P525/2
CHEMISTRY
Paper 2
Sept./Nov. 2022

2 ½ hours.

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THE CHEMISTRY DEPARTMENT

2022

CHEMISTRY

MID TERM III, Paper 2

2 hours 30 minutes

INSTRUCTIONS:

Attempt only 3 questions in section A and only 2 questions in section B.

Write the answers in the answer booklet(s) provided.

Begin each question on a fresh page.

Mathematical tables and graph papers are provided.

Non-programmable scientific calculators may be used.

Use equations where necessary to illustrate your answers.

SECTION A : (60 MARKS)

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

1. Beryllium, magnesium, calcium and barium are some of the elements that belong to group II of the Periodic Table.

   (a)   State what would be observed and write equation for the reaction when:

      (i)   Magnesium is heated in steam   *(2 ½ marks)*

      (ii)   Calcium is added to water   *(2 ½ marks)*

   (b)   Illustrating your answers with equations, compare how beryllium and barium react with sulphuric acid.   *(07 marks)*

   (c)   (i) State how the solubility of the hydroxides of group II vary down the group.   *(01 mark)*

      (ii)   Explain your answer in (c)(i).   *(03 marks)*

   (d)   Write equation for the reaction between;

      (i)   Water and calcium carbide   *(1 ½ marks)*

      (ii)   Beryllium and hot concentrated sodium hydroxide solution   *(1 ½ marks)*

   (e)   State **two** reasons why beryllium differs from the rest of group II elements of the Periodic Table.   *(01 mark)*

2. (a) Define the terms **relative atomic mass**   *(01 mark)*

(b)   (i) Briefly describe how the relative atomic mass of an element can be determined using a mass spectrometer (**No diagram required**).   *(08 marks)*

(ii) Copper has a relative atomic mass of 63.55 and consists of two isotopes ^{63}Cu and ^{65}Cu. Determine the percentage composition of the isotopes in the naturally occurring copper.   *(03 marks)*

(iii) When chlorine gas was analysed in a mass spectrometer, peaks were recorded at mass number 70, 72 and 74. Explain this observation.

         (2 ½ marks)

(iv) State **one** advantage of using a mass spectrometer in the determination of relative atomic masses.   *(01 mark)*

(c) The first, second, third and fourth ionization energies of **Y** are 738, 1451, 7733 and 10541 respectively.

(i) Write equation to show second ionization of element **Y**.

(01 mark)

(ii) State and explain the trend in the ionization energies of element **Y**. *(3 ½ marks)*

3. A hydrocarbon **R** on complete combustion yielded 13.2g of carbon dioxide and 2.7g of water. When 9.4g of **R** was vapourised at 273K and 760mmHg, it occupied a volume of $2.7 \times 10^{-3} m^3$.

(a) (i) Calculate the empirical formula of **R**. *(03 marks)*

(ii) Determine the molecular formula of **R**. *(03 marks)*

(b) R burns with a sooty flame. Write the structural formula and IUPAC name of **R**. *(02 marks)*

(c) Briefly describe, using equations only, how **R** can be synthesised from ethanol. *(05 marks)*

(d) Discuss the reactions of **R** with;

(i) Bromine *(3 ½ marks)*

(ii) Propene *(3 ½ marks)*

(Your answer should include conditions for the reaction and mechanisms for the reactions where possible)

4. (a) State Raoult's law and the conditions under which the law holds.

(03 marks)

(b) Benzene and methylbenzene form a liquid mixture that is ideal. A liquid mixture of the two compounds was made by adding 23.4g of benzene to 46g of methylbenzene at 25°C. The vapour pressures of benzene and methylbenzene are $203 Nm^{-2}$ and $76 Nm^{-2}$ respectively at 25°C. Calculate the:

(i) vapour pressure of the mixture. *(04 marks)*

(ii) composition of each component in the vapour. *(03 marks)*

(c)Explain why the mixture of benzene and methylbenzene is ideal.

(d)   (i) Sketch a boiling point-composition diagram for the mixture of benzene and methylbenzene. (Boiling points of benzene and methylbenzene are 80℃ and 111℃ respectively)

    (ii)   Using the diagram, describe what will happen when a liquid mixture containing 50% of each component is distilled.

(06 marks)

SECTION B : (40 MARKS)
*Answer any **two** questions from this section*

5. (a) Write the formula and name of an ore of aluminium. *(02 marks)*

(b) Describe the process of extraction of pure aluminium metal from its ore. *(07 marks)*

(c) State the conditions and write equations for the formation of aluminium chloride from the metal. *(03 marks)*

(d) The relative molecular mass of aluminium chloride in a vapour phase is 267.

(i) Write the molecular formula of aluminium chloride in a vapour phase. *(01 mark)*

(ii) Write a structural formula to show the bonding in aluminium chloride vapour. *(01 mark)*

(iii) Note the types of bonds involved in the structure you have drawn in (ii) above. *(01 mark)*

 (e) With reference to aluminium oxide, explain the term amphoteric property. Write appropriate equations. *(3 ½ marks)*

(f) Explain, giving the necessary equation(s) why aluminium utensils should not be washed using soap solutions. *(2 ½ marks)*

6. Explain the following observations
   (a) The first electron affinity of phosphorus is less than that of sulphur. *(03 marks)*
   (b) When magnesium ribbon is added to an aqueous solution of aluminium nitrate, a white precipitate and bubbles of a colourless gas are observed. *(05 marks)*
   (c) Ethene undergoes electrophilic addition reactions whereas benzene undergoes electrophilic substitution reactions. *(05 marks)*
   (d) Hydrochloric acid is not usually used to acidify potassium manganate(VII) during redox titrations. *(03 marks)*
   (e) Both 2-nitrophenol and 4-nitrophenol exhibit hydrogen bonding and yet the boiling points of the two compounds differ greatly. *(04 marks)*

7. Write equations to show how the following compounds can be synthesized.
   (a) Ethene to pent-2-ene *(05 marks)*
   (b) CH_3CHCH_3 from $CH_3CH_2CH_2OH$ *(03 marks)*
        $\overset{|}{O}H$
   (c) $BrCH_2CH_2Br$ to $CH_3C \equiv CCH_2CH_2CH_3$ *(05 marks)*
   (d) Ethyne to propan-1-ol *(03 marks)*
   (e) Ethyne from ethanol *(04 marks)*

8. (a) Define the following terms;
   (i)   **Standard enthalpy change for the reaction** *(01 mark)*
   (ii)   **Standard enthalpy of formation** *(01 mark)*
   (iii) **Standard enthalpy of combustion** *(01 mark)*
   (b) (i) Describe an experiment that can be used to determine the emthalpy of combustion of sugar(sucrose) by a method of Bomb calorimeter. (Diagram **not** required) *(06 marks)*
   (c) (i) State **Hess' law.** *(01 mark)*
   (ii) The table below shows some heats of combustion of some selected compounds/elements. *(04 marks)*

Substance	Heat of combustion, $\Delta H_{25}^{\theta}\,(kJmol^{-1})$
Ethane	-1542
Ethyne	-1310
Hydrogen	-285

Calculate the heat of hydrogenation of ethyne to ethane *(04 marks)*

END