Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	CHEMISTRY
COURSE CODE	:	DAM 13102
PROGRAMME CODE	:	DAM
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	2 HOURS AND 30 MINUTES
INSTRUCTIONS	:	1. ANSWER **ALL** QUESTIONS IN **PART A** AND **TWO (2)** QUESTIONS ONLY IN **PART B** 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK** 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

THIS QUESTION PAPER CONSISTS OF **TWELVE (12)** PAGES

PART A

Q1 (a) Copper and iron (generally in the form of steel) are two of the many metals used in designing the machines with electrochemistry method. Using standard reduction potentials in **Table Q1(a)**, answer the following questions.

Table Q1(a)

Reduction reaction	Standard reduction potential, E ° (V)
$Zn^{2+} + 2e^- \rightarrow Zn$	− 0.7630
$Fe^{2+} + 2e^- \rightarrow Fe$	− 0.4400
$Cu^{2+} + 2e^- \rightarrow Cu$	+ 0.3370
$Ag^{+} + e^- \rightarrow Ag$	− 0.7994

(i) Write the half-reactions for anode and cathode.

(6 marks)

(ii) Determine the cell potential, E^o_{cell} for a galvanic cell composed of copper and iron.

(3 marks)

(iii) Write the cell diagram for the above galvanic cell.

(3 marks)

(b) Given two half-reactions below.

$$Ni^{2+}{}_{(aq)} + 2e^- \leftrightarrow Ni_{(s)} \quad E^o = -0.25\,V$$

$$Cr^{3+}{}_{(aq)} + 3e^- \leftrightarrow Cr_{(s)} \quad E^o = -0.74\,V$$

Answer the following questions.

(i) Show the electrode reaction for this electrochemical series.

(3 marks)

(ii) Using a balanced equation, calculate the overall cell reaction.

(4 marks)

(iii) Calculate the cell potential, E when $[Ni^{2+}] = 0.001$ M and $[Cr^{3+}] = 0.002$ M.

(6 marks)

Q2 (a) Given the following acid base reaction.

$$H_2S_{(g)} + H_2O_{(l)} \leftrightarrow H_3O^+_{(aq)} + HS^-_{(aq)}$$

(i) Identify the acid and base conjugate for the above.

(2 marks)

(ii) Justify your answer in **Q2(a)(i)**.

(2 marks)

(b) pH of Dutch Lady milk is 10.25. Find

(i) pOH

(3 marks)

(ii) Concentration of hydrogen ion, $[H^+]$.

(3 marks)

(iii) Concentration of hydroxide ion, $[OH^-]$.

(3 marks)

(c) Given the ionization equation of weak acid solution, CH_3COOH as below. The CH_3COOH solution was prepared by dissolving 0.05 g of acetic acid (60.05 g/mol) in 50 ml distilled water.

$$CH_3COOH_{(aq)} \leftrightarrow CH_3COO^-_{(aq)} + H^+_{(aq)} \qquad K_a = 1.8 \times 10^{-5}$$

(i) Find the concentration of CH_3COOH solution in M.

(2 marks)

(ii) Determine the concentration of CH_3COO^- and H^+ at equilibrium.

(8 marks)

(iii) Calculate pH of the solution.

(2 marks)

PART B

Q3 (a) Write the definition of heterogenous mixture and homogenous mixture. Give an example for each definition to explain your answer.

(4 marks)

(b) The mass of an atom is very small. Therefore, a chemist determines the mass of an atom by comparing the mass of the atom with another atom which is called relative atomic mass. **FigureQ3(b)** shows the comparison of mass between atom X with atom carbon-12.

(i) Identify the atom X.

(1 mark)

(ii) Determine the relative atomic mass of atom X. Justify your answer.

(2 marks)

(c) The balance pictured in **FigureQ3(c)**, was set to zero (tared) when just the weighing boat was present. The sample of sulfur weighs 4.07 g.

(i) Calculate the number of moles of sulfur are present.

(1 mark)

(ii) Write total number of sulfur atoms in the sample.

