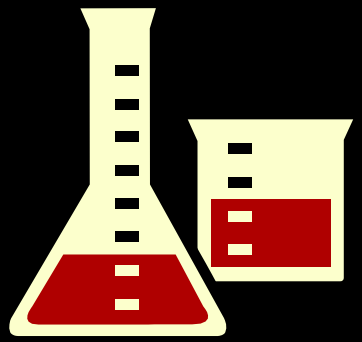
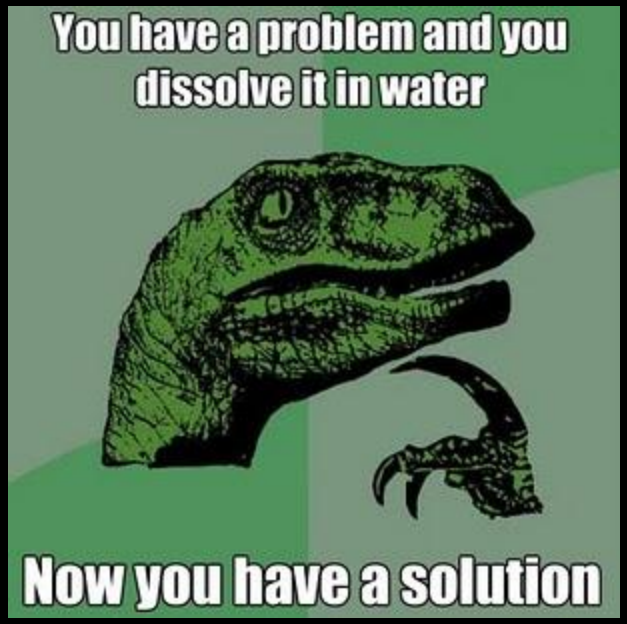
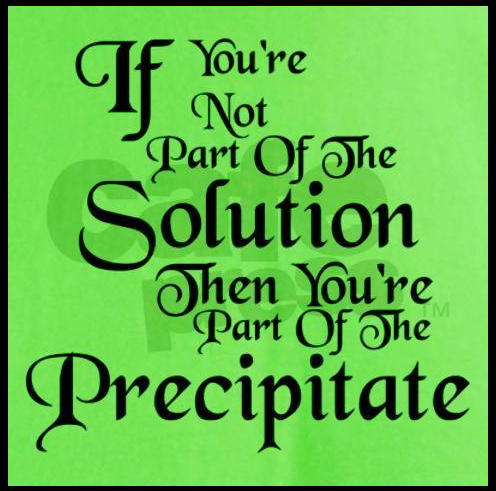
Solutions







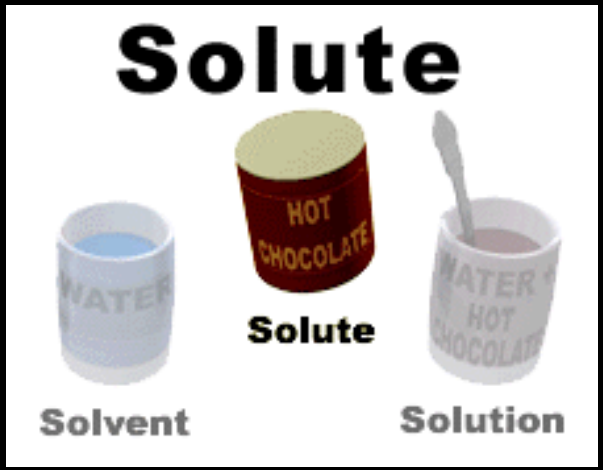
Terms

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



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)

