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 CO₂ and 0.54 g H₂O.
 - (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, C₇H₈ is 0.867 g mL⁻¹, and the density of thiophene, C₄H₄S 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, H₂S gas has the odour of rotten eggs. It reacts with oxygen, O₂ gas in the air to form sulphur dioxide, SO₂ gas and water, H₂O.
 - (i) Write the balanced chemical equation for the above reaction.
 - (ii) If 6 dm³ H₂S is burnt in 12 dm³ 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.

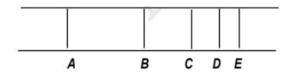


FIGURE 1

- 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**.
 - 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, CCl₄ and sulfur tetrachloride, SCl₄ are some of the covalent compounds of chloride.

- i Determine the molecular geometry of CCl₄ and SCl₄.
- ii Deduce the polarity of CCl₄ and SCl₄.

[8 marks]

(b) Ozone is an inorganic molecule with the chemical formula O₃. Draw the Lewis structure of ozone and describe the hybridisation process for the central atom in ozone.

[5 marks]

- (c) Explain the statement below:
 - 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]

In an experiment, the following reaction system is observed in a 3.0 L container.

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

At equilibrium, the gas mixture has an amount of 2.4 mol COCl₂, 1.5 mol CO and 1.8 mol Cl₂ at 350 K.

- (a) Calculate the Kc of the reaction at 350 K.
- (b) At temperature of 520 K, the value of Kc was found to be 1.5 times higher than its initial value at 350 K. Determine the Kp 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 x10⁻³ M pyridine, C₅H₅N solution is 0.082%. Calculate the:
 - i dissociation constant, K_b of pyridine, C_5H_5N .
 - ii pH of the solution.

[7 marks]

(b) Calculate the pH of a solution containing 0.30 M CH₃COOH and 0.40 M CH₃COONa. (K_a of CH₃COOH = 1.8×10^{-5})

[2 marks]

(c) Given the solubility product, K_{sp} for magnesium phosphate, Mg₃(PO₄)₂ is 5.2x10⁻²⁴, calculate the solubility of Mg₃(PO₄)₂ in gL⁻¹. [5 marks]