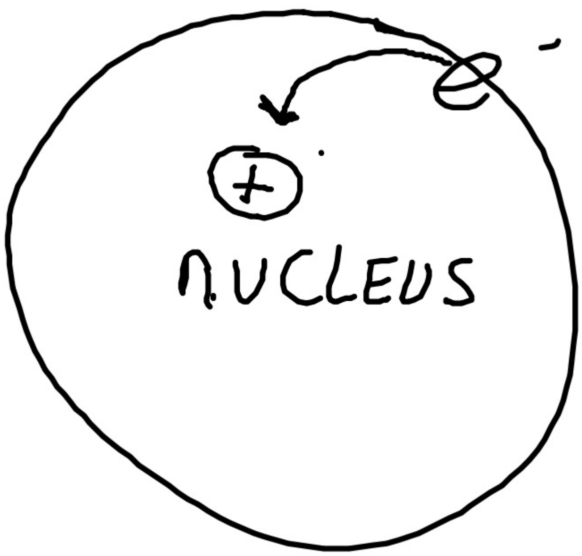
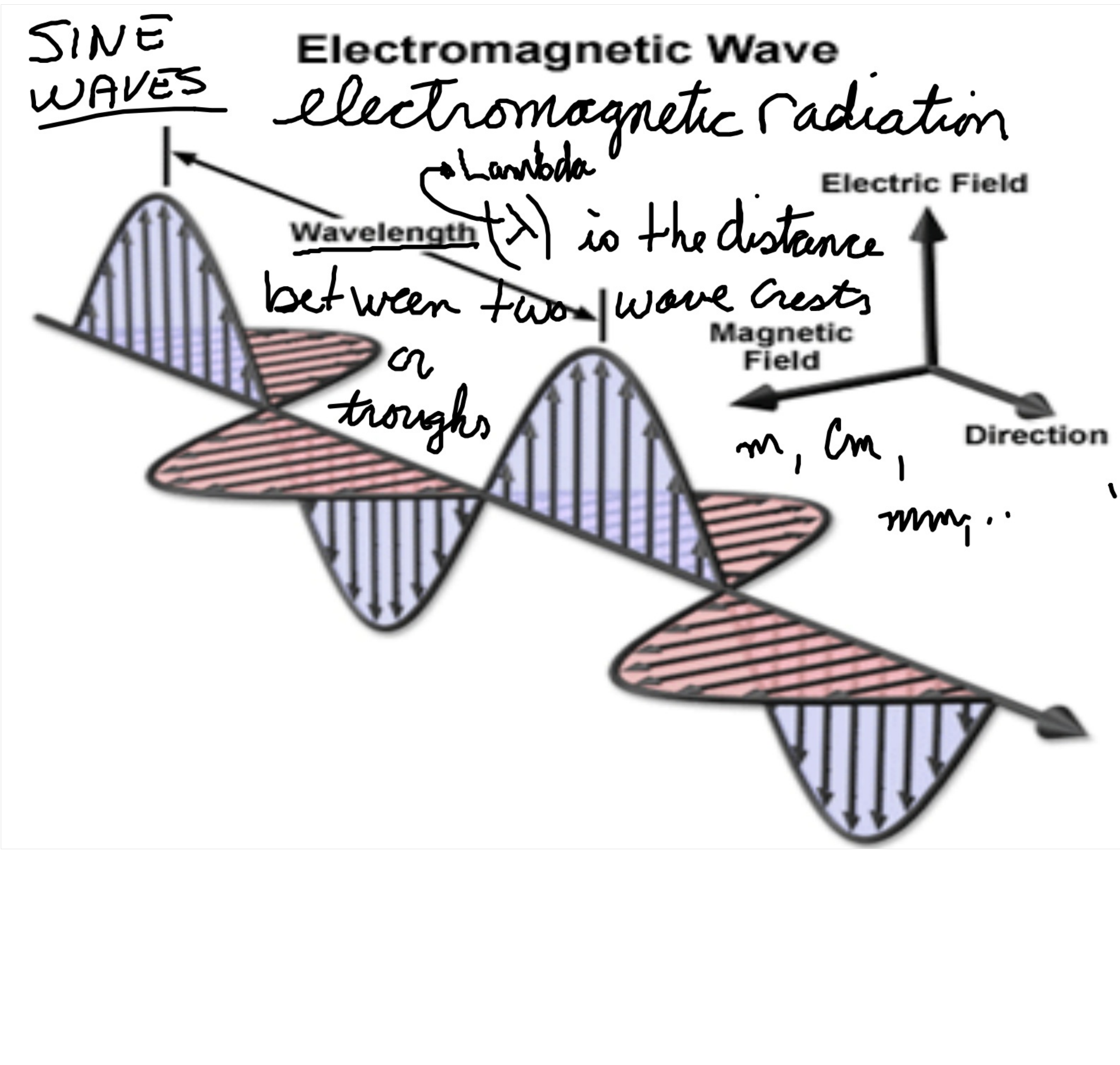
ATOMIC MODEL – RUTHERFORD

