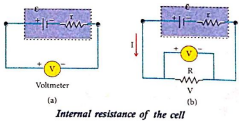
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Answers Key:

IV.ANSWER THE FOLLOWING

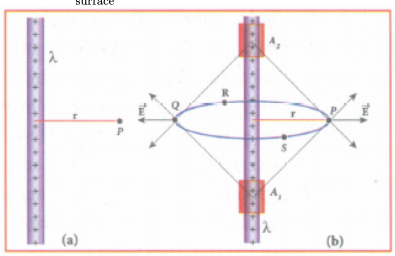
1. (i) The emf of cell ε is measured by connecting a high resistance voltmeter across it without connecting the external resistance R.
(ii) Since the voltmeter draws very little current for deflection, the circuit may be considered as open.
(iii) Hence the voltmeter reading gives the emf of the cell.
(iv) Then, external resistance R is included in the circuit and current I is established in the circuit.
(v) The potential difference across R is equal to the potential difference across the cell V.



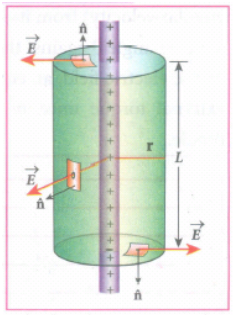
Internal resistance of the cell

(vi) The potential drop across the resistor R is,
v = IR .....(1)
(vii) Due to internal resistance r of the cell, the voltmeter reads a value V, which is less than the emf of cell ε. It is because, certain amount of voltage (Ir) has dropped across the internal resistance r.
Then V = ε - Ir
Ir = ε - v .....(2)
(viii) Dividing equation (2) by equation (1), we get
$\frac{Ir}{IR} = \frac{\varepsilon - V}{V}$
$r = \left|\frac{\varepsilon - V}{V}\right| R$
(ix) Since ε, V and R are known, internal resistance r can be determined.

2. (i) Consider an infinitely long straight wire having uniform linear charge density λ(charge per unit length).
(ii) Let P be a point located at a perpendicular distance r from the wire.
(iii) The electric field at the point P can be found using Gauss law. we choose two small charges elements A_1 and A_2 on the wire which are at equal distance from the point P.
(iv) The resultant electric field due to these two charge elements points radially away from the charged wire and the magnitude of electric field is same at all points on the circle of radius r.
This is shown in the Figure(b). From this property, the charged wire possesses a cylindrical symmetry.
(v) Let us choose a cylindrical Gaussian surface of radius r and length L .
The total electric flux through this closed surface is calculated as follows:
$\Phi_E = \oint \vec{E} \cdot d\vec{A}$
$= \int_{\text{Curved surface}} \vec{E} \cdot d\vec{A} + \int_{\text{top suffface}} \vec{E} \cdot d\vec{A} + \int_{\text{bottom surface}} \vec{E} \cdot d\vec{A}$ .....(1)
It is seen from Figure that for the curved surface, $\vec{E}$ is parallel to $\vec{A}$ and $\vec{E} \cdot d\vec{A} = EdA$. For the top and bottom surfaces, $\vec{E}$ is perpendicular to $\vec{A}$and $\vec{E} \cdot d\vec{A} = 0$
Substituting these values in the equation (1) and applying Gauss law to the cylindrical surface, we have
$\Phi_E = \int_{\text{Curved surface}} EdA = \frac{Q_{enc}}{\varepsilon_0}$ .....(2)



Electric field due to infinite long charged wire



Since the magnitude of the electric field for the entire curved surface is constant, E is taken out of the integration and Q_{encl} is given by Q_{encl} = λL where, λ is linear charge density (charge per unit length).

$E\int_{Curved\ surface} dA = \frac{\lambda L}{\varepsilon_0}$ ....(3)

Here, = $\int_{Curved\ surface} dA$ total area of the curved surface = 2πrL

Substituting this in equation (3), we get

E.2πrL = $\frac{\lambda L}{\varepsilon_0}$

$E = \frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}$ ...(4)

In vector form, $\vec{E} = \frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}\hat{r}$ ...(5)

The electric field due to the infinite charged wire depends on $\frac{1}{r}$ rather than $\frac{1}{r^2}$ for a point charge.

