



**STRATHMORE UNIVERSITY**  
**SCHOOL OF COMPUTING AND ENGINEERING SCIENCES**  
**Bachelor of Electrical Engineering**  
**Final Examination**  
**CHE1101: CHEMISTRY 1**

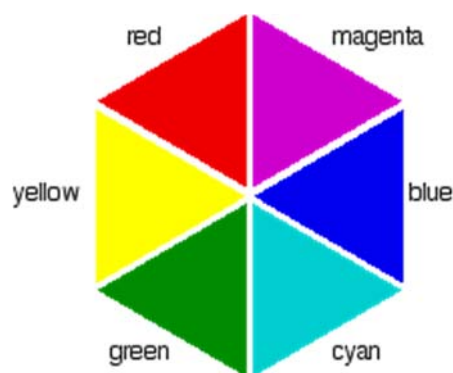
**DATE: 9<sup>th</sup> November 2021**

**TIME: 2 hours**

**Instruction: Answer question one and any two other questions.**

**Question One**

- I. Red cabbage indicator is a pH indicator made from the leaves of a red cabbage. It contains an anthocyanin-based dye that can be used as a pH indicator.

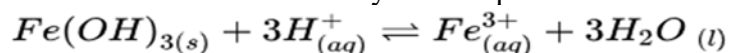


- a) Describe the process of extracting red cabbage indicator from red cabbage. ( 2 marks)
  - b) Explain why the above procedure was followed (2 marks)
  - c) What colors were observed when the indicator is added to acidic and basic solutions? (1 mark).
  - d) Explain using a graph the relationship between absorbance of electromagnetic waves and the wavelength of the waves absorbed in acidic and basic solutions. (2 marks)
  - e) Explain the chemical process that takes place when the indicator is added to acidic and basic solutions to enable electromagnetic energy absorption (3 marks)
- II.  
Titration of vinegar (acetic acid,  $CH_3COOH$ ) is done in the laboratory using a strong base, sodium hydroxide ( $NaOH$ ) and phenolphthalein indicator.  $K_a = 1.8 \times 10^{-5}$

- a) Describe the procedure of the experiment (2 marks).
- b) What is the pH at each of the following points in titration of 25 mL of 0.100M acetic acid with 0.100M sodium hydroxide
- Before addition of any sodium hydroxide (Initial pH) (2 marks)
  - After addition of 10 mL 0.100M sodium hydroxide (Before Equivalence point) (2 marks)
  - After addition of 12.50 mL of 0.100M sodium hydroxide (Half Neutralization) (2 marks)
  - After addition of 25.00 mL 0.100M sodium hydroxide( Equivalence Point) (3 marks)
  - After addition of 26 mL 0.100M sodium hydroxide (Beyond Equivalence point) (3 marks)
- c) Draw the titration curve. (3marks)
- d) What is the relationship between solubility and pH? (3 marks)
- (Total 30 Marks)**

### Question Two

- a) The following reaction is said to have attained dynamic equilibrium.



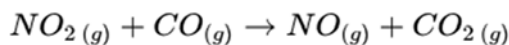
- What is your understanding of the term “dynamic equilibrium”? (2 mark)
  - Write the expression of dynamic equilibrium for the above reaction (2 mark)
  - Compute dynamic equilibrium concentration for Iron cation at pH 7. (3 marks)  
 **$K=9.1 \times 10^3$**
- b) Solid silver is added to a solution with these initial concentrations  $[Ag^+] = 0.200M$ ,  $[Fe^{2+}] = 0.100M$ , and  $[Fe^{3+}] = 0.300M$ .  $K_c=2.98$

The reaction is as follows:

- Write the equation for the reaction (2 marks)
- What are the ionic concentrations when equilibrium is established? (6 marks)

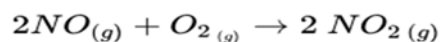
### Question Three

- a) The following rates of reaction were obtained in four experiments with the reaction



Experiment	$[\text{NO}_2]_0/\text{molL}^{-1}$	$[\text{CO}]_0/\text{molL}^{-1}$	$(\text{Rate of reaction})_0/\text{mol L}^{-1}\text{s}^{-1}$
1	0.15	0.15	0.011
2	0.30	0.15	0.045
3	0.60	0.30	0.18
4	0.60	0.60	0.18

- i) What is the rate law for this reaction? (4 marks)
- ii) How would the relation of reactants concentration and time look like graphically? (2 marks)
- b) Determine the intermediate reactions for the following overall reaction (2 marks)



- c) Show that this mechanism is consistent with rate law (7 marks)

#### Question Four

$\text{AgNO}_3(\text{aq})$  is slowly added to a solution that has  $[\text{CrO}_4^{2-}] = 0.010\text{M}$ , ( $K_{\text{sp}} = 1.1 \times 10^{-12}$ ) and  $[\text{Br}^-] = 0.010\text{M}$ , ( $K_{\text{sp}} = 5.0 \times 10^{-13}$ ).

- a) Show which compound is going to precipitate first. (6 marks)
- b) When the second compound begins to precipitate what is the concentration of the first compound in solution? (4 marks)
- c) Is complete separation of  $\text{Br}^-(\text{aq})$  and  $\text{CrO}_4^{2-}$  feasible? (5 marks)

#### Question Five

The acidity constant for an organic weak acid was determined by measuring its absorbance as function of pH, while maintaining a constant total concentration of acid.

Using the data in the following table

pH	Absorbance
3.66	0.035
4.11	0.072
4.35	0.103

4.75	0.169
4.88	0.193
5.09	0.227
5.69	0.288

- a) Plot the graph of the relation between absorbance and concentration (7 marks)
- b) Determine the acidity constant for organic weak acid. (8 marks)