

Solutions and Colloids

Learning Outcomes

1. Describe the relationship between the following terms: solute, solvent, solution.
2. Describe the change in solubility for most solids and gases when the temperature either increases or decreases.
3. Do the following calculations:

$$\text{Concentration} = \frac{\text{amount}}{\text{volume}}$$

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

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

$$M = \frac{\text{mol solute}}{\text{L solution}}$$

Common Mass/Volume Relationships for Human Health: $\frac{\text{mg}}{\text{dL}}$, $\frac{\mu\text{g}}{\text{dL}}$, and $\frac{\text{ng}}{\text{dL}}$

4. Explain what it means to dilute a solution
5. Calculate the concentration of a diluted solution.

Solutions Are A Homogeneous Mixture of Two or More Substances

Solute: Minority Component(s)

Solvent: Majority Component

For a salt-water solution which component is the solute and the solvent?



Problem 1

Which of the following are solutions? For a solution define the solute(s) and solvent.

- (a) Atmospheric Air
- (b) 100% Ethanol
- (c) Lemoncello
- (d) Yellow Brass (70% copper and 30% zinc alloy)
- (e) Simple Syrup [1 cup sugar (200 g) and 1 cup water (237 g)]
- (f) Elemental Gold
- (g) 18 k Rose Gold (75% Au, 20% Cu, and 5% Ag alloy)

Problem 1 - Solutions

(a) Atmospheric Air

Component	Percent (%)
N ₂	78.084
O ₂	20.946
Ar	0.9340
CO ₂	0.041332
Ne	0.001818
He	0.000524
CH ₄	0.000187
Kr	0.000114

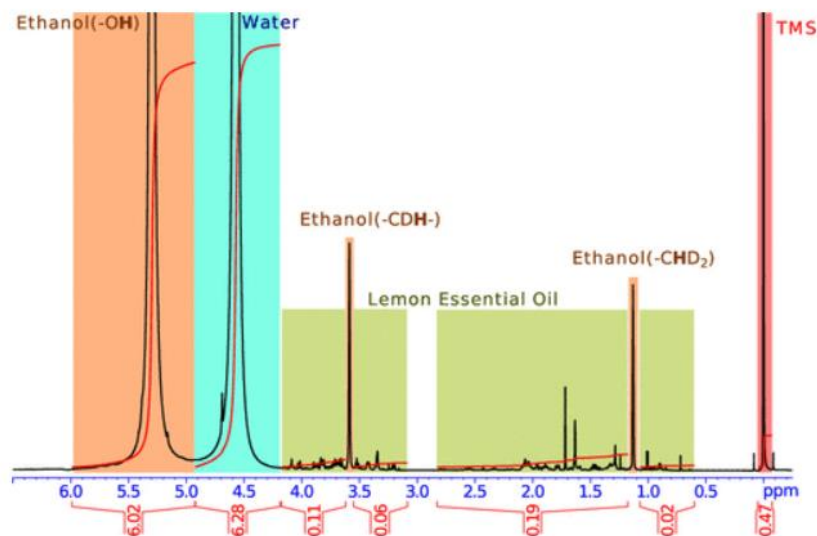
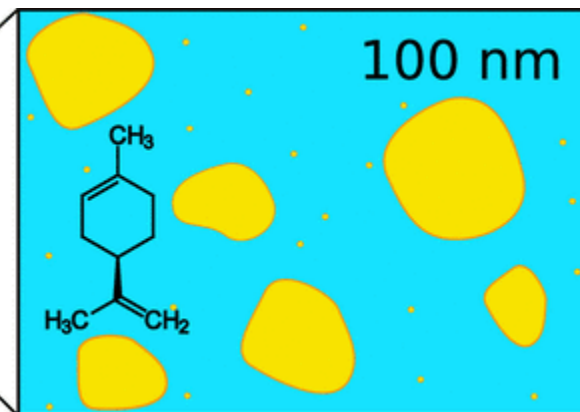
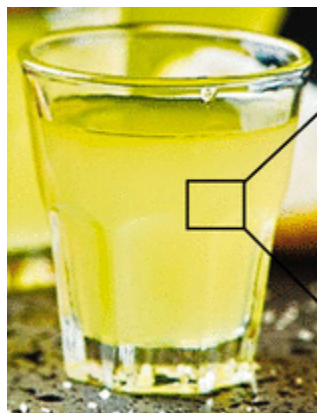
Problem 1 - Solutions

(b) 100% Ethanol



Problem 1 - Solutions

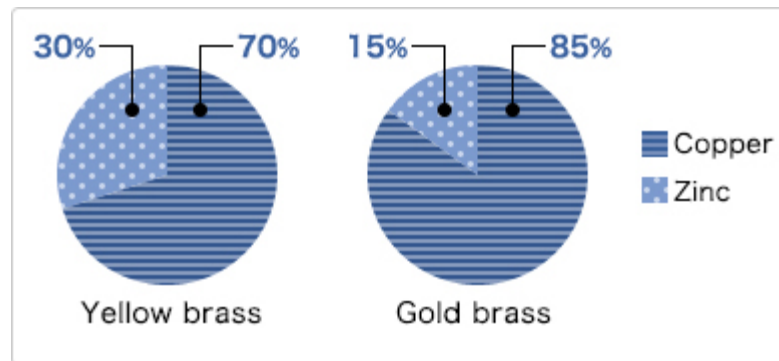
(c) Lemoncello



Problem 1 - Solutions

(d) Yellow Brass

(alloy of 70% copper and 30% zinc)



