

Matter

Matter, Minerals & Properties of
Minerals

2.1 Matter

- **Matter:** anything that has mass and takes up space.
 - Mass: the amount of matter in an object.
 - Volume: the amount of space an object takes up.
- **Atom:** the basic unit of matter
- **Elements:** made up of one type of atom.
- over 100 elements are known.

Periodic Table of the Elements

| | | | | | | | | | | | | | | | | | | | | | |
|---|--|--|--|---|---|--|--|--|---|---|--|---|---|--|---|--|---|--|--|--|--|
| | 1 IA 1A | | | | | | | | | | | | | | | | | | | 18 VIII A 8A | |
| | 1 1.008 H Hydrogen 1 1s ¹ | 2 6.941 Li Lithium 2 [He]2s ¹ | 3 9.012 Be Beryllium 2 [He]2s ² | | | | | | | | | | | | | | | | | 2 4.003 He Helium 2 1s ² | |
| 1 | | 2 | | | | | | | | | | | | | | | | | | | |
| 2 | 3 6.941 Li Lithium 2 [He]2s ¹ | 4 9.012 Be Beryllium 2 [He]2s ² | | | | | | | | | | | | | | | | | | | |
| 3 | 11 22.990 Na Sodium 3 [Ne]3s ¹ | 12 24.305 Mg Magnesium 2 [Ne]3s ² | | | | | | | | | | | | | | | | | | | |
| 4 | 19 39.098 K Potassium 4 [Ar]4s ¹ | 20 40.078 Ca Calcium 2 [Ar]4s ² | 21 44.956 Sc Scandium 3 [Ar]3d ¹ 4s ² | 22 47.88 Ti Titanium 4 [Ar]3d ² 4s ² | 23 50.942 V Vanadium 5 [Ar]3d ³ 4s ² | 24 51.996 Cr Chromium 6 [Ar]3d ⁵ 4s ¹ | 25 54.938 Mn Manganese 7 [Ar]3d ⁵ 4s ² | 26 55.845 Fe Iron 8 [Ar]3d ⁶ 4s ² | 27 58.933 Co Cobalt 9 [Ar]3d ⁷ 4s ² | 28 58.693 Ni Nickel 10 [Ar]3d ⁸ 4s ² | 29 63.546 Cu Copper 11 [Ar]3d ¹⁰ 4s ¹ | 30 65.38 Zn Zinc 12 [Ar]3d ¹⁰ 4s ² | 31 69.723 Ga Gallium 3 [Ar]3d ¹⁰ 4s ² 4p ¹ | 32 72.631 Ge Germanium 4 [Ar]3d ¹⁰ 4s ² 4p ² | 33 74.922 As Arsenic 5 [Ar]3d ¹⁰ 4s ² 4p ³ | 34 78.971 Se Selenium 6 [Ar]3d ¹⁰ 4s ² 4p ⁴ | 35 79.904 Br Bromine 7 [Ar]3d ¹⁰ 4s ² 4p ⁵ | 36 84.798 Kr Krypton 8 [Ar]3d ¹⁰ 4s ² 4p ⁶ | | | |
| 5 | 37 84.46 Rb Rubidium 5 [Kr]5s ¹ | 38 87.62 Sr Strontium 2 [Kr]5s ² | 39 88.906 Y Yttrium 3 [Kr]4d ¹ 5s ² | 40 91.224 Zr Zirconium 4 [Kr]4d ² 5s ² | 41 92.906 Nb Niobium 5 2 [Kr]4d ⁴ 5s ¹ | 42 95.95 Mo Molybdenum 6 2 [Kr]4d ⁵ 5s ¹ | 43 98.907 Tc Technetium 7 2 [Kr]4d ⁵ 5s ² | 44 101.07 Ru Ruthenium 8 2 [Kr]4d ⁷ 5s ¹ | 45 102.906 Rh Rhodium 9 2 [Kr]4d ⁸ 5s ¹ | 46 106.42 Pd Palladium 10 2 [Kr]4d ¹⁰ | 47 107.868 Ag Silver 11 2 [Kr]4d ¹⁰ 5s ¹ | 48 112.414 Cd Cadmium 12 2 [Kr]4d ¹⁰ 5s ² | 49 114.818 In Indium 3 2 [Kr]4d ¹⁰ 5s ² 4p ¹ | 50 118.711 Sn Tin 4 2 [Kr]4d ¹⁰ 5s ² 4p ² | 51 121.760 Sb Antimony 5 2 [Kr]4d ¹⁰ 5s ² 4p ³ | 52 127.6 Te Tellurium 6 2 [Kr]4d ¹⁰ 5s ² 4p ⁴ | 53 126.904 I Iodine 7 2 [Kr]4d ¹⁰ 5s ² 4p ⁵ | 54 131.29 Xe Xenon 8 2 [Kr]4d ¹⁰ 5s ² 4p ⁶ | | | |
