A Brief History of Atomic Structure
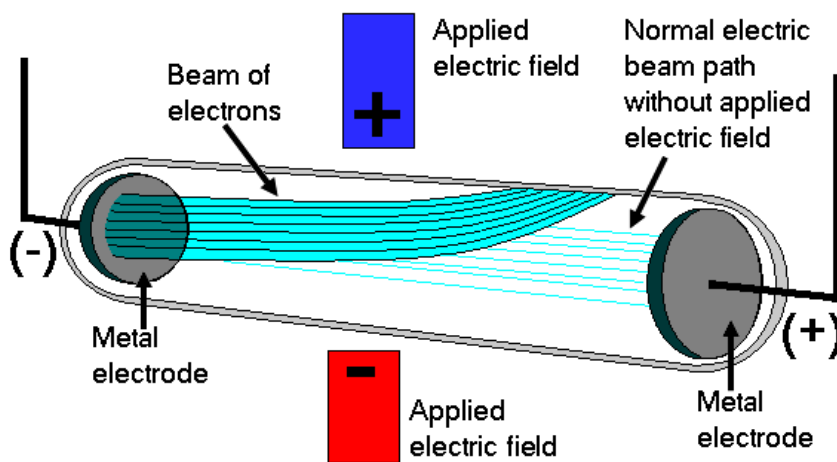
Democritus
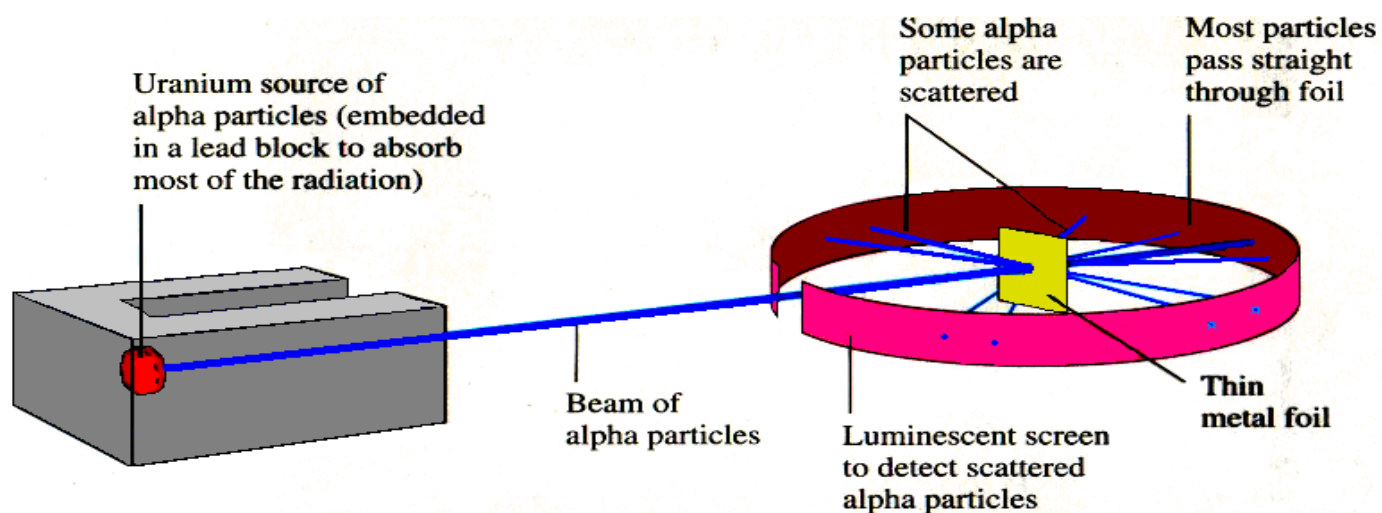
John Dalton
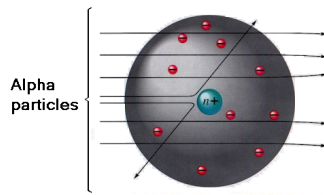
1)

2)

3)

4)

William Crookes

J. J. Thomson

Henri Becquerel

There are three major types of nuclear radiation:

Type	Symbol	Mass	Charge	Barrier
Alpha				
Beta				
Gamms				

Ernest Rutherford

Uranium source of alpha particles (embedded in a lead block to absorb most of the radiation)

Beam of alpha particles

Some alpha particles are scattered

Most particles pass straight through foil

Thin metal foil

Luminescent screen to detect scattered alpha particles

How did he explain this?

