REV-01
BSC/05/10

2024/11

SET A

B.Sc. CHEMISTRY
THIRD SEMESTER
PHYSICAL CHEMISTRY II
BSC – 931 IDMJ

[USE OMR FOR OBJECTIVE PART]

Duration: 3 hrs. **Full Marks: 70**

Objective

Time: 30 min. **Marks: 20**

Choose the correct answer from the following: ***1×20=20***

1. The process of adsorption on a solid surface is exothermic because
   a. Entropy decreases
   b. Entropy increases
   c. Free energy increases
   d. Enthalpy is positive

2. Choose the incorrect answer
   a. BET is multilayer adsorption
   b. BET is unilayer adsorption
   c. BET was proposed in 1938
   d. BET assumes uniform solid surface

3. Animal charcoal is a decoloriser for ----------
   a. Oil
   b. Salt
   c. Cane sugar
   d. Milk

4. The magnitude of adsorption increases with fall in temperature is based on
   a. Le Chatlier's principle
   b. Boyle's law
   c. BET
   d. Charles law

5. Impurities that retard the rate of a catalytic reaction is known as
   a. Promoters
   b. Catalytic poison
   c. Catalysts
   d. Additives

6. What is the term for the concentration of a solution in moles of solute per kilogram of solvent?
   a. Molarity
   b. Molality
   c. Normality
   d. Mole fraction

7. Which property measures the tendency of a solution to draw solvent through a semi-permeable membrane?
   a. Osmotic pressure
   b. Boiling point elevation
   c. Vapor pressure
   d. Freezing point depression

8. The addition of a non-volatile solute to a solvent causes which of the following changes?
   a. Increase in vapor pressure
   b. Increase in freezing point
   c. Decrease in vapor pressure
   d. Increase in temperature

9. Which property increases with an increase in the concentration of a non-volatile solute in a solution?
   a. Vapor pressure
   b. Freezing point
   c. Density
   d. Boiling point

10. The freezing point of a solution is always lower than that of the pure solvent because:
    a. It is an exothermic process
    b. Solute particles interfere with solvent freezing
    c. The solution temperature decreases
    d. None of the above

11. Which of the following is a strong electrolyte?
    a. NaCl
    b. NaOH
    c. HCl
    d. All of the above

12. Given an exothermic reaction:
    $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
    If the temperature is increased, then
    a. The equilibrium will not be disturbed
    b. The equilibrium will shift in the backward direction
    c. The equilibrium will shift in the forward direction
    d. Liquefaction of N_2

13. The relation between solubility product (Ksp) and molar solubility (S) of the sparingly soluble salt AB is
    a. $Ksp = S$
    b. $Ksp = \sqrt{S}$
    c. $Ksp = S^2$
    d. $Ksp = S^3$

14. The pH of 0.01M NaOH solution is
    a. 1
    b. 12
    c. 10
    d. 0.01

15. The pH of a solution containing an equal volume of 0.01 M NaOH and 0.01 M HCl is
    a. 1
    b. 12.65
    c. 7
    d. 14

16. The relation between Gibb's free energy and Helmholtz free energy is
    a. $\Delta G = \Delta A + P\Delta V$
    b. $\Delta A = \Delta U - T\Delta S$
    c. $\Delta A = \Delta G + P\Delta V$
    d. $\Delta G = \Delta H - T\Delta S$

17. A process is said to be spontaneous if
    a. $\Delta G > 0$
    b. $\Delta G < 0$
    c. $\Delta G = 0$
    d. None of the above

18. If one or more modes bring about a chemical change in one or more steps, then the amount of heat absorbed or evolved during the entire reaction is the same, whichever way was obeyed. This law is known as
    a. Hess law
    b. Kirchhoff Law
    c. Lavoisier law
    d. Laplace's Law

19. The relation between enthalpy, entropy and Gibb's free energy is
    a. $\Delta G = \Delta H - T\Delta S$
    b. $\Delta H = \Delta G - T\Delta S$
    c. $\Delta G = \Delta H + T\Delta S$
    d. None of the above