PLANETARY ATOM



ELECTRONIC CONFIGURATION

1865, JAMES MAXWELL
STUDIED LIGHT
DEVELOPED A COMPLICATED
EQUATION TO DESCRIBE LIGHT

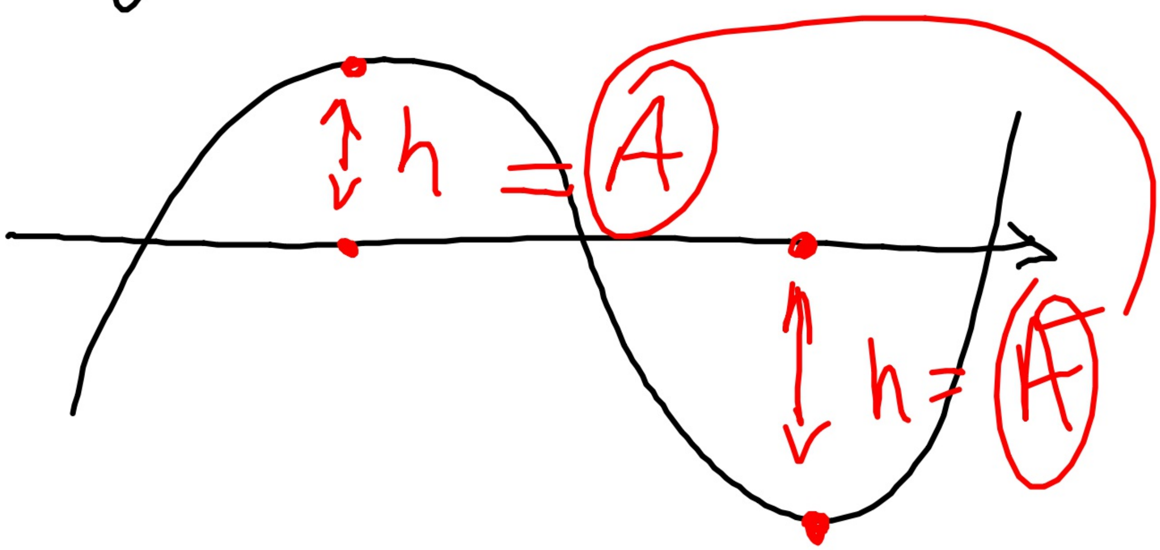

SINE WAVES
Electromagnetic Wave
electromagnetic radiation
Lambda
Wavelength (λ) is the distance between two wave crests or troughs
Electric Field
Magnetic Field
Direction
m, cm, mm, ..

<u>frequency</u> (ν, nu) is the number of complete waves that pass a point per unit time

Units: $\frac{\text{cycles}}{s}$ $\left(\frac{1}{s}, s^{-1}\right)$ =

hertz (hz)

AMPLITUDE (A) is the height of the wave



Speed of e.r.

