Grades: 7 – 12
Chemistry
"Are You a Trend Setter?"

2002 NTTI Master Teacher
Jane Kelly, Wilbraham Monson Academy, Wilbraham, MA

Overview:
Students will brainstorm ideas for basic tools of chemistry, practice the use of a balance for determining mass of substances and a graduated cylinder for determining displacement of water to measure volume. Students will be introduced to the periodic table, (the ultimate chemistry tool!) while viewing *The Periodic Table* video. Students will devise experimental procedure and perform lab activity to determine density of specific elements with a group from the periodic table. Students will analyze lab results graphically to determine trend within a group and predict density of other elements within that same group. Students will use the Web to find accepted density values of elements within a periodic group so they can calculate their percent error of both their experimental found densities and predicted densities based on their experimental values. Students will use the Web for further work including: graphically showing trends of another property of their choice within a group of the periodic table, learning more on history of Dmitri Mendeleev and the modern periodic table, and gaining introductory appreciation for early versions of the periodic table.

Time Allotment:
Four 45-minute periods and one extended lab period (minimum 1 hour.)

Learning Objectives:
Students will be able to:

- Understand how the original periodic table was developed.
- Identify elemental properties used by Mendeleev to organize the original periodic table.
- Identify the locations of groups and periods on the periodic table.
- Develop skills to use basic lab equipment.
- Devise and perform experimental procedure to determine density of irregular shaped samples of various elements.
- Plot data and predict patterns based on graphic results
- Make use of common scientific experimental evaluation formula of percent error calculation.
- Research Web sites to further their knowledge of the periodic table
- Write a complete lab report.

State Standards:
Massachusetts Science and Technology/Engineering: Curriculum Framework

Strand 1: Inquiry
1. Pose questions and state hypotheses based on prior scientific experiences.
2. Use mathematics to analyze and to support findings and to model conclusions.

Learning standards:
Grades 6 – 8

Properties of Objects
3. Volume and mass are two different measures for the amount of a material. Measurement of volume and mass requires understanding of the sensitivity of measurement tools (e.g., rulers, graduated cylinders, balances) and knowledge and appropriate use of significant digits.
* Measure volume by displacement of water.

Properties of matter:
A substance has characteristic properties such as density, a boiling point, and solubility, all of which are independent of the amount of the sample.
* Measure the densities of solids and gases.

High School Chemistry
6. The periodic table displays the elements in increasing atomic number and helps to demonstrate trends in physical and chemical properties of the elements.

National Science Education Standards
Science Content Standards: 9-12

Structure and Properties of Matter:
An element is composed of a single type of atom. When elements are listed in order according to the number of protons (called the atomic number), repeating patterns of physical and chemical properties identify families of elements with similar properties. This "Periodic Table" is a consequence of the repeating pattern of outermost electrons and their permitted energies.

Science as Inquiry:
The National Science Education standards state that "full inquiry involves asking a simple question, completing an investigation, answering the question, and presenting the results to others." Designing and conducting investigations encourages students to interpret, analyze, and evaluate what is known, how we know it, and how scientific questions are answered. Scientists rely on technology to enhance the gathering and manipulation of data. New techniques and tools provide new evidence to guide inquiry and new methods to gather data, thereby contributing to the advance of science. The accuracy and precision of the data, and therefore the quality of the exploration, depends on the technology used.

Program Standard C:
The science program should be coordinated with the mathematics program to enhance student use and understanding of mathematics in the study of science and to improve student understanding of mathematics.
Mathematics is essential in scientific inquiry. Mathematical tools and models guide and improve the posing of questions, gathering data, constructing explanations and communicating results.

Media Components:
Video:
The World of Chemistry*; Program #7-*The Periodic Table (The Annenberg/CPB Collection)

Web Sites:
The Massachusetts Institute of Technology's Periodic Properties Table
http://wulff.mit.edu/pt/
This site allows you to choose the property you want and display it in graphic form. You can also graph properties vs. atomic number to investigate trends.

History of the Periodic Table:
http://.web.buddyproject.org/web017/web017/history.html
This is a good introduction to the history and development of the periodic table particularly with regard to Mendeleev's work.

How to Read the Periodic Table:
http://web.buddyproject.org/web017/web017/pertab.html
This is a good introduction to the basic organization of the periodic table. It also has some good links to short quizzes on the table and elements.

