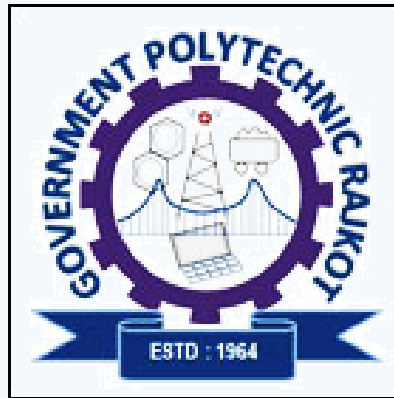


Utilization of Electrical Power

D104000181



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Government Polytechnic, Rajkot**



Unit – 4

Street Lighting

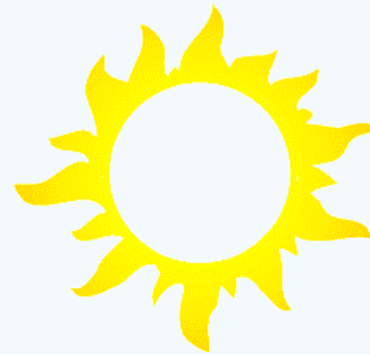
Light

❖ All activities of human beings ultimately depends upon light.

❖ Natural Light

❖ Sun

❖ Moon



❖ Artificial Light

Limitations

1. Space
2. Time

Light

❖ Artificial Light

- ❖ Easy control
- ❖ Reliable
- ❖ Constant Output
- ❖ Remote control
- ❖ Atomization
- ❖ Clean
- ❖ Pollution free
- ❖ Cheap
- ❖ User friendly
 - ❖ Protecting health, eyes, nervous system
 - ❖ Low accident risk at work space