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

Solubility Curve

Solubility

Supersaturated

Saturated

Unsaturated

Temperature

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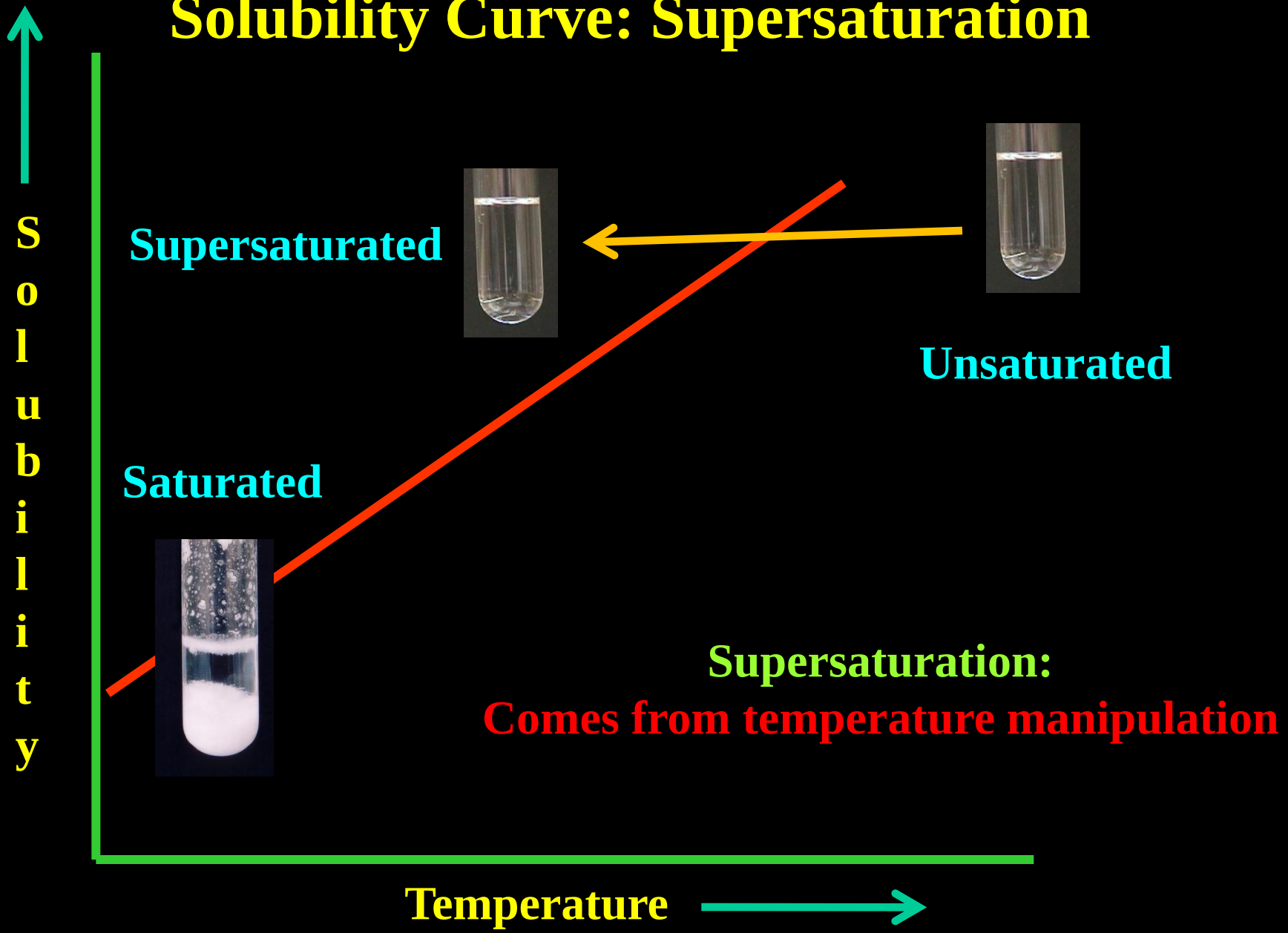
Solubility Curve: Supersaturation



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Solubility Curve:
Adding More Than Saturated

