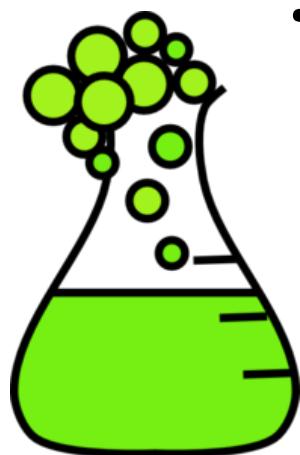
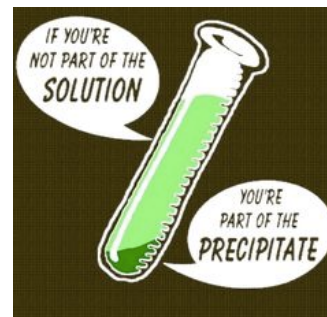


Name: _____



A Particle View of Solutions



Investigating Homogeneous Mixtures



Do Now:

Using your glossary, define the following terms:

Homogeneous Mixture	
Solution	
Solvent	
Solute	

Components of a Solution

Aqueous Potassium Nitrate

Solute <hr style="width: 80%; margin: 0 auto;"/>	Solvent <hr style="width: 80%; margin: 0 auto;"/>
---	--

Types of Solutions (Phases of Solute and Solvent)

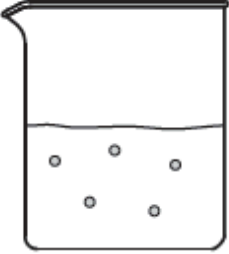
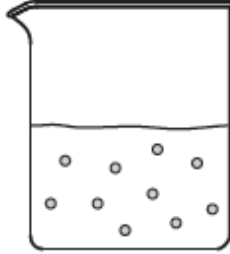
	
	

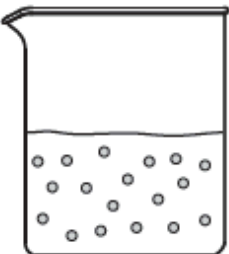
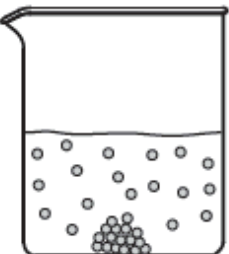
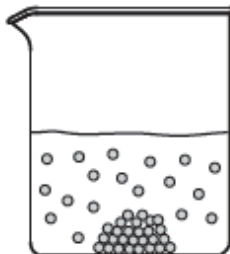
Is there a limit to the amount of solute that will dissolve in a solvent?

Saturated and Unsaturated Solutions

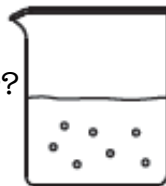
We use solutions every day. People who wear contact lenses use “lens solution” to rinse their contacts and keep them wet. Athletes who consume sport drinks after exercising benefit from the electrolytes in those solutions.

Let’s explore whether or not there is a limit to how much of one substance can dissolve in another.

<ul style="list-style-type: none"> • All beakers contain 10.0 g of water. • All beakers are kept at 20 °C. • All solutions are stirred for 2 hours. • Solute is the same substance in all beakers. 	Unsaturated Solutions	
	Beaker A	Beaker B
	 <p>1.0 g of solute added</p>	 <p>2.0 g of solute added</p>
Number of dissolved particles	5	
Number of solid particles		0

Saturated Solutions		
Beaker C	Beaker D	Beaker E
 <p>3.6 g of solute added</p>	 <p>7.0 g of solute added</p>	 <p>9.0 g of solute added</p>
		18
	17	

- Which illustration below represents
 - solute particles in a solid state in water?
 - solute particles in an aqueous state?



2. Count the particles present in each beaker present in each beaker (A-E). Fill in the table to show the number of dissolved solute and number of solid solute particles.

3. What variables are kept constant in all five beakers?

_____ , _____

_____ , _____

4. Using your glossary, define the term **unsaturated solution**.

- a. Which beakers (A-E) represent **unsaturated solutions**? _____
- b. When a small amount of additional solute is added to an **unsaturated solution**, what happens to the number of dissolved particles?

5. Using your glossary, define the term **saturated solution**.

- a. Which beakers (A-E) represent **saturated solutions**? _____
- b. When a small amount of additional solute is added to a **saturated solution**, what happens to the number of dissolved particles?

