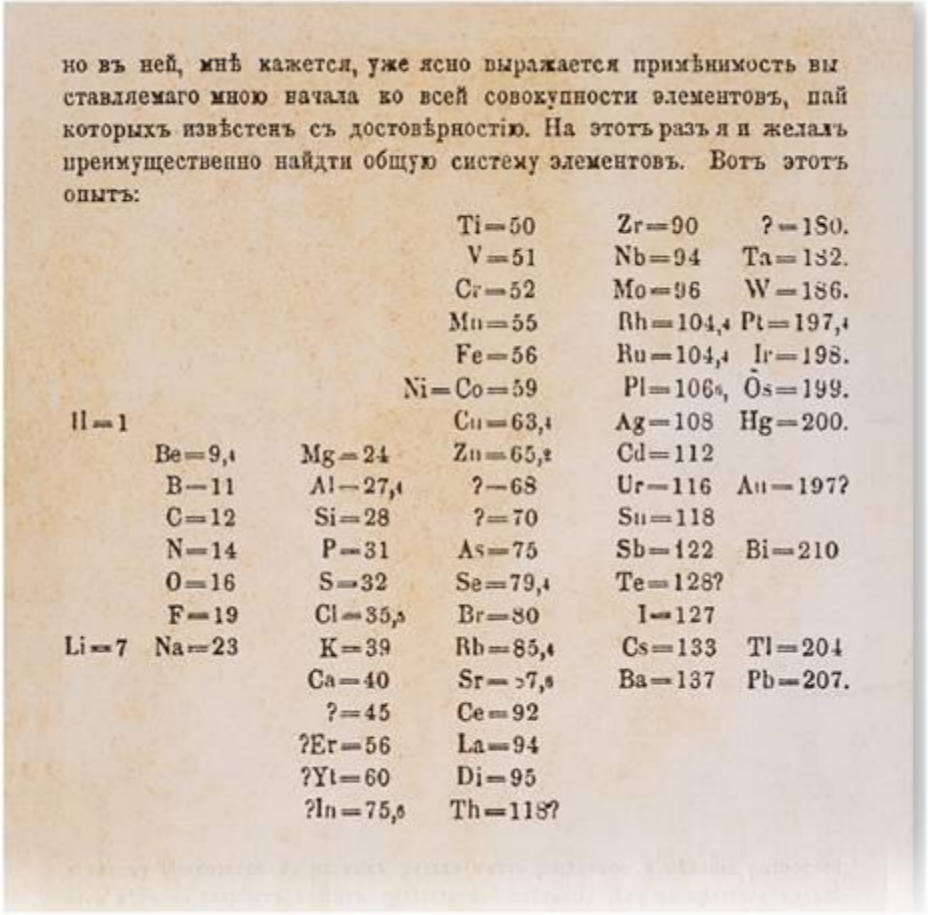
Unit 2

The Periodic Table & Quantum Theory

Mendeleev's Periodic Table – THE FIRST

- Arranged the elements in his periodic table in order of **increasing atomic mass**
- Also arranged using **properties** of the elements
- The periodic table can be used to predict the properties of undiscovered elements.
- 1869

An Early Version of Mendeleev's Periodic Table



но въ ней, мнѣ кажется, уже ясно выражается примѣнимость вы ставляемаго мною начала ко всей совокупности элементовъ, пай которыхъ извѣстенъ съ достовѣрностію. На этотъ разъ я и желалъ преимущественно найдти общую систему элементовъ. Вотъ этотъ опытъ:

			Ti=50	Zr=90	?=180.
			V=51	Nb=94	Ta=182.
			Cr=52	Mo=96	W=186.
			Mn=55	Rh=104,4	Pt=197,4
			Fe=56	Ru=104,4	Ir=198.
			Ni=Co=59	Pl=106,6	Os=199.
H=1			Cu=63,4	Ag=108	Hg=200.
	Be=9,4	Mg=24	Zn=65,2	Cd=112	
	B=11	Al=27,4	?=68	Ur=116	Au=197?
	C=12	Si=28	?=70	Sn=118	
	N=14	P=31	As=75	Sb=122	Bi=210
	O=16	S=32	Se=79,4	Te=128?	
	F=19	Cl=35,5	Br=80	I=127	
Li=7	Na=23	K=39	Rb=85,4	Cs=133	Tl=204
		Ca=40	Sr=87,6	Ba=137	Pb=207.
		?=45	Ce=92		
		?Er=56	La=94		
		?Yt=60	Di=95		
		?In=75,6	Th=118?		

