

# Energy, Wavelength, Frequency Relationships

Planck-Einstein Relation

$$E = h\nu = hc/\lambda$$

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

Higher frequency → Higher energy  
Shorter wavelength → Higher energy



## 💡 Energy in eV

$$E (\text{eV}) = 1240 / \lambda (\text{nm})$$

## ⚠️ Wavelength Conversion

$$\lambda (\text{nm}) = 10^7 / \nu (\text{cm}^{-1})$$

## ⌚ Frequency Relation

$$\nu (\text{Hz}) = c / \lambda (\text{m})$$

## 🌟 Photon Flux

$$\Phi = P / (h\nu)$$

photons per second

~2 eV

Visible light  
photosynthesis

~0.1 eV

IR vibrations  
molecular bonds

~4 eV

UV damage  
DNA breaks

~25 meV

$k_B T$  at 25°C  
thermal energy

## ⚡ Biological Energy Scales