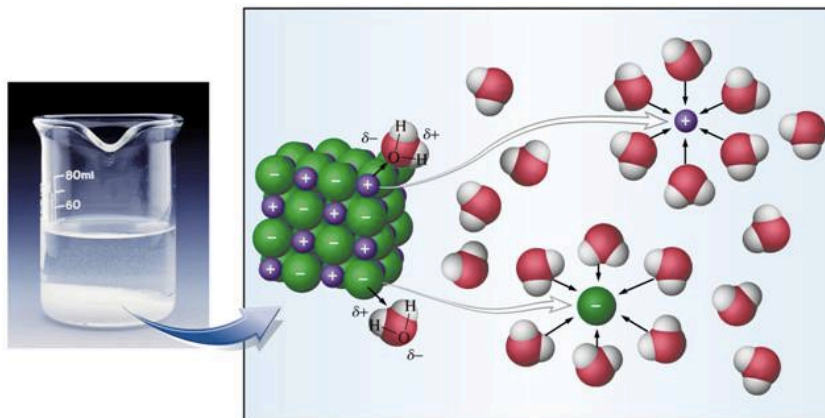
c. Watch the videos on my website and summarize using the table below.

Unsaturated Solution	Saturated Solution	Supersaturated Solution

6. Observe the teacher's demonstration of a supersaturated solution.



Quick Review of the Dissolving Process



Copyright © 2005 Pearson Prentice Hall, Inc.

Dissolving Sodium Chloride (NaCl) in Water
Sodium chloride exhibits _____ bonding

Dissociation Equation

Define Electrolyte:

Dissolving Sucrose ($C_{12}H_{22}O_{11}$) in Water
Sucrose exhibits _____ bonding

Equation

Define Nonelectrolyte:

Suppose...

A student measured the conductivity of six aqueous solutions. Each solution had equal concentrations of solute. Solutes that produce a similar amount of particles when they dissociate into ions will have similar conductivity values. The magnitude of the conductivity value is proportional to the number of ions in the solution. The SI conductivity unit is the microsiemens/cm ($\mu\text{S}/\text{cm}$). The table on the next page gives the student's results.

Student's Results

Solution	Conductivity ($\mu\text{S}/\text{cm}$)
Potassium chloride, KCl	2050
Aluminum chloride, AlCl_3	4500
Calcium chloride, CaCl_2	3540
Sodium Hydroxide, NaOH	2180
Ethanol, $\text{C}_2\text{H}_6\text{O}$	0
Magnesium bromide, MgBr_2	3490

1. Why does ethanol solution have zero conductivity?

2. Write out the balanced **dissociation** equation for the following solutions:

KCl _(aq)
NaOH _(aq)
CaCl₂ _(aq)
MgBr₂ _(aq)

Explain why the KCl_(aq) and NaOH_(aq) have similar conductivities.

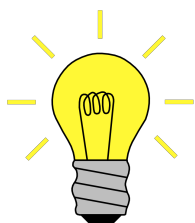
Explain why the CaCl_{2(aq)} and MgBr_{2(aq)} have similar conductivities.

3. AlCl₃ solution has a conductivity that is about twice that of KCl solution. Explain why.

Did you know?

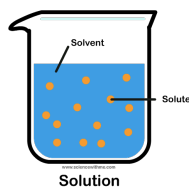
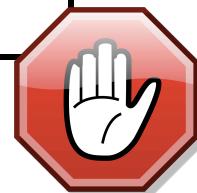
Electrolytes are substances that break up (dissociate-ionic, ionize-acids) in water to produce ions. These ions are capable of conducting an electric current.

Generally, electrolytes consist of acids (**Table K**), bases (**Table L**), and salts (ionic compounds). **Nonelectrolytes** are usually molecular compounds, with exception of acids that are soluble in water.



Using your knowledge of chemistry, the information on the previous page and your reference tables, classify each of the following solutions as either an **electrolyte** or a **nonelectrolyte**.

