NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED CHEMISTRY

GENERAL CHEMISTRY FOR SBB AND ESH

SCH1217

Supplementary Examination Paper

August 2015

This examination paper consists of 5pages

Time Allowed: **3 hours**

Total Marks: **100**

Examiner's Name: Dr. Stephen Majoni and Mr. D. Dube

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) Draw box electron configurations of these elements:

   Se; Nd; Co; Fr; Rn [5 marks]

   (b) Using NaCl as an example, explain the difference between physical change and chemical change. [3 marks]

   (c) How many moles are in 10g of Potassium permanganate ($KMnO_4$)? [2 marks]

2. (a) Give examples of 3 molecules that are not compounds. [3 marks]

   (b) Which quantum numbers are used to describe an orbital and how are they related? [4 marks]

   (c) Write a balanced chemical equation of hydration of maltose ($C_{12}H_{22}O_{11}$) to glucose. (3 marks)

3. (a) The concentration of hydroxyl ions in a solution of household bleach is 3.6×10^{-2} M, calculate the pH of the bleach. [3 marks]

   (b) What is a buffer solution, give an example? [3 marks]

   (c) With the aid of examples distinguish between strong and weak acids. [4 marks]

4. (a) State the four laws of thermodynamics. [4 marks]

   (b) Aspirin, acetylsalicylic acid ($HC_9H_7O_4$), has a K_a value of 3.0×10^{-4}. Calculate the pH of a solution made by dissolving 0.65 g of acetylsalicylic acid in 50 mL of water. [6 marks]

SECTION B

5. (a) Predict the bond angles for the following:

ClO_2; ClO_4^-; MnO_4^{2-}; O_3; NO_2^- [15 marks]

(b) Given the following equation: $LiOH + KCl \rightarrow LiCl + KOH$

(i) Calculate the theoretical yield from 20 grams of lithium hydroxide. [3 marks]

(ii) If 6 grams of lithium chloride are actually produced. What is the actual yield? [2 marks]

6. (a) If it takes 3.36×10^{-19} J of energy to eject an electron from the surface of a certain metal, calculate the longest possible wavelength, in nanometers, of light that can ionize the metal.

Given:

$h = 6.626 \times 10^{-34}$ J s and $c = 3.00 \times 10^8$ m/s [5 marks]

(b) 2.50 dm^3 of an unknown gas had a mass of 4.17 g at 18°C and a pressure of 101 kPa. Calculate the relative molecular mass of the gas.

Given:

$R = 8.31441$ J K^{-1} mol^{-1} [5 marks]

(c) If 3,17g of Chlorine (Cl_2) gas occupy one litre (at standard conditions), calculate the molecular mass of the Chlorine (show your working). [3 marks]

(d) Explain the difference between the ionization energies of Ca (6.113 eV) and Zn (9.394 eV). [4 marks]

(e) Explain the term Bohr radius and why an electron does not spiral into the nucleus. [3 marks]

7. (a) 2 moles of O_2 and 2 moles of SO_2 are placed in a $1dm^3$ container and allowed to come to equilibrium in the following reaction; $2SO_2(g) + O_2(g) \rightleftharpoons SO_3(g)$. The total pressure at equilibrium is 10 bar and the number of moles of O_2 at equilibrium is 1.5 moles, write the expression for *Kp* and calculate its value at the same temperature. [8 marks]

(b) Calculate Δ_rH^o, Δ_rS^o and Δ_rG^o at 298K for the oxidation of SO_2(g) in air represented by the equation $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$, and estimate the value of the equilibrium constant at 298 K.

$\Delta_fH^o(SO_2)$ = - 296.9 kJ; $\Delta S^o(SO_2)$ = +248.5 J/K

$\Delta_fH^o(SO_3)$ = - 395.2 kJ; $\Delta S^o(SO_3)$ = + 256.2 J/K

$\Delta_fH^o(O_2)$ = 0.00; $\Delta S^o(O_2)$ = + 205 J/K [12 marks]

8. (a) At 170K, the molar enthalpy of fusion of solid ammonia is 5.65 kJ mol^{-1}, and the molar entropy of fusion is 28.9 J K^{-1} mol^{-1}. Is the transition shown in the equation below at equilibrium or not, if not in which direction is the reaction proceeding in and at what temperature is the reaction going to be at equilibrium?

$$NH_3(s) \rightleftharpoons NH_3(l)$$ [10 marks]

(b) A nuclear power plant emits into the atmosphere a very small amount of krypton-85, a radioactive isotope with a half-life of 10.76 years.

