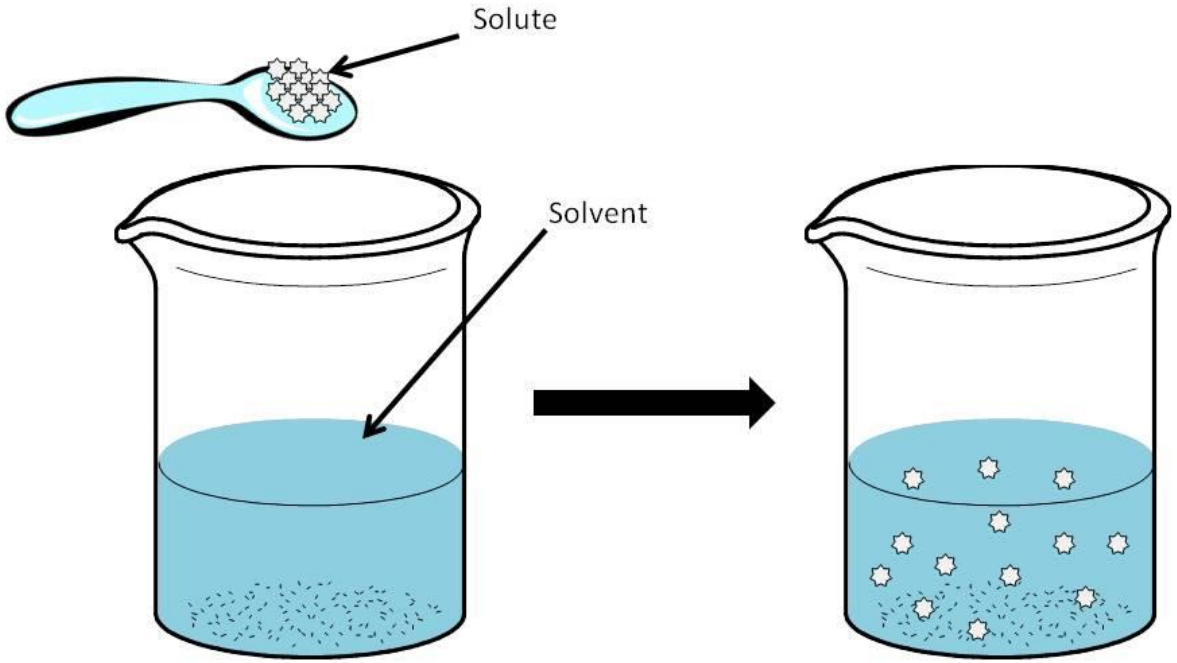
Chapter 3 Part 3

Dr. Turner

Solutions



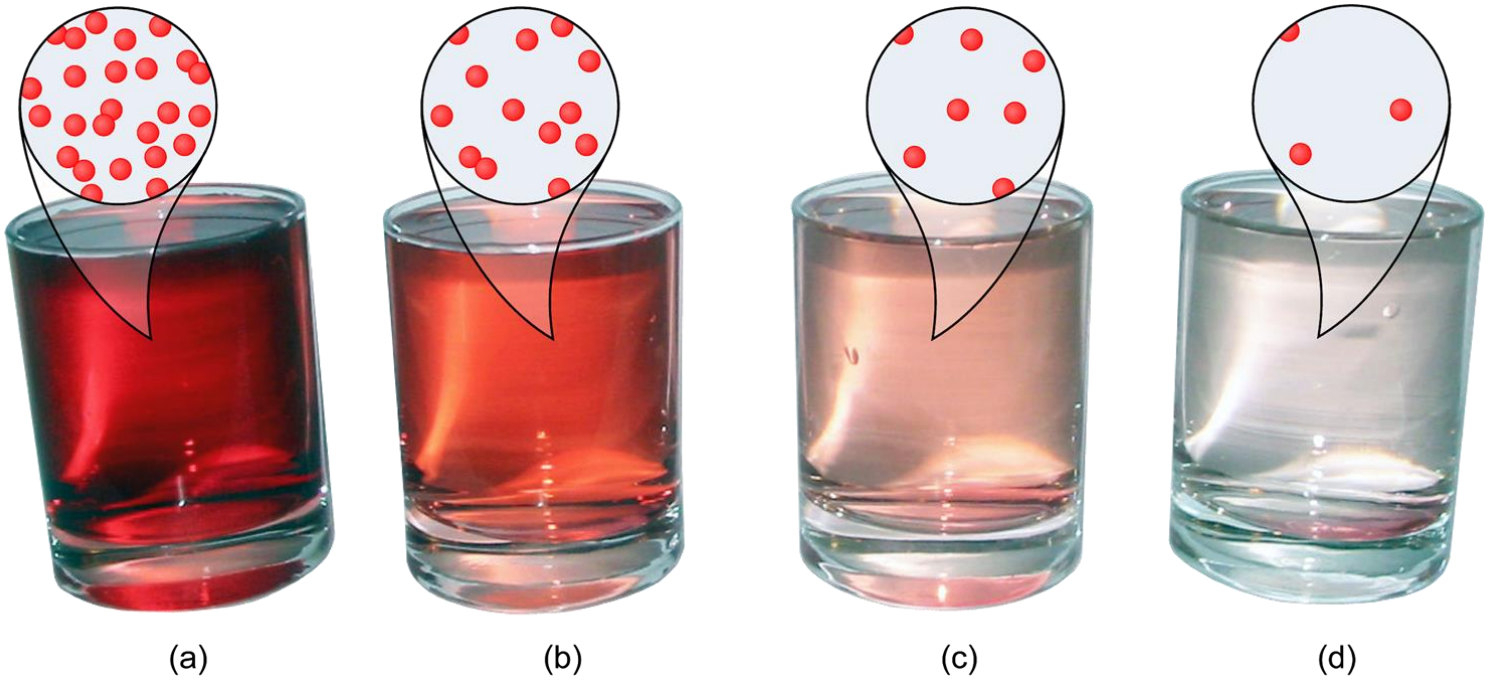
The **solute** is the substance that gets dissolved, the **solvent** is the substance that does the dissolving.

Once mixed, the solute will dissolve and become evenly dispersed within the solvent.

Solutions and Concentration

- A solution is a homogeneous mixture of two or more substances.
  - The component present in the greatest amount is the solvent, and
  - the substance or substances dissolved in the solvent are the solutes.
- Concentration expresses the quantity of a solute in a given quantity of solvent or solution.
  - Solutions with a relatively large amount of solute per volume of solvent are concentrated.
  - Solutions with a relatively small amount of solute per volume of solvent are dilute.

Concentrated and Dilute Solutions



Molarity

- Molarity, M, is a type of concentration, defined as the number of moles of solute per liter of solution:

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{liter of solution}}$$

- The unit of molarity is molar, symbolized as M.
- 0.50 M NaCl means that there are 0.50 moles of NaCl in each 1.0 L of the solution.

Molarity

What is the concentration of a solution made from dissolving 3.0 mol NaCl in water to make 6.0 L of solution?

A. 0.50 M
B. 2.0 M
C. 3.0 M
D. 9.0 M
E. 18.0 M

Molarity

A lab technician adds 0.040 grams of NaOH (40.0 g/mol) to 100. mL of water. What is the molarity of this new solution?

