South High School

Chemistry Lab Manual

TABLE OF CONTENTS FOR LABORATORY EXPERIMENTS

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Format For Laboratory Reports

1. Some laboratory activities require a formal laboratory report. The laboratory report is the method by which the experimenter conveys the essence of an experiment to a reader.
2. Laboratory reports must be done on the computer and must be stapled BEFORE you get to class. The completed report is due the first day your class meets of the week after the activity was performed.
3. Keep the original lab in your lab section so you have it to study from for tests. Only submit the formal lab report.
4. Each lab report must have a cover sheet including the following information: Lab #, title of the experiment, date lab was performed, your name, your partner's name, and your teacher's name. Graphics and illustrations are encouraged.
5. The body of the laboratory report should include the following:
   - I. Purpose: State the problem being examined briefly in your own words.
   - II. Materials: State the instruments and chemicals used
   - III. Procedure: Give a brief description of the method followed. DO NOT copy the directions from the lab manual.
   - IV. Data and Observations: This is the most important section of the lab report. It includes both quantitative readings taken from burets, balances, etc., and qualitative visual observations, such as the appearance of solutions and precipitates. Whenever possible list data in a tubular format. Include units and be careful of significant figures.
   - V. Analysis of Data: You will usually need to work with data to get the information needed to solve the problem. State any formulas used and show all work. Be careful of significant figures and units. Graphs are very often used to make relationships apparent. They may be done using your computer or graph paper. They MUST have a title and remember to label your axis including unit. The x-axis is used for the independent variable and the y- axis is for the dependent variable. (Not all lab reports will have this section)
   - VI. Questions: Answer any questions stated in the lab handout. Do not copy the question; just rephrase the question in your answer.
   - VII. Summary and error analysis: In each experiment the final answer to the original problem should be stated specifically in 50-100 words. If you have a measured quantity for which there is an accepted value compare your result with known value and evaluate the accuracy by computing the percent error.

     Accepted value- experimental value/accepted x 100

     Also include the major sources of errors in the experiment. Describe how the error affected your result.

Introduction to Safety in the Laboratory

Do now:

1. Read all of the following directions before you do anything.
2. Print your name, last name first then your first name and middle initial (if you have one), at the top of this page.
3. Draw a line through the word "all" in direction 1.
4. Underline the word "directions" in direction 1.
5. In direction 2, circle the words "your first name."
6. In direction 3, place an "X" in front of the word "through."
7. Cross out the numbers of the even-numbered directions above.
8. In direction 7, cross out the word "about" and write the word "below" above it.
9. Write "Following directions is easy" under your name at the top of this page.
10. In direction 9, add the following sentence after the word "page." "That's what you think!"
11. Draw a square in the upper right-hand corner of this page.
12. Draw a triangle in the lower left-hand corner of this page.
13. Place a circle in the center of the square.
14. Place an "X" in the center of the triangle.
15. Now that you have read all the directions as instructed in direction 1, follow directions 2 and 16 only.
16. Please do not give away what this test is about by saying anything or doing anything to alert your classmates. If you have reached this direction, make believe you are still writing. See how many of your classmates really know how to follow directions.

LAB #1: Introduction to Safety in the Laboratory

I. Purpose: To become familiar with various safety precautions that are to be followed in the laboratory.

II. Materials: safety guidelines, ruler, and pen/pencil

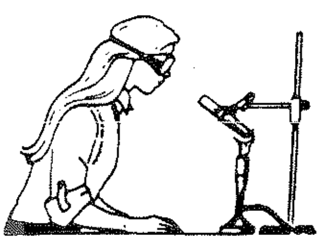
III: Procedure:

1. Read and review the safety the article entitled "Safety Procedures in the Laboratory". Upon completion of the article sign the safety declaration and hand it in with your formal lab write-up. Keep one in your lab notebook to refer back to throughout the year.
2. Draw a floor plan of the classroom and laboratory area. Include: teacher's lab table, student desks, lab tables, doors, sink, garbage, eye wash, fire extinguisher, fire blanket, and goggle cabinet
3. Describe when you should use each piece of safety equipment: eye wash, fire extinguisher, fire blanket and goggles.
4. Locate the fire alarm box outside your classroom. Describe the fire exit route.

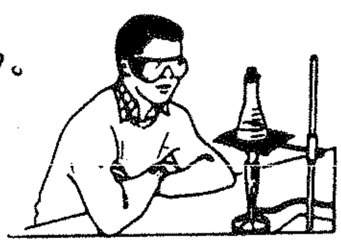
IV. Data and observations: Record your observations for each step above.

V. Questions:

1. Out of all the safety rules you learned in this lab choose three that you feel are the most important and why?
2. For each drawing below describe what the person is doing incorrectly. (Note: Some of the drawings illustrate more than one thing incorrect.



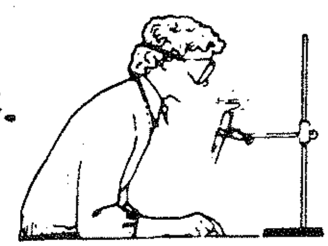
b.



c.

d.

e.



3. Explain the following statement: "You are only as safe as the least safe person in the laboratory"

VI: Summary: Include a discussion of safety rules and safety equipment. Why do you think this lab is important? Why do you think we do this lab first?

SAFETY PROCEDURES IN THE LABORATORY

The science laboratory provides a hands-on experience with equipment and chemicals which must be handled correctly and safely. Carefully read and study the rules below to insure your safety and that of your classmates. After these rules are discussed and explained by your teacher, please sign the statement and place these rules in your laboratory report folder.

1. You may enter and work in the laboratory only with the approval and under the supervision of a teacher.
2. Each laboratory inquiry must be read before attempting to do it. Particular attention must be given to safety precautions outlined in the lesson. Follow exactly the teacher's instruction and the directions as they are written. If you are in doubt about any part of the experiment, ask your teacher for assistance.
3. The laboratory is a place of serious study and investigation. Any misbehavior of any nature is unacceptable.
   a. The laboratory furniture and equipment must be used for their intended purposes. Never remove any materials from the lab.
   b. Windows may be opened or closed only with a specific directive from the teacher.
4. Keep the laboratory and your work station neat and clean.
   a. Make sure all equipment and glassware is clean before and after an experiment.
   b. Keep wash sinks free from solid materials; use the waste baskets for paper and refuse.
   c. Use dust pan to sweep up broken glass which is to be discarded in a designated container.
   d. Keep the aisles clear at all times.
5. Every student must know the location and the proper use of the following safety equipment: eye-face wash station, fire blanket, fire extinguisher, fire alarm box, gas and electric master shut-off valves, fire exit route, and telephone.
6. Chemicals are to be used only when and as directed by the teacher:
   a. Carefully read the label on the bottle and identify the chemical.
   b. Do not taste, touch, and sniff any chemical.
   c. If you spill any chemicals notify the teacher immediately. If you spill any chemicals on yourself, skin or clothing, rinse your skin area under cold water for 10-15 minutes and with cold water wash out chemical from the clothing.
   d. Never return used chemicals to their stock bottle; do not mix chemicals if directed to discard into a specific container.
   e. Carefully remove and replace stoppers to the proper bottles.
   f. When diluting an acid, always pour the acid into water. Never pour water into the acid.
   g. When transferring chemicals from one container to another, hold the containers out away from your body and if possible, over a sink.
   h. Suction bulbs should be used to fill pipettes with chemical reagents. Mouth suction is never to be use..

7. When heating a substance
   a. always hold a test tube in such a way that it will not splatter on you or your neighbor.
   b. never heat a substance in a closed container.
   c. use tongs or clamps when handling hot containers
   d. wear safety goggles
   e. never reach across a flame or hot plate.
   f. never look into the container
   g. add boiling chips to the container.
8. You may use a Bunsen burner only after your teacher has demonstrated the correct procedures for lighting it. If you encounter any difficulty in lighting the burner, turn the gas off immediately and request teacher assistance. Never leave a lighted burner unattended The upper part of the burner is very hot after use; do not touch.
9. Never eat or drink anything in the laboratory. Wash your hands thoroughly when indicated.
10. Report all accidents immediately to your teacher. If your teacher is involved in an accident and needs assistance, contact the nearest teacher.
11. Notify your teacher of any medical problems that may relate to lab work. Students who normally wear contact lenses should notify the teacher.
12. Clothing should be appropriate for working in the laboratory. Jackets, ties, and other loose clothing should be removed or secured. Long sleeves should be rolled up. Jewelry that might present a safety hazard, such as necklaces, chains, medallions, or bracelets, should not be worn in the laboratory. Long hair should be tied back or covered. Wear shoes that cover the entire foot; sandals and canvas shoes should not be worn.
13. Safety glasses, protective gloves, and a lab apron should be worn when you are heating substances, working with chemicals, doing dissections, or handling living or preserved specimens.
14. Glass tubing or a thermometer is to be inserted into a cork or stopper only after the teacher's demonstration. When inserting a glass tube, the ends must be fire polished, and the end to be inserted should be lubricated with glycerine. Carefully twist the cork or stopper onto the tube.
15. Always remove the electric plug from the socket by holding the plug, NOT the wire.

I, ______________________________, have read, understand, and agree to follow these science safety rules and procedures. I will follow any additional instructions provided by my science teacher and as indicated in the laboratory exercise.

____

Student signature   Date

LAB # : LABORATORY EQUIPMENT

I. Purpose: To identify common laboratory equipment and tools and to explain their uses.

II. Materials: handouts, glassware and hardware

III. Procedure:

1. Set up your lab stations with the equipment listed on the handout. Check for missing equipment. When your draws are complete, sign the bottom of the sheet and hand into your teacher.
2. Identify each item in your drawers and cupboard. Prepare a data table including the piece of equipment, illustration of the item, and its function. Note: do not do a 400, 250, 100 and 50 ml beaker separately—list collectively under beaker. Use the handout on lab equipment to help you.

IV. Data and Observations: Insert data table here.

V. Questions:

Use the handout on lab equipment to answer the following questions. Answer in complete sentences.

1. Which piece of equipment is used for safety?
2. Which piece of equipment is used to measure mass?
3. List 4 pieces of equipment that can <u>hold</u> a specific volume of liquid.
4. Which piece of equipment is used to measure temperature?
5. Which piece of equipment is used for heating?
6. List four pieces of equipment used for dispensing or <u>delivering</u> a specific volume of liquid.
7. List two pieces of equipment that can be used to hold hot glassware or a crucible.
8. Which piece of equipment is used to place a crucible on while heating?
9. Which piece of equipment is used to heat small amounts of a solid substance at high temperatures?
10. Which piece of equipment is used to contain a small volume of a liquid being evaporated?

VI. Summary: What did you learn from this lab? Why is this lab important? If you were to divide all the equipment from the handout into four categories what categories would you use? Explain.

LABORATORY STATION EQUIPMENT

Please check to make sure that the following equipment is at your station. It is your responsibility to insure that the equipment is stored neatly and that all glassware is kept clean.

GLASSWARE DRAWER

"Nest" of Glass Beakers:
50,100, 250, 400 ml.

2 Erlenmeyer Flasks:
125 & 250 ml.

2 Graduated Cylinders:
Large & Small

Funnel

Watch Glass

evaporating dish

HARDWARE DRAWER

Wire Gauze

Test Tube Clamp

Test Tube Holder

Beaker Tongs

Crucible Tongs

Pipestem Triangle

2 Iron Rings
Large & Small

spatula

CUPBOARD

6 Test Tubes in Test Tube Rack

Test Tube Brush

Tripod

ring stand

Sponge

Check Out Equipment:
Date:

____
student signature

Check In Equipment:
Date:

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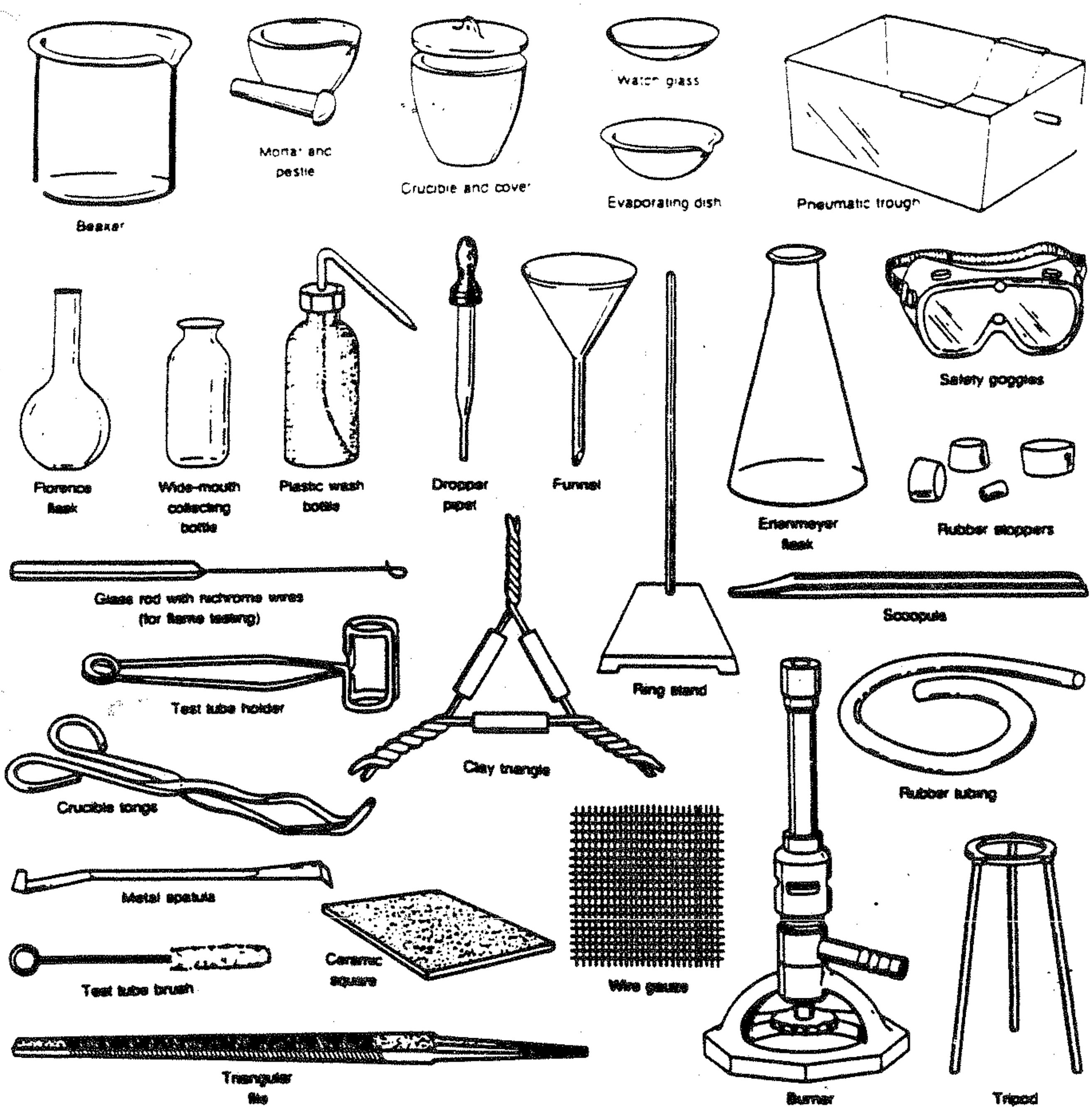
instructor signature

