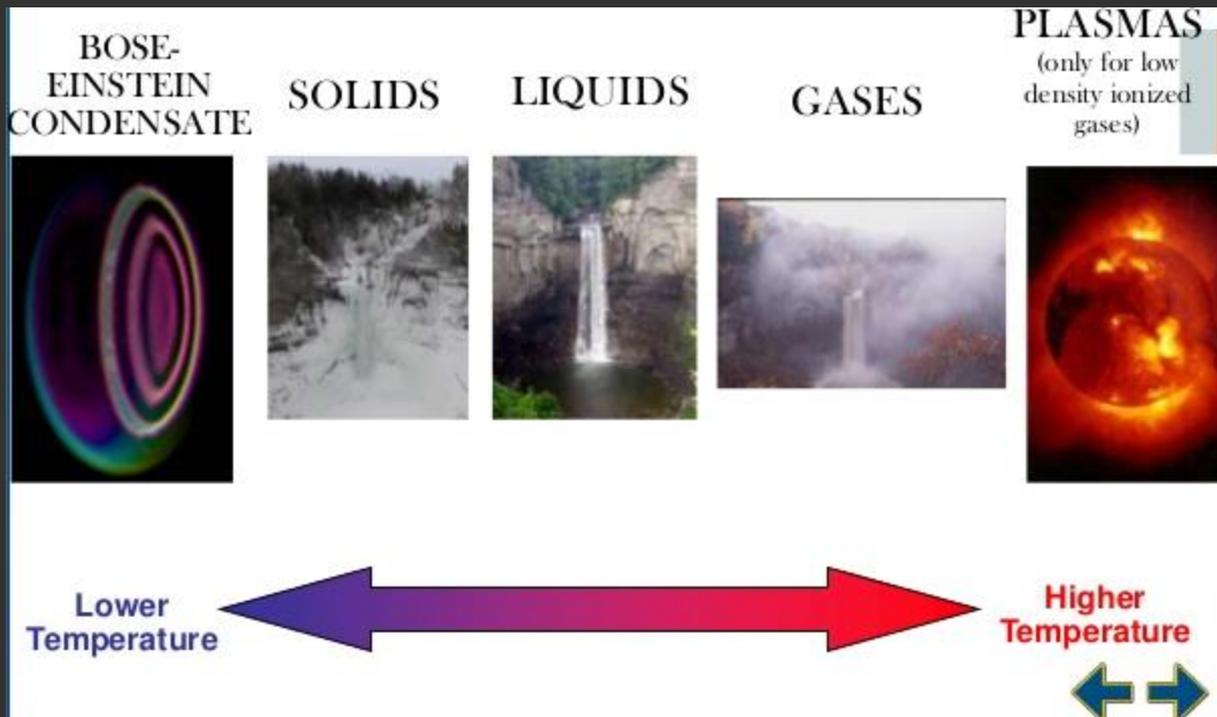


Chemistry Notes: Atomic Structure

What is matter?

- ▶ Matter is anything that has mass and volume.
- ▶ It can be a solid, liquid, gas, plasma, or B.E. condensate



What is an element?

- ▶ A substance that is made of atoms of the same type. Each element is made of a different type of atom. There are over 100 known naturally occurring elements.

