Candidate Name	Centre Number	Candidate Number
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ZIMSEC
For Performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Ordinary Level

CHEMISTRY

4024/2

PAPER 2 Theory

2 hours

JUNE 2024 SESSION

Additional materials:
Electronic calculator
Answer booklet

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page and on all separate answer paper used.

Answer **all** questions in **Section A** and any **four** from **Section B.**

At the end of the examination, fasten any separate answer paper used securely to the question paper.

Enter the numbers of **Section B** questions you have answered in the grid.

INFORMATION FOR CANDIDATES

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 16.

FOR EXAMINER'S USE	
Section A	
Section B	
TOTAL	

This question paper consists of 16 printed pages.

[Turn over

Section A

*Answer **all** questions from this section.*

Write your answers in the spaces provided on the question paper.

For Examiner's Use

1. **(a)** **Fig 1.1** shows the dot and cross diagram of two ions of elements represented by *X and Y*.

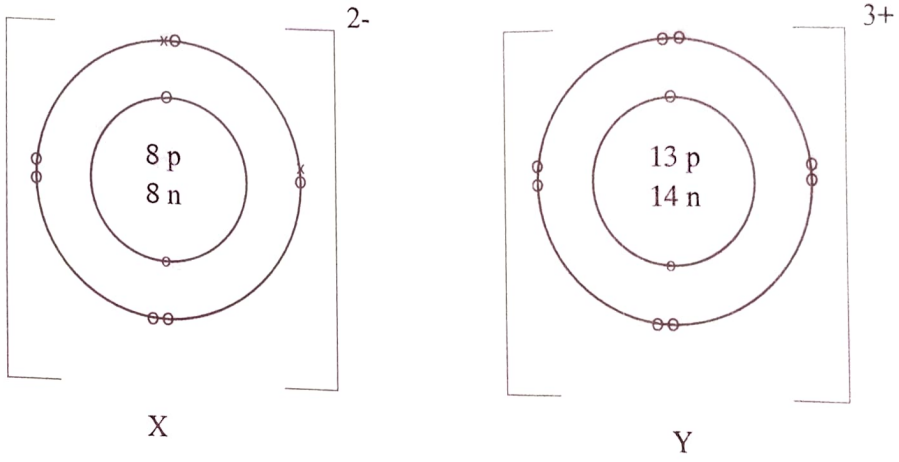

Fig 1.1

(i) Write the formula of compound formed when elements represented by X and Y chemically combine.

.....

[1]

(ii) Explain why the compound exists as a solid at room temperature.

.....

.....

[1]

(iii) Draw a dot and cross diagram to show the bonding in the compound formed between Y and fluorine.

For Examiner's Use

.....

[2]

(b) Explain why

1. a mixture of iodine and sodium chloride can be separated by heating,

.....

.....

2. rain water corrodes buildings.

.....

.....

.....

[2]

(c) Write balanced chemical equations to describe what happens when

1. magnesium burns in air,

.....

2. barium chloride solution is added to dilute sulphuric acid.

.....

[2]

2. **(a)** **Fig 2.1** shows a chromatogram obtained using solutions of three single dyes (green, brown and purple) and three other substances (**D**, **E** and **F**).

For Examiner's Use

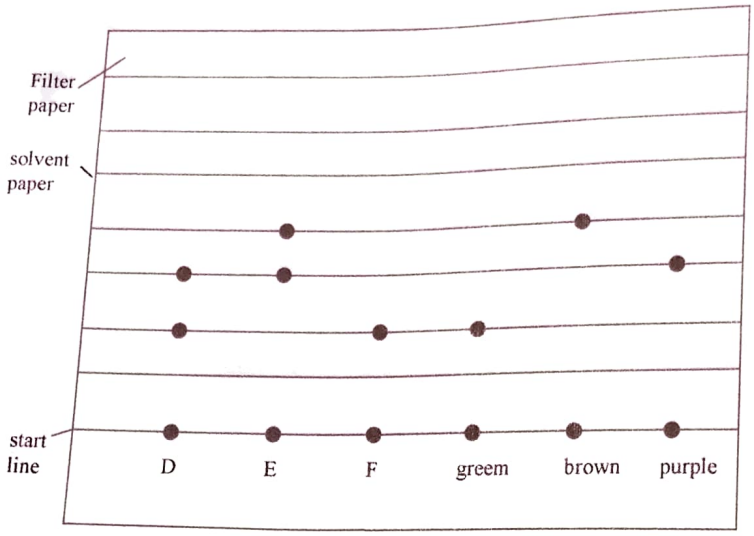

Fig 2.1

(i) Identify the **two** dyes present in substance **D**.

