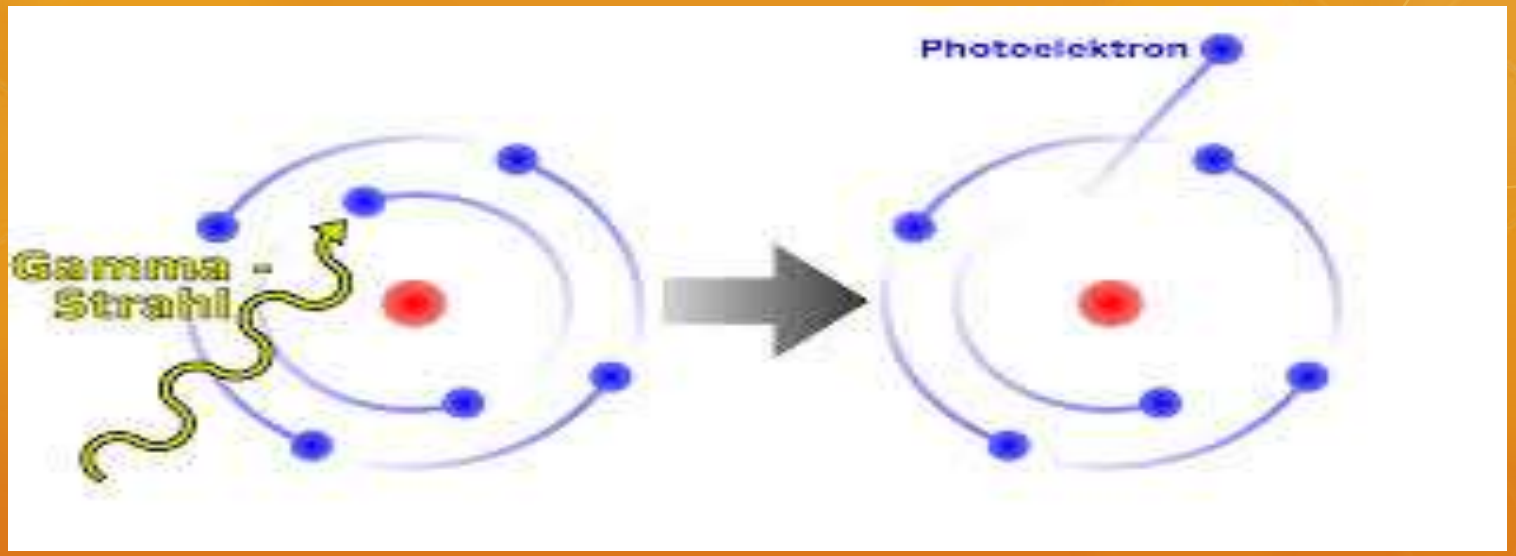


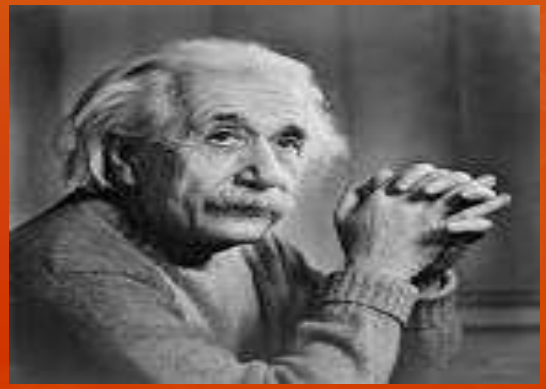
CHAPTER

MODERN PHYSICS

PHOTO ELECTRICITY

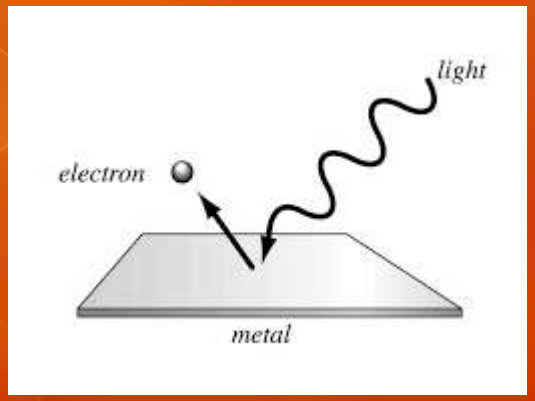
Represented by

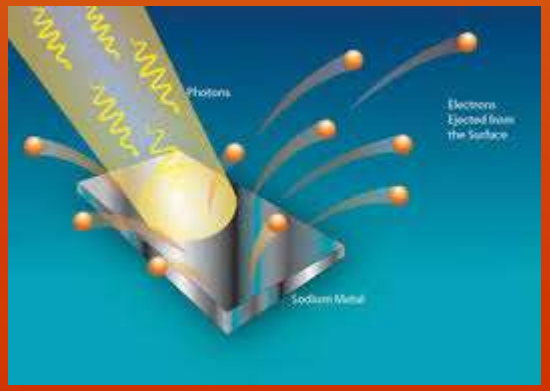
Prof. Mr. S.N. jadhav

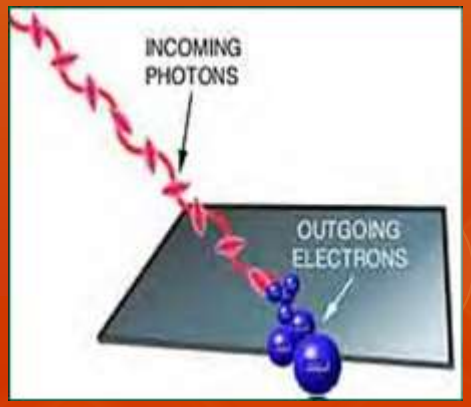


PHOTON (QUANTUM OF LIGHT)

- In 1905, Einstein proposed that electromagnetic radiation or light is made up of photons. Thus the photon is the elementary element of light or light is made up of photons.
