

KATHMANDU UNIVERSITY
End Semester Examination
June/July, 2023

Marks Scored:

Level : B.E./B.Sc./B.Tech.
Year : I

Course : CHEM 101
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date :

07 JUL 2023

SECTION "A"
[20Q. × 1 = 20 marks]

Mark [×] against the most appropriate answer from each set of choices.

- The conjugate base of HSO_4^- is
 H_2SO_3 H_2SO_4 SO_3^{2-} SO_4^{2-}
- For a reaction, $\text{A} + \text{B} \longrightarrow \text{C}$; the rate law equation is $\frac{d[\text{C}]}{dt} = k[\text{A}]^2[\text{B}]^{\frac{1}{2}}$. On increasing the concentration of A and B by four times, the rate of reaction is increased by times.
 8 16 32 64
- If the equilibrium constants for $2\text{H}_{2(\text{g})} + \text{O}_{2(\text{g})} = 2\text{H}_2\text{O}_{(\text{g})}$ and $\text{H}_2\text{O}_{(\text{g})} = \text{H}_{2(\text{g})} + \frac{1}{2}\text{O}_{2(\text{g})}$ are K_1 and K_2 respectively, which one of the following relations is correct?
 $K_2 = \frac{1}{K_1}$ $K_2 = \left(\frac{1}{K_1}\right)^{\frac{1}{2}}$ $K_2 = \frac{1}{2}\left(\frac{1}{K_1}\right)$ $K_2 = \left(\frac{1}{K_1}\right)^2$
- Which one of following steps in chain reaction produces more free radicals or chain carriers than they consume?
 chain initiation chain propagation
 chain branching chain termination
- A process is spontaneous at high temperature if.....
 $\Delta H > 0$ & $\Delta S > 0$ $\Delta H < 0$ & $\Delta S < 0$
 $\Delta H > 0$ & $\Delta S < 0$ $\Delta H > 0$ & $\Delta S = 0$
- The unit of rate constant for first order reaction is
 sec^{-1} M sec^{-1} $\text{M}^{-1} \text{sec}^{-1}$ $\text{M}^{-2} \text{sec}^{-1}$
- Which one of the aqueous solutions of following salts has pH below seven?
 CH_3COONa NH_4Cl NaCl $\text{CH}_3\text{COONH}_4$
- The standard electrode potential of two half cells are,
 $\text{Zn}^{2+} + 2\text{e}^- = \text{Zn}$ $E^\circ = -0.76 \text{ v}$
 $\text{Fe}^{2+} + 2\text{e}^- = \text{Fe}$ $E^\circ = -0.44 \text{ v}$
Which one of following is the strongest reducing agent?
 Fe Zn Fe^{2+} Zn^{2+}

9. Which one of the following is the colligative property?
 viscosity surface tension
 osmotic pressure refractive index
10. Which one of the following is the correct relation between equilibrium constant, standard entropy change and standard enthalpy change?
 $K = e^{\frac{\Delta S^\circ}{RT}} e^{-\frac{\Delta H^\circ}{R}}$ $K = 10^{\frac{\Delta S^\circ}{2.3RT}} 10^{-\frac{\Delta H^\circ}{2.3R}}$
 $K = e^{-\frac{\Delta S^\circ}{R}} e^{\frac{\Delta H^\circ}{RT}}$ $K = 10^{\frac{\Delta S^\circ}{2.3R}} 10^{-\frac{\Delta H^\circ}{2.3RT}}$

Fill in the blanks with appropriate words and values.

