Candidate Name:	Class:	Index No.:

FUHUA SECONDARY SCHOOL
Secondary Four Express
PRELIMINARY EXAMINATION 2024

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CHEMISTRY **6092/01**

Paper 1 Multiple Choice

Additional Material: Optical Mark Recognition (OMR)

DATE	**28 August 2024**
TIME	**0800 – 0900**
DURATION	**1 hour**

READ THESE INSTRUCTIONS FIRST
Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class, index number on the OMR and this question booklet.

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 OMR.

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

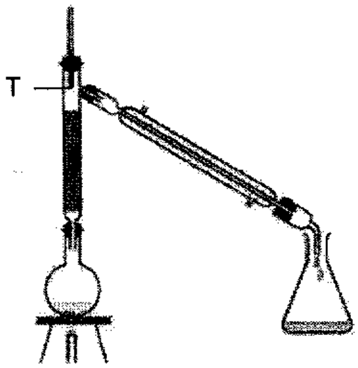
FOR EXAMINER'S USE		PARENT'S SIGNATURE
	40	

This document consists of 15 printed pages, including this page.

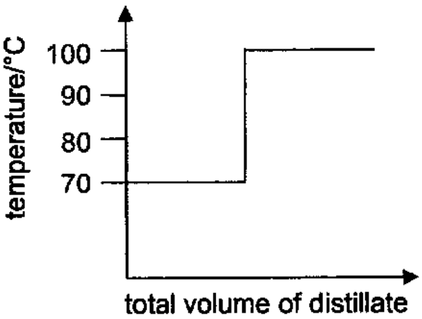
1 Nitrogen dioxide gas is almost twice as dense as nitrogen gas. A gas jar of nitrogen dioxide was placed on top of a gas jar of nitrogen gas with the open ends together. After half an hour, which of these statements would be true?

A Both gases would not have mixed.
B The bottom gas jar contained nitrogen gas only.
C The top gas jar contained nitrogen dioxide gas only.
D Some of each gas would have moved into the other gas jar.

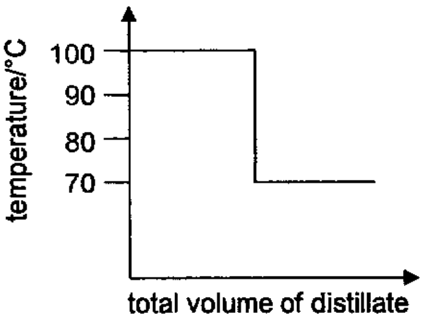
2 The diagram shows the apparatus used to separate hexane (boiling point 70°C) and water.



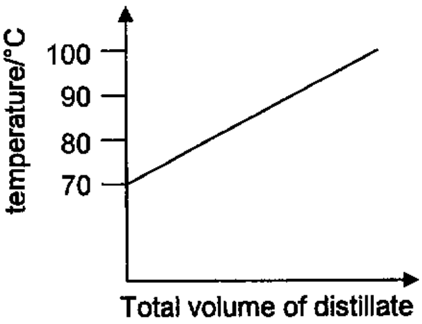
Which graph would be obtained if the temperature at point T was plotted against the total volume of distillate collected?



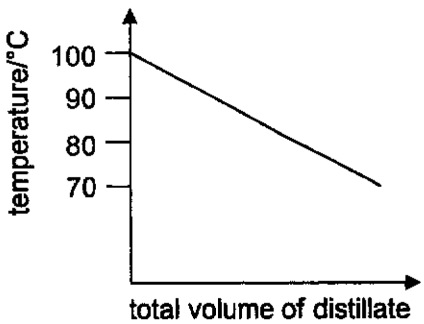
A



B

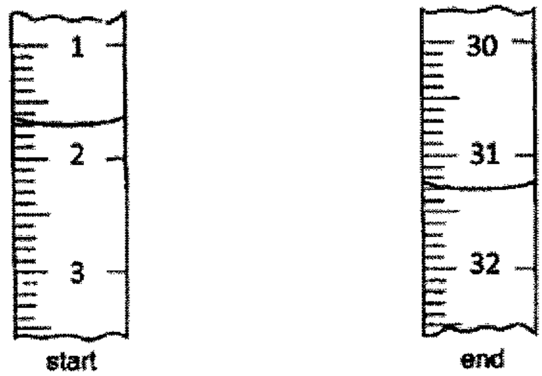


C



D

3 A student titrated 25.0 cm^3 of sodium hydroxide with hydrochloric acid. The diagram shows the volume of hydrochloric acid in the burette at the start and the end of the titration.



What volume of hydrochloric acid was added from the burette?

A 29.00 cm^3
B 29.60 cm^3
C 31.30 cm^3
D 32.70 cm^3

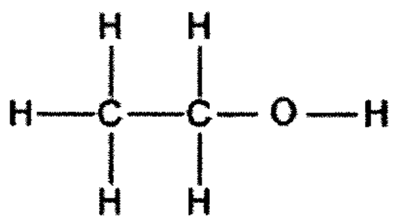
4 The formulae of the ions of some elements are shown below:

P^{3-} S^{2-} Cl^- Li^+ Mg^{2+}

Which of the following statements about these ions is correct?

A They all have more electrons than protons.
B They all have the same number of electron shells.
C They all have the same number of neutrons in their nuclei.
D They all have the same electronic structures as noble gases.

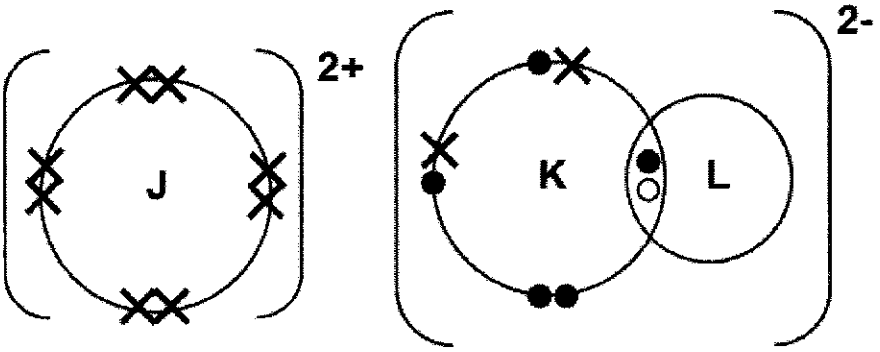
5 Ethanol has the structure shown.



How many of the electrons in a molecule of ethanol are **not** involved in bonding?

A 4
B 6
C 8
D 10

6 J, K and L are three different elements in the Periodic Table. The 'dot and cross' diagram (showing only the valence electrons) of the compound formed between J, K and L is shown:



Which of the following statements is/are correct?

1 Element L is hydrogen.
2 Element J belongs to Group 2 of the Periodic Table.
3 Elements J, K and L are bonded together by ionic bonds only.

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

7 Elements X and Y form an ionic compound of formula X_3Y. What could the atomic numbers of X and Y be?

	X	Y
A	3	1
B	8	4
C	11	7
D	13	9

8 Magnesium oxide has a similar structure to that of sodium chloride. Which of the following statements is true?

A Magnesium oxide has a lower melting point than sodium chloride.
B Magnesium oxide and sodium chloride can conduct electricity in the molten state only.
C In a lattice structure, each magnesium ion is surrounded by six oxide ions while each oxide ion is surrounded by six magnesium ions.
D When magnesium reacts with oxygen, every mole of magnesium atoms loses a mole of electrons. Likewise, every mole of oxygen molecules loses a mole of electrons.

9 Which of the following reactions shows the amphoteric property of zinc oxide?

A $2ZnO + C \rightarrow 2Zn + CO_2$
B $ZnO + Mg \rightarrow MgO + Zn$
C $ZnO + 2HCl \rightarrow ZnCl_2 + 2H_2O$
D $ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$

10 The following statements about dilute sulfuric acid are all correct.

1 It reacts with copper(II) oxide, forming a blue solution.
2 It turns anhydrous copper(II) sulfate from white to blue.
3 A white precipitate is formed when aqueous barium nitrate is added.
4 Addition of methyl orange shows that the solution has a pH value of less than 4.0.

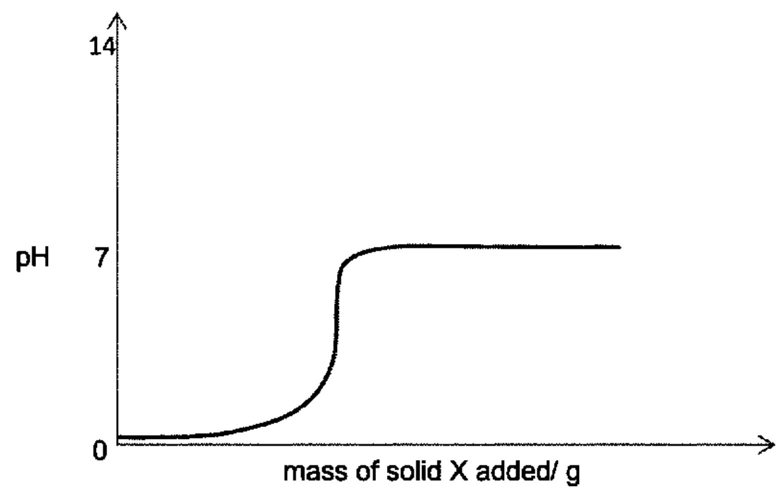
Which two statements confirm the acidic nature of the solution?

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

11 A titration method can be used to prepare aqueous potassium sulfate from potassium carbonate and dilute sulfuric acid. Which of the following conclusions from this information is correct?

A Potassium carbonate is an acidic salt.
B Potassium carbonate is insoluble in water.
C Potassium carbonate neutralises dilute sulfuric acid.
D Potassium carbonate reacts more vigorously than sodium carbonate with dilute sulfuric acid.

12 Solid X is gradually added to aqueous solution Y. The changes in pH are shown in the graph below.



What could X and Y be?

