

Dilution

- We recognize that the number of moles of solute are the same in dilute and concentrated solutions.
- So:

$$M_{\text{dilute}} V_{\text{dilute}} = \text{moles} = M_{\text{concentrated}} V_{\text{concentrated}}$$
$$M_1 V_1 = M_2 V_2$$



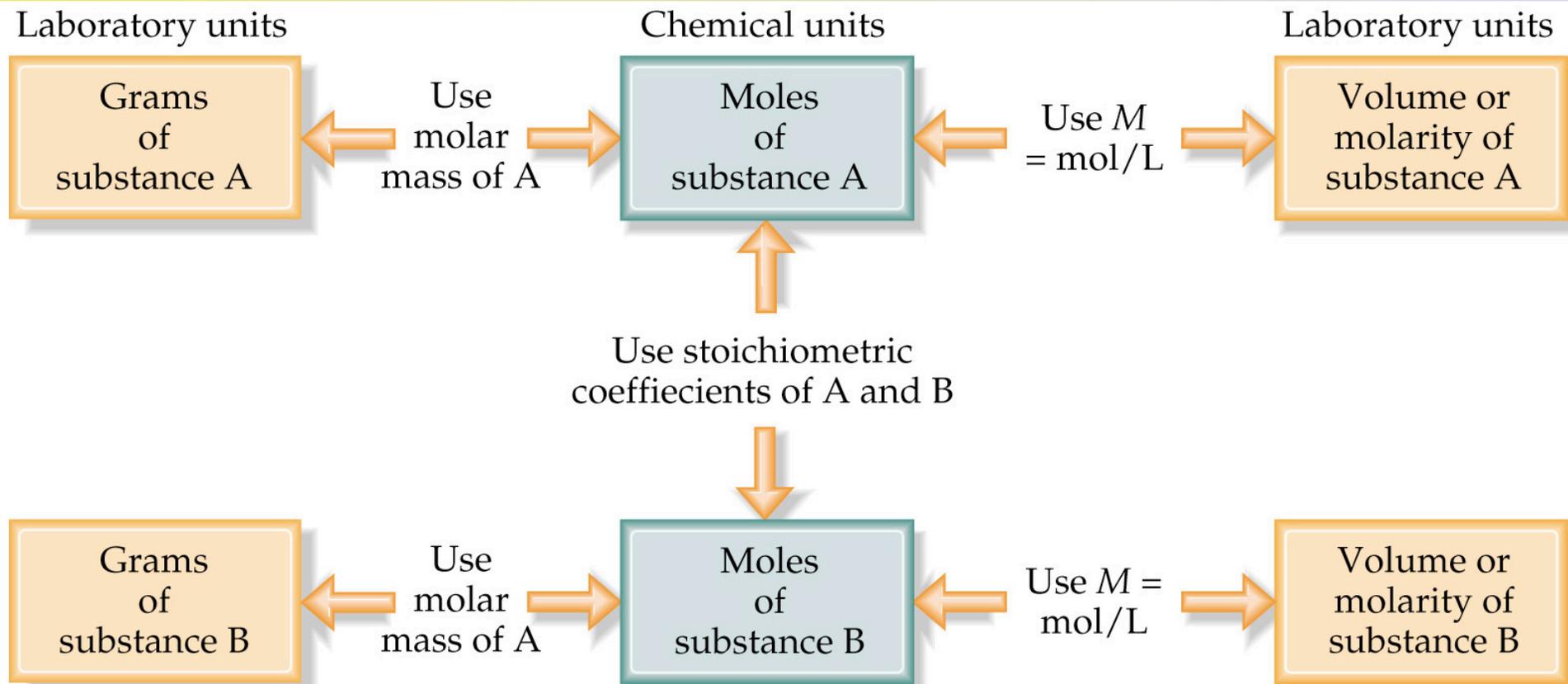
Example: What volume of 18.0 M H_2SO_4 solution is required to prepare 1000.0 mL of 1.00 M H_2SO_4 ?

55.6 mL or 0.0556 L

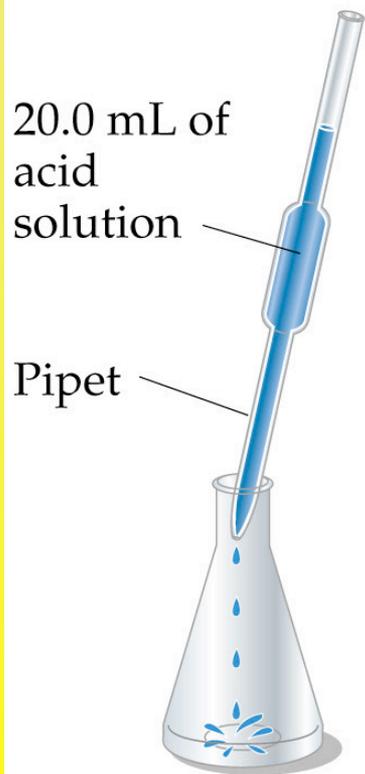
Solution Stoichiometry and Chemical Analysis

- There are two different types of units:
 - laboratory units (measured in lab);
 - chemical units (relate to moles).
- Always convert the laboratory units into chemical units first.
 - Grams are converted to moles using molar mass.
 - Volume or molarity of solution are converted into moles using $M = \text{mol/L}$.

