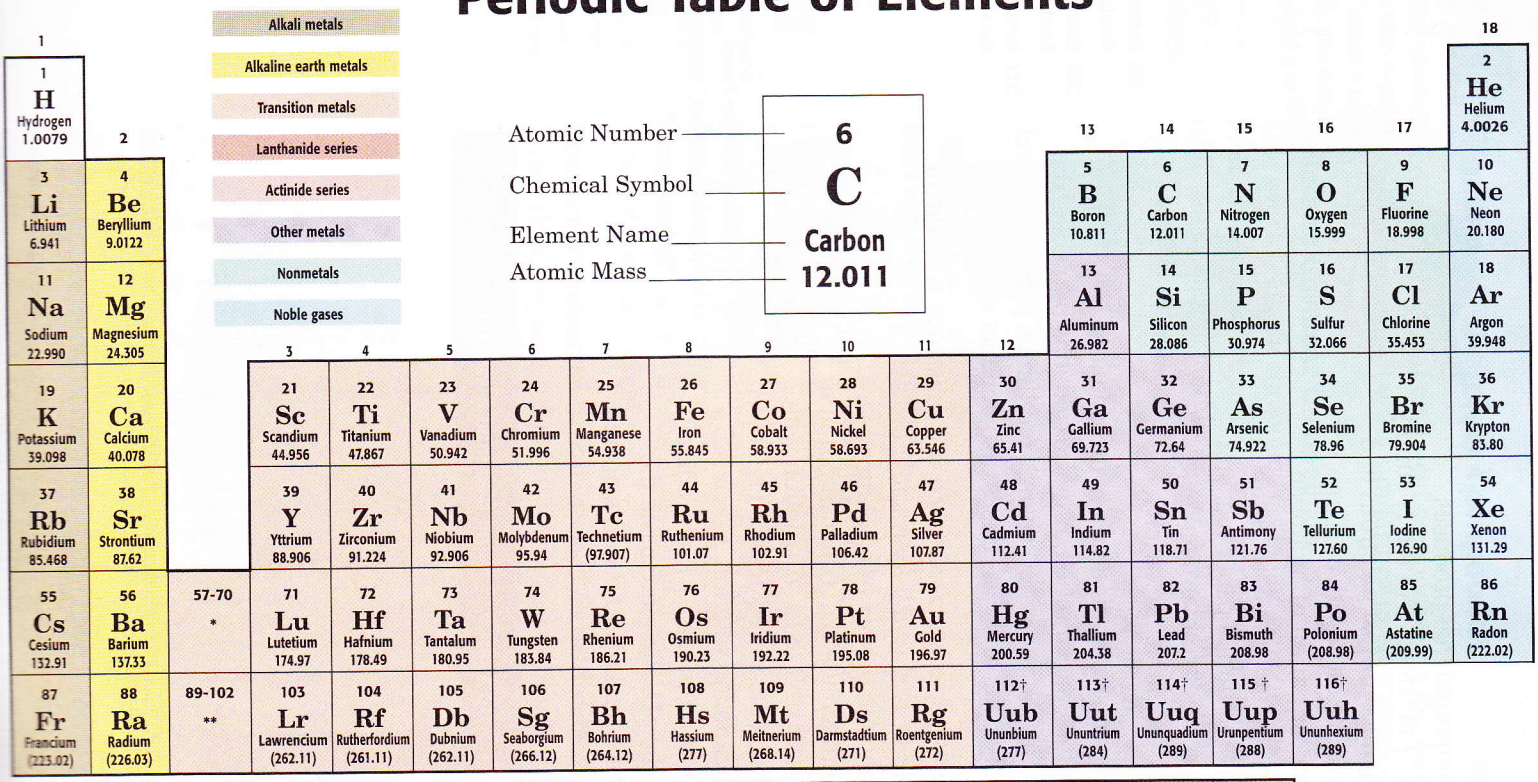
Periodic Table of Elements



†Scientists have discovered elements 112, 113, 114, 115, and 116, but other scientists have to repeat their experiments to make these elements official.

Periodic Table

Back in 1869, Russian chemist Dmitri Mendeléev organized all the known elements into a chart according to their properties. Today that chart is known as the **periodic table of elements.**

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The periodic table is made up of horizontal rows and vertical columns of boxes. Each box contains specific information about a single element. This information includes the element's name, the chemical symbol for the element, the element's atomic number, and the element's atomic mass.

The **chemical symbol** is one or two letters used to represent the element's name. The first letter is always capitalized; the second letter, if there is one, is always lowercase. The **atomic mass** is the average mass of an atom of that element. Atomic mass is measured in atomic mass units (amu). The **atomic number** is the number of protons in an atom of that element.

Word Watch!

Many of the chemical symbols used in the periodic table come from the Latin words for those elements. For example, *Fe* is the symbol for the element iron. The Latin word for iron is *ferrum*.

Each row of elements in the periodic table is called a **period.** If you read the elements in each period from left to right, you will see that they are arranged in order by their atomic number.

Each column in the periodic table is called a **group** or **family.** The elements in each group share similar physical and chemical properties.

The chemical properties of an element are determined by the number of electrons in the outermost energy level of its atoms.

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251 Properties of Matter
256 Atomic Structure

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Chemical Formulas, Reactions, and Equations

"A water molecule contains two atoms of hydrogen and one atom of oxygen." If you had to describe each chemical compound like this, you'd spend all day writing! To simplify how we talk about chemicals, scientists came up with a form of shorthand in which symbols and numbers take the place of words.

