



Structure and Properties of Matter

Atomic Structure

Unit 1 - Lesson 4

Atomic Structure

Learning Objectives:

- Describe the structure of an atom
- Describe the properties of the three main subatomic particles
- Determine the relationship between an atom's mass number, its atomic number, and the number of subatomic particles it possesses.

Core Vocabulary:

subatomic particles, nucleus, proton, neutron, electron, orbital
atomic number, atomic mass,

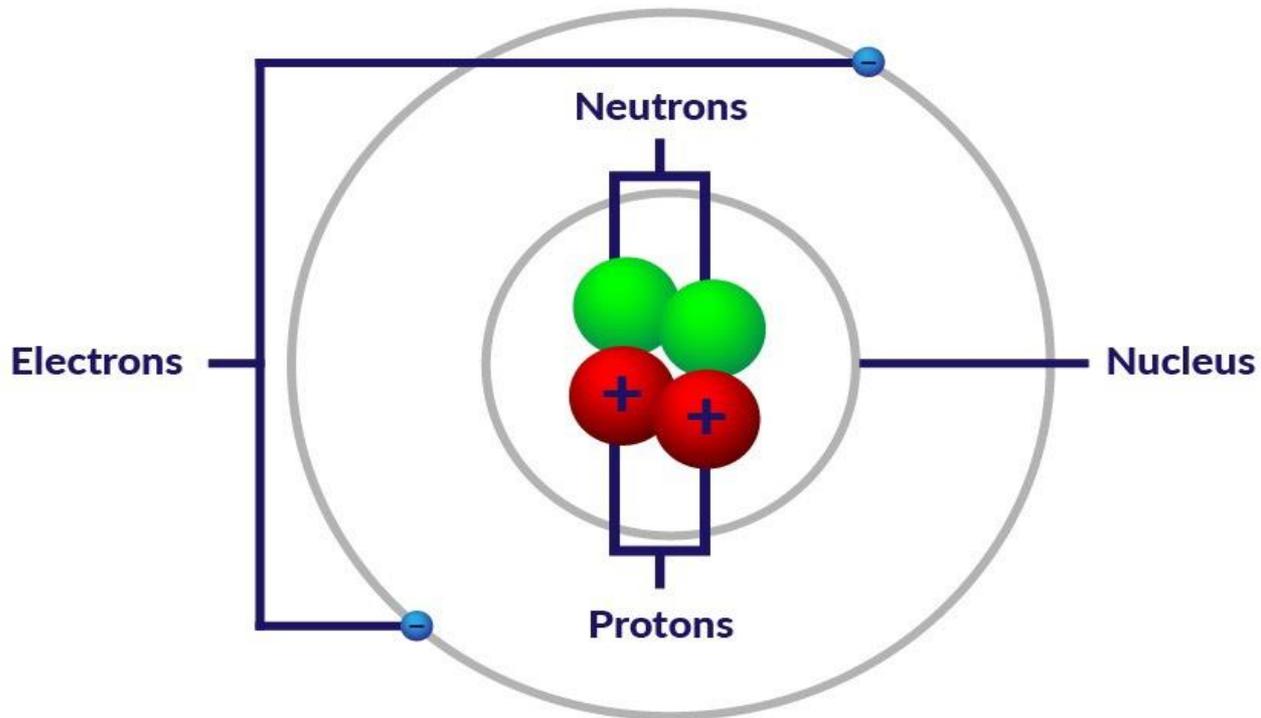
Atomic Structure

Basic Structure of the Atom

- All atoms consist of a nucleus which contains two types of subatomic particles - protons and neutrons. The nucleus is surrounded by a cloud of electrons at varying energy levels.
- These subatomic particles are composed of even smaller particles known as quarks which came together after the Big Bang around 13.7 million years ago.

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Basic Structure of the Atom



Atomic Structure

The Nucleus

- The nucleus is held together by the "strong force," which binds the quarks together.
- This force found in the nucleus has sufficient strength to overcome the repulsive electrical force which aims to push like charges apart. Because this binding force varies from atom to atom, sometimes the nucleus decays into other elements as it breaks apart.

