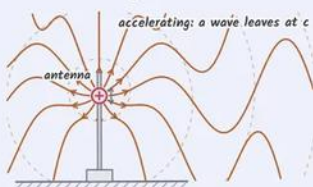


Electromagnetic Waves and Communication System

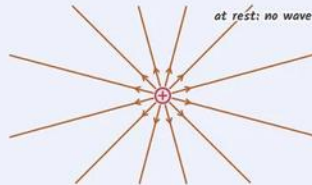
the spectrum, propagation, and the elements of a communication link

What an EM wave is *

- Maxwell's equations link E and B: Gauss's laws for E and for B
- Faraday: a changing B induces an emf; Ampere-Maxwell: a current or changing E makes B
- charge at rest: only a steady E; steady speed: a steady B too; still no wave
- an accelerated charge radiates: oscillating E makes oscillating B, which regenerates E
- the wave has the frequency of the charge's oscillation; its energy comes from the source



a charge oscillating on an antenna: kinks in its field lines travel out at c , an electromagnetic wave



a charge at rest: straight, still field lines, no wave

learn these Speed and the E-B ratio

speed in free space

$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}} = 3 \times 10^8 \text{ m s}^{-1}$$

speed in a medium

$$v_m = \frac{1}{\sqrt{\mu \epsilon}}$$

ratio of amplitudes

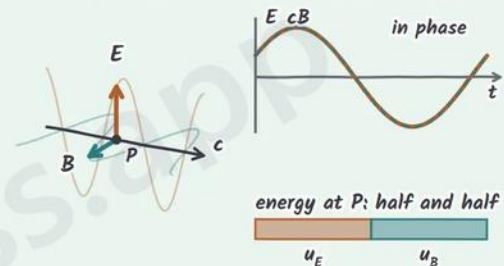
$$\frac{E_0}{B_0} = c$$

intensity

$$I \propto E_0^2 \propto B_0^2$$

frequency and wavelength

$$c = f\lambda$$

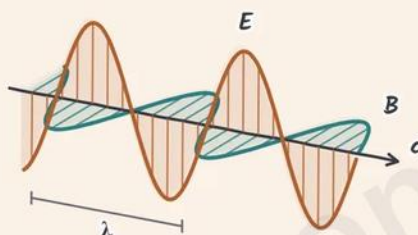


at one point E and B rise and fall together; the energy is shared equally, $u_E = u_B$

E is often called the **light vector**, since E_0 dominates the optical effects. $E \times B$ points along the travel direction

Characteristics of EM waves

- needs no medium: it crosses vacuum
- E, B and the propagation direction are mutually perpendicular, so EM waves are transverse
- E and B oscillate in phase: they peak together
- obey superposition; carry no charge, so E and B fields don't deflect them



$E \perp B \perp c$, in phase

E (up and down) and B (sideways) along the travel direction: perpendicular, in phase, moving on at c