JKBOSE PATTERN
TEST PAPER
CLASS - XII
SUBJECT PHYSICS
ANSWER & SOLUTIONS

ALLEN CAREER INSTITUTE KOTA (RAJASTHAN) path to success

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ANSWER AND SOLUTIONS

Section A:Objective Type Questions (1marks each)

(i)Lenz law is a consequence the law of conservation of :

(a) Charge

(b) Mass

(c) Momentum

*(d) Energy

(ii)The magnitude of Saturation Photo-electric current depends upon :

(a) Frequency

*(b) Intensity

(c) Work function

(d) Stopping potential

(iii)The average power dissipation in pure capacitor in AC circuit is:

(a) $\frac{1}{2}cv^2$ (b) cv^2

(c) $\frac{1}{2}Q^2/C$ *(d) Zero

(iv) Which waves among the following waves cannot be Polarized ?

(a) X-rays

*(b) Sound waves

(c) Radio waves

(d) γ-rays

(v)What is the stopping potential, when the metal with work function 0.6 eV is illuminated with the light of 2 eV ?

(a) 2.6 V

(b) 3-6 V

(c)0.8 V

*(d)1-4 V

(vi)The refracting angle of a prism is 60° and minimum deviation 30°, the angle of incidence will be :

(a) 30°

*(b) 45°

(c) 60°

(d) 90°

(vii)Transformer is based upon the principle of :

(a) Self-induction

*(b) Mutual induction

(c) Eddy current

(d) None of the above

(viii) Threshold frequency of potassium is $3\times10^{14}\,Hz.$ The work function is :

(a) $3\times10^{-19}\,J$

(b) $2\times10^{-19}\,J$

(c) $4\times10^{-19}\,J$

*(d) $2\times10^{-19}\,J$

(xi)The average binding energy of a nucleus is :

(a) 8 eV

(b) 8 KeV

*(c) 8 MeV

(d) 8 J

(x) A semiconductor is heated from T_1 K to T_2 K. Its resistance.

*(a) will decrease

(b) will increase

(c) will not change

(d) will first decrease and then increase

ANSWER AND SOLUTIONS

Section B:Very Short type Questions (2 marks each)

Q.No.2: Find the capacitive reactance of $10\mu F$ capacitor when it is a part of a circuit whose frequency is 100 Hz

ANSWER: We know that

$$XC = \frac{1}{\omega C}$$

$$= \frac{1}{2\pi fC}$$

$$= \frac{1}{2\times 3.14\times 100\times 10^{-5}}$$

$= 159.2\ \Omega$

Q.No.3: Explain the term stopping potential and threshold frequency

ANSWER: Stopping potential is the minimum negative voltage applied to the anode to stop the photocurrent. The maximum kinetic energy of the electrons equal the stopping voltage, when measured in electron volt.

The threshold frequency is the lowest frequency below which the photoelectric effect does not occur. The threshold frequency is defined as the lowest incident radiation frequency below which photoelectric emission is absolutely impossible regardless of the strength of the incident radiation.

Q.No.4: Explain mass defect

ANSWER: Careful measurements have shown that the mass of a particular atom is always slightly less than the sum of the masses of the individual neutrons, protons, and electrons of which the atom consists. The difference between the mass of the atom and the sum of the masses of its parts is called the mass defect.

Q.No.5: State laws of photoelectric effect.

ANSWER: 1. For every given frequency of light. the photoelectric current is proportional to the intensity of light (Y >Y Th).

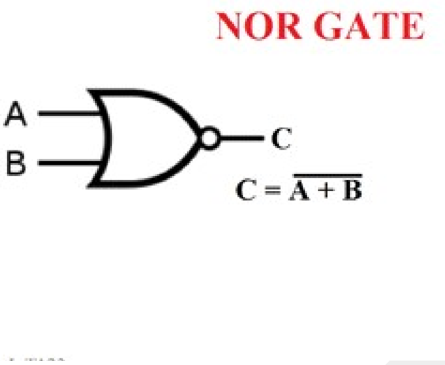
2. The discharge of photoelectrons stops completely below a particular minimum (energy) frequency for a certain material, known as the threshold frequency, regard less of the intensity of input light.

