AHMEDABAD UNIVERSITY
School of Engineering and Applied Science
2025-2026 Monsoon

Physical Chemistry (CHE101)
End-Term Examination
November 30, 2025, Sunday, 5:00 pm – 7:00 pm

Name:	Roll no.	A U 2	Marks /60

A. Short answer type questions. Show the calculations where ever necessary (3 marks each)

1. a) In the following reaction identify the oxidized and reduced specie, oxidizing and reducing agent. $Fe^{2+} + 2H^+ + NO_3^- \rightarrow Fe^{3+} + NO_2 + H_2O$

b) "CH_3COONH_4 can act as a buffer". Justify whether this statement is true or false.

2. Explain what is a basic buffer and how it works? Derive an expression of pH for basic buffer solutions.

3. Classify the following species as Arrhenius acids/bases, Brønsted–Lowry acids/bases, or Lewis acids/bases: HCl, NH_4^+, OH^-, NH_3, BF_3, Al^{3+}. Give one line justification in each case.

4. Calculate the partial pressure of gaseous hydrochloric acid above a sample of ammonium chloride(s). Decomposition of ammonium chloride(s) gives ammonia gas and gaseous hydrochloric acid. Standard Gibb's free energy values in the same order are -202.96 kJ/mole; 16.48 kJ/mole and -95.30 kJ/mole respectively.

5. a) Explain the difference between Hydrogen electrode and Calomel electrode with the help of a diagram. Also write the cell reaction for both.

b) What is ionic product of water, explain by giving its expression.

6. Predict whether the following reaction is feasible or not.

$$2Ag\ (s) + Zn^{2+} \rightarrow Ag^+\ (aq) + Zn\ (s)$$

Given that $E^o_{Ag^{+}/Ag} = -0.80$ V and $E^o_{Zn^{2+}/Zn} = -0.76$ V.

7. How are resistance, conductance, specific resistance and specific conductance related? Develop a relationship between current carried by an ion and speed of that ion. How is it related to the transport number of the ion?

8. Develop a relation between the three equilibrium constants.

9. a) Compound A decomposes to form B and C and this reaction is first order. At 25 °C the rate constant is 0.450 s^{-1}. What is the value of $t_{0.5}$ at this temperature?
b) In kinetics what is law of mass action, also write the rate law (rate expression) using the Law of Mass Action: $NO + O_2 \rightarrow NO_2$

10. a) 0.5 N solution of a salt placed between two Pt electrodes, 20 m apart and cross-section area 4 sq. cm has a resistance of 25 ohms. Calculate specific conductance.

b) What is the molarity of a solution with 5 g sodium chloride resulting in a solution of 250 ml.

B. Long answer type questions (5 marks each)

1. A solution of H_2O_2 when titrated against $KMnO_4$ solution at different time intervals gave the following results:

t (minutes)	0	10	20
Vol of $KMOnO_4$ used for 10 ml H_2SO_4	23.8 ml	14.7 ml	9.1 ml

Show that the decomposition of H_2O_2 is a first order reaction.

2. What will be the value of pH before and after the addition of 0.01 mol of NaOH to 1 litre of a buffer solution that is 0.1 M in acetic acid and 0.1 M in sodium acetate. The dissociation constant of acetic acid is 1.7×10^{-5}

3. a) Explain the difference between homogeneous and heterogeneous equilibrium giving an example in each case.

b) Extent of dissociation of phosphorous pentachloride at a certain temperature is 25% at 1 atm pressure. Calculate the pressure at which the substance is ¾ dissociated at the same temperate.

4. a) Derive the expression for rate constant and half-life for zero order reaction.

b) What types of batteries are used in torches, mobile phones, and vehicles, and how are they different from each other? Give the features, advantages and disadvantages of each of these. Also, explain the reactions involved in any one of these.

5. Consider the equilibrium reaction: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + \text{heat}$

Using Le Chatelier's Principle, predict what will happen to the amount of NH_3 formed when:

i) Pressure is increased
ii) Temperature is increased
iii) More N_2 gas is added
iv) A catalyst is added
v) Define Le-Chatelier's Principle

6. a) Calculate the pH of a 0.01 M solution of acetic acid if ka for the acid is 1.8×10^{-5} at 25°C

b) Derive the expression for Nernst Equation, mentioning what each term in the derived equations refers to.