Electron Configuration Battleship

The Importance of Electrons

- In an electron configuration: ($1s^2 2s^2 2p^6 3s^2 3p^6$...)

  coefficient --> # of the energy level

  superscript --> # of electrons in those orbitals

- In general, as energy level increases, electrons:

  A. Have more energy

  B. Are further away from the nucleus

5. We categorize electrons into 2 groups

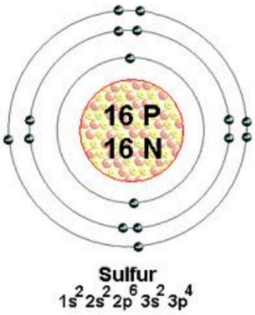
A. <u>Core Electrons</u>

a. These are electrons that are not part of the outer most energy level.

b. These electrons are close to the nucleus.

c. These are not involved in chemical bonds.

Ex:



Sulfur has 10 Core Electrons

$1s^2 2s^2 2p^6 3s^2 3p^4$

10

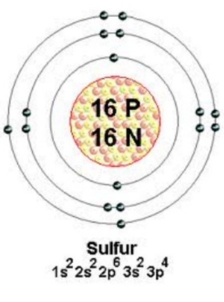
B. <u>Valence Electrons</u>

1. The outer most electrons: in the highest energy level.

2. Are involved in chemical bonding

3. The sum of the s and p orbitals in the outer energy level.

Ex:



Sulfur has 6 valence electrons

$1s^2 2s^2 2p^6 3s^2 3p^4$

10 6

Examples: Determine how many kernel and valence electrons each element has when it is neutral.

	Core Electrons	**Valence Electrons**
Aluminum		
Flourine		
Phosphorus		
Nickel		
Silver		

The Octet Rule

1. Atoms want to have a full outer energy level.

2. If they do not, they are highly unstable.

3. With the s and p orbitals being the outermost energy levels of an atoms electron configuration, atoms want to fill those two which for most elements that would mean 8 electrons. (s=2, p=6)

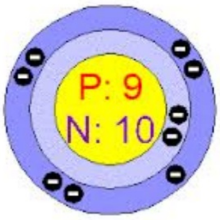
4. The octet rule states atoms have the tendency to "want" 8 valence electrons.

   a. They want to be like their closest noble gas

   b. Exceptions to this rule include H, He, Li, Be, B (their closest noble gas is He and He only has two valence electrons)

5. Noble gases atoms have full valence shells. This makes them stable, low-energy, and unreactive.

Examples of the octet rule:
*Remember: other atoms "want" to be like noble gas atoms. They can either give away or acquire electrons.



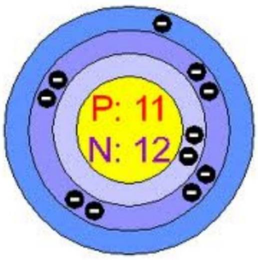
Fluorine atom, F
9 p^+ and 9 e^-

Lose 7 e^- or steal 1 e^-?

9 p^+ and 10 e^- --> F^{1-}

F atom would rather be F^{1-} ion.

Examples of the octet rule:
*Remember: other atoms "want" to be like noble gas atoms. They can either give away or acquire electrons.



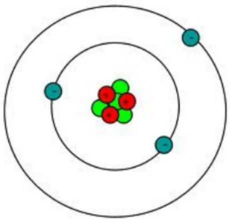
Sodium atom, Na
11 p^+ and 11 e^-

Lose 1 e^- or steal 7 e^-?

11 p^+ and 10 e^- --> Na^{1+}

Na atom would rather be Na^{1+} ion.

Examples of the octet rule:
*Remember: other atoms "want" to be like noble gas atoms. They can either give away or acquire electrons.



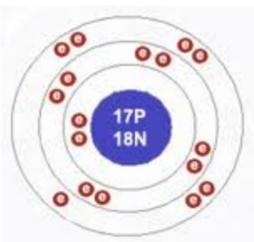
Lithium atom, Li
3 p^+ and 3 e^-

Lose 1 e^- or steal 7 e^-?