| 6 | 55 132.905 Cs Cesium 6 2 [Xe]6s ¹ | 56 137.328 Ba Barium 2 2 [Xe]6s ² | 57-71 Lanthanide Series | 72 178.49 Hf Hafnium 6 2 [Xe]4f ¹⁴ 5d ² 6s ² | 73 180.948 Ta Tantalum 7 2 [Xe]4f ¹⁴ 5d ³ 6s ² | 74 183.84 W Tungsten 8 2 [Xe]4f ¹⁴ 5d ⁴ 6s ² | 75 186.207 Re Rhenium 7 2 [Xe]4f ¹⁴ 5d ⁵ 6s ² | 76 190.23 Os Osmium 8 2 [Xe]4f ¹⁴ 5d ⁶ 6s ² | 77 192.217 Ir Iridium 9 2 [Xe]4f ¹⁴ 5d ⁷ 6s ² | 78 195.085 Pt Platinum 10 2 [Xe]4f ¹⁴ 5d ⁹ 6s ¹ | 79 196.967 Au Gold 11 2 [Xe]4f ¹⁴ 5d ¹⁰ 6s ¹ | 80 200.592 Hg Mercury 12 2 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² | 81 204.383 Tl Thallium 3 2 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ¹ | 82 207.2 Pb Lead 4 2 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ² | 83 208.980 Bi Bismuth 5 2 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ³ | 84 [208.982] Po Polonium 6 2 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ⁴ | 85 209.987 At Astatine 7 2 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ⁵ | 86 222.018 Rn Radon 8 2 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ⁶ | | | |
| 7 | 87 223.020 Fr Francium 7 2 [Rn]7s ¹ | 88 226.025 Ra Radium 2 2 [Rn]7s ² | 89-103 Actinide Series | 104 [261] Rf Rutherfordium 6 2 [Rn]5f ¹⁴ 6d ² 7s ² | 105 [262] Db Dubnium 7 2 [Rn]5f ¹⁴ 6d ³ 7s ² | 106 [266] Sg Seaborgium 8 2 [Rn]5f ¹⁴ 6d ⁴ 7s ² | 107 [264] Bh Bohrium 9 2 [Rn]5f ¹⁴ 6d ⁵ 7s ² | 108 [269] Hs Hassium 10 2 [Rn]5f ¹⁴ 6d ⁶ 7s ² | 109 [268] Mt Meitnerium 11 2 [Rn]5f ¹⁴ 6d ⁷ 7s ² | 110 [269] Ds Darmstadtium 12 2 [Rn]5f ¹⁴ 6d ⁸ 7s ² | 111 [272] Rg Roentgenium 13 2 [Rn]5f ¹⁴ 6d ⁹ 7s ² | 112 [277] Cn Copernicium 14 2 [Rn]5f ¹⁴ 6d ¹⁰ 7s ² | 113 unknown Uut Ununtrium 3 2 [Rn]5f ¹⁴ 6d ¹⁰ 7s ² 7p ¹ | 114 [289] Fl Flerovium 4 2 [Rn]5f ¹⁴ 6d ¹⁰ 7s ² 7p ² | 115 unknown Uup Ununpentium 5 2 [Rn]5f ¹⁴ 6d ¹⁰ 7s ² 7p ³ | 116 [298] Lv Livermorium 6 2 [Rn]5f ¹⁴ 6d ¹⁰ 7s ² 7p ⁴ | 117 unknown Uus Ununseptium 7 2 [Rn]5f ¹⁴ 6d ¹⁰ 7s ² 7p ⁵ | 118 unknown Uuo Ununoctium 8 2 [Rn]5f ¹⁴ 6d ¹⁰ 7s ² 7p ⁶ | | | |

