

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

DATE: 11th NOVEMBER 2022

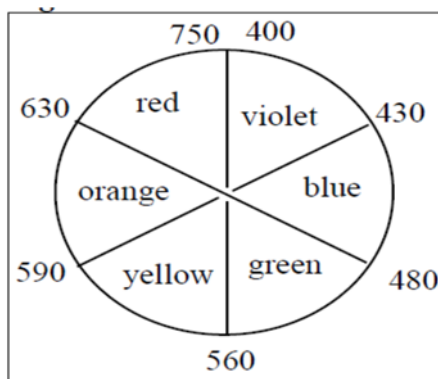
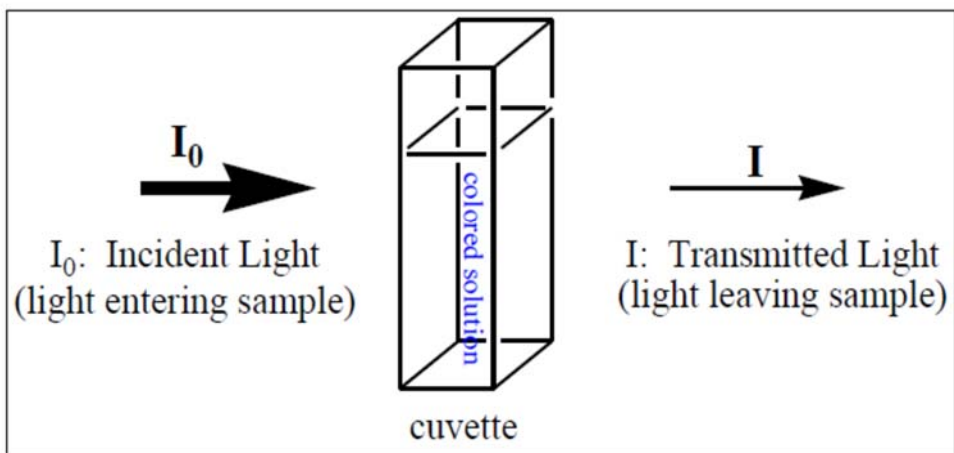
TIME: 3 HOURS

INSTRUCTION: ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS.

QUESTION ONE [TOTAL 30 MARKS]

I

- a) Describe the procedure for an experiment on forming Calcium Sulphate crystals in a solution.(4 Marks)
- b) The vessel below contains copper sulfate solution. What would be the observed and absorbed colors of the solution? (2 Marks).
- c) What is your understanding of the relationship between electromagnetic radiation and the colors of chemical species? (4 Marks).



II

a) Is it possible for a weak acid solution to have a lower pH than a strong acid solution? If not, why not? If it is possible, under what conditions? (3 Marks)

b) Hydrochloric Acid is placed in a beaker and diluted using distilled water up to a concentration of 1.0×10^{-8} M. Calculate the pH of the final solution. (3 Marks)

c) A titration experiment is carried out in the lab for Acid 1 and 2 using a 0.1 M, NaOH base and methyl orange indicator. The titration details are as follows.

	Acid 1	Acid 2
Volume	50.mL	50 mL
Dissociation constant (K_a)	$K_a > 1$	$K_a = 1.76 \times 10^{-5}$
Moles/litre	0.1M	0.1M

i) Identify the strong acid and weak acid. (1 Mark)

The volume of NaOH added (mL)	pH	
	Titration 1	Titration 2
0	3	4.4
10	4.2	5.8
20	4.4	6.4
30	4.6	6.6
40	5.0	7.2
50	6.0	7.4
50	7.0	7.8
50	8.0	8.4
50	9.0	9.6
50	10	10
60	12	12
70	13	13
80	14	14

