

Centre Number				Examination Number									



50000394



# EXAMINATIONS COUNCIL OF ZAMBIA



Examination for School Certificate Ordinary Level

## Chemistry Paper 2 Theory

**5070/2**

**Wednesday**

**17 NOVEMBER 2021**

Candidates answer on the question paper

**Additional Materials:**

Calculators (non-programmable)

Graph paper

**Time: 2 hours**

**Marks: 80**

### Instructions to Candidates

**1** Write the **centre number** and your **examination number** on **every page** of this question paper and on the separate **Answer Booklet/Paper** provided.

**2** There are **twelve questions** in this paper.

**(i) Section A**

Answer **all** questions.

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

**(ii) Section B**

Answer any **three** questions.

Write your answers in the separate Answer Booklet provided.

**3** At the end of the examination, fasten your Answer Booklets securely to the question paper.

### Information for Candidates

**1** The number of marks is shown in brackets [ ] at the end of each question or part question.

**2** The **Periodic Table** is on page **12**.

**3** Cell phones are **not allowed** in the examination room.

<i>For Examiner's Use</i>	
<b>Section A</b>	
<b>Section B</b>	
<b>B9</b>	
<b>B10</b>	
<b>B11</b>	
<b>B12</b>	
<b>TOTAL</b>	

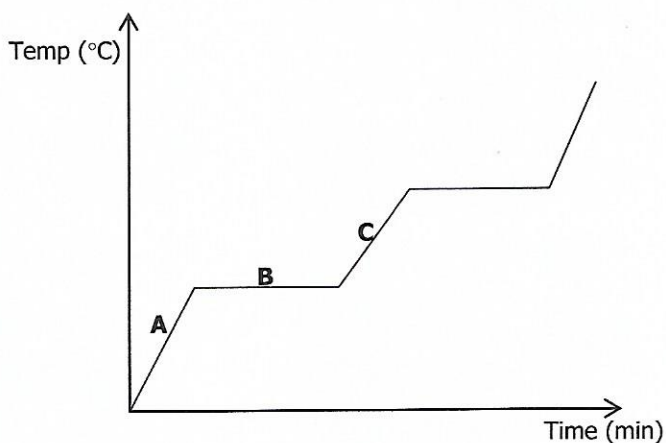


Centre Number					Examination Number															

**Section A: [50 marks]**

Answer **all** questions in the spaces provided.

**A1** The following is a heating curve for substance **W**.



- (a) In what state(s) is substance **W** at point
  - (i) A, ..... [1]
  - (ii) B, ..... [1]
  - (iii) C? ..... [1]

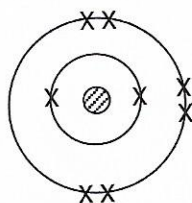
(b) State whether substance **W** is pure or not. Explain your answer.  
.....  
.....  
..... [2]

**[Total: 5]**



Centre Number	Examination Number										

A3 The following diagram shows the structure of an element X.



(a) What type of bonds would be formed when X reacts with hydrogen?

..... [1]

(b) Give a reason for your answer in (a).

..... [1]

(c) Draw the dot and cross structure of the compound formed when X bonds with hydrogen atoms.

[2]

(d) Give **two** characteristics of the compound formed in (c).

.....

..... [2]

**[Total: 6]**

Centre Number	Examination Number												

**A4** A learner wanted calcium oxide for drying ammonia gas but had only 2.80g of calcium carbonate in the laboratory. She heated the chemical strongly and it decomposed completely to form calcium oxide and carbon dioxide. She weighed the calcium oxide and was found to be 1.35g.

(a) Write a chemical equation for this decomposition.

..... [1]

(b) Calculate the theoretical yield of calcium oxide.

[3]

(c) Calculate the percentage yield of calcium oxide.

[2]

(d) Calculate the volume of carbon dioxide gas collected at room temperature and pressure in this experiment.

[2]

[Total: 8]



Centre Number				Examination Number																	

**A5** Sodium metal is kept under oil to avoid the reaction of the metal with atmospheric oxygen to produce the ionic compound, sodium oxide.

(a) Construct a balanced equation for the reaction of sodium metal and oxygen. Include state symbols.

..... [2]

(b) Explain why the reaction between sodium metal and oxygen is considered a redox one.