$$\nu \times \lambda = c = 3.0 \times 10^{8}\ m/s$$

$(186{,}000\ mi/s)$

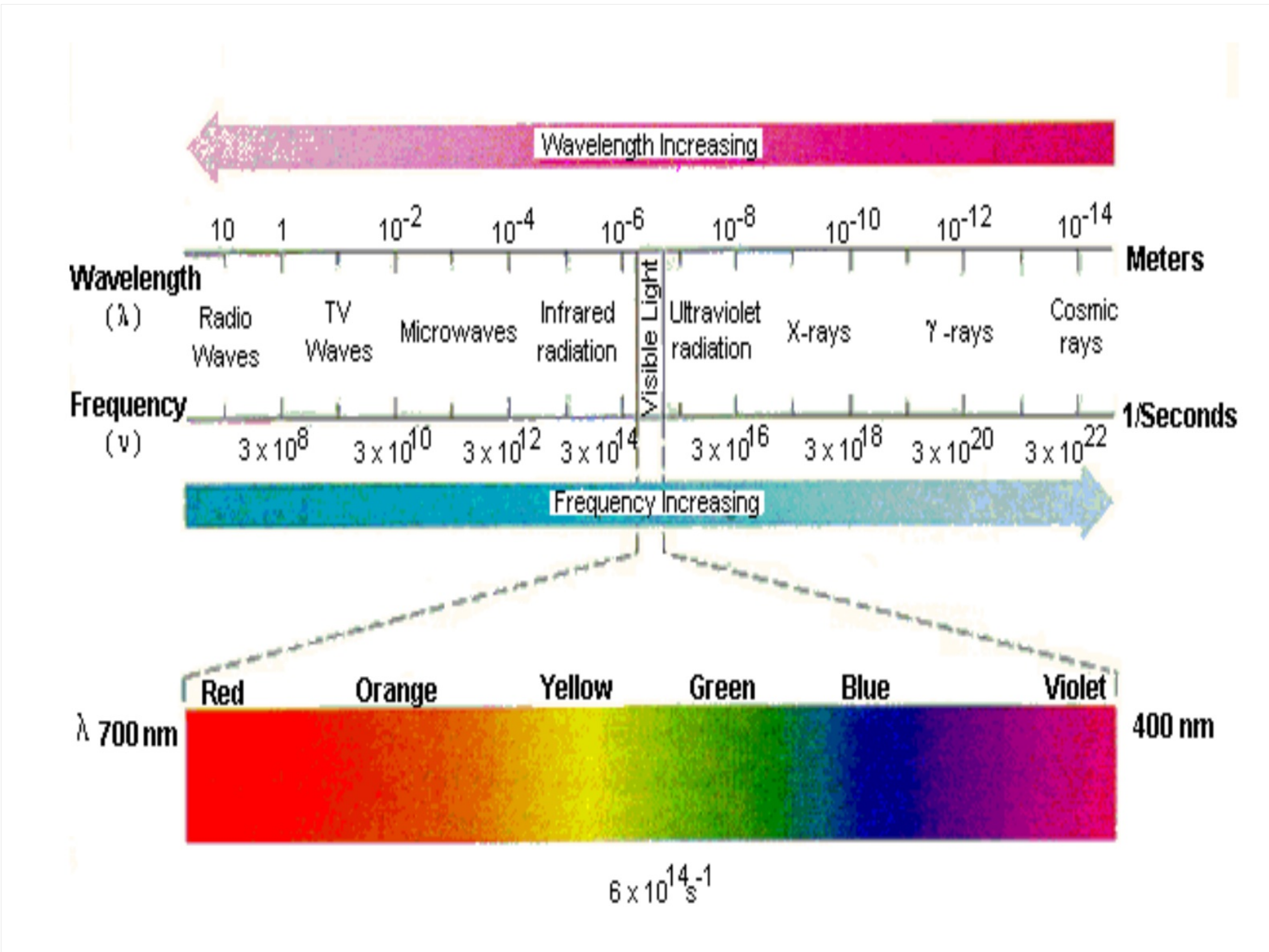
$$\lambda = \frac{c}{\nu}$$

$$\nu = \frac{c}{\lambda}$$

Example: $1\ hz = 1\ s^{-1}$
$1\ Ghz = 1 \times 10^9\ s^{-1}$

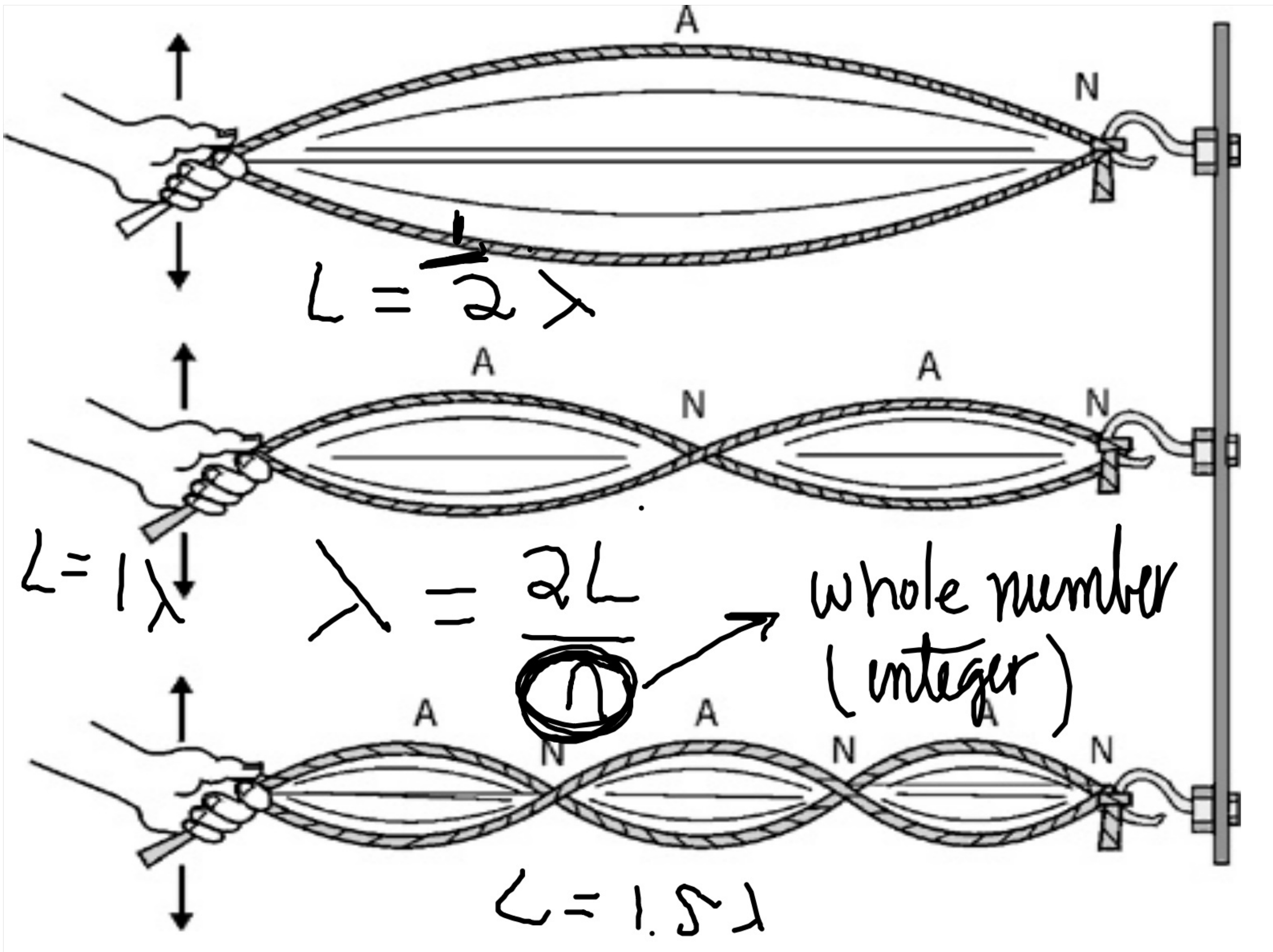
the microwave radiation in microwave ovens in the U.S. has a frequency, ν of 2.5 Ghz. What is its wavelength, λ?

$$\lambda = \frac{c}{\nu} = \frac{3.0 \times 10^8\ m/s}{2.5 \times 10^9\ s^{-1}} = 0.122\ m$$



Wavelength Increasing
10
1
10-2
10-4
10-6
10-8
10-10
10-12
10-14
Meters
Wavelength
(λ)
Radio Waves
TV Waves
Microwaves
Infrared radiation
Visible Light
Ultraviolet radiation
X-rays
γ -rays
Cosmic rays
Frequency
(ν)
1/Seconds
3 x 10^8
3 x 10^10
3 x 10^12
3 x 10^14
3 x 10^16
3 x 10^18
3 x 10^20
3 x 10^22
Frequency Increasing
Red
Orange
Yellow
Green
Blue
Violet
λ 700 nm
400 nm
6 x 10^14 s-1

STANDING OR STATIONARY
WAVES - A WAVE THAT
CAN NOT TRAVEL


A
N
L = 1/2 λ
A
N
A
N
L = 1 λ
λ = 2L / n
whole number (integer)
A
N
A
N
A
N
L = 1.5 λ

<u>1900</u> MAX PLANCK

<u>ASSUMED</u> LIGHT or ER is ABSORBED OR EMITTED IN SMALL PACKETS (QUANTA)

$$\varepsilon = h\nu$$

h → PLANCK'S Constant

$h = 6.626 \times 10^{-34}\ J \cdot s$

JOULE (J) = $1\ \frac{kg\ m^2}{s^2}$

<u>Ex</u>: $\lambda = 635\ nm$ $\nu = 4.80 \times 10^{14}\ s^{-1}$

ORANGE LIGHT

$E_{OL} = (6.626 \times 10^{-34}\ J \cdot \cancel{s})(4.80 \times 10^{14}\ \cancel{s^{-1}})$