Nature of Light

- ❖ Light is a form of radiant energy
- ❖ heat is radiated from hot body

❖ Red-hot

- ❖ Large wave-length
- ❖ Energy in form of heat

Speed of Light = $3 \times 10^8 \text{ m/s}$

❖ White-hot

- ❖ Small wave-length
- ❖ Range of light wave-length
- ❖ Low energy

Wavelength of Light
0.4 to 0.75 micron

1 micron (μm) = 10^{-6} m

1 Angstrom ($\text{\AA}$) = 10^{-10} m

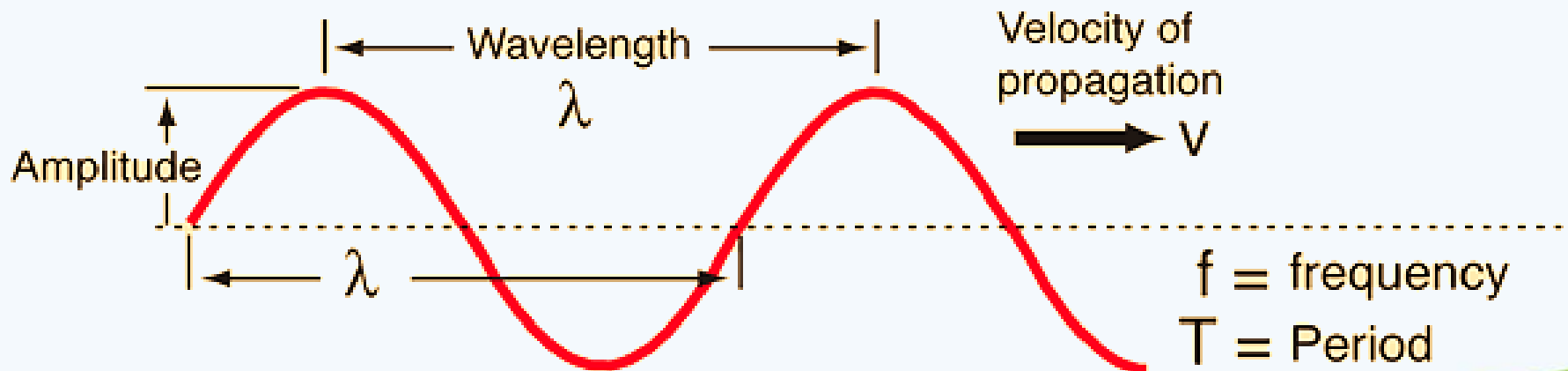
Relation : Frequency & Wavelength

$$v = f\lambda$$

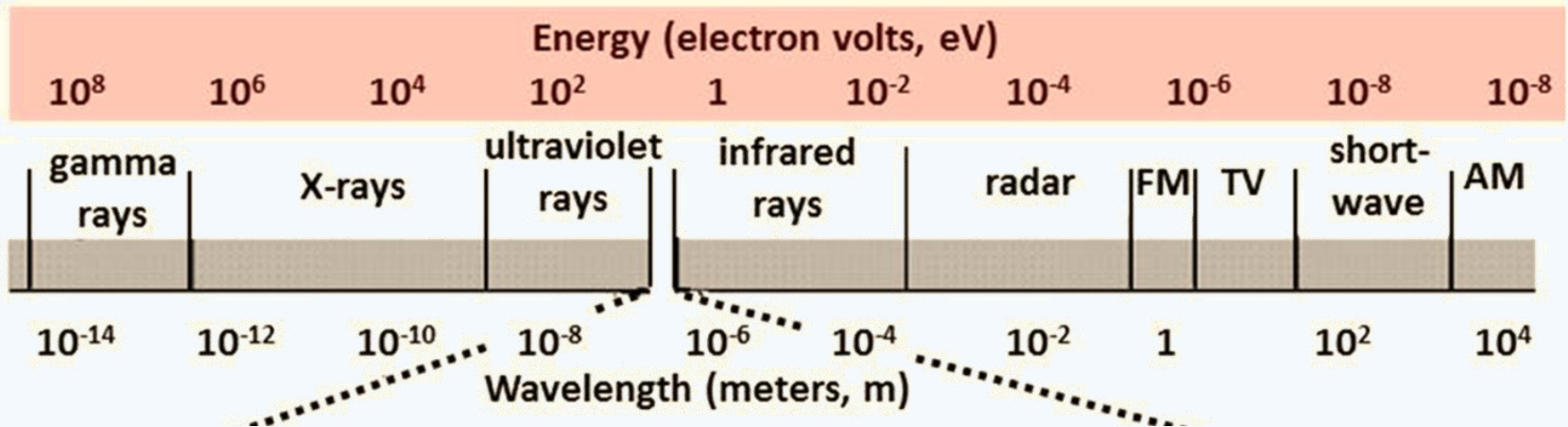
f = Frequency, Hz

λ = Wavelength, m

v = Velocity, m/Sec



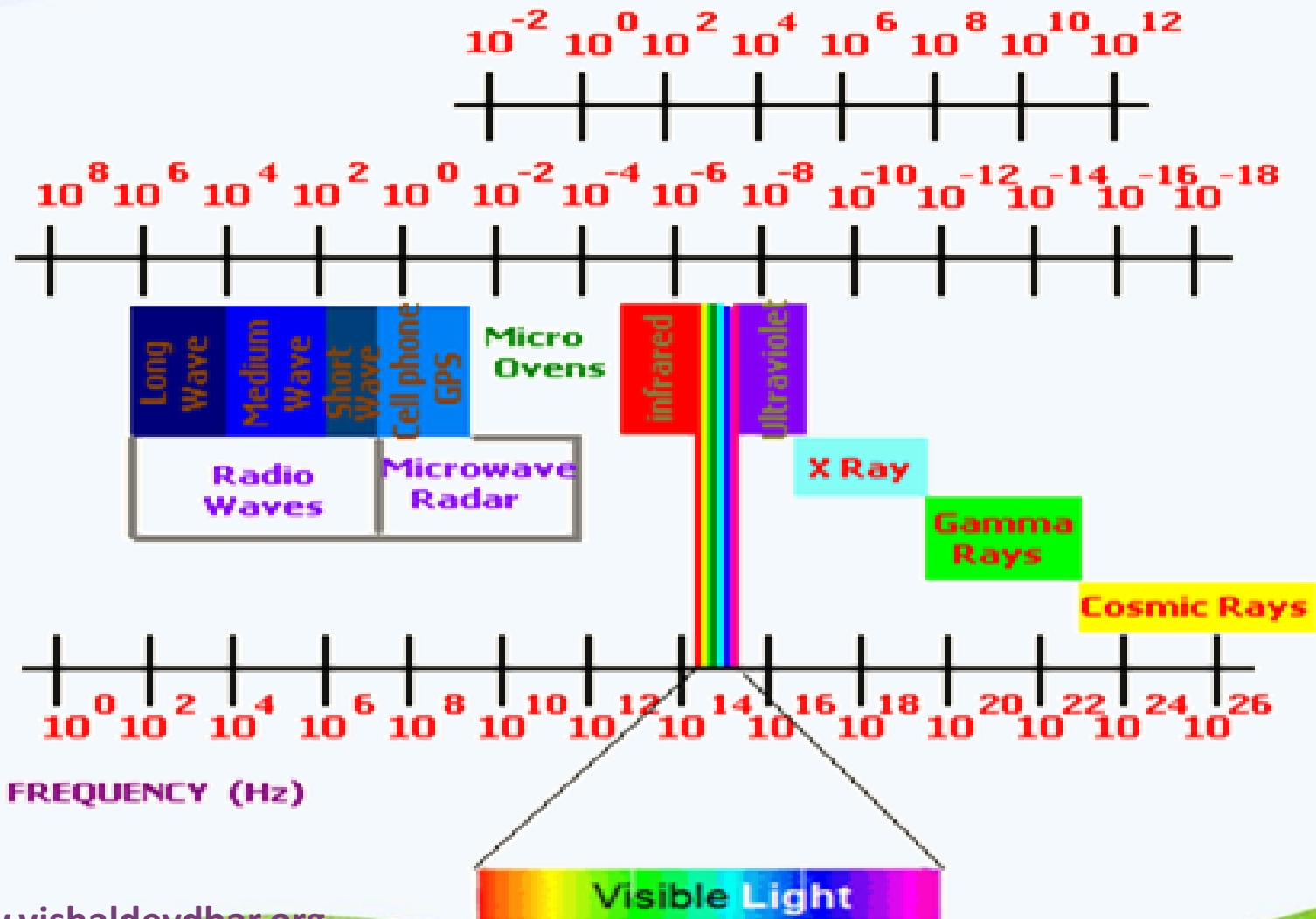
Electromagnetic waves spectrum



Visible Spectrum - Wavelengths in nanometers



Electromagnetic waves spectrum



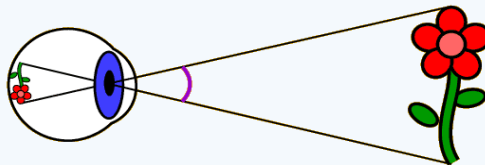
Terms related to Illumination

❖ Light : Q (Lumen-hour)

Radiated energy range that will give visual sensation

❖ Luminous Flux : F (Lumen)

Rate of flow of light from luminous source



Terms related to Illumination

❖ Luminous Intensity : I (Candela)

A point light source when gives luminous flux per unit solid angle in one direction is known as luminous intensity.

$$I = \frac{F}{w} = \frac{\text{Luminous Flux}}{\text{Steradian}}$$

❖ Illumination : E (Lumen/m² or Lux)

Available quantity of luminous flux on unit surface area.

$$E = \frac{F}{A} = \frac{\text{Lumen}}{\text{Area}}$$

Terms related to Illumination

❖ Brightness : L (Nit or Stib)

Luminous intensity per unit projected area of the surface in given direction.

❖ Lumen :

Amount luminous flux given out in a space represented by one unit of solid angle by a source having intensity of one candle power in all direction. **$\text{Lumens} = \text{Candle Power} \times \text{Solid Angle}$**

Terms related to Illumination

❖ Candle Power : (c.p)

Light radiating capacity of a source in given direction.

OR

Number of lumens given out by the source in a unit solid angle in a given direction.

$$\text{Candle Power} = \frac{\text{Lumens}}{\text{Solid Angle}}$$

Terms related to Illumination

❖ Lux or Meter Candle :

Luminous flux falling per m^2 on the surface which is everywhere perpendicular to the rays of light from a source of 1cp and 1m away from it.

OR

Luminous flux falling on a surface of a sphere of 1m radius where a light source of 1cp is kept in the centre of sphere.

Terms related to Illumination

❖ Foot Candle :

Luminous flux falling on a surface of a sphere of 1 foot radius where a light source of 1cp is kept in the centre of sphere.

$$1 \text{ Foot Candle} = \frac{\text{Lumen}}{\text{Foot}^2} = \frac{\text{Lumen}}{0.305^2} = \frac{10.75 \text{ Lumen}}{\text{m}^2}$$

$$1 \text{ meter Candle} = \frac{\text{Lumen}}{\text{m}^2}$$

$$1 \text{ meter} = 3.28 \text{ feet}$$

$$1 \text{ foot} = 0.305 \text{ meter}$$

Terms related to Illumination

❖ Mean Horizontal Candle Power (MHCP)

The mean of candle power in all direction in the horizontal plane containing the source of light.

❖ Mean Spherical Candle Power (MSCP)

The mean of candle power in all direction and in all planes from the source of light.

Terms related to Illumination

❖ Mean Hemispherical Candle Power (MHSCP)

The mean of candle power in all direction above/below the horizontal plane from the source of light.

❖ Reduction Factor

The ratio of MSCP to MHCP is known as reduction factor.

$$\text{Reduction Factor} = \frac{\text{MSCP}}{\text{MHCP}}$$

Terms related to Illumination

❖ Nit

One candle per square meter.

❖ Stib

One candle per square centimeter.

❖ Glare

Brightness within the field of vision cause any kind of discomfort to eye fatigue.

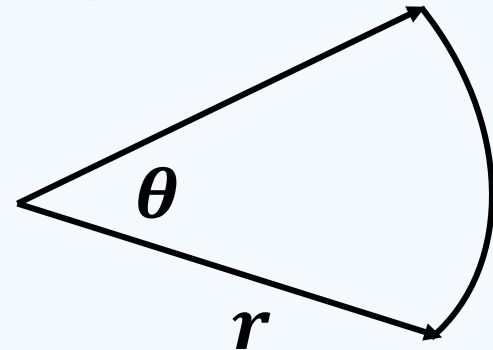
Terms related to Illumination

❖ Plane Angle : θ (Radians)

It is particular point by two straight line in one plane.

Maximum value of θ is 2π radians.

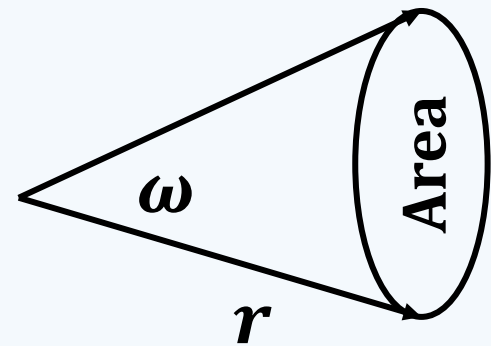
$$\text{Plane Angle}(\theta) = \frac{\text{Arc}}{\text{Radius}} = \frac{A}{r} \text{ radians}$$



Terms related to Illumination

❖ Solid Angle : ω (steradians)

It is angle generated by the surface passing through the point in space and the periphery of the area.



$$\text{Solid Angle}(\omega) = \frac{\text{Area}}{\text{Radius}^2} = \frac{A}{r^2} \text{ steradians}$$

Terms related to Illumination

❖ Relation between Plane Angle & Solid Angle

$$\text{Solid Angle}(\omega) = \frac{\text{Area}}{\text{Radius}^2}$$

$$= \frac{2\pi r H}{r^2}$$

$$= \frac{2\pi r H}{r^2}$$

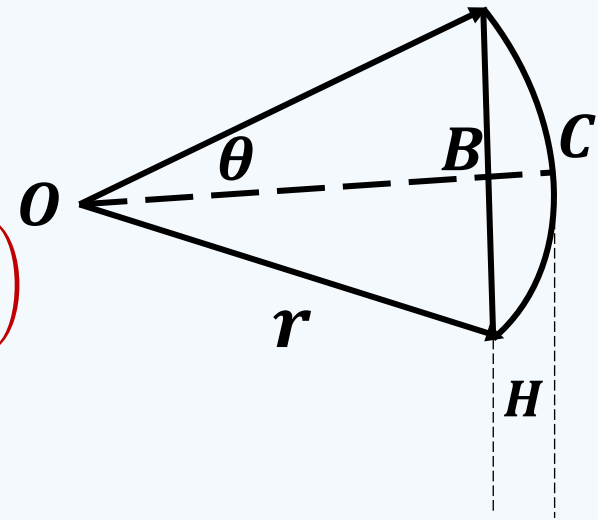
$$= \frac{2\pi r^2}{r^2} \left(1 - \cos \frac{\theta}{2}\right)$$

$$\omega = 2\pi \left(1 - \cos \frac{\theta}{2}\right)$$

$$H = OC - OB$$

$$= r - r \cos \frac{\theta}{2}$$

$$= r \left(1 - \cos \frac{\theta}{2}\right)$$



Terms related to Illumination

❖ Lamp Efficiency

The ratio of output luminous flux by lamp to electrical energy required to produce it.