Robert Andrews Millikan
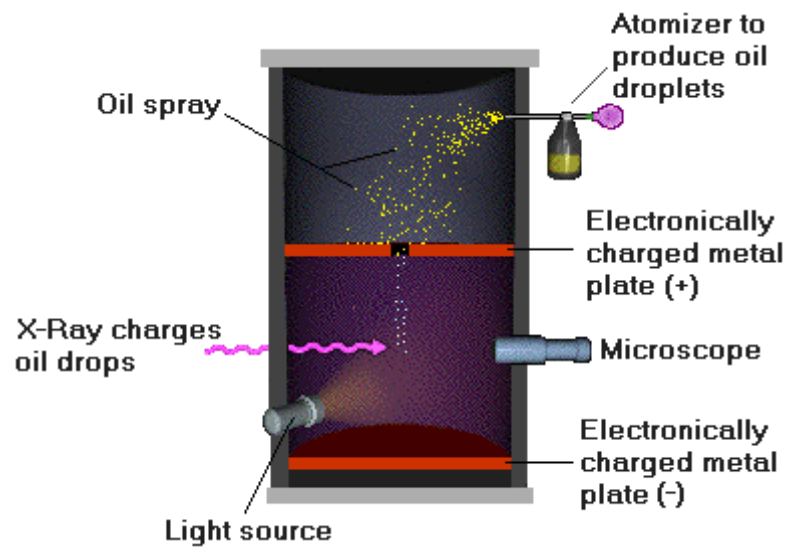
James Chadwick

Ions & Isotopes

What happens to an atom if it gains or loses…

an electron?

a neutron?

a proton?

Atomic number

Atomic mass

Mass number

Species	atomic #	mass #	protons	neutrons	electrons
C					
Mg^{2+}					
Br^-					

Protium(we call it Hydrogen), Deuterium, and Tritium

Species	atomic #	mass #	protons	neutrons	electrons
H					
$^2H(D)$					
$^3H(T)$					

Why do the atomic masses on the periodic table have all those decimals?

