SRSI PU COLLEGE, BELLUR

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Presenting

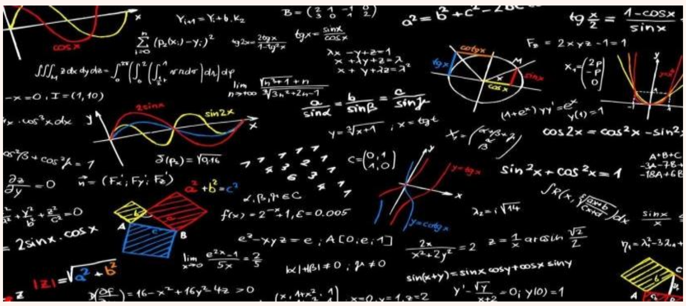
II-PU PASSING PACKAGE EASY CAPSULES.

(As per Reduced syllabus 2020-21)

SOLVED MODEL QUESTION PAPERS

FOR THE SUBJECT:

"PHYSICS"



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Model Question Paper 1 Solved

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II PUC : PHYSICS (33)

Unit No.	Ch No.	TOPIC	Teaching Hours	Marks	1 M	2 M	3 M	5 M (T)	5 M (NP)
I	1	Electric charges and fields	8	10		✓	✓	✓	
II	2	Electric potential & capacitance	9	11	✓	✓	✓		✓
III	3	Current Electricity	11	14	✓	✓	✓✓		✓
IV	4	Moving charges and magnetism	11	13	✓	✓✓	✓	✓	
V	5	Magnetism and matter	2	3	✓	✓			
	6	Electromagnetic induction	7	8	✓	✓		✓	
VI	7	Alternating current	6	8			✓		✓
	8	Electromagnetic waves	1	1	✓				
VII	9	Ray optics & optical instruments	5	6	✓			✓	
VIII	10	Wave optics	5	7		✓			✓
IX	11	Dual nature of radiation & matter	5	6	✓				✓
	12	Atoms	5	6	✓			✓	
X	13	Nuclei	3	4	✓		✓		
	14	Semiconductor Electronics	6	8			✓	✓	
TOTAL			84	105	10	16	24	30	25

(105 Marks /84 Teaching hours = 1.25 marks/teaching hour)

PART-A

Q.No

I Answer all the following questions: 10 x 1 = 10

1. What is electrostatic shielding?

The electrostatic shielding is the phenomenon of protecting a certain region of space from external electric field.

2. A wire of resistivity is stretched to three times its length. What will be its new resistivity?

For a given material of the conductor , resistivity is independent of its dimensions. Resistivity remains same.

3. Mention the SI unit of magnetic moment.

A m^2

4. State Gauss's law in magnetism.

The net magnetic flux through any closed surface is always zero.

5. Name the law used to find the polarity of induced emf in a coil.

Lenz law

6. Name the physical quantity which remains same for microwaves of wavelength 1mm and UV radiations of 160nm in vacuum.

Speed of light (C)

7. A concave lens of refractive index 1.5 is immersed in a medium of refractive index 1.65. What is the nature of the lens?

It behaves as Convex lens. (i.e $n_g < n_s$)

8. How does the stopping potential of a photosensitive material vary with intensity of incident radiation?

Stopping potential is independent of intensity of incident radiation

9. Mention any one limitation of Bohr's atomic model.

- Bohrs theory is Applicable only for hydrogen and hydrogen like atoms. (Any one)
- The relativistic variation of mass is not taken in to account in Theory.
- It could not explain fine structure of spectral line.
- It could not explain wave nature of electrons.

10. Write the relation between radius of the nuclei and its mass number

$R = R_0 A^{\frac{1}{3}}$

PART-B

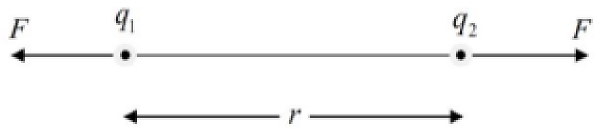
II Answer any five of the following questions: 5 x 2 = 10

11. State and explain Coulomb's law.

Statement: The electrostatic force of attraction or repulsion between any two point charges is directly proportional to the product of magnitude of charges and inversely proportional to the square of distance between them.

Explanation:

- Consider two point charges q_1 and q_2 separated by a distance r in free space.



If F is the magnitude of the force between the charges, then from Coulomb's law

$$F \propto \frac{q_1 q_2}{r^2} \quad \text{or} \quad F = k\frac{q_1 q_2}{r^2} \qquad \dots (1)$$

- From equation (1), the magnitude of the force between the charges is

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2} \qquad \dots (2) \qquad \left[k = \frac{1}{4\pi\varepsilon_0} = 9\times10^9\right]$$

12. Write the relation between electric field and potential. A point charge +Q is placed at point O as shown in the figure. Is the potential difference $V_A - V_B$ positive, negative or zero?

- $E = -\frac{dV}{dr}$

  $dV \rightarrow$ potential difference between the points

  $dr \rightarrow$ separation between the points

- $(V_A - V_B)$ is positive.

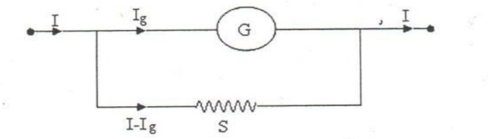
13. Define the terms: (a) drift speed and (b) mobility of an electron in a conductor.

- **Drift speed :**
  Average velocity with which the free electrons in a conductor get drifted in direction opposite to the applied field is called drift velocity.

- **Mobility :**
  Drift velocity acquired by charge carrier per unit electric field is called its mobility.