	X	Y
A	potassium carbonate	ethanoic acid
B	potassium oxide	ethanoic acid
C	sodium oxide	hydrochloric acid
D	zinc oxide	hydrochloric acid

13 An aqueous solution, Z, contains one cation and two anions. Some tests were carried out on the solution to determine the possible identities of the ions present. The observations of the tests carried out are recorded as follows:

Test 1	White precipitate forms when aqueous barium nitrate is added to solution Z.
Test 2	When solution Z is heated with aqueous sodium hydroxide and aluminium, a gas that turns moist red litmus blue is evolved.
Test 3	No visible change is observed when dilute hydrochloric acid is added to solution Z.

Which ions are likely to be present in solution Z?

A Al^{3+}, Cl^-, SO_4^{2-}
B Al^{3+}, NO_3^-, SO_4^{2-}
C Pb^{2+}, NO_3^-, SO_4^{2-}
D Pb^{2+}, Cl^-, NO_3^-

14 G is a white powder that turns yellow upon heating and gives off a colourless gas which is slightly soluble in water to produce a solution with pH less than 7. The residue reacts with dilute nitric acid and the aqueous solution formed white precipitate that is soluble in excess aqueous ammonia. Which of the following could be the identity of G?

A aluminium carbonate
B aluminium oxide
C zinc carbonate
D zinc oxide

15 One mole of a sample of hydrated sodium sulfide contains 162 g of water of crystallisation. What is the correct formula of this compound?

A $Na_2S.3H_2O$
B $Na_2S.5H_2O$
C $Na_2S.7H_2O$
D $Na_2S.9H_2O$

16 When solid sodium hydrogencarbonate is heated strongly, the following reaction occurs.

$$2NaHCO_3\ (s) \rightarrow Na_2CO_3\ (s) + H_2O\ (g) + CO_2\ (g)$$

What is the loss in mass when 33.6 g of solid sodium hydrogencarbonate is heated?

A 10.8 g
B 12.4 g
C 21.2 g
D 24.6 g

17 1.36 g of aqueous solution XCl_2 reacts with 20.0 cm^3 of 0.500 mol/dm^3 aqueous sodium hydroxide to form $X(OH)_2$. Determine the relative atomic mass of X.

A 65
B 136
C 201
D 272

18 Mixing 100 cm^3 of 0.100 mol/dm^3 aqueous lead(II) nitrate with 50 cm^3 of 0.100 mol/dm^3 dilute sulfuric acid resulted in the formation of a white precipitate. The precipitate is filtered off, dried, and weighed. What is the maximum possible mass of precipitate collected?

A $\frac{50 \times 0.100 \times 303}{1000} g$

B $\frac{100 \times 0.100 \times 303}{1000} g$

C $\frac{150 \times 0.100 \times 303}{1000} g$

D $\frac{150 \times 0.200 \times 303}{1000} g$

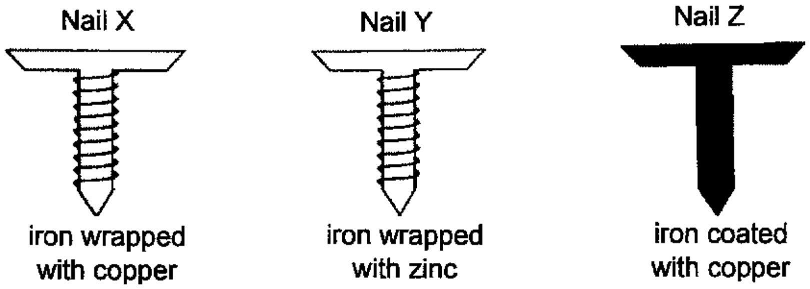
19 The table shows the solubility of some salts of metal M in cold water.

salt	solubilty in cold water
carbonate	insoluble
chloride	insoluble
sulfate	insoluble

What is metal M?

A barium
B calcium
C lead
D zinc

20 An experiment was carried out to investigate the process of rusting in iron nails.



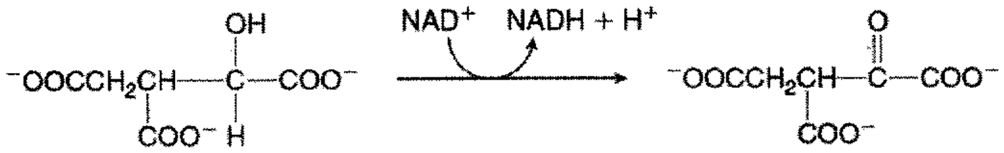
Which of the following statements is correct?

A None of the nails rusted.
B X rusted the fastest.
C Y rusted the fastest.
D Z rusted the fastest.

21 In which of the following reactions does the oxidation state of nitrogen show the greatest increase?

A ammonia to nitrogen gas
B ammonia to ammonium ion
C nitrogen dioxide to nitric acid
D nitrogen monoxide to nitrogen dioxide

22 The Krebs Cycle is part of the pathway for the breakdown of glucose and all metabolites in the human body. The following equation depicts a reaction in the Krebs Cycle.



isocitrate   oxalosuccinate

Which of the following statements is true?

A Isocitrate is reduced by NAD^+ to form oxalosuccinate.
B NAD^+ serves as a reducing agent in the above reaction.
C NADH serves as an oxidising agent in the above reaction.
D The conversion of isocitrate to oxalosuccinate is an oxidation reaction.

23 What can the destruction of the ozone layer lead to?

A The number of cases of skin cancer will increase.
B The number of flooded costal regions will increase.
C The number of hurricanes and typhoons will increase.
D The temperature of the oceans will decrease.

24 Element X is one of the components found in car fuels. It forms an oxide Y when burnt in car engines and gets further oxidised into Z when it is released in the atmosphere. Which of the following statements is true about the substances X, Y and Z?

A Element X could be sulfur.
B Substances X, Y and Z exist naturally as gases.
C Substances Y and Z increase the pH of river water.
D Substance Z binds irreversibly to haemoglobin in blood cells resulting in respiratory difficulties in humans.

25 Waste gases from a coal-burning power station are passed through powdered calcium carbonate to reduce pollution to the atmosphere.

Which waste gas will **not** be removed by the powdered calcium carbonate?

A carbon dioxide
B carbon monoxide
C nitrogen dioxide
D sulfur dioxide

26 Ammonia is manufactured on a large scale by a reversible reaction in the Haber process. Which of the following is true about the reversible reaction?

A A catalyst is not required for the reaction.
B A high temperature is required for the reaction.
C The reaction must have a low activation energy.
D The yield of ammonia will always be less than 100%.

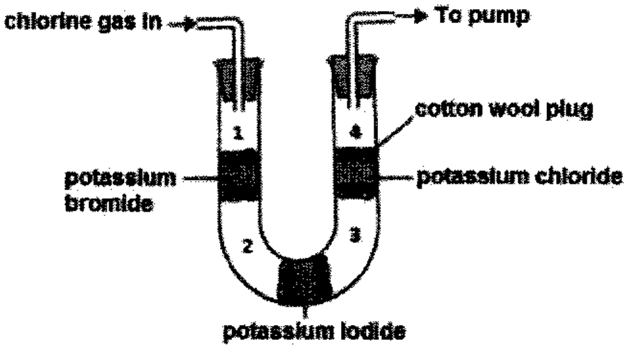
27 Elements P, Q and R have the following properties:

- P reacts with Group 1 metals to form ionic compounds.
- Q reacts with oxygen to form compounds with giant covalent structures and with very high melting and boiling points.
- R reacts violently with acids to give off hydrogen gas.

What is the arrangement order of these elements across a period in the Periodic Table?

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

28 Gaseous chlorine was passed through the apparatus set-up shown below. The apparatus was continuously heated throughout with a Bunsen flame and the observations were recorded.



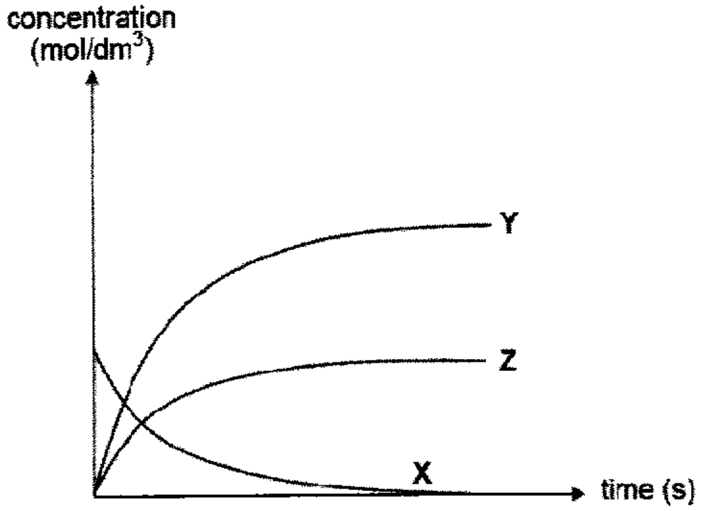
What would be the observations made at regions 1, 2, 3 and 4?

	region 1	region 2	region 3	region 4
A	brown gas	yellow-green gas	violet gas	yellow-green gas
B	violet gas	yellow-green gas	brown gas	violet gas
C	yellow-green gas	brown gas	violet gas	violet gas
D	yellow-green gas	brown gas	brown gas	brown gas

29 Phosphorus and nitrogen are both from Group 15 of the Periodic Table. Which ions would be produced if phosphine, PH_3, was dissolved in water?

A PH_3^+ , H^+
B PH_3^+ , OH^-
C PH_4^+ , H^+
D PH_4^+ , OH^-

30 The following graph shows the change in reactant and product concentrations with time during a chemical reaction.



Which equation represents the reaction shown in the graph?

