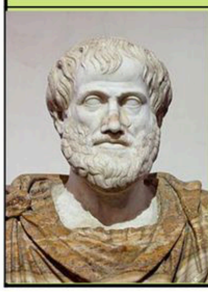
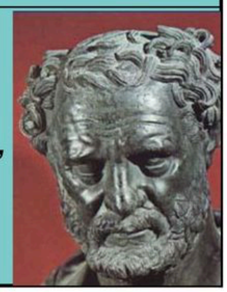
CHEMISTRY UNIT 2 NOTES

Chapter 4 Notes

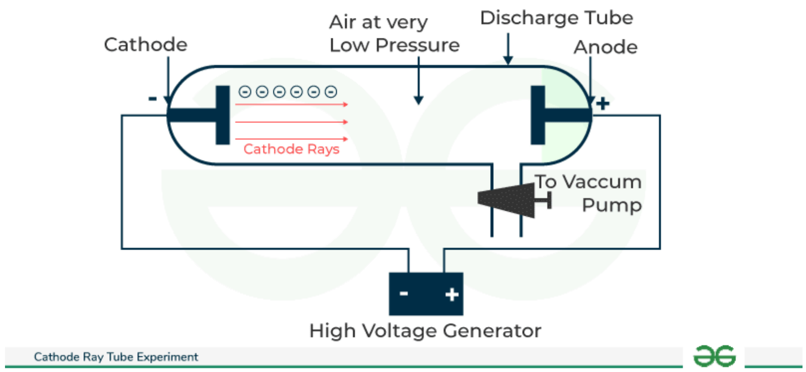
Ancient Greeks

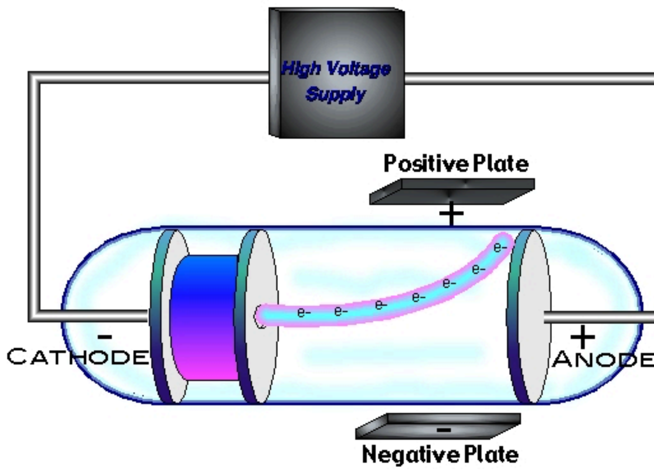
What are all things made of? The debate about the nature of matter!

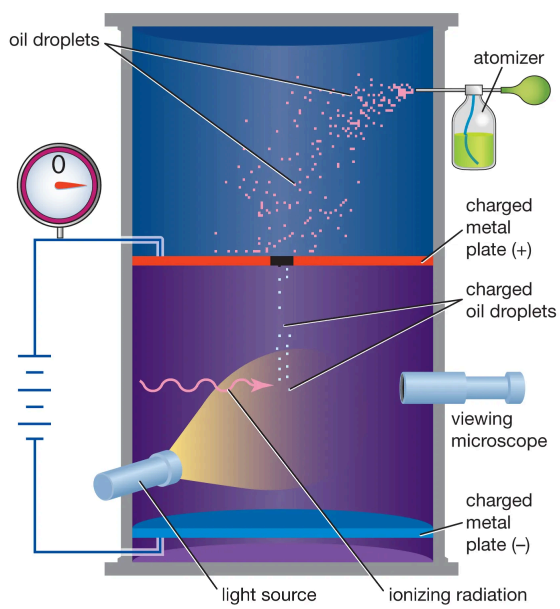
Aristotle	Democritus (**440 BC**)
→ Break things apart forever and keep their identity → All things were composed of 4 'elements' (**Earth, Air, Fire, Water**)	→ Keep breaking in half - eventually get to something that can't be broken down (***indivisible particle***) → **"THE ATOM"**
	**Democritus was a PHILOSOPHER, not a SCIENTIST.** **He used *reasoning*, not *experiments* to come up with his idea.** 

Dalton's Atomic Theory

1. Elements are made of tiny particles called **atoms**.
2. All atoms of a given element are identical.
3. The atoms of a given element are different from those of any other element.
4. Atoms of one element can combine with atoms of other elements to form compounds. A given compound always has the same relative numbers and types of atoms.
5. Atoms are indivisible in chemical processes. That is, atoms are not created or destroyed in chemical reactions. A chemical reaction simply changes the way the atoms are grouped together.







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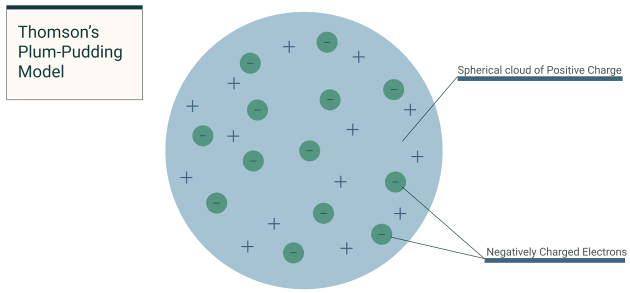
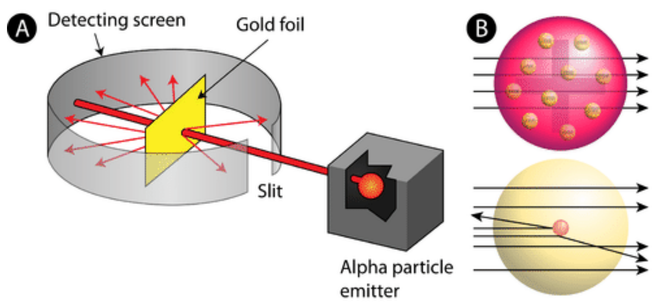
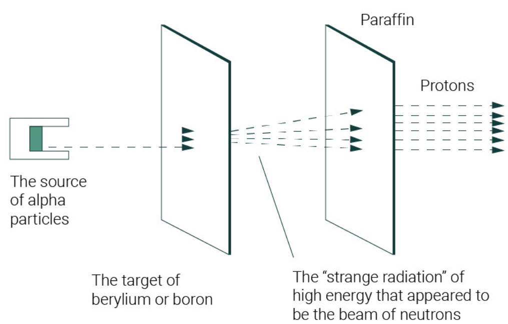
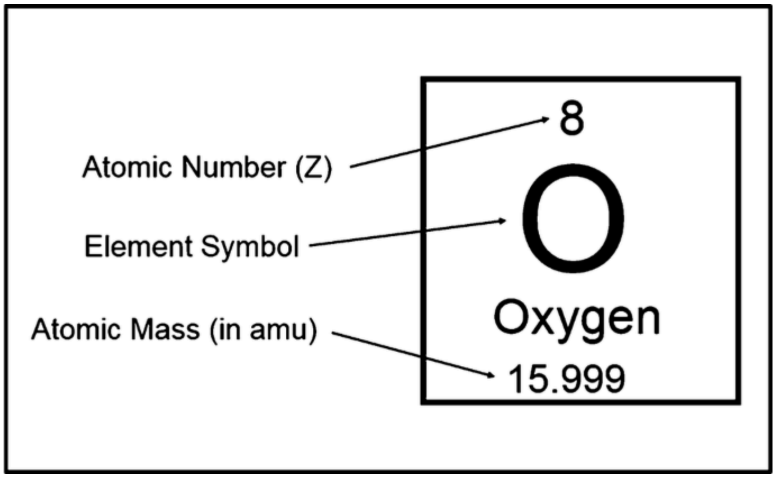