14. Explain how galvanometer can be converted to an ammeter.

A galvanometer can be converted into an ammeter by connecting a suitable low resistance in parallel to the galvanometer



Consider a galvanometer of resistance G connected in parallel with a low resistance S as shown in fig.
Since G and S are in the parallel
P.d. across S = P.d. across G
i.e. (I – Ig) S = Ig G.

$$S = \frac{I_g\ G}{(I - I_g)}$$

15. Write the expression for magnetic field inside a solenoid and explain the terms.
Magnetic field inside a solenoid is

$B = \mu_0 n I$

- B = Magnetic field inside the solenoid.
- n = number of turns per unit length of solenoid.
- I = current through the solenoid
- μ_0 = Absulute permeability of free space (Any Two terms)

16. Define magnetic dip and declination.

Magnetic dip or inclination :
- Magnetic dip at a place is the angle between the direction of earth's total magnetic field and the horizontal in the magnetic meridian at that place.

Magnetic declination:
- The angle between magnetic meridian and geographic meridian

17. A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes from 0 to 20 A in 0.5 s, what is the change of flux linkage with the other coil?

- *Change of magnetic flux linkage with the other coil is*

$$\Delta\phi = M\ (I_2 - I_1)$$

$$\Delta\phi = 1.5 \times (20 - 0)$$

$$\Delta\phi = 30\ Wb$$

18. What is a wave front? Name the type of wave front observed from a distant point source.

Wave front

- Wave front is the locus of points of constant phase.
- Plane wave front.

PART-C

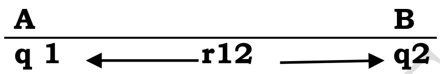
III. Answer any five of the following questions: 5 x 3=15

19.Write any three properties of electric field lines.

- Starts from positive charge and ends at negative charge.
- Never intersect each other.
- Never forms a closed loop.
- Do not pass through the conductor.
- Always normal to the surface of the conductor. (Any Three)

20. Derive the expression for potential energy of a system of two point charges i the absence of an external electric field.

Consider **two point charges** and at and respectively separated by a **distance** as show in the figure.



- Work done W_1 in bringing the charge q_1 from infinity to the point A is zero as there is no electric field yet to work against it.

Hence $W_1 = 0$

- Work done W_2 in bringing the charge q_2 from infinity to the point B against the electric field of q_1 is

$W_2 = V\, q_2$ $\quad V = \frac{1}{4\pi\varepsilon_0}\frac{q_1}{r_{12}}$ → electric potential at B due to the charge q_1

$$W_2 = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}}$$

- By definition, this is the potential energy U of the two charge system. Hence

$$U = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}}$$

21. Write any three limitations of Ohm's law.

1. Ohm's law is applicable only if all the physical condions remains same.
2. Ohm's law is not applicable to non-ohmic devices (like semiconductor devices, discharge tube)
3. Ohm's law is not applicable at very low and at very high temperature

22. State Kirchhoff's law's . Name the Kirchhoff's law which is a consequence of principal of conservation of energy.

- At any junction, the sum of the currents entering the junction is always equal to the sumof the currents leaving from the junction.
- The algebraic sum of changes in potential around any closed loop involving resistors andcells in the loop is zero.
- Kirchhoff's loop rule.

23. Obtain the expression for radius of circular path of charged particle in a magnetic field.

Let a charge particle of mass m and charge q enters to the magnetic field B with a velocity v atan angle $\theta = 90^0$ then it describes a circular path of radius r

The force on the charge particle is $F = Bqv \sin\theta$ Or

$F = Bqv$ ..... (1)

This force is balanced by centripetal force $F = \frac{mv^2}{r}$ ..... (2)

From Equation (1) and (2)

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

$$r = \frac{mv}{Bq}$$

24. Name any three sources of energy loss in a transformer.

The Sources of energy loss are,

- Loss due to Eddy current,
- Magnetic flux leakage,
- Hysteresis loss.

25. Write any three characteristics of nuclear force.

- Strongest forces in nature.
- Charge independent force. (Any Three)
- Short range force.
- Spin dependent force.

26. **Give any three differences between n-type and p-type semiconductors**

n - type Semiconductor	**p - type Semiconductor**
• It is formed when a pentavalent impurity is added to an intrinsic semiconductor.	• It is formed when a trivalent impurity is added to an intrinsicsemiconductor.
• Free electrons are majority charge carriers and holes are minority charge carriers.	• Holes are majority charge carriersand free electrons are minority charge carriers.

• The electrical conductivity ismainly due to free electrons.	• The electrical conductivity ismainly due to holes.