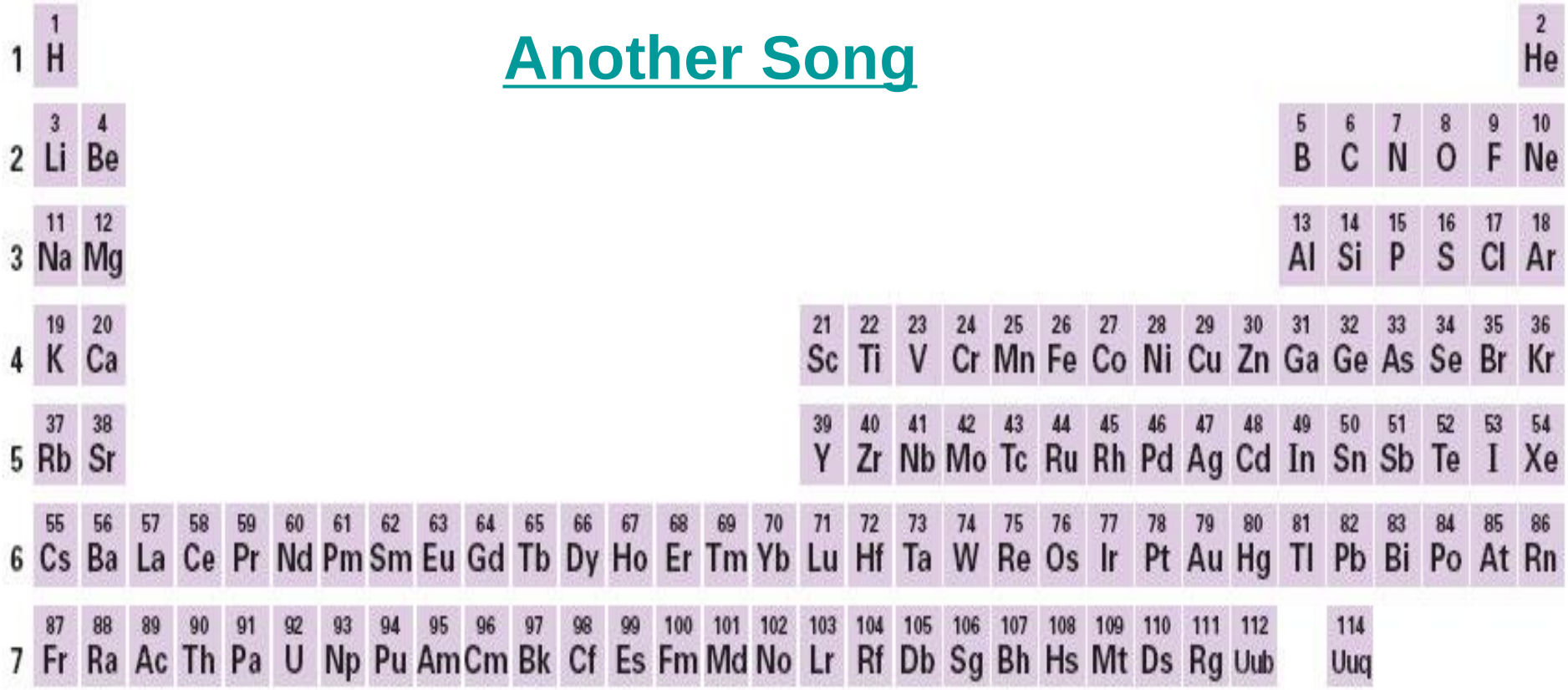
A Song

Another Song

The MODERN Periodic Table

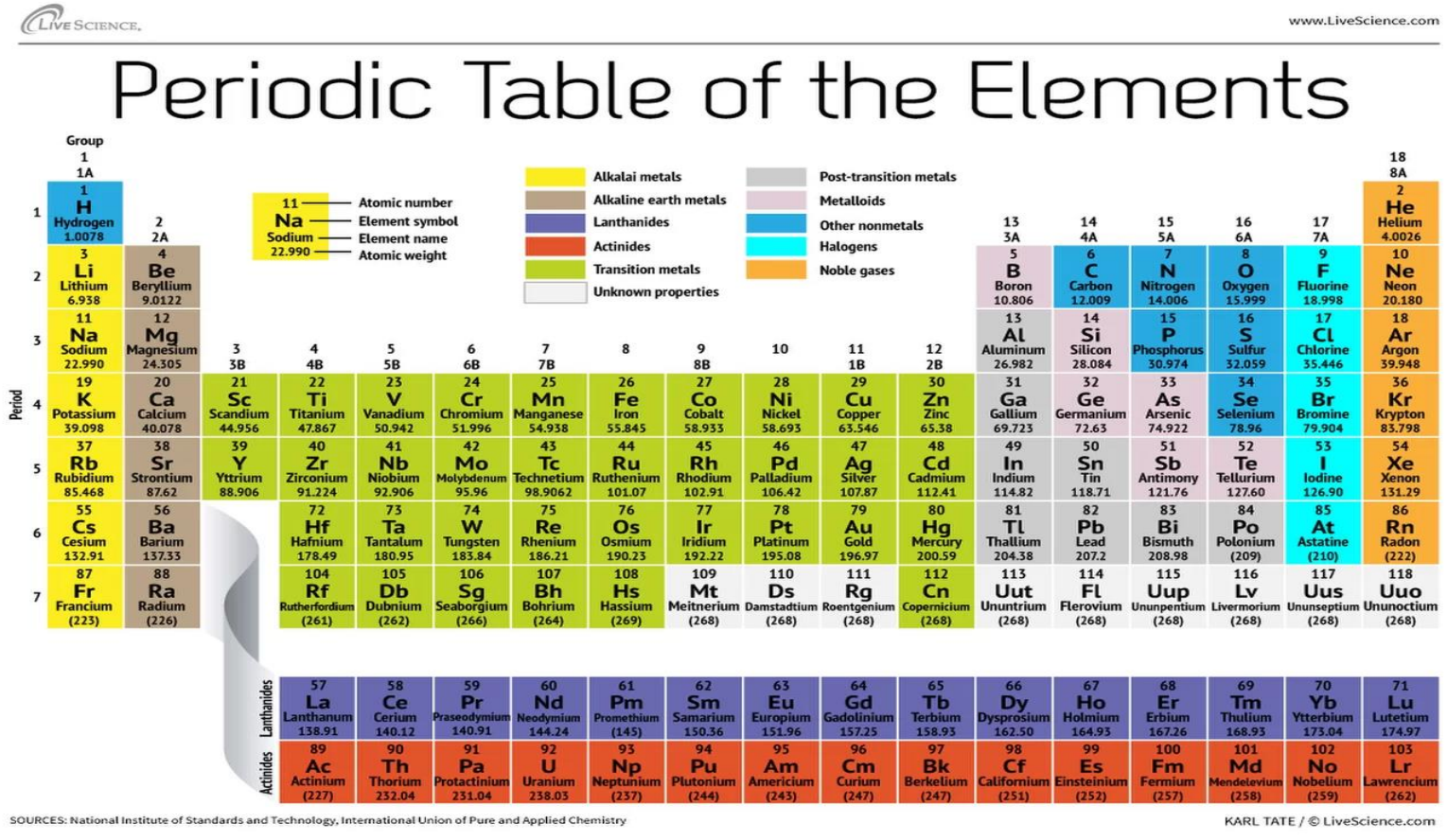
- **Elements are arranged in order of increasing atomic number.**

Another Song

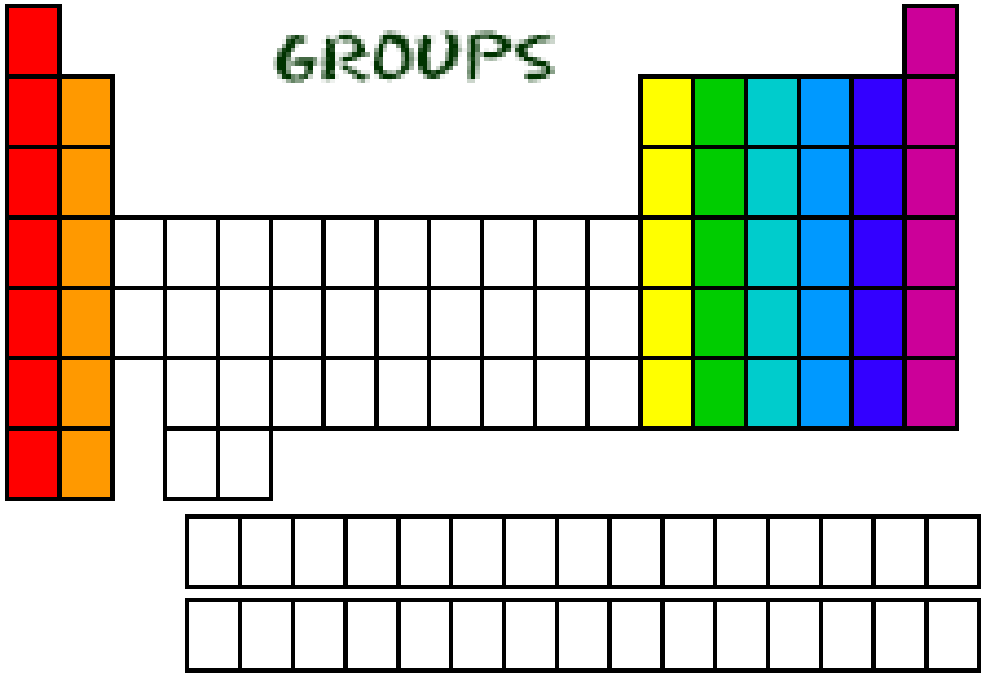


Periodic Law

When elements are arranged in order of increasing atomic number, a repeating pattern of properties can be seen.



- **Elements with similar properties are grouped in a columns (up and down)**
- **Called groups or FAMILIES**



- The Group 1A elements are called **alkali metals.**

Alkali Metal Reactions

- The Group 2A elements are called **alkaline earth metals.**

Alkaline Earth Metal Reactions

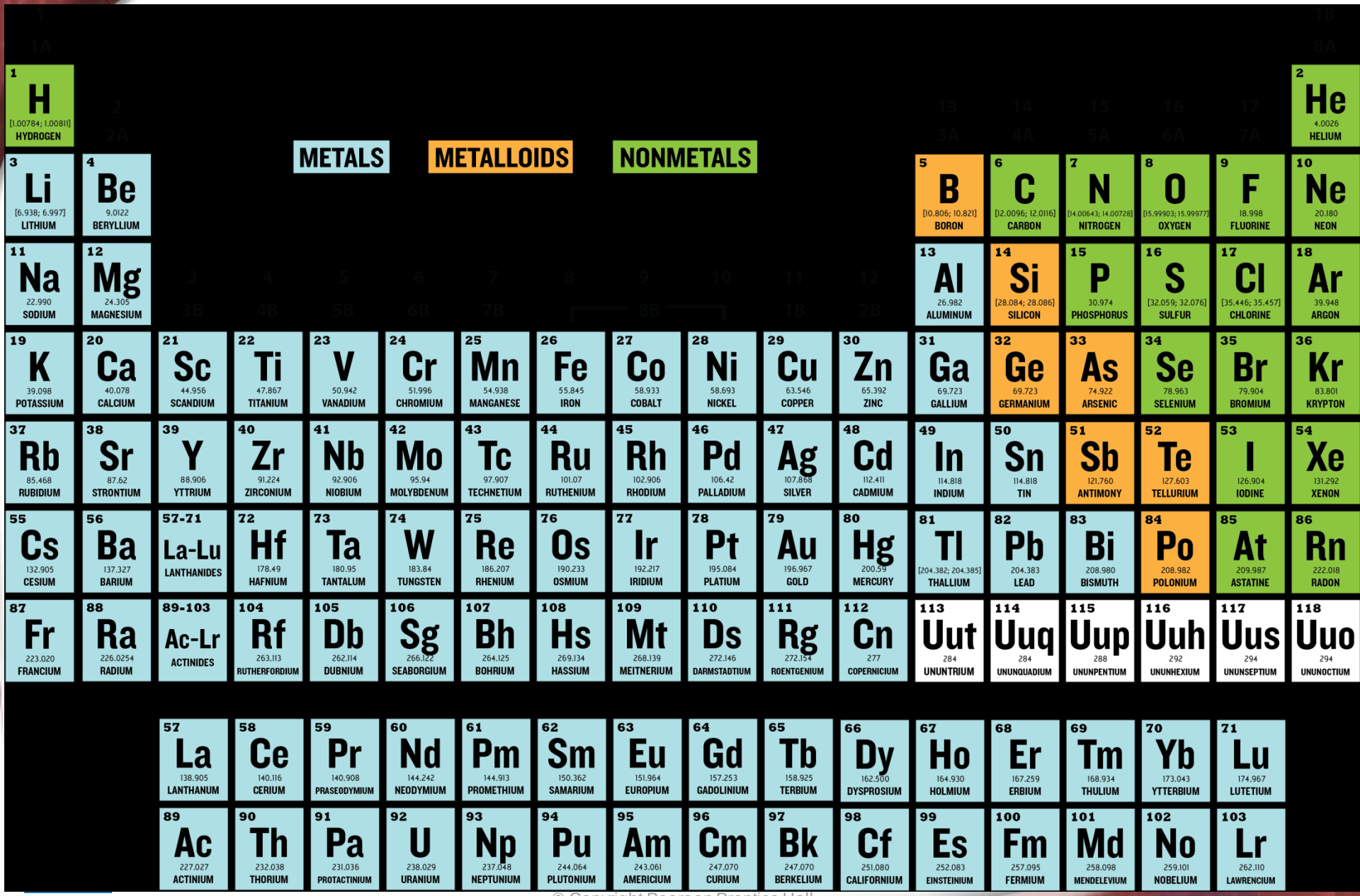
The nonmetals of Group 7A are called **halogens.**

