

## 2.1 The Nature of Matter

# THINK ABOUT IT

What are you made of?

- Just as buildings are made from bricks, steel, glass, and wood, living things are made from chemical compounds.
- When you breathe, eat, or drink, your body uses the substances in air, food, and water to carry out chemical reactions that keep you alive.
- The first job of a biologist is to understand the chemistry of life.

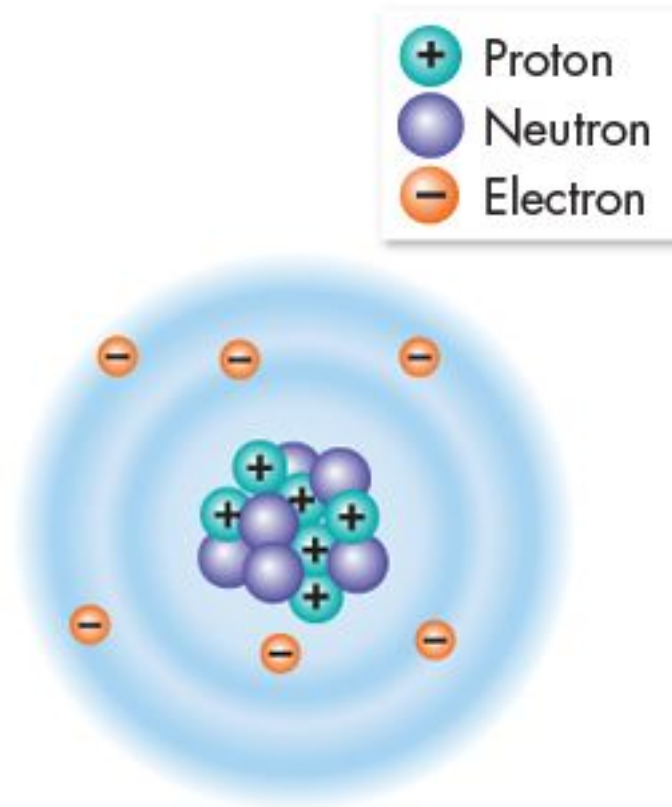
# What 3 subatomic particles make up atoms?



Students, write your response!

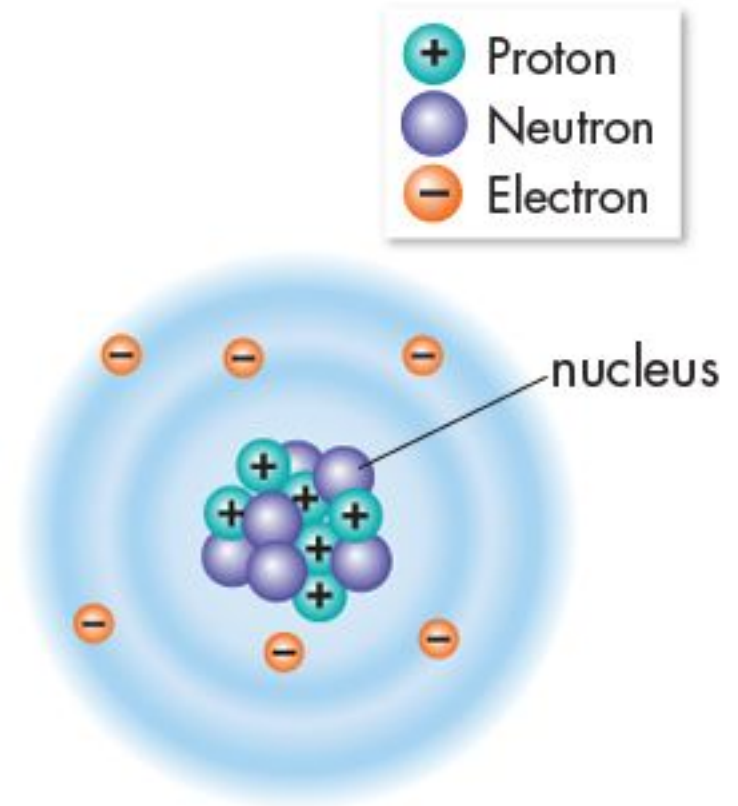
# Atoms

- The atom is the basic unit of matter, made up of three subatomic particles: **protons**, **neutrons**, and **electrons**.



