


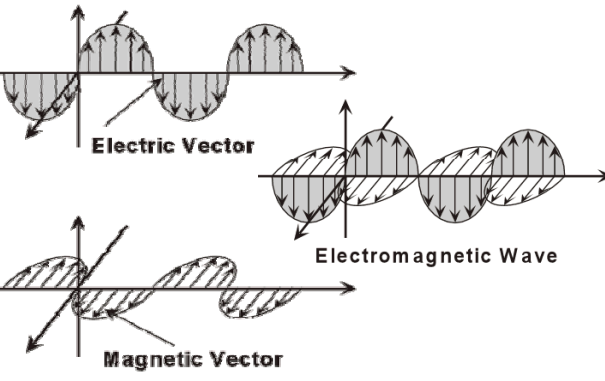
Electromagnetic Waves

Electromagnetic Radiation – form of energy that has wavelike behavior as it travels through space (light, radio waves, x-rays, etc.)



Electromagnetic Spectrum – all forms of electromagnetic radiation presented together (Visible light is only a tiny part ,p92)

Electromagnetic Wave

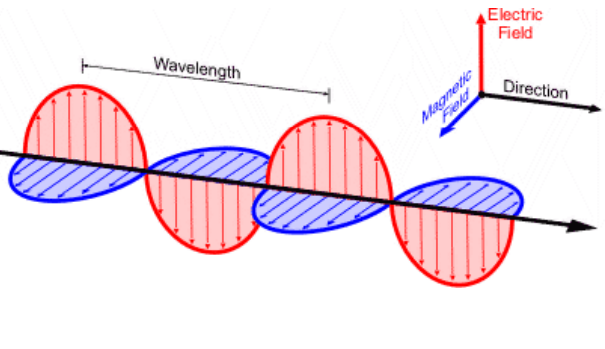


Electric Vector

Magnetic Vector

Electromagnetic Wave

Electromagnetic Wave



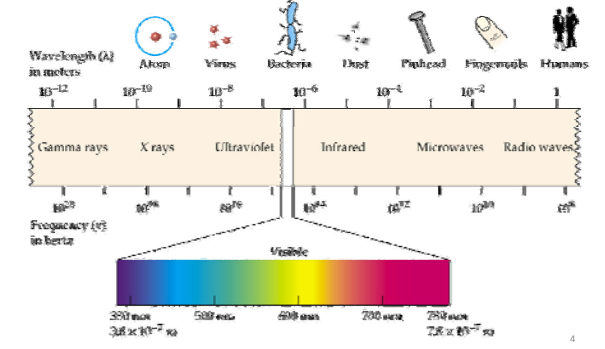
Wavelength

Electric Field

Magnetic Field

Direction

Electromagnetic Spectrum



Wavelength (λ) in meters

Frequency (ν) in hertz

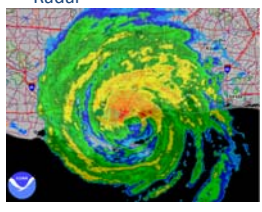
Visible

380 nm, 500 nm, 600 nm, 700 nm, 750 nm


The Electromagnetic Spectrum

Radiation Sources	Type of Radiation	Wavelength (m)	Detectable Objects
Radio antenna	Radio waves	10^2 m (1 km) to 100 m	House
Klystron or magnetron	Microwaves	10 m to 1 m	Baseball
Laser	Infrared	10^{-3} m (0.1 mm) to 1 cm	Eye
Lamps and lasers	Light	10^{-6} m (1 μ m)	Cell
Synchrotron radiation sources	Ultraviolet	10^{-8} m (1 nm)	Virus
X-ray tubes	X rays	10^{-10} m (1 pm)	Molecule
Radioactive sources	Gamma rays	10^{-12} m	Atom
Particle accelerators		10^{-15} m	Nucleus
			Proton


Radar




Infrared



UV



X-ray



EM and Mechanical Waves

Both are waves and both contain energy. They transfer energy from one point to another.

Sound cannot be converted into light since sound waves by definition are mechanical waves and light is electromagnetic radiation.

Travel Properties

Sound waves need a medium to travel. Mechanical waves travel faster through a more dense medium. They cannot travel through a vacuum.

EM waves do not need a medium to travel. Electromagnetic waves travel fastest through a vacuum and slower through more dense mediums.

Section 4-1 Frequency and Wavelength

$$c = \lambda \nu$$

$$c = \lambda f$$

$$c = 3 \times 10^8 \text{ m/s (speed of light)}$$

$$\lambda = \text{lambd} \quad \nu = \text{nu}$$

Inverse relationship between frequency(ν) and wavelength(λ)

Higher frequency \rightarrow Lower wavelength

Lower frequency \rightarrow Higher wavelength

c is always constant

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Section 4-1 Developing the Bohr Model

Quantum – minimum quantity of energy that can be lost or gained by an atom

Max Planck related energy of electromagnetic radiation to its frequency

$$E = hf$$

$$E = h\nu$$

$$h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s (Planck's Constant)}$$



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$$E_{\text{photon}} = h\nu$$

700 nm
1.77 eV

550 nm
2.25 eV

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

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

400 nm
3.1 eV

no electrons

Potassium - 2.0 eV needed to eject electron

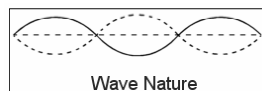
Photoelectric effect

Section 4-1 Developing the Bohr Model

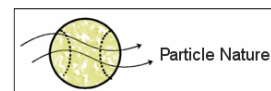
Albert Einstein proposed light had a dual wave-particle nature

Light behaves as a wave

Light behaves as a stream of particles



Wave Nature



Particle Nature

Photon – particle of electromagnetic radiation with zero rest mass and carrying a quantum of energy

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