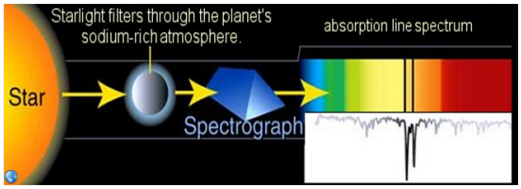
4.1 – Light and Quantized Energy



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1. Flame Observation

I will heat different elements in a flame. What do you see as different metals are heated?

Electrons in elements are responsible for chemical properties as well as physical characteristics.

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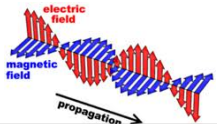
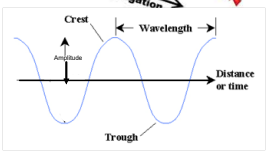
Electromagnetic (EM) Radiation

Energy with oscillating electric and magnetic components, with both wave-like and particle-like behavior.





Characteristics:
Wavelength (λ = lambda): distance between equivalent points of a wave. Units = m.
Frequency (ν = nu): waves passing a point in one second. Units: cycles/second, or Hz (Hertz).
Amplitude: height from axis to crest or trough.

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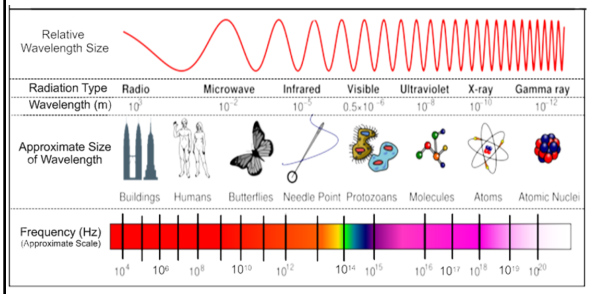
EM Spectrum Resource P. 2

Six types: radio, microwave, infrared, visible, ultraviolet, x-ray, gamma-ray.



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Wave Equation

Unites frequency and wavelength through speed:

$$c = \lambda \nu$$

c = speed of light (3.00 E 8 m/s). **All** EM radiation travels at this speed.
λ = wavelength (m) (Greek letter lambda)
ν = frequency (Hz, or cycles/second) (Greek letter nu)

Other algebraic derivations:

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

Terrible Chemistry Joke:

Nerdy Person 1: What's new?

Nerdy Person 2: c over lambda!

(What's nu? Get it?)

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2. Frequency Example

What is the frequency of EM radiation with a wavelength (λ) of 8.72 E – 2 m?

$$c = \lambda \bullet \nu$$

$$\nu = \frac{c}{\lambda} = \frac{3.00\,E\,8\,m/s}{8.72\,E-2\,m} = 3.44\,E\,9\,Hz$$

What type of radiation is it?

λ of 10^{-2}m = microwave.

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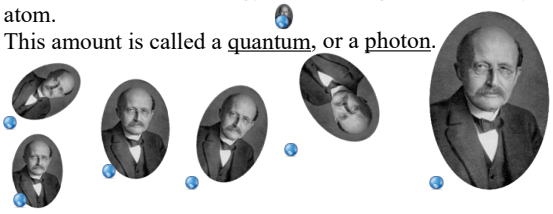
Deficiency 1: Heating Metals

Heating metals makes them emit colors at different temperatures.

Max Planck (in 1900) proposed that the energy emitted by a hot object is "quantized". This means that there is a minimum amount of energy that can be gained or lost by an atom.

This amount is called a quantum, or a photon.



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Energy Equation

Planck's equation calculates the energy of a photon:

$$E_{Photon} = h \bullet \nu$$

h = Planck's Constant: 6.63 E -34 J·s

ν = frequency of the radiation. (units = 1(cycle)/s)

A Joule (J) is the SI unit of energy.

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3. Energy Example

What is the energy of a photon with a frequency of 7.23 E 14 Hz?

$$E_{Photon} = h \bullet \nu = (6.63E-34 J \bullet s)(7.23E14/s)$$
$$= 4.79E-19 J$$

What type of radiation is this? Use Resources P. 2.

Visible/ultraviolet radiation.

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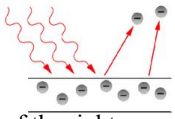
Deficiency 2: The Photoelectric Effect

Makes solar panels work.

Electrons are ejected from the surface of a metal when photons of a specific minimum frequency or greater shine on it.



Significance: if a light source is not of the right frequency, the photoelectric effect won't happen no matter how intense.

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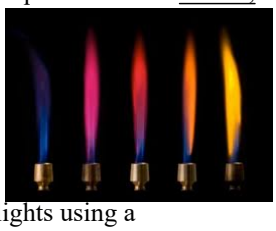
Deficiency 3: Elemental Spectra

All elements emit specific frequencies when heated, .

Cold elements absorb those same frequencies.



Demo: Look at fluorescent lights using a spectroscope to see mercury's emission spectrum.

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Homework

Preview 4.2

4.1 Problems in your Booklet
Due: Next Class

Lab Soon! –
be prepared.

Planck is watching you.

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