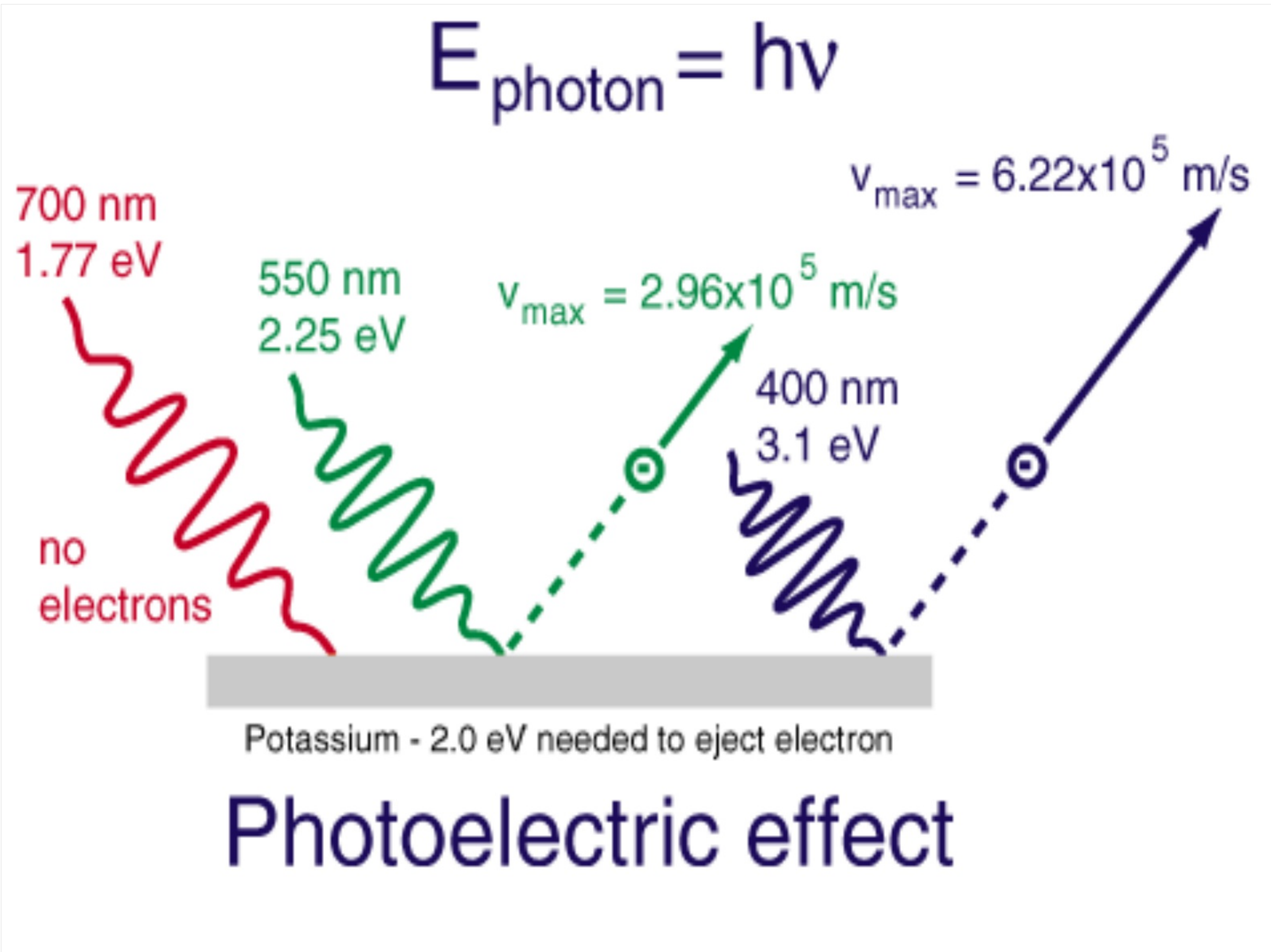
$= 3.18 \times 10^{-19}\ J$

<u>1905</u> ALBERT EINSTEIN

PHOTOELECTRIC EFFECT

treat er AS A MASSLESS PARTICLE

Quanta ⟶ <u>photons</u>


$E_{photon} = h\nu$
700 nm
1.77 eV
no
electrons
550 nm
2.25 eV
$v_{max} = 2.96 \times 10^5$ m/s
400 nm
3.1 eV
$v_{max} = 6.22 \times 10^5$ m/s
Potassium - 2.0 eV needed to eject electron
Photoelectric effect

Ex: using $E_{photon} = h\nu$

CD PLAYERS USE LASERS TO EMIT RED LIGHT with $\lambda = 685$ nm

WHAT IS THE ENERGY OF ONE PHOTON OF THIS LIGHT? 1 mol OF PHOTONS?

$$E_{rl} = (6.626 \times 10^{-34}\ J \cdot \cancel{s})(4.38 \times 10^{14}\ \cancel{s^{-1}})$$

$$= 2.90 \times 10^{-19}\ J/\text{photon}$$

$$\times 6.022 \times 10^{23}\ \frac{\text{photons}}{\text{mol}}$$

175 kJ

$$\nu = \frac{c}{\lambda} \qquad c = 3.0 \times 10^{8}\ m/s$$

$$\nu = \frac{3.0 \times 10^{8}\ m/s}{6.85 \times 10^{-7}\ m} = 4.38 \times 10^{14}\ s^{-1}$$

