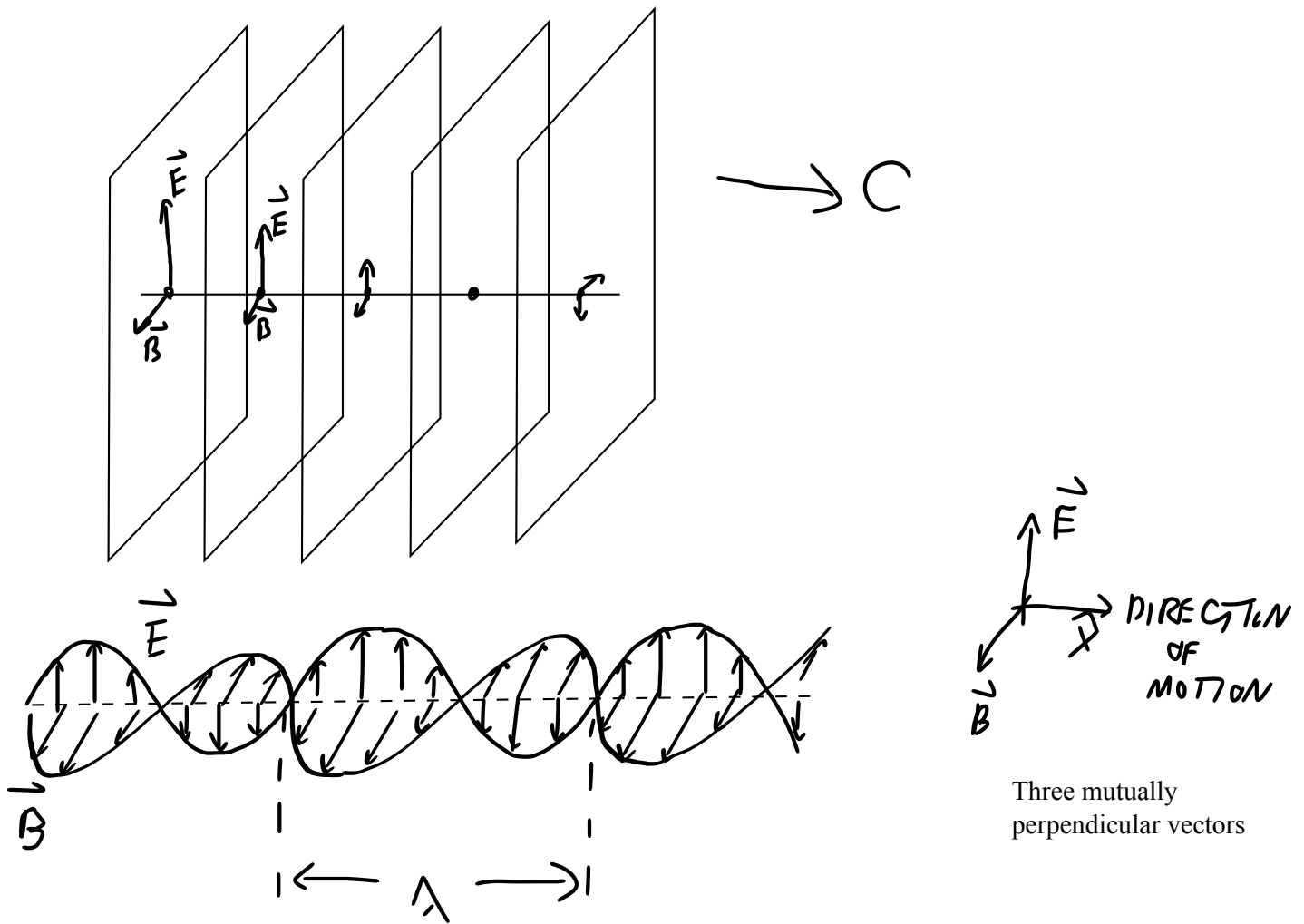


## Classical radiation

Maxwell's equations allow for solutions with no sources: space-filling plane electromagnetic waves:



-> clicker question

IN EQUATIONS

$$\vec{E}(t, x) = \vec{E}_0 \cos \left( 2\pi \left( \frac{x}{\lambda} - ft \right) + \phi \right)$$

Amplitude and polarization (direction of E-field)

