Lesson Title	Periodic Properties
Length of Lesson	110 minutes
Created By	David Wilson
Subject	Chemistry / Physical Science / Eighth Grade Science
Grade Level	9-12th Grade
State Standards	2a, 3b / 4d / 1b, 1d, 2b
DOK Level	1, 2 / 2 / 3, 3, 2
DOK Application	Describe and Classify, Analyze / Utilize / Distinguish, Analyze, Predict
National Standards	K-12: Unifying Concepts and Processes / 5-8: A: Science as Inquiry, B: Physical Science, G: History and Nature of Science / 9-12: A: Science as Inquiry, B: Physical Science
Graduate Research Element	The periodic nature of the properties of the elements on the periodic table allow me to choose metals to use in my research which have no biological activity, but serve as good spectroscopic models for metals which do have biological activity but are spectroscopically silent.

Student Learning Goal:

State Standards: (Chemistry)

2) Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

a. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK1)

3) Develop an understanding of the periodic table.

b. Analyze patterns and trends in the organization of elements in the periodic table and compare their relationship to position in the periodic table. (DOK2)

State Standards: (Physical Science)

4) Develop an understanding of the atom.

d. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK2)

State Standards: (Eighth Grade Science)

1) Draw conclusions from scientific investigations including controlled experiments.

b. Distinguish between qualitative and quantitative observations, and make inferences based on observations. (DOK3)

d. Analyze evidence that is used to form explanations and draw conclusions. (DOK3)

2) Apply concepts relating to an understanding of chemical and physical changes, interactions involving energy, and forces that affect motion of objects.

b. Predict the properties and interactions of given elements using the periodic table. (DOK2)

National Science Standards: (K-12)
Unifying Concepts and Processes:

As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes:

- **Systems, order, and organization**
- **Evidence, models, and explanation**
- Constancy, change, and measurement
- Evolution and equilibrium
- Form and function

National Science Standards: (5-8)
A: Science as Inquiry: Abilities necessary to do scientific inquiry:

- DEVELOP DESCRIPTIONS, EXPLANATIONS, PREDICTIONS, AND MODELS USING EVIDENCE. Students should base their explanation on what they observed, and as they develop cognitive skills, they should be able to differentiate explanation from description—providing causes for effects and establishing relationships based on evidence and logical argument. This standard requires a subject matter knowledge base so the students can effectively conduct investigations, because developing explanations establishes connections between the content of science and the contexts within which students develop new knowledge.
- THINK CRITICALLY AND LOGICALLY TO MAKE THE RELATIONSHIPS BETWEEN EVIDENCE AND EXPLANATIONS. Thinking critically about evidence includes deciding what evidence should be used and accounting for anomalous data. Specifically, students should be able to review data from a simple experiment, summarize the data, and form a logical argument about the cause-and-effect relationships in the experiment.

B: Physical Science: Properties and Changes of 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. A mixture of substances often can be separated into the original substances using one or more of the characteristic properties.

G: History and Nature of Science: Nature of Science.

- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models. Although all scientific ideas are tentative and subject to change and improvement in principle, for most major ideas in science, there is much experimental and observational confirmation. Those ideas are not likely to change greatly in the future. Scientists do and have changed their ideas about nature when they encounter new experimental evidence that does not match their existing explanations.

National Science Standards: (9-12)
A: Science as Inquiry: Abilities necessary to do scientific inquiry.

- FORMULATE AND REVISE SCIENTIFIC EXPLANATIONS AND MODELS USING LOGIC AND EVIDENCE. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical. In the process of answering the questions, the students should engage in discussions and arguments that result in the revision of their explanations. These discussions should be based on scientific knowledge, the use of logic, and evidence from their investigation.

B: Physical Science: 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.

Materials Needed (supplies, hand-outs, resources):
{**WARNING**: Some of these chemicals in "sealed ampules" are quite harmful. Think carefully about your student population before using them. These chemicals should NOT be released from their ampules.}
[Chemicals needed]
1.0 Molar HCl
In dishes: carbon (graphite rods), magnesium ribbon (not oxidized), elemental silicon, sulfur (not powdered or sublimed), tin metal (not foil), elemental selenium (not powdered), aluminum metal (not foil).
In sealed ampules if available: red phosphorus, nitrogen gas, elemental arsenic, antimony, copper metal, bismuth, iodine crystals.
[Quantities of the following supplies listed are per each group.]
6 test tubes, test tube rack, conductivity apparatus, small hammer, petri dishes, disposable plastic pipets, forceps.

Lesson Performance Task/Assessment:

1) Students will investigate four properties of eight elements and one property of another four elements.
2) Students will categorize each element into its class of matter (metal, nonmetal, or metalloid) based on the properties of the elements.
3) Students will make use of three experimental skills by determining the malleability, reactivity, and conductivity of the elements.
4) Students will evaluate the validity of assigning elements to classes. They will justify the use of "black-and-white" labels to categorize elements into groups.
5) Students will uncover the identity of each element based on a possible list by comparing the reviewed properties of each element of interest.

Lesson Relevance to Performance Task and Students:

The students will gain experience at pulling information out of the periodic table in the same manner that scientists do to solve practical problems. The students will gain an appreciation for the dynamic nature of the periodic table and the less than severely defined periodicity described by the periodic table.

Anticipatory Set/Capture Interest:

This anticipatory set should be done midway through the class period preceding the day of the lab. As an introduction to the odd behavior of some elements, the teacher will demonstrate the effect of heating sulfur to produce polymeric sulfur. Letting the polymer sit for a short time allows the polymer to recrystallize rather rapidly. One additional demonstration will be the sublimation of iodine.

Guided Practice:

At this point, the students will have gone over the properties of metals, nonmetals, and metalloids in class, and they will have had practice distinguishing between the different types. This lab is meant to give them independent, practical practice in applying what they have learned.

Independent Practice:

The purpose of this lab is to give the students experience in applying the principles they will have learned up to this point. So, the entire lab is an exercise in independent practice.

Remediation and/or Enrichment:

Remediation: Individual IEP.
Enrichment: Taking into account the elements tested in this lab and the periodic nature of the properties of the elements on the Periodic Table based on an element's position on the table, students will be asked to predict, on a sliding or gradient scale, the properties of those metalloids which were unavailable for testing due to issues with toxicity. They will justify their predictions in detail.

Check(s) for Understanding:
The final assessment in this lab is the construction of a periodic table on which the students will place those elements tested and in sealed ampules with their student-assigned element class. An additional check might be another unknown for which the students must assign a class. Gallium, lead, or boron are good candidates. (Boron sticks may be cost prohibitive.)

Closure:
The teacher will lead a final discussion of the enrichment topic to highlight the use of assumptions and, more importantly, generalizations that must be drawn in order to make scientific models like the periodic table useful.

Possible Alternate Subject Integrations:
This lesson is purely physical science.

Teacher Notes:
This lesson was derived from a lab described in Chemistry: Matter and Change, by Glencoe (McGraw-Hill Companies) (2002). The lab is found on page 171. Demonstrations can be found on Youtube: 1) Sublimation of Iodine - http://youtu.be/4fAOI6BeMZY , 2) Polymerization of Sulfur - http://youtu.be/PqEaYgdrRRg or http://youtu.be/WtqGO6W5M3k .