Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2015/2016

COURSE NAME	:	CHEMISTRY
COURSE CODE	:	DAS 12203
PROGRAMME CODE	:	1 DAA / 3 DAM
EXAMINATION DATE	:	JUNE/JULY 2016
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	SECTION A) ANSWER **ALL** QUESTIONS
		SECTION B) ANSWER **TWO (2)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q2 (a) Given NO_3^-, HSO_4^- and CH_3COOH, select the species that behave as

(i) Brønsted-Lowry acid
(ii) Brønsted-Lowry base
(iii) Both Brønsted-Lowry acid and base.

(3 marks)

(b) (i) Define the term pH.

(1 mark)

(ii) Find the pH at 25 °C of 2.00×10^{-3} M HCl.

(2 marks)

(iii) Calculate the $[OH^-]$, $[H^+]$, pH and pOH of 2.50×10^{-2} M NaOH at 25 °C. ($K_w = 1.0 \times 10^{-14}$)

(8 marks)

(c) A voltaic cell utilizes the following redox reaction:

$$Bi(s) + 3Fe^{3+}(aq) \rightarrow 3Fe^{2+}(aq) + Bi^{3+}(aq)$$

(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 the standard cell potential, $E°_{cell}$, for this electrochemical cell. ($E^\circ_{Bi^{3+}/Bi} = 0.308$ V, $E^\circ_{Fe^{3+}/Fe^{2+}} = 0.771$ V)

(3 marks)

(iv) State whether the reaction is spontaneous or non-spontaneous and give your reasons.

(2 marks)

SECTION B

Q3 (a) Mandelic acid is an organic acid composed of carbon (63.15 %), hydrogen (5.30%) and oxygen (31.55 %). Determine the

(i) empirical formula of mandelic acid

(4 marks)

(ii) molecular formula given its molar mass is 152.0 g/mol.
(Relative atomic mass : H = 1, C = 12, O = 16)

(4 marks)

(b) Find the mass of solute present in 113.0 mL of 1.43 M Na_2CO_3.
(Relative atomic mass : C = 12, O = 16, Na = 23)

(4 marks)

(c) 2.00 L of a gas is collected at 25.0 °C and 745.0 mmHg. Determine the volume at STP.

(5 marks)

(d) 1.40 g of sodium bicarbonate ($NaHCO_3$) was allowed to react with HCl as shown in the equation :

$$NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + H_2O(\ell) + CO_2(g)$$

(i) Find the number of moles of $NaHCO_3$.
(Relative atomic mass : H = 1, C = 12, O = 16, Na = 23, Cl = 35.5)

(3 marks)

(ii) Calculate the volume of CO_2 produced at 0.95 atm and 17 °C.
(R = 0.0821 L.atm/mol.K)

(5 marks)

Q4 (a) Determine the number of orbitals that correspond to the following designations.

(i) $n = 5$
(ii) $2s$
(iii) $3p$
(iv) $5d$
(v) $6f$

(5 marks)

(b) (i) Write the full and abbreviated electron configuration for silicon, Si (Z = 14).

(2 marks)

(ii) Give the set of 4 quantum numbers (n, ℓ, m_ℓ, m_s) for the valence electrons in Si.

(5 marks)

(c) Given the elements Be, N and Na.

(i) Determine their respective group and period.
(Atomic number, Z : Be = 4, N = 7, Na = 11)

(6 marks)

(ii) Arrange the elements in order of increasing radius.

(2 marks)

(iii) Identify the element that has the lowest ionization energy. Explain your answer.

(3 marks)

(iv) State the element that is most electronegative.

(2 marks)

Q5 (a) Define :

(i) An ionic bond

(2 marks)

(ii) A covalent bond

(2 marks)

(b) Using suitable combinations of the elements H, Li and F, use Lewis dot symbols to show the formation of

(i) An ionic bond

(3 marks)

(ii) A covalent bond

(3 marks)

(Atomic number, Z : H = 1, Li = 3, F = 9)

(c) Draw the Lewis structure of $OSCl_2$ (where S is the central atom) and calculate formal charges.
(Atomic number, Z : O = 8, S = 16, Cl = 17)

(5 marks)

(d) (i) The thermochemical equation for the combustion of nitrogen is

$N_2(g) + O_2(g) \rightarrow 2NO(g), \quad \Delta H^\circ_c = 180.5$ kJ

Find the heat absorbed when 5 moles of NO is produced during a lab test.

(2 marks)

(ii) Determine the heat of formation of ethanol, C_2H_5OH from the following information.

$C_2H_5OH(\ell) + 3\ O_2(g) \rightarrow 3\ H_2O(\ell) + 2\ CO_2(g), \quad \Delta H^\circ_c = -1366.8$ kJ

$\Delta H^\circ_f(H_2O(\ell)) = -285.8$ kJ/mol, $\Delta H^\circ_f(O_2) = 0$ kJ/mol,
$\Delta H^\circ_f(CO_2(g)) = -393.5$ kJ/mol

(4 marks)

(iii) Calculate the heat of reaction for the formation of sulfur trioxide, SO_3.

$S(s) + \frac{3}{2}\ O_2(g) \rightarrow SO_3(g)$

Given the following thermochemical equations

$S(s) + O_2(g) \rightarrow SO_2(g), \quad \Delta H^\circ_{rxn} = -296.8$ kJ
$2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g), \quad \Delta H^\circ_{rxn} = -197.0$ kJ

(4 marks)

Q6 (a) The reaction $A \rightarrow 2B + C$ is found to be second order with respect to the reactant, A.

(i) Write the rate law.

(1 mark)

(ii) Find the value of the rate constant when the concentration of A is 0.01M and the rate is 1.0×10^{-2} M/min.

(3 marks)

(iii) Calculate the new rate when the concentration of A is increased to 0.05M.

(2 marks)

(b) For the reaction $2NO(g) + H_2(g) \rightarrow N_2O(g) + H_2O(g)$, the following rate data were collected:

Experiment	Initial [NO]/M	Initial $[H_2]$/M	Initial rate/Ms^{-1}
1	0.60	0.37	3.0×10^{-3}
2	1.20	0.37	1.2×10^{-2}
3	1.20	0.74	1.2×10^{-2}

(i) Determine the order of [NO] and $[H_2]$.

(7 marks)

(ii) Write the rate law equation.

(1 mark)

(iii) Determine the value of the rate constant, *k* (complete with units).

(4 marks)

(c) The reaction, $A \rightarrow B$, is first order with a half-life of 2.75 days.

(i) Find the rate constant, *k*.

(2 marks)

(ii) Determine the time to reduce the concentration of A from 1.0 M to 0.03 M.

(5 marks)

- END OF QUESTION -