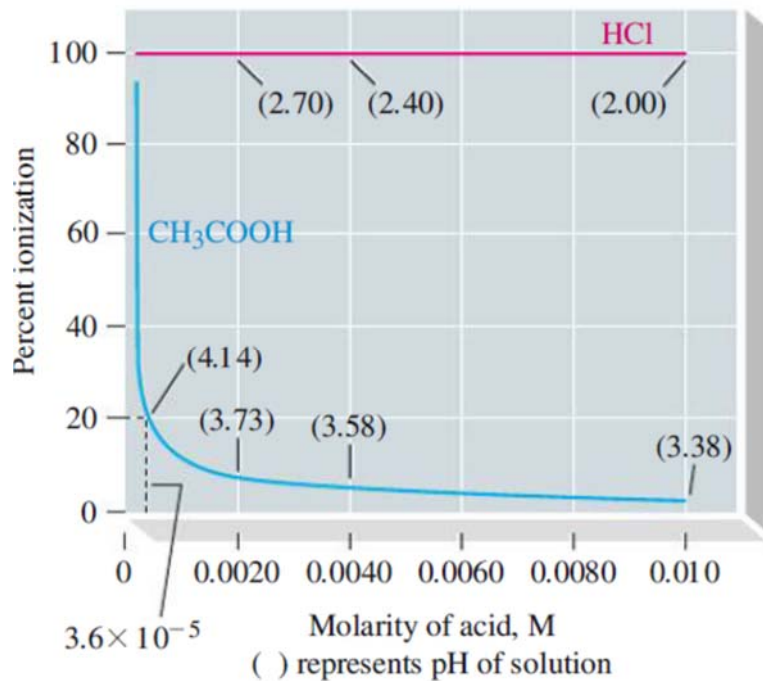
ii) Construct the titration curves. (4 Marks)

iii) Explain the shape of the curves before neutralization, at the neutralization point, and after neutralization. (4 Marks)

d) Calcium sulfate (CaSO_4 , solubility product $K_{sp} = 2 \times 10^{-5} \text{ M}^2$), is added to initially pure water, such that solid CaSO_4 remains at equilibrium. (Assume the sulfate does not participate in a reaction other than the solubility product; no HSO_4^- formed). What is the pH of the solution at equilibrium?

(3 marks)

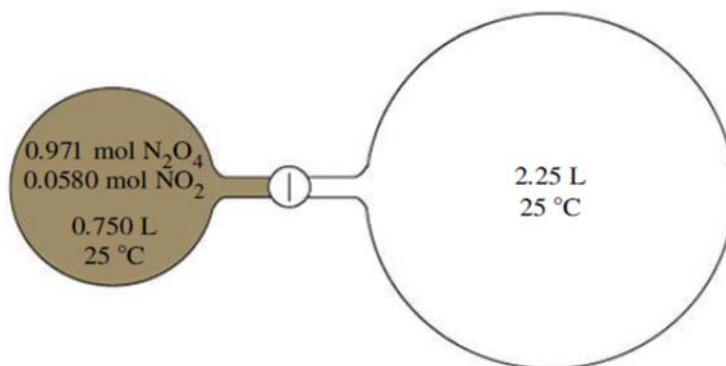
e) The following graph shows the percent ionization and solution molarity for a weak acid and a strong acid. Explain the trend for the two curves (4 marks)



QUESTION TWO (EQUILIBRIUM CONSTANT) [TOTAL 15 MARKS]

a) How do you know that a chemical reaction equilibrium is dynamic? (2 Marks)

(ii) The N_2O_4 - NO_2 equilibrium mixture in the flask on the left in the figure is allowed to expand into the evacuated flask on the right.



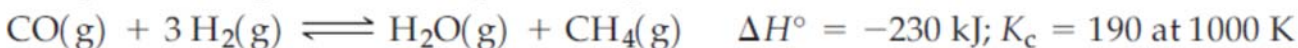
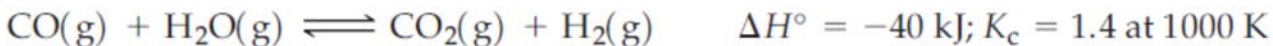
What is the composition of the gaseous mixture when equilibrium is re-established in the system consisting of the two flasks? (6 marks)

b) In the manufacture of ammonia, the chief source of hydrogen gas is the following reaction for the reforming of methane at high temperatures.



At 1000 K, 1.00 mol each of CH_4 and H_2O are allowed to come to equilibrium in a 10.0 L vessel.

The following additional data are also given.

