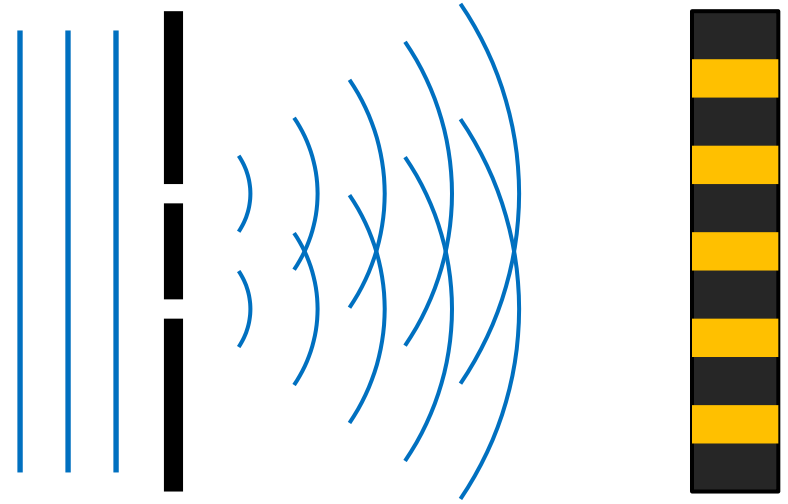


Essential Question

Is light a wave or a particle?

Light Acts Like a Wave

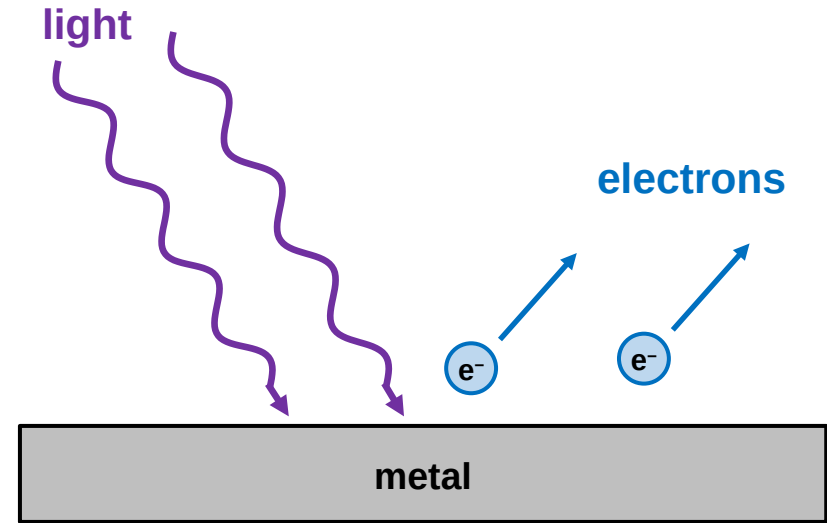
- Interference: bright and dark bands
- Diffraction: spreads past edges
- Refraction: bends in new materials



two slits: bright and dark bands

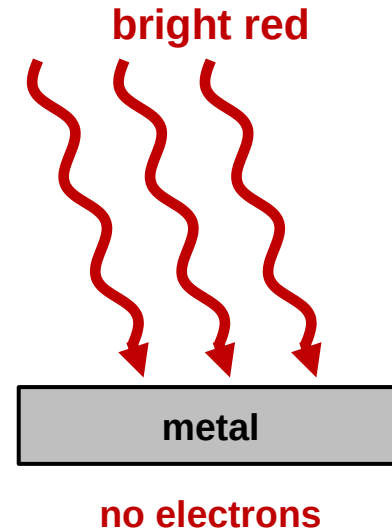
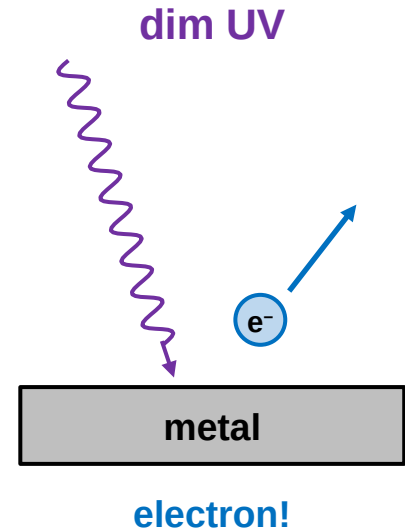
The Photoelectric Effect

- Light shines on a metal
- Electrons get knocked out
- Used in solar cells and sensors



The Puzzle: Frequency Matters

- Needs a minimum frequency
- Bright red light: no electrons
- Dim UV light: electrons fly out



Photons: Light in Packets

$$E = h f$$

E

photon energy (J)

$h = 6.63 \times 10^{-34} \text{ J}\cdot\text{s}$

Planck's constant

f

frequency (Hz)

light comes in packets called photons

Brightness vs. Frequency

- Brightness: number of photons
- Frequency: energy per photon
- Each photon needs enough energy

Brighter light

more photons each second
→ more electrons (same energy)

Higher frequency

more energy per photon
→ faster electrons

Wave-Particle Duality

- Light travels like a wave
- Light interacts like a particle
- We need both models

Wave evidence

interference, diffraction, refraction

Particle evidence

photoelectric effect

light is both

Example: Energy of a Photon

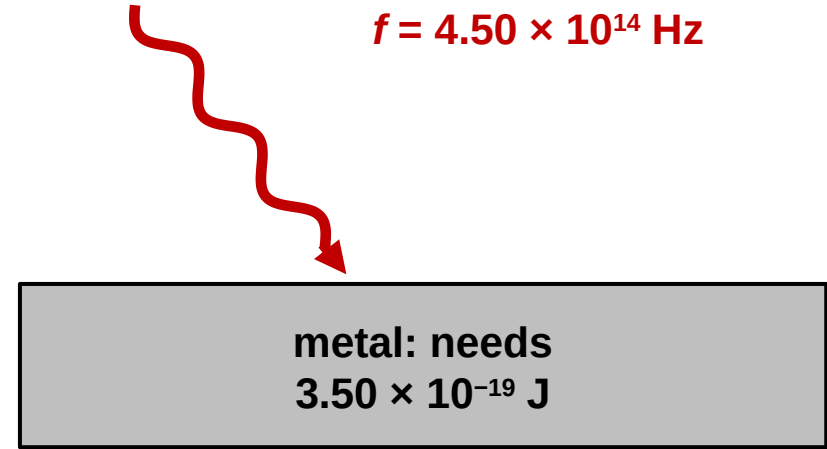
Green light has a frequency of 6.00×10^{14} Hz. What is the energy of one photon of green light?

Example: Photon from Wavelength

Ultraviolet light has a wavelength of 2.50×10^{-7} m. What is the energy of one UV photon?

Example: Will It Work?

A metal needs at least $3.50 \times 10^{-19} \text{ J}$ to free one electron. Will red light with a frequency of $4.50 \times 10^{14} \text{ Hz}$ free electrons from this metal?



Example: X-Ray Frequency

One X-ray photon carries $1.99 \times 10^{-15} \text{ J}$ of energy. What is its frequency?

Big Ideas

- Light travels like a wave
- Light hits matter as photons
- $E = hf$: higher f , more energy
- Below threshold f : no electrons