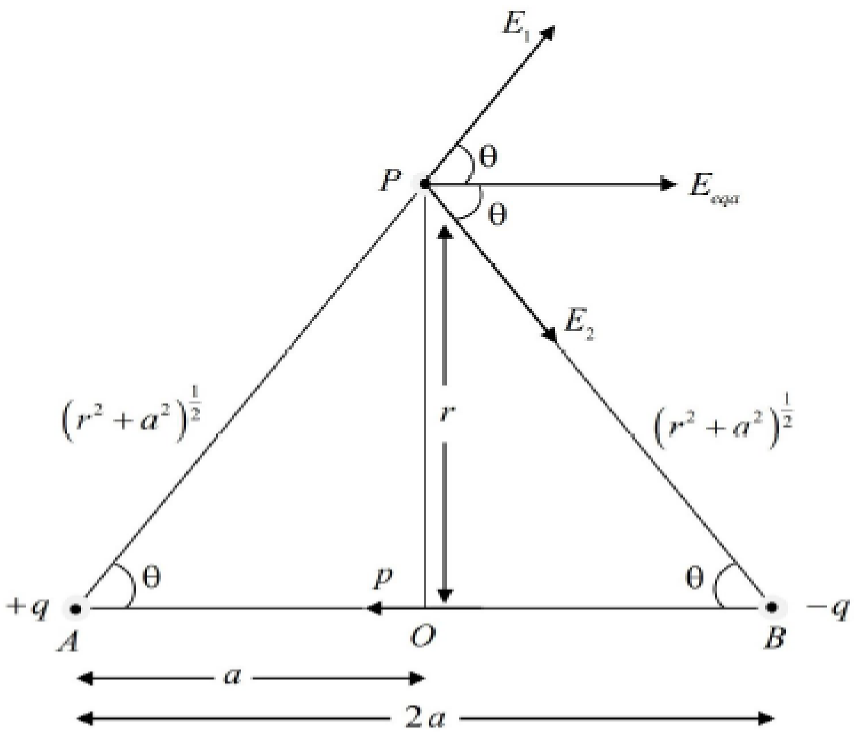
PART-D

IV. Answer any two of the following questions: 2 x 5 = 10

27. Derive an expression for electric field on the equatorial line of an electric dipole.

- Consider an electric dipole consisting of charges $+q$ and $-q$ separated by a distance $2a$ in free space. Its dipole moment is $p = q \times 2a$.

  Let P be a point on the equatorial line of the dipole at a distance r from the centre O of the dipole. (as shown in the figure)



- Electric field intensity at P due to the charge $+q$ is

$$E_1 = \frac{1}{4\pi\varepsilon_0}\frac{q}{AP^2}$$

$$E_1 = \frac{1}{4 \pi \varepsilon_0} \frac{q}{(r^2 + a^2)} \quad \text{along } AP$$

- Electric field intensity at P due to the charge $-q$ is

$$E_2 = \frac{1}{4 \pi \varepsilon_0} \frac{q}{BP^2}$$

$$E_2 = \frac{1}{4 \pi \varepsilon_0} \frac{q}{(r^2 + a^2)} \quad \text{along } PB$$

- The magnitudes of E_1 and E_2 are equal.

i.e., $|E_1| = |E_2| = E = \dfrac{1}{4 \pi \varepsilon_0} \dfrac{q}{(r^2 + a^2)}$

- Clearly, the components of E_1 and E_2 perpendicular to the dipole axis will cancel out and the components parallel to the dipole axis add up.
- The resultant electric field intensity at P is

$$E_{eqa} = E_1 \cos\theta + E_2 \cos\theta \quad \text{or} \quad E_{eqa} = 2 E \cos\theta = 2 \times E \times \frac{AO}{AP}$$

$$E_{eqa} = 2 \times \frac{1}{4 \pi \varepsilon_0} \frac{q}{(r^2 + a^2)} \times \frac{a}{(r^2 + a^2)^{\frac{1}{2}}}$$

$$E_{eqa} = \frac{1}{4 \pi \varepsilon_0} \frac{q \times 2a}{(r^2 + a^2)^{\frac{3}{2}}}$$

$$E_{eqa} = \frac{1}{4 \pi \varepsilon_0} \frac{p}{(r^2 + a^2)^{\frac{3}{2}}} \quad \text{antiparallel to } \vec{p}$$

- For a short dipole, $r >> 2a$ and hence a^2 may be neglected as compared to r^2.

$$E_{eqa} = \frac{1}{4 \pi \varepsilon_0} \frac{p}{r^3} \quad \text{antiparallel to } \vec{p}$$

- In vector form, $\vec{E}_{eqa} = -\dfrac{1}{4 \pi \varepsilon_0} \dfrac{p}{(r^2 + a^2)^{\frac{3}{2}}} p$

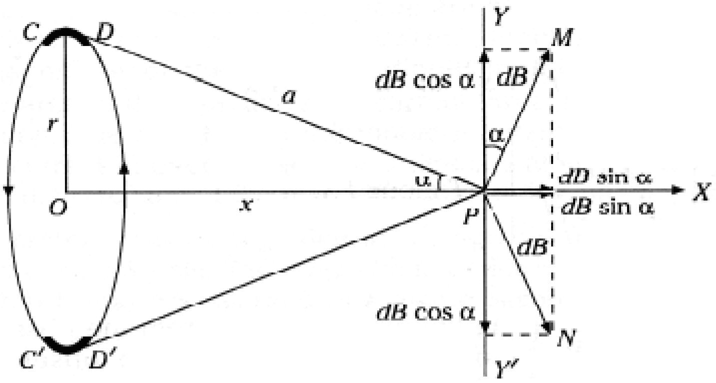
For a short dipole, $\vec{E}_{eqa} = -\dfrac{1}{4 \pi \varepsilon_0} \dfrac{p}{r^3} p$

28. Using Biot Savart's law, obtain the expression for magnetic field along the axis of a circular current loop.

- Consider a current loop of radius r carrying current I in the direction as shown in the figure.

Let the plane of the loop be perpendicular to the plane of the paper. Let P be a point on its axis at a distance x from the centre O of the current loop.

The entire loop is assumed to be divided into a large number of small current elements each of length dl.



Consider one such current element $CD = I\,\vec{dl}$ of the loop.

According to the Biot – Savart's law, the magnitude of magnetic field $\vec{dB}$ at the point P due this current element is

$$dB = \left(\frac{\mu_0}{4\pi}\right)\frac{I\,dl\,\sin 90^\circ}{a^2}$$

$$dB = \left(\frac{\mu_0}{4\pi}\right)\frac{I\,dl}{a^2} \qquad \text{along } PM$$

- The magnetic field dB along PM can be resolved into its rectangular components
  - $dB\cos\alpha$ along PY (perpendicular to the axis of loop) and
  - $dB\sin\alpha$ along PX (parallel to the axis of loop)

  For any two diametrically opposite current elements of the loop, the components perpendicular to the axis of the loop will be equal and opposite and hence they will cancel out. While, their axial components will be equal and along the same direction and hence they get added up.