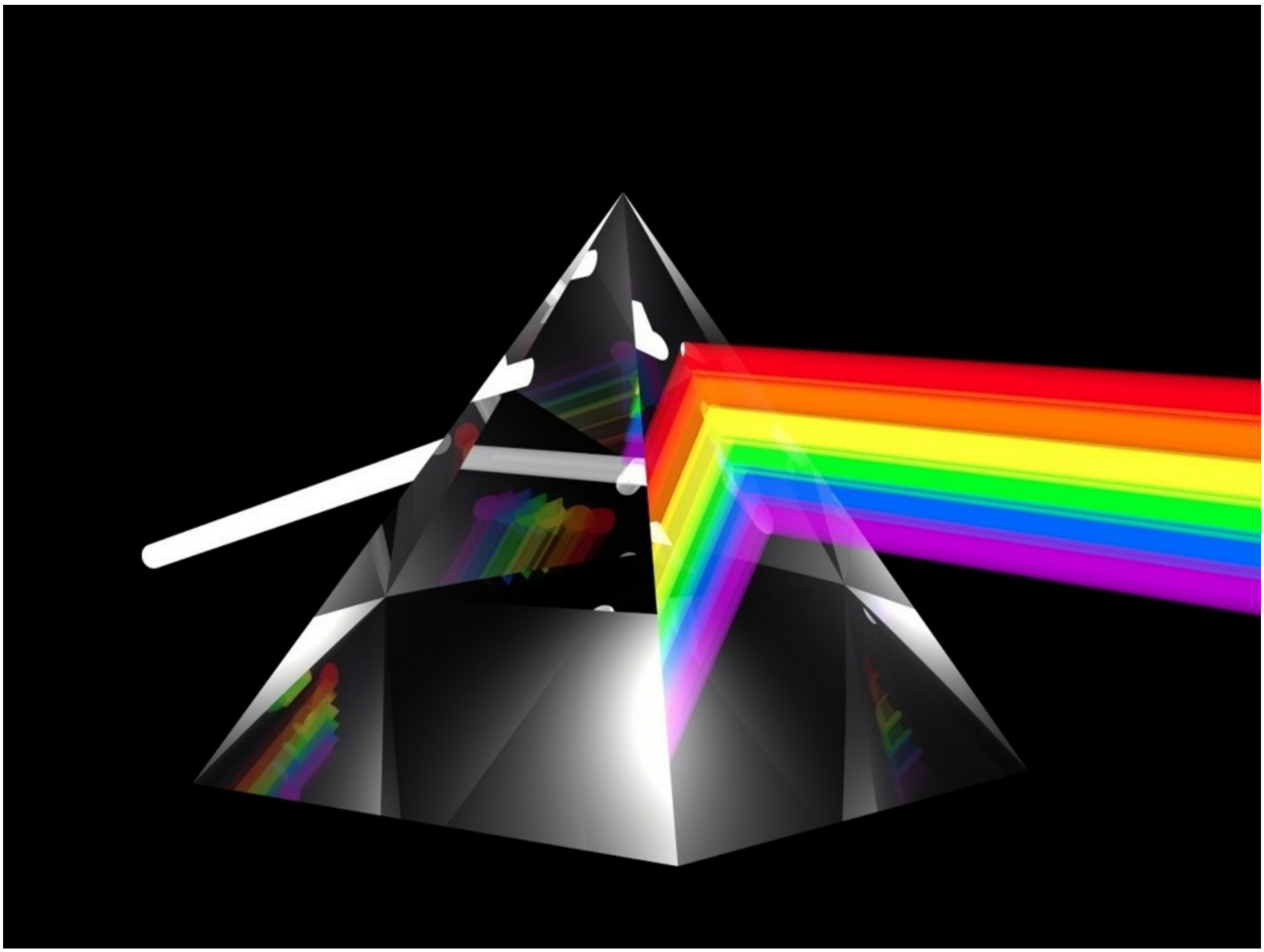
$$\lambda = 685\ nm = 6.85 \times 10^{-7}\ m$$

