Ionic Equilibrium

Date Planned : __ / __ / __	Daily Tutorial Sheet	Expected Duration : 90 Min
Actual Date of Attempt : __ / __ / __	Level-0	Exact Duration :_____

Very Short Answer Type (1 Mark)

1. What is meant by the conjugate acid-base pair ? Find the conjugate acid/base for the following species. HNO_2, CN^-, $HClO_4$, F^-, OH^-, CO_3^{2-} and S^{2-}

2. Which of the given species are Lewis acids ? H_2O, BF_3, H^+, NH_4^+

3. What will be the conjugate bases for the Bronsted acids ? HF, H_2SO_4 and HCO_3^-

4. Write the conjugate acids for the Bronsted bases : NH_2^-, NH_3 and $HCOO^-$.

5. The species : H_2O, HCO_3^-, HSO_4^- and NH_3 can act both as Bronsted acid and base. For each case give the corresponding conjugate acid and base.

6. Classify the following species into Lewis acids and Lewis base and show how these acts as Lewis acid/base?

   (a) OH^- **(b)** F^- **(c)** H^+ **(d)** BCl_3

Short Answer Type-I (2 Marks)

7. The ionization constant of HF, HCOOH and HCN at 298 K are 6.8×10^{-4}, 1.8×10^{-4} and 4.8×10^{-9} respectively. Calculate the ionization constants of the corresponding conjugate base.

8. The first ionization constant of H_2S is 9.1×10^{-8}. Calculate the concentration of HS^- ion in its 0.1 M solution. How will this concentration be affected if the solution is 0.1 M in HCl also? If the second dissociation constant of H_2S is 1.2×10^{-13}, calculate the concentration of S^{2-} under both conditions.

9. It has been found that pH of a 0.01 M solution of an organic acid is 4.15. Calculate the concentration of the anion, the ionization constant of the acid and its pK_a.

10. The degree of ionization of a 0.1 M bromoacetic acid ($BrCH_2COOH$) solution is 0.132. Calculate the pH of the solution and the pK_a of bromoacetic acid.

11. What is the pH of 0.001 M aniline solution? The ionization constant of aniline is 4.27×10^{-10}. Calculate the degree of ionization of aniline in the solution. Also calculate the ionization constant of the conjugate acid of aniline.

12. Calculate the degree of ionization of 0.05 M acetic acid if its pK_a value is 4.74. How is the degree of dissociation affected when its solution also contains :

   (a) 0.01 M HCl **(b)** 0.1 M in HCl

13. The ionization constant of dimethylamine (CH_3NHCH_3) is 5.4×10^{-4}. Calculate its degree of ionization in its 0.02 M solution. What percentage of dimethylamine is ionized if the solution is also 0.1 M in NaOH?

Short Answer Type-II (3 Marks)

14. Calculate the hydrogen ion concentration in the following biological fluids whose pH are given below :

    (a)   Human muscle – fluid, 6.83   (b)   Human stomach fluid, 1.2

    (c)   Human blood, 7.38   (d)   Human saliva, 6.4

15. The pH of milk, black coffee, tomato juice, lemon juice and egg white are 6.8, 5.0, 4.2, 2.2 and 7.8 respectively. Calculate the corresponding hydrogen ion concentration in each.

16. The solubility of $Sr(OH)_2$ at 298 K is 19.23 g/L of solution. Calculate the concentrations of strontium and hydroxyl ions and the pH of the solution.

17. The ionization constant of propanoic acid (CH_3CH_2COOH) is 1.32×10^{-5}. Calculate the degree of ionization of the acid in its 0.05 M solution and also its pH. What will be its degree of ionization if the solution is 0.01 M in HCl also?

18. The pH of 0.1M solution of cyanic acid (HCNO) is 2.34. Calculate the ionization constant of the acid and its degree of ionization in the solution.

19. The ionization constant of nitrous acid (HNO_2) is 4.5×10^{-4}. Calculate the pH of $0.04\,M$ sodium nitrite $\left(NaNO_2\right)$ solution and also its degree of hydrolysis.

Long Answer Type (5 Marks)

20. A 0.02 M solution of pyridinium hydrochloride $\left[C_5H_5NH^+Cl^- \right]$ has pH = 3.44. Calculate the ionization constant of pyridine.

21. Predict if the solutions of the following salts are neutral, acidic or basic :
    $$NaCl, KBr, NaCN, NH_4NO_3, NaNO_2, KF$$

22. The ionization constant of chloroacetic acid $\left[ClCH_2COOH \right]$ is 1.35×10^{-3}. What will be the pH of 0.1 M acid and its 0.1 M sodium salt solution?

23. Calculate the pH of the resultant mixtures :
    (a)   10 mL of 0.2 M Ca(OH)$_2$ + 25 mL of 0.1 M HCl
    (b)   10 mL of 0.01 M H$_2$SO$_4$ + 10 mL of 0.01 M Ca(OH)$_2$
    (c)   10 mL of 0.1 M H$_2$SO$_4$ + 10 mL of 0.1 M KOH

24. Determine the solubilities of silver chromate, barium chromate, ferric hydroxide, lead chloride and mercurous iodide at 298 K from their solubility product constants.
    $$[K_{sp}(Ag_2CrO_4) = 1.1 \times 10^{-12}; \quad K_{sp}(BaCrO_4) = 1.2 \times 10^{-10}$$
    $$K_{sp}[Fe(OH)_3 = 1.0 \times 10^{-38}, K_{sp}(PbCl_2) = 1.6 \times 10^{-5}, \quad K_{sp}(Hg_2I_2) = 4.5 \times 10^{-29}]$$
    Determine also the molarities of individual ions.

25. The solubility product (K_{sp}) of Ag_2CrO_4 and AgBr are 1.1×10^{-22} and 5.0×10^{-13} respectively. Calculate the ratio of the molarities of their saturated solutions.