3. The photoelectrons' maximum kinetic energy rises as the frequency of the incident light rises (assuming frequency Y > Y the exceeds the threshold limit). The maximum kinetic energy is independent of light intensity,

4. Photo-emission is a phenomenon that occurs in a split second.

Q.No.6: Give Boolean expression and truth table of NOR gate.

ANSWER:



TRUTH TABLE

INPUT		OUTPUT
A	B	A NOR B
0	0	1
0	1	0
1	0	0
1	1	0

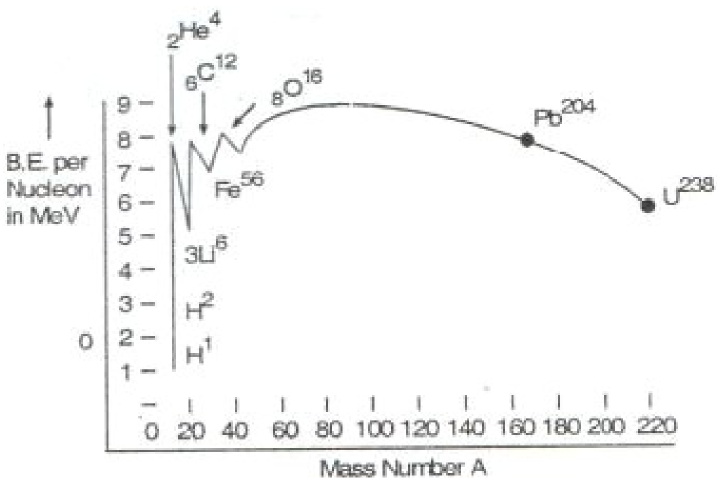
Q.No.7: Define work function and give its S. I. Units.

ANSWER: Work function is a property of a material, which is defined as the minimum quantity of energy which is required to remove an electron to infinity from the surface of a given solid.

The SI unit of work is joule (J).

Q.No.8: Define binding energy. Sketch the graph between binding energy per nucleon and mass number

ANSWER: **Binding energy**, amount of energy required to separate a particle from a system of particles or to disperse all the particles of the system. Binding energy is especially applicable to subatomic particles in atomic nuclei, to electrons bound to nuclei in atoms, and to atoms and ions bound together in crystals



ANSWER AND SOLUTIONS

Q.No.9: What are the limitations of Bohr's atomic model?

ANSWER: Bohr’s model of an atom failed to explain the Zeeman Effect (effect of magnetic field on the spectra of atoms).

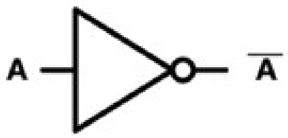
It also failed to explain the Stark effect (effect of electric field on the spectra of atoms).

It violates the Heisenberg Uncertainty Principle.

It could not explain the spectra obtained from larger atoms.

Q.No.10: Give the logic symbol and truth table for NOT gate.

ANSWER:



2 input NOT gate

A	$\overline{A}$
0	1
1	0

Section C:Short answer type question (3marks each)

Q.No. 11: What are Diamagnetic Substances ? Give properties of dia- magnetic substances.

ANSWER: Diamagnetic materials are those materials that people find non-magnetic such as wood, water, gold, copper, etc. These materials show the property of diamagnetism. They are not attracted to any magnetic field.

Q.No.12: What is Einstein's explanation of photoelectric effect.

ANSWER: Eintein resolved this problem using Plankc’s revolutionary idea that light was a particle. The energy carried by each particle of light (called quanta or photon) is dependent on the light’s frequency (v) as shown :

$$E = hv$$

Where h = planck’s constant = 6.6261×10^{-34} Js.

