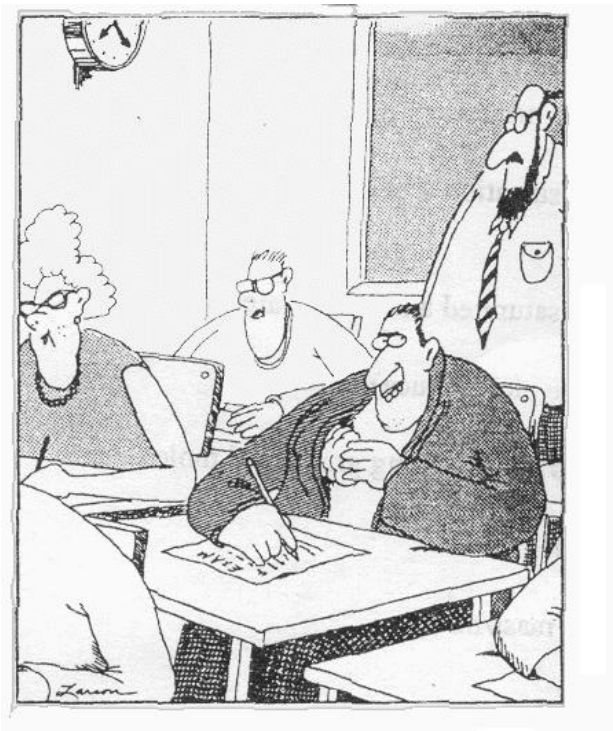
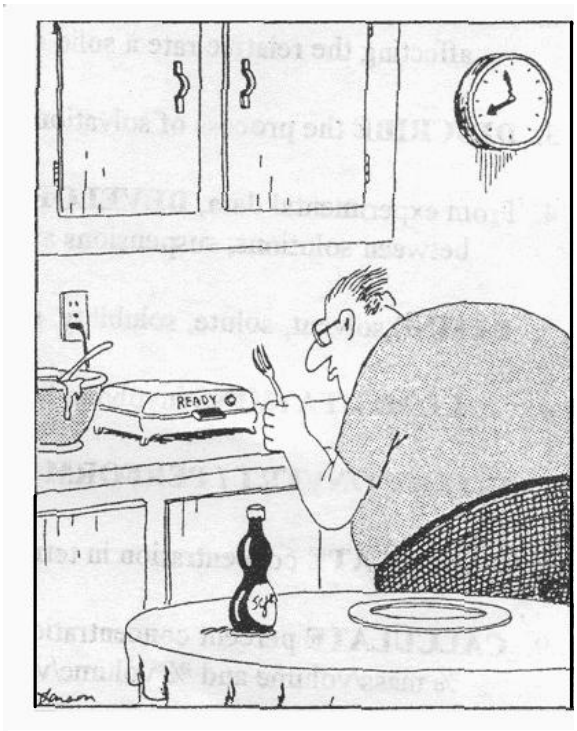
CONCENTRATE

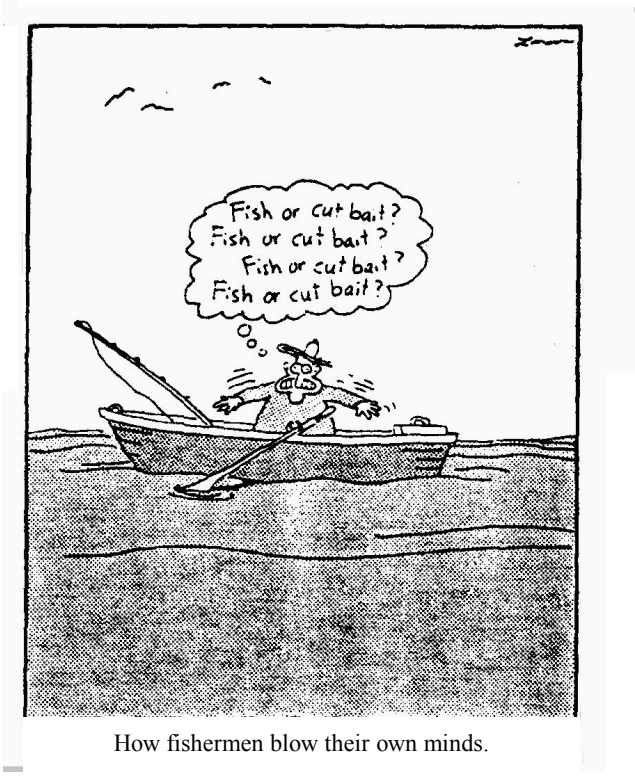
ON THIS



Midway through the exam, Allen pulls out a bigger brain.



Wendall Zurkowitz: Slave to the waffle light.



How fishermen blow their own minds.

"Mr. Osborne, May I be excused? My brain is full."

STUDENT NUMBER: _____ HOUR: _____

Unit Objectives:

1. **APPLY** the Kinetic Theory of Matter in the differentiation between solids, liquids and gases. **DESCRIBE** what happens on a particle level at the melting point and the boiling point of a substance.

2. Using the heating curve of water, **LABEL** the melting point, the boiling point, the heat of fusion, the heat of vaporization.

3. **DESIGN, CONDUCT,** and **EVALUATE** experiments that investigate factors affecting the relative rate a solid dissolves in a solvent.

4. **DESCRIBE** the process of solvation in the dissolving process.

5. **MAKE INFERENCES** about the heat of solution and solubility of substances.

6. **DEFINE** solvent, solute, solubility, saturated, super-saturated and unsaturated.

7. **QUANTIFY /CALCULATE** the effects of concentration on the colligative properties (e.g., boiling points, freezing points, vapor pressure) of solutions. **GRAPH** the results.

8. Perform **COMPUTATIONS** involving factor analysis (the picket fence).

9. **INTER-CONVERT / PERFORM CALCULATIONS** involving grams and moles.

10. In a complete sentence, **EXPLAIN** what is meant by the term concentration, as applied to a solution.

11. **CALCULATE** concentration in terms of molarity (M).

12. **CALCULATE** percent concentration in terms of % mass/mass, % mass/volume and % volume/volume

13. **CALCULATE** concentration in terms of parts per million (PPM, mg/Kg).

14. Accurately **MAKE** a solution of a specified concentration.

15. **USE** analytical techniques to determine the concentration of solutions.

16. **EXPLAIN** the concept of dilution and **INFER** implications for environmental pollution.

17. Using the dilution formula, **CALCULATE** the missing number to make a dilution of a stock solution and **DESCRIBE** how to actually make the specified diluted solution.

Density, Temperature and the Kinetic Theory

The story so far.....

1. All matter is made up of small particles in motion.
2. Mass measures the amount of matter in something.
3. Density measures the amount of mass is in a specific volume (e.g. cm^3).
4. Therefore, density is an indirect measurement of how many particles are in a given volume.
5. Temperature measures the average kinetic energy (related to the speed) of the particles moving in something.

