Building the Periodic Table from Scratch

Name:
Period:

Introduction:

Before the periodic table could be built, the individual elements had to be found and their properties tested. Although elements such as gold, silver, tin, copper, lead and mercury have been known since antiquity, the first scientific discovery of an element occurred in 1649 when Hennig Brand discovered phosphorous. During the next 200 years, a vast body of knowledge concerning the properties of elements and their compounds was acquired by chemists. By 1869, a total of 63 elements had been discovered. As the number of known elements grew, scientists began to recognize patterns in properties and began to develop classification schemes.

The Russian scientist, Mendeleev noticed patterns in the properties and atomic weights of halogens, alkali metals and alkaline metals. In an effort to extend this pattern to other elements, he created a card for each of the 63 known elements. Each card contained the element's symbol, atomic weight and its characteristic chemical and physical properties. When Mendeleev arranged the cards on a table in order of ascending atomic weight grouping elements of similar properties together in a manner not unlike the card arrangement in his favorite solitare card game, the periodic table was formed. From this table, Mendeleev developed his statement of the periodic law and published his work *On the Relationship of the Properties of the Elements to their Atomic Weights* in 1869. The advantage of Mendeleev's table over previous attempts was that it exhibited similarities not only in small units such as the triads, but showed similarities in an entire network of vertical, horizontal, and diagonal relationships. Also, he was able to predict the existence of undiscovered elements and left gaps on the periodic table where the elements should be placed. In 1906, Mendeleev came within one vote of being awarded the Nobel Prize for his work.

In this activity, you will use the same information they had to construct your own periodic table.

Materials: 42 element cards, glue, and paper to paste the elements onto

Pre-lab Questions:

1. On which side of the chart do you find the metallic elements? The nonmetals? Metalloids?
2. Define the term allotropic. Give examples.

Procedure:

1. Work in your assigned lab groups.
2. Without using a periodic table, arrange the elements in rows and columns in a logical manner so that there is a repeating pattern in the listed properties.
   a. Decided where to place the mystery element.

3. Compare with a group either in front of you or behind you. If your arrangements aren't the same, work it out. Be ready to explain your logic!
   Other group check-off: _____

4. Once another group has checked your work, have your teacher check it, too.
   Teacher check-off: _____

5. Check your table by looking a periodic table in your book. Glue your chart to a piece of paper and use a marker to add group and period numbers.

Post Lab Questions:

1. What happens to the mass (and also the atomic radius) of atoms of each element as you move *down* a group? Write a sentence that describes the relationship of the sizes of the atoms of elements in the same group (family).

3. What might account for the trend described in the previous question? Explain.

4. What happens to the atomic radius of the atoms of each element as you move across a period? Explain why this happens.

5. Elements in the same group (family) usually share some similar chemical properties. Find the element sodium. List the symbols for four other elements in the same family.

6. Look at the chemical properties of the elements in the group in question 4. Are they similar or different? How?

7. The word "periodic" refers to the rows of elements whose properties repeat themselves. Boron and aluminum are members of the same group. How are they similar?

8. How are boron and aluminum different?

9. Explain your reasoning used to decide where to place the mystery element.

10. The blank card represents one of the three undiscovered elements for which Mendeleev left gaps in his chart. He was able to predict the properties of this unknown element by looking at the properties of aluminum and indium. Using the properties for these two elements, predict the following about the unknown element:

- **a.** Atomic mass (approximate range): _____
- **b.** Metal or nonmetal: _____
- **c.** Color: _____
- **d.** Hard or soft: _____

11. Francium is a radioactive element that appears directly below cesium in the periodic table. Make predictions for the following properties of francium:

- **a.** Atomic mass (approximate) _____
- **b.** Metal or nonmetal _____
- **c.** Color _____
- **d.** Number of electrons in outer shell _____