- Einstein show that- light energy is not emitted continuously but it is emitted by individual amount of energy called as quantum of energy.





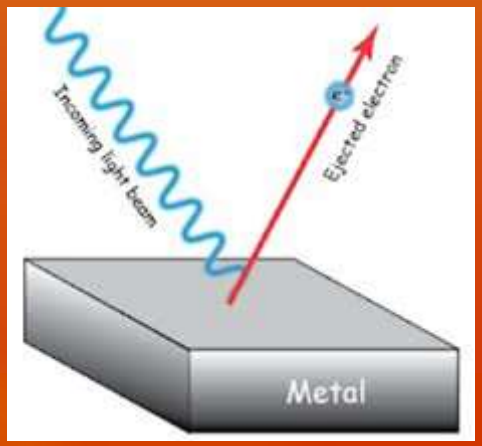


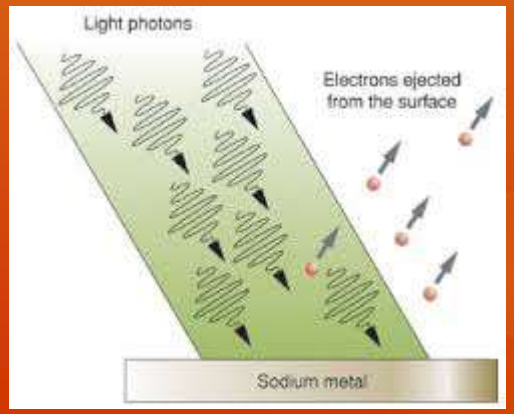
Energy of photon

- According to Einstein, each photon of a light wave of frequency has the energy E is given by,
  E= hv ……1
- where E= energy of photon(joule)

  h= planks constant-6.626 x 10^{-34} J.s

  v= frequency of photon(Hz)

