Chapter 15: Solutions

15.1 What are solutions?

- **Solution** – a homogeneous mixture of two or more substances in a single physical state.

- Properties of solutions –
  - The particles are very small (atoms, molecules or ions)

  - The particles in a solution are evenly distributed or uniformly mixed (a spoonful of lemonade tastes the same as the whole glass)

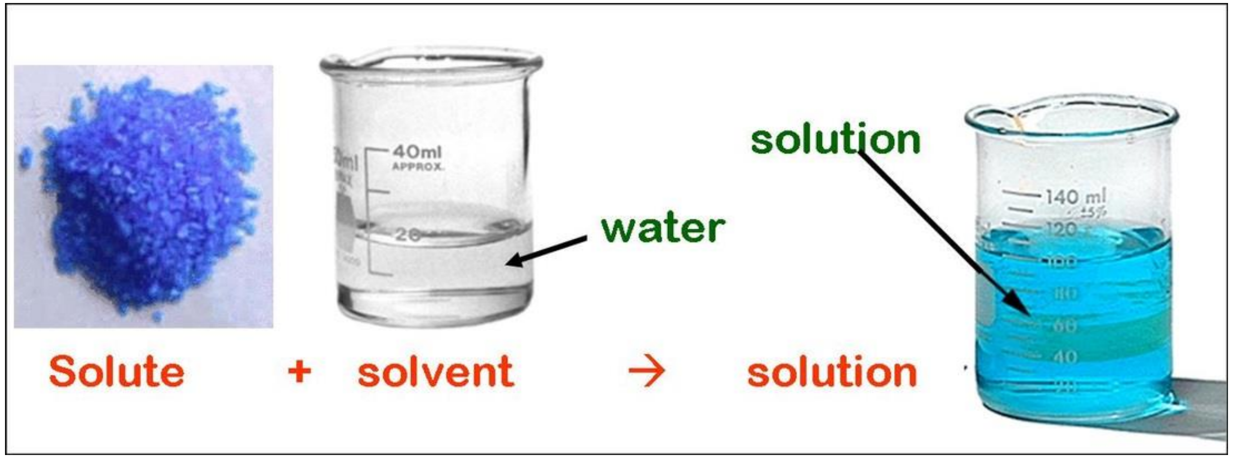
Types of solutions

9 Types of Solution

Original state of solute	Solvent	Examples
gas	gas	air; natural gas; oxygen-acetylene mixture used in welding
gas	liquid	carbonated drinks; water in rivers and lakes containing oxygen
gas	solid	hydrogen in platinum
liquid	gas	water vapour in air; gasoline-air mixture
liquid	liquid	alcohol in water; antifreeze in water
liquid	solid	amalgams, such as mercury in silver
solid	gas	mothballs in air
solid	liquid	sugar in water; table salt in water; amalgams
solid	solid	alloys, such as the copper-nickel alloy used to make coins

