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**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER I  
SESSION 2021/2022**

COURSE NAME : CHEMISTRY  
COURSE CODE : DAM 13102  
PROGRAMME CODE : DAM  
EXAMINATION DATE : JANUARY / FEBRUARY 2022  
DURATION : 2 HOURS AND 30 MINUTES  
INSTRUCTION : 1. ANSWER ALL QUESTIONS IN SECTION A  
2. ANSWER TWO (2) QUESTIONS ONLY IN SECTION B  
3. THIS FINAL EXAMINATION IS AN ONLINE ASSESSMENT AND CONDUCTED VIA CLOSE BOOK

THIS QUESTION PAPER CONSISTS OF EIGHT (8) PAGES

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UNIVERSITI TUN HUSSEIN ONN MALAYSIA  
JALAN SEMBAYANG  
71800 BATU PAHAT, JOHORE  
BAHRU, MALAYSIA  
TEL: 07-5566111  
FAX: 07-5566112  
WWW.UTHM.MY

## SECTION A

- Q1** (a) A mixture containing 0.84 mol of  $\text{PCl}_5$  and 0.18 mol of  $\text{PCl}_3$  was allowed to achieve equilibrium in a closed container of capacity  $1.0 \text{ dm}^3$  at  $300^\circ\text{C}$ . It was found that 0.72 mol of  $\text{PCl}_5$  remains. Calculate  $K_c$  for the decomposition of  $\text{PCl}_5$ .

(5 marks)

(b)



A mixture containing 1.0 mol of ethanoic acid and 5.0 mol of ethanol was allowed to achieve equilibrium at room temperature. The amount of ethanoic acid left requires  $289 \text{ cm}^3$  of 0.2 M NaOH to complete reaction.

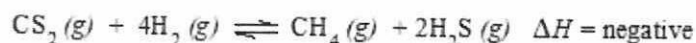
- (i) Find the number of moles of ethanoic acid reacted for the reaction.

(4 marks)

- (ii) Determine the value of  $K_c$  for the reaction.

(8 marks)

(c)



State and explain the effect of the following changes (if any) on the  $K_p$  and the amount of methane,  $\text{CH}_4$  in the equilibrium mixture of the given reaction.

- (i) Increasing the temperature

(2 marks)

- (ii) Increasing the pressure

(2 marks)

- (iii) Adding more hydrogen gas

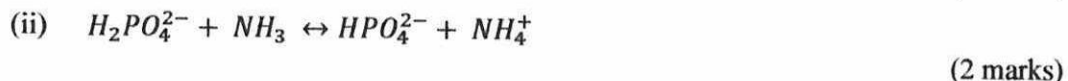
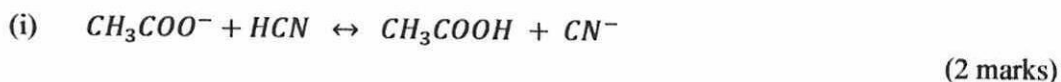
(2 marks)

- (iv) Addition of a suitable catalyst

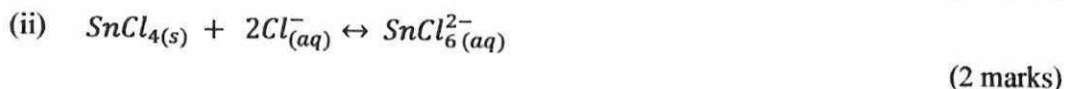
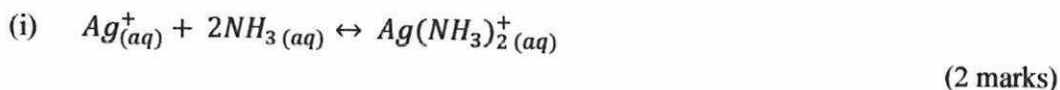
(2 marks)

Q2 (a) Differentiate the acid and base according to Lewis and Bronsted Lowry theory. (4 marks)

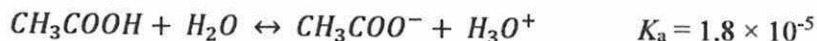
(b) Identify the acid-base conjugate pairs in each of the following reactions. Justify your answer.



