PART B
ESSAY
2 hours
[100 marks]

Answer **four** *questions in all:* **three** *questions from* Section I *and* **one** *question from* **either** Section II **or** Section III.
All questions carry equal marks.
Credit will be given for clarity of expression and orderly presentation of material.

SECTION I
FOR ALL CANDIDATES

Answer **three** *questions from this section.*

1. *(a)* Define **each** of the following terms and indicate **one** use of **each**:
(i) *Nuclear fission;*
(ii) *Nuclear fusion.*
[4 marks]

(b) Alpha particle emission by $^{235}_{92}U$ produces an element **A**. Beta particle emission by the particle **A** produces another element **B**. Element **B** also undergoes alpha particle emission to produce $^{227}_{89}Ac$. Write balanced equations to represent the above statement.
[4 marks]

(c) The models below represent the filling of orbitals in an atom.

State which rule(s) is/are violated or obeyed by **each** model.
[6 marks]

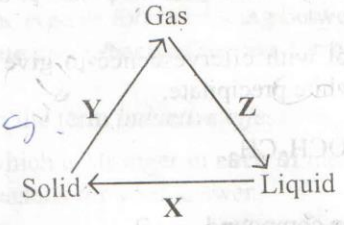
(d) Explain why the boiling point of H_2S with relative molecular mass of 34 is lower than that of H_2O with relative molecular mass of 18.
[4 marks]

(e) HCl is passed into **each** of the following solvents:
(i) water;
(ii) methylbenzene.
I. State the effect of **each** solution on blue litmus paper.
II. Compare the electrical conductivities of the **two** solutions.
[4 marks]

(f) Zinc dust is added to copper (II) tetraoxosulphate (VI) solution.
State (i) what is observed;
(ii) the type of reaction that occurs.
[3 marks]

2. *(a)* (i) State **two** differences between the properties of solids and gases.

(ii) What process does **each** of **X, Y** and **Z** represent in the changes shown below?



[5 marks]

(b) (i) State *Charles' Law.*

(ii) Draw a sketch to graphically illustrate Charles' Law. [4 marks]

(c) 60 cm^3 of hydrogen diffused through a porous membrane in 10 minutes. The same volume of a gas **G** diffused through the same membrane in 37.4 minutes. Determine the relative molecular mass of **G**.

[H = 1] [4 marks]

(d) (i) State **two** assumptions of the *kinetic theory.*

(ii) Consider the reaction represented by the following equation:

$$H_{2(g)} + Cl_{2(g)} \longrightarrow 2HCl_{(g)}.$$

Use the kinetic theory to explain how the rate of formation of $HCl(g)$ would be affected by

I. increase in temperature;
II. decrease in pressure. [8 marks]

(e) Giving different examples, mention **one** metal in **each** case which produces hydrogen on reacting with

(i) dilute mineral acid;
(ii) cold water;
(iii) steam;
(iv) hot, concentrated alkali. [4 marks]

3. *(a)* State the following laws of chemical combination:

(i) *Law of constant composition;*

(ii) *Law of multiple proportion.* [4 marks]

(b) Copper reacts with oxygen to form **two** oxides **X** and **Y**. On analysis, 1.535 *g* of **X** yielded 1.365 *g* copper and 1.450 *g* of **Y** yielded 1.160 *g* of copper.

(i) Determine the chemical formula of **X** and **Y**.

(ii) Calculate the mass of copper which can react with 0.500 *g* of oxygen to yield.

I. X.
II. Y.

(iii) Which of the laws of chemical combination is illustrated by the result in 3*(b)*(i) above.

[O = 16, Cu = 63.5] [13 marks]

Turn over

(c) Write the structure of the product responsible for the observation in each of the following reactions:

(i) A mixture of butanoic acid and ethanol warmed in the presence of concentrated H_2SO_4 gives off a fragrant odour.

(ii) Sodium dissolves in propan-2-ol with effervescence to give a solution which on evaporation to dryness leaves a white precipitate. [4 marks]

(d) Consider the compound $CH_3CH_2COOCH_2CH_3$.

(i) Name the compound.

(ii) Write the structural formula of the compound.

(iii) State the reagents and conditions for the formation of the compound. [4 marks]

4. *(a)* A solution of $CuSO_4$ was electrolyzed between pure copper electrodes and the following results were obtained:

Mass of copper anode before experiment = 7.20 *g*
Mass of copper anode after experiment = 4.00 *g*
Mass of copper cathode before experiment = 5.75 *g*

From the information provided,

(i) calculate the mass of the cathode, after the experiment.

(ii) write an equation for the reaction at the
I. anode,
II. cathode.

(iii) state whether the colour of the solution would change during the electrolysis. Give a reason for your answer.

(iv) if the electrolysis was carried out for 1 hour 20 minutes with a current of 2.0 amperes, determine the value of the Faraday. [10 marks]

(b) Consider the reaction represented by the following equation:

$$MnO_4^- + I^- + H^+ \longrightarrow I_2 + H_2O + Mn^{2+}$$

Write balanced half equation for the

(i) oxidation reaction,

(ii) reduction reaction. [4 marks]

(c) (i) Describe briefly how tin can be extracted from its ore.

(ii) State **one** use of tin.

(iii) Mention **one** property that makes tin suitable for the use stated in **4***(c)*(ii). [7 marks]

(d) (i) What is meant by the term *pollution*?

(ii) Explain why it is dangerous to run a generator in a closed room. [4 marks]

SECTION II

FOR CANDIDATES IN **GHANA ONLY**.