Problem 1 - Solutions

(e) Simple syrup

[1 cup sugar (200 g) and 1 cup water (237 g)]



Problem 1 - Solutions

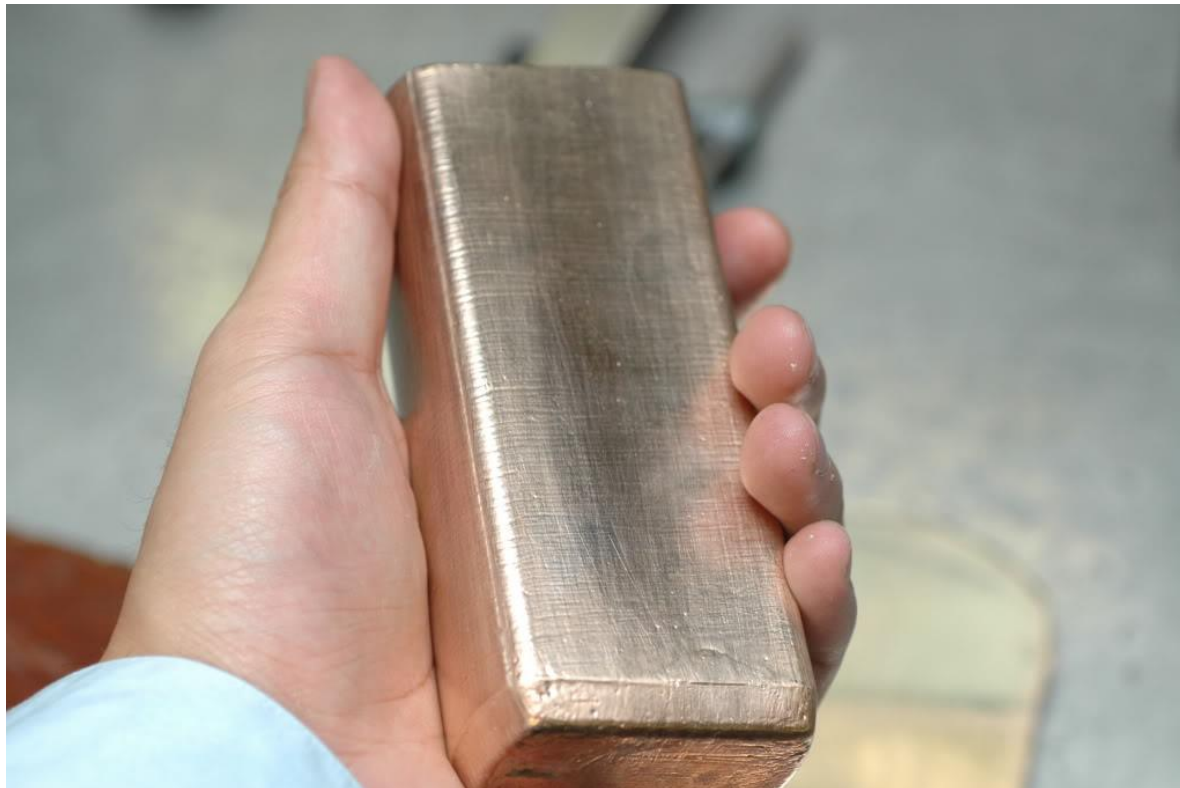
(f) Elemental Gold



Problem 1 - Solutions

(g) 18 k Rose Gold

(75% Au, 20% Cu, and 5% Ag alloy)