1. .....

2. .....

[2]

(ii) Identify, with a reason, the dye that is most absorbed by the filter paper.

dye .....

reason .....

.....

.....

[3]

(b) **(i)** Name any **one** factor that enables dyes to be separated by paper chromatography.

.....

[1]

(ii) State **two** other uses of paper chromatography other than separation of dyes.

1. .....

2. .....

[2]

For Examiner's Use

3. **(a)** **Fig 3.1** shows a simple cell.

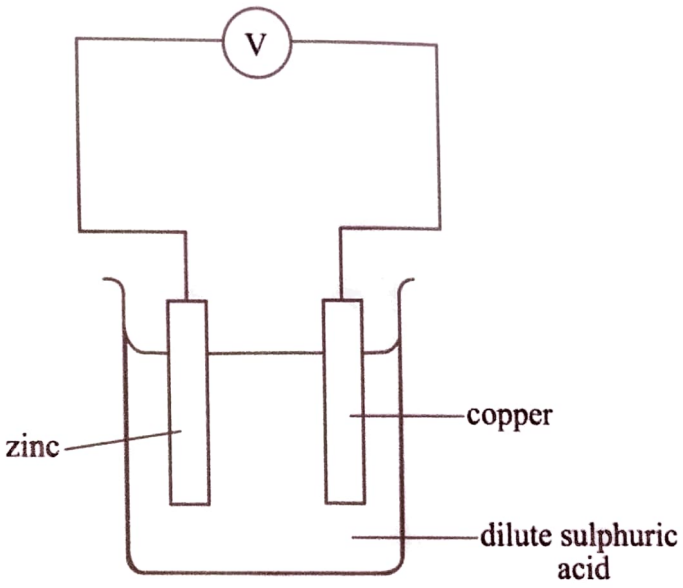

Fig 3.1

(i) Identify the positive and negative electrodes.

positive .....

negative .....

[2]

(ii) Write an equation of the reaction that occurs at the negative electrode.

.....

[1]

(iii) State the observation made on the positive electrode.

.....

[1]

(b) **(i)** Dilute sulphuric acid can be electrolysed to produce hydrogen and oxygen

Identify the products at the

1 cathode, ...

2 anode. .....

[2]

(ii) Write half equations for the reaction at the

1 anode, ...

2 cathode. .....

[2]

4. **(a)** **Table 4.1** is an incomplete Table showing some environmental pollutants and their effects.

Table 4.1

pollutant	environmental effect(s)
NO_2	
CO	
	global warming

Complete the **Table 4.1** by stating the missing information.

[3]

(b) **Fig 4.1** shows the energy profile diagram for the manufacture of ammonia by the Haber process.

For Examiner's Use

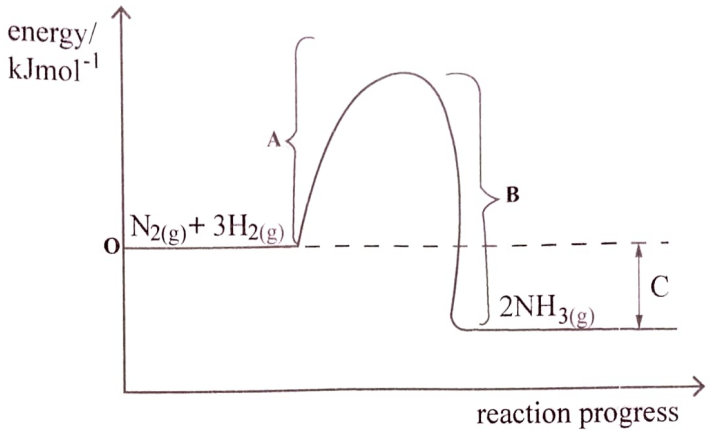

Fig 4.1

(i) Describe and explain what happens in sections labelled

1. **A,** .....

