Lab 5: Properties of a Group in the Periodic Table

Goals

1. To introduce the concept of element groups

2. To show how elements in their groups are similar to one another and to explain why this is so

Materials and Equipment

Slide of elements:
- Carbon
- Silicon
- Germanium
- Tin

Digital voltmeter

Materials Not Included

Periodic table
Ice
Hot water
Shallow dish

Introduction

The periodic table is periodic, which means that it repeats. This happens because atoms fill their outer-shell electron orbits in an organized way. As it turns out, the outer-shell electrons are almost entirely responsible for the chemical properties of the elements.

The columns on the periodic table contain elements that have identical outer-shell electrons. These columns are called element groups. Group I elements are comprised of the alkali metals, and they are all very reactive. They form ionic compounds with many elements that are in the group VI and group VII columns. Other groups have other similarities.

In this laboratory we will study the group IVB elements, which are carbon, silicon, germanium, tin, and lead. We will omit lead from the actual hands-on examination. All the group IVB elements are quite commonly seen in ordinary life. Elemental carbon can been seen if you badly burn your toast or in the pencil "lead" you write with. Silicon is the basis for most electronic microchips in use today. Germanium is less common, but it too is used to make microchips. Tin is used in most solders. Lead is a solder, as well as a weight for fishing and balancing car tires.

Many of the group IVB elements are classified as semiconductors. They are not insulators since they can pass some current, but they are not conductors since they have a higher resistance than most metals. Semiconductors have an electrical resistance that is sensitive to temperature. You will investigate their changing resistance in this laboratory.

Devotional

"When I consider your heavens, the work of your fingers, the moon and the stars, which you have set in place, what is man that you are mindful of him, the son of man that you care for him? You made him a little lower than the heavenly beings and crowned him with glory and honor. You made him ruler over the works of your hands; you put everything under his feet … O Lord, our Lord, how majestic is your name in all the earth! Ps. 8:3-6, 9

Principle: God's world is surprisingly well organized. When we recognize this, it may bring a sense of wonder.

From the heavens above, to the seasons, to the migrating birds, to the smallest particles, all creation shows forth God's organization. The periodic table is clear evidence of God's organized patterns in the world of chemistry. The organization of the table is due to electrons filling their outer-shell orbitals. The groups, which are found in columns in the periodic table, all have similar properties. The elements on the left side weakly hold their electrons, while those on the right side fight to gain more electrons.

The metals all have similar "metallic" properties. The rare earth elements, such as the lanthanide series metals, fill their f-shell, which makes them so similar to each other that they are almost impossible to separate. The patterns are clear. And for all of us who see God's hand in these patterns, the elegance of the periodic table can bring a sense of wonder. How wonderful are your works our LORD!

Procedure

1. Using a periodic table, write out the electronic structures of all the group IVB elements. Put your answers into Table 1.

2. Check the room temperature resistance of C, Si, Ge, and Sn. To do this you will put the multimeter on the resistance range in the 200 Ohm scale. Touch one probe to each end of each sample provided. Wait until the value is relatively stable and report an approximate value. The values do move around a bit, so make your best estimate. Report the values in Table 2.

3. Make some ice water and pour it into a very shallow dish. Place the slide with the sample elements into the ice water and wait a minute for them to cool. Dry the samples and quickly measure the resistance of each sample. Again, you will need to wait for the resistance value to stabilize and then make your best estimate of the value. Record your results in Table 2.

4. Repeat the test again, using hot water in the shallow dish instead of cold water. You will need to preheat the dish with hot water to make sure the water remains as hot as possible.

5. Take a knife or small screwdriver and attempt to make a very small scratch on the element samples. If you have access to a lead wheel weight or a lead fishing weight, you may examine that and add the results to the table. Try to determine if the samples tend to be hard and brittle, or soft and ductile. Fill out column 3 in Table 1.

Lab 5

Questions for Properties of a Group in the Periodic Table

Table 1

Element	Electronic Structure	Brittle/Ductile/In Between
Carbon		
Silicon		
Germanium		
Tin		
Lead		

Table 2

Element	Resistance, In Ice Water	Resistance, Room Temperature	Resistance, In Hot Water
Carbon			
Silicon			
Germanium			
Tin			

1. In what ways are the electronic structures of the group IVB elements similar? In what ways are they different?

2. Compare the room temperate resistances for all the samples. Are they similar or quite different?

3. How does resistance change with temperature? Is there more resistance or less resistance at higher temperatures? Compare the change in resistance for all the samples.

4. Are the samples soft and ductile or hard and brittle? Are some in between?

5. What do you think causes the difference between the elements on the top of the periodic table, like carbon, with those on the bottom of the periodic table, like tin or lead?