

The Periodic Table

The **periodic law**, which is the basis for the modern periodic table, states that when elements are arranged in order of increasing atomic number, their physical and chemical properties show a periodic pattern. In this lesson, we will learn about these periodic patterns, or trends.

Basic Organization

The shape of the periodic table comes in part from the periodic law. Elements that have similar properties are aligned in vertical columns, called **groups** or **families**. The horizontal rows in the table are called **periods**. The periodic table has 7 periods and 18 groups.

Periodic Table of the Elements

Atomic number	14
Symbol	Si
Atomic mass	28.086
Name	Silicon

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H 1.008 Hydrogen																	2 He 4.0026 Helium
2	3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.011 Carbon	7 N 14.007 Nitrogen	8 O 15.999 Oxygen	9 F 18.998 Fluorine	10 Ne 20.179 Neon
3	11 Na 22.990 Sodium	12 Mg 24.305 Magnesium											13 Al 26.982 Aluminum	14 Si 28.086 Silicon	15 P 30.974 Phosphorus	16 S 32.066 Sulfur	17 Cl 35.453 Chlorine	18 Ar 39.948 Argon
4	19 K 39.098 Potassium	20 Ca 40.08 Calcium	21 Sc 44.956 Scandium	22 Ti 47.88 Titanium	23 V 50.942 Vanadium	24 Cr 51.996 Chromium	25 Mn 54.938 Manganese	26 Fe 55.847 Iron	27 Co 58.933 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.546 Copper	30 Zn 65.39 Zinc	31 Ga 69.72 Gallium	32 Ge 72.61 Germanium	33 As 74.922 Arsenic	34 Se 78.96 Selenium	35 Br 79.904 Bromine	36 Kr 83.80 Krypton
5	37 Rb 85.468 Rubidium	38 Sr 87.62 Strontium	39 Y 88.906 Yttrium	40 Zr 91.224 Zirconium	41 Nb 92.906 Niobium	42 Mo 95.94 Molybdenum	43 Tc (98) Technetium	44 Ru 101.07 Ruthenium	45 Rh 106.42 Rhodium	46 Pd 106.42 Palladium	47 Ag 107.868 Silver	48 Cd 112.41 Cadmium	49 In 114.82 Indium	50 Sn 118.71 Tin	51 Sb 121.763 Antimony	52 Te 127.60 Tellurium	53 I 126.904 Iodine	54 Xe 131.29 Xenon
6	55 Cs 132.905 Cesium	56 Ba 137.33 Barium	57 La 138.906 Lanthanum	72 Hf 178.49 Hafnium	73 Ta 180.948 Tantalum	74 W 183.84 Tungsten	75 Re 186.207 Rhenium	76 Os 190.23 Osmium	77 Ir 192.22 Iridium	78 Pt 195.08 Platinum	79 Au 196.967 Gold	80 Hg 200.59 Mercury	81 Tl 204.383 Thallium	82 Pb 207.2 Lead	83 Bi 208.980 Bismuth	84 Po (209) Polonium	85 At (210) Astatine	86 Rn (222) Radon
7	87 Fr (223) Francium	88 Ra 226.025 Radium	89 Ac 227.028 Actinium	104 Rf (261) Rutherfordium	105 Db (262) Dubnium	106 Sg (263) Seaborgium	107 Bh (262) Bohrium	108 Hs (265) Hassium	109 Mt (266) Meitnerium	110 (269) Darmstadtium								
Lanthanide Series			58 Ce 140.12 Cerium	59 Pr 140.908 Praseodymium	60 Nd 144.24 Neodymium	61 Pm (145) Promethium	62 Sm 150.36 Samarium	63 Eu 151.97 Europium	64 Gd 157.25 Gadolinium	65 Tb 158.925 Terbium	66 Dy 162.50 Dysprosium	67 Ho 164.930 Holmium	68 Er 167.26 Erbium	69 Tm 168.934 Thulium	70 Yb 173.04 Ytterbium	71 Lu 174.967 Lutetium		
Actinide Series			90 Th 232.038 Thorium	91 Pa 231.036 Protactinium	92 U 238.029 Uranium	93 Np 237.048 Neptunium	94 Pu (244) Plutonium	95 Am (243) Americium	96 Cm (247) Curium	97 Bk (247) Berkelium	98 Cf (251) Californium	99 Es (252) Einsteinium	100 Fm (257) Fermium	101 Md (258) Mendelevium	102 No (259) Nobelium	103 Lr (262) Lawrencium		

