respect to reactant **A**	The rate of reaction is proportional to the concentration of **A**.	If you double the concentration of **A**, the rate doubles. If you increase the concentration of **A** by a factor of 4, the rate goes up 4 times.
Second order reaction with respect to reactant **A**	The rate of reaction is proportional to the square of the concentration of **A**.	If you double the concentration of **A**, the rate would go up 4 times (2^2). If you tripled the concentration of **A**, the rate would increase 9 times (3^2).

(a) The student carried out four experiments using solutions at room temperature and one experiment using solutions at a lower temperature.

Which experiment was carried out at a lower temperature?

Explain your reasoning using information from Table 9.1.

....

....

....

.... [2]

(b) **(i)** Using information from Table 9.1, describe how the rate of reaction changes as the concentration of ClO_2 changes.

....

....

....

.... [2]

(ii) Hence, determine the order of reaction with respect to ClO_2.

.... [1]

(c) Determine the rate of reaction when the concentrations of both ClO_2 and OH^- are 0.01 mol/dm^3.

.... [1]

(d) Explain, in terms of collision between reacting particles, the effect of concentration on the rate of reaction.

....

....

....

.... [2]

(e) Oxides of chlorine, other than ClO_2, can also exist as Cl_2O.

Draw a 'dot-and-cross' diagram to show the bonding in Cl_2O.
Show outer electrons only.

[2]

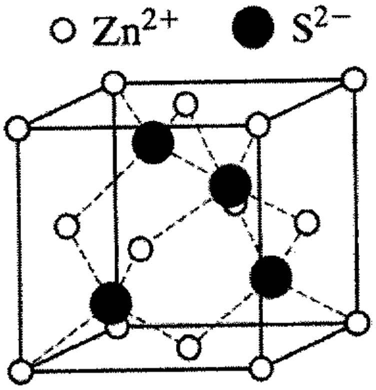
[Total: 10]

Section B

Answer **one** question from this section.

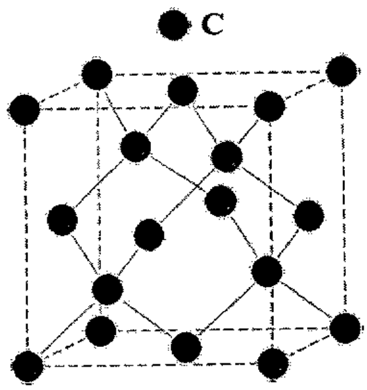
10 Sphalerite is the chief ore mineral of zinc containing zinc sulfide. It exists in crystalline form and is the most important mineral of zinc.

Fig. 10.1 and 10.2 shows the structures and melting points of zinc sulfide and diamond.



melting point: 1700 °C

Fig. 10.1



melting point: 3550 °C

Fig. 10.2

(a) State the type of structure zinc sulfide has.

.... [1]

(b) Explain why the melting points of the two substances differ from each other.

....

....

....

....

.... [2]

Zinc can be extracted from sphalerite via reduction by carbon in the blast furnace.

Sphalerite is first heated to produce zinc oxide.

$$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$$

The zinc oxide is then heated in a blast furnace with carbon and hot air.

$$2C(s) + O_2(g) \rightarrow 2CO(g)$$

$$ZnO(s) + CO(g) \rightarrow Zn(g) + CO_2(g)$$

Zinc vapour and other waste gases are collected at the top of the furnace.

(c) Draw a 'dot-and-cross' diagram to show the bonding in zinc oxide.
Show outer electrons only.

[2]

(d) The three reactions occurring in the blast furnace are known as redox reactions.

With reference to any one of the reactions, explain why it is a redox reaction.

....

....

....

....

.... [2]

(e) The waste gases collected need to be treated before releasing into the environment.

Describe one harmful effect on the environment and one harmful effect on humans if the waste gases are not treated.

....

....

....

....

.... [2]

(f) Briefly describe the method used to separate zinc from the rest of the waste gases.

....

.... [1]

[Total: 10]

11 Petrol and diesel vehicles are fitted with catalytic converter to reduce the amount of polluting substances emitted from the exhaust. For diesel engines, the catalytic converter may also include a particle filter to remove solid particles of carbon. Fig. 11.1 shows one design of diesel particle filter.

