NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED CHEMISTRY

GENERAL CHEMISTRY FOR SBB AND ESH

SCH 1217

Supplementary Examination Paper

July 2016

This examination paper consists of 5 pages

Time Allowed: **3 hours**

Total Marks: **100**

Examiner's Name: Dr. S. Majoni and 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) Classify each of the following as a mixture or a pure substance:

(i) Pea soup.
(ii) The content of propane tank.
(iii)Lead.
(iv)Urine.
(v) A multivitamin tablet. [5 marks]

b) Hydrogen peroxide, often used in solutions to cleanse cuts and scrapes, breaks down to yield water and oxygen: $Hydrogen\ peroxide \rightarrow oxygen + water$

(i) Identify the reactants and products. [2 marks]

(ii) Which of the substances are chemical compounds, and which are elements? [3 marks]

2) a) Calculate the density of mercury if 1.00×10^2 occupies a volume of 7.36 cm^3. [3 marks]

b) Calculate the volume of 65.0 g of liquid methanol (wood alcohol) if its density is 0.791 g/mL. [3 marks]

c) What is the mass in grams of a cube of gold (density = 19.32 g/cm^3) if the length of the cube is 2.00 cm. [4 marks]

3) Calculate ΔG° at 1273K for the following reaction $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ and hence determine if the reaction is spontaneous at 1 bar pressure. ΔH_f° values are; -1206.9 -635.1, and $-393.5kJ$ for $CaCO_3$ (s), CaO(s), and CO_2 (g) respectively. The S^o values are 92.9, 38.2, 213.7 J/K for $CaCO_3$ (s), CaO(s), and CO_2 (g) respectively [10 marks]

4) a) The initial temperature of a 350 g sample of iron is 293.2 K. If the sample absorbs 2.5 kJ of energy as heat, what is its final temperature? The specific heat capacity of iron is $0.45 Jg^{-1}K^{-1}$ [4 marks]

b) Using the following rate equation; rate = $k[A][B]^2$, what is the order of reaction with respect to A and B, what is the overall order of reaction? [3 marks]

c) Using the rate expression in question "4 b" above, by what factor does the rate change if the concentration of B is halved and that of A is unchanged? [3 marks]

SECTION B

3) a) Write the electron configuration for the following ions.

(i) Rb^{+}

(ii) Br^{-}

(iii) S^{2-}

(iv) Ba^{2+}

(v) Al^{3+} [10 marks]

b) Give the number of protons, neutrons, and electrons in each of the following species:

(i) $Carbon - 13$ [2 marks]

(ii) ${}^{18}_{9}F$ [2 marks]

(iii) ${}^{195}_{79}Au$ [3 marks]

(iv) ${}^{197}_{79}Au$ [3 marks]

4) a) Sulphur (S) is a non-metallic element that is present in coal. When coal is burned, sulphur is converted to sulphur dioxide and eventually to sulfuric acid, which gives rise to the acid rain phenomenon. How many atoms are in 25.1 g of S? [5 marks]

b) Methane (CH_4) is the principal component of natural gas. How many moles of CH_4 are present in 4.83 g of CH_4? [5 marks]

c) Phosphoric acid (H_3PO_4) is a colourless, syrupy liquid used in detergents, fertilizers, toothpastes, and in carbonated beverages for a "tangy" flavour. Calculate the percent composition by mass of H, P, and O in this compound. [10 marks]

5) a) A reaction occurs via second order kinetics, write the rate law for the reaction and what would be the units of the rate constant for such a reaction. [2 marks]

b) Copy and complete the table below for data that was obtained for a reaction in aqueous solution at different temperatures. [8 marks]

Temperature/ K	Rate Constant (k) s^{-1}	1/T	ln k
288	2.51×10^{-4}		
293	4.57×10^{-4}		
303	1.445×10^{-3}		
313	4.113×10^{-3}		

c) Plot a graph of $\ln k$ *vs* $1/T$ and hence determine the activation energy of the reaction [10 marks]

6) a) A mixture at equilibrium contains SO_2, O_2, and SO_3, at concentrations of 3.2×10^{-3} M, 4.5×10^{-3} M, and 2.9×10^{-2} M respectively. Calculate the equilibrium constant (K_c) for the following reaction at the particular temperature of interest.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$ [4 marks]

b) Calculate the p-function of concentration of the various ions in a 1.0 L solution that is 2.5×10^{-2} M in acetic acid and 4.75×10^{-3} M NaOH. K_a value for acetic acid is 1.76×10^{-5} [12 marks]

c) The radioactive isotope of Br $\left({}^{82}_{35}Br\right)$ decays by emission of a beta particle.