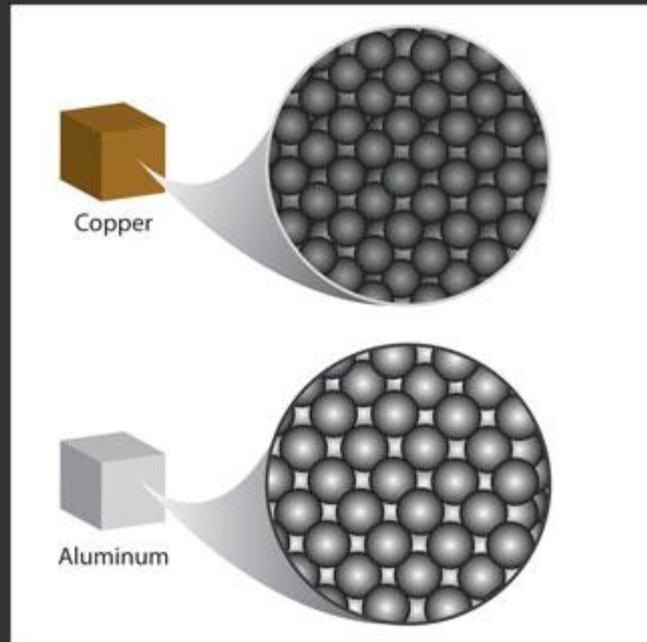
Periodic Table of the Elements

1 IA 1A	2 IIA 2A											13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A	
1 H Hydrogen 1.008													5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
3 Li Lithium 6.941	4 Be Beryllium 9.012												13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.056	17 Cl Chlorine 35.453	18 Ar Argon 39.948
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 9	10 VIII 10	11 IB 1B	12 IIB 2B							
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.933	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 84.80	
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29	
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine 209	86 Rn Radon 222.018	
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [293]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown	
57 La Lanthanum 138.906	58 Ce Cerium 140.315	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium [145]	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967				
89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]				
Alkali Metal	Alkaline Earth	Transition Metal	Basic Metal	Semimetal	Nonmetal	Halogen	Noble Gas	Lanthanide	Actinide									

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What is an atom?

- ▶ The smallest particle that makes up any type of element. All matter is made of atoms. Atoms are very very small.

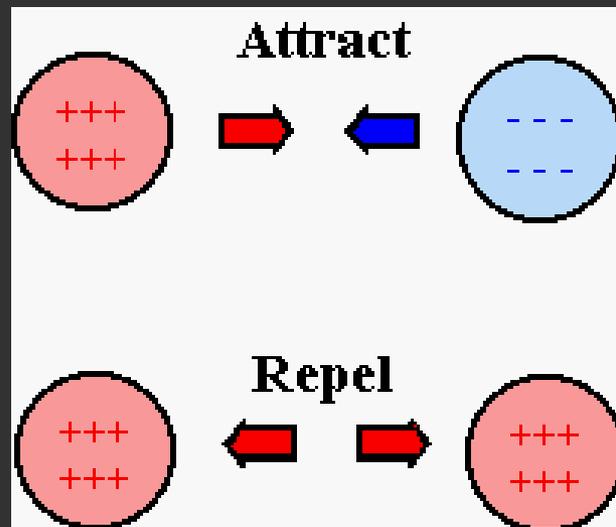


What makes up an atom?

- ▶ An atom is made up of 3 charged particles:
 1. Protons — have a positive (+) charge and are found in the nucleus.
 2. Neutrons — have no (0) charge (think: neutral) and are found in the nucleus.
 3. Electrons — have a negative (-) charge and are found in the electron shell or cloud.

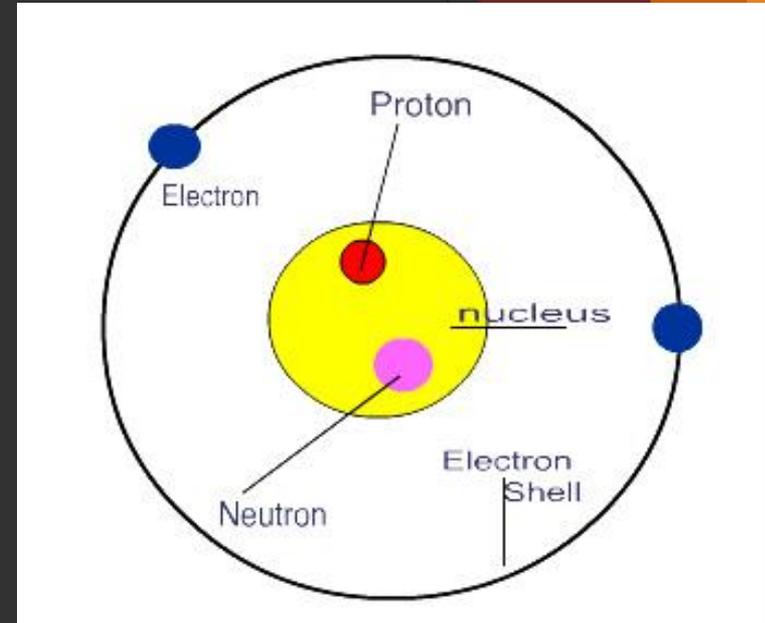
How do charged particles interact?

