



Module 12

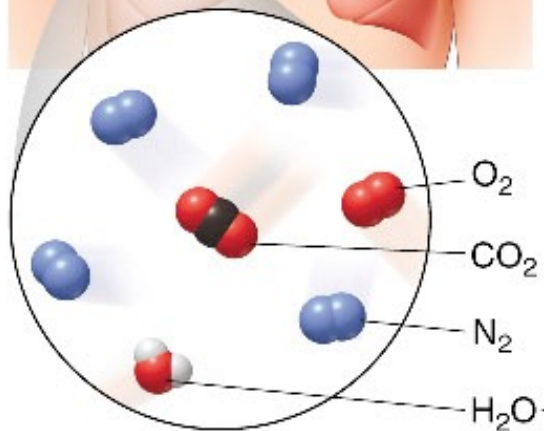
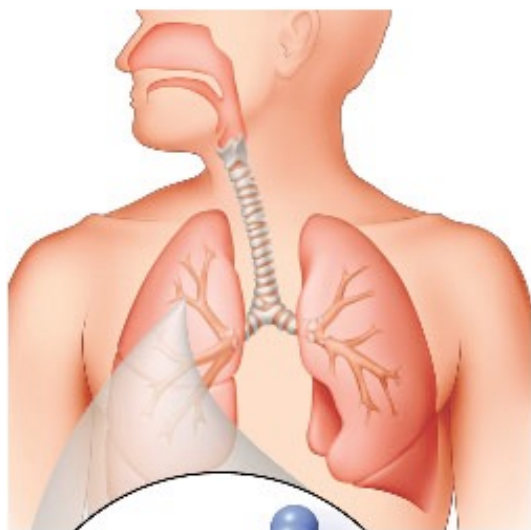
Brad Ashburn, PhD
BIOC 141

Solutions (Section 8.1)

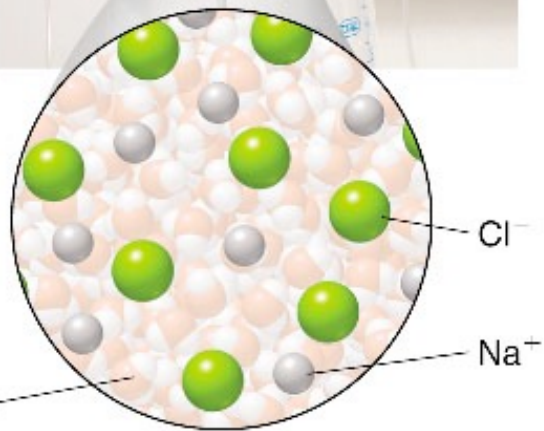


Examples of Solutions

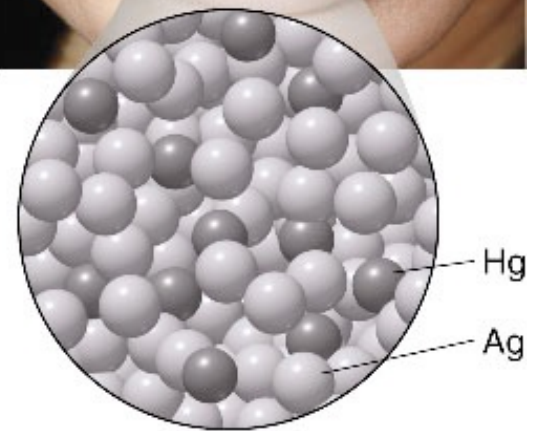
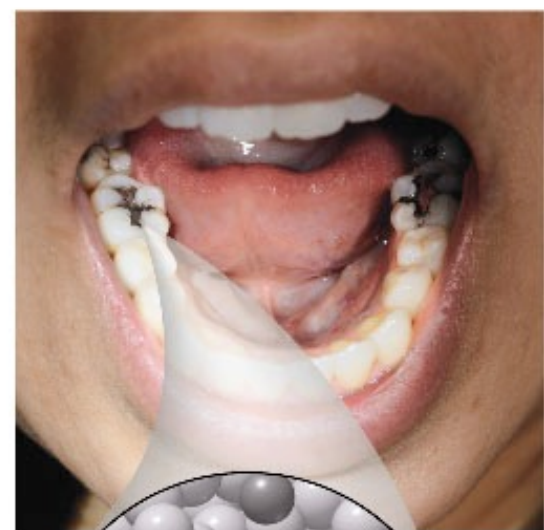
Air



Saline



Dental filling



Solubility

Solutions consist of two parts:

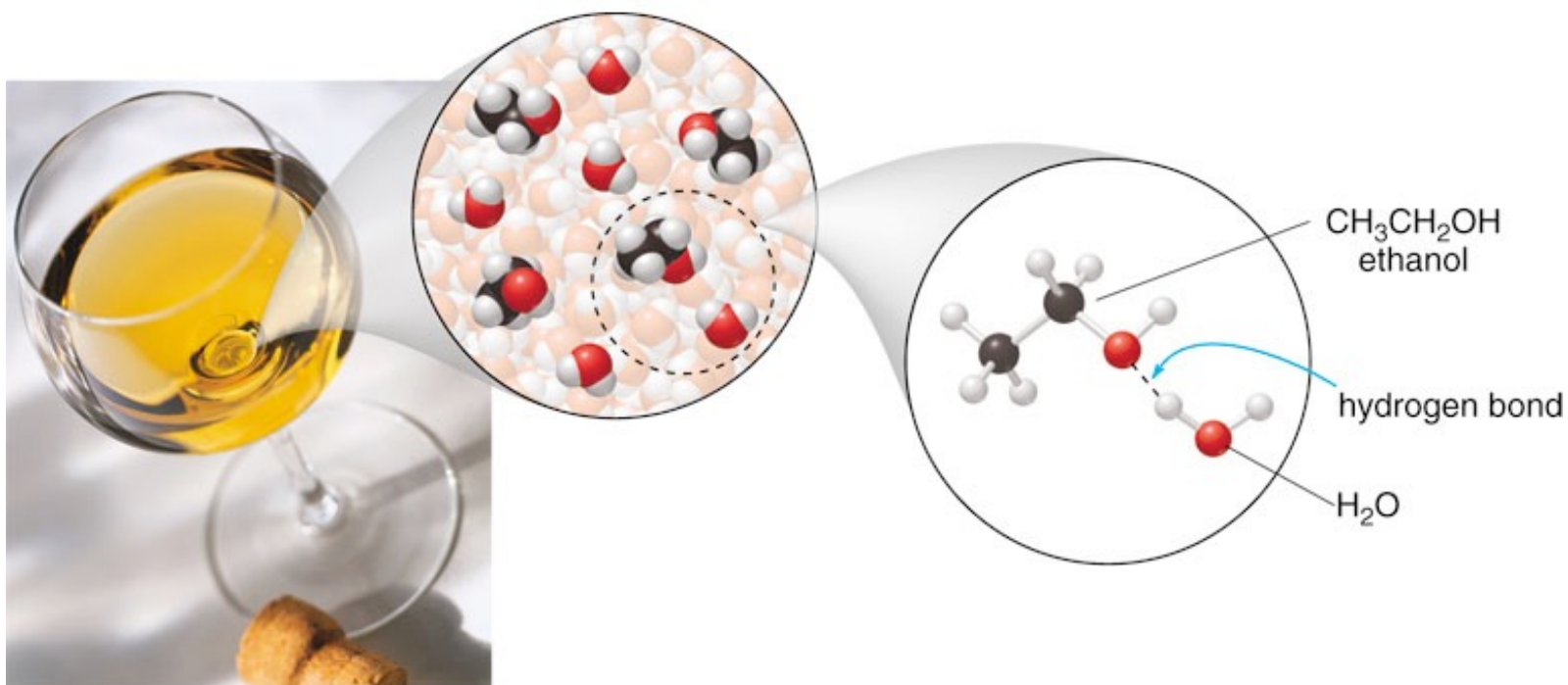
Solute - substance in lesser amount

Solvent - substance in larger amount

Solubility is the amount of solute that dissolves in a given amount of solvent.