Halogen Video

Group 8A – noble gases

Noble Gases

Organizing the Elements >



Metals

- Most elements are metals
- High luster (shiny)
- Ductile (able to be pulled into a wire)
- Malleable (able to be bent)
- Good conductors of heat and electricity

Metalloids

A **metalloid** generally behaves kind of like a metal and kind of like a nonmetal.

Information about Metalloids

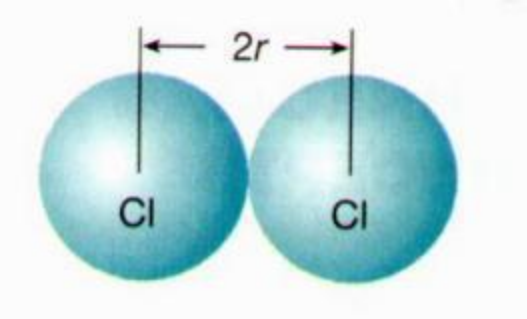
Nonmetals

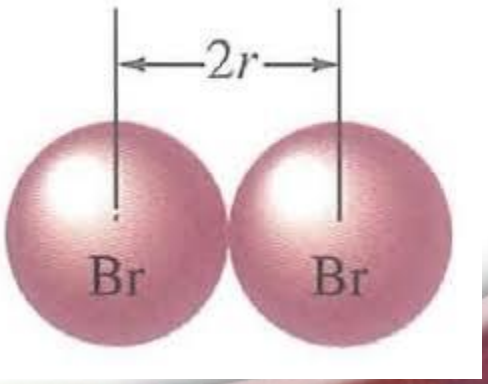
- Most are gases at room temperature.
- Some are solids(sulfur and phosphorus & iodine)
- One nonmetal, bromine, is a dark-red liquid
- Poor conductors of heat and electricity

Periodic Trend – a repeating pattern in the periodic table when the atoms are arranged by atomic number.

