

- What is the pH of a 0.020 M solution of HF? The pK_a of HF is 3.17.

Marks
2

As HF is a weak acid, $[H_3O^+]$ must be calculated using a reaction table:

	HF	H ₂ O	\rightleftharpoons	H ₃ O ⁺	F ⁻
initial	0.020	large		0	0
change	-x	negligible		+x	+x
final	0.020 - x	large		x	x

The equilibrium constant K_a is given by:

$$K_a = \frac{[H_3O^+][F^-]}{[HF]} = \frac{x^2}{0.020 - x}$$

As $pK_a = -\log_{10}(K_a)$, $K_a = 10^{-3.17}$ and is very small. Hence, $0.020 - x \sim 0.020$ and hence:

$$x^2 = 0.020 \times 10^{-3.17} \quad \text{or} \quad x = 3.68 \times 10^{-3} \text{ M} = [H_3O^+]$$

Hence, the pH is given by:

$$pH = -\log_{10}[H_3O^+] = -\log_{10}(3.68 \times 10^{-3}) = 2.43$$

$$pH = 2.43$$

- What is the pH of a solution that is 0.075 M in acetic acid and 0.150 M in sodium acetate? The pK_a of CH₃COOH is 4.76.

2

This solution containing a weak acid (CH₃COOH) and its conjugate base (CH₃COO⁻) is a buffer and the Henderson-Hasselbalch equation can be used to calculate the pH:

$$pH = pK_a + \log_{10} \left(\frac{[\text{base}]}{[\text{acid}]} \right) = pK_a(\text{CH}_3\text{COOH}) + \log_{10} \left(\frac{[\text{CH}_3\text{COO}^-]}{[\text{CH}_3\text{COOH}]} \right)$$

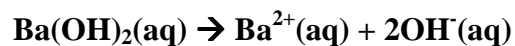
$$pH = 4.76 + \log_{10} \left(\frac{0.150}{0.075} \right) = 5.06$$

$$pH = 5.06$$

THE ANSWER CONTINUES ON THE NEXT PAGE

- What is the pH of a 0.010 M solution of Ba(OH)₂?

Ba(OH)₂ is a strong base and dissociates completely according to the equation:



Hence a 0.010 M solution has $[\text{OH}^-(\text{aq})] = 2 \times 0.010 = 0.020 \text{ M}$.

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

In aqueous solution, $\text{pH} + \text{pOH} = 14.00$ so $\text{pH} = (14.00 - 1.70) = 12.30$

pH = 12.30