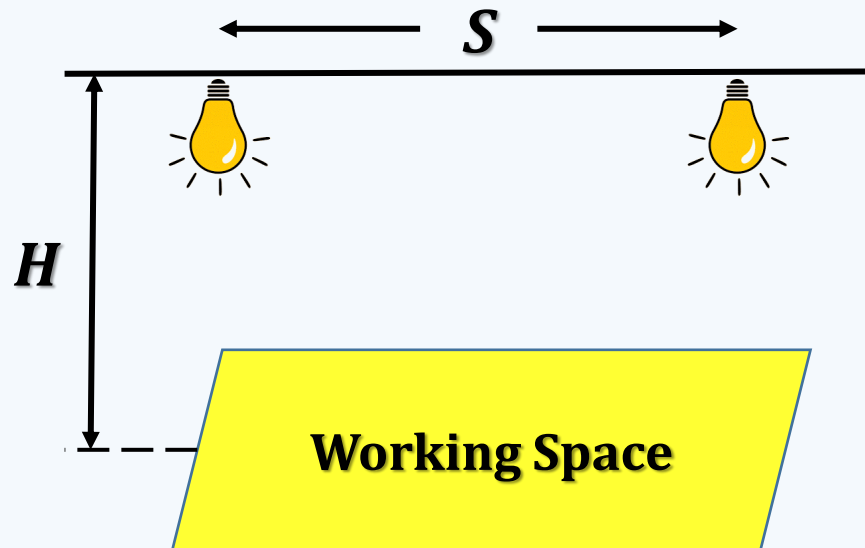
$$\text{Lamp Efficiency} = \frac{\text{Lumens output by lamp}}{\text{Watt input to lamp}}$$



Terms related to Illumination

- ❖ Space Height Ratio : SHR (Between 1.0 to 2.0)
Horizontal distance between two lamps to the mounting height of the lamp.

$$SHR = \frac{S}{H}$$



Terms related to Illumination

❖ Utilization Factor

$$UF = \frac{\text{Total lumens received by working plane}}{\text{Total lumens emitted by lamp}}$$

Direct Lighting – 0.25 to 0.5

Indirect Lighting – 0.1 to 0.3

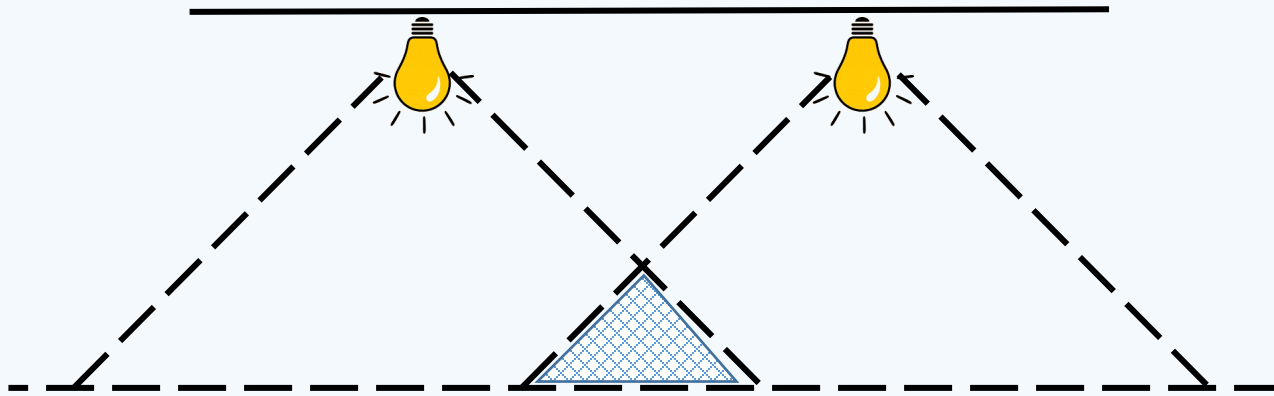
❖ Depreciation Factor

$$DF = \frac{\text{Lumens received from lamp in normal condition}}{\text{Lumens received when surface of lamp is clean}}$$

DF = 0.4 to 0.8

Terms related to Illumination

❖ Waste Light Factor



Overlapping

Terms related to Illumination

❖ Absorption Factor

$$AF = \frac{\text{Lumens available after absorption on surface}}{\text{Lumens output by lamp}}$$

$$AF = 0.5 \text{ to } 1$$

❖ Reflection Factor

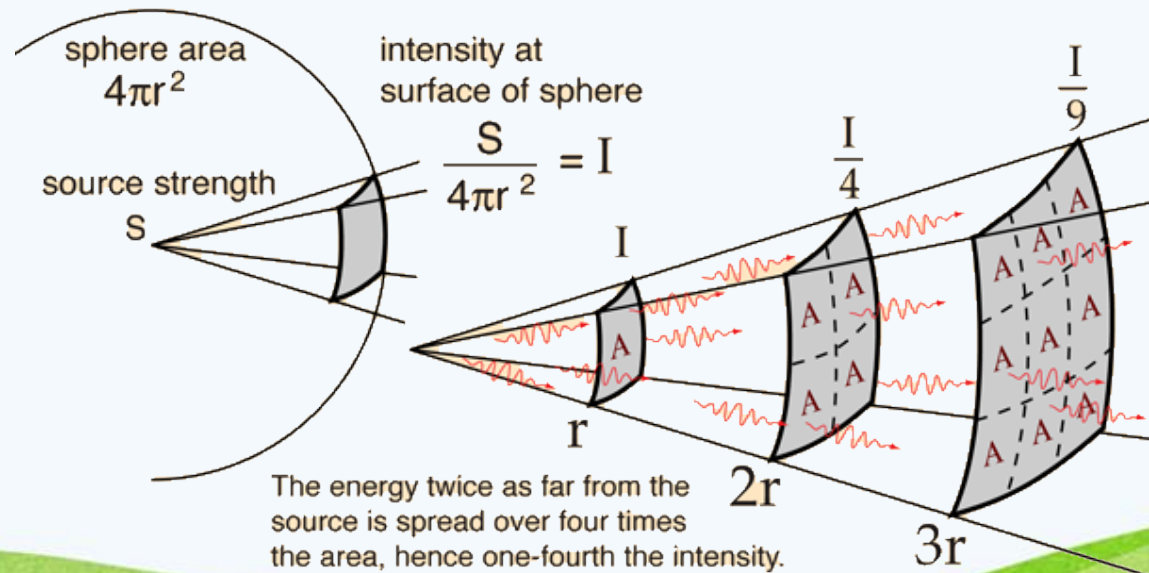
$$RF = \frac{\text{Lumens Reflected}}{\text{Lumens Incident}}$$

Laws of Illumination

❖ Law of Inverse Squares

Illumination received on any surface is inversely proportional to the square of the distance between surface and a light source.

$$\text{Illumination} = \frac{cp}{d^2}$$



Laws of Illumination

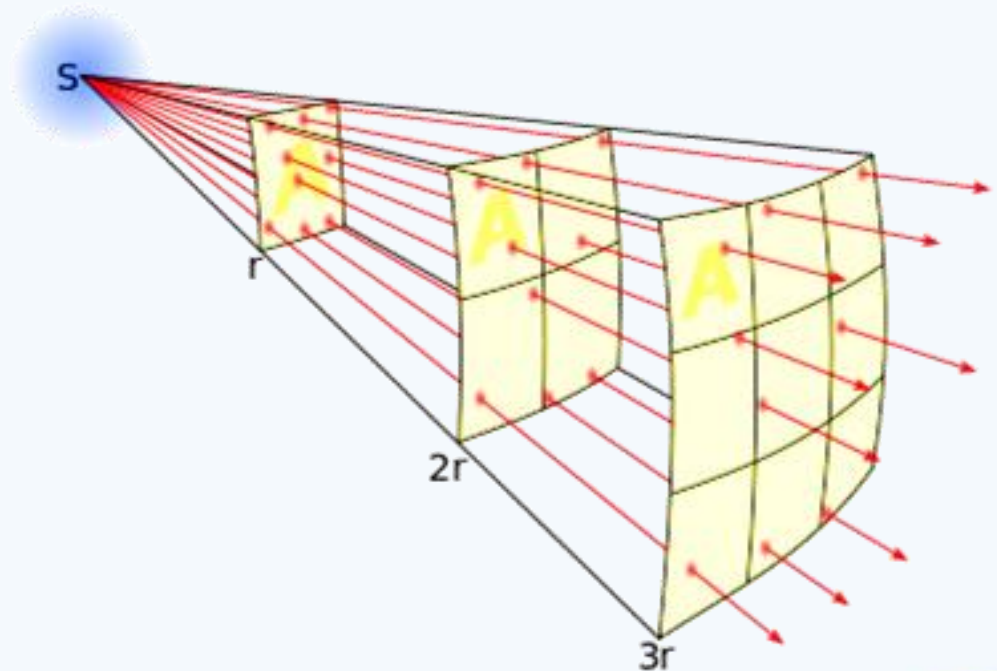
❖ Law of Inverse Squares

I = Intensity of illumination in lumen

Luminous Flux = $I \omega$

$$A_1 = d_1^2 \omega$$

$$\begin{aligned} \text{Illumination, } E_1 &= \\ \frac{I \omega}{A_1} &= \frac{I \omega}{d_1^2 \omega} = \frac{I}{d_1^2} \end{aligned}$$