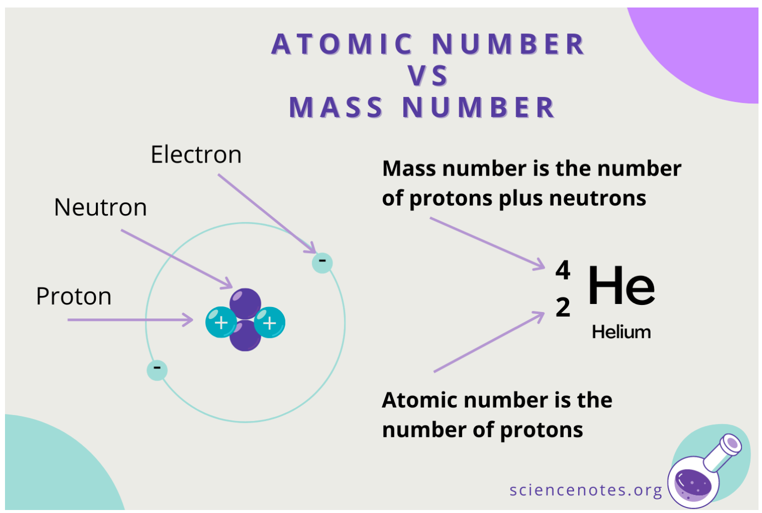


Subatomic Particle Properties

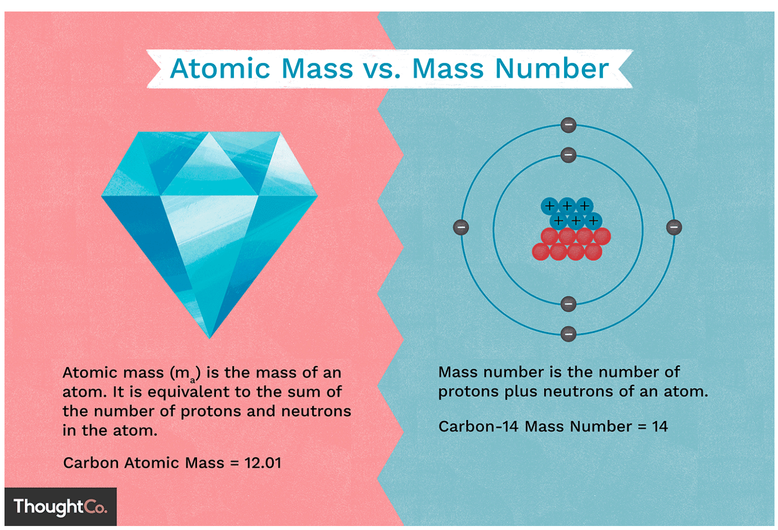
Particle	Symbol	Location	Charge	Relative Mass (amu)	Actual Mass (g)
electron	e^-	Electron cloud	–	1/1840 approx 0	9.11×10^{-28}
proton	p^+	nucleus	+	1	1.67×10^{-24}
neutron	n^0	nucleus	0	1	1.67×10^{-24}



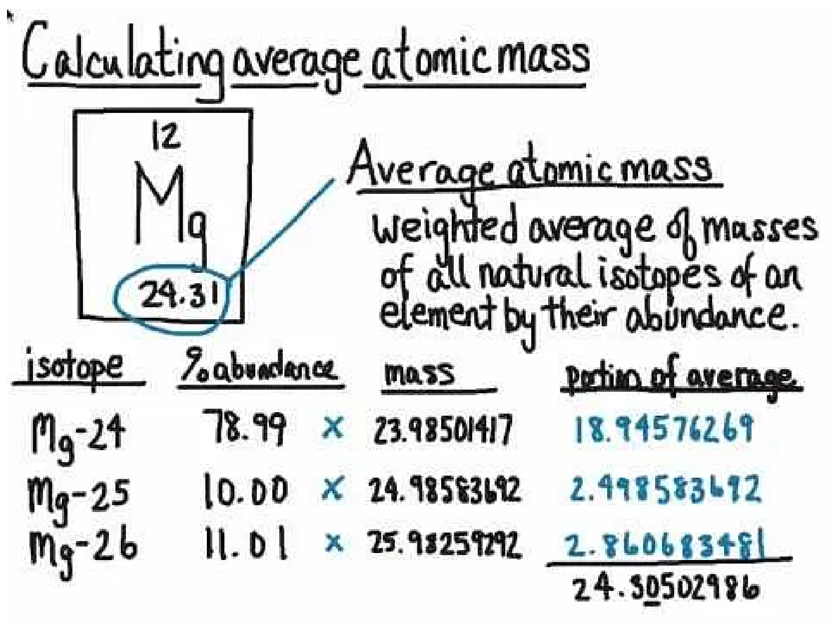
8
Atomic Number (Z)
O
Element Symbol
Oxygen
Atomic Mass (in amu)
15.999



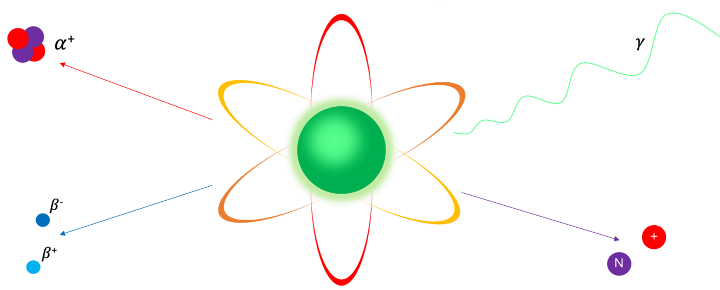
ATOMIC NUMBER
VS
MASS NUMBER
Electron
Neutron
Proton
Mass number is the number of protons plus neutrons
4
2
He
Helium
Atomic number is the number of protons
sciencenotes.org



Atomic Mass vs. Mass Number
Atomic mass (m_a) is the mass of an atom. It is equivalent to the sum of the number of protons and neutrons in the atom.
Carbon Atomic Mass = 12.01
Mass number is the number of protons plus neutrons of an atom.
Carbon-14 Mass Number = 14
ThoughtCo.