3 p^+ and 2 e^- --> Li^{1+}

Li atom would rather be Li^{1+} ion.

Examples of the octet rule:
*Remember: other atoms "want" to be like noble gas atoms. They can either give away or acquire electrons.



Chlorine atom, Cl
17 p^+ and 17 e^-

Lose 7 e^- or steal 1 e^-?

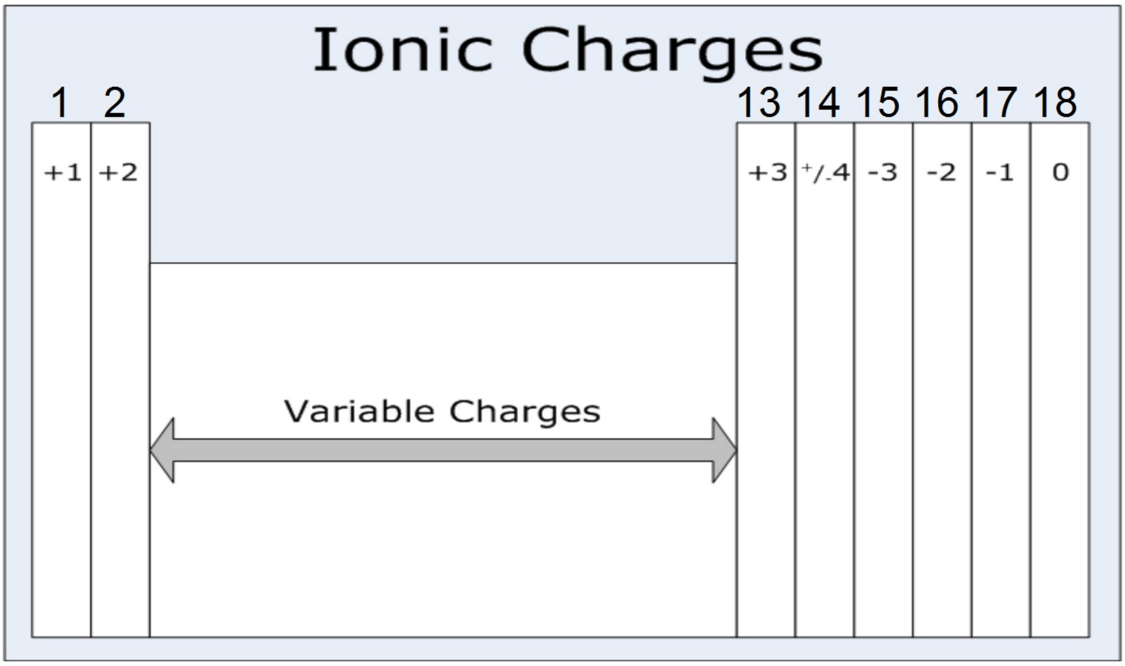
17 p^+ and 18 e^- --> Cl^{1-}

Cl atom would rather be Cl^{1-} ion.

Formal Charges of ions in the columns of the Periodic Table

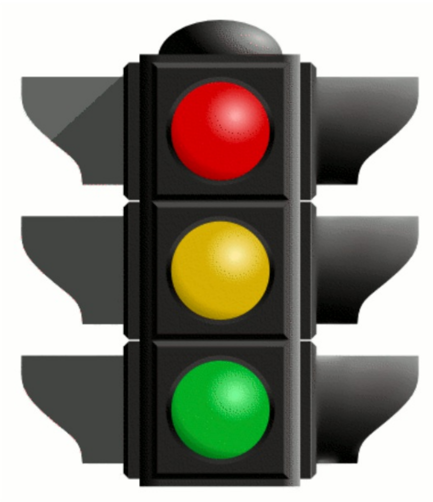
Group 1: 1+
Group 2: 2+
Group 3: 3+

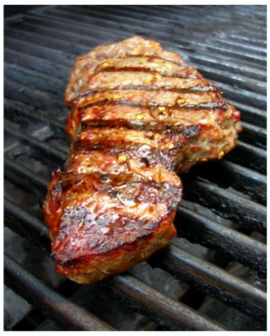
Group 15: 3-
Group 16: 2-
Group 17: 1-
Group 18: 0



Flame Test Lab

Light





Question: Why does hamburger have lower energy than steak?

