

CLASS 12

PHYSICS

REVISION NOTES

Class 12 Physics Chapter 11 Dual Nature of Radiation and Matter – Revision Notes

Quick revision notes for Class 12 Physics Chapter 11 – Dual Nature of Radiation and Matter, covering the photoelectric effect, Einstein's photoelectric equation, and de Broglie's matter waves — ideal for last-minute board exam revision.

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Quick revision notes for **Class 12 Physics Chapter 11 – Dual Nature of Radiation and Matter**, covering the photoelectric effect, Einstein's photoelectric equation, and de Broglie's matter waves — ideal for last-minute board exam revision.

Electron Emission and Work Function

Electrons can be emitted from a metal surface by supplying enough energy to overcome the attractive forces holding them in — via heat (thermionic emission), strong electric fields (field emission), or light (photoelectric emission). **Work function (ϕ_0)** is the minimum energy needed to just free an electron from the metal surface with zero extra kinetic energy, measured in eV.

Photoelectric Effect

The phenomenon of electron emission from a metal surface when light of suitable frequency falls on it. Key experimental observations: emission is **instantaneous** (no time lag); it occurs only **above a threshold frequency ν_0** , regardless of intensity; the **saturation current** increases with intensity at fixed frequency; and the **maximum kinetic energy of photoelectrons depends only on frequency**, not intensity — observations the classical wave theory of light could not explain.

Einstein's Photoelectric Equation

$KE_{\max} = h\nu - \phi_0$. Light consists of discrete energy packets called **photons**, each of energy $E = h\nu$. A photon is absorbed by a single electron instantaneously and completely — explaining both the instantaneous emission and the frequency threshold ($\nu_0 = \phi_0/h$). The **stopping potential V_0** (the reverse voltage needed to just stop the fastest photoelectrons) relates to $KE_{\max}$ by $eV_0 = KE_{\max}$, giving $V_0 = (h/e)\nu - (\phi_0/e)$ — a straight line of slope h/e when plotted against ν , used experimentally (Millikan) to measure Planck's constant.

Photon: Particle Nature of Light

Each photon carries energy $E = h\nu = hc/\lambda$ and momentum $p = h/\lambda = E/c$. Photons travel at speed c , have zero rest mass, and in a photon-particle collision, energy and momentum are conserved just as in an ordinary elastic collision.

De Broglie's Matter Waves

Not just light, but **all moving matter has an associated wavelength**: $\lambda = h/p = h/(mv)$, the de Broglie wavelength. For macroscopic objects (a ball, a bullet) this wavelength is far too tiny to observe. For microscopic particles like electrons accelerated through ordinary laboratory voltages, λ becomes comparable to atomic spacings, producing observable diffraction — confirmed experimentally by the Davisson-Germer experiment, which is direct evidence for the wave nature of matter.

One-Line Summary

Chapter 11 establishes the dual (particle-and-wave) nature of both radiation and matter — the photoelectric effect shows light behaving as discrete photons, while de Broglie's hypothesis and its experimental confirmation show that moving matter carries a wavelength of its own, unifying the wave and particle

descriptions of the physical world.

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