Solutions

chemists have all the solutions

You have a problem and you dissolve it in water

Now you have a solution

If You're Not Part Of The **Solution** Then You're Part Of The **Precipitate**

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Terms

Solvent
 Single substance that does the dissolving
 substance present in the largest amount

Solute
 1 or more substance that is dissolved
 substance present in the lower amount

Solute

HOT CHOCOLATE

Solute

WATER

WATER HOT CHOCOLATE

Solvent   Solution

Solution
 The result of dissolving the solute in a solvent

Solubility
 Quantity of a solute that will dissolve at a fixed temperature
 Typically expressed a grams solute/per 100 (mL or g)

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1

Terms

Saturated
Solution contains the **maximum amount** of solute
A dynamic equilibrium exists

Unsaturated
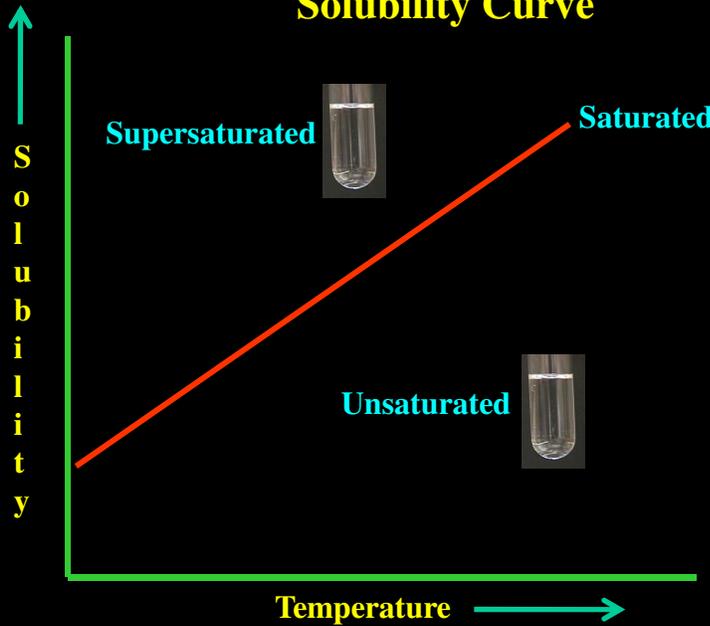Solution contains less than the maximum amount of solute

Supersaturated
Solution contains more than the maximum amount of solute
Carefully prepared
Unstable

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Solubility Curve

Supersaturated

Saturated

Unsaturated

S o l u b i l i t y

Temperature ⟶

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Solubility Curve: Supersaturation

Supersaturated

Unsaturated

Saturated

Solubility *(vertical axis label)*

Supersaturation:
Comes from temperature manipulation

Temperature

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Solubility Curve:
Adding More Than Saturated