Now for the lab part.....

1. Thoroughly dry the 25 mL graduated cylinder and **accurately** mass it.
   Record its mass here: _____ g

2. Fill the graduated cylinder with 25.0 mL of cold water. Use a beral pipette to do this **accurately**.
   Do not have any excess water on the outside of the cylinder. Record the temperature of this water: ____°C. Accurately mass the cylinder with the water and calculate the density of the water. Show the setup for your density calculation here:

3. From the data table supplied, what should the density of this water be?
   Calculate your percent error. . **Show the setup for your percent error calculation here:**

4. Fill the graduated cylinder with 25.0 mL of hot water. Use a beral pipette to do this accurately.
   Do not have any excess water on the outside of the cylinder. Record the temperature of this water: ___°C. Accurately mass the cylinder with the water and calculate the density of the water. Show the setup for your density calculation here:

5. From the data table supplied, what should the density of this water be?
   Calculate your percent error. **Show the setup for your percent error calculation here:**

Now for the mind part.....

1. As temperature increases, what happens to the density of water?

2. As the temperature of the water increases, what happens to the speed of individual water particles?

3. As the temperature of the water increases, what happens to the number of water particles in a mL (cm^3)?

4. Make a general statement that relates the number of particles in a given volume to their relative speed. Make an analogy to a stomp with a slow dance and a fast dance and the number of dance partners that can fit in a defined area.

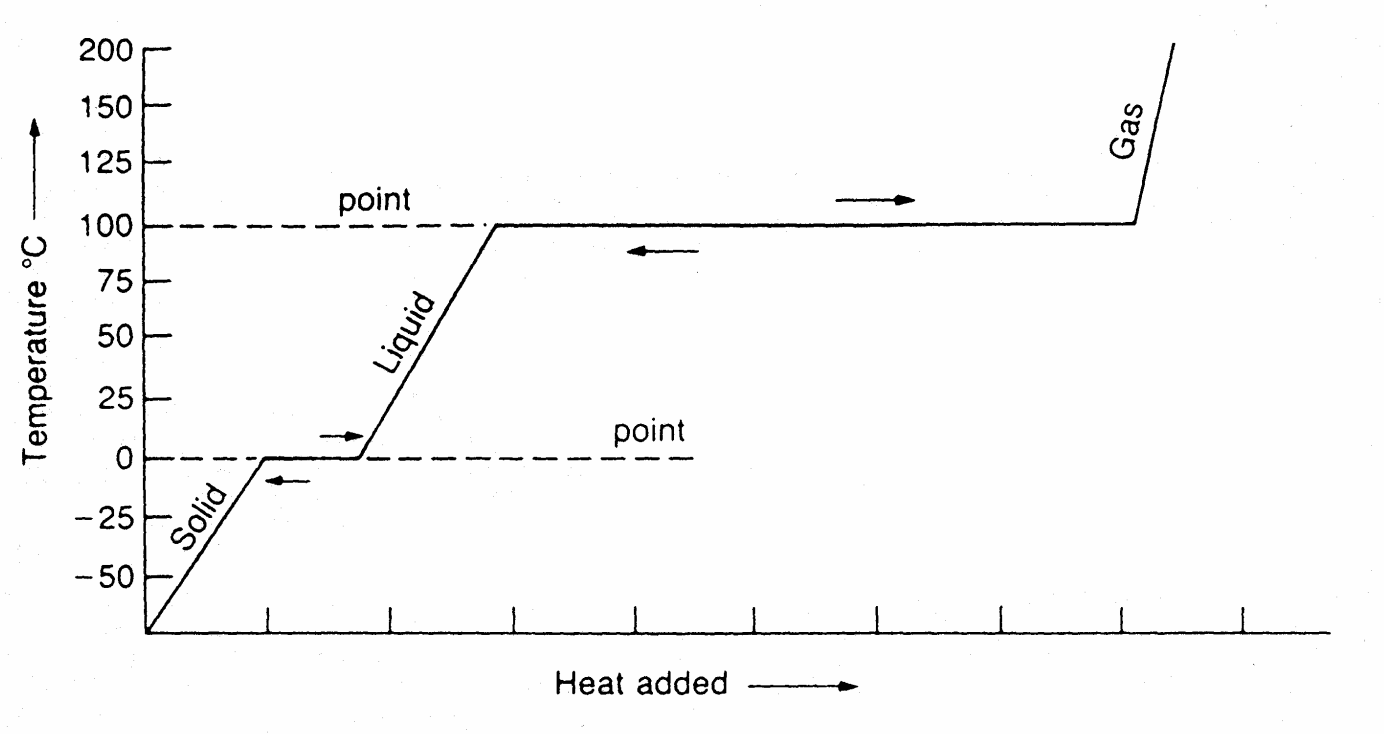
5. Based on your results, complete the table below that **generalizes** the states of matter. Fill in the relative number of particles/mL, density, and temperature categories with the words "low", "medium" and "high". Fill in the space between particles category with "widely spaced", "medium spaces", or "closely spaced". Fill in the speed category with "slow", "medium" and "fast".

	Gas	Liquid	Solid
Relative number of particles/mL			
Relative space between particles			
Relative density			
Relative speed of particles			
Relative Temperature			

6. Summarize the properties of a gas, a liquid, and a solid.

<u>GAS</u> <u>LIQUID</u> <u>SOLID</u>

TITLE: Heating Curve for Water:



1. Describe what happens on a particle level as a substance changes from a liquid to a gas?

2. Why does the temperature of boiling water remain a 100°C (at sea level) until all of the water has been changed to steam? Remember, temperature measures the **average** kinetic energy of all the particles present.

Factors Controlling the Rate of *Dissolution*

Problem: To devise and conduct experiments that demonstrate how the rate of dissolution can be changed.

Instructions:
Construct an experimental design box to test the effect each of the factors listed below has on how fast something dissolves (rate of dissolution). In each experiment, the dependent variable will be the time it takes a substance to dissolve. Also, **make a numbered list** of the procedures you will use to conduct the experiment. After performing the experiment, **record your results** and make a conclusion.

Part I. Particle Size
Using small equal masses of rock salt (NaCl) and table salt; develop and conduct an experiment that demonstrates the effect of particle size on the rate of dissolution.

Complete the experimental design box below:

Problem:	
Hypothesis:	
IV:	**Units: None**
DV:	**Units:**
Constants	

Procedures:

1.

2.

3.

4.

5.

Results:

Conclusion:

Part II. Agitation/Shaking

Using one type of salt, develop and conduct an experiment that demonstrates the effects of agitation/shaking on the rate of dissolution.

Complete the experimental design box below:

Problem:	
Hypothesis:	
IV :	**Units: None**
DV:	**Units:**
Constants	

Procedures:

1.

2.

3.

4.

5.

