



# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION SEMESTER I SESSION 2010/2011

COURSE NAME	:	CHEMISTRY
COURSE CODE	:	DAS 12203/DSK 1913
PROGRAMME	:	1 DAA/DAC/DAI/DAM 2 DAA/DAC/DAI/DAM
EXAMINATION DATE	:	NOVEMBER/DECEMBER 2010
DURATION	:	2½ HOURS
INSTRUCTION	:	ANSWER ALL QUESTIONS IN <b>PART A AND FOUR (4)</b> QUESTIONS IN <b>PART B</b>

THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

**PART A**

**Q1** (a) Given the reaction between oxide ion ( $O^{2-}$ ) and water :



Identify

- (i) the Brønsted-Lowry acid and base  
 (ii) the conjugate acid-base pairs

(2 marks)

(b) The pH of a window-cleaning solution is 8.28. Find the  $[H^+]$  and  $[OH^-]$ .  
 ( $K_w = 1.0 \times 10^{-14}$ )

(4 marks)

(c) What is the pH of a 0.015 M  $Ca(OH)_2$  solution?

(5 marks)

(d) Calculate the  $[H^+]$ ,  $[OH^-]$ ,  $[NH_4^+]$  and pH of a 0.20 M aqueous ammonia,  $NH_3$  solution.  
 ( $K_b = 1.8 \times 10^{-5}$ )

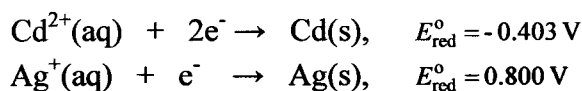
(9 marks)

**Q2** (a) Determine the oxidation number of the underlined element.

- (i) Mn $O_4^-$   
 (ii) Mn $O_2$   
 (iii) C $_2O_4^{2-}$

(3 marks)

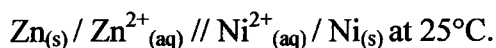
(b) A voltaic cell is set up based on the following standard half-reactions.



- (i) write the half-cell reactions at the anode and cathode as well as the cell diagram/notation  
 (ii) find the standard cell potential,  $E_{cell}^{\circ}$ .

(6 marks)

(c) For the following cell



- (i) Write the overall cell reaction.  
 (ii) Calculate  $E_{cell}^{\circ}$  for the cell ( $E_{Zn^{2+}/Zn}^{\circ} = -0.763 \text{ V}$ ,  $E_{Ni^{2+}/Ni}^{\circ} = -0.280 \text{ V}$ ).  
 (iii) Calculate  $E_{cell}$  given  $[Zn^{2+}] = 0.90 \text{ M}$  and  $[Ni^{2+}] = 0.20 \text{ M}$ .

(7 marks)

- (d) Calculate the mass of magnesium metal produced in 1 hour by the electrolysis of molten  $\text{MgCl}_2$  if the current is 60.0 A.  
(Molar mass of Mg = 24.3, 1 Faraday = 96 500 C)
- (4 marks)

**PART B**

- Q3** (a) According to the equation below :



The oxidation of 25.0 mL of a solution containing  $\text{Fe}^{2+}$  requires 26.0 mL of 0.025M  $\text{K}_2\text{Cr}_2\text{O}_7$  in acidic solution. Calculate the molar concentration of  $\text{Fe}^{2+}$ .

(4 marks)

- (b) Compare quantitatively the rates of diffusion of methane,  $\text{CH}_4$  and ammonia,  $\text{NH}_3$ .  
(Relative atomic mass : C = 12, H = 1, N = 14)
- (3 marks)

- (c) A sample of  $\text{KClO}_3$  is partially decomposed, producing  $\text{O}_2$  gas that is collected over water. The volume of gas collected is 0.550 liter at  $25^\circ\text{C}$  and 657 torr total pressure. (Partial pressure of water,  $\text{H}_2\text{O}$  at  $25^\circ\text{C}$  = 23.76 torr,  $R = 0.0821 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$ )



- (i) How many moles of  $\text{O}_2$  are collected?  
(ii) If the  $\text{O}_2$  were dry, what volume would it occupy at the same temperature and pressure?
- (8 marks)

- Q4** (a) A family of elements is characterized by an  $ns^2np^2$  electron configuration in the outermost shell.