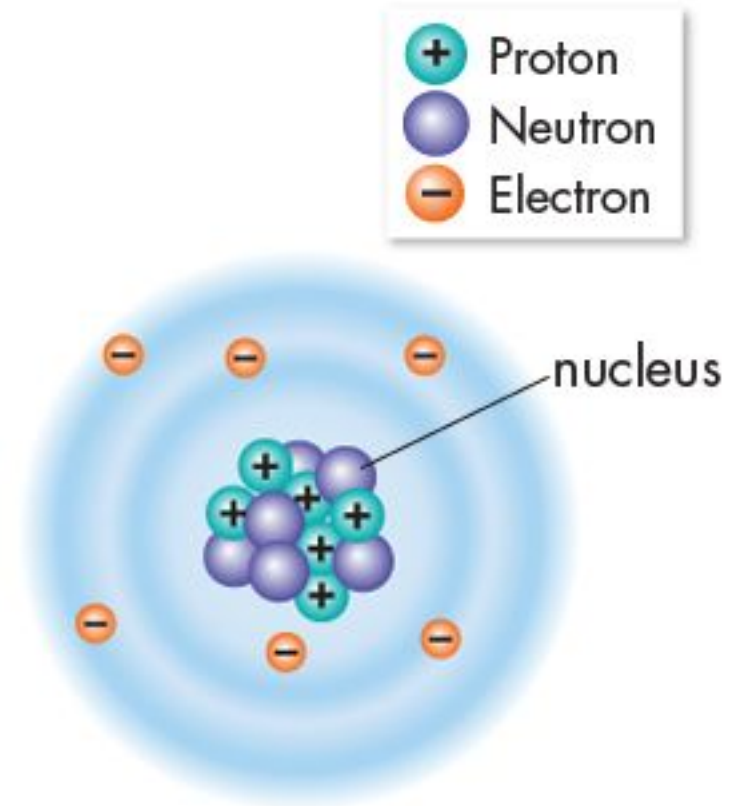
# Subatomic Particles

- **Protons** are positively charged.
- **Neutrons** carry NO charge (neutral).
- **Electrons** are negatively charged.



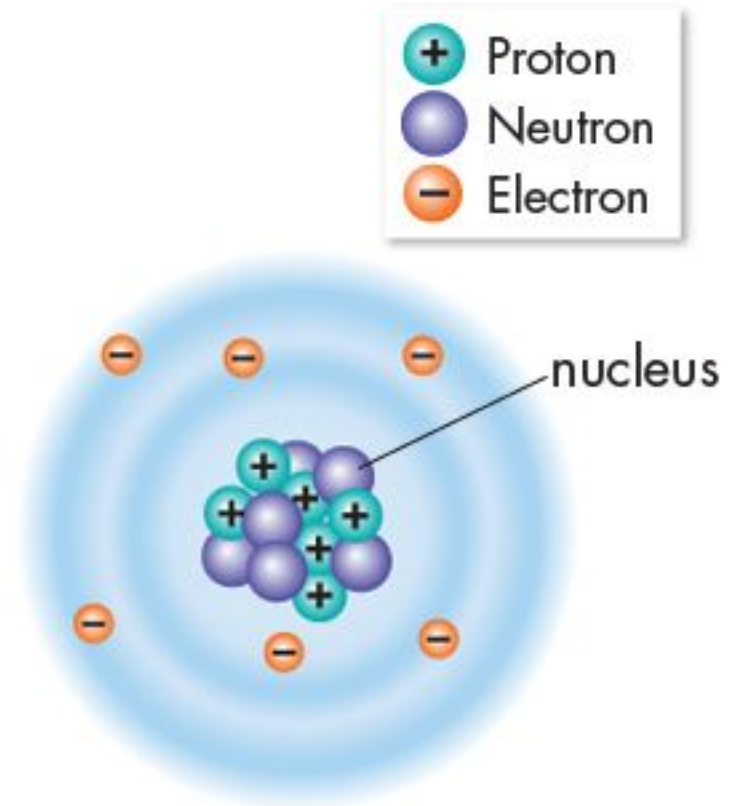
# Subatomic Particles

- **Protons** and **Neutrons** have about the same mass.
- **Electrons** are about 1/1840 the mass of a proton.