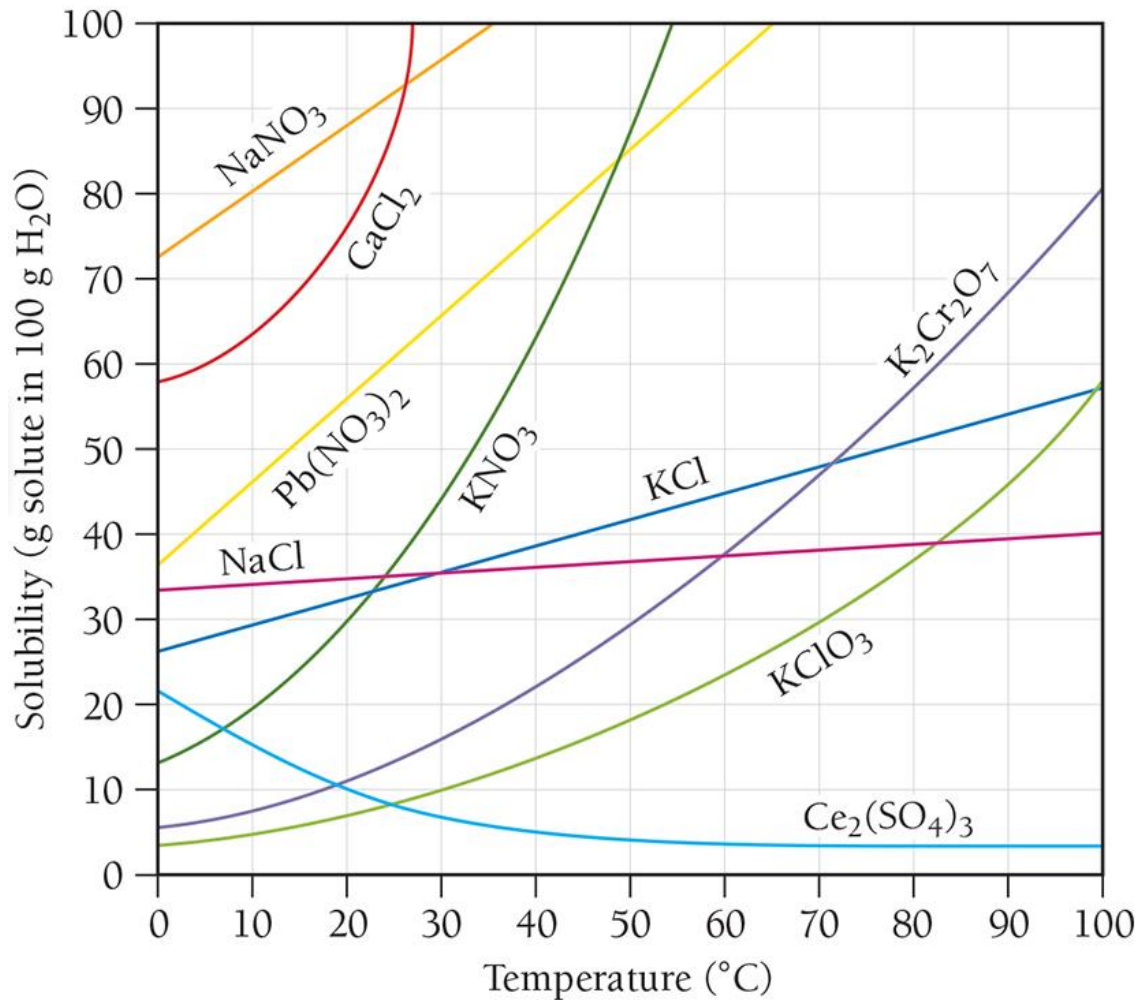
Solutions

TABLE 13.1 Common Types of Solutions

Solution Phase	Solute Phase	Solvent Phase	Example
gaseous solutions	gas	gas	air (mainly oxygen and nitrogen)
liquid solutions	gas	liquid	soda water (CO ₂ and water)
	liquid	liquid	vodka (ethanol and water)
	solid	liquid	seawater (salt and water)
solid solutions	solid	solid	brass (copper and zinc) and other alloys

Solubility of Liquids

In General Increases with Temperature



Think-Pair Share

Does the solubility of gas molecules increase or decrease with temperature?

Hint, what is the worst time to go fishing?

FAVORED
TEMPERATURE
RANGE



Muskellunge

55° to 73°



Northern Pike

55° to 75°



Walleye

53° to 72°



Crappie

65° to 75°



Bluegill

65° to 75°



Largemouth Bass

60° to 77°



Smallmouth Bass

58° to 71°



Yellow Perch

55° to 72°



Rainbow Trout

50° to 65°



Lake Trout

42° to 55°



Coho (Silver) Salmon

44° to 60°



Brown Trout

52° to 73°



Brook Trout

48° to 65°



Chinook (King) Salmon

44° to 60°

Champaign Bubbles

More bubbles = higher temperature!



Concentration

What does it mean when a solution is more concentrated? What ideas do you have about representing a concentration mathematically?



Concentration Units

$$\text{Concentration} = \frac{\text{amount}}{\text{volume}}$$

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

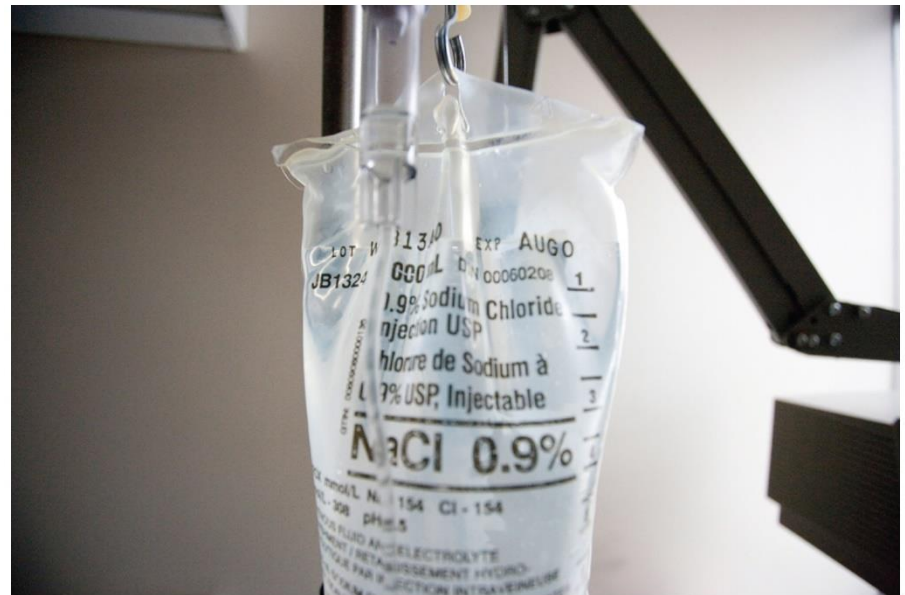
$$(\text{v/v}) \% = \frac{\text{mL solute}}{\text{mL solution}} \times 100$$

$$\text{M} = \frac{\text{mol solute}}{\text{L solution}}$$

Common Mass/Volume Relationships for Human Health: $\frac{\text{mg}}{\text{dL}}$, $\frac{\mu\text{g}}{\text{dL}}$, and $\frac{\text{ng}}{\text{dL}}$