- ▶ Particles with the same type of charge repel each other — they push away from each other. Particles with opposite charges attract each other — they are drawn toward one another. (This is where the saying “opposites attract” came from.)



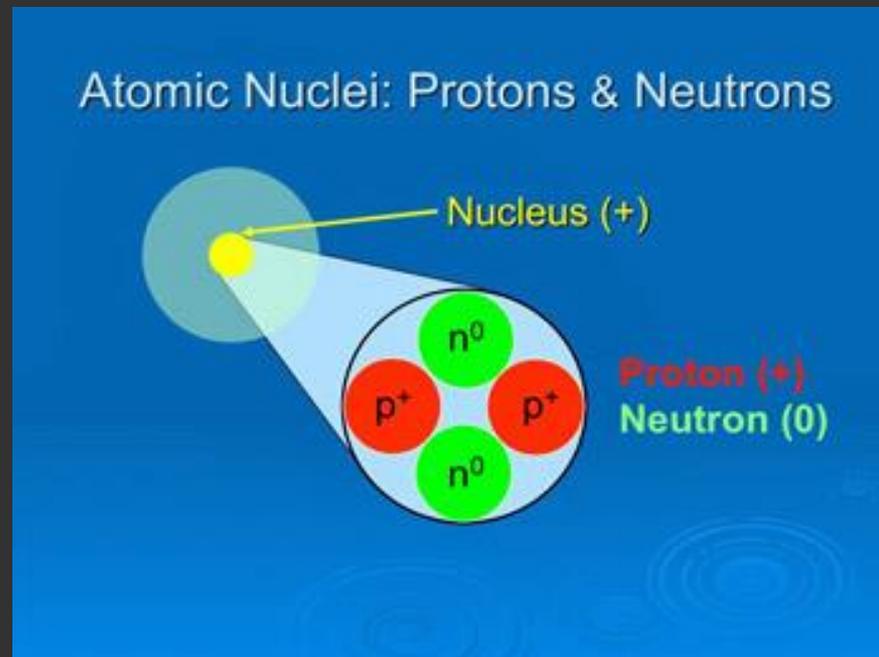
What is the structure of an atom?

- ▶ The protons and neutrons are grouped together in the center of the atom.
 - ▶ The center of the atom is called the nucleus.
- ▶ Electrons move around outside the nucleus in what we call an electron cloud.
- ▶ The nucleus has an overall positive charge (because it contains protons).
- ▶ The electron cloud has a negative charge (because it contains electrons).



