UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	CHEMISTRY
COURSE CODE	:	DAS 12102
PROGRAMME	:	2 DAE
EXAMINATION DATE	:	DECEMBER 2014 / JANUARY 2015
DURATION	:	2½ HOURS
INSTRUCTION	:	**ANSWER FOUR (4) QUESTIONS ONLY**

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

Q1 (a) Determine the empirical formula of a compound with the following weight percent composition.

C = 40.1% ; H = 6.6% and O = 53.3%

(7 marks)

(b) Sodium hydroxide (NaOH) reacted with sulphuric acid (H_2SO_4) forming sodium sulphate (Na_2SO_4) and water molecule (H_2O).

(i) Write a balance chemical equation of the reaction.

(3 marks)

(ii) From **Q1(b)(i)**, find the number of gram of Na_2SO_4 being formed when 4 mole of NaOH reacted.

(6 marks)

(c) A container with a volume of 10 L has a mixture of two gases, H_2 (hydrogen) and O_2 (oxygen). At 65 °C, the partial pressures of the hydrogen and oxygen are 0.250 and 0.500 atm respectively. Find the total number of mole of the gas in the mixture. Gas constant, R = 0.0821 L.atm/mol.K .

(9 marks)

(Atomic Mass: C = 12 ; H = 1 ; O = 16 ; Na = 23 ; S = 32)

Q2 (a) Atomic number (Z) of two elements, calcium (Ca) and chlorine (Cl) are 20 and 17 respectively.

(i) Write the electron configuration of both elements.

(4 marks)

(ii) Determine the group and period of both elements.

(4 marks)

(iii) Write equations showing the formation of calcium and chlorine ions and ionic compound calcium chloride.

(6 marks)

(b) Draw the Lewis structure formula of chlorate ion, ClO_3^- . Atomic number of Cl = 17 and O = 8.

(6 marks)

(c) A gas occupies a volume of 50 L at a pressure of 5 atm and temperature of 60 °C. Find the temperature if both the volume and pressure were raised to 100 L and 50 atm respectively.

(5 marks)

Q3 (a) Define the following terms complete with the correct unit.

(i) Heat capacity, *C*.

(3 marks)

(ii) Specific heat, *s* .

(3 marks)

(iii) Calculate the specific heat of iron if 10 gram of it needs 500 J of heat to increase the temperature from 20 °C to 50 °C.

(5 marks)

(b) Find ΔH^o_{rxn} of the following reaction.

$$4NO(g) + 6H_2O(g) \rightarrow 4NH_3(g) + 5O_2(g)$$

Given:

$\Delta H^o_f(NH_3) = -45.9$ kJ/mol ; $\Delta H^o_f(H_2O) = -241.8$ kJ/mol

$\Delta H^o_f(NO) = 90.3$ kJ/mol ; $\Delta H^o_f(O_2) = 0$

(5 marks)

(c) Using Hess's Law and the following thermochemical reactions, find the heat of formation (ΔH^o_f) of pentane (C_5H_{12}).

$C(s) + O_2(g) \rightarrow CO_2(g)$; $\Delta H^o_{rxn} = -393.5$ kJ

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$; $\Delta H^o_{rxn} = -571.6$ kJ

$C_5H_{12}(g) + 8O_2(g) \rightarrow 5CO_2(g) + 6H_2O(l)$; $\Delta H^o_{rxn} = -3536$ kJ

(9 marks)

Q4 (a) Write the rate expression for the following reaction.

$$CO_2(g) + 2H_2O(g) \rightarrow CH_4(g) + 2O_2(g)$$

(4 marks)

(b) Consider the following reaction:

$$2NO(g) + H_2(g) \rightarrow N_2O(g) + H_2O(g)$$

A rate study of this reaction was conducted at 298 K. The data that were obtained are shown in the table.

Experiment	[NO]/M	[H_2]/M	Initial Rate/Ms^{-1}
1	0.30	0.35	2.835×10^{-3}
2	0.60	0.35	11.340×10^{-3}
3	0.60	0.70	22.680×10^{-3}

(i) Find the reaction order of NO and H_2.

(8 marks)

(ii) Write the rate law of the reaction.

(1 mark)

(iii) Find the value of rate constant, *k*.

(3 marks)

(c) (i) Explain the effects of increasing temperature on the reaction rate.

(3 marks)

(ii) Define a catalyst.