Answer: Because it's in the ground state.

The Connection between Electrons and Light

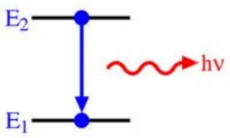
1. When all electrons are in lowest possible energy state, an atom is in the ground state.

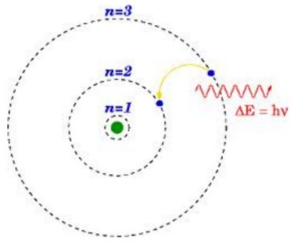
   Ex: He --> $1s^2$

2. If the right amount of energy is absorbed by an electron, it can "jump" to a higher energy level. This is an unstable, momentary condition called the excited state.

   Ex: He --> $1s^1 2s^1$

3. When the electron falls back to a lower-energy, more stable orbital (it might be the orbital it started out in, but it might not), atom releases the "right" amount of energy as light.



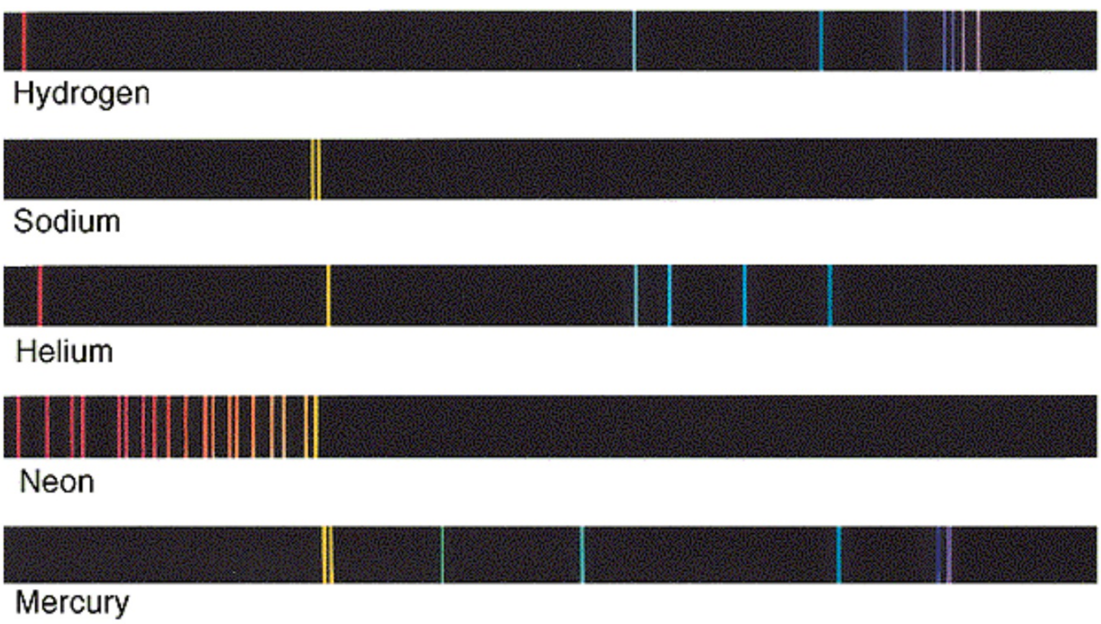


A. When light energy is released from different substances, it has been found that the colors emitted are unique to the substance.

B. <u>Emission spectrum</u> - the spectrum of bright lines, bands, or continuous radiation produced by a specific substance.

C. This information made people question what light was made up of.

D. Two ideas arose, light was a wave and light was a particle.



So, why bands and not a continous color for neon?

