IONIC EQUILIBRIUM

1. If K_{sp} of Ag_2CO_3 is 8×10^{-12}, the molar solubility of Ag_2CO_3 in 0.1M $AgNO_3$ is :

(1) 8×10^{-12} M (2) 8×10^{-10} M

(3) 8×10^{-11} M (4) 8×10^{-13} M

2. 25 ml of the given HCl solution requires 30 mL of 0.1 M sodium carbonate solution. What is the volume of this HCl solution required to titrate 30 mL of 0.2 M aqueous NaOH solution?

(1) 25 mL (2) 50 mL

(3) 12.5 mL (4) 75 mL

3. A mixture of 100 m mol of $Ca(OH)_2$ and 2g of sodium sulphate was dissolved in water and the volume was made up to 100 mL. The mass of calcium sulphate formed and the concentration of OH^- in resulting solution, respectively, are : (Molar mass of $Ca(OH)_2$, Na_2SO_4 and $CaSO_4$ are 74, 143 and 136 g mol^{-1}, respectively; K_{sp} of $Ca(OH)_2$ is 5.5×10^{-6})

(1) 1.9 g, 0.14 mol L^{-1}

(2) 13.6 g, 0.14 mol L^{-1}

(3) 1.9 g, 0.28 mol L^{-1}

(4) 13.6 g, 0.28 mol L^{-1}

4. The pH of rain water, is approximately :

(1) 6.5 (2) 7.5

(3) 5.6 (4) 7.0

5. 20 mL of 0.1 M H_2SO_4 solution is added to 30 mL of 0.2 M NH_4OH solution. The pH of the resulatant mixture is :

[pk_b of NH_4OH = 4.7].

(1) 9.4 (2) 5.0

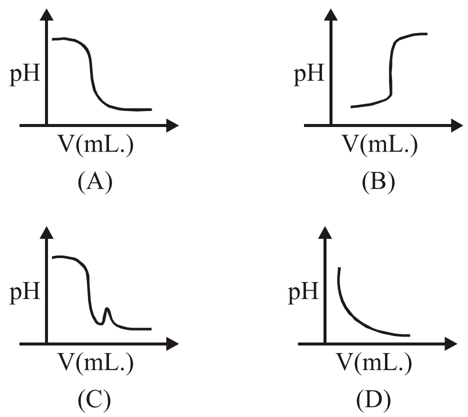
(3) 9.0 (4) 5.2

6. If solubility product of $Zr_3(PO_4)_4$ is denoted by K_{sp} and its molar solubility is denoted by S, then which of the following relation between S and K_{sp} is correct

(1) $S=\left(\frac{K_{sp}}{929}\right)^{1/9}$ (2) $S=\left(\frac{K_{sp}}{216}\right)^{1/7}$

(3) $S=\left(\frac{K_{sp}}{144}\right)^{1/6}$ (4) $S=\left(\frac{K_{sp}}{6912}\right)^{1/7}$

7. In an acid-base titration, 0.1 M HCl solution was added to the NaOH solution of unknown strength. Which of the following correctly shows the change of pH of the titraction mixture in this experiment?



(1) (A) (2) (C) (3) (D) (4) (B)

8. Consider the following statements

(a) The pH of a mixture containing 400 mL of 0.1 M H_2SO_4 and 400 mL of 0.1 M NaOH will be approximately 1.3.

(b) Ionic product of water is temperature dependent.

(c) A monobasic acid with $K_a = 10^{-5}$ has a pH = 5. The degree of dissociation of this acid is 50%.

(d) The Le Chatelier's principle is not applicable to common-ion effect.

the correct statement are :

(1) (a), (b) and (d) (2) (a), (b) and (c)

(3) (a) and (b) (4) (b) and (c)

9. The pH of a 0.02M NH_4Cl solution will be [given $K_b(NH_4OH)=10^{-5}$ and log2=0.301]

(1) 4.65 (2) 5.35

(3) 4.35 (4) 2.65

10. What is the molar solubility of $Al(OH)_3$ in 0.2 M NaOH solution ? Given that, solubility product of $Al(OH)_3 = 2.4 \times 10^{-24}$:

(1) 12×10^{-23} (2) 12×10^{-21}

(3) 3×10^{-19} (4) 3×10^{-22}

11. The molar solubility of $Cd(OH)_2$ is 1.84×10^{-5} M in water. The expected solubility of $Cd(OH)_2$ in a buffer solution of pH = 12 is :

(1) 6.23×10^{-11} M (2) 1.84×10^{-9} M

(3) $\frac{2.49}{1.84} \times 10^{-9}$ M (4) 2.49×10^{-10} M

SOLUTION

1. Ans. (2)

$$Ag_2CO_3\ (s) \rightleftharpoons 2Ag^+(aq.) + CO_3^{-2}(aq)$$

$$(0.1+2S)\ M \qquad S\ M$$

$$Ksp = [Ag^+]^2[CO_3^{-2}]$$

$8 \times 10^{-12} = (0.1 + 2S)^2\ (S)$

$S = 8 \times 10^{-10}$ M

2. Ans. (1)

HCl with Na_2CO_3

Eq. of HCl = Eq. of Na_2CO_3

$$\frac{25}{1000} \times M \times 1 = \frac{30}{1000} \times 0.1 \times 2$$

$$M = \frac{6}{25} M$$

Eq of HCl = Eq. of NaOH

$$\frac{6}{25} \times 1 \times \frac{V}{1000} = \frac{30}{1000} \times 0.2 \times 1$$