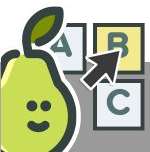
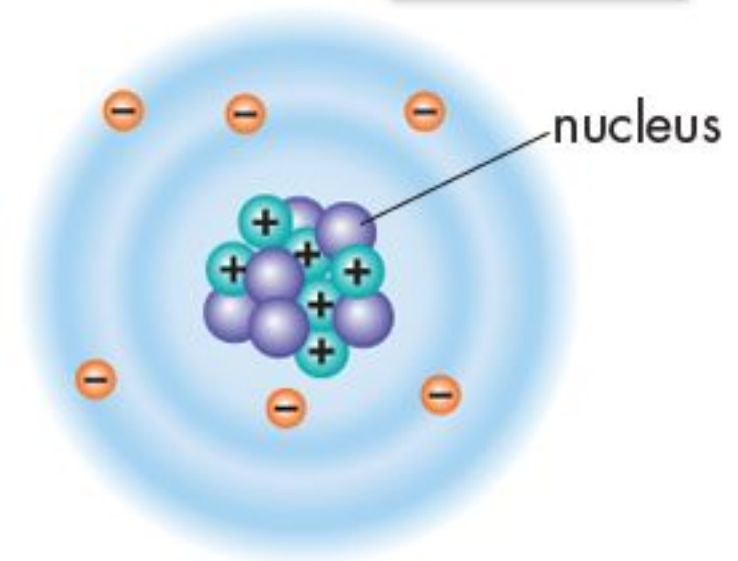
# Subatomic Particles

- Strong forces bind **protons** and **neutrons** together to form the **nucleus**, at the center of the atom.
- **Electrons** constantly move around the space surrounding the atom's nucleus.



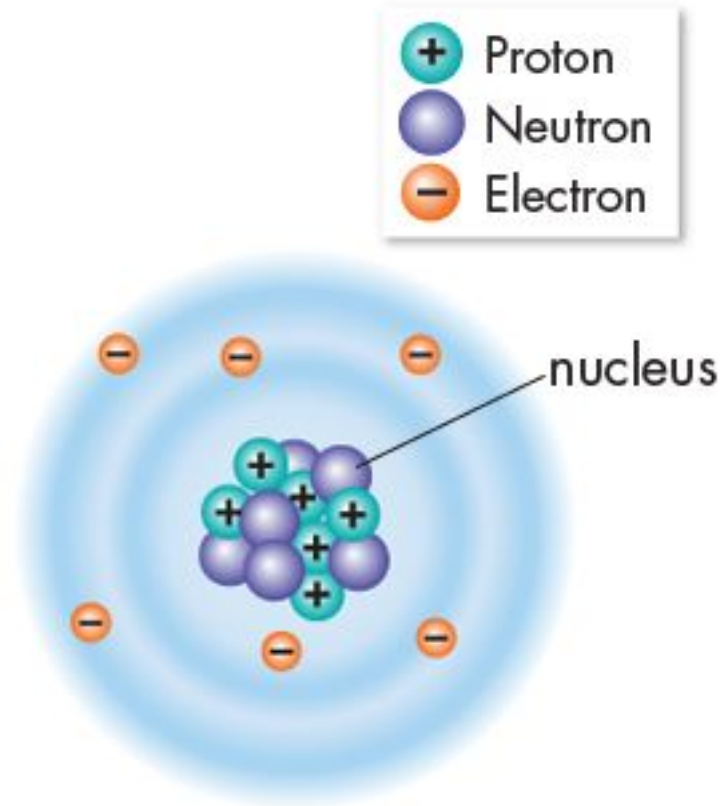
If an atom has the same number of **protons** and **electrons**, what is the charge of an atom?

