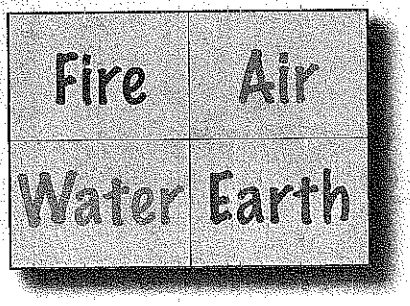
ELEMENTS

Two thousand years ago, people were trying to figure out what things were made of. One idea was that everything was a mix of four basic properties: hot, cold, wet, and dry.

If you had just the right mix of hot and dry, that might make rock. A little less hot and a bit of wet might make wood. The right amount of all four properties might make a leaf.

Pure samples of the four properties were fire, air, earth, and water. These four substances were thought to be the elements from which everything was made. A table of the ancient elements looked like this.



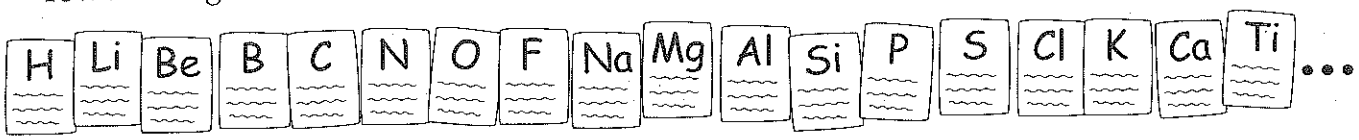
Some people had a different idea about what things were made of. Chemists in the 1800s were busy investigating a lot of different **substances**. They heated substances as hot as they could. They put acid on them. They ran electric currents through them. Sometimes the substances separated into new substances when they did their experiments. When this happened, they tested the new substances with heat, acid, and electricity. Some of the substances would not change any more. They called the unchangeable substances **elements**. These new elements had different names than the ancient elements. The new elements had names like iron, copper, carbon, oxygen, sulfur, and gold.

An element is a **fundamental** substance that cannot be broken into simpler substances. Elements are the building blocks of **matter**. Elements combine to form all the different substances in the world.

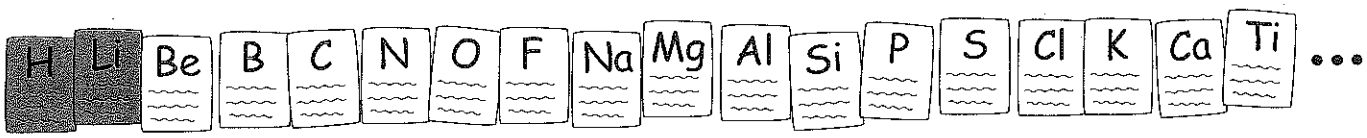
By the middle of the 1800s, about 60 elements had been discovered. A lot was known about them. Scientists knew some of their **chemical properties**, such as what other elements they combine with. They knew some of their **physical properties**, such as the weight of standard samples of the elements. When scientists made a list of the elements, they put them in order by weight, starting with the lightest element they knew about, hydrogen.

THE FIRST PERIODIC TABLE

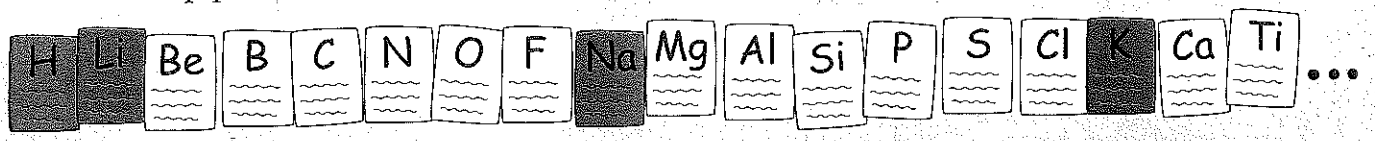
In 1869, a Russian chemist named Dmitry Ivanovich Mendeleyev (1834–1907) was writing a book about the elements. He made a set of element cards. Each card had one element's name and symbol and everything that was known about it. He put the cards in one long row from lightest to heaviest, hydrogen to uranium.