A $X \rightarrow Y + Z$
B $X \rightarrow 2Y + Z$
C $Z \rightarrow 2X + Y$
D $Z \rightarrow 2Y + X$

31 Copper(II) sulfate reacts violently in excess magnesium powder to give magnesium sulfate and copper metal, as shown.

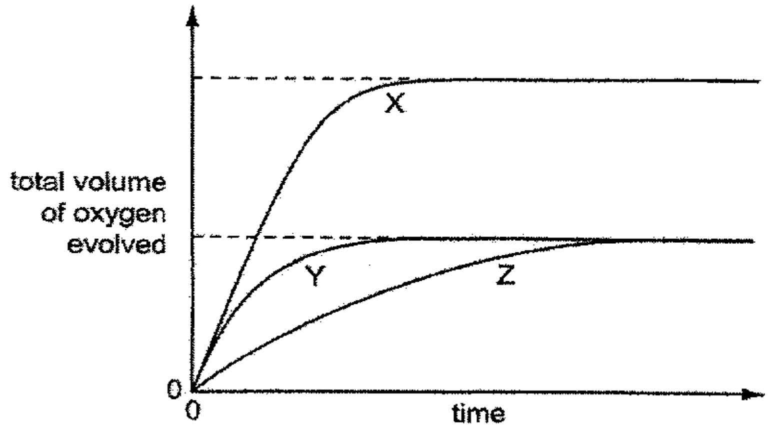
$$CuSO_4\ (aq) + Mg\ (s) \rightarrow MgSO_4\ (aq) + Cu\ (s) \qquad \Delta H = -164\ kJ/mol$$

Which of the following will be observed when 25 cm^3 of 0.05 mol/dm^3 copper(II) sulfate is reacted with 2 g of magnesium powder?

A 164 kJ of heat is absorbed in the reaction.
B 328 kJ of heat is released in the reaction.
C The temperature of the solution increases.
D The solution remains blue as there is insufficient magnesium powder.

32 Hydrogen peroxide solution is catalytically decomposed by manganese(IV) oxide to yield water and oxygen gas. To study the effect of the concentration of the solutions on the rate of reaction, the total volume of oxygen evolved was recorded against time.

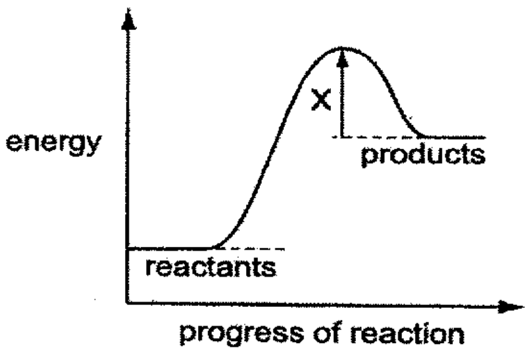
Three experiments were performed using a fixed mass of catalyst but with:
(i) 50 cm^3 of 2.0 mol/dm^3 hydrogen peroxide.
(ii) 100 cm^3 of 1.0 mol/dm^3 hydrogen peroxide.
(iii) 100 cm^3 of 2.0 mol/dm^3 hydrogen peroxide.



On the graph above, which of the curves X, Y and Z relate to the solutions (i), (ii) and (iii)?

	(i)	(ii)	(iii)
A	X	Y	Z
B	X	Z	Y
C	Y	Z	X
D	Z	Y	X

33 The energy profile diagram shows the energy changes that occur as a reaction takes place.



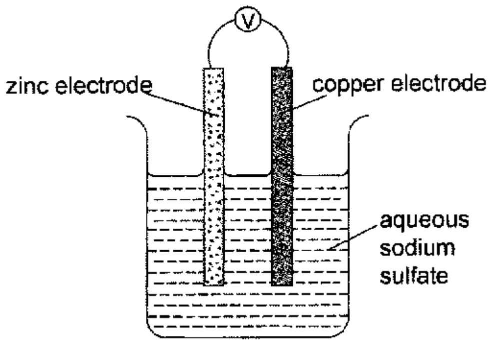
From the diagram, which statement about this reaction is correct?

A The reaction could be $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$.
B The reaction has a negative ΔH value.
C X shows the activation energy for the reaction.
D X shows the activation energy for the reverse reaction.

34 During the electrolysis of a molten manganese salt, 27.5 g of manganese is deposited at the cathode by 2 moles of electrons. What is the formula of the manganese ion that has been discharged?

A Mn^{2+}
B Mn^{3+}
C Mn^{4+}
D Mn^{5+}

35 What happens when a current is drawn from the simple cell shown below?

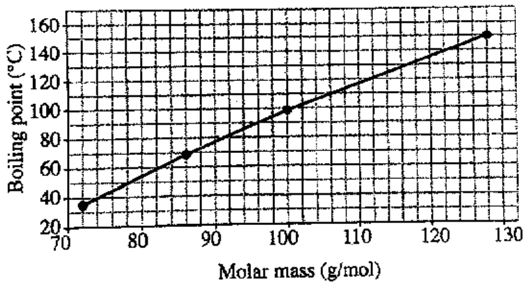


A Copper electrode dissolves to form copper(II) ions.
B Electrons flow from the copper to zinc electrode.
C Hydrogen gas is liberated at the zinc electrode.
D Zinc electrode dissolves to form zinc ions.

36 Which of the following statements about biofuel is true?

A Biofuel can be separated by simple distillation.
B Biofuel is an alternative fuel source to petroleum.
C Biofuel is formed from the remains of dead animals.
D Biofuel is the main feedstock for the petrochemical industry.

37 The following graph shows the relationship between the boiling points of some alkanes and their molar masses.



Which of the following is a likely explanation for the graph?

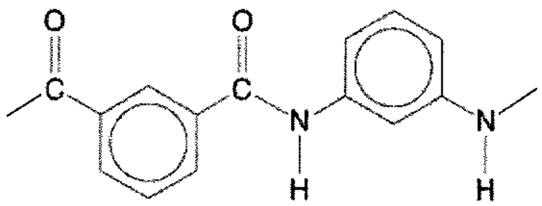
A Covalent bonds of alkane molecules become stronger as the molar mass increases.
B Higher the molar mass of the alkane, the stronger its carbon-carbon covalent bonds.
C Intermolecular forces of attraction get stronger as the alkane molecules get bigger.
D Structure of the alkane changes from simple molecular to giant molecular as the size of the molecules increases.

38 The reaction between a carboxylic acid, $C_xH_yCO_2H$ and an alcohol, $C_nH_{2n+1}OH$, produces an ester.

How many hydrogen atoms does one molecule of the ester contain?

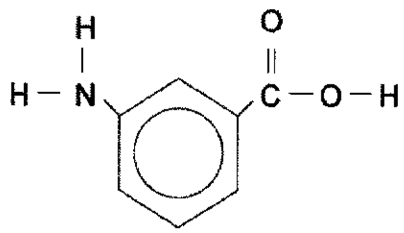
A y+2n
B y+2n+1
C y+2n+2
D y+2n+3

39 Nylon is sometimes used for electrical insulation. However, if there is a risk of high temperatures, then a polymer such as Nomex, with a higher melting point is used. The repeat unit of Nomex is shown below.

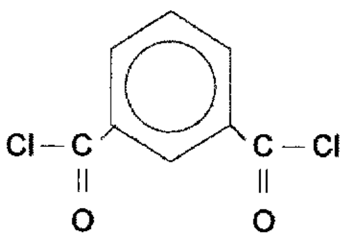


Which of the following is a possible monomer of Nomex?

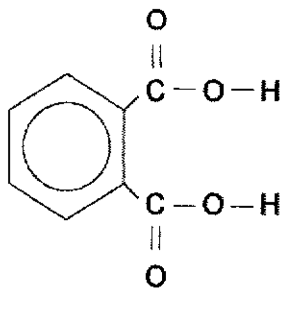
A



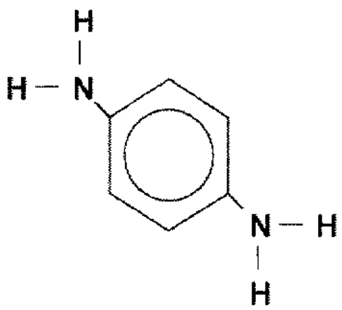
B



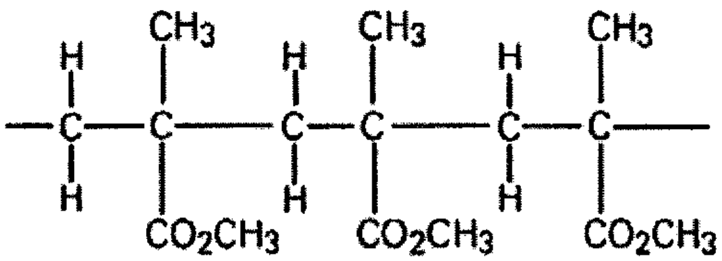
C



D

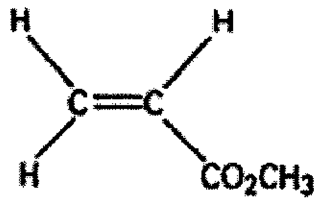


40 Poly(methyl methacrylate), PMMA, is a polymer used to make hard contact lenses. Part of the polymer structure is shown below.

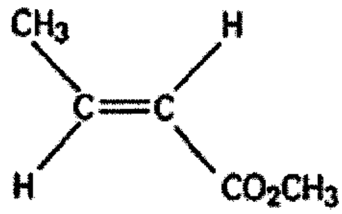


What is the structure of the monomer from which PMMA is made from?

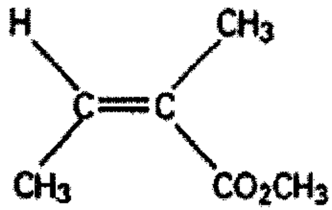
A



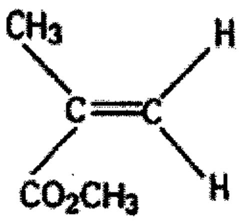
B



C



D



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

Candidate Name:	Class:	Index No.:

FUHUA SECONDARY SCHOOL
Secondary Four Express
PRELIMINARY EXAMINATION 2024

4E

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CHEMISTRY **6092/2**

Paper 2

DATE **16 August 2024**
TIME **1045 - 1230**
DURATION **1 hour 45 minutes**

READ THESE INSTRUCTIONS FIRST

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

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

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

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

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

PARENT'S SIGNATURE

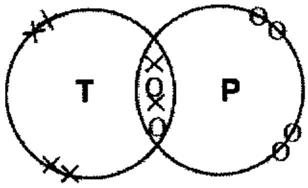
FOR EXAMINER'S USE		
Section A	Section B	**Total**
/70	**/10**	**/80**

This document consists of **23** printed pages and **1** blank page.

