



**School of Computing and Engineering Sciences**

Bachelor of Science in Electrical and Electronic Engineering

End of Semester Examination

Course Code: CHE 1101

Unit Name: Chemistry I

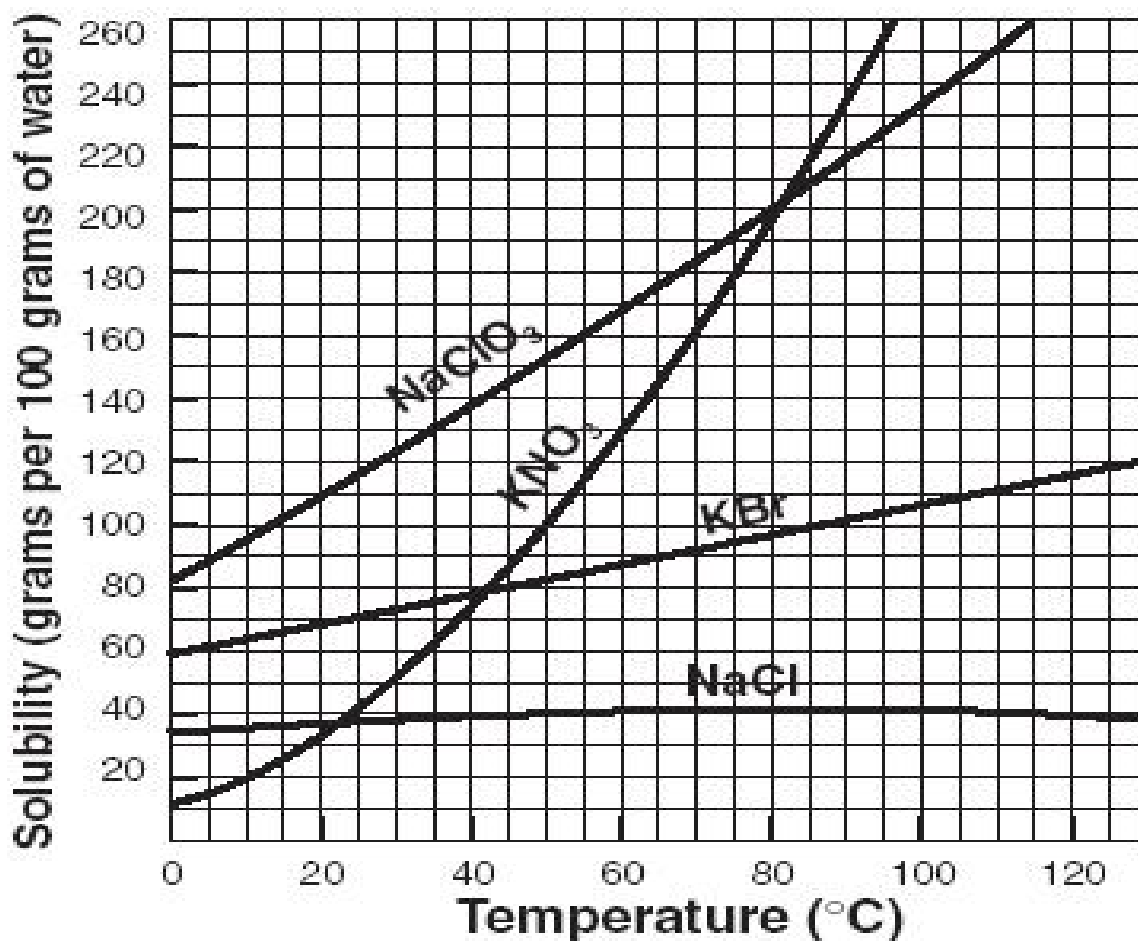
**Date: 22<sup>nd</sup> OCTOBER 2024**

**Time 08:00-10:30 Hours**

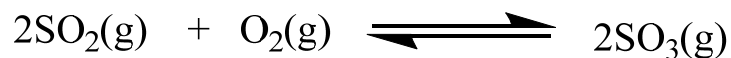
**Instructions:** Answer Question **ONE** and any other **TWO** Questions

**QUESTION 1 (20 MARKS)**

- (a) Differentiate the following terms:-
- (i) saturated and supersaturated solutions [2 marks]
  - (ii) Ionization energy and electron affinity [2 marks]
- (b) Bohr and Rutherford discovered different theories in order to determine the structure of an atom.
- (i) Differentiate between Rutherford's and Bohr's model [2 marks]
  - (ii) State the weakness of Bohr's model [1 mark]
- (c) An atomic orbital can be defined by four different quantum numbers. Given the principal quantum number  $n=2$ ;
- (i) Determine the orbital quantum numbers [2 marks]
  - (ii) Give the properties of an atom that can be explained by magnetic quantum numbers and spin quantum numbers [2 marks]
- (d) Ionic radius of sodium is smaller than its atomic radius while that of chlorine the ionic radius is bigger than the its atomic radius [3 marks]
- (e) A solution of NaOH has a pH of 11.50. Determine the concentration of this solution [3 marks]
- (f) The graph shows solubility curves for some salts. Use it to answer the questions that follows;