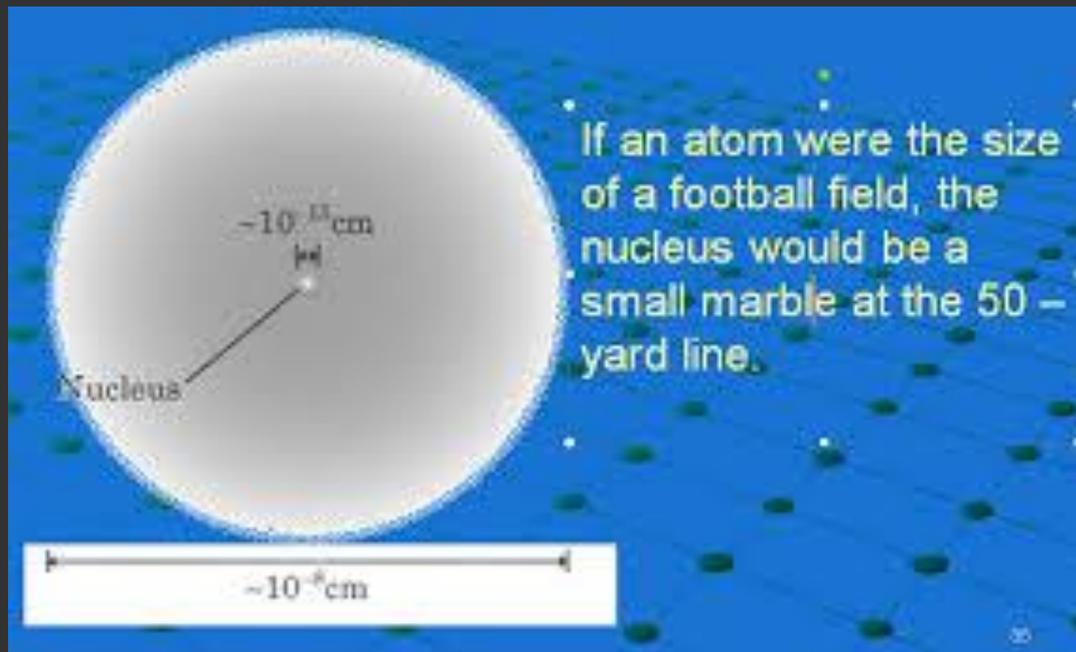
What is the relationship between a proton and a neutron?

- ▶ A neutron has about the same mass as a proton. They are grouped together in the nucleus.



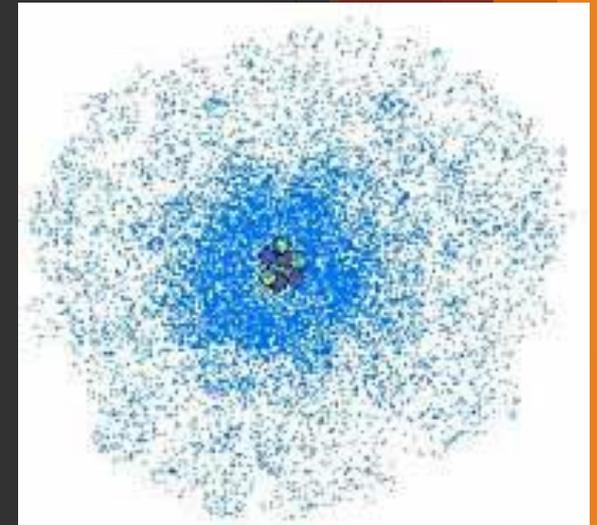
How big is an atom?

- ▶ Atoms are extremely small. The electron cloud is about 10,000 times the size of the nucleus.



What is special about electrons?

- ▶ Electrons are much smaller than protons (2000 times smaller).
- ▶ Electrons move around the nucleus very quickly. Scientists have found that it is not possible to determine the exact position of any single electron in an atom because they are moving too fast. This is why we picture electrons as a cloud around the nucleus.

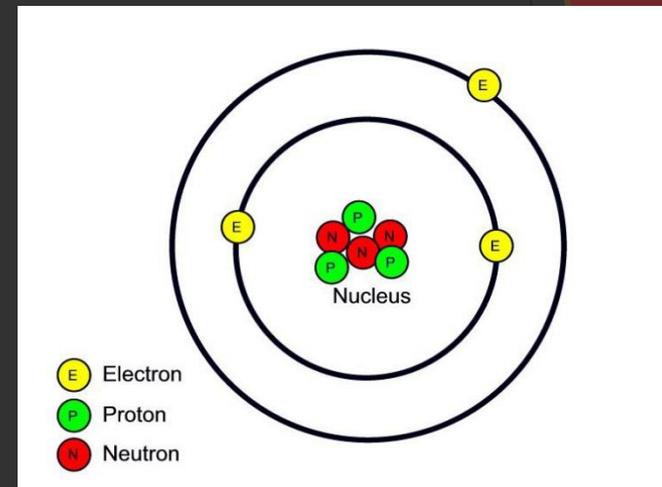


How do atoms stay together?