Equation (5) indicates that the electric field is always along the perpendicular direction $(\hat{r})$ to wire. In fact, if λ > 0 then $\vec{E}$points perpendicular outward $(\hat{r})$ from the wire and if λ < 0, then $\vec{E}$ points perpendicular inward $(-\hat{r})$.

3. (i) Electromagnetic waves are produced by any accelerated charge

(ii) Electromagnetic waves do not require any medium for propagation. So electromagnetic wave is a non mechanical wave.

(iii) Electromagnetic waves are transverse in nature. This oscillating electric field vector, oscillating magnetic field vector and propagation vector (gives direction of propagation) are mutually perpendicular to each other.

(iv) Electromagnetic waves travel with speed which is equal to the speed of light in vacuum or free space,

$c = \frac{1}{\sqrt{\varepsilon_0\mu_0}}$

$= 3 \times 10^8\ ms^{-1}$

where ε_0 is the permittivity of free space or vacuum and μ_0 is the permeability of free space or vacuum.

(v) In a medium with permittivity ε and permeability μ, the speed of electromagnetic wave is less than speed in free space or vacuum, that is, v < c. In a medium of refractive index, $\mu = \frac{c}{v}$

$n = \frac{\frac{1}{\sqrt{\varepsilon\mu}}}{\frac{1}{\sqrt{\varepsilon_0\mu_0}}} = \sqrt{\varepsilon_r\mu_r}$

where ε_r is the relative permittivity of the medium (also known as dielectric constant) and μ_r is the relative permeability of the medium

(vi) Electromagnetic waves are not deflected by electric field or magnetic field.

(vii) Electromagnetic waves can exhibit interference, diffraction and polarization.

(viii) Like other waves, electromagnetic waves also carry energy, linear momentum and angular momentum.

(ix) If the electromagnetic wave incident on a material surface is completely absorbed, then the energy delivered is U and momentum imparted on the surface is $p = \frac{U}{C}$

(x) If the incident electromagnetic wave of energy U is totally reflected from the surface, then the momentum delivered to the surface is

$\Delta p = \frac{U}{C} - \left(-\frac{U}{C}\right) = 2\frac{U}{C}$

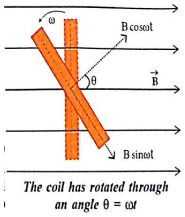
4. (i) Consider a rectangular coil of turns kept in a uniform magnetic field $\vec{B}$ as shown in Figure (a). The coil rotates in anti-clockwise direction with an angular velocity ω about an axis, perpendicular to the field, and to the plane of the paper.

(ii) At time = 0, the plane of the coil is perpendicular to the field and the flux linked with the coil has its maximum value $\Phi_m = BA$ (where A is the area of the coil).

(iii) In a time t seconds, the coil is rotated through an angle θ (= ωt) in anti-clockwise direction. In this position, the flux linked is NBA cos ωt, is due to the component of B normal to the plane of the coil (Figure(b)). The component parallel to the plane (B sin ωt) has no role in electromagnetic induction. Therefore, the flux linkage with the coil at this deflected position is

$N\Phi_B$ = NBA cosθ = NBA cos ωt

According to Faraday's law, the emf induced at that instant is



$\varepsilon = -\frac{d}{dt}(N\Phi_B) = -\frac{d}{dt}(NBA cos\omega t)$

= -NBA (-sin ωt)ω

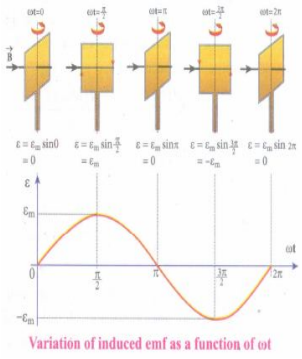
= NBAω sin ωt

(iv) When the coil is rotated through 90^0 from initial position, sin ωt = 1. Then the maximum value of induced emf is

ε_m = NBAω

Therefore, the value of induced emf at that instant is then given by,

$\varepsilon = \varepsilon_m \sin\omega t$ ....(1)



Variation of induced emf as a function of ωt

(vii) It is seen that the induced emf varies as sine function of the time angle ωt. The graph between induced emf and time angle for one rotation of coil will be a sine curve (Figure) and the emf varying in this manner is called sinusoidal emf or alternating emf.