- (i) give the possible values of  $\ell$  and  $m_\ell$  for the  $s$  and  $p$  orbital  
(ii) draw the orbital diagram for all electrons in  $ns^2np^2$   
(iii) is the element diamagnetic or paramagnetic? Why?  
(iv) identify the group of this family in the periodic table and state your reasons.
- (7 marks)

- (b) Arrange the following ions  $\text{K}^+$ ,  $\text{Cl}^-$ ,  $\text{S}^{2-}$  and  $\text{Ca}^{2+}$  in the order of decreasing ionic radii with suitable explanation.  
(Atomic number,  $Z$  : K = 19, Ca = 20, Cl = 17, S = 16)
- (4 marks)

- (c) (i) What is the difference between ionization energy and electron affinity?  
(ii) Write equations to represent each process in (i) using the element sodium, Na as example.
- (4 marks)

- Q5** (a) Use Lewis dot symbols to show the formation of aluminium oxide,  $\text{Al}_2\text{O}_3$ .  
(Atomic number,  $Z$ : Al = 13, O = 8) (5 marks)

- (b) Given 2 skeletal structures of formaldehyde, HCHO



- (i) Complete the Lewis structure.  
(ii) Calculate formal charges for all atoms in both structures.  
(iii) Which structure is more stable? Give suitable reasons.  
(Atomic number,  $Z$ : O = 8, H = 1, C = 4)

(10 marks)

- Q6** (a) 455 grams of water is heated from  $75^\circ\text{C}$  to  $200^\circ\text{C}$ . Calculate the amount of heat that has been absorbed by the water.  
Given the specific heat capacity of water is  $4.18 \text{ J}\cdot\text{g}^{-1}\cdot^\circ\text{C}^{-1}$ .

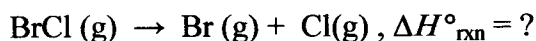
(3 marks)

- (b) Calculate the standard enthalpy of formation,  $\Delta H_f^\circ$ , for methanol,  $\text{CH}_3\text{OH}$ .

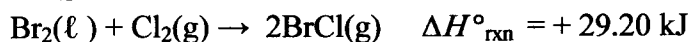


(5 marks)

- (c) Calculate the standard enthalpy change for the reaction

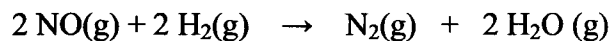


Given the following data :



(7 marks)

- Q7** (a) For the following reaction at 1100 °C :



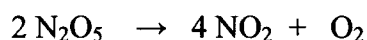
From the data collected, determine:

- (i) Rate law  
 (ii) Rate constant,  $k$ .

Experiment	[NO] M	[H <sub>2</sub> ] M	Reaction rate (M/s)
1	$5.0 \times 10^{-3}$	0.32	0.012
2	$1.0 \times 10^{-2}$	0.32	0.024
3	$1.0 \times 10^{-2}$	0.64	0.096

(10 marks)

- (b) The decomposition of  $\text{N}_2\text{O}_5$  in solution in carbon tetrachloride is a first order reaction.



The rate constant,  $k$  is  $5.25 \times 10^{-4} \text{ s}^{-1}$ . If the initial concentration of  $\text{N}_2\text{O}_5$  is 0.200 M, find the concentration after 10 minutes.

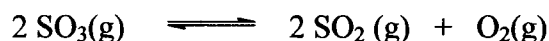
(5 marks)

- Q8** (a) Write the equilibrium expression,  $K_c$  for the following equations:

- (i)  $\text{CO}_2(\text{g}) + \text{H}_2(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + \text{H}_2\text{O}(\text{l})$   
 (ii)  $\text{SnO}_2(\text{s}) + 2 \text{CO}(\text{g}) \rightleftharpoons \text{Sn}(\text{s}) + 2 \text{CO}_2(\text{g})$   
 (iii)  $3 \text{Fe}(\text{s}) + 4 \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{Fe}_3\text{O}_4(\text{s}) + 4 \text{H}_2(\text{g})$

(3 marks)

- (b) Sulfur trioxide decomposes at a high temperature in a sealed container :

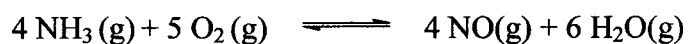


Initially, the vessel is charged at 1000 K with  $\text{SO}_3(\text{g})$  at a partial pressure of 0.500 atm. At equilibrium, the  $\text{SO}_3$  partial pressure is 0.200 atm. Calculate the partial pressures of  $\text{SO}_2$  and  $\text{O}_2$  at equilibrium and the value of  $K_p$ .

(8 marks)

(c) Predict the shift on the equilibrium position for the following reactions :

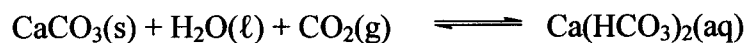
(i) Ammonia (g) is removed from the following reaction



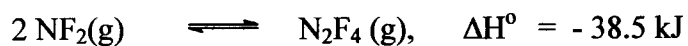
(ii) Catalyst is added to reaction below



(iii)  $\text{CO}_2(\text{g})$  is added



(iv) Heat is added to the system



(4 marks)