- ▶ Atoms do not have a shell or anything else separating them from the rest of the world. The negatively charged electrons are attracted to the positively charged protons.
- ▶ However, electrical charges that are alike (such as two negative charges) repel each other. This is why electrons remain spread out in the electron cloud.

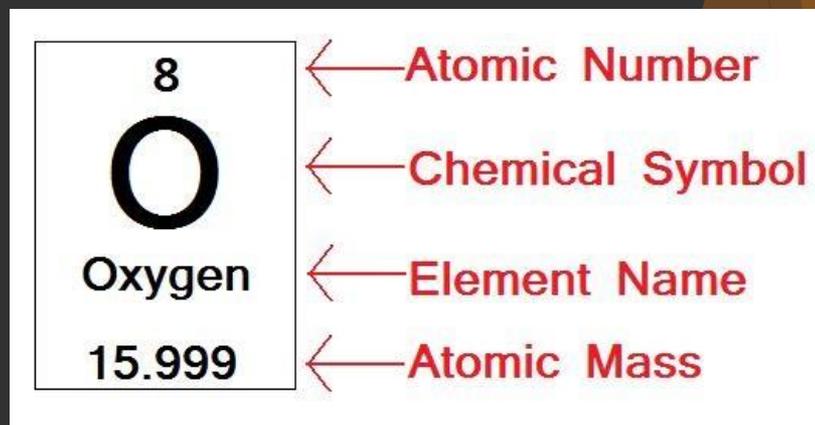
What are neutral atoms?

- ▶ Atoms that have no overall electrical charge because they have an equal number of protons and electrons.



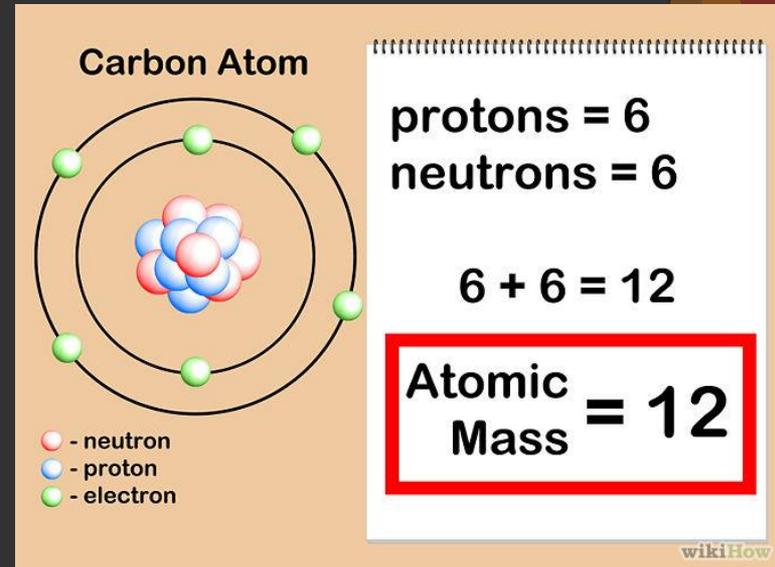
What is an atomic number?

- ▶ The atomic number is the number of protons in the nucleus of an atom. This determines the identity (type) of the atom.
- ▶ **Example:** Oxygen has an atomic number of 8, while Carbon has an atomic number of 6. This means that Oxygen has 8 protons, and Carbon has 6 protons.



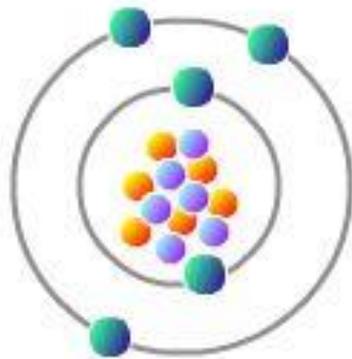
What is an atomic mass number?