Light as a Wave

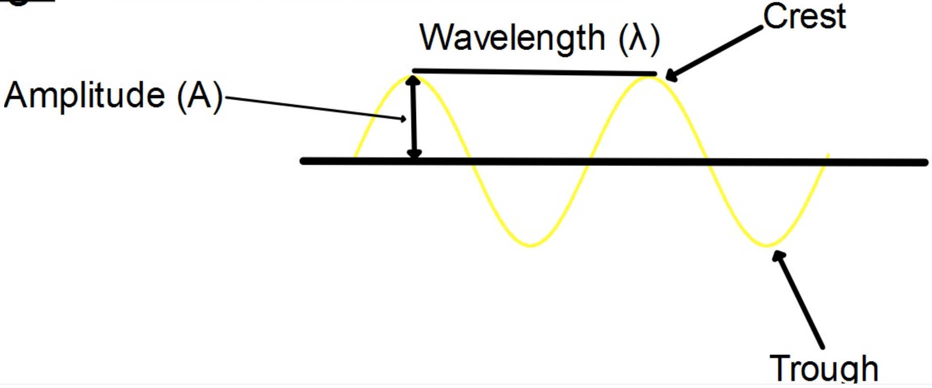
- Wave - a transfer of energy where no permanent displacement occurs to the medium (air, water, etc...).

- Wavelength (λ) - length of one complete wave

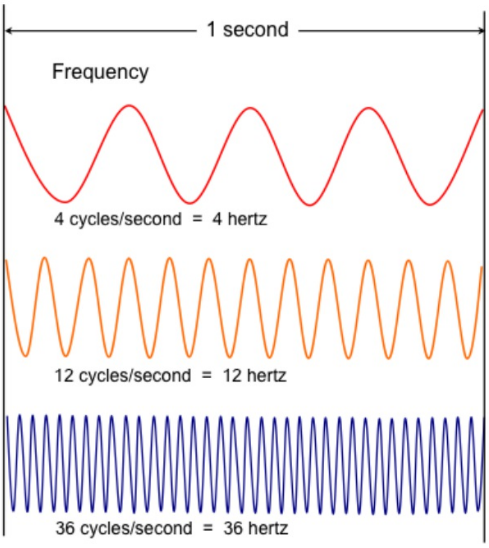
- Amplitude (A) - distance from the origin to the trough or crest

- Crest - Highest Point of the Wave

- Trough - Lowest Point of the Wave



- Frequency (f) - # of waves that pass a point during a certain time period
  - hertz (Hz) = 1/s



Formula connecting f and λ

$c = f \lambda$

c = speed of light 3×10^8 m/s

f = frequency - Hz

λ = wavelength - m

The energy of light is closely related to its color. High energy light appears purple, low energy light appears red, and intermediate energies of light have intermediate colors such as blue, green, yellow, and orange.

Energy and Light

1. The amount of energy from photons is directly related to its frequency.

$$E = h f$$

E = energy (Joules or J)

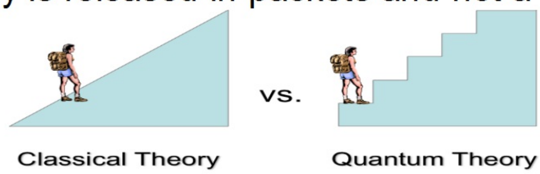
h = Planck's constant (6.6×10^{-34} J/s)

f = frequency (1/s)