20. Standard enthalpy of a reaction is determined at
    a. 298 K and 1 bar pressure
    b. 25 K and 1 atm pressure
    c. 25° C and 1 atm pressure
    d. 25 K and 1 bar pressure

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Descriptive

Time : 2 hrs. 30 min. **Marks : 50**

[Answer question no.1 & any four (4) from the rest]

1. **a.** Write six characteristics of catalytic reactions. **3+3+2+2 =10**

   b. State Roults Law. Explain the negative deviation of it.

   c. Calculate pOH of a 3.2×10^{-3} M solution of $Ba(OH)_2$ in water at 25 °C.

   d. Derive the relation between Gibb's free energy and Helmholtz free energy.

2. **a.** How does selectivity and specificity of a catalyst affect the rate and product of a reaction? **4+2+4 =10**

   b. Write the limitations of Langmuir adsorption theorem.

   c. Calculate how long a hydrogen atom will remain on the surface of a solid at 1000 K if its desorption activation energy is (a) 15 kJ mol^{-1} (b) 150 kJ mol^{-1}. Assume that $\tau_o = 10^{-13}$ s.

3. **a.** Write four applications of adsorption. **2+3+3+2 =10**

   b. Write factors affecting the efficiency of nanocatalysts.

   c. Derive the equation: $\theta = Kp/(1+Kp)$ and prove the Langmuir adsorption isotherm.

   d. Define adsorption isobar and isotere.

4. **a.** Define colligative property. List two colligative properties. **3+2+2+3 =10**

   b. A solution contains 36.0 g water and 46.0 g ethyl alcohol (C_2H_5OH). Determine the mole fraction of each component in the solution.

   c. The relative lowering of vapour pressure produced by dissolving 7.2 g of a substance in 100 g water is 0.00715. What is the molecular mass of the substance?

   d. The osmotic pressure of an aqueous solution of a protein containing 0.63 g of a protein in 100 g of water at 300 K was found to be 2.60×10^{-3} atm. Calculate the molar mass of the protein. R= 0.082 L atm K^{-1} mol^{-1}

5. **a.** Calculate the normality of the solution obtained by dissolving 0.321 g of the salt sodium carbonate (Na_2CO_3) in 250 mL water. (Molar Mass of Na_2CO_3 = 106 g/mol). **2+2+2+4 =10**

b. Calculate the osmotic pressure of 3% Urea solution at 0°C.

c. Write the differences between ideal and non-ideal solutions.

d. Derive the Gibb's-Helmholtz's equation

$$\Delta G = \Delta H + T\left[\frac{d(\Delta G)}{dT}\right]_P$$

6. **a.** What is enthalpy of formation, enthalpy of fusion and Enthalpy of sublimation? Explain with examples. **2+3+2+2 +1 =10**

b. Drive the equation of variation for enthalpy of reaction with temperature.

c. Explain the Hess's law and its application.

d. What is flame and explosion temperature?

e. What is Gibb's free energy and Helmholtz free energy?

7. **a.** Caculate the pH of an aqueous solution obtained by mixing 25 ml of 0.2 M HCl with 50 ml of 0.25 M NaOH. **3+4+3 =10**

b. Explain the two different types of buffer mixtures. Derive Henderson-Hasselbalch equation for the calculation of pH of a buffer mixture.

c. A buffer solution contains 0.20 mole of NH_4OH and 0.25 mole of NH_4Cl per litre. Calculate the pH of the solution. Dissociation constant of NH_4OH at room temperature is 1.81×10^{-5}.

8. **a.** What is ionic product of water? What is known as salt hydrolysis? Explain the hydrolysis of the salt of weak acid and strong base. **5+5=10**

b. What do you mean by solubility product? The solubility of AgCl in water at 25 °C is 0.00179 gL^{-1}. Calculate its solubility product.

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