8.5C: Periodic Table

Reflect

Suppose you wanted to organize your locker at school. How could you separate and arrange everything in an organized way? You could place the books, notebooks, and folders on a shelf that is separate from the pencils, pens, and erasers. You might order the books from smallest to largest with the notebooks and folders on the end. Or you might arrange the books and folders by subject.

Scientists use properties to organize things too. The elements are organized in a specific way on the Periodic Table of Elements (Periodic Table for short). What properties do scientists use to organize the Periodic Table? What does this tell us about the elements?

Atomic Number

Elements are organized on the Periodic Table according to atomic number. The *atomic number* of an element refers to the number of protons in the nucleus of that atom. Each atom of an element always has the same number of protons, therefore, the same atomic number. Here is a version of the periodic table.

Periodic Table of Elements

1A												3A	4A	5A	6A	7A	8A
1 H 1.008	2A																2 He 4.002
3 Li 6.941	4 Be 9.0121											5 B 10.811	6 C 12.010	7 N 14.006	8 O 15.999	9 F 18.998	10 Ne 20.179
11 Na 22.989	12 Mg 24.305	3B	4B	5B	6B	7B	← 8B →		1B	2B		13 Al 26.981	14 Si 28.085	15 P 30.097	16 S 32.065	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.955	22 Ti 47.867	23 V 50.941	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.409	31 Ga 69.723	32 Ge 72.64	33 As 74.921	34 Se 78.96	35 Br 79.904	36 Kr 83.798
37 Rb 85.467	38 Sr 87.62	39 Y 88.905	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc 98	44 Ru 101.07	45 Rh 102.905	46 Pd 106.42	47 Ag 107.868	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.904	54 Xe 131.293
55 Cs 132.905	56 Ba 137.327	57-71	72 Hf 178.49	73 Ta 180.947	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.966	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po 209	85 At 210	86 Rn 222
87 Fr 223	88 Ra 226	89-103	104 Rf 261	105 Db 262	106 Sg 266	107 Bh 264	108 Hs 277	109 Mt 268	110 Ds 271	111 Rg 272	112 Cn 285	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo

Lanthanide series	57 La 138.905	58 Ce 140.116	59 Pr 140.907	60 Nd 144.24	61 Pm 145	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.925	66 Dy 162.500	67 Ho 164.930	68 Er 167.259	69 Tm 168.934	70 Yb 173.04	71 Lu 174.967
Actinide series	89 Ac 227	90 Th 232.038	91 Pa 231.035	92 U 238.028	93 Np 237	94 Pu 244	95 Am 243	96 Cm 1247	97 Bk 247	98 Cf 251	99 Es 252	100 Fm 257	101 Md 258	102 No 259	103 Lr 262

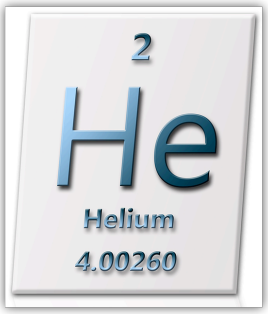
Moving across (left to right) each row of the Periodic Table, the atomic number increases sequentially (in order.) For example, the atomic number of carbon (C) is 6 and the atomic number of nitrogen (N) is 7. These two elements are next to each other in the second row of the Periodic Table. Cesium (Cs) has an atomic number of 55 and Barium has an atomic number of 56. They are found next to each other in the sixth row. The atomic number increases as you go to the right across and as you go down the Periodic Table.

Atomic Mass

Because elements are arranged according to their atomic number, the atomic mass of each element also increases when moving to the right and down the Periodic Table. *Atomic mass* is the average mass of one atom of an element.

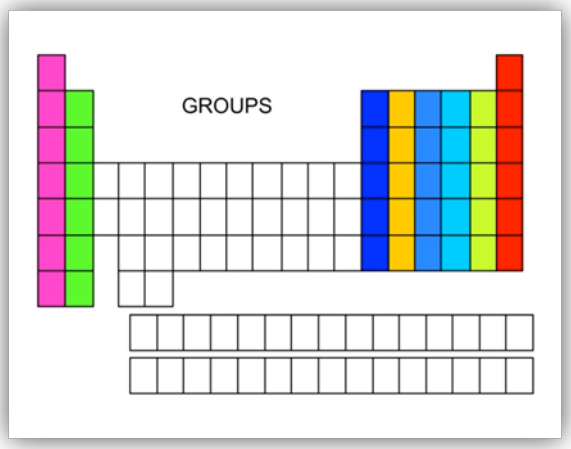
Look Out!

