UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	CHEMISTRY
COURSE CODE	:	DAM 10403
PROGRAMME CODE	:	DAM
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	PART A: ANSWER **ALL** QUESTIONS PART B: ANSWER **TWO (2)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

PART A

Q1 (a) 20 mol of nitrosyl chloride (NOCl) is placed inside an empty 4L container. At equilibrium, 8 mol of chlorine (Cl_2) and $2x$ mol of nitric oxide (NO) was found in the container. Calculate the value of K_c for this reaction.

(9 marks)

(b) The equilibrium constant (K_c) for the formation of nitrosyl chloride from nitric oxide and molecular chlorine is 6.5×10^4 at 35 °C.

$$2NO_{(g)} + Cl_{2(g)} \rightleftharpoons 2NOCl_{(g)}$$

In a certain experiment, 2.0×10^{-2} mol of NO, 8.3×10^{-3} mol of Cl_2 and 6.8 mol of NOCl are mixed in a 2L flask. Determine the direction of the system to reach equlilbrium.

(7 marks)

(c) The reaction between carbon monoxide (CO) and hydrogen (H_2) gas will produce methane gas (CH_4) and water vapour. The K_c for this reaction is 2.41×10^{-2}. Determine the K_p of the reaction at 25 °C.

(4 marks)

Q2 (a) Write

(i) the conjugate base of H_2S

(ii) the conjugate acid of HCO_3^-

(2 marks)

(b) A solution formed by dissolving an antacid tablet has a pH of 9.18. Calculate

(i) pOH

(ii) $[H^+]$

(iii) $[OH^-]$

(6 marks)

(c) Rewrite the following equation and identify the Lewis acid and base.

$$Co^{3+}_{(aq)} + 6NH_{3(aq)} \longrightarrow Co(NH_3)_6^{3+}{}_{(aq)}$$

(2 marks)

(d) Calculate the pH of a 0.100 M NH_3.
($K_b = 1.8 \times 10^{-5}$)

(10 marks)

Q3 (a) Determine the oxidation number of the underlined element in the following compounds.

(i) $Na_2\underline{S}O_3$

(ii) $\underline{Cr}_2O_7^{2-}$

(4 marks)

(b) Determine the species with better oxidizing agent under standard-state conditions.

(i) Br_2 or Au^{3+}

(ii) Cd^{2+} or Cr^{3+}

(5 marks)

(c) An electrochemical cell is made up of a Zn electrode in a 1.0 M $ZnSO_4$ solution and a Cu electrode in a 1.0 M $CuSO_4$ solution.

(i) Write the anode, cathode and the overall cell reactions.

(ii) Calculate the standard ***emf*** of the cell.

(5 marks)

(d) A current of 12 A is passed through $SnCl_2$ solution for 50 minutes.

(i) Determine the mass of Sn deposited on the cathode

(ii) Determine the number of moles of $Cl_{2(g)}$ that is liberated at the anode

(iii) Calculate the volume of $Cl_{2(g)}$ at STP.

(6 marks)

PART B

Q4 (a) Coal can be converted to methane gas by a process called gasification. The equation for the is as shown below.

(i) Rewrite and balance the equation:

$$C_{(s)} + H_2O_{(l)} \rightarrow CH_{4\,(g)} + CO_{2\,(g)}$$

(2 marks)

(ii) Determine the mass (gram) of carbon, C is required to react with water, H_2O to form 32 gram of CH_4 .

(8 marks)

(b) An analysis required 0.2 M $AgNO_3$. Calculate the volume of a 0.2 M in mL $AgNO_3$ solution containing 8.5 grams of $AgNO_3$.

(5 marks)

(c) In a titration, 0.2 M HCl is titrated with 0.1 M NaOH as the following equation.

$$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$$

Determine the volume of 0.200 M HCl that is required to react completely with 50 mL of 0.100 M NaOH.

(5 marks)

Q5 (a) The electron configuration of Se^{2-} is $1s^2\ 2s^2\ 2p^8\ 3s^2\ 4s^2\ 3p^6\ 3d^{12}$. Explain briefly the mistake in the configuration.

(5 marks)

(b) Illustrate the electron configuration of Co, write the electron configuration and determine if the element is paramagnetic of diamagnetic.

(5 marks)

(c) Determine the maximum number of electron in a $3d^8$ orbital. Write all possible quantum number for this orbital.

(8 marks)

(d) Calculate how many electrons can inhibit the n = 4 orbital.

(2 marks)

Q6 (a) Give definition of the following chemical bonding

(i) A covalent bond

(ii) An ionic bond

(4 marks)

(b) Draw the Lewis structures for ammonium ion, NH_4^+ (your answers must include atomic number and electron valence for each element).