.....

.....

2. **B.** .....

.....

.....

[4]

(ii) Name energy change represented by **C**.

.....

[1]

5. **(a)** The inter-conversion between dichromate, $Cr_2O_7^{2-}$ and chromate (VI) ions, CrO_4^{2-}, can be shown by the following dynamic equilibrium.

For Examiner's Use

$$\underset{\textit{orange}}{Cr_2O_{7\,(aq)}^{2-}} + H_2O_{(l)} \rightleftharpoons \underset{\textit{yellow}}{2CrO_{4\,(aq)}^{2-}} + 2H^+_{(aq)}$$

(i) Define the term *dynamic equilibrium.*

.....

.....

.....

[1]

(ii) Describe and explain what happens to the equilibrium when

1. the concentration of H^+ ions is increased,

.....

.....

.....

2. CrO_4^{2-} ions are removed.

.....

.....

.....

.....

[4]

(b) State the observable changes that occur when sulphur dioxide gas is bubbled in sodium dichromate solution.

.....

.....

[1]

(c) Name the type of reaction which occurs when

1. fats are boiled in sodium hydroxide,

.....

2. a carboxylic acid reacts with an alcohol.

.....

[2]

Section B

*Answer any **four** questions from this section.*

Write your answers on separate answer paper provided.

For Examiner's Use

6. **(a)** **Fig 6.1** shows a cooling curve of a substance, **M**.

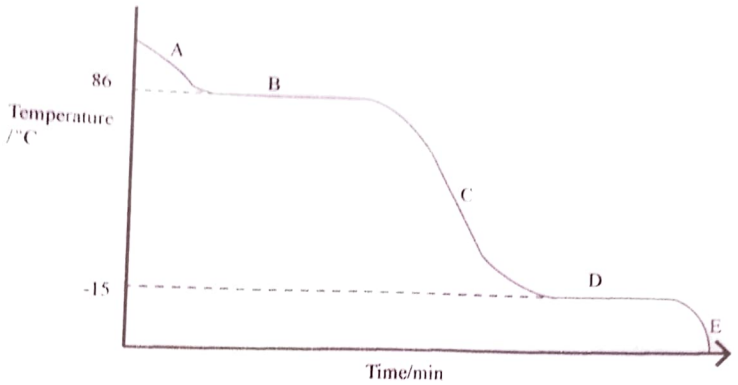

Fig 6.1

(i) Explain the shape of the curve at section B. [2]

(ii) Deduce the boiling point of substance **M**. [1]

(iii) State the processes occurring at section

1. C,

2. D. [2]

(iv) Name the state of the substance at room temperature. [1]

(v) State and explain the effect of the impurities on the boiling point of substance **M**. [2]

(b) Explain why

(i) different solids do not mix when placed on top of each other, [1]

(ii) cigarette smoke can affect a by-stander in the same room. [1]

(c) Draw an energy level diagram for an endothermic reaction. [2]

(d) **(i)** Explain what happens to the anode and cathode when a lead-acid battery is discharging. [2]

(ii) Describe any **one** way for maintaining and caring of the lead-acid battery. [1]

7. **(a)** **(i)** A catalytic converter converts unburnt hydrocarbons such as C_8H_{18} to harmless wastes. The reaction that occurs is shown.

$$C_8H_{18(g)} + \frac{25}{2}O_{2(g)} \longrightarrow 8CO_{2(g)} + 9H_2O_{(g)}$$

Calculate the volume of carbon dioxide produced when 1.96 g of the hydrocarbon reacts. [3]

(ii) Describe any **two** disadvantages of the use of carbon based fuels. [2]

(b) **(i)** **Fig 7.1** shows stages in the purification of water.