Since light is bundled upto into photons, Einstein theorized when a photon falls on the surface of a metalm the entire photon’s energy is transferred to the electron. A part of this energy is used to remove the electron from the metal atom’s grasp and the rest is given to the ejected electron as kinetic energy. Electrons emitted from underneath the metal surface lose some kinetic energy during the collision.

But the surface electrons carry all the kinetic energy imparted by the photon and have the maximum kinetic energy.

We can write this mathematically as :

= energy required to eject an electron (work function) + maximum kinetic energy of the electron

$$E = W + KE$$

$$h\nu = W + KE$$

$$KE = h\nu - w$$

At the threshold frequencym V_o, electrons are just ejected and do not have any kinetic energy. Below the frequency, there is no electron emission. Thus, the energy of a photon with this frequency must be the work function of the metal.

$$w = h\nu_0$$

Thus, maximum kinetic energy equation becomes :

$$KE = 1/2mv^2{}_{max} = h\nu - h\nu_0$$

$$1/2\ mv^2{}_{max} = h(\nu - \nu_0)$$

V_{max} is the maximum kinetic energy of the electron . it is calculated experimentally using the stopping potential. Please read our article in Lenard's observations to understand this part.

Stopping potential $= ev_0 = 1/2mv^2{}_{max}$

Thus, Eintein explained the Photoelectric effect by using the particle nature light.

The below video is a quick revision of what is photoelectric effect.

Q.No.13: State the postulates of Bones model of atom.

ANSWER: Postulates of Bohr's Model of Atom

In an atom, electrons(negatively charged) revolve around the positively charged nucleus in a definite circular path called orbits or shells.

Each orbit or shell has a fixed energy and these circular orbits are known as orbital shells.

The energy levels are represented by an integer (n=1,2,3...) known as the quantum number. The range of quantum number starts from nucleus side with n =1 having the lowest energy level. The orbits n =1,2,4... are assigned as K,L,M,N.... shells and when an electron attains the lowest energy level, it is said to be in the ground state.

The electrons in an atom move from a lower energy level to a higher level by gaining the required energy and an electron moves from a higher energy level to lower energy level by losing energy.

Q.No.14: Find wavelength of first line of Layman series

ANSWER:

Step 1 Introducing the formula : The Ryderg's Equation

$$\frac{1}{\lambda}=109677\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right)z^2 \text{ cm}^{-1}$$

Step:2 Gathering data about the first line of the Lyman series :

For the Lyman series, $n_1 = 1$

For the shortest wavelength in the Lyman series the $n_2 = 2$

Step 3: Putting all the data in the Rydberg's equation

$$\frac{1}{\lambda}=109677\left(\frac{1}{1^2}-\frac{1}{2^2}\right)1^2 \text{ cm}^{-1}$$

$$\frac{1}{\lambda}=109677 \text{ cm}^{-1}\left(\frac{1}{1^2}-\frac{1}{4}\right)1^2$$

$$\frac{1}{\lambda}=109677\text{cm}^{-1}\left(\frac{4-1}{4}\right)$$

$$\frac{1}{\lambda}=109677\left(\frac{3}{4}\right) \text{ cm}^{-1}$$

$$\lambda=\frac{4}{3\times109677}cm=\frac{4}{329031}cm$$

$$\lambda=1.21\times10^{-7}m=121\times10^{-9}m$$

$$\lambda=121nm$$

Therefore, the wavelength of the first line of the Lyman Series is 121nm.

Q.No15: Establish the relation between drift velocity of electrons and electric current.

ANSWER: Relation between drift velocity and electric current :

E = V/I-----------------(1)

Let n = Total number of free electrons /unit volume

ie n = N/V = N/A x 1 or N = n x A1----------(2)

wkt amount of charge flows through given cross section Q = Ne = nA1e

But I = Q/t = nAI e/t since I/t = V_d

Hence I = nA V_d e

Derivation of Ohm's Law :

I = nA V_d e -------------------(1)

Also Vd = eE r/m and E=V/1 substituting in(1)

I = nA eE r/m=nA eV r e/m1

Hence V/I=R=m1/ne2 A r = constant

R is the resistance of the conductor

Q.No.16: State Faraday's laws of electromagnetic induction.