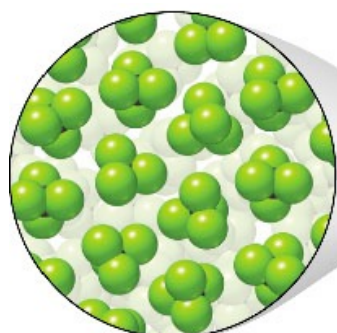
Solubility

Polar molecules are soluble in polar solvents.

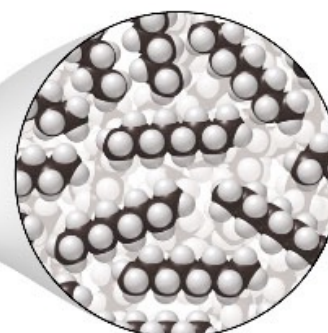


Solubility

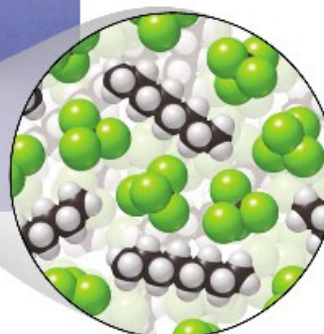
Non-polar molecules are soluble in non-polar solvents.



CCl_4



octane



octane in CCl_4

Concept Check

Soluble or not?

NaCl and water

water and C_8H_{18}

water and NH_3



Concept Review (Section 8.1)

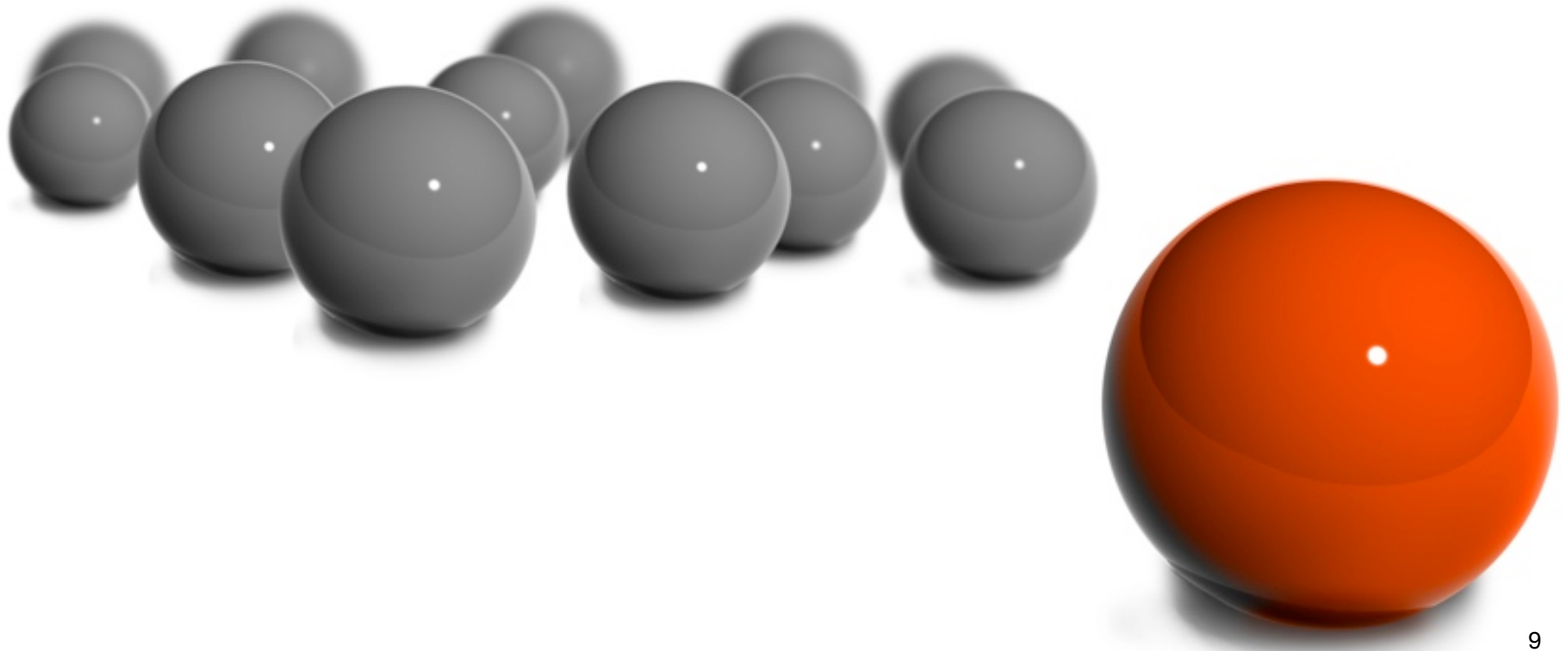
CONCEPT REVIEW EXERCISES

1. What causes a solution to form?
2. How does the phrase *like dissolves like* relate to solutions?

Practice Problems: 1-10

Math Review: Percentages

If there are 50 marbles in a bag and 3 are red colored, what percentage of marbles are red?



Math Review: Percentages

If 4% of all people drive a Toyota,
how many people out of 100 drive Toyotas?



Concentration (Section 9.2)

The **concentration** of a solution tells us how much solute is dissolved in a given amount of solution.

$$\text{w/v \%} = \frac{\text{mass of solute (g)}}{\text{volume of solution (mL)}} \times 100$$

Concentration

The **concentration** of a solution tells us how much solute is dissolved in a given amount of solution.

$$v/v \% = \frac{\text{volume of solute (mL)}}{\text{volume of solution (mL)}} \times 100$$

Example

Household vinegar contains 5 mL of acetic acid in 100 mL of solution. What is the **v/v % concentration**?



Concept Check

Pepto-Bismol, an OTC medication used for upset stomach, contains 535 mg of bismuth subsalicylate in each 15 mL dose. What is the **w/v % concentration**?