If this alternating voltage is given to a closed circuit, a sinusoidally varying current flows in it. This current is called alternating current and is given by,

$i = I_m \sin\omega t$ ....(2)

Where, I_m is the maximum value of induced current.

5. **Cyclotron:**

Device used to accelerate the charged particles to gain large kinetic energy.

Principle:

When a charged particle moves perpendicular to the magnetic field, it experiences magnetic Lorentz force.

Construction:

(i) The particles are allowed to move in between two semi-circular metal containers called Dees (hollow D - shaped objects).

(ii) The uniform magnetic field is controlled by an electromagnet. The direction of magnetic field is normal to the plane of the Dees.

(iii) Source is kept between two Dees.

(vi) Dees are connected to high frequency alternating potential difference.

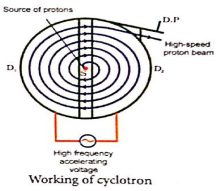
Working:

(i) The ion ejected from source is positively charged.

(ii) It is accelerated towards negative potential Dees

(iii) This ion undergoes a circular path.

(iv) At this time, the polarities of the Dees are reversed, so that the ion is now accelerated towards Dee-2 with a greater velocity. For this circular motion, the centripetal force of the charged particle q is provided by Lorentz force.



Working of cyclotron

$\frac{mv^2}{r} = qvB$

$\Rightarrow r = \frac{m}{qB}v$ .....(1)

$\Rightarrow r \propto v$

(v) If radius of the circular paths, increases, velocity also increases particles undergo spiral path with increasing radius.

(vi) When the frequency f at which the positive ion ciculates in the magnetic field must be equal to the constant frequency of the electrical oscillator f_{osc}. This is called Resonance condition.

From equation, $f = \frac{qB}{2\pi m}$ we have

$f_{osc} = \frac{qB}{2\pi m}$,

The time period of oscillation is

$T = \frac{2\pi m}{qB}$

The kinetic energy of the charged particle is,

$KE = \frac{1}{2}mv^2 = \frac{q^2B^2r^2}{2m}$ .....(2)

Limitations:

(i) The speed of ion is limited.

(ii) Electron cannot be accelerated.

(iii) Uncharged particles cannot be accelerated.

6. (i) At any instant t, the number of decays per unit time, called rate of decay $\left(\frac{dN}{dt}\right)$ is proportional to the number of nuclei (N) at the same instant.

$\left(\frac{dN}{dt}\right) \propto N$

$\frac{dN}{dt} = -\lambda N$ ...(1)

(ii) Here, proportionality constant λ is called decay constant which is different for different radioactive sample and the negative sign in the equation implies that the N is decreasing with time. From (1)

$\frac{dN}{N} = -\lambda dt$ ...(2)

(iii) Here, dN represents number of nuclei decaying in the time interval dt.

(iv) Let us assume that at time t = 0 s, the number of nuclei present in the radioactive sample is N_o.

(v) By integrating the equation (2), we can calculate the number of undecayed nuclei N at any time t.

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$\int_{N_0}^{N} \frac{dN}{N} = -\int_0^t \lambda dt$

$[\ln N]_{N_0}^{N} = -\lambda t$

$\ln\left[\frac{N}{N_0}\right] = -\lambda t$

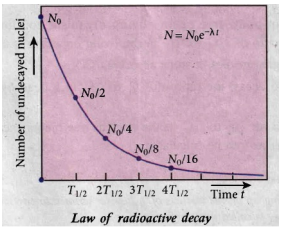
Taking exponential on both sides, we get

$N = N_0 e^{-\lambda t}$ .....(3)

(vi) Equation (3) is called the law of radioactive decay.

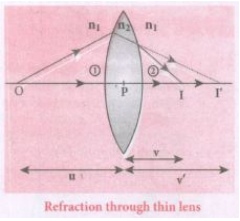
(vii) Here N denotes the number of undecayed nuclei present at any time t and N_0 denotes the number of nuclei present initially time t = 0.

