

Earth Chemistry

An introduction to Chemistry

Matter

- Every object in the universe is made up of particles of some substance
- Matter: anything that takes up space and has a mass

Properties of Matter

- Two Types:
 - ◆ Physical
 - ◆ Chemical

Physical Properties

- Characteristics that can be observed without changing the composition of the substance.
 - ◆ Density
 - ◆ Color
 - ◆ Boiling/ Freezing Point
 - ◆ Ability to conduct electricity

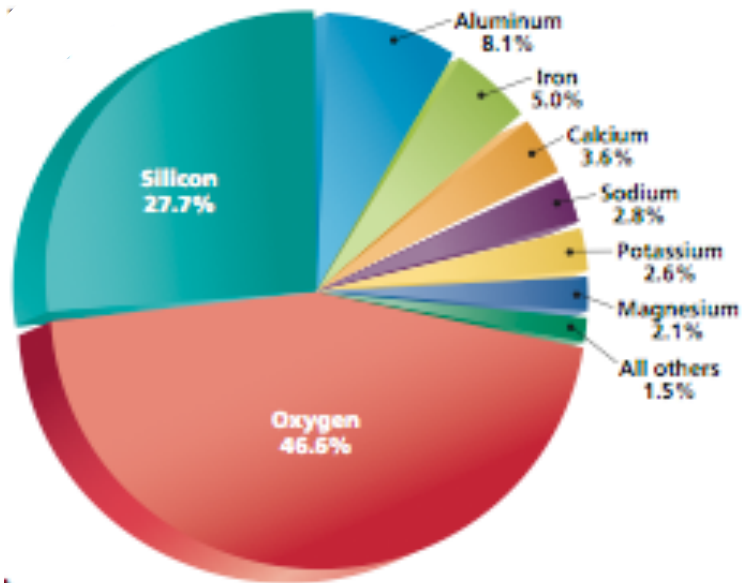
Chemical Properties

- Properties that describe how a substance reacts with other substances
 - ◆ Iron → rust

Element

- A substance that cannot be broken down into simpler, stable substances.
- Each element has a set of chemical and physical properties that can be used to identify it.

Elements (con.)



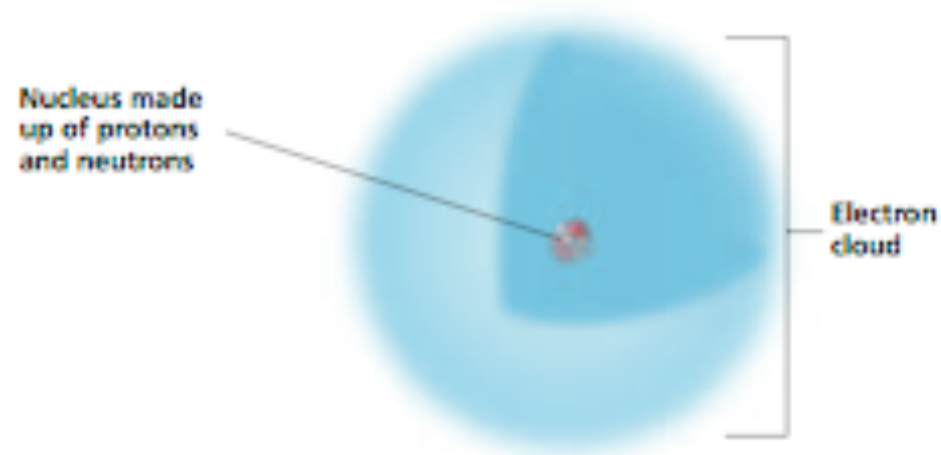
- More than 90 elements occur naturally on Earth.
- Of the naturally occurring, 8 make up 98% of the Earth's crust.
- ~24 have been made in a lab.

Atoms

- The smallest unit of an element that has the chemical properties of the element
- Made of three parts:
 - ◆ proton (positive charge)
 - ◆ neutron (No Charge)
 - ◆ electron (Negative Charge)

The nucleus

- Made of protons and neutrons
- Makes up most of the atom's mass but not the volume



The Electron Cloud

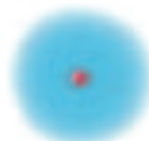
- The range of space that can contain electrons

Atomic Number

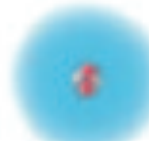
- The number of protons in a nucleus
- Sets atoms apart from each other
- Atoms are ordered on the periodic table by their atomic number

Atomic Mass

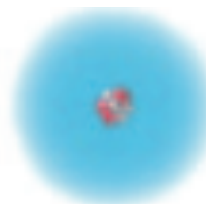
- The sum of the protons and neutrons
- Mass of protons and neutrons is too small so they get a special value
 - ◆ 1 amu
 - ◆ electrons don't count in mass at all!



