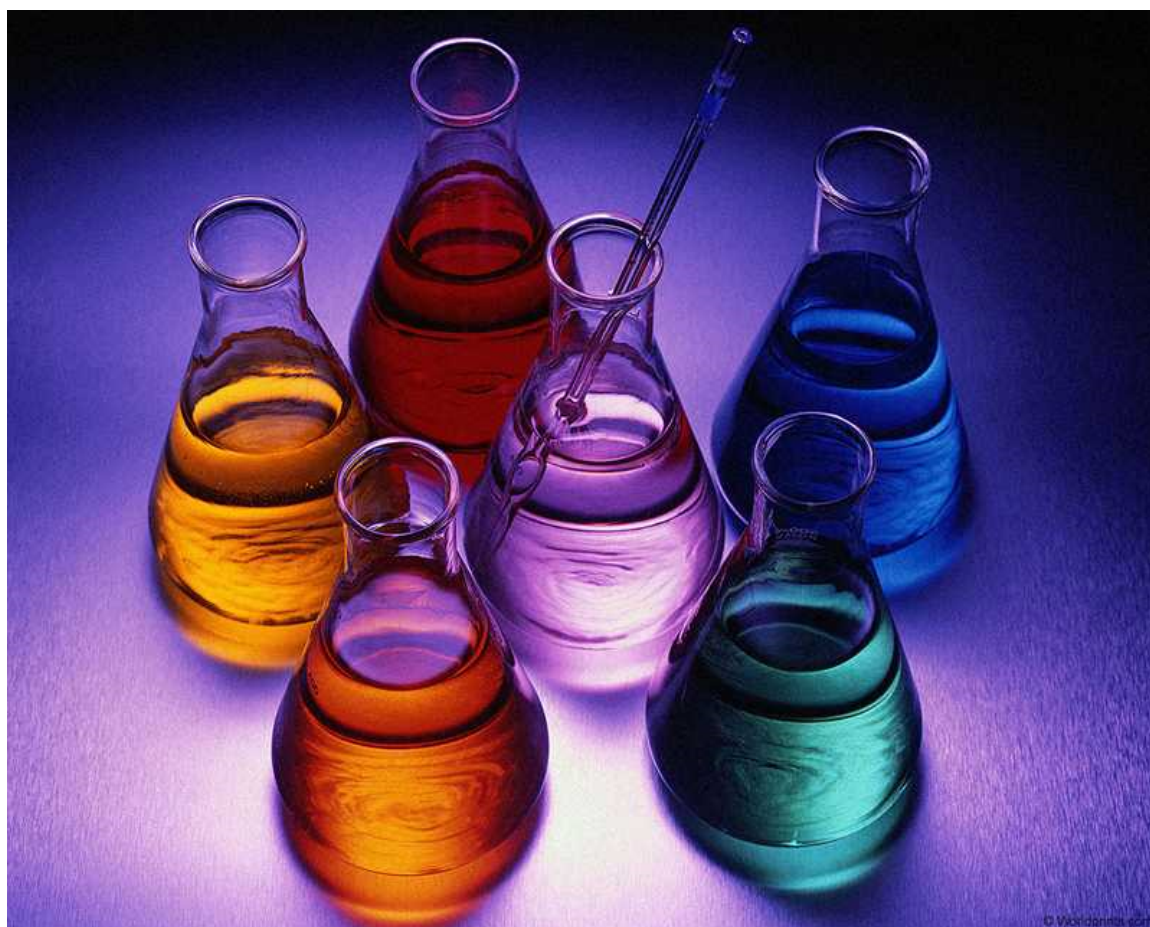


# Solutions



2015

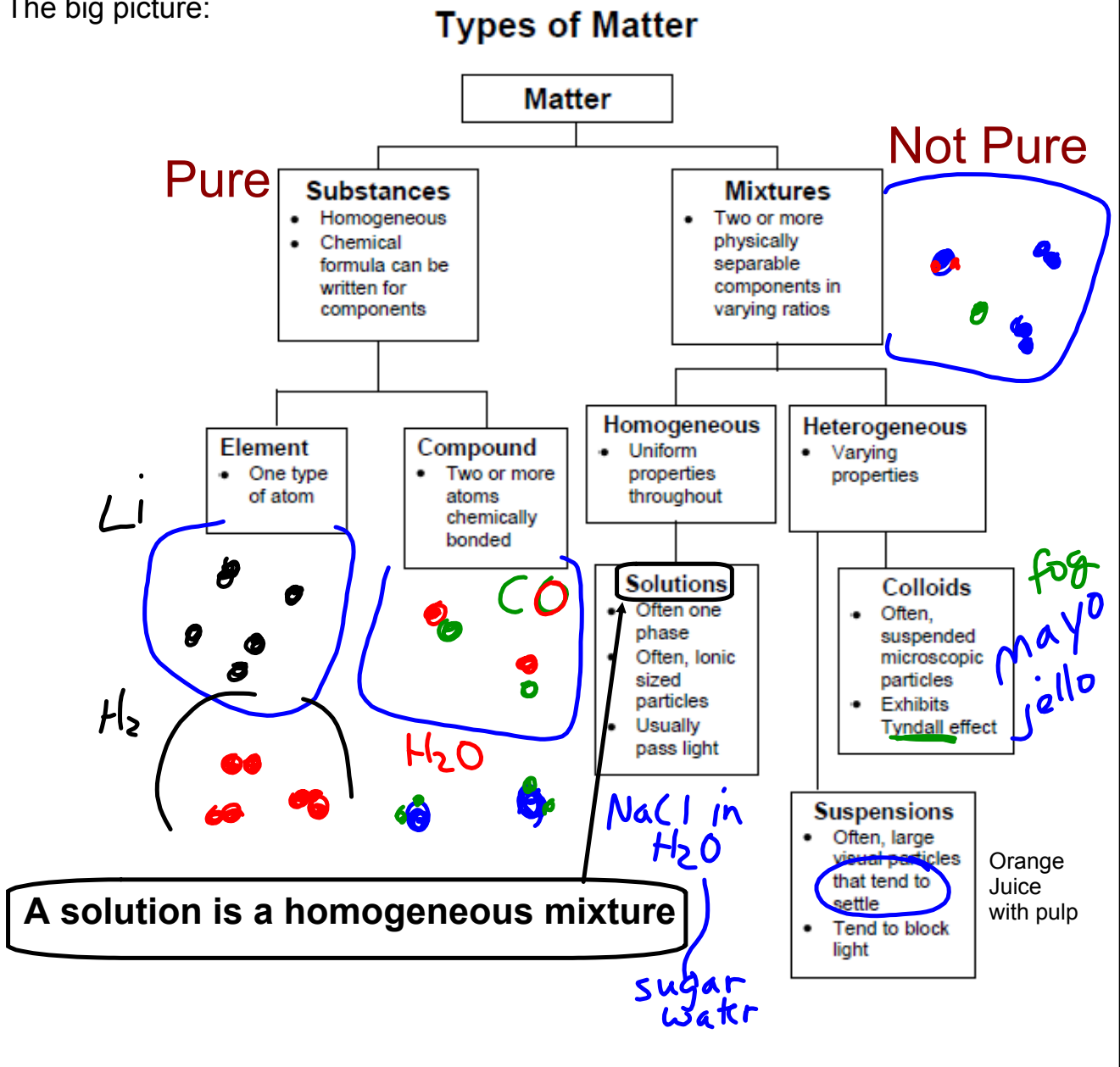
# Solutions

## OBJECTIVES:

1. I can distinguish between a heterogeneous and a homogeneous solution.
2. I can list different solute-solvent combinations.
3. I can distinguish between an electrolyte and a nonelectrolyte.
- 4. I can explain the meaning of “like dissolves like” in terms of polar and nonpolar.
- 5. I can list and explain 3 factors that affect the rate at which a solid solute dissolves in a liquid.
6. I can model the dissolution of soluble ionic compounds in water.
7. I can compare dissolution of ionic compounds with ionization of molecular compounds.
8. I can determine solubility of a salt or gas on a solubility chart.
9. I can calculate Molarity, amount of solute, or amount of solution using  $M = \text{mol/liter}$ .
10. I can calculate dilutions using  $M_1V_1 = M_2V_2$ .
11. I can calculate solutions based on % by mass and % by volume.
12. I can calculate solution based on ppm.