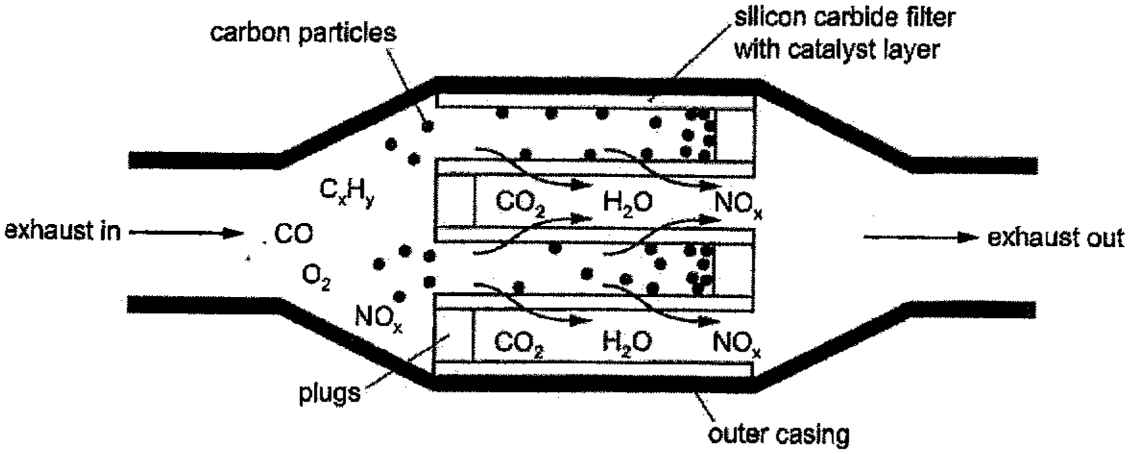


Fig. 11.1

The wall of the particle filter are made from silicon carbide, SiC. This is a hard solid that will **not** melt at the high temperature of the exhaust.

(a) Suggest how the structure and bonding of silicon carbide makes it resistant to melting, even at high temperature.

....

....

....

....

.... [3]

(b) The catalytic converters make use of catalysts to remove pollutants from the exhaust.

(i) State the catalysts involved in the catalytic converters.

.... [1]

(ii) Describe how the catalysts speed up the reactions for the removal of pollutants.

....

.... [1]

(c) **(i)** Using the information provided Fig. 11.1, write a balanced chemical equation of a redox reaction that occurs in the catalytic converter.

.... [1]

(ii) Identify the oxidising agent for the redox reaction for your answer in **(c)(i)**.

.... [1]

(d) Diesel engines may also be fitted with a second catalytic converter to remove the remaining oxides of nitrogen. This second converter uses ammonia as the reducing agent. One possible reaction, for the removal of nitrogen dioxide, is shown by the following **unbalanced** equation.

$$\ldots\ldots NH_3 + \ldots\ldots NO_2 \rightarrow \ldots\ldots N_2 + \ldots\ldots H_2O$$

(i) Balance the equation by filling in the blanks above. [1]

(ii) Nitrogen monoxide is also removed by the catalytic converter as it will damage the ozone layer if released into the atmosphere. The two-step reaction is as shown.

Step 1: $NO + O_3 \rightarrow NO_2 + O_2$

Step 2: $NO_2 + O_3 \rightarrow NO + 2O_2$

It was discovered that one nitrogen monoxide molecule can destroy thousands of ozone molecules.

Use the equations from steps 1 and 2 to explain why.

....

....

....

.... [2]

[Total: 10]

End of Paper

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The Periodic Table of Elements

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

Group

1	2	3	4	5	6	7	8	9	10	11	12	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											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 –

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

KUO CHUAN PRESBYTERIAN SECONDARY SCHOOL
SECONDARY FOUR EXPRESS
CHEMISTRY
PRELIMINARY EXAMINATION 2024
Answer Scheme

Paper 1 – Multiple Choice Questions (40 marks)

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
A	B	B	D	B	B	C	A	D	D

Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
D	B	A	A	C	A	B	D	C	C

Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
B	D	D	B	C	A	C	A	C	C

Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40
A	A	C	B	C	C	B	C	C	B

KUO CHUAN PRESBYTERIAN SECONDARY SCHOOL
SECONARY FOUR EXPRESS CHEMISTRY 6092
PRELIMINARY EXAMINATION 2024

MARK SCHEME

Section A (70 marks)