Results:

Conclusion:

Part III. Temperature

Using table salt, develop and conduct an experiment that demonstrates the effects of temperature on the rate of dissolution.

Complete the experimental design box below:

Problem:	
Hypothesis:	
IV :	**Units: None**
DV:	**Units:**
Constants	

Procedures:

1.

2.

3.

4.

5.

Results:

Conclusion:

Solutions

Substances _____ in water are aqueous solutions.

Nature of solutions

1. _____ and stable.
2. Both _____ and _____ particles pass through _____ paper and do _____ settle with time.
3. Solvents and solutes may be gases, liquids or solids.
4. Substances that _____ most readily in water are _____ compounds and _____ covalent molecules forming ionic solutions.
5. _____ covalent molecules do not dissolve in water.

The Golden Rule of Solutions: **Like Dissolves Like!!**

Miscible - When _____ liquids can _____ in each other.
Immiscible - When two _____ can't _____ in each other.

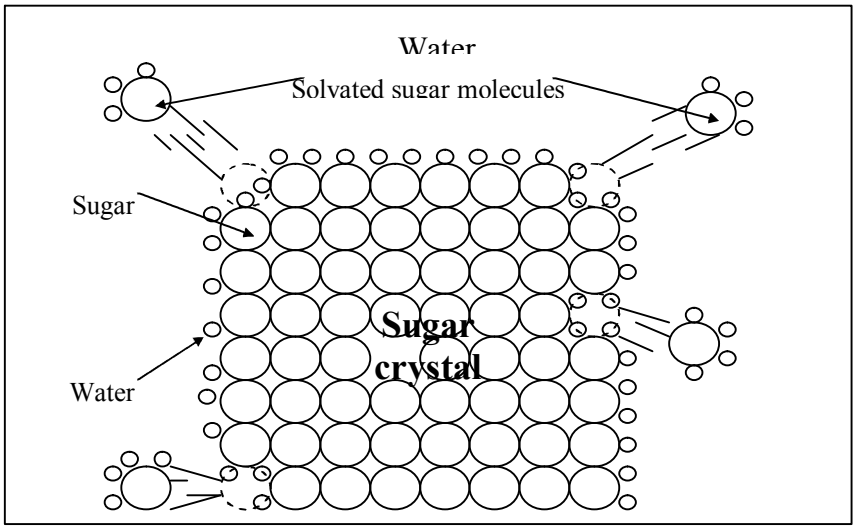
The Process of Dissolving (Solvation)

Components

1. _____ - the _____ medium, frequently water.
2. _____ - the _____ particles.

The Mechanisms

1. The process of dissolving is _____. The process is based on the _____ energy of matter.
2. Solute particles are _____



from the solid, because of the _____ of the solute and solvent particles. This action _____ energy.

3. _____ particles are moved _____ to allow solute particles to enter the _____ environment. This action takes up energy.

4. _____ particles are _____ to solvent particles. This _____ energy.

5. The first two steps are _____ processes and the third step is _____.

6. If the temperature of the solution _____ as the dissolving process occurs, the _____ process is greater than the two endothermic processes. (Negative heat of solution). The solubility of the substance _____ with rising temperature.

7. If the temperature of the solution _____ as the dissolving process occurs, the _____ processes are greater than the exothermic process (Positive heat of solution). The solubility of the substance _____ with rising temperature.

Table 13-3
HEATS OF SOLUTION
(Kcal mole solute in 200 moles H_2O)

Substance	Heat of solution
$AgNO_{2(s)}$	+5.44
$CO_{2(g)}$	-4.76
$CuSO_4$	-16.20
$HC_2H_3O_{2(l)}$	-0.38
$HCl_{(g)}$	-17.74
$HI_{(g)}$	-7.02
$KCl_{(s)}$	+4.20
$KClO_{3(s)}$	+10.04
$KI_{(s)}$	+5.11
$KNO_{3(s)}$	+8.52
$KOH_{(s)}$	-13.04
$LiCl_{(s)}$	-8.37
$Li_2CO_{3(s)}$	-3.06
$MgSO_4 \cdot 7H_2O_{(s)}$	+3.80
$NaCl_{(s)}$	+1.02
$NaNO_3(s)$	+5.03
$NaOH_{(s}$	-9.94
$Na_2SO_4 \cdot 10H_2O_{(s)}$	+18.76
$NH_{3(g)}$	-8.28
$NH_4Cl_{(s)}$	+3.88
$NH_4NO_{3(s)}$	+6.08

Applications:

1. If KClO3 were dissolved in water, would the temperature of the solution increase or decrease?

2. If NAOH is dissolved in water, how would you expect the temperature of the solution to change?

3. Name the three best substances on the chart to the right, which could be used to make athletic hot packs?

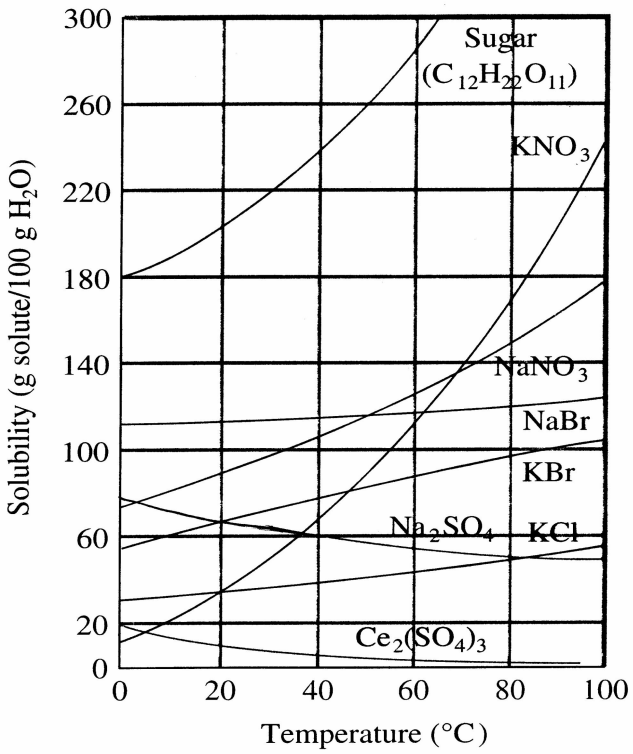
4. Name the best three best substances on the chart to the right, which could be used to make athletic cold packs?

Solubility of Solids

In General:

A. When an excess amount of _____ is added to a given _____ of solvent at a given _____, the dissolving _____ will take place until _____ more solute can dissolve in the solvent.

- the _____ of substance that_____ in a given quantity of _____ at a given temperature to produce a _____ solution.



B. Condition of _____ will be reached.

1. There is _____ net _____ in the overall system.

2. Particles of _____ move from the _____ to the _____ state and back to the solid state.

3. This _____<------> _____ process happens at the _____ rate producing a dynamic equilibrium.

C. Definitions

_____ solution-

holds the _____ amount of _____ for a given amount of _____ at a constant _____.