- The total magnetic field at the point P due to the loop is

  $$B_A = \int dB\sin\alpha$$

But $dB = \left(\frac{\mu_0}{4\pi}\right)\frac{I\,dl}{a^2}$ and $\sin\alpha = \frac{r}{a}$

- $B_A = \int \left(\frac{\mu_0}{4\pi}\right)\frac{I\,dl}{a^2}\frac{r}{a}$

$B_A = \left(\frac{\mu_0}{4\pi}\right)\frac{I\,r}{a^3}\int dl$

- $\int dl = 2\pi r \rightarrow$ total length of all the current elements

From the figure, $a = \left(r^2 + x^2\right)^{1/2}$

- $B_A = \left(\frac{\mu_0}{4\pi}\right)\frac{I\,r}{a^3}\times 2\pi r$

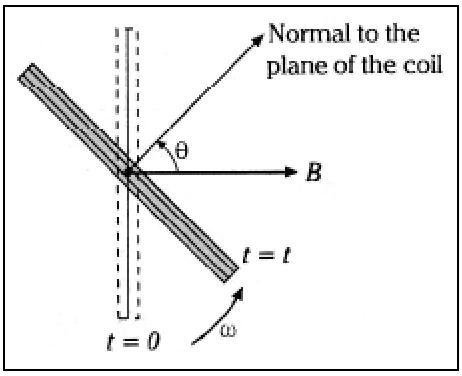
$B_A = \left(\frac{\mu_0}{4\pi}\right)\frac{2\pi I r^2}{\left(r^2 + x^2\right)^{3/2}}$

This field is along the axis of the loop and into the loop if the current is in the clockwise direction and away from the loop if the current is in the anticlockwise direction.

29. What is AC generator? Derive an expression for the instantaneous emf in AC generator.

- Consider a rectangular coil of N turns and area A placed in a uniform magnetic field B.
- Let the coil is rotated with constant angular velocity ω about an axis parallel to the plane of the coil and perpendicular to the magnetic field.

Let the coil is rotated through an angle θ in time t.



Then, $\omega = \frac{\theta}{t}$ or $\theta = \omega t$

- The magnetic flux linked with the coil in its deflected position is

$$\phi = N\,A\,B\cos\theta$$

$$\phi = N\,A\,B\cos(\omega t) \quad \dots (1)$$

From equation (1), it follows that as the coil rotates in the magnetic field, magnetic flux linking with the coil changes continuously.

- According to the law of electromagnetic induction, the induced emf in the coil at any instant is given by

$$e = -\frac{d\phi}{dt}$$

$$e = -\frac{d}{dt}\left[N\,A\,B\cos(\omega t)\right]$$

$$e = -N\,A\,B\left[-\sin(\omega t)\right]\omega$$

$$e = N\,A\,\omega\,B\sin(\omega t)$$

$$e = e_0\sin(\omega t) \quad \dots (2)$$

$e_0 = N\,A\,\omega\,B \rightarrow$ peak value of induced emf

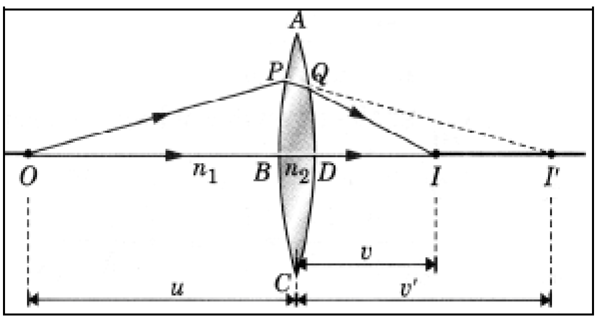
V. Answer any two of the following questions: 2 x 5 = 10

30. Derive lens makers formula.

- Consider a thin convex lens of focal length f and refractive index n_2 surrounded by a rarer medium of refractive index n_1. $(n_2 > n_1)$

  Let R_1 and R_2 be the radii of curvature of the surface ABC and ADC respectively.

- Consider a luminous point object O placed on the principal axis in the rarer medium.



A ray OB incident along the principal axis proceeds undeviated. Another paraxial ray OP after refraction emerges along QI.

The refracted rays meet at I. Hence I is the real image of O.

The formation of the image I can be considered in two stages.

Stage – 1: Refraction at the surface ABC

- In the absence of the surface ADC, the refracted ray PQ will meet the principal axis at I'. Hence I' is the real image of O formed in the medium of refractive index n_2.

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

Stage – 2: Refraction at the surface ADC

- For the refraction at ADC, I' serves as virtual object. Its real image I is formed in the medium of refractive index n_1.

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

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Stage – 2: Refraction at the surface ADC

- For the refraction at ADC, I' serves as virtual object. Its real image I is formed in the medium of refractive index n_1.

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

- Adding equation (1) and (2),

$$-\frac{n_1}{u}+\frac{n_2}{v'}-\frac{n_2}{v'}+\frac{n_1}{v}=\frac{(n_2-n_1)}{R_1}-\frac{(n_2-n_1)}{R_2}$$

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

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

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

- When the object is at infinity, the image is formed at the principal focus of the lens. i.e., when $u=\infty$, $v=f$.

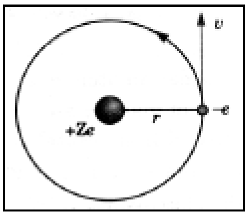
$$\left(-\frac{1}{\infty}+\frac{1}{f}\right)=\left(\frac{n_2}{n_1}-\frac{n_1}{n_1}\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\frac{1}{f}=\left(\frac{n_2}{n_1}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$ – Lens Maker's formula.