Problem 2

A common saline solution for IVs is often prepared by dissolving 9.00 g of salt in 1 L of water. Calculate the concentration in molarity. Note, $\rho_{\text{water}} = 1.00 \text{ g/mL}$.



Problem 2 - Solution

$$M_{\text{NaCl}} = \frac{n_{\text{NaCl}}}{V_{\text{solution}}}$$

$$M_{\text{NaCl}} = \frac{9 \text{ g NaCl} \times \frac{1 \text{ mol NaCl}}{58.44 \text{ g NaCl}}}{1 \text{ L}}$$

$$M_{\text{NaCl}} = \frac{0.154 \text{ mol NaCl}}{1 \text{ L}}$$

$$M_{\text{NaCl}} = 0.154 \frac{\text{mol}}{\text{L}}$$

$$M_{\text{NaCl}} = 0.154 \text{ M}$$

Problem 3

If 6 g of NaCl is dissolved in enough water to make 300. mL of solution, what is the w/v percent of NaCl?

Problem 3 - Solution

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

$$(\text{w/v}) \% = \frac{6.0 \text{ g}}{300 \text{ mL}} \times 100$$

$$(\text{w/v}) \% = 0.02 \times 100$$

$$(\text{w/v}) \% = 2\% \text{ (w/v)}$$

Problem 4

A vodka manufacturer prepares a vodka product by mixing 80. mL ethanol and 120. mL water. Calculate the v/v percent ethanol.

Problem 4 - Solution

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

$$(\text{v/v}) \% = \frac{80. \text{ mL ethanol}}{80. \text{ mL ethanol} + 120. \text{ mL water}} \times 100$$

$$(\text{v/v}) \% = \frac{80. \text{ mL ethanol}}{200. \text{ mL solution}} \times 100$$

$$(\text{v/v}) \% = 0.40 \times 100$$

$$(\text{v/v}) \% = 40. \% (\text{v/v})$$

Dilution



Diluted ← → Concentrated

Problem 5

A 0.20 M NaCl solution has a volume of 5 mL. What must the total volume be for the solution to have a concentration of 0.10 M?

Dilution Math

$$M_1 V_1 = M_2 V_2$$

Term	Physical Meaning	Notes
M_1	Starting concentration	For a dilution, this is the higher concentration.
M_2	Final Concentration	For a dilution, this is the lower concentration.
V_1	Starting Volume	For a dilution, this is a smaller volume.
V_2	Final Volume	For a dilution, this is a larger volume since the added solvent dilutes the solution.

Problem 6

A 5 mL of a 0.20 M NaCl solution is diluted to a final volume of 18 mL. What is the concentration of the diluted solution?

Learning Outcomes

1. Describe, at the atomic/molecular level, what occurs when water-soluble ionic and molecular compounds dissolve in water.
2. Explain what makes a solution an electrolyte.
3. ***Qualitatively*** describe diffusion, osmosis, and dialysis.
4. **Chemical Connections: Electrolyte solutions in body and intravenous fluids**
5. **Chemical Connections: Hemodialysis**

Why Do Some Materials Dissolve While Other Do Not?



VS.



Person-Netflix Interaction > Person-Yardwork Interaction

Why Do Some Materials Dissolve While Other Do Not?