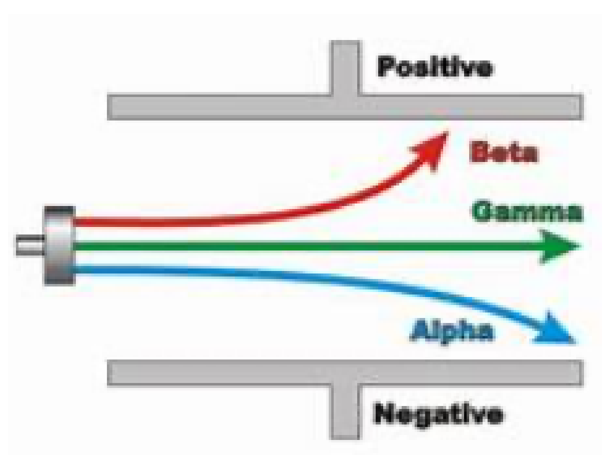


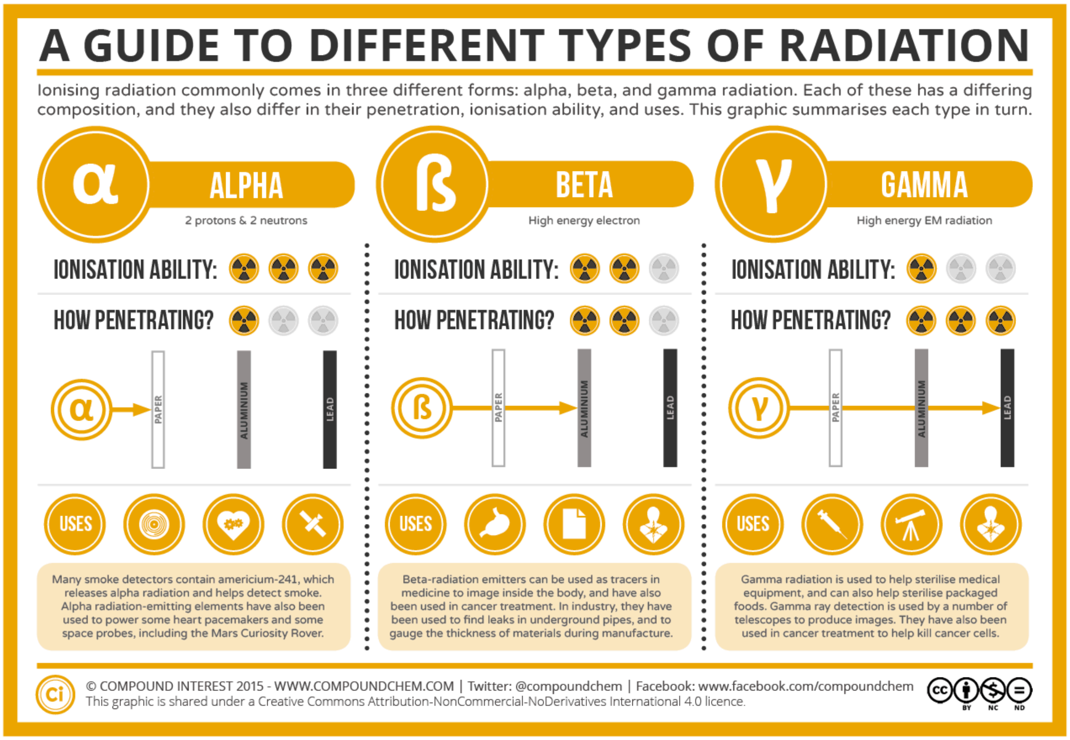
Radioactivity



Radiation is energy transmitted in the form of waves or particles. ***Light*** and ***Heat*** are forms of radiation.

Radioactive Decay is the ***spontaneous*** emission of this energy due to nuclear instability.




A GUIDE TO DIFFERENT TYPES OF RADIATION
Ionising radiation commonly comes in three different forms: alpha, beta, and gamma radiation. Each of these has a differing composition, and they also differ in their penetration, ionisation ability, and uses. This graphic summarises each type in turn.
α ALPHA
2 protons & 2 neutrons
IONISATION ABILITY:
HOW PENETRATING?
PAPER
ALUMINIUM
LEAD
USES
Many smoke detectors contain americium-241, which releases alpha radiation and helps detect smoke. Alpha radiation-emitting elements have also been used to power some heart pacemakers and some space probes, including the Mars Curiosity Rover.
ß BETA
High energy electron
IONISATION ABILITY:
HOW PENETRATING?
PAPER
ALUMINIUM
LEAD
USES
Beta-radiation emitters can be used as tracers in medicine to image inside the body, and have also been used in cancer treatment. In industry, they have been used to find leaks in underground pipes, and to gauge the thickness of materials during manufacture.
γ GAMMA
High energy EM radiation
IONISATION ABILITY:
HOW PENETRATING?
PAPER
ALUMINIUM
LEAD
USES
Gamma radiation is used to help sterilise medical equipment, and can also help sterilise packaged foods. Gamma ray detection is used by a number of telescopes to produce images. They have also been used in cancer treatment to help kill cancer cells.
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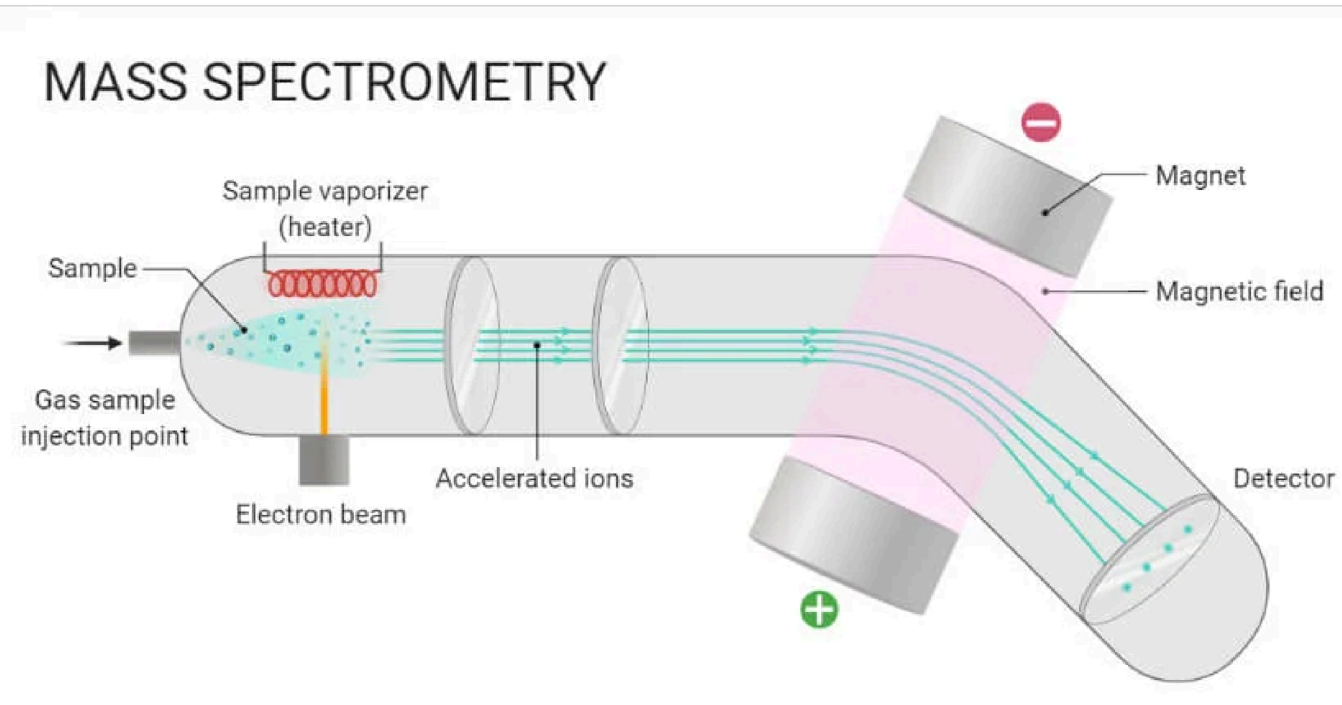
MASS SPECTROMETRY
Sample vaporizer
(heater)
Sample
Gas sample
injection point
Electron beam
Accelerated ions
Magnet
Magnetic field
Detector