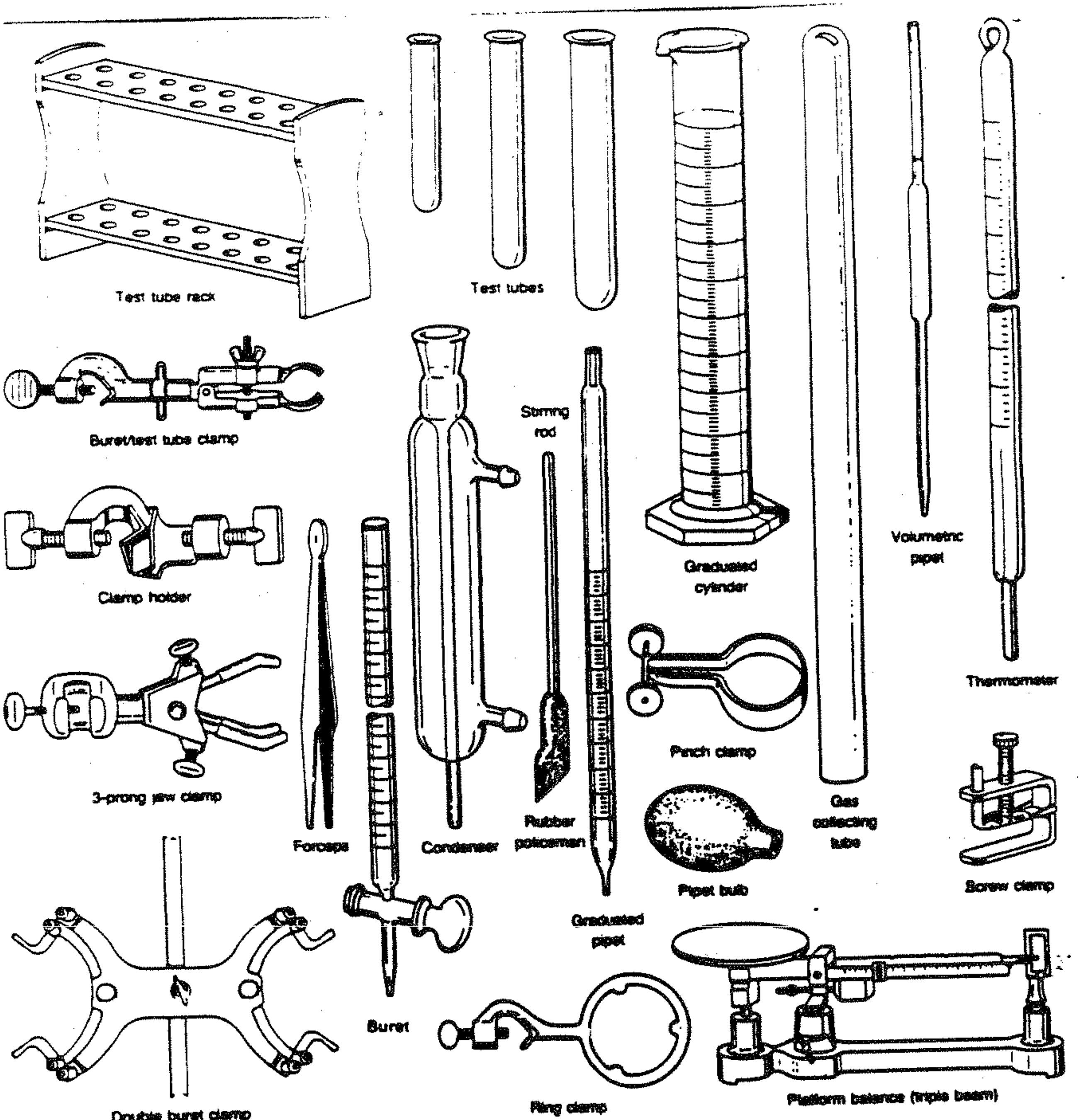
Figure 1



Beaker: glass or plastic; common sizes are 50-mL, 100-mL, 250-mL, 400-mL; glass beakers may be heated.
Buret: glass; common sizes are 25-mL, and 50-mL; used to measure volumes of solutions in titrations.
Ceramic square: used under hot apparatus or glassware.
Clamps: the following types of clamps may be fastened to support apparatus: buret/test-tube clamp, clamp holder, double buret clamp, ring clamp, 3-pronged jaw clamp.
Clay triangle: wire frame with porcelain supports, used to support a crucible.
Condenser: glass; used in distillation procedures.
Crucible and cover: porcelain, used to heat small amounts of solid substances at high temperatures.
Crucible tongs: iron or nickel, used to pick up and hold small i...ms.
Dropper pipet: glass tip with rubber bulb, used to transfer small volumes of liquid.
Erlenmeyer flask: glass, common sizes are 100-mL, 250-mL; may be heated, used in titrations.

Evaporating dish: porcelain, used to contain small volumes of liquid being evaporated.
Florence flask: glass, common sizes are 125-mL, 250-mL, 500-mL, may be heated, used in ...king and for storing solutions.
Forceps: metal, used to hold or pick up small objects.
Funnel: glass or plastic, common size holds 12.5-cm diameter filter paper.
Gas burner: connected metal; to a gas supply with rubber tubing; used to heat chemicals (dry or in solution) in beakers, test tubes, and crucibles.
Gas collecting tube: glass, marked in mL intervals; used to measure gas volumes.
Glass rod with nichrome wire: used in flame tests.
Graduated cylinder: glass or plastic, common sizes are 10-mL, 50-mL, 100-mL, used to measure approximate volumes; must not be heated.
Graduated pipet: glass, common sizes are 10-mL, 25-mL; used to measure solution volumes; less accurate than a volumetric pipet.

Figure 1 continued



Mortar and pestle: porcelain, may be used to grind crystals and lumpy chemicals to a powder.
Pipet bulb: rubber, used in filling a pipet with a solution, a pipet must never be filled by mouth.
Plastic wash bottle: flexible plastic, squeeze sides to dispense water.
Platform balance: also known as a triple beam balance.
Pneumatic trough: galvanized container with shelf, used in experiments where a gas is collected.
Ringstand: metal rod fixed upright in a heavy metal base; has many uses as a support.
Rubber stoppers: several sizes.
Rubber tubing: used to connect apparatus so as to transfer liquids or gases.
Safety goggles: plastic; must be worn at all times while working in the laboratory.
Screw clamp, pinch clamp: metal, used to block off rubber tubbing.
Spatula, scoopula: metal or porcelain; used to transfer solid chemicals; the scoopula has a larger capacity.
Stirring rod and rubber policeman: glass with rubber sleeve; used to stir, assist in pouring liquids, and for removing precipitates from a container.
Test tube brush: bristles with wire handle, used to scrub small diameter glassware.
Test tube holder: spring metal, used to hold test tubes or glass tubing.
Test tube rack: wood or plastic, holds test tubes in a vertical position.
Test tubes: glass, common sizes small (13 mm x 100 mm), medium (20 mm x 150 mm), large (25 mm x 200 mm), may be heated.
Thermometer: mercury in glass, common range −10°C to 110°C.
Triangular file: metal, used to scratch glass tubing prior to breaking to desired length.
Tripod: iron, used to support containers of chemicals above the flame of a burner.
Volumetric pipet: glass, common sizes are 10-mL, 25-mL, used to measure solution volumes accurately, must not be heated.
Watch glass: glass, used to cover an evaporating dish or beaker.
Wide-mouth bottle: glass, used with pneumatic trough.

Lab # : The Thickness of Aluminum Foil

I. Purpose: To measure indirectly the thickness of aluminum foil.
Estimate the number of aluminum atoms that give the foil its thickness.

II. Materials: balance, ruler, aluminum cylinder, 100 ml graduated cylinder, aluminum Foil

III. Procedure:

1. Use a balance to determine the mass of a cylinder of aluminum.
2. Use water displacement to determine the volume of the aluminum cylinder. Record the initial volume, final volume and actual volume.
3. Obtain a piece of aluminum foil (approximately 12 cm x 12 cm) and measure the exact length and width of the foil. Calculate its area.
4. Use a balance and determine the mass of the aluminum foil.

IV. Data and Observations: Create a detailed data table showing all recorded values. Include units and be careful of significant figures.

V. Analysis of Data: (Include formulas and show work!!)

1. Calculate the density of the aluminum cylinder.
2. Using the density of the Al cylinder and the mass of the Al foil, calculate the volume of the foil.
3. Calculate the thickness of the Al foil. (Hint: Volume of the foil= l x w x h, where h would be the thickness of the foil and l x w its area)
4. If one Al atom is 2.5×10^{-8} cm in diameter, calculate the number of atoms in the thickness of your piece of foil.
5. Assume that an Al atom is a sphere; calculate the volume of an Al atom. (Hint: use diameter of 2.5×10^{-8} cm and $V=4/3\ \pi\ r^{3}$)
6. Calculate the number of atoms in a sample. (Hint: use the volume of foil --#2 above—and the volume of an atom--# 5 above).

VI. Summary: What conclusion can you draw about the atom from this lab. Include some sources of error.

Lab # . The Penny Lab

I. Purpose: To review basic measuring skills
To calculate the average mass of a penny
To calculate the density of a penny
To relate these concepts to atomic isotopes

II. Materials: balance, graduated cylinder, and 25 pennies

III. Procedure:

1. Individually mass 25 pennies. Prepare Data Table 1 with the following information: Penny #1-25, year and each mass in grams.
2. Mass the 25 pennies in the following manner: Start with 0 pennies and a mass of 0. Then find the mass of one penny and record. Without removing the penny add another penny and record the cumulative mass. Prepare Data Table 2 with the following information: Total # of coins and cumulative mass.
3. Using water displacement find the volume of 25 pennies. Record the initial, final, and actual volume in Data Table 3.

IV. Data and Observations: Insert Data Tables 1,2, and 3

V. Analysis of Data:

1. Using Data Table 1
   a. Find the total mass of 25 pennies and compute the average mass.
   b. Using the year of each penny calculate the fractional abundance of pennies pre-1982 and post 1982. (Hint: # of each category/25)
   c. Calculate the average mass of pre 1982 and post 1982 pennies.
   d. Using the relative abundance in "b" above calculate the average atomic mass. (Hint: like an isotope problem)
   e. Compare your results in "a" to "d".
2. Using Data Table 2
   a. Using the cumulative mass of 25 pennies compute the average mass of a penny.
   b. Prepare a computerized graph (or you may use graph paper) showing the total # of coins vs. cumulative mass. (Remember a graph must have a title and labeled axis)
   c. Calculate the slope of the graph.
   d. Compare your answer in "a" to "c".
   e. What do you think the slope represents.
3. Using Data Table 3
   a. Find the average volume of a penny.
   b. Using 2a from above calculate the density of a penny.

VI. Questions:

1. In this lab you calculated the mass of a penny in three ways (1a, 2a, and 2c). How do they compare and how should they compare?
2. Pennies minted before 1982 were made of copper and have an average mass of 3.0 g while pennies minted after 1982 are made of zinc with a coating of copper and have a mass of 2.5 g. How do you explain your average mass from question 1 above?
3. Why are the atomic masses for most elements not whole numbers?
4. How are the three isotopes of hydrogen (hydrogen-1, hydrogen-2, hydrogen-3) alike? Different?
5. Copper has two isotopes Cu-63 and Cu-65. Cu-63 has a relative abundance of 69.1%, while Cu-65 has a relative abundance of 30.9%. Calculate the average atomic mass of Cu?

VII. Summary: Summarize the three ways you found the average mass of a penny. How does what you learned in this lab relate to isotopes? What are some sources of error?

Guide to Creating a Data Table and Graph Using Microsoft Excel

Computer programs are excellent tool s to create graphs and analyze information. Any graphs that need to be constructed this year can be done by hand or by using Microsoft excel. The following is a list of instructions for creating the graph for your penny lab. Keep these instructions handy for use in creating future graphs.

1. Open the excel program by double clicking on the desktop icon. This will bring you to a blank spreadsheet.
2. In box or cell A1 (the very top left box) type the name of the independent variable. (ex: Total number of Pennies)
3. In box A2 enter your first value. (ex: 0). And hit return. Continue entering your vales. (in this case your last value should be 25 and it should appear in cell A26}
4. Bring the cursor to cell B1. Type the name of dependent variable. (ex: Cumulative Mass (grams)) and hit return.
5. In cell B2 enter your first value. (ex: 0) and hit return. Continue entering all your data.
6. Make sure you have your values to the correct number of significant figure. Left click on a column that needs to be corrected. . This should highlight the entire column. Right click and a scroll down to format cells. Left click. Go to number and change to the correct number of decimal places. (ex: if your mass needs to be to the tenth place you need 1 to appear in the decimal place line, if it needs to be to the hundredth place use 2 in the decimal place line.)
7. Now you are ready to create a graph.
8. Go to cell A2 and left click. Move to cell B2 and drag your cursor so that all your data is highlighted. (Except cell A2)
9. Go to "insert" on the tool bar and pull down menu. And select charts. This opens the chart wizard. You can also click on the chart wizard icon on the tool bar.
10. Chose xy (scatter) and hit "next" at the bottom.
11. A graph will appear on your screen, if it appears correct hit "next" again.
12. "Chart options" will appear on your screen. Enter chart title (ex: Total Number of Pennies vs. Cumulative Mass (g)), x axis (ex: Total Number of Pennies), and y axis (ex: Cumulative Mass (g)) Don't forget to include units. When you are satisfied hit "next" on the bottom of your screen.
13. On the next screen go to place chart as object in sheet 1 if you want the data table to be included.
14. Hit "finish" and check your graph.
15. Notice the points are not connected. Left click on your chart to highlight the graph. The toolbar should be modified and the word "chart" should appear. Click on chart and pull down to "Add trendline" and left click. Select the word "linear". This should connect your points with a "best fit" line. Go to options and select display equation on chart.. Hit "okay".
16. Click on any cell above your graph and you may add text. (ex: your name)
17. If you want to print the graph only highlight just the graph and go to file "print". If you want the data table and graph do not highlight anything and go to file "print"
18. Collect your graph.
19. Don't for get to log off your computer.

GOOD LUCK!!!!!

Lab . Emission Spectroscopy

I. Purpose: Identify gases using gas tubes and their bright line spectrums.

II. Materials: gas tubes, diffraction grating, and high voltage generator

III. Procedure:

1. Look at the fluorescent light through your diffraction grating, record what you see.
2. Your teacher will show you several gas tubes. When the tube is lit brightly look at the light through your diffraction grating. Record the colors that you see.
3. Your teacher will show you an unknown gas. Using your line patterns from above, identify your unknown.

IV. Data and Observations:

Create a data table using three columns: Gas/Color of tube/Line Patterns.
(Begin with white light, all the gases and end with the unknown)
Use colored pencils to neatly present the spectrums you observed.
The following website contains an excellent virtual lab, look at it so you can get more accurate data for your spectrums. (http://phys.educ.ksu.edu/vqm/html/emission.html)

V. Questions:

1. What are emission spectra?
2. What is the difference between a continuous spectrum and a line spectrum?
3. How is a spectroscope useful in identifying substances?
4. How can you relate what you learned in this lab to aerial fireworks?