..... [2]

(c) State the balanced ionic equation representing the half reaction for oxidation process, using the equation for the reaction in (a).

..... [1]

**[Total: 5]**

**A6** Use the Periodic Table to answer the following questions.

(a) State **two** nuclides in Period 3 that have the same number of neutrons.

..... [2]

(b) Give the name of the element in Group V and in Period 3.

..... [1]

(c) Give the name of the most electronegative element in Group VII.

..... [1]

(d) State the chemical formula for calcium selenide.

..... [1]

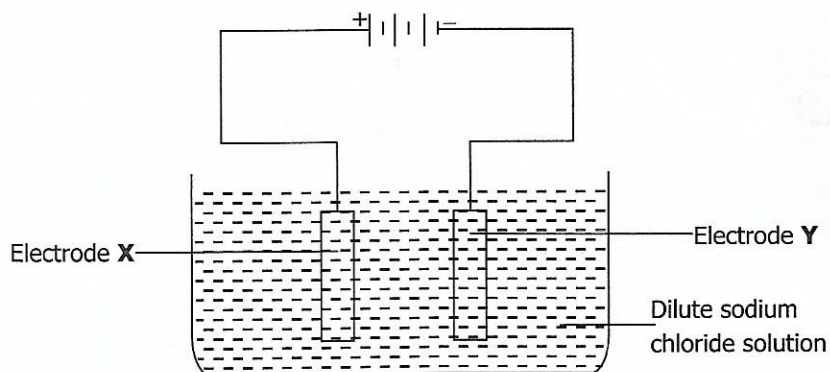
(e) State the number of metals, if any, in Group VI.

..... [1]

**[Total: 6]**

Centre Number	Examination Number										

A7 Sodium chloride solution was electrolysed using the experiment arranged as shown:



- (a) Write down the formulae for all the ions present in sodium chloride solution.  
..... [2]
- (b) What observations would be made at electrode Y?  
..... [1]
- (c) Write an equation for the reaction that takes place at electrode X.  
..... [1]
- (d) What difference would be in the experiment if concentrated sodium chloride was electrolysed?  
..... [1]
- (e) Explain why solid sodium chloride **cannot** be electrolysed.  
..... [1]

[Total: 6]

Centre Number					Examination Number															

**A8** Ammonia is manufactured by the Haber process according to the following equation:



- (a) The reaction reaches a state of dynamic equilibrium. What is meant by dynamic equilibrium?

.....  
 ..... [2]

- (b) At equilibrium, only 10% of ammonia is produced.

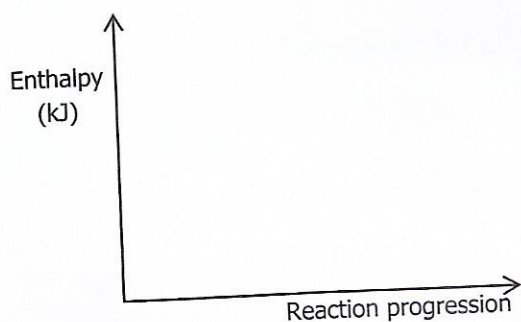
- (i) Describe how ammonia is separated from the 90% of the unreacted nitrogen and hydrogen.

.....  
 ..... [1]

- (ii) State what happens to the 90% of the unreacted nitrogen and hydrogen.

.....  
 ..... [1]

- (c) Complete the energy level profile diagram for the formation of ammonia from nitrogen and hydrogen indicating the activation energy,  $E_a$  and the enthalpy change,  $\Delta H$ .



[3]

- (d) Explain why manufacturers avoid higher temperatures like 1 000°C.

..... [1]

[Total: 8]

2 0 2 1



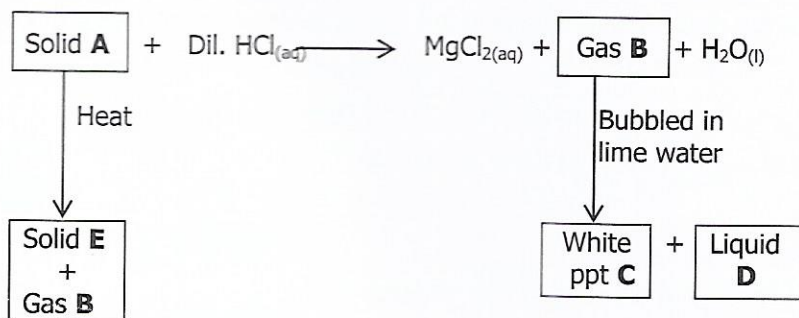
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**Section B (30 marks)**

Answer **three** questions from this section.