Laws of Illumination

❖ Lambert's Cosine Law

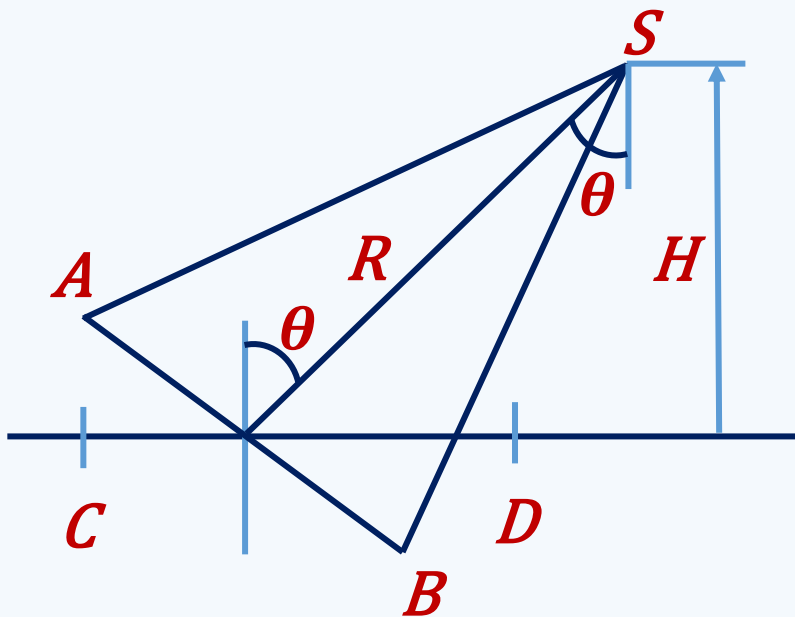
Illumination at any point on a surface is proportional to the cosine of angle between the normal at any point and the direction of luminous flux.

$$E = \frac{I \cos \theta}{d^2}$$

Laws of Illumination

❖ Lambert's Cosine Law

$$E = \frac{I \cos \theta}{d^2}$$

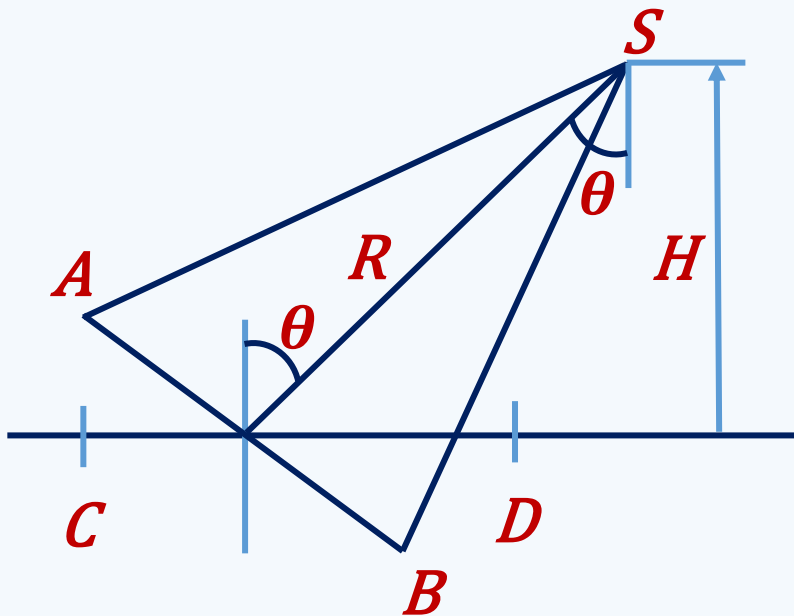


$$\begin{aligned} \text{Illumination Surface } AB \\ &= \frac{\text{luminous flux}}{\text{Area of } AB} = \frac{cp}{R^2} \end{aligned}$$

$$\begin{aligned} \text{Illumination Surface } CD \\ &= \frac{\text{luminous flux}}{\text{Area of } AB} \times \cos \theta \\ &= \frac{cp}{R^2} \times \cos \theta \end{aligned}$$

Laws of Illumination

❖ Lambert's Cosine Law



$$\cos \theta = \frac{H}{R} \Rightarrow R = \frac{H}{\cos \theta}$$

Illumination Surface CD

$$= \frac{cp}{R^2} \times \cos \theta$$

$$= \frac{cp}{H^2} \times \cos \theta$$

$$= \frac{cp}{H^2} \times \cos^3 \theta$$

Sources of Light

- Incandescent Lamp
- Discharge / Luminescent Lamp
- Metal Halide Lamp
- LED Lamp

Incandescent Lamp

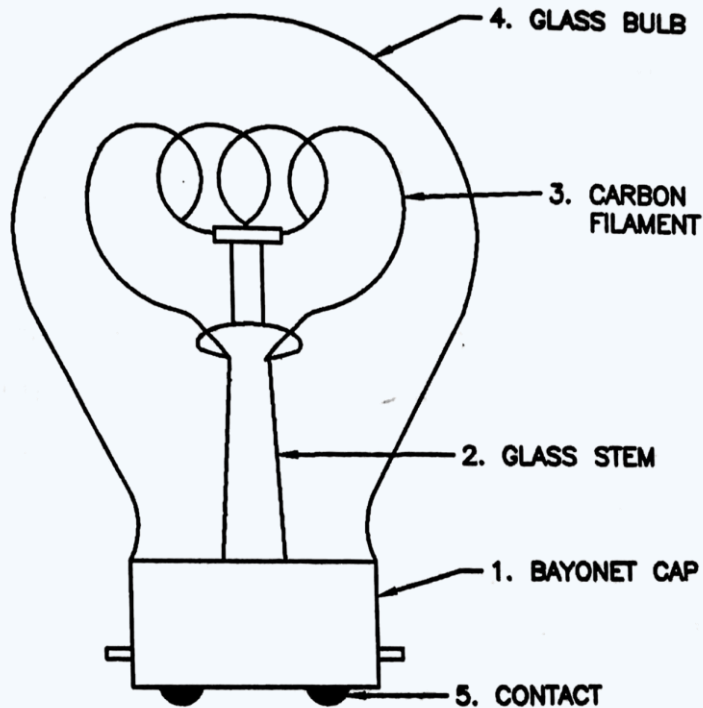
❖ *Carbon Filament Lamp*

❖ *Metal Filament Lamp*

❖ *Halogen Lamp*

Incandescent Lamp

❖ Carbon Filament Lamp



(Fig. 1.10 Carbon filament lamp)



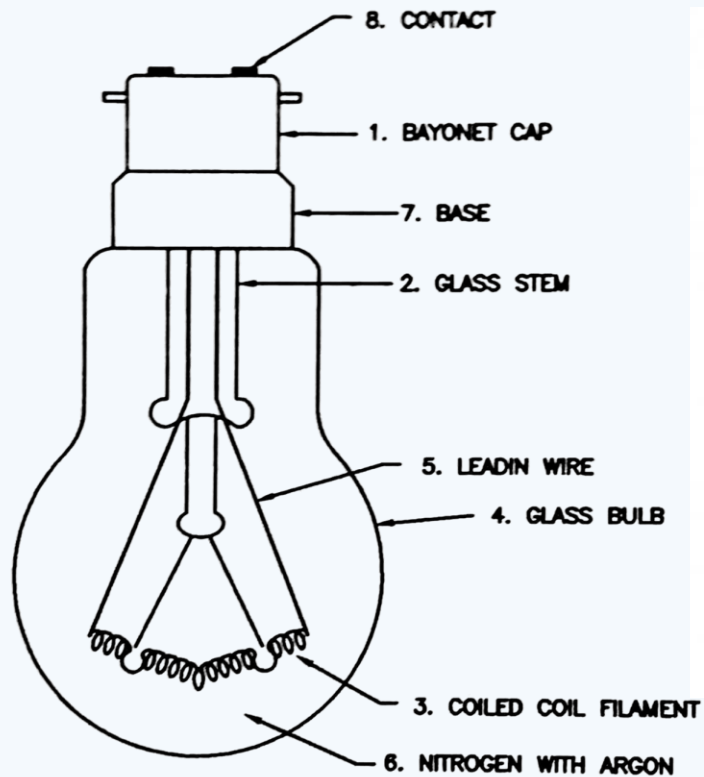
Incandescent Lamp

❖ Carbon Filament Lamp

Sr. No	Description	Value
1	Working Temperature	1600 to 1800°C
2	Efficiency	2 to 3.5 Lumen/Watt
3	Life	800 Hour