31. Using Bohr's postulates obtain the expression for total energy of electron in hydrogenatom.

- The electron revolving round the nucleus has
  - Potential energy – due to its presence in the electrostatic field of nucleus and
  - Kinetic energy – due to its motion
- Consider an atom of atomic number Z. The charge on the nucleus is Ze.

  Let an electron of mass m, charge $-e$ be revolving round the nucleus in the n^{th} stationary orbit of radius r.



- Potential energy:

  The potential energy of an electron is given by

$$E_p=-\frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{r} \quad \ldots (1)$$

- Kinetic energy:

  The kinetic energy of an electron is given by

$$E_K = \frac{1}{2} m v^2 \qquad \dots (2)$$

- From Bohr's postulate,

$$\frac{m v^2}{r} = \frac{1}{4 \pi \varepsilon_0} \frac{Z e^2}{r^2} \quad \text{or} \quad m v^2 = \frac{1}{4 \pi \varepsilon_0} \frac{Z e^2}{r} \qquad \dots (3)$$

Substituting equation (3) in equation (2),

$$E_K = \frac{1}{2} \left(\frac{1}{4 \pi \varepsilon_0} \frac{Z e^2}{r} \right) \qquad \dots (4)$$

- Total energy of the electron is the sum of its potential and kinetic energies.

$$E_n = E_K + E_P$$

$$E_n = \frac{1}{2} \left(\frac{1}{4 \pi \varepsilon_0} \frac{Z e^2}{r} \right) - \frac{1}{4 \pi \varepsilon_0} \frac{Z e^2}{r}$$

$$E_n = \frac{1}{4 \pi \varepsilon_0} \frac{Z e^2}{r} \left(\frac{1}{2} - 1 \right)$$

$$E_n = -\frac{1}{2} \left(\frac{1}{4 \pi \varepsilon_0} \frac{Z e^2}{r} \right)$$

$$E_n = -\frac{1}{8 \pi \varepsilon_0} \frac{Z e^2}{r}$$

- But, $r = \frac{\varepsilon_0 n^2 h^2}{\pi m Z e^2}$

$$E_n = -\frac{1}{8 \pi \varepsilon_0} \frac{Z e^2}{\frac{\varepsilon_0 n^2 h^2}{\pi m Z e^2}}$$

$$E_n = -\frac{m Z^2 e^4}{8 \varepsilon_0^2 n^2 h^2} \qquad \dots (5)$$

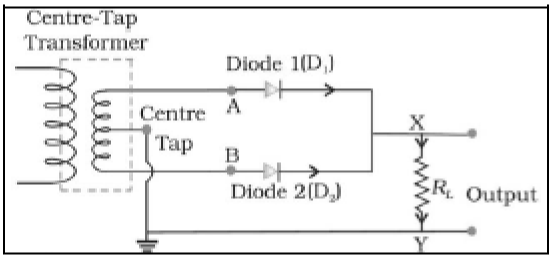
The negative sign indicates that the electron is bound to the atom. In other words, the energy must be supplied to remove an electron from the atom.

- For Hydrogen atom, $Z = 1$.

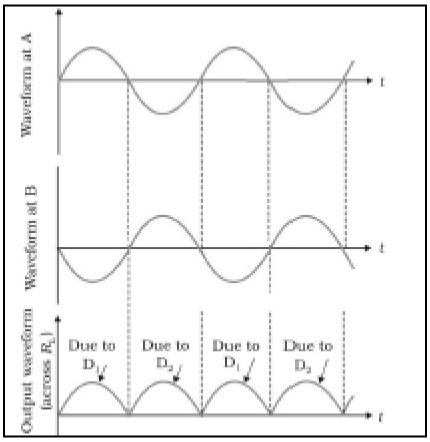
$$E_n = -\frac{m e^4}{8 \varepsilon_0^2 n^2 h^2}$$

32. With the help of a neat circuit diagram, explain the working of full wave rectifier.

- **The full wave rectifier circuit is as shown in the figure**



- AC voltage to be rectified is applied to the primary P of the transformer. It induces a voltage in the secondary of the transformer.
- During the positive half cycle, A is positive. The diode D_1 is forward biased and D_2 is reverse biased. Current flows through D_1 and no current flows through D_2. The current flows through R_L from X to Y. Therefore a voltage is developed across R_L.
- During the negative half cycle, A is negative. The diode D_1 is reverse biased and D_2 is forward biased. Current flows through D_2 and no current flows through D_1. Again the current flows through R_L from X to Y. Therefore a voltage is developed across R_L.
- This means, both diodes conduct but alternately. Further, the current always flows through the load resistance in the same direction in both the half cycles. Thus, full wave rectification is achieved.
- The output of the rectifier is not steady but pulsating DC.
- The input and the output voltage waveforms of a full wave rectifier are as shown in the fig.



VI. Answer any THREE of the following questions: 3 x 5 = 15

33. A $4\ \mu F$ capacitor is charged by a $200\ V$ supply. It is then disconnected from the supply, and is connected to another uncharged $2\ \mu F$ capacitor. How much electrostatic energy of the first capacitor is lost in the form of heat and electromagnetic radiation?

- $C_1 = 4\ \mu F = 4\times10^{-6}\ F$, $C_2 = 2\ \mu F = 2\times10^{-6}\ F$, $V_1 = 200\ V$, $V_2 = 0$, $\Delta U = ?$
- Loss of energy, $\Delta U = \frac{1}{2}\times\frac{C_1 C_2}{C_1+C_2}\times(V_1 - V_2)^2$

$$\Delta U = \frac{4\times10^{-6}\times2\times10^{-6}\times(0-200)^2}{2\times(4\times10^{-6}+2\times10^{-6})}$$

$$\Delta U = \frac{4\times10^{-6}\times2\times10^{-6}\times(-200)^2}{2\times6\times10^{-6}}$$

$$\Delta U = 0.0267\ J$$

34. Six lead-acid type of secondary cells each of emf $2.0\ V$ and internal resistance $0.015\ \Omega$ are joined in series to provide a supply to a resistance of $8.5\ \Omega$. What are the current drawn from the supply and its terminal voltage?

