

**B.SC. CHEMISTRY
THIRD SEMESTER
PHYSICAL CHEMISTRY- II
BSC – 301
[USE OMR FOR OBJECTIVE PART]**

**SET
A**

Duration: 3 hrs.

Full Marks: 70

Time: 30 min.

(Objective)

Marks: 20

Choose the correct answer from the following:

1X20=20

- The relation between enthalpy, entropy and Gibb's free energy is
 - $\Delta G = \Delta H - T\Delta S$
 - $\Delta H = \Delta G - T\Delta S$
 - $\Delta G = \Delta H + T\Delta S$
 - None of the above
- A process is said to be spontaneous if
 - $\Delta G < 0$, $\Delta H = -Ve$, and $\Delta S = -Ve$
 - $\Delta G < 0$, $\Delta H = -Ve$, and $\Delta S = +Ve$
 - $\Delta G = 0$, $\Delta H = -Ve$, and $\Delta S = -Ve$
 - None of the above
- The relation between Gibb's free energy and Helmholtz free energy is
 - $\Delta G = \Delta A + P\Delta V$
 - $\Delta A = \Delta U - T\Delta S$
 - $\Delta A = \Delta G + P\Delta V$
 - $\Delta G = \Delta H - T\Delta S$
- Standard enthalpy of a reaction is determined at
 - 298 K and 1 atm pressure
 - 25 K and 1 atm pressure
 - 25° C and 1 bar pressure
 - 25 K and 1 bar pressure
- Freundlich adsorption isotherm is given by the expression $x/m = kp^{1/n}$, which of the following conclusions can be drawn from this expression
 - When $1/n = 1$, the adsorption is directly proportional to pressure
 - When $1/n = 1$, the adsorption is independent of pressure
 - When $n = 0$, plot of x/m vs p is a curve
 - None of the above
- The correct option representing a Freundlich adsorption isotherm is
 - $\frac{x}{m} = k p^{-0.3}$
 - $\frac{x}{m} = k p^{2.5}$
 - $\frac{x}{m} = k p^{0.5}$
 - $\frac{x}{m} = k p^{-1}$
- A monoatomic gas, X, adsorbed on a surface, follows Langmuir adsorption isotherm. A plot of the fraction of the surface coverage, θ against the concentration of the gas [X], for very low concentration of the gas is described by the equation,
 - $\theta = K[X]$
 - $1 - \theta = 1 / K[X]$
 - $\theta = K^{1/2} [X]^{1/2}$
 - $\theta = K[X] / (1 + K[X])$
- The criterion for the spontaneity of a process is
 - $\Delta S_{sys} > 0$
 - $\Delta S_{surr} > 0$
 - $\Delta S_{sys} + \Delta S_{surr} > 0$
 - $\Delta S_{sys} - \Delta S_{surr} > 0$

9. If a non-volatile solute is added to a solvent, vapour pressure
 - a. Increases
 - b. Decreases
 - c. Remains same
 - d. Becomes zero
10. Boiling point of solution compared to pure solvent is:
 - a. Lower
 - b. Higher
 - c. Same
 - d. Variable
11. Which property is used to determine molar mass of polymers?
 - a. Osmotic pressure
 - b. Boiling point elevation
 - c. Freezing point depression
 - d. Vapour pressure lowering
12. For non-ideal solutions showing positive deviation, ΔH_{mix} is:
 - a. Zero
 - b. Negative
 - c. Positive
 - d. Infinite
13. Molality is independent of
 - a. Temperature
 - b. Solvent mass
 - c. Solute moles
 - d. Pressure
14. Relative lowering of vapour pressure is equal to:
 - a. Mole fraction of solute
 - b. Mole fraction of solvent
 - c. Molality
 - d. Molarity
15. The pH of an aqueous solution of sodium acetate is:
 - a. 7
 - b. Less than 7
 - c. Greater than 7
 - d. 0
16. The hydrolysis constant (K_h) of a salt of weak acid and strong base is given by:
 - a. $K_h = K_w / K_a$
 - b. $K_h = K_w \times K_a$
 - c. $K_h = K_a / K_w$
 - d. $K_h = K_w / K_b$
17. According to Le Chatelier's principle, if temperature is increased in an exothermic reaction, the equilibrium will:
 - a. Not change
 - b. Shift to the right
 - c. Shift to the left
 - d. Stop completely
18. For the equilibrium

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + \text{heat}$$
 What happens if pressure is increased?
 - a. The equilibrium shifts to the right
 - b. The equilibrium shifts to the left
 - c. No change
 - d. Reaction stops
19. The solubility product (K_{sp}) of AgCl is 1.0×10^{-10} at 25 °C. The solubility of AgCl in pure water is:
 - a. $1.0 \times 10^{-5} \text{ mol L}^{-1}$
 - b. $1.0 \times 10^{-10} \text{ mol L}^{-1}$
 - c. $1.0 \times 10^{-4} \text{ mol L}^{-1}$
 - d. $1.0 \times 10^{-2} \text{ mol L}^{-1}$
20. If 100 mL of 0.1 M NaOH is added to 100 mL of 0.1 M HCl, the resulting pH is:
 - a. 7
 - b. 0
 - c. 14
 - d. 12

(Descriptive)

Time : 2 hrs. 30 min.