<table>
<tr><td>1</td><td>a</td><td>Ar</td><td>[1]</td></tr>
<tr><td></td><td>b</td><td>Ca, Ar</td><td>[1]</td></tr>
<tr><td></td><td>c</td><td>C, Aℓ</td><td>[1]</td></tr>
<tr><td></td><td>d</td><td>Na</td><td>[1]</td></tr>
<tr><td></td><td>e</td><td>Cu, Zn</td><td>[1]</td></tr>
<tr><td></td><td>f</td><td>C, Pt</td><td>[1]</td></tr>
<tr><td></td><td></td><td>Note: Penalise if incomplete or extra answers are given. Penalise one mark overall if names were given instead of symbols.
Marker's comment: Majority of the students missed out on giving complete answers. Common mistakes for (e) make up of brass is carbon and iron and (f) electrodes is copper and zinc.</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td><table><tr><th>Mixture</th><th>separation technique</th></tr><tr><td>ammonium chloride + sodium chloride</td><td>Sublimation [1]</td></tr><tr><td>water + lead(II) sulfate</td><td>Filtration [1]</td></tr><tr><td>methanol + glucose solution</td><td>(fractional/simple) distillation [1]</td></tr></table>1m each</td><td>[3]</td></tr>
<tr><td></td><td></td><td>Marker's comment: Common mistake is to give preparation methods instead of separation techniques. For lead(II) sulfate, evaporation to dryness was rejected as question asked for the **most** appropriate technique.</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

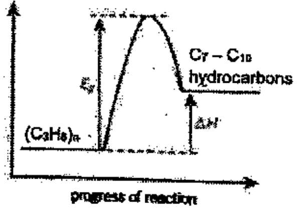
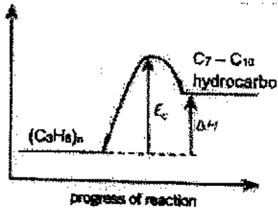
3	a	Thermometer, Conical flask, Measuring cylinder All correct 2m, 2 correct 1m. Penalise for spelling once throughout the paper.	[2]
	b	No of mol of Mg = 2 / 24 = 0.083333	[1]
		No of mol of HNO_3 = 100 / 1000 x 1.5 = 0.150	[1]
		Mole ratio of Mg : HNO_3 is 1 : 2 For 0.15 mol of HNO_3 used, ½ x 0.15 = 0.075 mol of Mg is needed. As there's 0.0833 mol of Mg, it is in excess. OR For 0.0833 mol of Mg used, 2 x 0.0833 = 0.167 mol of HNO_3 is needed. Since there is only 0.15 mol of HNO_3, it is the limiting reactant and Mg is in excess.	[1]
		Marker's comment: (a) students incorrectly identify gas jar, missing out that the apparatus has markings. (b) poorer response was the inability to do the link/explain clearly why Mg is in excess. Some calculations were given in fractions and was unclear which value was greater/smaller.	
4	a	A_r of Cu = (69.15/100 x 63) + (30.85/100 x 65) = 63.617	[1]
		= 64 (nearest whole number)	[1]
	bi	$AgNO_3$: White precipitate forms.	[1]
		NH_3: Light blue / Blue precipitate forms,	[1]
		soluble in excess to give a dark blue solution. Penalize once overall if short-form (ppt) was given.	[1]
	bii	Precipitation	[1]
	biii		[3]

Element	Cu	F	K
% in 100g	21.5	38.7	39.8
Ar	64	19	39
No. of mol	0.33594	2.0368	1.0205
Mol ratio	0.33594 / 0.33594 = 1	2.0368 / 0.33594 = 6.06	1.0205 / 0.33594 = 3.04
Simplest ratio	1	6	3

Empirical formula: **CuF_6K_3**

1m – Indication of the conversion from % to mass, 1m – workings, 1m – empirical formula (accept any combination of the formula)