Objective: I can distinguish between heterogeneous and homogeneous mixtures.

The big picture:



Objective: I can distinguish between heterogeneous and homogeneous mixtures.

## Mixtures can be either homogeneous or heterogeneous.

### Heterogeneous:

You can see the different parts of the mixture.

Ex: Soil, cereal, eggs, sand, or salad



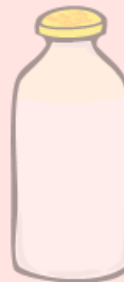
### Homogeneous:

You cannot see the different parts of the mixture.

Ex: Air, Fruit punch, milk, or chocolate.



$N_2$   
 $O_2$   
 $CO_2$



## Solutions are homogeneous mixtures.



Obj: I can distinguish parts of a solution and list different solute-solvent combinations

### Solutions

a homogeneous mixture of two or more substances in a single phase

2 parts to a solution:

**Solute:** <sup>smaller part</sup> substance being dissolved

**Solvent:** substance that the solute is dissolving in

larger part



### Types of Solutions

Solutes and solvents can be any phase (gas, liquid, or solid)

Types of Solutions			
Solute	Solvent	Solution	Example
Gas	Gas	Gas	Air ( $O_2$ in $N_2$ )
Gas	Liquid	Liquid	Carbonated beverages ( $CO_2$ in $H_2O$ ) Swimming pool ( $Cl_2$ in $H_2O$ )
Liquid	Liquid	Liquid	Wine (ethanol in $H_2O$ ) Vinegar (acetic acid in $H_2O$ )
Liquid	Solid	Solid	Dental amalgam for fillings (liquid mercury in solid silver)
Solid	Liquid	Liquid	Saline ( $NaCl$ in $H_2O$ ) Sugar in water
Solid	Solid	Solid	14-karat gold ( $Ag$ in $Au$ ) <b>Alloys</b> Steel (carbon in iron)

Same

Solute	Solvent	Types of solutions	Examples
Solid	Solid	Solid in solid	Alloys
Liquid	Solid	Liquid in solid	Hydrated salts
Gas	Solid	Gas in solid	Dissolved gases in minerals
Solid	Liquid	Solid in liquid	Salt solution in water
Liquid	Liquid	Liquid in liquid	Alcohol in water
Gas	Liquid	Gas in liquid	Aerated drinks
Solid	Gas	Solid in gas	Iodine vapours in air
Liquid	Gas	Liquid in gas	Humidity in air
Gas	Gas	Gas in gas	Air

Review

1. Classify the following as heterogeneous or homogeneous:

- a. chocolate milk that says to shake before drinking *het.*
- b. tap water *homogeneous*

2. Describe one way to prove that a mixture of sugar and water is a solution and that a mixture of sand and water is not a solution.

3. Label the solute and solvent in each:

a. 14 karat gold

b. water vapor in air

c. carbonated or sparkling water

d. hot tea

	solute	solvent
a. 14 karat gold	$Ag(s)$	$Au(s)$
b. <u>water</u> vapor in air	$H_2O(g)$	air (g)
c. carbonated or sparkling water	$(O_2(g))$	$H_2O(l)$
d. hot tea	tea leaves (s)	$H_2O(l)$

Obj: Explain the meaning of "like dissolves like" in terms of polar and nonpolar

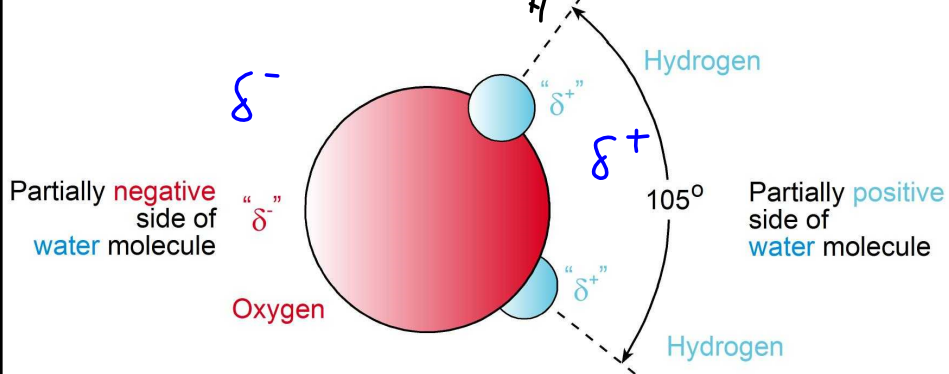
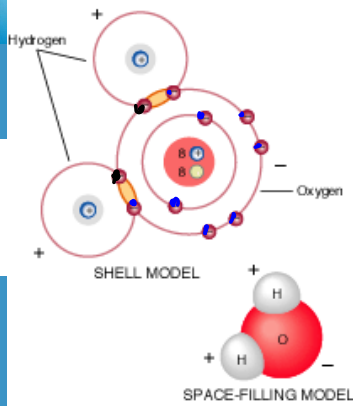
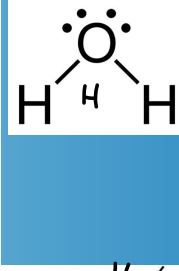
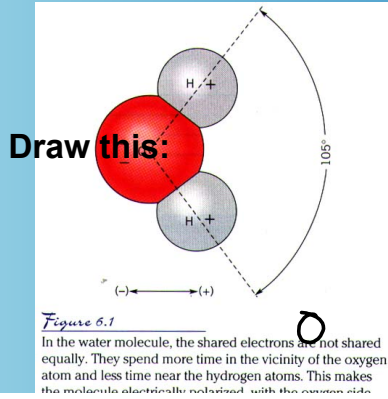
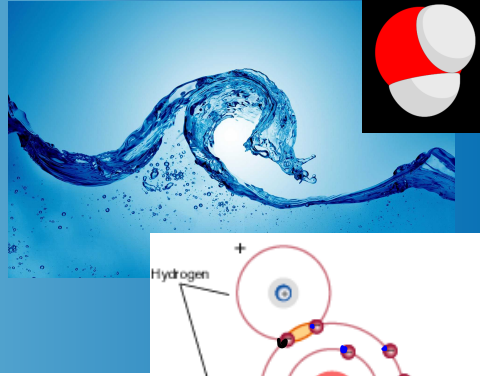
# Water - the "universal solvent"

## Structure of H<sub>2</sub>O

Hydrogens are 105° apart

### Polarity of water:

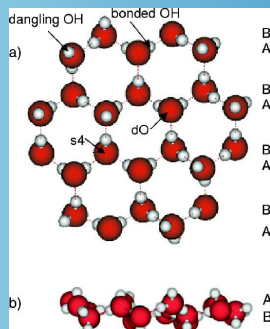
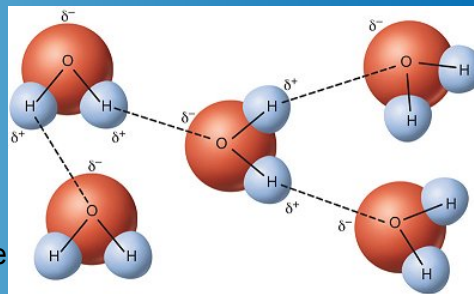
"O" side - partial negative charge  
 "H" side - partial positive charge



## Hydrogen bonding

in water, the hydrogen (partial positive) is attracted to the oxygen (partial negative)

- affects boiling and melting point
- gives properties such as cohesion, adhesion, surface tension
- gives hexagonal arrangement in ice crystals



- allows ionic substances to dissolve

Internal factor - bond type affects solubility

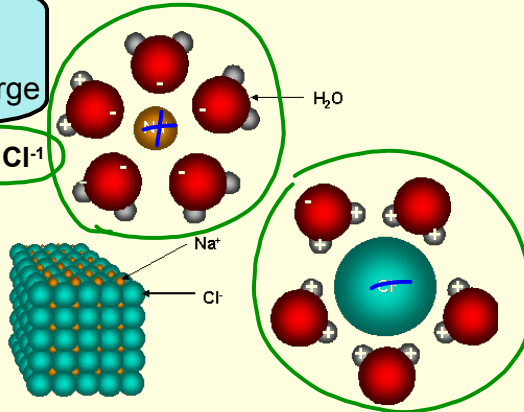
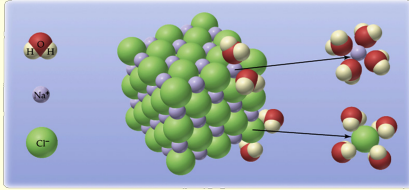
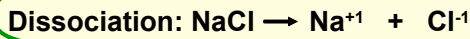
**Electrolytes Vs. Nonelectrolytes**