CHEMystery Periodic Table of the Elements
http://library.thinkquest.org/3659/pertable

http://www.chemlab.pc.maricopa.edu/periodic/bookreview.html

A review of a great little book on the periodic table. *The Periodic Kingdom* by Peter Atkins

Materials:
Lab portion: (per group- 2-3 students)

Day 1:
Balance, weighing dishes, various sizes of graduated cylinders, irregularly shaped samples of various solids

Day 3 and 4:
Balance, weighing dishes, graduated cylinders, beakers, samples of lead shot, silicon and tin pieces, graph paper, straightedge
Video: *The World of Chemistry*
"Focus for Media Interaction" worksheet #1

Prep for Teachers:
Teachers should have lab equipment and materials ready. Preview video so you are aware of where students might ask you to pause and rewind as they try to answer focus questions on worksheet #1. Preview Web sites. Make copies of: "Focus for media interaction" worksheet #1, "Lab Activity Sheet", and "Lab Report Grading Rubrics". Students should have had some very basic exposure to: basic ideas of matter including atomic structure; chemical and physical

properties; and importance of scientific method involving good experimental procedure, how to use formula and calculate percent error of experimental findings prior to these activities.

Introductory Activity: Setting the Stage
Day 1:
Ask the students to brainstorm what pieces of equipment would be absolutely vital for scientifically sound experimentation. Accept any legitimate ideas, but remind them to think of equipment that they feel would be available to them. Move into the lab and give general tour of lab, including major safety points. Tell students that two very basic yet vital pieces of equipment would be the balance and graduated cylinder. (Be sure students understand that these are used to obtain key measurements that make up all matter: mass and volume!) Demonstrate use of whatever types of balances are available to your students. Have all students gain proficiency with balance by determining mass and recording measurement of few different samples. Have students practice water displacement method of obtaining volume of same solid samples that were measured for mass. Use few different samples to make students be aware of different size graduated cylinders. (Key term in reading graduated cylinders: meniscus). Students should write steps used to get final volume calculation of sample using water displacement. Once students have shown proficiency with these two measurements explain the key relationship between the two measurements that give determines a major physical property of all substances – density. Have students practice this calculation with the mass and volume measurements that they have already recorded. Now tell students that density is a great example of a property that can be observed and predicted using the greatest of all chemistry tools – the periodic table. A copy of "**focus for viewing worksheet "#1** may be given out at end of class and students can get started on answering some of the questions by doing any of following as homework assignment:
Read appropriate assigned readings from your chosen textbook or go to the following Web sites:

History of the Periodic Table:
http://web.buddyproject.org/web017/web017/history.html

followed by:

How to Read the Periodic Table:
http://web.buddyproject.org/web017/web017/pertab.html
This is a good introduction to the basic organization of the periodic table. It also has some good links to short quizzes on the table and elements.

CHEMystery Periodic Table of the Elements
http://library.thinkquest.org/3659/pertable

Learning Activities:
Day 2:
If you have not already done so, give copy of "**focus for viewing"worksheet #1** and let students read over questions before starting video. Tell students that worksheet will be collected after video is shown. **Start** tape and have the student's view approximately the first seven minutes of The Periodic Table video as they answer questions on worksheet. Encourage students to ask for tape to **be paused or rewound if needed when they realize an answer to a question has been given**.
(Reminder: tape should be started from very beginning as the answer to first question is given in the introduction, even before the favorite theme song of the video series). **Stop** video immediately after woman narrator states, "You can begin to see the different types of information that can be derived from the periodic table." Check to see if there are any questions left unanswered, then ask if anyone would like to share his or her answer to the last question. That last question is a good lead in to the next part of the whole lesson plan. Tell students that now that they have become familiar with both the idea of density and the importance of the periodic table, they should be able to make a hypothesis as to what type of trend might be observed as one moves down a group within the periodic table. Explain to the students that it is their job to devise a simple procedure to determine the density of three solid samples of elements within group 4A of the periodic table. This will be their assignment for the night. They will then carry out their procedure the next day and analyze their results. Give students the lab investigation sheet and grading rubrics so they can work on their procedure, and so that they can

be aware of just what type of analysis and final report they will be expected to complete.

Day 3 & 4:
Have samples of lead shot, tin and silicon pieces available along with all other needed lab materials.
Check student procedures before allowing them to begin their actual lab work. Be clear as to just how specific you want them to be in their steps. (Grading rubrics would help here).
Once students have determined the densities of their samples let them work on setting up graphs, plotting experimental values, and making predictions of carbon and germanium densities from their graphically displayed experimental results. Reminder: some of this analysis work can certainly be assigned as homework in order to fit within suggested time frame.

