

## The Periodic Table

The Periodic Table is an organized chart of all known elements arranged by their atomic number, electron configurations, and recurring chemical properties. Created by Dmitri Mendeleev in the 19th century, it is now an essential tool in chemistry for understanding and predicting the behavior of elements.

## Structure and Organization of the Periodic Table

The Periodic Table is arranged in rows and columns based on atomic structure, with elements grouped by their properties.

**Periodic Table of the Elements**

1 1IA 11A												13 IIIA 3A		14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A															
1 H Hydrogen 1.00794												5 B Boron 10.811		6 C Carbon 12.011	7 N Nitrogen 14.00644	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797															
3 Li Lithium 6.941		4 Be Beryllium 9.012182											11 Na Sodium 22.98976928		12 Mg Magnesium 24.304											13 Al Aluminum 26.9815386		14 Si Silicon 28.0855	15 P Phosphorus 30.973762	16 S Sulfur 32.06	17 Cl Chlorine 35.4527	18 Ar Argon 39.948	
19 K Potassium 39.0983		20 Ca Calcium 40.078	21 Sc Scandium 44.955912	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.9216	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80															
37 Rb Rubidium 85.4678		38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium 98.90625	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.90447	54 Xe Xenon 131.29															
55 Cs Cesium 132.90545196		56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.084	79 Au Gold 196.966569	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.98037	84 Po Polonium 209	85 At Astatine 209	86 Rn Radon 222.01758															
87 Fr Francium 223		88 Ra Radium 226.0254	89-103 Actinide Series	104 Rf Rutherfordium 261	105 Db Dubnium 262	106 Sg Seaborgium 266	107 Bh Bohrium 264	108 Hs Hassium 277	109 Mt Meitnerium 268	110 Ds Darmstadtium 285	111 Rg Roentgenium 272	112 Cn Copernicium 285	113 Uut Ununtrium unknown	114 Uuq Ununquadium 289	115 Uup Ununpentium unknown	116 Uuh Ununhexium 288	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown															
		57 La Lanthanum 138.90547	58 Ce Cerium 140.12	59 Pr Praseodymium 140.90766	60 Nd Neodymium 144.24	61 Pm Promethium 144.9127	62 Sm Samarium 150.36	63 Eu Europium 151.965	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967																	
		88 Ac Actinium 227	89 Th Thorium 232.0377	90 Pa Protactinium 231.03688	91 U Uranium 238.02891	92 Np Neptunium 237	93 Pu Plutonium 244	94 Am Americium 243	95 Cm Curium 247	96 Bk Berkelium 247	97 Cf Californium 251	98 Es Einsteinium 252	99 Fm Fermium 257	100 Md Mendelevium 258	101 No Nobelium 259	102 Lr Lawrencium 262																	
		Alkali Metal	Alkaline Earth	Transition Metal	Basic Metal	Semimetals	Nonmetals	Halogens	Noble Gas	Lanthanides	Actinides																						

### Atomic Number:

Elements are ordered by increasing atomic number (number of protons). This order directly influences the arrangement of electrons in each element and, consequently, its chemical properties.

### Rows (Periods):

The horizontal rows are called periods, and each row corresponds to the filling of a particular electron shell. There are currently 7 periods in the Periodic Table.

### Columns (Groups):

The vertical columns are called groups. Elements in the same group share similar chemical properties because they have the same number of valence (outermost) electrons. This similarity leads to shared reactivity patterns within each group.

## Main Divisions:

- Metals: Located on the left and center (including the transition metals).
- Non-Metals: Located on the right side of the table.
- Metalloids: Found along a zigzag line between metals and non-metals. Metalloids exhibit properties of both metals and non-metals.

## Where are metals, non-metals, and metalloids?

1 H																	2 He																														
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne																														
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar																														
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr																														
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe																														
55 Cs	56 Ba			72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn																													
87 Fr	88 Ra			104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn																																			
<p>Blue = metal Red = nonmetal Green = Metalloid</p>																																															
<table border="1"> <tr> <td>57 La</td><td>58 Ce</td><td>59 Pr</td><td>60 Nd</td><td>61 Pm</td><td>62 Sm</td><td>63 Eu</td><td>64 Gd</td><td>65 Tb</td><td>66 Dy</td><td>67 Ho</td><td>68 Er</td><td>69 Tm</td><td>70 Yb</td><td>71 Lu</td> </tr> <tr> <td>89 Ac</td><td>90 Th</td><td>91 Pa</td><td>92 U</td><td>93 Np</td><td>94 Pu</td><td>95 Am</td><td>96 Cm</td><td>97 Bk</td><td>98 Cf</td><td>99 Es</td><td>100 Fm</td><td>101 Md</td><td>102 No</td><td>103 Lr</td> </tr> </table>																		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr
57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu																																	
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr																																	

## Groups and Periods

### Periods:

Each period in the Periodic Table signifies a new principal energy level for electrons. Moving from left to right across a period, elements increase in atomic number and have progressively more electrons.