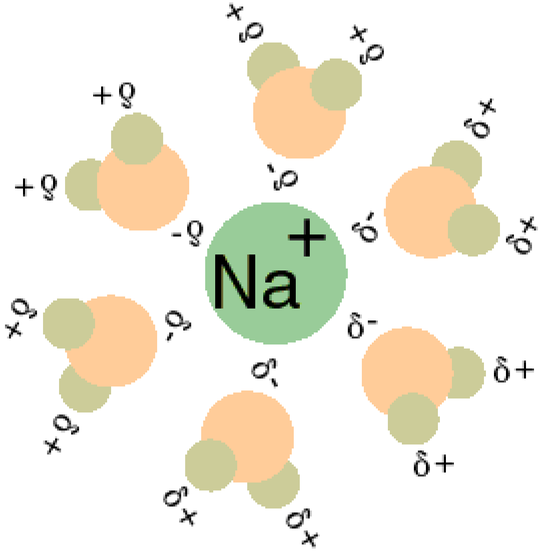
Parts of solutions

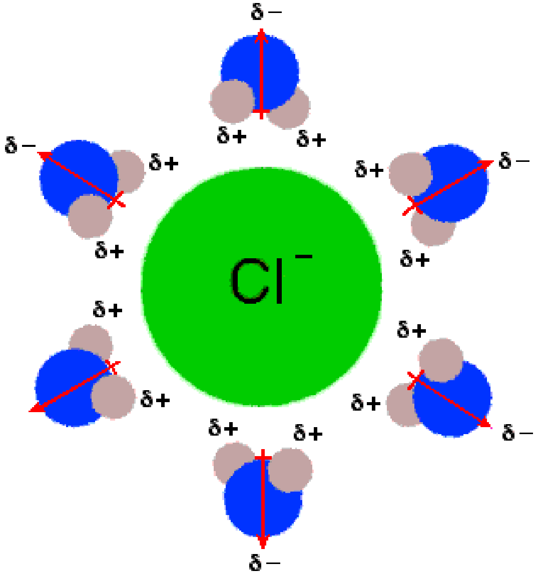
- **Solute** – the substance that dissolves in a solvent
- **Solvent** – a substance that can dissolve other substances
- **Soluble** – able to be dissolved (salt is soluble in water)
- **Insoluble** – unable to be dissolved (mercury is insoluble in oil)



Parts of solutions

- **Solvation** – the process of surrounding solute particles with solvent particles to form a solution
- **Saturated solution**: contains the maximum amount of dissolved solute
- **Unsaturated solution**– contains less dissolved solute than a saturated solution



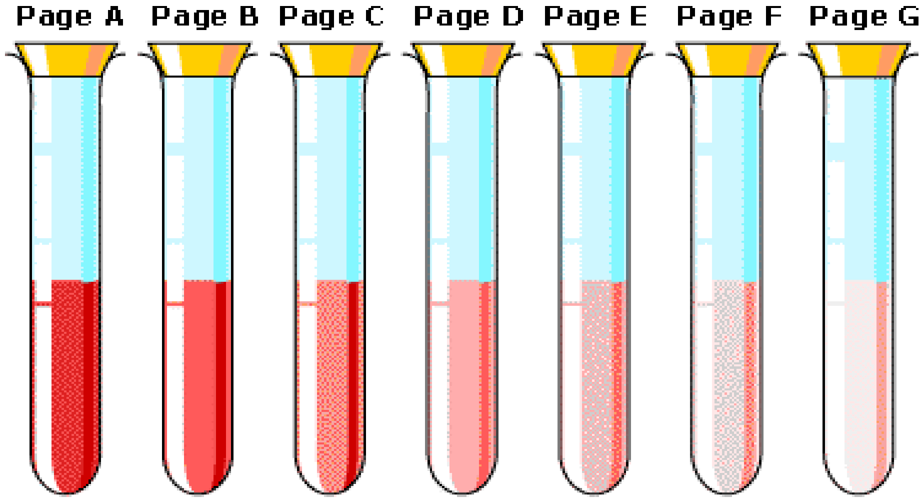


Types of solutions

- Miscible – liquids that can be mixed in any amount (water and ethanol)
- Immiscible – liquids that cannot mix in any proportion (oil and water)

15.2 Solution concentration

- **Concentration** – the amount of solute in a given amount of solvent.
- **Molarity- (M)** the number of moles of solute dissolved per liter of a substance
- **Percent by mass:** concentration expressed as a percent in a ratio between the measured amount of solute to measured amount of solution.



Molarity (M)

- Molarity(M) = $\frac{\text{Moles of solute}}{\text{Liters of solution}}$

- Example problem…

What is the Molarity of a NaOH solution if 10.0g of NaOH is dissolved in enough solvent to make 0.100L of solution?