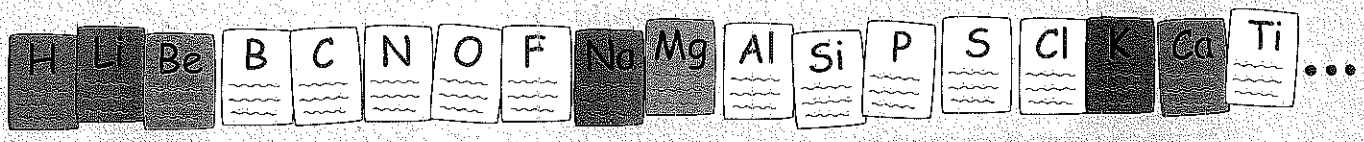
Mendeleyev looked at the line of element cards and saw something interesting. The first two elements, hydrogen (H) and lithium (Li), had similar chemical properties.



And as he looked down the line, he noticed that sodium (Na) and potassium (K) also had chemical properties similar to hydrogen and lithium. The similar chemical properties showed up periodically in his lineup.

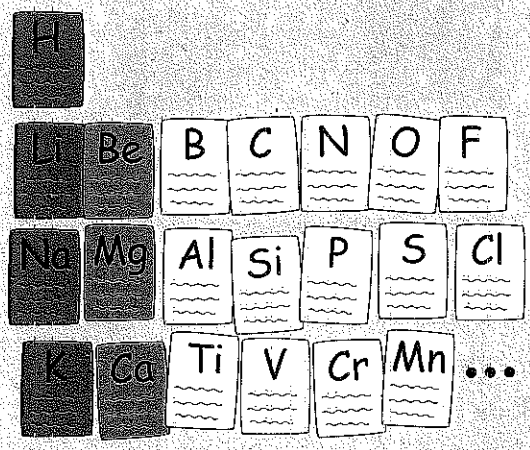


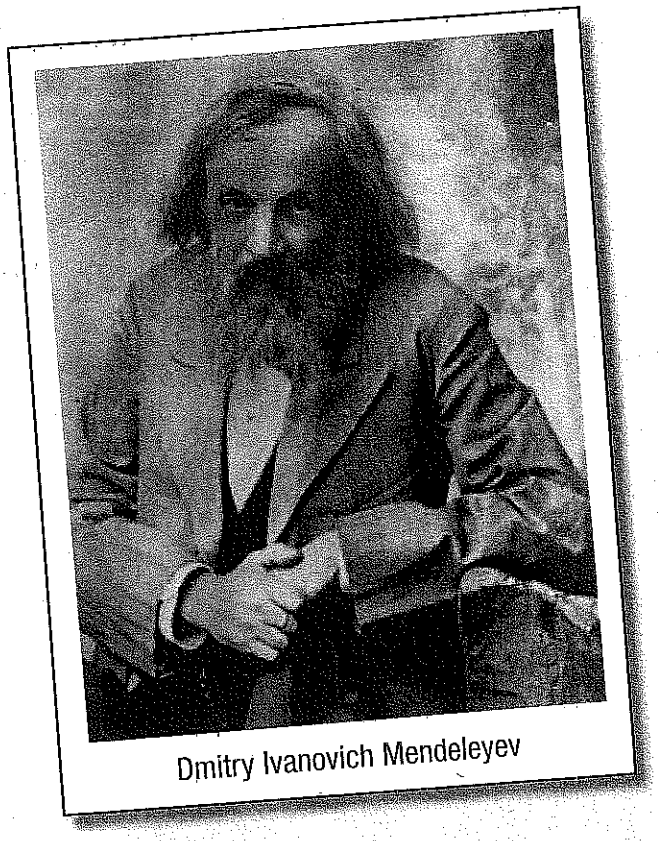
Then Mendeleyev saw that beryllium (Be), magnesium (Mg), and calcium (Ca) all had similar, but different properties. The similar chemical properties of beryllium, magnesium, and calcium showed up periodically, too.



Mendeleyev had an idea. He reorganized the cards into several short rows. This way all the elements with similar properties lined up in columns. The columns are called groups.

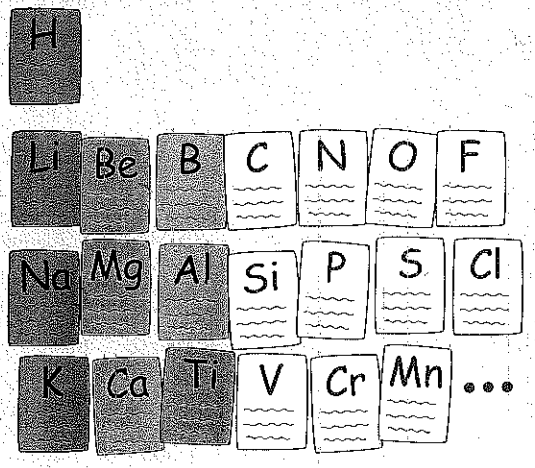
The periodic recurrence of similar chemical properties is why the element table is called the periodic table of the elements.