_____ solution-

holds _____ solute than a _____ solution.

_____ solution -

holds _____ solute than it _____ hold at a given _____. This is accomplished by _____ the temperature of a _____ solution, having the _____ solid dissolve and then letting the system slowly _____ undisturbed.

Solubility of Gases

A. The solubility of gases behaves _____ of solids.

B. _____ and _____ temperature decreases the solubility of a _____.

C. _____ law - at a given temperature the _____ of a gas in a liquid is _____ proportional to the _____ of the gas _____ the liquid.

Colligative Properties of Solutions

The _____ properties of a solution are _____ from those of the _____ solvent.

Colligative properties are _____ properties that depend on the _____ of _____ in a given mass of solvent.

- _____ point is _____, it is higher than the boiling point of the pure solvent.

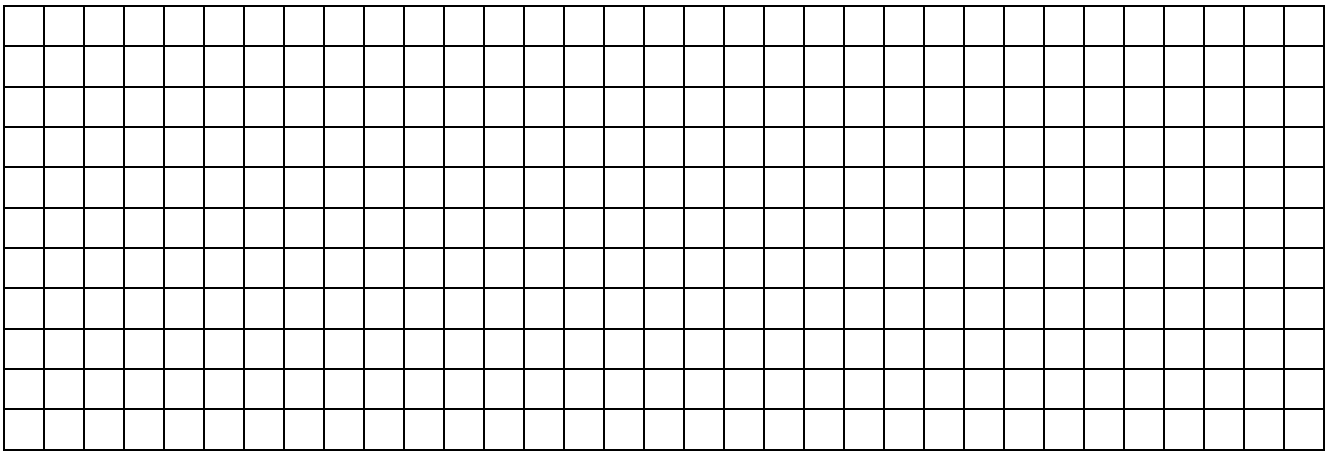
- Freezing point is _____, it is lower than the freezing point of the pure solvent.

The magnitude of the change is _____ proportional to the _____ of the solutes.

$$\Delta T = k\ m$$

A _____ that dissociates into _____ particles, like sodium chloride, has an even _____ effect on colligative properties.

TITLE: Heating Curve for Water with NaCl added:



How does this curve compare to the curve for pure water above?

User Friendly Units

PROBLEM: How many drops from a beral pipette are in one cup of water?

SOLUTION: Show all of your work for solving this problem.

Proportions are _____ between things, so at when one number changes the other changes as _____ of the first. It does not matter if proportions are flipped, for example, 3 tsp/1Tbsp says the _____ as 1 Tbsp/3tsp.

Units are the _____ that identify what a number is _____ about. For example, you are about 5.0×10^8 old. What?! Yes, you are about 5.0×10^8 seconds old.

PRACTICE WITH UNITS

Directions: Convert the following phrases to proportions.

1. There are 8 oz. in a cup.
2. My car goes 365 miles with 11 gallons of gas.
3. For 12 ears of sweet corn, I have to pay $1.32.
4. We hiked for 8 hours and only covered 15 miles.
5. Candy bars are on sale five for two dollars.
6. Rabbits can have up to 16 bunnies in three years.

Directions: For these questions what are the units in the answers?

1. How many cookies can be made from one bag of flour?
2. How many kernels of corn are in a bushel?
3. How many cups of milk are in a gallon?
4. How many songs are on a CD?
5. How many leaves are on a maple tree?
6. How many feet are in one kilometer?

The Picket Fence

When solving problems that use proportions, it is _____ to make sure that all units _____, except for those units in the answer.

The picket fence is a _____ used to make sure that the units cancel.

When a number is on the _____ of the picket fence, it means the number is used to _____ others numbers by it.

When a number is on the _____ of the picket fence, it means the number is sued to _____ other numbers by it.

STEPS FOR USING THE PICKET FENCE:

Step 1. Write out any _____ given in the problem and any others that may be of use.

Step 2. Identify what _____ are needed to satisfy what the problem is asking.

Step 3. Start the picket fence in the _____ hand corner by filling it in with the number and the units that **are not** part of any proportion and is given to you in the problem.

Step 4. Fill in the picket fence from left to right, making sure to _____ the units as you go along. Remember, only when the same units are on the top and bottom of a picket fence do they cancel each other.

EXAMPLE:

You have 23 marbles, which cost $1.79. How much do 567 marbles cost?

Step 1:

Step 2:

Step 3 & 4:

PROPORTIONS AND THE PICKET FENCE

Solve the following challenges using the picket fence format. Make sure to show <u>ALL</u> of your work and label and cancel <u>ALL</u> of the units!!

1. Katie can earn $9.00 for working two hours. How much would she earn for working 5.5 hours?

2. William can go 985 miles on 11 gallons of gasoline. How many gallons of gasoline will he burn on a trip of 595 miles?

3. Mr. Sanchez paid $345.00 taxes for his lot, which was valued at $65,000.00. At the same rate, what is the value of Mr. Gomez's lot who paid $468.75 in taxes?

4. An inch is 2.54 centimeters. How tall are you in centimeters?

5. A silk material for a dress costs $14.75 a square meter, how much material could you buy for $18.00?

6. You are a donut addict. Store 'A' offers donuts for $1.75 a dozen. How many donuts can you buy with $5.00

The warm and Fuzzy MOLE

Chemists have devised a means of keeping track of the amount of _____ involved in chemical reactions. This method uses the gram formula mass better known as the molar mass - _____ for short.

In each element box on the periodic table are two numbers - the molar mass of an element is the _____ of these two numbers. For example:

The molar mass of carbon is _____ grams/mole (rounded off)

What is the molar mass of each of the following elements? Be sure to include the units!

1. Co
2. Cr
3. Mn
4. copper
5. strontium
6. krypton

To find out what the mass of a molecule is (remember a molecule is more than one atom joined together), you must first count up the different _____ and _____ of atoms. For example.