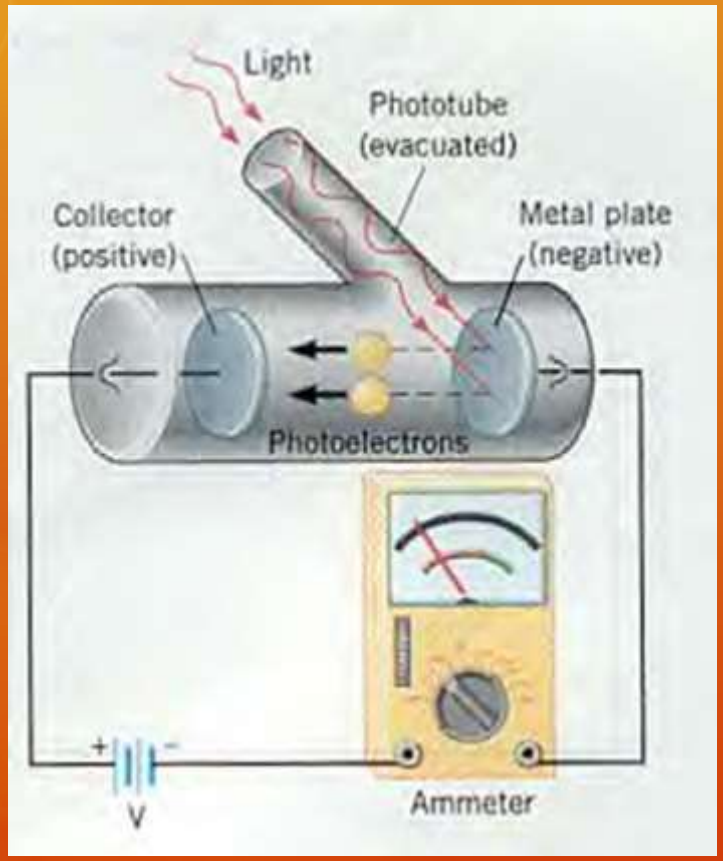




Properties of photon

- A photon does not have any mass.
- A photon does not have any charge and are not deflected in electric field or magnetic field.
- All the quantum numbers are zero for a photon
- In empty space, the photon moves at speed of light.
- In the interaction of radiation with matter, radiation behaves as if it is made up of particles called photons.
- The energy and momentum of a photon are related as follows E= p.c where p- magnitude of momentum and c is the speed of light.
- Photon is called as a virtual particles.
- The energy of a photon is directly proportional to frequency and inversly proportional to its wavelength.

Photo electric effect



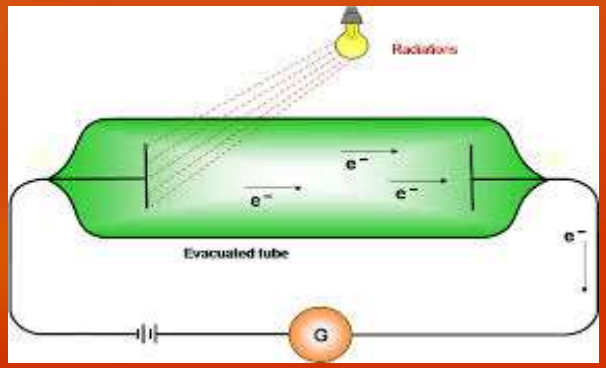
- When a beam of light of sufficiently high frequency onto a clean metal surface then the light will cause electrons to leave the surface.
- Definition : the phenomenon of emission of electrons by the metals when they are exposed to light of suitable frequency is called as the **photo electric effect** and emitted electrons is called as **photoelectrons**.

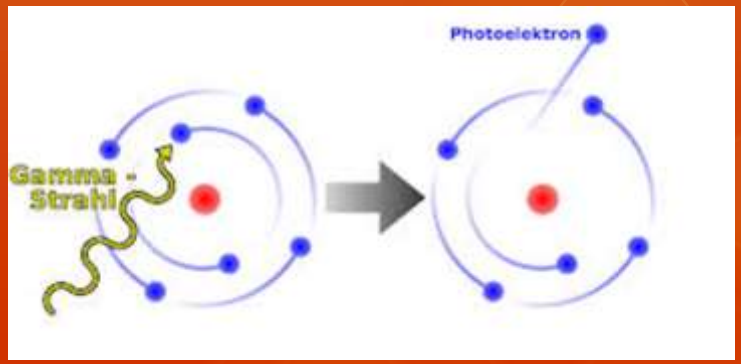
Photoelectric effect- construction and working

- Construction: 1)the Hertz experimental set up used for studying the photoelectric effect is shown in above fig.
- 2) the set up consist of an evacuated glass tube that has a photosensitive metal plate C and another metal plate A as shown.
- A monochromatic light source emerging from the source S of sufficiently short wavelength enters the glass window W and fall on photosensitive plate C, is called emmiter.