VI. Summary: Write a paragraph discussing how you can relate energy levels, excited and ground states, and using a spectroscope to identify unknown elements.

Lab # : The Mole

Purpose: To determine and compare the number of moles for several everyday substances.

Materials: Samples of: aluminum, copper, iron, lead, sulfur, tables salt, chalk, and table sugar. Electronic balances

Procedures: Set up: 8 stations each containing one of the following samples: Aluminum (Al), Copper (Cu), Iron (Fe), Lead (Pb), Sulfur (S), Table Salt (NaCl), Chalk ($CaCO_3$), and Table Sugar ($C_{12}H_{22}O_{11}$)

1. At each station tare the balance with the empty container that will be used to mass your substance.
2. Find the mass of each substance and record in your data table.
3. After you have recorded all 8 masses return to your seat and work on completing your data table.

Data and Analysis of Data:
Prepare a data table with the following headings: Substance, Measure mass (g), Molar Mass (g), Number of Moles, Number of Particles, and Type of Particle
For each substance calculate the following:

1. Molar mass to the nearest tenth place.
2. Number of moles (watch significant figures but then round each to the nearest tenth place)
3. Number of particles
4. Determine the type of particles (atoms, ions, formula units, or molecules)

Questions:

1. Define the term mole.
2. Write down three formulas that you can use to calculate the mole. (Mass, number of particles, volume)
3. In a sealed container you measured the mass of carbon dioxide to be 88 grams at STP.
    a. Write the formula for the gas.
    b. Determine the number of moles of gas you have.
    c. Determine the number of molecules you have in your sample.
    d. Determine the number of atoms you have in your sample.
    e. Determine the number of liters you have in your sample.

Summary: What is a mole and why is it important? What did you notice about the number of moles you had for each sample? What is the relationship between the number of moles, number of particles, and type of particles? What are some sources of errors in this lab?

Lab # : Percent Water in a Hydrate

Purpose: Determine the percent of water in a hydrate

Materials: test tube, test tube clamp, ring stand, Bunsen burner, balance, goggles
Copper II sulfate pentahydrate crystals

Procedure:
1. Heat an empty test tube for a minute and cool.
2. Tare the balance with the empty test tube and add approximately 2.00 grams of your hydrate. Record the mass in your data table,
3. Gently heat your hydrate until the blue color disappears. (Make sure your test tube is pointed away from other classmates. Heat gently to avoid any splattering. You can move the burner up and down the test tube so the material on the sides are heated evenly) Continue heating for about 5 minutes.
4. Allow the test tube to cool for about 1 minute. (Be careful the glass and metal clamps are HOT) Immediately find the mass of the test tube and anhydrous salt. Record this in your data table as the mass of the anhydrous material after the first heating.
5. Reheat the test tube very gently for about 1 more minute, allow to cool and reweigh. Record this value as the mass of the anhydrous material after the second heating. (Use this value as the mass of the anhydrous material if it differs only slightly from step 4. If it differs considerably further heating is required)
6. Rinse your test tube in the sink with water. Note what happens to the color of the salt. Clean your work area.

Data and Observations:
Prepare a data table including the mass of the hydrate and mass of the anhydrous salt.

Analysis of Data:
1. Find the mass of the water lost.
2. Find the experimental percent of water in your hydrate.

Questions:
1. What is the correct formula of copper II sulfate pentahydrate?
2. From the formula calculate the actual percent of water.
3. Find your percent error.
4. Define the terms hydrate and anhydrous.
5. Explain what happened in step 5 of the procedure above. (Use the terms from question 4 above)
6. What errors could have caused you to get a percent water above the accepted value?
7. What errors could have caused you to get a percent water below the accepted values?.

Summary: Discuss the two ways to calculate percent composition. Discuss the errors that you could have made in this lab.

P.

Lab # : Percent Sugar in Bubblegum

Purpose: To calculate the percent of sugar in a piece of bubblegum.

Materials: balance, piece of bubblegum

Procedure: Devise a step-by-step procedure to experimentally determine the percent of sugar in bubblegum. (Reminder: You cannot place the gum directly on the balance. You may place it in the wrapper but remember to zero the balance with the empty wrapper on it.)

Data and Observations: Prepare a data table that coincides with the procedure you designed. Include the brand of gum.

Analysis of Data:

1. Calculate the mass of sugar in your gum.
2. Calculate the percent of sugar in your gum.

Questions:

1. Make a list of the brands of gum tested and the percent of sugar in each.
2. Are the values above what you would have expected.
3. What other foods do you think you can find the percent of?

Summary: Discuss the results of this experiment. What interesting information did you discover in this lab. Discuss the mechanics behind the procedure you used. (Biological information)

Lab # : Determining an Empirical Formula

Purpose: Find the empirical formula for a compound made from magnesium and oxygen.

Materials: Crucible and cover, tripod, clay triangle, crucible tongs, eye dropper, scissors, Bunsen burner, goggles, magnesium ribbon.

Procedure:

1. Clean a crucible and cover. Use your crucible tong to hold the crucible and cover in the flame for 2 minutes. Allow them to cool. Measure the mass of the empty crucible. Record your mass to the nearest .1-gram in your data table.
2. Cut a 35 cm strip of magnesium into 1 cm pieces. Place the pieces in the crucible and measure the mass. Record your mass of the crucible and magnesium in your data table.
3. Cover the crucible and place it on a clay triangle. Heat gently for two minutes. Using crucible tongs, carefully tilt the cover to provide an opening for air to enter the crucible. Heat the partially covered crucible strongly for 10 minutes. (CAUTION: Do not place the magnesium directly into the flame. Do not stare directly in the crucible. Always wear safety goggles. Do no touch the hot crucible.)
4. Turn off the burner, cover the crucible, and allow the contents to cool. When the crucible is cool enough to touch, remove the cover and examine the contents. If any magnesium did not react, tilt the cover and reheat strongly for several more minutes.
5. Once again put the cover on and allow to cool. After all the magnesium has reacted, use an eyedropper to add jus enough water to the crucible to cover the contents. Wash any material that may have splattered on the inside of the cover into the crucible.
6. Holding the burner in your hand gently heat the contents of the uncovered crucible by moving the burner slowly back and forth. Avoid splattering. Observe the odor (by wafting it towards your nose) and write your observations in the data table.
7. When all the liquid has boiled off, repeat steps 5 and 6.
8. After the second time continue heating the uncovered crucible strongly for 5 more minutes.
9. Turn off the burner and allow the crucible and its contents to cool. Measure the mass of the crucible and newly formed oxide.

Data and observations: Create a data table consisting of the mass of the empty crucible, mass of crucible and magnesium strips, mass of crucible and oxide, and the odor of the vapor.

Analysis of Data: Label clearly. Show work. Watch units and significant figure!!!!

1. Find the mass of the magnesium used.
2. Find the mass of the oxygen reacted.
3. Find the number of moles of magnesium used.
4. Find the number of moles of oxygen reacted.
5. Find the ratio of the moles of magnesium to moles of oxygen.

Questions:

1. Write the empirical formula of magnesium oxide based on your calculations. What should the formula be? How does your experimental formula compare?
2. What is the ratio of the mass in grams of magnesium used to the mass in grams of oxygen used? Relate this ratio to the law of definite proportions.
3. Why is the ratio found in question 2 above different from the ratio found in step 5 under analysis of data?
4. What do subscripts represent in a chemical formula? (Two different things)
5. The molecular formula for hydrogen peroxide is H_2O_2, what is its empirical formula?
6. How is the chemical formula of carbon monoxide similar to that of carbon dioxide? How is it different?
7. A sample of sulfur has a mass of 1.28 g combines with oxygen to form a compound with a mass of 3.20 grams. What is the empirical formula of the compound? (Hint: Use these values by do The analysis of data section)

Summary: Discuss the difference between an empirical and molecular formula. What did this lab teach you about determining an empirical formula experimentally? How did your empirical formula compare to the actual empirical formula? What are some sources of error?

Lab#C: Formula of Lead Iodide

I. Purpose: Can you determine the chemical formula for lead iodide?

II. Materials: goggles,9 small test tubes, grease pencil, test tube rack, eye dropper, .1M solution of Sodium iodide, .1 M solution of lead II nitrate, metric ruler

III. Procedure: SPECIAL SAFETY GUIDELINES—lead compounds are toxic.
Wear goggles and latex gloves during this lab.
Dispose of all lead compounds in special waste containers.
Wash your hands very well after the lab

1. Label 9 test tubes 1-9 and place them in a test tube rack.
2. Using the combinations below add sodium iodide to each test tube using a graduated cylinder or pipette. Rinse the cylinder with water and add the desired amount of lead 11 nitrate to each test tube. Discard of any excess lead solutions in the waste container. You can include this in your data table.

Test tube	Volume of NaI solution (ml)	Volume of $Pb(NO_3)_2$ (ml)
1	4.5	0.5
2	4.0	1.0
3	3.5	1.5
4	3.0	2.0
5	2.5	2.5
6	2.0	3.0
7	1.5	3.5
8	1.0	4.0
9	0.5	4.5
	22.5	22.5

3. Let stand for about 15 minute or until the precipitate settles to the bottom of each test tube.
4. With a metric ruler measure the height of each precipitate in mm.
5. Set up a data table consisting of three columns. Test tube (number from #1-9), Ratio of ml of lead 11 nitrate: ml of sodium iodide (Hint: Set up each ratio to give the number of ml of sodium iodide that would correspond to 1 ml of lead nitrate), Height of Precipitate in mm.
6. Dispose of your precipitate in the waste containers. Wash your hands!!

IV: Data and observations: Insert your data table here

V. Analysis of Data: Prepare a bar graph showing the test tube # vs. the height of the lead iodide precipitate. Beside each section of your graph place the ratio from your data table.

VI. Questions:

1. Which reaction ratio(s) yielded the greatest amount of precipitate?
2. What can you conclude from your graph of precipitate heights and reaction ratios?
3. Based on the ratio that you determined in response to question 1, what is the correct formula for lead iodide?
4. Use your textbook to define the term limiting reagent. Which reagent Ran out first in test tube 1? Test tube 7? Explain this in terms of being a limiting reagent.
5. Why is it important that the proper ratio be used when writing the formula of a substance?
6. Would this procedure be used for every compound? Explain.
7. Is the formula you found empirical or molecular? Explain.

VII: Summary: Discuss the meaning and importance of a chemical formula. How did this lab help you in determining the formula for lead iodide? What are some of the major sources of error you could have made?

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Lab # : Types of Chemical Reactions

Purpose:

How do you classify different types of chemical reactions? How do we write a balanced equation for each reaction?

Equipment

Burner	Test tubes	Test tube holder	Crucible Tongs
Test tube rack	Spot plate	Evaporating dish	

Materials

Zinc	Copper wire	Magnesium Ribbon	Sandpaper
Copper (II) Carbonate	6 M HCl	1 M Copper (II) Sulfate	Wood Splints
0.1 M Zinc Acetate	0.1 M Sodium Phosphate	0.02 M Potassium Iodide	
0.01 M Lead Nitrate	3% hydrogen peroxide	Manganese Dioxide	

Procedure

Synthesis

1) Use a piece of sandpaper to clean a piece of copper wire. Examine the wire and note its appearance.
2) Using crucible tongs, hold the wire in the hottest part of the burner flame for 1-2 minutes. Examine the wire and note any changes in the wire caused by the heat.
3) Repeat the process with a piece of magnesium ribbon. Place an evaporating dish next to the base of the burner. DO NOT LOOK DIRECTLY AT THE FLAME. HOLD THE BURNING MAGNESIUM AWAY FROM YU AND OVER THE EVAPORATING DISH.

Decomposition

1) Place two microspatulas of copper (II) carbonate in a clean, dry test tube. Note the appearance of the sample.
2) Using a test tube holder, heat the sample in a burner flame for about three (3) minutes. Turn off the burner and insert a burning wood splint in the test tube. What gas does the results of this test suggest as one of the product of the reaction? Note any changes in the appearance of the material in the test tube.
3) Place a very small amount of manganese dioxide into a clean dry test tube and place the test tube in the test tube rack. Record your observation of the hydrogen peroxide and then add about 1 mL of hydrogen peroxide to the test tube with the MnO_2. After the reaction begins, place a glowing wood splint in the mouth of the test tube. What gas does the result of this test suggest as one of the products? Note any changes in the appearance of the materials in the test tube.

Single Replacement

1) Half fill one of the wells in the spot plate with 6 M HCl. Record its appearance. Add a small piece of zinc to the acid and immediately cover the well with a small test tube. Observe what happens.
2) Removfe the inverted test tube with the test tube holder after about 30 seconds and quickly insert a burning wood splint into the mouth of the test tube. What gas does the results of this test suggest as one of the products
3) Add 5 drops of copper (II) sulfate solution to another well of the spot plate. Now place a clean piece of mossy zinc into the well and let it remain there for 3 minutes. Remove the zinc from the solution. Note the appearance of the zinc and the solution before and after the reaction.

Double Replacement

1) Add 2 drops of 0.1 M zinc acetate to a clean dry well in the spot plate. Next add about 2 drops of 0.1 M sodium phosphate to the same well. Observe what happens and note any changes in the mixture.
2) Repeat procedure 10, except use 0.020 M lead (II) nitrate and 0.010 M potassium iodide.

Data

Create a data table to keep track of all the properties of the reactants and products in each of your reactions.

Analysis of Data

Write equations for the following:

- Synthesis of copper (II) oxide
- Synthesis of magnesium oxide
- Decomposition of copper(II) carbonate
- Decomposition of hydrogen peroxide
- Single replacement reaction between zinc and hydrochloric acid
- Single replacement reaction between zinc and copper (II) sulfate
- Double replacement reaction between zinc acetate and sodium phosphate
- Double replacement reaction between lead (II) nitrate and potassium iodide

Questions

1. In this experiment, what method was used to test for the presence of CO_2 gas?
2. What test was used to check for the presence of hydrogen gas? Write a balanced equation for this test.

Summary

Define synthesis, decomposition, single replacement, and double replacement reactions. Explain how to identify which type of reaction you have when you are given a reaction equation.

Lab # : Mass and Mole Relationships in a Chemical Reaction

Purpose: Compare the experimental mass of a product of a chemical reaction with the mass predicted for that product by calculation.

Materials: balance, burner, evaporating dish, watch glass, 10 ml graduated cylinder, 50 ml beaker, eye dropper, ring stand, iron ring, wire gauze, sodium hydrogen carbonate ($NaHCO_3$), 3M HCl, goggles.

Procedure:

1. Place a dry clean watch glass on top of a clean evaporating dish. Find the mass and record the mass of the evaporating dish and watch glass in your data table.
2. Add between two and three grams of sodium hydrogen carbonate to the evaporating dish. Measure the mass of the evaporating dish, watch glass and sodium hydrogen carbonate and record this in your data table.
3. Bring a 50 ml beaker to your teacher and obtain about 25 ml of 3M HCl. (Be careful this acid is caustic and corrosive. Avoid contact with skin and eyes. Avoid breathing the vapors). Carefully pour 10 ml of HCl into a graduated cylinder. Add this acid to the sodium hydrogen carbonate in the evaporating dish very slowly. Carefully add a small amount of HCl with an eyedropper to the evaporating dish until the bubbling stops.
4. Place the evaporating dish on the wire gauze that has been placed on the iron ring attached to the ring stand. Place the watch glass concave side up on top of the dish, but tipped slightly so steam can escape.
5. Gently heat the evaporating dish with a small flame until only a dry solid remains. Make sure no water droplets remain on the underside of the watch glass.
6. Turn off the burner. Allow the apparatus to cool (About 10 minutes) Determine the mass of the evaporating dish, watch glass and residue. (NaCl). Record this value in your data table.
7. Rinse the residue down the sink and clean up your lab station.