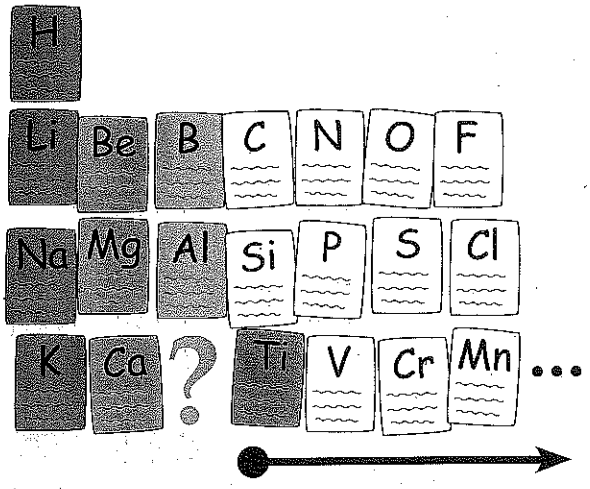
Dmitry Ivanovich Mendeleyev

When Mendeleyev had all the elements laid out, he noticed something was wrong. For instance, the chemical properties of titanium (Ti) were not like those of aluminum (Al) and boron (B) above it.



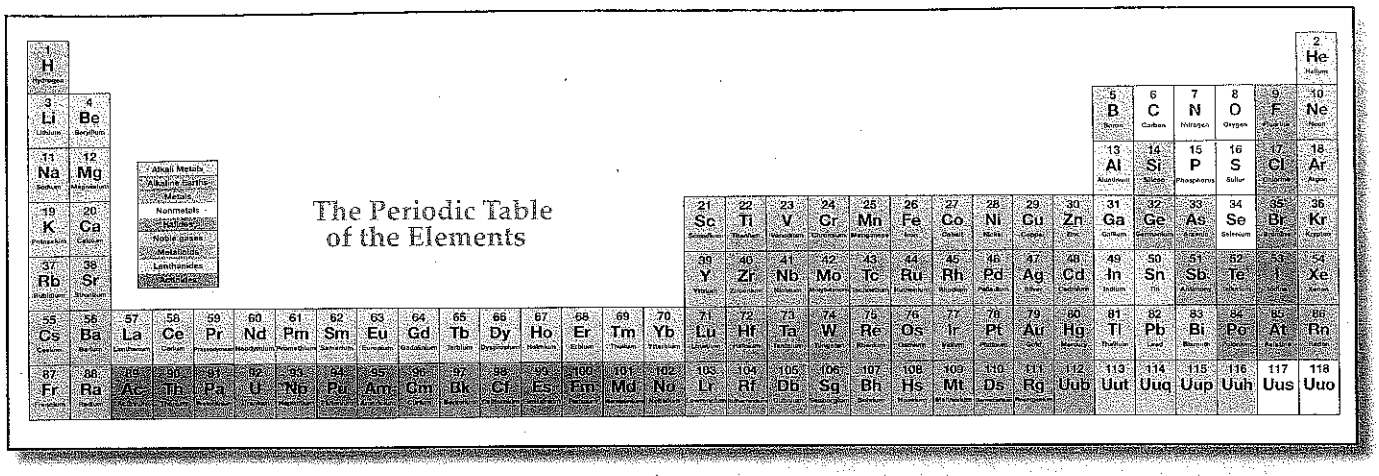
When Mendeleyev moved titanium and its neighbors to the right, two things happened. The chemical properties of the elements lined up better. And there was a gap in the table of elements.

Mendeleyev looked at the gap and **predicted** that an undiscovered element must fit in that spot. Furthermore, he predicted the properties that the new element would have. By moving the known elements around so that their properties lined up, Mendeleyev predicted about 30 new elements. Over the next 30 years, most of them were discovered.