(viii) From equation (3) the number of atoms is decreasing exponentially over the time. This implies that the time taken for all the radioactive nuclei to decay will be infinite.



Law of radioactive decay

7. (i) Let us consider a thin lens made up of a medium of refractive index n_2 is placed in a medium of refractive index n_1. Let R_1 and R_2 be the radii of curvature of two spherical surfaces (1) and (2) respectively and P be the pole.



Refraction through thin lens

(ii) Consider a point object 'O' on the principal axis. A paraxial ray from 'O' which falls very close to P, after refraction at the surface (1) forms image at 1'.

(iii) Before it does so, it is again refracted by the surface (2). Therefore the final image is formed at I.

(iv) The general equation for the refraction at a single spherical surface is given from Equation,

$\frac{n_2}{v} - \frac{n_1}{v} = \frac{(n_2 - n_1)}{R}$

For the refracting surface (1), the light goes from n_1 to n_2

$\frac{n_2}{v'} - \frac{n_1}{u} = \frac{(n_2 - n_1)}{R_1}$ .....(1)

For the refracting surface (2), the light goes from n_2 to n_1

$\frac{n_1}{v} + \frac{n_2}{v'} = \frac{(n_1 - n_2)}{R_2}$ .....(2)

For surface (2) I' acts as virtual object.

Adding the above two equations (1) and (2)

$\frac{n_1}{v} - \frac{n_1}{u} = (n_2 - n_1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

on further simplifying and rearranging,

$\frac{1}{v} - \frac{1}{u} = \left(\frac{n_2 - n_1}{n_1}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{v} - \frac{1}{u} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ....(3)

If the object is at infinity, the image is formed at the focus of the lens. Thus, for u = ∞, v = f. Then the equation becomes.

$\frac{1}{f} - \frac{1}{\infty} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ .....(4)

If the lens is kept in air, then we can take n_2 = n and n_1 = 1. So the equation (4) becomes,

$\frac{1}{f} = (n - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ..(5)

The above equation is called the lens maker's formula.

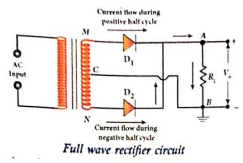
Significance:

It tells the lens manufacturers what curvature is needed to make a lens of desired focal length with a material of particular refractive index to make a lens of desired focal length. This formula holds good also for a concave lens.

8. **Full wave rectifier :**

The positive and negative half cycles of the AC input signal pass through the full wave rectifier circuit and hence it is called the full wave rectifier

Construction:



Full wave rectifier circuit

(i) It consists of two p-n junction diodes, a center-tapped transformer, and a load resistor (R_1)

(ii) The centre is usually taken as the ground or zero voltage reference point.

(iii) Due to the centre tap transformer, the output voltage rectified by each diode is only one-half of the total secondary voltage.

Working:

During positive half cycle :

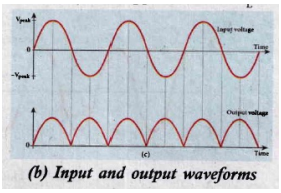
(i) When the positive half cycle of the ac input signal passes through the circuit, terminal M is positive, G is at zero potential and N is at negative potential.

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(ii) This forward biases diode D_1 and reverse biases diode D_2.
(iii) Hence, being forward biased, diode D_1 conducts and current flows along the path MD_1AGC.

During negative half cycle:

(i) When the negative half cycle of the AC input signal passes through the circuit, terminal N becomes positive, C is at zero potential and M is at negative potential.
(ii) This forward biases diode D_2 and reverse biases diode D_1.
(iii) Hence, being forward biased, diode D_2 conducts and current flows along the path ND_2BGC.
(iii) During both positive and negative half cycles of the input signal, the current flows through the load in same direction.



(b) Input and output waveforms

(iv) The output signal corresponding to the input signal is shown in Figure. Though both half cycles of AC input are rectified, the output is still pulsating in nature.
(v) The efficiency (η) of full wave rectifier is twice that of a half wave rectifier and is found to be 81.2 %.