Incandescent Lamp

❖ Metal Filament Lamp



(Fig. 1.11 Metal filament lamp)



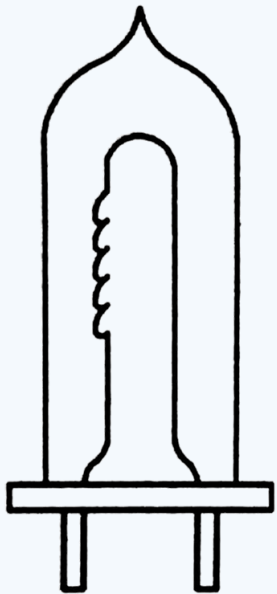
Incandescent Lamp

❖ Metal Filament Lamp

Sr. No	Description	Value
1	Working Temperature	2000°C
2	Efficiency	10 to 20 Lumen/Watt
3	Life	800 Hour

Incandescent Lamp

❖ Halogen Lamp



(a)



(b)



(Fig. 1.12 Halogen lamps)

Incandescent Lamp

❖ Halogen Lamp

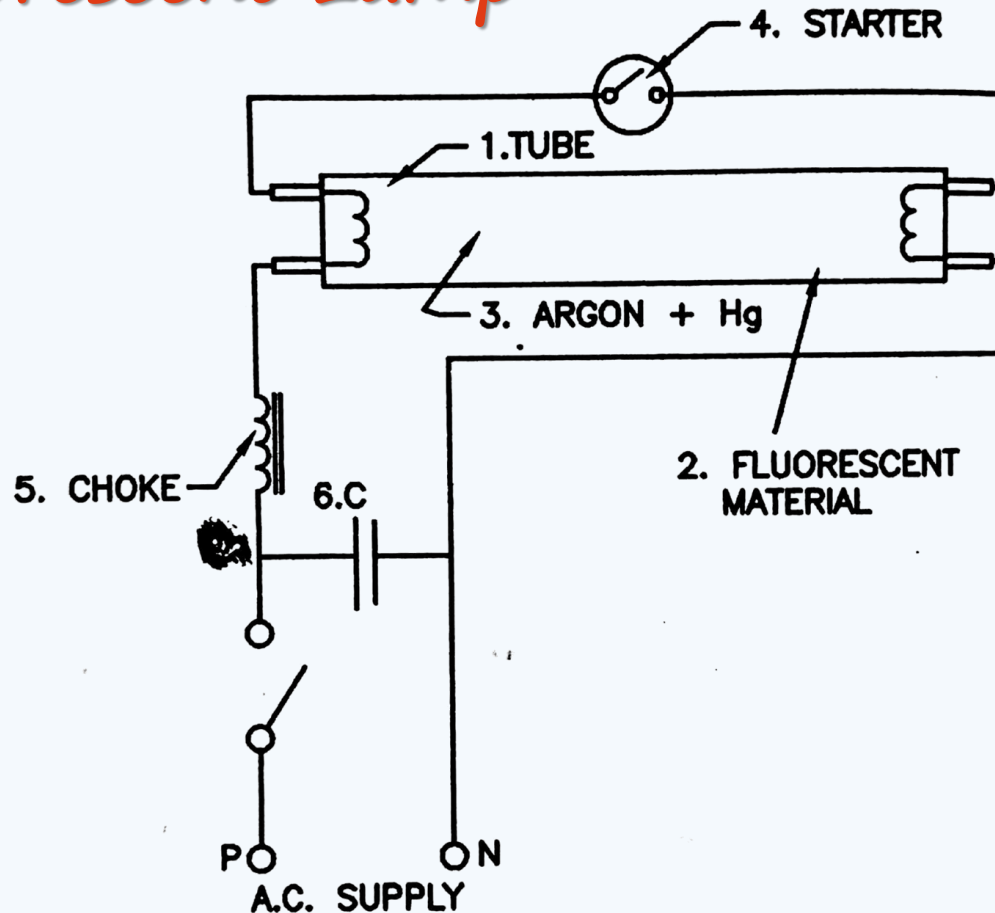
Sr. No	Description	Value
1	Working Temperature	540°C
2	Efficiency	25 to 35 Lumen/Watt
3	Life	2000 Hour

Discharge / Luminescent Lamp

- ❖ Fluorescent Lamp
- ❖ High Pressure Mercury Vapor Lamp
- ❖ Sodium Vapor Lamp
- ❖ Compact Fluorescent Lamp
- ❖ Neon Lamp