**Electrolytes: ionic salts, bases, or acids**

a substance that dissolves in water to give a solution that conducts electric current

ex: salt dissolved in water

solute (ionic)  
-dissociates - breaks apart  
-water orients with ion charge

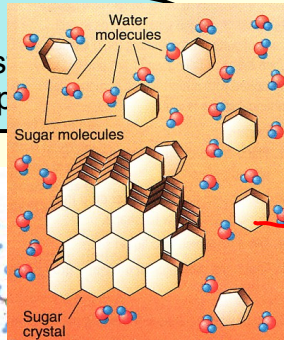
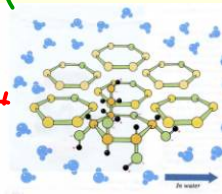
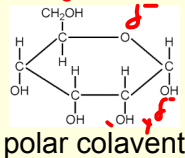
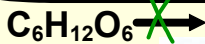


**Nonelectrolytes:**

ex: sugar dissolved in water

a substance that dissolves in water to give a solution that does not conduct electric current

solute (covalent)  
-does not dissociate, sugar s  
-H<sub>2</sub>O orients with polarity (if p



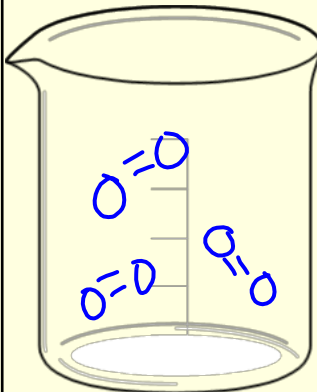
*ionic*  
metal/nonmetal  
ion chart  
+ ion/- ion

*Covalent*  
2 or more  
non metals

(Hint: Determine if covalent or ionic first)

How does O<sub>2</sub> dissolve?

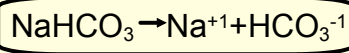
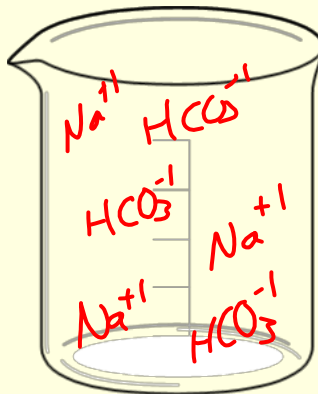
*covalent*  
~~O<sub>2</sub> →~~



covalent  
(does not dissociate)

How does NaHCO<sub>3</sub> dissolve?

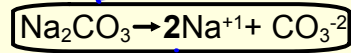
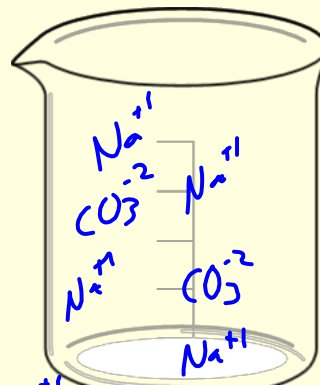
*ionic*



ionic

How does Na<sub>2</sub>CO<sub>3</sub> dissolve?

*ionic*



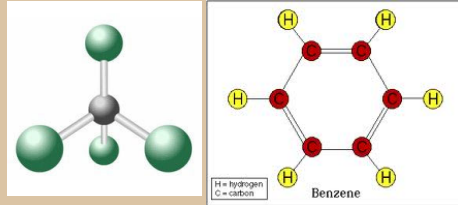
ionic

obj: I can Explain the meaning of "like dissolves like" in terms of polar and nonpolar

# Solubility: "Like dissolves like"

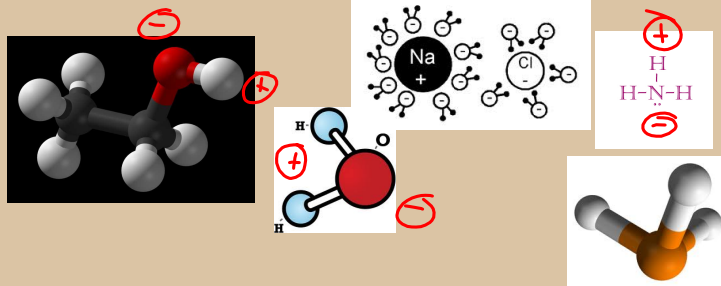
Two substances with similar **intermolecular** forces are likely to be soluble in each other.

- **non-polar** molecules are soluble in **non-polar** solvents  
CCl4 in C6H6



*Symmetrical*

- **polar (and ionic)** molecules are soluble in **polar** solvents  
C2H5OH in H2O, NaCl in H2O



why?

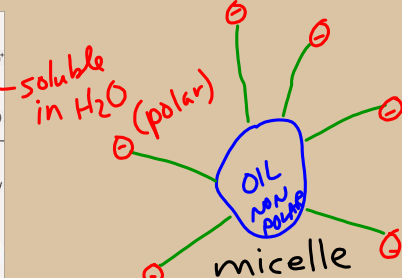
coloumbic attraction:  $F = \frac{q^+ \cdot q^-}{d^2}$

*opposites attract*

## Molecules with polar and nonpolar ends:

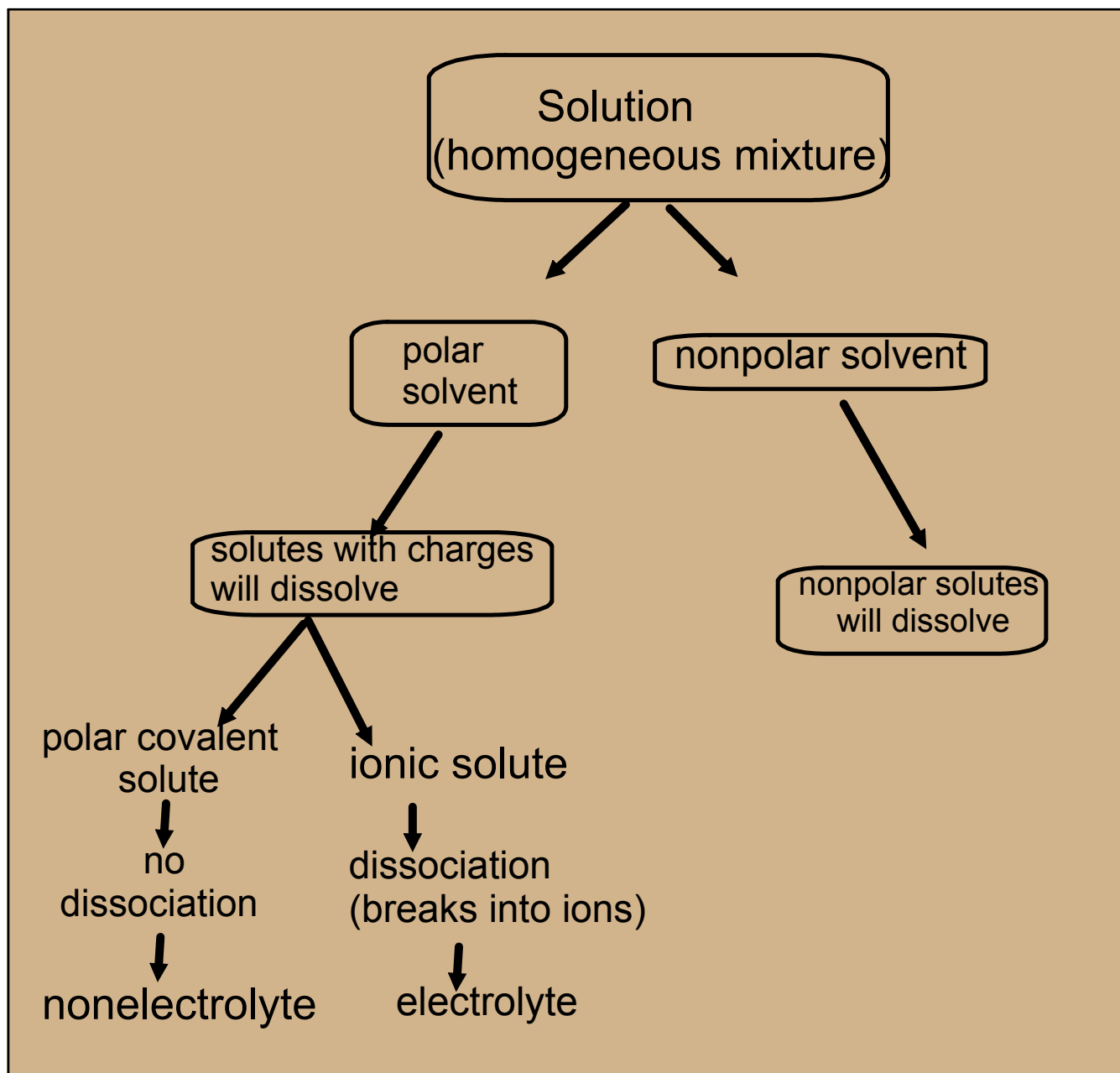
**Soap** *soluble in oil* *soluble in water*  
 Soap cleans oil and grease because one end of the soap molecule is soluble in water

- other end is soluble in oil and grease.