Write your answers in the Answer Booklet provided.

**B9** Study the reaction schemes and answer the questions that follow.



- (a) Identify substances **A**, **B**, **C**, **D** and **E** by chemical formulae. [5]
- (b) Write a balanced chemical equation including state symbols when gas **B** reacts with lime water. [2]
- (c) What would you see when magnesium chloride solution is added to equal volume of silver nitrate solution? [1]
- (d) Gas **B** can be prepared and collected in a laboratory. State the method of collection of gas **B** and justify your answer. [2]

[Total: 10]

Centre Number				Examination Number																			

- B10** Crude oil is a raw material which is processed in an oil refinery. Two of the processes are fractional distillation and cracking. The following table shows the percentage by mass of some different fractions in crude oil. The table also shows the demand for each fraction expressed as a percentage.

Fraction	Number of carbon atoms per molecule	Percentage in crude oil	Percentage needed by the refinery to supply demand
Petroleum gas	1 – 4	4%	11%
Gasoline	5 – 9	11%	22%
Kerosene	10 – 14	12%	20%
Gas oil	15 – 20	18%	15%
Waxes and bitumen	Over 20	23%	4%

- (a) What variation in physical properties is used to separate crude oil by fractional distillation? [1]
- (b) (i) Define the term cracking. [1]  
(ii) Use the information in the table to explain how cracking helps an oil refinery match the supply of gasoline with the demand for gasoline. [2]
- (c) The hydrogen  $C_{15}H_{32}$  can be cracked to make propene and one other hydrocarbon.  
(i) Draw the structure of propene. [1]  
(ii) Write an equation for this reaction. [1]
- (d) Propene is used to make alcohols and a polymer.  
(i) Describe how propene can be converted into an alcohol and draw the structure of this alcohol. [2]  
(ii) Draw and name the polymer formed by propene. [2]

[Total: 10]

- B11** The following table shows chemical properties of metals **W**, **X**, **Y** and **Z**.

Metal	Reaction with		Effect of heat on their	
	atmospheric air	steam	hydroxides	carbonates
<b>W</b>	x	✓	✓	✓
<b>X</b>	x	x	✓	✓
<b>Y</b>	✓	✓	x	x
<b>Z</b>	✓	✓	✓	✓

Key: ✓ – reaction takes place  
x – No reaction

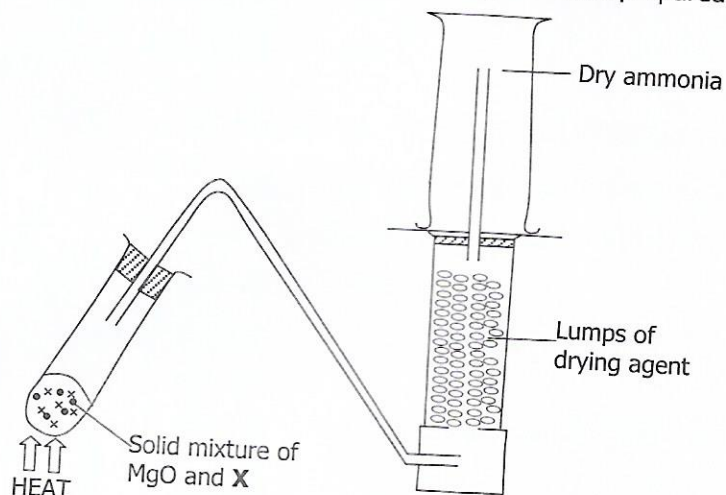


Centre Number	Examination Number										

- (a) Arrange the metals in their increasing order of their reactivity. [1]
- (b) Using the given letters of the metals in the table, choose a metal which can be
- (i) stored in oil, [1]
  - (ii) used to make ornaments, [1]
  - (iii) extracted by electrolytic reduction of its ore. [1]
- (c) Construct a balanced chemical equation for the reaction of element Y with cold water, include state symbols. [2]
- (d) Which **two** metals from the table can be used to form the alloy brass? Give a reason for your answer. [2]
- (e) Consider the following chemical processes:  
Rusting of iron and combustion of fuels. Give **one** similarity and **one** difference between the two chemical processes. [2]

[Total: 10]

B12 The following diagram shows how ammonia gas can be prepared in the laboratory.