Percentage to Fraction

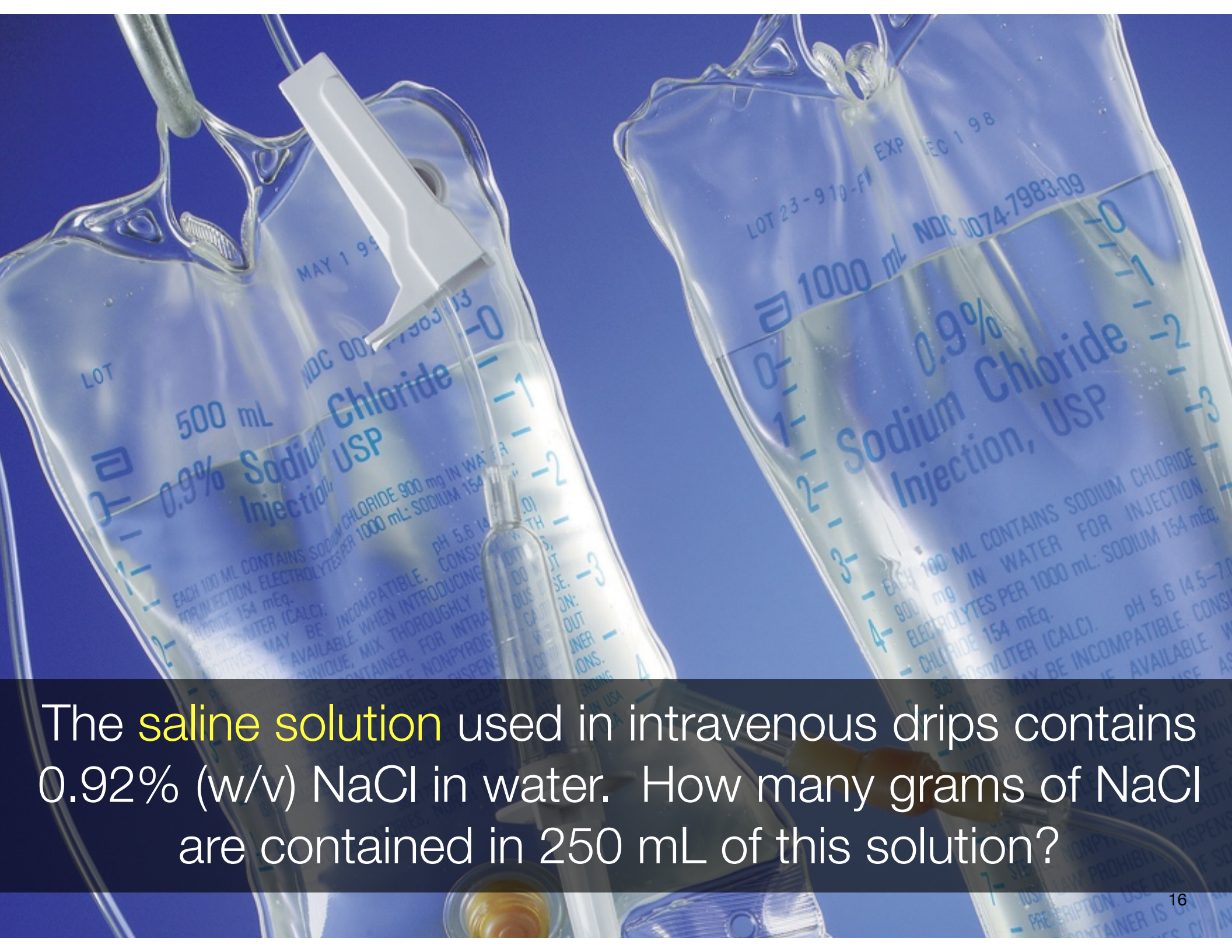
Convert w/v or v/v % into a **conversion factor**

Recall **w/v = g/mL** and **v/v = mL/mL**

Examples:

25% w/v glucose solution

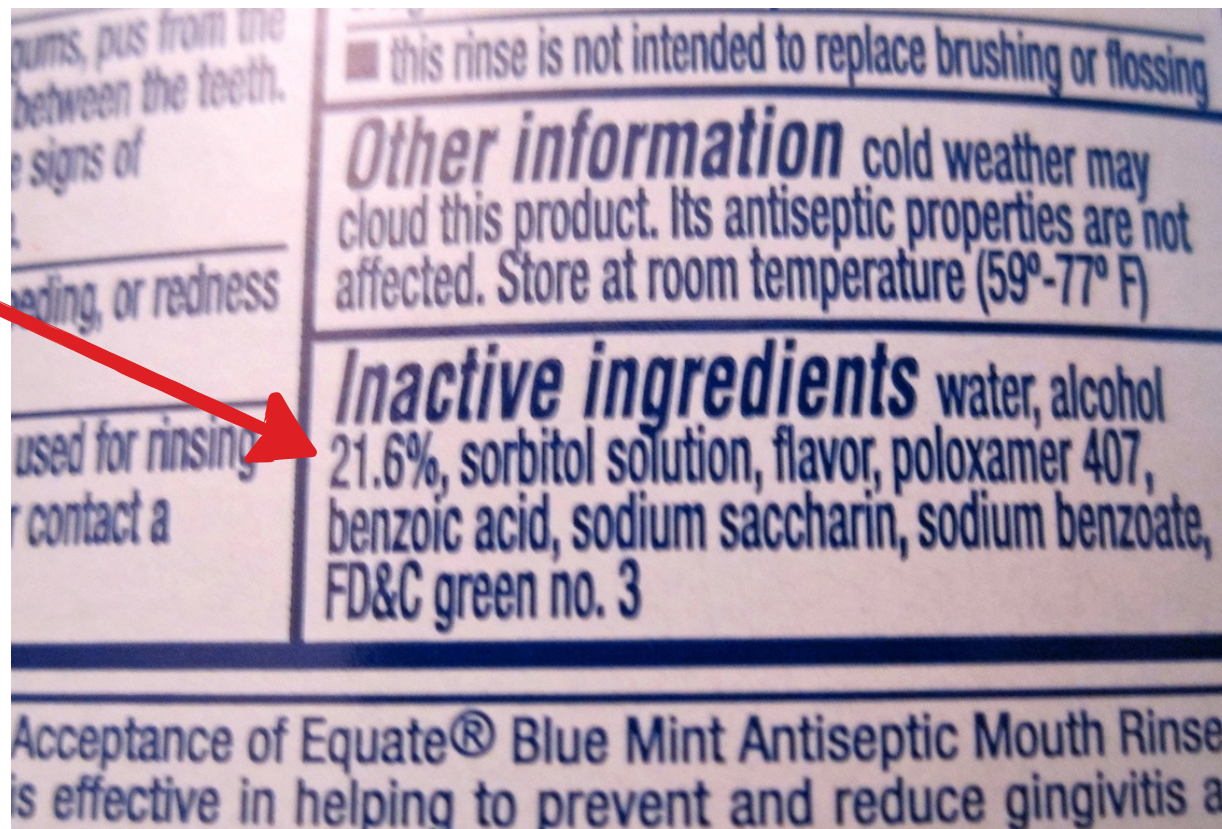
7.3% v/v alcohol solution

Two clear plastic IV bags are shown against a solid blue background. The bag on the left is partially filled with a clear liquid and has a white plastic drip chamber attached to its top. The bag on the right is also partially filled. Both bags have blue printed text and markings. The text includes 'LOT', '500 mL' and '1000 mL' volume markings, '0.9% Sodium Chloride Injection, USP', and 'NDC 0074-7983-09'. There are also smaller markings for 'MAY 1 99' and 'EXP DEC 1 98'. The bags are connected by clear plastic tubing. The overall image has a clinical, medical feel.

The **saline solution** used in intravenous drips contains 0.92% (w/v) NaCl in water. How many grams of NaCl are contained in 250 mL of this solution?

Mouthwash or Martini?

How many milliliters of alcohol are contained in the recommended 20.0 mL portion of mouthwash with a 21.6% (v/v) of alcohol?