Compound	Type of Substance	Electrolyte	Nonelectrolyte
NaCl _(aq)			
HCl _(aq)			
C₆H₁₂O₆ _(aq)			
NaOH _(aq)			
CuSO₄ _(aq)			
CH₃OH _(alcohol)			
H₂SO₄ _(aq)			



Factors that Affect Solubility

Agitation

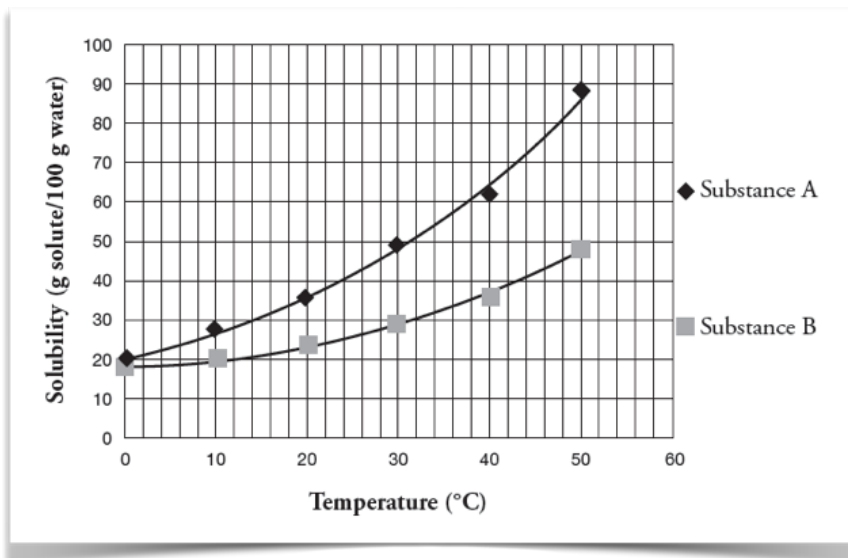
Surface Area

Pressure

Temperature

Solubility is a measure of the maximum amount of solute that can dissolve in a given amount of solvent (ratio of solute to solvent) at a specific temperature.

Solubility Curves



Answer the following questions based on the graph above.

1. Solubility is the variable on the y-axis. What are the units for solubility?

What is the variable on the x-axis?

2. According to the graph, what is the solubility of substance A at 30°C?

Is this solution saturated or unsaturated? _____

3. Describe the trend in solubility for Substance A and B as temperature increases.

4. If a saturated solution of **Substance A** in 100.0 g of water is cooled from 30°C to 10°C, what mass of solid solute would crystallize out?

_____ grams of Substance A would crystallize out.

- **5. If a saturated solution of **Substance B** in 50.0 g of water at 30°C is warmed to 50°C, what mass of solute would need to be added to make the solution saturated again?

_____ grams



Interpret Graphs

Table G-Solubility Curves

	Unsaturated Solution	Saturated Solution	Supersaturated Solution
Using NaNO₃(aq) at 40°C as an example, predict a mass that would classify each type of solution.	_____ g NaNO ₃ in 100 g H ₂ O _____ the curve	_____ g NaNO ₃ in 100 g H ₂ O _____ the curve	_____ g NaNO ₃ in 100 g H ₂ O _____ the curve

Let's Practice:

1. Using the line that shows the solubility of sodium nitrate (NaNO₃), how many grams of this salt will dissolve in 100 g of water at 10°C? _____
2. At 30°C, 90 g of sodium nitrate is dissolved in 100 g of water. Is this solution saturated, unsaturated, or supersaturated? _____
3. Which salt is least soluble in water at 40°C? _____
4. Which salt shows the least change in solubility from 0°C to 100°C? _____
5. How many grams of KCl can be dissolved in 200 g of water at 80°C? _____
6. Which compound(s) shows a decrease in solubility from 0°C to 100°C?

Explain why.

7. A saturated solution of potassium chlorate is formed from 100 g of water. If the saturated solution is cooled from 80°C to 50°C, how many grams of precipitate are formed?
_____ grams will precipitate out.
8. Which salt is most soluble at 10°C? _____
9. At 40°C, how much potassium nitrate can be dissolved in 50 g of H₂O? _____ grams
10. Which two substances have the same solubility at 76°C? _____ and _____
11. You have a solution of ammonium chloride containing 42 g at 85°C. How many grams of solute can be added to make the solution saturated? _____ grams
12. At what temperature does KI have a solubility of 140g/100 g H₂O? _____ °C
13. How many grams of ammonia can be dissolved in 300 g of water at 20°C? _____

Nature of the Solute and Solvent

Generally, **“like dissolves like.”** Polar molecules dissolve other polar molecules and ionic compounds. Nonpolar molecules dissolve in other nonpolar molecules. Alcohols, which have characteristics of both, tend to dissolve in both types of solvents, but will not dissolve ionic solids.