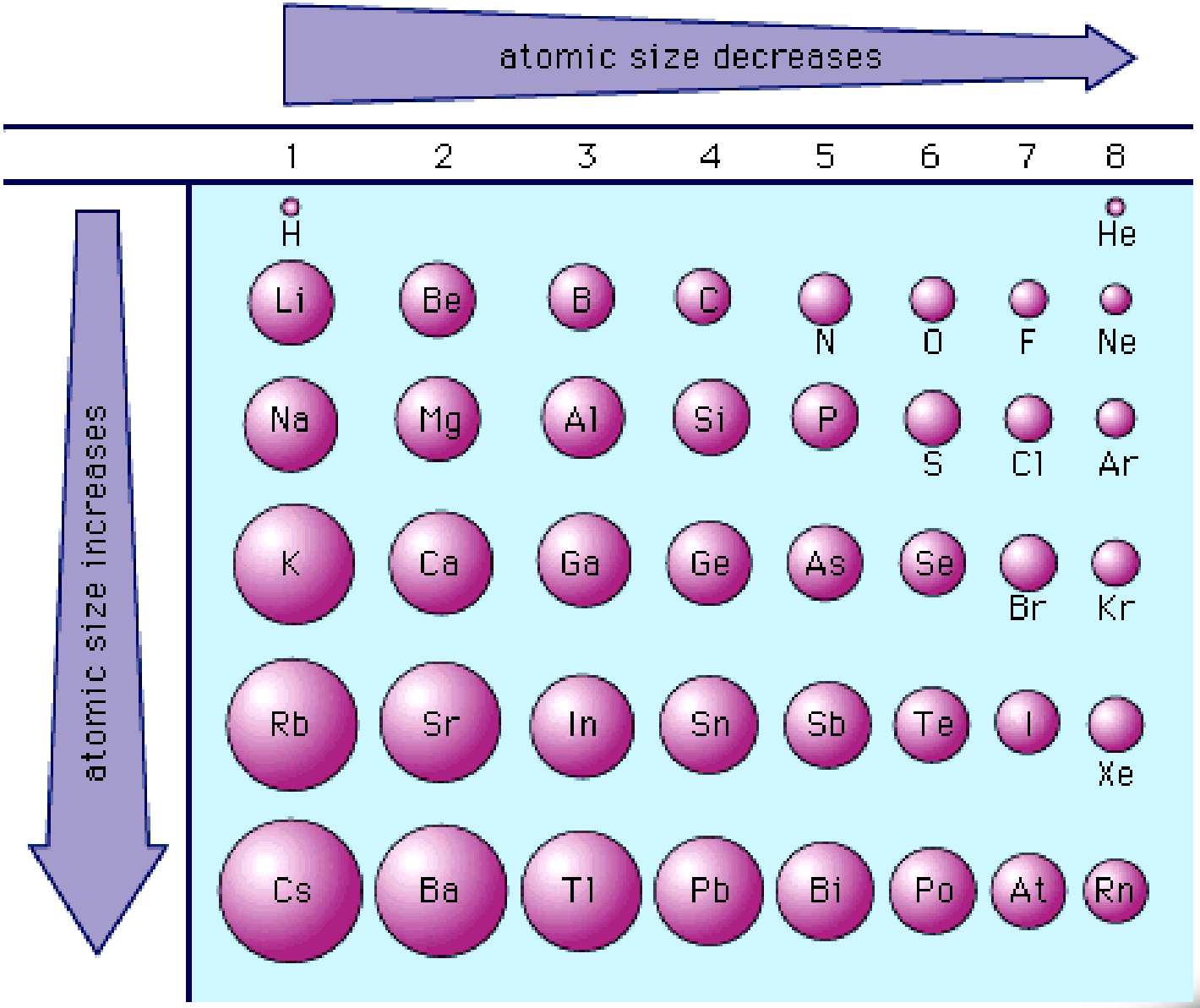
Atomic Radius

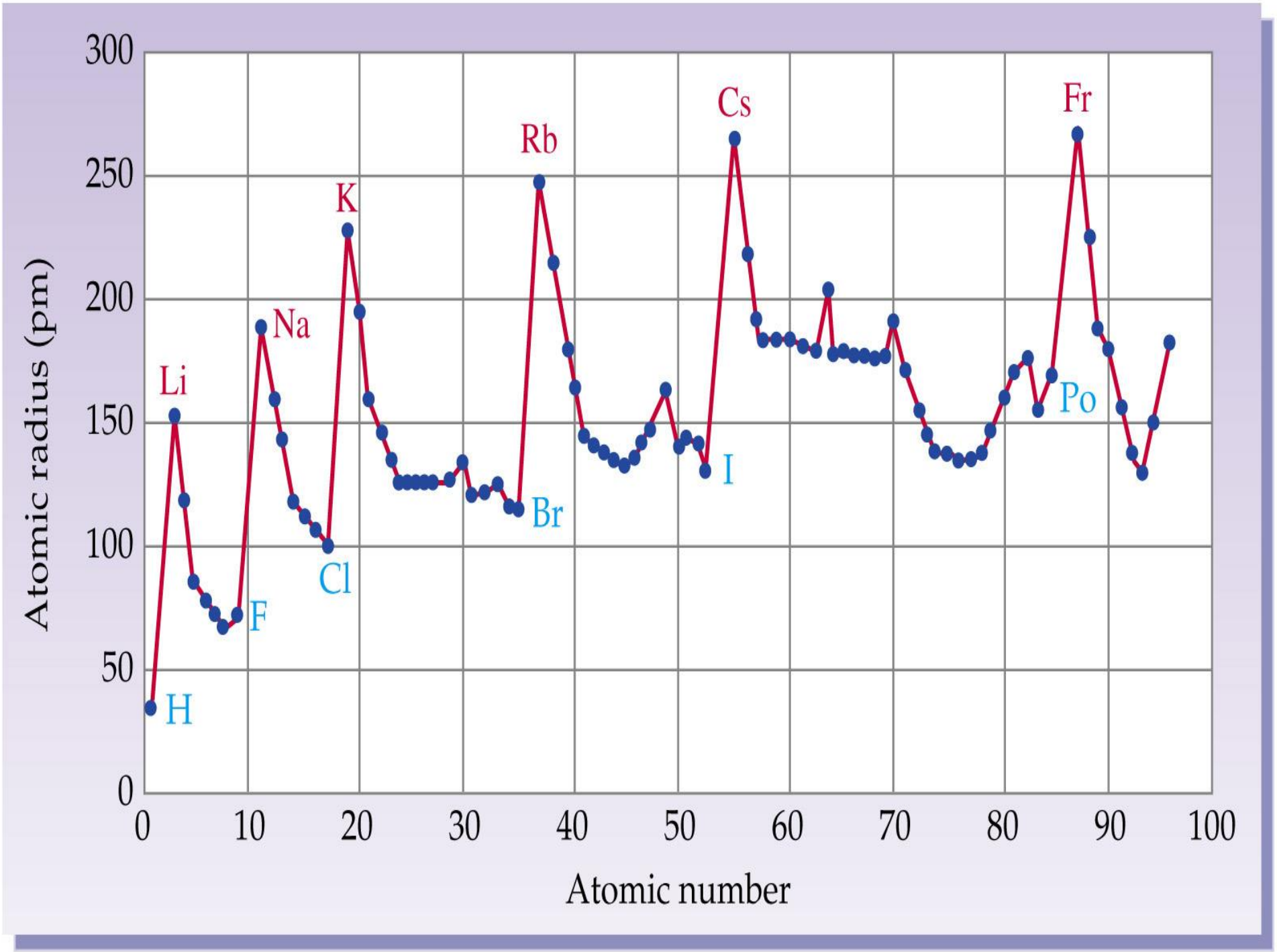
Distance from the nucleus to the edge of the electron cloud.





Organizing the Elements >

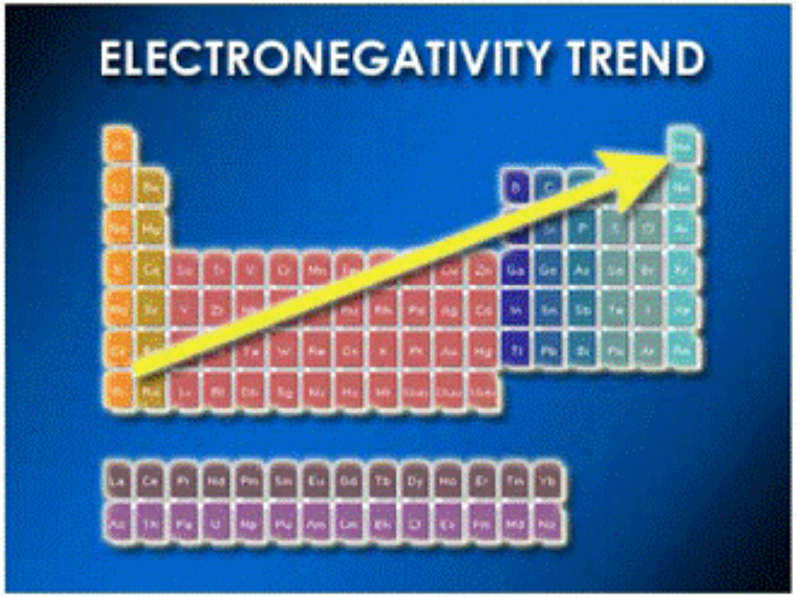



Atomic radius (pm)
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
90
100
Atomic number
H
Li
F
Na
Cl
K
Br
Rb
I
Cs
Po
Fr

