



Chemistry Notes: Atomic Structure

What is matter?

- Matter is anything that has mass and volume. It can be a solid, liquid, or gas.



SOLID



LIQUID



GAS

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.

hydrogen 1 H 1.0079																		helium 2 He 4.0026																			
lithium 3 Li 6.941		beryllium 4 Be 9.0122																		boron 5 B 10.811		carbon 6 C 12.011		nitrogen 7 N 14.007		oxygen 8 O 15.999		fluorine 9 F 18.998		neon 10 Ne 20.180							
sodium 11 Na 22.990		magnesium 12 Mg 24.305																		aluminium 13 Al 26.982		silicon 14 Si 28.086		phosphorus 15 P 30.974		sulfur 16 S 32.065		chlorine 17 Cl 35.453		argon 18 Ar 39.948							
potassium 19 K 39.098		calcium 20 Ca 40.078		scandium 21 Sc 44.956		titanium 22 Ti 47.867		vanadium 23 V 50.942		chromium 24 Cr 51.996		manganese 25 Mn 54.938		iron 26 Fe 55.845		cobalt 27 Co 58.933		nickel 28 Ni 58.693		copper 29 Cu 63.546		zinc 30 Zn 65.39		gallium 31 Ga 69.723		germanium 32 Ge 72.61		arsenic 33 As 74.922		selenium 34 Se 78.96		bromine 35 Br 79.904		krypton 36 Kr 83.80			
rubidium 37 Rb 85.468		strontium 38 Sr 87.62		yttrium 39 Y 88.906		zirconium 40 Zr 91.224		niobium 41 Nb 92.906		molybdenum 42 Mo 95.94		technetium 43 Tc [98]		ruthenium 44 Ru 101.07		rhodium 45 Rh 102.91		palladium 46 Pd 106.42		silver 47 Ag 107.87		cadmium 48 Cd 112.41		indium 49 In 114.82		tin 50 Sn 118.71		antimony 51 Sb 121.76		tellurium 52 Te 127.60		iodine 53 I 126.90		xenon 54 Xe 131.29			
caesium 55 Cs 132.91		barium 56 Ba 137.33		57-70 ★		lutetium 71 Lu 174.97		hafnium 72 Hf 178.49		tantalum 73 Ta 180.95		tungsten 74 W 183.84		rhenium 75 Re 186.21		osmium 76 Os 190.23		iridium 77 Ir 192.22		platinum 78 Pt 195.08		gold 79 Au 196.97		mercury 80 Hg 200.59		thallium 81 Tl 204.38		lead 82 Pb 207.2		bismuth 83 Bi 208.98		polonium 84 Po [209]		astatine 85 At [210]		radon 86 Rn [222]	
francium 87 Fr [223]		radium 88 Ra [226]		89-102 ★ ★		lawrencium 103 Lr [262]		rutherfordium 104 Rf [261]		dubnium 105 Db [262]		seaborgium 106 Sg [266]		bohrium 107 Bh [264]		hassium 108 Hs [269]		meitnerium 109 Mt [268]		unnilium 110 Uun [271]		ununium 111 Uuu [272]		unbibium 112 Uub [277]		ununquadium 114 Uuq [289]											