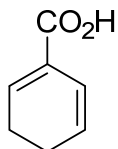
- (i) Determine the amount of KBr that can dissolve in 100 grams of water at 20° C [1 mark]
- (ii) Calculate the number of moles of KNO<sub>3</sub> that can dissolve in 100g of water at 60° C [2 marks]
- (iii) Give the amount in grams of NaCl that can dissolve in 100 g of water at 100° C [1 mark]
- (iv) At 20 °C you dissolve 100 g of NaClO<sub>3</sub>. Determine whether the solution is unsaturated, saturated or supersaturated. [1 mark]
- (g) Consider the following equilibrium, for which  $\Delta H < 0$ :



Explain how each of these will affect the equilibrium mixture of the three gases

- (i) O<sub>2</sub>(g) is added to the system [1 mark]
- (ii) Catalyst is introduced to the system [1 mark]
- (iii) The pressure of the system is decreased [2 marks]

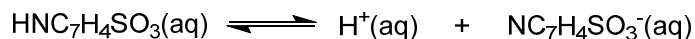
(h) Study the structure and use it to answer the question that follow



State any TWO spectroscopic techniques that you would use to identify the compound. Give explanations for your answer [4 marks]

### **QUESTION 2 (15 MARKS)**

(a) Saccharin, a sugar substitute, is a weak acid with  $pK_a = 2.32$  at  $25^\circ \text{C}$ . It ionizes in aqueous solutions as follows:



Calculate the pH of a 0.01 M solution of this substance [5 marks]

(b) Write a balanced equation for the following reaction

i) Lithium and water [2 marks]

ii) Aluminium and hydrochloric acid [2 marks]

(c) A buffer solution contains 0.10 moles of acetic acid and 0.13 moles of sodium acetate in 1.00 L. ( $K_a = 1.8 \times 10^{-5}$ )

i) Calculate the pH of the buffer [2 marks]

ii) Calculate the pH after addition of 0.01 M NaOH [4 marks]

### **QUESTION 3 (15 MARKS)**

(a) Write the electronic configuration of the following elements [3 marks]

i) Asernic

ii) Strontium

iii) Lead

(b) The value of  $K_{sp}$  for Manganese (II) hydroxide,  $\text{Mn}(\text{OH})_2$  is  $1.6 \times 10^{-13}$ .

i) Describe the common ion effect [2 marks]

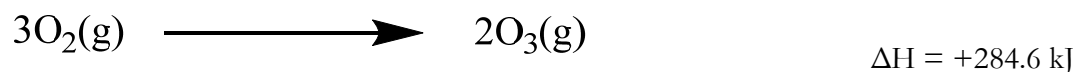
- (c) The value of  $K_{sp}$  for Manganese (II) hydroxide,  $Mn(OH)_2$  is  $1.6 \times 10^{-13}$ .
- Determine the solubility of  $Mn(OH)_2$  at this temperature [3 marks]
  - Calculate the molar solubility of  $Mn(OH)_2$  in a solution that contains 0.02M NaOH [2 marks]
- (d) Describe the theory behind UV spectroscopy [5 marks]

**QUESTION 4 (15 MARKS)**

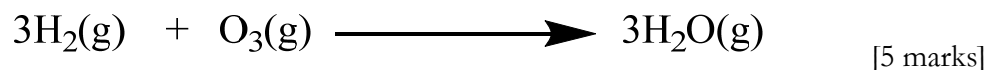
- (a) A mixture of  $5.0 \times 10^{-3}$  moles of  $H_2$  and  $1.0 \times 10^{-2}$  moles  $I_2$  is placed in a 5L container and allowed to come to equilibrium. Analysis of the equilibrium mixture shows that the concentration of HI is  $1.8 \times 10^{-3}$  M. Calculate  $K_c$  at  $448^\circ C$  for the reaction [6 marks]
- (b) Discuss any TWO factors that can affect the equilibrium concentration b[6 marks]
- (c) Calculate the pH of an aqueous solution of  $Ca(OH)_2$  that has a pH of 12.00 [3 marks]

**Question 5 (20 marks)**

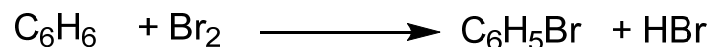
- (a) Use the following reaction equations to answer the questions that follow



- State Hess's law [1 mark]
- Calculate the heat of the reaction



- (b) Give four properties of non-metals [4 marks]
- (c) A student reacts benzene,  $C_6H_6$ , with bromine,  $Br_2$  to prepare bromobenzene,  $C_6H_5Br$ .



- Calculate the theoretical yield of bromobenzene in this reaction when 30.0 g of benzene reacts with 65.0 g of bromine [4 marks]
- If the actual yield of bromobenzene was 56.7 g, calculate the percentage yield [1 mark]

