Properties of Solutions

Objectives

1. To learn to solve stoichiometric problems involving solution reactions
2. To do calculations involving acid-base reactions
3. To learn about normality and equivalent weight
4. To use normality in stoichiometric calculations
5. To understand the effect of a solute on solution properties

Properties of Solutions

A. Stoichiometry of Solution Reactions

Steps for Solving Stoichiometric Problems Involving Solutions

Step 1 Write the balanced equation for the reaction. For reactions involving ions, it is best to write the net ionic equation.

Step 2 Calculate the moles of reactants.

Step 3 Determine which reactant is limiting.

Step 4 Calculate the moles of other reactants or products, as required.

Step 5 Convert to grams or other units, if required.

Properties of Solutions

B. Neutralization Reactions

- An acid-base reaction is called a neutralization reaction.
- Steps to solve these problems are the same as before.

Steps for Solving Stoichiometric Problems Involving Solutions

Step 1 Write the balanced equation for the reaction. For reactions involving ions, it is best to write the net ionic equation.

Step 2 Calculate the moles of reactants.

Step 3 Determine which reactant is limiting.

Step 4 Calculate the moles of other reactants or products, as required.

Step 5 Convert to grams or other units, if required.

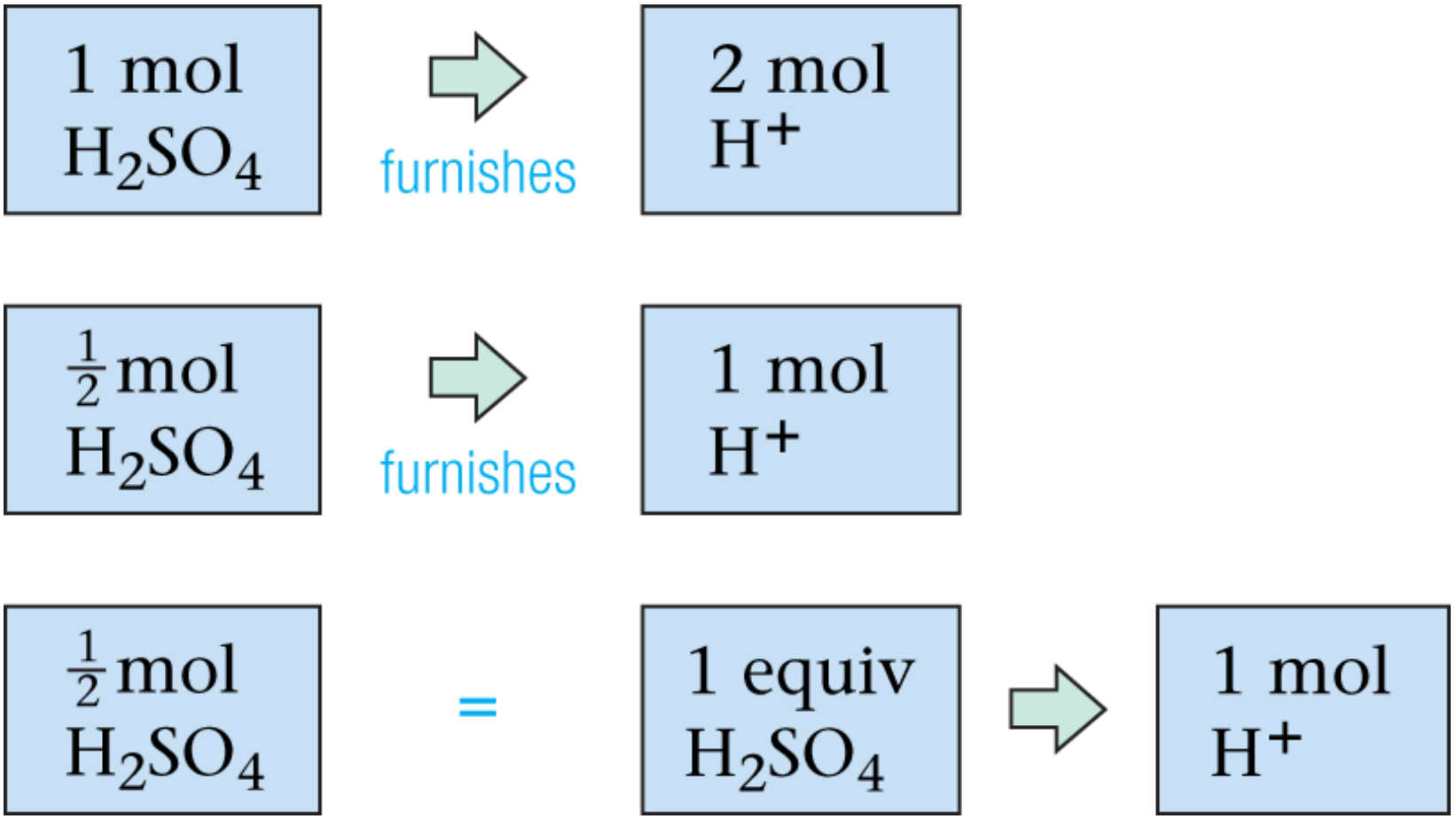
Properties of Solutions

C. Normality

- Unit of concentration
  - One equivalent of acid – amount of acid that furnishes 1 mol of H^+ ions
  - One equivalent of base – amount of base that furnishes 1 mol of OH^- ions
  - Equivalent weight – mass in grams of 1 equivalent of acid or base

Properties of Solutions

C. Normality



Properties of Solutions

C. Normality

Table 15.2

The Molar Masses and Equivalent Weights of the Common Strong Acids and Bases

	Molar Mass (g)	Equivalent Weight (g)
Acid		
HCl	36.5	36.5
HNO_3	63.0	63.0
H_2SO_4	98.0	$49.0 = \frac{98.0}{2}$
Base		
NaOH	40.0	40.0
KOH	56.1	56.1

Properties of Solutions

C. Normality

$$\text{Normality} = \text{N} = \frac{\text{number of equivalents}}{\text{liter of solution}} = \frac{\text{equivalents}}{\text{liter}} = \frac{\text{equiv}}{\text{L}}$$

- To find number of equivalents

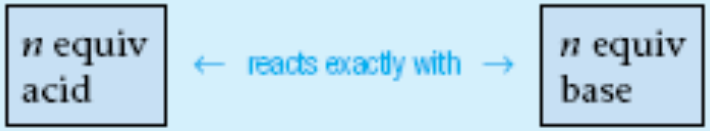
$$N \times V = \frac{\text{equiv}}{\cancel{\text{L}}} \times \cancel{\text{L}} = \text{equiv}$$

Properties of Solutions

C. Normality

- Advantage of equivalents

n equivalents of any acid will exactly neutralize *n* equivalents of any base.