Molarity

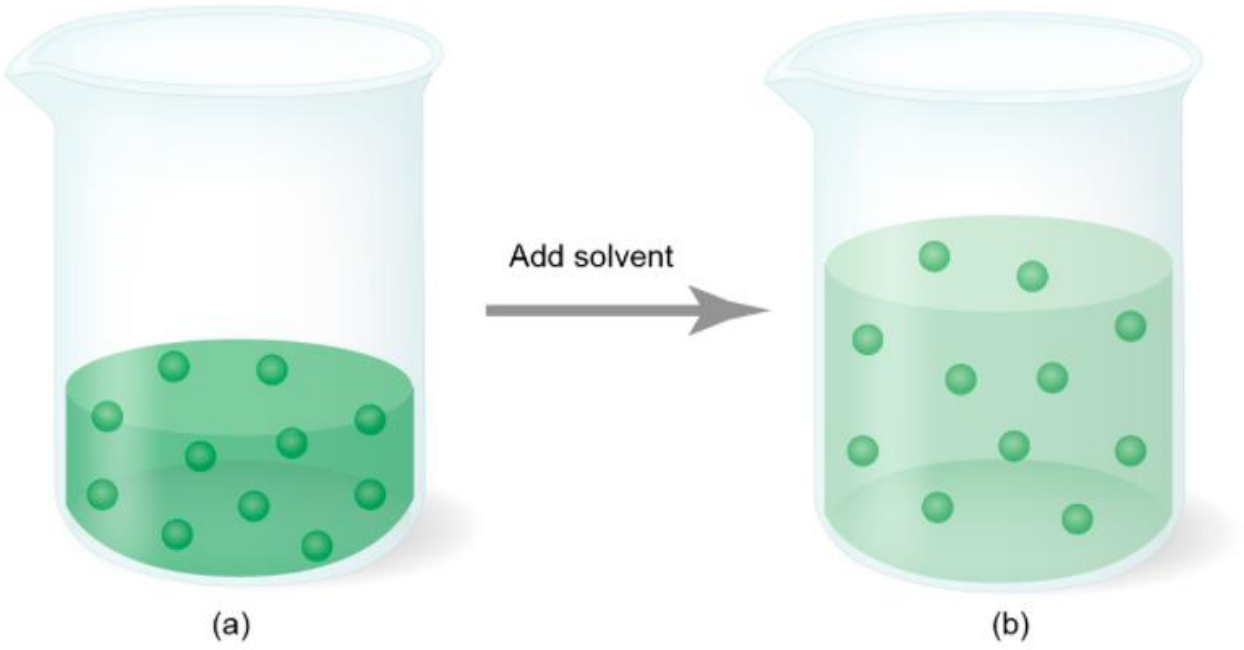
A laboratory procedure calls for making 400.0 mL of a 1.1 M $NaNO_3$ solution. What mass of $NaNO_3$ (in grams) is needed?

Molarity

What volume of 0.200 M ethanol solution contains 0.45 grams of ethanol, C_2H_6O?

Dilution

- Dilution is the process of adding more solvent to decrease the concentration of solute in a solution.



Dilution Formula

$$M_1V_1 = M_2V_2$$

- M_1 is the concentration of the concentrated solution
- V_1 is the volume of the concentrated solution
- M_2 is the concentration of the diluted solution
- V_2 is the volume of the diluted solution

Dilution

How many liters of 0.35 M CH_3OH can be prepared from 40. mL of 0.50 M CH_3OH?

Dilution

If 0.123 L of a 1.1 M glucose solution is diluted to 500.0 mL, what is the molarity of the diluted solution?

Molarities of Ions

- Strong electrolytes dissociate into ions when dissolved in water.
- The molarity of any ion is the number of moles of *that ion* per liter of solution.
- The subscripts in a chemical formula indicate the mole ratio of the compound to its constituent elements
- In a 1.0 M solution of $AlCl_3(aq)$, the ion concentrations are 1.0 M Al^{3+} and 3.0 M Cl^-.

Molarities of Ions

Calculate the concentration of each ion in a solution of 0.818 M $CaCl_2$.

Molarities of Ions

How many moles of $Na^+(aq)$ ions are in a solution containing 1 mol $Na_2S(aq)$?

A. nearly zero
B. 0.5 mol
C. 1 mol
D. 2 mol
E. 3 mol

Molarities of Ions

Determine the mass of $Ba(NO_3)_2$ that is required to provide 0.750 moles of Ba^{2+}.

Molarities of Ions

The average adult human male has a total blood volume of 5.0 L. If the concentration of sodium ion in this average individual is 0.135 M, what is the mass of sodium ion circulating in the blood?

Mass Percentage and Volume Percentage

$$\text{Mass percentage} = \frac{\text{mass of component}}{\text{mass of solution}} \times 100$$

$$\text{Volume percentage} = \frac{\text{volume of component}}{\text{volume of solution}} \times 100$$

But practically…

$$\text{Mass percentage} = \frac{\text{g of component}}{\text{100 g of solution}}$$

$$\text{Volume percentage} = \frac{\text{mL of component}}{\text{100 mL of solution}}$$

Forms of Concentration (Percentages)

Express the following concentrations as molarities.