This is how we can determine the mass of an element and its isotopes.
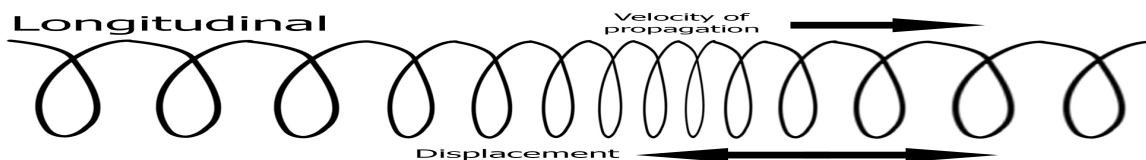
Mass Spectrometer
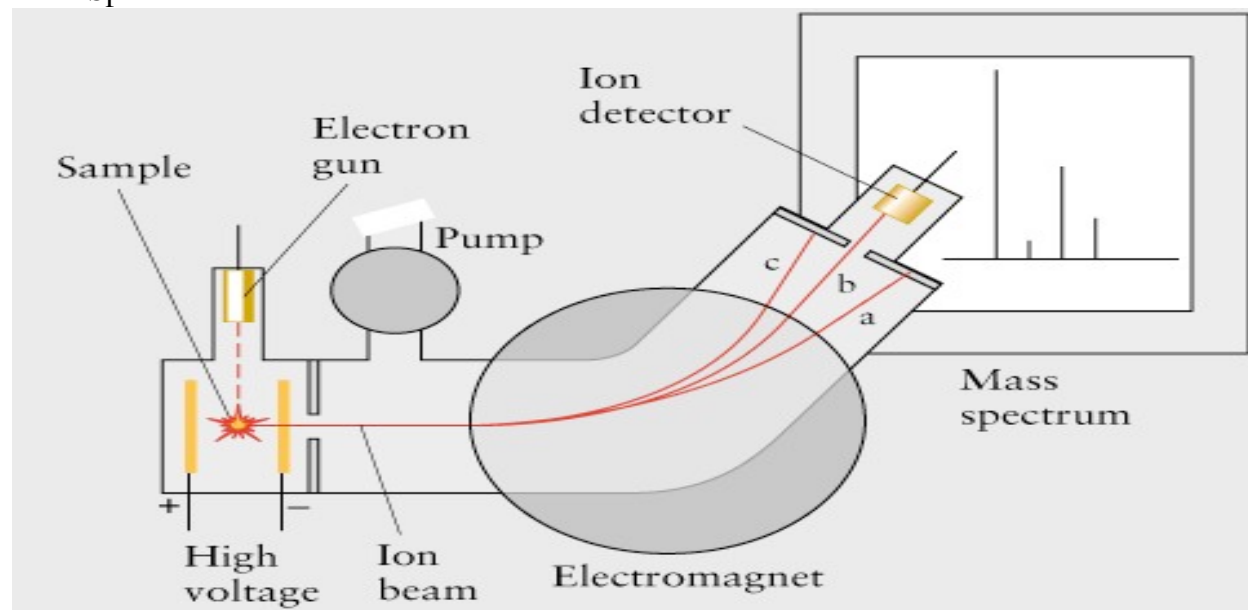
This can give us a print out that looks like:

Bromine
^{81}Br exists and is 45% of naturally occurring bromine. ^{79}Br exists and is 55% of naturally occurring bromine.
Find the average atomic mass for bromine.

Now a question for you to think about tonight. How does an atom stay together? How does an atom keep it's protons from repelling each other (they have the same charge) and it's electrons from flying into the nucleus (opposite charge of the protons). Shouldn't everything we have just taught you be wrong

Waves

Longitudinal

Velocity of propagation

Displacement

Transverse

The wave is moving in this direction

Crests

Wavelength

Amplitude

Troughs

One Complete Cycle
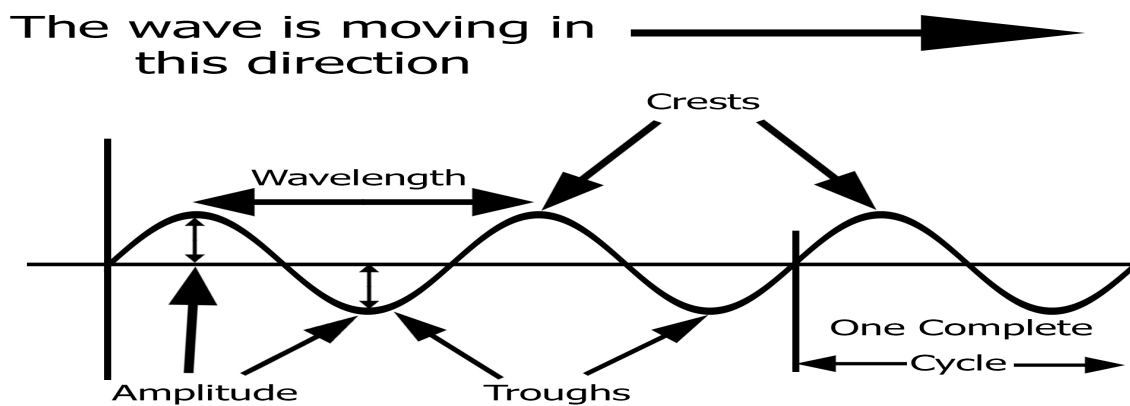
Wave Properties

Name	Symbol	Unit	Definition
Wavelength			
Frequency			
Period			
Amplitude			
Wave Number			

The Speed of Light is given the symbol c.

