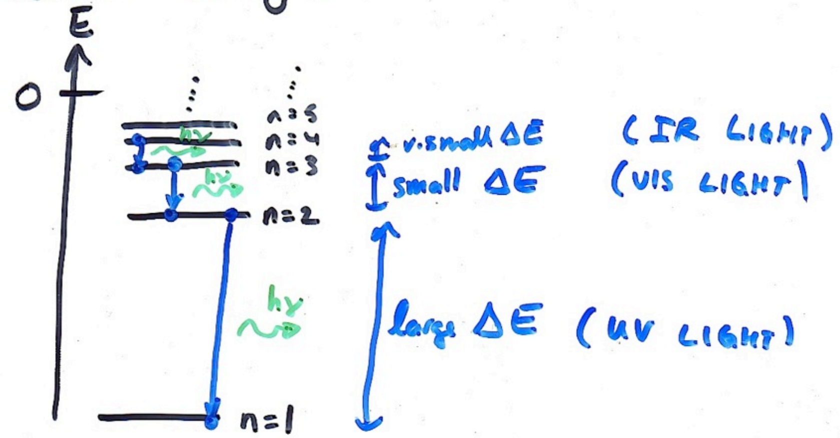
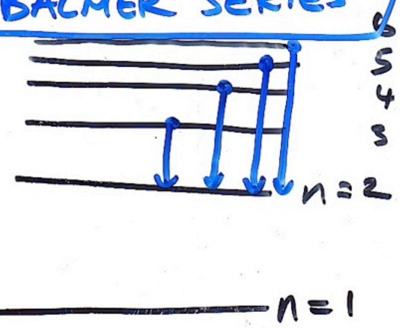
Bohr

Model for H-atom that explains this discrete spectrum.