$CuSO_4$ ---> __ copper atom + __ sulfur atom + __ oxygen atoms

Count up the number and types of atoms in the following molecules:

1. H_2--->

2. $AlCl_3$--->

3. $C_6H_{12}O_6$--->

4. $Ca(NO_3)_2$--->

Next, _____ the number of each type of atom by the molar mass of that element. For example:

$CuSO_4$---> (1 X ____ g/mole) + (1 X ___ g/mole) + (4 X ___ g/mole)

Calculate the molar mass, or gram formula mass (gfm), for each of the following molecules:

1. H_2--->

2. $AlCl_3$--->

3. $C_6H_{12}O_6$--->

4. $Ca(NO_3)_2$--->

You now know how to construct a _____ for the molar mass of a substance:

$$\text{Molar Mass} = \frac{\text{grams}}{\text{mole}}$$

We can use this proportion with the _____ to calculate the number of moles or the number of grams in a quantity of a substance. For example:

1. How many moles are in 26 g of H_2?

Solution:

$$1 \text{ Molar mass of } H_2 = \frac{2 \text{ grams}}{\text{mole}}$$

$$\frac{26 \text{ g}}{} \Big| \frac{\text{mole}}{2 \text{ g}} = \_\_\_\_ \text{ moles of H2}$$

2. How many grams are in 2.1 moles of $AlCl_3$?

Solution:

$$1 \text{ Molar mass of } AlCl_3 = \frac{133.5 \text{ grams}}{\text{mole}}$$

$$\frac{2.1 \text{ moles}}{} \Big| \frac{\_\_\_\_\_ \text{ g}}{\text{mole}} = 280.4 \text{ g of } AlCl_3$$

3. How many moles are in 107 grams of $C_6H_{12}O_6$?

4. How many grams are in 8.3 moles of $Ca(NO_3)_2$?

5. How many moles are in 127 grams of PCl_3?

6. How many grams are in 1.89 moles of Hg_2O?

How Concentrated Is It?

Concentration - the amount of _____ dissolved in a given quantity of solvent at a given temperature.

There are two main methods of stating concentration:

A. Qualitative - based on judgment, described with words
   1. Dilute - the solution contains a relatively _____ amount of solute.
   2. Concentrated - the solution contains a _____ amount of solute.

B. Quantitative - involves quantities, described with _____

   1. Molarity (M)
   2. Percent concentration (%)
   3. Parts per million (ppm)

I. Molarity

Molarity - the number of _____ of a solute dissolved in one liter (L) of solution, not solvent.

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

Example: Enough water is added to 2 moles of glucose to make 5 L of solution, what is it's molarity?

$$\frac{\text{2 moles of glucose}}{\text{5 L of \_\_\_\_\_}} = \_\_\_\_\_ \text{ moles/L (M)}$$

1. What is the concentration (M) of a 2.5 L solution containing 1.3 moles of ethylene glycol (anti-freeze)?

2. What is the molarity of 800 mL of a solution containing 0.25 moles of salt?

Because molarity is a _____, it can be used in the picket fence to solve more complex problems. Review the steps for using the picket fence!
For example:

1. A salt solution contains 0.90 g of NaCl per 100 mL of solution.
   What is its molarity?

Solution:

Step 1: proportions given and needed

$$\frac{\text{0.90 g NaCl}}{\_\_\_\_\_} \text{ (given in problem)} \qquad \frac{\text{1000 mL}}{\text{L}} \qquad \frac{\text{58.5 g NaCl}}{\_\_\_\_\_}$$

Step 2: The answer needs the units expressed in $\frac{\text{moles}}{\text{L}}$ (___)

Step 3 & 4: Because only a proportion is given in the problem, start the picket fence with it.

$$\frac{\text{0.90 g NaCl}}{\text{100 \_\_\_\_}} \Big| \frac{\text{1000 \_\_\_\_}}{\text{\_\_\_}} \Big| \frac{\text{mole}}{\text{58.5 g NaCl}} = \text{0.15 moles (M)}$$

2. An aqueous solution has a volume of 1.8 L and contains 46.0 grams of glucose. If the gram formula mass of glucose is 180 grams / mole, what is the molarity of the solution?

3. 800 mL of a solution contain 32.4 g of $NaC_2H_3O_2$. What is its molarity?

4. How many grams of LiOH are needed to make 25 mL of a .125 M solution?

Solution:

Step 1: proportions given and needed

$\frac{0.125 \text{ moles}}{\text{L}}$ (given in problem) $\frac{24 \text{ g LiOH}}{\text{mole}}$ $\frac{1000 \text{ mL}}{\text{L}}$

Step 2: the units for the answer are _____

Step 3 & 4:

$$\frac{25 \text{ mL}}{} \Big| \frac{\_\_\_\_}{1000 \text{ mL}} \Big| \frac{0.125 \text{ moles}}{\_\_\_\_} \Big| \frac{24 \text{ g LiOH}}{\text{mole}} = 0.075 \text{ grams}$$

5. How many grams of $CaCO_3$ are needed to make 4.5 L of a 2.1 molar solution?

6. How many grams of H_2SO_4 are needed to make 500 mL of a 3 M solution?

How Many Moles Spell Pain Relief?

DATA TABLE:

Brand Name _____

Mass of Aspirin Tablet _____ grams

Molarity of NaOH _____ moles/liter

Volume of NaOH Required to Neutralize All Acid Material:

Final buret reading _____ mL

Beginning buret reading _____ mL

Volume of NaOH used _____ mL

Assuming that the only acid present is acetylsalicylic acid, calculate the number of moles and grams present in the aspirin tablet.

1. Use the following formula to find the molarity:

Volume of Base X Molarity of Base = Volume of Acid X Molarity of Acid

2. Use a picket fence to find the number of milligrams of aspirin in the tablet:
(the molar mass of acetylsalicylic acid is 180 grams/mole)

_____mL_| _____L___|_____|_____|_____ = _____ mg
| | | |

3. Find the % aspirin in the tablet:

4. If the label on the bottle says each tablet contains 325 mg of aspirin. What is the percent error in your laboratory analyses.

Now For Some Hands-On

Problem: To make a 100 mL of a _____M $CuSO_4 \cdot 5H_2O$ and water solution.
Solution:

1. Graph the % transmittance vs. molarity of the standard $CuSO_4 \cdot 5H_2O$ solutions on the supplied graph. **Make sure to accurately label the axis of your graph!**
2. Show your calculations of how many grams of $CuSO_4 \cdot 5H_2O$ are needed to make 100 mL of your solution.

____mL__|_____|_____|_____ = _____ g
| | |

3. Write the procedures you would use to mix up the solution.

4. **Accurately** make 100 mL of your assigned solution.
5. **Filter** the solution to remove any cloudiness.
6. **Predict** what % transmittance your solution should have based on a reading from your graph. The predicted value is _____% transmittance
7. **Record** the actual % transmittance of your solution _____ %
8. **Calculate** the % error between your prediction and the actual reading.