Marks : 50

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

1. a. Establish the relation between Gibb's free energy and Helmholtz free energy. 2+2+1+2
+3=10
b. Explain graphically the variation of Adsorption isobar for physisorption and chemisorption.
c. Write the equation for multilayer adsorption isotherm process.
d. A 25.00 mL sample of sulfuric acid solution requires 18.00 mL of 0.200 N NaOH for complete neutralization. What is the normality of the H_2SO_4 solution?
e. Derive the expression for the solubility of a salt of type AB_2 and A_2B_3 in terms of its solubility product constant.
2. a. What is thermochemistry? Write about the enthalpy of formation and enthalpy of combustion. Explain with examples. 3+3+2+2
=10
b. Derive the Kirchhoff equation for variation of enthalpy of a reaction with temperature?
c. Explain the Hess's law and its application.
d. What is flame and explosion temperature?
3. a. Why the adsorption process occurs? Explain. 2+2+2+2
+2=10
b. What is the role of adsorption in heterogeneous catalysis?
c. Explain graphically the variation of adsorption isotherm at three different temperature (T_1 , T_2 and T_3 when $T_1 > T_2 > T_3$).
d. What are the limitations of Freundlich Adsorption isotherm?
e. At low pressure and high pressure, how the surface coverage is related to the pressure. Explain mathematically.
4. a. Write the postulates of Langmuir Adsorption isotherm. 2+3+2+3
=10
b. The adsorption of a gas is described by Langmuir adsorption isotherm with the equilibrium constant $k = 0.9 \text{ K.Pa}^{-1}$ at 25°C . Calculate the pressure in K.Pa at which fractional surface coverage is 0.95.

- c. Derive the relation $S = -\left(\frac{\partial G}{\partial T}\right)_p$
- d. Derive the Gibb's-Helmholtz's equation.
5. a. Deduce the thermodynamic derivation of elevation of boiling point (ΔT_b)? 3+2+3+2
=10
- b. What is the relationship between latent heat of fusion and molal depression constant? Calculate the molal depression constant for water as solvent.
- c. 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. $R = 0.082 \text{ L atm K}^{-1} \text{ mol}^{-1}$
- d. Discuss the positive deviation of Raoult's Law.
6. a. 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? 3+2+2+3
=10
- b. Deduce the relationship between Relative lowering of vapour pressure and Osmotic Pressure.
- c. Write the Vant Hoff's Avogadro's Law for osmotic pressure with expression.
- d. The boiling point of benzene is 353.23 K. When 1.80 g of a non-volatile solute was dissolved in 90 g of benzene, the boiling point is raised to 354.11 K. Calculate the molar mass of the solute. K_b for benzene is $2.53 \text{ K kg mol}^{-1}$
7. a. Calculate K_c for the reaction $2\text{SO}_3(\text{g}) \rightleftharpoons 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g})$ for which $K_p = 3.5 \times 10^{-23} \text{ atm}$ at 27°C . 3+3+3+1
=10
- b. Explain the effect of pressure on the freezing point of water and sulphur based on Le Chatelier's principle.
- c. The equilibrium constant K_p for the reaction $\text{H}_2(\text{g}) + \text{S}(\text{g}) \rightleftharpoons \text{H}_2\text{S}(\text{g})$ is 20.2 atm^{-1} at 945°C and 9.1 atm^{-1} at 1065°C . Calculate ΔH° .
- d. State Le Chatelier's principle.

8. a. A solution of 0.1M CH_3COOH is found to be dissociated to the extent of 1.33 % at room temperature. Calculate the dissociation constant of the acid at this temperature. 2+3+2+2
+1=10
- b. 25 ml of 0.1 M CH_3COOH is titrated against 0.1 M NaOH . Calculate the pH value of the titration solution after addition of 25 ml of NaOH solution.
- c. Calculate the pH of a buffer solution of 0.1M CH_3COOH and 0.1M CH_3COONa . K_a for CH_3COOH 1.75×10^{-5} .
- d. Explain the action of Phenolphthalein as indicator.
- e. Explain the relationship between the solubility product (K_{sp}) and the ionic product (Q) in determining whether a precipitate will form.

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