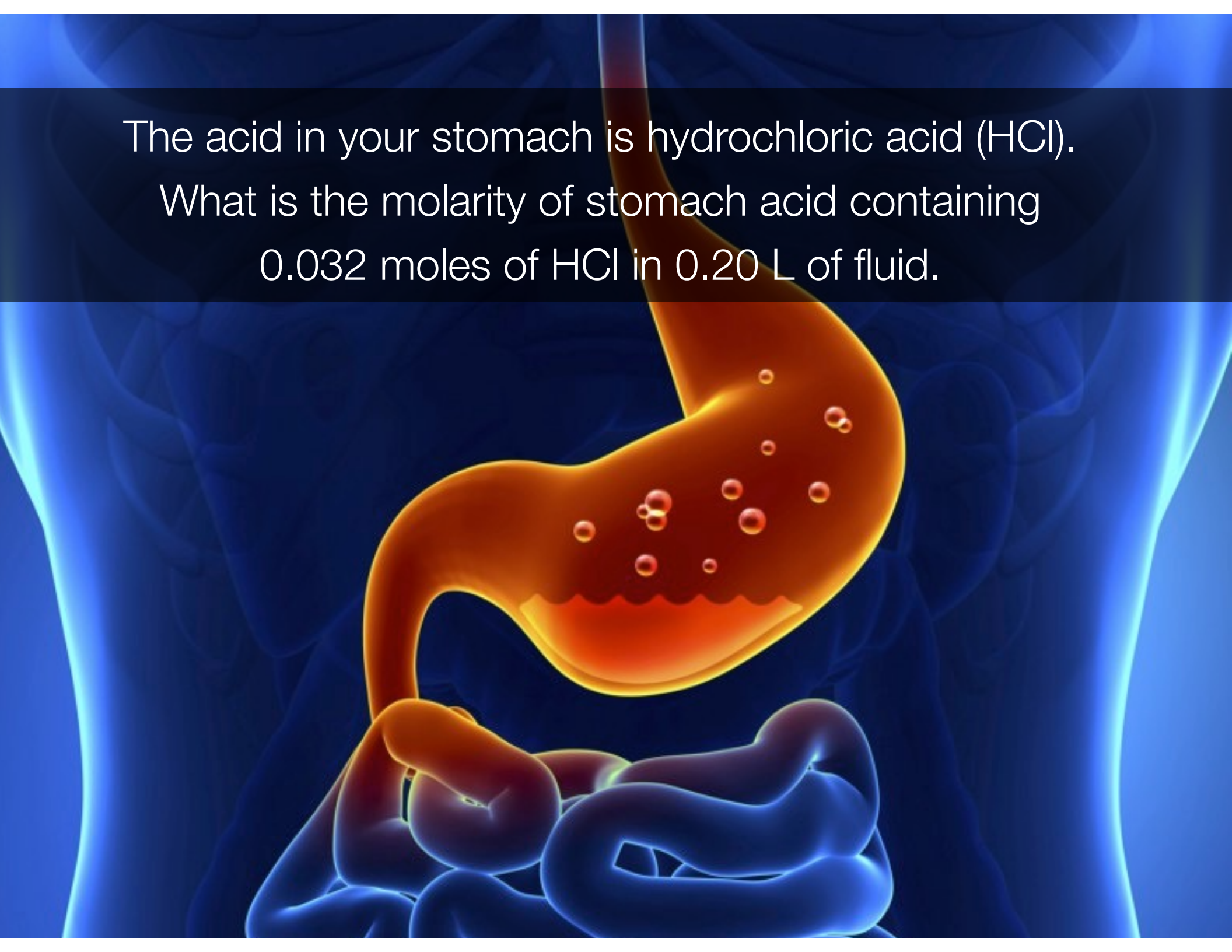
Molarity

$$M = \frac{\text{moles of solute (mol)}}{\text{liter of solution (L)}}$$

Step 1: Convert the quantities to moles and liters.

Step 2: Divide moles by liters.

The acid in your stomach is hydrochloric acid (HCl).
What is the molarity of stomach acid containing
0.032 moles of HCl in 0.20 L of fluid.



Dilution

Many drugs come from manufacturers as **concentrated** solutions despite patients only needing **dilute** amounts.

Dilution is the **addition of solvent** to decrease the concentration.



initial solution

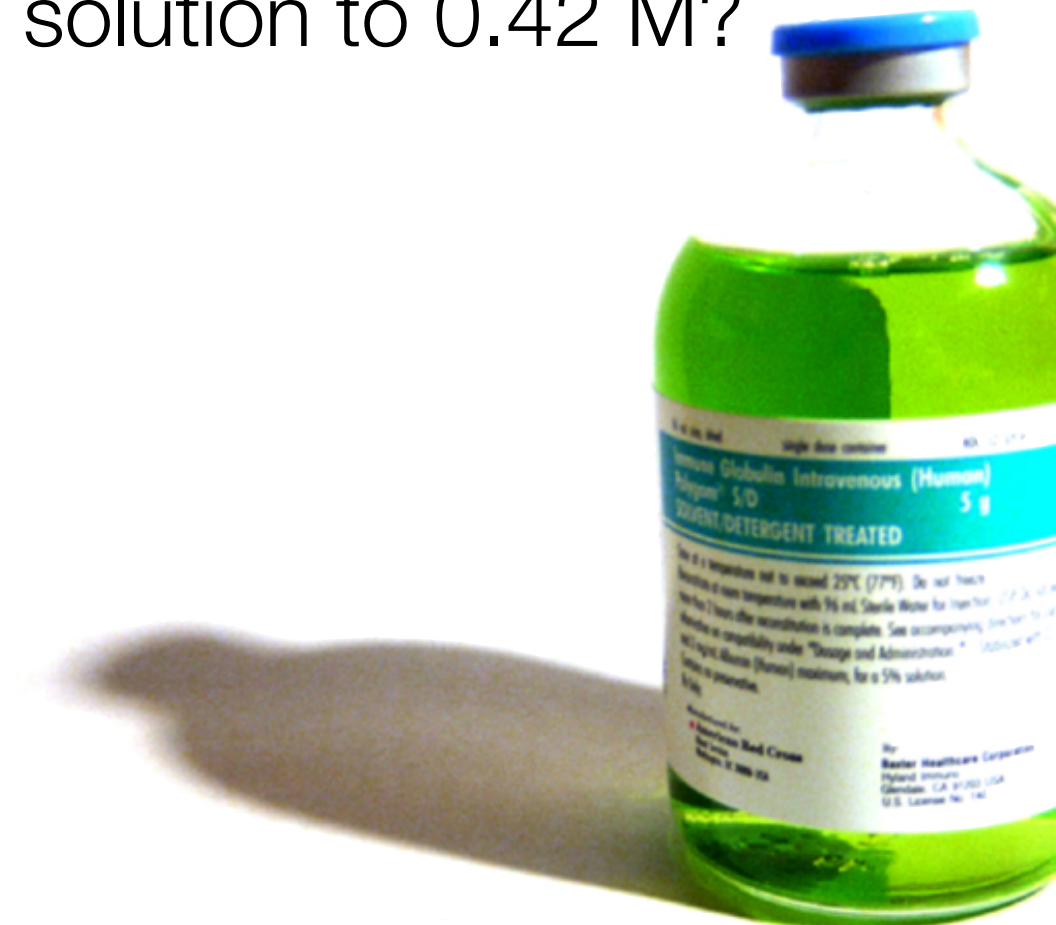
Example

What is the **molarity** of a solution formed by diluting 5.0 mL of a 3.2 M glucose solution to 40.0 mL?

$$C_1 \times V_1 = C_2 \times V_2$$

Concept Check

Prontosil comes as a concentrated 1.6 M solution in 120 mL bottles. What is the new volume (in mL) needed to dilute the solution to 0.42 M?



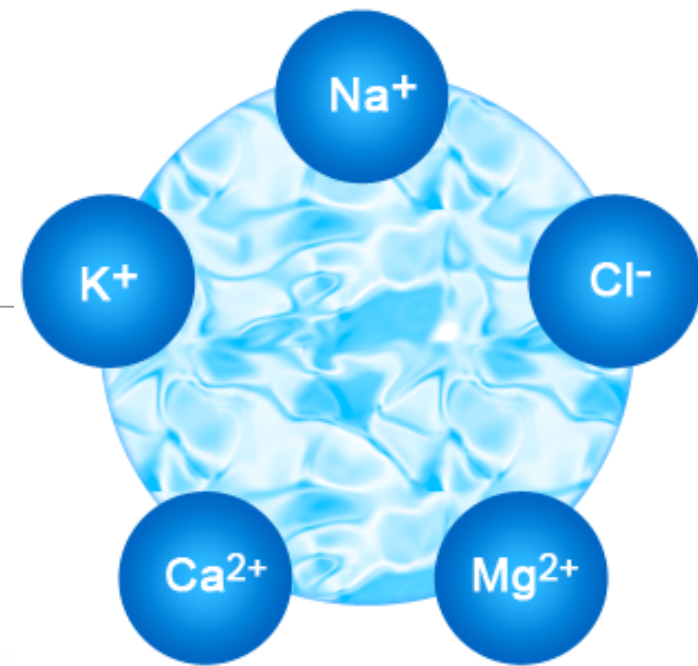
Concept Review (Section 9.2)

