SK015
Chemistry
Semester 1
Session 2023/2024
2 hours

SK015
Kimia
Semester 1
Sesi 2023/2024
2 jam

STRIVE FOR EXCELLENT

CHEMISTRY

2 hours

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INSTRUCTIONS TO CANDIDATE:

This question paper consists of **6 questions**.

Answer **all** questions.

Maximum marks awarded are shown in brackets at the end of each question or section.

The use of electronic calculator is permitted.

1 (a) An element **X** contains two isotopes. **TABLE 1** shows percentage of the relative abundances of each isotope.

TABLE 1

Isotopic mass (amu)	6	7
Relative abundance (%)	4.85	95.15

(i) Calculate relative atomic mass of element **X.**

(ii) Predict the element X.

[4 marks]

(b) Compound Y has a mass of 31.64 g. Analysis of Y shows that it contains 7.85 g potassium, 10.98 g manganese and oxygen. Determine the empirical formula of Y.

[4 marks]

(c) 1 liter solution containing 292 g of magnesium nitrate, $Mg(NO_3)_2$ with a density of 1.18 g mL^{-1}. Calculate the

(i) molality

(ii) percent by mass

of $Mg(NO_3)_2$ in the solution.

[6 marks]

(d) Sodium bicarbonate, $NaHCO_3$ reacts with citric acid, $H_3C_6H_5O_7$ as follows:

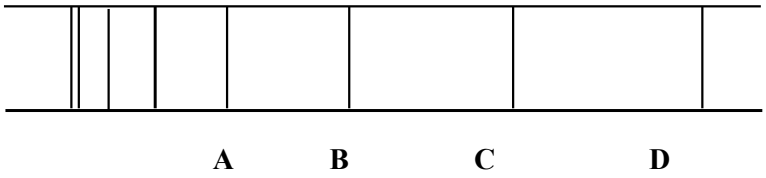
$$3NaHCO_3 + H_3C_6H_5O_7 \rightarrow 3CO_2 + 3H_2O + Na_3C_6H_5O_7$$

In an experiment, 1.0 g of sodium bicarbonate and 1.0 g of citric acid are allowed to react.

(i) Calculate the mass of carbon dioxide formed.
(ii) Determine the mass of excess reactant remain after the reaction is completed.

[7 marks]

2 (a) The Brackett series of hydrogen emission spectrum is shown below.



(i) State the electron transition that produces line **A**.

(ii) Determine the wavelength of line **A**.

(iii) Illustrate the electronic transition of lines **A**, **B**, **C** and **D** on the energy level diagram of the hydrogen atom.

[6 marks]

(b) Chromium is the fourth element in the first row of *d* block of the Periodic Table.

(i) Write the expected configuration of chromium according to aufbau principle and the actual configuration of chromium.

(ii) Give reason(s) for the anomaly in (b)(i).

(iii) Give one set of four quantum numbers for an electron in the highest energy level in chromium atom.

[4 marks]

3 (a) By using Lewis structure and valence shell electron pair repulsion (VSEPR) theory, explain the difference in the bond angles between PCl_3 and H_2O compounds.

[4 marks]

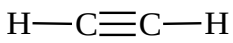
(b) The cyanate ion is an ambidentate ligand, forming complexes with a metal ion has chemical formula written as OCN^- or NCO^-.

(i) Illustrate possible resonance structures for the cyanate ion

(ii) Determine the most plausible Lewis structure of cyanate ion. Explain your answer.

[6 marks]

(c) The Lewis structure of ethyne, C_2H_2 is shown below :



(i) Predict the type of hybridization of C atom in this molecule.

[2 marks]

(ii) Illustrate the hybridization process of the central atom and the overlapping of orbitals showing all the σ and π bonds formed in the ethyne.

[5 marks]

4 (a) A gaseous sample contains 0.35 moles of argon at a temperature of 13°C and a pressure of 568 torr.

(i) If it is heated to 56°C and a pressure of 897 torr, calculate the change in volume that occurs.