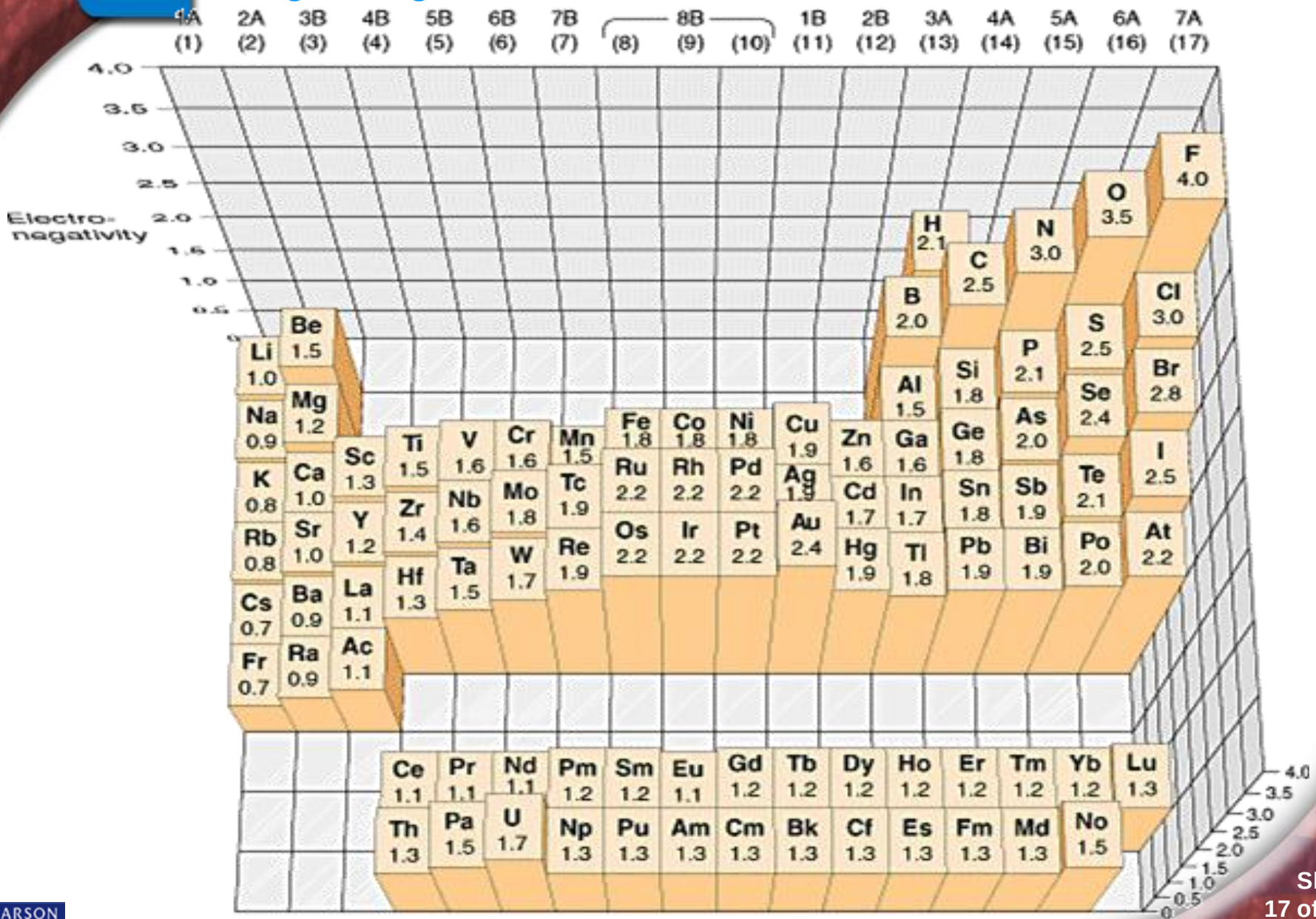
Periodic Trend - Electronegativity

Electronegativity is the power of an atom to attract an electron

Highest number is 4.0 - fluorine

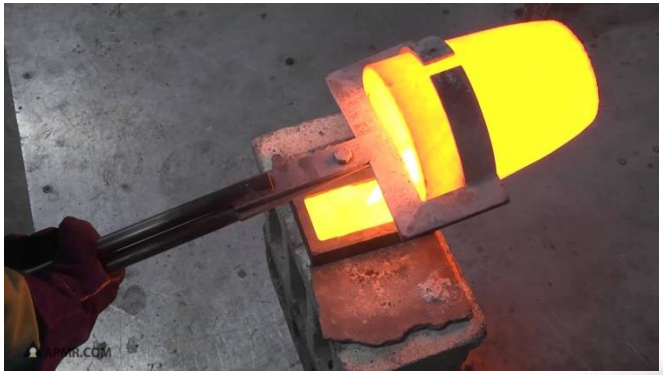


Organizing the Elements >

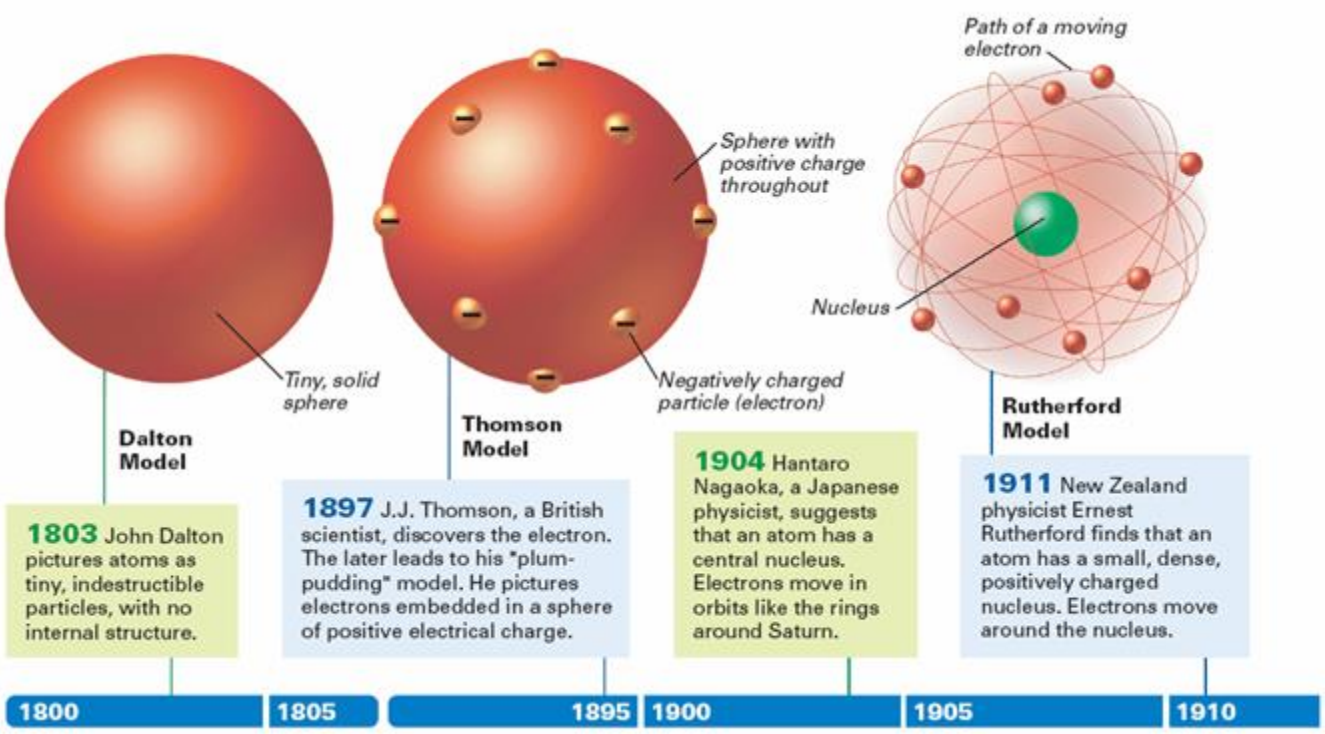


A NEW Question

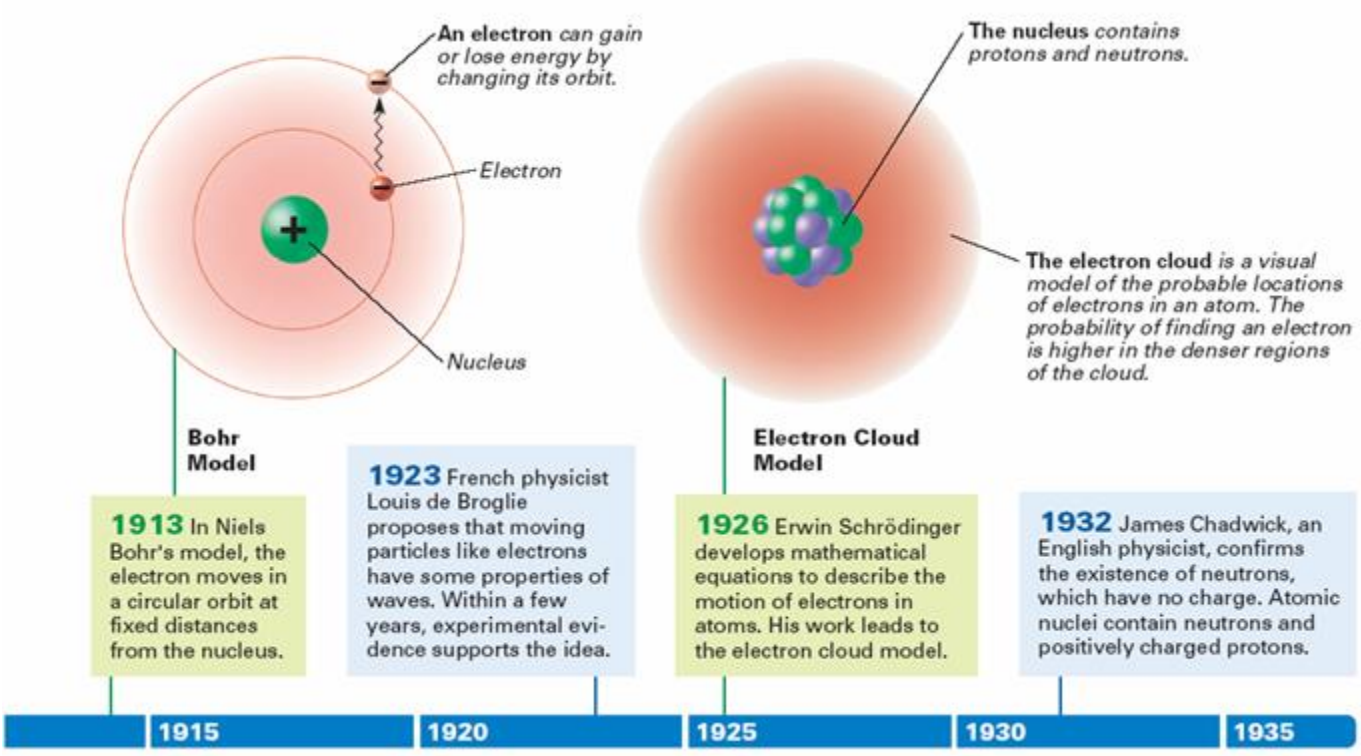
Rutherford's atomic model could not explain why objects change color when heated.



The timeline shows the development of atomic models from 1803 to 1911.



The timeline shows the development of atomic models from 1913 to 1932.



BOHR Findings

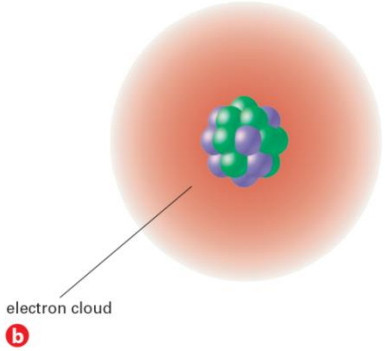
- Electrons have fixed energy
- Fixed energies are called energy levels
- Quantum is the amount of energy required to move an electron from one energy level to another energy level.