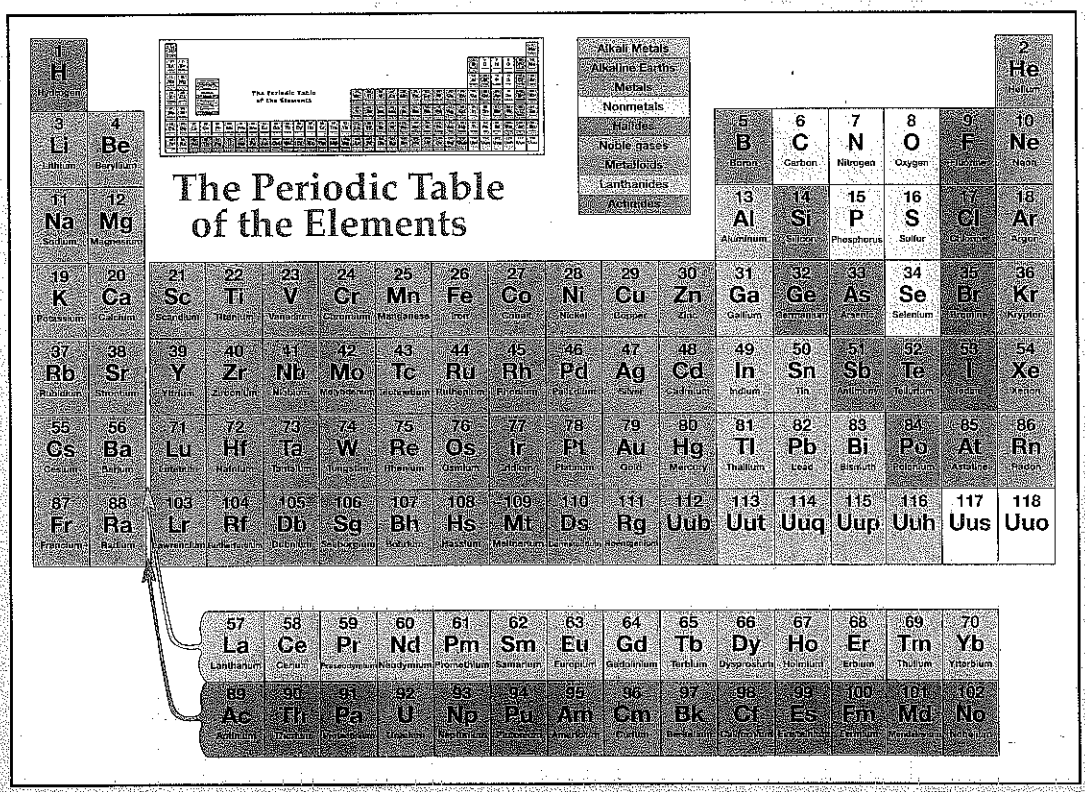


THE MODERN PERIODIC TABLE OF THE ELEMENTS

The modern **periodic table of the elements** organizes and displays all the elements from simplest to most complex. Hydrogen, the simplest element, is number 1. Mendeleyev's idea of putting the elements in rows under each other, so that the chemical properties are similar in the columns, is still used. But Mendeleyev didn't know what we know today. There are 2 elements in row 1, 8 elements in rows 2 and 3, 18 elements in rows 4 and 5, and 32 elements in rows 6 and 7. This is the modern periodic table.



This layout makes the table very long. Often 28 of the elements are pulled out and shown below the others. Then the table fits better on a standard piece of paper.

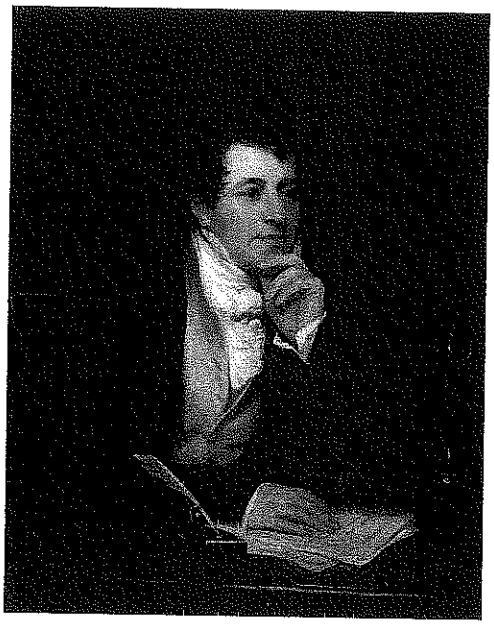


Color helps to show which elements have similar chemical properties. In the periodic table used in this course, elements that are orange, light blue, dark blue, light lavender, dark lavender, and yellow green are **metals**. Green, red, yellow, and aqua elements (plus hydrogen) are nonmetals. The green elements on the right are called **noble gases**. They are interesting because they don't react with other elements.

