KEY IDEAS

As you read this section, keep these questions in mind:
• How did Dmitri Mendeleev organize his periodic table?
• How are the elements arranged in a modern periodic table?

How Are the Elements Organized?

People organize things so that a particular item is easier to find. For example, a person may organize her CDs by the names of the bands. Another person may organize his books by subject.

In the 1860s, scientists knew of about 60 elements. A Russian schoolteacher named Dmitri Mendeleev was trying to organize these elements. Mendeleev listed the properties of each element on a separate piece of paper. He then tried to arrange the pieces of paper into rows and columns so that they formed a pattern.

MENDELEEV'S PERIODIC TABLE

In 1869, Mendeleev published the first periodic table of the elements. In his periodic table, Mendeleev arranged elements in rows by increasing atomic mass. Within a row, elements with lower atomic masses were on the left. Mendeleev started a new row every time the chemical properties of the elements repeated. Thus, all the elements in a column had similar properties.

Each row of Mendeleev's periodic table represented a repeating pattern. Because the pattern of chemical properties repeated by rows, all elements lined up in a column had similar properties.
SECTION 1 Organizing the Elements continued

PREDICTING ELEMENTS

When Mendeleev arranged the elements in a table, he left gaps, or spaces, in the table. Look again at Mendeleev’s table on the last page. Notice that Mendeleev included question marks in his table. The question marks represented elements with certain properties that scientists had not discovered yet. Because he saw patterns of chemical properties, Mendeleev predicted that scientists would eventually find the elements that filled those gaps.

Mendeleev was not the only person to develop a periodic table. However, he was the first to use the table to make predictions. For example, Mendeleev left a space in his table for an element after silicon. He predicted that this element would be a gray metal that had a high melting point. In 1886, the element germanium was discovered.

Properties of Germanium

<table>
<thead>
<tr>
<th>Property</th>
<th>Mendeleev’s prediction</th>
<th>Actual Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic mass</td>
<td>70</td>
<td>72.6</td>
</tr>
<tr>
<td>Density</td>
<td>5.5 g/cm³</td>
<td>5.3 g/cm³</td>
</tr>
<tr>
<td>Appearance</td>
<td>Dark gray metal</td>
<td>Gray metalloid</td>
</tr>
<tr>
<td>Melting point</td>
<td>High</td>
<td>937 °C</td>
</tr>
</tbody>
</table>

Germanium has the properties similar to those that Mendeleev predicted.

PROBLEMS WITH MENDELEEV’S TABLE

Mendeleev found that some elements did not fit the pattern in his table. For example, Mendeleev had to place tellurium (Te) before iodine (I) in his table so that they fit the pattern of chemical properties. However, when he switched Te and I, they were no longer in order of increasing atomic mass.

Mendeleev thought that the values for the atomic masses of Te and I might be incorrect. He thought that careful measurements would show that the atomic mass of Te was actually less than that of I. However, measurements by other scientists showed that the atomic masses of the two elements were correct. This problem was finally solved about 40 years later by an English chemist named Henry Moseley.

READING CHECK

2. Explain Why did Mendeleev leave gaps in the periodic table?

3. Explain Why did Mendeleev have problems arranging the elements Te and I?
How Is the Periodic Table Organized Today?

Unlike Mendeleev, Mosely did not organize elements by increasing atomic masses. Instead, he organized the elements into a periodic table by atomic number. Recall that an element’s atomic number is the number of protons in an atom of the element.

The new way of organizing did not change the locations of most elements in the periodic table. However, a few elements, including Te and I, did move. Although Te has a higher atomic mass than I, it has a lower atomic number. Thus, Mosely could place Te before I in the periodic table without disturbing the pattern of chemical properties.

The modern periodic table has more than 100 elements, and organizes the elements by atomic number. Because elements are arranged by atomic number, elements with similar properties are located in the same column. Therefore, the properties of the elements on the periodic table repeat at regular intervals. This principle is known as the periodic law.

PERIODS AND GROUPS

A horizontal row on the periodic table is called a period. There are seven periods on the periodic table. The properties of the elements in a period are different. A vertical column on the periodic table is called a group. All the elements in a group have similar chemical properties.
Section 1 Review

SECTION VOCABULARY

**group**  a vertical column of elements in the periodic table; elements in a group share chemical properties

**period**  in chemistry, a horizontal row of elements in the periodic table

**periodic law**  the law that states that the repeating chemical and physical properties of elements change periodically with the atomic numbers of the elements

1. **Compare**  Find oxygen, sulfur, and fluorine in the periodic table in the back of the book. Are the chemical properties of oxygen more similar to those of sulfur or to those of fluorine? Explain your answer.

2. **Identify**  Complete the table below to describe several elements. Use the periodic table in the back of the book to help you. Round off atomic masses to the nearest whole number. For example, change 15.9994 to 16.

<table>
<thead>
<tr>
<th>Element</th>
<th>Symbol</th>
<th>Atomic number</th>
<th>Atomic mass</th>
<th>Period</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td></td>
<td>47</td>
<td></td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Fe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. **Predict**  If scientists found element 117, into which period and group would they place it? Identify one element that would have properties similar to those of element 117.

4. **Infer**  Before 1937, scientists had not found element 43. Chemists predicted the properties of element 43. How was it possible for chemists to predict these properties?