

PENANG MATRICULATION COLLEGE
CHEMISTRY SK 015
SESSION 2023/2024
PRE PSPM

Answer **all** the questions within 2 hours.

- 1 (a) X^{3+} ion contains 18 electrons and 24 neutrons. Determine the number of protons of atom **X**. [1 mark]
- (b) An organic compound **Y** consists of carbon, C, hydrogen, H, and oxygen, O atoms. The combustion of 1.18 g sample of **Y** yields 1.76 g CO_2 and 0.54 g H_2O .
(i) Determine the empirical formula of compound **Y**.
(ii) Determine the molecular formula of compound **Y** if its molecular mass is 118 g mol^{-1} . [6 marks]
- (c) The density of toluene, C_7H_8 is 0.867 g mL^{-1} , and the density of thiophene, C_4H_4S is 1.065 g mL^{-1} . A solution is made by dissolving 9.660 g of thiophene in 260.0 mL of toluene. Calculate the molality of the thiophene in the solution. [4 marks]
- (d) Hydrogen sulphide, H_2S gas has the odour of rotten eggs. It reacts with oxygen, O_2 gas in the air to form sulphur dioxide, SO_2 gas and water, H_2O .
(i) Write the balanced chemical equation for the above reaction.
(ii) If 6 dm^3 H_2S is burnt in 12 dm^3 oxygen gas at room temperature, determine the limiting reactant.
(iii) Calculate the final volume of the gaseous mixture after the reaction. [10 marks]

- 2 (a) **FIGURE 1** shows the emission spectrum of hydrogen atom for Pfund series.



FIGURE 1

- i Draw and label the transition of electrons for lines **B**, **C** and **D** by using energy level diagram.
ii Calculate the energy in kJ that corresponds to line **A**.
iii Arrange the above lines in the ascending order of wavelength. [5 marks]
- b) Given that the proton number of ion J^{2+} is 22.
i Write the electronic configuration for atom **J** by using spdf notation.
ii Draw the orbital diagram for the valence electrons of atom **J**.
iii Draw and label the three dimensional shape of the orbitals with quantum number $n = 3$ and $l = 2$ for atom **J**.
iv Write a set of quantum numbers for one of the valence electrons in atom **J**.
v State the number of electrons for atom **J** with $l = 1$ [5 marks]
- 3(a) Carbon tetrachloride, CCl_4 and sulfur tetrachloride, SCl_4 are some of the covalent compounds of chloride.

- i Determine the molecular geometry of CCl_4 and SCl_4 .
 ii Deduce the polarity of CCl_4 and SCl_4 . [8 marks]
- (b) Ozone is an inorganic molecule with the chemical formula O_3 . Draw the Lewis structure of ozone and describe the hybridisation process for the central atom in ozone. [5 marks]
- (c) Explain the statement below:
 i The boiling point of water is 100°C , while ammonia is -33.34°C .
 ii Aluminium has higher boiling point than magnesium. [4 marks]
- 4 (a) A 12.5 L mixture of neon, helium and nitrogen gas at 405 K has a mole ratio of 1:2:1 respectively. The partial pressure of neon in the mixture is 1.3 atm.
 i Calculate the total pressure of the gas mixture.
 ii If the gas mixture is compressed until it reaches volume of 5.0 L, calculate the new partial pressure of helium gas? [3 marks]
- (b) State the conditions when a gas deviates from ideal gas behavior. Explain. [3 marks]
- (c) The equilibrium data for substance **A** are shown in **TABLE 1**.

	Temperature (K)	Pressure (atm)
Triple point	200	0.5
Critical point	650	12.1
Melting point	240	1.0
Boiling point	310	1.0

TABLE 1

- Plot and label the phase diagram for substance **A**. [3 marks]
- 5 In an experiment, the following reaction system is observed in a 3.0 L container.
- $$\text{COCl}_2(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + \text{Cl}_2(\text{g})$$
- At equilibrium, the gas mixture has an amount of 2.4 mol COCl_2 , 1.5 mol CO and 1.8 mol Cl_2 at 350 K.
- (a) Calculate the K_c of the reaction at 350 K.
 (b) At temperature of 520 K, the value of K_c was found to be 1.5 times higher than its initial value at 350 K. Determine the K_p value at 520 K.
 (c) Explain how the equilibrium position would be affected if :
 i the concentration of carbon monoxide is increased.
 ii the pressure of the container is reduced. [9 marks]
- 6 (a) The percentage ionisation of a 2.5×10^{-3} M pyridine, $\text{C}_5\text{H}_5\text{N}$ solution is 0.082%. Calculate the:
 i dissociation constant, K_b of pyridine, $\text{C}_5\text{H}_5\text{N}$.
 ii pH of the solution. [7 marks]
- (b) Calculate the pH of a solution containing 0.30 M CH_3COOH and 0.40 M CH_3COONa . (K_a of $\text{CH}_3\text{COOH} = 1.8 \times 10^{-5}$) [2 marks]
- (c) Given the solubility product, K_{sp} for magnesium phosphate, $\text{Mg}_3(\text{PO}_4)_2$ is 5.2×10^{-24} , calculate the solubility of $\text{Mg}_3(\text{PO}_4)_2$ in g L^{-1} . [5 marks]

END OF QUESTIONS