Title:

Conclusions:

1. Did a chemical reaction occur when you mixed the copper sulfate in the water? How do you know?

2. Why does the mixture need to be filtered? Use the words suspension and solution in your answer.

II. Percent Concentration

_____ concentrations can be used in the following ways:

A. % mass / mass (% m/m) - is the number of grams of solute per gram of _____, expressed as a percent.

$$\frac{\text{grams of solute}}{\text{grams of \_\_\_\_\_}} \times 100 = \text{\% m/m concentration}$$

B. % mass / volume (% m/v) - is the number of _____ of solute per milliliter of solution, expressed as a percent.

$$\frac{\text{grams of solute}}{\text{\_\_\_\_\_ of solution}} \times 100 = \text{\% m/v concentration}$$

C. % volume / volume (% _____) - is the number of milliliters of solute per milliliter of solution, expressed as a percent.

$$\frac{\text{mL of solute}}{\text{mL of solution}} \times \text{\_\_\_\_\_} = \text{\% v/v concentration}$$

Useful conversions for WATER only!

1 g = 1 mL = 1 cm^3 = 0.001 Kg = 0.0001 L 1 L = 1 Kg = 1,000 g = 1,000 mL

Examples:

1. Calculate the percent concentration (m/m) of a solution of 25 g $CuSO_4$ in 975 mL of water (Remember to add the masses together to find the total mass of the solution).

2. Calculate the percent concentration (m/m) of a solution of 2.5 g $CuSO_4$ in 247.5 mL of water (remember to add the masses together to find the total mass of the solution).

3. Calculate the percent concentration (m/v) of a solution 48 g NaCl to make 250 mL of a NaCl/water solution.

4. Calculate the percent concentration (m/v) of a solution of 56 g NaCl to make 2 L of a NaCl/water solution.

5. Calculate the percent concentration (v/v) of a solution of 1.5 mL ethanol in 550 mL of an ethanol/water solution.

6. Calculate the percent concentration (v/v) of a solution of 32 mL ethanol in 0.75 L of an ethanol/water solution.

III. Parts Per Million (ppm, mg/Kg)

Parts per million is a concentration expression that relates _____ of solute to kilograms of solution (mg/Kg)

$$\frac{\text{mg of solute}}{\text{of solution}} = \text{ppm (mg/Kg)}$$

Useful Conversions

1g = 1,000 mg; 0.0001g = 1mg; 1Kg = 1,000g = 1,000,000mg

Examples:

1. Calculate the concentration of a solution in ppm when 33.4 mg of naphthalene are mixed with benzene to make 1.5 Kg of solution.

2. Calculate the concentration of a solution in ppm when 145 mg of naphthalene are mixed with benzene to make 550 g of solution.

3. Calculate the concentration of a solution in ppm when 2.3 g of naphthalene are mixed with benzene to make 2,550 g of solution.

Dilutions

A useful laboratory technique is to make concentrated solutions and then _____ them with water to make less concentrated solutions that you need. The more concentrated solution is called a _____ solution.

To make a solution by dilution, you use the following equation:

$$\text{Volume}_{\text{concen.}} \times \text{Concentration}_{\text{concen.}} = \text{Volume}_{\text{dilute}} \times \text{Concentration}_{\text{dilute}}$$

Example:

What volume of 1.5 M sodium nitrate solution would you use to make 200 mL of a .5 M solution?

$$\text{Volume}_{\text{concen.}} \times 1.5\text{ M} = 200\text{ mL} \times .5\text{ M}$$

$$\text{Volume}_{\text{concen.}} = \frac{200\text{ mL} \times .5\text{ M}}{1.5\text{ M}}$$

$$\text{Volume}_{\text{concen.}} = 66.6\text{ mL}$$

1. What volume of water should be added to 10.19 mL of an 8.0 M acetic acid solution in order to obtain a final solution that is 1.50 M?

2. What volume of a 8.75 M formic acid solution should be used to prepare 2.0 L of a .15 M formic acid solution?

3. What is the molarity of a solution of ammonium chloride prepared by diluting 50.0 mL of a 5.70 M ammonium chloride solution to 2.0 L?

Is dilution the Solution for Pollution?

Introduction:
Copper chloride is a byproduct from such industrial processes such as copper smelting. Copper chloride is toxic to human health and must be treated before being released into the environment. Is dilution a solution?

	Color of Solution		
Microwell	After Water Dilution	After Ammonia is Added	Concentration
1			50,000 ppm
2			
3			
4			
5			

The Aluminum Clean-up

Appearance	Copper Chloride Solution	Aluminum Foil
Before Reaction		
After Reaction		

Record any observations you made:

DILUTION OF COPPER WASTE

Prepare a dilution of the copper waste

SPECTOPHOTOMETER READING _____

1. What would lead you to believe a chemical reaction occurred when you added ammonia to the copper solution?

2. What is the lowest concentration of a copper solution that can be visually detected with the ammonia test? Was a blue color visible in that concentration before adding the ammonia? How could this test be useful in finding harmful levels of copper in water in the environment?

3. How much water must be added to one liter of 50,000 ppm copper chloride waste solution to dilute it to 5 ppm?

4. What is the % (m/m) in a 50,000 ppm copper chloride solution. Show all of your work.

5. After adding the ammonia to the decanted liquid and comparing it to the previous diluted microwells, what is the concentration of copper in the liquid?

6. After decanting the liquid, describe the solid material. What do you think it is? Why?

7. Is the decanted liquid now safe for human consumption? Why or why not? Account for what happened to the aluminum foil as the copper deposited.

8. As an environmental engineer for Kennecott copper mine, you are in charge of disposing a 50,000 ppm $CuCl_2$ waste stream into a nearby creek. The EPA mandates only a 1 ppm waste stream can enter the creek. What will you do? Discuss dilution and/or treatment in your answer.

CONCENTRATE ON THIS SKILL PRACTICE

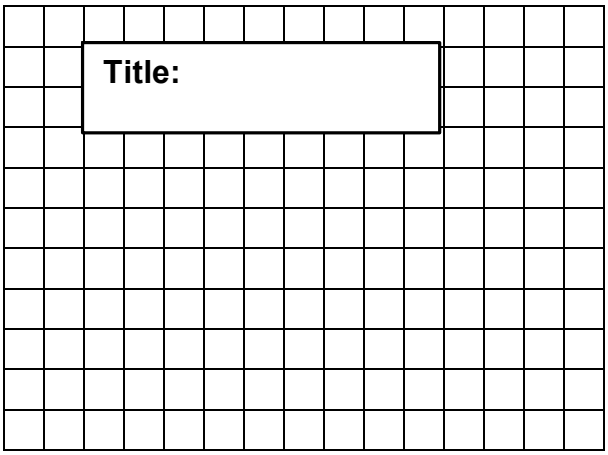
1. Using the concepts in the Kinetic Theory of matter and the following phrases to describe a solid, a liquid, and a gas. PHRASES: Relative density, Number of particles/mL, Relative space between particles, Relative speed of particles, Relative temperature

   A solid has...