$c = 3.00 \times 10^8$ m/sec $= 3.00 \times 10^{10}$ cm/sec $= 186{,}282$ miles/sec $= 299{,}792.458$ km/sec

Wavelength
(in Metres)

Radio	Microwave	Infrared	Visible	Ultraviolet	X-ray	Gamma Ray
10^3	10^{-2}	10^{-5}	10^{-6}	10^{-8}	10^{-10}	10^{-12}

Frequency
(in Hertz)

10^4	10^8	10^{12}	10^{15}	10^{16}	10^{18}	10^{20}
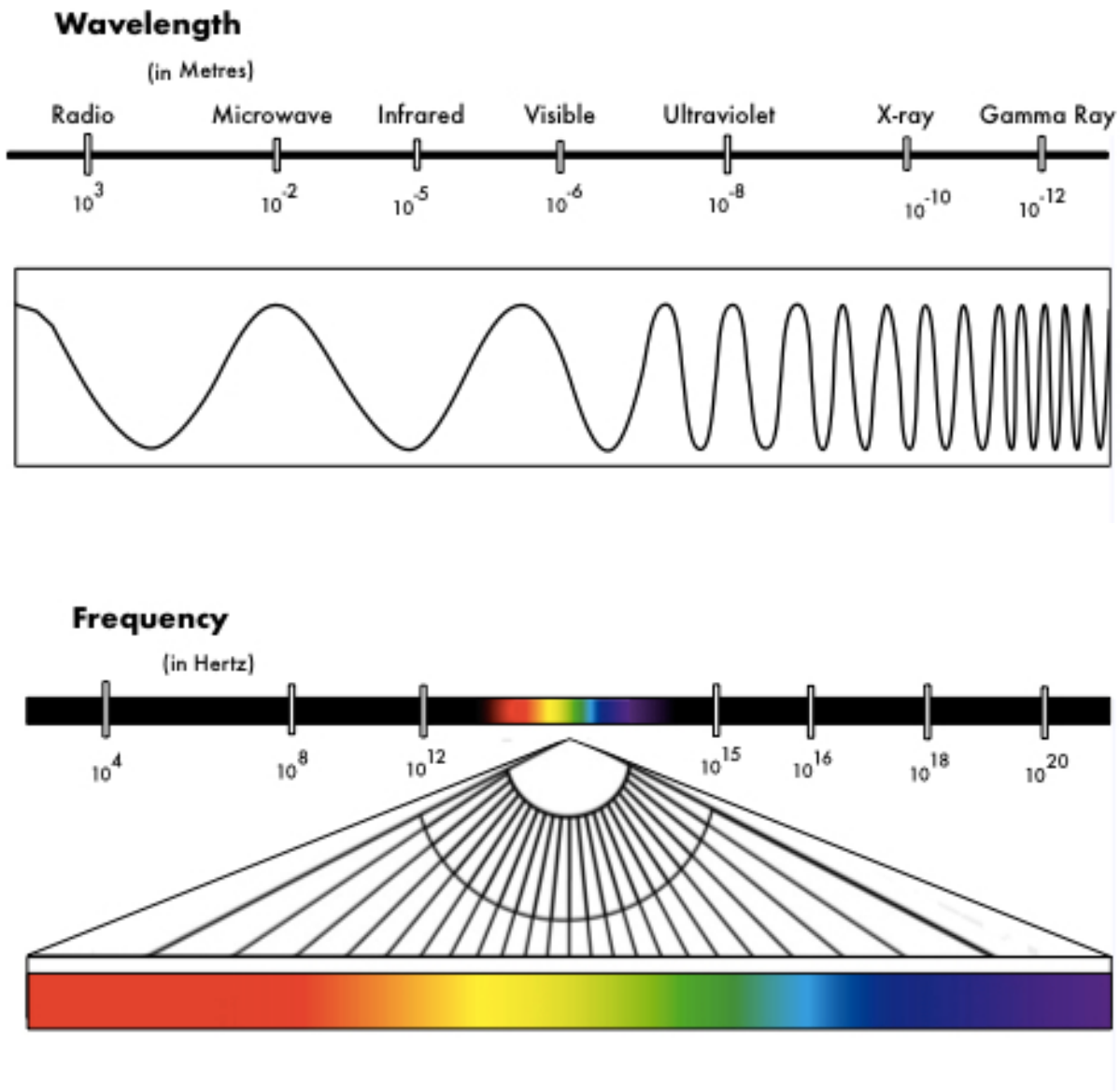
Continuous Spectrum

