CONCEPT 2

Elements can be organized by their properties.

Activity

Element Cards

Work in groups. Your teacher will give your group a set of cards. On each card is an element and information about its properties. Your challenge is to arrange the cards in rows and columns in a way that makes sense to you and your team members. When you are finished, explain your reasoning to the rest of the class.

In the mid-1800s, scientists had identified nearly 60 elements, and nobody knew how many more there might be. Scientists needed a classification system that would organize their observations. They were already grouping elements into "families" based on similar properties, but many family relationships were not obvious. What else could a classification system be based on?

By the 1860s, some scientists were trying to sort the known elements according to atomic mass. *Atomic mass* is the average mass of an atom of an element. Among them was a Russian chemist named Dmitri Mendeleev (1834–1907).

To help him experiment with different ways to organize the elements, Mendeleev made a card for each one. On each of these cards, he put data similar to the data you see in **Figure 2.7**. He shuffled and reordered the cards, playing a game of "chemical solitaire" to try to make sense of the repeating patterns of properties.

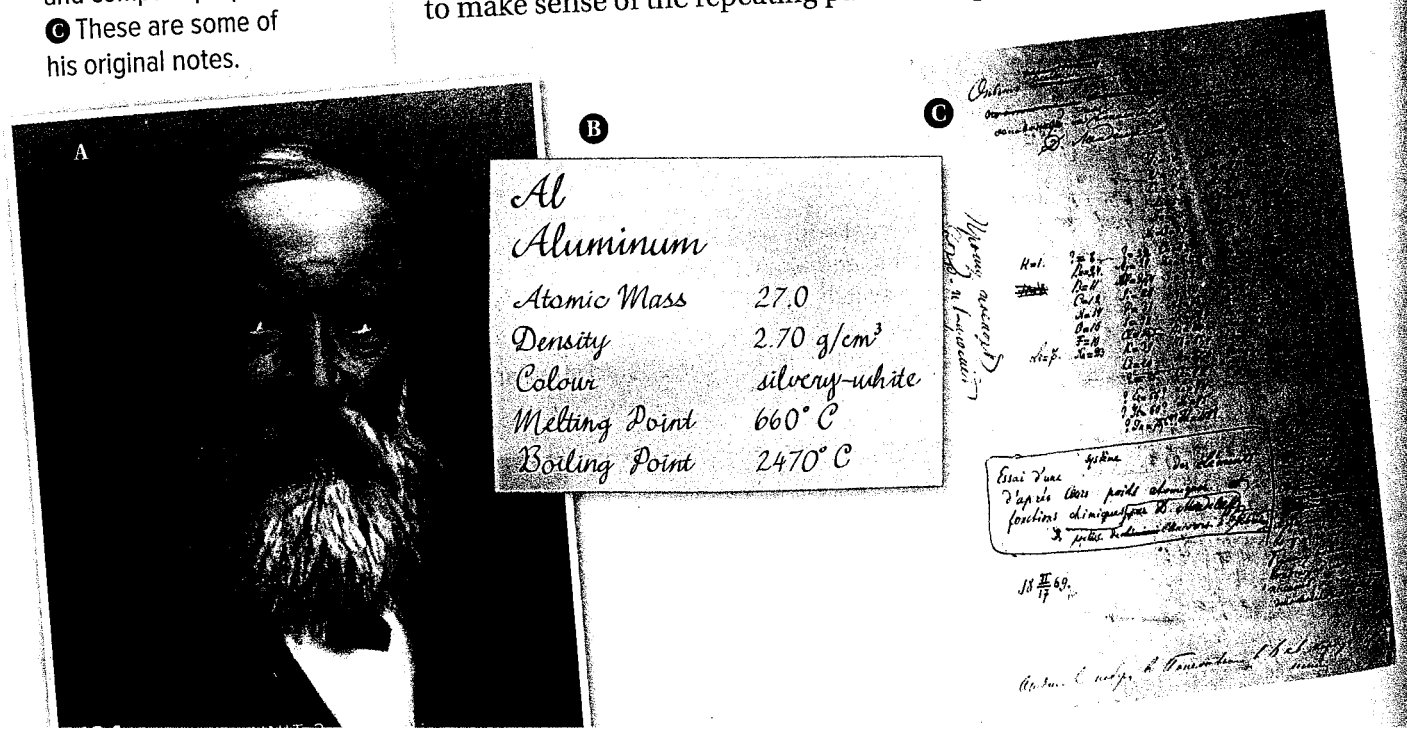
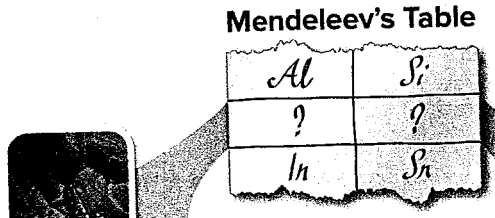


Figure 2.7 A Dmitri Mendeleev was a Russian teacher and chemist. He was the youngest of 17 children. B Mendeleev wrote the properties of elements on cards like this one so he could rearrange them and compare properties. C These are some of his original notes.



Properties of Gallium

Property	Mendeleev's Prediction	Actual Data
Atomic mass	68	69.72
Density (g/cm^3)	6.0	5.904
Melting point (°C)	low	29.78

Properties of Germanium

Property	Mendeleev's Prediction	Actual Data
Atomic mass	72	72.61
Density (g/cm^3)	5.5	5.32
Melting point (°C)	high	947

Figure 2.8 The gaps in Mendeleev's table predicted the existence of yet-to-be-discovered elements. Mendeleev used the properties of other elements in the same families to predict the properties of these elements.