Thus, the soap molecule provides a link between two substances that would otherwise be immiscible.

## Cell Membranes



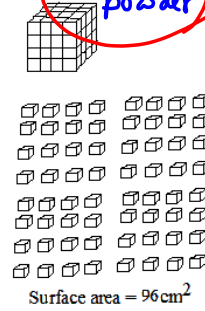
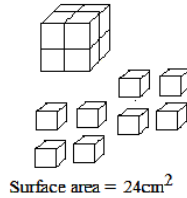
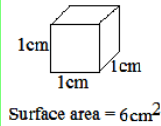
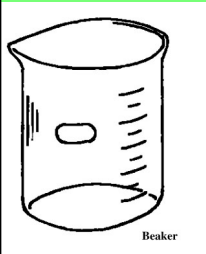


objective: List and explain 3 factors that affect the rate at which a solid solute dissolves in a liquid

### Factors that affect the rate of dissolution:

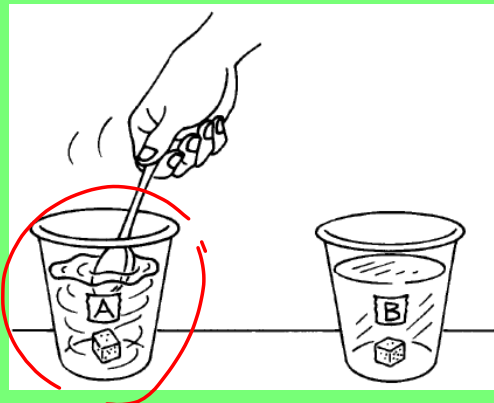
Which will dissolve fastest?

- 1. Increasing the surface area of the solute  
dissolving occurs at the surface of the solute



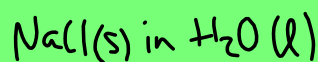
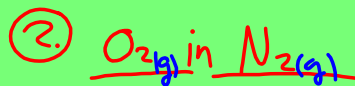
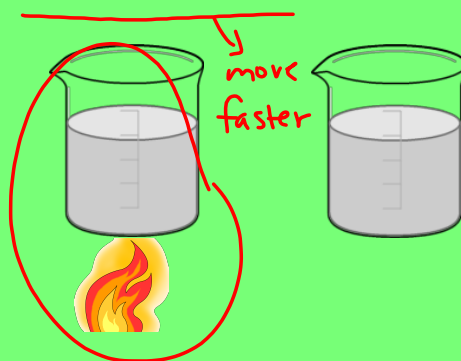
- 2. Agitating a solution (stirring or shaking)

increases contact with solvent and solute surface area



- 3. Heating a solvent

Increase kinetic energy of molecules disperses the solute molecules quicker





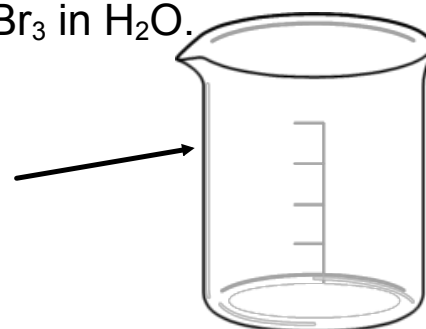
Review - look over notes and pages 2-5 in packet.

1.a. Write the equation for the dissociation of  $\text{AlBr}_3$  in  $\text{H}_2\text{O}$ .



hint: use ion sheet and balance

b. Make a drawing of 2 particles in a solution



c. What is the solvent? What is the solute?

d. Why does  $\text{AlBr}_3$  dissolved in water conduct electricity?

e. Why does  $\text{AlBr}_3$  as a solid salt not conduct electricity?

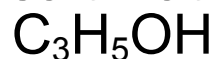
2. a. Why doesn't sugar water conduct electricity?

b. What are substances called that do not conduct electricity?

3. Classify: (as element, compound, homogeneous mixture, heterogeneous mixture)



salt water



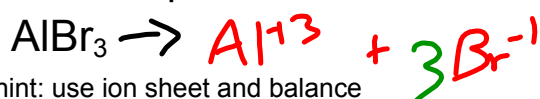
orange juice with pulp

tossed salad



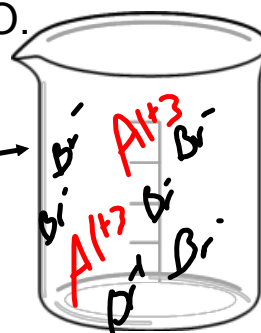
Review - look over notes and pages 2-5 in packet.

1.a. Write the equation for the dissociation of  $\text{AlBr}_3$  in  $\text{H}_2\text{O}$ .



hint: use ion sheet and balance

b. Make a drawing of 2 particles in a solution



c. What is the solvent? What is the solute?

$\text{H}_2\text{O}$

$\text{AlBr}_3$

d. Why does  $\text{AlBr}_3$  dissolved in water conduct electricity?

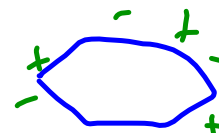
ionic - dissociate - ions can move / e- move

e. Why does  $\text{AlBr}_3$  as a solid salt not conduct electricity?

ions do not move

2. a. Why doesn't sugar water conduct electricity?

$\text{C}_6\text{H}_{12}\text{O}_6$  - covalent



b. What are substances called that do not conduct electricity?

nonelectrolyte

3. Classify: (as element, compound, homogeneous mixture, heterogeneous mixture)

$\text{N}_2$  E

salt water HO mix

$\text{C}_3\text{H}_5\text{OH}$  C

orange juice with pulp  
HE MIX

tossed salad

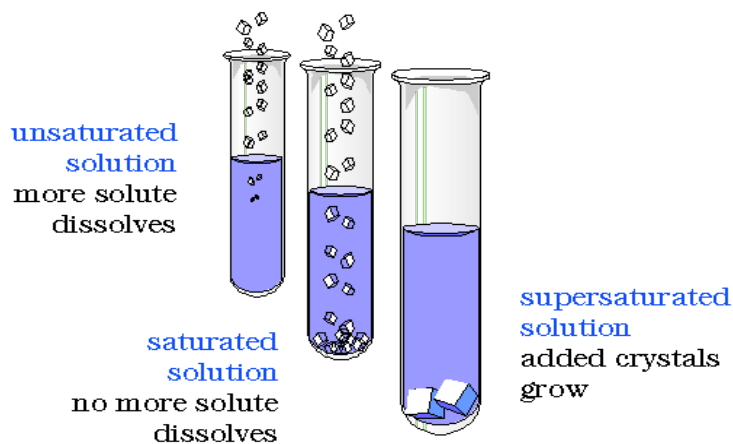
$\text{CaCl}_2$  C

Ca E

HE MIX

Solutions can be classified:

## Saturated Solutions



A **saturated** solution **contains the maximum quantity** of solute that dissolves at that temperature.

