Session 5: Modern Physics

- Recap
- Photoelectric equation
- Experimental setup
- Graphs in PEE
- Numericals

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

($h \rightarrow 6.626 \times 10^{-34}$ Js; ν → (Hz))

Q 1. Arrange blue (B), green (G), yellow (Y) and red (R) in increasing wavelength/ frequency/ energy/ momentum order?

(wavelength → (A); frequency → (C); energy → (C); momentum → (C))

A). B<G<Y<R B). R>Y>G>B

C). B>G>Y>R D). B<G<R<Y

$P = 4\,kJ/s$ (power)

$N_p = 10^{20}$ per sec.

$E_p = P/N_p = \frac{4\times10^3}{10^{20}} = 4\times10^{-17}\,J$

Q 2. If a source of power 4 kW produces 1020 (10^{20}) photons/second, the radiation belongs to

A). microwaves

B). In UV range

C). Gamma rays

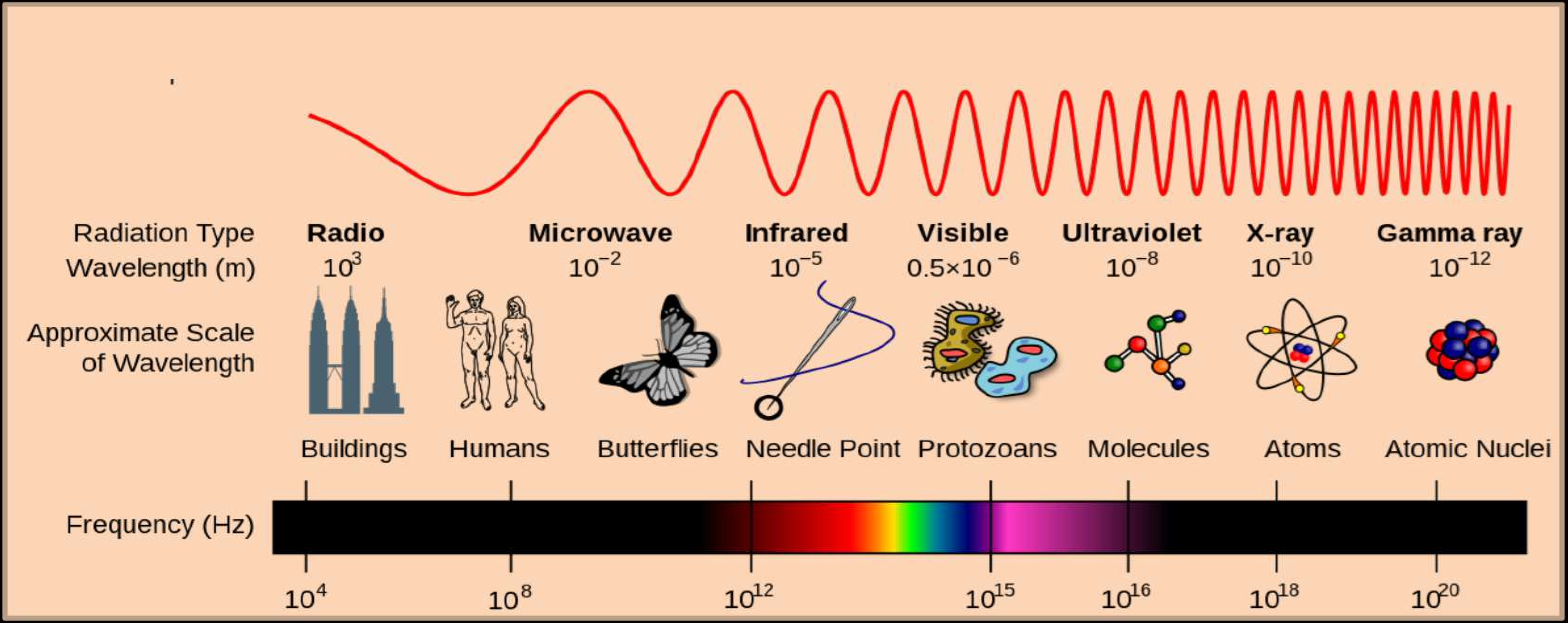
D). X rays

$E_p = \frac{hc}{\lambda}$

$\lambda = \frac{hc}{E_p} = \frac{6.62\times10^{-34}\times3\times10^{8}}{4\times10^{-17}} = 50\,\mathring{A}$

Electromagnetic Spectrum

X rays → 0.1 Å – 100 Å
UV → 100 Å – 3500 Å
Visible light → 3500 Å – 8000 Å



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Q 3. Let n_r and n_b be respectively the number of photons emitted by a red bulb and a blue bulb of equal power in a given time.