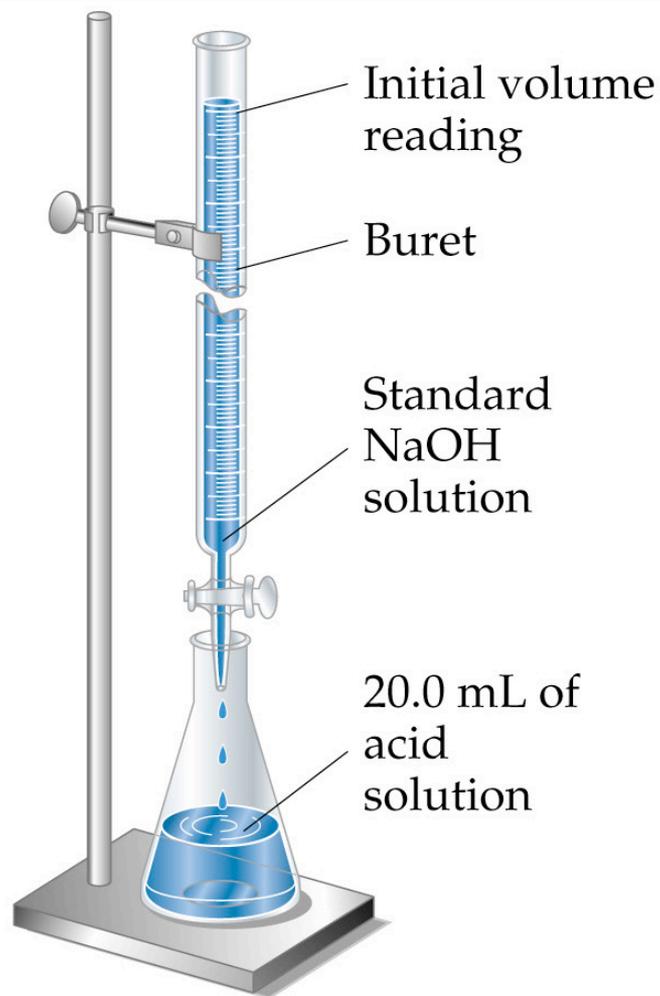
- Use the stoichiometric coefficients to move between reactants and product.



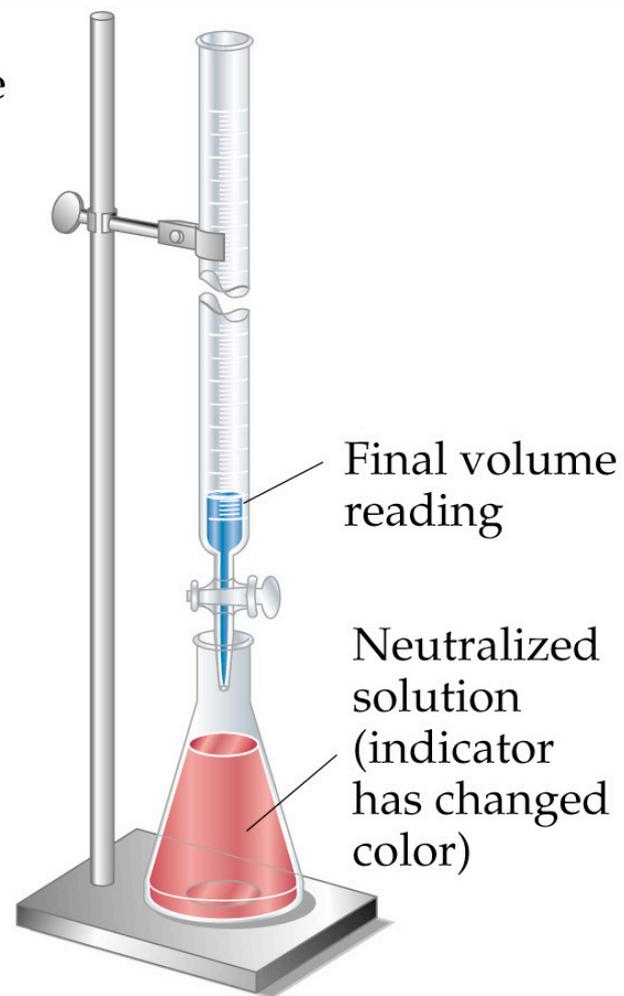
Titrations



(a)



(b)



(c)

Titration

- *Suppose we know the molarity of a NaOH solution and we want to find the molarity of an HCl solution.*
- We know:
 - molarity of NaOH, volume of HCl.
- What do we want?
 - Molarity of HCl.
- What do we do?
 - Take a known volume of the HCl solution, measure the mL of NaOH required to react completely with the HCl.

Titration

- What do we get?
 - Volume of NaOH. We know molarity of the NaOH, we can calculate moles of NaOH.
- Next step?
 - We also know $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$. Therefore, we know moles of HCl.
- Can we finish?
 - Knowing mol(HCl) and volume of HCl (20.0 mL above), we can calculate the molarity.

Examples:

1. Standardization of NaOH: A primary standard called potassium hydrogen phthalate is used to determine the exact molarity of a solution of base. KHP is a monoprotic weak acid (MW = 204.22). In one example, 0.4977 g of KHP is dissolved in 100.0 mL of water. This solution requires 14.86 mL of a solution of NaOH to neutralize it. What is the molarity of the NaOH solution?
2. Solid Acid: An unknown solid acid is analyzed by titration. 1.75 g of the acid is weighed and dissolved in 150.0 mL of distilled water. This solution is titrated with 0.250 M KOH, and requires 19.07 mL of the KOH solution to reach the endpoint. What is the molar mass of the solid, assuming it is monoprotic?

Examples:

1. .164 M

2. 367.1 g mol⁻¹

3. Unknown Solution: A solution of the weak base, Na_2SO_4 , is analyzed by titration with 0.1000 M HCl. A 10.00 mL sample of the base requires 38.04 mL of HCl to reach the endpoint. What is the molarity of the sodium sulfate solution?

3. .1902 M