Energy Levels are Kind Of Like a Ladder Because…

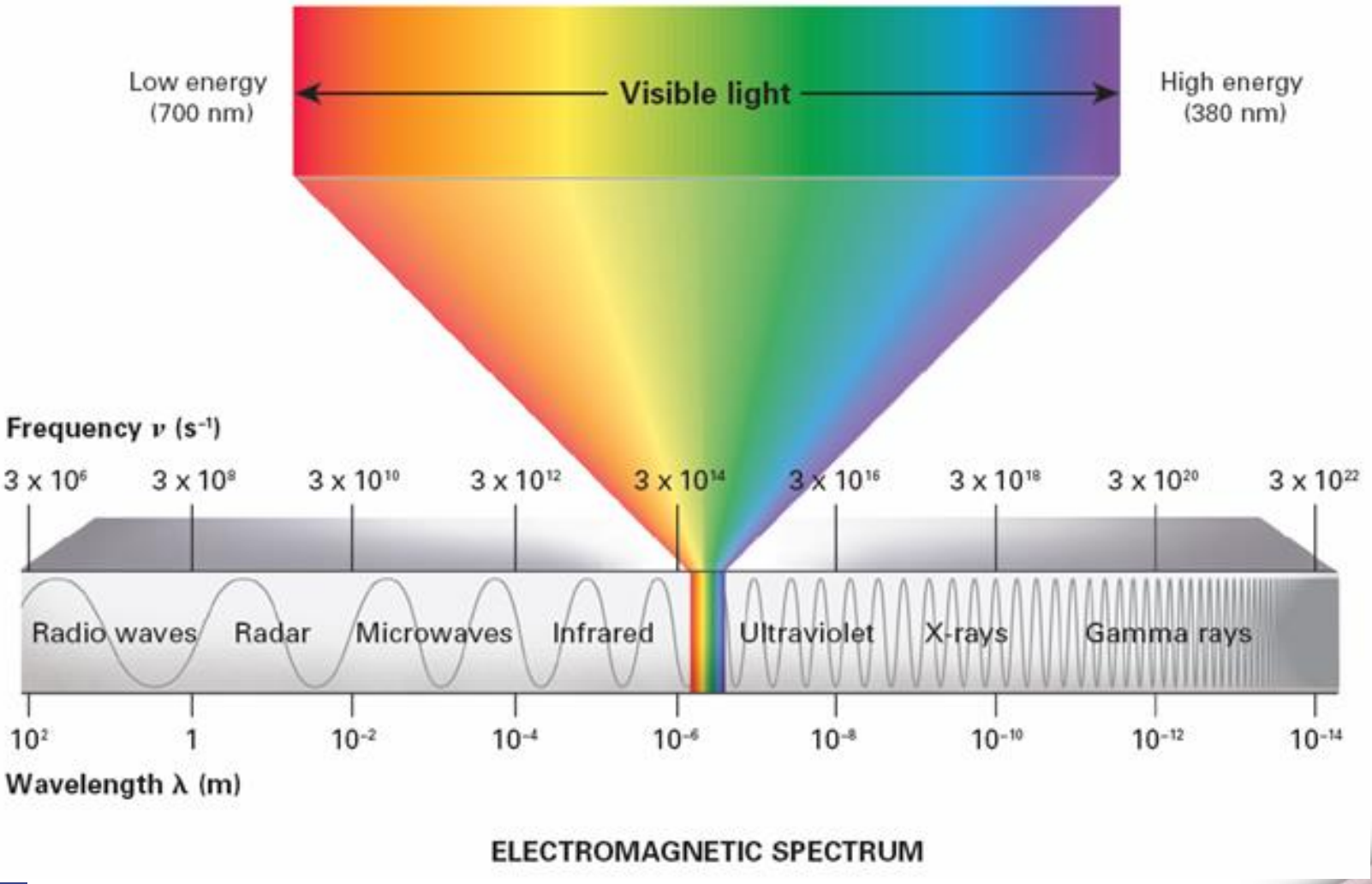
- Energy levels are spaced out (not all equally)
- Ground State – close to the nucleus (low energy)
- Excited states – move away from lowest energy level – move up the ladder – higher energy

Erwin Schrödinger (1887–1961)

- Quantum mechanical model
- Mathematical proof
- Creates a "fuzzy" cloud of where electrons are likely to be found
- Give an address to location using quantum numbers.



The Electromagnetic Spectrum

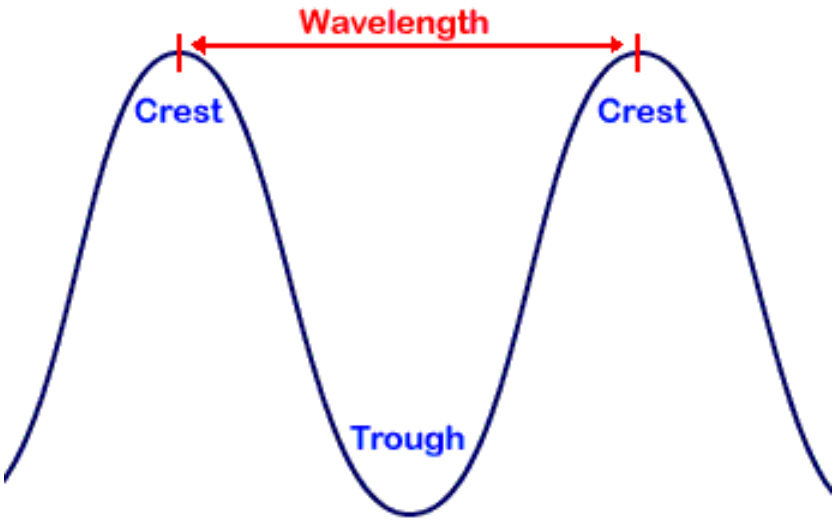


ELECTROMAGNETIC SPECTRUM

Important Words When Talking About Radiation

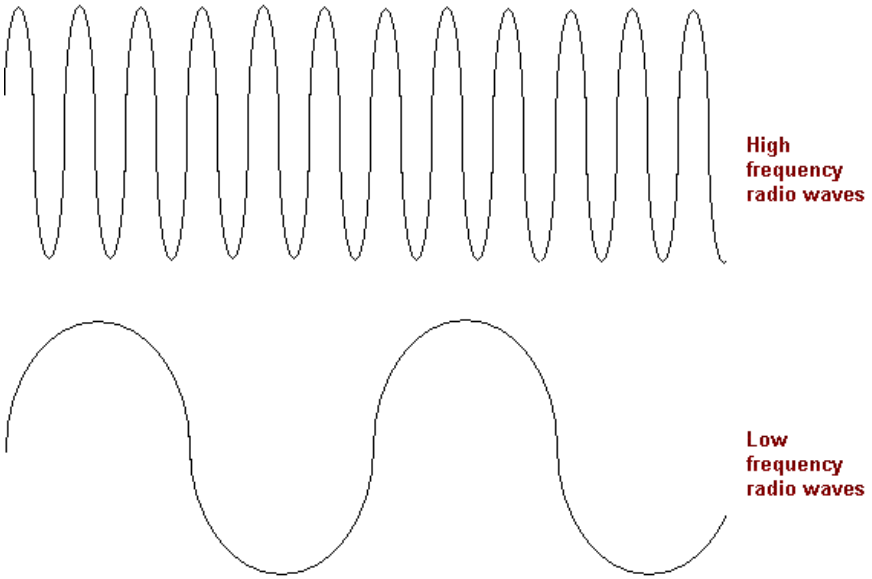
Wavelength

- is the distance between the crests
- Represented by greek letter λ
- Measures in meters, nanometers, centimeters



Frequency –

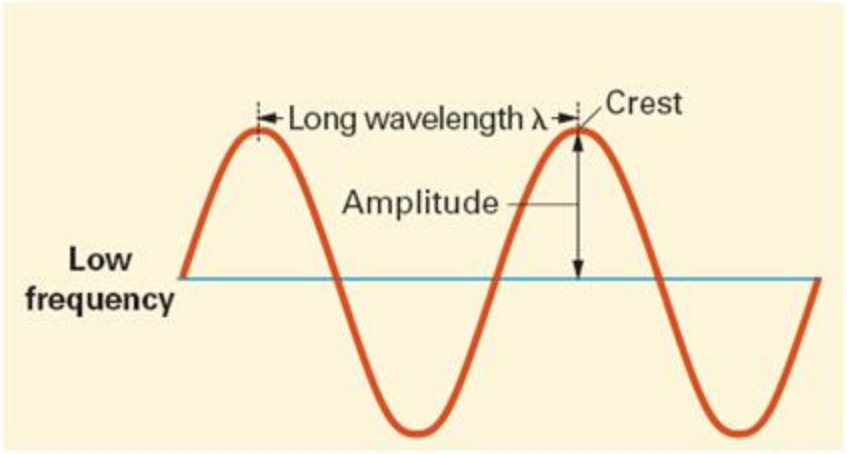
- is the number of wave cycles to pass a given point per unit of time (measured in Hertz or Hz)
- Represented by greek letter v