CONCEPT REVIEW EXERCISES

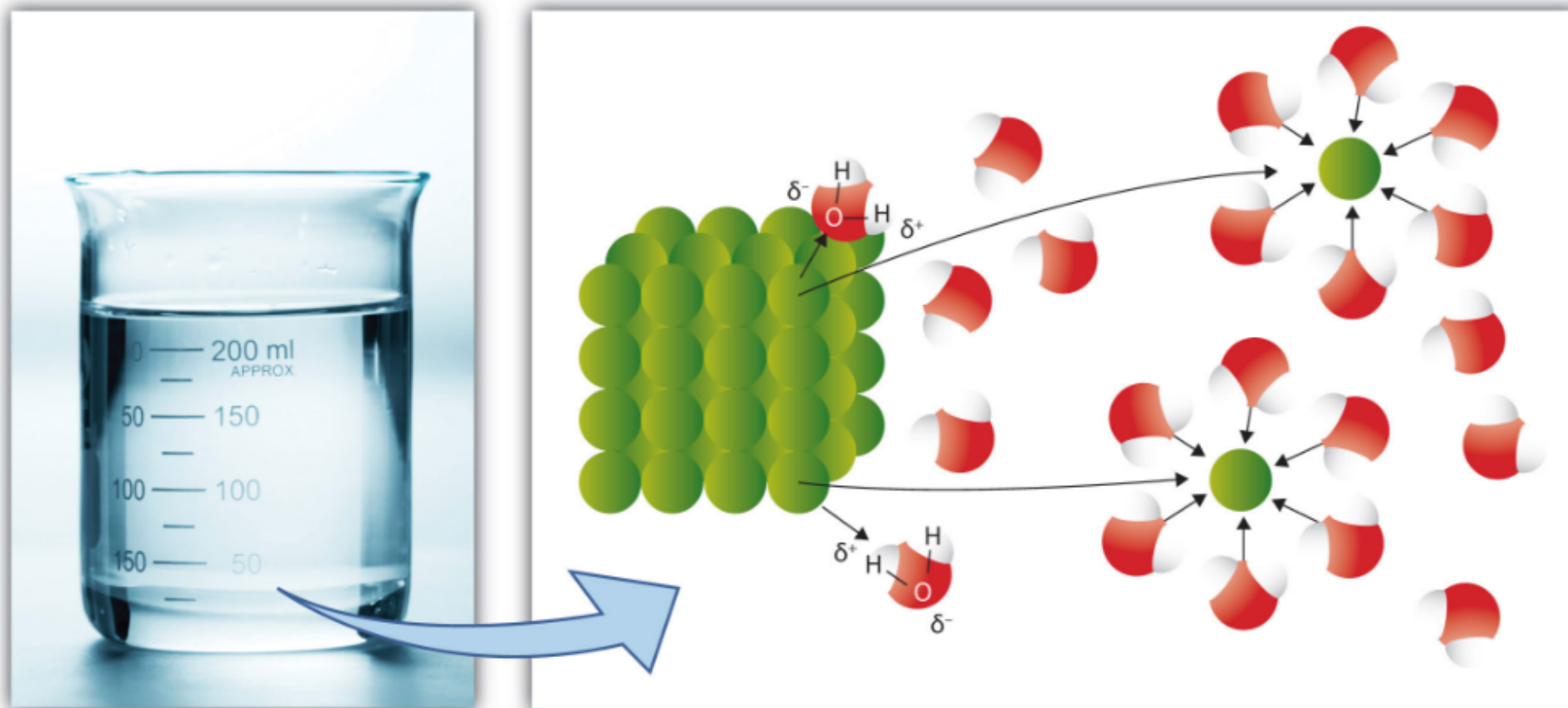
1. What are some of the units used to express concentration?
2. Distinguish between the terms *solubility* and *concentration*.

Practice Problems: 1-24

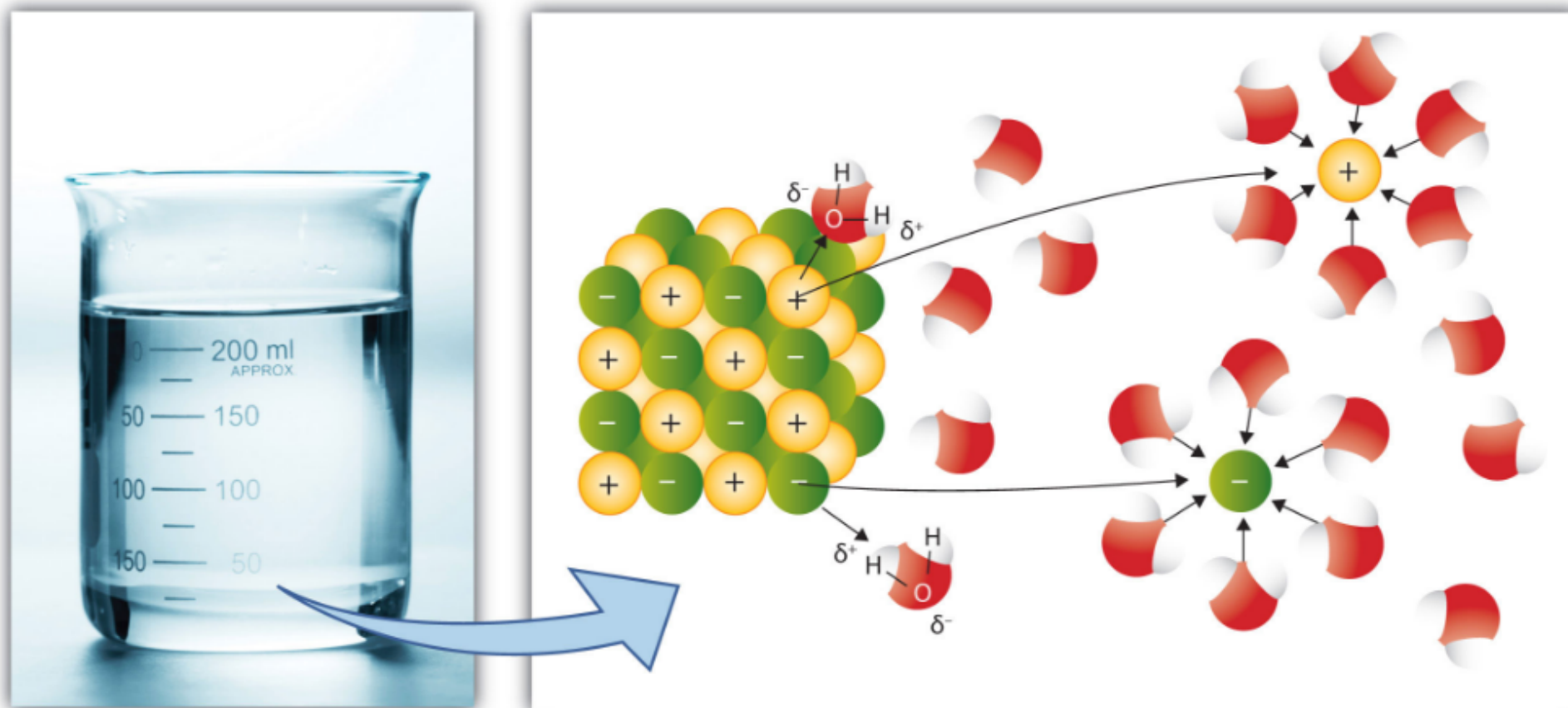
Dissolving (Section 8.3)