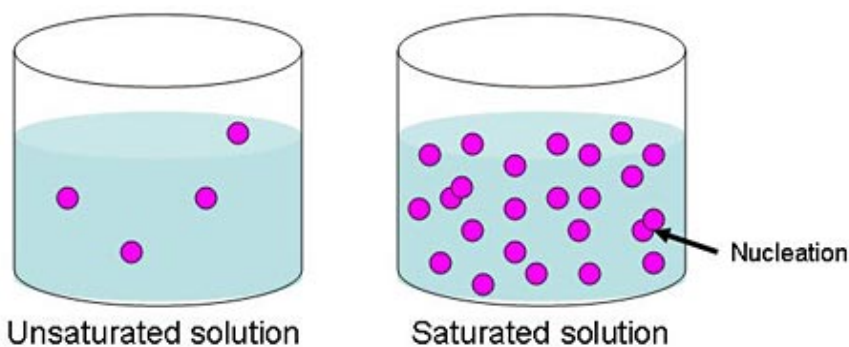
An **unsaturated** solution **contains less** than the maximum amount of solute that can dissolve at a particular temperature

An **supersaturated** solution **contains more** than the maximum amount of solute that can normally dissolve at a particular temperature.

-unstable.

-2 ways to get this:

- cool saturated solution
- Evaporate some of the solvent carefully

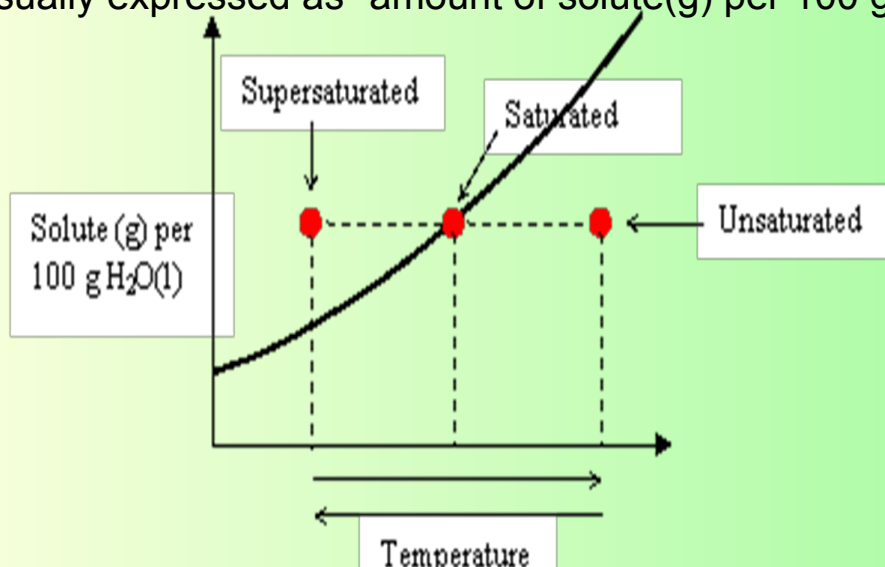


**Nucleation** is a physical process that occurs when parts of a solution start to precipitate out.

### Solubility:

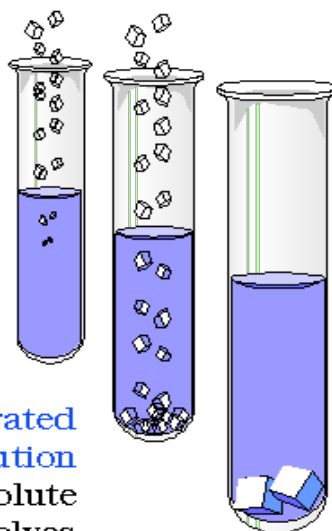
-the measure of the maximum amount of solute that can dissolve in a given solvent at a specific temperature.

-usually expressed as "amount of solute(g) per 100 grams of H<sub>2</sub>O



## Saturated Solutions

unsaturated  
solution  
more solute  
dissolves



saturated  
solution  
no more solute  
dissolves

supersaturated  
solution  
added crystals  
grow

## Review

You are making orange juice from frozen concentrate.  
What can you do to speed up the process of dissolving the concentrate in water?



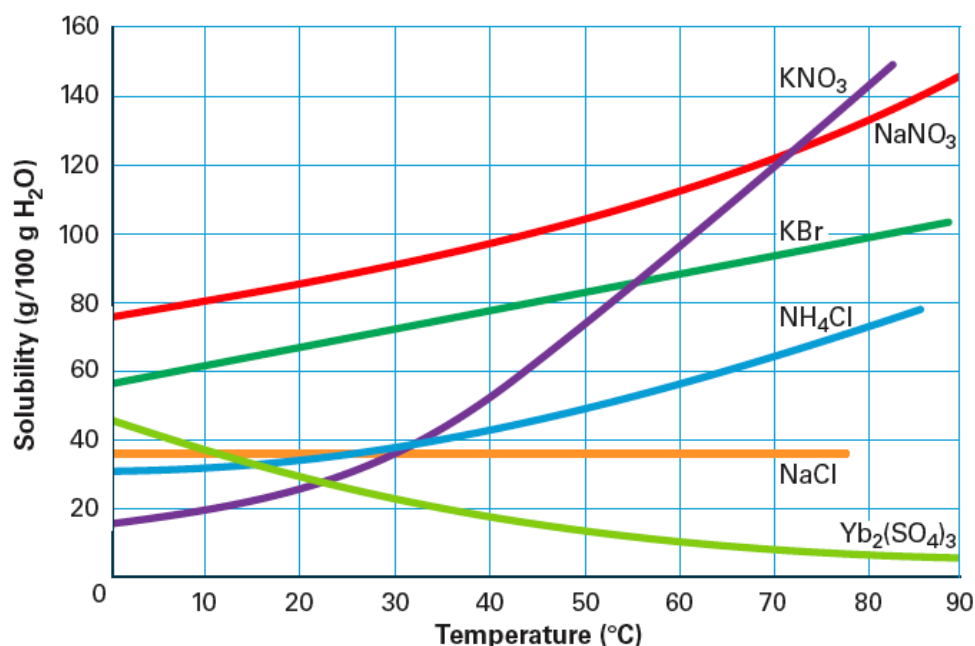
and  $H_2O =$



# Solubility Charts



Solubility Varies with Temperature



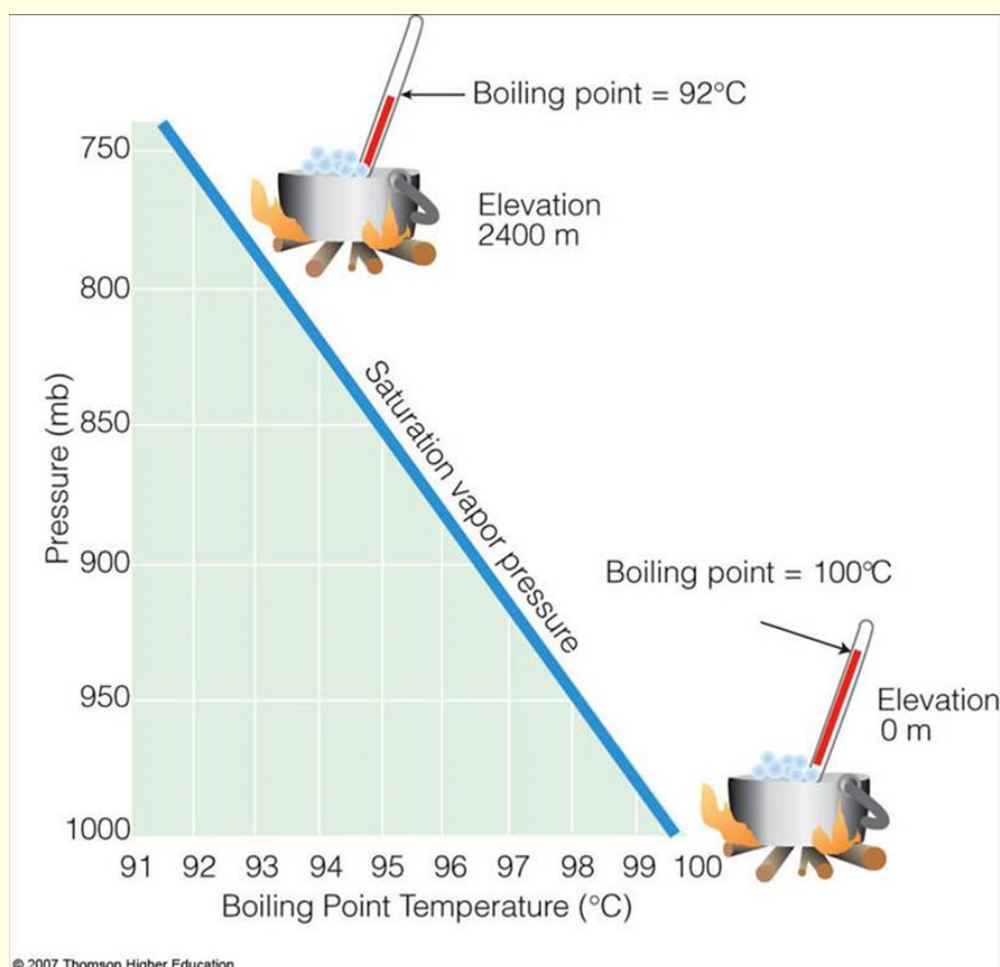
1. On the graph above, show how you can make an unsaturated solution of NaNO<sub>3</sub> at 75°C become supersaturated.

