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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016**

COURSE NAME : PHYSICAL CHEMISTRY
COURSE CODE : DAS 12303
PROGRAMME : 1 DAU
EXAMINATION DATE : DECEMBER 2015/JANUARY 2016
DURATION : 2 HOURS 30 MINUTES
INSTRUCTION : SECTION A

ANSWER ALL QUESTIONS

SECTION B

**ANSWER TWO (2) QUESTIONS
ONLY**

THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

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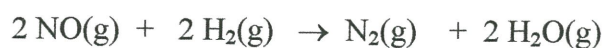
SECTION A

Q1 (a) The decomposition of N_2O_5 is as follows :



- (i) Write the rate expression for the above reaction. (3 marks)
- (ii) If the concentration of N_2O_5 is decreasing at a rate of $4.2 \times 10^{-7} \text{ Ms}^{-1}$, determine the rate at which the concentration of NO_2 and O_2 is increasing. (3 marks)

(b) The following data were collected for the reaction of nitric oxide with hydrogen.



Experiment	Initial concentration of NO (M)	Initial concentration of H_2 (M)	Initial rate (Ms^{-1})
1	0.10	0.10	1.23×10^{-3}
2	0.10	0.20	2.46×10^{-3}
3	0.20	0.10	4.92×10^{-3}

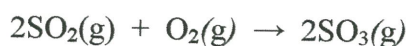
- (i) Determine the order for the reactants NO, H_2 and the overall order. (10 marks)
- (ii) Calculate the rate constant, k . (4 marks)
- (iii) Calculate the rate when $[\text{NO}] = 0.050 \text{ M}$ and $[\text{H}_2] = 0.150 \text{ M}$. (2 marks)
- (c) Find the half-life for a first order reaction given the rate constant, k is $2.2 \times 10^{-5} \text{ s}^{-1}$. (3 marks)

- Q2** (a) Determine the maximum number of electrons that can have the following quantum numbers
- (i) $n = 5$ (1 mark)
 - (ii) $n = 4, \ell = 2$ (1 mark)
 - (iii) $n = 2, \ell = 1$ (1 mark)
 - (iv) $n = 0, \ell = 0, m_\ell = 0$ (1 mark)
 - (v) $n = 1, \ell = 0, m_\ell = 0$ (1 mark)
- (b) (i) Write the electron configuration for the atoms Si and Ca.
(Atomic number, Z : Si = 14, Ca = 20) (3 marks)
- (ii) Select the atom that has diamagnetic properties. (4 marks)
- (c) Using NH_3 and MgO as examples,
- (i) Discuss ionic and covalent bonds. (4 marks)
 - (ii) Use Lewis dot symbols to show the formation of NH_3 and MgO .
(Atomic number, Z : H = 1, N = 7, O = 8, Mg = 12) (4 marks)
- (d) Write the Lewis structure of HOCl and calculate formal charges.
(Atomic number, Z : H = 1, O = 8, Cl = 17) (5 marks)

SECTION B

- Q3** (a) The gas pressure in an aerosol can is 1.5 atm at 25 °C. Find the pressure if the can is heated to 450 °C.
(5 marks)
- (b) An inflated balloon has a volume of 6.0 L at sea level where the temperature is 22 °C and the pressure is 1.0 atm. Calculate the volume of the balloon when the temperature is – 21 °C and the pressure is 0.45 atm.
(5 marks)
- (c) Tennis balls are usually filled with air or N₂ gas to a pressure above atmospheric pressure to increase their "bounce." If a tennis ball has a volume of 144 mL and contains 0.33 g of N₂ gas, calculate the pressure inside the ball at 24 °C.
(Relative atomic mass : N = 14, R = 0.0821 L.atm/mol.K)
(8 marks)
- (d) Calculate the density of carbon tetrachloride vapour, CCl₄ at 714 torr and 125 °C.
(Relative atomic mass : C = 12, Cl = 35.5, R = 0.0821 L.atm/mol.K)
(7 marks)

- Q4** (a) (i) Define entropy, *S*.
(2 marks)
- (ii) Arrange PCl₅(s), PCl₅(g) and PCl₃(g) in order of increasing *S*.
(1 mark)
- (b) Consider the following reaction carried out at 25°C and 1 atm.



