

KATHMANDU UNIVERSITY
End Semester Examination
September 2024

Marks Scored:

Level : B.E.

Year : I

Exam Roll No. :

Registration No.:

Time: 30 mins.

Course : CHEM 101

Semester : I

F. M. : 20

Date : 22 SEP 2024

SECTION "A"

[20Q. × 1 = 20 marks]

Choose and mark [X] in the most appropriate answer. Symbols have their usual meanings.

- The equilibrium constant K is given by the relation:
 $e^{\Delta S^0 / RT - \Delta H^0 / RT}$ $e^{\Delta H^0 / RT - \Delta S^0 / RT}$
 $e^{\Delta H^0 / R - \Delta S^0 / RT}$ $e^{\Delta S^0 / R - \Delta H^0 / RT}$
- The first order rate constant for the decomposition of N_2O_5 is $6.2 \times 10^{-4} \text{ sec}^{-1}$. Which of the followings is the half-life period for this decomposition?
 1107 sec 1218 sec 1118 sec 1018 sec
- An azeotropic mixture,
 Is a compound with fixed boiling point.
 Has the same composition in vapour and liquid phase
 Is pure solvent obtained by removing volatile solute
 Can be separated into components only by fractional distillation.
- The vapor pressure of water at 20°C is 17.50 atmosphere. What is the vapor pressure of sucrose solution if the mole fraction of the sucrose is 0.70?
 5.25 atm. 15.5 atm 1 atm. 4.39 atm
- For the reaction, $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$, if pressure of the system is doubled, the equilibrium constant value:
 Doubles Remains same
 Becomes half Increases by four times
- In galvanic cell, which statement is true?
 Oxidation occurs at cathode
 Electrical energy produces the chemical reaction
 Reduction occurs at anode
 Chemical reaction produces the electrical energy
- An acetic acid and sodium acetate buffer has $\text{pH} = 5.36$. The ratio of concentrations $[\text{OAc}]/[\text{HOAc}]$ is: (pKa of acetic acid = 4.76)
 6 : 1 4 : 3 1 : 1 4 : 1
- In the Arrhenius equation $k = A \exp\left(\frac{-E_a}{RT}\right)$, the rate constant
 Increases with activation energy and temperature
 Decreases with activation energy and temperature
 Increases with activation energy and decreasing temperature
 Decreases with increasing activation energy and increases with temperature

9. If the equilibrium constants of the following equilibria, $\text{SO}_2(\text{g}) + 1/2\text{O}_2 = \text{SO}_3(\text{g})$ and $\text{SO}_3(\text{g}) = \text{SO}_2(\text{g}) + 1/2\text{O}_2(\text{g})$ are K_1 and K_2 respectively. Which of the following relation is correct?
 $K_2 = [1/K_1]^2$ $K_1 = [1/K_2]^3$ $K_2 = [1/K_1]$ $K_2 = [K_1]^2$
10. One faraday of electricity can reduce which one of the followings:
 Three moles of Al^{+++} Half mole of Ca^{++}
 One mole of Mg^{++} Three moles of Na^+

Fill in the blanks with most appropriate value or words.

11. A 2.0 gm sample containing calcium is treated to precipitate 3.0 gm of $\text{Ca}_3(\text{PO}_4)_2$ (MW=310). The mass percent of calcium in the original sample is closest to _____ percent
12. The charge required for the reduction of one mole of Cr_2O_7^- ion to Cr^{3+} is _____ coulombs
13. In a concentration cell, the flow of electrons occurs from the region of _____ ion concentration to the region of _____ ion concentration, driving the cell's spontaneous redox reaction.
14. The reciprocal of the reactant concentration increases linearly as time increases in _____ order type of reaction.
15. The unit of rate constant for zero order reaction is _____
16. The entropy is a measure of the number of _____ states associated with a particular _____ state.
17. A solution contains indicator HIn , which ionizes as, $\text{HIn}(\text{red}) + \text{H}_2\text{O} = \text{In}^-(\text{yellow}) + \text{H}_3\text{O}^+$. The colour of the solution at pH 1.02 would be _____
18. Ideal solutions are formed by _____ of heat.
19. The change in enthalpy is numerically equal to the heat absorbed by the system when the process is carried out at _____
20. The weight of ethylene glycol, $\text{C}_2\text{H}_6\text{O}_2$ that must be included in each 1000 gms of aqueous solvent to lower the freezing point to -10°C is _____ [where, K_f for water is 1.86]