Practice Problems

Find the Molarity of a solution formed by mixing 10.0g of H2SO4 with enough water to make 100.0mL of solution

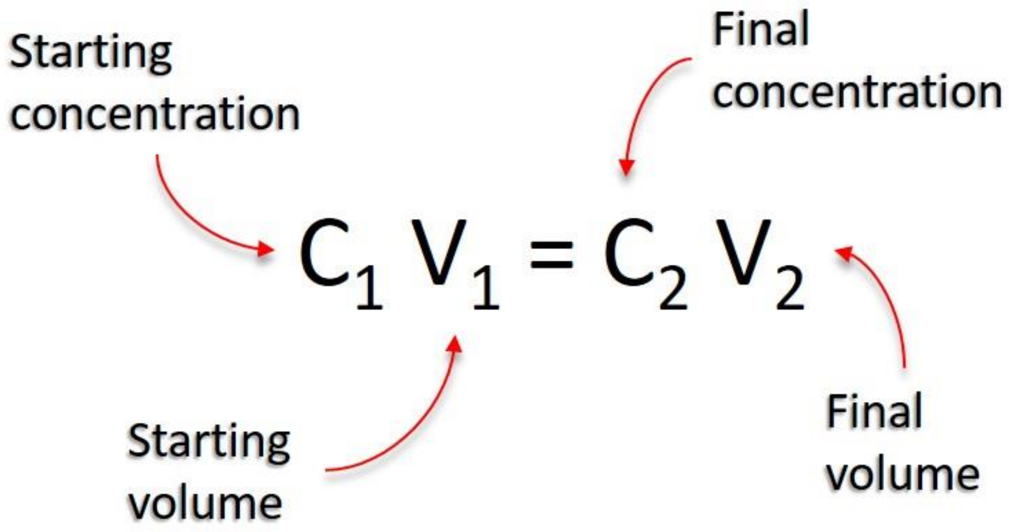
$$10.0\text{g } H_2SO_4 \times \frac{1 \text{ mol } H_2SO_4}{98.1 \text{ g } H_2SO_4} = 0.102 \text{ mol}$$

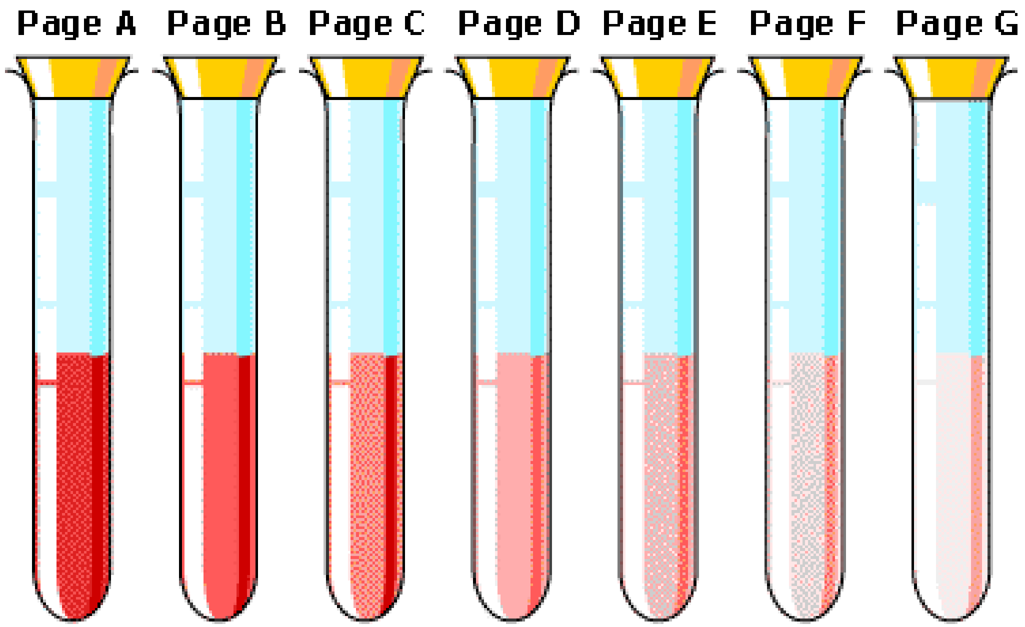
$$100.0 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = 0.100 \text{ L}$$

$$M = \frac{\text{moles}}{\text{Liters}} = \frac{0.102 \text{ mol}}{0.100 \text{ L}} = 1.02 \text{ mol/L or } 1.02 \text{ M}$$

Diluting

- **Dilution:** the process of preparing a less concentrated solution from a more concentrated one.