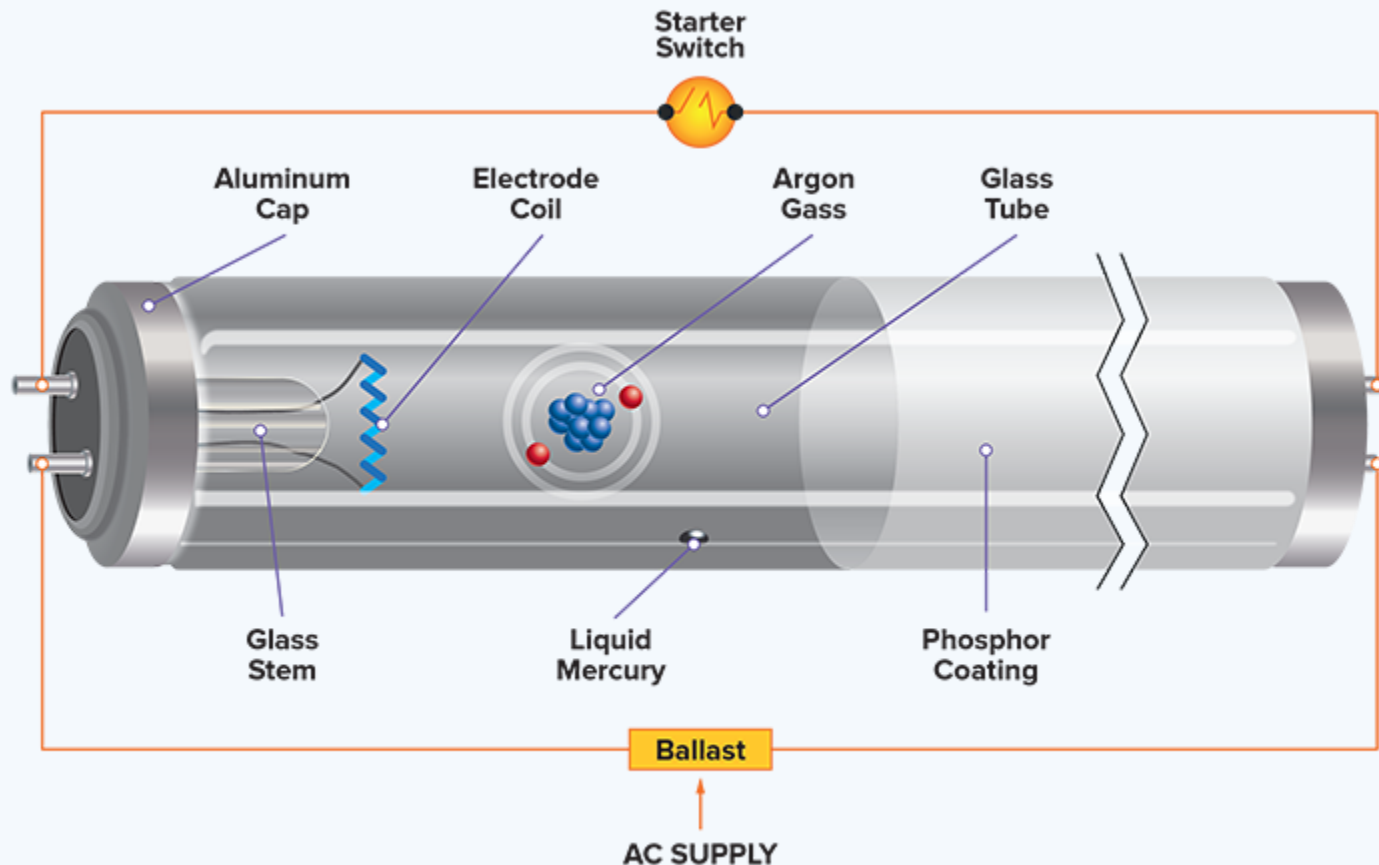
Discharge / Luminescent Lamp

❖ Fluorescent Lamp



Discharge / Luminescent Lamp

❖ Fluorescent Lamp



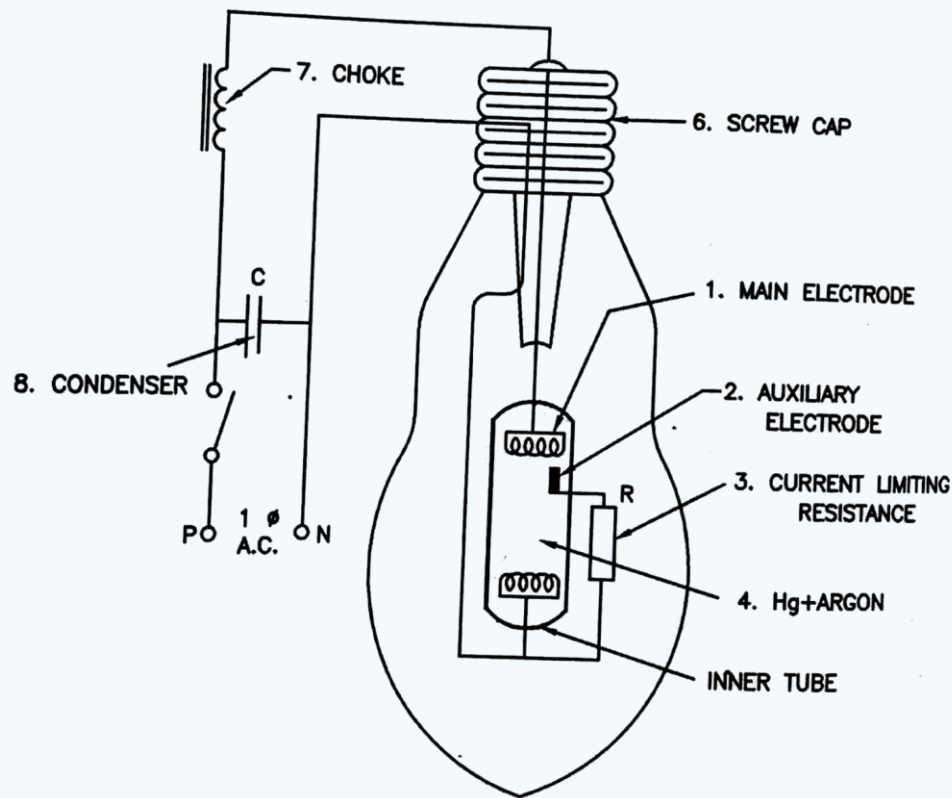
Discharge / Luminescent Lamp

❖ Fluorescent Lamp

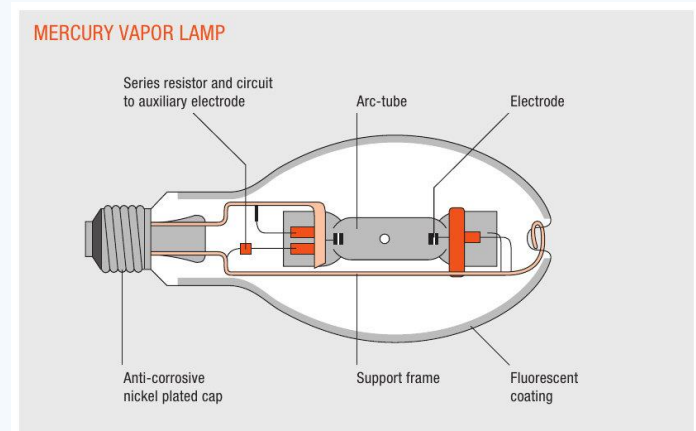
Sr. No	Description	Value
1	Working Temperature	40°C
2	Efficiency	40 Lumen/Watt
3	Life	4000 Hour

Discharge / Luminescent Lamp

❖ High Pressure Mercury Vapor Lamp



(Fig. 1.14 High pressure mercury vapour lamp)



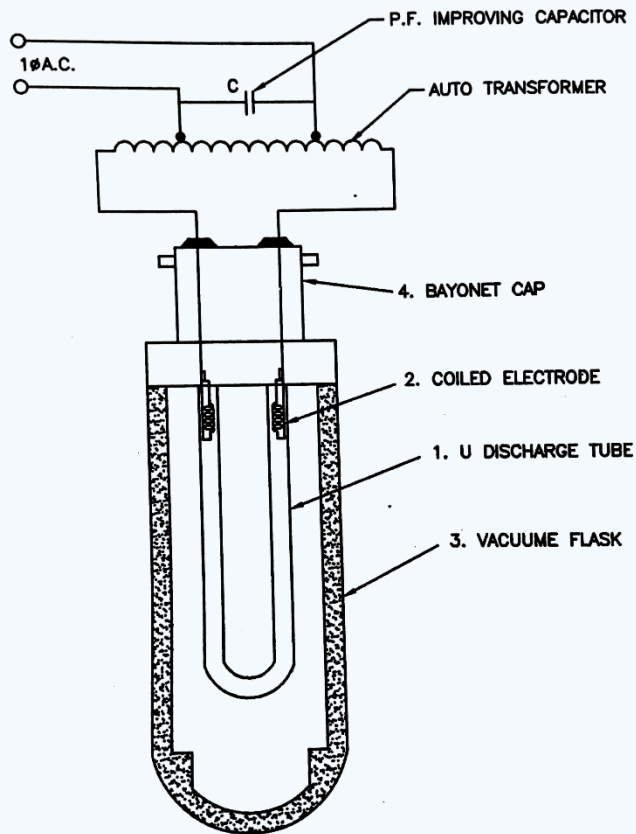
Discharge / Luminescent Lamp

❖ High Pressure Mercury Vapor Lamp

Sr. No	Description	Value
1	Working Temperature	150°C
2	Efficiency	30 to 60 Lumen/Watt
3	Life	24000 Hour

Discharge / Luminescent Lamp

❖ Sodium Vapor Lamp



(Fig. 1.15 Sodium vapour lamp)

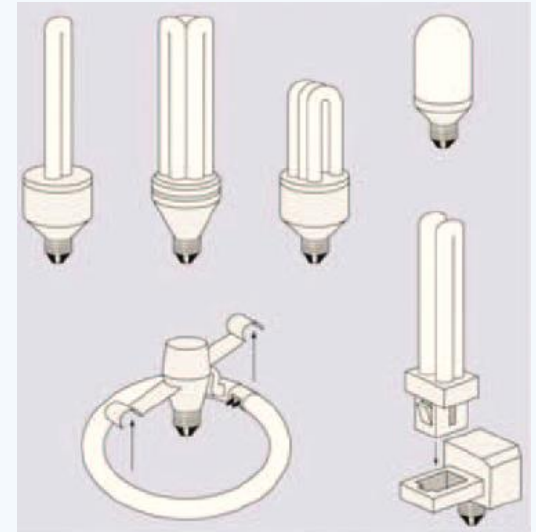
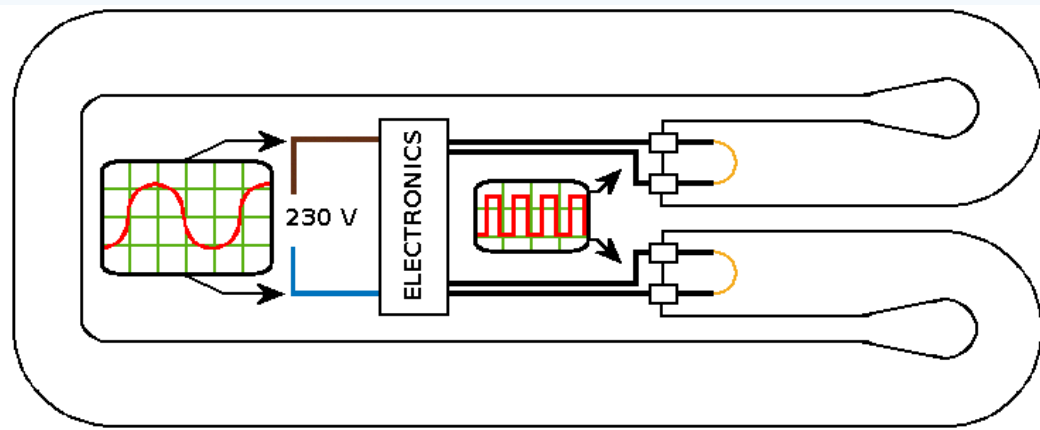
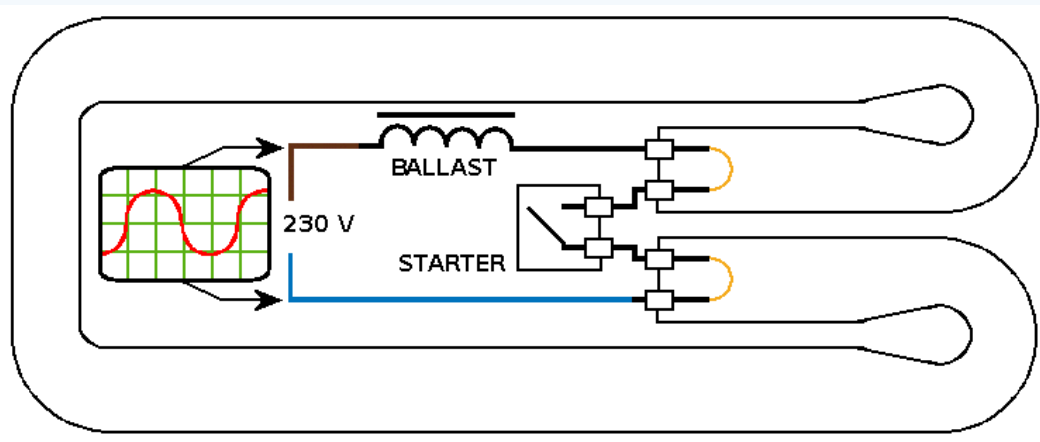
Discharge / Luminescent Lamp

