2024/II

SET A

B.Sc. CHEMISTRY
THIRD SEMESTER
PHYSICAL CHEMISTRY- II
BSC - 301
[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 pH of a solution containing an equal volume of 0.1 M NaOH and 0.1 M HCl is
   a. 1.00 b. 2.0
   c. 7.0 d. 12.65

2. Which of the following solutions will act as a buffer?
   a. NaOH and NaCl b. HCl and KCl
   c. NH_4OH and NH_4Cl d. HCl and NaOH

3. The pH of 0.1M NaOH solution is
   a. 1 b. 13
   c. 10 d. 12

4. The solubility product for a salt of type AB is 4×10^{-8}. The molar solubility of its standard solution will be
   a. 2×10^{-4} mol/L b. 2×10^{-16} mol/L
   c. 16×10^{-16} mol/L d. 4×10^{-4} mol/L

5. Given an endothermic reaction:
   $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$
   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 H_2O

6. What is the general mechanism of an enzyme?
   a. It acts by reducing the activation energy b. It acts by increasing the activation energy
   c. It acts by decreasing the pH d. It acts by increasing the pH

7. The catalyst quantity and composition at the end of the reaction
   a. Diminishes b. Both changes
   c. Both remain unchanged d. Becomes negligible

8. The factor which changes when catalyst is used in a reaction is
   a. Enthalpy of reaction b. Activation energy
   c. Equilibrium constant d. Temperature

9. The standard enthalpy at a fixed surface coverage is known as ----------

a. Isobaric enthalpy
b. Isochoric enthalpy
c. Isosteric enthalpy
d. Absolute enthalpy

10. If pressure (p) and temperature (t) for a given amount of adsorption of a system are plotted graphically, then the curve of this plot is known as ----------
a. Isostere
b. Isobar
c. Isochor
d. Desorption curve

11. Which of the following describes Raoult's Law?
a. The partial pressure of a component is equal to its mole fraction in the vapor phase
b. The partial pressure of a component is equal to its mole fraction in the liquid phase
c. The boiling point of a solution increases with solute concentration
d. The freezing point of a solution decreases with solute concentration.

12. The freezing point depression of a solution depends on
a. The nature of the solute
b. The concentration of the solute particles
c. The boiling point of the solute
d. The density of the solution

13. When a solution is prepared by dissolving 0.5 mol of NaCl in 1 kg of water, it is termed as
a. 0.5 molal solution
b. 0.5 molar solution
c. 1 molar solution
d. 1 molal solution

14. What is the effect on vapor pressure when a volatile solute is added to a solvent
a. Vapor pressure increases
b. Vapor pressure decreases
c. Vapor pressure remains constant
d. Vapor pressure becomes zero

15. The boiling point elevation constant (KbK_bKb) is specific to
a. The solute
b. The solvent
c. The temperature of the solution
d. The molality of the solution

16. 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

17 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

18. 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

19. Aprocess is spontaneous if
a. $\Delta G > 0$
b. $\Delta G < 0$
c. $\Delta G = 0$
d. None of the above

20. 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 $\Delta G = \Delta H - T\Delta S$

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Descriptive

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

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

1. a. Calculate the pH of a buffer solution prepared by mixing of 10 ml of 0.1 M acetic acid and 10 ml of 0.01 M sodium acetate. (Given pKa=4.76) **2+3+2+3 =10**

   b. Calculate how long a hydrogen atom will remain on the surface of a solid at 298 K if its desorption activation energy is: (i) 15 kJ mol^{-1} and (ii) 150 kJ mol^{-1}. Assume that $\tau_o = 10^{-13}$ s.

   c. Define colligative property. List two colligative properties.

   d. What is thermochemistry? Write about the enthalpy of formation and enthalpy of combustion. Explain with examples.

2. a. What do you mean by buffer capacity? How many types of buffer mixture are there and what are they? Give one example of each type of buffer. **2+2+2 =6**

   b. What would be the pH of an aqueous solution obtained by mixing 5 g of acetic acid and 7.5 g of sodium acetate and making the volume equal to 500 ml? Dissociation constant of acetic acid at 25 °C is 1.75×10^{-5}. **4**

3. a. Derive the relationship between solubility product and molar solubility of a sparingly soluble salt AB. **3+3+4 =10**

   b. The solubility product of $Mg(OH)_2$ at 25 °C is 1.4×10^{-11}. Calculate the solubility of $Mg(OH)_2$ in gL^{-1}. (Mg = 24, O = 16, H = 1)

   c. What are the different categories of hydrolysis of salt? Explain any one.

4. a. In an acid hydrolysis reactioin $A + H_2O + H^+ \rightarrow P$ where $[H^+]$ = 0.1 mol L^{-1} and H_2O is present in large excess, the apparent rate constant is 1.5×10^{-5} s^{-1}. Calculate the true rate constant. **2+4+4 =10**

   b. Prove the following for a diatomic gas: $\theta = (Kp)^{1/2}/(1+Kp)^{1/2}$

   c. Draw a Langmuir plot and explain how θ varies with pressure.

5. **a.** Write the factors affecting the activity of nanocatalysts. **3+5+2 =10**

b. Prove the rate of the reaction $r = k_2[E]_o[S]/K_m + [S]$ for an enzyme catalysing the conversion of sugar into maltose.

c. How does the specificity and selectivity of catalyst affect its catalytic activity?

6. **a.** Discuss the positive deviation of Raoult's Law. **2+2+2+4 =10**

b. 10g of a substance is dissolved in 250 mL of H_2O. The osmotic pressure of solution is 600 mm at 15°C. Calculate the mol. wt. of the substance?

c. Find out the molarity of a solution which contains 32.0 g of methyl alcohol (CH_3OH) in 200 mL solution.

d. What is Gibbs free energy and Helmholtz free energy? Derive the relation between Gibb's free energy and Helmholtz free energy.

7. **a.** 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} **3+3+2+2 =10**

b. Deduce the thermodynamic relation between relative lowering of vapour pressure and osmotic pressure.

c. Calculate the normality of a solution of NaOH if 0.4 g of NaOH is dissolved in 100 mL of the solution.

d. 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.

8. **a.** Derive the Kirchhoff equation for enthalpy of a reaction. **2+3+2+3 =10**

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

c. What is flame and explosion temperature?

d. The heat of dissociation per mole of a gaseous water at 18 °C and 1 atm Pressure is 241750 J, Calculate its value at 68 °C.

Data given are Cp (H_2O) = 33.56, Cp (H_2) = 28.83, Cp (O_2) = 29.12 $JK^{-1}mol^{-1}$

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