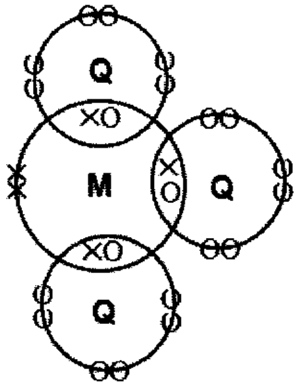
Section A
Answer **all** questions.

1 Fig. 1.1 shows 'dot-and-cross' diagrams for molecule 1, 2 and 3 that contain elements from Period 2 and 3 of the Periodic Table. The elements are represented by the letters **M**, **Q**, **R**, **T** and **Z**.

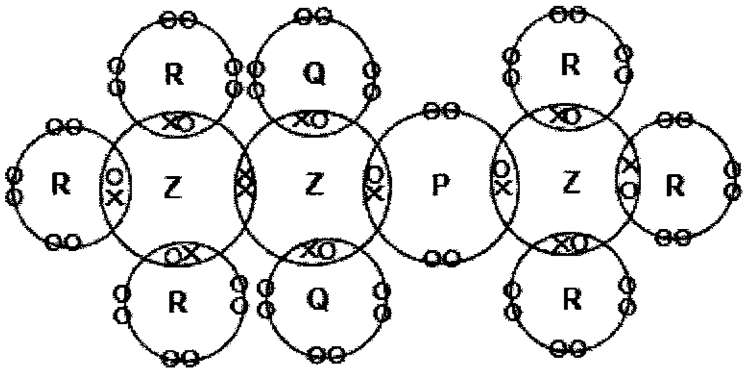
Each diagram shows outer electrons only.



molecule 1



molecule 2



molecule 3

Fig. 1.1

(a) Which elements are in Group 17?

____ [1]

(b) What is the formula of the compound formed between **Z** and **T**?

____ [1]

(c) **(i)** Draw a 'dot-and-cross' diagram to show the bonding of the compound formed between element **P** and **R**.

[2]

(ii) Draw a 'dot-and-cross' diagram to show the bonding of the compound formed between magnesium and element **M**.

[2]

(d) The following are some statements about the substances in Fig. 1.1.

Put a tick (✓) in **one** box in each row to show which statements are true and which are false.

	true	**false**
Molecule 3 has lower boiling point then molecule 2.		
Molecule 3 is a saturated organic compound.		
Only element **Z** reacts with oxygen to form acidic oxide.		
Elements **P** and **T** are in Group 16.		

[2]

[Total: 8]

2 Three experiments were carried out to measure the rate of reaction between excess barium carbonate powder and a strong monobasic acid. The reaction produces a gas which escapes from the reaction flask. The ionic equation for the reaction is

$$BaCO_3\,(s) + 2H^+\,(aq) \rightarrow Ba^{2+}\,(aq) + H_2O\,(l) + CO_2\,(g)$$

The rate of reaction was followed by measuring the change in mass of the reaction flask at regular time intervals.

The results of the three experiments are shown in the Fig. 2.1.

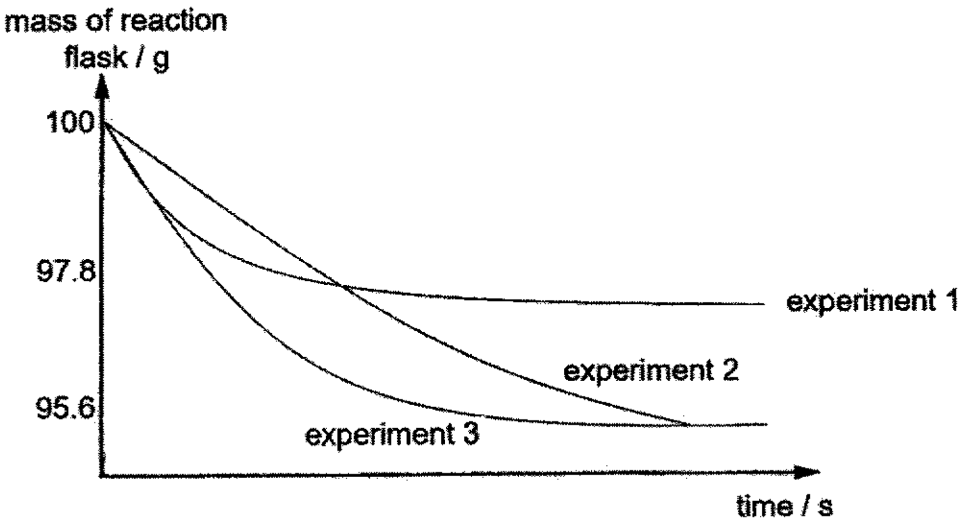


Fig. 2.1

(a) **(i)** Calculate the number of moles of carbon dioxide gas produced in experiment 1.

[1]

(ii) Hence, deduce and state the conditions of each experiment by completing the table below.

experiment	particle size	volume of acid / cm^3	concentration of acid / $mol dm^{-3}$
1	powder		2.0
2	lumps		1.0
3			

[3]

(b) Explain, in terms of reacting particles, how particle size of barium carbonate affects the rate of the reaction.

....

....

....

.... [2]

(c) The acid used is either hydrochloric acid or nitric acid. Describe a test to confirm the identity of the acid used.

....

....

.... [1]

(d) A further experiment, experiment 4, was carried out using ethanoic acid of the same volume and concentration as experiment 1.

Predict and explain how the rate of reaction and change in mass of the reaction flask of experiment 4 would be different from experiment 1.

....

....

....

.... [3]

[Total: 10]

3 Electrolysis is commonly used to give an object an attractive appearance or to prevent corrosion of a metal.

Fig. 3.1 shows a set-up prepared to electroplate an iron object using 200 cm^3 of aqueous copper (II) sulfate as the electrolyte.

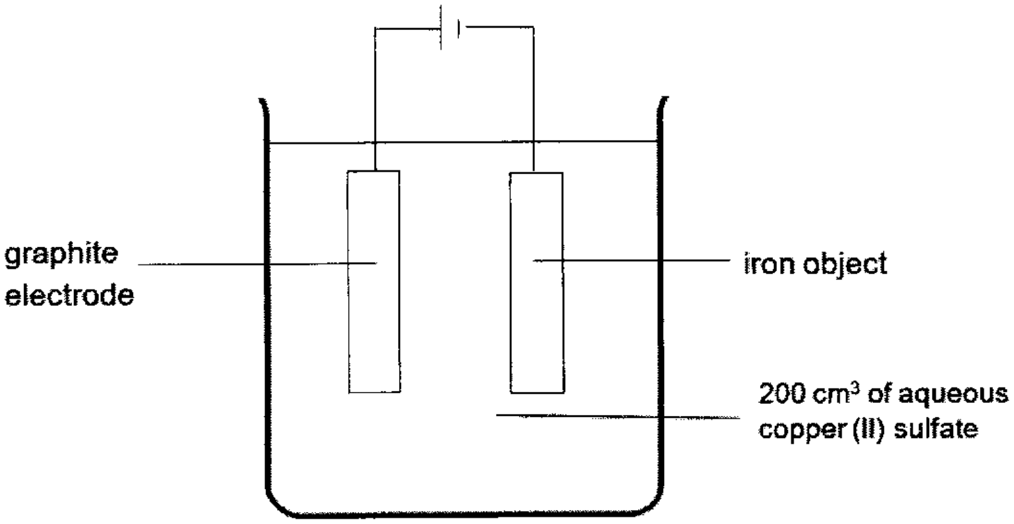


Fig. 3.1

Electrolysis was carried out and Fig. 3.2 shows the concentration of aqueous copper (II) sulfate against time.

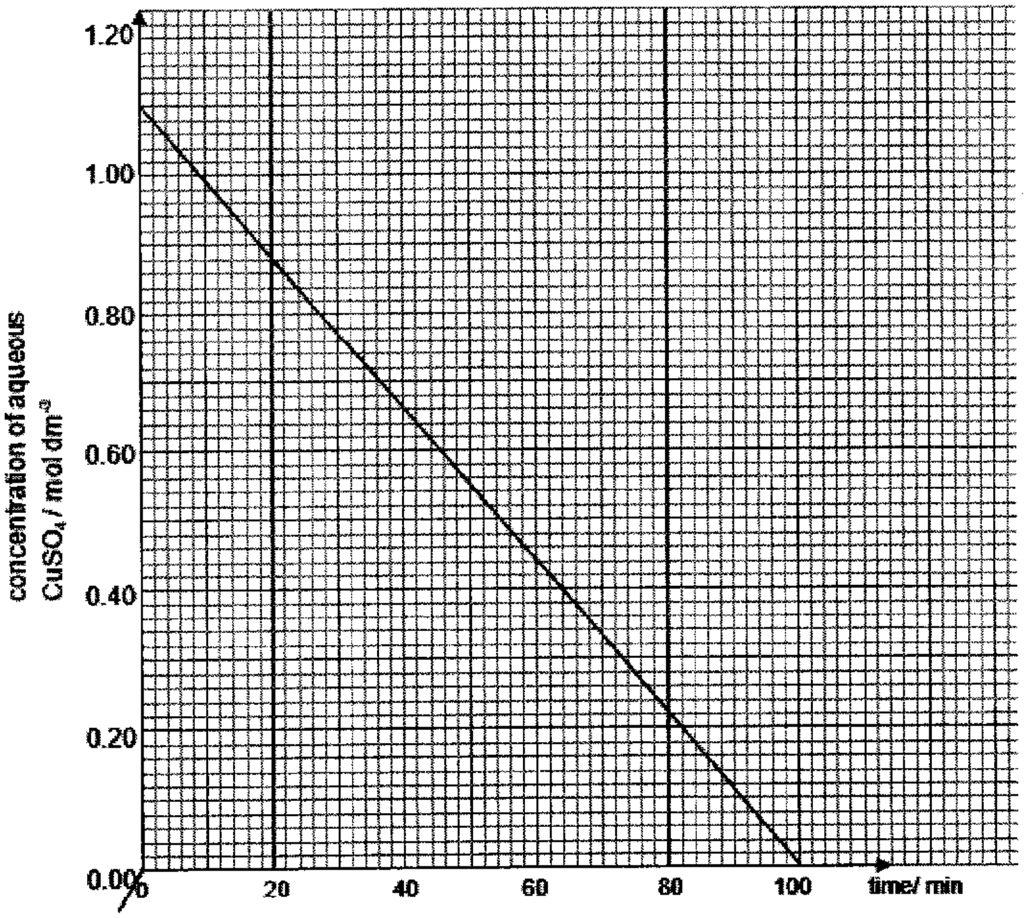


Fig. 3.2

(a) **(i)** Explain the shape of the graph by using an appropriate half-equation to support your answer.