Hydrogen H -nonmetal -gas - 1 valence electron -radius: 37 pm mass = 1	Helium He -nonmetal -gas -very stable -2 valence electrons -radius: 31 pm mass = 4	Lithium Li -metal -soft, silver -reacts with water to from H_2 gas -1 valence electrons -radius: 152 pm mass = 7	Beryllium Be -metal -dark, lustrous -poor conductor -2 valence electrons -radius: 112 pm mass = 9	Boron B -metalloid -rare -doesn't occur naturally in pure form -insulator -3 valence electrons -radius: 85 pm mass = 11
Carbon C -nonmetal -abundant -allotropic -4 valence electrons -radius: 77 pm mass = 12	Nitrogen N -nonmetal -gas -5 valence electrons -radius: 75 pm mass = 14	Oxygen O -nonmetal -gas -abundant -allotropic -6 valence electrons -radius: 73 pm mass = 16	Fluorine F -nonmetal -green gas -poisonous -reacts violently with metals to form a salt -7 valence electrons -radius: 72 pm mass = 19	Neon Ne -nonmetal -gas -very stable -8 valence electrons -radius: 71 pm mass = 20
Sodium Na -metal -soft, silver -reacts with water to form H_2 gas -1 valence electron -radius: 186 pm mass =23	Magnesium Mg -metal - silver-white, -reacts with hot water to form a base -2 valence electrons -radius: 160 pm mass = 24	Aluminum Al -metal -soft, silver -abundant -doesn't occur in pure form -conductor -3 valence electrons radius: 143 pm mass = 27	Silicon Si -metalloid -stable -allotropic -4 valence electrons -radius: 118 pm mass = 28	Phosphorous P -nonmetal -allotropic -soft, white -poisonous compounds -very reactive -5 valence electrons -radius: 110 pm mass = 31
Sulphur S -nonmetal -solid; allotropic -forms compounds with obnoxious odors -6 valence electrons -radius: 103 pm mass = 32	Chlorine Cl -nonmetal -green toxic gas reacts with metals to form a salt -7 valence electrons -radius: 100 pm mass = 35	Argon Ar -nonmetal -gas -very stable -8 valence electrons -radius: 98 pm mass = 39	Potassium K -metal -soft, silver -low density -bursts into flame in water -1 valence electron -radius: 227 pm mass = 39	Calcium Ca -metal -silver-white -reacts with water to form a base -2 valence electrons -radius: 197 pm mass = 40

Mystery Element 	Germanium Ge -metalloid -rare -allotropic -4 valence electrons -radius: 122 pm mass = 73	Arsenic As -metalloid -gray, lustrous -reactive -allotropic -toxic cmpds. -5 valence electrons -radius: 120 pm mass = 75	Selenium Se -semimetal -solid; allotropic -forms compounds with unpleasant odors -6 valence electrons -radius: 119 pm mass = 79	Bromine Br -nonmetal (toxic) -brown liquid -reacts with metals to form salts -7 valence electrons -radius: 114 pm mass = 80
Krypton Kr -nonmetal -gas -very stable -8 valence electrons -radius: 112 pm mass = 84	Rubidium Rb -metal -soft, silver -reacts violently with water -1 valence electron -radius: 248 pm mass = 85	Strontium Sr -metal -soft, silver-white, lustrous -reacts with water to form a base -2 valence electrons -radius: 215 pm mass = 88	Indium In -metal -soft, gray-silver -shiny -very rare -3 valence electrons -radius: 167 pm mass = 115	Tin Sn -metal -hard, silver-gold -allotropic -4 valence electrons -radius: 140 pm mass =119
Antimony Sb -metalloid -brittle, gray -poor conductor -doesn't react with dilute acid -toxic cmpds. -5 valence electrons -radius: 140 pm mass = 122	Tellurium Te -metalloid -solid -allotropic -forms compounds with obnoxious odors -6 valence electrons -radius: 142 pm mass = 128	Iodine I -nonmetal -solid -violet -reacts easily with metals to form salts -7 valence electrons -radius: 133 pm mass = 127	Xenon Xe -nonmetal -gas -very stable -8 valence electrons -radius: 131 pm mass = 131	Cesium Cs -metal -soft, shiny silver -conductor -reacts violently in water -1 valence electron -radius: 265 pm mass = 133
Barium Ba -metal -soft, silver-white -shiny -reacts with cold water to form a base -2 valence electrons -radius: 222 pm mass = 137	Thallium Tl -metal -soft, gray-white -very dense -lustrous -3 valence electrons -radius: 170 pm mass = 204	Lead Pb -metal -soft, silver -lustrous -very dense -allotropic -4 valence electrons -radius: 146 pm mass = 207	Bismuth Bi -metal -lustrous -brittle -allotropic -conductor -5 valence electrons -radius: 150 pm mass = 209	Polonium Po -metalloid -rare -radioactive -6 valence electrons -radius: 168 pm mass =209

Astatine At -metalloid -man-made element -solid (?) -radioactive -7 valence electrons -radius: 140 pm mass = 210	Radon Rn -nonmetal -gas -stable -rare -radioactive -8 valence electrons -radius: 140 pm mass = 222			