ANSWER: <u>Faraday's law of electromagnetic Induction :</u>

1. Due to charging magnetic field, the electromagnetic force (EMF) is induced in a circuit, and therefore, a current is produced. This is called electromagnetic induction.

2. First Law : It states that whenever there is a change in magnetic flux associated with a coil, EMF is induced in that coil.

3. Second Law : It states that the magnitude of EMF induced in the coil is directly proportional to the rate of change of Magnetic flux associated with the coil.

4. Mathematically, it can expressed as $\in = -\frac{d\phi}{dt}$, where $\in$ is the induced EMF and $\frac{d\phi}{dt}$ is the rate of change of magnetic flux.

5. For n number turns in the coil, the expression is given as $\in = -n\frac{d\phi}{dt}$.

6. The diagram below illustrates the generation of current in a coil due to a moving magnet, and no current is generated due to a static magnet.

Q.No.17: Show that the de-Broglie wavelength A of an electron of energy E is given by the relation :

$$\lambda = \frac{h}{\sqrt{2mE}}.$$

Let E be energy and p momentum of electron,

so $E = \frac{1}{2}mv^2 = \frac{m^2v^2}{2m} = \frac{p^2}{2m}$

or $p = \sqrt{2mE}$ ....(i)

since de-Broglie wavelength associated by an electron is given by :

$$\lambda = \frac{h}{p}$$

Using Eq. (i) we get

$$\lambda = \frac{h}{\sqrt{2mE}} \text{..........}(ii)$$

Q.No.18: Define binding energy and mass defect. Obtain an expression for binding energy per nucleon.

ANSWER: The amount of energy required to separate a particle from a particle system or disperse all of the system's particles is known as binding energy.

The mass of the nucleus is about 1 percent smaller than the mass of its individual protons and neutrons. This difference is called the mass defect.

$$\Delta m = Zm_p + (A - Z)m_n - m_{nuc}$$

$$E_b = (\Delta m)c^2.$$

Q.No.19: How will you convert galvanometer into Voltmeter ?

ANSWER: Step 3: Voltmeter from Galvometer

1. Ammeters and voltmeters are the modified forms of the galvometers
2. By connecting a high resistance in series connection with a galvometer, it can be converted into a voltmeter.
3. The resistance is connected in series with the galvanometer to convert it into a voltmeter in order to get a maximum resistance.
4. In this case, the scale of the instrument will change to volt (^{v}).
5. The range of the voltmeter is decided by the value of the resistance connected in series with the galvanometer.
6. In general, the value of resistance connected in series to the galvanometer must be very high so that so that errors can be prevented while recording the reading.

Section D:Long answer type questions (5 marks each)

Q.No.20: What are dia, para and ferromagnetic materials ? Discuss their important properties.

ANSWER: Diamagnetism is the tendency of a substance to oppose an applied magnetic field and hence, to repel the applied magnetic field. It can be found in all materials.

Characteristics of diamagnetic materials:

1. The magnetic moment of each atom in a diamagnetic substance is calculated to be zero.
2. They can be repelled by a weak magnetic field.
3. Diamagnetic substances shift from the stronger to the weaker side of the field when they are placed in a non-uniform magnetic field.
4. When these materials are exposed to an external magnetic field, they become weakly magnetised in the opposite direction as the field.
5. In diamagnetic materials, magnetic susceptibility is shown to be negative.
6. Diamagnetism occurs in substances such as copper, silver, gold etc.

Paramagnetism

The electron spin of unpaired electrons causes paramagnetism. When a group of electrons is subjected to a magnetic field, the dipole moments of the electrons seem to line up with the field, just like a tiny bar magnet.