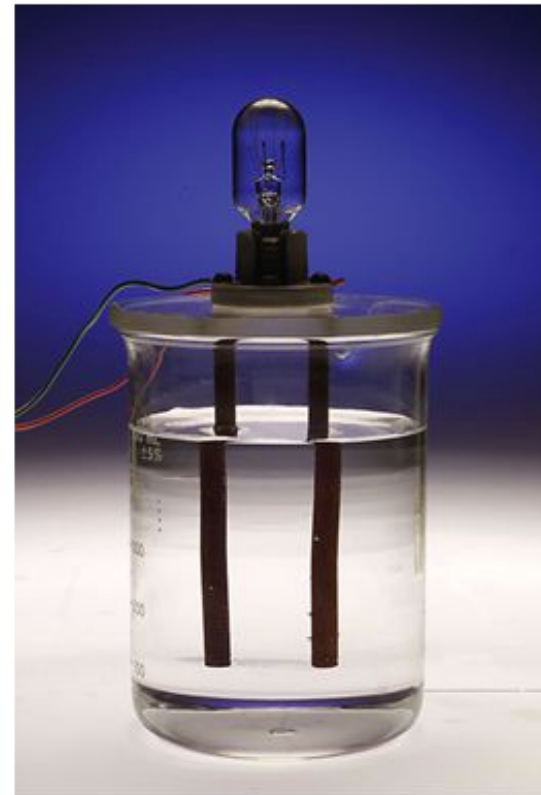
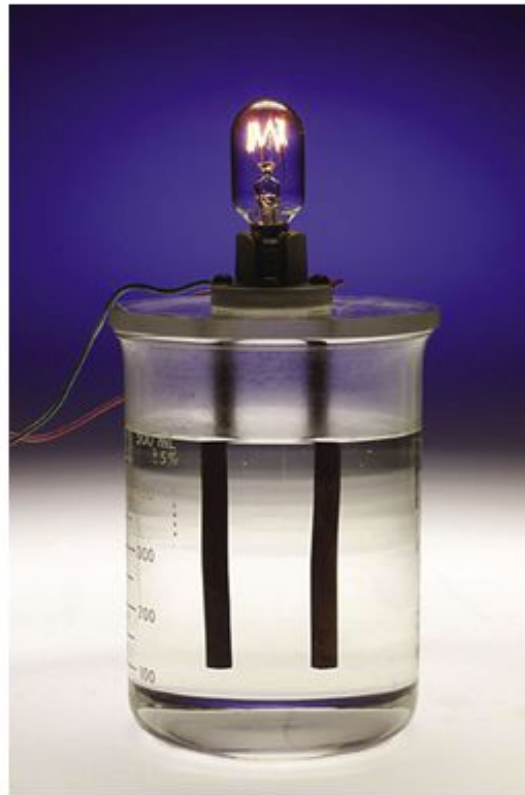
Solvation of Covalent Molecules



Solvation of Ionic Compounds (Electrolytes)



Electrolytes



Concept Review (Section 8.3)

CONCEPT REVIEW EXERCISE

1. Explain how the solvation process describes the dissolution of a solute in a solvent.

Practice Problems: 1-6

Colligative Properties (Section 8.4)

Practice Problems: 1-6

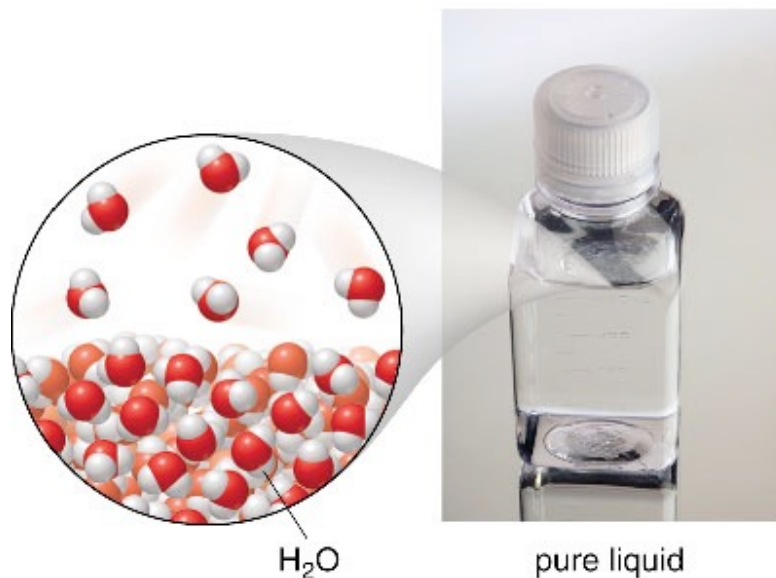
Colligative Properties (Section 8.4)

Colligative properties of a solution depend only on the **amount of solute**, **not its identity**.

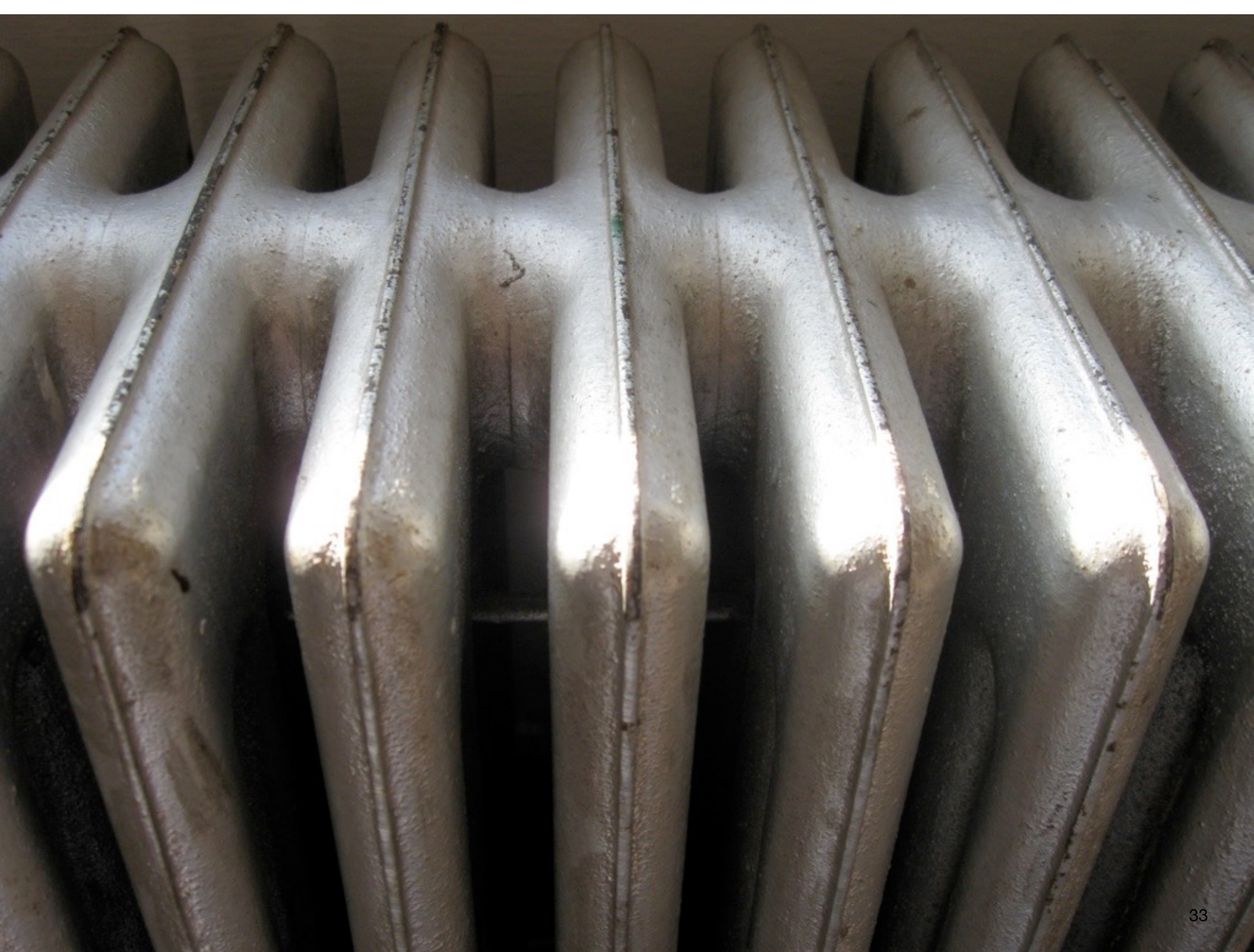
Boiling Point Elevation
Freezing Point Depression
Osmosis

Boiling Point Elevation

A liquid solution that contains a non-volatile solute has a **higher boiling point** than **pure solvent** alone.