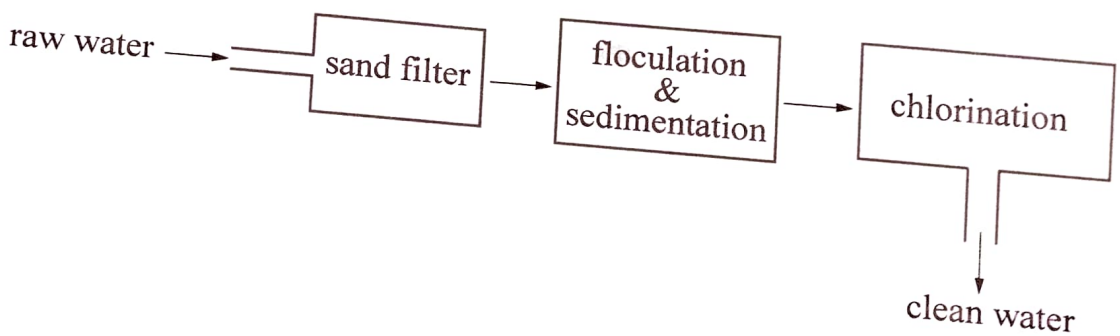

Fig 7.1

Describe and explain what happens in

1. sand filters,
2. flocculation and sedimentation tank. [3]

(ii) Name any **two** home based water treatment methods. [2]

(c) **(i)** The chemical equation shows how calcium oxide is produced in large quantities in Lime Kiln.

For Examiner's Use

$$CaCO_{3(s)} \xrightarrow{heat} CaO_{(s)} + CO_{2(g)}$$

Calculate the mass of calcium carbonate required to produce 61.60 Kg of calcium oxide. [2]

(ii) Describe the problems associated with the quarrying of calcium carbonate. [2]

(iii) Describe the steps that could be taken to overcome the problems in **(ii)**. [1]

8. **(a)** **Fig .8.1** shows how an organic compound, **G**, can be converted to different organic compounds.

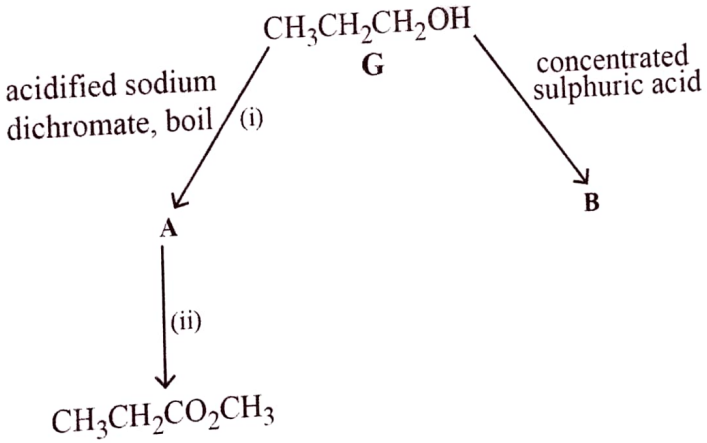

Fig 8.1

(i) Draw displayed structural formula of

1. **A**,
2. **B**. [2]

(ii) State the homologous series to which **B** belongs. [1]

(iii) State the type of reaction occurring in

1. reaction (i),

2. reaction (ii).

[2]

(iv) State the observable changes that occur in

1. reaction (i),

2. reaction (ii).

[2]

(b) **(i)** **Fig. 8.2** shows results when a metal, **M**, was reacted with dilute hydrochloric acid.

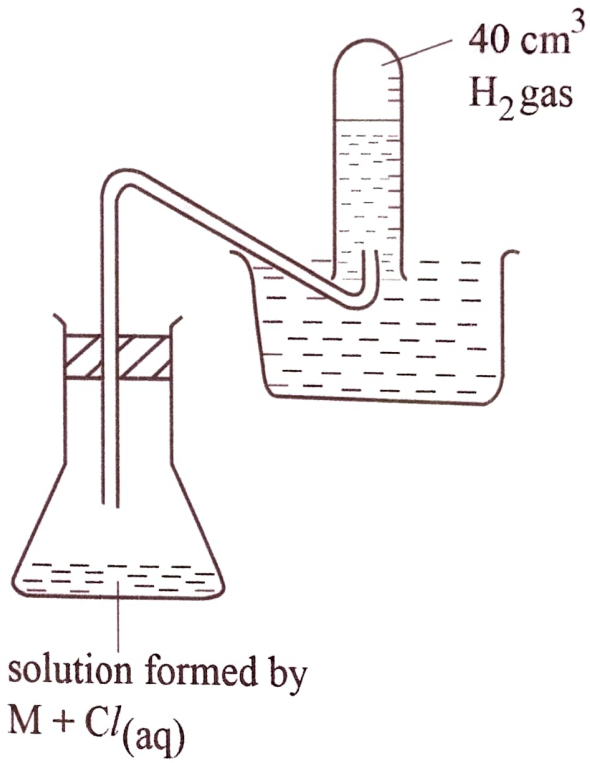

Fig 8.2

The experiment was repeated with metals N ad P. The results are shown in the table.