Characteristics of paramagnetic materials:

1. Every atom in this substance is thought to be a magnetic dipole with a magnetic moment as a result.
2. These materials are attracted to the external magnetic field via a weak attraction.
3. When placed in a non-uniform field, they travel from the weaker to the stronger area of the field.
4. When the external magnetic field is removed, these materials lose their magnetism.
5. Paramagnetism occurs in substances such as lithium, tantalum and magnesium.

Ferromagnetism

Because of the electron's magnetic properties, ferromagnetism also exists. Unlike paramagnetism, ferromagnetism can exist even when there is no external field. Because it is energetically advantageous, the magnetic dipole moments of the atoms naturally lineup with one another.

Characteristics of ferromagnetic materials:

1. Ferromagnetic compounds are made up of a high number of tiny domains.
2. When the external magnetic field is removed, these substances retain their magnetism.
3. When heated over the curie point, certain materials become paramagnetic.
4. Ferromagnetic compounds are highly attracted by the external magnetic field.
5. When the magnetic field is non-uniform, these ferromagnetic materials tend to shift from the weaker to the stronger section of the field.
6. When a ferromagnetic rod is placed in a homogeneous magnetic field, it will come to rest with its length parallel to the field's direction.

OR

Describe the principle, construction and working of moving coil galvanometer.

ANSWER:

Working Principle of A Moving Coil Galvanometer:

Moving coil galvanometers work on the principle that a current-carrying coil experiences torque when placed in a magnetic field. As the electric current is passed through the coil, a torque acts on it, which deflects the coil.

Construction of A Moving Coil Galvanometer

A moving coil galvanometer is made up of a rectangular coil with multiple turns coiled on a metallic frame. It is usually made of fine copper wire that is sparsely insulated. In a suspended coil galvanometer, the coil may be suspended in a uniform radial magnetic field by a strip of phosphor-bronze coupled to an adjustable torsion head.

Working of A Moving Coil Galvanometer

The objective of the moving coil galvanometer is to measure the amount of the current passed through the coil. The current is passed through a coil that has n turns.

As the coil starts rotating, the restoring torque keeps on increasing. The point at which the applied torque is balanced by the torque is when the coil stops rotating. The angle at which it stops rotating is denoted by. This is the equilibrium condition.

At this stage, applied torque = restoring torque

NIBA$\sin\theta$ =Cϕ

$$1= \frac{C\phi}{NAB\sin\theta}$$

Only the angles ϕ and θ are variable terms in the formula.

This means, I $\alpha \dfrac{\phi}{\sin\theta}$

only the angles ϕ and θ are variable terms in the formula.

This means, I $\alpha \dfrac{\phi}{\sin\theta}$

CURRENT Sensitivity

Current sensitivity is defined as the ratio of deflection and the amount of current.

Current sensitivity = $\dfrac{\phi}{I} = \dfrac{NAB}{C}$

VOLTAGE Sensitivity

It is defined as the ratio of the deflection and amount of voltage.

voltage senstivity = $\frac{\phi}{V}$

By modifying the galvanometer, the voltage can also be measured. The galvanometer is highly sensitive when a small voltage shows a higher deflection. To increase the voltage sensitivity, we can increase the number of turns and area of the coil or decrease the resistance value.

Q.No.21:What is Electric Potential? Derive an expression for electric potential at a distance 'r' from a charge 'q'.

ANSWER:Consider the electric potential due to a point charge q, As we move from point A, at distance r_A from the charge q, to point B, at distance r_B from the charge q,the change in electric potential is

$$\triangle V_{BA} = V_B - V_A = -\int_A^B E.ds$$

$$E.\ ds = \left[k\frac{q}{r^2}\right]\hat{r}.ds$$

$$\hat{r}.ds = dr$$

Only the radial distance r determines the work done or the potential. We can move through any angle we like and, as long as the radial distance remains constant, no work is done or there is no change in the electric potential.

$$\triangle V_{BA} = V_B - V_A = -\int_{r_A}^{r_B} Edr = --\int_{r_A}^{r_B}\left[k\frac{q}{r^2}dr\right]$$

$$\triangle V_{BA} = V_B - V_A = kq[(-1)r^{-1}]_{r_A}^{r_B}$$

$$\triangle V_{BA} = V_B - V_A = kq[\frac{1}{r_B} - \frac{1}{r_B}]$$

This is the change in electric potential due to a point charge as we move from r_A to r_B.

