QUANTUM THEORY OF LIGHT

B.Sc. T. Y.

Quantum theory of light

- 1887-Heinrich Heartz-Observed light changes the voltage at which the sparking takes place i.e. relation between light and electricity.
- 1900- Philipp Lenard: Demonstrated the interaction between light and matter.
- Classical physics – unable to explain Photoelectric effect
  - *Photoelectric effect by classical physics*
  - *Light as em waves*
  - *Time delay*
  - *More intense light ,greater energies of electrons*
  - *-The relations between frequency and electron energy*

Quantum theory of light

- Purposed by Albert Einstain's 1905
- Realised- Energy in light wave not spread out over wave fronts but concentrated in small packet *photon*
- Each photon of frequency υ has energy $h\upsilon$ same as Planck

Energy was not only given to em waves in separate quanta but also carried by waves in separate quanta

Observations of Photoelectric effect – Einstains hypothesis

1). EM waves concentration in photons so no delay

2). Intensity changes, no. of photoelectrons not energy

WORK FUNCTION:

- *Threshold Frequency(v_o):Minimum frequency below which no photoelectric effect*
- *Work function(ϕ) :Minimum energy ϕ for an electron to escape from particular metal surface is work function of metal*
  - Relations between (ϕ) and (v_o)
  - Work function $\phi = hv_o$
  - Greater work function-more energy needed to leave surface-higher the threshold frequency for photoelectric emission.

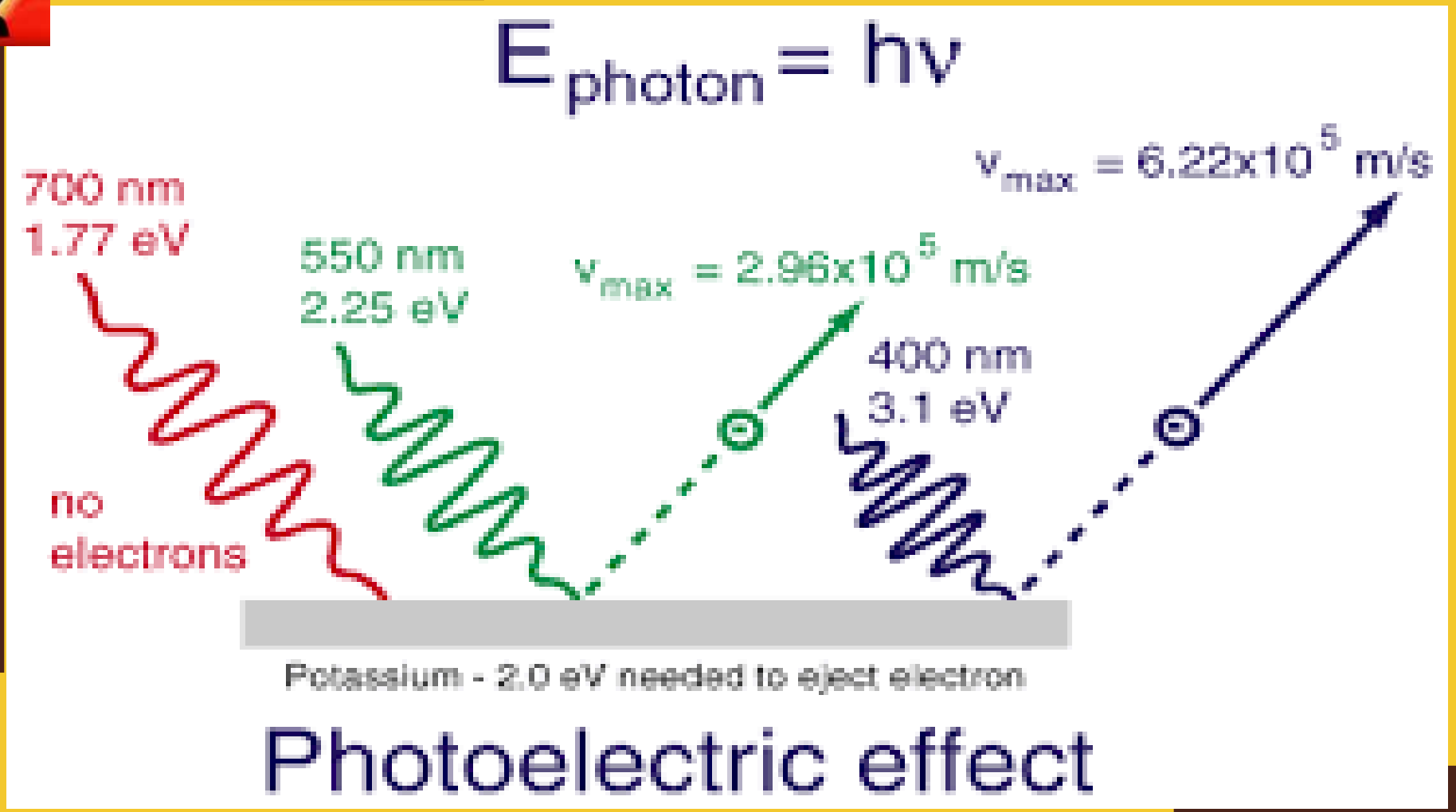
Photoelectric work functions:

Sr. No.	Metal	Symbol	Work function ,eV
1	Cesium	Cs	1.9
2	Potassium	K	2.2
3	Sodium	Na	2.3
4	Lithium	Li	2.5
5	Calcium	Ca	3.2
6	Silver	Ag	4.7
7	Platinum	Pt	6.4

Photoelectric effect is phenomenon of visible and Ultraviolet region

Einstein's Photoelectric Equation

- *According to Einstein, the photoelectric effect in a given metal should obey the equation*
  - $h\upsilon = K\,E_{Max} + \phi$
  - $h\upsilon$ is Photon energy
  - $K\,E_{Max}$ is maximum photoelectron energy
  - ϕ is work function and $\phi = h\upsilon_o$
  - $h\upsilon = K\,E_{Max} + h\upsilon_o$ and
  - $K\,E_{Max} = h\upsilon - h\upsilon_o = h(\upsilon - \upsilon_o)$
- Photon energy in terms of electronvolts is
- $E = \left(\frac{6.626X10^{-34}\,J.s}{1.602X10^{-19}J/eV}\right)\upsilon = \left(4.136 \times 10^{-15}\right)\upsilon$ eV.s
- In terms of wavelength
- $E = \left(\frac{(4.136 \times 10^{-15}\text{eV.s})(3\times10^{8}m/s}{\lambda}\right) = \left(1.24 \times 10^{-6}\right)$ eV.m



Photoelectric effect