2

1? 2? 3?

3

Q: Why does water boil at lower temperatures at higher altitudes?

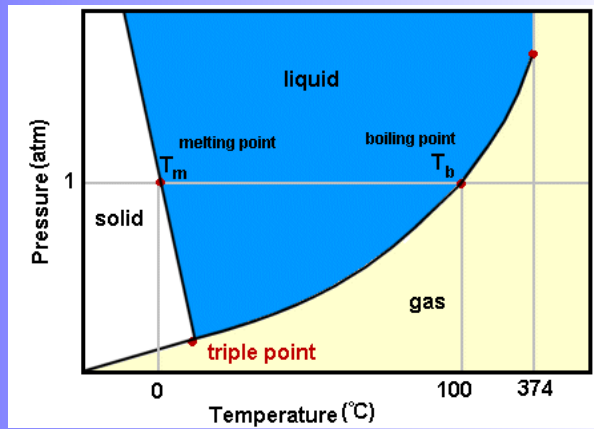


Pressure matters!



Consider temperature and pressure at the same time:

Use a  
Phase Diagram:



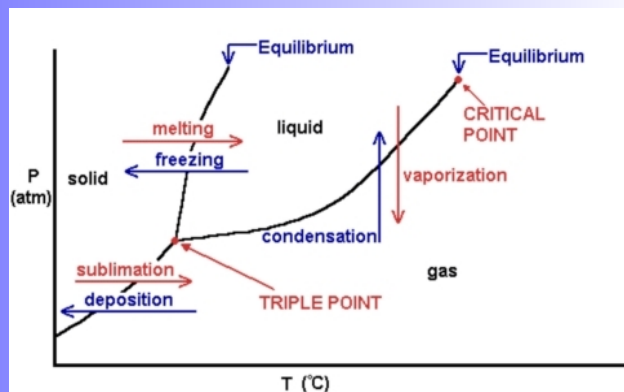
What happens when you cross a "line" into a different phase?

**triple point** --all 3 phases exist at one temp and pressure

<http://www.youtube.com/watch?v=r3zP9Rj7Inc>

<http://www.youtube.com/watch?v=BLRqpJN9zeA>

**critical point:**temperature is so high liquid can no longer be sustained

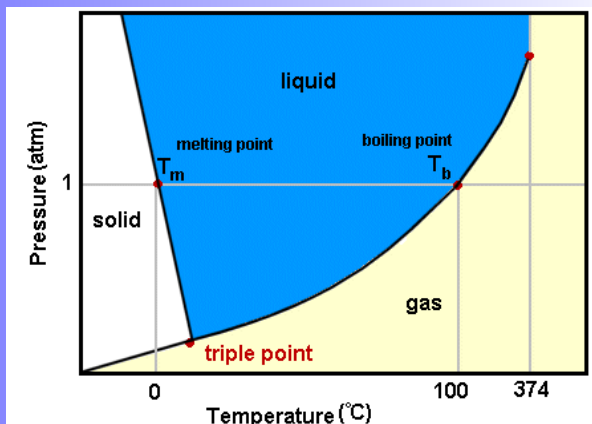


Increasing temperature pushes a substance toward being a

Increasing the atmospheric pressure pushes or compresses the substance more toward being a

Consider temperature and pressure at the same time:

Use a  
Phase Diagram:



melting pt at 1 atm-

boiling pt at 1 atm-

At 1 atm of pressure, what is the melting and freezing point?

What is the approximate melting and freezing point at 0.5 atm?

What phase change occurs if the sample starts at 50°C and 0.75 atm and the pressure is dropped to 0.25 atm?

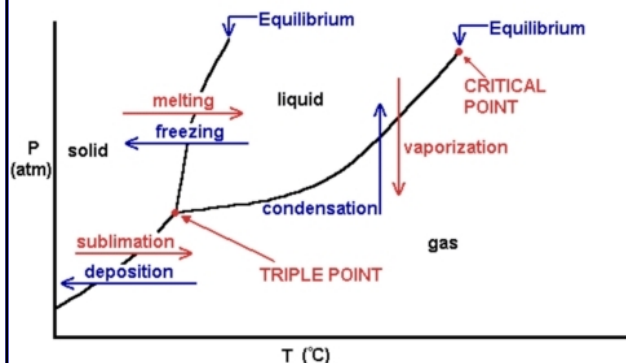
What phase change occurs if the sample starts at 50°C and 0.75 atm and the pressure is dropped to 0.25 atm?

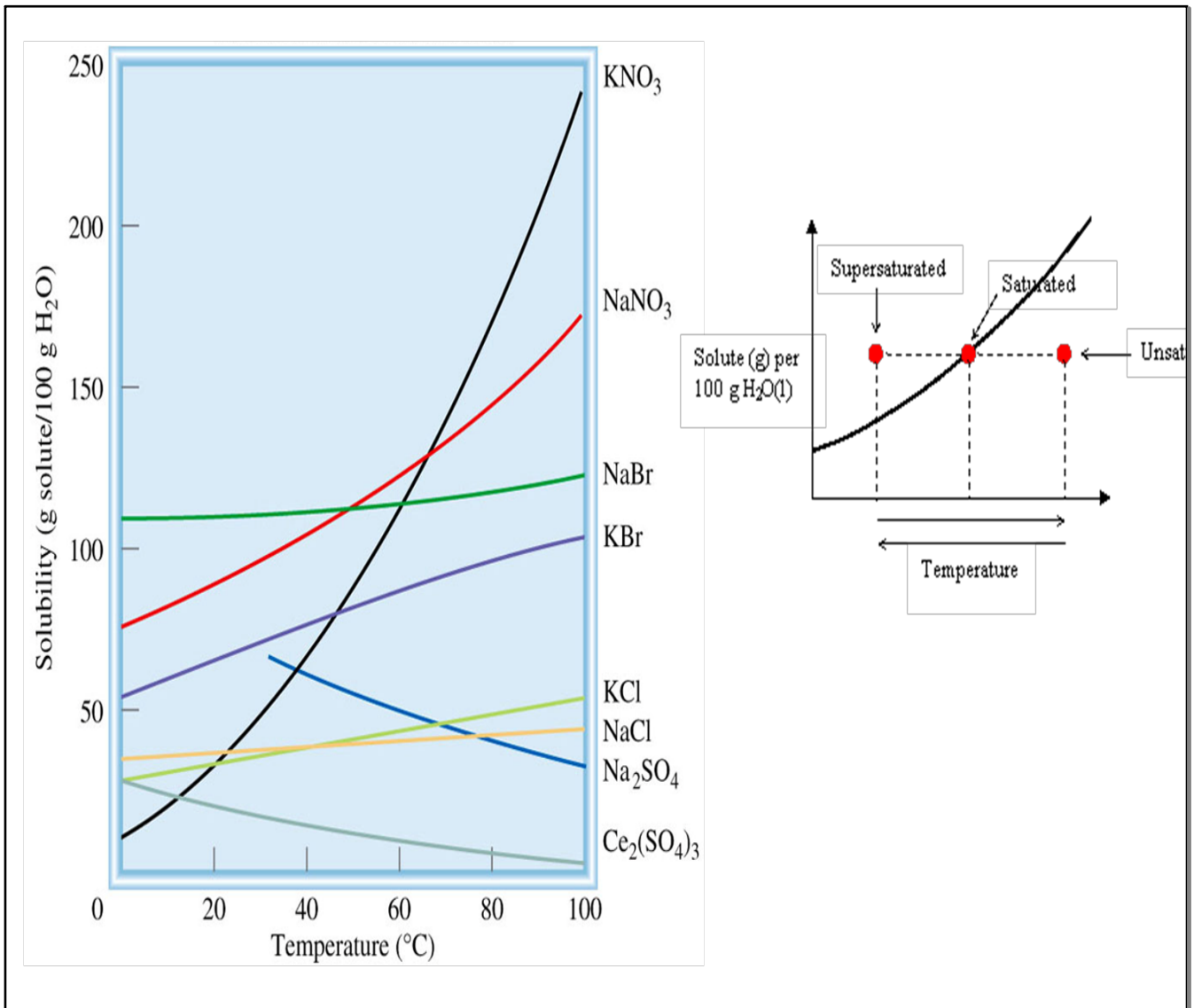
**triple point** --all 3 phases exist at one temp and pressure