The Dilution Equation

$$M_1V_1 = M_2V_2$$

M_1 = initial molarity (“stock solution”)
V_1 = initial volume (Liters)
M_2 = final (desired) molarity
V_2 = final volume (Liters)

This equation is used when you have a “stock solution” of higher molarity than you need and you need to dilute it to a lower molarity by adding additional solvent.

Dilution Practice Problem #1

In an experiment, a student needs 250.0 mL of a 0.100 *M* CuCl2 solution. A stock solution of 2.00 *M* CuCl2 is available.

How much of the stock solution is needed?

Solution:

$$M_1V_1 = M_2V_2$$

(2.00 *M* CuClCl2)(Vi) = (0.100 *M* CuCl2)(0.2500 L)

V2 = 0.0125 L or 12.5 mL

To make the solution:

1.Pipet 12.5 mL of stock solution into a 250.0 mL volumetric flask.
2. Dilute to the calibration mark.

Dilution Practice Problem #2

If a 32 mL stock solution of 6.50 *M* H_2SO_4 is diluted to a volume of 500mL, what would be the resulting concentration?

Solution:

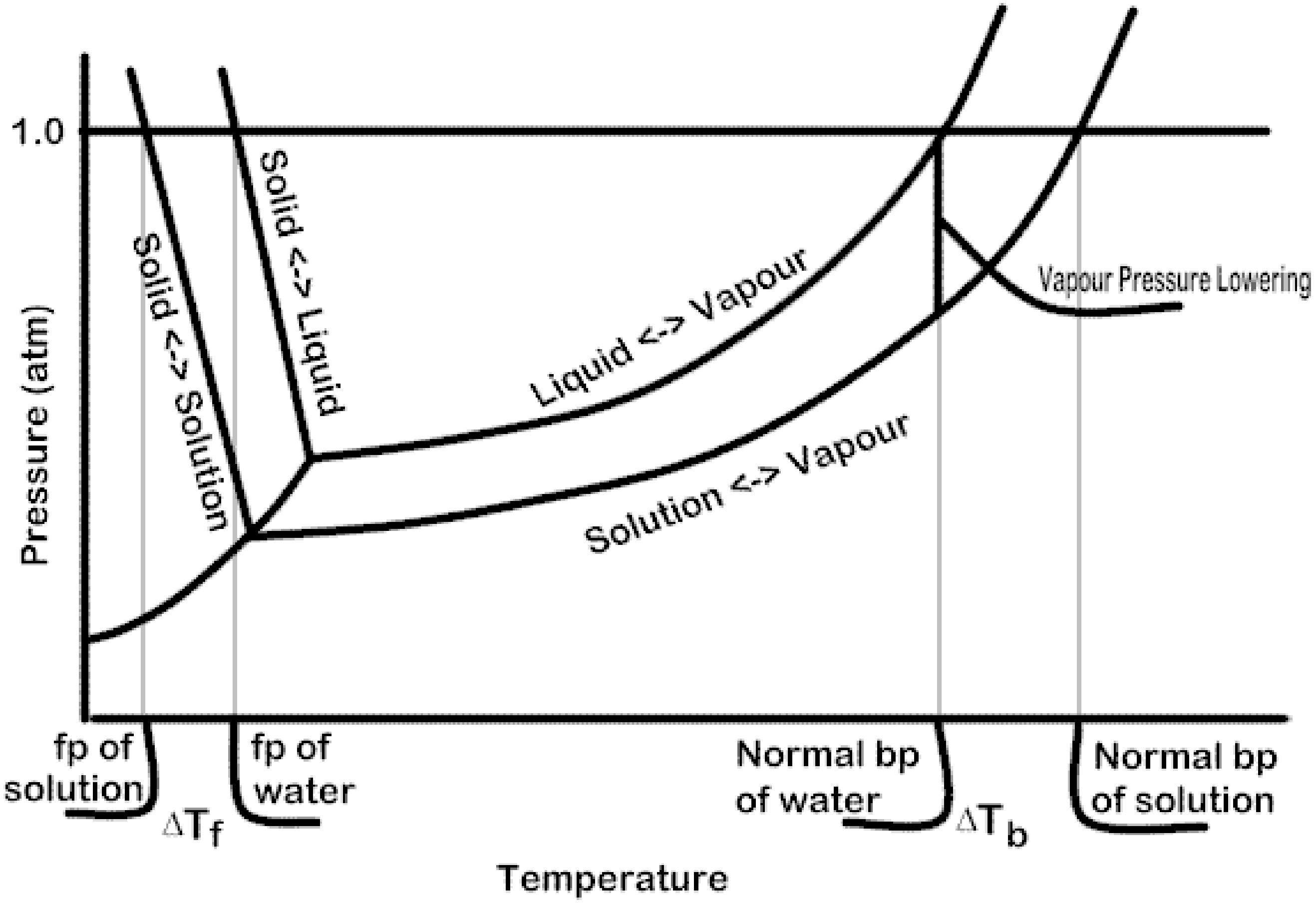
$$M_1V_1 = M_2V_2$$

$$(6.50\ M)(32\ \text{mL}) = (C2)(500\ \text{mL})$$

$$M_2 = 0.42\ \text{M}$$

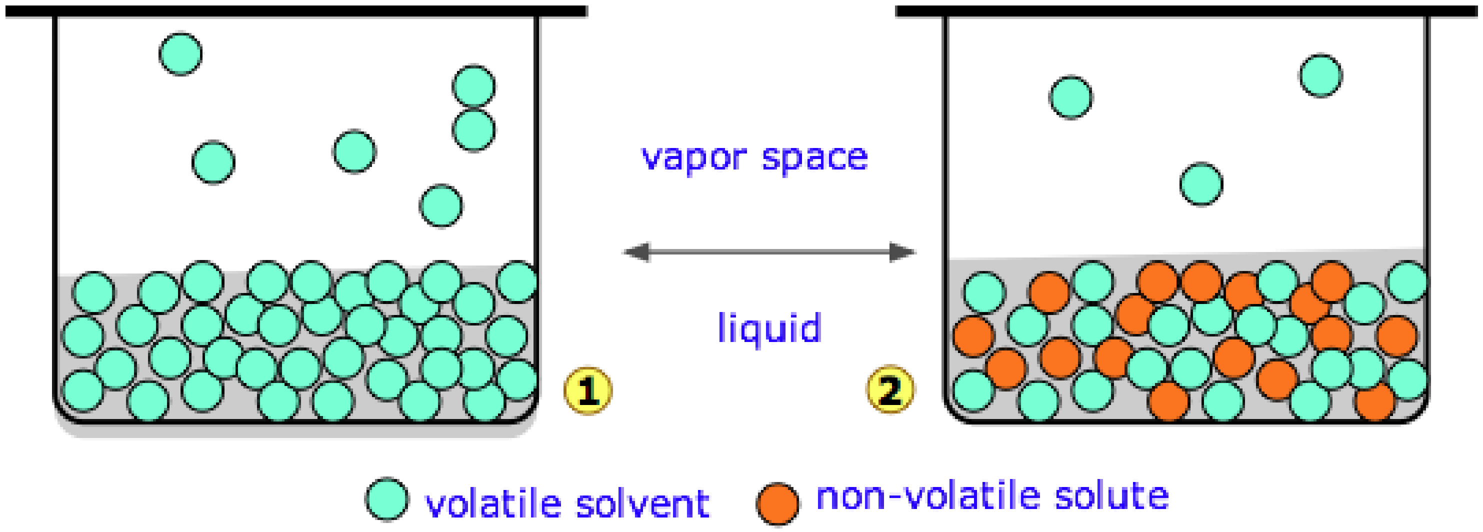
15-3 Colligative Properties

- **Colligative Properties** – physical properties that are affected by the *number* of particles of solute.
  - Ex.
    - Vapor pressure decreases
    - Melting point decreases
    - Freezing point decreases
    - Boiling point increases



