The three pure substances pictured below have the distinction of being among the top ten elements that make up the human body. All three of them belong to the class of elements called nonmetals. Most of the elements that comprise the human body - as well as the majority of other living things - are nonmetals. In fact, seven of the top ten elements in your own body belong to this class of elements. What do you know about nonmetals? What are their properties, and how are they different from other elements? In this article, you'll find out.

![Figure 1: Elemental carbon, phosphorus, and sulfur.](image)

**What Are Nonmetals?**

**Nonmetals** are elements that generally do not conduct electricity. They are one of three classes of elements (the other two classes are metals and metalloids). Nonmetals are the second largest of the three classes after metals. They are the elements located on the right side of the periodic table.

**Properties of Nonmetals**

As their name suggests, nonmetals generally have properties that are very different from the properties of metals. Properties of nonmetals include a relatively low boiling point, which explains why many of them are gases at room temperature. However, some nonmetals are solids at room temperature, including the three pictured above, and one nonmetal - bromine - is a liquid at room temperature. Other properties of nonmetals are illustrated and described in the table below.

<table>
<thead>
<tr>
<th>Illustration</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Image" /></td>
<td>Most nonmetals are poor conductors of heat. In fact, they are such poor conductors of heat that they are often used for insulation. For example, the down filling in this sleeping bag is full of air, which consists primarily of the nonmetal gases oxygen and nitrogen. These gases prevent body heat from escaping to the cold outside air.</td>
</tr>
<tr>
<td><img src="image" alt="Image" /></td>
<td>Solid nonmetals are generally dull and brittle like these pieces of iodine. Like other nonmetals, iodine lacks the luster of metals and will easily crack and crumble.</td>
</tr>
</tbody>
</table>

**Reactivity of Nonmetals**

Reactivity is how likely an element is to react chemically with other elements. Some nonmetals are extremely reactive, whereas others are completely nonreactive. What explains this variation in nonmetals? The answer is their number of valence electrons. These are the electrons in the outer energy level of an atom that are involved in interactions with other atoms. Let's look at two examples of nonmetals, fluorine and neon. Simple atomic models of these two elements are shown in the figure below.
Although neon has just one more electron than fluorine in its outer energy level, that one electron makes a huge difference. Fluorine needs one more electron to fill its outer energy level in order to have the most stable arrangement of electrons. Therefore, fluorine readily accepts an electron from any element that is equally "eager" to give one up, such as the metal lithium or sodium. As a result, fluorine is highly reactive. In fact, reactions with fluorine are often explosive. Neon, on the other hand, already has a full outer energy level. It is already very stable and never reacts with other elements. It neither accepts nor gives up electrons. Neon doesn't even react with fluorine, which reacts with all other elements except helium.

**Why Most Nonmetals Cannot Conduct Electricity**

Like most other nonmetals, fluorine cannot conduct electricity, and its electrons explain this as well. An electric current is a flow of electrons. Elements that readily give up electrons (the metals) can carry electric current because their electrons can flow freely. Elements that gain electrons instead of giving them up cannot carry electric current. They hold onto their electrons so they cannot flow.

**Summary**

- Nonmetals are elements that generally cannot conduct electricity. They are the second largest class of elements after metals. Examples of nonmetals include hydrogen, carbon, chlorine, and helium.
- Properties of nonmetals include a relatively low boiling point, so many nonmetals are gases. Nonmetals are also poor conductors of heat, and solid nonmetals are dull and brittle.
- Some nonmetals are very reactive, whereas others are not reactive at all. It depends on the number of electrons in their outer energy level.
- Reactive nonmetals tend to gain electrons. This explains why they cannot conduct electricity, which is a flow of electrons.

**Explore More**

Watch the video about nonmetals at the following URL, and then answer the questions below.

- [http://www.youtube.com/watch?v=-q1OW8vJ3wA](http://www.youtube.com/watch?v=-q1OW8vJ3wA)
1. The science teacher in the video does an experiment in which he tests the reactivity of four nonmetal gases. How does he test them?

2. What is the outcome of the experiment?

3. Based on this outcome, what conclusion can you draw?

4. Why do the gases differ in reactivity?

Contributors and Attributions

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