Chemical Formulas

Just as each individual element in the periodic table is represented by a chemical symbol, so are molecules and compounds represented by combinations of chemical symbols and numbers. A **chemical formula** is a shorthand way of describing a chemical compound.

SEE ALSO
265 Periodic Table
255 Atoms
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For example, H_2 is the chemical formula for a molecule of hydrogen. The small number 2 in the subscript, or lowered, position indicates that the hydrogen molecule contains two hydrogen atoms bonded together. $3H_2$ is the chemical formula for three hydrogen molecules, each of which contains two hydrogen atoms. The large number 3 in front of the H is called a **coefficient.**

CO_2 is the chemical formula for the compound carbon dioxide. A molecule of carbon dioxide contains one atom of carbon (C) bonded to two atoms of oxygen (O_2). The formula $Ca(NO_3)_2$ represents a compound whose molecules consist of one calcium atom bonded to two groups each of one nitrogen atom and three oxygen atoms. That makes a total of one calcium atom, two nitrogen atoms, and six oxygen atoms in each molecule of the compound.

Adding a plus or minus sign in the superscript, or raised, position following a chemical symbol indicates that the atom or compound is an ion—it has a charge. For example, Na^+ is the symbol for a positive sodium ion. Cl^- is the symbol for a negative chlorine ion.

Electron-Dot Diagrams

Another way to represent molecules and compounds is with **electron-dot diagrams.** In these diagrams, electrons in the outermost energy level of an atom are represented as dots around an element's symbol. Here are the electron-dot diagrams for some common elements.

Remember, the number of electrons in the outermost energy level of an atom determines the chemical properties of that element.

SEE ALSO
256 Atomic Structure

Word Watch!

The electrons in the outermost energy level of an atom are often called *valence electrons.*

Carbon		Sodium	
Oxygen		Aluminum	
Neon		Chlorine	

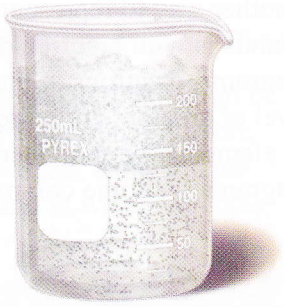
Electron-dot diagrams can be used to show how two elements share electrons in covalent bonding.

SEE ALSO
263 Chemical Bonds

H_2O—A molecule of water

One oxygen atom shares a pair of electrons with each of two hydrogen atoms.

269 Chemical Reactions



Have you ever added vinegar to baking soda? When these two substances are mixed together, they begin to bubble and fizz. That's because carbon dioxide gas is produced when the vinegar reacts chemically with the baking soda.

A **chemical reaction** takes place when one or more substances change to form one or more new substances. The substances that undergo the change are called the **reactants.** The substances that result from this change are called the **products.** In the example above, vinegar and baking soda are the reactants, and carbon dioxide gas is one of the products.

The products of a chemical reaction can include compounds that did not exist before the reaction. However, chemical reactions never produce compounds with elements not found in the reactants. Chemical reactions can only rearrange elements in the reactants to produce new compounds.

270 Chemical Equations

SEE ALSO
267 Chemical Formulas

How could you describe a chemical reaction to someone without using words? You could write a chemical equation. A **chemical equation** is a way of describing a chemical reaction using chemical formulas.

For example, hydrogen and oxygen atoms react chemically to produce water. The chemical equation that represents this is as follows:

$$2H_2 + O_2 \rightarrow 2H_2O$$

The reactants in a chemical equation are always on the left side of the equation, and the products are always on the right.

In any chemical reaction, the number and kinds of atoms in the reactants must equal the number and kinds of atoms in the products. In other words, the equation must be balanced. This rule obeys the **law of conservation of mass,** which states that matter can be neither created nor destroyed.

Let's look again at the equation

$$2H_2 + O_2 \rightarrow 2H_2O$$

Four hydrogen atoms ($2 \times H_2$) combine with two oxygen atoms (O_2) to form two molecules of water ($2 \times H_2O$):

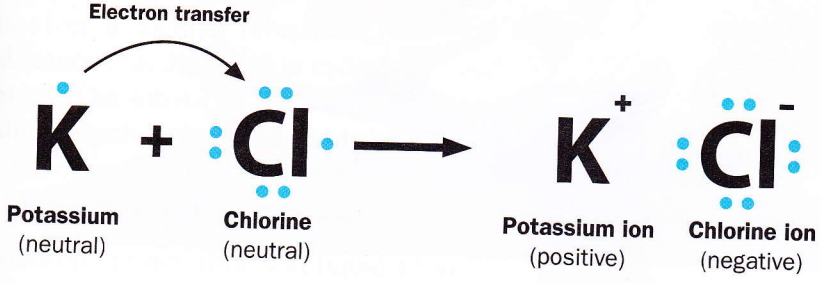
$2H_2$ + O_2 → $2H_2O$

4 hydrogen atoms + 2 oxygen atoms → 4 hydrogen atoms and 2 oxygen atoms combined as 2 molecules of water

Note that the coefficient "2" is needed before each "H_2" in order for the equation to be balanced.

You can also use electron-dot diagrams in an equation to represent a chemical reaction.

SEE ALSO
268 Electron-Dot Diagrams



Potassium and chlorine combine to form potassium chloride.