**# of Protons = # of Electrons**





Because an atom has the same number of **protons** and **electrons**, it is electrically neutral.



**Draw the atomic structure of a carbon atom. The carbon atom contains 6 protons, 6 neutrons, and 6 electrons.**



Students, draw anywhere on this slide!

**An atom of calcium contains 20 protons.  
How many electrons does it have?**



Students, enter a number!

# Elements

- A chemical **element** is a pure substance that consists entirely of one type of atom.

**Periodic Table of the Elements**

Atomic Number    Boiling Point  
**Symbol**  
 Name  
 Atomic Mass

Normal boiling points are in °C.  
 SP = Triple Point.  
 Pressure is listed if not 1 atm.  
 Allotrope is listed if more than one allotrope.

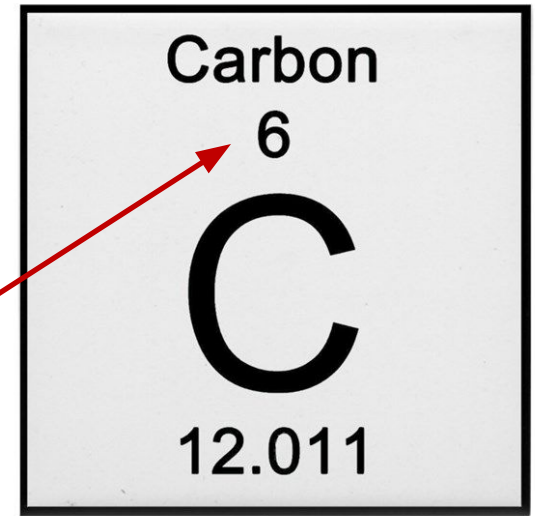
1 1A 1A 1 H Hydrogen 1.008	2 2A 2A 4 He Helium 4.003																	18 VIII 8A 2 He Helium 4.003																
3 13A 1A 3 Li Lithium 6.941	4 14A 2A 4 Be Beryllium 9.012																	10 VIIIA 8A 10 Ne Neon 20.180																
11 11A 1A 11 Na Sodium 22.990	12 12A 2A 12 Mg Magnesium 24.305	13 IIIB 3B 3 Al Aluminum 26.982	14 IVB 4B 4 Si Silicon 28.086	15 VB 5B 5 P Phosphorus 30.974	16 VIB 6B 6 S Sulfur 32.066	17 VIIB 7B 7 Cl Chlorine 35.453	18 VIIIB 8B 8 Ar Argon 39.948																	18 VIIIA 8A 18 Kr Krypton 83.80										
19 19A 1A 19 K Potassium 39.098	20 20A 2A 20 Ca Calcium 40.078	21 IIIB 3B 21 Sc Scandium 44.956	22 IVB 4B 22 Ti Titanium 47.88	23 VB 5B 23 V Vanadium 50.942	24 VIB 6B 24 Cr Chromium 51.996	25 VIIB 7B 25 Mn Manganese 54.938	26 VIII 8 26 Fe Iron 55.933	27 VIII 8 27 Co Cobalt 58.933	28 VIII 8 28 Ni Nickel 58.693	29 VIII 8 29 Cu Copper 63.546	30 VIII 8 30 Zn Zinc 65.39	31 IIIB 3B 31 Ga Gallium 69.723	32 IVB 4B 32 Ge Germanium 72.63	33 VB 5B 33 As Arsenic 74.922	34 VIB 6B 34 Se Selenium 78.972	35 VIIB 7B 35 Br Bromine 79.904	36 VIIIB 8B 36 Kr Krypton 83.80																	36 VIIIA 8A 36 Xe Xenon 131.29
37 19A 1A 37 Rb Rubidium 85.468	38 20A 2A 38 Sr Strontium 87.62	39 IIIB 3B 39 Y Yttrium 88.906	40 IVB 4B 40 Zr Zirconium 91.224	41 VB 5B 41 Nb Niobium 92.906	42 VIB 6B 42 Mo Molybdenum 95.95	43 VIIB 7B 43 Tc Technetium 98.907	44 VIII 8 44 Ru Ruthenium 101.07	45 VIII 8 45 Rh Rhodium 102.906	46 VIII 8 46 Pd Palladium 106.42	47 VIII 8 47 Ag Silver 107.868	48 VIII 8 48 Cd Cadmium 112.411	49 IIIB 3B 49 In Indium 114.818	50 IVB 4B 50 Sn Tin 118.71	51 VB 5B 51 Sb Antimony 121.760	52 VIB 6B 52 Te Tellurium 127.6	53 VIIB 7B 53 I Iodine 126.904	54 VIIIB 8B 54 Xe Xenon 131.29																	54 VIIIA 8A 54 Xe Xenon 131.29