As you move across the Periodic Table from left to right, the atomic number of each element increases by one. Typically this number is written as a whole number above the *chemical symbol* (the one- or two-letter code that represents an element). Be careful not to confuse this with the number below the chemical symbol, which is the atomic mass. Take a look at the illustration on the right. The element helium (He) has an atomic number of 2, which is the number above the symbol He. The average atomic mass of helium is 4.00260. The average atomic mass is written below the He symbol.



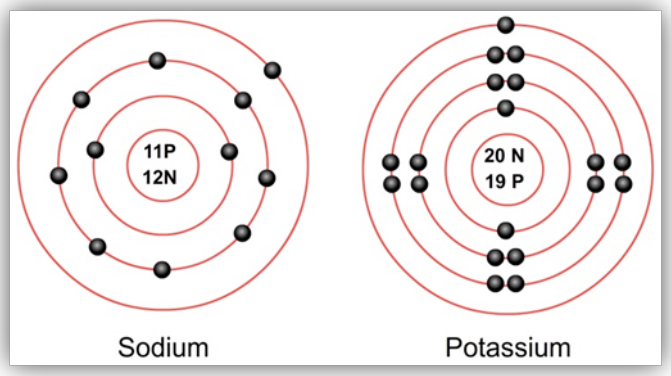
Groups and Periods

There are additional patterns of arrangement on the Periodic Table. The vertical columns are known as *groups*. If you look at the Periodic Table on the previous page, you will notice that numbers and letters are used to identify groups. For example, the first group from the left is 1A. Elements in the same group have the same number of valence electrons. *Valence electrons* are the electrons in the outer energy level. They determine the chemical behavior of an element. So, elements in the same group have similar chemical properties because they have the same number of valence electrons. There are some exceptions to this order. These exceptions are shown by the un-shaded elements in the diagram at the right.

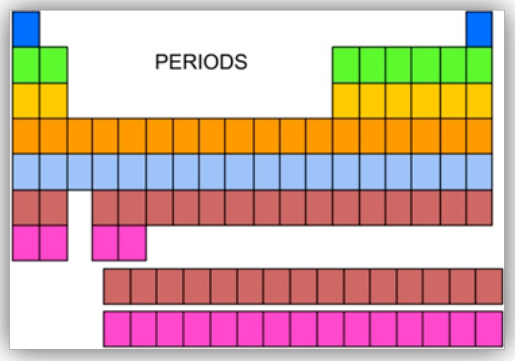


Let's discuss the elements in the first column, or group 1A, of the Periodic Table. Each element in this group has one valence

electron. Sodium (Na) and potassium (K) are two elements in this group. The electron arrangements of these two elements are shown in the figures below. These elements are metals and tend to donate their single valence electron to other elements in order to have a full outer energy level. The other elements in this group also tend to donate their single valence electron.



Elements in other groups also have the same number of valence electrons as other elements in that group. For example, elements in the second column, or group, have two valence electrons and tend to donate these two electrons. Elements in group 17, the second to last column from the left, have seven valence electrons. They need one electron to fill their outer energy level. They tend to react with other elements to gain one electron. Alternatively, the elements in the last column are known as the *noble gases*. These elements have a complete outer energy level, so they tend to keep their electrons and are very stable elements. They do not react easily with other elements.