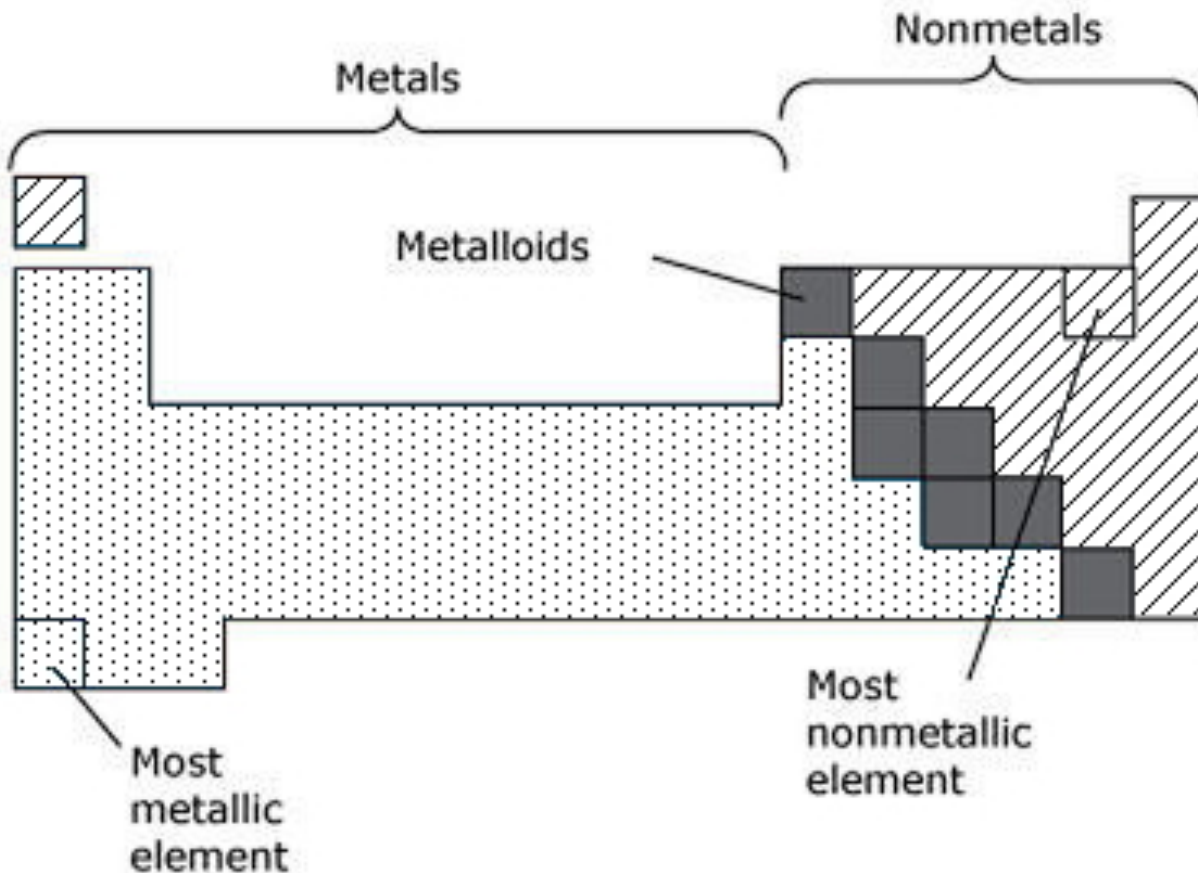
Mass numbers in parentheses are those of the most stable or most common isotope.

You have learned the names of several of the groups in previous science courses:

Group	Name
1	Alkali Metals
2	Alkaline Earth Metals
3 – 12	Transition Metals
16	Chalcogens
17	Halogens
18	Noble Gases

Metals, Nonmetals, and Semimetals

The squares on the periodic table below are shaded with 3 different patterns to indicate whether the element in each square is a metal, a nonmetal, or a semimetal.



Metals

- mostly solids at room temperature (mercury is a liquid)
- shiny, malleable, ductile
- good conductors of heat and electricity

Nonmetals

- many are gases at room temperature, some are solids, bromine is a liquid
- not shiny, may be hard solids or soft solids
- most are poor conductors of heat and electricity

Metalloids (semi-metals)

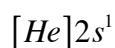
- have some properties of metals and some of nonmetals
- may have properties that are somewhere between a metal and a nonmetal

Electron Configuration

The electrons that occupy the highest principal energy level are the atom's outermost electrons. These electrons, which are largely responsible for an atom's chemical behavior are called **valence electrons**.

On the periodic table, elements that are in the same group have similar properties because they have valence electrons in similar configurations. For example, all of the elements in group 1 (alkali metals) have a single valence electron, and it resides in an *s* orbital.