Data: Insert these three mass measurements into your data table.

Analysis of Data: Show work!!

1. Calculate the mass of the reactant, $NaHCO_3$.
2. Calculate the number of moles of $NaHCO_3$.
3. Calculate the mass of the product, NaCl.
4. Calculate the moles of NaCl produced.
5. Calculate the experimental mole ratio of $NaHCO_3$ to NaCl.

6. Write a balanced equation between sodium hydrogen carbonate and hydrochloric acid. Assume the products to be sodium chloride, carbon dioxide and water.
7. Using the coefficients from the above equation determine the theoretical mole ratio of the sodium hydrogen carbonate to sodium chloride.
8. Determine the percent error between your experimental ratio in #5 and the theoretical ratio in #7.
9. From the moles of sodium carbonate in #2 compute the mass of sodium chloride you should have produced. (Do a three step problem)
10. Determine the percent error between the masses of NaCl you should have produced (#9) with the mass you produced in #3. (Experimental value)

Questions: (Show work!!)

1. If the masses of all but one of the substances that take part in a chemical reaction are known, explain why it is possible to determine the unknown mass by subtraction.
2. In the chemical reaction $CaCO_3 \rightarrow CaO + CO_2$, if 40.0 grams of $CaCO_3$ is decomposed:
a. How many grams of CaO is produced?
b. How many grams of CO_2 is produced?
3. In the reaction $N_2 + 3H_2 \rightarrow 2NH_3$, if 20.0 grams of hydrogen reacts:
a. How many grams of ammonia is produced?
b. How many grams of nitrogen reacts?

Summary: Discuss the two ways to do a mass-mass problem: experimental and mathematical. Compare your two results in this lab. Discuss sources of error.

Lab #: Periodic Table Lab—Part I

Purpose: To construct a colored coded periodic table in order to review the structure of the periodic table.

Material: reference table
colored pencils

Procedure:
Use the accompanying blank periodic table to fill in the following information:

1. Using black, red and blue colored pencils write in the symbols for atomic #1-89. Use black for solids, blue for liquids and red for gases at room temperature.
2. On the top of each column indicate the group number (1-18)
3. On the left side of the table indicate the period number (1-7)
4. Put a bracket to show the following: s block, p block, d block, f block, transition elements, lanthanide series and actinide series.
5. Using a heavy black line draw the "steps" to separate the metals from the nonmetals.
6. Shade your table as follows:
   a. Alkali metals (group1) red. Except hydrogen shade pink.
   b. Alkaline earth metals (group 2) orange
   c. Transition metals yellow
   d. All other metals green
   e. Halogens (group 17) blue
   f. Noble gases (group 18) purple
   g. All other nonmetals brown
   h. Metalloids gray

Data: Include your color- coded periodic table.

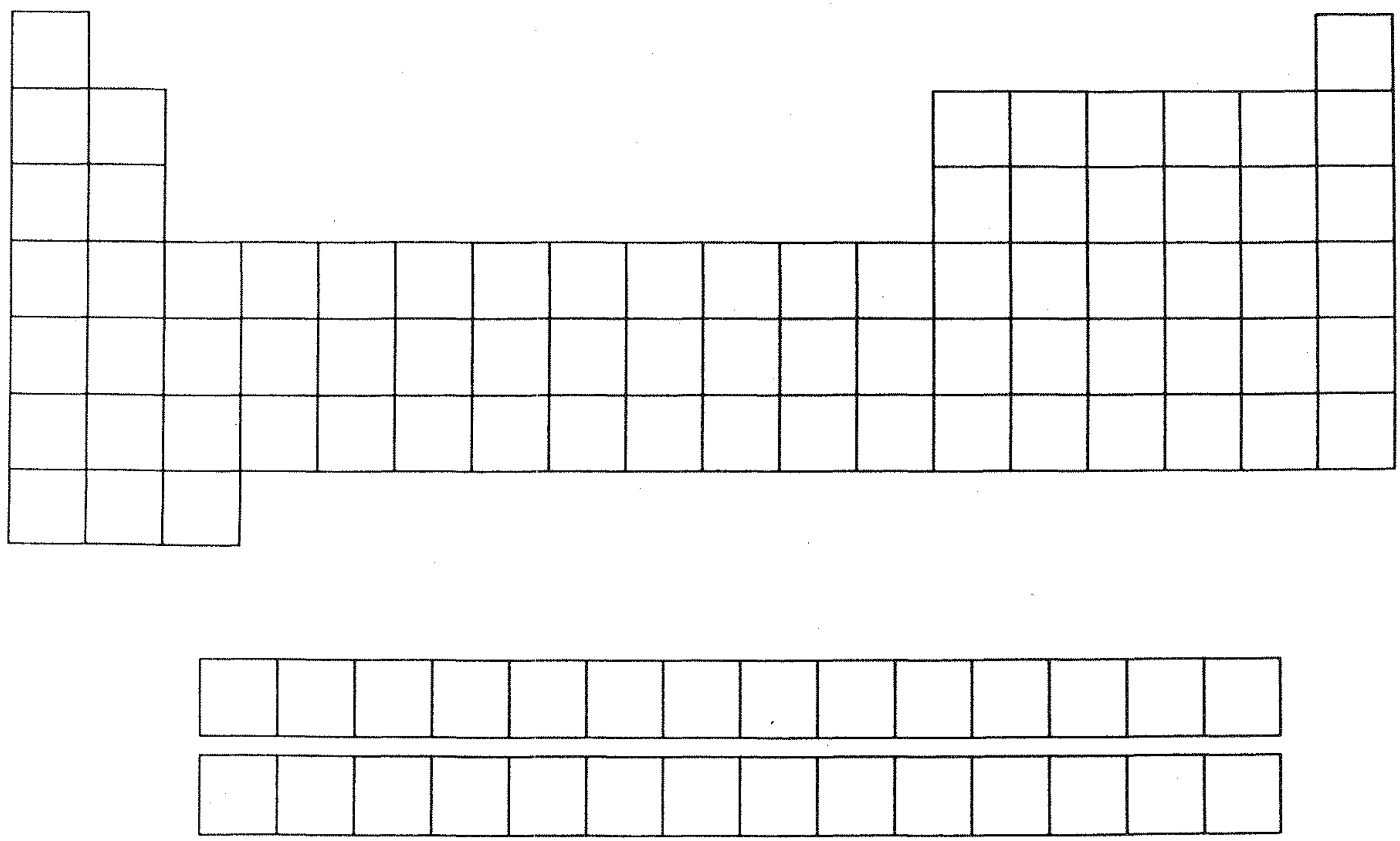
Questions:

1. What does the group number tell you? Explain.
2. Indicate the number of valence electrons, name of the group, and group number with the following valence shell electron configuration:
   a. s^1 b. s^2 c. s^2p^5 d. s^2p^6
3. What does the period number tell you?
4. Elements in the same ____ tend to react in a similar fashion because _____.
5. What is the name and symbol of the element in group 16 and period 3?
6. Metals tend to lose/gain electrons to form positive/negative ions. Therefore its ionic radius is smaller/larger than its atomic radius.
7. Nonmetals tend to lose/gain electrons to form positive/negative ions. Therefore its ionic radius is smaller/larger than its atomic radius.
8. For each of the following trends tell if it increases or decreases in a group and give an explanation: atomic mass, atomic radii, ionization energy, and metallic properties.

9. For each of the following trends tell if it increases or decreases in a period and give an explanation: atomic mass, atomic radii, ionization energy and metallic properties.
10. Active metals are found in the upper/lower left/right of the periodic table. In general they have. In general they have large/small atomic radius and high/low ionization energy.
11. Active nonmetals are found in the upper/lower left/right of the periodic table. In general they have large/small atomic radius and high/low ionization energy.
12. What are the symbols and name of the seven metalloids?
13. Why are the noble gases considered inactive?
14. Where on the reference table can you find the values for ionization energy and atomic radius?
15. What are the names and symbols for the seven diatomic elements?

Summary:
Write a paragraph describing the structure of the periodic table. Include such things as the meaning of the group#, period #, s and p blocks, location of metals and nonmetals etc.

Periodic Table



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Lab # . : Periodic Table Lab—Part 2

Purpose: The purpose of this activity is to investigate the properties of many chemical elements and discover the underlying structure to the Periodic Table. It is also an opportunity to become with the Reference Tables.

Materials: Reference table, graph paper

Procedure:
In this activity you will create three graphs. You may do computerized graphs or they may be done on graph paper.
Graph#1: First Ionization Energy vs. Atomic Number
Graph#2: Electronegativity vs. Atomic Number
Graph#3: Atomic Radius vs. Atomic number
Plot the atomic number on the x-axis for #1-56. Plot the dependent variable on the y-axis. Remember to label the axis with the correct variable and units. You should obtain the values for the variable from table S on your reference table. Each graph must have a title. Put the symbol of each element next to the points on the graphs and use brackets to show which elements belong to the same period. This will make it easier to see the trends.

Data: Include three graphs. Remember to title the graph, label the axis, and include the symbols and periods.

Summary:
Write a summary in three sections—one for each graph.

a. Define the dependent variable. (Ionization energy, electronegativity, and atomic radii}
b. Discuss the trend in a group. Tell if it increases or decreases and explain why.
c. Discuss the trend in a period. Tell if it increases or decreases and explain why?

Lab # : Periodic Table Puzzle

Purpose: In this exercise you will use periodic properties and a list of clues to correctly arrange the elements scrambled periodic table. You will also predict values for any information missing from the table.

Materials: scissors and glue

Procedure:

1. Locate handout 1: Each block on the table represents the position of a different element from the main group elements, Group 1,2,13-18).
2. Cut out the blocks A-Z from handout 2. The code letters A-Z have been arbitrarily assigned to the first 26 of this short form of the periodic table. These code letters do NOT represent the chemical symbols nor have they been assigned in alphabetical order. These letters are presented in groups and your task is to arrange these elements in the proper order according to the information given pertaining to certain members of the group. The best way to start this puzzle is to find out in which group each element belongs and then arrange the elements within the group. The following elements belong to the same group:
ZRD JXBE LHT PSIF QKA WOV YMC GUN
3. Use the following clues and arrange the elements in their correct position, glue them in place on handout 1.
   a. **B** has 10 protons.
   b. **C** has 5 electrons in its outer energy level.
   c. **D** has the largest atomic mass in the group.
   d. **E** is a noble gas.
   e. **F** is a gas.
   f. Atoms of **I** are larger than those of **S.**
   g. I_2A is the simple formula of an oxide.
   h. **J** has an atomic number three times that of **T.**
   i. The atomic radius of **K** is the largest of the group.
   j. **M** has an atomic number one less than that of **A.**
   k. The electrons of atom **N** are distributed over three energy levels.
   l. **L** is an alkaline earth element with an atomic mass of 40.
   m. **O** has an atomic number larger than V.
   n. **O** is a halogen.
   o. **P** is less dense than S.
   p. **Q** has an atomic mass 2 times that of **A.**
   q. The atomic mass of **T** is more than that of **H.**
   r. **S** is an alkali metal.
   s. **U** has a total of 6 electrons.
   t. **W** is a liquid.
   u. **X** has an atomic number one higher than **F.**
   v. **Y** is a metalloid.
   w. **Z** has the smallest atomic mass in its group.

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4. Cut out the remaining 16 blocks from handout 2. Use the information provided in each block and your knowledge of periodic properties to arrange these elements in their proper position on handout 1. Glue the blocks in place.
5. Some information is missing from each block. Predict the values for the missing items from the location of the element on the periodic table. Place your predictions on the table.

Data: Attach handout #1

Questions:

1. The density of an element *increasing atomic number* and ________(decreases, increases) within a row with ________(decreases, increases) within a group.
2. The atomic radius of an element *increasing atomic number* and ________(decreases, increases) within a row with ________(decreases, increases) within a group.
3. The melting point of an element *increasing atomic number* and ________(decreases, increases) within a row with ________(decreases, increases) within a group.
4. The ionization energy of an element *increasing atomic number* and ________(decreases, increases) within a row with ________(decreases, increases) within a group.
5. Explain the relationship between **oxidation numbers** and the
   (a) group number of Groups IA (1) through VIIIA (18)

Group Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Oxidation Number																		

Summarize the Trend: As the Group Number increases, the oxidation number:

____

   (b) number of valence electrons for Groups IA (1) through VIIIA (18).

Group Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Valence Electrons																		

Summarize the Trend: As the group number increases, the number of valence electrons:

____

6. (a) How can an atom's electron configuration be predicted on the basis of its location in the periodic table?

____

   (b) ____________All atoms in a group of the Periodic Table have similar electron structures. Which quantum number of the valence shell electrons is different?

Summary: Attach a separate sheet of paper. Discuss the purpose of a periodic table and the meaning of the periodic law. How does this lab support the periodic law. Where are atoms similar in a group or a period? Why?

HANDOUT 1

Legend

Atomic #		Symbol
Density	Code Letter	Phase **
	Oxidation Number	
Atomic Radius		Melting Point, °C

	IA (1)	IIA (2)	IIIA (13)	IVA (14)	VA (15)	VIA (16)	VIIA (17)	VIIIA (18)
1								
2								
3								
5								
6								

HANDOUT 2

Legend

Atomic #		Symbol
Density	Code Letter	Phase **
	Oxidation Number	
Atomic Radius		Melting Point, °C

1.43 A gas .65 .55	0.0009 B gas .51 −249	1.82 C .128 44	5.90 D .141 29.8	0.0018 E gas 88 94	0.00009 F gas 0.053 −259	5.32 G .137 937	1.85 H .112 1278
0.862 I .235 64	0.0037 J gas .103 −157	4.79 K .140 217	1.55 L 197 839	0.0013 M gas .92 -210	2.33 N .132 1410	0.003 O gas 97 −101	0.534 P 0.155 181
2.07 Q .137 113	2.70 R 143 660	0.971 S 190 98	1.74 T 160 649	3.51 U .91 3520	0.0016 V gas .57 −219	3.12 W liquid .111 −7	0.00018 X gas .50 −272
5.72 Y .139 817	2.34 Z .98 2079	1.53 * 1+ .248 39	7.31 * 2+,4+ .162 232	6.69 * 3+,5+ .159 631	0.0059 * gas 0 .124 112	* 1− .145 302	9.3 * 2+,4+ .167 254
9.75 * 3+,5+ .170 271	1.87 * .265 28	6.24 * 2−,4+,6+ 450	7.31 * ,3+ .166 157	4.93 * 1− .132 114	11.85 * 1+,3+ .178 304	0.0097 * gas 0 .134 −71	3.5 * 2+ 725
11.3 * 2+,4+ 175 328	2.54 * 2+ .215 769						

* No code letter ** All are solids unless otherwise indicated

Lab # .: Shapes and Polarity of Covalent Molecules

Purpose: To build several covalent molecules and predict each molecule's polarity on the basis of their molecular shape.