(2 marks)

(iii) Draw an energy diagram showing the path of a reaction with and without a catalyst.

(4 marks)

Q5 (a) Phosgene decomposes at high temperatures to carbon monoxide and chlorine:

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

At 600 K, 0.124 M (mol/L) of $COCl_2$ is placed in a container and allowed to achieve equilibrium.

(i) Redraw and complete the following table:

Table Q5(a)

	$COCl_2$ (g)	CO (g)	Cl_2(g)
Initial/M	0.124	0	0
Change/M	– x		
Equilibrium			

(5 marks)

(ii) Assuming x <<< 0.124, find x, given K_c = 0.0041 at 600 K.

(6 marks)

(b) Define

(i) Lewis acid.

(2 marks)

(ii) Lewis base.

(2 marks)

(c) Identify the Bronsted Lowry acid and base and their conjugate pairs in the following reaction:

$$NH_4^+(aq) + Br^-(aq) \rightleftharpoons NH_3(aq) + HBr(aq)$$

(4 marks)

(d) Concentration of OH^- ion in a detergent solution is equal to 0.0025 M. Given, pK_w = 14 for neutral water at 25 ^oC, find the

(i) Concentration of H^+ ion in the detergent solution.

(3 marks)

(ii) pH of the detergent solution.

(3 marks)

Q6 (a) (i) Define the redox reaction.

(3 marks)

(ii) Given the following redox reaction of

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

Write the oxidation and reduction reactions.

(2 marks)

(b) Explain the following electrochemical cells.

(i) Galvanic/voltaic cell.

(3 marks)

(ii) Electrolytic cell.

(3 marks)

(c) Given the voltaic cell reaction of

$$2Al(s) + 3Mn^{2+}\,(aq) \rightarrow 2Al^{3+}\,(aq) + 3Mn(s)$$

(i) Write the anode and cathode reactions.

(4 marks)

(ii) Find E^{o}_{cell}. Given $E^{o}_{Al^{3+}/Al} = -1.66$ V and $E^{o}_{Mn^{2+}/Mn} = -1.18$ V

(5 marks)

(d) (i) Define the term corrosion.

(3 marks)

(ii) Explain two methods to prevent corrosion.

(2 marks)

- END OF QUESTION –

UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	CHEMISTRY
COURSE CODE	:	DAS 12102
PROGRAMME	:	2 DAE
EXAMINATION DATE	:	DECEMBER 2014 / JANUARY 2015
DURATION	:	2½ HOURS
INSTRUCTION	:	**ANSWER FOUR (4) QUESTIONS ONLY**

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

Q1 (a) Determine the empirical formula of a compound with the following weight percent composition.

C = 40.1% ; H = 6.6% and O = 53.3%

(7 marks)

(b) Sodium hydroxide (NaOH) reacted with sulphuric acid (H_2SO_4) forming sodium sulphate (Na_2SO_4) and water molecule (H_2O).

(i) Write a balance chemical equation of the reaction.

(3 marks)

(ii) From **Q1(b)(i)**, find the number of gram of Na_2SO_4 being formed when 4 mole of NaOH reacted.

(6 marks)

(c) A container with a volume of 10 L has a mixture of two gases, H_2 (hydrogen) and O_2 (oxygen). At 65 °C, the partial pressures of the hydrogen and oxygen are 0.250 and 0.500 atm respectively. Find the total number of mole of the gas in the mixture. Gas constant, R = 0.0821 L.atm/mol.K .

(9 marks)

(Atomic Mass: C = 12 ; H = 1 ; O = 16 ; Na = 23 ; S = 32)

Q2 (a) Atomic number (Z) of two elements, calcium (Ca) and chlorine (Cl) are 20 and 17 respectively.

(i) Write the electron configuration of both elements.

(4 marks)

(ii) Determine the group and period of both elements.

(4 marks)

(iii) Write equations showing the formation of calcium and chlorine ions and ionic compound calcium chloride.

(6 marks)

(b) Draw the Lewis structure formula of chlorate ion, ClO_3^- . Atomic number of Cl = 17 and O = 8.

(6 marks)

(c) A gas occupies a volume of 50 L at a pressure of 5 atm and temperature of 60 °C. Find the temperature if both the volume and pressure were raised to 100 L and 50 atm respectively.

(5 marks)

Q3 (a) Define the following terms complete with the correct unit.

(i) Heat capacity, *C*.

(3 marks)

(ii) Specific heat, *s* .