		Markers' comment: (a) poorer response did not follow instructions to give answers to nearest whole number. (b)(i) majority was not able to give complete answers for the observation. Misconception of ppt turning into solution. (b)(ii) most common mistake was "metal displacement". Students did not understand the reaction. (b)(iii) common mistake was not converting % to mass and not showing calculations.	
5	a	Set-up A: Anticlockwise Set-up B: Clockwise	[1]
	bi	Zinc electrode in set–up A increased in size, whereas the zinc electrode in set–up B decreased in size.	[1]
		In set-up A, Zn^{2+} ions are discharged / gained 2e- / reduced to formed Zn metal which causes the electrode to increase in size.	[1]
		In set-up B, Zinc is more reactive than copper and loses electrons to form Zn^{2+} ions causing the electrode to decrease in size.	[1]
		Set-up A: Zn^{2+} (aq) + 2e → Zn (s)	[1]
		Set-up B: Zn (s) → Zn^{2+} (aq) + 2e	[1]
	bii	The copper electrode in A will decrease in size whereas the copper electrode in B will increase in size.	[1] [1]

		The blue aqueous $CuSO_4$ colour will intensify in A whereas the blue aqueous $CuSO_4$ colour will fade in B.	
	c	Zn (s) / ZnO (s) / $ZnCO_3$ (s) CuO(s) / $CuCO_3$ (s) Penalize once for missing state symbols.	[1] [1]
		Markers' comment: (b)(i) students did not read the question carefully that both setup changes in size. Half-equations were missing state-symbols. Explanations were missing the key concept (more reactive metal has a higher tendency to lose electrons) of simple cell. (b)(ii) Students gave only one differences or incomplete comparisons. (c) common mistake was giving salts as answers and students thinking that copper can be used, forgetting that it is an unreactive metal.	
6	a	Ammonia particles are far apart and disorderly. They move about rapidly in all direction.	[1]
	b	As the number of bonds between nitrogen atoms increases from single to triple bond, the bond energy increases from 160 kJ/mol to 941 kJ/mol. This is due to a stronger attraction between the nitrogen atoms due to more electrons shared between them, require more energy to break the bonds. Note: Vice versa accepted.	[1] [1]
	ci	Total energy absorbed = 941 + 3(436) = 2249 kJ Total energy released = 2 x 3(391) = 2346 kJ Overall enthalpy change = 2249 – 2346 = –97 kJ	[1] [1] [1]
	cii	+97kJ	[1]
		Markers' comment: (a) incomplete answers. Commonly missing out the idea of "disorderly" or "rapid movement"	
		(b) misconception that bond were "overcome" when it is broken or that intermolecular forces of attraction were incorrectly discussed showing poor understanding of question. (c)(i) Incorrect use of data. N-N data used instead of N≡N Poor statements given and incorrect calculation of the number of bonds. (ii) missing signs and incorrect units given. 2 moles of ammonia decomposes hence it isn't kJ/mol.	
7	a	 reaction without catalyst  reaction with catalyst 1m – same reactant and product height, labelled 1m – correct Ea / Ec 1m – same ΔH (endothermic)	[3]
	bi	 Empirical formula: CH_2	[1] [1]
	bii	$2CH_2 + 3O_2 \rightarrow 2CO_2 + 2H_2O$	[1]
	biii	No. of mol of poly(propene) = 5000 / (12+2) = 357.14 Mole ratio of CO_2 : Poly(propene) = 2 : 2 ∴ No. of mol of CO_2 = 357.14 Vol of CO_2 = 357.14 x 24	[1]