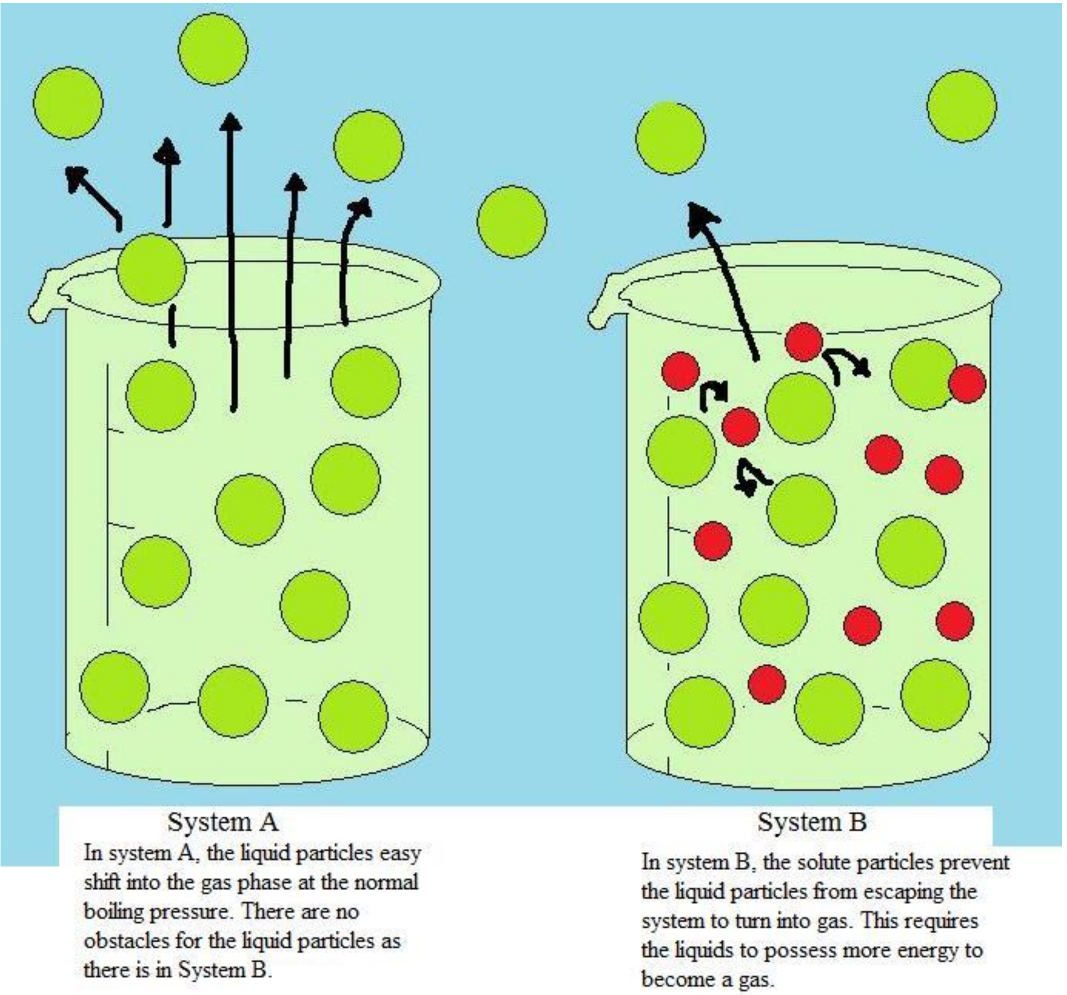
Vapor pressure reduction

- When a nonvolatile solute is added to a solvent, the solute takes up space at the surface which prevents some of the solvent from evaporating.
- Gases are still returning to the liquid at the same rate. The vapor pressure of the solution is reduced.



Boiling point elevation

- Antifreeze is added to a car to keep the water in the radiator from boiling. Antifreeze is a nonvolatile substance, so it reduces the vapor pressure
- The boiling point increases because it takes more energy to reach atmospheric pressure



Freezing Point Depression

- the temp at which a liquid becomes a solid is decreased when there are solute particles because they get in the way of the attractive forces, so the particles must slow down more to freeze

15.4 Heterogenous mixtures

- **Heterogenous mixture**: a combination of two or more substances that keep their basic identity
- *This is not a solution! Only homogenous mixtures are solutions!*