____

____

____ [2]

(ii) Using data from the graph, calculate the increase in mass of the iron object after the electrolysis was conducted for 80 minutes.

[2]

(b) The set-up was modified as shown in Fig. 3.3 below.
Electrolysis was conducted using the same quantity of electricity as in the previous set-up.

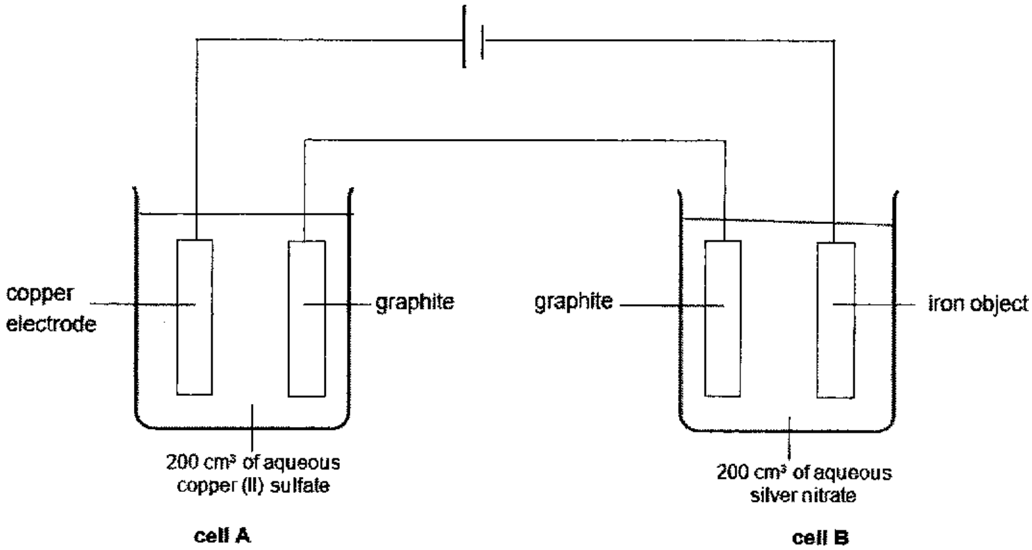


Fig. 3.3

(i) Sketch a graph, on Fig. 3.2, to show the concentration of aqueous copper (II) sulfate against time in **cell A** for the set-up in Fig. 3.3.
The initial concentration of aqueous copper (II) sulfate was same as the set-up in Fig. 3.1. Label your graph clearly.

[1]

(ii) Describe the observations at the graphite and iron electrodes in **cell B**.

____

____ [2]

(c) Sheets of iron are coated in tin and made into tin cans. The cans are filled with pineapple pieces and water. One of the cans becomes "dented" and the tin coating is scratched.
Suggest why the can corrodes more rapidly when it has a dent on its side compared to a pure iron can.

....

....

.... [2]

[Total: 9]

4 (a) Table 4.1 shows information about some organic compounds.
Complete the table by filling in the missing names, formulae and by completing the description of the processes.

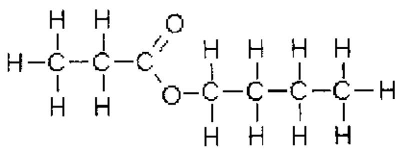
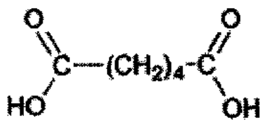
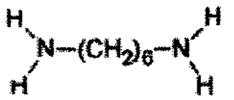
name of compound	structural formula	process(es) used to produce the compound
		Warming of ____________ and ____________ with concentrated sulfuric acid.
propane		Catalytic ____________ to propene.
polybutene		____________ of butene
nylon-6,6		____________ of monomers  and 

Table 4.1

[5]

(b) Alkyl halides are a homologous series of organic compounds. They are formed when one halogen atom (X = C*l*, Br, I) bonds with carbon atoms.
Table 4.2 shows the condensed formulae and boiling points of some alkyl halides.

condensed formula	boiling point / °C		
	X		
	C*l*	Br	I
CH_3X	-24.2	3.6	42.4
CH_3CH_2X	12.3	38.4	72.3
$CH_3CH_2CH_2X$	46.6	71.0	102.5
$CH_3CH_2CH_2CH_2X$	78.4	101.6	130.5

Table 4.2

(i) Besides having the same functional group, use the information in the table to give two other pieces of evidence that suggest that the alkyl halides are a homologous series.

____

____

____

____ [2]

(ii) Describe and explain the trend in boiling points of alkyl halides when the halogen atom changes from C*l* to I.

____

____

____

____

____

____

____ [3]

(iii) Alkyl halides can be prepared by the reaction of halogen acids with alcohols. For example, hydrochloric acid reacts with methanol to produce methyl chloride and water.
Write an equation for the preparation of **ethyl iodide**, showing all the displayed formulae of all organic compounds.

[2]

[Total: 12]

5 Experiments on three metals (copper, manganese and chromium) were conducted.

Table 5.1 shows the appearance of the metals and the results of their reactions with air.

metal	appearance	reaction with air
copper	reddish-brown solid	Burns in air to form black copper (II) oxide.
manganese	shiny grey solid	Burns in air with an intense white light forming a red solid, manganese (II,III) oxide, Mn_3O_4.
chromium	shiny grey solid	Burns in air to form green chromium (III) oxide, Cr_2O_3.

Table 5.1

Small amounts of the three metals were also added to their aqueous metal nitrate solutions. The results are shown in Table 5.2.

metal	aqueous chromium (III) nitrate	aqueous manganese (II) nitrate	aqueous copper (II) nitrate
manganese	Green solution turned pale pink and grey metal coated with a silvery solid.	X	Blue solution turned pale pink and grey metal coated with a reddish-brown solid.
chromium	X	No visible change observed.	
copper	No visible change observed.	No visible change observed.	X

Table 5.2

(a) Chromium metals are heated with manganese (II,III) oxide and copper (II) oxide in two separate experiments.
State and explain what you would expect to see in each experiment.

[3]

(b) Construct an ionic equation for the reaction involving manganese and chromium (III) nitrate.

[1]

(c) Complete Table 5.2 by stating the observations when chromium is added to aqueous copper (II) nitrate.

[1]

[Total: 5]

6 This question is on elements in Group 17.

(a) Complete Table 6.1 to show the colour and state of chlorine, bromine and iodine at room temperature and pressure.

	colour and state at room temperature and pressure
chlorine	
bromine	
iodine	

Table 6.1

[2]

(b) A brown solution is formed in two separate experiments. In the first experiment, aqueous bromine is added to aqueous iodide ions and in the second experiment, aqueous iodine is added to aqueous chloride ions.
Explain why.

[2]

(c) Chlorine reacts with the OH^- ion to form chloride ions and hypochlorite (OCl^-) ions.

$$Cl_2\ (aq) + 2OH^-\ (aq) \rightarrow Cl^-\ (aq) + OCl^-\ (aq) + H_2O\ (l)$$

This is a disproportionation reaction in which chlorine is oxidised and reduced simultaneously.

Use oxidation state to explain why this is a disproportionation reaction.

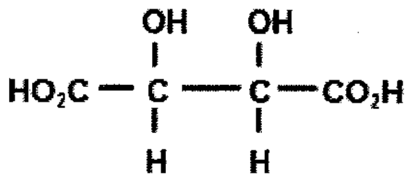
[2]

[Total: 6]

7 Both phosphoric acid and tartaric acid are weak acids. The formulae of both acids are given as follows:

H_3PO_4

phosphoric acid



tartaric acid

(a) Describe a simple test that can be used to show that tartaric acid or phosphoric acid is a weak acid.

____

____ [1]

(b) A solution of 0.200 mol / dm^3 potassium hydroxide was titrated against phosphoric acid and tartaric acid separately.

Deduce the ratio of the volume of potassium hydroxide used in titrating fixed volumes and concentrations of phosphoric acid and tartaric acid respectively.

____ [1]

(c) Tartaric acid and its salts have many applications.
One such salt is copper (II) tartarate which is insoluble in water.

