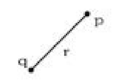
Logic gates pdf class 12

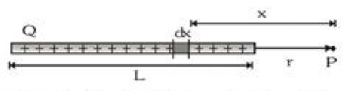
- **Electric Potential due to a point charge in its surrounding :**



The potential at a point P at a distance r from the charge q $V_P = \frac{U}{q_0}$. Where U is the potential energy of charge q_0 at point p, $U = \frac{kqq_0}{r}$. Thus potential at point P is $V_P = \frac{kq}{r}$

Electric Potential due to a charge Rod :

Figure shows a rod of length L, uniformly charged with a charge Q. Due to this we'll find electric potential at a point P at a distance r from one end of the rod as shown in figure.



For this we consider an element of width dx at a distance x from the point P.

Charge on this element is $dQ = \frac{Q}{L}dx$

The potential dV due to this element at point P can be given by using the result of a point charge as

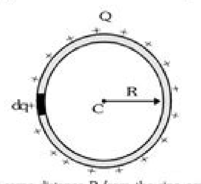
$$dV = \frac{kdq}{x} = \frac{kQ}{Lx}dx$$

Net electric potential at point P : $V = \int dV = \int_r^{r+L} \frac{kQ}{Lx}dx = \frac{kQ}{L}\ln\left(\frac{r+L}{r}\right)$

Electric potential due to a charged ring

Case – I : At its centre

To find potential at the centre C of the ring, we first find potential dV atcentre due to an elemental charge dq on ring which is given as $dV = \frac{kdq}{R}$ Total potential at C is $V = \int dV = \int \frac{kdq}{R} = \frac{kQ}{R}$.



As all dq's of the ring are situated at same distance R from the ring centre C, simply the potential due to all dq's is added as being a scalar quantity, we can directly say that the total electric potential at ring centre is $\frac{kQ}{R}$. Here we can also state that even if charge Q is non-uniformly distributed on ring, the electric potential C will remain same.

GOLDEN KEY POINTS

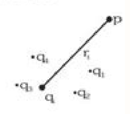
- Charged particle in an electric field always experiences a force either it is at rest or in motion.
- In presence of a dielectric , electric field decreases and becomes $\frac{1}{\epsilon_r}$ times of its value in free space.
- Test charge is always a unit (+ ve) charge. $\vec{E} = \frac{\vec{F}_{test}}{\text{test charge}}$
- If identical charges are placed on each vertices of a regular polygon, then $\vec{E}$ at centre = zero.

ELECTRIC FIELD INTENSITIES DUE TO VARIOUS CHARGE DISTRIBUTIONS

Due to discrete distribution of charge

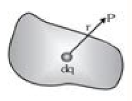
Field produced by a charge distribution for discrete distribution:-

By principle of superposition intensity of electric field due to i^{th} charge $\vec{E}_{ip} = \frac{kq}{r_i^2}\hat{r}_i$



$\therefore$ Net electric field due to whole distribution of charge $\vec{E}_P = \sum_{i=1} \vec{E}_i$

Continuous distribution of charge



Treating a small element as particle $\vec{E} = \frac{1}{4\pi\epsilon_0}\int \frac{dq}{r^3}\vec{r}$

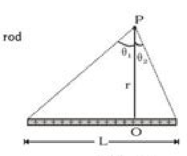
Due to linear charge distribution $E = k\int_{\ell} \frac{\lambda d\ell}{r^2}$ [λ = charge per unit length]

Due to surface charge distribution $E = k\int_s \frac{\sigma ds}{r^2}$ [σ = charge per unit area]

Due to volume charge distribution $E = k\int_v \frac{\rho dv}{r^2}$ [ρ = charge per unit volume]

Electric field strength at a general point due to a uniformly charged rod

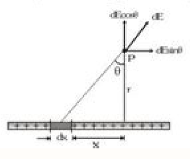
As shown in figure, if P is any general point in the surrounding of rod, to find electric field strength at P, we consider an element on rod of length dx at a distance x from point O as shown in figure. Now if dE be the electric field at P due to the element, then



$dE = \frac{kdq}{(x^2+r^2)}$ Here $dq = \frac{Q}{L}dx$

Electric field strength in x-direction due to dq at P is

$dE_x = dE\sin\theta = \left[\frac{kdq}{(x^2+r^2)}\right]\sin\theta = \frac{kQ\sin\theta}{L(x^2+r^2)}dx$



Here we have $x = r\tan\theta$ and $dx = r\sec^2\theta\, d\theta$

Thus $dE_x = \frac{kQ}{L}\frac{r\sec^2\theta\, d\theta}{r^2\sec^2\theta}\sin\theta$, Strength $= \frac{kQ}{Lr}\sin\theta\, d\theta$

INTERFERENCE OF LIGHT

When two light waves of same frequency with zero initial phase difference or constant phase difference superimpose over each other, then the resultant amplitude (or intensity) in the region of superimposition is different from the amplitude (or intensity) of individual waves.

This modification in intensity in the region of superposition is called interference.

(a) **Constructive interference**

When resultant intensity is greater than the sum of two individual wave intensities [$I > (I_1 + I_2)$], then the interference is said to be constructive.

(b) **Destructive interference**

When the resultant intensity is less than the sum of two individual wave intensities [$I < (I_1 + I_2)$], then the interference is said to destructive.

There is no violation of the law of conservation of energy in interference. Here, the energy from the points of minimum energy is shifted to the points of maximum energy.