| | |
|------------------------|-------------|
| Atomic Number | Atomic Mass |
| Symbol Name | |
| Electron Shells | |
| Electron Configuration | |

Element symbol represents state at room temperature.

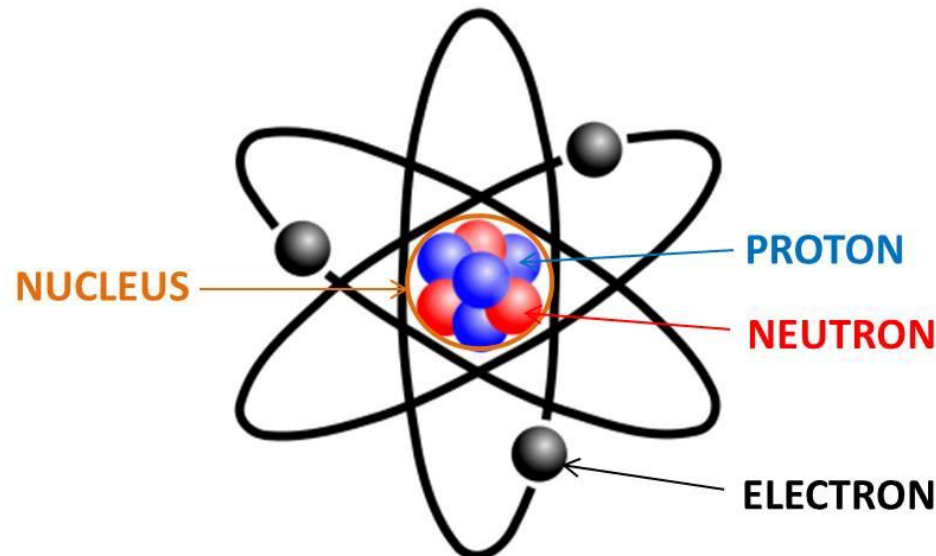
Solid, Liquid or Gas

| | | | | | | | | | | | | | | |
|---|--|--|--|---|---|---|---|--|---|---|--|--|---|---|
| 57 138.905 La Lanthanum 2 2 [Xe]5d ¹ 6s ² | 58 140.116 Ce Cerium 2 2 [Xe]4f ¹ 5d ¹ 6s ² | 59 140.908 Pr Praseodymium 3 2 [Xe]4f ³ 6s ² | 60 144.243 Nd Neodymium 4 2 [Xe]4f ⁴ 6s ² | 61 144.913 Pm Promethium 5 2 [Xe]4f ⁵ 6s ² | 62 150.36 Sm Samarium 6 2 [Xe]4f ⁶ 6s ² | 63 151.964 Eu Europium 7 2 [Xe]4f ⁷ 6s ² | 64 157.25 Gd Gadolinium 8 2 [Xe]4f ⁷ 5d ¹ 6s ² | 65 158.925 Tb Terbium 9 2 [Xe]4f ⁹ 6s ² | 66 162.500 Dy Dysprosium 10 2 [Xe]4f ¹⁰ 6s ² | 67 164.930 Ho Holmium 11 2 [Xe]4f ¹¹ 6s ² | 68 167.259 Er Erbium 12 2 [Xe]4f ¹² 6s ² | 69 168.934 Tm Thulium 13 2 [Xe]4f ¹³ 6s ² | 70 173.055 Yb Ytterbium 14 2 [Xe]4f ¹⁴ 6s ² | 71 174.967 Lu Lutetium 15 2 [Xe]4f ¹⁴ 5d ¹ 6s ² |
| 89 227.028 Ac Actinium 2 2 [Rn]6d ¹ 7s ² | 90 232.038 Th Thorium 3 2 [Rn]6d ² 7s ² | 91 231.036 Pa Protactinium 4 2 [Rn]5f ² 6d ¹ 7s ² | 92 238.029 U Uranium 5 2 [Rn]5f ³ 6d ¹ 7s ² | 93 237.048 Np Neptunium 6 2 [Rn]5f ⁴ 6d ¹ 7s ² | 94 244.064 Pu Plutonium 7 2 [Rn]5f ⁶ 7s ² | 95 243.061 Am Americium 8 2 [Rn]5f ⁷ 7s ² | 96 247.070 Cm Curium 9 2 [Rn]5f ⁷ 5d ¹ 7s ² | 97 247.070 Bk Berkelium 10 2 [Rn]5f ⁹ 7s ² | 98 251.080 Cf Californium 11 2 [Rn]5f ¹⁰ 7s ² | 99 [254] Es Einsteinium 12 2 [Rn]5f ¹¹ 7s ² | 100 257.095 Fm Fermium 13 2 [Rn]5f ¹² 7s ² | 101 258.1 Md Mendelevium 14 2 [Rn]5f ¹³ 7s ² | 102 259.101 No Nobelium 15 2 [Rn]5f ¹⁴ 7s ² | 103 [262] Lr Lawrencium 16 2 [Rn]5f ¹⁴ 6d ¹ 7s ² |

- Alkali Metal
- Alkaline Earth
- Transition Metal
- Basic Metal
- Metalloid
- Nonmetal
- Halogen
- Noble Gas
- Lanthanide
- Actinide