Chemistry Chapter 5 Notes

Subatomic Particle Properties

Particle	Symbol	Location	Charge	Relative Mass (amu)	Actual Mass (g)
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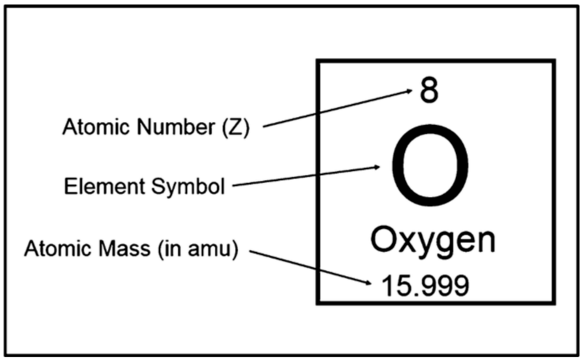
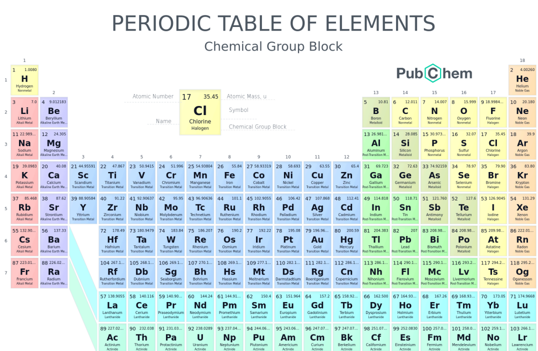




What do we still not know at this point? (early 1900s)

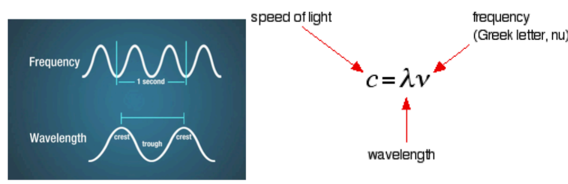
How are electrons arranged in space around the nucleus?

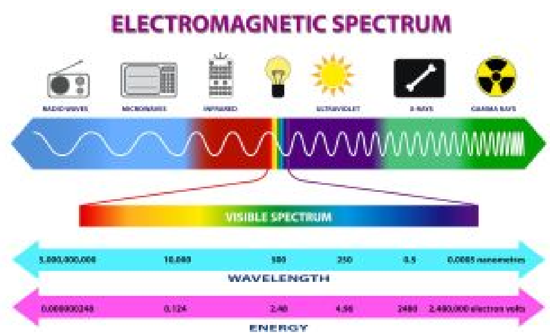
Why are negatively charged electrons not pulled in to positively charged nucleus?

Why do different elements have different chemical behaviors?

Scientists observed that elements emitted visible light when heated in a flame. Analysis revealed that chemical behavior is related to arrangement of electrons.

Let's take a side trail into the nature of light...





What does light as a wave not explain?

1. Why do heated objects emit only certain frequencies of light at a given temperature?

2. Why do some metals emit electrons when light of a specific frequency shines on them?

3. The photoelectric effect- electrons, called photoelectrons, are emitted from a metal's surface when light of a certain frequency shines on it.

Planck and Einstein- working together!

Planck concluded: matter can gain or lose energy only in small, specific amounts called **quanta**.

Einstein concluded that light has wave-like and particle-like properties. It's like a **beam of bundles of energy called photons** (which carry a quantum of energy.

Photon Energy

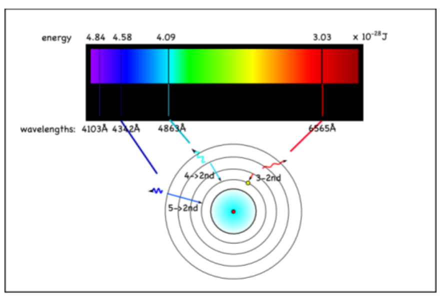
- The energy of a photon is given by this equation:

$$E = h\nu$$

- where $h = 6.6262 \times 10^{-34}$ J•s
  v = frequency (Hz)

Atomic emission spectrum- why discontinuous?

Niels Bohr- certain allowable energy states, and the lowest is **ground state**. When electrons are excited they are in **excited state**. Assigned **quantum numbers** to each orbit. Because only certain energies are possible, only certain frequencies are emitted.