Describe how you will prepare a pure and dry sample of this salt in the laboratory,

____

____

____

____

____ [2]

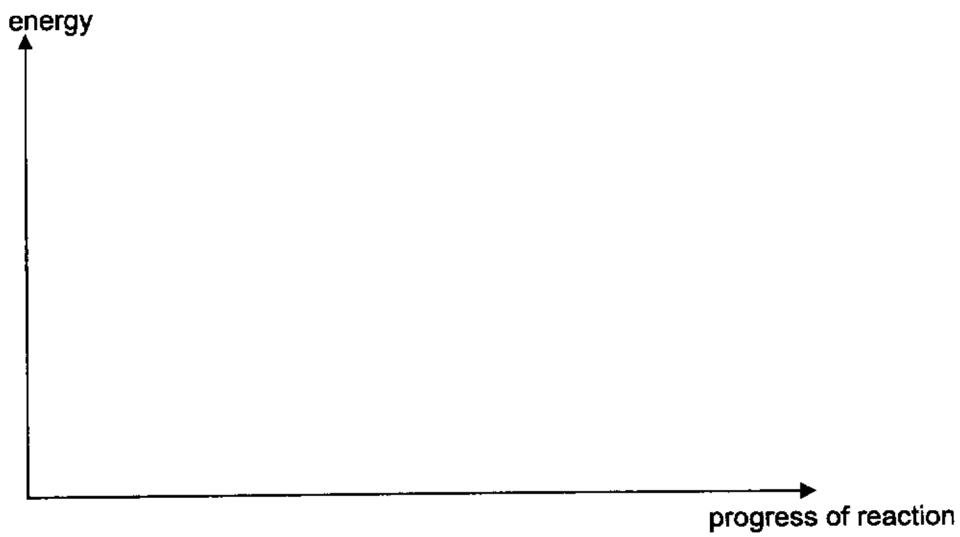
(d) **(i)** A 2.0 cm length of magnesium ribbon was added to 100 cm^3 of 2.00 mol / dm^3 phosphoric acid. All the magnesium reacted and the temperature of the acid increased by 6.0°C.

Predict the temperature change when 2.0 cm length of magnesium ribbon was reacted completely with 100 cm^3 of 2.00 mol / dm^3 tartaric acid. Explain your answer.

[2]

(ii) Complete the energy level diagram for reaction between magnesium ribbon and phosphoric acid.
Your diagram should include

- formulae of reactants and products
- enthalpy change of reaction
- activation energy



[2]

[Total: 8]

8 Chlorofluorocarbons (CFCs)

Chlorofluorocarbons (CFCs) are compounds containing chlorine, fluorine and carbon. CFCs are also known as freons. They were widely used in refrigerants and aerosol products before the 1990s, until they were phased out in several countries due to their negative impact on the ozone layer. When CFCs are released into the environment, they vapourise and move up the atmosphere.

Ozone Depleting Potential (ODP)

Ozone depleting potential (ODP) is a measure of how much damage a chemical can cause to the ozone layer compared with a similar mass of trichlorofluoromethane (CFC-11). CFC-11, with an ozone depleting potential of 1.00, is used as the base figure for measuring ozone depleting potential.

Global Warming Potential (GWP)

Global Warming Potential (GWP) of a refrigerant is its global warming impact relative to the impact of the same quantity of carbon dioxide over a 100 year period. All effects beyond 100 years are disregarded.

Table 8.1 gives the ODP and GWP of some common CFCs.

CFC	structural formula	ODP	GWP
CFC-11	CCl_3F	1.00	4000
CFC-12	CCl_2F_2	0.82	8500
CFC-113	$C_2F_3Cl_3$	0.90	11700
CFC-114	?	0.85	5000

Table 8.1

Alternatives to CFCs

Two of the chemical classes under consideration for replacing CFCs are hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs). Use of HCFCs and HFCs as transitional refrigerants allows industries to phase out the production of CFCs and offer environmental benefits over the continued use of CFCs. Because they contain hydrogen, HCFCs and HFCs break down more easily in the atmosphere than do CFCs.

Table 8.2 gives the ODP and GWP of some common HCFCs and HFCs.

HCFC	structural formula	ODP	GWP
HCFC-22	$CHClF_2$	0.04	1700
?	$C_2HCl_2F_3$	0.014	93
HFC-23	CHF_3	$< 4 \times 10^{-4}$	12100
HFC-125	?	$< 3 \times 10^{-5}$	3200

Table 8.2

Naming of CFCs, HCFCs and HFCs

The naming of CFCs follows the rule of 90 which determines the number of chlorine, fluorine and carbon atoms in the molecule.

Fig. 8.3 gives the example of the naming of trichlorofluoromethane (CCl_3F). Adding 90 to 11 gives 101. The first digit gives the number of carbon atoms, second digit gives the number of hydrogen atoms and the third digit gives the number fluorine atoms. Given that all carbon atoms must have four bonds, any other bonds left is a carbon-chlorine bond. Trichlorofluoromethane (CCl_3F) is named CFC-11.

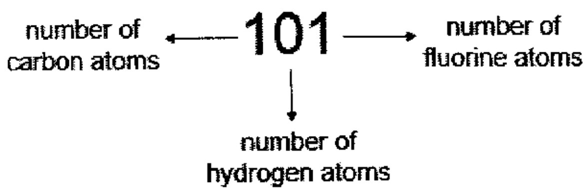


Fig. 8.3

The naming of HCFCs and HFCs follows the same format except with the addition of 'H' at the front.

Bond energy values

Table 8.4 gives some bond energy values for some carbon-hydrogen and carbon-halogen bonds.

bond	bond energy / kJ mol^{-1}
C - C*l*	328
C - F	485
C - H	413

Table 8.4

(a) Referring to Table 8.1, Table 8.2 and Fig. 8.3 and using the rule of 90, answer the following questions.

(i) Derive the naming for $C_2HCl_2F_3$.

.... [1]

(ii) State the structural formula for

CFC-114 HFC-125

....

[2]

(b) Using evidence from the information, compare the alternative use of HCFCs and HFCs against CFCs in relation to the impact on ozone layer depletion and global warming.

[4]

(c) CFCs break down ozone in several steps. The first step occurs when energy from the sunlight breaks a bond in CFC to produce a chlorine atom.

$$CCl_3F \rightarrow CCl_2F + Cl$$

Chlorine atoms break down the ozone in two steps.

$$Cl + O_3 \rightarrow ClO + O_2$$
$$ClO + O_3 \rightarrow Cl + 2O_2$$

(i) Explain how the equations show that one molecule of CFC can destroy thousands of ozone molecules.

[2]

(ii) A student made the following comment.
'HFCs have lower ODP values than CFCs because of the bond energy values.'
Explain whether you agree with the student.

[2]

(d) Although not as effective, ammonia and carbon dioxide are also used as refrigerants and both have ODP values of 0.00.
Explain why.

[1]

[Total: 12]

Section B

Answer **one** question from this section.

9 **(a)** Fig. 9.1 gives the reaction scheme of organic compound **A**.

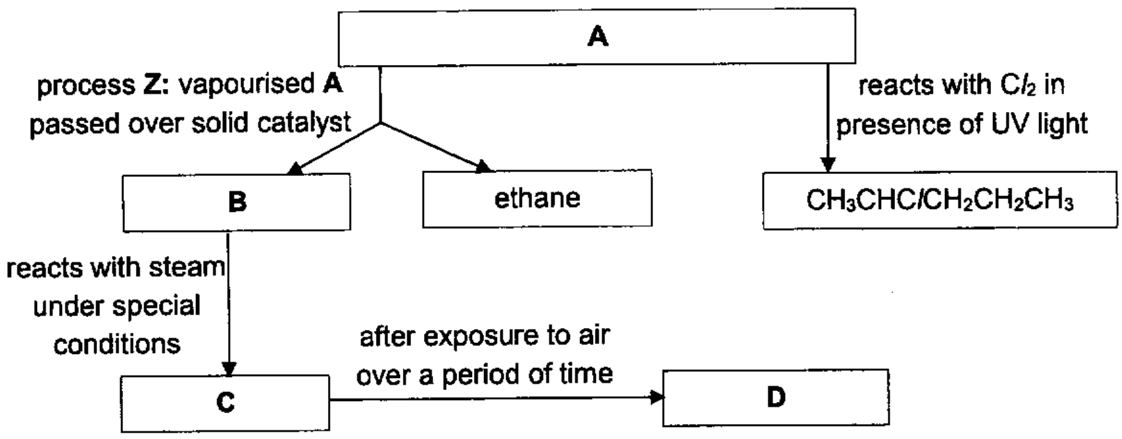


Fig. 9.1

(a) **(i)** Construct a balanced chemical equation for process **Z**.

.... [1]

(ii) Describe a test to differentiate compound **A** from **B**.

....

....

.... [2]

(iii) Draw the displayed formula of the compound formed when **C** and **D** are heated with concentrated sulfuric acid.

[1]

(b) Table 9.2 gives structures of two polymers **X** and **Y** are shown below.

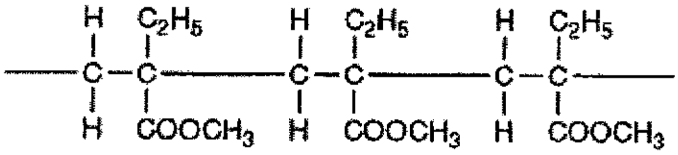
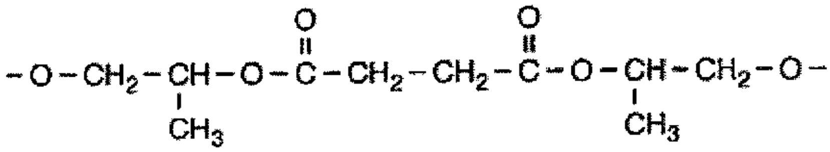
polymer **X**	
polymer **Y**	

Table 9.2

(i) A potential customer requires the chain length of the polymer **X** to be controlled so that the polymer molecules have an average relative molecular mass in the range of 16 000 to 50 000.

What is the range of the average number of repeat units in the polymer molecules? Show your working.

[2]

(ii) Draw the displayed formulae of the monomers where polymer **Y** could be made with.

[2]

(iii) Calculate the mass of polymer Y produced when 1 kg of each of the monomers reacted.

[2]

[Total: 10]

10 **(a)** Three reactions take place in the catalytic converter installed in car exhaust systems.

1. Conversion of nitrogen oxides (NO, NO_2) into nitrogen.
2. Conversion of carbon monoxide into carbon dioxide.
3. Conversion of hydrocarbons into carbon dioxide and water.