(i) What is a beta particle? [1 mark]
(ii) Write the balanced equation for the decay of Br-82 [3 marks]

Periodic Table of the Elements

1A												3A	4A	5A	6A	7A	8A
1 **H** 1.00794 Hydrogen	2A																2 **He** 4.002602 Helium
3 **Li** 6.941 Lithium	4 **Be** 9.012182 Beryllium											5 **B** 10.811 Boron	6 **C** 12.0107 Carbon	7 **N** 14.0067 Nitrogen	8 **O** 15.9994 Oxygen	9 **F** 18.9984032 Fluorine	10 **Ne** 20.1797 Neon
11 **Na** 22.989769 Sodium	12 **Mg** 24.3050 Magnesium	3B	4B	5B	6B	7B	8B			1B	2B	13 **Al** 26.9815386 Aluminum	14 **Si** 28.0855 Silicon	15 **P** 30.973762 Phosphorus	16 **S** 32.065 Sulfur	17 **Cl** 35.453 Chlorine	18 **Ar** 39.948 Argon
19 **K** 39.0983 Potassium	20 **Ca** 40.078 Calcium	21 **Sc** 44.955912 Scandium	22 **Ti** 47.867 Titanium	23 **V** 50.9415 Vanadium	24 **Cr** 51.9961 Chromium	25 **Mn** 54.938045 Manganese	26 **Fe** 55.845 Iron	27 **Co** 58.933195 Cobalt	28 **Ni** 58.6934 Nickel	29 **Cu** 63.546 Copper	30 **Zn** 65.38 Zinc	31 **Ga** 69.723 Gallium	32 **Ge** 72.64 Germanium	33 **As** 74.92160 Arsenic	34 **Se** 78.96 Selenium	35 **Br** 79.904 Bromine	36 **Kr** 83.798 Krypton
37 **Rb** 85.4678 Rubidium	38 **Sr** 87.62 Strontium	39 **Y** 88.90585 Yttrium	40 **Zr** 91.224 Zirconium	41 **Nb** 92.90638 Niobium	42 **Mo** 95.96 Molybdenum	43 **Tc** [98] Technetium	44 **Ru** 101.07 Ruthenium	45 **Rh** 102.90550 Rhodium	46 **Pd** 106.42 Palladium	47 **Ag** 107.8682 Silver	48 **Cd** 112.411 Cadmium	49 **In** 114.818 Indium	50 **Sn** 118.710 Tin	51 **Sb** 121.760 Antimony	52 **Te** 127.60 Tellurium	53 **I** 126.90447 Iodine	54 **Xe** 131.293 Xenon
55 **Cs** 132.9054519 Cesium	56 **Ba** 137.327 Barium	57-71 Lanthanides	72 **Hf** 178.49 Hafnium	73 **Ta** 180.94788 Tantalum	74 **W** 183.84 Tungsten	75 **Re** 186.207 Rhenium	76 **Os** 190.23 Osmium	77 **Ir** 192.217 Iridium	78 **Pt** 195.084 Platinum	79 **Au** 196.966569 Gold	80 **Hg** 200.59 Mercury	81 **Tl** 204.3833 Thallium	82 **Pb** 207.2 Lead	83 **Bi** 208.98040 Bismuth	84 **Po** [209] Polonium	85 **At** [210] Astatine	86 **Rn** [222] Radon
87 **Fr** [223] Francium	88 **Ra** [226] Radium	89-103 Actinides	104 **Rf** [267] Rutherfordium	105 **Db** [268] Dubnium	106 **Sg** [271] Seaborgium	107 **Bh** [272] Bohrium	108 **Hs** [270] Hassium	109 **Mt** [276] Meitnerium	110 **Ds** [281] Darmstadtium	111 **Rg** [280] Roentgenium	112 **Cn** [285] Copernicium	113 **Uut** [284] Ununtrium	114 **Fl** [289] Flerovium	115 **Uup** [288] Ununpentium	116 **Lv** [293] Livermorium	117 **Uus** [294] Ununseptium	118 **Uuo** [294] Ununoctium

Lanthanides	57 **La** 138.90547 Lanthanum	58 **Ce** 140.116 Cerium	59 **Pr** 140.90765 Praseodymium	60 **Nd** 144.242 Neodymium	61 **Pm** [145] Promethium	62 **Sm** 150.36 Samarium	63 **Eu** 151.964 Europium	64 **Gd** 157.25 Gadolinium	65 **Tb** 158.92535 Terbium	66 **Dy** 162.500 Dysprosium	67 **Ho** 164.93032 Holmium	68 **Er** 167.259 Erbium	69 **Tm** 168.93421 Thulium	70 **Yb** 173.054 Ytterbium	71 **Lu** 174.9668 Lutetium
Actinides	89 **Ac** [227] Actinium	90 **Th** 232.03806 Thorium	91 **Pa** 231.03588 Protactinium	92 **U** 238.02891 Uranium	93 **Np** [237] Neptunium	94 **Pu** [244] Plutonium	95 **Am** [243] Americium	96 **Cm** [247] Curium	97 **Bk** [247] Berkelium	98 **Cf** [251] Californium	99 **Es** [252] Einsteinium	100 **Fm** [257] Fermium	101 **Md** [258] Mendelevium	102 **No** [259] Nobelium	103 **Lr** [262] Lawrencium