(c) Identify the Lewis acid and Lewis base in each of the following reactions. Justify your answer.



(d) A 0.056 g quantity of acetic acid is dissolved in distilled water to make 50 ml solution. The acetic acid dissolves in distilled water according to the following equations. (Molar mass of acetic acid = 60.052 g/mol).



(i) Calculate the concentration of acetic acid solution in Molar (M). (2 marks)

(ii) Determine the concentration of  $CH_3COOH$ ,  $CH_3COO^-$  and  $H_3O^+$  at equilibrium. (9 marks)

(iii) Calculate the pH of the solution. (2 marks)

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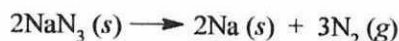
## SECTION B

- Q3** (a) The density of water at 4°C is 1.00 gcm<sup>-3</sup>. Determine the number of water molecules in 4.5 cm<sup>3</sup> of water at the same temperature. (5 marks)
- (b) Pitchblende is the most important compound of uranium. Mass analysis of an 84.2 g sample shows that it contains 71.4 g of uranium, with oxygen the only other element. Determine the amount of uranium (in grams) are in 102 kg of pitchblende. (5 marks)
- (c) In mammals, lactose (milk sugar) is metabolized to glucose, C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>, the key nutrient for generating chemical potential energy. Determine the mass percent of each element in glucose. (7 marks)
- (d) During excessive physical activity, lactic acid forms in muscle tissue and it is responsible for muscle soreness. Elemental analysis shows that this compound contains 40.0 mass % C, 6.71 mass % H, and 53.3 mass % O.
- (i) Determine the empirical formula of lactic acid. (5 marks)
- (ii) Determine the molecular formula of lactic acid.  
(Given: Molecular mass of lactic acid is 90.08 g/mol) (3 marks)
- Q4** (a) Classify the following substances as ionic or covalent compounds. Justify your answer.
- (i) MgO (3 marks)
- (ii) CS<sub>2</sub> (3 marks)
- (iii) KF (3 marks)
- (iv) SiCl<sub>4</sub> (3 marks)
- (b) Show the steps to draw the Lewis structure for NO<sub>2</sub><sup>+</sup> ion. (5 marks)
- (c) A polyatomic ion HCO<sub>2</sub><sup>-</sup> has two (2) resonance structures.
- (i) Draw the possible resonance structures for HCO<sub>2</sub><sup>-</sup> (4 marks)
- (ii) Determine the formal charge for each atom in both resonance structures. (4 marks)

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- Q5 (a) Sodium azide ( $\text{NaN}_3$ ) decomposes according to the equation:



Determine the volume of nitrogen produced at  $21^\circ\text{C}$  and  $120\text{ kPa}$  on the decomposition of  $60.0\text{ g}$  of sodium azide.

(7 marks)

- (b) A chemical engineer uses waste  $\text{CO}_2$  from a manufacturing process, instead of chlorofluorocarbons, as a “blowing agent” in the production of polystyrene. Find the density (in  $\text{g/L}$ ) of  $\text{CO}_2$  and the number of molecules per liter:

- (i) at standard temperature and pressure

(7 marks)

- (ii) at  $20.0^\circ\text{C}$  and  $1.00\text{ atm}$

(3 marks)

- (c) Acetylene ( $\text{C}_2\text{H}_2$ ), an important fuel in welding, is produced in the laboratory when calcium carbide ( $\text{CaC}_2$ ) reacts with water:



For a sample of acetylene collected over water, total gas pressure (adjusted to barometric pressure) is  $738\text{ torr}$  and the volume is  $523\text{ mL}$ . At the temperature of the gas ( $23^\circ\text{C}$ ), the vapor pressure of water is  $21\text{ torr}$ . Calculate mass (grams) of acetylene that are collected.

(8 marks)

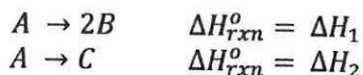
- Q6 (a) A  $250\text{ g}$  of water is heated from  $22^\circ\text{C}$  to  $98^\circ\text{C}$ . Calculate the amount of heat ( $q$ ) absorbed by the water. Given the specific heat of water is  $4.18\text{ Jg}^{-1}\text{ }^\circ\text{C}^{-1}$ .