Good and bad of Bohr's model

1. It explained hydrogen's spectral lines, but no other element's.

2. Did not fully account of chemical behavior of atoms.

3. We now believe that electrons do not move around nucleus in circular orbits.

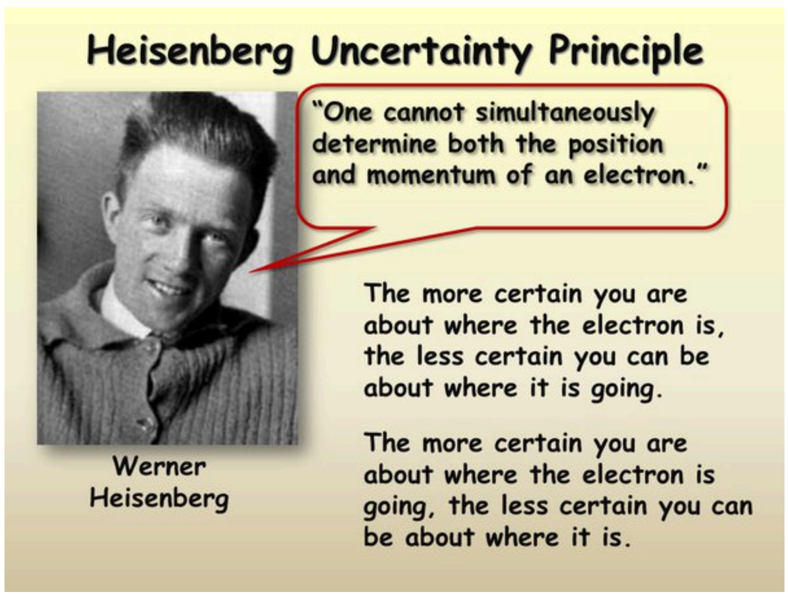
Enter de broglie

1. Quantized orbits had characteristics similar to waves.
2. Could electrons have both particle and wave like characteristics?

De Broglie's Equation

$$\lambda = \frac{h}{mv}$$

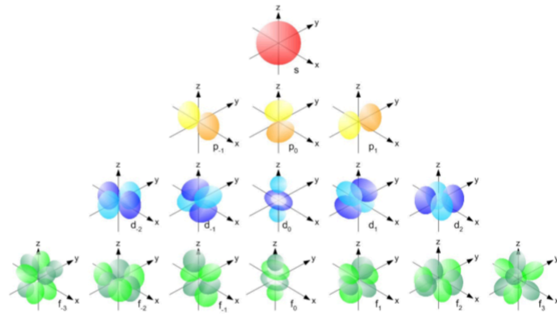
Where
λ = wavelength in meters
v = the velocity in meters/sec
m = the mass in kilograms
h = Plancks's constant in J/Hz



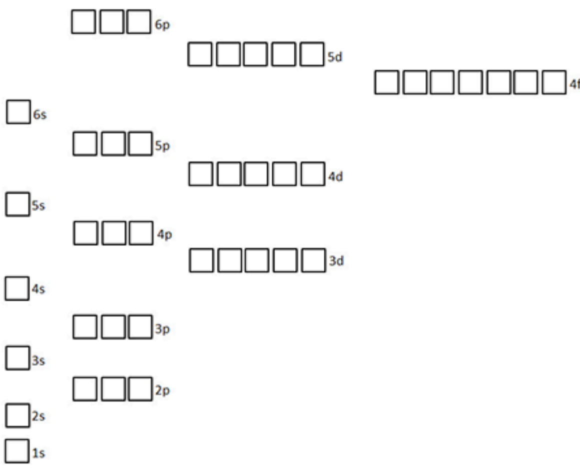
Schroedinger's quantum mechanical model of atom

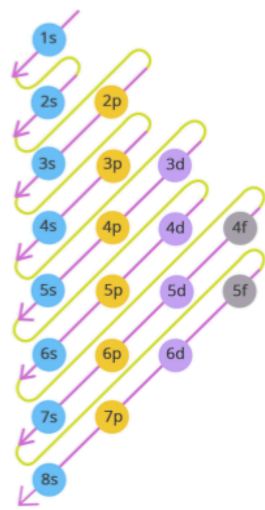
1. Electrons are treated as waves.
2. Limits electrons to certain energy values.
3. Does not try to describe the electron's path.
4. Establishes idea of atomic orbital which is the electron's probably location.
5. Works for all elements.
6. 4 principle quantum numbers or principal energy levels indicating relative size and energy of atomic orbitals with their own energy sublevels.

Shapes of orbitals



Electron configuration: arrangements of electrons in an atom

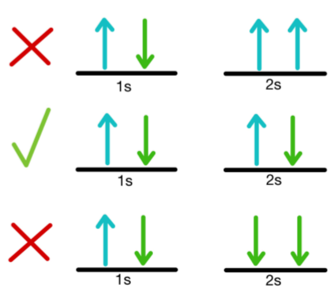




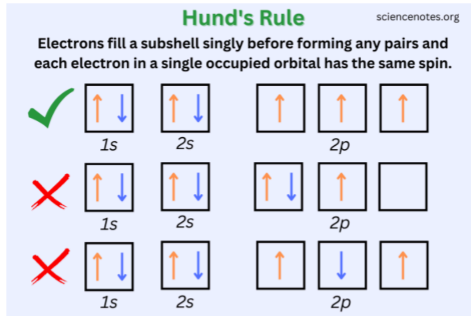
Aufbau principle: each electron occupies the lowest energy orbital available.

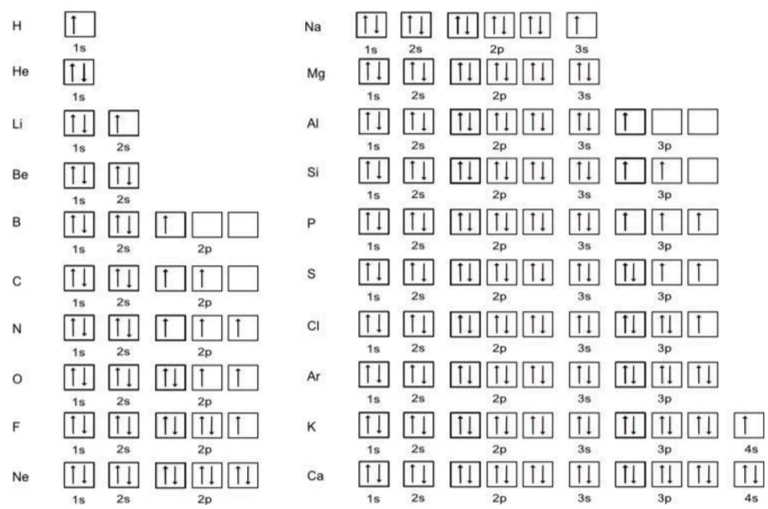
Electron configuration: arrangements of electrons in an atom

Pauli exclusion principle: a maximum of two electrons can occupy a single atomic orbital, but only if the electrons have opposite spins.