For any neutralization reaction,

$$N_{acid} \times V_{acid} = N_{base} \times V_{base}$$

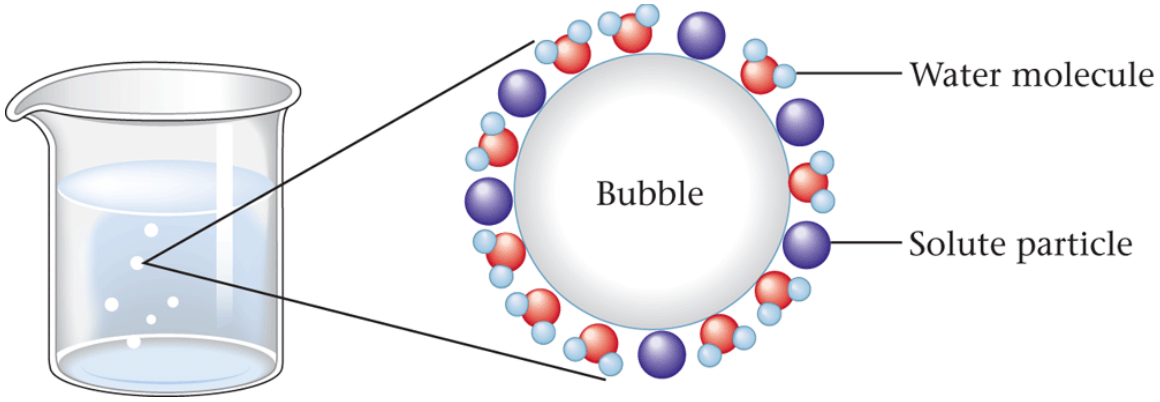
Properties of Solutions

D. Boiling Point and Freezing Point

- The presence of solute “particles” causes the liquid range to become wider.
  - Boiling point increases
  - Freezing point decreases

D. Boiling Point and Freezing Point

- Why does the boiling point of a solution increase?
  - Forming a bubble in a solution

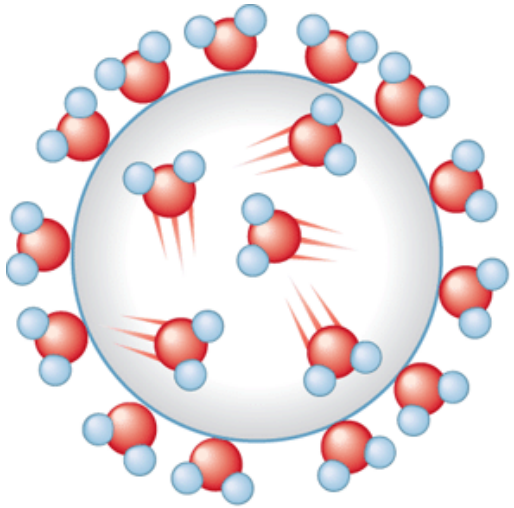


  - Solute particles block some of the water molecules trying to enter the bubble.
  - Need higher pressure to maintain the bubble.

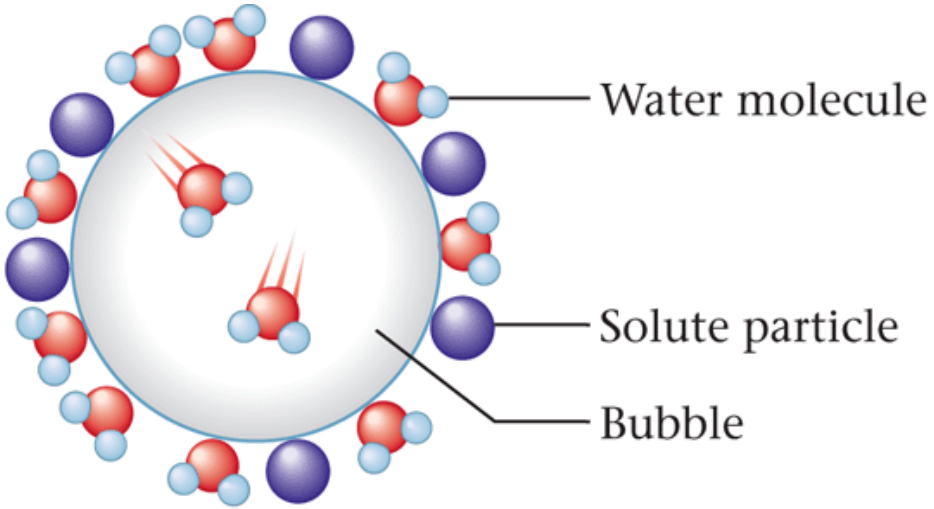
Properties of Solutions

D. Boiling Point and Freezing Point

– Comparing bubbles



Pure water



Solution (contains solute)

Properties of Solutions

D. Boiling Point and Freezing Point

- Colligative property – a solution property that depends on the number of solute particles present