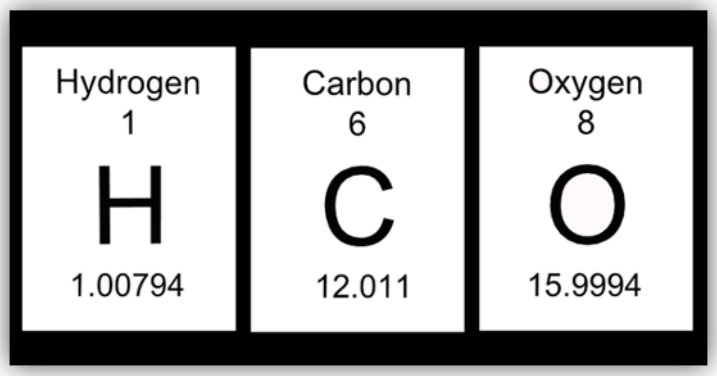


You learned earlier in the lesson that atomic number increases as you move from left to right across rows and down the rows of the Periodic Table. These rows are called *periods* and they correspond to the number of energy levels in an element. Energy levels are the different orbits in which electrons move around the center of an atom. For example, every element in the top row (first period) has the same number of energy levels. This period contains only two elements, hydrogen (H) and helium (He). These elements have only one energy level. The elements in the second period (Li, Be, B, C, N, O, Cl, and Ne) have two energy levels. This pattern continues as you move down the rows of the Periodic Table.

The arrangement of elements in the Periodic Table based on atomic number, reactivity and valence electrons allows you to predict reactivity and behavior of elements based on their locations on the table.

What Do You Think?

Take a look at the diagram below. For each element, identify the group and period to which each element belongs. Use a Periodic Table for reference. What can you determine about each element based on its location on the Periodic Table?



Metals, Non-metals, and Metalloids

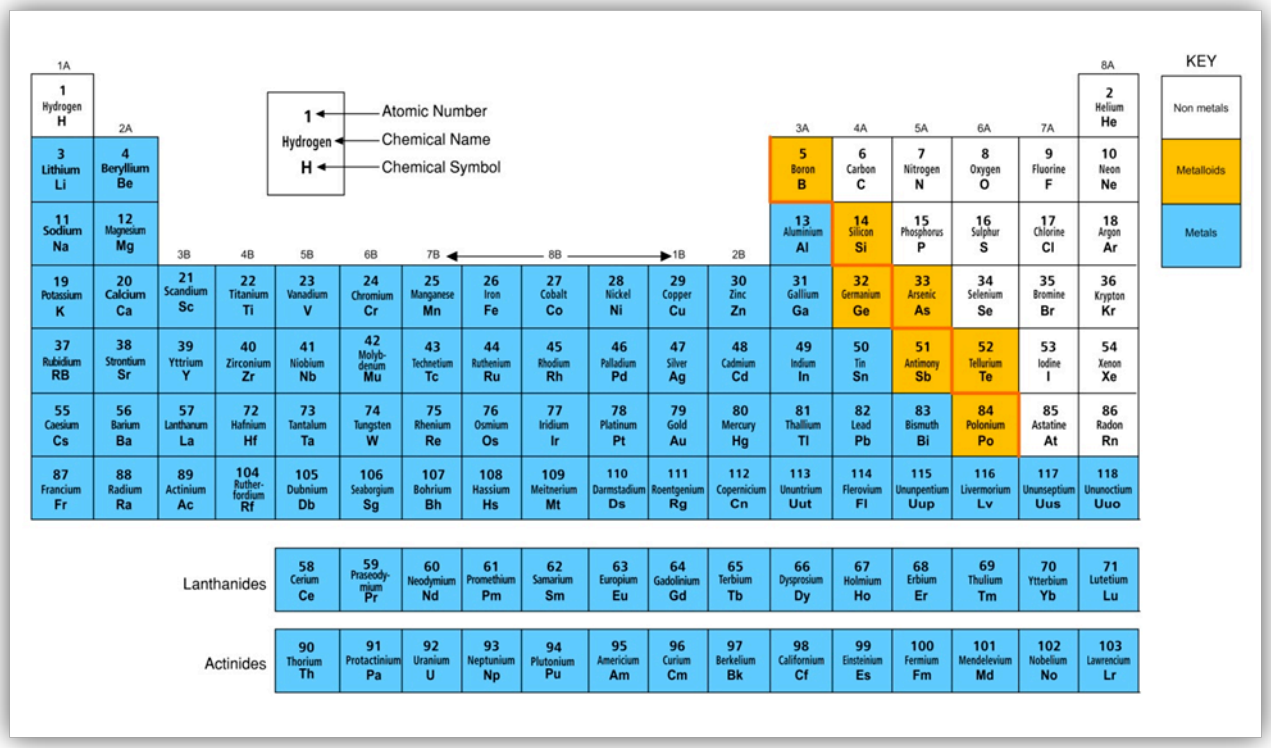
Because elements are arranged on the Periodic Table according to similar chemical properties, three main types of elements are arranged in a pattern on the table as well. The three main types are metals, non-metals, and metalloids.

