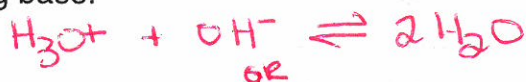


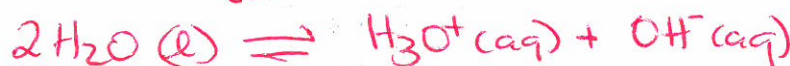
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Chemistry 12
ACID BASE PART II Lesson # 12 15
Mixing STRONG acids and Bases

Recall the NET IONIC EQUATION for the NEUTRALIZATION reaction of a strong acid with a strong base:



OR



Ratio
1 H₃O⁺ : 1 OH⁻

When you MIX A STRONG ACID WITH A STRONG BASE there are THREE POSSIBLE OUTCOMES:

1. $[\text{H}_3\text{O}^+] = [\text{OH}^-] = \text{neutral}$ (pH = 7)
2. $[\text{H}_3\text{O}^+] > [\text{OH}^-] = \text{acidic}$ (pH < 7)
3. $[\text{H}_3\text{O}^+] < [\text{OH}^-] = \text{basic}$ (pH > 7)

TO SOLVE THESE PROBLEMS THE FOLLOWING EQUATIONS ARE USED:

A. IF THE SOLUTION IS BASIC (pH > 7)

$$[\text{OH}^-]_{\text{XS}} = [\text{OH}^-]_{\text{ST}} - [\text{H}_3\text{O}^+]_{\text{ST}}$$

B. IF THE SOLUTION IS ACIDIC (pH < 7)

$$[\text{H}_3\text{O}^+]_{\text{XS}} = [\text{H}_3\text{O}^+]_{\text{ST}} - [\text{OH}^-]_{\text{ST}}$$

Example 1. If 10.0 mL of 0.100 M HCl is mixed with 90.0 mL of 0.100 M NaOH, What is the pH of the resulting mixture?

1. HCl is a strong acid, $[\text{HCl}] = [\text{H}_3\text{O}^+]$ NaOH is a strong base; $[\text{NaOH}] = [\text{OH}^-]$

$$[\text{H}_3\text{O}^+]_{\text{I}} = 0.100 \text{ M}$$

$$[\text{OH}^-]_{\text{I}} = 0.100 \text{ M}$$

2. Dilution calculations for $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$:

$$[\text{H}_3\text{O}^+]_{\text{ST}} = \frac{0.100 \text{ M} \times 0.0100 \text{ L}}{0.100 \text{ L}} = 0.0100 \text{ M H}_3\text{O}^+$$

$$[\text{OH}^-]_{\text{ST}} = \frac{0.100 \text{ M} \times 0.0900 \text{ L}}{0.100 \text{ L}} = 0.0900 \text{ M OH}^-$$

3. Which ion has the larger concentration? $[\text{H}_3\text{O}^+]$ or $[\text{OH}^-]$?

$$0.0900 \text{ M OH}^- > 0.0100 \text{ M H}_3\text{O}^+$$

4. Solve for the XS of OH⁻.

$$[\text{OH}^-]_{\text{XS}} = [\text{OH}^-]_{\text{ST}} - [\text{H}_3\text{O}^+]_{\text{ST}}$$

$$= 0.0900 - 0.0100 \rightarrow 0.0800 \text{ M OH}^-_{\text{XS}}$$

5. Solve for the pH

$$\text{pOH} = -\log(0.0800)$$

$$\text{pOH} = 1.097$$

$$\text{pH} = 14.000 - 1.097$$

$$\boxed{\text{pH} = 12.903}$$

Example 2. Calculate the pH that results when 50.0 mL of 0.150 M LiOH is mixed with 50.0 mL of 0.200 M HNO₃.

1. HNO₃ is a strong acid; [HCl] = [H₃O⁺] LiOH is a strong base; [LiOH] = [OH⁻]

$$[\text{H}_3\text{O}^+]_i = 0.200 \text{ M} \quad [\text{OH}^-]_i = 0.150 \text{ M}$$

2. Dilution calculations for [H₃O⁺] and [OH⁻]:

$$[\text{H}_3\text{O}^+]_{\text{ST}} = \frac{0.200 \text{ M} \times 0.0500 \text{ L}}{0.100 \text{ L}} = 0.100 \text{ M H}_3\text{O}^+$$

$$[\text{OH}^-]_{\text{ST}} = \frac{0.150 \text{ M} \times 0.0500 \text{ L}}{0.100 \text{ L}} = 0.0750 \text{ M OH}^-$$

3. Which ion has the larger concentration? [H₃O⁺] or [OH⁻]?

$$0.100 \text{ M H}_3\text{O}^+ > 0.0750 \text{ M OH}^-$$

4. Solve for the XS of H₃O⁺.

$$[\text{H}_3\text{O}^+]_{\text{XS}} = [\text{H}_3\text{O}^+]_{\text{ST}} - [\text{OH}^-]_{\text{ST}}$$

$$[\text{H}_3\text{O}^+]_{\text{XS}} = 0.100 \text{ M} - 0.0750 \text{ M} = \boxed{0.025 \text{ M H}_3\text{O}^+}$$

5. Solve for the pH

$$\text{pH} = -\log(0.025)$$

$$\boxed{\text{pH} = 1.60}$$

Example 3. How many grams of NaOH must be added to 40.0 mL of 0.180 M HCl to produce a solution having a pH of 12.500. Assume NO CHANGE in volume when the NaOH is added.

1. pH of 12.500 means the solution is BASIC. There is an excess of OH⁻!

2. Use pH to solve for the excess concentration of OH⁻_{XS}.

$$\text{pOH} = 14.000 - 12.500$$

$$\text{pOH} = 1.500$$

$$[\text{OH}^-] = \text{antilog}(-1.500) = 3.16 \times 10^{-2} \text{ M OH}^-_{\text{XS}}$$

3. Rearrange the XS equation to solve for OH⁻_{ST}.

$$[\text{OH}^-]_{\text{XS}} = [\text{OH}^-]_{\text{ST}} - [\text{H}_3\text{O}^+]_{\text{ST}} \quad \therefore [\text{OH}^-]_{\text{ST}} = [\text{OH}^-]_{\text{XS}} + [\text{H}_3\text{O}^+]_{\text{ST}}$$

$$[\text{OH}^-]_{\text{ST}} = 3.16 \times 10^{-2} \text{ M} + 0.180 \text{ M} = 0.212 \text{ M OH}^-$$

4. Now convert concentration into grams!

$$\frac{0.212 \text{ mol OH}^-}{1 \text{ L}} \times 0.0400 \text{ L} \times \frac{40.0 \text{ g NaOH}}{1 \text{ mol}} = \boxed{0.339 \text{ g NaOH}}$$

$$\text{Na} = 23.0$$

$$\text{O} = 16.0$$

$$\text{H} = \frac{1.0}{40.0}$$

SEATWORK/HOMEWORK: Exercises 58 - 68 pgs 143-144 in Hebden
PLO's: P5