



INFORMATION AND COMMUNICATIONS UNIVERSITY

END OF SEMESTER EXAMINATION

ADVANCED CHEMISTRY

TIME: 3HRS

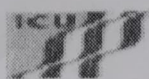
DATE OF EXAMINATIONS: JUNE 2019

INSTRUCTIONS

1. Answer ONE COMPULSORY Question in Section A
2. Answer any FOUR (4) Questions in Section B.
3. Please write as clearly as possible as illegible handwriting cannot be marked.
4. Number the answers to the questions clearly before answering
5. Illustrate your answers where possible.
6. Non-programmable scientific calculators are allowed

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

*Makanya Fem  
Chigwe Vera*



**Section A: This section is compulsory Answer All the questions.**

- 1) Define the following terms: **[ 3 marks]**
- i. Electronegativity
  - ii. Bond polarity
  - iii. Ionization energy
- 2) What is the difference between ionic bonds, covalent bonds and polar covalent bonds?  
Give two examples of each **[ 6 marks]**
- 3) Draw Lewis structures for each of the following: **[ 10 marks]**
- i.  $\text{BH}_3$
  - ii.  $\text{BF}_4$
  - iii.  $\text{H}_2\text{SO}_4$
  - iv. Azide
- 4) Arrange each of the following in the order of increasing electronegativity  
Oxygen, Nitrogen, Lithium, Francium. **[ 1 mark]**

**Section B: Choose ANY four questions from this section. Each question carries 20 marks**

1. Suppose a substance has been prepared that is composed of carbon, hydrogen, and nitrogen. When 0.3156 gram of this compound is reacted with oxygen, 0.1638 gram of carbon dioxide ( $\text{CO}_2$ ) and 0.1676 gram of water ( $\text{H}_2\text{O}$ ) are collected. If all the carbon in the compound is converted to  $\text{CO}_2$
- I. Determine the mass of Carbon and hydrogen in the sample **[ 4 marks]**
  - II. Calculate the percent composition of Carbon, Nitrogen and Hydrogen in the substance **[ 3 marks]**
  - III. Calculate the mass of nitrogen in the substance **[ 2 marks]**
  - IV. Calculate the empirical formula of the sample. **[2 marks]**
  - V. Suppose the molecular mass of the substance was 93 g/mol, find the molecular formula. **[2 marks]**
  - VI. Name the compounds in part a-d and write the formulas for the compounds in parts e-h. **[7 marks]**
    - a.  $\text{CuO}$
    - b.  $\text{FeBr}_3$
    - c. Tin (II) nitride
    - d. Cobalt (III) iodide
    - e. Tin (II) nitride
    - f. Cobalt (III) iodide
2. The following concentrations were observed for the Haber process at  $127^\circ\text{C}$
- $$\text{NH}_3 = 3.1 \times 10^{-2} \text{ mol/L}$$
- $$\text{H}_2 = 8.1 \times 10^{-1} \text{ mol/L}$$
- $$\text{N}_2 = 3.1 \times 10^{-3} \text{ mol/L}$$
- a) State three reaction conditions and the catalyst needed for this reaction to take place **[4marks]**
  - b) Write the mass action expression for the reaction to form ammonia **[3marks]**
  - c) Hence, calculate the equilibrium constant for the Haber process at  $127^\circ\text{C}$  **[2marks]**
  - d) State Le Chateliers principle **[2marks]**
  - e) Predict the shift, whether left, right or no change, that would occur if:
    - i) More ammonia was added
    - ii) Hydrogen/Oxygen was removed
    - iii) Temperature is increased
    - iv) Pressure increased
    - v) Volume reduced **[5marks]**
    - vi) Calculate the concentration of Hydrogen if the concentration of a is reduced to  $2.0 \times 10^{-1} \text{ mol/L}$  while the other conditions are kept the same **[2marks]**

- vii) Calculate the concentration of Nitrogen if the concentration of hydrogen is increased to  $8.5 \times 10^{-1} \text{ mol/L}$  while the other conditions are kept the same  
**[2marks]**

3.

a. Calculate the pH of each of the following solutions at  $25^\circ\text{C}$ . Identify each solution as neutral, acidic, or basic. **[ 12 marks]**

- i)  $[\text{OH}^-] = 3.0 \times 10\text{M}$   
ii)  $[\text{OH}^-] = 9.3 \times 10^{16} \text{M}$   
iii)  $[\text{OH}^-] = 14\text{M}$   
iv)  $[\text{OH}^-] = 6.4 \times 10^{-5}\text{M}$

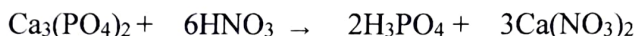
b) Differentiate between an Arrhenius acid, a Bronsted-lowry acid and a Lewis acid  
**[3marks]**

c) A  $50\text{cm}^3$  solution containing 1.9g of a weak acid HA has a pH of 3.50. Calculate the molar mass of the acid, given that it has a  $K_a$  of  $2.0 \times 10^{-6} \text{ moldm}^{-3}$

**[5marks]**

4.

(a) Calcium phosphate reacts with aqueous nitric acid to produce phosphoric acid and calcium nitrate as shown in the equation.



(a)

(i) A 7.26 g sample of calcium phosphate reacted completely when added to an excess of aqueous nitric acid to form  $38.0 \text{ dm}^3$  of solution.

Calculate the concentration, in  $\text{moldm}^{-3}$ , of phosphoric acid in this solution. Give your answer to 3 significant figures.

**[5 marks]**

(ii) Calculate the percentage atom economy for the formation of calcium nitrate in this reaction. Give your answer to 1 decimal place.

**[4 marks]**

(b) Write an equation to show the reaction between calcium hydroxide and phosphoric acid to produce calcium phosphate and water. **[2 marks]**

(c) Calcium dihydrogenphosphate can be represented by the formula  $\text{Ca}(\text{H}_2\text{PO}_4)_x$  where x is an integer. A 9.76 g sample of calcium dihydrogenphosphate contains 0.1 g of hydrogen, 2.59 g of phosphorus and 5.33 g of oxygen.

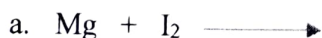
Calculate the empirical formula and hence the value of x. Show your working. **[4 marks]**

5.

a. What is your understanding of the Heisenberg's Uncertainty principle? **[1 mark]**

b. Distinguish between Physical and Chemical reactions. **[2 marks]**

c. Predict the products and balance the following reaction given the incomplete chemical reactions below. **[4 marks]**



d. Determine the empirical and molecular formulas for a compound that gives the following percentages on analysis (in mass percents):

71.65% Cl 24.27% C 4.07% H

The molar mass is known to be 98.96 g/mol

**[4 marks]**

e. Calculate the molarity of a solution prepared by dissolving 1.56 g of gaseous HCl in enough water to make 26.8 mL of solution. **[ 3 marks]**

f. Magnesium has three naturally occurring isotopes. 78.70% of Magnesium atoms exist as Magnesium-24 (23.9850 g/mol), 10.03% exist as Magnesium-25 (24.9858 g/mol) and 11.17% exist as Magnesium-26 (25.9826 g/mol). What is the average atomic mass of Magnesium? **[ 7 marks]**