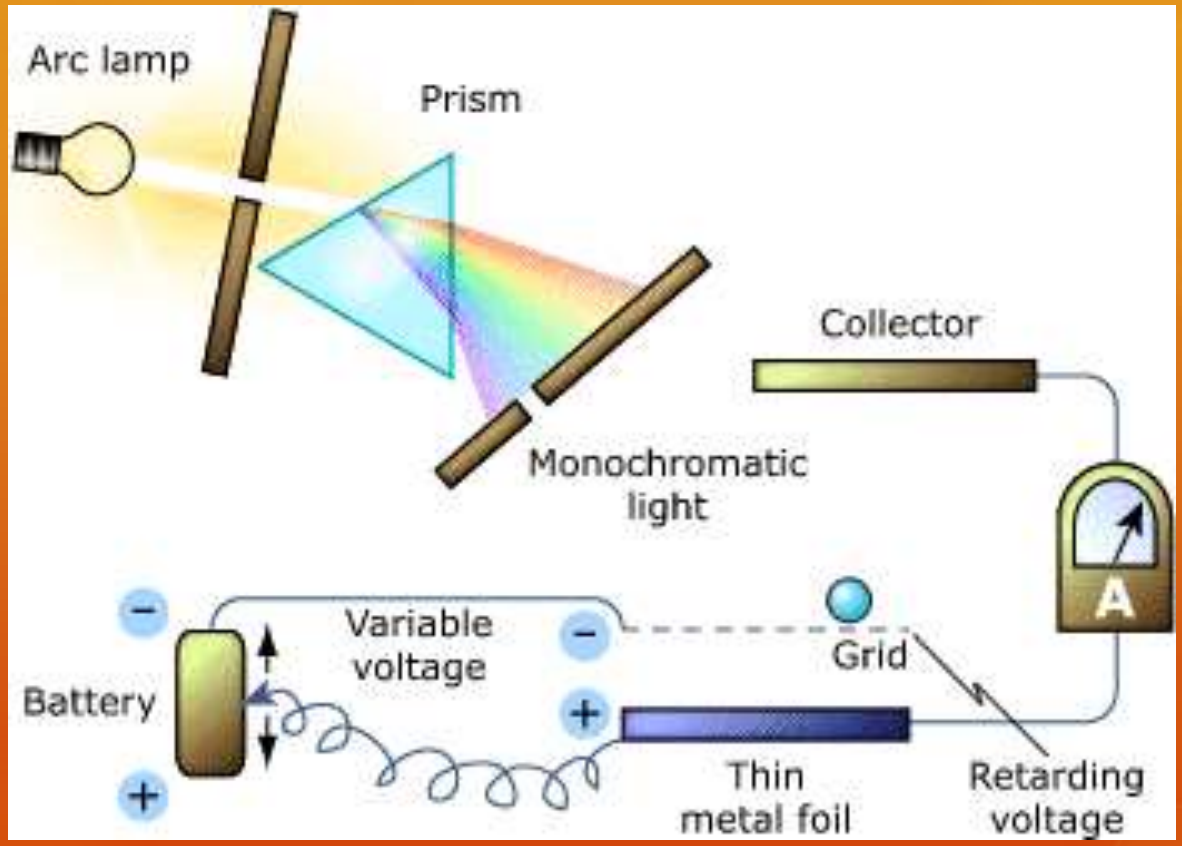
Photoelectric effect- working

- Working: when a beam of light fall on photosensitive metal plate c which is called emitter.
- The plate c emits photoelectrons due to photoelectric effect. The photo electrons emitted by plate c will be attracted towards the positive plate A. these electron flows in the eternal ckt to cause an electric current in the ckt.
- Such a current is known as the photoelectric current and measured by the micrommeter connected in the ckts.





Lenard's Photoelectric Apparatus:

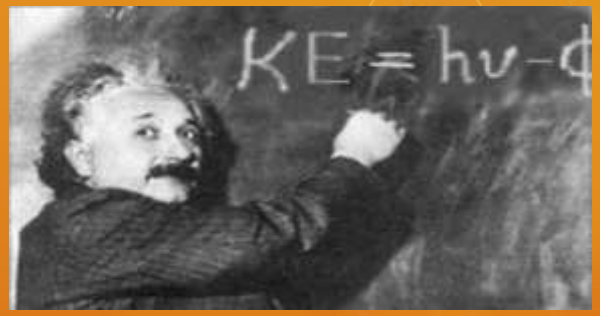


Characteristic of photoelectric effect

- **Photoelectric effect-** When light of suitable frequency is incident on metal surface then electrons are emitted from surface called as Photoelectric effect.
- **Characteristics of photoelectric effect-**
- 1. Threshold frequency is different for different material.
- 2. Photoelectric current is directly proportional to intensity of light.
- 3. The K.E. of photoelectrons is directly proportional to frequency of light.
- 4. Stopping potential is directly proportional to frequency.
- 5. The process is instantaneous.