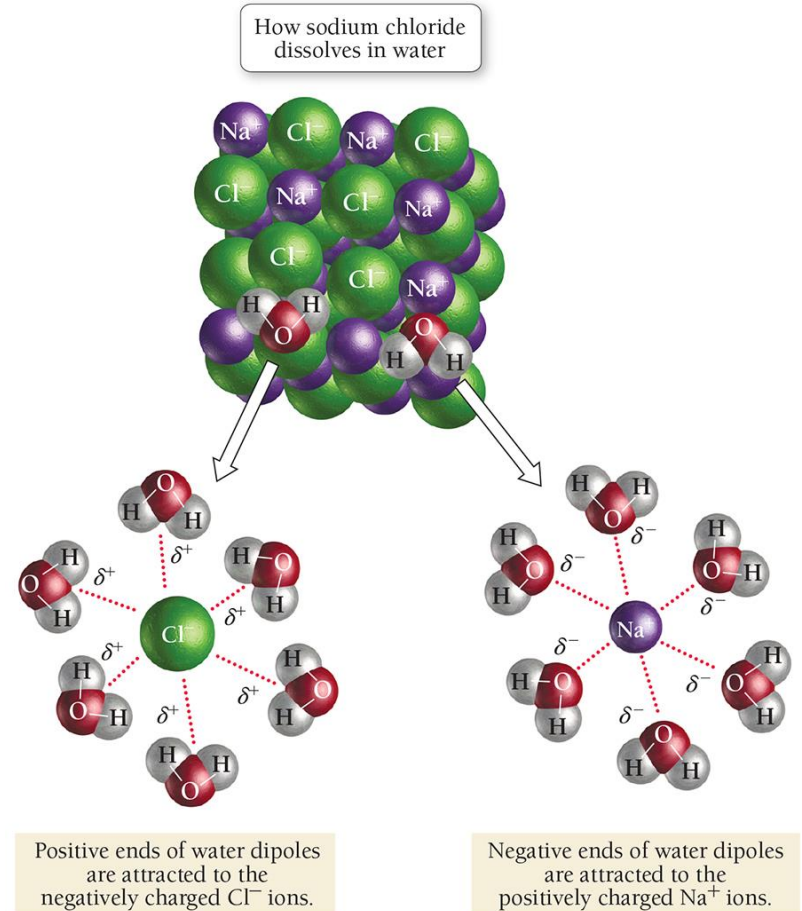
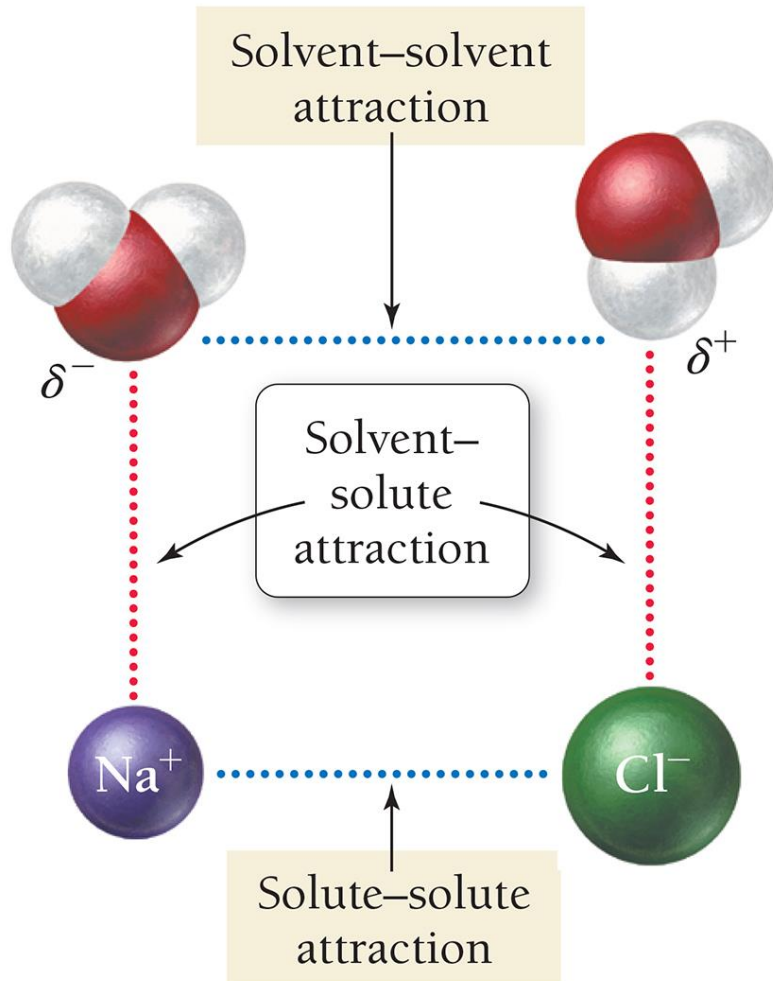


vs.



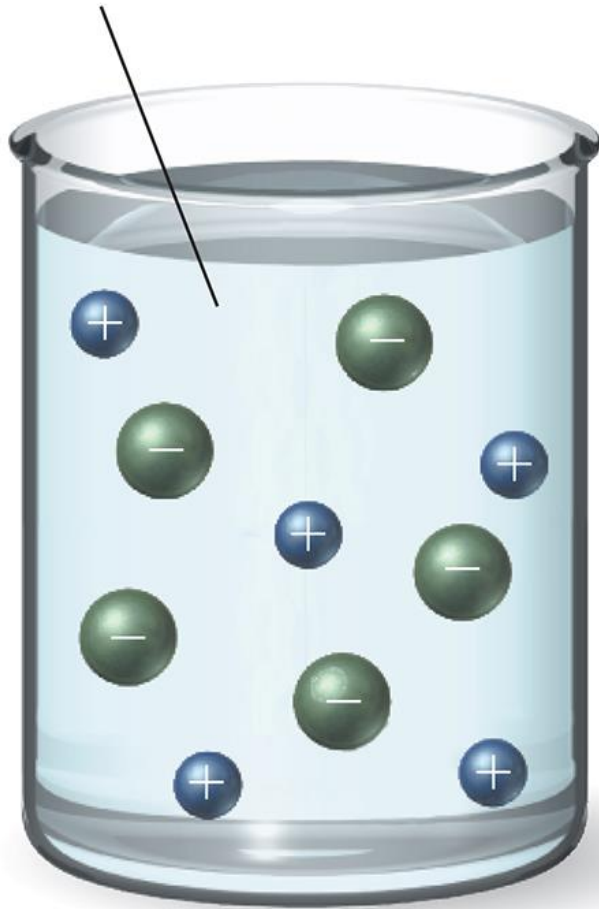
Person-Dessert Buffet Interaction > Person-Netflix Interaction

Why Do Some Materials Dissolve While Other Do Not?