55 19A 1A 55 Cs Cesium 132.905	56 20A 2A 56 Ba Barium 137.327	57-71 Lanthanide Series	72 IVB 4B 72 Hf Hafnium 178.49	73 VB 5B 73 Ta Tantalum 180.948	74 VIB 6B 74 W Tungsten 183.85	75 VIIB 7B 75 Re Rhenium 186.207	76 VIII 8 76 Os Osmium 190.23	77 VIII 8 77 Ir Iridium 192.22	78 VIII 8 78 Pt Platinum 195.08	79 VIII 8 79 Au Gold 196.967	80 VIII 8 80 Hg Mercury 200.59	81 IIIB 3B 81 Tl Thallium 204.383	82 IVB 4B 82 Pb Lead 207.2	83 VB 5B 83 Bi Bismuth 208.980	84 VIB 6B 84 Po Polonium [209]	85 VIIB 7B 85 At Astatine [209]	86 VIIIB 8B 86 Rn Radon 222.018																	86 VIIIA 8A 86 Rn Radon 222.018
87 19A 1A 87 Fr Francium [223]	88 20A 2A 88 Ra Radium [226]	89-103 Actinide Series	104 IVB 4B 104 Rf Rutherfordium [261]	105 VB 5B 105 Db Dubnium [262]	106 VIB 6B 106 Sg Seaborgium [266]	107 VIIB 7B 107 Bh Bohrium [264]	108 VIII 8 108 Hs Hassium [265]	109 VIII 8 109 Mt Meitnerium [269]	110 VIII 8 110 Ds Darmstadtium [271]	111 VIII 8 111 Rg Roentgenium [272]	112 VIII 8 112 Cn Copernicium [277]	113 IIIB 3B 113 Uut Ununtrium [285]	114 IVB 4B 114 Fl Flerovium [289]	115 VB 5B 115 Uup Ununpentium [288]	116 VIB 6B 116 Lv Livermorium [293]	117 VIIB 7B 117 Uus Ununseptium [294]	118 VIIIB 8B 118 Uuo Ununoctium [294]																	118 VIIIA 8A 118 Uuo Ununoctium [294]
		57 Lanthanum 138.905	58 Cerium 140.115	59 Praseodymium 140.908	60 Neodymium 144.24	61 Promethium 144.913	62 Samarium 150.36	63 Europium 151.966	64 Gadolinium 157.25	65 Terbium 158.925	66 Dysprosium 162.50	67 Holmium 164.930	68 Erbium 167.26	69 Thulium 168.934	70 Ytterbium 173.04	71 Lutetium 174.967																		
		89 Actinium 227.028	90 Thorium 232.038	91 Protactinium 231.036	92 Uranium 238.029	93 Neptunium 237.048	94 Plutonium 244.064	95 Americium 243.061	96 Curium 247.070	97 Berkelium 247.070	98 Californium 251.080	99 Einsteinium [254]	100 Fermium 257.095	101 Mendelevium 258.1	102 Nobelium 259.10	103 Lawrencium [262]																		
		<b>Alkali Metal</b>	<b>Alkaline Earth</b>	<b>Transition Metal</b>	<b>Basic Metal</b>	<b>Semimetal</b>	<b>Nonmetal</b>	<b>Halogen</b>	<b>Noble Gas</b>	<b>Lanthanide</b>	<b>Actinide</b>																							

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# Elements

- The number of **protons** in the nucleus of an element is called its **atomic number**.



