

IB Physics HL Notes

Option G

Electromagnetic Waves

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Q (OPTION) Electromagnetic Waves

Types of EM

ROYGBIV

Radio Micro ~~IR~~ IR Visible UV X-ray Gamma

MEMORISE

$f \rightarrow$ $10^{2 \rightarrow 8}$ 10^{10} 10^{13} 10^{14} 10^{16} 10^{18} 10^{19+}

$+ f \rightarrow$

- Refer to by frequency, not λ , because when refracted, freq. stays constant, λ changes (may).

Characteristics:

- * $c = 3 \times 10^8 \text{ ms}^{-1}$ may/may not be considered medium
- * can be polarised
- * do not require medium (vacuum)
- * composed of electric and magnetic fields normal to each other.
- * propagate energy: $E \propto f$ photon's constant
- * transverse waves $E = hf$

- As an electric field is created, it also creates a magnetic field normal to the former.

* Source of EM wave: \pm accelerating electric charge

- visible light \rightarrow electron transitions

- gamma \rightarrow electron bombardment at a metal sheet.

- etc.

* Fields are sinusoidal, with f , λ , T

* Speed of light is dependent on medium. $n = \frac{c}{v}$ $c \leftarrow 3 \times 10^8$
speed of light in med.

$$n_{\text{water}} = 1.33 \rightarrow v_{\text{water}} = \frac{3 \times 10^8}{1.33}$$

* "Radiation" is referred to as "pure energy".

* With matter, not "radiation" \rightarrow α radiation He nucleus
 \rightarrow β radiation electrons

LIGHT

* $E = hf \Rightarrow h = 6.6 \times 10^{-34} \text{ Js}$

* Light has wave-particle duality

Source of each E.M. wave:

* Radio waves: "oscillator" \rightarrow oscillating electric current



* Microwaves: semiconductors \rightarrow deceleration of a current
- phones, radar, cooking

* Infrared: outer e^- in heated objects \rightarrow E_k of e^-
- wireless communication
- 'heat'
- IR NMR spectra.

* Visible light: e^- falling to lower energy levels.
ROYGBIV
400 \rightarrow 750 nm
- illumination
- coloured
- chemical reactions in eye.

* UV rays: outer orbital e^- of the sun.
- induces more chemical reactions
- substitution reaction catalyst

* X-rays: bombardment of electrons into a metal
- e^- slow down rapidly
- higher energy, more damaging
- medical application.

* Gamma rays γ :
 γ - cancer therapy