<http://www.youtube.com/watch?v=r3zP9Rj7Inc>

<http://www.youtube.com/watch?v=BLRqpJN9zeA>

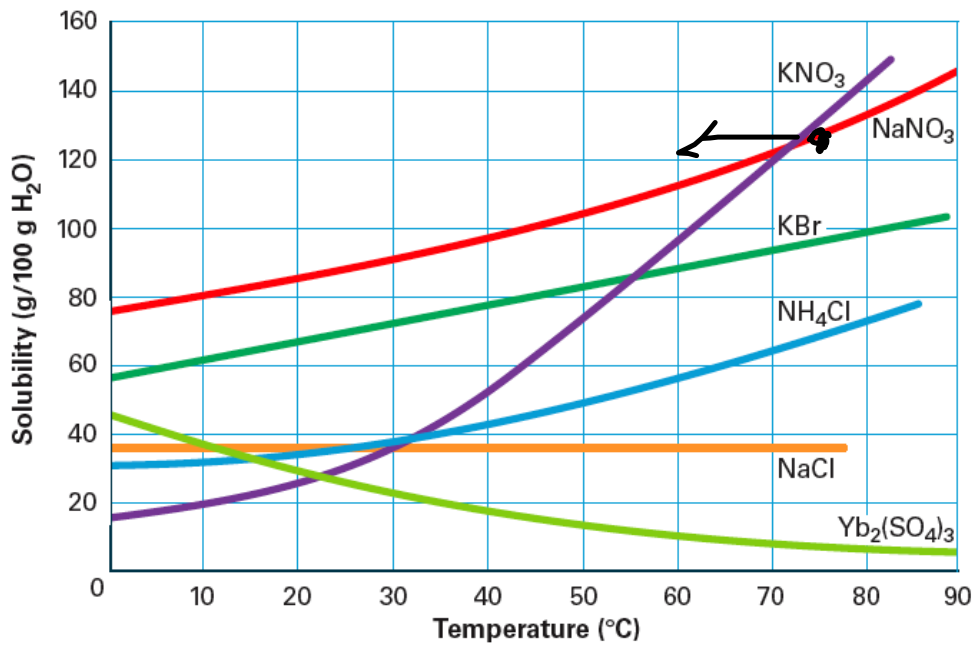
**critical point:** temperature is so high liquid can no longer be sustained





Word	Description	
	<p>part of the solution being dissolved</p> <p>homogeneous mixture</p> <p>part of the solution doing the dissolving</p> <p>process of dissolving a solute in a solvent</p> <p>process of breaking apart a crystal into ions</p> <p>amount of a solute needed to make a saturated solution at a given temp.</p>	
<input type="button" value="solvation"/>	<input type="button" value="solution"/>	<input type="button" value="solubility"/>
<input type="button" value="dissociation"/>	<input type="button" value="solute"/>	<input type="button" value="solvent"/>

Solubility Varies with Temperature



1. On the graph above, show how you can make an unsaturated solution of NaNO<sub>3</sub> at 75°C become supersaturated.

1? ✓ 2? ✓ 3? ✓

2

3

Click here!






Table Salt | **Slightly Soluble Salts** | Design a Salt

1 shake me!



2

Salt: Silver Bromide

Ions:  Silver  Bromide

Dissolved:


Bound:

Total:

Water Volume:  liters (L)

Reset All

Pause Step




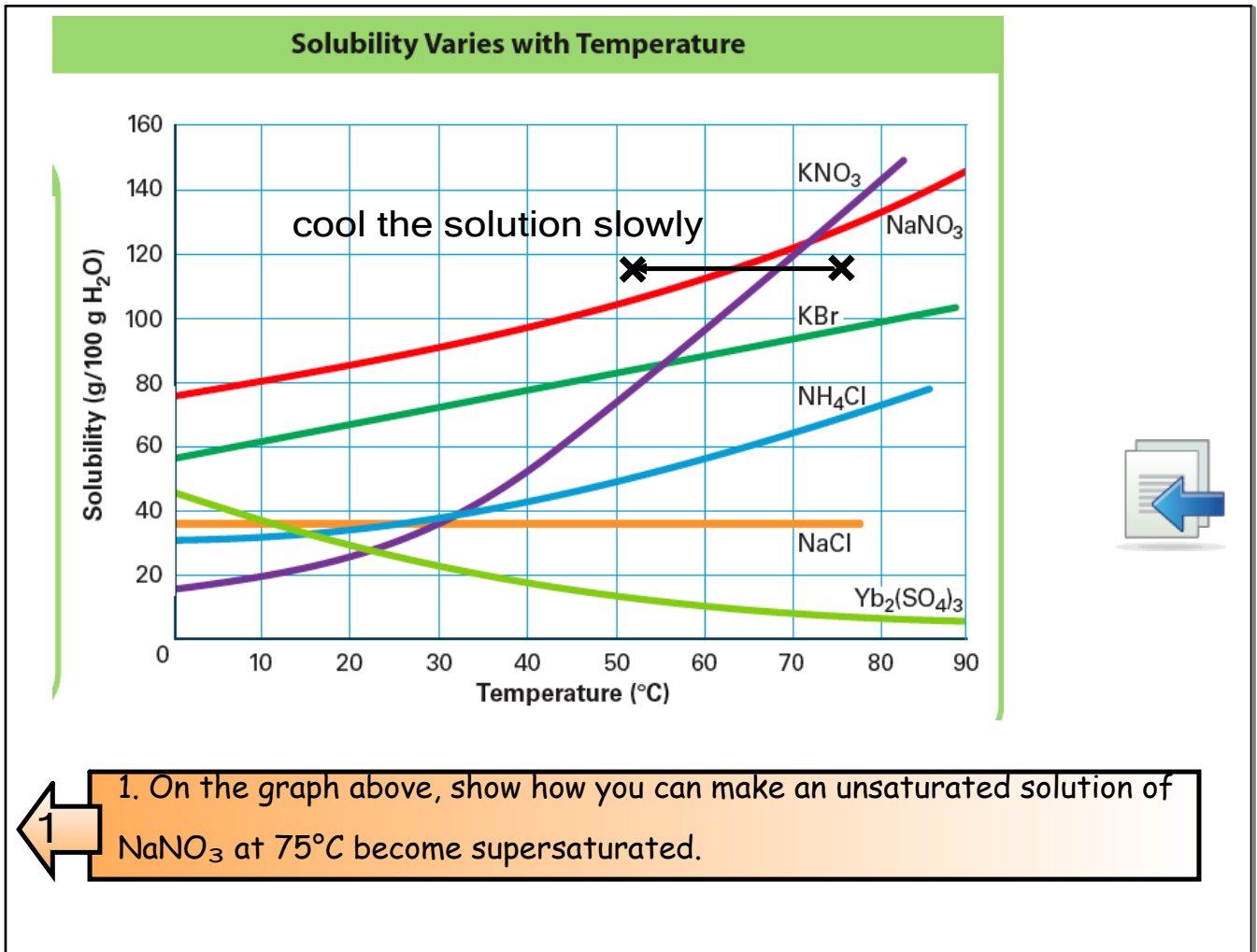


ANSWERS.....