Solubility

Saturated

Adding more than saturated:
Will not dissolve higher than saturated

Temperature

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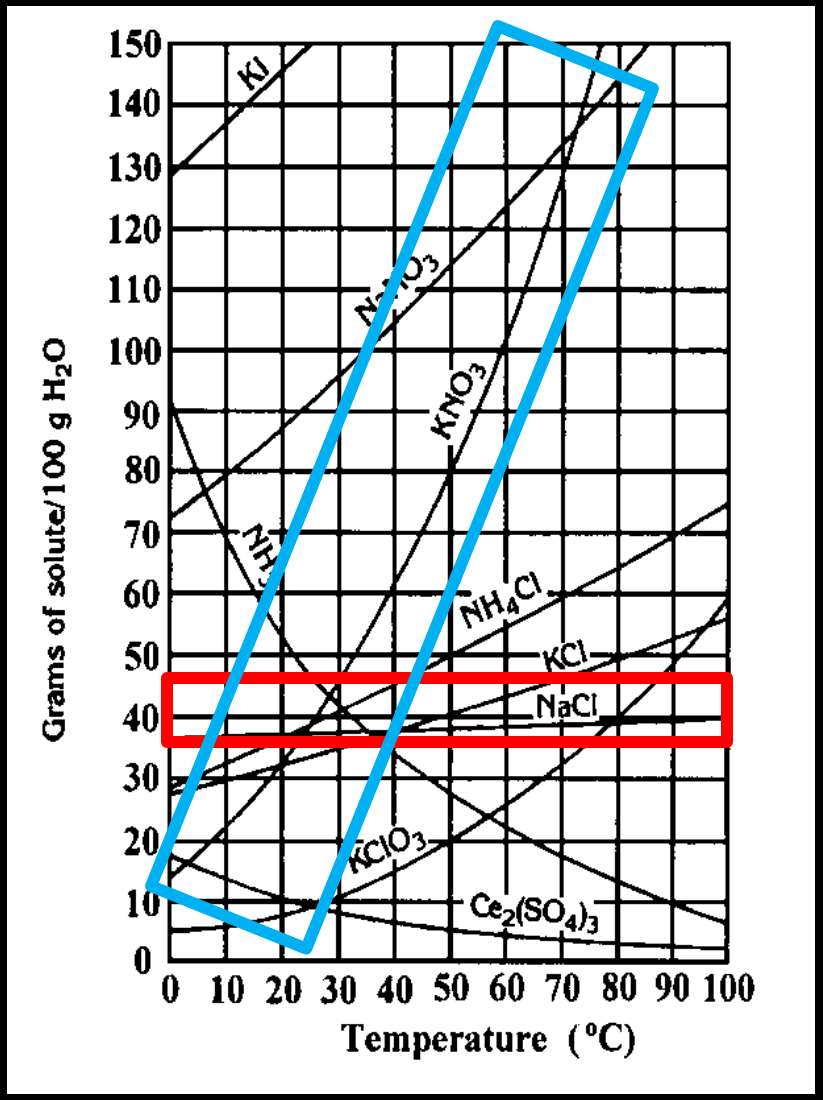
Solubility Curves



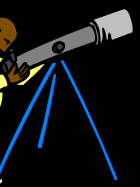
Plot of
Solubility vs. Temperature

For each compound (line):

Saturated
On the solubility line

Unsaturated
Below the line

Supersaturated
Above the line



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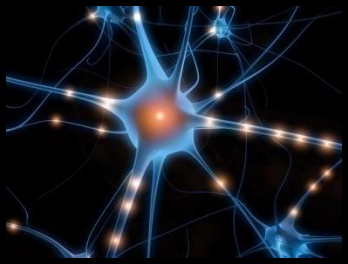
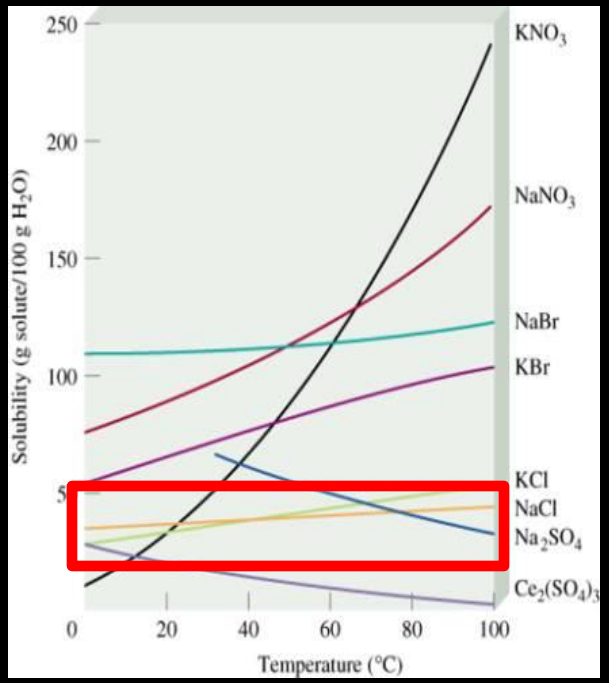
Solubility Curves