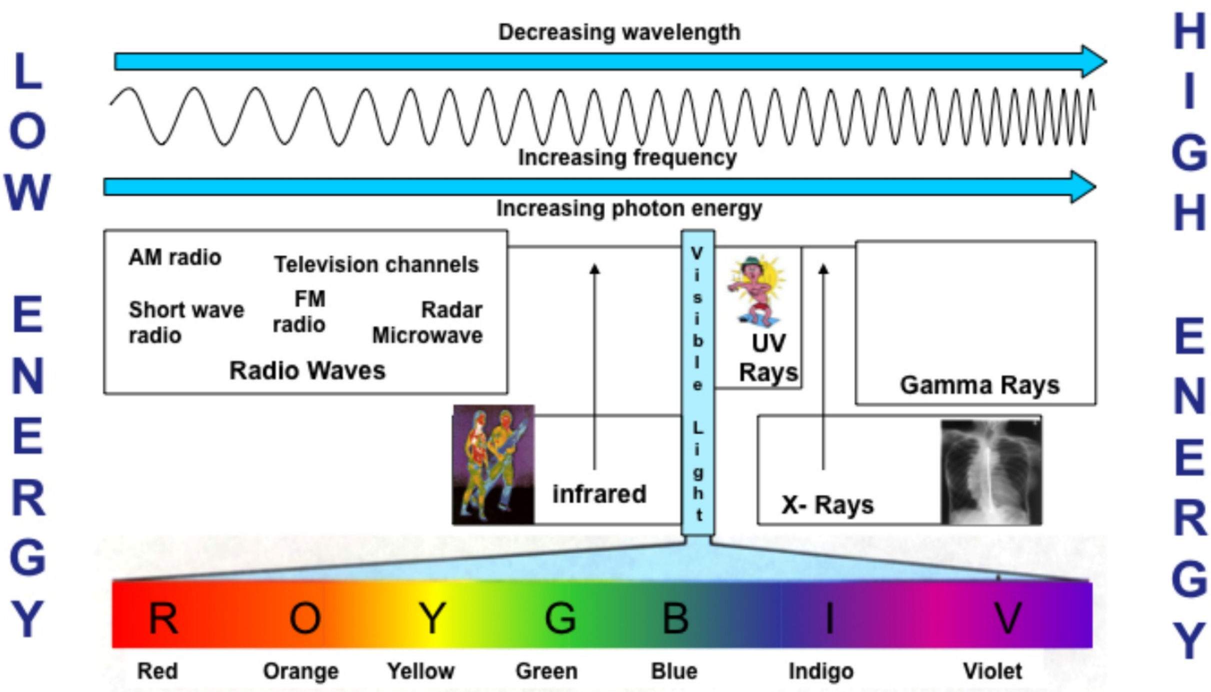
2. Therefore, the higher the frequency, the higher the energy.
   The lower the frequency, the lower the energy.

3. Thus, the shorter the wavelength, the higher the energy.
   Thus, the longer the wavelength, the lower the energy.

4. Max Planck: found that energy is released in packets and not a smooth increase in energy.

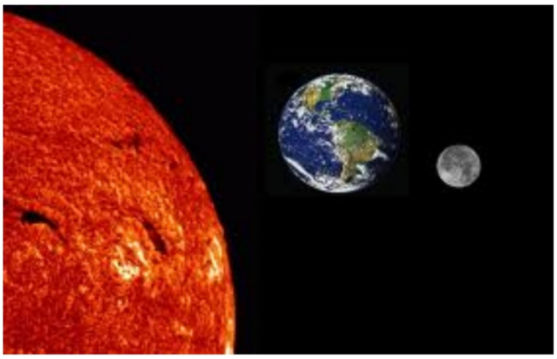


The Electromagnetic Spectrum



But, how do waves transfer energy when there is no medium?

Ex: How does light get from the Sun to Earth? Is there air?



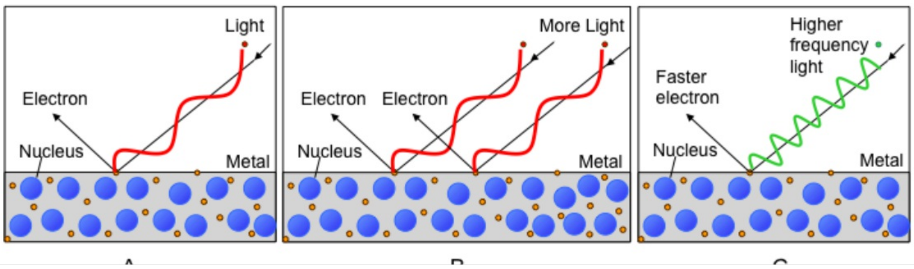
Light as a Particle --> The Photoelectric Effect

1. Albert Einstein conducted his experiment where he shot different frequencies of light at metal.

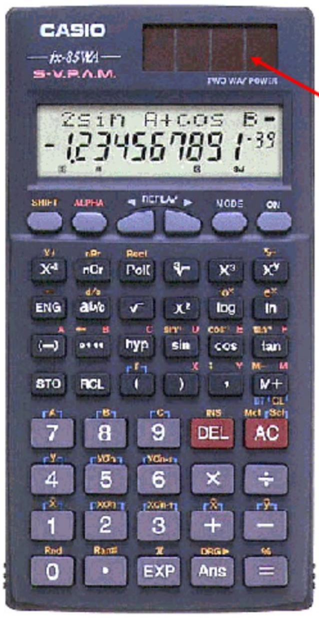
2. He found that when you have a large enough frequency, the metal would emit electrons from its surface.