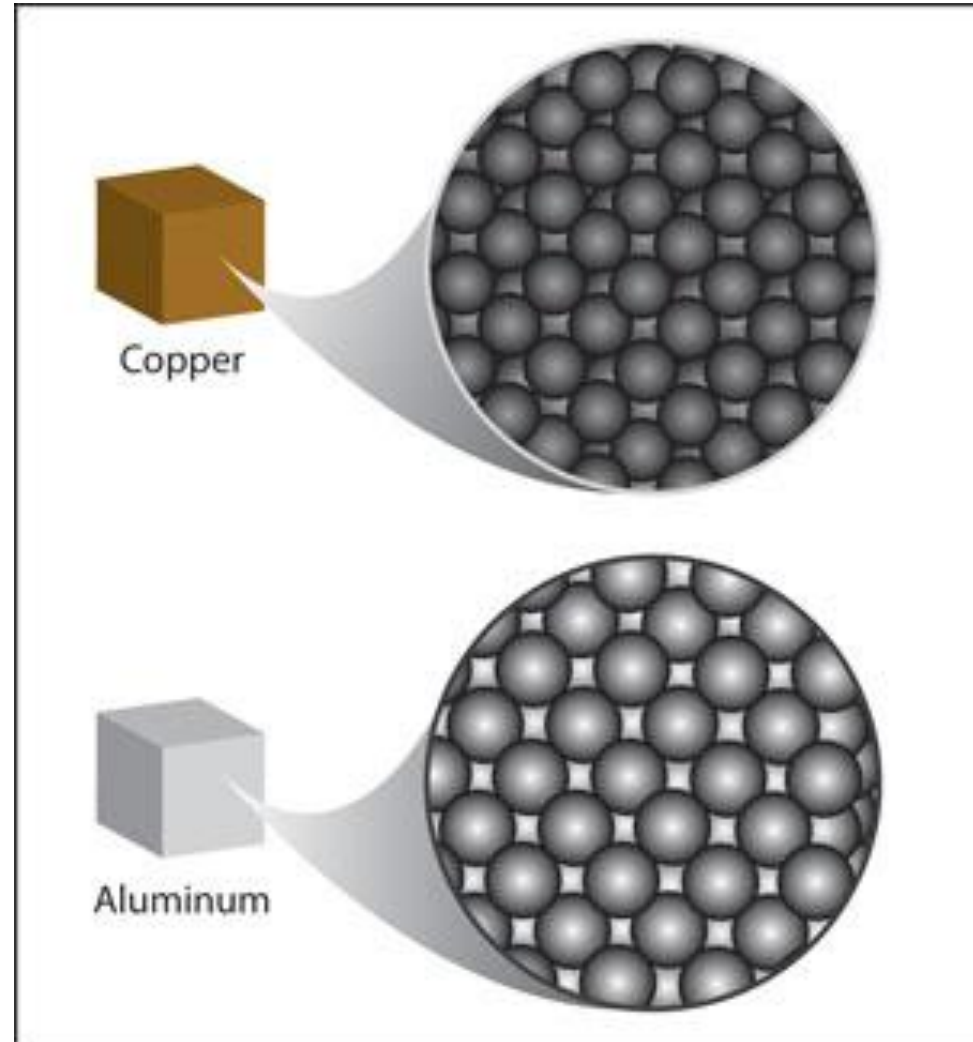
* Lanthanide series

** Actinide series

lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendeleevium 101 Md [258]	nobelium 102 No [259]

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?

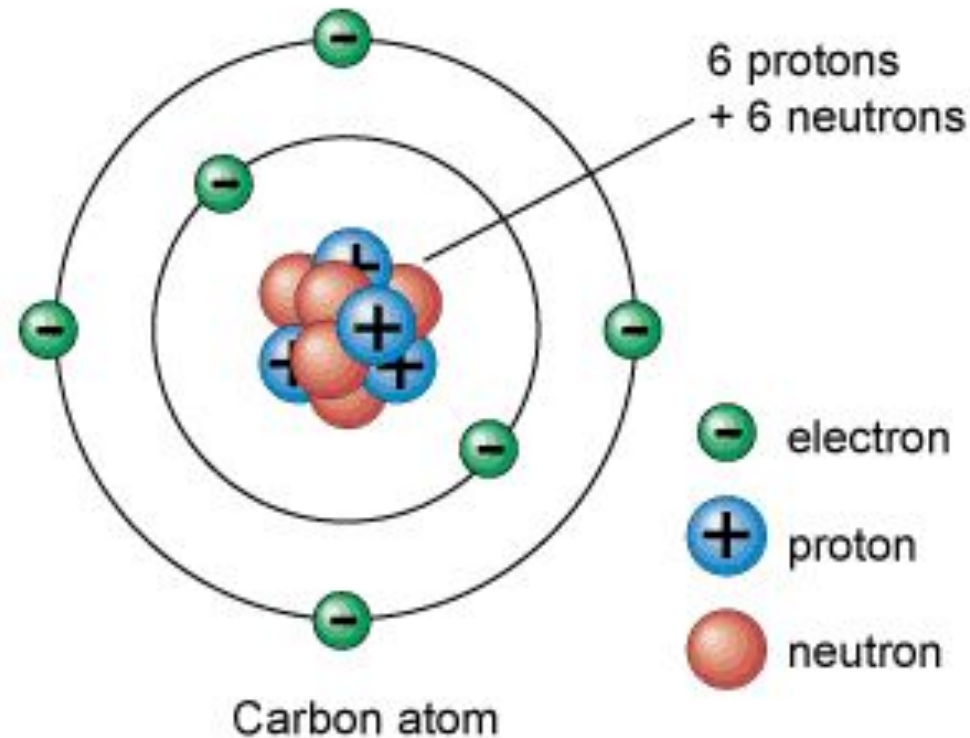
- An atom is made up of 3 charged particles:
 1. Protons—have a positive (+) charge
 2. Neutrons—have no (o) charge (think: neutral)
 3. Electrons—have a negative (-) charge

How do charged particles interact?