9. **Condition for bright fringe (or) maxima :**

The condition for the point P to have a constructive interference (or) be a bright fringe Is,
Path diference, $\delta = n\lambda$ Where, n = 0, 1, 2,....
$\therefore \frac{dy}{D} = n\lambda$
$y = n\frac{\lambda D}{d} (or) y_n = n\frac{\lambda D}{d}$ .....(4)
This is the condition for the point P to have a bright fringe. The distance y_n is the distance or the n^{th} bright fringe from the point O.

Condition for dark fringe (or) minima:

The condition for the point P to have a destructive interference (or) be a dark fringe is,
Path difference, $\delta = (2n-1)\frac{\lambda}{2}$ Where, n = 1, 2, 3....
$\therefore \frac{dy}{D} = (2n-1)\frac{\lambda}{2}$
$y = \left(\frac{(2n-1)}{2}\frac{\lambda D}{d}\right)(or)\left(\frac{(2n-1)}{2}\frac{\lambda D}{d}\right)$ .....(5)
This is the condition for the point P to have a dark fringe. The distance y_n is the distance of the n^{th} dark fringe from the point O

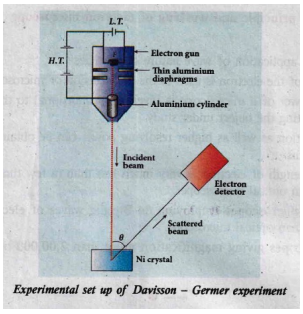
Bandwidth:

The bandwidth (β) is defined as the distance between any two consecutive bright or dark fringes.
$\beta = y_{(n+1)} - y_n = \left((n+1)\frac{\lambda D}{d}\right) - \left(n\frac{\lambda D}{d}\right)$
$\beta = \frac{\lambda D}{d}$ .....(6)
Bright and Dark tinges are of same width equally spaced on either side of the central bright fringe.

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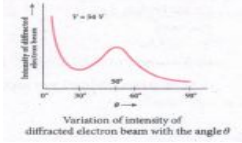
10. **Davisson - Germer experiment**

(i) The filament F is heated by a low tension (L . T) battery. Electrons are emitted from the hot filament by thermionic emission.
(ii) They are then accelerated due to the potential diference between the filament and the anode aluminum cylinder by a high tension (H.T) battery.
(iii) Electron beam is collimated by using two thin aluminum diaphragms and is allowed to strike a single crystal of Nickel.
(iv) The electrons scattered by Niatoms in diflerent directions are received by the electron detector which measures the intensity of scattered electron beam.
(v) The detector is capable of rotation in the plane of the paper, so that the angle (θ) between the incident beam and the scattered beam can be changed at our will.
(vi) The intensity of the scattered electron beam is measured as a function of the angle θ.



Experimental set up of Davisson – Germer experiment

(i) Figure shows the variation of intensity of the scattered electrons with the angle θ for the accelerating voltage of 54 V.
(ii) For a given accelerating voltage V, the scattered wave shows a peak or maximum at an angle of 50° to the incident electron beam.
(iii) This peak in intensity is attributed to the constructive interference of electrons diffracted from various atomic layers of the target material.


Variation of intensity of diffracted electron beam with the angle θ

(iv) From the known value of interplanar spacing of Nickel, the wavelength of the electron wave has been experimentally calculated as 1.65 $\mathring{A}$.

(v) The wavelength can also be calculated from de Broglie relation for V = 54 V from equation as

$\lambda = \frac{12.27}{\sqrt{V}} \overset{o}{A} = \frac{12.27}{\sqrt{54}}$

$\lambda = 1.67 \overset{o}{A}$

(vi) This value agrees very well with the experimentally observed wavelength of 1.65 $\overset{o}{A}$. Thus this experiment directly verifies de Broglie's hypothesis of the wave nature of moving particles.

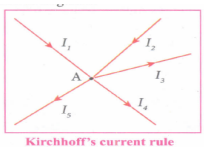
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11. **Kirchhoff's First rule: (current rule)**

(i) It states that the algebraic sum of the currents at any junction of a circuit is zero. It is a statement of law of conservation of electric charge.