(4 marks)

- (b) A quantity of  $1.922\text{ g}$  of methanol ( $\text{CH}_3\text{OH}$ ) was burned in a constant-volume bomb calorimeter. Consequently, the temperature of the water rose by  $4.20^\circ\text{C}$ . If the quantity of water surrounding the calorimeter was exactly  $2000\text{ g}$  and the heat capacity of the calorimeter was  $2.02\text{ kJ/}^\circ\text{C}$ , calculate the heat released (kJ) by the burning of  $1\text{ mol}$  methanol. Given the specific heat of water is  $4.18\text{ Jg}^{-1}\text{ }^\circ\text{C}^{-1}$ . (Molar mass of  $\text{CH}_3\text{OH} = 32\text{ g/mol}$ ).

(7 marks)

- (c) Consider the following two reactions:

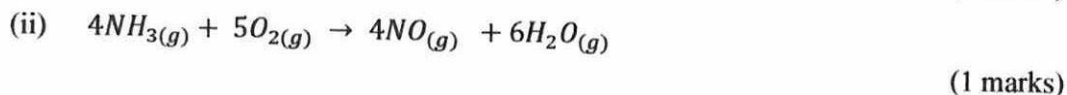


Write the thermochemical equation for

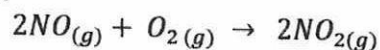
- (i) the formation of  $\frac{1}{2}B$  (2 marks)
- (ii) the dissociation of 4 moles of  $C$  (2 marks)
- (iii) the process of  $2B \rightarrow C$  (2 marks)
- (d) Calculate  $\Delta H^{\circ}$  for the reaction of  $H_{(g)} + Br_{(g)} \rightarrow HBr_{(g)}$  using the following data:
- $$\begin{array}{l} H_{2(g)} \rightarrow 2H_{(g)} \quad \Delta H^{\circ} = 436.4 \text{ kJ} \\ Br_{2(g)} \rightarrow 2Br_{(g)} \quad \Delta H^{\circ} = 192.5 \text{ kJ} \\ H_{2(g)} + Br_{2(g)} \rightarrow 2HBr_{(g)} \quad \Delta H^{\circ} = -72.4 \text{ kJ} \end{array}$$

(8 marks)

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



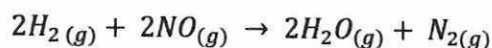
- (b) Consider the reaction below:

Suppose that at a particular moment during the reaction, nitric oxide ( $NO$ ) is reacting at the rate of 0.066 M/s. Determine:

- (i) at what rate  $NO_2$  is being formed. (2 marks)

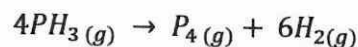
- (ii) at what rate  $O_2$  is reacting. (2 marks)

- (c) The following data were obtained from the reaction of



Experiment	$[H_2]$	$[NO]$	Initial Rate (M/s)
1	0.010	0.025	$2.4 \times 10^{-6}$
2	0.0050	0.025	$1.2 \times 10^{-6}$
3	0.010	0.0125	$0.60 \times 10^{-6}$

- (i) Write the rate law for the reaction. (2 marks)
- (ii) Determine the overall order of the reaction. (6 marks)
- (iii) Calculate the rate constant. (2 marks)
- (d) The thermal decomposition of phosphine ( $PH_3$ ) into phosphorus and hydrogen is a first order reaction.



The half-life of the reaction is 35.0 s at 680°C.

- (i) Calculate the rate constant for the reaction. (3 marks)
- (ii) If the initial concentration of phosphine is 0.25 M, find the concentration of phosphine after 5.0 minutes of reaction. (3 marks)
- (iii) The time required for 95% of the phosphine to decompose. (3 marks)

**-END OF QUESTIONS-**

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## FINAL EXAMINATION

SEMESTER / SESSION : SEM I 2021/2022

PROGRAMME CODE : DAM

COURSE NAME : CHEMISTRY

COURSE CODE : DAM 13102

## 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