e^- in the H-atom can only have certain Energies



BALMER SERIES

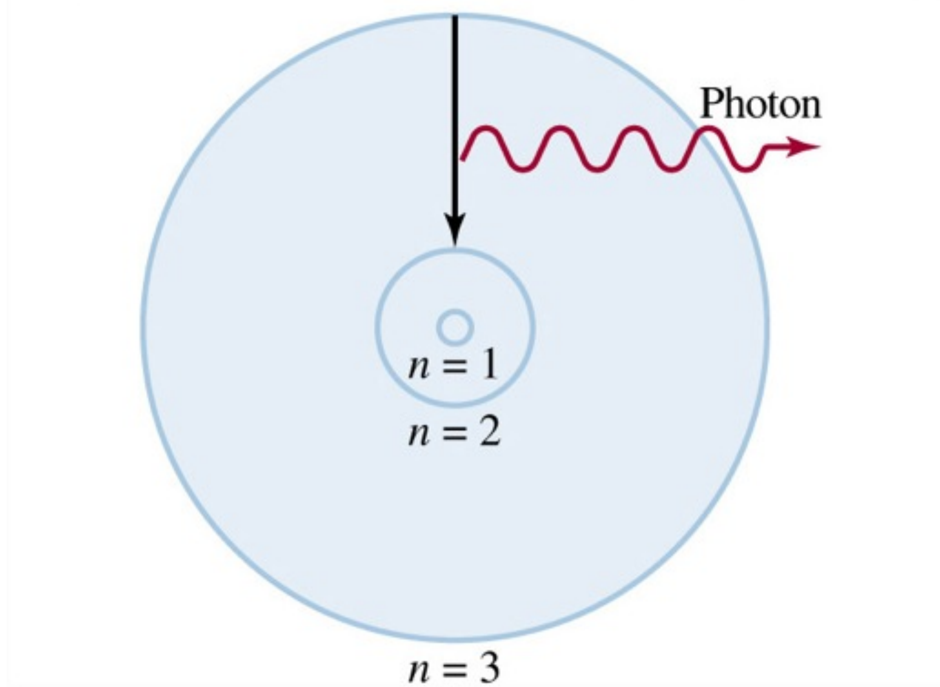


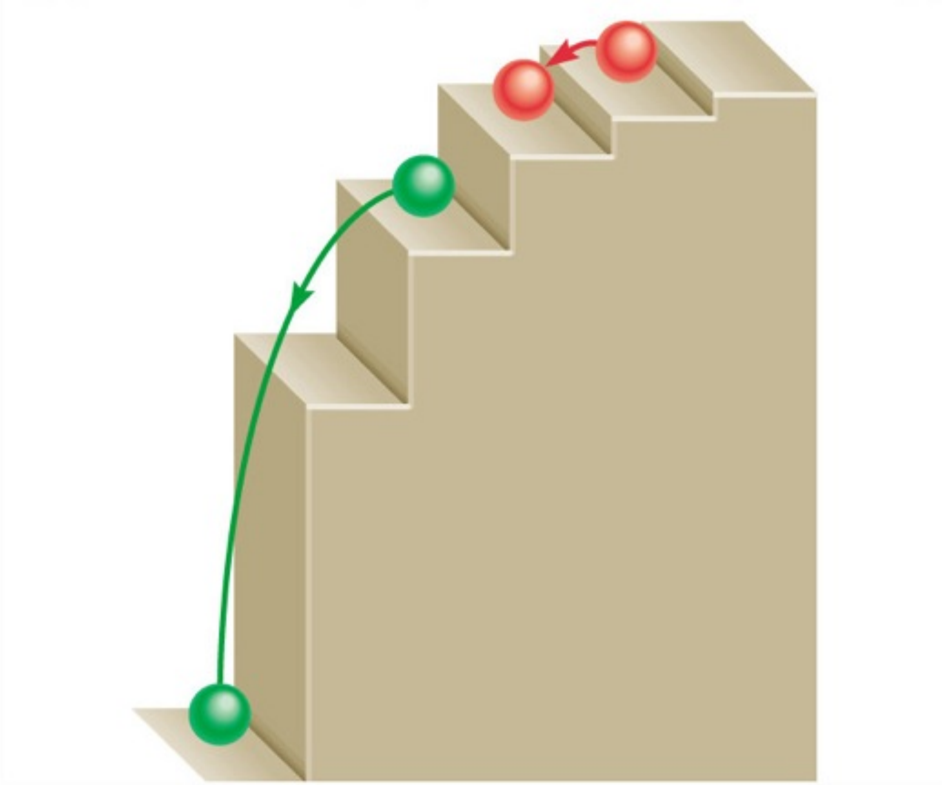
6 → 2 VIOLET

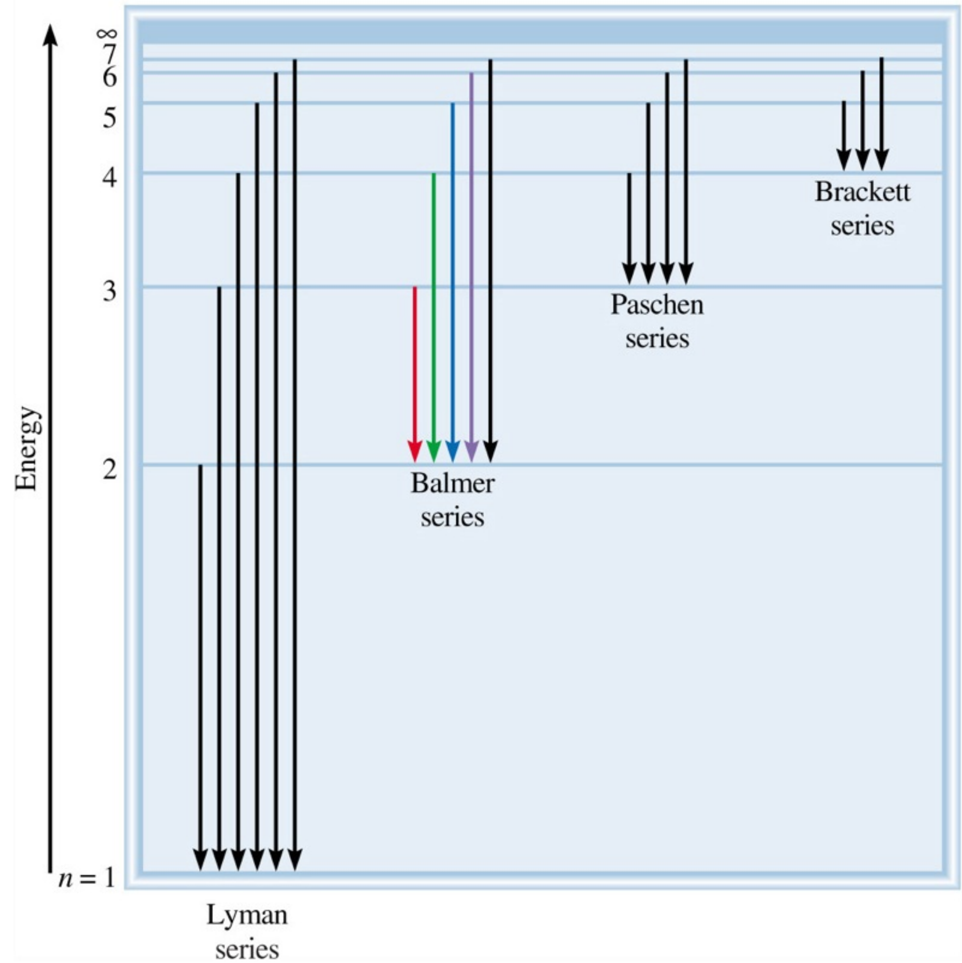
5 → 2 BLUE

4 → 2 GREEN

3 → 2 RED





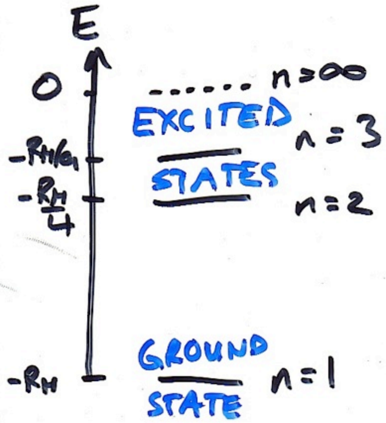

∞
7
6
5
4
3
2
n = 1
Energy
Lyman
series
Balmer
series
Paschen
series
Brackett
series

Bohr... calculated Energy levels.

$$E_n = \frac{-R_H}{n^2} \qquad n = 1, 2, 3, 4, \ldots$$

R_H = Rydberg Constant for H

$= 2.18 \times 10^{-18}$ J



$E_3 = -\frac{R_H}{3^2} = -\frac{R_H}{9}$

$E_2 = -\frac{R_H}{2^2} = -\frac{R_H}{4}$

$E_1 = -\frac{R_H}{1^2}$

ex: let's say an e^- in a H-atom undergoes a transition from $n=3$ (n_i) to $n=2$ (n_f).

Q: What is the λ of light that we will see?

$\Delta E = E_{final} - E_{init}$

$= E_{n_f} - E_{n_i}$

n_f = final value of n

n_i = init. value of n.