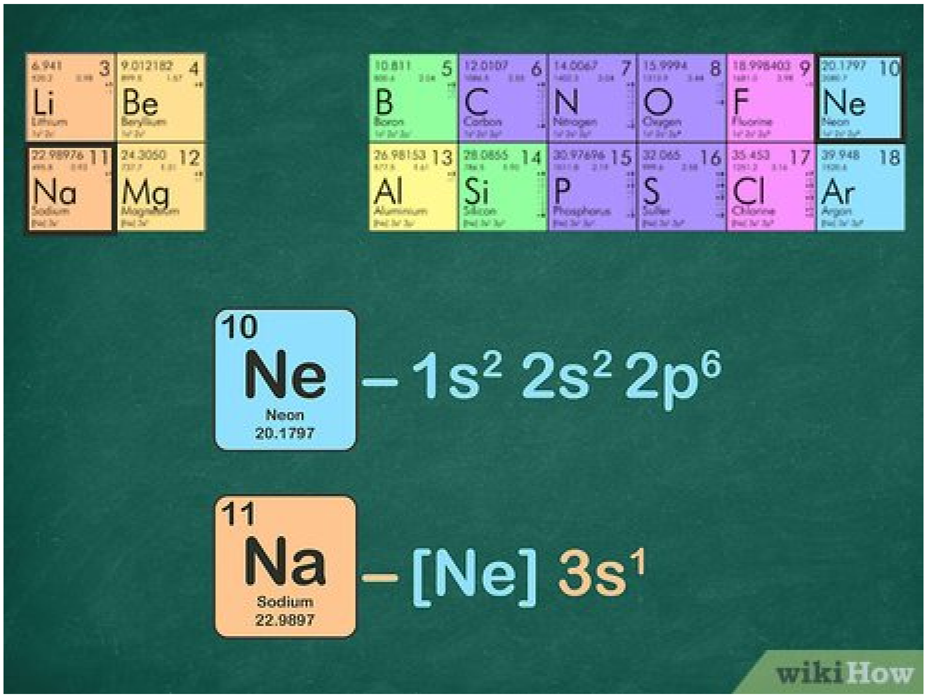


Electron configuration: arrangements of electrons in an atom





Element	Electron Configuration	Element	Electron Configuration
H	$1s^1$	Na	$1s^2 2s^2 2p^6 3s^1$
He	$1s^2$	Mg	$1s^2 2s^2 2p^6 3s^2$
Li	$1s^2 2s^1$	Al	$1s^2 2s^2 2p^6 3s^2 3p^1$
Be	$1s^2 2s^2$	Si	$1s^2 2s^2 2p^6 3s^2 3p^2$
B	$1s^2 2s^2 2p^1$	P	$1s^2 2s^2 2p^6 3s^2 3p^3$
C	$1s^2 2s^2 2p^2$	S	$1s^2 2s^2 2p^6 3s^2 3p^4$
N	$1s^2 2s^2 2p^3$	Cl	$1s^2 2s^2 2p^6 3s^2 3p^5$
O	$1s^2 2s^2 2p^4$	Ar	$1s^2 2s^2 2p^6 3s^2 3p^6$
F	$1s^2 2s^2 2p^5$	K	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
Ne	$1s^2 2s^2 2p^6$	Ca	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$



Atoms	Electronic Configuration	Lewis Symbol
sodium	$[Ne]3s^1$	Na•
magnesium	$[Ne]3s^2$	•Mg•
aluminum	$[Ne]3s^2 3p^1$	•Al• (3 dots)
silicon	$[Ne]3s^2 3p^2$	•Si• (4 dots)
phosphorus	$[Ne]3s^2 3p^3$	:P• (5 dots)
sulfur	$[Ne]3s^2 3p^4$	:S• (6 dots)
chlorine	$[Ne]3s^2 3p^5$	:Cl• (7 dots)
argon	$[Ne]3s^2 3p^6$	:Ar: (8 dots)

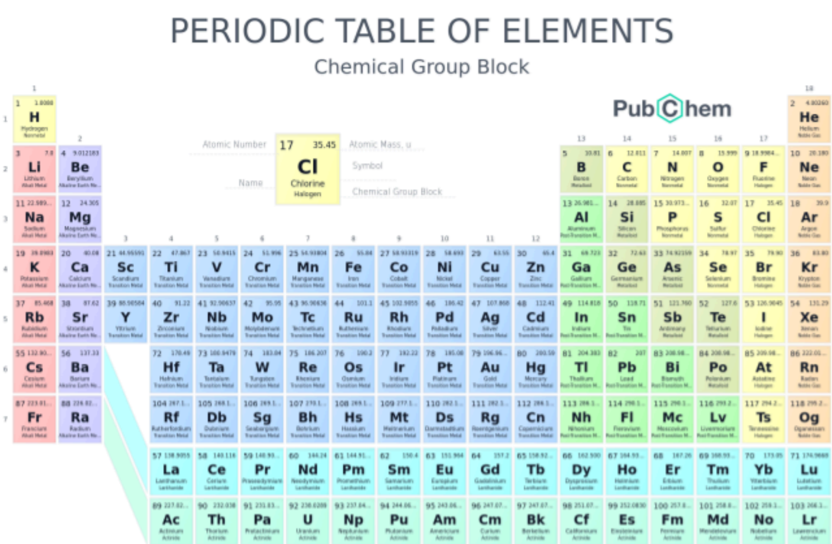
Valence Electrons- electrons in the atom's outermost orbitals

Chemistry Chapter 6 Notes

Development of Periodic Table

Periodic Law- that there is a periodic repetition of chemical and physical properties of the elements when they are arranged in increasing atomic mass

People	Contribution to Periodic Table
Lavoisier	Classified 33 elements in 4 categories: gases, metals, nonmetals, earth
Newlands	Arranged elements by increasing atomic mass, noticed repetition every 8th element
Meyer	Arranged elements by increasing atomic mass, noticed connection between atomic mass and properties
Mendeleev	Arranged elements by increasing atomic mass, noticed connection between atomic mass and properties, and predicted existence and properties of undiscovered elements
Moseley	Discovered atoms contain unique number of protons (atomic number), and arranged elements in order of increasing atomic number rather than mass



Red- **alkali metals**

Purple- **alkaline earth metals**

Light blue- **lanthanide series** (part of inner transition metals)

Sea Green- **actinide series** (part of inner transition metals)