Focus for media interaction:
For the internet: Once students have graphed their experimental data and made predictions based on their results, they are to determine their percent error by looking up accepted density values of group 4A elements using a periodic table on the Web.
Suggested Web site:
The Massachusetts Institute of Technology's Periodic Properties Table
This site allows you to choose the property you want and display it in graphic form. You can also graph properties vs. atomic number to investigate trends.
http://wulff.mit.edu/pt/

Culminating Activity:
Students will write complete lab reports that will include their original procedure, all data recorded from their experimental procedure, graphic analysis of results along with observations and predictions based on results. (See lab activity sheet and rubrics suggestion).

Cross Curricular Extensions:
History and English/ Writing:
Assign the students more research on the history of development of the periodic table.
A possible Web site for this:
http://www.periodictable.com/pages/AAE_History.html

Have the students read *The Periodic Kingdom* by Peter Atkins
A review of this great little book can be found at the following Web site:
http://chemlab.pc.maricopa.edu/periodic/bookreview1.html

Student Materials:
"Focus for viewing" worksheet #1
Lab Activity Sheet
Lab Report Grading Rubrics

Grading Rubrics for Periodic Trend Lab Experiment

Title:	1
Intro: (background info: periodic trends, density?)	2
Question:	1
Hypothesis: (with reason)	1
Procedure:	
Sequence of steps is logical	3
Equipment used is named correctly	2
Clearly states when a measurement is to be recorded	3
Includes clean-up procedure	2
Data:	
-Neatly prepared (straight edge?)	2.5
-Headings clear and logical	2.5
-All measurements taken are recorded (with units)	5
Calculations of Experimentally found Densities:	
-Measurements used are clearly shown and are actually those from your own data!!	6
Graph Preparation:	
-Graph paper used (tape to your paper in notebook)	2
-Appropriate size	1
-Title	1
-Axes clearly labeled:	
- With correct variables (density, period #) and units	3
-Experimental density values correctly plotted	3
-Estimated density values for C and Ge are plotted	2
Analysis and Conclusion	
-Complete sentences are used	2
-All conclusions or statements made are actually based on your results (graphic results, too!) Don't make statements that don't match your work!	4
-Calculations of % error are clearly and correctly done for all 5 elements	5
-Include possible changes in your procedure when answering last question; discuss whether or not your hypothesis was right	4
Web site used for accepted value densities is cited	2
Total	**60 pts!!**

Focus for Viewing Interaction Worksheet

Answer the following questions:

1. Who is considered to have invented the modern periodic table and when?

2. Define the two types of properties of matter and give an example of each.

3. What is the basis of the modern periodic table?

4. Name one element that is named after a person. Who is that person?

5. What two important numbers are always given in each box of the periodic table?

6. What do these numbers stand for?

7. Which of the two numbers given in your answer to # 5 question determines the position of an element in our modern periodic table?

8. Define the following two terms associated with the periodic table:
   Group:

   Period:

9. Fill in the blank: Elements within the same group have similar _____.

10. What is the name given to the group farthest to the right on the periodic table?

11. Name two properties that the elements within this group have in common.

12. What happens to the elements within this group as you move down along the group?

Are You a Trend Setter?
Lab Activity Sheet

Problem: Can a trend in the density of elements within a group be determined?

Your Goal:
Devise a simple experimental procedure to determine the density of three elements within group 4A of the periodic table. Samples of lead, tin, and silicon will be provided.

Based on the densities that you have determined, predict the densities of the two other elements within that group--carbon and germanium.

Key points for your investigation:

Be careful to think through the sequence of steps that you will use when writing each step of your procedure. You may not begin your actual experiment until your teacher has approved your procedure.

Be sure to record all your measurements in an organized table.

Calculate the density of each of your samples once you have made all measurements needed.

Analysis:

1. Prepare a graph of density vs. period number of each of your measured elements. Plot the density values that you have calculated.

2. What types of trend, if any, do you observe with regard to density and period number of element within a group?

3. Estimate the densities of carbon and germanium based on your results, and plot these values on your graph along with your experimental values.

4. Use the Web to find the accepted values of group 4A densities, and calculate your percent error for all five elements that you have determined.
Suggested Web site:
The Massachusetts Institute of Technology's Periodic Properties Table
This site allows you to choose the property you want. You can also graph properties vs. atomic number to investigate trends.
http://wulff.mit.edu/pt/

5. What might have been some possible sources of error in your procedure that could account for the percent error values you have calculated?