$= -\frac{R_H}{n_f^2} \ominus -\frac{R_H}{n_i^2}$

$= -\frac{R_H}{n_f^2} + \frac{R_H}{n_i^2} = \frac{R_H}{n_i^2} - \frac{R_H}{n_f^2}$

$\Delta E = R_H\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right) = R_H\left(\underbrace{\frac{1}{3^2} - \frac{1}{2^2}}_{\frac{1}{9} - \frac{1}{4}}\right)$ ~~$= R_H\left(\frac{1}{(3-2)^2}\right)$~~

$= 2.18 \times 10^{-18}\,J \times \left(\frac{1}{9} - \frac{1}{4}\right) = -3.03 \times 10^{-19}\,J$

Since $\Delta E = -ve$ ... the atom **lost** energy by **emitting** a photon of light with $E_{photon} = +3.03 \times 10^{-19}\,J$

What's λ?

$$E_{photon} = h\nu = \frac{hc}{\lambda}$$

ν = frequency ($\frac{1}{s}$ or s^{-1} or Hz)

c = speed of light, $c = 3.00 \times 10^{8}\,m/s$

h = Planck's constant $= 6.626 \times 10^{-34}\,J \cdot s$

λ = wavelength

So $E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{E} =$

$$\lambda = \frac{6.626 \times 10^{-34}\,J \cdot s \times 3.00 \times 10^{8}\,m/s}{3.03 \times 10^{-19}\,J}$$

$$= 6.56 \times 10^{-7}\,m$$

in nm... $n = 10^{-9}$

$nm = 10^{-9}\,m$

$$\Rightarrow \lambda(nm) = \frac{6.56 \times 10^{-7}\,m \;|\; 1\,nm}{\;|\; 10^{-9}\,m}$$

$= 656\,nm$ (RED)

What λ of light corresponds to an e^- undergoing a transition from $n=1 \longrightarrow n=2$.

$n_i = 1$ $n_f = 2$

$$\Delta E = R_H\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$$

$$= 2.18 \times 10^{-18}\,J\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$$

$$= +1.635 \times 10^{-18}\,J$$

$\Rightarrow$ Atom will **absorb** light with

$E_{photon} = 1.635 \times 10^{-18}$ J.

$$E = h\nu = \frac{hc}{\lambda}$$

$$\Rightarrow \lambda = \frac{hc}{E} = \frac{6.626\times10^{-34}\ J.s \times 3.00\times10^{8}\ \frac{m}{s}}{1.635\times10^{-18}\ J}$$

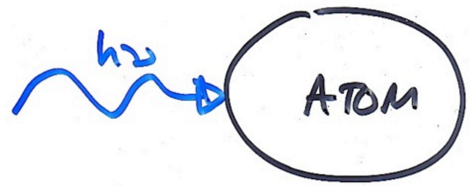
$$= 1.22\times10^{-7}\ m$$

$$\lambda = \frac{1.22\times10^{-7}\ m}{} \times \frac{nm}{10^{-9}\ m} = 122\ nm$$ (uv)

$$\frac{10^{-7}}{10^{-9}} = 10^{+2}$$

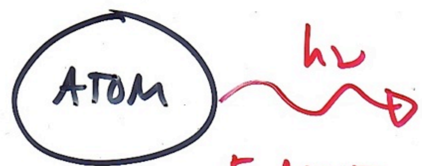
$$= 10^{-7--9} = 10^{-7+9} = 10^{+2}$$

If $\Delta E = +ve$



ABSORBS light

If $\Delta E = -ve$



EMITS light

Particles + Wave

de Broglie:

Planck's Constant

$$\lambda = \frac{h}{m \cdot u}$$

wavelength

mass of particle

speed of particle

($m \cdot u$ = momentum)

MATTER WAVES!

ex: electron, $M_e = 9.1094 \times 10^{-31}$ kg
if it travels @ speed of 25,000 m/s
what's its λ?

$$\lambda = \frac{h}{m \cdot u} = \frac{6.626 \times 10^{-34}\ J \cdot s}{9.1094 \times 10^{-31}\ kg \cdot 25{,}000\ m/s}$$

$$= 2.9 \times 10^{-8}\ m$$

$$= 29\ nm$$

$\left(1 J = \frac{1\ kg\,m^2}{s^2}\right)$

BLUE-LIGHT: 400 nm
UV-Light: 10-400 nm
X-Rays? <10 nm