# Acid-Base Titrations
Chem Worksheet 19-5

Name _____

An acid is neutralized by a base. If the concentration and volume of the base are accurately known, the concentration or the molar mass of an acid can be determined. The **concentration** of an unknown acid is equal to the moles of acid per liter of acid. The **molar mass** of an acid is the grams of acid per mole of acid.

**Titration Calculation Strategies**
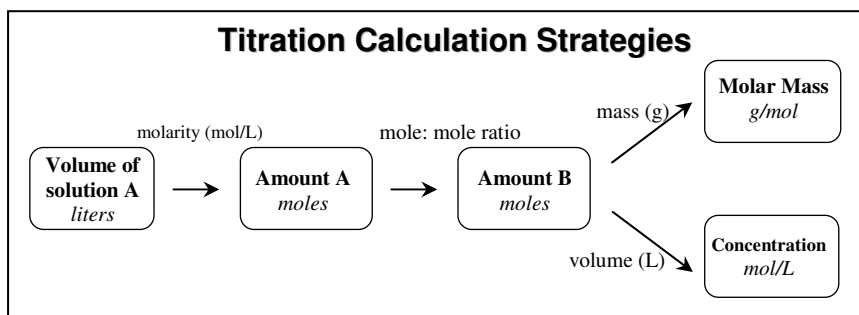
Examples

When 1.04 g of a monoprotic unknown acid (HA) is titrated with 0.300 M NaOH it takes 75.21 mL of base to neutralize the acid. Determine the **molar mass** of the unknown acid.

$$HA + NaOH \rightarrow NaA + H_2O$$

- begin with units of L on the bottom: (liters will be converted to moles, which are on the bottom of molar mass)

$$\frac{1}{0.07521 \text{ L NaOH}} \times \frac{1 \text{ L NaOH}}{0.300 \text{ mol NaOH}} \times \frac{1 \text{ mol NaOH}}{1 \text{ mol HA}} \times \frac{1.04 \text{ g HA}}{1} = 46.1 \frac{\text{grams HA}}{\text{mol HA}}$$

An unknown diprotic acid (H_2A) with a volume of 10.0 mL is titrated with 165 mL of 0.15 M KOH. Find the **concentration** of the acid in mol/L.

$$H_2A + KOH \rightarrow K_2A + 2H_2O$$
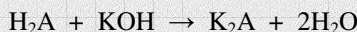
- begin with units of L on the top: (liters will be converted to moles, which are on the top of the molarity units)

$$\frac{0.165 \text{ L KOH}}{1} \times \frac{0.15 \text{ mol KOH}}{1 \text{ L KOH}} \times \frac{1 \text{ mol } H_2A}{2 \text{ mol KOH}} \times \frac{1}{0.0100 \text{ L } H_2A} = 1.2 \frac{\text{mol } H_2A}{\text{L } H_2A}$$

## Answer the following questions. Show all work and report answers with units.

1. Lactic acid, a chemical responsible for muscle fatigue, is a monoprotic acid. When 0.578 g of lactic acid is titrated with 0.206 M NaOH, a volume of 31.11 mL of NaOH is used. What is the **molar mass** of lactic acid?
$$HA + NaOH \rightarrow NaA + H_2O$$
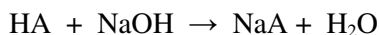
2. A volume of 25.0 mL of nitric acid, HNO_3 is titrated with 0.12 M NaOH. To completely neutralize the acid 10 mL of NaOH must be added. Find the **concentration** (mol/L) of the nitric acid.
$$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$$
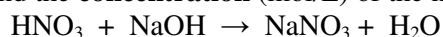
3. Malonic acid is a diprotic acid used in the production of pharmaceuticals. A 0.965 g sample of malonic acid requires 45.91 mL of 0.404 M LiOH to be neutralized. Determine the **molar mass** (g/mol) for malonic acid.
$$H_2A + 2 \text{ LiOH} \rightarrow Li_2A + 2 H_2O$$
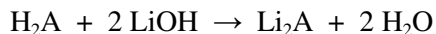
4. To find the molarity of sulfuric acid, H_2SO_4 it is titrated with 0.75 M KOH. It requires 328.4 mL of KOH to neutralize a 40.00 mL sample of sulfuric acid. Calculate the **concentration** (mol/L) of the sulfuric acid.
$$H_2SO_4 + 2 \text{ KOH} \rightarrow K_2SO_4 + 2 H_2O$$
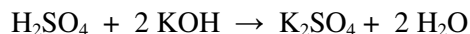
5. Boric acid is a triprotic acid that is used as an ant and roach killer. A 1.42-g sample of boric acid is neutralized by 157 mL of 0.4388 M NaOH. Determine the **molar mass** (g/mol) for boric acid.
$$H_3A + 3 \text{ NaOH} \rightarrow Na_3A + 3 H_2O$$
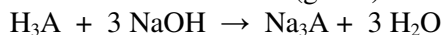
6. Tartaric acid, $H_2C_4H_4O_6$ is neutralized with 0.100 M NaOH. A sample of 3.0 g of tartaric acid reacts with 45 mL of base. How **concentrated** is the base?
$$H_2C_4H_4O_6 + 2 \text{ NaOH} \rightarrow Na_2C_4H_4O_6 + 2 H_2O$$