Saturated

Solubility *(vertical axis label)*

Adding more than saturated:
Will not dissolve higher than saturated

Temperature

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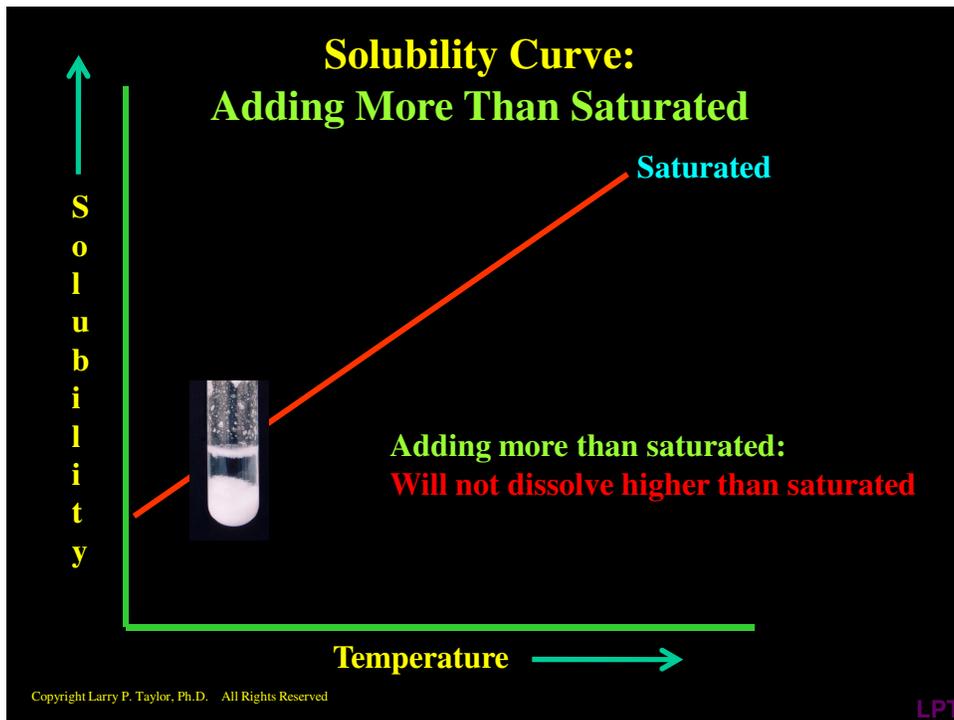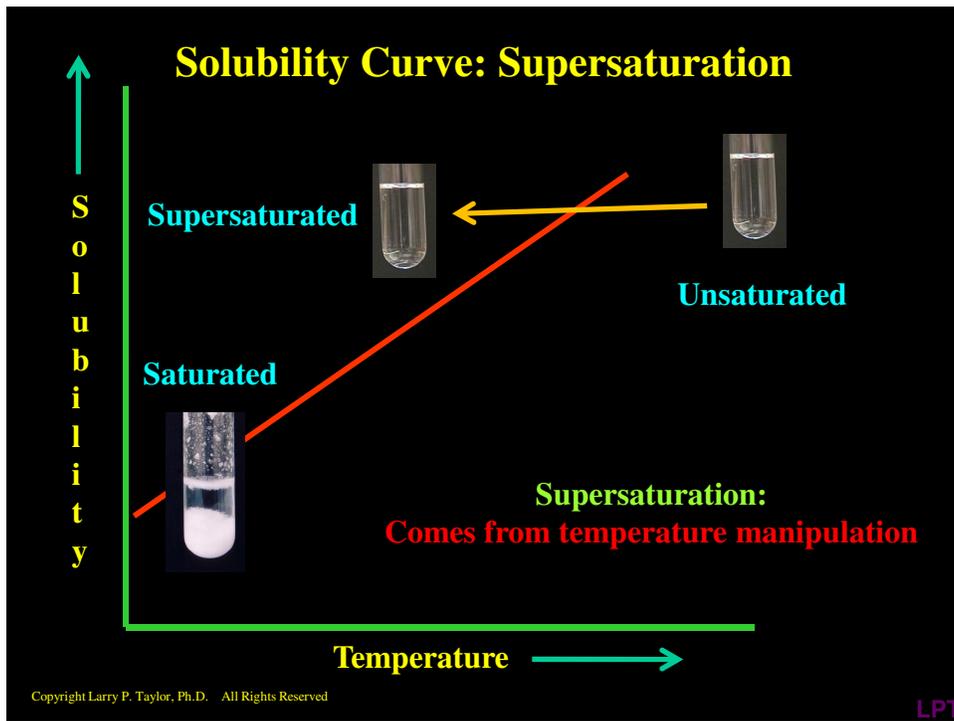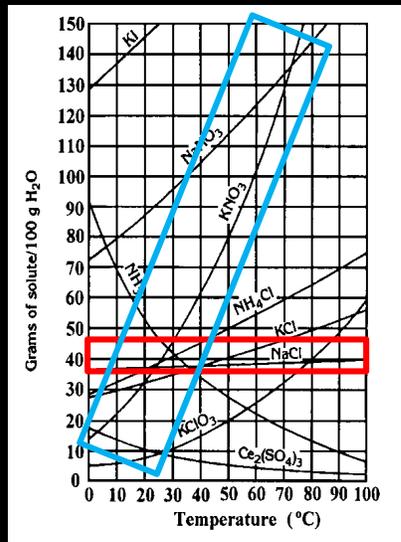
Solubility Curves

**Plot of
Solubility vs. Temperature**

For each compound (line):

Saturated
 On the solubility line

Unsaturated
 Below the line

Supersaturated
 Above the line

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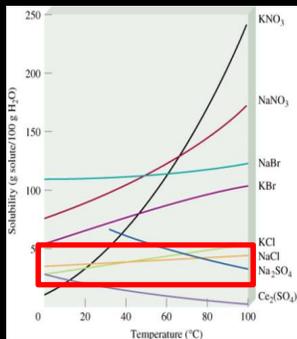
Solubility Curves

NaCl curve is "flat line"

Solubility does not change with temperature

Consider this:

 Our nervous system is dependent on Na⁺

**If Na⁺ solubility changed with temperature,
 Our nervous systems would alter with temperature**

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Solutions Alter Physical Properties
Dependent on Concentration of Solute