TYPES OF SOURCES

- **Coherent source**

Two sources are said to be coherent if they emit light waves of the same wavelength and start with same phase or have a constant phase difference.

Note : Laser is a source of monochromatic light waves of high degree of coherence.

Main points :

1. They are obtained from the same single source.
2. Their state of polarization is the same

- **Incoherent source**

Two independent monochromatic sources, emit waves of same wavelength.

But the waves are not in phase. So they are incoherent. This is because, atoms cannot emit light waves in same phase and these sources are said to be incoherent sources. By using two independent laser beams it has been possible to record the interference pattern.

Independent Source (non-coherent source)

METHOD FOR OBTAINING COHERENT SOURCE

- **Division of wave front**

In this method, the wavefront is divided into two or more parts by use of mirrors, lenses or prisms.

Example : Young's double slit experiment. Fresnel's Biprism and Lloyd's single mirror method.

- **Division of amplitude**

The amplitude of incoming beam is divided into two or more parts by partial reflection or refraction. These divided parts travel different paths and are finally brought together to produce interference.

Example : The brilliant colour seen in a thin film of transparent material like soap film, oil film, Michelson's Interferometer, Newtons' ring etc.

14.14. In a p-n junction diode, the current I can be expressed as

$$I = I_0 \exp\left(\frac{eV}{k_BT} - 1\right)$$

where I_0 is called the reverse saturation current, V is the voltage across the diode and is positive for forward bias and negative for reverse bias, and I is the current through the diode, kB is the Boltzmann constant (8.6×10^{-5} eV/K) and T is the absolute temperature. If for a given diode $I_0 = 5 \times 10^{-12}$ A and T = 300 K, then

(a) What will be the forward current at a forward voltage of 0.6 V?

(b) What will be the increase in the current if the voltage across the diode is increased to 0.7 V?

(c) What is the dynamic resistance?

(d) What will be the current if reverse bias voltage changes from 1 V to 2 V?

Solution:

Given:

The current I in a p-n junction diode, $I = I_0 \exp\left(\frac{eV}{k_BT} - 1\right)$

$I_0 = 5 \times 10^{-12}$ A

T = 300 K

$K_B = 8.6 \times 10^{-5}$ eV/K

(a) Forward voltage 0.6 V

$I = 5 \times 10^{-12} \exp\left(\frac{0.6}{8.6\times10^{-5}\times300} - 1\right)$

$\Rightarrow I = 5 \times 10^{-12} \exp(22.25) = 0.0231$ A

The forward current in the diode is 0.0231 A.

(b) Forward voltage 0.7 V

$I = 5 \times 10^{-12} \exp\left(\frac{0.7}{8.6\times10^{-5}\times300} - 1\right)$

$\Rightarrow I = 5 \times 10^{-12} \exp(26.13) = 1.116$ A

The forward current in the diode is 1.116 A.

(c) Dynamic Resistance is given as the ratio of change in voltage and change in current.

Dynamic Resistance $= \frac{\text{change in voltage}}{\text{change in current}} = \frac{0.7-0.6}{1.116-0.0231} = \frac{0.1}{1.093} =$ 0.091 Ω

Specific use of conducting materials :

- The **heating element** of devices like heater, geyser, press etc are made of **microhm** because it has high resistivity and high melting point. It does not react with air and acquires steady state when red hot at 800 C.
- **Fuse wire** is made of **tin lead alloy** because it has low melting point and low resistivity. The fuse is used in series, and melts to produce open circuit when current exceeds the safety limit.
- **Resistances** of resistance box are made of **manganin** or **constantan** because they have moderate resistivity and very small temperature coefficient of resistance. The resistivity is nearly independent of temperature.
- The **filament of bulb** is made up of **tungsten** because it has low resistivity, high melting point of 3300 K and gives light at 2400 K. The bulb is filled with inert gas because at high temperature it reacts with air forming oxide.
- The **connection wires** are made of **copper** because it has low resistance and resistivity.

COLOUR CODE FOR CARBON RESISTORS

Colour	Strip A	Strip B	Strip C	Strip D (Tolerance)
Black	0	0	10^0	
Brown	1	1	10^1	
Red	2	2	10^2	
Orange	3	3	10^3	
Yellow	4	4	10^4	
Green	5	5	10^5	
Blue	6	6	10^6	
Violet	7	7	10^7	
Grey	8	8	10^8	
White	9	9	10^9	
Gold	-	-	10^{-1}	± 5%
Silver	-	-	10^{-2}	± 10%
No colour	-	-	-	± 20%

May be remembered as
BBROY
Great Britain
Very Good Wife.

Example

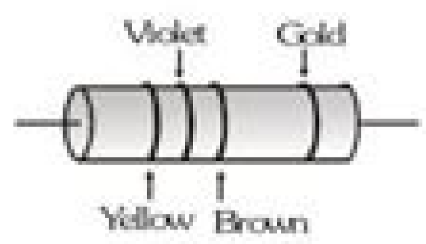
Draw a colour code for 42 k Ω ± 10% carbon resistance.

Solution

According to colour code colour for digit 4 is yellow, for digit 2 it is red, for 3 colour is orange and 10% tolerance is represented by silver colour. So colour code should be yellow, red, orange and silver.

Example

What is resistance of following resistor.



Solution

Number for yellow is 4, Number of violet is 7

Brown colour gives multiplier 10^1, Gold gives a tolerance of ± 5%

So resistance of resistor is 47 10^1 Ω ± 5% = 470 ± 5% Ω.

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