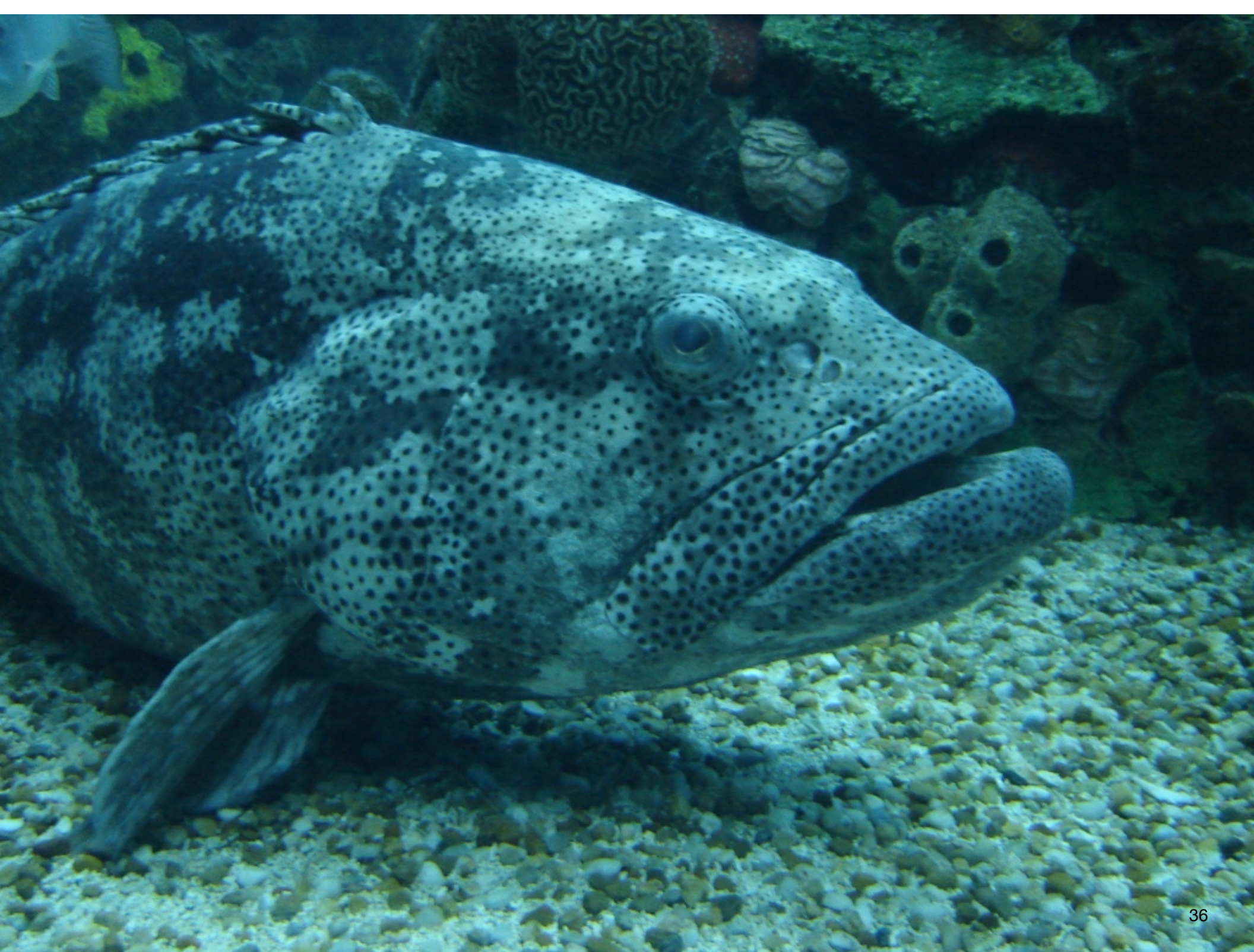




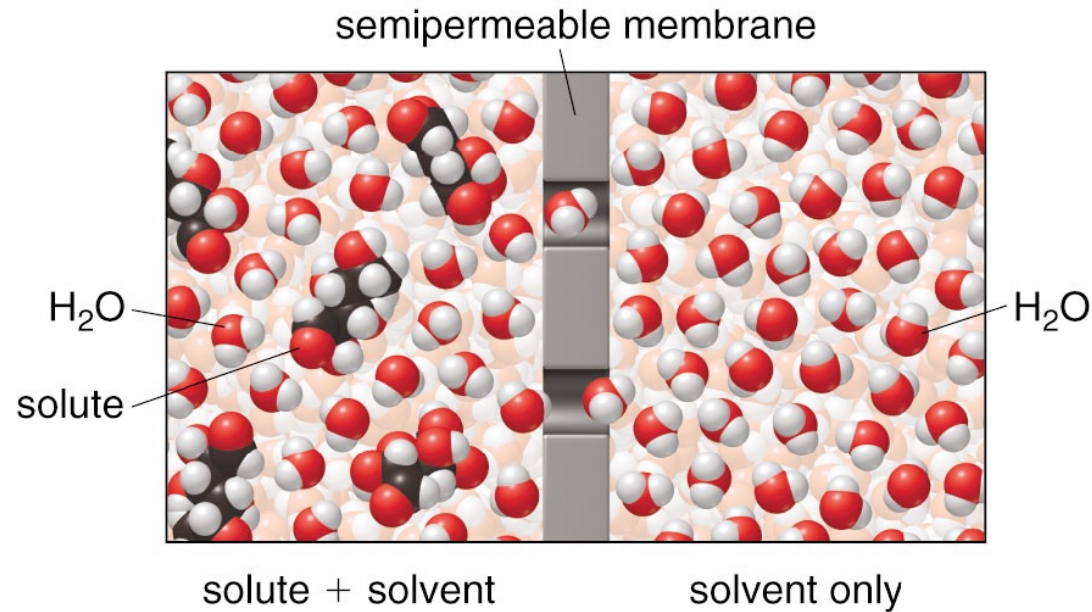
Freezing Point Depression

A liquid solution that contains a non-volatile solute has a **lower freezing point** than **pure solvent** alone.





Osmosis



Semi-permeable membranes allow only water to pass

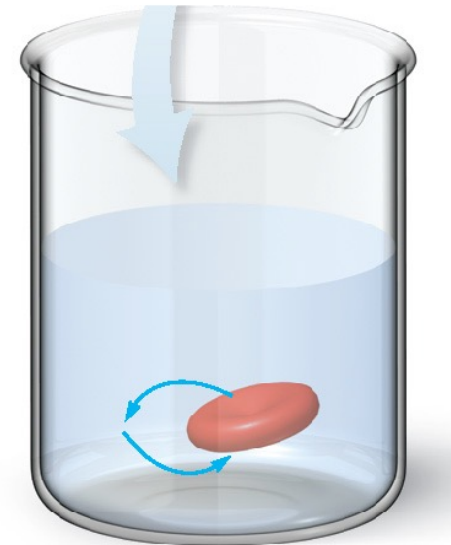
Osmosis is the flow of **water** across a membrane from a solution of **low** concentration to **high** concentration.

Osmosis - Isotonic

An **isotonic** solution has the same solute concentration than cellular fluids.