(3 marks)

(iii) Calculate the specific heat of iron if 10 gram of it needs 500 J of heat to increase the temperature from 20 °C to 50 °C.

(5 marks)

(b) Find ΔH^o_{rxn} of the following reaction.

$$4NO(g) + 6H_2O(g) \rightarrow 4NH_3(g) + 5O_2(g)$$

Given:

$\Delta H^o_f(NH_3) = -45.9$ kJ/mol ; $\Delta H^o_f(H_2O) = -241.8$ kJ/mol

$\Delta H^o_f(NO) = 90.3$ kJ/mol ; $\Delta H^o_f(O_2) = 0$

(5 marks)

(c) Using Hess's Law and the following thermochemical reactions, find the heat of formation (ΔH^o_f) of pentane (C_5H_{12}).

$C(s) + O_2(g) \rightarrow CO_2(g)$; $\Delta H^o_{rxn} = -393.5$ kJ

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$; $\Delta H^o_{rxn} = -571.6$ kJ

$C_5H_{12}(g) + 8O_2(g) \rightarrow 5CO_2(g) + 6H_2O(l)$; $\Delta H^o_{rxn} = -3536$ kJ

(9 marks)

Q4 (a) Write the rate expression for the following reaction.

$$CO_2(g) + 2H_2O(g) \rightarrow CH_4(g) + 2O_2(g)$$

(4 marks)

(b) Consider the following reaction:

$$2NO(g) + H_2(g) \rightarrow N_2O(g) + H_2O(g)$$

A rate study of this reaction was conducted at 298 K. The data that were obtained are shown in the table.

Experiment	[NO]/M	[H_2]/M	Initial Rate/Ms^{-1}
1	0.30	0.35	2.835×10^{-3}
2	0.60	0.35	11.340×10^{-3}
3	0.60	0.70	22.680×10^{-3}

(i) Find the reaction order of NO and H_2.

(8 marks)

(ii) Write the rate law of the reaction.

(1 mark)

(iii) Find the value of rate constant, *k*.

(3 marks)

(c) (i) Explain the effects of increasing temperature on the reaction rate.

(3 marks)

(ii) Define a catalyst.

(2 marks)

(iii) Draw an energy diagram showing the path of a reaction with and without a catalyst.

(4 marks)

Q5 (a) Phosgene decomposes at high temperatures to carbon monoxide and chlorine:

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

At 600 K, 0.124 M (mol/L) of $COCl_2$ is placed in a container and allowed to achieve equilibrium.

(i) Redraw and complete the following table:

Table Q5(a)

	$COCl_2$ (g)	CO (g)	Cl_2(g)
Initial/M	0.124	0	0
Change/M	– x		
Equilibrium			

(5 marks)

(ii) Assuming x <<< 0.124, find x, given K_c = 0.0041 at 600 K.

(6 marks)

(b) Define

(i) Lewis acid.

(2 marks)

(ii) Lewis base.

(2 marks)

(c) Identify the Bronsted Lowry acid and base and their conjugate pairs in the following reaction:

$$NH_4^+(aq) + Br^-(aq) \rightleftharpoons NH_3(aq) + HBr(aq)$$

(4 marks)

(d) Concentration of OH^- ion in a detergent solution is equal to 0.0025 M. Given, pK_w = 14 for neutral water at 25 ^oC, find the

(i) Concentration of H^+ ion in the detergent solution.

(3 marks)

(ii) pH of the detergent solution.

(3 marks)

Q6 (a) (i) Define the redox reaction.

(3 marks)

(ii) Given the following redox reaction of

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

Write the oxidation and reduction reactions.

(2 marks)

(b) Explain the following electrochemical cells.

(i) Galvanic/voltaic cell.

(3 marks)

(ii) Electrolytic cell.

(3 marks)

(c) Given the voltaic cell reaction of

$$2Al(s) + 3Mn^{2+}(aq) \rightarrow 2Al^{3+}(aq) + 3Mn(s)$$

(i) Write the anode and cathode reactions.

(4 marks)

(ii) Find E°_{cell}. Given $E^{\circ}_{Al^{3+}/Al} = -1.66$ V and $E^{\circ}_{Mn^{2+}/Mn} = -1.18$ V

(5 marks)

(d) (i) Define the term corrosion.

(3 marks)

(ii) Explain two methods to prevent corrosion.

(2 marks)

- END OF QUESTION –