- ▶ Atomic mass is the total number of protons **AND** neutrons in the nucleus. Atoms of the same element will always have the same number of protons, but may have different numbers of neutrons.

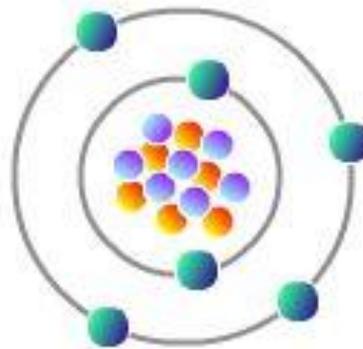


What is an isotope?

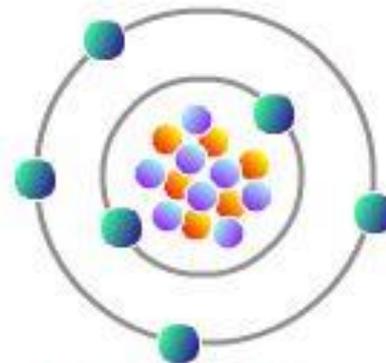
- ▶ Isotopes are atoms of the same element that have a different number of neutrons. Some elements have many isotopes, while other only have a few.



Carbon
● 6 Protons
● 6 Neutrons



Carbon-13
● 6 Protons
● 7 Neutrons



Carbon-14
● 6 Protons
● 8 Neutrons

How do I find the number of protons in an atom?

- ▶ # protons = Atomic # (the number above the element's symbol on the periodic table)

Atomic Number

The number of

Protons

in an atom, called the

Atomic Number

*distinguishes one type of
atom from another*

How do I find the number of neutrons in an atom?

- ▶ Atomic mass number minus (-) the number of protons
- ▶ Carbon has an atomic number of 6 - it has 6 protons - and an atomic mass of 12. To find neutrons, subtract atomic number from atomic mass.
 - ▶ $12 - 6 = 6$
 - ▶ Carbon has 6 neutrons

atomic number

atomic mass

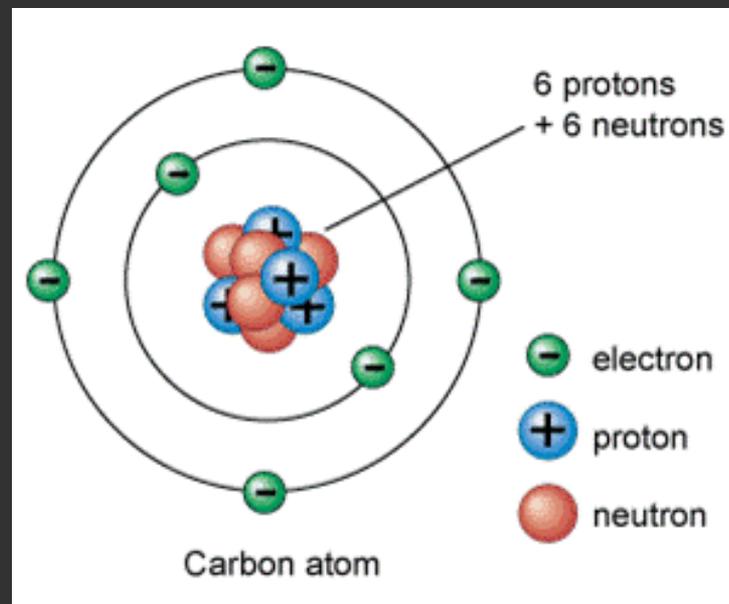
$$N = M - n$$

number of neutrons

The diagram shows the equation $N = M - n$ in red. Blue lines connect the labels to the variables: 'atomic number' points to 'n', 'atomic mass' points to 'M', and 'number of neutrons' points to 'N'. The entire diagram is enclosed in a light green rectangular border.

How do I find the number of electrons in an atom?

- ▶ In a neutral atom, the # of electrons is the same as the number of protons.



ASSIGNMENT:

- ▶ Complete the practice problems at the end of the notes.