ELEMENT FINDERS

Sir Humphry Davy (1778–1829)

Sir Humphry Davy was born in Cornwall, England, in 1778. As a young man, he was studying to be a doctor. But his life changed when he picked up a book on chemistry.



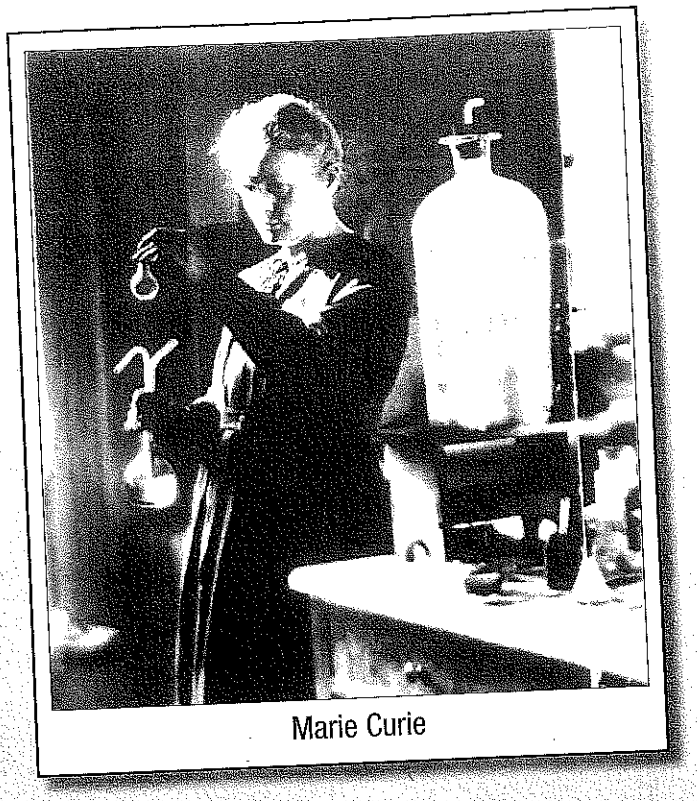
Sir Humphry Davy

Soon Davy was conducting experiments in his small laboratory. Some of his first efforts ended in explosions. Others filled his lab with strange gases. Davy's knowledge of chemistry grew. He took a teaching position at the university when he was 24 years old. There he became interested in separating substances until they could not be separated any more. He used a battery to run electricity through a solution of **potash**, which is potassium carbonate, K_2CO_3. The potash separated. Davy discovered his first element, potassium (K). People say that Davy actually danced around the room after this discovery.

Davy went on to become one of the greatest element finders of all time. He is credited with more element discoveries than anyone else! Using his electricity methods, Davy discovered seven elements, including some you've read about. They are sodium (Na), magnesium (Mg), boron (B), potassium (K), calcium (Ca), barium (Ba), and chlorine (Cl).

Marie Curie (1867–1934)

Marie Sklodowska Curie was born in Warsaw, Poland, on November 7, 1867. In 1891, she moved to Paris, France, to study mathematics, physics, and chemistry. After getting her degree in physics, she set up a small lab in the basement of the school where her husband, Pierre, taught. She studied the **radiation** coming from uranium ore. Curie thought that the amount of radiation was too strong to be only from uranium. She discovered two new elements, polonium (Po) and radium (Ra), in the ore sample. The samples of radium she produced glowed with a continuous green light. She invented the term ***radioactivity*** to describe the radiation given off by the elements.



Marie Curie

Curie was awarded the Nobel Prize in 1903. She was the first woman ever to win. She was awarded a second Nobel Prize in 1911, making her the first person ever to win twice! During World War I (1914–1918), Curie trained people to use X rays to find bullets in wounded soldiers.

Unfortunately, Curie didn't realize the dangers of radiation. In 1934, she died from an illness caused by exposure to radioactive materials. Her notes and laboratory equipment are still radioactive today, more than 100 years after she conducted her research.

REVIEW QUESTIONS

1. What is an element?
2. How are matter and elements related?
3. How was Mendeleyev able to predict the existence of elements that had not yet been discovered?
4. What is the periodic table of the elements?