   A liquid has ...

   A gas has .....

2. Draw in the space to the right a graph of a solid changing into a liquid. Label solid, liquid, melting point, freezing point and the axes of the graph



3. Why does each of the following factors speed up the rate of dissolution?
   Particle size...

   Agitation...

   Temperature...

4. Describe the mechanisms (steps) of dissolution, as a sugar cube dissolves in water.

Refer to the chart below to answer the following questions.

5. What substance in the table below would release the most heat when dissolving in water?

6. What substance would take in the most heat when dissolving in water?

7. If $NaNO_3$ is added to hot water rather than cold water would its solubility increase?

8. Because NaOH has a negative heat of solution, are the exothermic or the endothermic processes greater in the dissolving process?

9. What would happen to the solubility of KI as the temperature of water increased?

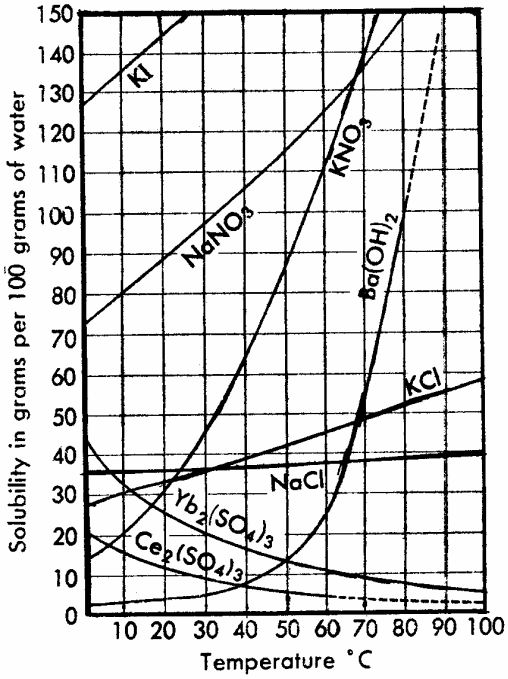
10. If H_2SO_4 is dissolved in water, what would the temperature of the solution do?

11. Given the equation: Heat + $KClO_{3\,(s)}$ -----→ $K^+_{(aq)}$ + $ClO_3^-{}_{(aq)}$ and the information in the chart, $KClO_3$ would be used to make _____ packs for atheletic injuries.

HEATS OF SOLUTION

(Kcal/mole solute in 200 moles H_2O)
[(s) = solid, (l) = liquid, (g) = gas at STP]

Substance	Heat of solution
$CuSO_4(s)$	-16.20
$CuSO_4 \cdot 5H_2O(s)$	+ 2.75
$H_2SO_4(l)$	-17.75
$KClO_3(s)$	+10.04
$KI(s)$	+ 5.11
$KOH(s)$	-13.04
$NaCl(s)$	+ 1.02
$NaNO_3(s)$	+ 5.03
$NaOH(s)$	- 9.94
$Na_2SO_4 \cdot 10H_2O(s)$	+18.76



Refer to the graph on the right to answer the following questions.

12. What substances' solubility is least affected by changes of temperature?
13. What substances show a decrease in solubility with increasing temperature?
14. What substances' solubility is most affected by changes of temperature?
15. What is the concentration of KCl at 50°C?
16. At what temperature does the solubility of KNO_3 begin to exceed that of KCl?
17. How many grams of $NaNO_3$ will dissolve in 400 grams of H_2O at 10°C?
18. As the temperature of a solution is decreased from 70°C to 20°C, what happens to the amount of KNO_3 that can dissolve in 100 grams of H_2O?
19. If 30 grams of KNO_3 is dissolved in 100 grams of water at 60°C would the solution be saturated, supersaturated or unsaturated?

20. As a pond warms its temperature during the summer what effect would this have on the amount of dissolved oxygen in the water?

Define the following:

21. Immiscible
22. Solvent
23. Solute
24. Solution
25. Saturated solution
26. Supersaturated solution
27. Unsaturated solution

The dissolution rate is a measure of how fast a substance dissolves in water or acid/water solutions (such as rainwater). Geologists study the dissolution rates of different minerals because the dissolution rate influences how minerals and rock weather (break down).

Experiment 1

The masses of 8 pieces of Mineral A, all of equal size and shape, were measured with a balance. Each piece was then placed in a separate beaker of a prepared hydrochloric acid solution of known pH (a measure of acidity with lower values corresponding with higher acidity) and stirred at a constant rate and temperature for a known time. After being removed from the beaker, each piece was rinsed, dried and re-measured. To determine how much of the piece dissolved. The dissolution rate for each piece was then calculated in milligrams per second (mg/sec). The results are in Table 1.

Table 1

Piece number	Initial pH of acid solution	Time in beaker (sec)	Dissolution rate (mg/sec)
1	3.5	600	0.31
2	3.5	1,200	0.30
3	3.5	1,800	0.31
4	3.5	2,400	0.29
5	2.0	600	0.72
6	3.0	600	0.37
7	4.0	600	0.18
8	5.0	600	0.10

Experiment 2
Four pieces of Mineral B were analyzed using the procedure from Experiment 1. The results are in Table 2.

Table 2

Piece Number	Initial pH of acid solution	Time in beaker (sec)	Dissolution rate (mg/sec)
1	2.0	600	0.60
2	3.0	600	0.31
3	4.0	600	0.15
4	5.0	600	0.07

Experiment 3
Using the same procedure as in Experiment 1, ten pieces of Mineral A were analyzed with rainwater samples (collected from various locations) instead of prepared acid solutions. The pH of rainwater varies from 3.5 to 5.5. It was determined that the lower the pH of the rainwater, the higher the dissolution rate.