Hydrogen
1 proton
1 electron
0 neutrons
Atomic number 1
Mass number 1



Helium
2 protons
2 electrons
2 neutrons
Atomic number 2
Mass number 4

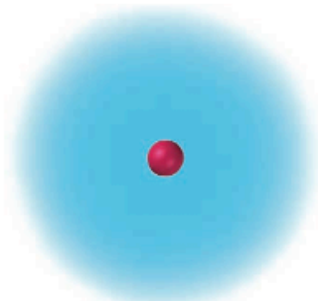


Lithium
3 protons
3 electrons
4 neutrons
Atomic number 3
Mass number 7

Isotopes

- An atom that has the same number of protons (same atomic number) but has a different number of neutrons (different atomic mass)

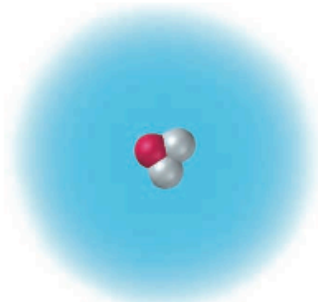
Isotopes of Hydrogen



Hydrogen-1, ${}^1_1\text{H}$
1 proton
1 electron
Atomic number 1
Mass number 1



Hydrogen-2, ${}^2_1\text{H}$
1 proton
1 neutron
1 electron
Atomic number 1
Mass number 2



Hydrogen-3, ${}^3_1\text{H}$
1 proton
2 neutrons
1 electron
Atomic number 1
Mass number 3

Valence Electrons

- Outermost electrons
- Chemical property is mainly determined by this

1	1 H Hydrogen 1.00794																		2								
2	Group 1	3 Li Lithium 6.941	Group 2	4 Be Beryllium 9.012182																							
3		11 Na Sodium 22.98976928		12 Mg Magnesium 24.3050	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9																
4		19 K Potassium 39.0983		20 Ca Calcium 40.078	21 Sc Scandium 44.955912	22 Ti Titanium 47.887	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938045	26 Fe Iron 55.845	27 Co Cobalt 58.933195																
5		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)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550																
6		55 Cs Cesium 132.9054519		56 Ba Barium 137.327	57 La Lanthanum 138.90547	72 Hf Hafnium 178.49	73 Ta Tantalum 180.94788	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.222																
7		87 Fr Francium (223)		88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (268)																

Key:

Atomic number — 6

Symbol — **C**

Name — Carbon

Average atomic mass — 12.0107

- Hydrogen
- Semiconductors (also known as metalloids)
- Metals**
 - Alkali metals
 - Alkaline earth metals
 - Transition metals
 - Other metals
- Nonmetals**
 - Halogens
 - Noble gases
 - Other nonmetals

										Group 13	Group 14	Group 15	Group 16	Group 17	Group 18
										5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.00642	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797
										13 Al Aluminum 26.9815385	14 Si Silicon 28.0855	15 P Phosphorus 30.973762	16 S Sulfur 32.065	17 Cl Chlorine 35.453	18 Ar Argon 39.948
Group 10	Group 11	Group 12													
28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.408	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.92160	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.798							
46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.290							
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 208.98040	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)							
110 Ds Darmstadtium (271)	111 Rg Roentgenium (272)	112 Uub* Ununbium (285)			114 Uuq* Ununquadium (289)			116 Uuh* Ununhexium (288)							

The discoveries of elements with atomic numbers 112, 114, and 116 have been reported but not fully confirmed.

* The systematic names and symbols for elements greater than 111 will be used until the approval of final names by IUPAC.

58 Ce Cerium 140.12	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.242	61 Pm Promethium (145)	62 Sm Samarium 150.36
90 Th Thorium 232.0377	91 Pa Protactinium 231.03688	92 U Uranium 238.02891	93 Np Neptunium (237)	94 Pu Plutonium (244)

63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92535	66 Dy Dysprosium 162.500	67 Ho Holmium 164.93032	68 Er Erbium 167.259	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.054	71 Lu Lutetium 174.967
95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

The atomic masses listed in this table reflect the precision of current measurements. (Each value listed in parentheses is the mass number of that radioactive element's most stable or most common isotope.)