		= 8571.42 = 8570 dm^3 (to 3 s.f.)	[1]
	c	Advantage: Poly(propene) is durable / does not rust unlike iron.	[1]
		Disadvantage: Poly(propene) is non-biodegradable and would contribute to waste, pollution problems.	[1]
8	ai	Butanedioic acid, $HOOC(CH_2)_2COOH$ OR $HOOCCH_2CH_2COOH$	[1]
	aii	$HOOC(CH_2)_nCOOH$ OR $(CH_2)_n(COOH)_2$	[1]
	b	Disagree with the claim. It is unable to undergo condensation polymerization on its own as it only has carboxyl functional group. OR does not contain hydroxyl or amine group.	[1]
	ci	The term weak acid means the acid undergoes only partial dissociation in water to form H+ ions.	[1]
		Circle the 2 acidic hydrogen of carboxy functional group.	[1]
	cii	Physical property: pH < 7, turns moist blue litmus paper red, turns green Universal Indicator orange/yellow. (any one)	[1]
		Chemical property: Reacts with metal to produce salt and hydrogen, reacts with metal carbonate to produce salt, water and carbon dioxide, undergoes redox reaction with potassium manganate (VII). (any one)	[1]
	ciii	Tartaric acid contain 2 carboxyl groups (per molecule) whereas butanoic acid contains only 1 carboxyl group (per molecule). Tartaric acid contains 2 types of functional groups (per molecule), hydroxyl and carboxyl whereas butanoic acid contains only 1 type of function group (per molecule), carboxyl. Tartaric acid contains a hydroxyl functional group (per molecule), whereas butanoic acid does not. Tartaric acid contains 4 functional groups (per molecule), whereas butanoic acid contains only 1 functional group. Any 2 of the above.	[2]
	civ		[1]
9	a	Experiment 4.	[1]
		Comparing Expt 3 and 4, with the same concentration of ClO_2 and OH^-, the initial rate of reaction was lower for expt 4, 0.00552 mol/dm^{3}s as compared to expt 3, 0.01104 mol/dm^{3}s.	[1]
	bi	The rate of the reaction increases by 4 times (2^2) when the concentration of ClO_2 doubles.	[1]
		From experiment 1 and 3, the rate of reaction increases from 0.00276 mol/dm^{3}s to 0.01104 mol/dm^3 s when the concentration increases from 0.02 mol/dm^3 to 0.04 mol/dm^3. (OR expt 2 and 5 with evidence)	[1]
	bii	Second order reaction Reject: 2 order, order 2, 2nd order.	[1]
	c	0.000230 mol/dm^3 s Penalise for wrong or missing units.	[1]
	d	Increasing concentration increases the number of particles per unit volume. This increases the frequency of collisions between reacting particles.	[1]
		As a results, the frequency of effective collisions increases and the rate of reaction increases.	[1]
	e	 1m for correct bonding electrons, 1m for correct valence electrons for all	[2]

Section B (10 marks)

10	a	Giant ionic lattice structure	[1]
	b	Zinc sulfide has strong electrostatic forces of attraction between the oppositely charged Zn^{2+} and S^{2-} ions but diamond has strong covalent bonds between the C atoms. More energy is needed to break the strong covalent bonds in diamond than to overcome the strong electrostatic forces of attraction in zinc sulfide hence melting point of diamond is higher than zinc sulfide.	[1] [1]
	c	 1m for each ion.	[2]
	d	C is oxidised as it gains oxygen to form CO, O_2 is reduced as it decreases in oxidation state from 0 (in O_2) to -2 (in CO). Hence it is a redox reaction. OR ZnO is reduced as it loses oxygen to form Zn. CO is oxidised as it gains oxygen to form CO_2. Hence it is a redox reaction. Accept all explanations of redox.	[1] [1] [1] [1]
	e	Environment: SO_2 forms acid rain when dissolved in clouds/rainwater which corrodes limestone building/metal structures when it falls. (Accept marine life impact) Human: CO reacts irreversibly with haemoglobin in blood to form carboxyhaemoglobin which reduces the ability to transport O_2 which causes breathing difficulties and even death.	[1] [1]
	f	Cool to room temperature and collect the solid formed / sieve out the solid.	[1]

11	a	Silicon carbide has a giant molecular structure. A lot of energy is needed to break the strong covalent bonds between silicon and carbon atoms. Hence its melting point is very high and makes it resistant to melting. 1m – Structure, 1m – energy + mp, 1m – breaking of strong covalent bonds	[3]
	bi	Platinum, Rhodium and Palladium Note: all must be stated.	[1]
	bii	Catalyst provides an alternative pathway with a lower activation energy which helps increase the frequency of effective collisions.	[1]
	ci	$2CO + O_2 \rightarrow 2CO_2$ OR 2NO + 2CO → N2 + 2CO2 OR $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ Accept any C_nH_{2n+2} molecules within $5 \leq n \leq 25$	[1]
	cii	OA highlighted above. Allow ecf	[1]
	di	…8.. NH_3 + …6.. NO_2 → …7.. N_2 + …12.. H_2O	[1]
	dii	In step 2, nitrogen monoxide produced is reused in step 1 to react with the ozone again in a continuous cycle. Thus, there is no net loss of nitrogen monoxide molecules.	[1] [1]