P525/2
Chemistry
Paper 2
2½ hours

MWALIMU EXAMINATIONS BUREAU

UACE PRE-MOCK EXAMINATIONS – 2022

CHEMISTRY
Paper 2
2 hours 30 minutes

Instructions to candidates

Answer **five** questions including **three** questions from section **A** and any **two** from section **B**.

Write the answers in the answer booklet provided.

Begin each question on a fresh page.

Mathematical tables and graph paper are provided.

Non-programmable scientific calculators may be used.

Use equations where necessary to illustrate your answers.

[$H = 1;\ C = 12;\ O = 16$]

SECTION A

Answer **three** questions from this section.

1. (a) Define the term **relative atomic mass**. (01 mark)

(b) Describe the main steps involved in the determination of the relative atomic mass of solid element **Y** using a mass spectrometer. (05 marks)

(c) An element **Y** has three naturally occurring isotopes with isotopic masses and relative abundances as shown as shown below:

Isotopic mass	**Relative abundance (%)**
23.98	78.60
24.98	10.11
25.98	11.29

(i) Calculate the average atomic mass of **Y**. (02 marks)

(ii) State **two** advantages of using a mass spectrometer over the depression of freezing point method for determining relative atomic masses. (02 marks)

(d) The first four successive ionisation energies of an element **Y** are 736, 1451, 7740 and 10500 respectively.

(i) Explain the trend in the variation of the ionisation energies of **y**. (3½ marks)

(ii) State the group in the Periodic Table to which Y belongs. (0½ mark)

(e) The initial count of a radioactive nucleus was 680 per second. After 350 seconds, the count rate was 125 per second. Determine the:

(i) decay constant. (02 marks)

(ii) half-life of the nucleus. (02 marks)

(iii) percentage of Y remaining after 650 seconds. (02 marks)

2. The elements beryllium, magnesium, calcium and barium belong to group II of the Periodic Table.

(a) Explain the trend in the electropositivity of the elements. (02 marks)

(b) State **three** chemical properties shown by the elements. In each case, illustrate your answer with an equation. (06 marks)

(c) Beryllium differs in some of its properties from the rest of the elements in the group.

(i) State **two** properties in which beryllium differs from the rest of the members of the group. (02 marks)

(ii) Give reasons why beryllium shows different properties from the rest of the elements. (01 mark)

(d) Name **one** reagent that can be used to distinguish between the following pairs of ions. State what would be observed and write equation(s) for the reaction(s) that would take(s) place in each case if each member of the pair is separately treated with the reagent you have named.

(i) Magnesium ions and barium ions.

(ii) Calcium ions and barium ions. (06 marks)

(e) A chloride of beryllium **Z** contains 11.25% beryllium and the rest being chlorine.

(i) Calculate the empirical formula of **Z**. (1½ marks)

(ii) Determine the molecular formula of **Z**. (The vapour density of Z=80) (01 mark)

(iii) Draw the structure of **Z**. (01 mark)

3. (a) State what meant by the terms:

(i) **Standard state of a substance.** (01 mark)

(ii) **Enthalpy of combustion**. (01 mark)

(b) Describe briefly how the enthalpy of combustion of hexane can be determined.
(No diagram required) (06 marks)

(c) The standard enthalpies of combustion for carbon, hydrogen, benzene, cyclohexene and cyclohexane are $-393.5\ kJ\ mol^{-1}$, $-285.7\ kJ\ mol^{-1}$, $-3280\ kJ\ mol^{-1}$, $-3800\ kJ\ mol^{-1}$ and $-3920\ kJ\ mol^{-1}$ respectively.
Use these values to calculate the standard enthalpy of
(i) formation of benzene. (03 marks)
(ii) hydrogenation of benzene. (03 marks)
(iii) hydrogenation of cyclohexene. (03 marks)

(d) Comment on the values obtained in (d)(ii) and (b)(iii). (03 marks)

