NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED CHEMISTRY

ANALYTICAL CHEMISTRY I

SCH 1206

Second Semester Examination Paper

May 2016

This examination paper consists of 4 pages

Time Allowed: **3 hours**

Total Marks: **100**

Examiner's Name: Dr. A. Maringa

INSTRUCTIONS

1. Answer ALL questions in section A and any three (3) questions in section B
2. Each question in section A carries 10 marks and each question in section B carries 20 marks

MARK ALLOCATION

QUESTION	MARKS
SECTION A: 1.	**10**
2.	**10**
3.	**10**
4.	**10**
SECTION B: 5	**20**
6	**20**
7	**20**
8	**20**
TOTAL POSSIBLE MARKS	**100**

SECTION A

1. a) Distinguish between qualitative analysis and quantitative analysis. Give examples. [4 marks]

   b) Write equilibrium-constant expressions *Kc* for each of the following reactions.

   $N_2O_3(g) \rightleftharpoons NO_2(g) + NO(g)$

   $2H_2S(g) \rightleftharpoons 2H_2(g) + S_2(g)$

   $PCl_3(g) + 3NH_3 \rightleftharpoons P(NH_2)_3(g) + 3HCl(g)$ [6 marks]

2. a) State the Le-Chatelier's principle. [2 marks]

   b) Predict the direction of reaction when H_2 is removed from a mixture in which the following equilibrium has been established:

   $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ [3 marks]

   c) Calculate the standard deviation and the relative standard deviation for the following data:

Measurement No.	Value (g)
1	16.7724
2	16.7735
3	16.7722
4	16.7756
5	16.7729
6	16.7716
7	16.7720
8	16.7733

[5 marks]

3. a) Explain briefly the salt effect. [3 marks]

   b) State the properties of activity coefficient. [5 marks]

   c) Explain why the solubility of an ionic compound increases as the ionic strength of a solution increases. [2 marks]

4. a) Distinguish between determinate and indeterminate errors. [4 marks]

   b) Calculate the ionic strength of a solution that is:

      (i) 0.030 M in $FeSO_4$.

      (ii) 0.30 M in $FeCl_3$ and 0.20 M in $FeCl_2$.

      (iii) 0.05 M in KNO_3 and 0.1 M in Na_2SO_4. [6 marks]

SECTION B

5. a) Describe 5 factors which affect the rate of a chemical reaction. [10 marks]

   b) An analyst determines that the analytical balance he used in a given analytical test is wrongly calibrated. Is this a determinate or an indeterminate error? Explain. [4 marks]

   c) A mixture of 1.20 mol of X, 2.10 mol of Y, and 0.950 mol of Z is found at equilibrium in a 1.00 L vessel. (*a*) Calculate *K*. (*b*) If the same mixture had been found in a 2.00 L reaction mixture, would the value of *K* have been the same? Explain. [6 marks]

6. a) Calculate the pH of 0.100 *M* NH_3. $K_b = 1.8 \times 10^{-5}$ [5 marks]

   b) Calculate the value of the equilibrium constant at a certain temperature for the following reaction if there are present at equilibrium 0.10 mol of N_2, 0.070 mol of O_2, and 1.4×10^{-3} mol of NO_2 in 2.0 L. [5 marks]

   c) Is NH_4Cl solution in water acidic or basic? Explain. [4 marks]

   d) Calculate the hydronium ion concentration of a 0.250 M acetic acid solution also containing 0.190 M sodium acetate. Ka = 1.81×10^{-5}. [6 marks]

7. a) Describe the factors that are ideal for a standard solution. [8 marks]

   b) A 100 mL sample of brackish water was ammoniacal and the sulfide it contained was titrated with 16.47 mL of 0.0231 M $AgNO_3$. The analytical reaction is

$$2Ag^- + S^{2-} \rightarrow Ag_2S$$

   Calculate the concentration of H_2S in water in parts per million. [12 marks]

8. a) Make a distinction between thermodynamic and concentration equilibrium. [4 marks]

   b) Calculate the solubilities of the following compounds in a 0.0167 M solution of $Ba(NO_3)_2$ using (1) activities and (2) molar concentrations:

   (i) $AgIO_3$. [4 marks]

   (ii) $Mg(OH)_2$. [4 marks]

   (iii) $BaSO_4$. [4 marks]

   (iv) $La(IO_3)_3$. [4 marks]