- $n = 6$, $E = 2\ V$, $r = 0.015\ \Omega$, $R = 8.5\ \Omega$, $I = ?$, $V = ?$
- Effective emf, $E_{eff} = n\ E$

$$E_{eff} = 6\times2$$

$$E_{eff} = 12\ V$$

- Effective internal resistance, $r_{eff} = n\ r$

$$r_{eff} = 6\times0.015$$

$$r_{eff} = 0.09\ \Omega$$

- Current drawn from the supply, $I = \frac{E_{eff}}{R + r_{eff}}$

$$I = \frac{12}{8.5+0.09} = \frac{12}{8.59}$$

$$I = 1.397\ A$$

- Terminal voltage, $V = I\ R$

$$V = 1.397\times8.5$$

$$V = 11.875\ V$$

35. A sinusoidal voltage of peak value $283\ V$ and frequency $50\ Hz$ is applied to a series LCR circuit in which $R = 3\ \Omega$, $L = 25.48\ mH$ and $C = 796\ \mu F$. Find (a) the impedance of the circuit (b) the phase difference between the voltage across the source and the current and (c) the power dissipated in the circuit.

- $V_0 = 283\ V$, $f = 50\ Hz$, $R = 3\ \Omega$, $L = 25.48\ mH = 25.48 \times 10^{-3}\ H$, $C = 796\ \mu F = 796 \times 10^{-6}\ F$, $Z = ?$, $\phi = ?$, $P = ?$

- Root mean square value of voltage, $V_{rms} = \frac{V_0}{\sqrt{2}}$

$$V_{rms} = \frac{283}{\sqrt{2}}$$

$$V_{rms} = 200.11\ V$$

- Inductive reactance, $X_L = 2\ \pi\ f\ L$

$$X_L = 2 \times 3.14 \times 50 \times 25.48 \times 10^{-3}$$

$$X_L = 8\ \Omega$$

- Capacitive reactance, $X_C = \frac{1}{2\ \pi\ f\ C}$

$$X_C = \frac{1}{2 \times 3.14 \times 50 \times 796 \times 10^{-6}}$$

$$X_C = 4\ \Omega$$

- Impedance, $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$$Z = \sqrt{3^2 + (8-4)^2} = \sqrt{9+16} = \sqrt{25}$$

$$Z = 5\ \Omega$$

- Power factor, $\cos\phi = \frac{R}{Z}$

$\cos\phi = \frac{3}{5}$

$\cos\phi = 0.6$

Phase difference between V and I, $\phi = \cos^{-1}(0.6)$

$\phi = 53°\,8'$

- Power dissipated, $P = V_{rms}\, I_{rms} \cos\phi$

$P = \frac{V_{rms}^2}{Z}\cos\phi \qquad \left(\because I_{rms} = \frac{V_{rms}}{Z}\right) \qquad$ Also, $P = \frac{V_0^2}{2\times Z}\cos\phi$

$P = \frac{200.11^2 \times 0.6}{5}$

$P = 4805.3\ W$

36. In a Young's double-slit experiment, the slits are separated by $0.28\ mm$ and the screen is placed $1.4\ m$ away. The distance between the central bright fringe and the fourth bright fringe is measured to be $1.2\ cm$. Determine the fringe width and the wavelength of light used in the experiment.

- $d = 0.28\ mm = 0.28\times10^{-3}\ m$, $D = 1.4\ m$, $x_4 = 1.2\ cm = 1.2\times10^{-2}\ m$, $n = 4$, $\beta = ?$, $\lambda = ?$
- For bright fringe, $x_n = n\,\beta$

$1.2\times10^{-2} = 4\,\beta$

$\beta = \frac{1.2\times10^{-2}}{4}$

Fringe width, $\beta = 0.3\times10^{-2}\ m$

- $\beta = \frac{\lambda\, D}{d}$ or $\lambda = \frac{\beta\, d}{D}$

$\lambda = \frac{0.3\times10^{-2}\times0.28\times10^{-3}}{1.4}$

Wavelength, $\lambda = 6\times10^{-7}\ m$

37. The work function of caesium is $2.14\ eV$. Find (a) the threshold frequency for cesium and (b) the wavelength of the incident light if the photocurrent is brought to zero by a stopping potential of $0.60\ V$.

- $W = 2.14\ eV = 2.14 \times 1.6 \times 10^{-19}\ J = 3.424 \times 10^{-19}\ J$, $V_S = 0.60\ V$, $f_0 = ?$, $\lambda = ?$
- $W = h\ f_0$ or $f_0 = \dfrac{W}{h}$

  $$f_0 = \frac{3.424 \times 10^{-19}}{6.625 \times 10^{-34}}$$

  Threshold frequency, $f_0 = 5.168 \times 10^{14}\ Hz$
- Kinetic energy, $K = e\ V_S$

  $K = 1.6 \times 10^{-19} \times 0.6$

  $K = 0.96 \times 10^{-19}\ J$
- Total energy of photon, $E = W + K$

  $E = (3.424 + 0.96) \times 10^{-19}$

  $E = 4.384 \times 10^{-19}\ J$

$E = \dfrac{h\ c}{\lambda}$ or $\lambda = \dfrac{h\ c}{E}$

$$\lambda = \frac{6.625 \times 10^{-34} \times 3 \times 10^{8}}{4.384 \times 10^{-19}}$$