Rate flowing in = Rate flowing out

Cell remains the same size



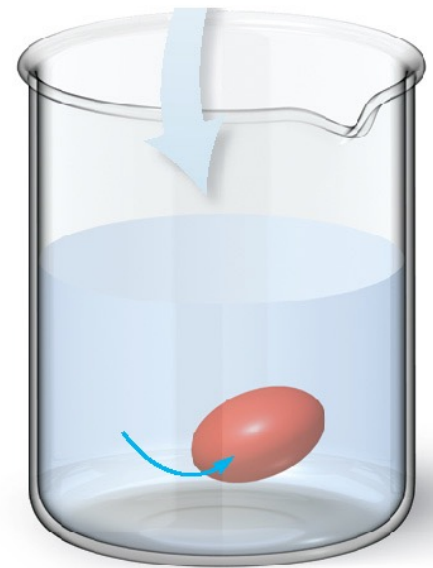
isotonic solution

Osmosis - Hypotonic

A **hypotonic** solution has lower solute concentration than cellular fluids.

Rate flowing in > Rate flowing out

Cell swells to the point it bursts



hypotonic solution

Osmosis - Hypertonic

A **hypertonic** solution has higher solute concentration than cellular fluids.

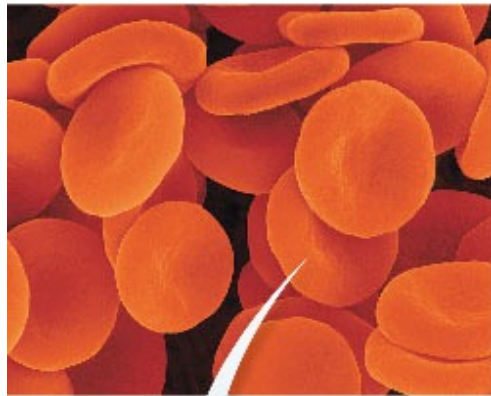
Rate flowing in < Rate flowing out

Cell loses water and shrinks

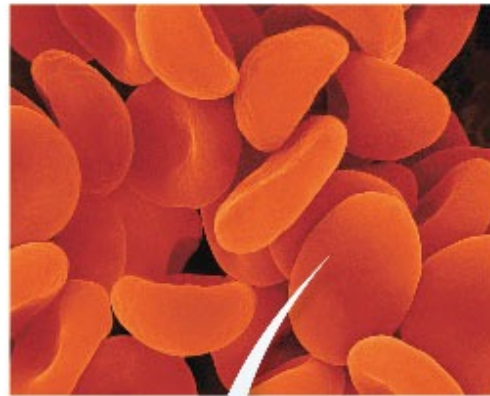


hypertonic solution

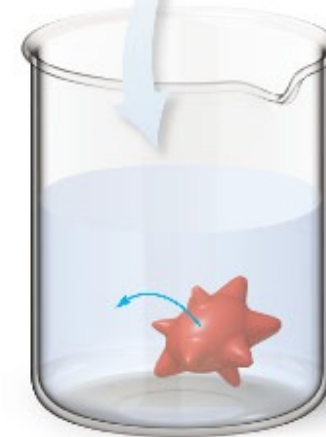
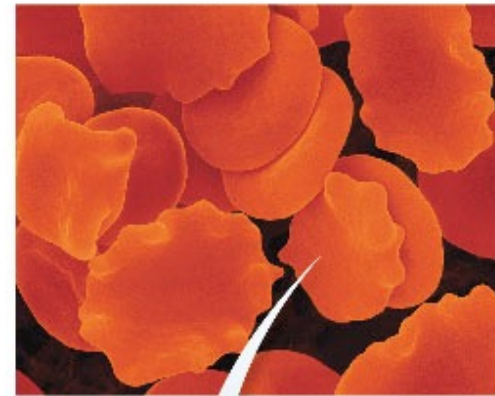
Red Blood Cell Summary



isotonic
solution

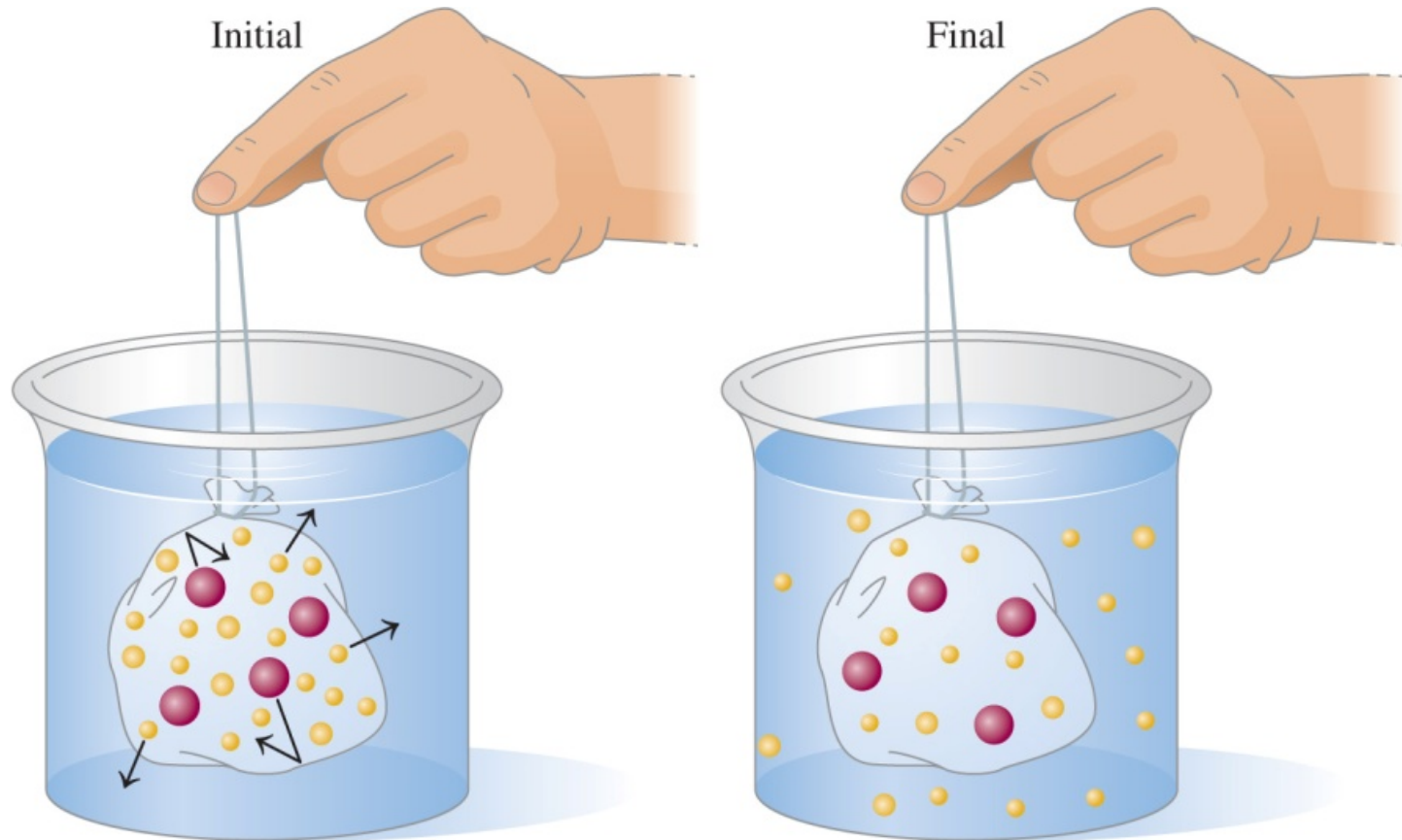


hypotonic
solution



hypertonic
solution

Dialysis



- Solution particles such as Na^+ , Cl^- , glucose
- Colloidal particles such as protein, starch

Solution particles pass through a dialyzing membrane but colloidal particles are retained.

Concept Check

Explain why a **cucumber** shrivels up when placed in pickling solution?



Concept Review (Section 8.4)

CONCEPT REVIEW EXERCISES

1. What are the colligative properties of solutions?

Practice Problems: Worksheet