(ii) Explain how argon can deviate from ideal behaviour at low temperature.

[4 marks]

(b) **FIGURE 1** below shows the vapor pressure for three different liquid which are diethyl ether, ethanol and water.

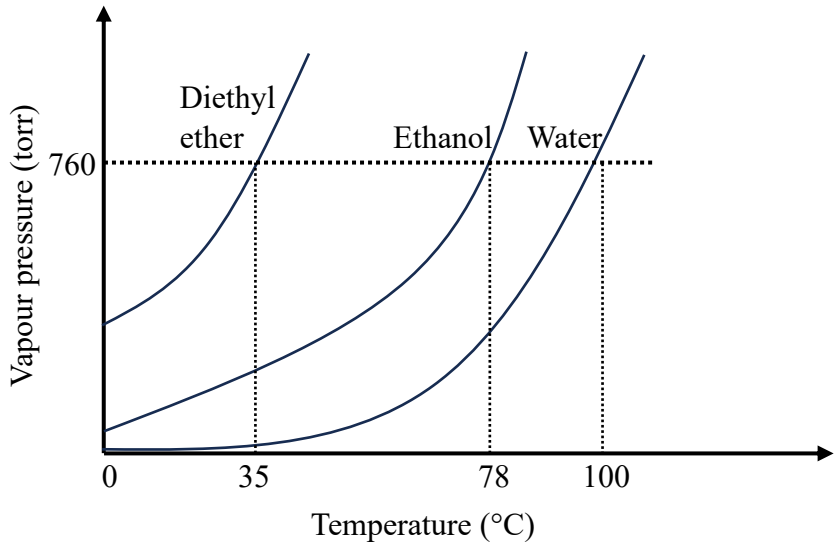


FIGURE 1

Identify the most volatile liquid and explain your answer in terms of intermolecular forces.

[2 mark]

(c) **Unknown X** is a compound where its solid state is denser than its liquid state. The triple point and critical point of **unknown X** is given in the following **TABLE 1**

	Pressure (atm)	**Temperature (°C)**
Triple point	5.1	-57
Critical point	73	31

TABLE 1

(i) Sketch a label phase diagram of **unknown X** by using the information given.

(ii) Explain why there is a difference in the slope of the equilibrium line of solid-liquid in the phase diagram of water.

[3 marks]

5 The equilibrium between nitrogen dioxide (dark brown) and dinitrogen tetraoxide (colourless) is represented by the equation below:

$$2NO_2\ (g) \rightleftharpoons N_2O_4\ (g) \qquad \Delta H = -58.84\ kJ$$

(a) At 100°C, the value of K_c is 5.0. Calculate K_p for the above reaction.

[2 marks]

(b) If initially 1 mole of NO_2 is filled into a 1L vessel, determine the concentration of N_2O_4 at equilibrium.

[3 marks]

(c) Sketch a graph showing how the concentrations of the **reactant** and **product** of the above reaction vary during the course of the reaction.

[2 marks]

(d) Explain how the temperature can cause the colour changes from colourless to dark brown.

[2 marks]

6 (a) Pyridine, C_5H_5N, is a weak base which is used to make many different products such as medicine, vitamins and food flavorings.

(i) Calculate the pH 0.60 M pyridine.
K_b $C_5H_5N = 1.7 \times 10^{-9}$

[4 marks]

(ii) Pyridine reacts with HCl to form pyridinium chloride salt, C_5H_6NCl. Explain qualitatively the classification of the salt formed.

[4 marks]

(b) For a titration between 25.00 mL of 0.1 M ethanoic acid, CH_3COOH with 0.30 M potassium hydroxide, KOH, sketch the titration curve of pH against volume of titrant and show the equivalence point and buffer region (if any).

[3 marks]

(c) Predict whether the precipitate will form when 0.5 M $CaCl_2$ is dissolved in 0.1 M NaF.
K_{sp} of $CaF_2 = 3.9 \times 10^{-11}$

[3 marks]