$\Delta T = K_b\ m$ $\qquad\qquad\qquad\qquad \Delta T = K_f\ m$

Boiling point elevation $\qquad\qquad$ Freezing point depression

pure liquid $\quad$ gas $\qquad$ solution $\quad$ gas $\qquad\qquad$ solid $\quad$ pure liquid $\qquad$ soid $\quad$ solution
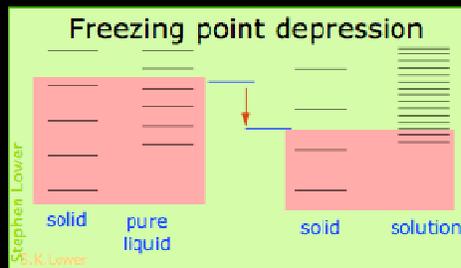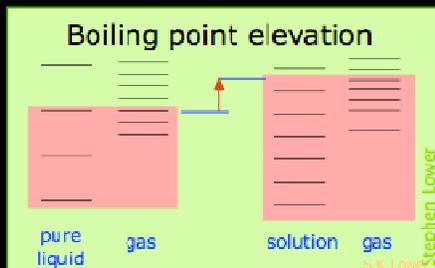
Adding salt to water: $\qquad\qquad$ Adding salt to water:
 Raises Boiling Point $\qquad\qquad$ Lowers Freezing Point
 Raises Cooking Temperature $\quad$ Keeps water on sidewalks liquid
(but not enough to be significant)

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WATER ON MARS
It has been found
www.jacanaent.com

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Solutions Lab

chemists have all the solutions

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Now you have a solution

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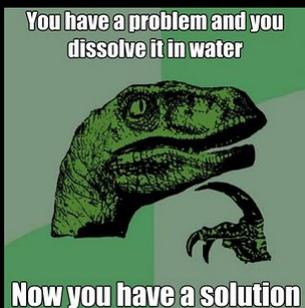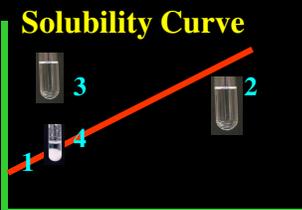
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Online Lab

Purpose
Observe the solubility- temperature relationship
Isolate 1.00 gram of NaCl by evaporation

Procedure
Instructor Demo of sodium acetate super-saturation

Solubility Curve

3

2

4

1

1 = Solid visible ➔ Solution is saturated
2 = After heating: All solid dissolved ➔ Solution unsaturated
3 = After slowly cooling: No solid visible ➔Supersaturated
4 = After Seeding: Solid visible ➔ Saturated

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Sodium Acetate Demo Photos

Ambient	~ 100 °C	After Cooling	After Seeding
White Solid Clear Liquid	No Solid Clear Liquid	No Solid Clear Liquid	White Solid Clear Liquid

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Solubility of NaCl & KNO$_3$

NaCl

KNO$_3$

Ambient	~ 100 °C	After Cooling		Ambient	~ 100 °C	After Cooling

Large or Small
Increase or Decrease in solubility
Less visible "stuff" ➔ greater the solubility

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Isolate 1.00 g of NaCl From 2 M Solution

Calculate volume needed (See calculation slide)
Pour 2 M solution into evaporating dish
Cover with watch glass (limits spattering)
Remove water by heating with a Bunsen Burner
Weigh remaining solid

Watch Glass

Evaporating Dish
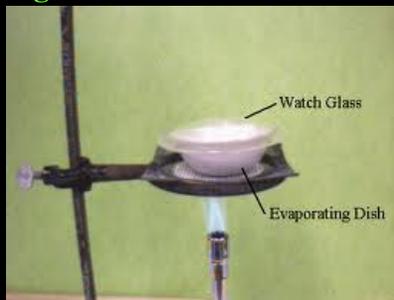
Hand On Set Up

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Volume of 2 M NaCl Solution Needed to Isolate 1.000 g NaCl

Determine Molecular Mass of NaCl
Na = 22.99
Cl = 35.45
58.44 g / mole

Dimensional analysis to solve for volume

1.000 g NaCl   x $\dfrac{1 \text{ mole NaCl}}{58.44 \text{ g}}$ x $\dfrac{1000 \text{ mL}}{2.000 \text{ mol}}$ = 8.560 mL

The M means Moles per Liter or Moles per 1000 mL

Whenever you see M (Molarity), think   moles / Liter or moles / 1000 mL

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Calculations

Mass of NaCl Solution:

Mass of evaporating dish , watch glass and NaCl Solution:
- Mass of evaporating dish and watch glass:
                                        Mass of liquid:

Mass of NaCl Isolated:

Mass of evaporating dish , watch glass and NaCl Solid:
- Mass of evaporating dish and watch glass:
                                        Mass of solid:

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Concentrations

% by Mass

% (by mass) = $\dfrac{\text{grams solute}}{\text{grams solution}}$ x 100

Molarity

Molarity (M) = $\dfrac{\text{moles solute}}{\text{Liters solution}}$

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Yields

% Yield = <u>Actual   (Obtained in Experiment)</u>   x 100
               Theoretical (Calculated Yield based on Stoichiometry)

% Error = <u>Actual Yield (g)   - Theoretical Yield (g)</u>   x   100
                              Theoretical Yield (g)

% Error should be small and negative

Conclusion

Describe the solubility of NaCl when the temperature changes
   Delete incorrect term
Compare the solubility change for KNO_3 to the NaCl

Describe % yield
Describe % error

Let's Boldly Go Explore Today's Lab

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