Blue- **transition metals**

Brown Green- **metalloids**

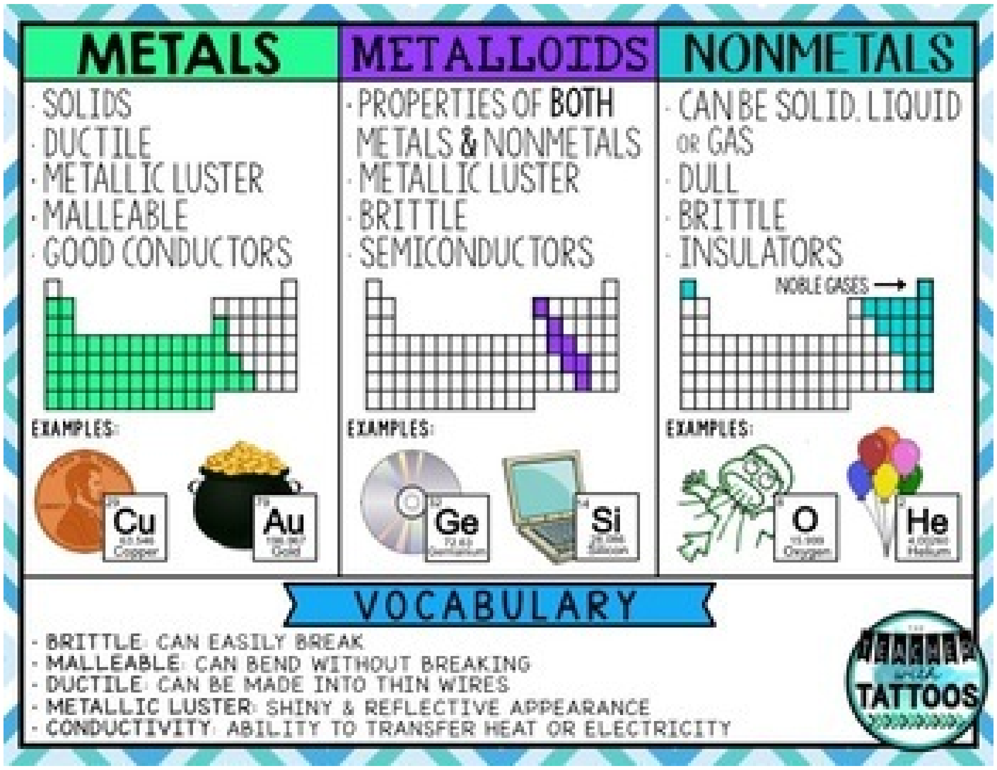
Group 17- **halogens**

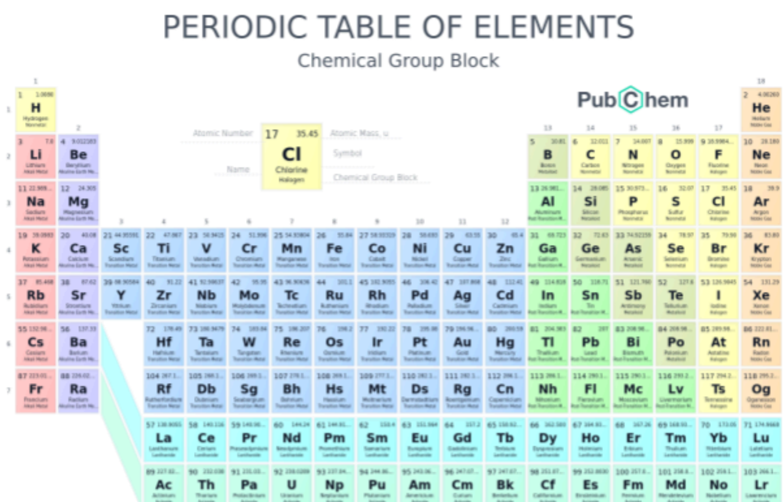
Orange- **noble gases**

Yellow- **nonmetals**

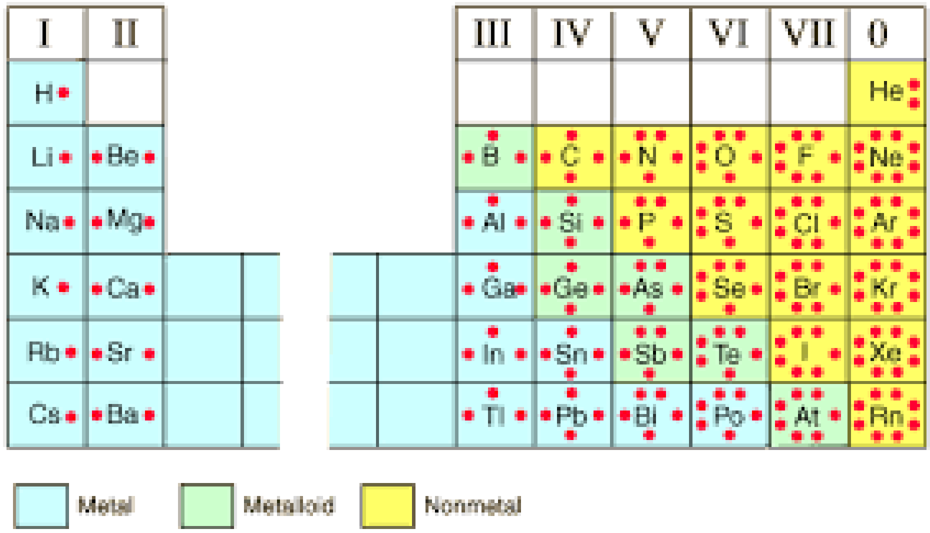
Representative elements- elements in groups 1, 2, 13-18

Transition elements- elements in groups 3-12

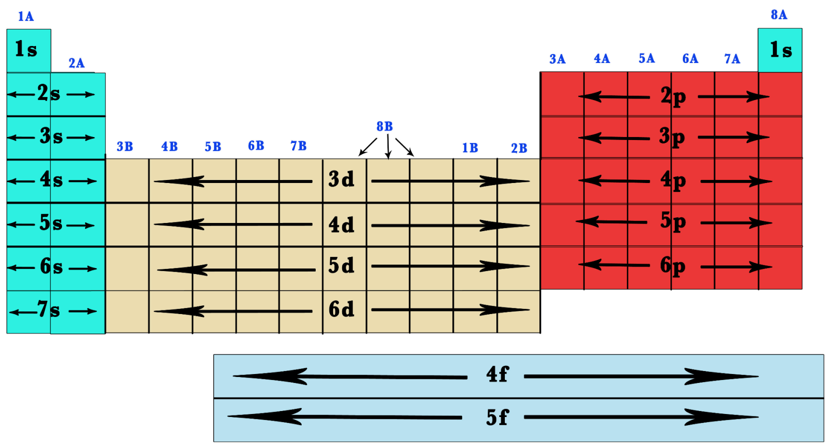


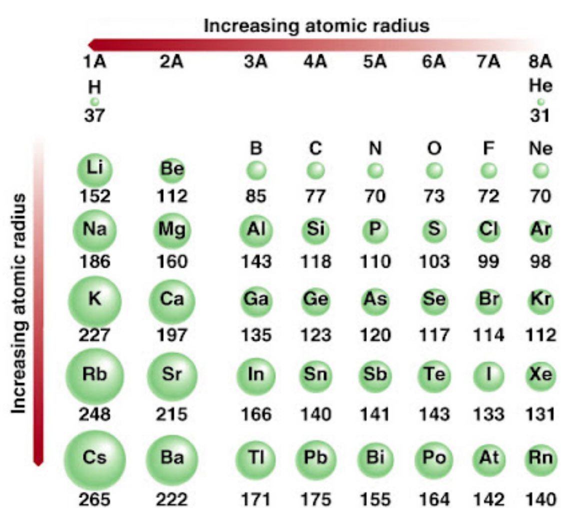


Atoms in the same group have similar chemical properties because they have the same number of valence electrons. The energy level of an element's valence electrons indicates the period on the periodic table in which it is found.



