What is the Photoelectric Effect?

Worksheet

The photoelectric effect occurs when photons with enough energy strike a metal, ejecting electrons. The maximum kinetic energy of the ejected electrons follows KE_max = hf − φ, where h is Planck's constant, f is the light's frequency, and φ is the metal's work function.

$$E_k = hf - \varphi$$

E_k = Kinetic energy of electron (J)
h = Planck constant (J·s)
f = Photon frequency (Hz)
φ = Work function (J)

Questions

1. What ejects an electron in the photoelectric effect?
A) A single photon with enough energy
B) The total light intensity
C) Heat alone
D) Any frequency of light

2. Light of frequency 6×10^{14} Hz hits a metal with φ = 2.0 eV. Photon energy ≈ 2.48 eV. What is KE_max?
A) 0.48 eV
B) 2.48 eV
C) 2.0 eV
D) 4.48 eV

3. What happens if the light frequency is below the threshold frequency?
A) Electrons are emitted slowly
B) No electrons are emitted, regardless of intensity
C) Electrons are emitted with negative energy
D) More electrons are emitted

4. Which constant relates photon energy to frequency?
A) Planck's constant h
B) Gas constant R
C) Boltzmann constant alone
D) Avogadro's number

5. Light of frequency 7×10^{14} Hz hits sodium, which has a work function of 2.3 eV. Find KE_max in eV.

6. A metal has a work function of 4.5 eV. Find the threshold frequency below which no electrons are emitted.

7. Light with wavelength 500 nm hits a metal with work function φ = 2.0 eV. Is emission possible, and what is KE_max?

8. Define: What is the photoelectric effect?

9. Define: What is the photoelectric effect formula?

10. Define: What is the work function?

Answer Key

1. A) A single photon with enough energy — Emission depends on a single photon carrying enough energy (hf > φ).

2. A) 0.48 eV — KE_max = E − φ = 2.48 − 2.0 = 0.48 eV.

3. B) No electrons are emitted, regardless of intensity — Below threshold, no photon carries enough energy to overcome the work function.

4. A) Planck's constant h — E = hf, where h is Planck's constant.

5. Photon energy E = hf; in eV, E = 4.136×10^{-15} × 7×10^{14} = 2.895 eV KE_max = 2.895 − 2.3 = 0.595 eV

6. φ = 4.5 eV = 4.5 × 1.602×10^{-19} J = 7.209×10^{-19} J f0 = φ/h = 7.209×10^{-19} / 6.626×10^{-34} ≈ 1.088×10^{15} Hz

7. f = c/λ = 3×10^{8} / 500×10^{-9} = 6×10^{14} Hz E = 4.136×10^{-15} × 6×10^{14} = 2.48 eV Since 2.48 eV > 2.0 eV, yes — KE_max = 2.48 − 2.0 = 0.48 eV

8. Emission of electrons from a metal when light of sufficient frequency strikes it.

9. KE_max = hf − φ.

10. The minimum energy needed to eject an electron from a metal's surface.