For Examiner's Use

metal	volume of hydrogen/cm^3
N	0
P	12

Arrange the three metals, **M**, **N** and **P** in decreasing order of reactivity. [1]

(ii) Explain the order in **(i)**. [3]

(iii) **M** forms an ion, M^{2+}.

Write a balanced chemical equation for the reaction of M with dilute hydrochloric acid. [2]

(c) A substance X with an M_r value of 34 is composed of 5.90 % hydrogen and 94.10 % oxygen.

Calculate the molecular formula of X. [2]

9. **(a)** **(i)** An element, X, of atomic mass 88, reacts with chlorine to form a chloride containing 44.7% chlorine.

Calculate the empirical formula of the chloride. [4]

(ii) Suggest the type of bonding that exist between X and chlorine. [1]

(b) **(i)** A mass of 0.048 g of magnesium was reacted with excess dilute hydrochloric acid at r.t.p to produce hydrogen.

Write a balanced chemical equation for the reaction. [2]

(ii) Calculate the volume of the gas produced at r.t.p. [3]

(c) **(i)** **Fig 9.1** shows part of a polymer.

For Examiner's Use

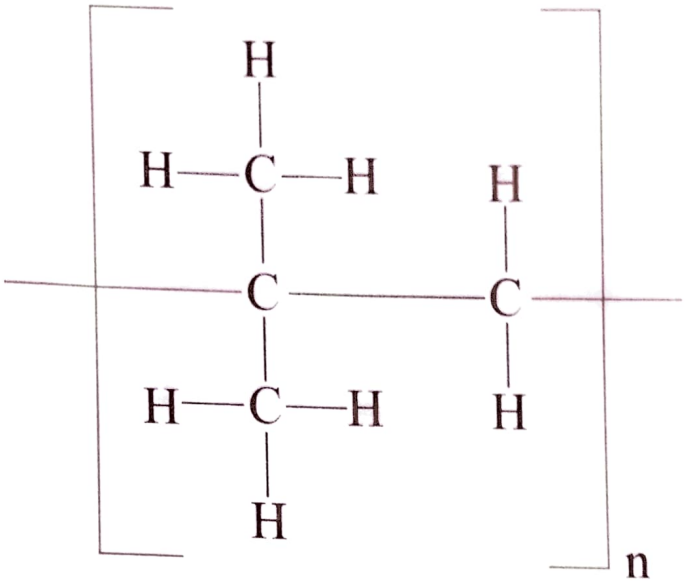

Fig 9.1

Deduce the structural formula of the monomer(s). [1]

(ii) State the type of polymerization that forms this polymer. [1]

(iii) Describe two environmental problems associated with the disposal of the polymer. [2]

(iv) Suggest one method of disposing off the polymer. [1]

10. **(a)** A mass of 0.54 g impure ammonium sulphate fertilizer reacted with warm sodium hydroxide solution. 140.00 cm^3 of ammonia gas were produced at room temperature and pressure. The chemical equation for the reaction is shown:

$$(NH_4)_2SO_{4(s)} + 2NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + 2NH_{3(g)} + 2H_2O_{(l)}$$

Calculate the

1. concentration of sodium hydroxide solution,

2. percentage purity of the fertilizer.

[6]

(b) Describe how pure crystals of sodium sulphate are produced. [3]

(c) **(i)** Describe and explain the difference in reactivity of magnesium and barium. [4]

(ii) Explain why a white solid is observed when calcium is added to magnesium sulphate solution. [2]

For Examiner's Use

DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group O
																	4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

*Lanthanoid series	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
†Actinoid series	232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) Number

The volume of one mole of any gas is 28 dm^3 at room temperature and pressure (r.t.p.)