In terms of polarity...

_____ solute will generally dissolve in _____ solvents.

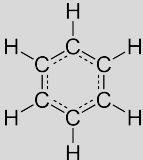
_____ solute will generally dissolve in _____ solvents.



Check the appropriate columns as to whether the solute is soluble in a polar or nonpolar solvent.

SOLVENTS

S
O
L
U
T
E
S

	H₂O	CCl₄
	Polarity: _____	Polarity: _____
CaCl₂		
I₂		
KNO₃		
NaOH		
 Benzene		
HCl		

What makes laundry detergents good at fighting stains?



Not all ionic compounds are soluble in H₂O!

Table F-Solubility Guidelines

Define the following terms:

Soluble	
Insoluble	
Precipitate	

Determine if the following compounds would be **soluble** or **insoluble** in H₂O.

LiCl _____

Ca(NO₃)₂ _____

AgCl _____

K₂CrO₄ _____

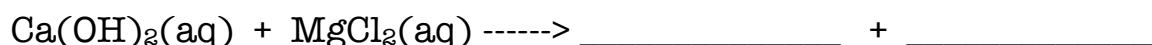
NaOH _____

BaSO₄ _____

PbBr₂ _____

(NH₄)₃PO₄ _____

Complete the following double replacement reactions. **Highlight the product** that is classified as a precipitate. Make sure the equation is balanced.



Practice Regents Questions:

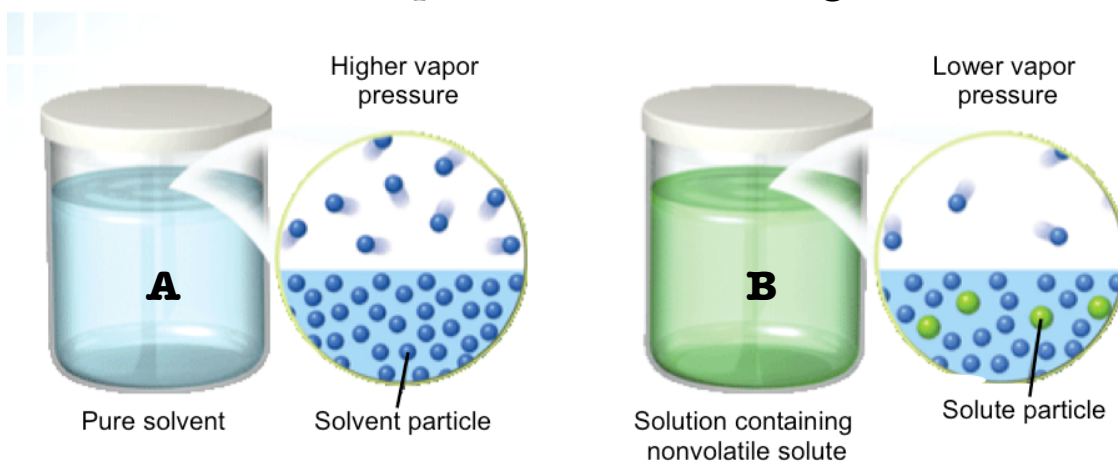
- Which phosphate is most soluble in water?
a. (NH₄)₃PO₄ b. FePO₄ c. Ca₃(PO₄)₂ d. Zn₃(PO₄)₂
- Which compound of zinc is most soluble in water?
a. ZnCO₃ b. Zn(OH)₂ c. Zn(NO₃)₂ d. Zn₃(PO₄)₂
- The solubility of carbonate compounds is most similar to the solubility of
a. sulfides b. chlorates c. chromates d. hydrogen carbonates
- According to Table F, which compound is least soluble in water?
a. K₂CO₃ b. KC₂H₃O₂ c. Ca₃(PO₄)₂ d. Ca(NO₃)₂
- Which chromate is soluble in water?
a. Na₂CrO₄ b. BaCrO₄ c. Ag₂CrO₄ d. ZnCrO₄