(2 marks)

(d) The volatile liquid ethyl mercaptan, C_2H_6S, is one of the most odoriferous substances known. It is sometimes added to natural gas to make gas leaks detectable. Calculate how many C_2H_6S molecules are contained in a 1.0 μL sample. The density of liquid ethyl mercaptan is 0.84 g/mL.

(5 marks)

(e) Dibutyl succinate is an insect repellent used against household ants and roaches. Its composition is 62.58% C, 9.63% H, and 27.79% O. Its experimentally determined molecular mass is 230 u. Identify the empirical and molecular formulas of dibutyl succinate.

(10 marks)

Q4 (a) (i)

Draw the electron diagram of these atoms. Determine which is the largest atom. Justify your answer.

(5 marks)

(ii) Potassium and magnesium are required in our diet. Write the electron configurations of the ions expected from these elements.

(2 marks)

(b) Write a plausible Lewis structure for *cyanogen*, C_2N_2, a poisonous gas used as a fumigant and rocket propellant.

(5 marks)

(c) Draw the Lewis structure for the carbonate ion, CO_3^{2-}. Show all possible resonance structures of carbonate. Indicate the formal charge of each atom.

(10 marks)

(d) Write the definition of resonance. Give an example to justify your answer.

(3 marks)

Q5 (a) Compute the volume occupied by 13.7 g of chlorine gas, Cl_2 at 45 °C and 98.4 kPa.

(6 marks)

(b) Calculate the value of pressure, in kPa, exerted by 1.00×10^{20} molecules of N_2 in 305 mL flask at 175 °C.

(6 marks)

(c) The situation pictured in **FigureQ5c(i)** is changed to that in **FigureQ5c(ii).** Calculate the pressure of the gas in **FigureQ5c(ii).**

(Hint: The amount of gas and volume are held constant!).

(6 marks)

(d) A 1.27 g sample of an oxide of nitrogen, believed to be either NO or N_2O, occupies a volume of 1.07 L at 25 °C and 0.982 bar. Identify, which oxide is it. Justify your answer.

(7 marks)

Q6 (a) Calculate the amount of heat (in kJ) required to increase the temperature of the following. Given specific heat for water = 4.18 $Jg^{-1}{}^{\circ}C^{-1}$; ethanol = 2.46 $Jg^{-1}{}^{\circ}C^{-1}$

(i) 25.0 g of water from 20.0 °C to 85.0 °C

(3 marks)

(ii) 110.0 g of ethanol from – 15.5 °C to 46.0 °C

(3 marks)

(b) Calculate the standard enthalpy change for the reaction below;

$$2\,Al_{(s)} + Fe_2O_{3\,(s)} \rightarrow 2\,Fe_{(s)} + Al_2O_{3\,(s)}$$

Given that:

$$Al_{(s)} + \frac{3}{4}O_{2\,(g)} \rightarrow \frac{1}{2}Al_2O_{3\,(s)} \qquad \Delta H^o\ reaction = -800.5\ kJ/mol$$

$$2\,Fe_{(s)} + \frac{3}{2}O_{2\,(g)} \rightarrow Fe_2O_{3\,(s)} \qquad \Delta H^o\ reaction = -821.0\ kJ/mol$$

(6 marks)

(c) Consider the reaction below;

$$H_{2(g)} + Cl_{2\,(g)} \rightarrow 2HCl_{\,(g)} \qquad \Delta H^o\ reaction = -184.6\ kJ/mol$$

Write the thermochemical equation for

(i) the dissociation of 4 mol $HCl_{(g)}$

(3 marks)

(ii) the formation of 1 mol $HCl_{(g)}$

(3 marks)

(d) Calculate the standard enthalpy change for the following reaction.

$$BrCl_{(g)} \rightarrow Br_{(g)} + Cl_{(g)}$$

Given:

$$Br_{2\,(l)} \rightarrow Br_{2\,(g)} \qquad \Delta H^o\ reaction = +30.91kJ$$

$$Br_{2\,(g)} \rightarrow 2\,Br_{(g)} \qquad \Delta H^o\ reaction = +192.90kJ$$

$$Cl_{2\,(g)} \rightarrow 2\,Cl_{(g)} \qquad \Delta H^o\ reaction = +243.40kJ$$

$$Br_{2\,(l)} + Cl_{2\,(g)} \rightarrow 2\,BrCl_{(g)} \qquad \Delta H^o\ reaction = +29.20kJ$$