The air/fuel ratio in the car engine affects how the conversion efficiency of the catalytic converter. A 'lean' air/fuel mixture to the engine has a higher ratio of air to fuel while a 'rich' air/fuel mixture has a lower ratio of air to fuel.

Fig. 10.1 gives the conversion efficiency of a converter based on air/fuel ratio.

HC: hydrocarbon
NO_x: oxides of nitrogen
CO: carbon monoxide

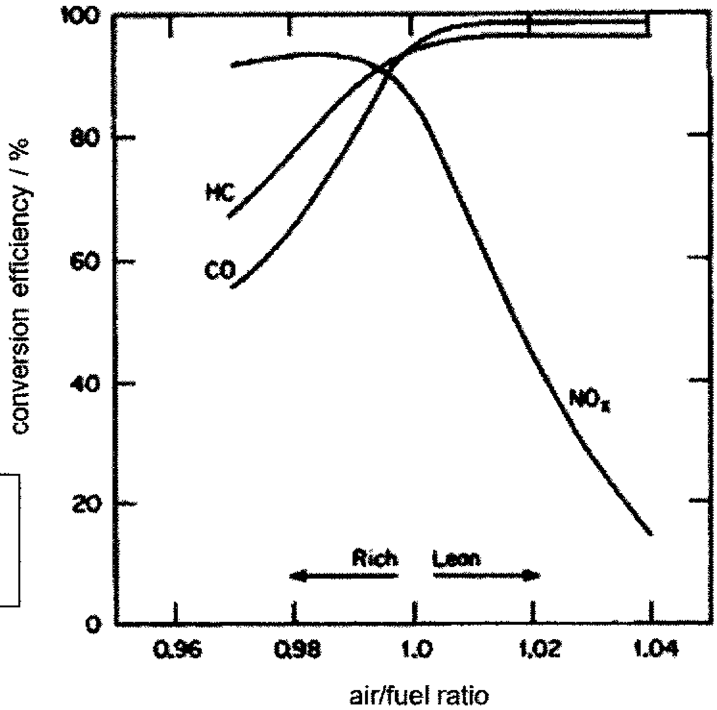


Figure 10.1

(i) Describe and explain how changing the air/fuel ratio from 'rich' to 'lean' affects the conversion efficiency of carbon monoxide, nitrogen monoxide and hydrocarbons in the catalytic converter.

____

____

____

____

____

____

____

____ [4]

(ii) The exhaust gas from vehicles without catalytic converters cause more harm to human health than those from vehicles fitted with catalytic converters.
Explain why this is true.

____

____

____ [2]

(b) The chloro-alkali industry is a chemical industry manufacturing chlorine, sodium hydroxide and other products, by the electrolysis of brine (concentrated sodium chloride solution). Sodium chloride is a readily available mineral existing as sea salt.

This mineral is, however, often contaminated with mud, Ca^{2+}, Mg^{2+}, Fe^{3+} and SO_4^{2-} ions, all of which must be removed before the purified salt is to be put into the electrolytic bath.

The first step of purification of sea salt involves dissolution and filtration of mud. The collected filtrate is then treated with the following chemicals in the order as shown below.

step 1: aqueous barium chloride solution
step 2: aqueous sodium carbonate solution
step 3: substance **Z**

(i) Explain the purpose of treating the filtrate with the chemicals listed in step 1 and step 2 above in order to obtain a reasonably pure sample of brine for the electrolytic process.

step 1:

____

____

step 2:

____

____ [2]

(ii) The filtrate is treated with substance **Z** in step 3 to remove excess carbonate ions from step 2. Identify substance **Z**.
Explain your choice

____

____

____ [2]

[Total: 10]

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The Periodic Table of Elements

Key: proton (atomic) number / atomic symbol / name / relative atomic mass

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

FUHUA SECONDARY SCHOOL
Sec 4E Chemistry 6092
Preliminary Examinations 2024 – Mark Scheme

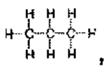
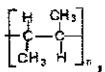
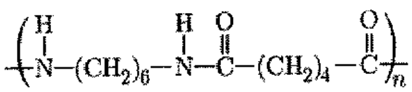
PAPER 1

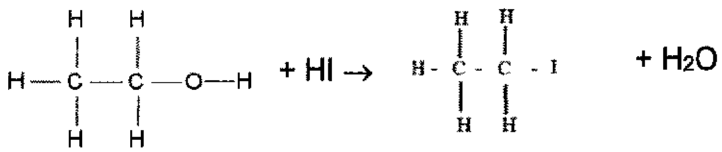
1	2	3	4	5	6	7	8	9	10
D	A	B	D	D	B	C	C	D	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	D	B	C	D	B	C	A	C	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	D	A	A	B	D	D	C	D	B
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
C	C	D	C	D	B	C	B	B	D

FUHUA SECONDARY SCHOOL
Sec 4E Chemistry 6092
Preliminary Examinations 2024 – Mark Scheme

PAPER 2
Section A [70 marks]

<table>
<tr><th>Q</th><th>Answer</th><th>Ma</th><th>Remarks</th></tr>
<tr><td>1a</td><td>Q and R</td><td>1</td><td></td></tr>
<tr><td>b</td><td>ZT_2</td><td>1</td><td></td></tr>
<tr><td>ci</td><td>shared electrons
non-bonded electrons</td><td>1
1</td><td></td></tr>
<tr><td>cii</td><td>Charge of Mg^{2+} and M^{3-} [;]
Three Mg^{2+} and two M^{3-} [;]
Outer electrons for Mg^{2+} and M^{3-}[;]</td><td>2</td><td>3; [2]</td></tr>
<tr><td>d</td><td>
<table>
<tr><th></th><th>true</th><th>false</th></tr>
<tr><td>Molecule 3 has lower boiling point then molecule 2.</td><td></td><td>✓</td></tr>
<tr><td>Molecule 3 is a saturated organic compound.</td><td>✓</td><td></td></tr>
<tr><td>Element Z reacts with oxygen to form acidic oxide only.</td><td></td><td>✓</td></tr>
<tr><td>Elements P and T are in Group 16.</td><td>✓</td><td></td></tr>
</table>
</td><td>2</td><td>4✓ [2]</td></tr>
<tr><td colspan="2" align="right">Total</td><td colspan="2">8 marks</td></tr>
<tr><td>2ai</td><td>Mass of CO_2 = 100 – 97.8 = 2.2 g
Moles of CO_2 = 2.2 / 44 = 0.05 mol</td><td>1</td><td></td></tr>
<tr><td>ii</td><td>
<table>
<tr><th>experiment</th><th>particle size</th><th>volume of acid / cm^3</th><th>concentration of acid / mol/dm^3</th></tr>
<tr><td>1</td><td>powder</td><td>50
e.c.f from (a)(i) mole</td><td>2.0</td></tr>
<tr><td>2</td><td>lump</td><td>200 [1]
(must be 4x of expt 1/ 2x of expt 3)</td><td>1.0</td></tr>
<tr><td>3</td><td>Powder [;]
Same as expt 1</td><td>100 [;]
2x of expt 1</td><td>2.0 [;]
Same as expt 1</td></tr>
</table>
Expt 1: mole of H^+ = 0.05 x 2 = 0.10 mol
Volume of acid = 0.10 / 2.0 = 0.05dm^3 = 50 cm^3
</td><td>1
1
1</td><td>3; [1]</td></tr>
<tr><td>2b</td><td>As <u>particle size decreases[;]</u>, there is a <u>larger exposed surface area[;]</u> of barium carbonate in contact with the acid. There are more collisions and <u>increase in frequency of effective collisions between barium carbonate and H^+ ions the acid particles[;]</u>, hence <u>increasing speed of reaction[;]</u>.</td><td>2</td><td>4; [2]
2; [1]</td></tr>
<tr><td>c</td><td>Add aq. silver nitrate solution to each acid, if white ppt forms, the acid is HCl. OR Add aq. NaOH, aluminium foil to each acid and heat the mixture, if ammonia gas is produced (moist red litmus turns blue), the acid is HNO_3.</td><td>1</td><td></td></tr>
</table>