Most of the elements on the Periodic Table are metals. Metals are usually shiny solids that are malleable and ductile. They are good conductors of heat and electricity. Examples include gold (Au), iron (Fe), lead (Pb), and silver (Ag.) The metals are shaded in gray on the Periodic Table below.

Non-metals are typically dull and brittle. Brittle materials break or crack easily. Non-metals are generally poor conductors of heat and electricity. There are only 18 non-metals on the Periodic Table, including hydrogen (N), carbon (C), and nitrogen (N.) The non-metals are un-shaded (white) on the Periodic Table below.

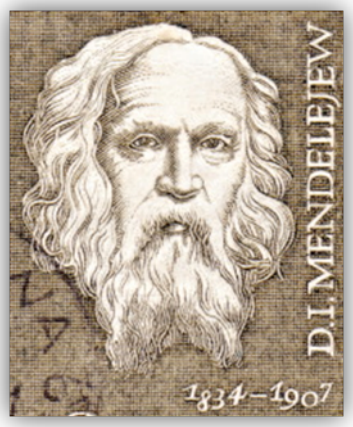
Metalloids have properties of both metals and non-metals. Some metalloids have a metallic luster, such as silicon (Si). Silicon is also brittle; therefore, it has characteristics of both the metals and the non-metals. Some metalloids are semi-conductors, meaning they carry an electrical charge under certain conditions. The metalloids are located along the “steps” that separate metals from non-metals on the Periodic Table. They are shaded orange on the Periodic Table on the next page.

8.5C: Periodic Table



Discover Science: Development of the Periodic Table

In the 1800s, a professor named Dmitri Mendeleev developed one of the first tables to arrange the elements. First, Mendeleev ordered the elements by increasing atomic mass and then further separated them based on their chemical properties. This work was the basis for our current Periodic Table of the Elements. At the time, there were only 63 known elements. However, Mendeleev was able to theorize about new elements, which were identified after his table of the elements was created.



In the years following Mendeleev's development, the elemental table was revised slightly. A scientist named Henry Moseley ordered the elements based on atomic number. This is the current method in which the elements are ordered.

What Do You Know?

The Periodic Table of the Elements is arranged based on the properties of elements. The chart below lists five elements. For each element, find a "matching" element in the box below the chart. A matching element is one that is in either the same group or the same period as the element in the chart. Then, write whether the elements are in the same group or the same period. Finally, write at least two characteristics that are shared by the matching elements based on their locations on the Periodic Table. You will need to refer to a Periodic Table to complete this activity.

Element	Matching Element	Matching Group or Period?	Shared Characteristics
Calcium (Ca)			
Flourine (F)			
Iodine (I)			
Argon (Ar)			

- Oxygen (O)
- Neon (Ne)
- Magnesium (Mg)
- Xenon (Xe)

Connecting With Your Child: Organization of the Periodic Table

To help your child learn more about the periodic table, work together to create an "element" game. For this activity, you or your child will need to make 10 flash cards. You will also need a copy of a Periodic Table, which can be found in science textbooks or on the Internet.

Decide who will be the "reader" and who will be the "guesser." The reader should spend some time making the flash cards by choosing 10 elements and writing information about each element on a single card. On one side of the card, write the chemical symbol for the element. On the other side, describe its location on the Periodic Table (group and period), its atomic mass, and its classification as a metal, non-metal, or metalloid. This information is to help the reader answer the questions asked by the guesser.

Have the reader choose a flash card to start the game. Make sure the guesser does not see the card. The guesser should begin by asking a series of questions until he or she correctly guesses the element. The only questions the guesser may ask are those that require a "yes" or "no" answer. For example, the guesser could ask, "Is the element a metal?" The guesser cannot ask, "What is the atomic number of the element?" Make sure the copy of the Periodic Table is available for the reader to use as a reference during the game.

Here are some questions to discuss with your child after you play the game:

- Which questions were most helpful to the guesser in identifying the element on each flash card?
- Were there any questions that were not helpful? If so, what were they?
- How does organizing the elements help scientists use the Periodic Table?