Materials: Molecular model set

Procedure:

1. Build molecular models for each molecule in the data table on the accompanying page.
2. Complete the data table with all the required information.
3. Use the following key to construct your models:

Ball Color	**Element**
Black	Carbon
Blue	Nitrogen
Yellow	Hydrogen
Red	Oxygen
Green	Chlorine
Orange	Bromine
Purple	Iodine

Connector	**Bond**
1" wooden peg	C—H single bond
2" wooden peg	All other single bonds
Spring	Double, triple, ring

4. After you complete sets 1 and 2 have your teacher check your models and table before continuing with sets 3 and 4.

Data: Insert data table

Questions:

1. Why can you only talk about molecules in relation to covalent bonds and not ionic bonds?
2. What is the difference between a nonpolar bond and a nonpolar molecule?
3. What is the difference between a polar bond and a polar molecule?
4. Which molecules have a nonpolar bond and are nonpolar molecules? What shapes are they?
5. Which molecules have a nonpolar bond and are polar molecules? What shapes are they?
6. Which molecules have a polar bond and are nonpolar molecules? What shapes are they?
7. Which molecules have a polar bond and are polar molecules? What shapes are they?
8. Both water and carbon dioxide contain three atoms. One is linear and the other is bent. Why does this happen and how do their shapes affect the molecule's polarity?

9. Both ammonia and sulfur trioxide contain four atoms. One is planar and the other is pyramidal? Why does this happen and how do their shapes affect the molecule's polarity?
10. CH_4 and CH_3Cl are both made of 5 atoms what shape molecules are they? How do they differ in terms of molecular polarity? Explain.

Summary: Write a paragraph relating the number of atoms, bond type, shapes and molecular polarity. Use the answers from your questions above to aid you in your discussion.

Data:

Molecular Formula	Bond Type Polar/Nonpolar	Electron Dot Formula	Shape of Molecule	Molecular Polarity
SET 1: H_2				
Cl_2				
O_2				
N_2				
HCl				
BrCl				
SET 2: H_20				
CO_2				
H_2S				
SCl_2				
HClO				
HCN				
SET 3: SO_3				
PH_3				
NH_3				
H_2CO				
SET 4: CH_4				
CCl_4				
CH_2Cl_2				
CH_3Cl				
CH_3OH				

Lab #[redacted]: Determining the Specific Heat of Aluminum

Purpose: To determine experimentally the specific heat of aluminum and compare it to a known value.

Materials: 250 ml beaker, graduated cylinder, tongs, 2 thermometers, Bunsen burner, calorimeter, ring stand, wire gauze, aluminum samples, balance

Procedure:

1. Measure the mass of a small cube, rectangular bar, and a large block of aluminum. Enter these values as the mass of metal in your data table.
2. Set up a ring stand with wire gauze to heat a 250 ml beaker.
3. Place the three aluminum samples in a 250 ml beaker. Fill the beaker about half way with water and heat until boiling. Insert a thermometer in the water bath so you can keep track of the initial temperature of the metal samples. For each of your three aluminum samples follow steps 4- 10 below:
4. Obtain a calorimeter. Zero the calorimeter on an electronic balance. With a graduated add exactly 100 ml of water. Find the mass of the water in the calorimeter.
5. Insert the second thermometer through the whole in the cover. Record the temperature as the initial temperature of the water.
6. Once the water bath has reached its boiling point, let the water boil for 4-5 minutes with the aluminum in the beaker. Record the temperature of the water bath as the initial temperature of the metal.
7. Remove the lid from the calorimeter, and carefully remove the aluminum from the beaker using tongs. Put the metal in the calorimeter and replace the top.
8. Gently swirl the calorimeter. Monitor the temperature change of the water and record the highest temperature reached. Enter this temperature as the final temperature of both the water and metal.
9. Calculate the change in temperature for the water and metal and record both these values in your data table.
10. Empty the water from your calorimeter, dry off your metal, and repeat the procedure steps 4-10 for the other two aluminum samples.

Data and Observations:

Construct a data table with three columns: cube, rectangle, and block.

Record the following information for each sample: mass of metal, mass of water, initial temperature of water, initial temperature of metal, final temperature of metal and water, change in temperature for metal and change in temperature for water.

Calculations: (show all work, including formulas and units)

1. Using the fact that heat lost by metal = heat gained by the water, calculate the specific heat of the aluminum cube in calories and joules.
2. Repeat and calculate the specific heat of the aluminum rectangle in calories and joules.
3. Repeat and calculate the specific heat of the aluminum block in calories and joules.

Questions:

1. Find the average of your three specific heat values.
2. Using the Internet find the theoretical value for the specific heat of aluminum.
3. Calculate the percent error for your experimental average from question 1 above.
4. What are some sources of error?

Conclusion:

Write a paragraph describing what you did in this lab. Was your experiment successful? Why or why not? From this lab explain to difference between temperature and heat. When do you use a thermometer and when would you use a calorimeter?

Lab #▓: Temperature and Change of State

Purpose: To study the temperature changes during the freezing of a liquid and melting of a solid.

Materials: paradichlorbenzene, ring stand, ring, wire gauze, test tube, 250 ml beaker (2), Bunsen burner, test tube clamp, thermometer (2)

Procedure:

Part A: Melting temperature of a solid

1. Obtain a test tube 1/3 full with paradichlorobenzene from your instructor. Place one of the thermometers into the test tube.
2. Fill a beaker ½ full with water and heat to approximately 85 ^{0}C.
3. Remove the heat source from your beaker, and immediately lower your test tube in the warm water bath
4. Record the temperature in your test tube at 30-second intervals. (Begin at time 0 seconds and room temperature. Use a cool thermometer not the hot one.)
5. Continue recording the temperature until there is no longer a rise in temperature. (Approximately 70 ^{0}C)

Part B: Freezing temperature of a liquid

1. Quickly place your test tube (should be about 70°C at time 0) in a 250 ml beaker that has been sitting at room temperature.
2. Slowly stir the liquid with a thermometer and record the temperature in your test tube at 30-second intervals.
3. Note the temperature at which you can no longer a stir the liquid.
4. Continue recording the temperature until there is no longer a drop in temperature. (About 25°C)

Data and Observations:

Construct two data tables including the following information: time (min), temperature (°C), and observations (phase or phase change). Make one for part A and one for part B.

Analysis of Data:

Plot a heating and cooling curve on the same sheet of graph paper. A computerized graph is also acceptable. Plot the time on the x axis and temperature on the y-axis. The graph should contain the following:

a. Each axis properly labeled with the variable and unit.
b. A title at the top indicating the meaning of the curve.
c. The graph should fill the entire sheet of graph paper.
d. The final curve should be smooth, connecting as many points as possible and allowing other points to fall equally above and below the curve.
e. Label your phases and phase changes.
f. Using your graph indicate the melting/freezing point.

Questions:

1. Define melting and freezing point.
2. How does your melting and freezing point compare? How should they compare? Explain.
3. How would the melting and freezing point be affected if a different amount of paradichlorobenzene was used?
4. Find the average of your melting and freezing point. Use reference point book or Internet site and find the actual melting/freezing point for paradichlorobenzene. Compute your percent error.
5. What are some sources of error?

Summary:
Write a paragraph including the following information: heating and cooling curves, phases and phase changes, melting and freezing point, changes in kinetic energy versus potential energy, and the equations used to calculate the heat absorbed/released in the various sections of your curve.

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Lab #____ Heat of Fusion of Ice

Purpose: In this experiment you will find the heat of fusion of ice using a simple calorimeter.

Materials: 250 ml beaker, 100 ml graduated cylinder, Bunsen burner, calorimeter, thermometer, tripod, wire gauze, tongs, ice cubes

Procedure:

1. Heat approximately 150 ml of water in a 250 ml beaker to 60 ^{0}C.
2. Measure approximately 100 ml of water (using a graduated cylinder) and pour it into the calorimeter. Record this as the initial volume of hot water (to the nearest .1 ml) in your data table.
3. Record the initial temperature of the hot water to the nearest .1 degrees.
4. Immediately add 2-3 ice cubes. Stir the ice-water mixture carefully with the thermometer. The calorimeter should contain ice at all times. Therefore if the last of the ice appears to melt, add another ice cube. Monitor the temperature of the ice-water mixture as you stir. Continue stirring, and adding ice as necessary, until the temperature levels off. Record this as final temperature of water and melted ice.
5. Carefully remove the unmelted ice. Allow any excess water to drain back into the calorimeter. Using a graduated cylinder record the volume of water and melted ice. (You volume will be more than 100 ml, so remember to measure to 100ml accurately, discard, and refill)

Data: Prepare a data table of the following information: volume of hot water, initial temperature of hot water, final temperature of water and melted ice and final volume of water and melted ice.

Analysis of Data:
(Remember to show all work, include units and watch for significant figures)

1. Calculate the change in temperature for the hot water.
2. Find the mass of the original volume of hot water. (Use the density of water is 1g/ml)
3. Calculate in joules the heat lost by the original mass of hot water (use $q=mc\Delta t$)
4. Find the volume of water resulting from the melted ice. ((Volume of water and ice-volume of hot water)
5. Find the mass of this volume of ice.
6. Find the heat of fusion of ice (q/mass of water from step 5)
7. Look up the heat of fusion of ice in joules per gram and calculate your percent error.

Summary: Define heat of fusion and melting. Do you think your experiment was successful? Why or why not? What are some possible sources of error in this lab?

Lab #: Boyle's Law by the book

Purpose: How does the volume of an enclosed sample of gas change as the pressure of the gas is changed?

Materials: safety goggles, Boyle's law apparatus, ring stand, clamp, 8 chemistry books,

Procedure:

1. Work in your families. One person operates the apparatus, two will steady the books and the fourth will record the data. Switch roles for trials 2 and 3.

2. Everyone puts on his or her safety goggles. Secure the Boyle's law apparatus with a ring stand and clamp. Set the syringe at 35 ml and record this as the volume of 0 books in your data table.

3. Place the apparatus on your lab desk. Place one book on top of the apparatus and record the new volume of air trapped in the syringe with 1 book. Add a second book and record the new volume of air with 2 books. Continue adding books until all eight books are resting steady on top of the apparatus. Remember to steady the apparatus especially when the volume is being read. Balance the books do not hold them!!!

4. Remove all the books from the apparatus and reset the syringe to 35 ml. Switch roles and repeat for two more trials.

5. Clean up your work area.

6. Compute the average volume for all trials for 1 book, 2 books, 3 books, etc.

7. Calculate P xV. Add this to your data table.

Data and Calculations: Construct a data table using the following headings: Number of books (0-8), Volume Trial 1, Volume Trial 2, Volume Trial 3, Average Volume, P xV

Analysis of Data:

Construct a graph using Microsoft excel (scatter graph). Plot the Number of books versus the average volume. Don't forget to label your axis and title your graph.

Questions:

1. What shape is your graph? What does the shape tell you about the relationship between pressure and volume?

2. Do your graph and your data support Boyle's law? Explain.

3. Was performing 3 trials necessary? Explain.

4. A balloon contains 30 liters of helium gas at 100 kPa. What is the volume when the balloon rises to an altitude when the pressure is only 25 kPa? Show your work!!!

5. Explain how the principle of Boyle's Law comes into effect in the operation of a bicycle pump?

Summary: State Boyle's Law in your own words. Include the mathematical equation for Boyle's Law. Explain the law using the kinetic molecular theory. Does your lab support Boyle's law? Explain. What are some sources of error in this lab?

Lab #: Charles's Law

Purpose: How does the volume of an enclosed sample of gas change as the temperature of the gas is changed?

Materials: 3 thermometers, (2) 1 liter beakers, hot plate, 250 ml beaker, small round balloon, string, tongs, metric ruler, ice

Procedure:

1. Blow up a round balloon so that the diameter of the balloon is about ½ the diameter of a large beaker. (It is not necessary to blow up the balloon all the way)

2. Wrap a piece of string around the widest part of the balloon. With a pen put a mark indicating this spot. Use a ruler to determine the length of the string. Record the circumference of the balloon in your data table. Record also the room temperature.

3. Prepare an ice-water bath in a 1-liter beaker. Record the temperature of the water in your data table. Place the balloon in the ice water. Use a 250 ml beaker to hold the balloon below the water for a bout 2 minutes. Remove the balloon from the ice water and quickly wrap the string around the widest part of the balloon. Use a ruler to determine the length of the string and record the circumference of the balloon in your data table.

4. Prepare a hot water bath in the second 1-liter beaker. Record the temperature of the water in your data table. Use a 250 ml beaker to hold the balloon below the water for about 2 minutes. Using tongs remove the balloon from the hot water and quickly wrap the string around the widest part of the balloon. Use a ruler to determine the length of the string and record the circumference of the balloon in your data table.

5. The circumference of the balloon is πd (d=diameter); calculate the diameter of the balloon at all three temperatures in mm.

6. Calculate the radius of the balloon at all three temperatures in mm.

7. The volume of the balloon is $4/3\pi r^3$; calculate the volume of the balloon in mm^3. (Use three significant figures in your answer!!)

8. Convert all three temperatures to the Kelvin scale. Add this to your data table.

Data and Calculations:

Construct a data table using the following headings: Temperature (°C), Circumference of balloon, Diameter of the balloon, Radius of the balloon, and Volume of gas in the balloon, Temperature (K). Make sure you include units in your heading or in your table.

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Analysis of Data:
Construct a graph using Microsoft excel (scatter graph). Plot the temperature (K) versus the volume of gas in the balloon. Don't for get to label your axis and title your graph.

Questions:

1. What shape is your graph? What does the shape tell you about the relationship between temperature and volume?

2. Do your graph and your data support Charles's law? Explain.

3. On a warm summer day the outdoor temperature may reach 27 ^{0}C. Use your graph to find the volume of the gas in the balloon at that temperature. Predict the Volume of the gas at 327^{0}C?

4. A balloon, inflated in an air-conditioned room at 27^{0}C, has a volume of 4.0 liters. The balloon is then heated to a temperature of 57^{0}C. What is the new volume of the balloon if the pressure remains constant?

5. The manufacturer of aerosol containers usually posts a warning on the container to keep in a cool area and to avoid leaving the product out in the sun. Use Charles's law to explain why this warning is important.

Summary: State Charles's Law in your own words. Include the mathematical equation for Charles's Law. Explain the law using the kinetic molecular theory. Does your lab support Charles's Law? Explain. What are some sources of error in this lab?

Lab #: Molar Volume

Purpose: What is the molar volume of hydrogen gas?

