UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2013/2014

COURSE NAME	:	CHEMISTRY
COURSE CODE	:	DAS 12102
PROGRAMME	:	3 DAE
EXAMINATION DATE	:	DECEMBER 2013/JANUARY 2014
DURATION	:	2 1/2 HOURS
INSTRUCTION	:	A) ANSWER **ALL** QUESTIONS FROM SECTION A
		B) ANSWER **TWO (2)** QUESTIONS ONLY FROM SECTION B

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

SECTION A

Q1 (a) The equilibrium constant K_c for the reaction

$$2\ SO_3(g) \rightleftharpoons 2\ SO_2(g)\ +\ O_2(g)$$

is 3.57×10^{-7} at 350 °C. Find K_p for this reaction.
$(R = 0.0821$ L.atm/mol.K)

(5 marks)

(b) The Haber process for the production of ammonia, NH_3 has a K_c value of 75 at 50 °C.

$$3\ H_2(g)\ +\ N_2(g) \rightleftharpoons 2\ NH_3(g)$$

(i) Determine K_c for the reverse reaction.

(2 marks)

(ii) Find $[NH_3]$, given that at equilibrium $[H_2] = 0.078$ M and $[N_2] = 0.023$ M.

(6 marks)

(iii) Calculate K_p at this temperature.
$(R = 0.0821$ L.atm/mol.K)

(5 marks)

(c) Given the following heterogeneous reaction :

$$C_6H_{12}O_6(s)\ +\ 6\ O_2(g) \rightleftharpoons 6\ CO_2(g)\ +\ 6\ H_2O(\ell)\ ,\ \Delta H = -2801.7\ \text{kJ/mol}$$
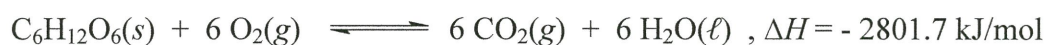
(i) Write the equilibrium expression K_c and K_p.

(4 marks)

(ii) Predict the shift in equilibrium when the temperature of the system is increased and give suitable reasons.

(3 marks)

Q2 (a) Identify the Brønsted-Lowry acid and base and their conjugate acid-base pairs for the reaction :

$$S^{2-}(aq)\ +\ NH_4^+(aq) \rightleftharpoons NH_3(g)\ +\ HS^-(aq)$$

(4 marks)

(b) The pH of a soft drink sample is 3.30.

    (i) Find pOH, $[H^+]$, $[OH^-]$.

          (6 marks)

    (ii) Classify the sample as acidic or basic.
       ($K_w = 1.0 \times 10^{-14}$)

          (1 marks)

(c) For a voltaic cell based on the reaction :

$$Pb^{2+}(aq) + Sn(s) \rightarrow Sn^{2+}(aq) + Pb(s)$$

    (i) Identify the anode and cathode and write the half-cell reaction at the anode and cathode.

          (4 marks)

    (ii) Write the cell diagram for the voltaic cell.

          (2 marks)

    (iii) Calculate E°_{cell} and E_{cell} given $[Pb^{2+}] = 1.0$ M and $[Sn^{2+}] = 0.068$ M.
       ($E^{\circ}_{Pb^{2+}/Pb} = -0.126$ V, $E^{\circ}_{Sn^{2+}/Sn} = -0.140$ V)

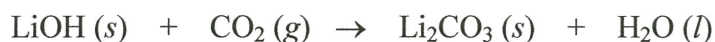   (8 marks)

SECTION B

Q3 (a) Urea $(NH_2)_2CO$, which is used as a fertilizer, in animal feed and in manufacture of polymer.

    (i) Calculate the molar mass of urea.

          (2 marks)

    (ii) Find out the number of moles of H atom present in 25.6 g of urea.

          (7 marks)

    (iii) How many of hydrogen atoms are present in 25.6 g of urea.
      (Relative Atomic Mass: N = 14, H = 1, C =12, O =16, $N_A = 6.022 \times 10^{23}$)

          (3 marks)

(b) A white powder is analyzed and found to have an empirical formula of P_2O_5. The compound has a molar mass of 283.88 g. What is the compound's molecular formula? (Relative Atomic Mass: P = 31, O = 16)

(3 marks)

(c) Lithium hydroxide is used in space vehicles to remove exhaled carbon dioxide from the living environment by forming lithium carbonate and liquid water.

$$\text{LiOH } (s) \quad + \quad CO_2 \ (g) \quad \rightarrow \quad Li_2CO_3 \ (s) \quad + \quad H_2O \ (l)$$

(i) Balance the equation given.