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

22 SEP 2024

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

SECTION "B"

[5Q. × 6 = 30 marks]

Attempt *ANY FIVE* questions.

1. Define the term conversion factor with appropriate example? The magnitude of the equilibrium constant gets affected by the units used to express reagent concentrations. Illustrate [2+4]
2. Give reasonable explanations: [2+2+2]
 - a. To deny the validity of second law of thermodynamics would be to show that gas compresses spontaneously.
 - b. A galvanic cell produces electrical energy at the cost of chemical energy.
 - c. The reaction rate is generally less than the total collision rate
3. Write the differences between ideal solution and non-ideal solution. Write an explanatory note on positive deviation from Raoult's Law. [2.5+3.5]
4. Define the following terms: [2+2+2]
 - a. Raoult's Law
 - b. Intensive property
 - c. Activated complex
5. Define rate law and rate constant. Show that the logarithm of the reactant concentration decreases linearly as the time increases in first order reaction. [2+4]
6.
 - a. Define the term "entropy change". Derive the expressions for the entropy changes for the ideal gases with temperature and volume changes. [1+2]
 - b. Prove that $\ln K$ is a linear function of $1/T$ when ΔH_0 and ΔS_0 are constant and independent of temperature. [3]
7. Define the term concentration cell with a suitable example. Complete and balance the following redox reactions by ion-electron method. [2+2+2]
 - i. $\text{Zn} + \text{NO}_3^- \longrightarrow \text{Zn}^{++} + \text{NH}_4^+$ (Acidic medium)
 - ii. $\text{Ag}_2\text{S} + \text{CN}^- + \text{O}_2 \longrightarrow \text{S} + \text{Ag}(\text{CN})_2^-$ (Basic medium)

SECTION "C"

[25 marks]

Attempt *ANY THREE* questions. (Q.N. 12 is compulsory)

8.
 - a. Define Lechatelier's principle. Explain, with examples, the effect of a temperature change on a system initially at equilibrium. [1+3]
 - b. Exactly 1000 gm of a certain solution contains 100 gram of sodium chloride. The density of the solution is 1.071 gm/ml. Calculate the molality and the molarity of NaCl. [4]

P.T.O.

- 9.
- Define cationic hydrolysis. Justify the statement "weaker the acid, greater will be the hydrolysis constant". [1+3]
 - What is conjugate acid base pair? Explain with suitable examples. Also point out the limitations of Lewis acid base concept. [1+2+1]
- 10.
- Derive the relation, $\Delta E = \Delta E^0 - [0.059]/n \log Q$, where the symbols have their usual meaning. [4]
 - Why is first law of thermodynamic unable to predict the direction of process? Define second law of thermodynamics and illustrate how it rectifies the weaknesses of the first law. [1+1+2]
- 11.
- A sample of pure calcium metal weighing 1.35 gm was quantitatively converted to 1.88 gram of pure CaO. If the atomic weight of oxygen is 16, what is the atomic weight of Calcium? [4]
 - Prove that the reciprocal of a reaction rate of enzyme catalytic reaction is a linear function of the substrate concentration when the total amount of enzyme is held constant. [4]
12. Explain briefly on *ANY THREE* of the following. [3+3+3]
- The standard hydrogen electrode
 - Catalysis
 - Third Law of thermodynamics
 - General features of equilibria
 - Buffer solutions