Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	CHEMISTRY
COURSE CODE	:	DAS 12203
PROGRAMME	:	1 DAM / 2 DAM / 3 DAM
EXAMINATION DATE	:	DECEMBER 2014/JANUARY 2015
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	A) ANSWER **ALL** QUESTIONS
		B) ANSWER **TWO (2)** QUESTIONS ONLY

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

SECTION A

Q1 (a) Write the equilibrium expression K_c for the following reactions :

(i) $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$

(1 mark)

(ii) $Sb^{3+}(aq) + Cl^-(aq) + H_2O(\ell) \rightleftharpoons SbOCl(s) + 2H^+(aq)$

(1 mark)

(iii) $2H_2(g) + O_2(g) \rightleftharpoons 2H_2O(\ell)$

(1 mark)

(b) Consider the following equilibrium:

$$2NO_2(g) \rightleftharpoons N_2O_4(g),\ K_c = 1.15$$

Calculate the equilibrium concentration of $N_2O_4(g)$ if the equilibrium concentration of NO_2 is 0.50 M.

(3 marks)

(c) Consider the following heterogeneous equilibrium

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

At 800°C the pressure of CO_2 is 0.236 atm. Calculate K_p and K_c for the reaction. (R = 0.0821 L.atm/mol.K)

(6 marks)

(d) Phosgene, $COCl_2$, forms from CO and Cl_2 according to the equilibrium

$$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$$

At 600°C, this gas mixture has initial partial pressures of 0.60 atm for CO and 1.10 atm for Cl_2. After it has reached equilibrium, the partial pressure of $COCl_2(g)$ at this temperature is measured to be 0.10 atm. Calculate the equilibrium constant , K_p for this reaction.

(8 marks)

(e) Heating solid sodium bicarbonate in a closed vessel establishes the following equilibrium:

$$2NaHCO_3(s) \rightleftharpoons Na_2CO_3(s) + H_2O(g) + CO_2(g)$$

Predict the shift in equilibrium position if

(i) CO_2 is removed from the system,
(ii) Na_2CO_3 is added to the system,
(iii) $NaHCO_3$ is removed from the system,
(iv) $H_2O(g)$ is added to the system.
(v) Pressure is increased.

(5 marks)

Q2 (a) Calculate :

(i) The pH of 0.02 M sulphuric acid, H_2SO_4.

(4 marks)

(ii) The pH of a sample of lemon juice given the concentration of hydroxonium ion (H_3O^+) is 8.1×10^{-3}M.

(2 marks)

(iii) The hydroxonium ion (H_3O^+) concentration of a sample of soap given the pH is 6.8.

(3 marks)

(iv) the hydroxide ion concentration of a blood sample given the hydroxonium ion concentration is 5.5×10^{-8} M. ($K_w = 1.0 \times 10^{-14}$)

(3 marks)

(b) A galvanic cell is set up using copper and silver half-cells.

$Cu\ (s)\ /Cu^{2+}\ (aq)\ //\ Ag^{+}\ (aq)/\ Ag(s)$

(i) Write the overall cell reaction.

(2 marks)

(ii) Calculate the cell potential under standard conditions, E°_{cell}.
($E^{\circ}_{Ag^+/Ag} = 0.8$ V, $E^{\circ}_{Cu^{2+}/Cu} = 0.34$ V)

(3 marks)

(iii) Calculate E_{cell} given $[Cu^{2+}] = 1.1$ M and $[Ag^+] = 0.7$ M.

(5 marks)

(c) State 3 prevention steps that should be taken to avoid corrosion.

(3 marks)

SECTION B

Q3 (a) (i) Define empirical formula.

(2 marks)

(ii) Determine the empirical formula of an organic acid given the following composition by mass

H.	C	O
2.20 %	26.70 %	71.10%.

(Relative atomic mass : H = 1, C = 12 , O =16 ,)

(6 marks)

(iii) The molar mass of acid is 90.0 $gmol^{-1}$, find the molecular formula.

(2 marks)

(b) State Dalton's Law of partial pressure.

(2 marks)

(c) A mixture of gases contains 30% by volume of carbon dioxide (CO_2) , 20 % by volume of oxygen (O_2) and 50 % by volume of carbon monoxide (CO). The total pressure of the gases is 101 kPa.

(i) Calculate the partial pressure of each gas.

(6 marks)

(ii) If carbon dioxide is removed from the mixture determine the partitial pressures of oxygen and carbon monoxide.