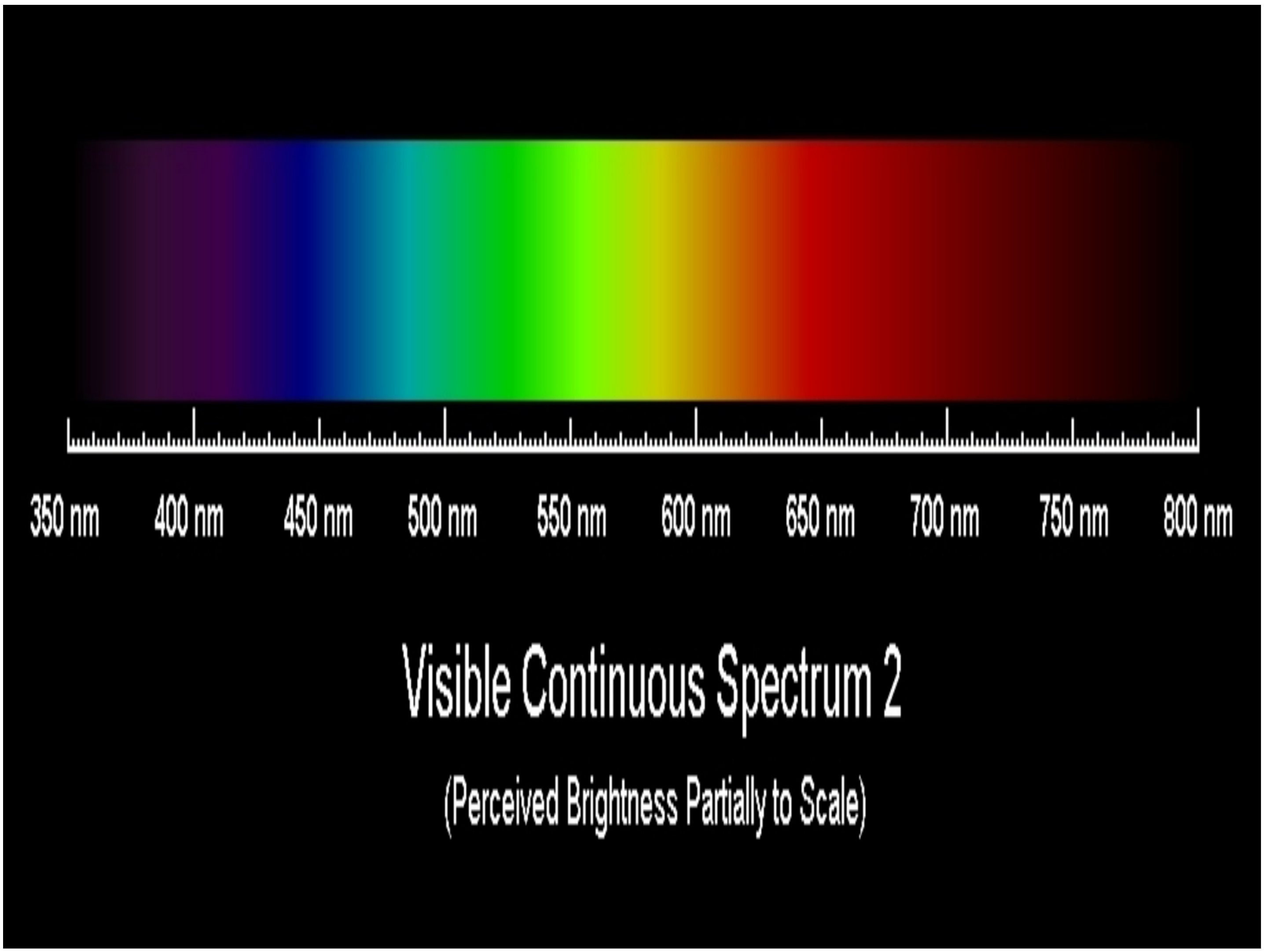
Spectra

<u>CONTINUOUS SPECTRUM</u> energies of er blend together

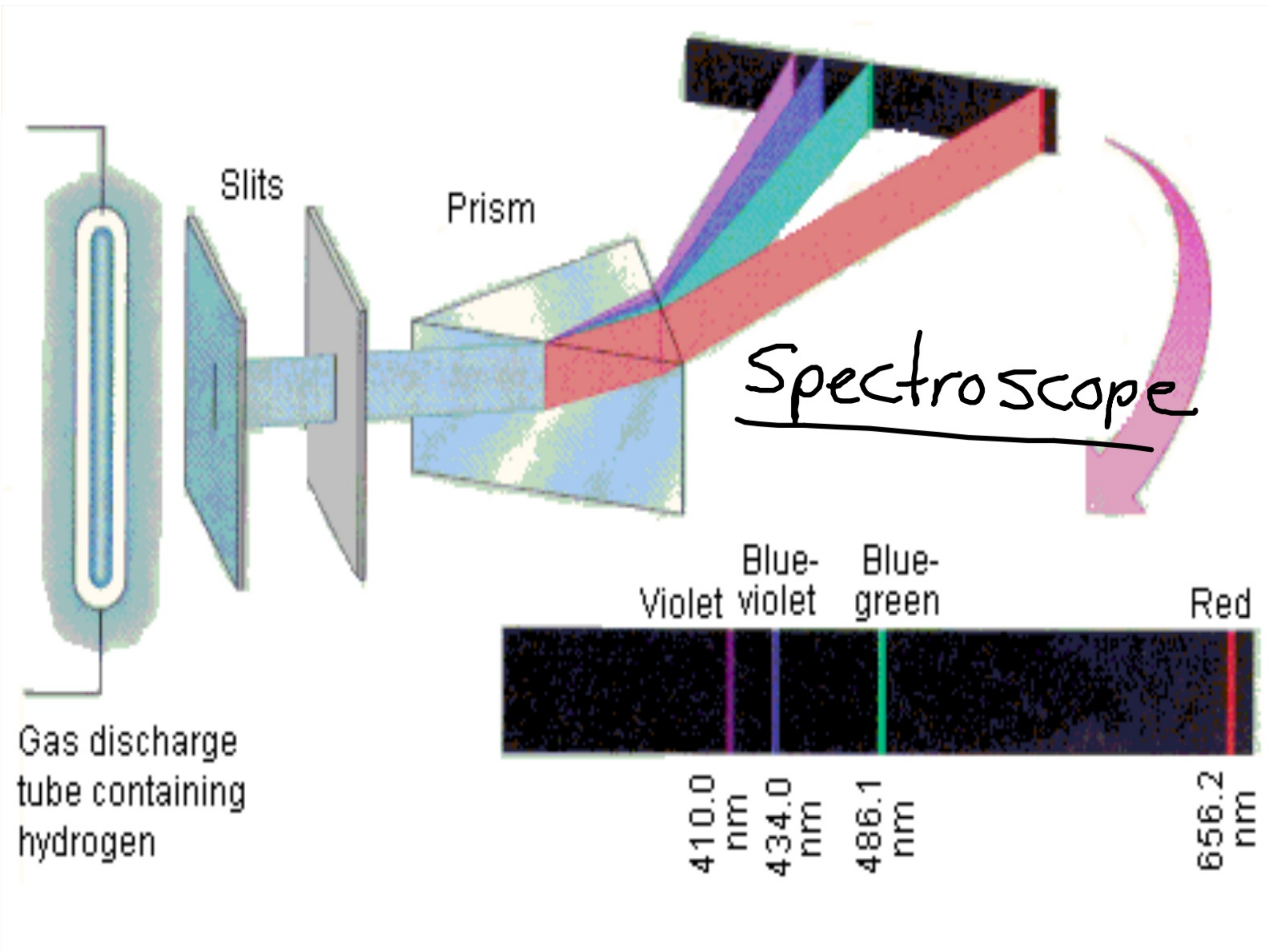
<u>LINE EMISSION SPECTRUM</u>

(BRIGHT LINE SPECTRUM) – NARROW BANDS OF Color