3. When he increased the amount of light at that frequency, it only increased the number of electrons emmitted.

4. When he increased the frequency of the light, the electrons that were emitted from the surface moved faster.



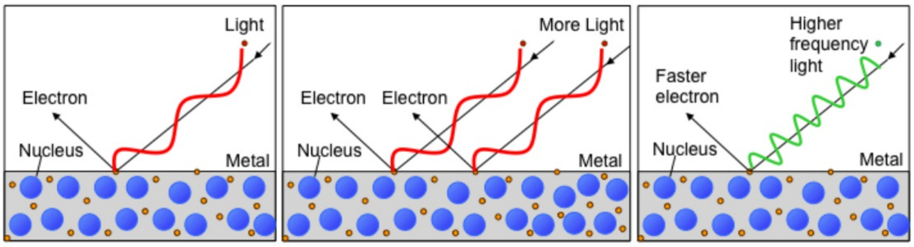
Solar Calculator



Solar Panel

If light only had wave properties,
*The wave of light would just be transfered through the solar cell
*Electricity could not be produced.

But,
*Electrons are emitted from metals with high enough frequencies.
*The electrons can be captured and put into an electrical circuit
*A voltage difference can be produced allowing a solar calculator to work.



A
When light strikes a metal surface, electrons are ejected.

B
If the threshold frequency has been reached, increasing the intensity only increases the number of electrons ejected.

C
If the frequency is increased, the Ejected electrons will travel faster.

So, if E=hf, and if f increases, then E increases

Einstein therefore came up with:

$E=mc^2$ which shows that if the energy is increasing, the mass must increase.

Einstein claimed that anything with a mass has energy.
The famous $KE=1/2mv^2$ is only kinetic energy and not all energy.

Quantum Theory

- **Einstein** (1905)
  - Concluded - light has properties of both waves and particles

"wave-particle duality"

  - Photon - particle of light that carries a quantum of energy

Therefore, $E = hf = mc^2$

Examples:

A certain photon has a wavelength of 422 nm. What is the frequency of the light?

[redacted]

What is the energy of the light from the previous problem?

[redacted]

What is the energy of a quantum of light with a frequency of 7.39×10^{14} Hz?

What is the wavelength of the light?

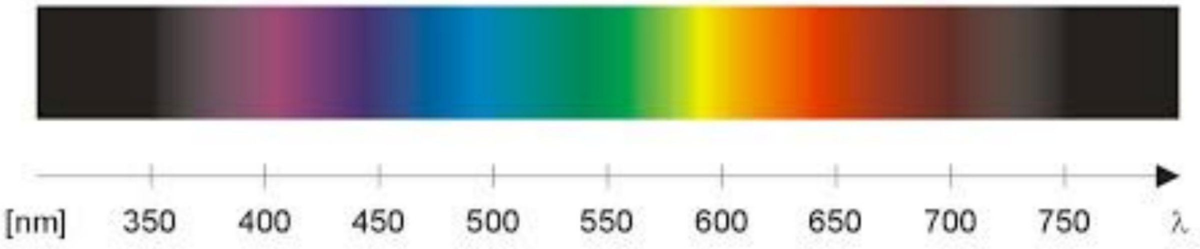
A certain red light has a wavelength of 680 nm. What is the frequency of the light?

What is the energy of the light?

A certain blue light has a frequency of 6.91×10^{14} Hz. What is the wavelength of the light?

What is the energy of a quantum of light from question 5?

The energy for a certain light is 2.84×10^{-19} J. What is the wavelength and color of this light?


[nm]
350
400
450
500
550
600
650
700
750
λ