11. A sample of 0.350 gram alloy of aluminium and copper was treated with aqueous HCl and gave 415 cc of H_2 measured at 273 K and 1-atm pressure. The aluminium dissolved according to the reaction, $Al + 3H^+ \longrightarrow Al^{3+} + \frac{3}{2}H_2$ but, the copper remained as the pure metal. The weight percentage of Al in the alloy is
12. The expression for the temperature dependence of entropy change for n mole of substance from T_1 to T_2 at constant pressure is
13. In a galvanic cell, reduction always occurs at
14. In exothermic process, the internal energy of products is than that of reactants.
15. The solubility of CaF_2 in 0.1M NaF solution is (K_{sp} of $CaF_2 = 1.7 \times 10^{-10}$)
16. The intersection of the vapour pressure curve of the solution with the vapour pressure curve of the pure solid solvent is the
17. The value of equilibrium constant (K) for the reaction, $I_{2(g)} = 2I_{(g)}$ is, when temperature increases.
18. The relation between K_p and K_c for a reaction, $N_{2(g)} + 3H_{2(g)} = 2NH_{3(g)}$, is
19. The solutions which distill with no change in composition are called
20. The value of ΔG_f° for the reaction, $\frac{3}{2}O_{2(g)} = O_{3(g)}$, is
- (Given, $\Delta H_f^\circ(O_3) = 34 \text{ kcal mol}^{-1}$; $S^\circ(O_2) = 49 \text{ cal mol}^{-1} \text{ K}^{-1}$ and $S^\circ(O_3) = 56.8 \text{ cal mol}^{-1} \text{ K}^{-1}$)

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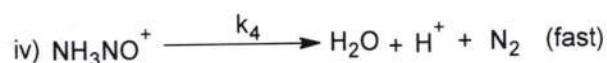
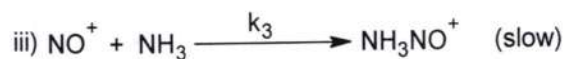
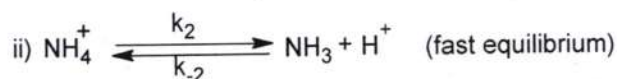
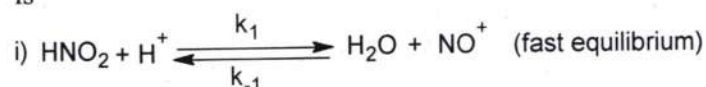
Level : B.E./B.Sc./B.Tech.
Year : I
Time : 2 hrs. 30 mins.

Course : CHEM 101
Semester : I
F.M. : 55

SECTION "B"
[5Q. × 6 = 30 marks]

Attempt ANY FIVE questions.

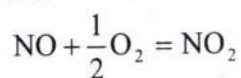
1. a. For a reaction, $\text{NH}_4^+ + \text{HNO}_2 \longrightarrow \text{N}_2 + 2 \text{H}_2\text{O} + \text{H}^+$, the proposed reaction mechanism is



Write the expression for differential rate law & rate law equation and total order for this reaction. [0.5+2+0.5]

- b. What is meant by anionic hydrolysis? Derive the relation between hydrolysis constant, ionic product of water and dissociation constant of weak acid. [1+2]
2. a. At 20°C, the vapor pressure of pure benzene is 22 mm, and that of pure toluene is 75 mm. What is the composition of the solution of these two components that has a vapor pressure of 50 mm at this temperature? What is the composition of the vapor in equilibrium with this solution? [3]

- b. Given, $\Delta G^\circ = -8.33 \text{ kcal}$ and $\Delta H^\circ = -13.5 \text{ kcal}$ at 298 K for the reaction



Calculate the equilibrium constants at 298 K and 598 K. [3]

3. Give reasonable explanations. (ANY THREE) [2+2+2]
- Equilibrium state is dynamic in nature.
 - The slowest step in a complex reaction is rate determining step.
 - The salt bridge balances the excess charge between two half cells in galvanic cell.
 - The colour of acid-base indicator in solution depends on the concentration of H_3O^+ .
4. Differentiate between the followings. (ANY THREE) [2+2+2]
- Buffer solution and azeotropic solution
 - Lewis acid and Bronsted acid
 - Enthalpy and internal energy
 - K_h and K_w