- Characteristics of Periods: Within a period, the properties of elements vary widely as one moves from metals on the left to non-metals on the right.
- Trend: Across a period, atomic radius generally decreases while ionization energy and electronegativity increase.

### Groups:

Groups are numbered from 1 to 18. Elements within the same group have similar properties due to their identical number of valence electrons. Some notable groups include:

- Group 1 (Alkali Metals): Highly reactive metals, especially with water.
- Group 7 (Halogens): Reactive non-metals known for forming salts.
- Group 8/0 (Noble Gases): Inert gases with a full valence electron shell, making them highly unreactive.

## Properties of Metals and Non-Metals

Metals:

# PROPERTIES OF METAL



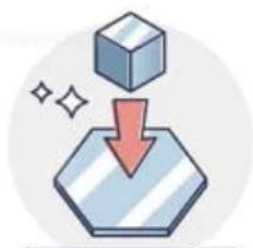
**LUSTER**



**HEAT CONDUCTIVE**



**DUCTILE**



**MALLEABLE**



**ELECTRICALLY CONDUCTIVE**



**STRONG**

**Physical Properties:** Metals are typically shiny (lustrous), ductile, malleable, and good conductors of heat and electricity.

Metals are a group of elements characterized by their high electrical and thermal conductivity, malleability, ductility, and luster. They are typically solid at room temperature (except for mercury) and have a high melting and boiling point. Metals tend to lose electrons easily, making them good conductors of electricity. Their malleability allows them to be hammered or rolled into thin sheets, while ductility enables them to be drawn into wires. The metallic bonds between metal atoms also contribute to their strength and rigidity, although they can vary in terms of hardness and brittleness. Additionally, metals tend to have a shiny appearance due to their ability to reflect light. These properties make metals essential in a wide range of applications, from construction materials to electrical wiring and machinery.

•**Chemical Properties:** Metals tend to lose electrons during chemical reactions, forming positive ions (cations). They usually react with non-metals to form ionic compounds and often react with oxygen to form oxides (e.g., rust in iron).

Non-Metals:



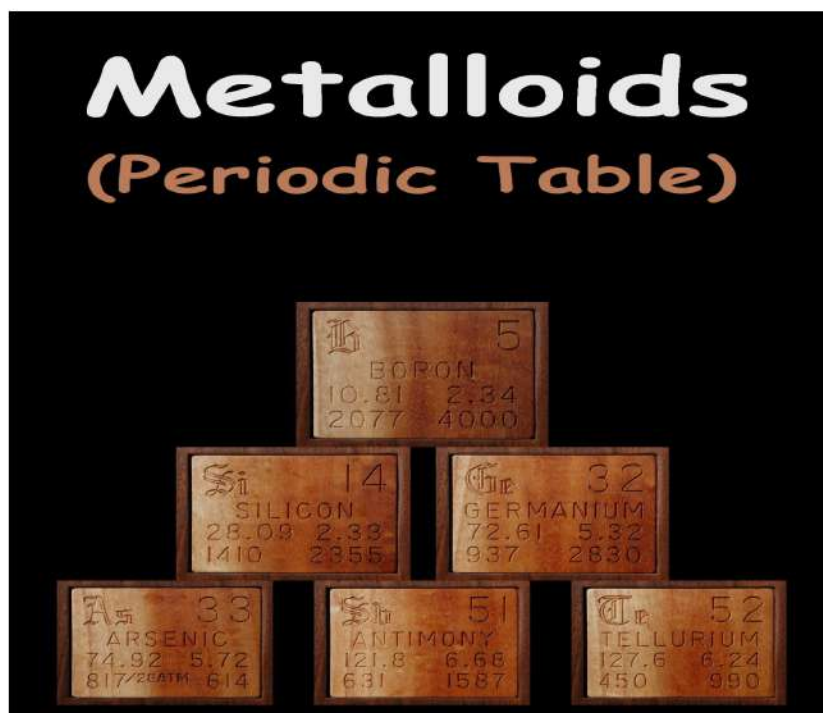
- Physical Properties: Non-metals are usually dull, brittle, and poor conductors of heat and electricity.