2.1 Matter: the atom

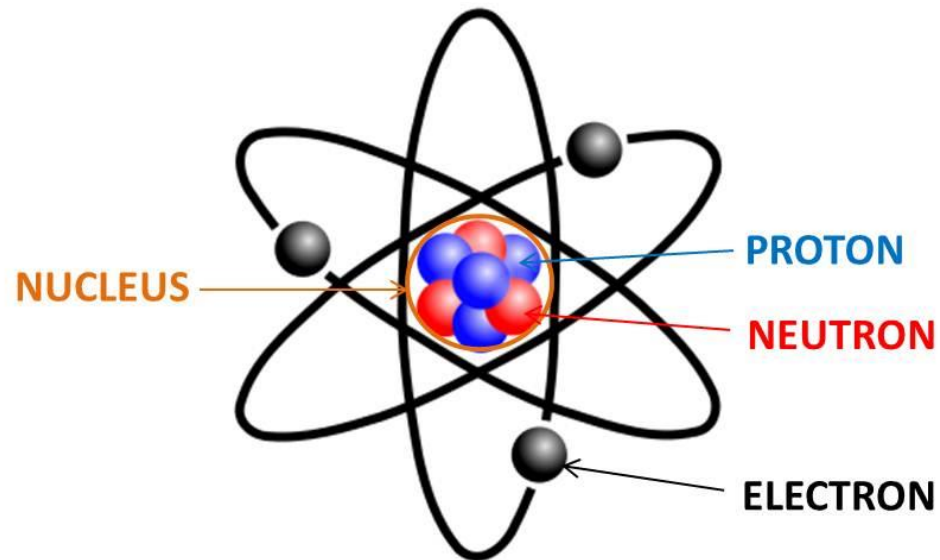
- **Atom** is the smallest particle of matter
- Nucleus: the central part of an atom; contains 2 subatomic particles
 - **Protons** (have a positive charge)
 - **Neutrons** (have no charge)
- Energy levels/shells surround the nucleus
 - Electrons are on these levels (have a negative charge)



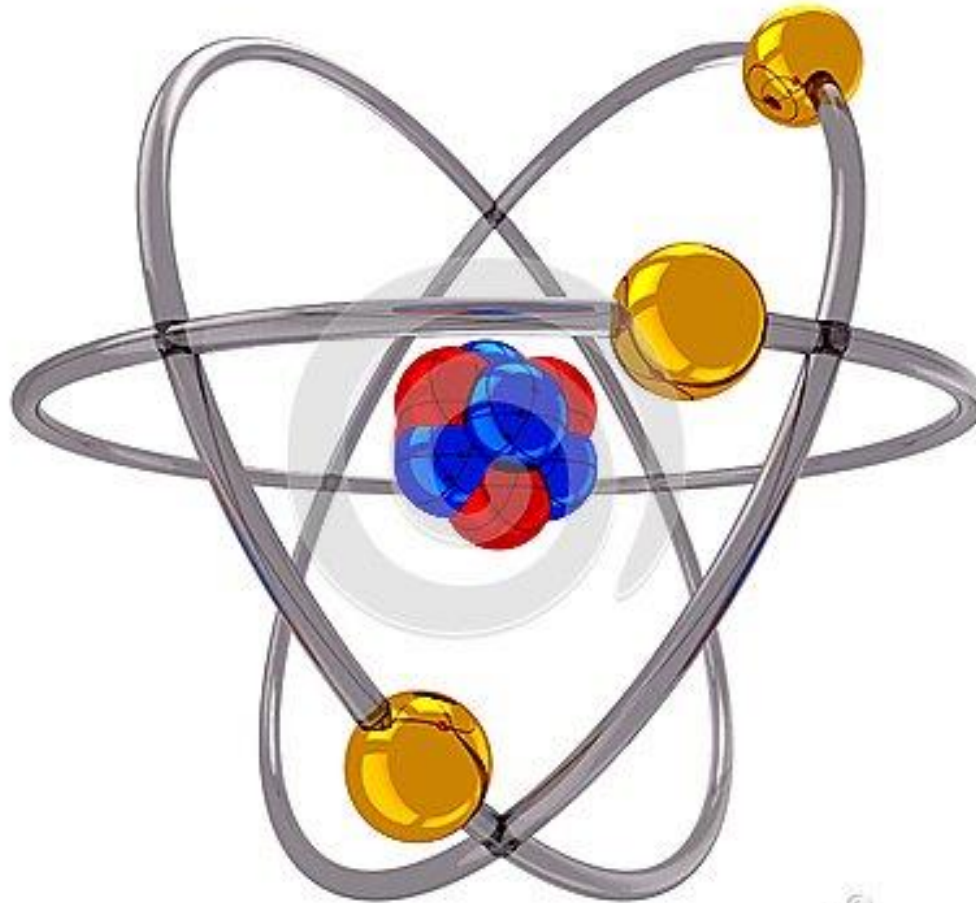
2.1 Matter: the atom

- The **atomic number** is the number of protons in the nucleus of an atom.
- The **mass number** is the number of neutrons and protons in the nucleus of an atom.
- **The number of electrons = number of protons**

| | |
|------------------------|-------------|
| Atomic Number | Atomic Mass |
| Symbol Name | |
| Electron Shells | |
| Electron Configuration | |