Materials:

Plastic bin	ice	tap water	metric ruler
Thermometer	barometer	magnesium strip	long stem micropipet
3.0 M HCl	graduated cylinder, 10 mL		plastic wrap
rubber band	pin		

Procedure:

1. Fill the plastic bin one third full of ice. Add tap water to a depth of 5-10 cm. Place a thermometer in the basin. Add more ice if necessary until the temperature is 0°C. Use a barometer to measure the atmospheric pressure in the laboratory. Record the temperature and the pressure in your data table.
2. Obtain a strip of magnesium that is about 1.0 cm long. With scissors, trim the edges so that they are straight across, rather than diagonally cut. Measure the length of the strip to the nearest 0.2 c, and record the length in your data table.
3. Use a micropipet to dispense approximately 3 mL of 3.0 M HCl into the bottom of an empty 10-mL graduated cylinder. Insert the micropipet into the center of the cylinder to avoid getting acid on the sides of the cylinder.
4. Rinse out the micropipet. Fill the rest of the graduated cylinder with tap water using the micropipet. Drip water down the inside surface of the cylinder to prevent mixing the acid with the water. The water should overfill the cylinder top slightly to form a smooth curved surface.
5. Roll or fold the magnesium and place it carefully onto the surface of the water in the cylinder. It should float. Quickly cover the cylinder with a square of plastic wrap, stretch the plastic tight, secure it with a rubber band. Make sure that there are no air bubbles trapped under the plastic wrap.
6. With a pin, poke a tiny hole in the plastic over the cylinder mouth. Holding the cylinder by the base, to avoid heating it, immediately invert it in the basin of ice water. Hold the inverted cylinder vertically with its mouth submerged. Do not block the pin hole.
7. The magnesium will react with the acid, producing hydrogen gas that collects in the cylinder. When the reaction is complete, choll the gas by submerging the cylinder completely in the ice water for about one minute, tipping it slightly if necessary.
8. To read the volume of hydrogen gas in the cylinder, lift the cylinder vertically until the liquid level inside the cylinder matches the level of water in the basin. This equalizes the pressure in the cylinder with the atmospheric pressure outside the cylinder. Record the volume of hydrogen gas in your data table.
9. Obtain the mass/length ratio of magnesium from your instructor.

Data:

Be sure to record the length of the magnesium strip, the volume of hydrogen you collected, the temperature of the water in the basin, and the atmospheric pressure in the laboratory on a data table.

Analysis of Data:

1. Determine the mass of the magnesium used in your trial using the mass to length ratio provided by your teacher.
2. Determine the number of moles of magnesium used in the experiment.
3. Use the number of moles of magnesium and the balanced chemical equation to determine the number of moles of hydrogen produced.
4. Find the volume of hydrogen produced at standard pressure in each trial using the following formula:

$$\text{Volume} = \text{measured volume (L)} \times \frac{atmospheric..pressure(mmHg)}{760mmHg}$$

Summary

Based on your data, what is the molar volume of hydrogen in liters H_2 per mole H_2? Compare this to the accepted value of 22.4 liters H_2 per mole H_2 by computing the percent error. Explain what type of reaction is taking place between the magnesium metal and the hydrochloric acid.

Lab #: Density and Mixtures

Directions: The following lab is an inquiry based laboratory activity. You are to submit a formal lab write-up similar to the laboratory write-ups you did this year. The difference is you will be given an objective for each section. The materials, procedure and presentation of the data are up to you. Remember to present your information in a neat and organized fashion. You may write the lab as three minilabs with separate procedures, data tables and conclusions or you may write the lab as one lab consisting of three sections. You then will have only one conclusion that includes **all** the questions from each part. Have fun!!!!

Part A: Density

Purpose: How do you determine the density of a liquid, regular and an irregular solid?
Procedure: With your lab partner work out a procedure to determine the density of 25 ml of water, a wooden block and a key.
Data: Include a data table of the values needed to calculate the density of all three samples.
Conclusion: Discuss the method you used to determine the density of your samples. Were they successful, why or why no?

Part B: Your Own Submarine

Purpose: Construct a "submarine" that sinks to the bottom of a large graduated cylinder and then rises to the top.
Procedure: The materials you have available to use are: a film canister with a whole in the lid, pennies, baking powder, baking soda, citric acid, alka seltzer and a large graduated cylinder. You may use any combination inside the film canister. Record the exact procedure you used to construct the submarine. Trial and error is necessary to create a working model. Show me your working sub. Be conservative with your materials. You may want to try out combinations of reactants on a spot plate before you begin your sub construction.
Data: Record your observations of your working sub.
Conclusion: Explain your successes and failures. Describe what causes your sub to sin, then float. Be specific.

Part C: Mixtures

Purpose: How could you separate a mixture of iron, small rocks, and salt? How can you determine the percent of each material in the original mixture?
Procedure: With your lab partner work out a procedure that would separate and determine the relative amounts of the three materials.
Data: List the observations and measurements you make in carrying out the procedure. Include the percents of each substance present in the original mixture?
Conclusion: How well did your procedure accomplish what you wanted to accomplish? What problems did you run into? What could you do differently to get better results?

Lab #. : Rock Candy

Various common chemicals can be used to grow crystals. In this lab, you will grow sugar crystals, commonly called rock candy. For good results, all of the equipment you use should be very clean. Your crystals should be grown in a location that is not subject to rapid temperature changes. Your crystals will require at least 1-10 days to form. Once large crystals are formed, remove them and dry them. Put them in a Ziploc bag and submit it with your formal lab report.

Purpose: To learn about solutions by making rock candy

Procedure: Re search a procedure that can be used to make rock candy. You may use the Internet and/or cookbooks. Don't forget to look at the lab from a scientific prospective.

Data and Observations: Record your observations on a daily basis. If you do not get crystal growth within 3-5 days, modify your procedure and continue recording observations.

Questions:

1. Describe the general shape of a sugar crystal?
2. Compare and contrast a sugar crystal from the sugar bowl at home and one of your sugar crystals.
3. What type of solution did you create to grow your crystals?

Conclusions:
Write a paragraph on how this lab relates to solutions. Was your lab successful, why or why not? If you were to do this lab again how would you modify your procedure? What sources did you use to help develop your procedure?

Lab # : Solubility of a Salt

Purpose: Collect the experimental data necessary to construct a solubility curve for potassium nitrate in water.

Materials: (per group) balance, burner, spatula, 4 test tubes, test tube rack, 400 ml beaker, 5 thermometers, 10 ml graduated cylinder, stirring rod, ring stand, iron ring, clamp, wire gauze, marking pencil, goggles

Procedure:
(You are to work in groups of 4)
1. Using a marking pencil, number test tubes 1-4 and place in a test tube rack.
2. Each person is responsible for one test. Set up the four test tubes in the following manner:
Test tube #1: 2.0 grams of potassium nitrate – 5ml of water
Test tube #2: 4.0 grams of potassium nitrate--5ml of water
Test tube #3: 6.0 grams of potassium nitrate—5 ml of water
Test tube #4: 8.0 grams of potassium nitrate—5ml of water
Record the exact grams used to the nearest tenth of a gram.
3. Fill a 400 ml beaker about three-fourths full of tap water to be used as a water bath. Set on a ring stand and wire gauze and heat to 90 degrees Celsius. Try to maintain this temperature.
4. Insert a thermometer in each test tube and put them together in the water bath. Stir gently until all the solute dissolves.
5. When all the solute dissolves remove the test tube and hold the test tube up to the light and watch for the first signs of crystallization. At the instant crystallization begin, observe and record the temperature.
6. Share your results with your lab group.

Data and Observations:
Prepare a data table including the following: test tube # 1-4, mass of solute per 5 ml of water, mass of solute per 100 ml of water, crystallization temperature.

Analysis of Data:
Prepare a graph using Microsoft excel of the following information: Temperature vs. grams of potassium nitrate /100 ml of water. Remember to label your axis and draw a smooth curve of your four data points.

Questions:
1. Use **your** graph to determine the number of grams of potassium nitrate than can be dissolved in 100 ml of water at the following temperatures: 30, 60 and 70 degrees Celsius.
2. Repeat question one above using Table G.
3. Using question 1 and 2 above, how do your values compare? How should they compare?
4. Define the following terms: unsaturated, saturated and supersaturated.
5. Classify the following solutions using the terms in question 4 above. (Use Table G) Explain your answers: 75 grams of potassium nitrate in 100 ml of water at 40 degrees Celsius and 60 grams of potassium nitrate in 100 ml of water at 50 degrees Celsius.
6. Do the solubilities of all the solutes on table G show an increase with increasing temperature? If not which ones do not and why?

Conclusion:
Explain the meaning of the terms solutions and solubility. Did you successfully create an accurate solubility curve for potassium nitrate? Explain. What are some sources of error in this lab?

Lab #: Freeing Point Depression – Making Ice Cream

Purpose:

What are colligative properties and how can we apply this knowledge in our lives?

Materials

1 – 1 quart zip lock bak
thermometer
ice cream cups and spoons
measuring spoons
sugar
milk
sodium chloride (NaCl)
1 – 1 gallon zip lock bag
balance
measuring cups
gloves
vanilla extract
ice
chocolate syrup

Procedure

1. To a 1-quart zip lock bag add: ¼ cup sugar, ¼ teaspoon vanilla extract, 1 cup milk
2. Close the bag tightly, making sure to remove some of the air. Gently mix the ingredients.
3. Into a 1 gallon zip lock bag add approximately 2 liters of ice cubes.
4. Measure the temperature of the ice. Record your data.
5. Mass out 250 grams of NaCl and add it to the ice.
6. Place the 1-quart zip lock bag with the ingredients in the 1-gallon bag. Close the bag tightly.
7. Gently rock the bags back and forth, kneading the ingredients for about 8 – 10 minutes until the ingredients become semi-hard. WEAR GLOVES
8. Open the 1 gallon bag and take the temperature of the ice water and salt mixture. Record your data.
9. Spoon the ice cream into cups and enjoy.

Data

Create a data table including all of the information gathered during the experiment, including the change in temperature of the ice water salt mixture.

Analysis of data

What is the formula for the determination of freezing point depression? Calculate the expected freezing point depression, assuming the 2 liters of ice weighs about 1500 grams. How do your actual results compare the value you calculated (percent error)? Explain any differences.

Summary

Explain why the addition of a solute lowers the freezing point of a solution.

' `#. .: Antifreeze is Anti-boil

Purpose: What is the effect on the boiling point of a solvent when a solute is added?

Materials: 4 test tubes, test tube rack, 2 test tube clamps, Bunsen burner, antifreeze, boiling chips, thermometer, ring stand

Procedure: Work in your families. Each pair is responsible for two test tubes. Which means each pair should set up a separate ring stand.

1. Obtain four test tubes and set in a test tube rack. Label the test tubes 1-4. In test tube #1 prepare 10 ml of a 0% by volume solution of antifreeze in water (10 ml of water). In test tube #2 prepare 10ml a 30% by volume solution of antifreeze in water (3 ml of antifreeze mixed with 7.0 ml of water. In test tube #3 prepare 10 ml of a 50% by volume solution (5 ml of antifreeze mixed with 5.0 ml of water. In test tube #4 prepare 10 ml of a 70% by volume solution (7 ml of antifreeze mixed with 3 ml of water).
2. Begin with test tube #1. Clamp the test tube to a ring stand. With a second clamp insert a thermometer close to but not touching the bottom of the test tube. Raise the test tube so that it is 6-8 inches away from the Bunsen burner flame. Add one to two boiling chips.
3. Heat the test tube and record the exact boiling point
4. Repeat steps 3-5 for each solution of antifreeze. Record your results in your data table.
5. For each solution calculate the elevation in the boiling point based upon that of your water sample.

Data and Observations:
Prepare a data table using the following headings: Test tube # (1-4), %antifreeze, (0, 30,50 and 70), ml of antifreeze, ml of water, boiling point, and boiling point elevation.

Analysis of Data: Prepare a graph using Microsoft Excel of % antifreeze vs. boiling point elevation temperature.

Questions:

1. Define the phrase colligative property? How does this lab illustrate a colligative property?
2. What is the relationship between boiling point elevation and an increase in concentration?
3. Why is the title of the lab appropriate?
4. Explain why antifreeze is used in a car engine.
5. Explain why salt is sprinkled on icy sidewalks.

Summary: Discuss the effects of adding a solute to a solvent on both the boiling point and freezing point. How does your lab support this? Was your lab successful? Why or why not? What are some sources of error in this experiment?

Lab# : Rates of Reaction

Purpose: Study the effect of changing the concentration of a reactant on the rate of a chemical reaction. Study the effect of changing the temperature on the rate of a chemical reaction.

Materials: 250 ml beaker, (2) 50 ml beakers, (2) 10 ml graduated cylinders, (2) large test tubes, thermometer, watch, 100 ml Solution A and 100 ml of solution B (per group)

Note: Solution "A" is a dilute solution of potassium iodate (KIO_3), which is the source of one of the reacting species, the iodate ion, $(IO_3)^{-1}{}_{(aq)}$
Solution "B" contains some starch and the other reacting species, the hydrogen sulfate ion, $(HSO_3)^{-1}{}_{(aq)}$
The initial step in the reaction can be represented by the equation:
$(IO_3)^{-1}{}_{(aq)} + 3(HSO_3)^{-1}{}_{(aq)} \rightarrow I^{-1}{}_{(aq)} + 3(SO_4)^{-2}{}_{(aq)} + 3H^{+1}{}_{(aq)}$
When the hydrogen sulfite ions are "used up", the iodide ions react with the remaining iodate ions to produce iodine:
$5I^{-1}{}_{(aq)} + 6H^{+1}{}_{(aq)} + (IO_3)^{-1}{}_{(aq)} \rightarrow 3I_{2(s)} + 3H_2O$
This molecular iodine forms a blue solution with the starch present in the solution, which indicates that the reaction has proceeded to this point.

Procedure: Work in groups of 4. Two students will perform part A and two students will perform part B. When both parts are complete you will exchange your data. Each group will receive 100 ml of solution A and 100 ml of solution B from their instructor.

Part A:

1. Obtain two 10 ml graduated cylinders and two 50 ml beakers and label one for solution A and the other for solution B. Do not interchange the glassware and the solutions.
2. Using a clean, dry 10 ml graduate measure 10 ml of solution A and pour into a 50 ml beaker marked for solution A.
3. Using the second 10 ml graduated cylinder, measure exactly 10 ml of solution B and pour into the second 50 ml beaker marked for solution B.
4. Prepare to time the reaction. While one lab partner pours solution A into solution B, the second partner should immediately start timing the reaction. Pour the solutions back and forth several times from one beaker to the other to insure thorough mixing. Then allow the mixture to stand. At the instant a color change occurs, the partner should note the elapsed time and record the time in your data table. Rinse and dry the beakers.
5. Measure exactly 10 ml of solution B into your graduated cylinder and pour into the beaker marked for solution B. Measure exactly 9 ml of solution A into the other graduated cylinder. Dilute this solution with 1 ml of water. Mix the solutions as described in step 3 above and time the reaction. Record the time in seconds in your data table. Rinse and dry the beakers.
6. Repeat step 5 four more times using increasingly dilute samples of Solution A. Use the following Solution A: water ratios in ml. 8:2, 7:3, 6:4, 5:5.

Part B:

1. Measure 10 ml of solution A in one test tube and 10 ml of solution B in a second test tube.
2. Insert the test tubes into the cold and hot water baths provided by your teacher.
3. Place the test tubes into the hot or cold-water bath and let them stand until the solutions are at the same temperature as the water bath. (Always rinse and wipe the thermometer after removing it from a solution.
4. When the solutions are at the same temperature as the water bath, prepare to time the reaction. One lab partner should start timing the reaction the instant the second partner pours Solution A into Solution B. Quickly pour the mixtures back and forth from tube to tube several times and return to the water bath. At the instant a color change appears, note the time elapsed and record the exact temperature of the water bath in your data table. Rinse and dry the test tubes.
5. Repeat steps 1-4 for the other water baths provided by your instructor. Record your observations in your data table.