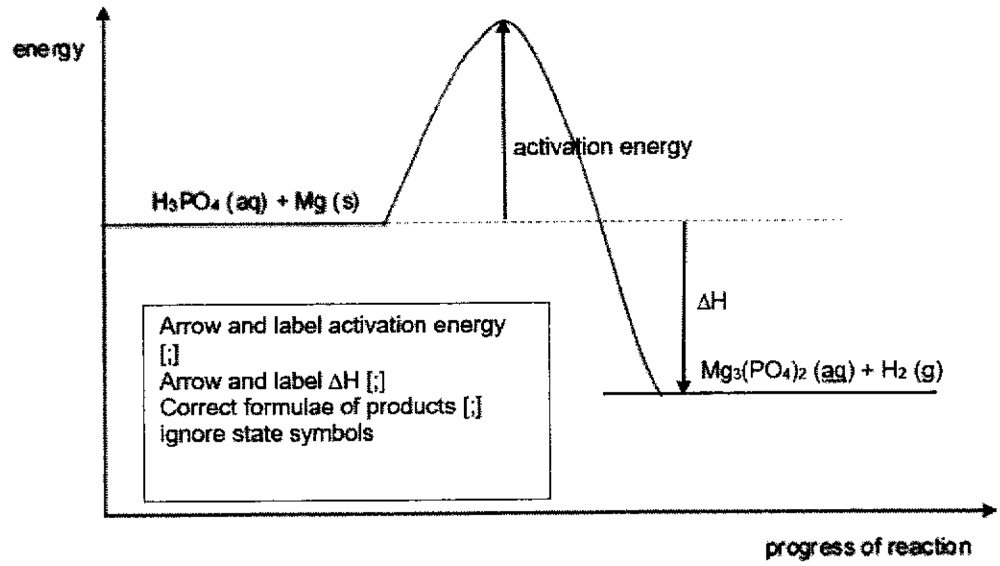
d	Rate will be slower [;] and change in mass will be the same [;] as experiment 1. Ethanoic acid is a <u>weak acid which dissociates partially in aqueous solution to give a lower concentration of H^+ ions [;]</u> compared to the strong acid, hence rate is slower. The <u>acid / H^+ ions remains as the limiting reagent / same number of moles of H^+ ions used [;]</u> hence mass of gas produced is the same and same change in mass of the reaction.	3	4[;] – [3], 2-3[;] – [2], 1[;] – [1]
	Total	10 marks	
3ai	Concentration of $CuSO_4$ decreases [;] from 1.10 mol/dm^3 until all Cu^{2+} ions in solution reduced to form Cu at the cathode. [;] $Cu^{2+}(aq) + 2e \rightarrow Cu(s)$ [;]	2	3; [2]
ii	Amount of Cu deposited = 200/1000 X (1.10 – 0.22) = 0.176 mol Mass of Cu = 0.176 X 64 =11.3 g	1 1	
bi	straight horizontal line at 1.10 g	1	
ii	Colourless gas given off at the graphite electrode. Grey / silvery solid deposited on the iron object.	1 1	
c	Once tin is scratched, <u>iron will lose electrons / oxidise more readily</u> to form iron(II) ions as <u>tin is less reactive than iron</u>	1 1	
	Total	9 marks	
4a	butyl propanoate[;], butanol[;], propanoic acid[;] , addition of hydrogen Accept catalytic hydrogenation. , addition polymerisation Reject 'additional polymerisation'  , condensation polymerisation	2 1 1 1	3 ; [2], 1; [1]
bi	Any two of the following: • Members have the same general formula $C_nH_{2n+1}X$ • There is gradual increase in boiling point as the number of carbon atoms increases. • Successive members differ from the next by a $–CH_2$ group.	2	
ii	As the halogen atom changes from C*l* to I, the boiling point of the alkyl halide increases. The size of halogen atom increases from C*l* to I, <u>molecular mass / molecular size of alky halide increases</u> [1] and hence boiling point increases. <u>Intermolecular forces of attraction between molecules increases</u> and <u>amount of energy taken in to overcome these forces increasesi</u>	1 1 1	
iii			

<table>
<tr><td></td><td>
displayed formulae of organic compounds
balanced equation and formulae of other chemicals</td><td>1
1</td><td></td></tr>
<tr><td></td><td>Total</td><td colspan="2">12 marks</td></tr>
<tr><td>5a</td><td>When chromium is heated with manganese oxide, there is no visible change. [;]
as chromium is less reactive than manganese. [;]
When chromium is heated with copper (II) oxide, black CuO turned to reddish-brown Cu / grey Cu turned to green Cr_2O_3./
black CuO and grey Cr turned to green Cr_2O_3 and reddish-brown Cu.
Chromium is more reactive than copper and displaces copper from CuO.</td><td>1

1

1</td><td>2; [1]</td></tr>
<tr><td>b</td><td>$3Mn\ (s) + 2Cr^{3+}\ (aq) \rightarrow 3Mn^{2+}\ (aq) + 2Cr\ (s)$</td><td>1</td><td></td></tr>
<tr><td>c</td><td>Blue solution turned green and grey metal coated with a reddish-brown solid.</td><td>1</td><td></td></tr>
<tr><td></td><td>Total</td><td colspan="2">5 marks</td></tr>
<tr><td>6a</td><td><table>
<tr><td></td><td>colour and state at room temperature and pressure</td></tr>
<tr><td>chlorine</td><td>Greenish-yellow gas [;]</td></tr>
<tr><td>bromine</td><td>Reddish-brown liquid [;]</td></tr>
<tr><td>iodine</td><td>Purplish-black solid [;]</td></tr>
</table></td><td>2</td><td>2; [1]
3; [2]</td></tr>
<tr><td>b</td><td>In the first experiment, bromine is more reactive than iodine [;] and displaces iodine from aqueous iodide[;] , forming aqueous iodine which is brown. [;]
In the second experiment, iodine is less reactive than chlorine [;] and unable to displace chlorine from aqueous chloride ions. Hence aqueous iodine remains and is brown solution. [;]</td><td>2</td><td>4; [2]
2; [1]</td></tr>
<tr><td>c</td><td>The oxidation state of chlorine increases from 0 in Cl_2 to +1 in OCl^- and decreases to -1 in Cl^-.
Therefore, chlorine is oxidised and reduced simultaneously.</td><td>1
1</td><td></td></tr>
<tr><td></td><td>Total</td><td colspan="2">6 marks</td></tr>
</table>

7a	Measure each sample of acid with a pH meter AND If the pH reading ranges from 3 to 6, then it is a weak acid OR Add a few drops of Universal indicator to each sample AND If the indicator changes to a yellow or orange colour, it is a weak acid [1]	1	
b	volume ratio 3: 2	1	
c	1. Add **aqueous sodium tartarate** to a fixed volume of **aqueous copper(II) nitrate** in a beaker till no more precipitate is formed. [1] 2. Filter the mixture to obtain copper(II) tartarate as a residue 3. Wash the residue with a little distilled water and pat dry between pieces of filter paper.	1 ; ;	2; [1]
di	6.0°C [;] Since the magnesium ribbon is the limiting reactant [;], amount of heat energy given out is the same for same no. of moles of Mg [;]	2	3; [2] 1-2; [1]
ii	(diagram below)	2	3; [2] 1-2;[1]



Total	8 marks

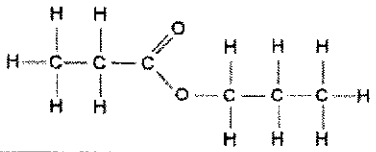
8ai	HCFC-123	2	
ii	CFC-114: $C_2Cl_2F_4$ HFC-125: C_2HF_5	1 1	
b	Comparing CFC-11 and HCFC-22 and HFC-23 with one carbon atom in each molecule, [;]		9; [4] 7-8; [3] 4-6; [2] 1-3; [1]

	HCFC	HFC	CFC
ODP	HCFC-22 has ODP of 0.04 less than CFC-11 but more than CFC-11. [;]	HFC-23 has the lowest ODP at less than 4×10^{-4}. [;]	CFC-11 has the highest ODP of 1.00. [;]

GWP	HCFC-22 has the least GWP of 1700 [;]	HFC-23 has the highest GWP at 12100. [;]	CFC-11 has GWP of 4000 [;]

Q	Answer	M	Remarks
	Although use of HFC reduces the ozone layer depletion the least, reduces ODP by 2500X but it increases global warming to the greatest extent, increases GWP by 3X. [;] Use of HCFC reduces ODP by 25X reduces GWP by 2.4X.[;]		
ci	CFC molecule releases one C*l* atom in presence of sunlight.[;] Chlorine atom consumed by reacting with one O_3 molecule [;] is regenerated when C*l*O reacts with another O_3 molecule in the second step. [;] Hence overall Cl atoms is not used up / no net loss of chlorine atoms.[;]	2	4; [2] 1-3; [1]
ii	Agree C-F and C-H have higher bond energy values (485 and 413 kJ/mol) than C-C*l* (328 kJ/mol) , less (light) energy is taken to break the C-C*l* bonds to release C*l* atoms which react with ozone.	1 1	
d	Ammonia and carbon dioxide do not react with ozone.	1	
	Total	12 marks	

Section B [10 marks]

Q	Answer	M	Remarks
9ai	$C_5H_{12} \rightarrow C_2H_6 + C_3H_6$	1	
ii	Add aqueous bromine to **A** and **B** separately. [;] For **A**, aqueous bromine remained reddish-brown. [;] For **B**, reddish-brown aqueous bromine turned colourless.[;]	2	3; [2]
iii	Displayed formula for propyl propanoate 	1	
bi	Mr of repeat unit = 114 When M_r = 16 000, number of repeating units = 16 000/114 = 140.35 [;] = 141 **[round up]** When Mr = 50 000, number of repeating units = 50 000/114 = 438.596 = 438 [**round down**] [;] Therefore, the range of the average number of repeating units is between 141 and 438 [1] inclusive.	1 1	2; [1]
ii	displayed formula $HOOCCH_2CH_2COOH$ $HOCH(CH_3)CH_2OH$	1 1	

iii	M_r of dicarboxylic acid ($C_4H_6O_4$) = 118 M_r of diol ($C_3H_8O_2$) = 76 No of moles of dicarboxlic acid = 1000/118 = 8.47458 Dicarboxyic acid is limiting. No of moles of polymer = 8.47458 Mass of polymer produced = 8.47458 × (118+76-2×18) = 1338 g = 1.34 kg OR consider terminating monomer for each molecule Mass of polymer produced = 8.47458 × (118+76)- (8.47458-1)(18) = 1509.5 g = 1.51 kg	1 1	
	Total	10 marks	
10ai	As the air/fuel ratio changes from rich to lean, the conversion efficiency of CO and HC increases but that of NOx decreases. As the air/fuel ratio changes from rich to lean, the amount of oxygen available to oxidise CO to CO_2 increases, amount of oxygen available to oxidise HC to CO_2 increases. lesser CO amount available to reduce NO and hence conversion of NO_x decreases.	1 1 1 1	
ii	Nitrogen oxide causes respiratory problems. Inhalation of carbon monoxide prevents haemoglobin from absorbing oxygen and may lead to suffocation / organ failure / headaches. [NB: discuss effect of each gas separately]	1 1	
bi	Step 1: Aqueous barium chloride removes the sulfate ions by precipitation due to formation of $BaSO_4$ which is insoluble. Step 2: Aqueous sodium carbonate removes the calcium, magnesium and iron(III) ions and the excess barium ions by precipitation due to the formation of $CaCO_3$, $MgCO_3$ & $Fe_2(CO_3)_3$ which are insoluble.	1 1	
ii	Substance **Z** is hydrochloric acid. Hydrochloric acid reacts with carbonate ions to form water and carbon dioxide gas.	1 1	
	Total	10 marks	