- (a) (i) Suggest the identity of X which when heated together with MgO produces ammonia gas. [1]
- (ii) Construct a balanced equation for the reaction. Include state symbols. [2]
- (iii) Name a suitable drying agent that can be used. [1]
- (iv) State the test for ammonia gas. [1]
- (b) Industrially, ammonia is produced by Haber process though the reaction is reversible.  
State and explain **two** essential conditions for this process. [4]
- (c) Give **one** commercial use of ammonia. [1]

[Total: 10]

[Turn over

DATA SHEET  
The Periodic Table of the Elements

Group		I	II	III	IV	V	VI	VII	0
		1 <b>H</b> Hydrogen 1							4 <b>He</b> Helium 2
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4			11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	14 <b>N</b> Nitrogen 7	16 <b>O</b> Oxygen 8	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12			13 <b>Al</b> Aluminium 13	14 <b>Si</b> Silicon 14	15 <b>P</b> Phosphorus 15	16 <b>S</b> Sulphur 16	35.5 <b>Cl</b> Chlorine 17	40 <b>Ar</b> Argon 18
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20			19 <b>Ga</b> Gallium 31	20 <b>Zn</b> Zinc 30	27 <b>Co</b> Cobalt 27	28 <b>Ni</b> Nickel 28	31 <b>Pd</b> Palladium 46	36 <b>Kr</b> Krypton 36
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38			56 <b>Fe</b> Iron 26	59 <b>Co</b> Cobalt 27	65 <b>Zn</b> Zinc 30	70 <b>Ga</b> Gallium 31	75 <b>As</b> Arsenic 33	84 <b>Kr</b> Krypton 36
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56			72 <b>Hf</b> Hafnium 72	73 <b>Ta</b> Tantalum 73	74 <b>W</b> Tungsten 74	76 <b>Os</b> Osmium 76	77 <b>Ir</b> Iridium 77	86 <b>Rn</b> Radon 86
87 <b>Fr</b> Francium 87	226 <b>Ra</b> Radium 88			89 <b>Y</b> Yttrium 39	91 <b>Zr</b> Zirconium 40	92 <b>Nb</b> Niobium 41	93 <b>Mo</b> Molybdenum 42	94 <b>Tc</b> Technetium 43	103 <b>Rh</b> Rhodium 45
				104 <b>Ru</b> Ruthenium 44	106 <b>Pd</b> Palladium 46	108 <b>Ag</b> Silver 47	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49	127 <b>I</b> Iodine 53
				144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	162 <b>Dy</b> Dysprosium 66	173 <b>Yb</b> Ytterbium 70
				141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	145 <b>Pm</b> Promethium 61	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	162 <b>Dy</b> Dysprosium 66
				140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	162 <b>Dy</b> Dysprosium 66
				232 <b>Th</b> Thorium 90	238 <b>U</b> Uranium 92	238 <b>Pa</b> Protactinium 91	238 <b>U</b> Uranium 92	238 <b>Pa</b> Protactinium 91	238 <b>U</b> Uranium 92
				232 <b>Th</b> Thorium 90	238 <b>U</b> Uranium 92	238 <b>Pa</b> Protactinium 91	238 <b>U</b> Uranium 92	238 <b>Pa</b> Protactinium 91	238 <b>U</b> Uranium 92
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				140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	162 <b>Dy</b> Dysprosium 66
				140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	162 <b>Dy</b> Dysprosium 66
				140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	162 <b>Dy</b> Dysprosium 66
				140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	162 <b>Dy</b> Dysprosium 66
				140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	162 <b>Dy</b> Dysprosium 66
				140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	162 <b>Dy</b> Dysprosium 66
				140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	162 <b>Dy</b> Dysprosium 66
				140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	162 <b>Dy</b> Dysprosium 66
				140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	162 <b>Dy</b> Dysprosium 66
				140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	162 <b>Dy</b> Dysprosium 66