NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
END OF SEMESTER EXAMINATIONS – APRIL/MAY 2014
GENERAL CHEMISTRY – SCH 1217
FOR SBB AND ESH

TIME – 3 HOURS

INSTRUCTIONS TO CANDIDATES:

1. ANSWER **ALL** QUESTIONS FROM SECTION A AND **ANY THREE** FROM SECTION B. SECTION A CARRIES 40 MARKS AND EACH QUESTION IN SECTION B CARRIES 20 MARKS. MARKS ARE ALLOCATED IS INDICATED IN BRACKET [ ]

2. START ANSWERING EACH QUESTION ON A NEW PAGE. (NOT EACH PART OF A QUESTION)

INFORMATION TO CANDIDATES

1. YOU ARE REMINDED FOR THE NEED TO USE CLEAR PRESENTATION AND GOOD ENGLISH

TOTAL MARKS = 100

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PRINTED PAGES (ON ONE SIDE ONLY) INCLUDING THE TOP PAGE WITH THE INSTRUCTIONS.

SECTION A:

1)

a) Write a balanced equation for:

a.i) The combination reaction between lithium metal and fluorine gas. [2 marks]

a.ii) The decomposition reaction that occurs when solid barium carbonate is heated (two products form, a solid and a gas). [2 marks]

a.iii) When methanol, $CH_3OH(l)$, is burned in air. [2 marks]

b) Define the following terms:

b.i) Ionization energy [2 marks]

b.ii) electron affinity [2 marks]

2)

a) Write the electron configuration for phosphorus, (element 15). [1 mark]

b) How many unpaired electrons does a phosphorus atom possess? [1 marks]

c) What is the characteristic valence electron configuration of the group 7A elements, the halogens? [1 marks]

d) Write the electron configuration for

d.i) Ca^{2+},

d.ii) Co^{3+}, and

d.iii) S^{2-}. [3 marks]

e) Define Hund's first rule and Pauli's exclusion Principle [4 marks]

3)

a) Calculate the work done by a system in which a reaction results in the formation of 1.0 mol CO_2 (g) at 25°C and 100 kPa. Assume ideal gas behaviour and use the relation 1 Pa m^3 = 1 J.) [4 marks]

b) Complete the following nuclear equations. Write the mass number, atomic number, and symbol for the remaining particle

(b.i.1.a.i)
(b.i.1.a.ii)
(b.i.1.a.iii)
(b.i.1.a.iv)
(b.i.1.a.v)
(b.i.1.a.vi)

[6 marks]

4)

a) The gas N_2O_4 can be formed from $NO_{2(g)}$ according to the following reaction; $2NO_{2(g)}$ $N_2O_{4(g)}$. At 25°C, the equilibrium concentrations of NO_2 and N_2O_4 are 0.018 M and 0.055 M respectively.

a.i) Calculate the equilibrium constant (K_{eq}) at 25°C.

a.ii) If in another equilibrium system of the same gases at the same temperature, the NO_2 concentration is found to be 0.08 M, what is the concentration of N_2O_4? [5 marks]

b) The acid-dissociation constant, K_a, of hydrofluoric acid is 6.8×10^{-4}.

b.i) What is the $[H_3O^+]$ in a 2M HF solution?

b.ii) What is the pH of the solution? [5 marks]

SECTION B:

1)

a) Calculate the percentage of carbon, hydrogen, and oxygen (by mass) in $C_{12}H_{22}O_{11}$ [3 marks]

b) Ethylene glycol, used in automobile antifreeze, is 38.7% C, 9.7% H, and 51.6% O by mass. Its molar mass is 62.1 g/mol.

b.i) What is the empirical formula of ethylene glycol? [4 marks]

b.ii) What is its molecular formula? [4 marks]

c) Name and describe the 3 main reaction types and give 2 examples of each [9 marks]

2)

a) Define the following terms:

a.i) Limiting reagent,

a.ii) Theoretical yield and

a.iii) Percentage yield [6 marks]

b) Calculate the formula weight of:

a.i) sucrose, $C_{12}H_{22}O_{11}$ (table sugar), and

a.ii) calcium nitrate, $Ca(NO_3)_2$ [4 marks]

c) Calculate the percentage of carbon, hydrogen, and oxygen (by mass) in $C_{12}H_{22}O_{11}$ [3 marks]

d) Calculate the number of moles of glucose ($C_6H_{12}O_6$) in 5.380 g of $C_6H_{12}O_6$[2 marks]

e) What is the mass, in grams, of:

e.i) 6.33 mol of $NaHCO_3$ and

e.ii) 3.0×10^{-5}mol of sulphuric acid [5 marks]

3) The Haber-Bosch process for the production of ammonia is one of the key industrial processes in developed countries.

a) Using the data below, calculate for the reaction at 298 K, 800 K, and 1300K

Temperature (K)		
298	-91.8	-198.12
800	-107.4	-225.4
1300	-112.4	-228.0

How does the free energy change for the reaction change with temperature?

b) Calculate the equilibrium constant at each of the three temperatures.

c) Calculate the mole fraction of ammonia in the equilibrium mixture at each of the three temperatures. At what temperature is the mole fraction of NH_3 the largest?

[20 marks]

4)

a) If we start with 1.000 grams of radioactive Sr-90, 0.953 grams will remain after 2.0 years.

a.i) What is the half-life of strontium-90?

a.ii) How much strontium-90 will remain after 5.00 years?

[8 marks]

b) The following data were collected for the rate of disappearance of NO in the reaction

Exp. No	[NO] $molL^{-1}$	$[O_2]$ $molL^{-1}$	Initial rate ($molL^{-1}$ s^{-1})
1	0.0126	0.125	1.41×10^{-2}
2	0.0252	0.250	1.13×10^{-1}
3	0.0252	0.125	5.64×10^{-2}

b.i) Write equation for the first order reaction and the second order reaction.

b.ii) Determine the rate law for the reaction.

b.iii) From the rate law, what is the overall order of reaction? [12 marks]

END OF QUESTION PAPER