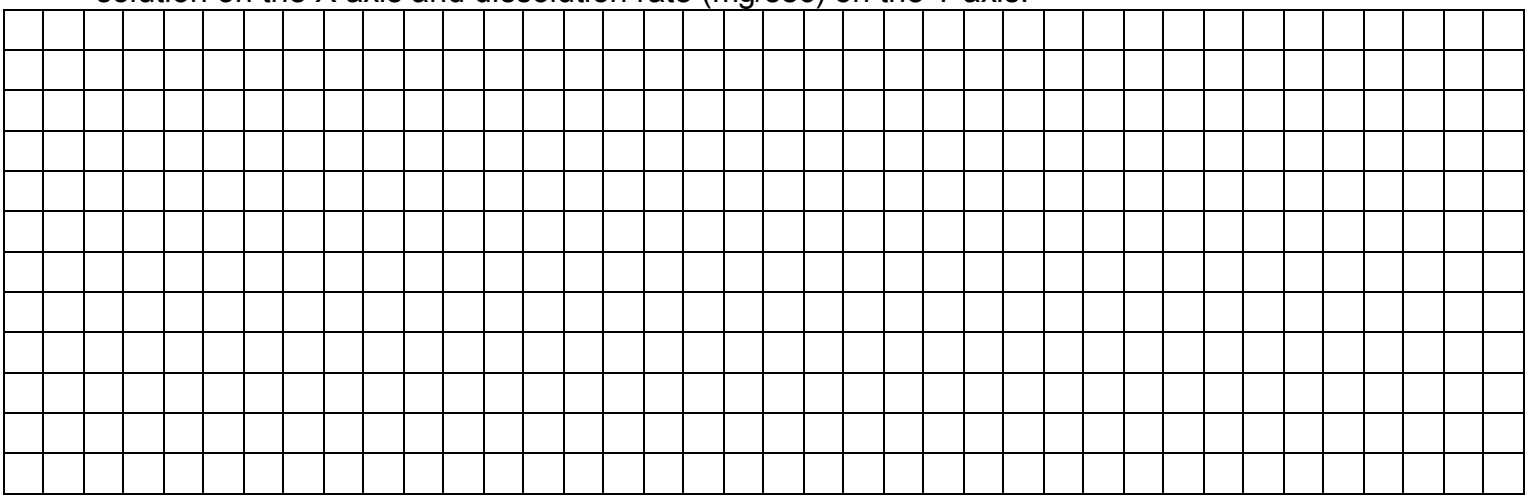
28. Which of the following factors was varied in Experiment 2?
    a. The length of time in the beaker of acid solution
    b. The initial pH of the acid solution
    c. The temperature of the acid solution
    d. The temperature of the rainwater

29. Which of the following explanations best describes why the mineral pieces were dried after being removed from the acid and rinsed?

a. So that all of the mineral pieces would have the same mass
b. To properly measure the mass of the liquid absorbed by each piece
c. To remove any liquid that might affect the measurement of the final mass of each piece
d. Because mineral pieces experience alternating wet and dry periods in nature

30. In which of the following ways, if any, did the experimental conditions for Pieces 1-4 differ from those for Pieces 5-8 in Experiment 1?
    a. The time in the beaker was varied for Pieces 1-4, while the initial pH was varied for Pieces 5-8.
    b. Rainwater was used for Pieces 1-4, while acid solutions were used for Pieces 5-8.
    c. Pieces 1-4 were composed of Mineral A, while Pieces 5-8 were composed of Mineral B.
    d. The experimental conditions were the same for Pieces 1-4 as they were for Pieces 5-8.

31. Use the following grid to graph the results of Experiment 2. Plot the initial pH of the acid solution on the X axis and dissolution rate (mg/sec) on the Y axis.



32. The results of Experiment 3 provide a better understanding of how minerals might dissolve in nature than do the results of the other experiments because:
    a. pieces of Mineral A were used instead of pieces of Mineral B
    b. 10 pieces of Mineral A were tested, rather than 8 pieces
    c. samples of rainwater, rather than prepared acid solutions, were tested
    d. lower pH resulted in greater dissolution rates than in the other experiments

33. The scientist repeated the part of Experiment 1 that involved Pieces 5-8, using a different mineral (Mineral C). At the end of the experiment, none of the mineral had dissolved. Based on what was learned from Experiment 1 and 3, the scientist would most likely conclude that Mineral C:
    a. has the same dissolution rate as Mineral B.
    b. has the same dissolution rate as Mineral A.
    c. would probably dissolve in rainwater.
    d. Would probably not dissolve in rainwater.

34. Solutions with pH less than 6 were mostly used in all of the experiments because:
    a. minerals dissolve too quickly in solutions with pH greater than 6.
    b. minerals won't dissolve in solutions with pH less than 6.
    c. rainwater samples have pH less than 6.
    d. rainwater samples have pH greater than 6.

Formula Masses: **Determine the formula weight for each of these compounds:**

35. NO_3
36. $MgCl_2$
37. NaCl
38. Al_2SO_3
39. Hg_2O
40. $Be(NO_3)_2$

Moles: **You are given 27.0 grams of each of the following substances. How many moles of each substance do you have?**

41. CaO
42. K2CrO4
43. $Na_2CO_3.10H_2O$
44. $Fe(NO_3)_3$

Give the number of grams in each quantity of substance.

45. 3 moles of boron
46. 5 moles of Hg_2O
47. 11.5 moles of oxygen
48. 7.28 moles of N_2O_4

Molarity **Calculate the molarity of each of the following solutions, which were prepared by dissolving the solute in enough water to achieve the final volume indicated**.

49. 15 g KCl in 2.50 L
50. 43 g $MgSO_4$ in 5.75 L
51. 5 g KBr in 0.5 L
52. .5 g NH_3 in 55.0 mL

Calculate the number of grams of solute needed to prepare each of the following solutions.

53. 2.50 L of 0.250 M $(NH_4)_2CO_3$
54. 725 mL of 2.50 M NH_4Cl
55. 37.5 mL of 0.685 M KI

Percent Concentrations

How would you prepare aqueous solutions of each of the following?

56. 168 mL of 14.0% isopropyl alcohol (by volume/volume)

57. 750 mL of 3.0% acetic acid (by volume/volume)

58. 30 g of 25% glucose (by mass/volume)

Parts per Million

Substance	Maximum contaminant level (PPM)	Substance	Maximum contaminant level (PPM)
Water Quality		**Air Quality**	
Arsenic	0.05	Ozone	0.12
Chromium	0.05	Carbon Monoxide	9
Lead	0.05	Nitrogen Dioxide	0.05
Mercury	0.002	Sulfur Dioxide	0.03
Nitrate	45.0	Hydrocarbons	0.24

59. A 25 Kg sample of water is tested for arsenic and is found to contain 5.1 mg of this toxic element. How many parts per million does this represent? Does this level fall within the allowable limits in the table above?

60. A car is tested for tail pipe emissions. A 8 Kg sample of exhaust was collected. The sample contained 8.5 grams of carbon monoxide and 298 mg of unburned hydrocarbons. How many parts per million of each substance was found in the exhaust. Did the car pass the emission standards test?

Dilutions

How would you prepare each of the following dilute solutions from the concentrated solution indicated?

61. 500 mL of 1 M HCL from 10 M HCL

62. 250 mL of 4.8 M HNO_3 from 15 M HNO_3

63. To what volume should 25 mL of an 2 M citric acid solution be diluted in order to obtain a final solution that is 1.5 M?

64. What volume of a 12 M hydrochloric acid solution should be used to prepare 2.6 L of a 2 M hydrochloric acid solution?

65. What is the molarity of a solution of sodium chloride prepared by diluting 750 mL of a 4 M sodium chloride solution to 1.3 L?