(7 marks)

Q7 (a) Write the reaction rate expression for the following reactions.

$$5Br^-_{(aq)} + BrO_3{}^-_{(aq)} + 6H^+_{(aq)} \rightarrow 3Br_{2(aq)} + 3H_2O_{(l)}$$

(5 marks)

(b) The following data were obtained for the chemical reaction:

$$A + B \rightarrow \text{Products}$$

Experiment no	Initial A (M)	Initial B (M)	Initial rate of formation of products (M/s)
1	0.040	0.040	9.6×10^{-6}
2	0.080	0.040	1.92×10^{-5}
3	0.080	0.020	9.60×10^{-6}

(i) Determine the rate law for this reaction.

(1 mark)

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

(5 marks)

(iii) Determine the initial rate of reaction when initial concentration of A and B are 0.120 M and 0.015 M respectively.

(2 marks)

(c) At 1000 K, $K_p = 1.85$ for the reaction below.

$$SO_{2\,(g)} + \frac{1}{2}O_{2(g)} \leftrightarrow SO_{3\,(g)}$$

(i) Find K_p for the reaction :

$$SO_{3\,(g)} \leftrightarrow SO_{2\,(g)} + \frac{1}{2}O_{2(g)}$$

(2 marks)

(ii) Find K_p for the reaction :

$$2SO_{3\,(g)} \leftrightarrow 2SO_{2\,(g)} + O_{2(g)}$$

(2 marks)

(d) Consider the following reaction:

$$3H_2O_{(g)} + 3C_{(s)} \leftrightarrow 3CO_{(g)} + 3H_{2\,(g)}$$

(i) Write the equilibrium expression K_c and K_p.

(2 marks)

(ii) Calculate K_p at 1000 K,if $K_c = 3.8 \times 10^{-3}$.

(3 marks)

(iii) If $K_p = 6.1 \times 10^4$ at 1398 K, find the value of K_c at the same temperature.

(3 marks)

- END OF QUESTIONS -

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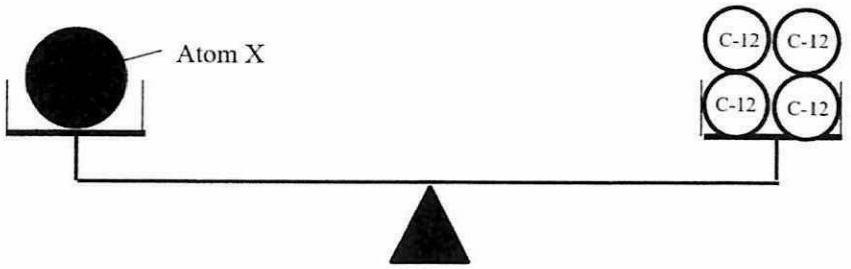
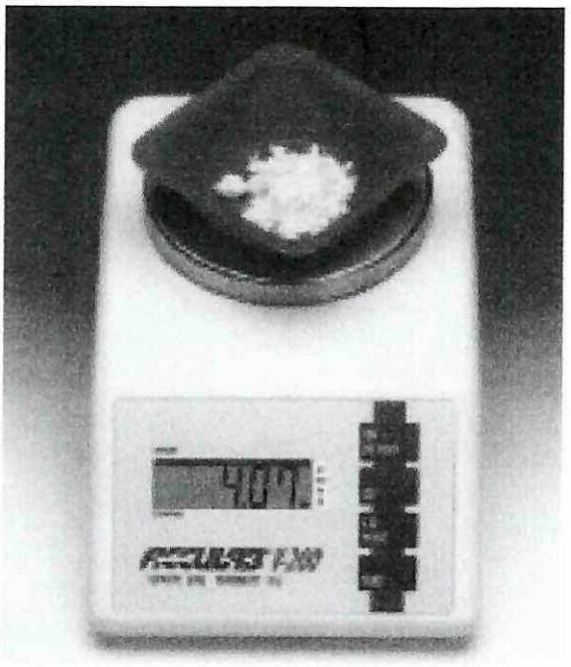