The Predictive Power of Mendeleev's Table

After several months of "chemical solitaire," Mendeleev arrived at an arrangement that organized the elements according to their properties. Like other scientists before him, Mendeleev knew that the properties of elements tended to repeat over regular intervals. Like other scientists, he was ordering the elements by increasing atomic mass. However, Mendeleev realized that he needed to leave gaps in his arrangement—blank spaces predicting the existence of elements not yet found or even suspected by other chemists.

Using these gaps, he was able to accurately predict properties of elements that were not yet known but would be discovered later, including scandium, gallium, and germanium. How did Mendeleev's table make it possible for him to predict the properties of undiscovered elements? Mendeleev noted which families had spaces. He inferred that the missing elements would have properties similar to those of other members of their family. Gallium and germanium, shown in **Figure 2.8**, are famous for having been discovered after Mendeleev predicted their existence and physical properties.

Extending the Connections

Other Contributors to the Periodic Table

Research to find out how other scientists contributed to the development of the periodic table. Choose one of the following scientists: John Dalton, Alexandre Béguyer de Chancourtois, John Newlands, Julius Lothar Meyer, or Henry Moseley.

Before you leave this page . . .

1. Why did Mendeleev leave gaps in his periodic table?
2. How was Mendeleev able to predict the properties of gallium and germanium?

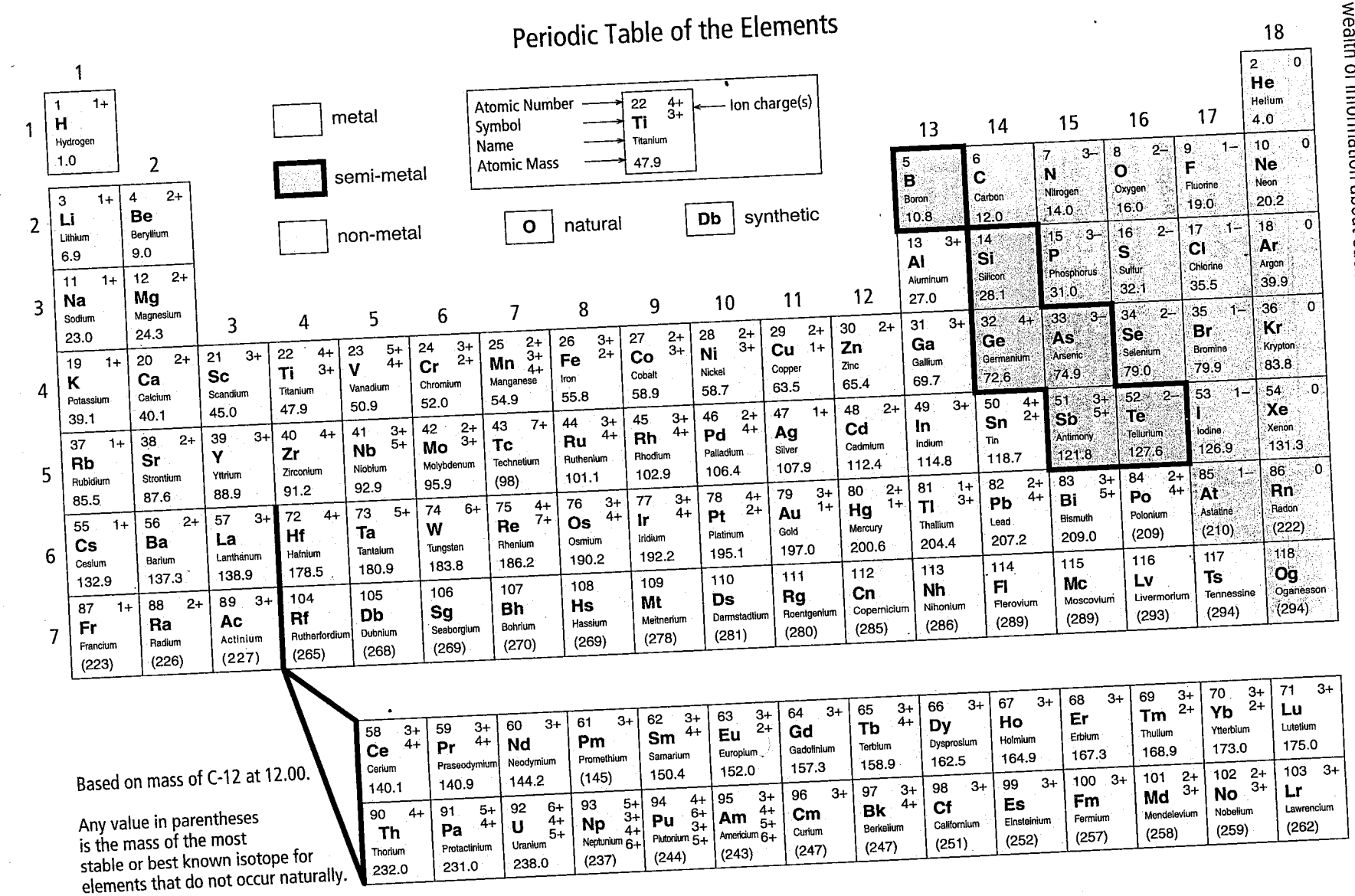


Figure 2.9 The modern periodic table enables the presentation of a wealth of information about each element on a single page.