Data and Observations: Prepare two data tables as follows:
Data table 1: Use the following headings: Solution B (ml), Solution A (ml), Water (ml), Time (sec)
Data Table 2: Trial #, Temperature (^{0}C), Time (sec)

Analysis of Data:

1. Plot your data from Part 1 (ml of Solution A vs. Reaction time)
2. Plot your data from Part 2 (Temperature vs. reaction rate).

Questions:

1. Based on your experimental data make a general statement about the effect of concentration of reactants on reaction rate.
2. Based on your experimental data, make a general statement about the effect of temperature on reaction rate.
3. Name at least two other factors that can affect the rate of a reaction.
4. How does the collision theory relate to the rate of a chemical reaction?

Conclusion:
Was your data for both parts A and B in agreement with the collision theory and what we learned in class about reaction rates? Explain. What are some sources of error in this lab?

Lab #: Determining the ΔH for Dissociation Reactions

Purpose: To determine the heat of reaction of 2 compounds ammonium chloride and sodium hydroxide.

Materials: calorimeter, thermometer, and 100 ml graduated cylinder, balance, ammonium chloride and sodium hydroxide

Procedure:

Part A: Sodium hydroxide

1. With a graduated cylinder measure 100 ml of water and add to an empty calorimeter. Find the mass of water and record this in your data table.
2. Calculate the mass of 0.10 mole of sodium hydroxide. Mass out this amount onto a watch glass. Record the exact mass into your data table.
3. Record the initial temperature of the water.
4. Add the sodium hydroxide to the calorimeter.
5. Observe the change in temperature. When the temperature stabilizes, record the value as the final temperature of the water.
6. Clean out your calorimeter.

Part B: Ammonium chloride

Repeat the steps above for the ammonium chloride. (The mass of ammonium chloride will be different from the sodium hydroxide)

Data: Prepare two data tables. (One for sodium hydroxide and one for ammonium chloride). Include the following information: mass of water, mass of solute, initial temperature of the water and final temperature of the water.

Calculations:

Part A: Sodium hydroxide

1. Calculate the temperature change for the water.
2. Calculate the heat absorbed or released by the water. (Joules=m x c x Δt)
3. Using the fact that heat lost = heat gained, calculate the ΔH for the sodium hydroxide. Watch your sign.
4. Your value from step 3 above is joules/. 1 mole. Calculate the value for ΔH in joules/mole.

Part B: Ammonium hydroxide

Repeat steps 1-4 above.

Questions:

1. What does the term enthalpy mean?
2. What is the difference between an endothermic and an exothermic reaction?
3. What does the sign of ΔH indicate?
4. Write the equations for the dissociation of sodium hydroxide and ammonium chloride.
5. Using your reference table, find the heat of reaction for the dissociation of sodium hydroxide and ammonium chloride.

6. Calculate the percent error for each solute.

Summary:
Explain what is meant by enthalpy and heat of reaction. In this lab you used two different solutes. One represented an endothermic reaction and the other an exothermic reaction. Which was endothermic and which was exothermic? How could you tell from this lab and your sign of ΔH? Was your lab successful? Why or why not? What are some sources of error?

Lab # : Chemical Equilibrium and Le Chatelier's Principle

Purpose: Study equilibrium systems and their responses to stress as described by Le Chatelier's principle.

Materials: .1N $FeCl_3$ (9 g in 20 ml of conc. HCl/1000 ml water)
.1N NH_4SCN (8 g/1000 ml water)
5 test tubes and test tube rack, 10 ml and 100 ml graduated cylinders
250 ml beaker, hot plate and hot water bath

Procedure:

1. Add 3 ml of 0.1N $FeCl_3$ solution and 3 ml of 0.1N NH_4SCN to 150 ml water in a 200 ml beaker. The read color that develops is the result of the reaction:
   $FeCl_3 + NH_4SCN \leftrightarrow Fe(SCN)^{+2} + 2Cl^- + NH_4Cl$
   (red)
2. Pour 15 ml of this solution into each of 5 test tubes and set them up in a test tube rack.
3. Proceed as follows:
   Test tube 1: Set aside as a control
   Test tube 2: Add 1 ml of $FeCl_3$ and observe.
   Test tube 3: Add 2ml of NH_4SCN solution and observe.
   Test tube 4: a. Add a small pinch of solid NH_4Cl crystal, mix and observe.
   b. Add a small pinch of solid NH_4SCN crystals, mix and observe.
   Test tube 5: a. Warm the test tube in a warm water bath and observe.
   b. Make another comparison when the tube has been cooled back to room temperature.

Data and Observations: Prepare a data table with the following information: Test tubes (1, 2, 3, 4a, 4b, 5a, 5b), Action/Stress, Observation (color description) and Conclusion (equilibrium shift)

Questions:

1. For each action taken (7 in total) discuss your results in terms of Le Chatelier's Principle.
2. State which of the reactions, forward or reverse, is exothermic and which is endothermic. Discuss the reasons for your choice.

Summary: Define the term chemical equilibrium. Explain Le Chalelier's Principle. Were your results in agreement with Le Chatelier's Principle? Which were and which were not? If any were not what do you think could have caused incorrect results?

Lab #: : Household Acids and Bases

Purpose: To determine if common household items are acidic, basic or neutral.

Materials: Make a list of the items you are going to test and the indicators used. A spot plate and other pieces of glassware might be useful in this lab.

Procedure: Write an organized procedure for testing 10 household items to see if they are acids, bases or salts. You must use red litmus, blue litmus, pH paper, phenolphthalein, and at least one other indicator.

Data: Arrange your data in an organized fashion. You must create a table showing the ten substances tested and their colors with each indicator used.

Questions:

1. Which household substances were acidic? How did you come up with this conclusion?
2. Which household substances were neutral? How did you come up with this conclusion?
3. Which household substances were basic? How did you come up with this conclusion?
4. For each indicator used identify the color in an acid and base. Use your reference table to help you.
5. Define the term indicator. List at least two other indicators not used in this lab and their color in an acid and base.
6. Compare and contrast an acid to a base. Include at least two ways in which they are similar and two ways in which they are different.

Conclusion:

Describe how indicators can be used to tell an acid from a base. Be specific. Were the substances you determined to be acidic, basic and neutral what you expected? Were there any surprises? Can you draw any connections between certain types of household items and whether or not they are acidic or basis?

Lab # : Properties of Acids and Bases

Purpose:

What are some of the properties of acids and bases we can observe?

aterials:

Well plate	HCl 3.0 M	Acetic acid 1.0 M	sodium hydroxide 0.5 M
Blue and Red Litmus paper		pH paper	phenolphthalein
Microspatula	zinc	magnesium ribbon	iron filings
Copper wire or sheet	5 test tubes	test tube rack	wooden splint
Match	1 – hole rubber stopper fit with right angle bend glass tubing		
Limewater	calcium carbonate	2 micropipets	

Safety

BE VERY CAREFUL when handling acids and bases. Acids are corrosive and bases are caustic. They can cause serious injury if they come in contact with skin or eyes. Wash spills and splashes with plenty of water and always tell your teacher about all accidents.

Procedure

PART A – Using indicators

1. Add five drops of each of the following solutions to separate labeled wells in the well plate: 1.0 M HCl; 1.0 M $HC_2H_3O_2$; 0.5 M NaOH.
2. Place a drop of each soltion onto a piece of red litmus paper. Record your observations.
3. Repeat step 2 using blue litmus paper and then pH paper. Record your observations.
4. Add one drop of phenolphthalein to each solution. Record your observations.

PART B – Reactions of Acids with Metals

5. To four separate, clean, labeled wells in your well plate, add a small piece of zinc, magnesium, iron, and copper.
6. To each of these depressions, add enough 1.0 M HCl to cover the metal. Observe and compare the relative speed of reaction of the metals with the acid. Record your observations.
7. Repeat Steps 5 and 6, using clean wells but substituting 1. M acetic acid for 1.0 M HCl. Compare the reactivity of each metal with $HC_2H_3O_2$ to its reactivity with HCl. Record your data.
8. Add a small amount of zinc to a well in your well plate. Cover the zinc with 1.0 M HCl. As the reaction proceeds, hold an inverted test tube over the zinc for about two minutes. Without turning the test tube upright, quickly insert a burning splint into the test tube. Record your observations.

PART C – Reactions of Acids with Carbonates

9. Put on protective gloves. Half fill a clean test tube with limewater solution. Into a second test tube, place a small amount of calcium carbonate ($CaCO_3$). Obtain a rubber stopper with a right angle piece of tubing.
10. Add enough 3.0 M HCl to cover the $CaCO_3$. Insert the rubber stopper into the test tube containing $CaCO_3$ and HCl. Place the open end of the glass tubing into the limewater. Record your observations.

PART D – Neutralization

11. Using a micropipet, add ten drops of 1.0 M HCl to a clean test tube. Add one drop of phenolphthalein. Test with pH paper. Record your observations.
12. Using a second micropipet, add 0.5 M NaOH to the acid, one drop at a time. After the addition of each frop, swirl the test tube to thoroughly mix the contents. Count and record the total number of drops of NaOH needed to cause a permanent color change. Once the color change is observed, test the solution again with pH paper. Record your results.

Data

Create data tables for all of the data to be collected in these experiments. One way is to set up two tables, one for the series of tests performed on the acids and the base, and one table for the speed of reactions with metals. You should also list the results the other tests performed during the lab.

Analysis of Data

For each metal that reacted with HCl, write a balanced chemical equation. For each metal that reacted with HC2H3O2, write a balanced chemical equation. List the reactivity of the metals in decreasing order. Explain the difference in reaction rates of a given metal with the two different acids. Explain the difference in volumes of HCl and NaOH required to produce a neutral solution in Part D.

Summary

Describe the type of reaction that occurs between certain metals and an acid? What is the effect of acid rain on statues made of marble (calcium carbonate)? Based on your data, write a brief paragraph summarizing some properties of acids and bases.

Lab # : Acid-Base Titration

Purpose: Determine the molarity of a NaOH solution by titrating it with a standard HCl solution. Determine the molarity of a sample of white vinegar.

Materials: (2) 50 ml berets, buret stand, buret clamp, 250 ml Erlenmeyer flask, 10 ml graduated cylinder, (2) 100 ml beakers, .100 M HCl solution, unknown concentration of NaOH, phenolphthalein

Procedure:

Part A: Standardizing the Base

1. Prepare two 50 ml burets for the titration by washing and rinsing both thoroughly.
2. Rinse one buret with two 5 ml portions of standard 0.100 M HCl and the other buret with the unknown concentration of NaOH. Be certain that you run some of the solution through the tips of the buret and remove any air bubbles.
3. Fill each of the burets with solution and record the initial volume of both burets to the nearest 0.01 ml. Add this to your data table.
4. Run 10-11 ml of 0.100 M HCl into a clean 250 ml Erlenmeyer flask, add 2-3 drops of phenolphthalein indicator, and wash down the sides of the flask with water from your wash bottle.
5. Add NaOH to the acid in the flask in small portions until the solution in the flask turns pink and stays pink for 20-30 seconds. Back titrate with HCl, drop wise, until the solution turns clear. Finally add NaOH drop wise until one drop of base just turns the solution pink. Swirl the solution after each addition and wash down the sides of the flask often. Record the final volume of each of the solutions in the burets to the nearest 0.01 ml. Add this to your data table.
6. For the HCl and NaOH calculate the volume used. Add this to your data table.
7. Rinse the flask, record the initial volumes of both solutions and repeat the titration for three more trials. It is not necessary to refill the burets. Simply read and record the volumes of the solutions carefully.

Part B: Titration of White Vinegar

1. Using a graduated cylinder measure out approximately 10.00 ml of white vinegar into a clean Erlenmeyer flask. Add 100 ml of distilled water.
2. Add three drops of phenolphthalein and carefully titrate using the same NaOH solution from part A.
3. If overtitration occurs, add a measured amount of vinegar to the flask until the solution is colorless. This time reach the endpoint carefully by titrating drop by drop with the NaOH solution.
4. Record in a second data table the volume of vinegar used, the initial, final and actual volume of NaOH used.

Data and Observations:

Prepare tow data tables as follows:

Data Table 1 for part A: In an organized fashion arrange data for four trials including the initial, final and actual volume of HCl and NaOH used.

Data Table 2 for part B: In an organized fashion show the volume of vinegar used, the initial, final and actual volume of NaOH used.

Analysis of Data:

1. For each trial calculate the molarity of the NaOH solution.
2. Find the average molarity of the NaOH solution.
3. Determine the molarity of the white vinegar using the average molarity of the NaOH from question 2 above.

Questions:

1. Define the following terms: neutralization reaction, titration, standard solution, and endpoint.
2. Explain why people can use white vinegar in preparing foods and in cooking without danger to the skin or the internal organs.
3. If 30.0 ml of 0.500 M KOH is needed to neutralize 10.0 ml of HCl of unknown concentration, what is the molarity of the HCl?
4. How many ml of 0.100 M NaOH is needed to titrate 20.0 ml of 0.100 M H_2SO_4?
5. A beaker contains 20.0 ml of 0.01 M HCl solution. How many moles of HCl are in the beaker? How many grams of HCl are in the beaker? How many moles of NaOH will it take to neutralize the acid in the beaker?

Summary: Write a paragraph explaining the relationship between a neutralization reaction and a titration. Describe in your own words how to perform a titration. Make sure you include such terms as: standard solution, endpoint, indicators, and the formula that you should use when performing a titration. Was your lab successful? Explain. Include some sources of errors in this lab.

Lab # : The Making of a Gold Penny

Purpose: How can you make a penny look like silver, and then gold?

Materials:
A penny (pre-1980 is better)
Beakers
isopropyl alcohol
About 2 grams Zn dust
10 mL NaOH solution (10 – 15 %)
Clean Tongs

Procedure

1) Turn a penny into a dime: Add the NaOH solution and the zinc to one of the beakers and swirl vigorously. This mixture can be used in the experiment and can be saved as your stock mixture.
2) Clean the penny by immersing it in the beaker containing the rubbing alcohol, swirl, and remove with CLEAN TONGS. DO NOT TOUCH THE PENNY WITH YOUR FINGERS – you'll get grease on it!
3) Heat the NaOH/Zn solution gently on a burner and put the penny (with clean tongs) into the mixture. Continue heating. (It is OK for the mixture to boil or simmer, though not too much – the NaOH vapor can get a bit thick with too much boiling). Observe the penny from time to time – it should take between 15 seconds and 1 minute for the penny to het coated with zinc. Remove the penny and rinse it under water to remove any clumps of zinc powder. DIME!
4) Dime → Gold piece. Holding the penny around the rim with clean tongs, heat gently over a Bunsen burner. In 15 – 30 seconds the dime will change to a "gold-piece."

   Don't melt the penny!!!

5) Cool the penny in water. To maintain shine, spray with lacquer or paint with clear nail polish when you get home.

Data

Record your observations as you go along.

Analysis of Data

Is there a redox reaction occurring? Why does the penny turn silver? Why does the penny turn gold? Why did we heat the penny to turn it "gold"? Write the reactions involved in this lab.

Lab # : Redox Reactions

Purpose: Prepare several different combinations of substances and observe whether or not any visible redox reactions occur. What does this say about the relative ease of oxidation of the metals?