How do we solve the mathematical problems involving light?

$$c = \lambda \times \nu$$

So who is this Hertz Dude?

Let's look at each part of the spectrum and what we use it for.

The Electromagnetic Spectrum

Radio

Microwave

IR

Visible

UV

X rays

Gamma

Cosmic?

What did we learn about waves yesterday?
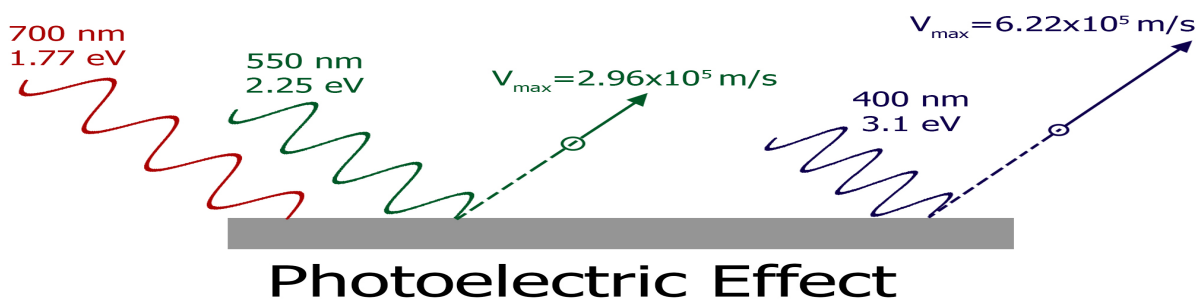
What was the Ultraviolet Catastrophe?

Max Planck

First Quantum Hypothesis

What is Planck's Constant?

This Explained the Photoelectric Effect

700 nm
1.77 eV

550 nm
2.25 eV

$V_{max}=2.96 \times 10^5$ m/s

$V_{max}=6.22 \times 10^5$ m/s

400 nm
3.1 eV

Photoelectric Effect

Some Important numbers for light:

400 nm = 4000 Å = 4.00 x 10⁻⁷ m = 4.00 x 10⁻⁵ cm

$$400 \text{ nm} = 4000 \text{ Å} = 4.00 \times 10^{-7} \text{ m} = 4.00 \times 10^{-5} \text{ cm}$$

What does a rainbow look like numerically?

Violet: 400 nm–450 nm   Blue: 450 nm–500 nm   Green: 500 nm–560 nm

Yellow: 560 nm–600 nm   Orange: 600 nm–640 nm   Red: 640 nm–750 nm

Color	Wavelength	Frequency	Velocity
Violet	4.000×10^{-7} m	7.500×10^{14} Hz	
Green	5.000×10^{-7} m	6.000×10^{14} Hz	
Yellow	5.750×10^{-7} m	5.217×10^{14} Hz	
KMET	3.17 m	94.7×10^{6} Hz	

1) What is the frequency of some green light that has a wavelength of 5.25×10^{-7} m?

2) What is the wavelength of some radio waves that broadcast at 9.55×10^{7} Hz?

3) What is the energy of a photon of blue light whose wavelength is 475 nm?

4) What is the energy of 10 photons of the same blue light?

5) What is the energy of a whole mole of photons of violet (400. nm light)?

The Bohr Model

What do football (soccer), Beer, and the 1908 Olympics have to do with chemistry?

The Bright Line Spectrum for Hydrogen is not continuous!

What is a continuous spectrum?