To save space in writing electron configurations, chemists often use something called **noble gas notation**. In noble gas notation, an atom's inner electrons are represented by the symbol for the nearest noble gas with a lower atomic number. For example, the noble gas notation for lithium is



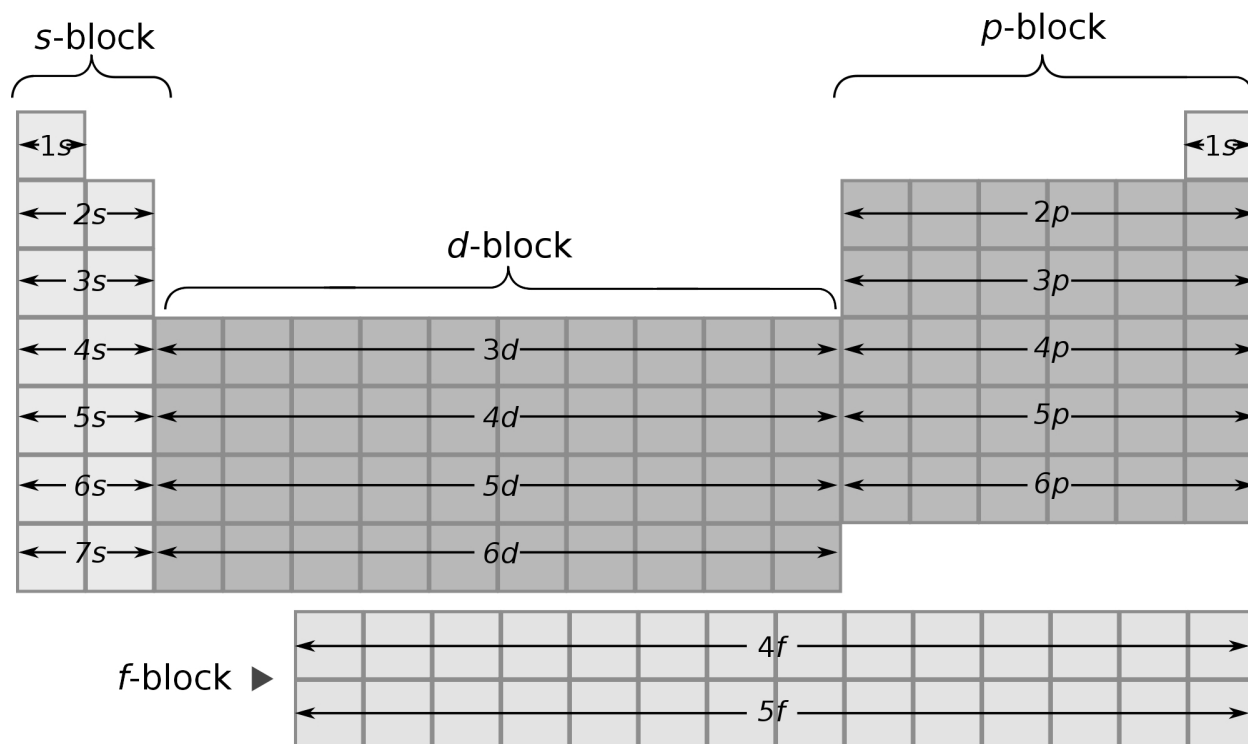
The symbol $[He]$ represents helium's electron configuration ($1s^2$).

Example

Write the electron configurations of the first four alkali metals in both sublevel and noble gas notation.

Orbital Blocks

The key to understanding the shape of the periodic table is to examine the elements' electron configurations. The simplest way to look at these electron configurations is to divide the periodic table into four sections, or blocks, as shown below.



The **s-block** is composed of all the elements in groups 1 and 2 (alkali metals and alkaline earth metals), plus hydrogen and helium. Elements in this block have valence electrons that are only in *s* orbitals. The *s*-block contains only two groups because an *s* orbital can hold a maximum of 2 electrons.

The **p-block** is composed of all the elements in groups 13 to 18, except helium. Remember that the first principal energy level has no *p* sublevel, which is why the first period of the table has no *p*-block elements. The first *p* orbital is the $2p$ orbital. The *p*-block is 6 elements wide because *p* orbitals can hold up to 6 electrons.

The **d-block** is composed of all the elements in groups 3 to 12, except the lanthanides and actinides. The first *d* orbital is the $3d$ orbital. A *d* orbital can hold up to 10 electrons, which is why the *d*-block is 10 elements wide.

The **f-block** elements are the 28 elements that are placed below the main body of the periodic table (atomic numbers 58 to 71 and 90 to 103). The *f*-block is 14 elements wide because an *f* sublevel can hold up to 14 electrons. It is important to note, however, that electrons do not fill *f* orbitals in a regular sequence. For this reason, we will not be writing any configurations for elements in this block.

Worksheet

1. Why do elements in a group have similar properties?
2. Sketch the general shape of the periodic table and label the *s*-, *p*-, *d*-, and *f*-blocks.
3. Describe the general differences between the elements on the right side of the periodic table and those on the left.
4. Write the electron configuration of each of the following elements in noble gas notation.
 - a) magnesium
 - b) iron
 - c) phosphorous
 - d) fluorine
 - e) argon
5. Complete the attached worksheet (5-2 Review and Reinforcement).