(2 marks)

(d) The density of a gas is 2.6 g/L at a temperature of 25°C and pressures of 101 kPa. Calculate the relative molecular mass of the gas.
($R = 8.315 \times 10^3$ L.Pa/mol.K)

(5 marks)

Q4 (a) A neutral atom has two (2) electrons with $n = 1$, eight (8) electrons with $n = 2$, eight (8) electrons with $n = 3$, and two (2) electrons with $n = 4$.

(i) Write the ground state electron configuration of the atom.

(2 marks)

(ii) Identify the group and period of the element.

(2 marks)

(iii) Write the set of quantum numbers (n, ℓ, m_ℓ, m_s) for an electron in the $2s$ and $3p$ subshell

(4 marks)

(b) Arrange the following ions in order of increasing ionic radii. Give your reasons.
Ca^{2+}, Be^{2+}, Ba^{2+}, Mg^{2+}
(Atomic number, Z : Ca = 20, Be = 4, Ba = 56, Mg = 12)

(4 marks)

(c) (i) Describe covalent and ionic bonding using Cl_2 and NaCl as examples.

(4 marks)

(ii) Use Lewis dot symbols to show bonding in both examples.
(Group in Periodic Table: Cl = 17 ; Na = 1)

(3 marks)

(d) Draw the Lewis structure of HOBr and calculate the formal charges.
(Group in Periodic Table: H = I ; Br = 17; O = 16)

(6 marks)

Q5 (a) A 100.0 g copper sample at 100 °C is added to 50.0 g of water at 26.5 °C. Determine the final temperature of the copper-water mixture.
($s_{Cu} = 0.385\ J.g^{-1}.°C^{-1}$, $s_{water} = 4.184\ J.g^{-1}.°C^{-1}$)

(5 marks)

(b) Given the following thermochemical equation:

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g) \quad , \quad \Delta H^\circ_{rxn} = -92.22\ kJ.$$

Write the thermochemical equation for:

(i) the formation of 1 mol of $NH_3(g)$

(2 marks)

(ii) the dissociation of 4 mol of $NH_3(g)$

(3 marks)

(c) Use the following information to find ΔH_f° of acetylene, C_2H_2.

$$2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g) \quad ; \quad \Delta H^\circ_{rxn} = -2511.6\ kJ$$

$$\Delta H_f^\circ \text{ of } CO_2(g) = -393.5\ kJ/mol \ ; \ \Delta H_f^\circ \text{ of } H_2O(g) = -241.8\ kJ/mol$$

(5 marks)

(d) Calculate ΔH for the reaction

$$N_2H_4(\ell) + 2H_2O_2(\ell) \rightarrow N_2(g) + 4H_2O(\ell)$$

Given the following set of reactions:

$N_2H_4(\ell) + O_2(g) \rightarrow N_2(g) + 2H_2O(\ell)$ $\quad \Delta H = -622.2$ kJ
$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(\ell)$ $\quad \Delta H = -285.8$ kJ
$H_2(g) + O_2(g) \rightarrow H_2O_2(\ell)$ $\quad \Delta H = -187.8$ kJ

(10 marks)

Q6 (a) Dinitrogen pentoxide gas decomposes to nitrogen dioxid gas and oxygen gas according to the following balanced equation.

$$2N_2O_5(g) \rightarrow 4\ NO_2\ (g) + O_2(g)$$

(i) Write the differential rate equation for the dissociation of N_2O_5 gas .

(3 Marks)

(ii) If the rate of disappearance of N_2O_5 gas is 1.0×10^2 mol dm^{-3} s^{-1} determine the rate of formation of NO_2 gas under the same conditions of temperature and pressure.

(3 Marks)

(b) The reaction of nitric acid with hydrogen at 1280 °C is as follows :

$$2NO\ (g) + 2H_2(g) \rightarrow N_2\ (g) + 2H_2O$$

Experiment	[NO](M)	$[H_2]$(M)	Initial Rate (M/s)
1	5.00×10^{-3}	2.00×10^{-3}	1.25×10^{-5}
2	10.00×10^{-3}	2.00×10^{-3}	5.00×10^{-5}
3	10.00×10^{-3}	4.00×10^{-3}	10.00×10^{-5}

From the data collected at the specific temperature , determine

(i) The rate law.

(10 Marks)

(ii) The rate constant, *k* (complete with units)

(4 Marks)

(c) Explain briefly 3 reasons that affect the reaction rate based on the following factors :

(i) Concentration
(ii) Particle surface area

(5 marks)

- END OF QUESTION -