## Example: Carbon

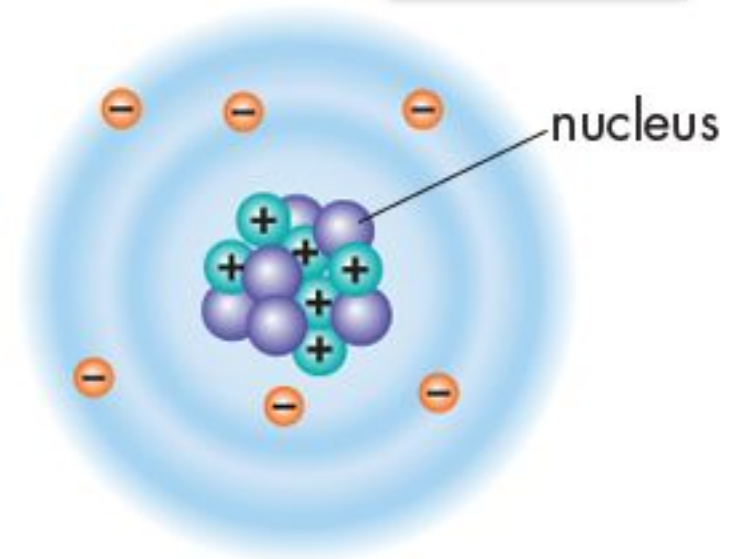
Atomic Number = 6

Atomic Number = Protons

Protons = 6

Protons = Electrons

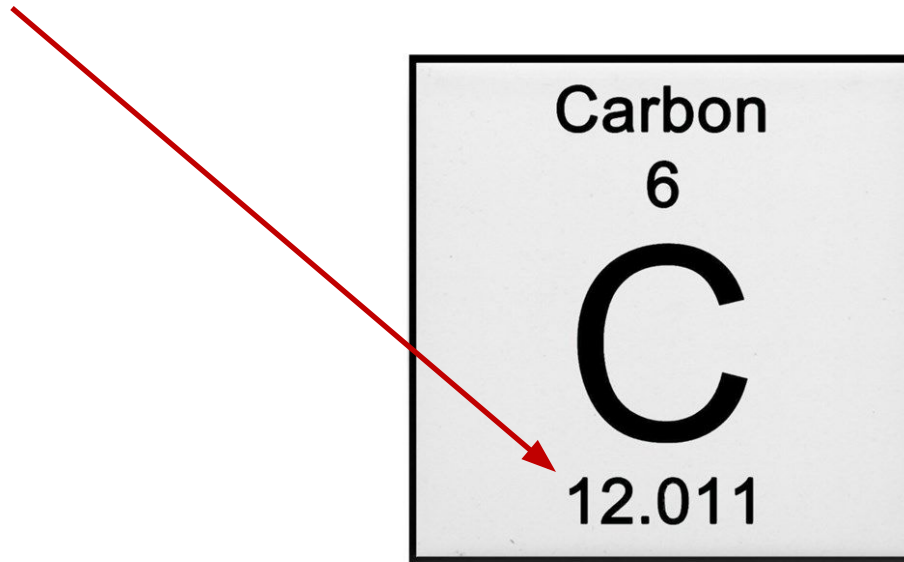
Electrons = 6



# Mass Number

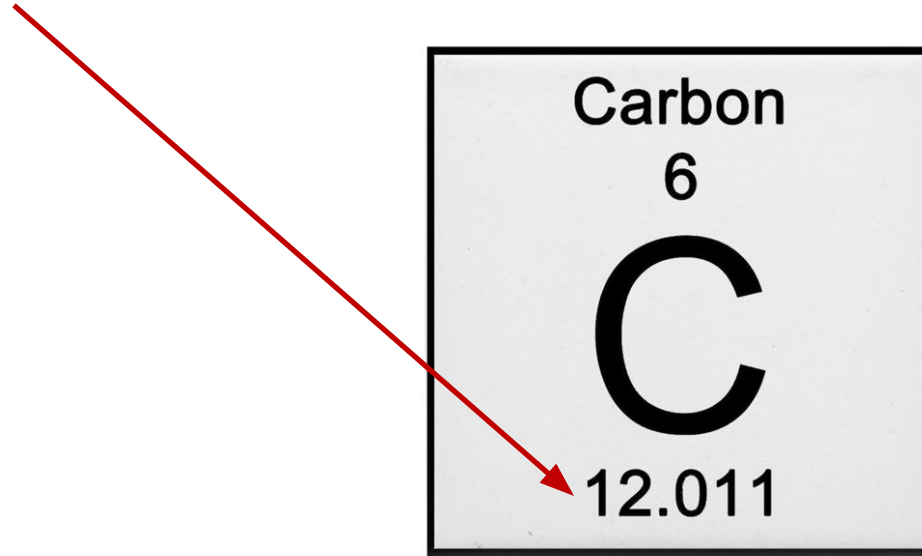
- The total number of protons and neutrons in the nucleus of an atom is called its **mass number**.

Mass Number = Protons + Neutrons



# How many neutrons does carbon have?

Mass Number = Protons + Neutrons