FigureQ3(b)



FigureQ3(c)

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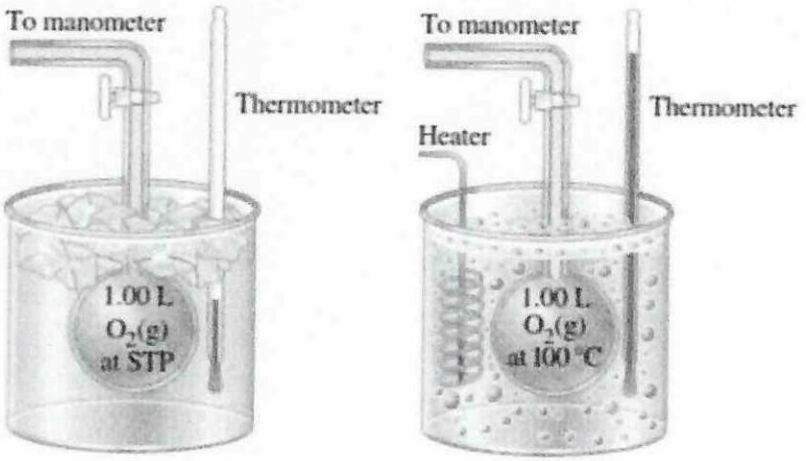

(i) Ice bath (ii) Boiling water

FigureQ5(c)

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List of chemical elements

Atomic No.	*Atomic Weight*	*Name*	*Sym.*	*Atomic No.*	*Atomic Weight*	*Name*	*Sym*
1	1.0	Hydrogen	H	31	69.72	Gallium	Ga
2	4.0	Helium	He	32	72.64	Germanium	Ge
3	6.9	Lithium	Li	33	74.92	Arsenic	As
4	9.0	Beryllium	Be	34	78.96	Selenium	Se
5	10.81	Boron	B	35	79.90	Bromine	Br
6	12.01	Carbon	C	36	83.80	Krypton	Kr
7	14.01	Nitrogen	N	37	85.47	Rubidium	Rb
8	16.00	Oxygen	O	38	87.62	Strontium	Sr
9	19.00	Fluorine	F	39	88.91	Yttrium	Y
10	20.18	Neon	Ne	40	91.22	Zirconium	Zr
11	22.99	Sodium	Na	41	92.91	Niobium	Nb
12	24.31	Magnesium	Mg	42	95.94	Molybdenum	Mo
13	26.98	Aluminum	Al	43	98.00	Technetium	Tc
14	28.09	Silicon	Si	44	101.07	Ruthenium	Ru
15	30.97	Phosphorus	P	45	102.91	Rhodium	Rh
16	32.07	Sulfur	S	46	106.42	Palladium	Pd
17	35.45	Chlorine	Cl	47	107.87	Silver	Ag
18	39.95	Argon	Ar	48	112.41	Cadmium	Cd
19	39.10	Potassium	K	49	114.82	Indium	In
20	40.08	Calcium	Ca	50	118.71	Tin	Sn
21	44.96	Scandium	Sc	51	121.76	Antimony	Sb
22	47.87	Titanium	Ti	52	127.60	Tellurium	Te
23	50.94	Vanadium	V	53	126.90	Iodine	I
24	52.00	Chromium	Cr	54	131.29	Xenon	Xe
25	54.94	Manganese	Mn	55	132.91	Cesium	Cs
26	55.85	Iron	Fe	56	137.33	Barium	Ba
27	58.93	Cobalt	Co	57	138.91	Lanthanum	La
28	58.69	Nickel	Ni	58	140.12	Cerium	Ce
29	63.55	Copper	Cu	59	140.91	Praseodymium	Pr
30	65.39	Zinc	Zn	60	144.24	Neodymium	Nd

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$$pV = nRT$$

$$d = \frac{m}{V}$$

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

$$E_{cell} = E^o_{cathode} - E^o_{Anode}$$

$$E_{cell} = E^o_{SRP} - E^o_{SOP}$$

$$pK_w = pH + pOH$$

$$C = ms$$

$$q = C\Delta T$$

$$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

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