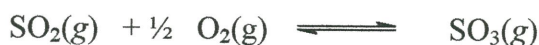
Calculate ΔH° , ΔS° , and ΔG° using the following data:

Substance	ΔH_f° (kJ/mol)	S° (J K ⁻¹ mol ⁻¹)
SO ₂ (g)	- 297	248
O ₂ (g)	0	205
SO ₃ (g)	- 396	257

(8 marks)

- (c) 30.0 g of urea, $(\text{NH}_2)_2\text{CO}$ is dissolved in 200 g of H_2O at 25°C .
- (i) Find the number of moles of $(\text{NH}_2)_2\text{CO}$ and H_2O .
(Relative atomic mass : H = 1, C = 12, N = 14, O = 16) (4 marks)
- (ii) Determine the mole fractions of H_3PO_4 and H_2O . (4 marks)
- (iii) Calculate the vapour pressure of the aqueous solution. The vapour pressure of pure H_2O at 25°C is 23.8 torr. (3 marks)
- (iv) Calculate the molarity of the solution.
(Assume density of solution is 1 g/mL) (3 marks)

Q5 (a) At 1000 K, $K_p = 1.85$ for the reaction



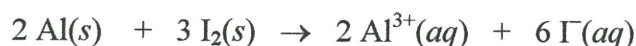
- (i) Find K_p for the reaction : $\text{SO}_3(\text{g}) \rightleftharpoons \text{SO}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g})$ (1 mark)
- (ii) Find K_p for the reaction : $2 \text{SO}_3(\text{g}) \rightleftharpoons 2 \text{SO}_2(\text{g}) + \text{O}_2(\text{g})$ (1 mark)
- (iii) Determine K_c for the reaction in (ii).
($R = 0.0821 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$) (4 marks)
- (b) A mixture of 0.10 mol of NO, 0.050 mol of H_2 , and 0.10 mol of H_2O is placed in a 1.0-L vessel at 300 K. The following equilibrium is established:



At equilibrium $[\text{NO}] = 0.062 \text{ M}$.

- (i) Calculate the equilibrium concentrations of H_2 , N_2 and H_2O . (4 marks)
- (ii) Calculate K_c . (3 marks)

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



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

(2 marks)

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

(2 marks)

(iii) Calculate E_{cell}° and E_{cell} given $[\text{Al}^{3+}] = 1.0 \text{ M}$ and $[\text{I}^{-}] = 0.068 \text{ M}$.

$$(E_{\text{Al}^{3+}/\text{Al}}^{\circ} = -1.66 \text{ V}, E_{\text{I}_2/\text{I}^{-}}^{\circ} = 0.54 \text{ V})$$

(8 marks)

Q6 (a) Identify the Brønsted-Lowry acid and base and their conjugate acid-base pairs for the reaction :



(b) A solution has $[\text{OH}^{-}] = 3.9 \times 10^{-6} \text{ M}$

(i) Calculate $[\text{H}^{+}]$, pH and pOH
($K_{\text{w}} = 1.0 \times 10^{-14}$) (8 marks)

(ii) Classify the solution as acidic, basic or neutral giving suitable reasons. (2 marks)

(c) Calculate the pH of $5.0 \times 10^{-2} \text{ M}$ $\text{Ca}(\text{OH})_2$ solution.
($K_{\text{w}} = 1.0 \times 10^{-14}$) (4 marks)

(d) The pH of a $1.00 \times 10^{-2} \text{ M}$ solution of cyanic acid (HOCN) is 2.77 at 25°C .

(i) Write an equation for the dissociation of cyanic acid. (1 mark)

(ii) Find the concentration of H^{+} ions. (2 marks)

(iii) Calculate K_{a} for HOCN. (4 marks)

- END OF QUESTION -