5. a. Balance the following redox reaction by ion-electron method. [2+2]
- i) $\text{ClO}_2 + \text{OH}^- \longrightarrow \text{ClO}_2^- + \text{ClO}_3^-$ (Basic medium)
- ii) $\text{MnO}_4^{2-} \longrightarrow \text{MnO}_2 + \text{MnO}_4^-$ (Acidic medium)
- b. How can you measure the single electrode potential experimentally? Explain with an example. [2]
6. a. From the following information, calculate the standard enthalpy change (ΔH°) for the reaction, $2\text{C}_{(s)} + \text{H}_{2(g)} \longrightarrow \text{C}_2\text{H}_{2(g)}$ $\Delta H^\circ = ?$ [3]
- i) $\text{C}_2\text{H}_{2(g)} + \frac{5}{2}\text{O}_{2(g)} \longrightarrow 2\text{CO}_{2(g)} + \text{H}_2\text{O}_{(l)}$ $\Delta H^\circ = -1299.5 \text{ kJ}$
- ii) $\text{C}_{(s)} + \text{O}_{2(g)} \longrightarrow \text{CO}_{2(g)}$ $\Delta H^\circ = -393.5 \text{ kJ}$
- iii) $\text{H}_{2(g)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{H}_2\text{O}_{(l)}$ $\Delta H^\circ = -285.8 \text{ kJ}$
- b. The equilibrium constant for the reaction, $\text{CO}_{2(g)} + \text{H}_{2(g)} = \text{CO}_{(g)} + \text{H}_2\text{O}_{(g)}$, is 0.1 at 690 K. What is the equilibrium pressure of each substance in a mixture prepared by mixing 0.50 mole of CO_2 and 0.50 mole of H_2 in a 5 liter flask at 690 K. [3]
7. a. The standard electrode potential (E°) for the half cell reactions are
- (i) $\text{e}^- + \text{Fe}^{3+} \longrightarrow \text{Fe}^{2+}$ $E^\circ = +0.771 \text{ v}$
- (ii) $2\text{e}^- + \text{I}_3^- \longrightarrow 3\text{I}^-$ $E^\circ = +0.536 \text{ v}$
- Write a net cell reaction and also calculate ΔE° and K . [3]
- b. A sample of an unknown oxide of barium gave upon exhaustive heating 5 gm of pure BaO and 366 cc of oxygen gas measured at 273 K and 1 atmospheric pressure. What is the empirical formula of the unknown oxide? What weight of oxide was present initially? (atomic mass of Ba = 137.33) [3]

SECTION "C"

[25 marks]

Attempt *ANY THREE* questions. **Question No. 8 is compulsory.**

8. a. Define enzyme catalysis with an example. Derive the Michaelis-Menten equation for enzyme catalysis and explain its kinetics. Why does the order of enzyme catalysis with respect to substrate change from first to zero order as concentration of substrate increases? [1+3+1]
- b. Define C_p and C_v . Derive the relationship between C_p and C_v . Why is the value of C_p always greater than that of C_v ? [1+2+1]
9. a. Explain the electrochemical theory of rusting of iron. [2]
- b. Derive the integrated rate law equation for second order reaction and also find its half life time. [2+1]
- c. Show that the work done on a system in a reversible process is less than in the corresponding irreversible process between the same two states. [3]

10. a. Establish the relation, $\Delta E = \Delta E^\circ - \frac{0.059}{n} \log Q$, where notations have their usual meaning. Also, write the relation between equilibrium constant (K) and standard cell potential (ΔE°) at equilibrium condition. [3+2]
- b. Explain the mechanism of acidic buffer solution to resist the change in pH due to the addition of strong acid and base. [3]
11. a. State third law of thermodynamics. How do you calculate the absolute entropy of a gaseous substance at 100°C if it melts at -98°C and vaporizes at 65°C? [1+3]
- b. State Raoult's law of dilute solution. Show how a positive deviation from Raoult's law occurs in non-ideal solution made from two volatile components? [1+3]
12. Write short notes on (*ANY FOUR*) [4 × 2 = 8]
- Molecular interpretation of entropy
 - H₂-O₂ fuel cell
 - First law of thermodynamics
 - Selection of acid-base indicators
 - Concentration cell
 - Phase equilibrium and its important features