UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2012/2013

COURSE NAME	:	CHEMISTRY
COURSE CODE	:	DAS 12102 / DSK 1912
PROGRAMME	:	1 DAE 2 DAE 3 DAE / DET / DEE / DAL
EXAMINATION DATE	:	OCTOBER 2012
DURATION	:	2½ HOURS
INSTRUCTIONS	:	ANSWER **ALL** QUESTIONS IN **PART A** AND **TWO (2)** QUESTIONS IN **PART B**

THIS QUESTION PAPER CONSISTS OF FIVE (5) PAGES

PART A

Q1 a) Based on the following half-reactions and E°_{red} values;

$VO_2^+(aq) + 2H^+(aq) + e \rightarrow VO^{2+}(aq) + H_2O(l)$ $\quad E^{\circ}_{red} = 1.00$ V

$Zn^{2+}(aq) + 2e \rightarrow Zn(s)$ $\quad E^{\circ}_{red} = -0.76$ V

i) Write the balanced redox equation representing the reaction occurs between VO_2^+ and Zn^{2+}.

ii) Determine the anode and cathode of the system constructed in (i).

iii) Calculate E°_{cell}.

(11 marks)

b) A zinc-copper battery is prepared as follows:

$Zn(s) \mid Zn^{2+}(0.10\ M) \parallel Cu^{2+}(2.50\ M) \mid Cu(s)$

i) Determine the cell potential, E°_{cell} when Zn/Zn^{2+} and Cu/Cu^{2+} react in standard condition.

ii) Calculate the cell potential E_{cell} of the zinc-copper battery at $[Zn^{2+}] = 0.10$ M and $[Cu^{2+}] = 2.50$ M.

iii) Evaluate the mass reduced from copper (Cu) electrode after 10.0 A of current flows within 10.0 hours.

($E^{\circ}_{Zn^{2+}/Zn} = -0.76$ V, $E^{\circ}_{Cu^{2+}/Cu} = +0.34$ V, 1F = 96500 C,
Relative Atomic Mass, Cu = 63.5)

(14 marks)

Q2 a) i) Write an expression for the dissociation constant K_a for the weak acid HX.

ii) For HX, $K_a = 4.25 \times 10^{-5}$ M. Calculate the pH of 0.45 M solution of this acid.

(10 marks)

b) The pH of 0.15 M solution of a weak acid, HA, is 2.82 at 300 K.

i) Write an expression for the acid dissociation constant, K_a, of HA.
ii) Determine the value of K_a for HA at 300 K and state its units.
iii) The dissociation of HA into its ions in aqueous solution is an endothermic process. How would its pH change if the temperature is increased? Explain your answer.

(15 marks)

PART B

Q3 a) Determine how many grams of sulfuric acid (H_2SO_4) solutes would be needed to make 250 mL of a 0.100 M solution.

(Relative Atomic Mass, H = 1, S = 32, O =16)

(6 marks)

b) Industrially, vanadium metal, V which is used in steel alloys, can be obtained by reacting vanadium (V) oxide, V_2O_5 with calcium (Ca) at high temperature. In this reaction, calcium oxide (CaO) will also be produced.

$$V_2O_5\,(s) + Ca\,(s) \rightarrow V\,(s) + CaO\,(s)$$

i) Balance the above equation.
ii) What mass of V_2O_5 is needed to produce 2.5 Kg of vanadium?

(Relative Atomic Mass, V = 50.9, Ca = 40, O =16)

(9 marks)

c) The balanced equation shows a complete decomposition reaction of 10.5 g of potassium chlorate.

$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

i) Calculate the number of moles of $KClO_3$ used in the reaction.
ii) Calculate the number of moles of oxygen gas produced.
iii) Compute the volume of oxygen gas produced at 1.00 atm and 25 °C.

(Relative Atomic Mass, K = 39.1, Cl = 35.5, O = 16,
R = 0.0821 L.atm $mol^{-1}.K^{-1}$)

(10 marks)

Q4 a) The electronic configurations of some elements K, L, M and N are given below.

(K) [Ne] $3s^2\ 3p^3$
(L) [Ne] $3s^2\ 3p^4$
(M) [Ne] $3s^2\ 3p^5$
(N) [Ar] $4s^1\ 3d^5$

i) Which element will be the most metallic? Explain your answer
ii) Draw orbital diagram for valence electron of K element.

(10 marks)

b) The values of ionization energy for elements of Na, Mg and Al are shown in Table Q4(b) below. Compare the values of ionization energies and explain.

Table Q4(b) : Ionization Energies of Na, Mg and Al

Element	Ionization energy ($kJ.mol^{-1}$)		
	E_1	E_2	E_3
Na	496	4,560	-
Mg	738	1,450	7,730
Al	57	1,816	2,744

(8 marks)

c) Define electronegativity. How does it vary across a period and down a group.

(7 marks)

Q5 a) i) Write the Lewis dot structure and show the formal charges for PO_3^{3-}
ii) Draw the resonance structure of NO_3^-

(Atomic number, *Z*: N = 7, P = 15, O = 8)

(10 marks)

b) Calculate the standard enthalpy change, ΔH^o, for the formation of 1 mol of strontium carbonate (the material that gives the red color in fireworks) from its elements.

$$Sr(s) + C(graphite) + \tfrac{3}{2}O_2(g) \rightarrow SrCO_3(s)$$

The information available is

$SrO(s) \rightarrow Sr(s) + \frac{1}{2}O_2(g)$ $\quad \Delta H° = +592\ kJ$

$SrO(s) + CO_2(g) \rightarrow SrCO_3(s)$ $\quad \Delta H° = -234\ kJ$

$CO_2(g) \rightarrow C(graphite) + O_2(g)$ $\quad \Delta H° = +394\ kJ$

(15 marks)

Q6 a) Urea (NH_2CONH_2) is the end product in animal's protein metabolism. The decomposition of urea in 0.1 M HCl occurs according to the equation:

$$NH_2CONH_2(aq) + H^+(aq) + 2H_2O(l) \rightarrow 2NH_4^+(aq) + HCO_3^-(aq)$$

The reaction is first order in urea and first order overall.
When $[NH_2CONH_2] = 0.200$ M, the rate at 60.5 °C is 8.56×10^{-5} M/s

i) What is the rate constant, *k*?
ii) What is the concentration of urea in this solution after 4.00×10^3 s if the starting concentration is 0.500 M?
iii) What is the half-life for this reaction at 60.5 °C?
iv) How long will it take for the initial concentration to become one-third?

(15 marks)

b) Calculate K_c at 500 °C, given the equilibrium concentrations, 0.5 M hydrogen gas, 0.5 M chlorine gas and 1.5 M hydrogen chloride gas.

(Hint : write the balanced equation)

(10 marks)