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 were possible.
6. Non-programmable scientific calculators are allowed

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Makaya Femi
Cisque Vira 1

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. BH_3
   ii. BF_4
   iii. H_2SO_4
   iv. Azide

4) Arrange each of the following in the order of increasing electronegativity
Oxygen, Nitrogen, Lithium, Francium. **[1 mark]**

Section B: Choose <u>ANY</u> 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 (CO_2) and 0.1676 gram of water (H_2O) are collected. If all the carbon in the compound is converted to 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. CuO
   b. $FeBr_3$
   e. Tin (II) nitride
   f. Cobalt (III) iodide

2. The following concentrations were observed for the Haber process at 127^0C

$NH_3 = 3.1 \times 10^{-2}$ mol/L
$H_2 = 8.1 \times 10^{-1}$ mol/L
$N_2 = 3.1 \times 10^{-3}$ 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 127^0C **[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 2.0×10^{-1}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 8.5×10^{-1}mol/L while the other conditions are kept the same **[2marks]**

3.

a. Calculate the pH of each of the following solutions at 25 ^{0}C. Identify each solution as neutral, acidic, or basic. **[12 marks]**

i) $[OH^-] = 3.0 \times 10M$

ii) $[OH^-] = 9.3 \times 10^{16}$ M

iii) $[OH^-] = 14M$

iv) $[OH^-] = 6.4 \times 10^{-5}M$

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

c) A 50cm^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 2.0×10^{-6}moldm^{-3}

[5marks]

4.

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

$$Ca_3(PO_4)_2 + 6HNO_3 \rightarrow 2H_3PO_4 + 3Ca(NO_3)_2$$

(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 dm^3 of solution.
Calculate the concentration, in 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 $Ca(H_2PO_4)x$ 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]**

a. $Mg + I_2 \longrightarrow$

b. $CuCl_2 + H_2S \longrightarrow$

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]**