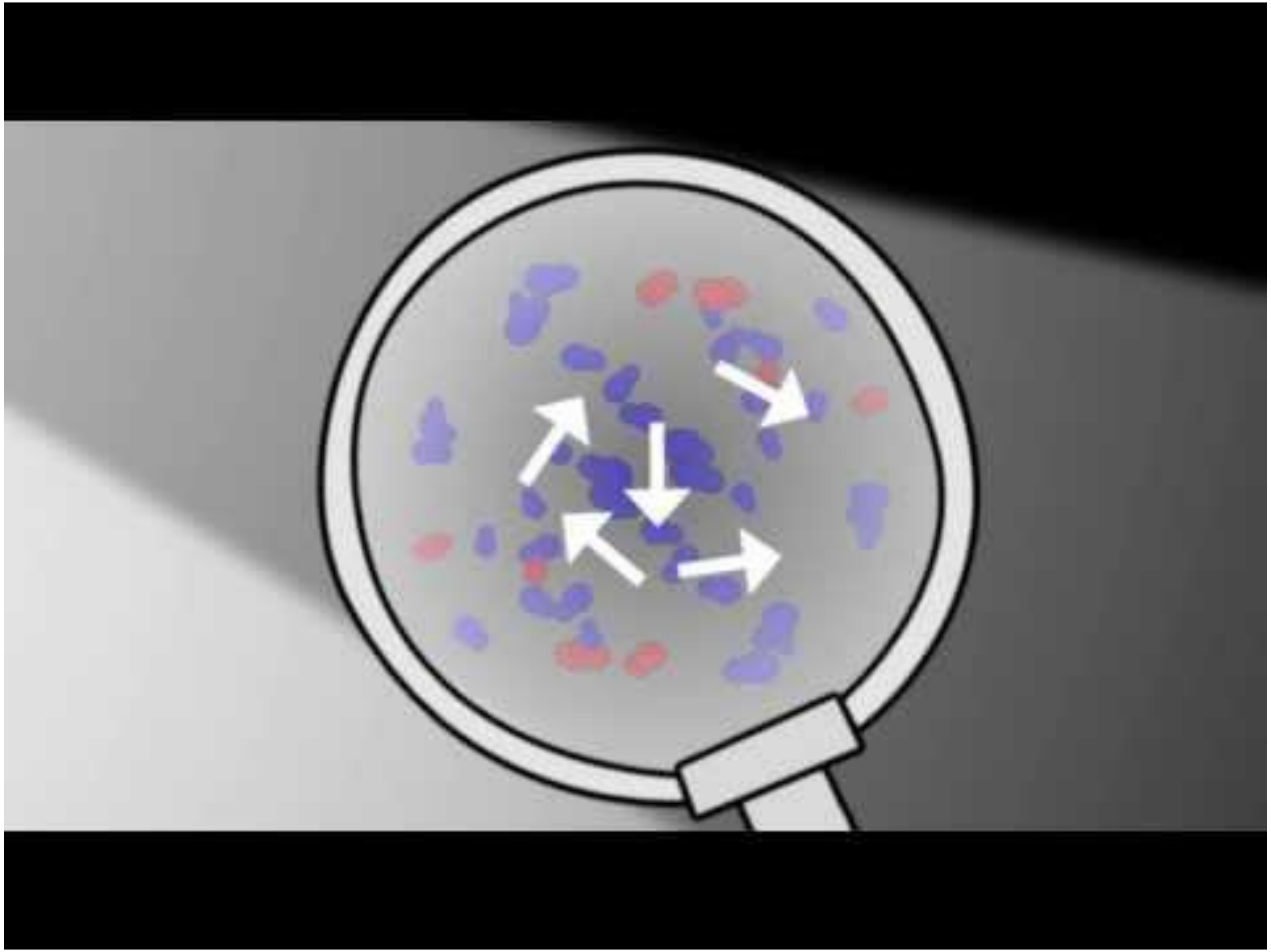
Colloids & Suspensions

- **Suspension:** A type of heterogenous mixture that contains particles that settle if left undisturbed. "sand+ water, muddy water"

-Can be separated through filtration

- **Colloid:** A heterogenous mixture of larger particles suspended in other particles but do not settle and cannot be filtered.

Brownian motion



https://www.youtube.com/watch?v=4m5JnJBq2AU