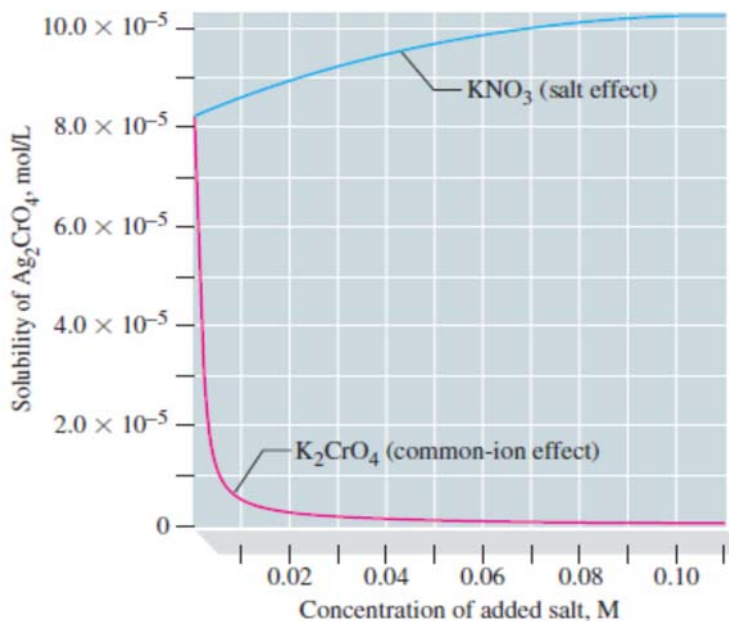


i) Calculate the number of moles of H_2 present at equilibrium. (5 Marks)

ii) Would the yield of H_2 increase if the temperature were raised above 1000 K? (2 Marks)

QUESTION THREE (SOLUBILITY) [TOTAL 15 MARKS]

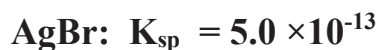
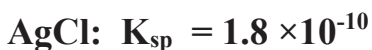
a) The following graph shows the comparison of the common-ion effect and the salt effect on the molar solubility of Ag_2CrO_4 .



i) Describe the effect of common ion and salt effect on solubility of Ag_2CrO_4 (2 Marks)

ii) Explain the effect of common ion and salt effect on solubility of Ag_2CrO_4 (4 Marks)

b) $\text{AgNO}_3(\text{aq})$ is slowly added to a solution with $[\text{Cl}^-] = 0.115 \text{ M}$, and $[\text{Br}^-] = 0.264 \text{ M}$.



i) What percent of the first ion remains unprecipitated at the point at the second ion begins to precipitate? (5 Marks)

ii) Verify the assertion that $[\text{Ag}^+]$ increases very rapidly between the point at which the first precipitate has finished precipitating and the second is about to begin. (4 marks)

QUESTION FOUR (CHEMICAL KINETICS) [TOTAL 15 MARKS]

a) In the reaction of gaseous nitrogen and hydrogen to form gaseous ammonia.

i) What are the relative rates of disappearance of the two reactants? (2 marks)

ii) How is the rate of formation of the product related to the rates of disappearance of the reactants? (2 marks)

b) The table below shows the concentration and time data for the decomposition of hydrogen peroxide

i) Using the data in the table and the equation given below, show that the decomposition of H_2O_2 is a first-order reaction (5 marks)

Time, seconds	$[\text{H}_2\text{O}_2]$
0	2.32
200	2.01
400	1.72
600	1.49
1200	0.98
1800	0.62
3000	0.25

$$\ln[A]_t = (-k)t + \ln[A]_0$$

ii) What is the time required for one-half of a reactant to be consumed? (3 marks)

iii) Determine the percent of H_2O_2 that has decomposed in the first 500.0 seconds after the reaction begins. (3 marks)

QUESTION FIVE (SPECTROCHEMICAL METHODS) [TOTAL 15 MARKS]

a) Which solution is expected to deviate from the straight line in a Beer's Law plot: the more concentrated or more dilute solution? (2 marks)

ii) Why is your answer the case (2 marks)

b) Absorbance readings are taken for seven standard cobalt (II) chloride solutions. A cobalt ion solution of unknown concentration is found to have an absorbance of 0.28 at a wavelength 560 nm.

Absorbance	Concentration, M
0.00	0.0038
0.10	0.044
0.20	0.048
0.30	0.058
0.40	0.08
0.50	0.12
0.60	0.20
0.70	0.30
0.80	0.40

i) Determine the concentration of unknown cobalt ion (5 marks)

ii) Calculate the solubility constant for cobalt (II) chloride (3marks)

iii) Why is the wavelength of light set at maximum absorbance when making a Beer's Law Plot? (3 marks)