A). $n_r = n_b$
B). $n_r < n_b$
C). $n_r > n_b$
D). Insufficient information

X-ray – 0.1 Å – 100 Å
0.01nm – 10nm

Q 4. Planck constant has the same dimensions as

A). Force X Time

B). Force X Speed

C). Force X Distance x time

D). Force X Distance X Speed

$E = h\nu$ s^{-1}

$h \rightarrow [J\text{-}s]$

Force x dist. x s.

Q 5. Work function of various photosensitive metals are given. Which one can emit electrons most easily?

Cesium 1.9 eV	Potassium 2.2 eV
Calcium 3.2 eV	Silver 4.7 eV
Platinum 5.6 eV	Sodium 2.3 eV
Lithium 2.5 eV	Copper 4.5 eV

A). Platinum B). Silver
C). Cesium D). Calcium

$E = \frac{1}{2}CV^2 = \frac{Q^2}{2C} = \frac{1}{2}QV$

Capacitor

Calculation shortcuts

Energy = E_0 eV

Wavelength = λ_0 Å

$E = \frac{hc}{\lambda}$

$E = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{\lambda}$

E → (eV)

λ → nm/Å

$E_0 \times 1.60217 \times 10^{-19}$ V

$= \frac{6.626 \times 10^{-34} \times 2.99792458 \times 10^8}{\lambda_0 \times 10^{-10}}$

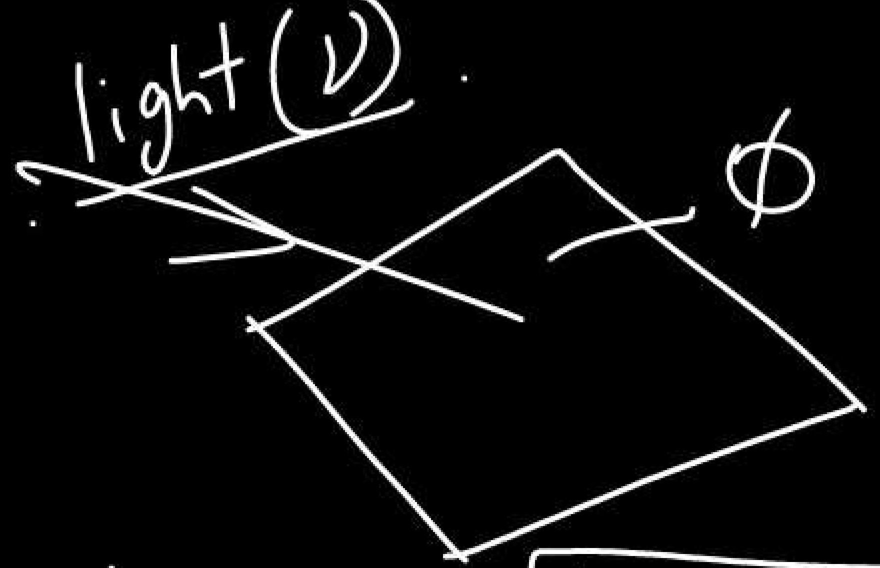
$E_0 = \frac{12400}{\lambda_0}$

E_0 → (eV)

λ_0 → (Å) → 10^{-10} m.

Example cases: hν vs ϕ

- $h\nu < \phi$
- $h\nu > \phi$
- $h\nu > 2\phi$



$h\nu < \phi$

No e^- will come out.

$h\nu = 5eV$

$h\nu = 2.5eV$

$\phi_{Ce} = 1.9eV$

$h\nu > \phi$ → energy of 1 photon or more than one.

A). e^- will come out

B). e^- will not " "

C). e^- may come out

D). more than one e^- will come out.

How to analyse photoelectric effect?

Parameters → frequency, intensity; nature of metal (ϕ)

effect of potential.

The excess energy of photon

→ How it will be used.

1. e^- will generate KE.

2. e^- will loose all the excess energy in collisions.

$$h\nu > \phi$$

→ Just the necessary condition for PEE

→ we have a large no. of photons

⇒ Distribution of KE of photo e^-.