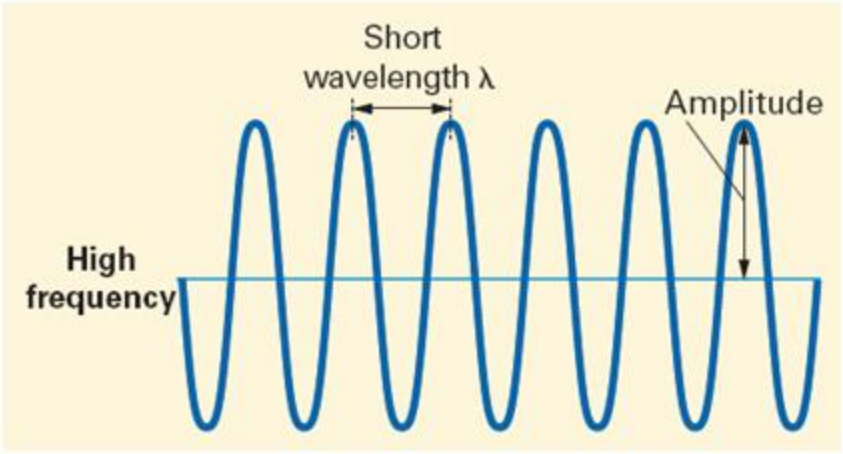


Slinky Demonstrations

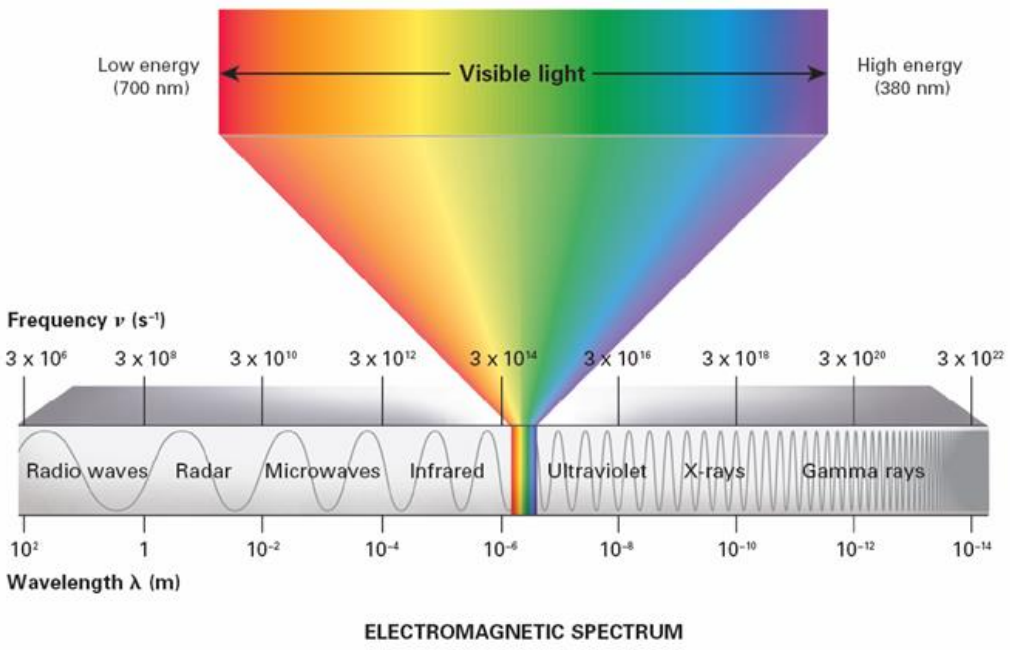
What is the relationship between energy and wavelength and frequency?

The wavelength and frequency of light are inversely proportional to each other.





Where is the HIGH ENERGY Radiation?



ELECTROMAGNETIC SPECTRUM

Describe the frequency and the wavelength of the high energy radiation.

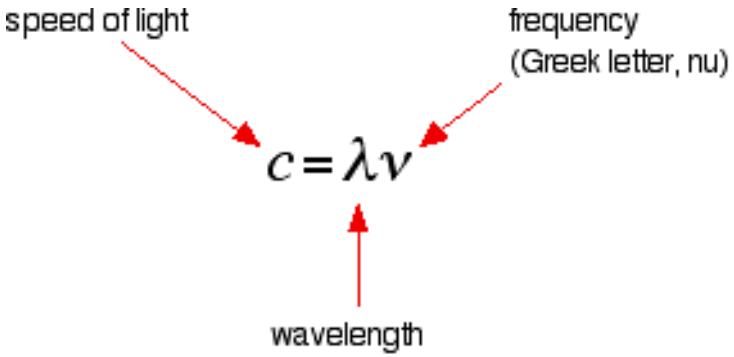
Important Wave Information

Photon

- packet of energy

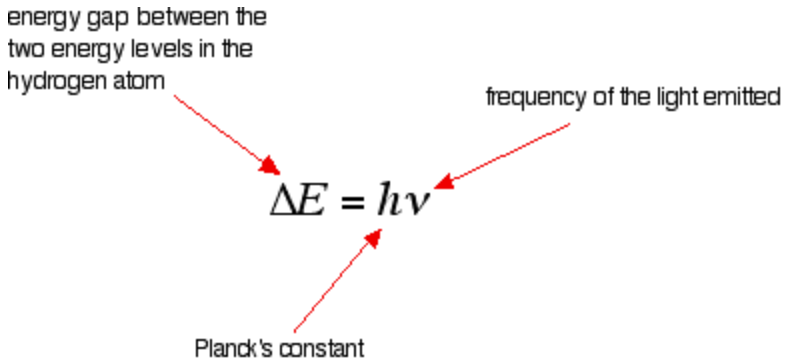
Speed of light

- how fast electromagnetic radiation travels in a vacuum
- Represented by letter “c”
- 3.0x 108 meters/second



Calculate the wavelength of radiation with a frequency of 7.6×10^{13}Hz.

What is the **wavelength, in nanometers,** of light with a frequency of 7.1×10^{14} Hz?



Calculate the energy of a photon of radiation with a frequency of 7.6×10^{14}Hz

A photon of light has a wavelength of 698 nm. How much **energy** does it have in Joules?

Atomic Spectra & How is it Created?

1) Atoms absorb energy

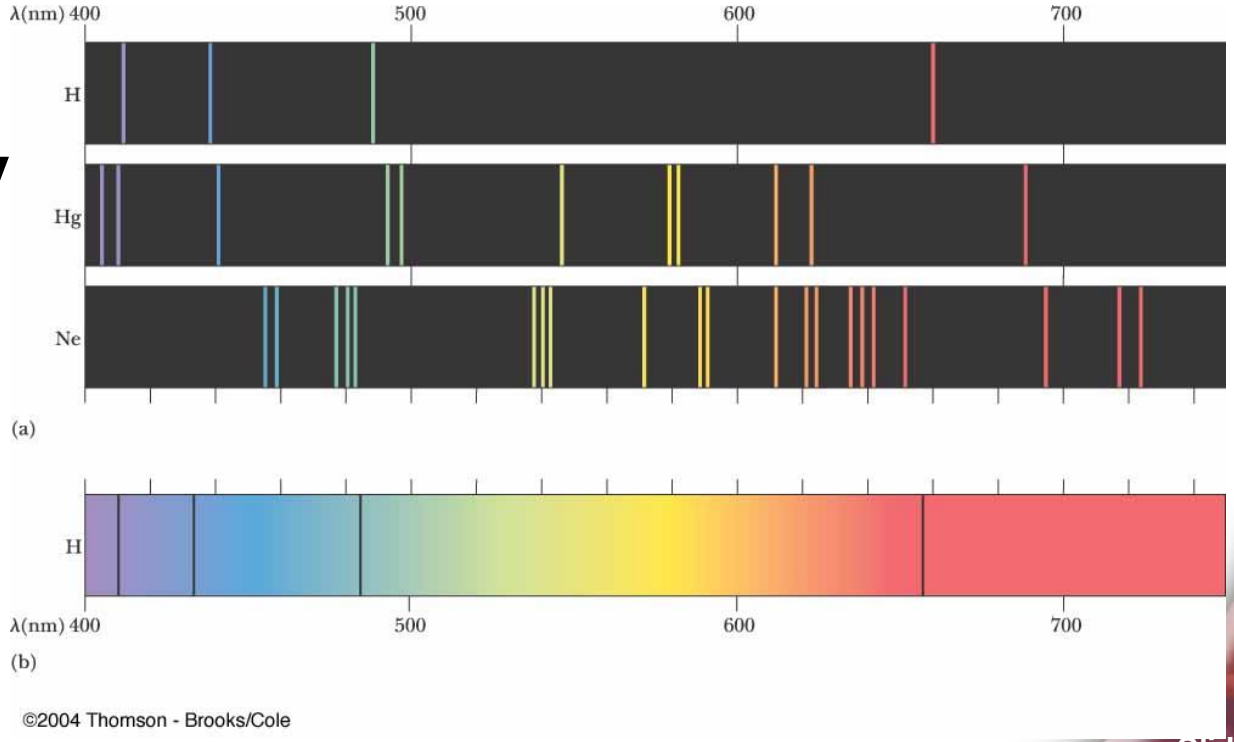
2) Electrons move into higher energy levels.

