

SAMPLE PROBLEM A

A 1.0×10^{-4} M solution of HNO_3 has been prepared for a laboratory experiment.

a. Calculate the $[\text{H}_3\text{O}^+]$ of this solution. b. Calculate the $[\text{OH}^-]$.

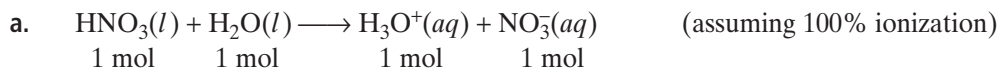
SOLUTION**1 ANALYZE**

Given: Concentration of the solution = 1.0×10^{-4} M HNO_3

Unknown: a. $[\text{H}_3\text{O}^+]$ b. $[\text{OH}^-]$

2 PLAN

HNO_3 is a strong acid, which means that it is essentially 100% ionized in dilute solutions. One molecule of acid produces one hydronium ion. The concentration of the hydronium ions thus equals the concentration of the acid. Because the ion product, $[\text{H}_3\text{O}^+][\text{OH}^-]$, is a constant, $[\text{OH}^-]$ can easily be determined by using the value for $[\text{H}_3\text{O}^+]$.



$$\text{molarity of HNO}_3 = \frac{\text{mol HNO}_3}{1 \text{ L solution}}$$

$$\frac{\cancel{\text{mol HNO}_3}}{\text{L solution}} \times \frac{1 \text{ mol H}_3\text{O}^+}{1 \cancel{\text{mol HNO}_3}} = \frac{\text{mol H}_3\text{O}^+}{\text{L solution}} = \text{molarity of H}_3\text{O}^+$$

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

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

3 COMPUTE

$$\text{a. } \frac{1.0 \times 10^{-4} \cancel{\text{mol HNO}_3}}{1 \text{ L solution}} \times \frac{1 \text{ mol H}_3\text{O}^+}{1 \cancel{\text{mol HNO}_3}} = \frac{1.0 \times 10^{-4} \text{ mol H}_3\text{O}^+}{1 \text{ L solution}} = 1.0 \times 10^{-4} \text{ M H}_3\text{O}^+$$

$$\text{b. } [\text{OH}^-] = \frac{1.0 \times 10^{-14}}{[\text{H}_3\text{O}^+]} = \frac{1.0 \times 10^{-14}}{1.0 \times 10^{-4}} = 1.0 \times 10^{-10} \text{ M}$$

4 EVALUATE

Because the $[\text{H}_3\text{O}^+]$, 1.0×10^{-4} , is greater than 1.0×10^{-7} , the $[\text{OH}^-]$ must be less than 1.0×10^{-7} . The answers are correctly expressed to two significant digits.

PRACTICE

Answers in Appendix E

- Determine the hydronium and hydroxide ion concentrations in a solution that is 1×10^{-4} M HCl.
- Determine the hydronium and hydroxide ion concentrations in a solution that is 1.0×10^{-3} M HNO_3 .
- Determine the hydronium and hydroxide ion concentrations in a solution that is 3.0×10^{-2} M NaOH.
- Determine the hydronium and hydroxide ion concentrations in a solution that is 1.0×10^{-4} M $\text{Ca}(\text{OH})_2$.

extension

Go to **go.hrw.com** for more practice problems that ask you to calculate concentration of hydronium and hydroxide ions.



Keyword: HC6ABTX