Answer **one** *question* **only** *from this section.*

No marks *will be awarded for answering questions* **not peculiar** *to your own country.*

5. *(a)* Describe briefly how you would determine the presence of nitrogen in an organic compound. [7 marks]

$CaCl_2$ — Conc H_2SO_4

2028 $CaSO_4$ is ... in the manufacture of $(NH_4)_2SO_4$

$CaCO_3$ (limestone) used as building materia

(b) (i) Name the **two** crystalline forms of carbon.
(ii) State the structure of **each** form.
(iii) State the type of hybridization in **each** of the two forms.
(iv) State the type of forces existing between **each** of the two crystalline forms.
(v) State **one** use of **each** of the two forms.
[10 marks]

(c) (i) Explain the term *inductive effect.*
(ii) State which is stronger in **each** of the following pairs of acids. Give reasons for your answer.
I. Phenylmethanoic acid and ethanoic acid
II. $CH_3CH_2CHClCOOH$ and $CH_3CHClCH_2COOH$
[8 marks]

6. (a) Define **each** of the following thermodynamic terms:
(i) *Surrounding;*
(ii) *Open system;*
(iii) *Closed system.*
[4 marks]

(b) What is a
(i) *Bronsted-Lowry acid;*
(ii) *Bronsted-Lowry base?*
[2 marks]

(c) In the following reaction, identify the Bronsted-Lowry acid and base in **both** the forward and reverse reactions:

$$NH_{3(aq)} + H_3PO_{4(aq)} \rightleftharpoons NH^+_{4(aq)} + H_2PO_{4(aq)}.$$

[4 marks]

(d) (i) Distinguish between *heavy chemicals* and *fine chemicals.*
(ii) Give **one** example **each** of heavy chemical and fine chemical.
[4 marks]

(e) Define the following:
(i) *Heat of formation;*
(ii) *Bond energy;*
(iii) *Hydration energy.*
[6 marks]

(f) Sodium oxide (Na_2O) is an ionic compound.
(i) Draw an energy cycle diagram to illustrate the formation of Na_2O stating what **each** energy change in the cycle represents.
(ii) Write an equation relating the energies of the various processes represented in the diagram.
[5 marks]

SECTION III

FOR CANDIDATES IN **NIGERIA, SIERRA LEONE** AND **THE GAMBIA.**

Answer **one** *question* **only** *from this section.*

No marks *will be awarded for answering questions* **not peculiar** *to your own country.*

7. (a) (i) Draw and label a diagram to illustrate the preparation and collection of dry chlorine gas in the laboratory.
(ii) List **two** uses of chlorine.
[9 marks]

(b) (i) Explain why river water flowing through an industrial town may be unsafe for drinking.
(ii) State the use of **each** of the following substances in water treatment:
I. Sand,
II. Chlorine, sterilization of water
III. Calcium oxide,
IV. Alum. [5 marks]

(c) Consider the reaction represented by the following equation:

$$2NaCl_{(s)} + H_2SO_{4(aq)} \longrightarrow Na_2SO_{4(aq)} + 2HCl_{(g)}$$

Calculate the volume of HCl gas that can be obtained at s.t.p. from 5.85 g of sodium chloride.
[H = 1, Na = 23, Cl = 35.5, Molar Volume = 22.4 dm^3 at s.t.p.] [4 marks]

(d) Give **one** example in **each** case of a
(i) metal that is a liquid at room temperature, Mercury
(ii) non-metal that is a liquid at room temperature,
(iii) gas at room temperature that is monatomic. [3 marks]

(e) State **two** differences between *metals* and *non-metals* with respect to their
(i) physical properties;
(ii) chemical properties. [4 marks]

8. (a) (i) Draw the energy profile diagram for the reaction

$$H_{2(g)} + I_{2(g)} \longrightarrow 2HI_{(g)} \quad \Delta H = -13\ kJmol^{-1}$$

(ii) If the concentration of HI increases from 0 to 0.001 $mol\ dm^{-3}$ in 50 seconds, what is the rate of the reaction? [5 marks]

(b) State the type of salt represented by **each** of the following compounds:
(i) $K_4Fe(CN)_6$, Complex salt
(ii) $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$, Double salt
(iii) $Mg(OH)NO_3$, Basic salt
(iv) NaH_2PO_4. Acid salt [4 marks]

(c) Explain, giving equations, the following observation:
When carbon (IV) oxide is passed into lime water, it turns milky initially but turns clear with excess carbon (IV) oxide. [4 marks]

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$ (first; $CaCO_3$ insoluble)

$CaCO_3 + H_2O + CO_2 \rightarrow Ca(HCO_3)_2$ (clear solution)

(d) (i) Give **one** use for **each** of the following compounds:
$CaCO_3$, $CaSO_4$, $NaHCO_3$.
(ii) State a drying agent for **each** of the following gases:
I. NH_3, CaO
II. HCl, Concentrated H_2SO_4
III. SO_2. " H_2SO_4
(iii) Write an equation to illustrate the reaction of ammonia as a reducing agent. [8 marks]

$3CuO + 2NH_3 \rightarrow 3Cu + H_2O + N_2$

(e) An industrial raw material has the following composition by mass:

Iron	=	28.1%
Chlorine	=	35.7%
Water of crystallization	=	36.2%

Calculate the formula for the material.
[H = 1, O = 16, Cl = 35.5, Fe = 56]. [4 marks]

$FeCl_2 \cdot 4H_2O$ = 1 : 2 : 4