Colligative Properties of Solutions

Colligative properties are the physical changes that result from adding solute to a solvent. **Colligative Properties depend on how many solute particles are present as well as the solvent amount, but they do NOT depend on the type of solute particles.**

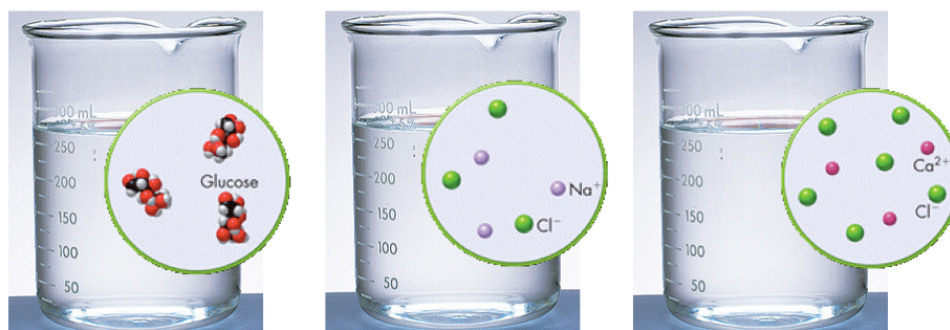
Three important colligative properties of solutions are:

Vapor-Pressure Lowering



Explain why beaker B would have a lower vapor pressure.

Which solution has the lowest vapor pressure?



dissolved
solute
particles

dissolved
solute
particles

dissolved
solute
particles

Using your glossary, define the following terms:

Freezing Point Depression	
Boiling Point Elevation	

Remember....

The separation of ions that occurs when an ionic compound dissolves is called **dissociation**.

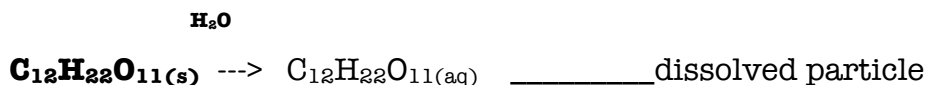
H₂O

Examples: $\text{NaCl}_{(s)} \xrightarrow{\text{H}_2\text{O}} \text{Na}^+_{(aq)} + \text{Cl}^-_{(aq)}$ _____ dissolved particles

H₂O

$\text{MgCl}_2_{(s)} \xrightarrow{\text{H}_2\text{O}} \text{Mg}_{(aq)} + 2\text{Cl}^-_{(aq)}$ _____ dissolved particles

Molecular substances such as sucrose when dissolved in water do not break up into smaller particles.



Using the examples above (NaCl, MgCl₂, and C₁₂H₂₂O₁₁) can you predict the following?

Which substance would have the <u>greatest</u> effect in lowering the freezing point of H ₂ O? (<0°C)	
Which substance would have the <u>greatest</u> effect in increasing the boiling point of H ₂ O? (> 100°C)	
Which substance would have the <u>least</u> effect in lowering the freezing point of H ₂ O?	
Which substance would have the <u>least</u> effect in increasing the boiling point of H ₂ O?	

Let's Practice:

1. Indicate how many particles are formed when the following solute dissolves in water.

Solute	# of particles	Solute	# of particles
C ₆ H ₁₂ O ₆		AlCl ₃	
Na ₂ SO ₄		CH ₃ OH	

2. Salt is often used to remove ice from roads and sidewalks.
a. Explain how this process works in terms of colligative properties.



- b. Why is calcium chloride a better choice than sodium chloride to use on icy roads and sidewalks?

3. What is the benefit of adding table salt to a pot of boiling water when cooking pasta?



3. Which would have a greater affect on the freezing and boiling point of water?

.5 moles of NaCl in 1000 grams of H₂O

OR

2 moles of NaCl in 1000 grams of H₂O

Explain your answer.

4. A solution consists of 0.50 mole of CaCl₂ dissolved in 100. grams of H₂O at 25°C. Compared to the boiling point and freezing point of 100. grams of H₂O at standard pressure, the solution at standard pressure has
- (1) a lower boiling point and a lower freezing point
 - (2) a lower boiling point and a higher freezing point
 - (3) a higher boiling point and a lower freezing point
 - (4) a higher boiling point and a higher freezing point