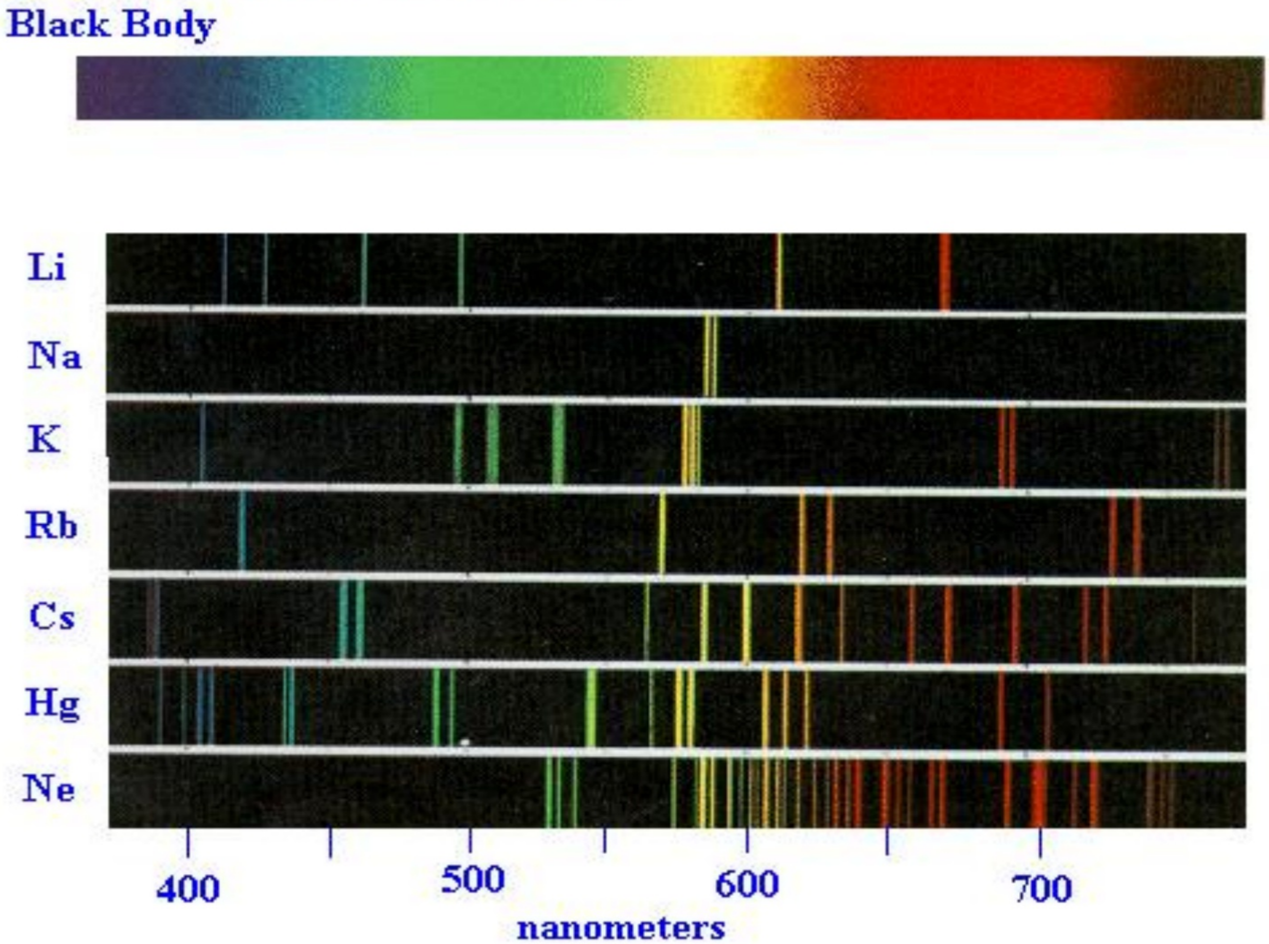


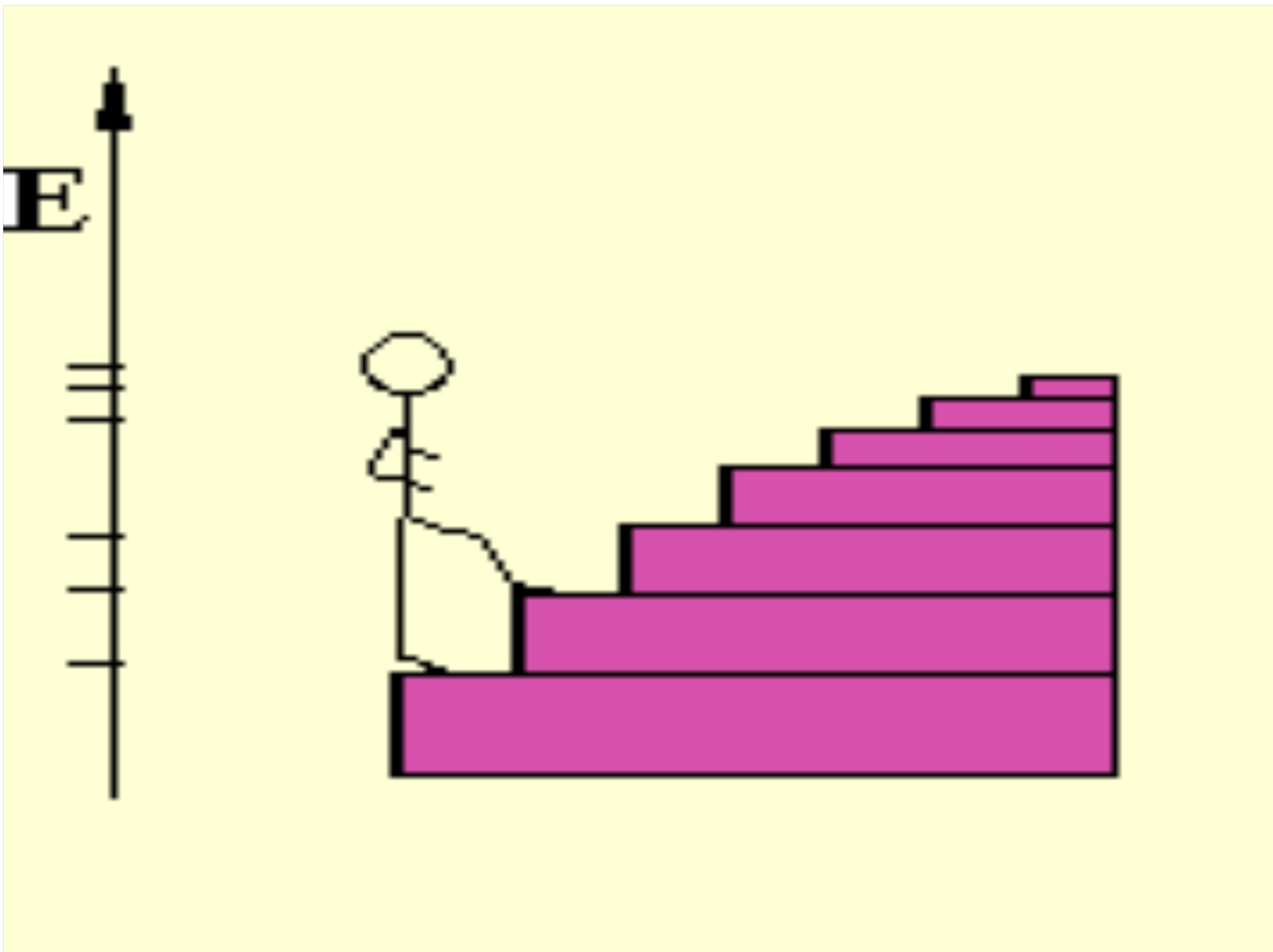


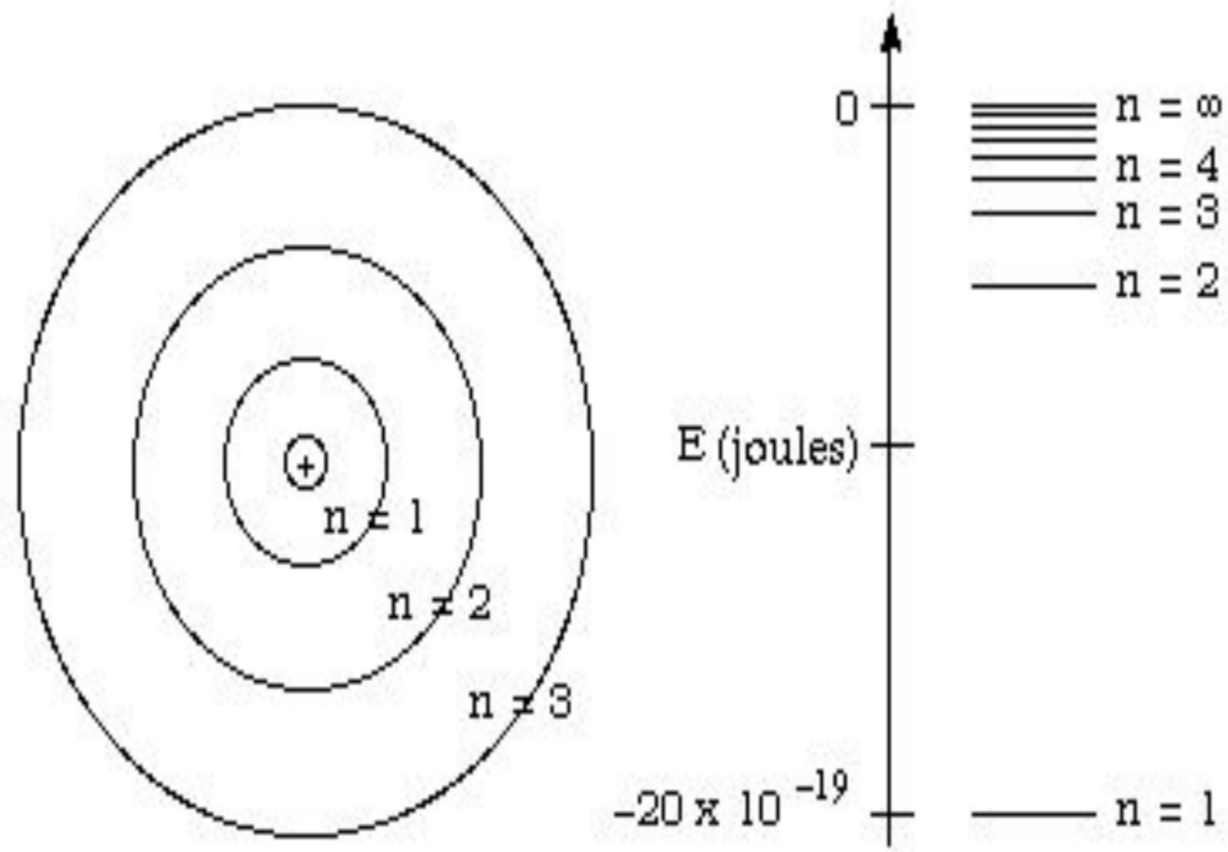
350 nm
400 nm
450 nm
500 nm
550 nm
600 nm
650 nm
700 nm
750 nm
800 nm
Visible Continuous Spectrum 2
(Perceived Brightness Partially to Scale)


Slits
Prism
Spectroscope
Gas discharge tube containing hydrogen
Violet
Blue-violet
Blue-green
Red
410.0 nm
434.0 nm
486.1 nm
656.2 nm

Black Body and Line Spectra




E



The three orbits closest to the nucleus

Energy levels