Einstein photoelectric equation

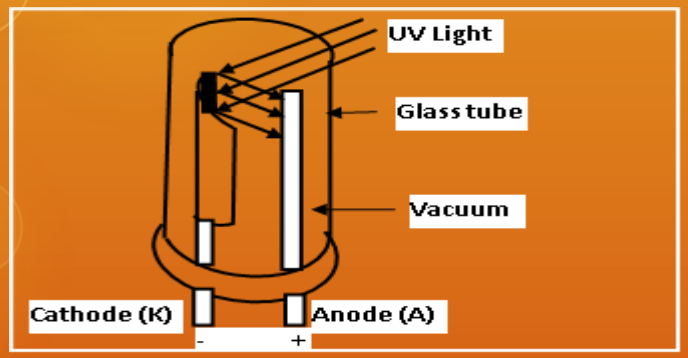
- **Einstein's photoelectric function-** According to quantum theory, radiation is considered as shower of particles called photons.
- Energy of photon absorbed by the atom (hu) is
- 1. Used to detach the electron (W0) and
- 2. K.E. is given to electron.
- hu= W0 + K.E.
- hu= W0 + $\frac{1}{2}MV^2$

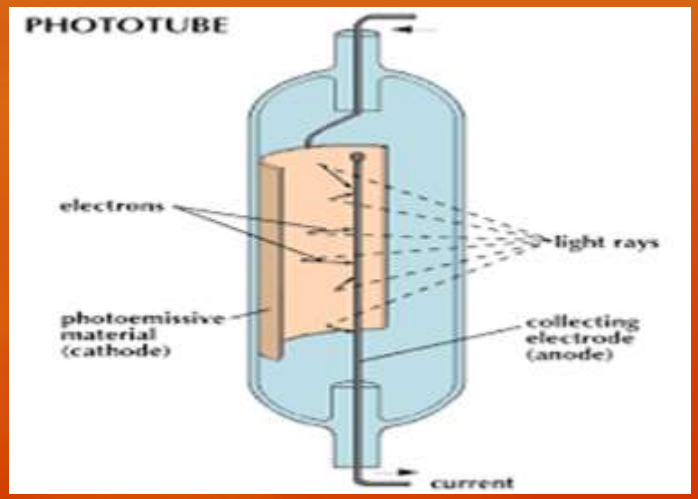


- = hu- W0 Where, W0= Photoelectric work function= hu0
- = hu - hu0
- = h (u- u0)
- Where, m= Mass of electron v= Velocity of electron h= Planck's constant
- u= Frequency of radiation u0= Threshold frequency
- **Significance-**
- 1. If u < u0 - Kinetic energy is negative. i.e. No emission.
- 2. If u = u0 - Kinetic energy is zero. i.e. Emission just begins.
- 3. If u > u0 - Kinetic energy is positive. i.e. Emission takes place.