So what does it look like for hydrogen?
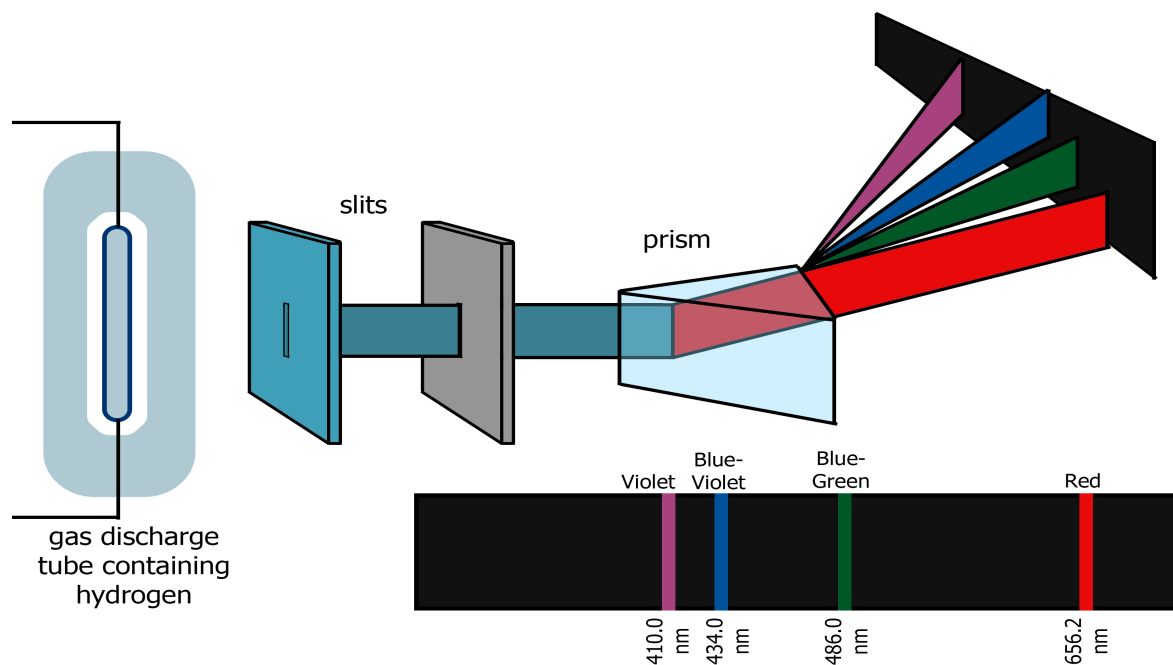
A Swiss High School Teacher?

Who is this Rydberg dude anyway?

So the whole thing looks like:

Name	n_f	n_i	Region of Electromagnetic Spectrum
Lyman			
Balmer			
Paschen			
Brackett			
Pfund			

What is the Plum Pudding Model?

What is Ernest Rutherford's Picture of an atom?

Niels Bohr

What do the funny little circles correspond to?

1) An electron drops from the n= 3 to the n= 2? What is the wavelength of the energy emitted?

2) An electron jumps from the n= 4 to the n= 2. What is the wavelength of the light emitted?

The Aufbau Principle

What is Aufbau?

What is Hunds Rule?

What is the Pauli Exclusion Principle?

