Elements that have similar chemical properties are grouped in columns called **groups (or families)**. As well as being numbered, some of these groups have names—for example, **alkali metals** (the first column of elements), **alkaline earth metals** (the second column of elements), **halogens** (the next-to-last column of elements), and **noble gases** (the last column of elements). In chemistry and atomic physics, the **main group** is the group of elements whose lightest members are represented by helium, lithium, beryllium, boron, carbon, nitrogen, oxygen, and fluorine as arranged in the periodic table of the elements. The main group includes the elements (except hydrogen, which is sometimes not included) in groups 1 and 2, and groups 13 to 18. Main-group elements (with some of the lighter transition metals) are the most abundant elements on earth, in the solar system, and in the universe. They are sometimes also called the **representative elements**. In older nomenclature the main-group elements are groups IA and IIA, and groups IIB to 0 (CAS groups IIIA to VIIIA). Group 12 is labelled as group IIB in both systems. Group 3 is labelled as group IIIA in the older nomenclature (CAS group IIIB).

Each row of elements on the periodic table is called a **period**. Periods have different lengths; the first period has only 2 elements (hydrogen and helium), while the second and third periods have 8 elements each. The fourth and fifth periods have 18 elements each, and later periods are so long that a segment from each is removed and placed beneath the main body of the table.

One way to categorize the elements of the periodic table is shown in Figure 1. The first two columns on the left and the last six columns on the right as mentioned earlier are the main group elements. The ten-column block between these columns contains the **transition metals**. The two rows beneath the main body of the periodic table contain the **inner transition metals**. The elements in these two rows are also referred to as, respectively, the **lanthanide metals** and the **actinide metals**.

![Elements diagram]

**Interactive periodic table of the elements, in pictures and words**

https://elements.wlonk.com/ElementsTable.htm

Interactive Periodic Table of the Elements, in Pictures and Words © 2005-2016 Keith Enevoldsen elements.wlonk.com

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elements.wlonk.com
Family Features: Outer Electron Configurations

Valence Electrons

The valence shell is the outermost shell of an atom in its uncombined state, which contains the electrons most likely to account for the nature of any reactions involving the atom and of the bonding interactions it has with other atoms. **Valence electrons** are the outer-shell electrons of an atom. These are electrons that can participate in the formation of a chemical bond. The presence of valence electrons can determine the element's chemical properties and whether it may bond with other elements.

An atom with a closed shell of valence electrons tends to be chemically inert. An atom with one or two valence electrons more than a closed shell is highly reactive, because the extra valence electrons are easily removed to form a positive ion. An atom with one or two valence electrons fewer than a closed shell is also highly reactive, because of a tendency either to gain the missing valence electrons (thereby forming a negative ion), or to share valence electrons (thereby forming a covalent bond).

The number of valence electrons of an element can be determined by the periodic table group (vertical column) in which the element is categorized. With the exception of groups 3–12 (the transition metals), the units digit of the group number identifies how many valence electrons are associated with a neutral atom of an element listed under that particular column.

<table>
<thead>
<tr>
<th>Periodic table group</th>
<th>Valence electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (I) (alkali metals)</td>
<td>1</td>
</tr>
<tr>
<td>Group 2 (II) (alkaline earth metals)</td>
<td>2</td>
</tr>
<tr>
<td>Groups 3-12 (transition metals)</td>
<td>2*</td>
</tr>
<tr>
<td>Group 13 (III) (boron group)</td>
<td>3</td>
</tr>
<tr>
<td>Group 14 (IV) (carbon group)</td>
<td>4</td>
</tr>
<tr>
<td>Group 15 (V) (pnictogens)</td>
<td>5</td>
</tr>
<tr>
<td>Group 16 (VI) (chalcogens)</td>
<td>6</td>
</tr>
<tr>
<td>Group 17 (VII) (halogens)</td>
<td>7</td>
</tr>
<tr>
<td>Group 18 (VIII or 0) (noble gases)</td>
<td>8**</td>
</tr>
</tbody>
</table>

* The general method for counting valence electrons is generally not useful for transition metals.

** Except for helium, which has only two valence electrons.
Family Groups

As previously noted, the periodic table is arranged so that elements with similar chemical behaviors are in the same group. Chemists often make general statements about the properties of the elements in a group using descriptive names with historical origins.

Group 1: The Alkali Metals

The alkali metals are lithium, sodium, potassium, rubidium, cesium, and francium. Hydrogen is unique in that it is generally placed in Group 1, but it is not a metal.
The compounds of the alkali metals are common in nature and daily life. One example is table salt (sodium chloride); lithium compounds are used in greases, in batteries, and as drugs to treat patients who exhibit manic-depressive, or bipolar, behavior. Although lithium, rubidium, and cesium are relatively rare in nature, and francium is so unstable and highly radioactive that it exists in only trace amounts, sodium and potassium are the seventh and eighth most abundant elements in Earth’s crust, respectively.

**Group 2: The Alkaline Earth Metals**

The alkaline earth metals are beryllium, magnesium, calcium, strontium, barium, and radium. Beryllium, strontium, and barium are rare, and radium is unstable and highly radioactive. In contrast, calcium and magnesium are the fifth and sixth most abundant elements on Earth, respectively; they are found in huge deposits of limestone and other minerals.