❖ Sodium Vapor Lamp

Sr. No	Description	Value
1	Working Temperature	700°C
2	Efficiency	100 to 200 Lumen/Watt
3	Life	18000 Hour

Discharge / Luminescent Lamp

❖ Compact Fluorescent Lamp



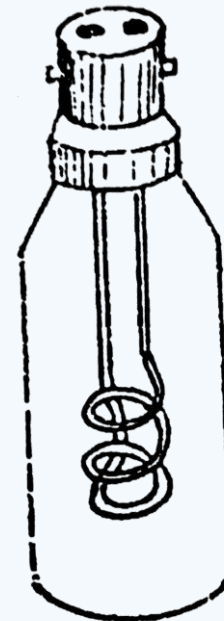
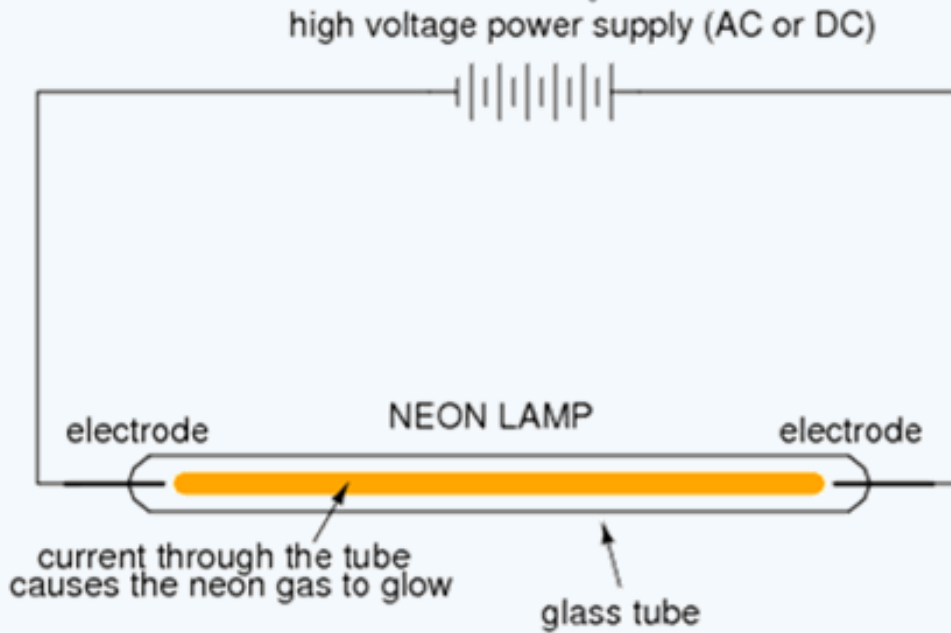
Discharge / Luminescent Lamp

❖ Compact Fluorescent Lamp

Sr. No	Description	Value
1	Working Temperature	40°C
2	Efficiency	50 Lumen/Watt
3	Life	6000 to 15000 Hour

Discharge / Luminescent Lamp

❖ Neon Lamp



(Fig. 1.17 Neon lamp)