	Order of filling	Periodic table row number
6s 6p 5d 4f	6p / 5d / 4f / 6s	6
5s 5p 4d	5p / 4d / 5s	5
4s 4p 3d	4p / 3d / 4s	4
Energy 3s 3p	3p / 3s	3
2s 2p	2p / 2s	2
1s	1s	1
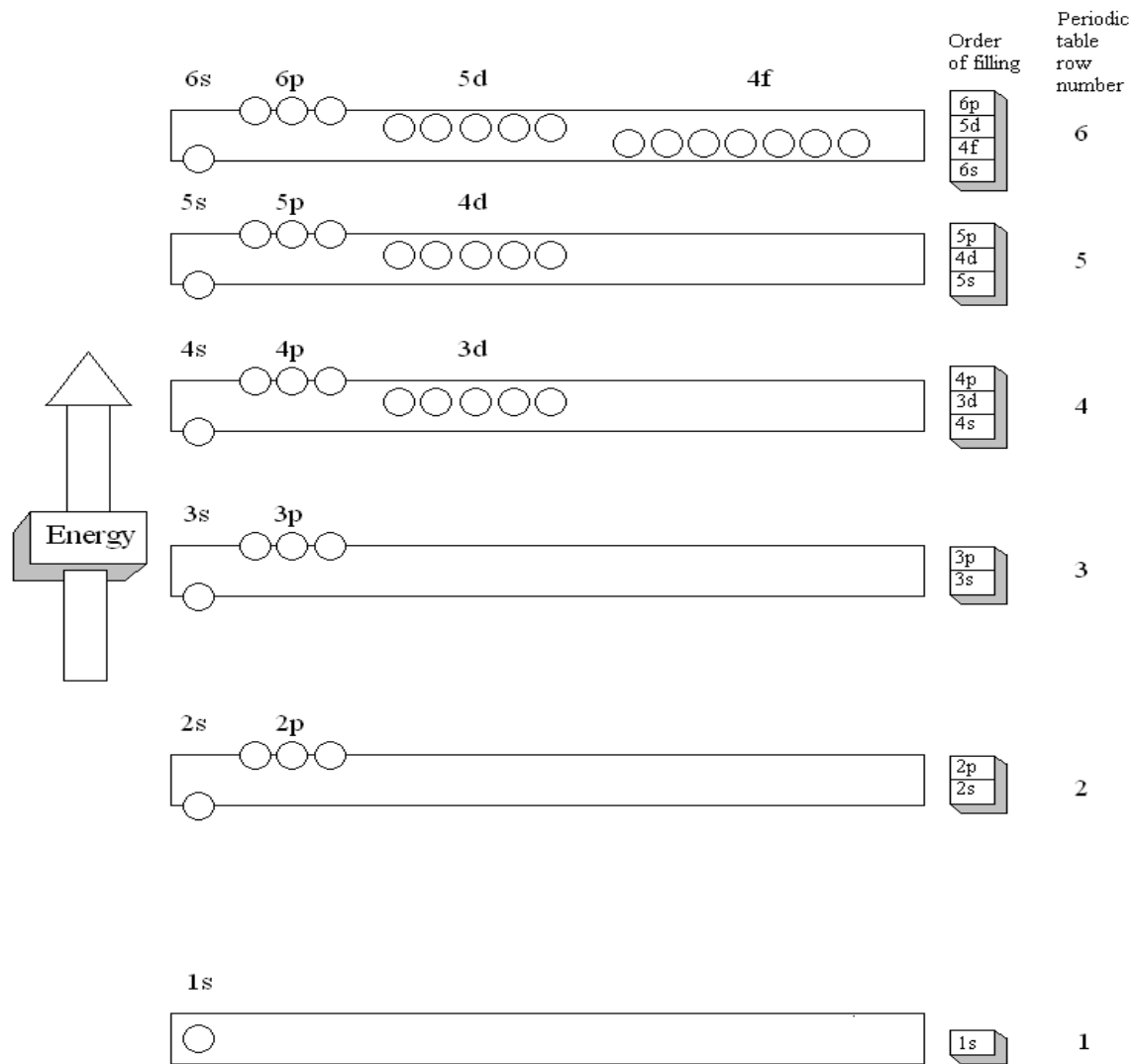
₁H   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₂He   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₃Li   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₄Be   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₅B   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₆C   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₇N   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₈O   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₉F   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₁₀Ne   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₁₁Na   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₁₂Mg   1S___2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₁₃Al   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₁₄Si   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₁₅P   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₁₆S   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₁₇Cl   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₁₈Ar   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₁₉K   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₂₀Ca   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₂₁Sc   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₂₂Ti   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₂₃V   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₂₄Cr   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___

₂₅Mn   1S___ 2S___ 2P ___ ___ ___ 3S ___ 3P___ ___ ___4S ___ 3d ___ ___ ___ ___ ___