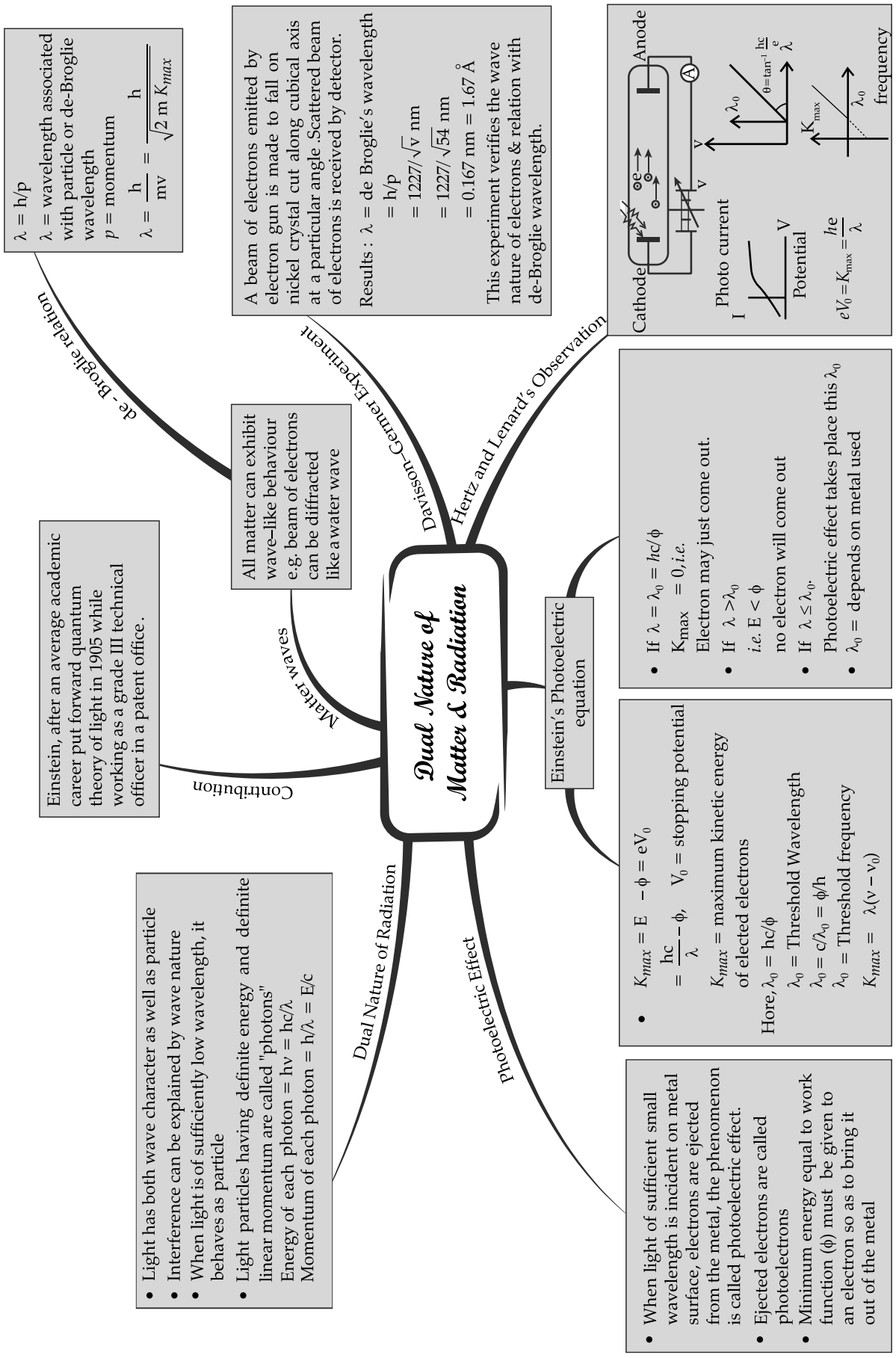


Dual Nature of Matter & Radiation



- Light has both wave character as well as particle
- Interference can be explained by wave nature
- When light is of sufficiently low wavelength, it behaves as particle
- Light particles having definite energy and definite linear momentum are called "photons"

Energy of each photon = $h\nu = hc/\lambda$
 Momentum of each photon = $h/\lambda = E/c$

Contribution

Einstein, after an average academic career put forward quantum theory of light in 1905 while working as a grade III technical officer in a patent office.

Matter waves

All matter can exhibit wave-like behaviour e.g. beam of electrons can be diffracted like a water wave

de - Broglie relation

$\lambda = h/p$
 $\lambda =$ wavelength associated with particle or de-Broglie wavelength
 $p =$ momentum
 $\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2 m K_{max}}}$

A beam of electrons emitted by electron gun is made to fall on nickel crystal cut along cubical axis at a particular angle. Scattered beam of electrons is received by detector.

Results : $\lambda =$ de Broglie's wavelength
 $= h/p$
 $= 1227/\sqrt{v}$ nm
 $= 1227/\sqrt{54}$ nm
 $= 0.167$ nm = 1.67 Å

This experiment verifies the wave nature of electrons & relation with de-Broglie wavelength.

- When light of sufficient small wavelength is incident on metal surface, electrons are ejected from the metal, the phenomenon is called photoelectric effect.
- Ejected electrons are called photoelectrons
- Minimum energy equal to work function (ϕ) must be given to an electron so as to bring it out of the metal

- $K_{max} = E - \phi = eV_0$
 $= \frac{hc}{\lambda} - \phi, V_0 =$ stopping potential of ejected electrons
 Here, $\lambda_0 = hc/\phi$
 $\lambda_0 =$ Threshold Wavelength
 $\lambda_0 = c/\lambda_0 = \phi/h$
 $\lambda_0 =$ Threshold frequency
 $K_{max} = \lambda(v - v_0)$

Einstein's Photoelectric equation

- If $\lambda = \lambda_0 = hc/\phi$, $K_{max} = 0$, i.e. Electron may just come out.
- If $\lambda > \lambda_0$, i.e. $E < \phi$ no electron will come out
- If $\lambda \leq \lambda_0$, Photoelectric effect takes place this λ_0
- $\lambda_0 =$ depends on metal used