4. 1.25 g of an organic compound **X**, on complete combustion gave 2153.45 cm^3 of carbon dioxide gas and 0.865 g of water at s.t.p. The vapour density of **X** is 3.482 gl^{-1}.
(a) Determine the;
(i) empirical formula of **X**. (02 marks)
(ii) molecular formula of **X**. (02 marks)
(b) **X** burns with a sooty flame and the pH of its aqueous solution is equal to 7. Write structural formula of **X**. (01 mark)
(c) Write equation to show how **X** can obtained from;
(i) 1,2-diiodoethane. (02 marks)
(ii) chlorobenzene. (03 marks)
(d) Discuss the reactions of **X** with:
(i) chlorine.
(ii) nitric acid.
(iii) sulphuric acid.
[Your description should include equations.] (07 marks)
(e) Outline the mechanism for the reaction in (d)(iii). (03 marks)

SECTION B

Answer **two** questions from this section

5. Explain each of the following observations. Illustrate your answers with equations where applicable.

(a) Ethene reacts bromine in carbon tetrachloride to form 1,2−bromoethane. But when the reaction was carried out in the presence of aqueous sodium chloride solution, 1−bromo−2−chloroethane is also formed. (06 marks)
(b) Magnesium oxide readily dissolves in dilute sulphuric acid whereas barium oxide does not. (03 marks)
(c) Hydrogen sulphide is a gas at room temperature whereas water is a liquid at the same temperature. (04 marks)
(d) When sodium sulphide solution was added to acidified solution potassium dichromate(VI), the orange solution turned green and a yellow precipitate was formed. (03 marks)
(e) Beryllium chloride readily dissolves in ethanol whereas barium chloride does not. (04 marks)

6. Outline a mechanism for the reaction that takes place in each of the following reaction mixtures.
   (a) 2-chlorobutane and hot alcoholic potassium hydroxide solution. (02 marks)
   (b) Benzene and propene in presence of hydrogen ions. (4½ marks)
   (c) Boiling methylbenzene and chlorine in presence of u.v light. (3½ marks)
   (d) Bromocyclohexane and hot aqueous solution of hydroxide ions. (02 marks)
   (e) A hot mixture of methanoic acid and cyclohexanol in the presence of dry hydrogen chloride. (05 marks)
   (f) Propan-2-ol and hot concentrated sulphuric acid. (03 marks)

7. (a) State
   (i) what is meant by the term **reversible reaction**? (01 mark)
   (ii) **three** characteristic of a dynamic equilibrium. (1½ marks)
   (b) Write an expression for the equilibrium constant, K_p, for each of the following reactions.
   (i) $CS_2(g) + 4H_2(g) \rightleftharpoons CH_4(g) + 2H_2S(g)$
   (ii) $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$
   (iii) $2NO_2(g) + 7H_2(g) \rightleftharpoons 4NH_3(g) + 4H_2O(g)$
   (iv) $Na_2CO_3(s) \rightleftharpoons Na_2O(s) + CO_2(g)$
   (v) $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$ (2½ marks)
   (c) Ethanol reacts with ethanoic acid according to the following equation.

$$C_2H_5OH(l) + CH_3CO_2H(l) \rightleftharpoons CH_3CO_2CH_2CH_3(l) + H_2O(l)$$

   (i) State the conditions for the reaction. (01 mark)
   (ii) Briefly describe how the equilibrium concentration of ethanoic acid in the mixture can be determined by titrimetric method. (05 marks)
   (iii) When 8.28 g of ethanol was heated at 90°C with 60 g of ethanoic acid, 49.74 g of the acid remained at equilibrium. What mass of ethyl ethanoate should be present in the equilibrium mixture formed from heating 13.8 g of ethanol with 12.0 g of ethanoic acid at 90°C? (09 marks)

8. During the extraction of aluminium from bauxite, the ore is first heated, powdered and then the powdered material is heated with sodium hydroxide solution and finally filtered.
   (a) State why the
   (i) ore is first heated before changing it to powder. (01 mark)
   (ii) powdered ore is heated with sodium hydroxide solution and then filtered. (02 marks)
   (b) Write equations for the reaction between the powdered ore and sodium hydroxide solution. (03 marks)
   (c) Briefly describe how pure aluminium can be obtained from the product from the reaction in (b). (Your answer should include equations.) (08 marks)
   (d) Write equations for the reaction between aluminium and
   (i) iron(III) oxide. (1½ marks)
   (ii) trimanganese tetraoxide. (1½ marks)
   (iii) chromium(III) oxide. (1½ marks)
   (e) Use equation to show how anhydrous aluminium chloride can be prepared. (1½ marks)

END