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Charged Subatomic Particles

- Protons and electrons are oppositely charged giving the atom an overall (net) charge of zero.
- The table below shows the charge and relative mass of each of the three particles found in the atom (the neutron is used as a point of comparison to find the relative mass of protons and electrons).

	Charge	Relative Mass
Proton	Positive	0.9986
Neutron	No charge (neutral)	1
Electron	Negative	0.0005439

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The Mass of an Atom:

- The majority of the mass of an atom is found in its nucleus. The protons and neutrons are approximately the same mass (with the proton being slightly less), known as one atomic mass unit (AMU) or one Dalton.
- Electrons are much smaller than protons and neutrons, so much so, that they do not contribute much to the mass of an atom.

Atomic Structure

Periodic Table of the Elements

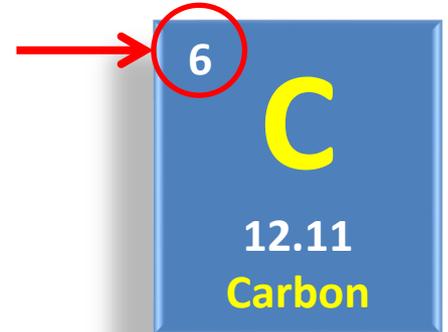
1 H Hydrogen 1.008																	2 He Helium 4.003	
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180	
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948	
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 84.798	
37 Rb Rubidium 85.468	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 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294	
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.227	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018	
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	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 Nh Nihonium unknown	114 Fl Flerovium [289]	115 Mc Moscovium unknown	116 Lv Livermorium [298]	117 Ts Tennessine unknown	118 Og Oganesson unknown	
Lanthanide Series		57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.242	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967		
Actinide Series		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 Metal	Transition Metal	Basic Metal	Semimetal	Nonmetal	Halogen	Noble Gas	Lanthanide	Actinide
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Atomic Structure

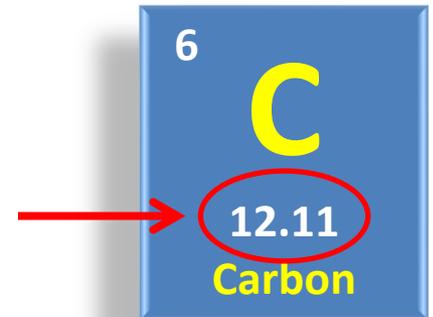
Atomic Number:

- The atomic number tells us how many protons it has. It is denoted by the letter 'Z'. This number can be found under the entry for each element on the periodic table.



Mass Number:

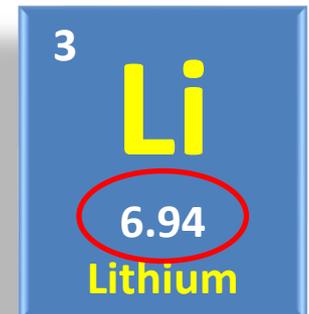
- The mass number provides information about the number of protons and neutrons contained in the atom's nucleus. It is denoted by the letter 'A'. To find the number of neutrons in any given element, the atomic number (or number of protons) is subtracted from the mass number.



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An example:

- A lithium atom has the atomic number (Z) of 3, and the atomic mass (A) of 6.94 (round it up to 7!).
- Therefore lithium contains three protons (found from Z), and three electrons (as the number of protons must be equal to the number of electrons in order for the atom to be neutral).
- Lithium also contains four neutrons ($7 - 3 = 4$).



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Practice:

Use the periodic table from your guided notes (page 2) to complete the table below:

	Number of protons	Number of electrons	Number of neutrons
Hydrogen		1	
Fluorine	9		10
Calcium		20	20
Iodine	53		
Gold	79	79	

Atomic Structure

Answers:

	Number of protons	Number of electrons	Number of neutrons
Hydrogen	1	1	0
Fluorine	9	9	10
Calcium	20	20	20
Iodine	53	53	74
Gold	79	79	118