(i) Show that a first order reaction is an exponential decay reaction. [4 marks]

(ii) What fraction of krypton remains after 25 years. [6 marks]

Alkali Metals
Alkaline Earth Metals
Transition Metals
Other Metals
Nonmetals
Noble Gases
Lanthanoids
Actinoids

C	Br	He	Tc
solid	liquid	gas	synthetic

key: element name / atomic number / **symbol** / atomic weight

hydrogen 1 **H** 1.00794																	helium 2 **He** 4.002602
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.012182											boron 5 **B** 10.811	carbon 6 **C** 12.0107	nitrogen 7 **N** 14.00674	oxygen 8 **O** 15.9994	fluorine 9 **F** 18.9984	neon 10 **Ne** 20.1797
sodium 11 **Na** 22.98977	magnesium 12 **Mg** 24.3050											aluminium 13 **Al** 26.981538	silicon 14 **Si** 28.0855	phosphorus 15 **P** 30.97376	sulphur 16 **S** 32.065	chlorine 17 **Cl** 35.453	argon 18 **Ar** 39.984
potassium 19 **K** 39.0983	calcium 20 **Ca** 40.078	scandium 21 **Sc** 44.95591	titanium 22 **Ti** 47.867	vanadium 23 **V** 50.9415	chromium 24 **Cr** 51.9961	manganese 25 **Mn** 54.93805	iron 26 **Fe** 55.845	cobalt 27 **Co** 58.9332	nickel 28 **Ni** 58.6934	copper 29 **Cu** 63.546	zinc 30 **Zn** 65.409	gallium 31 **Ga** 69.723	germanium 32 **Ge** 72.64	arsenic 33 **As** 74.9216	selenium 34 **Se** 78.96	bromine 35 **Br** 79.904	krypton 36 **Kr** 83.798
rubidium 37 **Rb** 85.4678	strontium 38 **Sr** 87.62	yttrium 39 **Y** 88.90585	zirconium 40 **Zr** 91.225	niobium 41 **Nb** 92.90638	molybdenum 42 **Mo** 95.94	technetium 43 **Tc** [98]	ruthenium 44 **Ru** 101.07	rhodium 45 **Rh** 102.9055	palladium 46 **Pd** 106.42	silver 47 **Ag** 107.8682	cadmium 48 **Cd** 112.411	indium 49 **In** 114.818	tin 50 **Sn** 118.710	antimony 51 **Sb** 121.760	tellurium 52 **Te** 127.60	iodine 53 **I** 126.9045	xenon 54 **Xe** 131.293
caesium 55 **Cs** 132.90545	barium 56 **Ba** 137.327	lutetium 71 **Lu** 174.967	hafnium 72 **Hf** 178.49	tantalum 73 **Ta** 180.9479	tungsten 74 **W** 183.84	rhenium 75 **Re** 186.207	osmium 76 **Os** 190.23	iridium 77 **Ir** 192.217	platinum 78 **Pt** 195.078	gold 79 **Au** 196.96655	mercury 80 **Hg** 200.59	thallium 81 **Tl** 204.3833	lead 82 **Pb** 207.2	bismuth 83 **Bi** 208.980	polonium 84 **Po** [209]	astatine 85 **At** [210]	radon 86 **Rn** [222]
francium 87 **Fr** [223]	radium 88 **Ra** [226]	lawrencium 103 **Lr** [262]	rutherfordium 104 **Rf** [261]	dubnium 105 **Db** [262]	seaborgium 106 **Sg** [266]	bohrium 107 **Bh** [264]	hassium 108 **Hs** [269]	meitnerium 109 **Mt** [268]	darmstadtium 110 **Ds** [271]	roentgenium 111 **Rg** [272]	ununbium 112 **Uub** [285]		ununquadium 114 **Uuq** [289]				

lanthanum 57 **La** 138.9055	cerium 58 **Ce** 140.116	praseodymium 59 **Pr** 140.90765	neodymium 60 **Nd** 144.24	promethium 61 **Pm** [145]	samarium 62 **Sm** 150.36	europium 63 **Eu** 151.964	gadolinium 64 **Gd** 157.25	terbium 65 **Tb** 158.9253	dysprosium 66 **Dy** 162.50	holmium 67 **Ho** 164.930	erbium 68 **Er** 167.259	thulium 69 **Tm** 168.934	ytterbium 70 **Yb** 173.04
actinium 89 **Ac** [227]	thorium 90 **Th** 232.038	protactinium 91 **Pa** 231.0359	uranium 92 **U** 238.0289	neptunium 93 **Np** [237]	plutonium 94 **Pu** [244]	americium 95 **Am** [243]	curium 96 **Cm** [247]	berkelium 97 **Bk** [247]	californium 98 **Cf** [251]	einsteinium 99 **Es** [252]	fermium 100 **Fm** [257]	mendelevium 101 **Md** [258]	nobelium 102 **No** [259]