V = 25 ml

3. Ans. (3)

$Ca(OH)_2$	$+ Na_2SO_4$	$\longrightarrow CaSO_4$	$+ 2NaOH$
100 m mol	14 m mol	—	—
—	—	14 m mol	28 m mol

$$w_{CaSO_4} = 14 \times 10^{-3} \times 136 = 1.9gm$$

$$[OH^-] = \frac{28}{100} = 0.28M$$

4. Ans. (3)

pH of rain water is approximate 5.6

5. Ans. (3)

20 ml 0.1 M $H_2SO_4 \Rightarrow \eta_{H^+} = 4$

30 ml 0.2 M $NH_4OH \Rightarrow \eta_{NH_4OH} = 6$

NH_4OH	+ H^+	$\rightleftharpoons NH_4^{\oplus}$	+ H_2O
$\Rightarrow$ 6	4	0	0
$\Rightarrow$ 2	0	4	4

Solution is basic buffer

$$pOH = pK_b + \log\frac{NH_4^+}{NH_4OH}$$

$$= 4.7 + \log 2$$

$$= 4.7 + 0.3 = 5$$

pH = 14 – 5 = 9

6. Ans.(4)

Sol. $Zr_3(PO_4)_4(s) \rightleftharpoons 3Zr^{4+}(aq.) + 4PO_4^{3-}(aq.)$

$$3S\ M \qquad 4S\ M$$

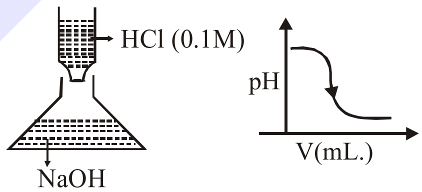
$K_{sp} = [Zr^{4+}]^3 [PO_4^{3-}]^4 = (3S)^3.(4S)^4 = 6912\ S^7$

$$\therefore S = \left(\frac{K_{sp}}{6912}\right)^{1/7}$$

Correct option : (4)

7. Ans. (1)

Sol.



8. Ans. (2)

Sol. (a) $H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

$400\times.1=40 \quad 400\times.1=40$

$20 \qquad 0$

$\therefore [H^+] = \frac{20\times2}{800} = \frac{1}{20} \Rightarrow pH = -\log\left(\frac{1}{20}\right)$

$\therefore$ pH = 1.3 so (a) is correct

(b) $\log\left(\frac{Kw_2}{Kw_1}\right) = \frac{\Delta H}{2.303R}\left[\frac{1}{T_1}-\frac{1}{T_2}\right]$

so ionic product of water is temp. dependent hence (b) is correct.

(c) $K_a = 10^{-5}$, pH = 5 $\Rightarrow [H^+] = 10^{-5}$

$K_a = \frac{c\alpha^2}{(1-\alpha)} \Rightarrow K_a = \frac{[H^+].\alpha}{(1-\alpha)}$

$\therefore 10^{-5} = \frac{10^{-5}.\alpha}{(1-\alpha)} \Rightarrow 1-\alpha=\alpha \Rightarrow \alpha = \frac{1}{2} = 50\%$

so (c) is correct.

(d) Le-chatelier's principle is applicable to common –Ion effect so option (d) is wrong

$\therefore$ correct answer (2)

9. Ans. (2)

Sol. For the salt of strong acid and weak base

$H^+ = \sqrt{\frac{K_w \times C}{K_b}}$

$\left[H^+\right] = \sqrt{\frac{10^{-14}\times2\times10^{-2}}{10^{-5}}}$

$-\log\left[H^+\right] = 6 - \frac{1}{2}\log 20$

$\therefore$ pH = 5.35

10. Ans. (4)

Sol. $Al(OH)_3 \rightleftharpoons Al^{+3} + 3OH^-$

$S' \qquad 0.2 + 3(S') \simeq 0.2$

$S' \times (0.2)^3 = k_{sp} = 2.4 \times 10^{-24}$

$(S') = 3 \times 10^{-22}$ M

11. Ans. (4)

Sol. $K_{sp} = 4(s)^3$

$= 4 \times (1.84 \times 10^{-5})^3$

$Cd(OH)_2 \rightleftharpoons Cd^{+2} + 2OH^-$

$S' \qquad S' \quad (10^{-2} + S') \simeq 10^{-2}$

$S' \times (10^{-2})^2 = 4 \times (1.84 \times 10^{-5})^3$

$S' = 4 \times (1.84)^3 \times 10^{-11}$

$(S') = 2.491 \times 10^{-10}$ M