Organizing the Elements

By the mid-1800s, about 60 elements had been discovered. Scientists had a lot of information about these elements, but it wasn't organized and therefore wasn't very useful. The scientists had tried to arrange the elements alphabetically, but found that each time they discovered another element, the whole list had to be changed. Organizing them by colour didn't work because too many elements looked the same. Taste didn't work because many elements were poisonous. The scientists found that properties such as conductivity, malleability, and lustre allowed them to group the elements into metals and nonmetals (**Figure 1**).

This was a good start, but most elements were metals. All metals conducted electricity, were malleable, and looked shiny. A better system was needed.

Finally, scientists found a property that not only could be measured, but also was different for every element. **Atomic mass**—the average mass of one atom of an element—was used to arrange the elements.

Figure 1
Physical and chemical properties suggest that elements can be organized into metals and nonmetals.

Mendeleev and the First Periodic Table

A Russian chemist, Dmitri Mendeleev, came up with the best arrangement for the 64 elements then known. Mendeleev looked at the chemical and physical properties of the elements and found that, based on their properties, some elements were similar to others. Mendeleev (**Figure 2**) had an idea that there was a pattern or relationship among the elements, but he was not quite sure what it was.

He began with each element's atomic number and then arranged and rearranged the elements until he began to see regular patterns. He found that elements with similar properties fit into the same vertical columns. Some elements fit because of their mass, but their properties were not similar. Mendeleev moved these elements to a column with similar properties and ignored their

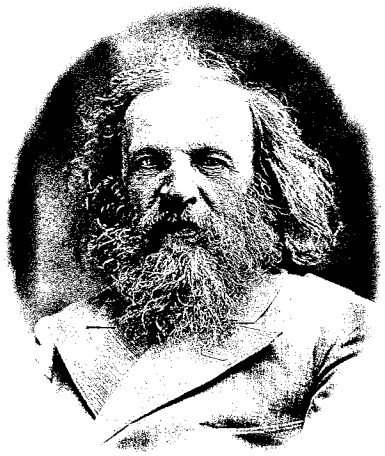

Figure 2
Dimitri Mendeleev's organization of the elements into a periodic table made the study of chemistry manageable.

mass. He even left spaces in his table for elements that had not yet been discovered. When he had finished with his arrangement, his table of elements showed a pattern that repeated based on the elements' properties. Anything that repeats according to the same pattern can be called **periodic** (for example, the days of the week, the months of the year, and even the migration of birds).

Mendeleev created a periodic law that stated:

If the elements are arranged according to their atomic mass, a pattern can be seen in which similar properties occur regularly.

Today's Periodic Table

Mendeleev's **periodic table** was a good place to start, but scientists like Mendeleev didn't know anything about the atomic structure of the atom. By the twentieth century, the nuclear atom and its subatomic particles had been discovered. Scientists had realized that the key to the identity of an element was the number of protons in the nucleus—the atomic number—not the atomic mass. A **modern periodic law** was written and a new periodic table was created.

If the elements are arranged according to their atomic number, a pattern can be seen in which similar properties occur regularly.

Elements in the modern periodic table are arranged by atomic number (**Figure 3**). With a few exceptions, atomic numbers are in the same order as atomic mass. The lightest element has the lowest atomic number, and the heaviest element has the greatest atomic mass.

The periodic table is divided into three main groups: metals, nonmetals, and metalloids. There are more metals than nonmetals, and the metals are on the left side of the table. The nonmetals are on the right side. The two groups are divided by a heavy, steplike line. Some elements have the properties of both metals and nonmetals. They are called **metalloids**. They are found on both sides of the step-wise line that divides the metals from the nonmetals. For example, silicon is a metalloid. It is shiny and silvery, but it is not malleable and is only a partial conductor of electricity.

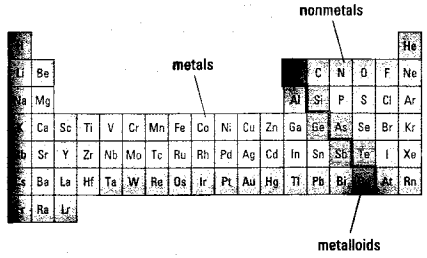

Figure 3
Location of the metals, nonmetals and the metalloids on the periodic table

Understanding Concepts

1. What are some of the properties that helped scientists organize elements into metals and nonmetals?
2. **(a)** What property of atoms did Mendeleev use to organize elements?
   (b) How did he use this property to organize them?
   (c) When did he ignore this property in building his table?
3. Explain why Mendeleev included spaces in his periodic table.
4. Why were properties such as colour and taste not used to arrange elements on the first periodic table?
5. Where on the modern periodic table do you find metals, nonmetals, and metalloids?

Challenge

3 Another scientist and his discoveries have been introduced in this section. Could he be your "famous scientist"?

Work the Web

Visit www.science.nelson.com and follow the links from *Science 9: Concepts and Connections*, 1.18. Read the biography of Dmitri Mendeleev, and make a list of his scientific contributions other than the periodic table.