FREQUENCY  $\downarrow$   $f$

PHASE  $\downarrow$   $\phi$

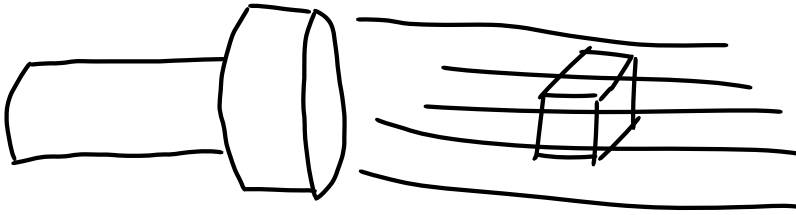
WAVELENGTH  $\uparrow$   $\lambda$

All radiation is simply linear superpositions (sums) of plane waves with different amplitudes, wavelengths, phases and polarizations.

-> clicker question

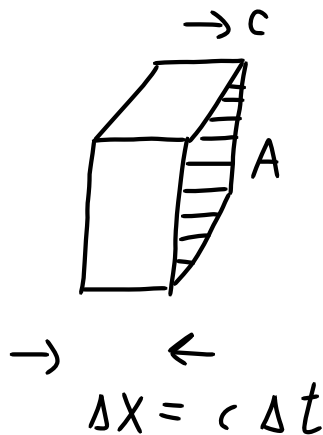
-> look at the spectrum picture

Light carries momentum and energy:



$$\text{ENERGY DENSITY } e = \frac{\text{ENERGY}}{\text{VOLUME}} \propto |E_0|^2$$

$$\text{INTENSITY} = \frac{\text{ENERGY}}{(\text{AREA})(\text{TIME})} = \bar{I}$$



All the energy in this box will cross the Area to the right in time  $\Delta t$  if the box has depth  $\Delta x = c \Delta t$

$$\bar{I} = \frac{e (A) (\Delta t c)}{A \Delta t} = e c \propto |E_0|^2$$

Intensity  $\propto (\text{Amplitude})^2$

-> clicker question

What produces radiation?

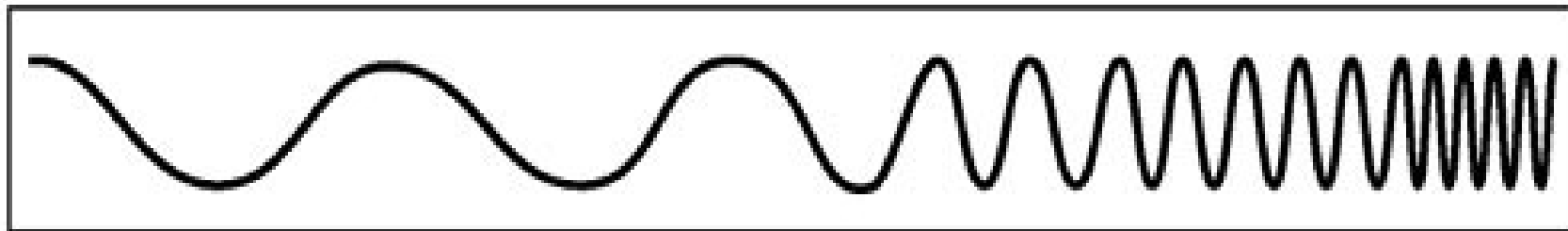
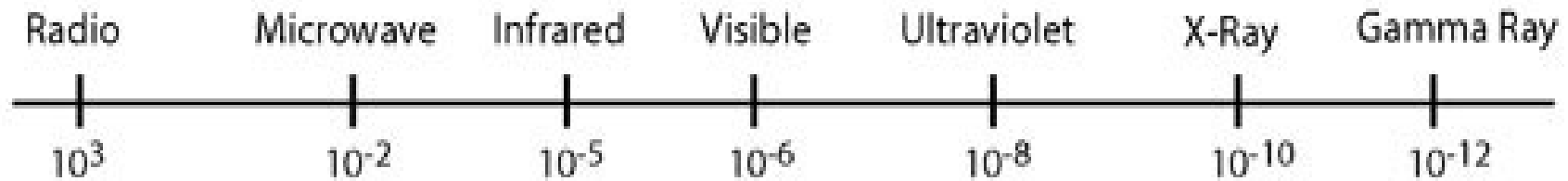
A: accelerating charges.

-> clicker question



# THE ELECTRO MAGNETIC SPECTRUM

Wavelength  
(metres)



Frequency  
(Hz)