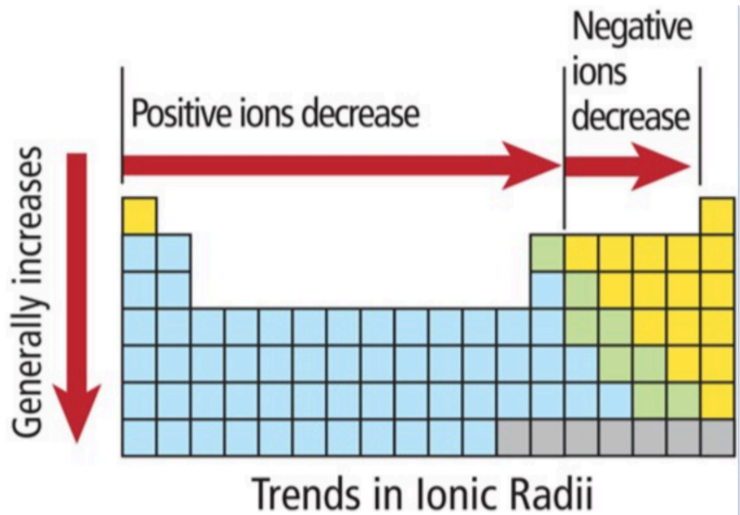
s,p,d,f blocks in the periodic table.



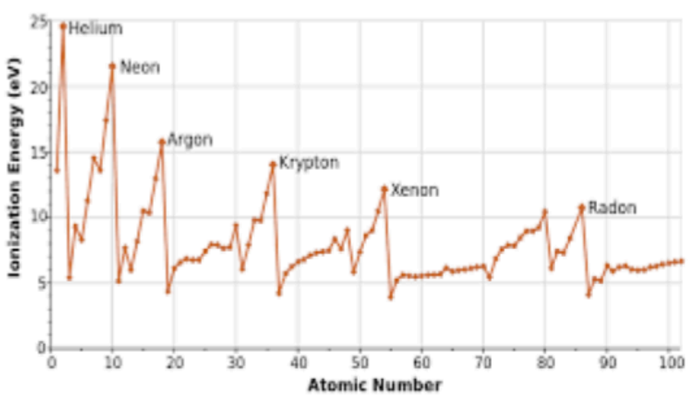


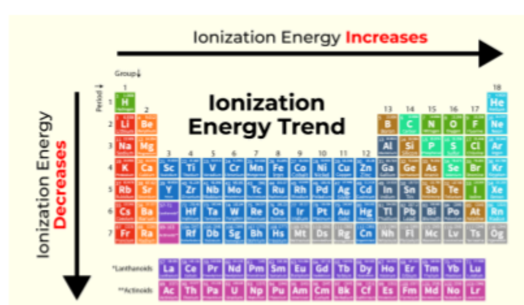
Ionic radius trend- we will revisit this in a later unit!

An ion is an atom or a bonded group of atoms that has a positive or negative charge



Ionization energy- the energy required to remove an electron from a gaseous atom. How strongly an atom's nucleus holds onto its valence electrons.

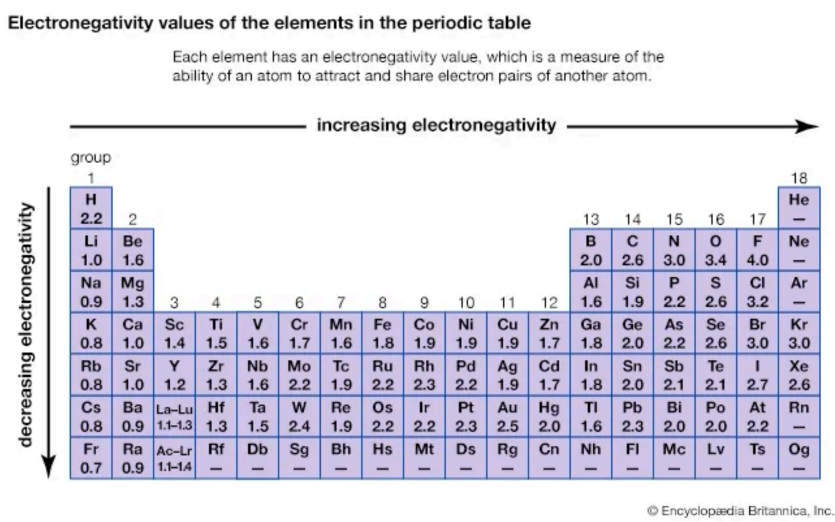




Octet Rule

Atoms tend to gain, lose, or share electrons in order to acquire a full set of 8 valence electrons.

Elements on left tend to lose electrons and form positive ions. Elements on right tend to gain electrons and form negative ions.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	H 2.2																	He —
2	Li 1.0	Be 1.6											B 2.0	C 2.6	N 3.0	O 3.4	F 4.0	Ne —
3	Na 0.9	Mg 1.3											Al 1.6	Si 1.9	P 2.2	S 2.6	Cl 3.2	Ar —
4	K 0.8	Ca 1.0	Sc 1.4	Ti 1.5	V 1.6	Cr 1.7	Mn 1.6	Fe 1.8	Co 1.9	Ni 1.9	Cu 1.9	Zn 1.7	Ga 1.8	Ge 2.0	As 2.2	Se 2.6	Br 3.0	Kr 3.0
5	Rb 0.8	Sr 1.0	Y 1.2	Zr 1.3	Nb 1.6	Mo 2.2	Tc 1.9	Ru 2.2	Rh 2.3	Pd 2.2	Ag 1.9	Cd 1.7	In 1.8	Sn 2.0	Sb 2.1	Te 2.1	I 2.7	Xe 2.6
6	Cs 0.8	Ba 0.9	La–Lu 1.1–1.3	Hf 1.3	Ta 1.5	W 2.4	Re 1.9	Os 2.2	Ir 2.2	Pt 2.3	Au 2.5	Hg 2.0	Tl 1.6	Pb 2.3	Bi 2.0	Po 2.0	At 2.2	Rn —
7	Fr 0.7	Ra 0.9	Ac–Lr 1.1–1.4	Rf —	Db —	Sg —	Bh —	Hs —	Mt —	Ds —	Rg —	Cn —	Nh —	Fl —	Mc —	Lv —	Ts —	Og —

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