Photo electric cell and LDR

Photo electric cell

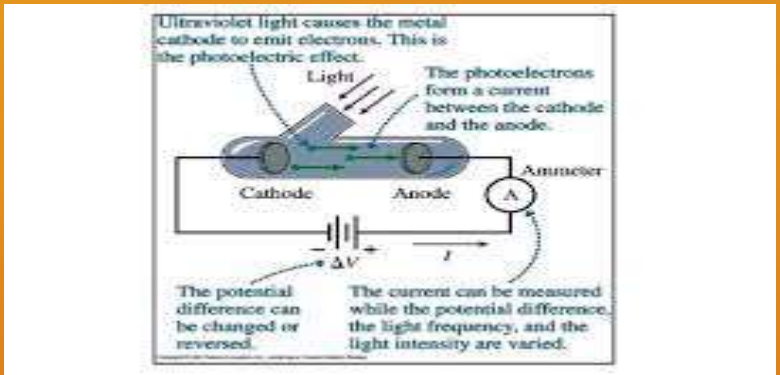




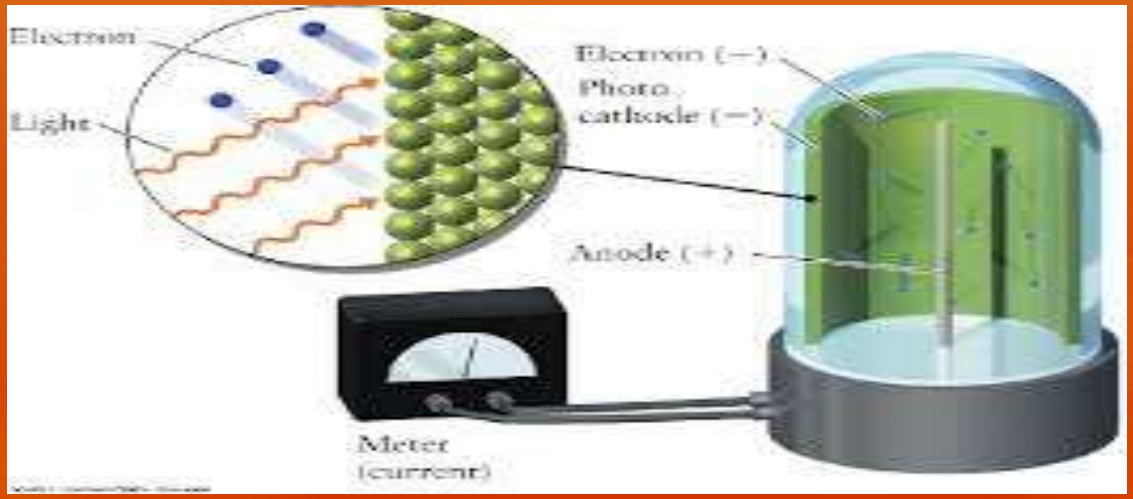
PRINCIPLE AND CONSTRUCTION

- Principle : a photoelectric cell is a device which converts the light energy into an electrical energy.
- Construction : it consists of an evacuted glass tube. Inside this tube photosensitive metal plate which is called emmiter and a wire loop A which is acts as collector.

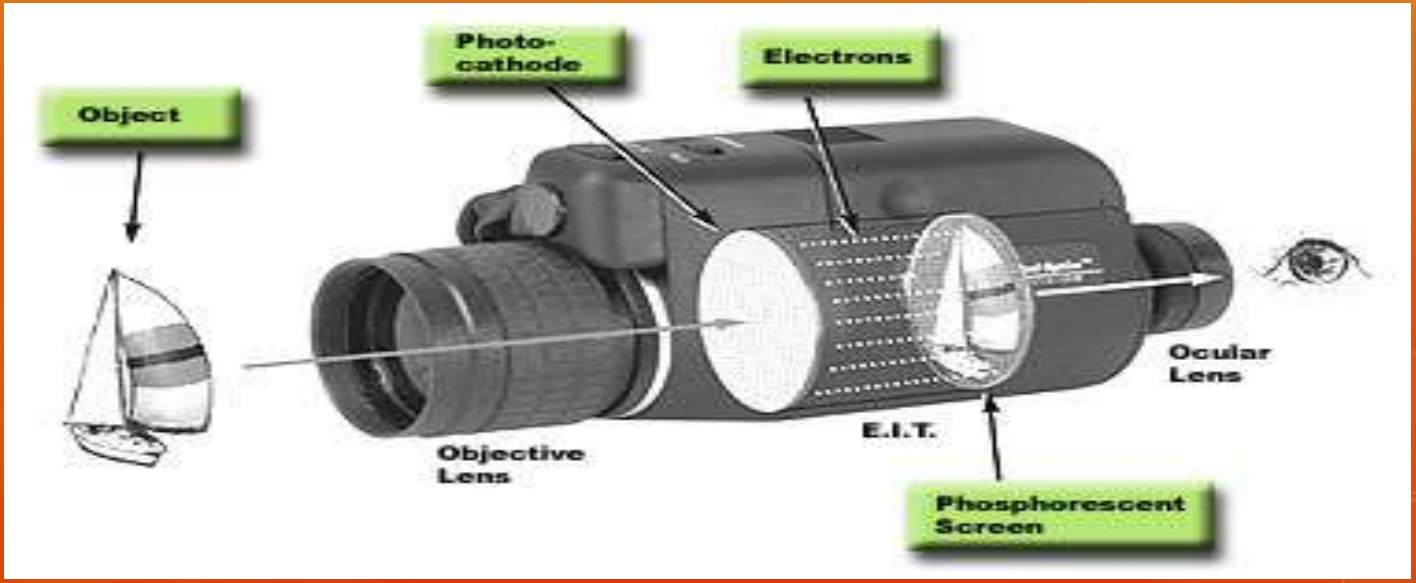
Working of photoelectric cell



- A high tension battery and micro ammeter (UA) are connected to plate C and loop A as shown in fig.
- Working : when the light of suitable frequency is incident on the emitter C, it start emitted the photoelectrons are attracted towards the collector A.