Wavelength, $\lambda = 4.534 \times 10^{-7}\ m$

PHYSICS(33)

MODEL QUESTION PAPER 2 SOLVED -2021
BLUE PRINT

Unit No.	Ch No.	TOPIC	Teaching Hours	Marks	1 M	2 M	3 M	5 M (T)	5 M (NP)
I	1	Electric charges and fields	8	10		✓	✓	✓	
II	2	Electric potential & capacitance	9	11	✓	✓	✓		✓
III	3	Current Electricity	11	14	✓	✓	✓✓		✓
IV	4	Moving charges and magnetism	11	13	✓	✓✓	✓	✓	
V	5	Magnetism and matter	2	3	✓	✓			
	6	Electromagnetic induction	7	8	✓	✓		✓	
VI	7	Alternating current	6	8			✓		✓
	8	Electromagnetic waves	1	1	✓				
VII	9	Ray optics & optical instruments	5	6	✓			✓	
VIII	10	Wave optics	5	7		✓			✓
IX	11	Dual nature of radiation & matter	5	6	✓				✓
	12	Atoms	5	6	✓			✓	
X	13	Nuclei	3	4	✓		✓		
	14	Semiconductor Electronics	6	8			✓	✓	
TOTAL			84	105	10	16	24	30	25

(105 Marks /84 Teaching hours = 1.25 marks/teaching hour)

PART-A

I Answer all the following questions: 10 x 1 = 10

1. What is an equipotential surface?

No work is done in moving a test charge from one point to another point over that surface.

Or Equipotential surface is one in which electric potential is same at all points over that surface

2. Mention one application of potentiometer.

- To Compare emfs of cells
- To determine internal resistance of a cell (Any One)
-

3. Write the value of Bohr magneton.

$\mu_l = 9.27\, X\, 10^{-24}\, A\, m^2$

4. What is the value of dip at a point on the magnetic equator?

Zero Or 0^0

5. How does self-inductance of an ideal coil vary with the current passing through it?

Self inductance of an ideal coil is independent of current

6. Which kind of electromagnetic radiations are used in LASIK eye surgery?

Ultra violet radiation (U V Rays)

7. Define critical angle for total internal reflection.

Angle of incidence in the denser medium for which the angle of refraction is 90^0

8. Write the expression for the de Broglie wavelength of a particle of mass m moving with a speed v.

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

9. Name the series of hydrogen spectrum that lies in visible region.

Balmer series

10. Give an example for conversion of mass to energy.

Nuclear fusion $\,{}^2_1H + {}^2_1H \rightarrow {}^4_2He + Q$

PART-B

II Answer any five of the following questions: 5 x 2 = 10

11. What is an electric dipole? Write the SI unit of dipole moment.

Two equal and opposite charges separated by a small distance.

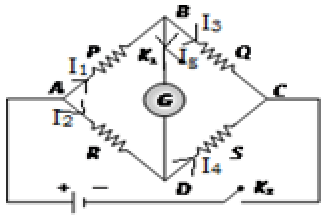
S I unit of electric dipole moment is C m

12. Mention any two factors on which capacitance of a parallel plate capacitor depends.

- Area of each plates
- Distance between the plates (Any Two)
- Dielectric medium between the plates

13. Draw a neat diagram of a Wheatstone's network. Mention the condition for its balance.

$$\frac{P}{Q} = \frac{R}{S}$$



14. **A proton and an electron enter a uniform magnetic field at the same angle with the field and with the same speed. Do they experience force of same magnitude? Justify your answer.**

Yes.

As both particles have same speed and moving in same field at same angle they experience same force but in opposite direction as they are oppositely charged.

15. **Calculate the magnitude of magnetic field at a distance of 2 m from a very long straight wire carrying a current of 5 A?**

$B = \frac{\mu_0}{4\pi} \frac{2I}{r}$

$B = 10^{-7} X 2 X 5$ $\qquad B = 5 X 10^{-7} T$

16. **Write any two properties of magnetic field lines.**

- Magnetic field lines start from the north pole and reach the south pole.
- Magnetic field lines are continuous closed loops. (Any Two)
- Two magnetic field lines never intersect each other.

17. **Write any two applications of eddy currents.**

- Induction furnace.
- Electromagnetic damping. (Any Two)
- Energy meters.

18. **What is the shape of the emergent wave front when a plane wave front is incident on: (a) a prism and (b) a convex lens?**

- Plane wave front
- Spherical wave front

PART-C

Answer any five of the following questions: **5 x 3 = 15**

19. **Write the fundamental properties of charges.**

- Like charges repel and unlike charges attract each other.
- Charge reside on the surface of a conductor
- Charge is additive in nature (Any Three)
- Charges are conserved.
- Charges are quantized.

20. **Derive an expression for energy stored in a charged capacitor.**

Consider a capacitor of capacitance C connected to a battery as shown in fig.
Let V' be the p.d. across the capacitor due to charge q then

$V' = \frac{q}{C}$ ….. (1)

If dW is the work done in transferring charge dq in time dt then

$dW = V' dq$

Or $dW = \frac{q}{C} dq$ ….. (2)

If W is the total work done then

$W = \int dW = \int_0^Q \frac{q}{C} dq$

Or $W = \frac{1}{C}\int_0^Q q \cdot dq$ ……. (3)

On integrating Eqn. (3) we get

$W = \frac{1}{C}\left[\frac{q^2}{2}\right]_0^Q$

Or $W = \frac{1}{2C}[Q^2 - 0]$

$W = \frac{Q^2}{2C}$ ….. (4)

$\because Q = CV$ Then Eqn. (4) becomes

$W = \frac{C^2V^2}{2C}$

Or $W = \frac{1}{2}CV^2$ ….. (5)

By definition, this work done is stored as potential energy i.e. $W = U$

$\therefore U = \frac{1}{2}CV^2$ …….. (6)

21. Arrive at the expression for the drift velocity of free electrons in a conductor in terms of applied electric field and relaxation time.