(7 marks)

(c) 10.0 g of calcium nitrate, $Ca(NO_3)_2$ is heated at 1 atm and a temperature of 300 °C, at which temperature it fully decomposes. The reaction of calcium nitrate heated is represented by the following balanced equation.

$$2Ca(NO_3)_{2\,(s)} \rightarrow 2CaO_{\,(s)} + 4NO_{2\,(g)} + O_{2\,(g)}$$

(i) Determine the volume of nitrogen dioxide produced

(6 marks)

(ii) Calculate the mass of calcium oxide, CaO is produced if calcium nitrate, $Ca(NO_3)_2$ is fully decomposed.

(3 marks)

Q7 (a) ΔH_f for the following reaction is – 186 kJ.

$$H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}$$

(i) Determine the kJ of heat produced from the reaction of 25 g Cl_2 .

(ii) Write the thermochemical equation for the reverse reaction.

(5 marks)

(b) Calculate ΔH combustion for the reaction :

$$2CH_3OH_{\,(\ell)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 4H_2O_{(\ell)}$$

Given:

$\Delta H_f\ CH_3OH_{\,(\ell)} = -239$ kJ/mol
$\Delta H_f\ CO_{2(g)} = -393.5$ kJ/mol
$\Delta H_f\ H_2O_{(\ell)} = -286.0$ kJ/mol

(5 marks)

(c) Write the rate expression for the reaction :

$$2C_8H_{18(\ell)} + 25O_{2(g)} \rightarrow 16CO_{2(g)} + 18H_2O_{(g)}$$

(2 marks)

(d) The rate law for the reaction $2NO_{(g)} + Cl_{2(g)} \rightarrow 2NOCl_{(g)}$ is

$$\text{Rate} = k\,[NO]^2[Cl_2]$$

(i) Determine the order with respect to NO, Cl_2 and the overall order.

(ii) Calculate the rate constant, k when [NO] = 0.250 M, $[Cl_2]$ = 0.250 M and rate = 1.43×10^{-6} Ms^{-1}.

(iii) Determine rate of the reaction when [NO] = 0.750 M and $[Cl_2]$ = 0.250M.

(8 marks)

– END OF QUESTIONS –

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ATOMIC NUMBER OF ELEMENTS

Name of Atom	Atomic Symbol	Atomic Number
Hydrogen	H	1
Oxygen	O	8
Cobalt	Co	27
Selenium	Se	34
Nitrogen	N	7

ATOMIC MASS OF ELEMENTS

Name of Element	Element Symbol	Atomic Mass /a.m.u
Argentum	Ag	108
Stanum	Sn	118.7
Calcium	Ca	40
Chlorine	Cl	35.5
Hydrogen	H	1
Carbon	C	12
Oxygen	O	16
Nitrogen	N	14

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FORMULAE

$K_w = [\,H^+\,][\,OH^-\,] = 1.0 \times 10^{-14}$

$pK_w = pH + pOH = 14$

$pH = -\log[H^+]$

$pOH = -\log[OH^-]$

$\Delta H_{rxn} = \Sigma\, \Delta H^\circ_f$ products - $\Sigma\, \Delta H^\circ_f$ reactants

$K_p = K_c(RT)^{\Delta n}$

$E^o_{cell} = E^o_{SRP} + E^o_{SOP}$

$E_{cell} = E^o_{cell} - \dfrac{0.0592}{n} \log \dfrac{[product]}{[\text{reactant}]}$

$m = \dfrac{MIt}{ZF}$ $\qquad 1\ F = 96\,500$ coulumb

$Molarity(M)$ of compound A $= \dfrac{\text{mol of solute (mol)}}{\text{volume of solution(L)}}$

Dilution : $M_1V_1 = M_2V_2$ $\qquad$ *Acid-Base Titration* : $\dfrac{M_a V_a}{a} = \dfrac{M_b V_b}{b}$

Quantum numbers : (n, l, m_l, m_s)

$PV = nRT$

1 mol gas at STP = 22.4L $\qquad R = 0.0821$ *Latm/mol.K*

$Rate(R) = k[A]^x[B]^y$

Standard Reduction Potentials E°_{SRP}

$E^o_{(Zn^{2+}/Zn)} = -0.76V$ $\qquad E^o_{(Br_2/Br^-)} = +1.07V$ $\qquad E^o_{(Au^{3+}/Au)} = +1.50V$

$E^o_{(Cu^{2+}/Cu)} = +0.34V$ $\qquad E^o_{(Cd^{2+}/Cd)} = -0.40V$ $\qquad E^o_{(Cr^{3+}/Cr)} = -0.74V$