We could ask about the change in electric potential energy as we move a charge q' from radius r_A to r_B due to a point charge q

$$\triangle U_{BA} = kq'q[\frac{1}{r_B} - \frac{1}{r_A}]$$

As with gravitational potential energy, it is more convenient and, therefore, useful to talk about the electric potential energy or the electric potential relative to some reference point. We will choose that reference point to be infinity. That is,

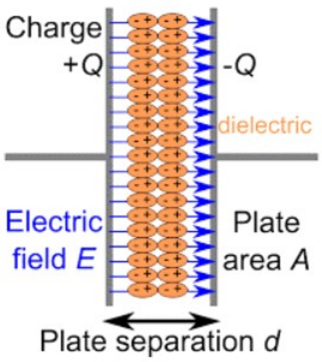
$r_A = \infty$

That means we can then write the electric potential at some radius r as $V = kq\,\frac{1}{r}$

Or

What is Parallel Plate Capacitor ? Obtain an expression for the capacitance of a parallel plate capacitor

ANSWER:



Parallel Plate Capacitors are the type of capacitors which that have an arrangement of electrodes and insulating material (dielectric). The two conducting plates act as electrodes. There is a dielectric between them. This acts as a separator for the plates.

The Capacitance of Parallel Plate Capacitor.The capacitance of the parallel plate capacitor determines the amount of charge that it can hold. If you see the above equation, you will see that greater the value of C. greater will be the charge that a capacitor can hold. Therefore we can see that the capacitance depends upon:

The distance d between two plates.

The area A of the medium between the plates.

According to the Gauss law, we can write the electric field as:

$$E = \frac{Q}{\varepsilon_0 A} \rightarrow Ed = V = \frac{Qd}{\varepsilon_0 d}$$

Since we know that the capacitance is defined as V=QC, so we can write capacitance as:

When the plates are placed very close and the area of plates are large, we get the maximum capacitance.

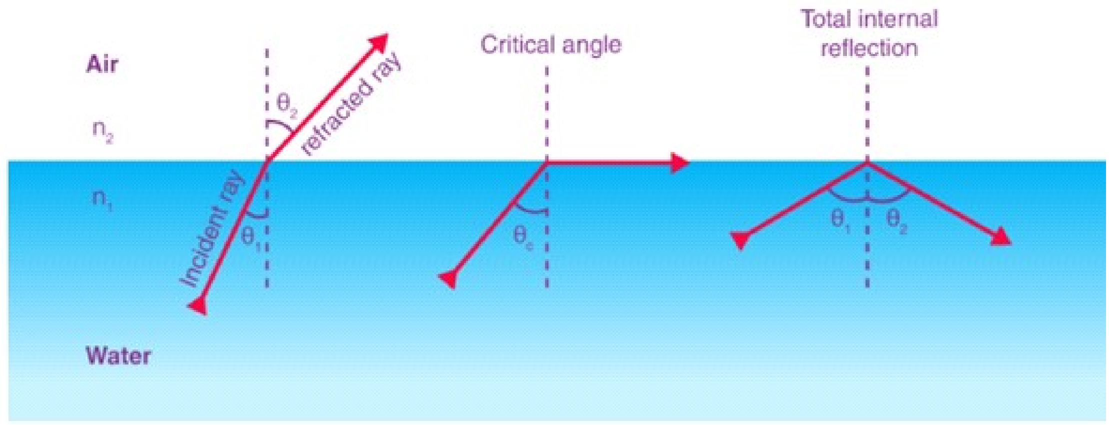
Q.No.22: Define total internal reflection. State its conditions. How do optical fibres transmit light without absorption ?