Students, enter a number!

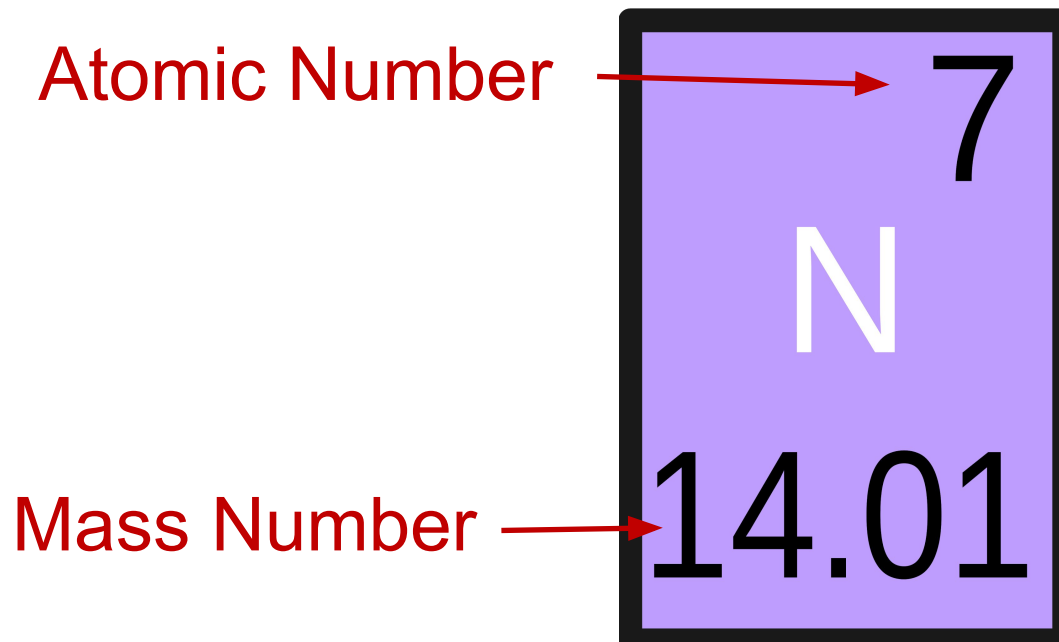


With your elbow partner, use the colored beads at your table and the key below to model the atomic structure of nitrogen.

**Red - Protons**

**White - Neutrons**

**Black - Electrons**



With your elbow partner, use the colored beads at your table and the key below to model the atomic structure of oxygen.

**Red - Protons**

**White - Neutrons**

**Black - Electrons**

Atomic Number



Mass Number