3) Electrons then lose energy by emitting light

4) Return to lower energy levels.

Each line in spectrum represents energy levels!

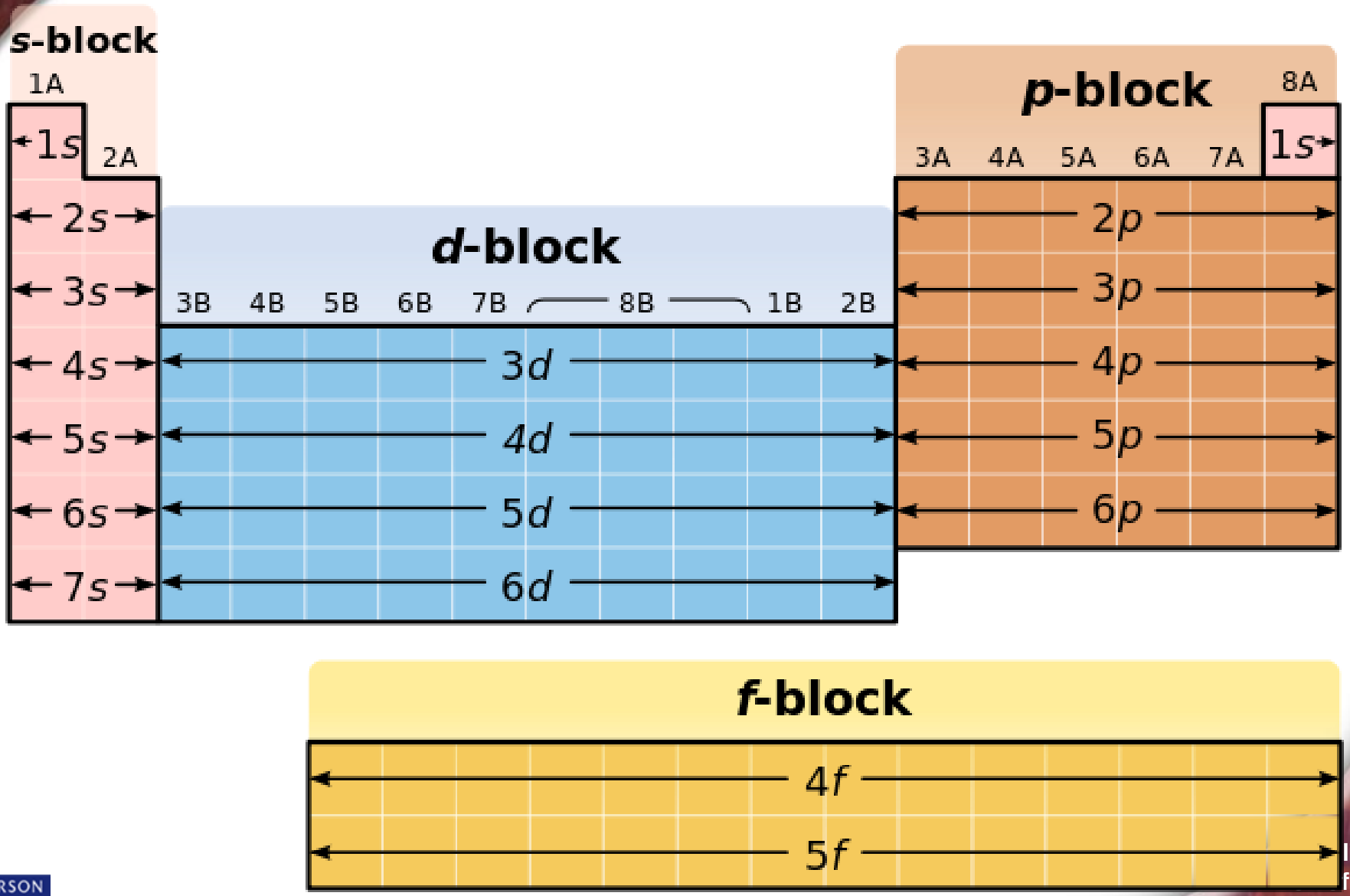
Mercury



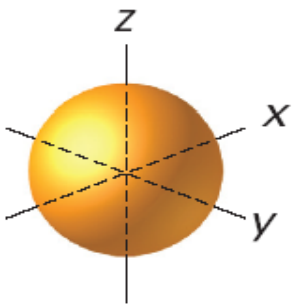
Flame Test Lab – Looking at Atomic Spectra

Electron Configurations

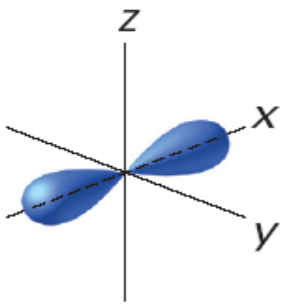
Give an address using quantum numbers describing where an electron lives



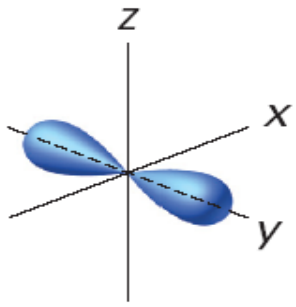
- **Different atomic orbitals are denoted by different letters and numbers.**
- **Each orbital can hold two electrons**
- **Electrons will not pair up unless they have to!**



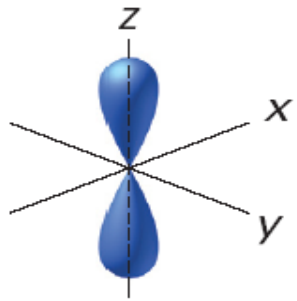
s orbital



p_x orbital

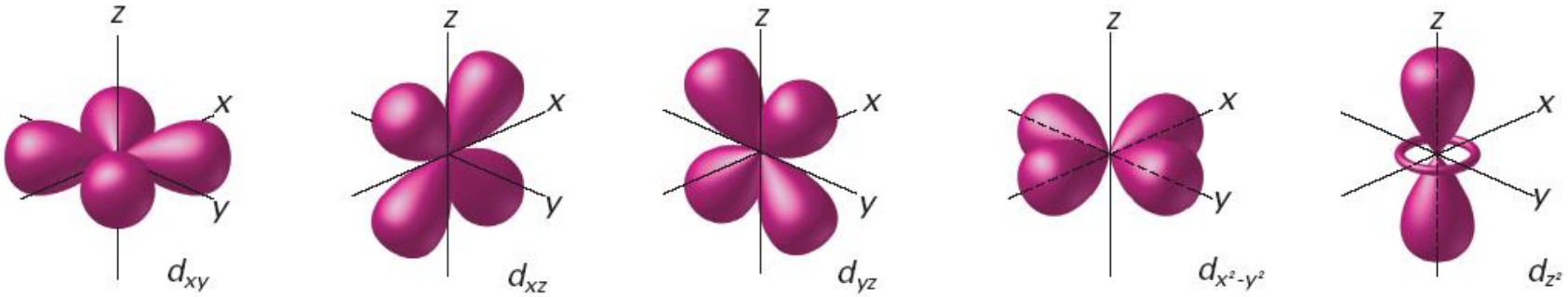


p_y orbital

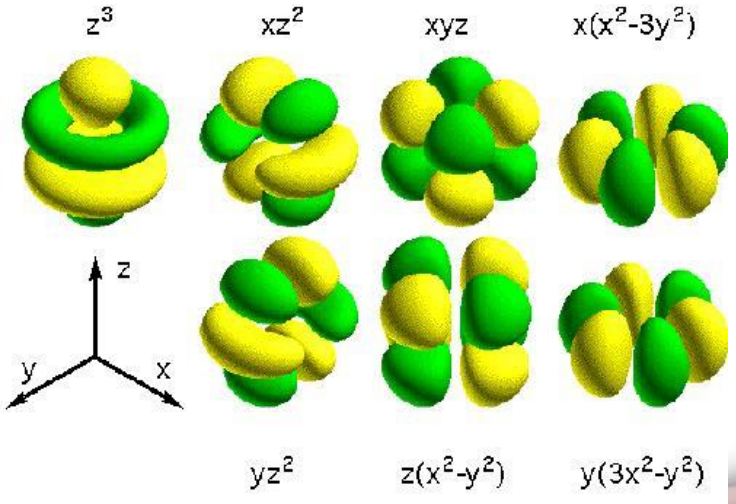


p_z orbital

d orbitals



f orbitals



Writing an Electron Configuration Using the Periodic

Li

C

Ar

Ca

Na

Br

Electron Configurations of Ions

Cations – positively charged – subtract electrons
Anions – negatively charged – add electrons

bromine ion

magnesium ion

Writing a Noble Gas Configuration

beryllium

carbon

phosphorus