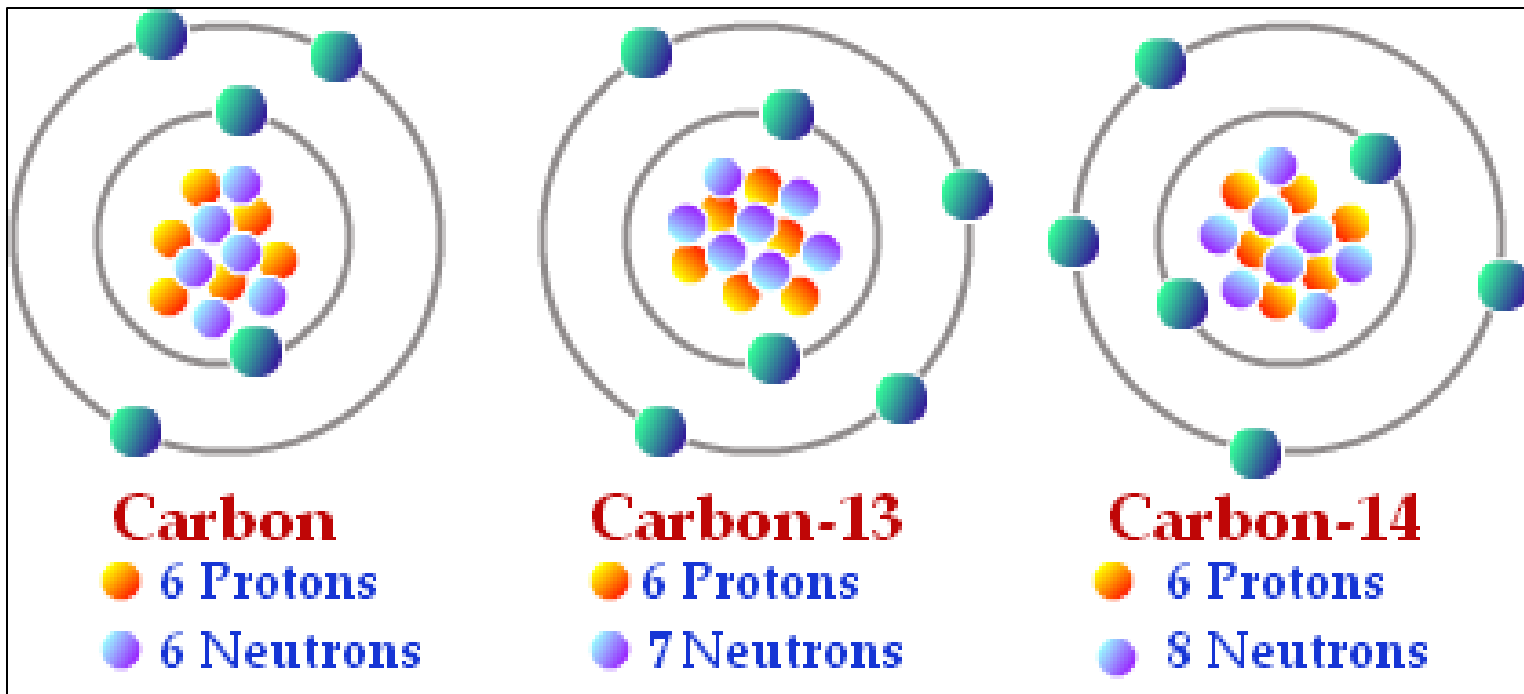


Model of an Atom



2.1 Matter: isotopes

- **Isotopes** of an element have the same number of protons but different numbers of neutrons.
 - Mass number is different (neutrons + protons)



2.1 Matter: chemical bonds

- When an atom's outer energy level does not have the maximum number of electrons, the atom is likely to form a **chemical bond** with one or more atoms.
 - When two or more elements combine, it makes a compound.

3 Types of Chemical Bonds:

1. **Ionic bonds** form when atoms give/take electrons.
2. **Covalent bonds** form when atoms share electrons.
3. **Metallic bonds** form when metal ions share electrons.