# PAPER 2
## ESSAY
[100 marks]

*Answer four questions in all: Question 1 in Section A and three questions from Section B.*

*All questions carry equal marks*

*Credit will be given for clarity of expression and orderly presentation of material.*

## SECTION A
*Answer all the questions in this section*

1. (a) (i) State *Graham's law of diffusion.*
   (ii) Write the mathematical expression for Graham's law.

   [3 marks]

   (b) Name **two** types of polymerization.

   [2 marks]

   (c) What is meant by *isomerism*?

   [2 marks]

   (d) Distinguish between a *covalent bond* and a *dative bond.*

   [2 marks]

   (e) Calculate the mass of magnesium oxide that would be obtained
   if 0.6 g of magnesium is completely burnt in oxygen.
   $(Mg = 24.0, O = 16.0)$

   [4 marks]

   (f) State **three** factors that would influence preferential discharge of
   ions during electrolysis.

   [3 marks]

   (g) **Briefly** describe how a mixture of sand and sodium chloride could
   be separated in the laboratory.

   [3 marks]

   (h) Why is the electron affinity of fluorine lower than that of chlorine?

   [2 marks]

   (i) What is the difference between *a concentrated solution of a base* and
   *a dilute solution of a base*?

   [2 marks]

   (j) Mention **two** salts that would decompose on heating to produce
   oxygen gas.

   [2 marks]

# SECTION B

*Answer* **three** *questions only from this section*

2.    (a)    (i)    Explain **one** disadvantage of equilibrium as an industrial process.

         (ii)    (α)    State **one** disadvantage of cooling industrial plants with water containing $Ca(HCO_3)_2$.

              (β)    Give a reason for the answer stated in 2(a)(i)(α).

                                                                    [4 marks]

   (b)    Consider the following reaction equation.

$$CaCO_{3(aq)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$$
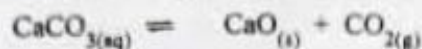
         (i)    State **one** condition necessary for the system to attain equilibrium.

         (ii)    Explain why crushing limestone increases its rate of decomposition.

         (iii)    What is meant by *an equilibrium position* in a reversible reaction.

         (iv)    What is the relationship between the enthalpy change for a forward reaction and that of its backward reaction.

                                                                      [7 marks]

   (c)    A current of 5.0 amperes is passed through $CuSO_{4(aq)}$ and $AgNO_{3(aq)}$ connected in series for 1 hour, 30 minutes.

       Calculate the mass of:

         (i)    copper deposited;

         (ii)    silver deposited.

                   $[Cu = 63.5; Ag = 108.0; F = 96,500\ C]$

                                                                         [10 marks]

   (d)    (i)    Define the term *allotropy*.

         (ii)    Name **two** crystalline allotropes of carbon.

                                                                        [4 marks]

3.    (a)    Copy and complete the table below.

| Chemical Process | Product(s) obtained | Condition(s) |
|---|---|---|
| $CH_3COONa + NaOH$ | | |
| Saponification | | |

                                                                            [4 marks]

   (b)    A mixture of aqueous calcium hydroxide and ammonium trioxonitrate(V) is warmed:

         (i)    identify the gas evolved;

         (ii)    write a balanced chemical equation for the reaction;

         (iii)    write a balanced chemical equation for the reaction of the gas evolved in (b)(i) with:

              (a)    dilute $H_2SO_4$;

              (β)    $CO_2$.

                                                                                    [7 marks]

(c) Give **one** reason for **each** of the following observations:
(i)  $SO_2$ shows more deviation from ideal gas behaviour than $H_2$;
(ii) the smell of nitrogen (II) oxide is difficult to detect;
(iii) a balloon filled with helium deflates faster than one filled with oxygen.

[7 marks]

(d) Name the crystalline allotrope of carbon that is:
(i)  **most** reactive;
(ii) can be used as an insulator;
(iii) **less** dense than air.

[3 marks]

(e) An aqueous solution of a salt $Na_2X$ has a pH **greater** than 7. A similar solution of another salt $Na_2Y$ has a pH of exactly 7. Suggest reasons for these observations.

[5 marks]

4. (a) Calculate the pH of an $0.01 mol\ dm^{-3}$ aqueous solution of dichloroethanoic acid given that its $K_a$ is $5.0 \times 10^{-12}$.

[4 marks]

(b) Magnesium ribbon was reacted with solution of tetraoxosulphate (VI) acid. The time taken for all the magnesium to react was recorded and the experiment was repeated. Another experiment was carried out with magnesium powder. The results are tabulated below.

| Expt. | Amt. of Mg / mol | Form of Magnesium | Acid solution / mol dm$^{-3}$ | Volume of acid / cm$^3$ | Time taken for the reaction /s |
|---|---|---|---|---|---|
| A | 0.01 | Ribbon | 0.500 | 100 | 280 |
| B | 0.01 | Ribbon | 0.250 | 100 | 1480 |
| C | 0.01 | Powder | 0.500 | 100 | 80 |
| D | 0.01 | Powder | 0.250 | 100 | 140 |

(i)  Write a balanced chemical equation for the reaction.
(ii) What information could be obtained from the results about the conditions which affect the rate of a chemical reaction?
(iii) Explain **briefly** the answers given in (ii).
(iv) Calculate the volume of gas evolved at stp in Exp. A
[Mg = 24.0, molar volume = $22.4\ dm^3 mol^{-1}$ at stp]

[12 marks]

(c) Given that the reaction in (b) is exothermic, draw an energy profile diagram for the reaction

[4 marks]

(d)  Explain **briefly** why removing an electron from a neutral gaseous aluminium atom is easier than from a gaseous magnesium atom.
[Mg = 12, Al = 13]

[5 marks]

5.  (a)  Methanoic acid reacts with ethanol to form an alkanoate.
  (i)  State the conditions necessary for the reaction.
  (ii)  Draw the structure of the alkanoate produced.
  (iii)  Name the alkanoate.

[5 marks]

(b)  Propene is bubbled into bromine water to form a compound **Q**.
  (i)  Name compound **Q**.
  (ii)  State what would be observed when propene is bubbled into bromine water.
  (iii)  What property is exhibited by propene.

[4 marks]

(c)  Calculate the volume of carbon (IV) oxide at stp that would be produced by the complete combustion of 2.40 g of ethene.

$$C_2H_{4(g)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 2H_2O_{(l)}$$

[H = 1.0, C = 12.0, 1 mole of gas at stp = 22.4 dm³]
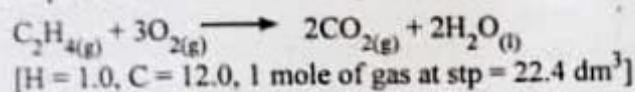
[3 marks]

(d)  Explain **briefly**, with the aid of chemical equation(s), why the formation of a sodium ion from a sodium atom is considered to be an oxidation reaction.

[5 marks]

(e)  (i)  Give **one** reason why burning of hydrogen does **not** cause air pollution.
  (ii)  List **three** uses of hydrogen.

[4 marks]

(f)  (i)  Define *Electrolysis*.
  (ii)  Mention **two** applications of electrolysis.

[4 marks]

## END OF ESSAY TEST