Materials: 0.1 M Solutions of: $AgNO_3$ $Zn(NO_3)_2$ $Cu(NO_3)_2$ $Pb(NO_3)_2$

Silver foil Zinc mossy Lead Shot Copper shot

Equipment: Microspatula, well plate, test tube rack, 1 test tube, droppers, goggles, apron

Procedure:

1) Half fill a well with 0.1 M $AgNO_3$ (aq). Add a piece of copper shot to this solution. Half fill another well with 0.1 M $Cu(NO_3)_2$(aq) and add a piece of silver foil to the solution. Allow both wells to stand for several minutes. Record your observations.
2) Half fill two wells with 0.1 M $Cu(NO_3)_2$(aq). Place a piece of zinc mossy in one well and a piece of lead shot in the other. Allow the wells to stand for a few minutes. Record your observations.
3) Using two clean, dry wells, repeat the procedure in Step 2 using 0.1 M $Pb(NO_3)_2$ and pieces of copper shot and zinc mossy. Record your observations.
4) Repeat the procedure a third time, using 0.1 M $Zn(NO_3)_2$ and pieces of copper shot and lead shot. After you have recorded your observations, discard the materials in the test tubes as instructed. Clean and rinse the wells.

Data:

Make a data table to record your results from the reactions performed in the lab.

Analysis of Data

Write reactions for each of the combinations which produced a reaction, and note no reaction when the combination of materials did not produce a visible change. For reactions which did produce a reaction, also include the oxidation and reduction half reactions. List the order of reactivity of the metals Ag, Cu, Pb, and Zn from the most to the least reactive as determined by your experimental results.

Summary

Compare your results to the Reference Tables. What is the relationship between the metals on Table J? What do you think is the relationship between the nonmetals on Table J?

LAB # . : ELECCTROCHEMISTRY DEMONSTRATIONS

Purpose: To compare and contrast the two types of electrochemical cells: voltaic and electrolytic.

Materials: Demonstration set-ups for an electrochemical cell, electrolysis and electroplating.

Procedure:

Part A: Electrochemical cell

1. Observe the set up for an electrochemical cell. Draw and label the set up provided by your instructor. Label the anode, cathode, and salt bridge and indicate the direction of electron flow.
2. Write the molecular equation for the reaction. Decide which substance is oxidized and reduced, the oxidizing agent, reducing agent, and write the two half reactions, electron volts produced by the reaction.
3. Using a voltmeter determine the actual volts produced.
4. Change one of the electrodes to several different metals and record the volts produced.
5. Arrange the metals used from most reactive to least reactive.

Part B: Electrolysis of water

1. Observe the set up for an electrolytic cell. Draw and label the set up provided by your instructor. Label the anode and cathode.
2. Write the molecular equation for the reaction. Decide which substance is oxidized, reduced, the oxidizing agent, reducing agent, and write the two half reactions.
3. Describe how you test for oxygen and hydrogen.

Part C: Electroplating

1. Observe the set up for an electroplating. Draw and label the set up provided by your instructor. Label the anode and the cathode.
2. Try electroplating different objects and record your observations.

Data and Observations:

For each demonstration include the appropriate diagram and equations. Answer the questions in an organized fashion.

Questions:

1. Which demonstrations show a voltaic cell? Explain.
2. Which demonstrations show an electrolytic cell? Explain.
3. Define the term electrochemical cell.
4. What are the similarities between Voltaic and Electrolytic Cells?
5. What are the differences between Voltaic and Electrolytic Cells?
6. Relate some ways in which electrochemistry is relevant to your lives.

Conclusion: Prepare a table comparing electrolytic and voltaic cells. Include at least five pieces of information in your table.

Lab #…: Designing your own electrochemical cell

Purpose: How can you make an electrochemical cell out of household items?

Materials: List the materials you used in YOUR electrochemical cell

Procedure: Read the article "How can I make a battery out of a lemon?" and also research several other Internet sources on electrochemical cells. After doing some research you are to design a chemical cell that produces an electric current. Record exactly the setup you are using and bring it to class on _________. We will test the cells at this time and measure the volts produced. The person who designs the cell with the most volts will win the contest.

Data and Observations: Draw a diagram of the cell you designed. Write the reaction for the oxidation and reduction half reactions. Using the table of electron volts predict the voltage produced by your electrochemical cell. Leave a space in your data section to record the actual volts produced in class.

Questions:

1. How did you determine which metals to use as your electrodes?
2. How did you determine which medium to place your electrodes in?
3. What are some factors that affect the volts produced?
4. After observing several homemade electrochemical cells what electrodes, medium and conditions were the most affective? (Leave blank until you get to class)

Conclusion: Describe an electrochemical cell. (In class continue with the following) How did the cell you created compare to the rest of the class? Were you pleased with your design? What modifications can you do to improve the volts produced? Site at least two Internet sources that you used aid you in doing this lab. (You may also attach the information)

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General Chemistry Online!

How can I make a battery out of a lemon?

It's easy to make a voltaic cell with a lemon, a penny, and strip of zinc. Polish the zinc and the penny with a piece of sand paper. Squeeze the lemon without breaking through the peel to release the juices inside. Cut a pair of slits in the top of the lemon about 1-2 cm apart. Insert the penny in one slit and the zinc in the other. Touching the leads of a voltmeter to the penny and the zinc will show that a small voltage is produced.

If you don't have a voltmeter, a speaker from an old transistor radio can be used to detect the current. It will click when you touch the leads to the electrodes on the lemon cell.

If you've tried to hook a flashlight bulb up to the battery, you may have been disappointed. One lemon cell doesn't produce a lot of current. To light up a flashlight bulb, you'll probably have to connect several lemon cells in series. Connect the copper terminal of one lemon cell with the zinc terminal of another; attach the remaining copper and zinc electrodes to the bulb and try again. Chain more cells together if the bulb still won't light. (You've made a true **battery**, which is actually a lot of individual cells linked together.)

It is possible to light the bulb with just one lemon, if you add a few easily obtained electronic components (e. g. a capacitor) to your setup. See this article in the Journal of Chemical Education for details.

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Many other fruits and vegetables can be used for the cell. You can also use a silver or nickel coin in place of the penny, or a galvanized nail in place of the zinc strip. Soda pop or fruit juice in a cup can be used in place of the lemon. Can you use magnesium ribbon or freshly polished aluminum foil instead of zinc? Which combination of materials gives you the highest output voltage? Experiment!

If you build several different batteries you'll notice that the output voltage depends on the fruit, the electrode materials, the placement of the electrodes, and other factors. Combining an active metal with an inactive one works best; and juicy, acidic fruits work better than drier, more neutral ones. See a previous question (How are battery reactions chosen?) for a brief list of factors that can affect the output voltage of your homemade cells.

References

1. J. Worley, J. Fournier, *Journal of Chemical Education*, **65**, 158 (1988).

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General Chemistry Online! How can I make a battery out of a lemon?

Comments & questions to senese@antoine.frostburg.edu
Last Revised 03/14/02.URL:
http://antoine.frostburg.edu/chem/senese/101/redox/faq/lemon-battery.shtml

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Lab #   : Models of Organic Molecules

Purpose: To construct three-dimensional molecular models to help visualize organic compound compounds. To practice naming organic compounds.

Materials: Molecular model kits

Procedure: Note: Use yellow balls for hydrogen, black for carbon, red for oxygen, blue for nitrogen and green for chlorine. Use the wooden sticks for single bonds and the spring connectors for double and triple bonds.

Part A: Alkanes

1. Make models of the following alkanes: methane, ethane, propane, butane and pentane.
2. For butane and pentane make models for their isomers.

Part B: Alkenes

1. Make models of the following alkenes: ethane, propene, butene and pentene.
2. For butene and pentene make models of their isomers.

Part C: Alkynes

1. Make models of the following alkynes: ethyne, propyne, butyne, and pentyne.
2. For butyne and pentyne make models of their isomers.
3.

Part D: Aromatic

1. Make models of the following aromatics: benzene and toluene

Part E: Other Organic Compounds

1. Make models of the following compounds: dichloromethane, propanol, propanal, propanoic acid, propanone, ethyl methyl ether, methyl propanoate, 1 propanamine, propanamide.

Data and Observations:

Prepare two data tables as follows:

Data Table 1: (for parts A, B, C, and D) In a chart list the Name, Molecular formula, and Structural formula for each model.

Data Table 2: (for part E) In a chart list the Name, Class of Compound, Molecular formula, and Structural formula for each model.

Questions:

1. What is the relationship between the names of the compounds and the number of carbon atoms?
2. What do the structural formulas in part A have in common? What is the general formula for these compounds? What is the suffix used?
3. Answer question 2 for part B?
4. Answer question 2 for part C?

5. Answer question 2 for part D?
6. What does the term saturated and unsaturated mean? Which classes of hydrocarbons are saturated? Ur^aturated?
7. What does the term isomer mean? What is the relationship between the number of carbon atoms and the number of isomers?
8. For each class of compounds from part E give the functional group and suffix ending?

Conclusion:

Construct the following two tables:

Table 1: Make a table of the following information: Alkane, alkene, alkyne and benzene. For each hydrocarbon gives the general formula, brief description of the bond arrangement, saturated/unsaturated, reactivity, suffix ending.

Table2: Make a table of the following information: halide, alcohol. ether, aldehyde, ketone, organic acid, ester, amine and amide. For each class of compound give the general formula.

Lab # .: How unsaturated is your oil?

Introduction: Most animal fats, which are solids at room temperature, are composed of saturated hydrocarbons. Vegetable fats on the other hand are liquids at room temperature and are composed of unsaturated hydrocarbons. Both animal and vegetable fats are essential in our diets, but medical research has shown that eating high levels of saturated fat can contribute to health problems such as heart disease. Testing how quickly a red-brown iodine solution added to each fat is decolorized can compare different amounts of unsaturation. The lighter the color the faster the reaction. A faster reaction indicates a higher degree of unsaturation and a healthier choice.

Purpose: Determine which type of oil is the healthiest to consume?

Materials: 4 different cooking oils (for example: canola, corn, peanut and vegetable)
4 test tubes, 10 ml graduated cylinder, tincture of iodine solution.

Procedure:

1. Work in groups of 4, each person in the group is responsible for one oil sample.
2. Place 10 ml of each sample in four different test tubes.
3. Add two drops of a tincture of iodine solution to each test tube at the same time.
4. After several minutes (about 5) record the oils in order from lightest to darkest in color. For each oil record the total amount of fat in grams and the amount of both saturated and unsaturated fats.

Data and Observations: Arrange the oils from lightest to darkest in color.
Record the data on the grams of saturated and unsaturated fats in each oil.

Questions:

1. What is the different between a saturated and unsaturated hydrocarbon?
2. What type of reaction do saturated hydrocarbons undergo? Unsaturated hydrocarbons?
3. Which type of hydrocarbon is more reactive –unsaturated or saturated? Explain.
4. Relate the color of the oil after a given period of time to the reactivity of a substance?
5. Relate the oils reactivity in terms of saturated versus unsaturated fats?
6. If you had to choose an oil to cook with, which oil would you chose? Explain your choice.

Summary: What is the difference between an animal fat and a vegetable fat? Which type of fat is a healthier choice? Explain? What oil did you conclude was the healthier choice? Compare the amounts of saturated and unsaturated fats in each oil from the information you obtained from their labels. Was your choice consistent with this information? Explain.

Lab # · :: Radioactive Decay and Half-life

Purpose: How can we measure the rate of radioactive decay? What is meant by the half-life of a radioactive isotope?

Materials: 100 pennies

Procedure:

1. Put 100 pennies in a Ziploc baggie. This is time zero. Record 100 at time=0.
2. Shake the pennies in the baggie and pour them onto the table. Remove all the pennies that came up "head" and count the remaining pennies. Record this number as the number of pennies remaining at Time =1.
3. With the remaining pennies in the baggie, repeat step#2 and record the number of remaining pennies in your data table. Put the remaining pennies back in the baggie.
4. Continue to repeat this procedure until Time= 5.

Data:
Create a data table consisting of the following information: Number of half -lives (0-5) and Number of Pennies Remaining (start with 100)

Analysis of Data: Plot a graph of time vs. the number of pennies remaining and draw a smooth curve.

Questions:

1. Do the pennies "decay" at a constant rate? If not what happens to the rate of decay as time increases?
2. Use your graph to determine the approximate amount of time needed to have only 50 pennies remaining.
3. Use your graph to determine the approximate amount of time needed to go from 50 to 25 pennies remaining.
4. According to your graph, approximately how many periods will it take for 30 pennies to "decay" to 15 pennies?
5. If 75 undecayed atoms remain in a sample, which originally contained 2400 pennies, then how many half-life periods occurred?
6. Cobalt – 60 has a half-life period of 5.3 years. If a pellet that has been in storage for 26.5 years contains 14.5 grams of cobalt-60, how much of this isotope was present when the pellet was put in storage?
7. Given that the half-life of carbon-14 is 5730 years, consider a sample of fossilized wood that originally contained 24 grams of carbon-14. It now contains 1.5 grams of carbon-14. How old is the sample?

Summary: Define the terms radioactivity and half-life. Discuss at least one similarity and one difference between the simulation of radioactivity and actual radioactive decay. How would you modify the procedure to show that the isotopes of an element undergoing radioactive decay have different half-lives?

Lab#: ; Half Life of M&M's

Purpose: How can M&M's be used to create a simulation representing radioactive decay? How can we graph the data showing the relationship between time elapsed and mass remaining radioactive?

Materials:

Paper bag
Tray
Centimeter Ruler
100 M&M's
Computer
Graphing Program

Procedure

1. Count out 100 M&M's. Put them all in the tray emblem facing down. This is Trial 1 in your data. The number of M&M's still radioactive = 100.
2. Place all the M&M's in the paper bag, shake them up a bit, then pour them back into the tray.
3. Remove (and dispose of as you like) all M&M's showing their emblem on top. Count the number of M&M's with the emblem facing down (these are still radioactive). Record this as Trial 2 on your data table.
4. Repeat steps 2 and 3 several times, until all the M&M's are gone, recording your data each time on your data table.
5. Using a graphing program on a computer, make a line graph of the data putting "Trial Number" is the independent variable and "# of M&M's still radioactive" is the dependent variable. The title of this graph should be "Group Results."
6. Combine class data and also graph these results in the same manner as described in step 5 but this graph should have the title "Class Results."

Data:

Create a data table showing the number of M&M's which have not decayed after each of five (5) trials. Also include a pace for data collected as the class average for each of five trials.

Analysis of Data:

Plot a graph showing the time vs. the number of M&M's remaining and draw a smooth curve through the points.

Summary:

1. When was the rate of decay fastest, during the first trials or the last trials?
2. What factor does the rate of decay depend upon?
3. Based on your graph, what kind of relationship exists between time that has elapsed and mass of M&M's still radioactive?

For the rest of the questions, use the analogy that each trial represents on half-life. Also presume that the half-life of an M&M is 12.4 seconds.,

4. What is the number of seconds required for a radioactive M&M to pas through three half-life periods?
5. What fraction of a sample of radioactive M&M's will remain after 37.2 seconds?
6. Approximately how many grams of a 40 gram sample of radioactive M&M's would remain after 24.8 seconds?
7. After three half-life periods, 12.5 grams of an original sample of radioactive M&M's remains unchanged. What was the mass of the original sample?
8. Compare the two graphs prepared, one representing group results, the other representing class results. Which simulation comes closest to approximating half-life? Why?