ANSWER:**Solution:** The phenomenon which occurs when the light rays travel from a more optically denser medium to a less optically denser medium. A ray of light passes from a medium of water to that of air. Light ray will be refracted at the junction separating the two media. Since it passes from a medium of a higher refractive index to that having a lower refractive index, the refracted light ray bends away from the normal.

Following are the two conditions of total internal reflection:

- The light ray moves from a denser medium to a less dense medium.
- The angle of incidence must be greater than the critical angle.

The light in a fiber-optic cable travels through the core (hallway) byconstantly bouncing from the cladding (mirror-lined walls), a principle called total internal reflection. Because the cladding does not absorbany light from the core, the light wave can travel great distances.



Formula of Total Internal Reflection

Total internal reflection	$\frac{n_1}{n_2} = \frac{sin r}{sin i}$
Critical angle, θ	$sin\theta = \frac{n_2}{n_1}$

Or

Derive the conditions for constructive and destructive interference.

ANSWER:Solution: Derive an expression for conditions of constructive interference and destructive interference - Sarthaks eConnect | Largest Online Education Community

Conditions of constructive interference and destructive interference.

consider two coherent waves travelling in the same direction along a straight line

Frequency of each wave is given by $\frac{\omega}{2\pi}$,

Amplitude of electric field vectors are a_1 and a_2 respectively.

Wave equation is represented by,

$y_1=a_1 \sin \omega t$ ....(i)

$y2 = a_2 \sin(\omega t+\phi)$....(ii)

Using the theory of superposition,

$y = y_1 + y_2$.......(iii)

Here, y_1 and y_2 are the points of electric field.

Putting values from (ii) and (iii) in (i), we have

$y=a_1\sin \omega t+a_2\sin(\omega t+\phi)$.

Now using trignometric identities, we have

$\sin(\omega t+\phi)= \sin \omega t \cos \phi + \cos \omega t \sin\phi$

we get,

$y=a_1 \sin \omega t +a_2 \sin \omega t \cos \phi + \cos \omega t \sin\phi)$

$=(a_1+ a_2 \cos \phi) \sin \omega t +(a_2 \sin \phi) \cos \omega t$ ....(iv)

Assume,

$a_1 + a_2 \cos\phi=A \cos\theta$

and

$a_2 \sin \phi =A \sin\theta$

so, eqn. (iv) gives,

$y=A\tilde{}\cos\theta\tilde{}\sin\omega t +A\tilde{}\sin\theta \cos \omega t$

=A~sin($\omega t+\phi$)

Amplitude of the resultant wave is given by,

Amplitude A= $\sqrt{a_1^2+a_2^2+2a_1a_2\cos\phi}$

Intensity of the wave is proportional to the amplitude of the wave.

Thus, **intensity of the resultant wave is given by.**

$I=A^2=a_1^2+a_2^2+2a_1a_2\cos\phi$

Constructive interference:

For maximum intensity at any point, cos = +1

phase difference, ϕ =0,2π,4π,6π,.......

=2nπ(n=0,1,2,...)

So, maximum intensity is,

Imax ={$a_1^2+a_2^2+2a_1a_2=(a_1+a_2^2$

Path difference is,

$\triangle=\frac{\lambda}{2\pi}$ x Phase difference = $\frac{\lambda}{2\pi}\times2n\pi=$ $\pi\lambda$

Constructive interference is obtained when the path difference between the waves is an integral multiple of A Destructive interference: For minimum intensity at any point, cos=-1 phase difference is given by,

$\phi=\pi,3\pi,5\pi,7\pi,$...........

$=(2n-1)\pi,n=1,2,3,$......

Minimum Intensity is,

Imin $=a_1^2+a_2^2-2a_1a_2=(a_1-a_2)^2$

Path difference is,

$\triangle=\frac{\lambda}{2\pi}\times$ phase difference

$=\frac{\lambda}{2\pi}\times(2n-1)\pi=(2n-1)\frac{\lambda}{2}$

In destructive interference, **path difference is odd multiple of** $\frac{\lambda}{2}$.