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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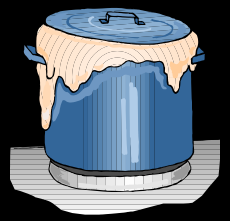
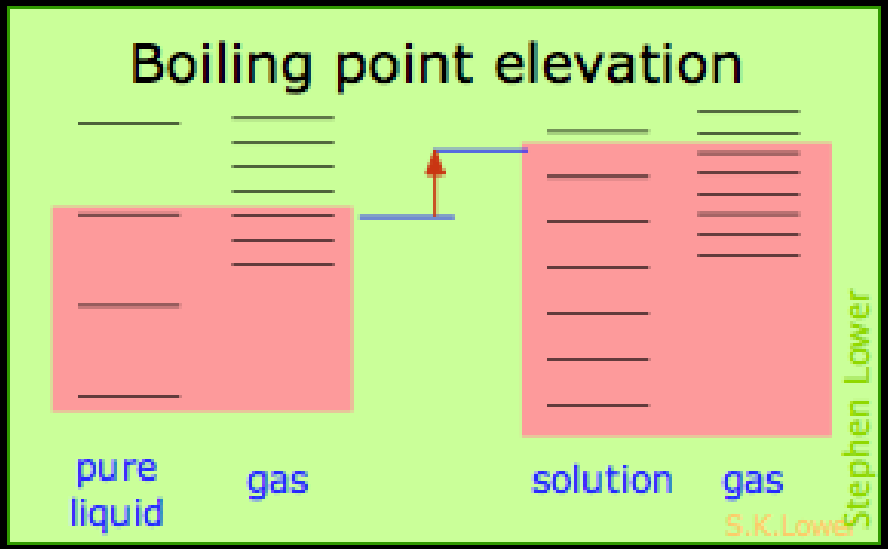
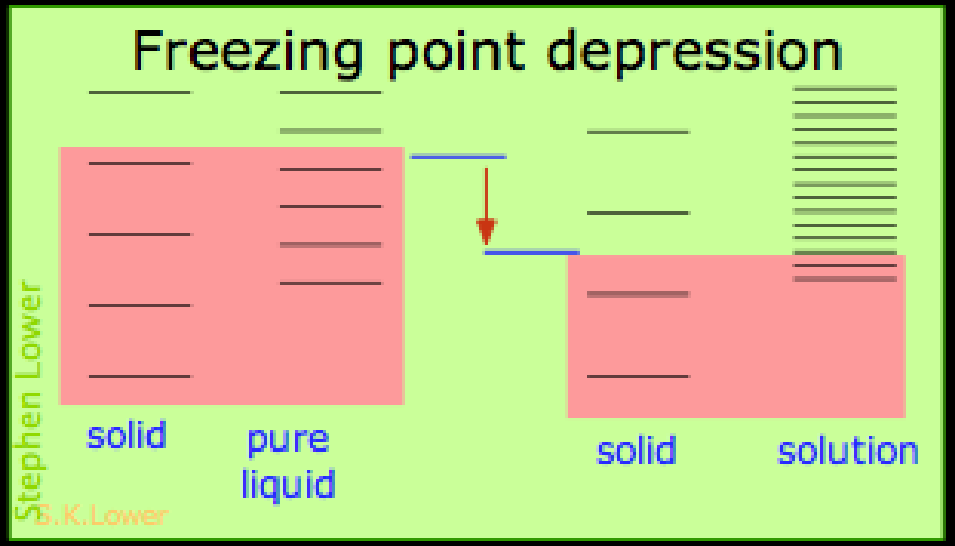


Solutions Alter Physical Properties
Dependent on Concentration of Solute

$\Delta T = K_b\ m$



$\Delta T = K_f\ m$



Adding salt to water:
- **Raises Boiling Point**
- **Raises Cooking Temperature**

(but not enough to be significant)

Adding salt to water:
- **Lowers Freezing Point**
- **Keeps water on sidewalks liquid**