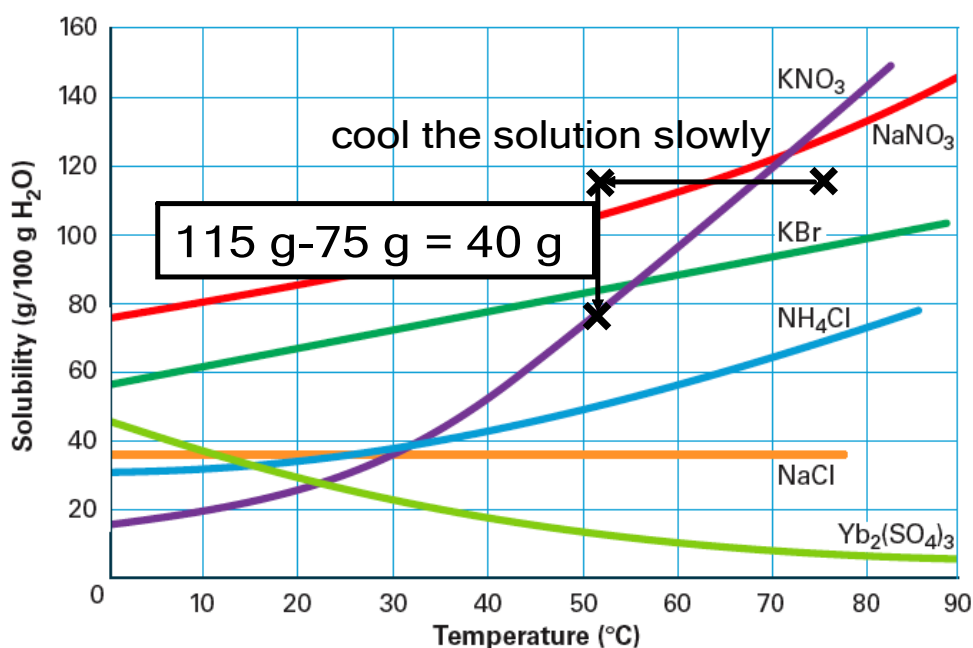


Word	Description
solute	part of the solution being dissolved
solution	homogeneous mixture
solvent	part of the solution doing the dissolving
solvation	process of dissolving a solute in a solvent
dissociation	process of breaking apart a crystal into ions
solubility	amount of a solute needed to make a saturated solution at a given temp.



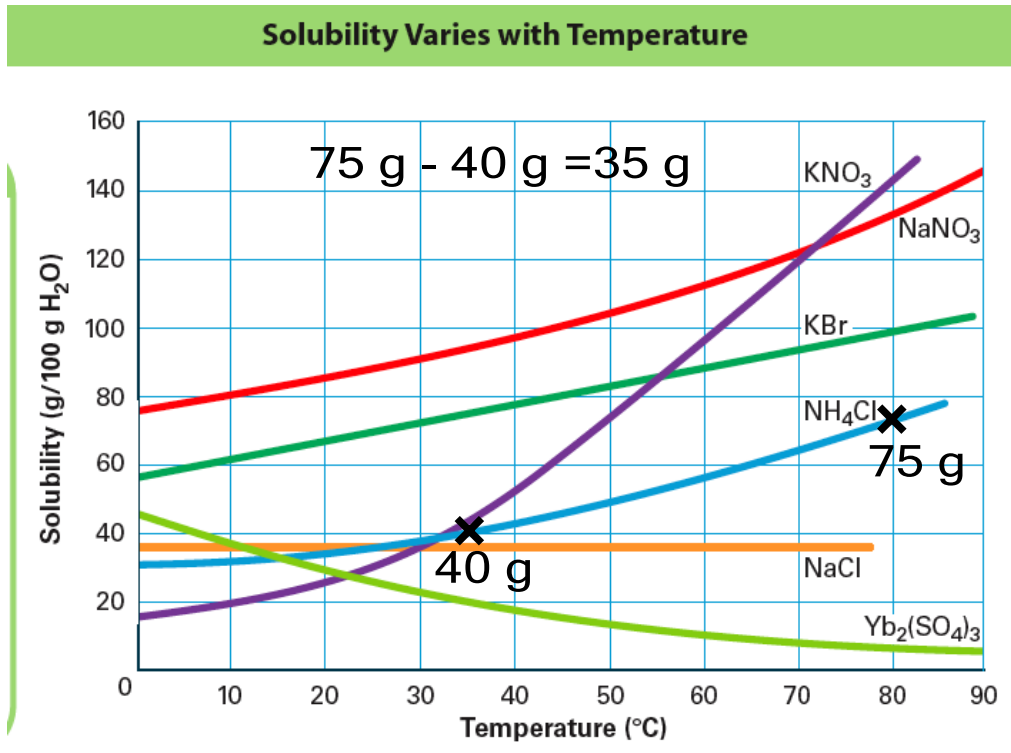


Solubility Varies with Temperature




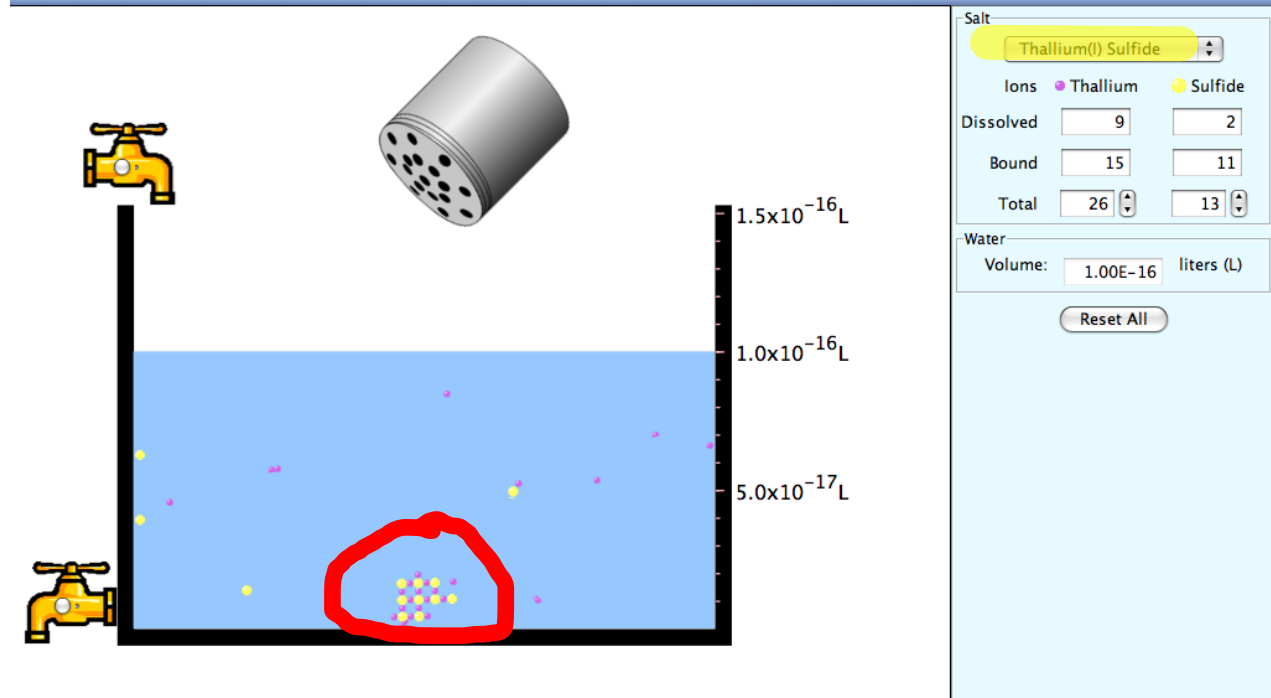
2

2. Show how you would determine the amount of excess solute that would crystallize once the supersaturated solution is disturbed.



3. Show on the graph how you would determine the additional amount of solute that could be dissolved in a solution of NH<sub>4</sub>Cl at 80°C compared to a solution of NH<sub>4</sub>Cl at 35°C.

Table Salt   Slightly Soluble Salts   **Design a Salt**   



The simulation shows a tank of water with a faucet on the left and a showerhead above. A red circle highlights a precipitate at the bottom of the tank. The right panel displays the following data:

Salt	
Thallium(I) Sulfide	
Ions	Thallium (purple dot)   Sulfide (yellow dot)
Dissolved	9   2
Bound	15   11
Total	26   13

Water	
Volume:	1.00E-16 liters (L)

[Reset All](#)

Simulation ANSWER

## Attachments

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soluble-salts\_en-1.jnlp