- Particles with the same type of charge repel each other—they push away from each other. Particles with different/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?

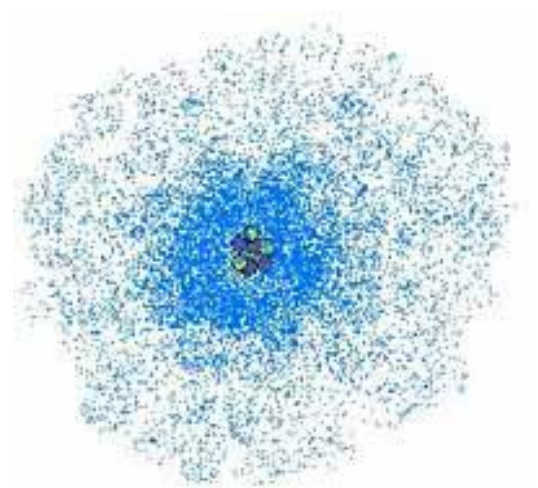
- A neutron has about the same mass as a proton. They are grouped together in the nucleus.

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.

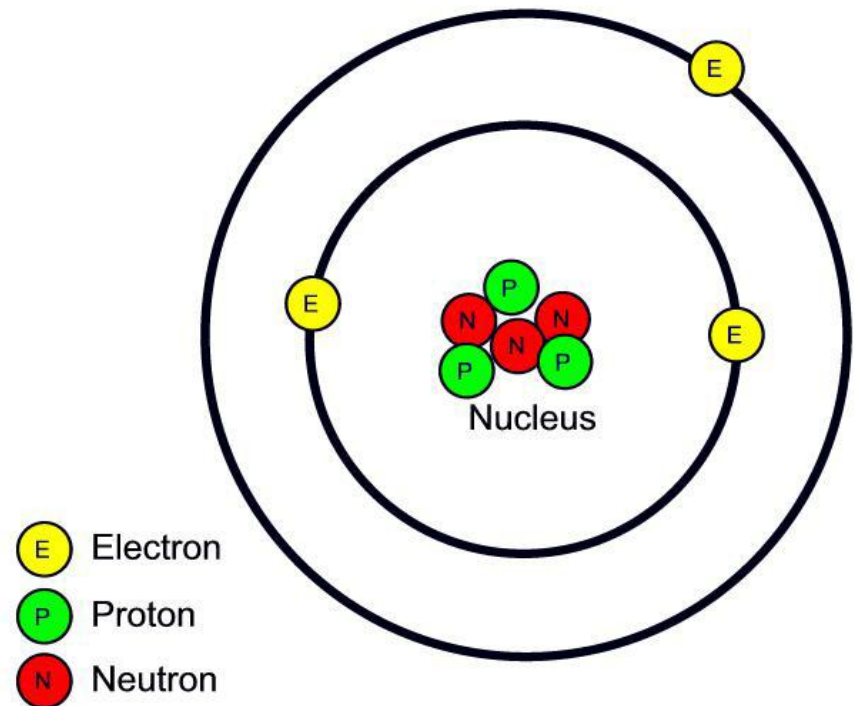


How do atoms stay together?

- 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 number 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.

How do we show that something is an isotope?

- An isotope is described by the name of the element and the total number of its protons and neutrons (atomic mass number).

Ex: Chlorine-35 (name-atomic mass number)

What is an ion?

- An ion is an **atom** that has electric charge. The charge can be positive or negative. Ions have different numbers of protons and electrons.

How is an ion formed?

- An ion is formed when an atom gains or loses one or more electrons.
- An ion is described by its name (or symbol) and charge.
- Ex: Oxygen (-2) or O^{2-}

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

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

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

- Atomic mass number minus (-) the number of protons

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

- In a neutral atom, the number of electrons is the same as the number of protons.
- In an ion (with a positive or negative charge), the number of electrons is different from the number of protons. To find the number of electrons subtract the charge from the number of protons the atom has.
 - # protons - charge = # electrons