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WATER ON MARS

It has been found

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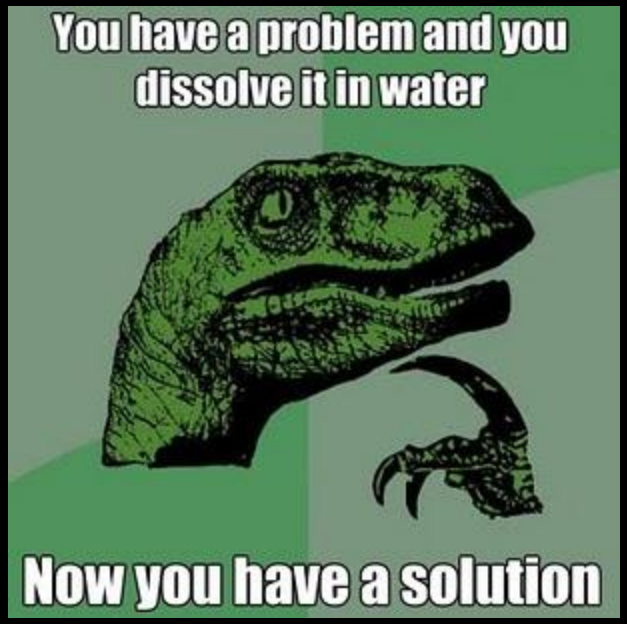
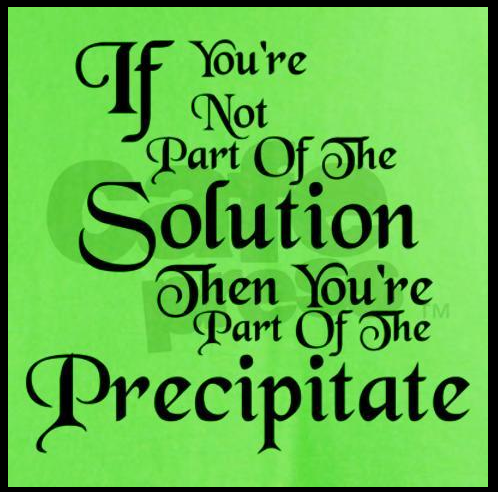
Solutions Lab





Online Lab

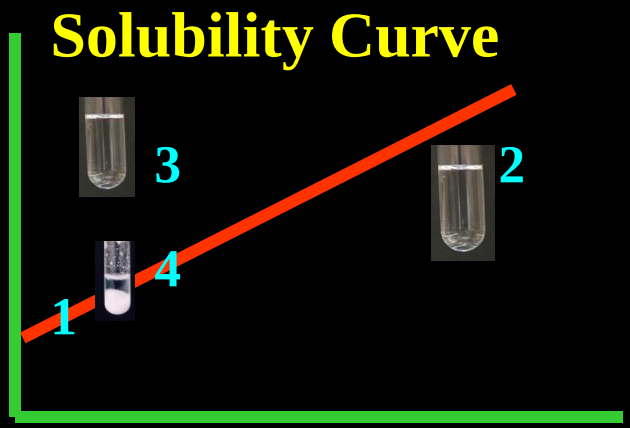
Purpose

Observe the solubility- temperature relationship

Isolate 1.00 gram of NaCl by evaporation

Procedure

Instructor Demo of sodium acetate super-saturation



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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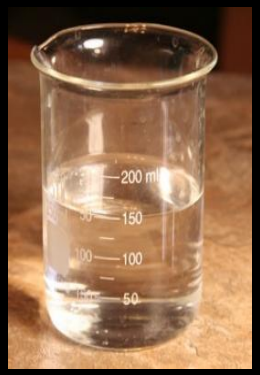
Sodium Acetate Demo Photos

Ambient

White Solid
Clear Liquid

~ 100 °C

No Solid
Clear Liquid



After Cooling

No Solid
Clear Liquid

After Seeding

White Solid
Clear Liquid

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Solubility of $NaCl$ & KNO_3

NaCl

Ambient

~ 100 °C

After Cooling

KNO_3

Ambient

~ 100 °C

After Cooling

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

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

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

$$1.000\ g\ NaCl \times \frac{1\ mole\ NaCl}{58.44\ g} \times \frac{1000\ mL}{2.000\ mol} = 8.560\ mL$$

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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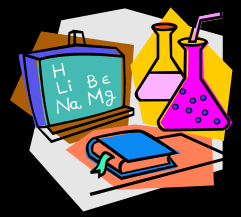
Concentrations

% by Mass

$$\%\ (\text{by mass}) = \frac{\text{grams solute}}{\text{grams solution}} \times 100$$

Molarity

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

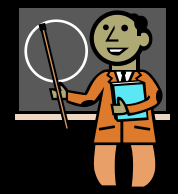


Yields

$$\% \text{ Yield} = \frac{\text{Actual (Obtained in Experiment)}}{\text{Theoretical (Calculated Yield based on Stoichiometry)}} \times 100$$

$$\% \text{ Error} = \frac{\text{Actual Yield (g)} - \text{Theoretical Yield (g)}}{\text{Theoretical Yield (g)}} \times 100$$

% 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

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Let’s Boldly Go Explore Today’s Lab

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