



ANSWER KEY & SOLUTIONS

(ACIDS, BASES & SALTS (Theories of Acids & Bases, pH, pOH, Kw))

1.

Here we are given that

$$[\text{H}_3\text{O}^+] = 1.3 \times 10^{-5}$$

$$\text{pH} = -\log [\text{H}_3\text{O}^+] = -\log (1.3 \times 10^{-5})$$

$$= -(\log 1.3 + \log 10^{-5})$$

$$= -0.1139 + 5 = 4.8861$$

$$= 4.89$$

As pH is less than 7, the black coffee is *acidic*.

2.

Concentration of HNO_3 solution =

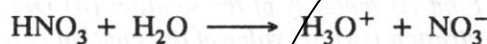
0.63 g per 100 ml (Given)

$$= 6.3 \text{ g per litre} = \frac{6.3}{63} \text{ moles/litre}$$

$$= 10^{-1} \text{ M}$$

(\because Mol. wt. of $\text{HNO}_3 = 63$)

Now, HNO_3 completely ionizes as



$$\therefore [\text{H}_3\text{O}^+] = [\text{HNO}_3]$$

$$= 10^{-1} \text{ M}$$

$$\therefore \text{pH} = -\log [\text{H}_3\text{O}^+]$$

$$= -\log 10^{-1} = 1$$

3.

$$N_1V_1 = N_2V_2, 25 \times 1 / 100 = N_2 \times 500$$

$$\text{or } N_2 = 5 \times 10^{-4} \text{ N}$$

$$[\text{H}^+] = [\text{HCl}] = 5 \times 10^{-4} \text{ M}$$

$$\text{pH} = -\log (5 \times 10^{-4})$$

$$= 4 - \log 5 = 4 - 0.6990 = 3.301.$$

4.

(i) Calculation of molarity :

Weight of NaOH dissolved = 4.0 g/litre

Mol. wt. of NaOH = 40

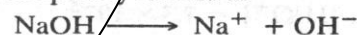
\therefore Molarity of the solution

$$= \frac{\text{Strength in g/ litre}}{\text{Mol. wt.}}$$

$$= \frac{4.0}{40} = 0.1 \text{ M}$$

(ii) Calculation of the OH^- ion conc.

NaOH completely ionizes as



$$\therefore [\text{OH}^-] = [\text{NaOH}] = 0.1 \text{ M} = 10^{-1} \text{ M}$$

(iii) Calculation of pH :

We know that

$$[\text{H}_3\text{O}^+] [\text{OH}^-] = K_w = 1.0 \times 10^{-14}$$

$$\therefore [\text{H}_3\text{O}^+] = \frac{K_w}{[\text{OH}^-]} = \frac{1.0 \times 10^{-14}}{10^{-1}}$$

$$= 10^{-13} \text{ M}$$

$$\therefore \text{pH} = -\log [\text{H}_3\text{O}^+]$$

$$= -\log 10^{-13} = 13.$$

2

5. $pH = 3$ means $[H^+] = 10^{-3}$ M and
 $pH = 5$ means $[H^+] = 10^{-5}$ M. On mixing equal
 volumes, in the final solution,

$$[H^+] = \frac{(10^{-3} + 10^{-5})}{2}$$

$$= \frac{10^{-3}(1 + 10^{-2})}{2}$$

$$= \frac{1.01 \times 10^{-3}}{2} = 0.505 \times 10^{-3} \text{ M}$$

$$= 5.05 \times 10^{-4} \text{ M}$$

$$\therefore pH = -\log(5.05 \times 10^{-4}) = 4 - 0.7033$$

$$\approx 3.3$$

6. $pH = 4$ means $[H^+] = 10^{-4}$ M and
 $pH = 10$ means $[H^+] = 10^{-10}$ M
 or $[OH^-] = 10^{-4}$ M. Thus they will exactly
 neutralise each other and pH of the resulting solu-
 tion will be = 7.

7. 100 cm³ of solution with $pH = 3$ con-
 tains H^+

$$= \frac{10^{-3}}{1000} \times 100 = 10^{-4} \text{ mole}$$

400 cm³ of solution with $pH = 4$ contains

$$H^+ = \frac{10^{-4}}{1000} \times 400$$

$$= 4 \times 10^{-5} \text{ mole}$$

$$\text{Total } H^+ = 10^{-4} + 4 \times 10^{-5}$$

$$= 10^{-4}(1 + 0.4) = 1.4 \times 10^{-4}$$

$$\text{Total volume} = 500 \text{ cm}^3$$

$$\therefore [H^+] = \frac{1.4 \times 10^{-4}}{500} \times 1000 \text{ M}$$

$$= 2.8 \times 10^{-4} \text{ M}$$

$$pH = -\log(2.8 \times 10^{-4})$$

$$= 4 - 0.4472$$

$$\approx 3.55$$

8. (a) $pH = 7$.

(b) M/10 HCl left unneutralized = 10 ml of M/10

Total volume = 100 ml.

$$\therefore 10 \times \frac{M}{10} = 100 \times ? \text{ M}$$

$$\therefore [HCl] = \frac{1}{100} = 10^{-2} \text{ M. } pH = 2$$

(c) solution is basic, pH will be > 7 .

(d) 75 ml M/5 HCl = 15 millimoles, 25 ml of M/5
 NaOH = 5 millimoles. HCl left unneutralised = 10
 millimoles. Volume = 100 ml.

$$\therefore [HCl] = \frac{10}{100} = 0.1 \text{ M}$$

$$pH = -\log(0.1) = 1.$$

9. 75 ml of (M/5) HCl + 25 ml of (M/5) NaOH

10. 0.001 M KOH means $[OH^-] = 10^{-3}$

$$\text{Hence } [H_3O^+] = 10^{-11}.$$

2

11. $\text{pH} = 7$
12. Ag^+ ion is a Lewis acid. CH_4 is neither Lewis acid nor Lewis base.
13. $\text{NH}_2^- + \text{H}^+ = \text{NH}_3$.
14. Higher the $[\text{H}^+]$, lower is the pH .
1 M H_2SO_4 has highest $[\text{H}^+]$.
15. $\text{pH} = 7$ at the end point is only for strong acid with strong base.

2

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