(ii) All charges that enter a given junction in a circuit must leave that junction since charge cannot build up or disappear at a junction. By convention current entering the junction is taken as positive and current leaving the junction is taken as negative.

Applying law to the junction A in Figure.



Kirchhoff's current rule

$I_1 + I_2 - I_3 - I_4 - I_5 = 0$

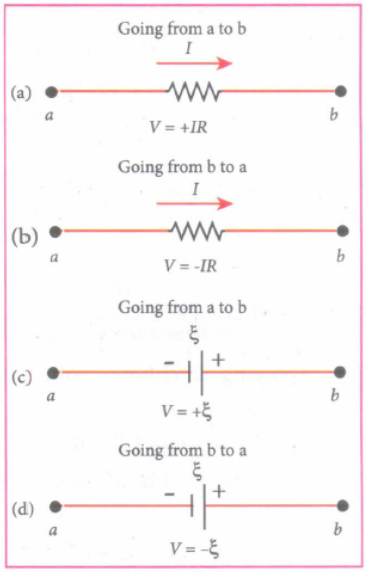
(or)

$I_1 + I_2 = I_3 + I_4 + I_5$

Kirchhoff's Second rule (Voltage rule or Loop rule)

(i) It states that in a closed circuit the algebraic sum of the products of the current and resistance of each part of the circuit is equal to the total emf included in the circuit.

(ii) This rule follows from the law of conservation of energy for an isolated system (The energy supplied by the emf sources is equal to the sum of the energy delivered to all resistors).



Kirchhoff voltage rule

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(iii) Kirchhof's voltage rule has to be applied only when all currents in the circuit reach a steady state condition.

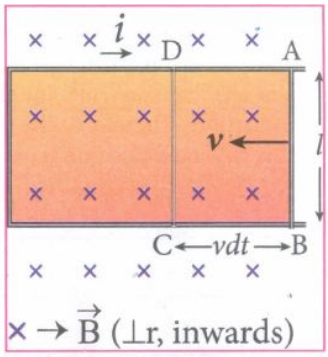
(iv) The current in the various branches are constant. The product of current and resistance is taken as positive when the direction of the current is followed.

(v) Suppose if the direction of current is opposite to the direction of the loop, then product of current and voltage across the resistor is negative. It is shown in Figure (a) and (b).

(vi) The emf is considered positive when proceeding from the negative to the positive terminal of the cell.

12. Consider a conducting rod of length l moving with a velocity v towards left on a rectangular fixed metallic framework as shown in Figure. The whole arrangement is placed in a uniform magnetic field $\vec{B}$ whose magnetic lines are perpendicularly directed into the plane of the paper.

As the rod moves from AB to DC in a time dt , the area enclosed by the loop and hence the magnetic flux through the loop decreases.



Induction of emf by changing the area enclosed by the loop

The change in magnetic flux in time dt is

$d\Phi_B = B$ x change in area (dA)

= B x Area ABCD

$d\Phi_B$ = Blvdt (Since area ABCD = I (vdt))

(or) $\frac{d\Phi_B}{dt} = Blv$

As a result of change in flux, an emf is generated in the loop. The magnitude of the induced emf is

ε = $\frac{d\Phi_B}{dt}$

ε = Blv

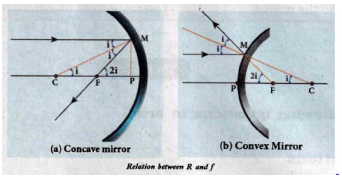
This emf is called motional emf.

13. **Relation between f and R:**

C ⇒ Center of curvature

F ⇒ Principal focus

i ⇒ Angle of incidence



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The angles From right angle triangles ΔMCR, and ΔMFP,

$\tan i = \frac{PM}{PC}$ and $\tan 2i = \frac{PM}{PF}$

As the angles are small, tan i = i and tan 2i = 2i.

$i = \frac{PM}{PC}$ and $2i = \frac{PM}{PF}$

Simplifying further,

$2\frac{PM}{PC} = \frac{PM}{PF}; 2PF = PC, R = 2f$

PF is focal length f and PC is the radius of curvature R.

