# University of Information Technology & Sciences (UITS)
## Faculty of Science and Engineering
### Department of CSE
Term Final Examination, Spring-2024
Course Code: CHEM 175
Course Title: Chemistry

Marks: 50                                                                Time: 3 Hours

*Answer all the questions. Assume necessary data/values if missing*

1. (a) Most of the times, we assume that half-life of any reaction is dependent   **4**
on initial concentration of the reactants. Sometimes, it appears to be false.
Identify the half-life of a first-order and a second-order reaction and show
that one of them is not dependent on initial concentration of reactant.

(b) You are assigned to design programming codes for a sensor to detect   **3**
acids and bases. Hence, you require theoretical explanation of acid-base to
test your codes. Now, describe Brønsted–Lowry and Lewis Acid-Base
using the following reaction:

$$H^+ + \ddot{N}H_3 \rightarrow NH_4^+$$

(c) Discuss $sp^3$ hybridization in $H_2O$ molecule with electronic configuration   **3**
and diagram.

2. (a) A researcher is synthesizing semiconductor materials where he requires   **4**
constant pH environment. He used buffer solution. Describe the reaction
mechanisms of acidic and basic buffer solutions to fulfill his purpose.

(b) You need 0.5M HCl for a laboratory experiment but you have found 4M   **3**
HCl in the lab. Therefore, you need to dilute the solution before use.
Determine the volume of water needed to dilute 200 mL of a 4 M solution
to a final concentration of 0.5M.

(c) Red cabbage juice turns red in acidic solutions and green in basic   **3**
solutions. You have three unknown solutions. By mixing a small amount
of each solution with red cabbage juice, you observe following changes:
Solution A + cabbage juice → pink, Solution B + cabbage juice → dark
purple, Solution C + cabbage juice = teal blue. Knowing that a neutral
solution with cabbage juice turns purple, can you analyze the solutions
from strongest acid to strongest base?

3. (a) Discuss the Effect of temperature on an exothermic and endothermic    4
       reaction at equilibrium.

   (b) Describe the factors that can affect chemical equilibrium.             3

   (c) You are working in a production engineering team where you are assigned   3
       to design a vessel structure to sustain at the highest pressure. Therefore,
       the partial pressure is required to be calculated. The equilibrium constant
       $(k_p)$ for the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ is $10^2$ at a certain
       temperature. If the partial pressures of $SO_2$ and $O_2$ are 0.2 atm and 0.4
       atm, respectively. Determine the partial pressure of $SO_3$ at equilibrium.


4. (a) Derive rate equation of first order reaction with half-life            4

   (b) A first order reaction takes 20 min for 15% completion. Determine the   3
       rate constant and how long it takes to 60% completion.

   (c) One day you have found a reagent bottle containing $OH^-$ where it labeled   3
       as $1 \times 10^{-4}$ M. You want to write the pH on the label for convenience.
       Determine the pH of a solution with a hydroxide ion concentration of $1 \times 10^{-4}$ M.


5. (a) Explain Lewis dot structure of $CH_2O$ and $NH_3$.                      4

   (b) Stability of compound can be evaluated using their bond order. Show the   4
       order of stability of $H_2$, $H_2^-$, $H_2^+$ using that concept.

   (c) Assume that you are working as programming engineer at chemical          2
       industry. There is a boiler in which pressure should be below 70 kPa.
       Suggest any code in programming language for controller so that sensor
       detects the pressure and when pressure is above 70 kPa, the vent should
       be opened automatically; after the pressure reduced down to 70 kPa, the
       vent should be closed again.