Non-metals are a diverse group of elements that generally exhibit opposite properties to metals. They are poor conductors of heat and electricity, making them insulators. Non-metals tend to be brittle in their solid state, rather than malleable or ductile, and they can break or shatter when subjected to stress. Unlike metals, non-metals have low melting and boiling points, and many exist as gases at room temperature (e.g., oxygen, nitrogen). They are also characterized by their lack of metallic luster, often appearing dull. Non-metals can readily gain electrons in chemical reactions, forming negative ions or covalent bonds. These elements are found in a variety of forms, such as gases, liquids, and solids, and play crucial roles in biological processes, chemical reactions, and the composition of many substances, including water, air, and organic compounds.

- Chemical Properties: Non-metals tend to gain electrons in chemical reactions, forming negative ions (anions) or sharing electrons to form covalent bonds. Non-metal oxides often form acidic solutions when dissolved in water. Non-metals have high electronegativity, meaning they strongly attract electrons when forming bonds, often resulting in the formation of negative ions (anions) or covalent bonds. For example, chlorine, a non-metal, readily gains an electron to form a chloride ion ( $\text{Cl}^-$ ) in ionic compounds. Non-metals also tend to react with metals to form ionic compounds, where they accept electrons from the metal.

- Examples: Oxygen, sulfur, carbon, nitrogen.

Metalloids:



- Properties: Metalloids have properties of both metals and non-metals. They can conduct electricity but not as well as metals (semi-conductors).
- Examples: Silicon, boron, arsenic.

### Trends and Patterns in Groups and Periods, Focusing on Groups 1, 7, and 8/0

#### Group 1: Alkali Metals (e.g., Lithium, Sodium, Potassium)

- Reactivity: Alkali metals are highly reactive, especially with water, forming hydroxides and releasing hydrogen gas.
- Reactivity Trend: Reactivity increases down the group as atoms have a larger atomic radius and the outer electron is more easily lost.
- Physical Properties: These metals are soft, have low densities, and are excellent conductors.
- Chemical Properties: They form ionic compounds with non-metals and typically have a +1 oxidation state due to the loss of their single valence electron.

#### Group 7: Halogens (e.g., Fluorine, Chlorine, Bromine)

- Reactivity: Halogens are reactive non-metals, particularly with alkali metals, forming salts.
- Reactivity Trend: Reactivity decreases down the group because the atomic radius increases, making it harder to gain an additional electron.
- Physical Properties: Halogens exist in various states at room temperature (e.g., chlorine as a gas, bromine as a liquid, iodine as a solid).
- Chemical Properties: They readily gain one electron to achieve a full outer shell, forming anions with a -1 charge.

**Group 8/0: Noble Gases (e.g., Helium, Neon, Argon)**

- Reactivity: Noble gases are extremely unreactive due to their complete outer electron shells.
- Physical Properties: They are all colorless, odorless gases at room temperature.
- Uses: Because of their low reactivity, noble gases are used in applications like neon lights and inert environments for chemical reactions.

**Periodic Trends Across Periods and Down Groups:**

- Atomic Radius: Increases down a group (more electron shells) and decreases across a period (increased nuclear charge pulls electrons closer).
- Ionization Energy: Decreases down a group (easier to remove an electron) and increases across a period (harder to remove an electron due to higher nuclear charge).
- Electronegativity: Decreases down a group and increases across a period, with non-metals generally having higher electronegativity than metals.

The Periodic Table organizes elements based on atomic number and chemical properties. Elements are grouped into metals, non-metals, and metalloids, with specific groups (like the alkali metals, halogens, and noble gases) showcasing unique reactivity trends. Periods show variations in properties from left to right, while groups show patterns in atomic size, reactivity, ionization energy, and electronegativity.

**Conclusion**

The periodic table is a powerful tool in chemistry, organizing elements based on their atomic number, electron configuration, and recurring chemical properties. It reveals the periodicity of element characteristics, such as electronegativity, ionization energy, and atomic radius, which vary in a predictable manner across periods (rows) and groups (columns). Elements within the same group share similar chemical behaviors due to their similar valence electron configurations, while elements across a period exhibit trends related to increasing atomic number and changes in their physical and chemical properties. The periodic table also provides insight into the relationships between different elements, highlighting trends that aid in understanding chemical reactions, bonding, and the formation of compounds. With its systematic arrangement, the periodic table remains a fundamental reference for predicting element properties, guiding research, and advancing our understanding of chemistry and materials science.