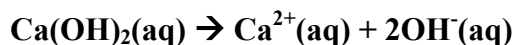


- What is the pH of a 0.010 M solution of Ca(OH)_2 ?

Marks
2

Ca(OH)_2 is a strong base and dissociates completely according to the equation:



A 0.010 M solution therefore has $[\text{OH}^{-}(\text{aq})] = 0.020 \text{ M}$ and

$$\text{pOH} = -\log_{10}([\text{OH}^{-}(\text{aq})]) = -\log_{10}(0.020) = 1.70$$

As $\text{pH} + \text{pOH} = 14.00$, $\text{pH} = (14.00 - 1.70) = 12.30$

$$\text{pH} = 12.30$$

- What is the pH of a 0.010 M solution of HNO_2 ? The $\text{p}K_a$ of HNO_2 is 3.15.

2

Nitrous acid is a weak acid so $[\text{H}_3\text{O}^{+}]$ must again be calculated:

	$\text{HNO}_2(\text{aq})$	$\text{H}_2\text{O}(\text{l})$	\rightleftharpoons	$\text{H}_3\text{O}^{+}(\text{aq})$	$\text{NO}_2^{-}(\text{aq})$
initial	0.010	large		0	0
change	-x	negligible		+x	+x
final	$0.010 - x$	large		x	x

The equilibrium constant K_a is given by:

$$K_a = \frac{[\text{H}_3\text{O}^{+}][\text{NO}_2^{-}]}{[\text{HNO}_2]} = \frac{x^2}{0.010 - x}$$

As $K_a = 10^{-3.15}$ is very small, $0.010 - x \sim 0.010$ and hence:

$$x^2 = 0.010 \times 10^{-3.15} \quad \text{or} \quad x = 2.66 \times 10^{-3} \text{ M} = [\text{H}_3\text{O}^{+}(\text{aq})]$$

Hence, the pH is given by:

$$\text{pH} = -\log_{10}[\text{H}_3\text{O}^{+}(\text{aq})] = -\log_{10}[(2.66 \times 10^{-3})] = 2.58$$

$$\text{pH} = 2.58$$

ANSWER CONTINUES ON THE NEXT PAGE

- What is the pH of a solution that is 0.020 M in CH_3COOH and 0.010 M in CH_3CO_2^- ?
The K_a of CH_3COOH is 1.8×10^{-5} M.

The solution contains a mixture of a weak acid (CH_3COOH) and its conjugate base (CH_3COO^-) so acts as a buffer and the Henderson-Hasselbalch equation can be used:

$$\text{pH} = \text{p}K_a + \log_{10} \left(\frac{[\text{base}]}{[\text{acid}]} \right)$$

with $[\text{base}] = [\text{CH}_3\text{COO}^-(\text{aq})]$ and $[\text{acid}] = [\text{CH}_3\text{COOH}(\text{aq})]$.

As $K_a = 1.8 \times 10^{-5}$, $\text{p}K_a = -\log_{10}K_a = -\log_{10}(1.8 \times 10^{-5}) = 4.74$.

Hence:

$$\text{pH} = 4.74 + \log_{10} \left(\frac{[0.010]}{[0.020]} \right) = 4.44$$

$$\text{pH} = 4.44$$