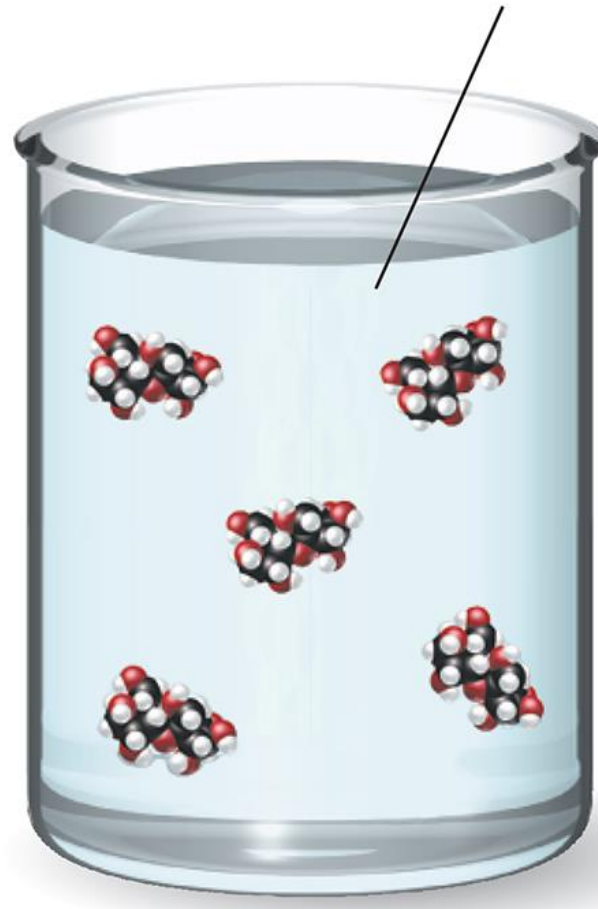
Electrolyte (Ionic) vs. Nonelectrolyte (Nonionic) Solutions

Dissolved ions (NaCl)



Electrolyte solution

Dissolved molecules (sugar)




Nonelectrolyte solution

Diffusion, Osmosis, and Dialysis

<https://www.youtube.com/watch?v=tHzkRtzVmUM>

Diffusion, osmosis and dialysis have importance in biological processes



1:20 / 1:35

Diffusion, Osmosis and Dialysis (IQOG-CSIC)

203,728 views • Mar 26, 2017

1.7K 85 SHARE SAVE ...

Diffusion

<https://www.youtube.com/watch?v=uyg1sa0HxPA>



#homeschool #preschool #education

Diffusion of Food Dye In Hot & Cold & Warm Water

36,099 views • Feb 11, 2018

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Cucumber Science

<https://www.youtube.com/watch?v=dD9dGFrFcoo>



#OpenUniversity #science

Cucumber experiment: How to measure osmosis in a cucumber - Think like a scientist (4/10)

17,157 views • Oct 29, 2014

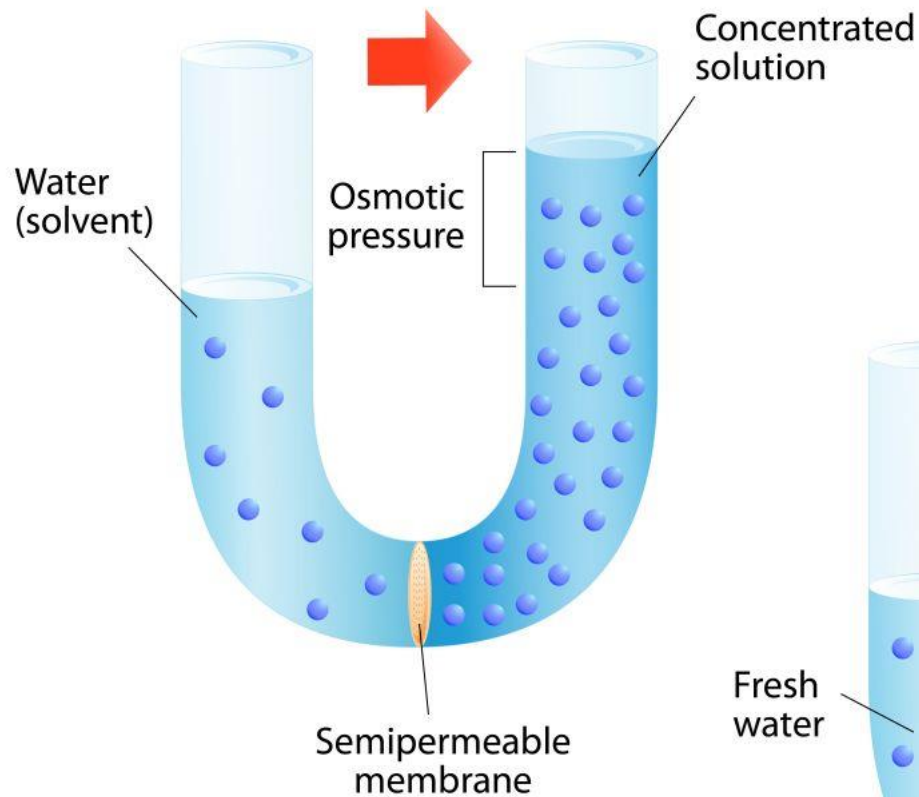
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Cucumbers and Osmosis