APPLICATION OF PHOTOELECTRIC EFFECT:- 1) photoelectric cell used in camera for exposure meter.



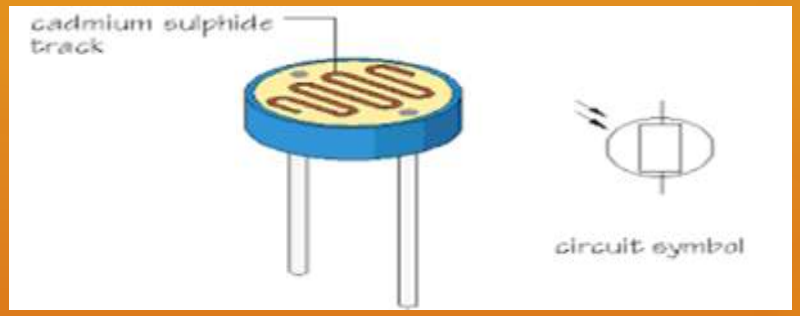
Photocell

- The photoelectric effect is commonly used to measure light.
  - Camera light meter
- It can also generate electricity.
  - Photovoltaic cell

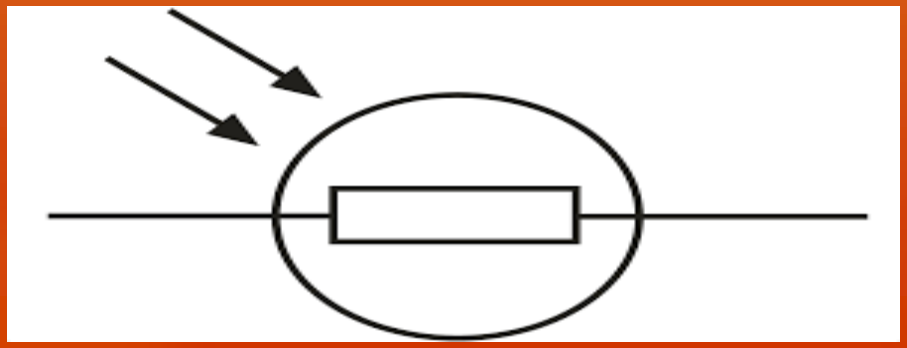
next

3) Photoelectric cell are also used for burglar alarm.

Photo resistor (light dependent resistor)

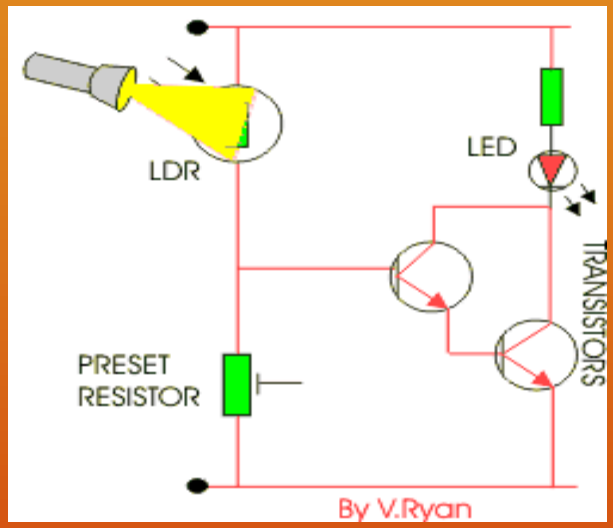


- Principle : A photoresistor or LDR is a resistor whose resistance decreases with increasing incident light intensity.
- Symbol for LDR



CONSTRUCTION AND OPERATIOIN OF LDR

- Construction: a light sensitive material such as cadmium sulphide(cds) is deposited on a ceramic substrate.
- Then the substrate along with the photosensitive layer of cds is enclosed in a metal container.
- Light is incident on the light sensitive material throught the glass cap or lens which is added at the top of this assembly.
- OPERATION :when light is incident on the photosensitive semiconductor material, the incident photons collide with the atoms of light sensitive material and impart energy to them.
- Due to this energy, the valence electron will cross the forbidden energy gap and enters into conduction band.
- Due to more number of electron entering the conduction band, conductivity increases and resistivity decreases. Thus resistance of the photosensitive material decreases with increases in intensity of light.


LDR
LED
TRANSISTORS
PRESET
RESISTOR
By V.Ryan