R = 2f (or) f = R/2

14. (i) Cathode rays possess energy and momentum and travel in a straight line with high speed of the order of 10^7m s^{-1}or $(\frac{1}{10})^{th}$ of the speed of light.
(ii) It can be deflected by application of electric and magnetic fields. The direction of deflection indicates that they are negatively charged particles.
(ii) When the cathode rays are allowed to fall on matter, they produce heat. They affect the photographic plates and also produce fluorescence when they fall on certain crystals and minerals.
(iii) When the cathode rays fall on a material of high atomic weight, x-rays are produced.
(iv) Cathode rays ionize the gas through which they pass.

15. A = 108, Z =47, N = 108 - 47 = 61

m_p = 1.007825 u, m_n = 1.008665 u, M = 107.905949 u

(a) $\Delta m = Z\, m_P + N m_n - M$

Δm = (47 x 1 .007825 + 61 x 1 .008665 - 107 .905949)

Δm = 47.367775 + 61.528565 -107.905949

Δm = 108.89634 - 107.905949

Δm = 0.990391 u

$BE = \Delta m \times 931 MeV$

BE = 0.990391 x 931 MeV = 922.054 MeV

(c) $\overline{BE} = \frac{BE}{A}$

$\overline{BE} = \frac{922.054}{108} = 8.537 MeV = 8.5 MeV$

16. (i) An electron of mass m is accelerated through a potential difference of V volt. The kinetic energy acquired by the electron is given by

$\frac{1}{2}mv^2 = ev$

(ii) Therefore, the speed v of the electron is

$v = \sqrt{\frac{2ev}{m}}$

Hence, the de Broglie wavelength of the matter waves associated with electron is

$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mev}}$

(iii) Substituting the known values in the above equation, we get

$\lambda = \frac{6.26 \times 10^{-34}}{\sqrt{2V \times 1.6 \times 10^{-19} \times 9.11 \times 10^{-31}}}$

$= \frac{12.27 \times 10^{-10}}{\sqrt{V}} m$

$\lambda = \frac{12.27}{\sqrt{V}} \overset{o}{A}$

(iv) Since the kinetic energy of the electron, K = eV, then the de Broglie wavelength associated with electron can be also written as

$\lambda = \frac{h}{\sqrt{2mK}}$

17. **Advantages of FM:**

i) In FM, there is a large decrease in noise. This leads to an increase in signal-noise ratio.

ii) The operating range is quite large.

iii) The transmission efficiency is very high as all the transmitted power is useful

iv) FM Bandwidth covers the entire frequency range which humans can hear. Due to this, FM radio has better quality compared to AM radio.

Limitations of FM:

i) FM requires a much wider channel.

ii) FM transmitters and receivers are more complex and costly.

iii) In FM reception, less area is covered compared to AM.

18. (i) When the spectrum obtained from the Sun is examined, it consists of large number of dark lines . These dark lines in the solar spectrum are called Fraunhofer lines.

(ii) The Absorption spectra for various materials are compared with the Fraunhofer lines in the solar spectrum, which helps in identifying elements present in the Sun's atmosphere.

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OF THE REMAINING ANSWER ANY 5

19. Electric field at the point P at a distance r from the point charge q is the force experienced by a unit positive placed at that point P and is given by

$\vec{E} = \frac{\vec{F}}{q_0} = \frac{kq}{r^2}\hat{r} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\hat{r}$

where $\hat{r}$ is the unit vector pointing from q to the point of interest P.

20. The displacement current can be defined as the current which comes into play in the region in which the electric field or the electric flux is changing with time.

21. Magnetic susceptibility is defined as the ratio of the intensity of magnetisation ($\vec{M}$) induced in the material due to the magnetising field $|\vec{H}|$.

$\chi_m = \frac{|\vec{M}|}{|\vec{H}|}$.

22. An endoscope is an instrument used by doctors which has a bundle of optical fibres that are used to see inside a patient's body. Endoscopes work on the phenomenon of total internal reflection. The optical fibres are inserted in to the body through mouth, nose or a special hole made in the body.