**Group 17: The Halogens**

The halogens are fluorine, chlorine, bromine, iodine, and astatine. The name halogen is derived from the Greek words for "salt forming," which reflects that all the halogens react readily with metals to form compounds, such as sodium chloride and calcium chloride (used in some areas as road salt).

Compounds that contain the fluoride ion are added to toothpaste and the water supply to prevent dental cavities. Fluorine is also found in Teflon coatings on kitchen utensils. Although chlorofluorocarbon propellants and refrigerants are believed to lead to the depletion of Earth’s ozone layer and contain both fluorine and chlorine, the latter is responsible for the adverse effect on the ozone layer. Bromine and iodine are less abundant than chlorine, and astatine is so radioactive that it exists in only negligible amounts in nature.

**Group 18: The Noble Gases**

The noble gases are helium, neon, argon, krypton, xenon, and radon. Because the noble gases are composed of only single atoms, they are called monatomic. At room temperature and pressure, they are unreactive gases. Because of their lack of reactivity, for many years they were called inert gases or rare gases. However, the first chemical compounds containing the noble gases were prepared in 1962. Although the noble gases are relatively minor constituents of the atmosphere, natural gas contains substantial amounts of helium. Because of its low reactivity, argon is often used as an unreactive (inert) atmosphere for welding and in light bulbs. The red light emitted by neon in a gas discharge tube is used in neon lights.

Example (PageIndex{2}): Groups

Provide the family or group name of each element.

a. Li  
   b. Ar  
   c. Cl

**Solution**

a. Lithium is an alkali metal (Group 1)
b. Argon is a noble gas (Group 18)
c. Chlorine is a halogen (Group 17)

Exercise \(\PageIndex{2}\): Groups

Provide the family or group name of each element.

a. F
b. Ca
c. Kr

**Answer a:**
Fluorine is a halogen (Group 17)

**Answer b:**
Calcium is an alkaline earth metal (Group 2)

**Answer c:**
Krypton is a noble gas (Group 18)

---

**Metals and Nonmetals**

Certain elemental properties become apparent in a survey of the periodic table as a whole. Every element can be classified as either a metal, a nonmetal, or a metalloid (or semi metal), as shown in Figure \(\PageIndex{2}\). A **metal** is a substance that is shiny, typically (but not always) silvery in color, and an excellent conductor of electricity and heat. Metals are also malleable (they can be beaten into thin sheets) and ductile (they can be drawn into thin wires). A **nonmetal** is typically dull and a poor conductor of electricity and heat. Solid nonmetals are also very brittle. As shown in Figure \(\PageIndex{2}\), metals occupy the left three-fourths of the periodic table, while nonmetals (except for hydrogen) are clustered in the upper right-hand corner of the periodic table. The elements with properties intermediate between those of metals and nonmetals are called **metalloids** (or semi-metals). Elements adjacent to the bold line in the right-hand portion of the periodic table have semimetal properties.

![Types of Elements](image)

*Figure \(\PageIndex{2}\): Types of Elements. Elements are either metals, nonmetals, or metalloids (or semi-metals). Each group is located in a different part of the periodic table.*
Based on its position in the periodic table, classify each element below as metal, a nonmetal, or a metalloid.

a. Se
b. Mg
c. Ge

Solution

a. In Figure \( \PageIndex{1} \), selenium lies above and to the right of the diagonal line marking the boundary between metals and nonmetals, so it should be a nonmetal.
b. Magnesium lies to the left of the diagonal line marking the boundary between metals and nonmetals, so it should be a metal.
c. Germanium lies within the diagonal line marking the boundary between metals and nonmetals, so it should be a metalloid.

Exercise \( \PageIndex{1} \)

Based on its location in the periodic table, do you expect indium to be a nonmetal, a metal, or a metalloid?

Answer

Indium is a metal.

Example \( \PageIndex{3} \): Classification of Elements

Classify each element as metal, non metal, transition metal or inner transition metal.

a. Li
b. Ar
c. Am
d. Fe

Solution

a. Lithium is a metal.
b. Argon is a non metal
c. Americium is an inner transition metal
d. Iron is a transition metal.

Exercise \( \PageIndex{3} \): Classification of Elements

Classify each element as metal, non metal, transition metal or inner transition metal.

a. F
b. U
c. Cu

Answer a:

Fluorine is a nonmetal.
Answer b: 
Uranium is a metal (and an inner transition metal too)

Answer c: 
Copper is a metal (and a transition metal too)

Alkali Metals

Media, iframe, embed and object tags are not supported inside of a PDF.

Video \(\PageIndex{2}\) Alkali metals in water.

Summary

• Elements that exhibit similar chemistry appear in vertical columns called groups (numbered 1–18 from left to right).
• The seven horizontal rows are called periods. Some of the groups have widely-used common names, including the alkali metals (Group 1) and the alkaline earth metals (Group 2) on the far left, and the halogens (Group 17) and the noble gases (Group 18) on the far right.
• An important grouping of elements in the periodic table are the main group elements, the transition metals, and the inner transition metals (the lanthanides, and the actinides).
• The elements can be broadly divided into metals, nonmetals, and semi metals. Semi metals exhibit properties intermediate between those of metals and nonmetals. Metals are located on the left of the periodic table, and nonmetals are located on the upper right. They are separated by a diagonal band of semi metals.
• Metals are lustrous, good conductors of electricity, and readily shaped (they are ductile and malleable). Solid nonmetals are generally brittle and poor electrical conductors.
References


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