A. 46% $C_{12}H_{22}O_{11}$ by mass. The $C_{11}H_{22}O_{11}$ solution has a density of 1.21 g/mL.

B. 50.00% CH_3OH by volume. Pure CH_3OH has a density 0.792 g/mL.

Parts per Million and Parts per Billion

$$\text{ppm} = \frac{\text{mg of solute}}{\text{L of solution}}$$

$$\text{ppb} = \frac{\mu\text{g of solute}}{\text{L of solution}}$$

Forms of Concentration (Parts per)

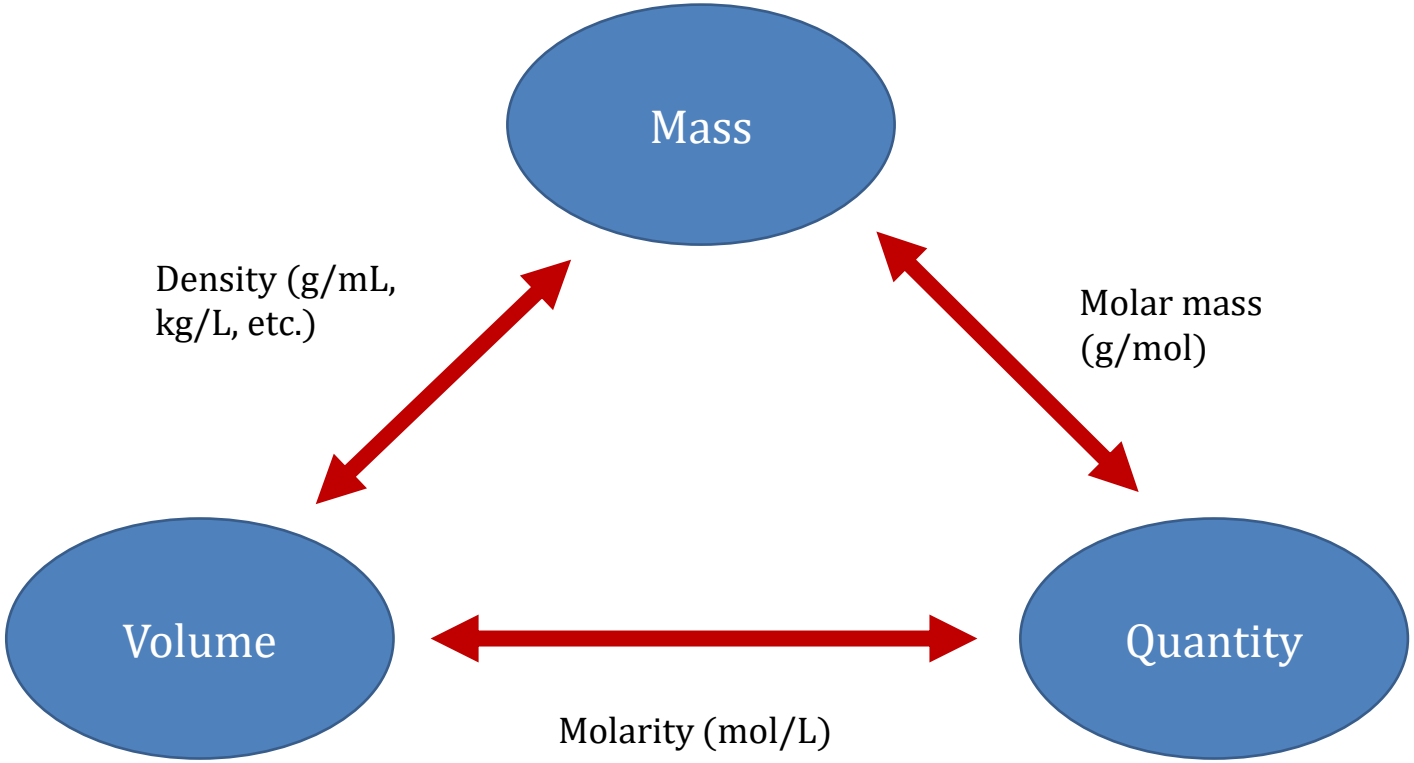
Express the following concentrations as molarities.

A. 2.74 ppm Zn^{2+}
B. 4.18 ppb Ni^{2+}

Working Problems

- Determine which property you have (Mass, Volume, Temperature, Quantity, Time, etc.)
- Determine the property for which you are looking
- Determine how to relate the properties
- Use dimensional analysis to gain the proper units

Converting Properties



Solutions

How much methanol CH_3OH (d = 0.792 g/mL), in milliliters, must be dissolved in water to produce 2.25 L of 0.485 M CH_3OH (32.042 g/mol)?

Solutions

The hardness count of water is usually expressed in parts per million of $CaCO_3$ (100.087 g/mol). What is the molar concentration of Ca^{2+} ions in a water sample with a hardness count of 175 ppm?

Solutions

How many moles of fluorine are in a 75.0 mL sample of $C_2HBrClF_3$? (d = 1.871 g/mL)?