23. Dispersion is splitting of white light into its constituent colours. This band of Colours of light is called its spectrum.

24. When a ray of unpolarised light is incident on a calcite crystal, two refracted rays are produced, Hence, two images of a single object are formed. This phenomenon is called double refraction.

25. **Advantages of Robotics:**

(i) Robots are more precise and error free in performing the task.

(ii) Robots never get tired like humans. It can work for 24 x 7. Hence absenteeism in work place can be reduced.

Disadvantages of Robotics:

(i) Unemployment problem will increase.

(ii) Robots can perform defined tasks and cannot handle unexpected situations.

26. P = 50 mW; λ = 640nm = 640 x 10^{-9} m

P = 50 x 10^{-3}W

$n = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{640 \times 10^{-9}} = 3.106 \times 10^{-19} J$

$n = \frac{E}{h\nu} = \frac{50 \times 10^{-3}}{3.106 \times 10^{-19}} = 1.61 \times 10^{17} s^{-1}$

n = 1.61 x 10^{17} s^{-1}

I.CHOOSE THE BEST ANSWER

27. V = 230 V

$P = \frac{V^2}{R}$ since V is same P $\propto \frac{1}{R}$

$\frac{1}{R_2} = \frac{1}{\frac{R_1}{2}} + \frac{1}{\frac{R_1}{2}} = \frac{2}{R_1} + \frac{2}{R_1} = \frac{2+2}{R_1}$

$\frac{1}{R_2} = \frac{4}{R_1}$

$\therefore R_2 = \frac{R_1}{4}$

$R_1 = 4R_2$

$\therefore \frac{P_2}{P_1} = \frac{R_1}{R_2} = \frac{4R_2}{R_2} = 4$

28. The electric flux of D is less than that of C

The electric flux of C is less than that of B

The electric flux of B is less than that of A

29. $B_o = \frac{E_o}{C} = \frac{\sqrt{2}E_{rms}}{C}$

$B_o = \frac{\sqrt{2} \times 3}{3 \times 10^8} = 1.414 \times 10^{-8} T$

30. $A_1 = 4 \times 10^{-4}$ m^2

$N_1 = 10$ turns

$A_2 = 4 \times 10^{-4}$ m^2

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$N_2 = 15 \times 10^{-} = 1500\text{turn/m}$

$\phi = B_2A_2 = (\mu_0 n_2 I_2)A_1$

$Where, n_2 = \frac{N_2}{l} = 1500\text{turn/m}$

The mutual Inductance is,

$M = \frac{N_1\phi_{12}}{I_2} = \mu_0 n_2 N_1 A_1$

$= 4\pi \times 10^{-7} \times 1500 \times 10 \times 4 \times 10^{-4}$

$= 7.54 \times 10^{-6}\text{H} = 7.54\mu\text{H}$

31. $tan\ I = \frac{B_V}{B_H} = 1$

$\therefore$ I = 45°

32. (b) positive

33. (a) 30°

34. n = tan i_p = tan 60° = $\sqrt{3}$

35. $\frac{hc}{\lambda} = \phi + \text{K. E.} \ldots . (1)$

$\frac{2hc}{\lambda} = \phi + 3\ \text{K. E.} \ldots . . (2)$

multiply eqn. (1) by 3, we get

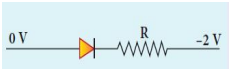
$\frac{3hc}{\lambda} = 3\phi + 3\ \text{K. E.} \ldots . (3)$

Subtract eqn. (2) from (3), we get

$\frac{hc}{\lambda} = 2\phi$

$\phi = \frac{hc}{2\lambda}$

36. Cathode rays are stream of negatively charged electron.

37. (a) 

38. They are thin strands of wire made of shape memory alloys. They can contract by 5% when electric current is passed through them.

39. $\alpha = \frac{I_c}{I_e}; I_c = \alpha I_t = 9\ \text{mA}$

$I_B = I_t - I_c = 10 - 9 = 1\ \text{mA}$

40. (a) 3.3 x 10^{-18}C

41. (b) + 1

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