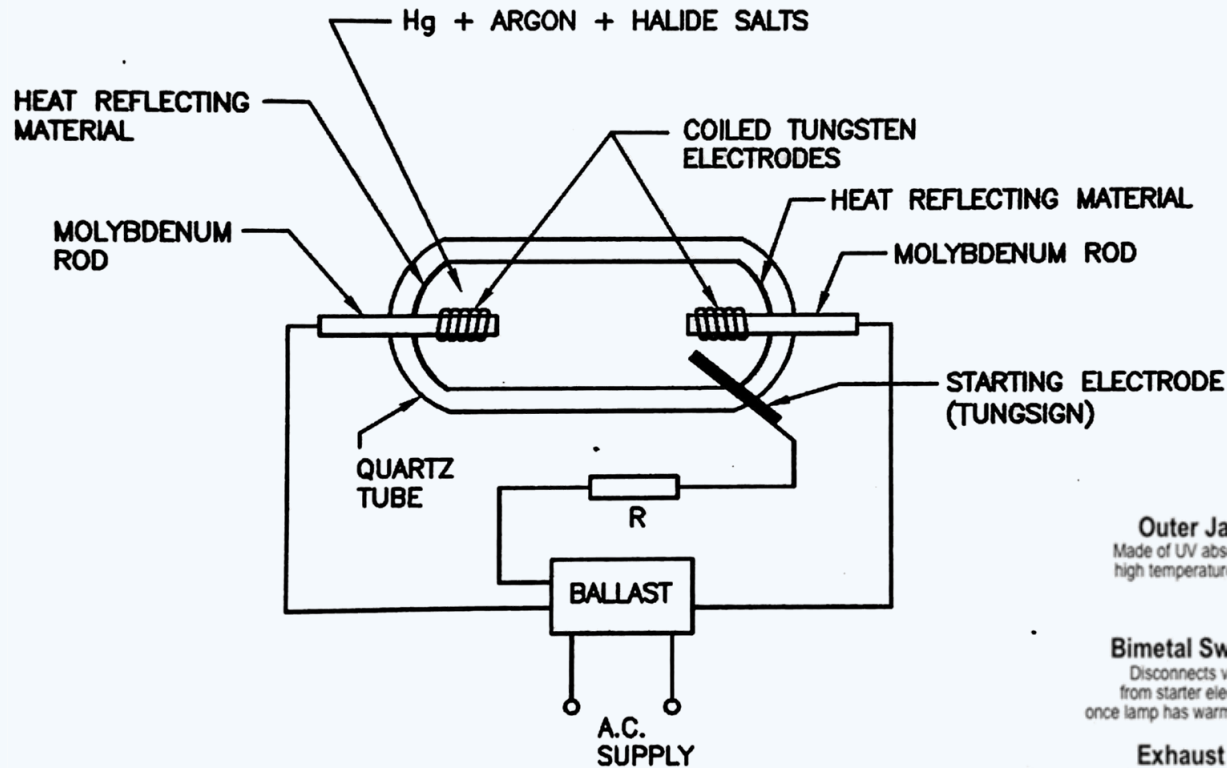


small neon indicator lamp

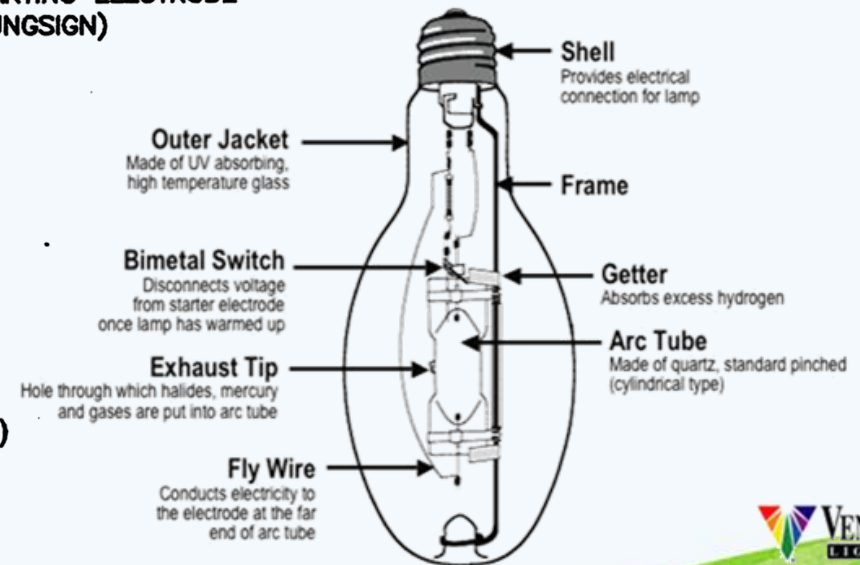


Neon lamp schematic symbol

Metal Halide Lamp



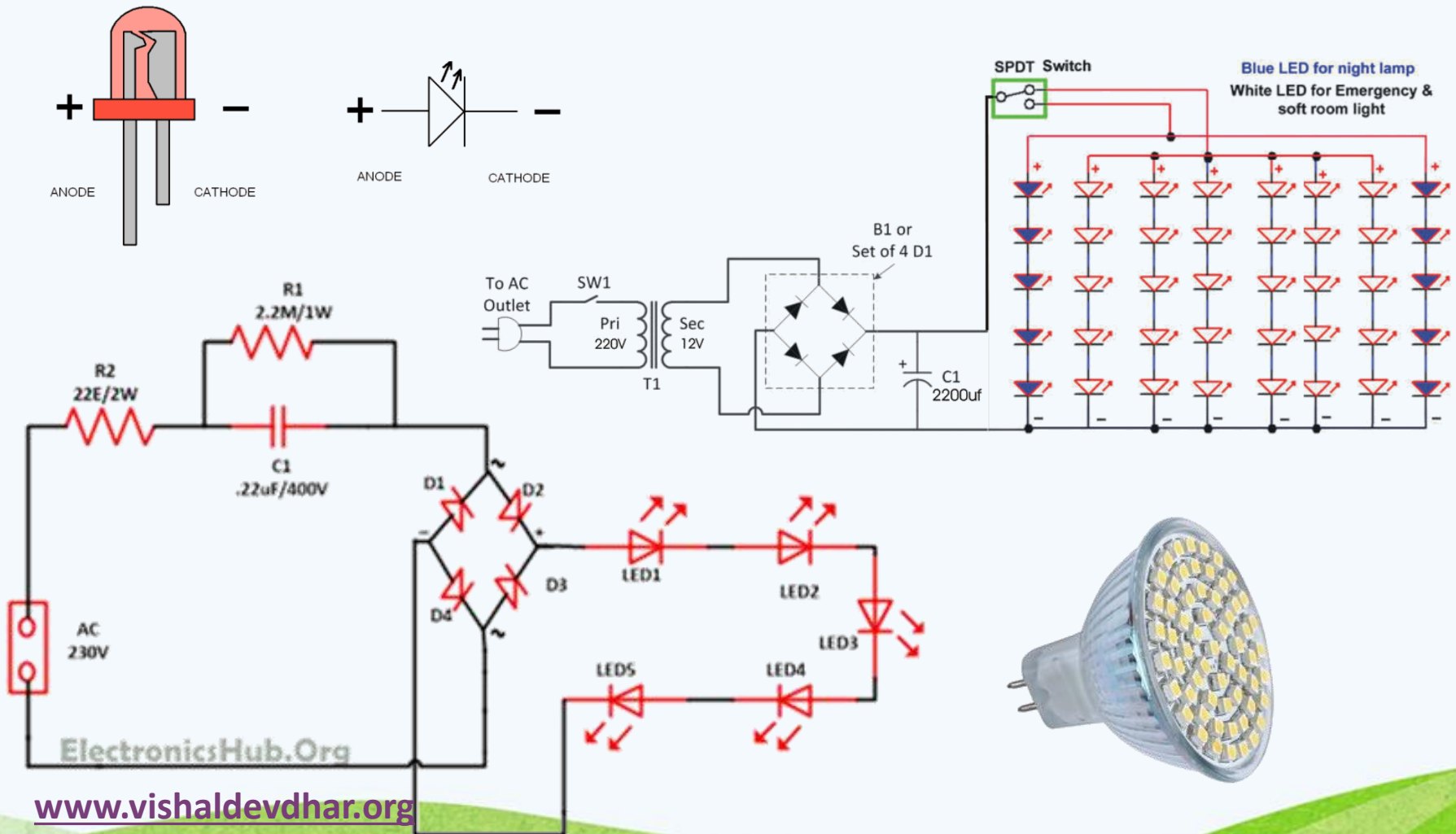
(Fig. 1.18 Discharge tube of metal halide lamp)



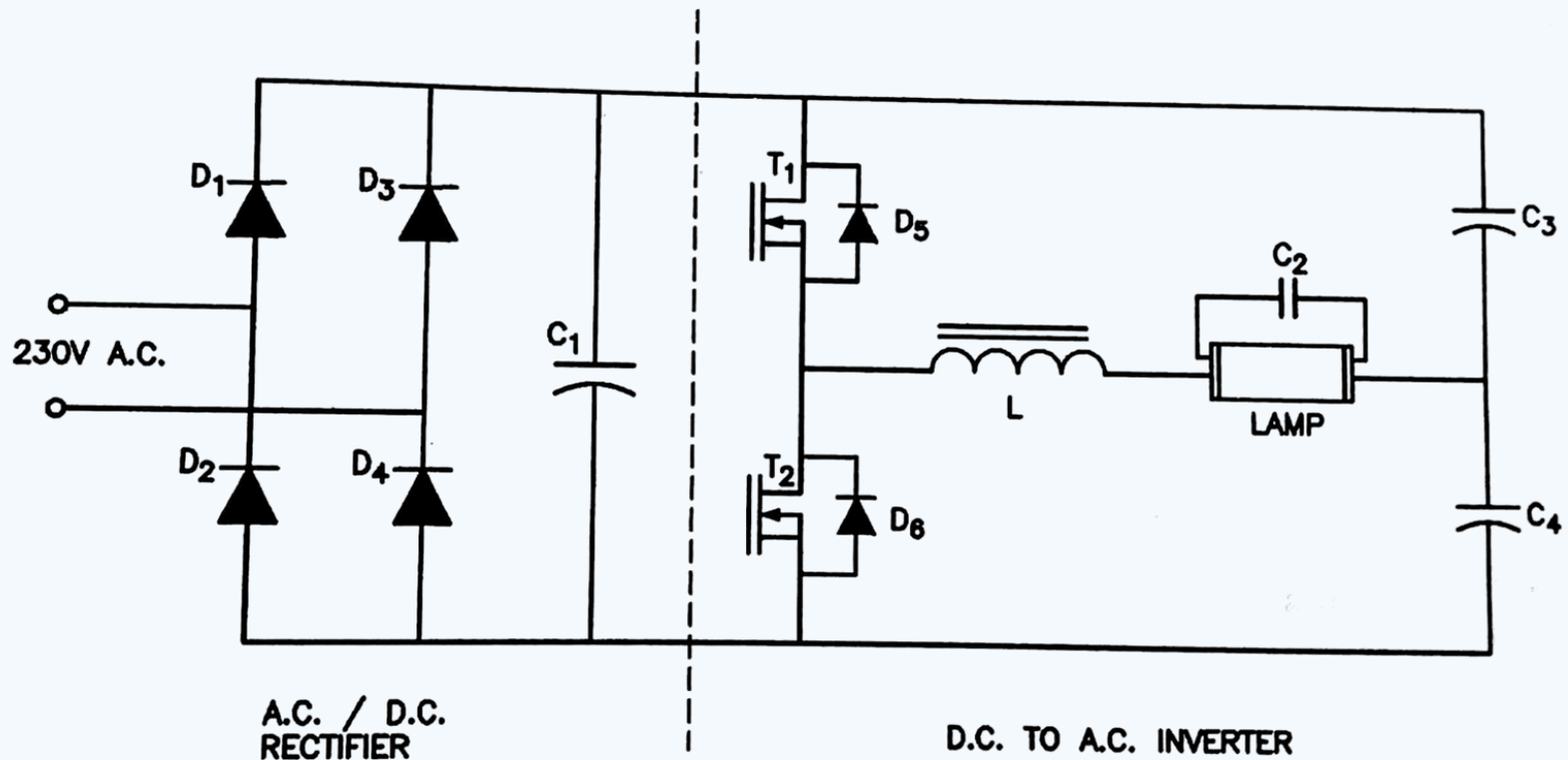
Metal Halide Lamp

Sr. No	Description	Value
1	Working Temperature	1000 to 3000°C
2	Efficiency	115 Lumen/Watt
3	Life	10000 to 20000 Hour

Light Emitting Diode (LED) Lamp

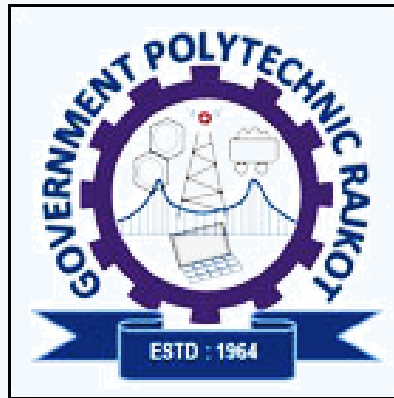


Electronic Ballast



(Fig. 1.19 Electronic ballast circuit)

Thank You



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