(1 marks)

(ii) Calculate the mass of gaseous carbon dioxide can be absorbed by 1.00 kg of lithium hydroxide. (Relative atomic mass: Li = 6.94, O = 16.00, H = 1.01)

(9 marks)

Q4 (a) Given the elements Na, F, N and P

(i) Determine the group and period of each element.

(6 marks)

(ii) Which element has the largest atomic radius? Give suitable reasons to support your answer.

(3 marks)

(iii) Which element has the lowest ionization energy? Give suitable reasons.

(3 marks)

(iv) Which element forms a basic oxide? Write the formula of the oxide and the balanced equation for the reaction of the oxide with water.
(Atomic number, Z : Na = 11, F = 9, N = 7, P = 15)

(3 marks)

(b) State the equations to represent the reaction for the formation of ionic bond of calcium fluoride by using the Lewis dot symbol.
(Atomic number, Z : Ca = 20, F = 9)

(4 marks)

(c) Given a hydronium ion, H_3O^+. Draw the Lewis structure and determine the formal charge for each atom, oxygen and hydrogen.
(Atomic number, Z : H = 1, O = 8)

(6 marks)

Q5 (a) (i) A SCUBA tank is filled with air at 16.7 atm and 24 °C. Find the tank pressure when the tank is left out in the sun and the temperature is increased to 65 °C.

(5 marks)

(ii) Hydrogen, H_2 reacts with nitrogen, N_2 to produce ammonia according to the equation :
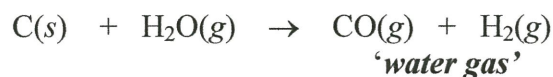
$$3\,H_2(g) \;+\; N_2(g) \;\rightarrow\; 2\,NH_3(g)$$
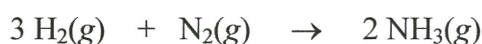
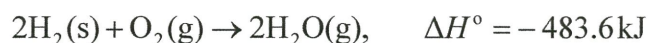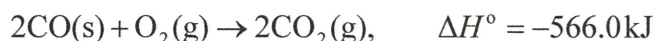Calculate the volume of NH_3 produced at standard temperature and pressure (STP) when 10.0 g of H_2 reacts with N_2.
(Relative atomic mass : H = 1, N = 14, R = 0.0821 L.atm/mol.K)

(10 marks)

(b) **Water gas** is the name for the industrially important mixture of CO and H_2 prepared by passing steam over hot charcoal at 1000 °C:
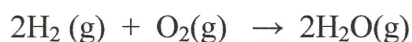
$$C(s) \;+\; H_2O(g) \;\rightarrow\; CO(g) \;+\; H_2(g)$$
$$\textit{'water gas'}$$

Use the following information to calculate ΔH°_{rxn} for the above reaction.

$$C(s) + O_2(g) \rightarrow CO_2(g), \qquad \Delta H^\circ = -393.5\,kJ$$
$$2CO(s) + O_2(g) \rightarrow 2CO_2(g), \qquad \Delta H^\circ = -566.0\,kJ$$
$$2H_2(s) + O_2(g) \rightarrow 2H_2O(g), \qquad \Delta H^\circ = -483.6\,kJ$$

(10 marks)

Q6 (a) Given a reaction between hydrogen and oxygen gas to produce water molecule.

$$2H_2(g) \;+\; O_2(g) \;\rightarrow\; 2H_2O(g)$$

(i) Write the rate expression for the above reaction.

(3 marks)

(ii) If the concentration of H_2 is decreasing at a rate of 0.30 Ms^{-1}, determine the rate at which the concentration of oxygen is decreasing.

(3 marks)

(iii)   Calculate the rate of increase in concentration of H_2O.

(1 marks)

(b)   The following data were collected for the reaction $A + B \rightarrow C + D$

Experiment	Initial concentration of A (M)	Initial concentration of B (M)	Initial rate (Ms^{-1})
1	1.50	1.50	3.20×10^{-1}
2	1.50	2.50	3.20×10^{-1}
3	3.00	1.50	6.40×10^{-1}

(i)   Determine the order for the reactants A, B and the overall order.

(12 marks)

(ii)   Calculate the rate constant, k.

(3marks)

(iii)   Calculate the rate when [A] = 2.50 M and [B] = 5.00 M.

(3 marks)

-    **END OF QUESTIONS -**