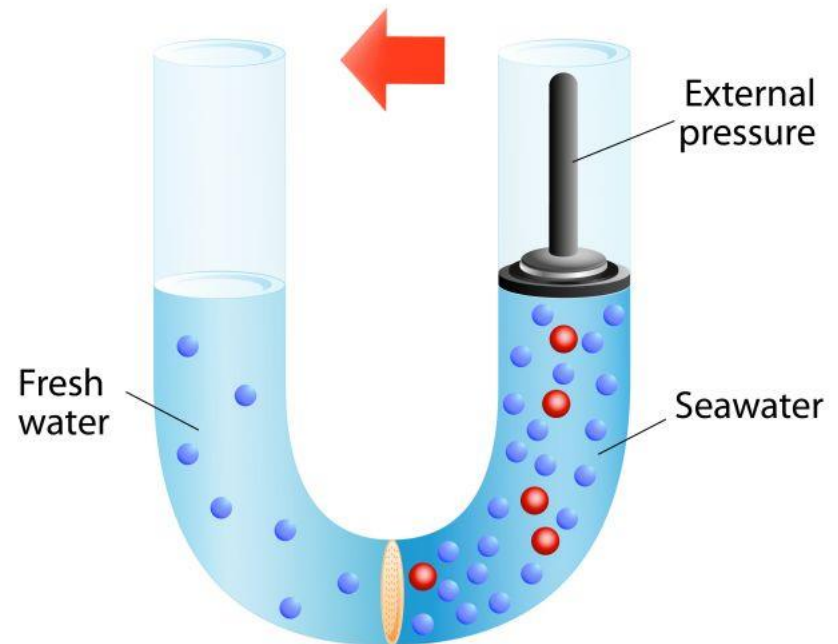


Osmosis

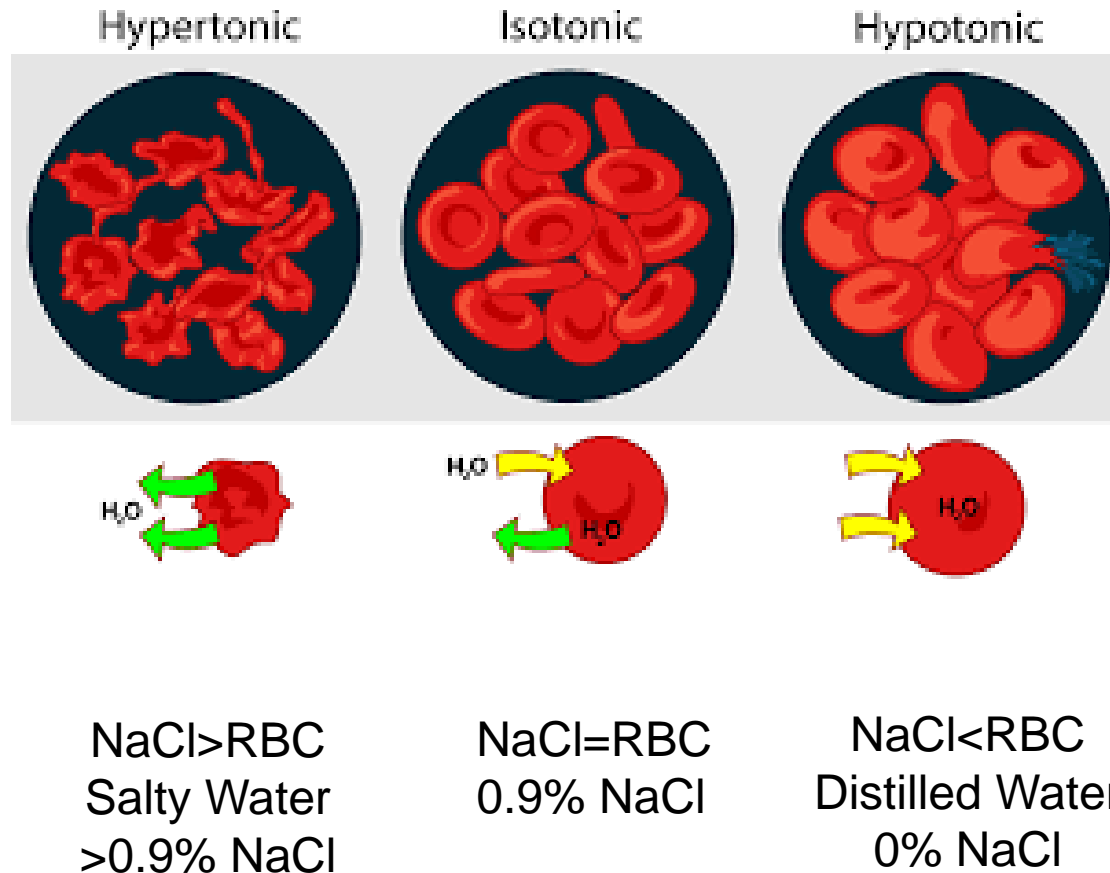
Osmosis



Reverse osmosis



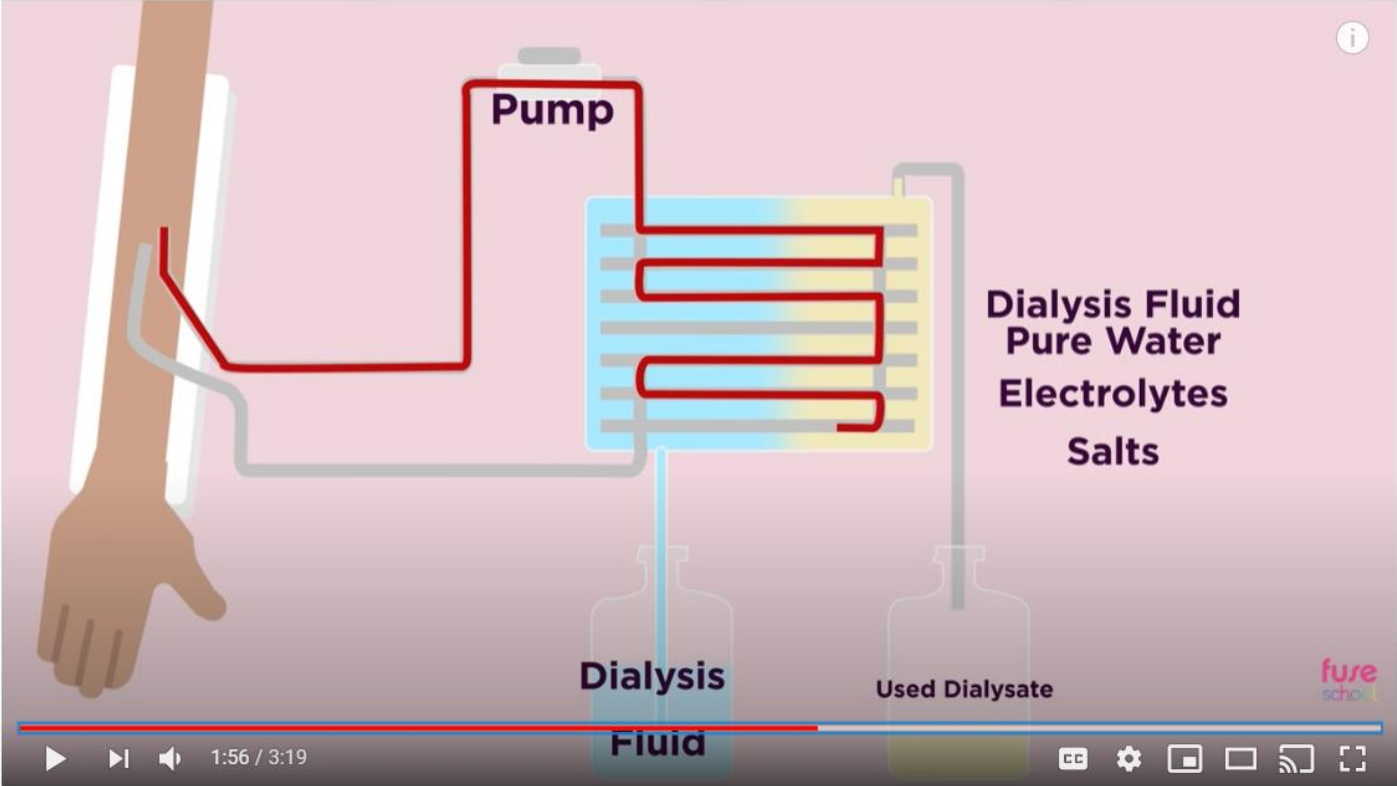
Red Blood Cells and Osmosis



RBC = Red Blood Cell

Dialysis

<https://www.youtube.com/watch?v=9KZHowze7lg>



The diagram illustrates the components and flow of a dialysis machine. On the left, a patient's arm is shown with a catheter. A red line represents the blood flow path, starting from the arm, passing through a **Pump**, and then entering a **Dialyzer** (a coiled tube). A grey line represents the dialysis fluid flow path, starting from a reservoir on the right, passing through the **Dialyzer**, and then entering a container labeled **Used Dialysate**. The dialyzer is shown with a blue and yellow gradient. To the right of the dialyzer, the components of the dialysis fluid are listed: **Dialysis Fluid**, **Pure Water**, **Electrolytes**, and **Salts**. Below the dialyzer, two containers are shown: **Dialysis Fluid** (blue liquid) and **Used Dialysate** (yellow liquid). The video player interface at the bottom shows a progress bar at 1:56 / 3:19, and the video title is **Kidney Disease and Dialysis | Health | Biology | FuseSchool**. The video has 29,508 views and was posted on Jan 8, 2019. The FuseSchool logo is visible in the bottom right corner of the video frame.

Kidney Disease and Dialysis | Health | Biology | FuseSchool

29,508 views • Jan 8, 2019

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