In the absence of the electric field, the average thermal velocity of free electrons is zero

i,e. $\vec{v}_o = \frac{1}{N}\sum_{i=1}^{n} \vec{v}_i = 0$ ……. (1)

When electric field is applied each free electrons experience a force which is given by

$\vec{F} = -e\vec{E}$…….. (2)

If $\vec{a}$ is the acceleration produced due to electric field then

$\vec{a} = \frac{\vec{F}}{m}$

Or $\vec{a} = \frac{-e\vec{E}}{m}$ ……. (3)

If $\vec{v}_d$ is the drift velocity of free electrons then

$\vec{v}_d = \vec{v}_o + \vec{a}\tau$

From eqn. (1) and (3)

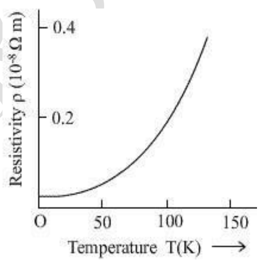
$\vec{v}_d = 0 + \left(\frac{-e\vec{E}}{m}\right)\tau$

Or

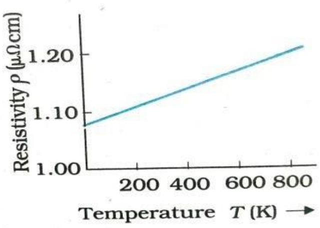
$\vec{v}_d = \left(\frac{-e\vec{E}}{m}\right)\tau$……. (4)

22. Draw graphs showing variation of resistivity with temperature for (a) copper, (b) nichrome and (c) a semiconductor.

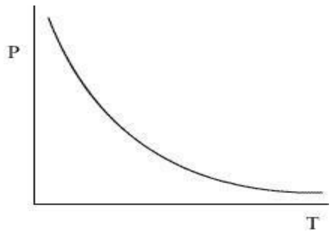
(a) Copper



(b) Nichrome

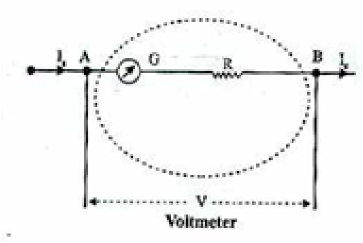


(c) Semiconductor



23. How do you convert a galvanometer into a voltmeter? Explain with a circuit diagram.

A galvanometer can be converted into a voltmeter by connecting a suitable high resistance in series with galvanometer.



Since G and R are in series

P.d. across the combination = P.d. across G + P.d. across R.

$V = I_g . G + I_g R.$

$V = I_g (G+R)$

$$\frac{V}{I_g} = G + R$$

$$R = \frac{V}{I_g} - G$$

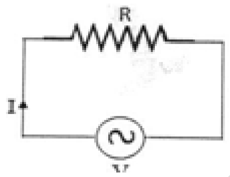
24. Show that the current and the voltage are in phase for the passage of AC through a resistor.

Consider an ac circuit containing only resistor of resistance R.

Instantaneous voltage is given by :

$V = V_0 \sin \omega t$ …………….. (1)

From Kirchhoff's loop rule :



$V = IR$ ....(2)

From Equations (1) and (2) :

$IR = V_0 \sin \omega t$

$$I = \frac{V_0}{R} \sin \omega t$$

$I = I_0 \sin \omega t$...................................(3)

From Eqn. (1) and (3) current is in phase with applied voltage

25. Write any three differences between nuclear fission and nuclear fusion.

Nuclear Fission	Nuclear Fusion
Takes place at ordinary temperature	Takes place at very high temperature of about 10^9 K
Energy released per fission reaction is more	Energy released per fusion reaction is less
End product is radioactive	End product is non radioactive

Process in which nucleus of heavy elements breaks in to two lighter nuclei of comparable masses	Process in which two or more lighter nuclei fuse to form a single heavy nucleus

26. Distinguish between conductors, insulators and semiconductors based on the band theory of solids.

S.No	Properties	Conductors	Insulators	Semiconductors
(1)	Energy gap	Zero or very small i.e. valence band and conduction band is over lapped each other.	Very large it is greater than 3eV.	Small energy gap less than 3eV.
(2)	Condition of V.B. and C.B. at ordinary temperature	V.B. and C.B. are completely filled or C.B. is somewhat empty	V.B. – completely filled C.B. – completely unfilled	V.B. –somewhat empty C.B. – somewhat filled
(3)	Examples	Cu, Ag, Au, Na, Pt, Hg etc.	Wood, plastic, mica, diamond, glass etc.	Ge, Si, Ga As etc.

PART-D

IV Answer any two of the following questions: 2 x 5 = 10

27. State Gauss law in electrostatics. Derive an expression for electric field at a point due to an infinitely long uniformly charged wire.

Statement: The total electric flux over any closed surface is always equal to $\frac{1}{\varepsilon_0}$ times the total charge enclosed in that surface.

Consider an infinitely long uniformly charged straight wire of linear charge density $\lambda = \frac{q}{l}$

Let P be a point on an imaginary Gaussian surface of radius r as shown in fig.

The electric flux over the surfaces A and B is zero. Since $\theta = 90^0$

The electric flux over the curved surface C at a point P is

$\Delta\phi_E = E \cdot \Delta S$ Since $\theta = 0$

If ϕ_E is the total electric flux over the entire surface then

$\phi_E = \sum \Delta\phi_E$

Or $\phi_E = E \sum \Delta S$ ..... (1)

Since $\sum \Delta S = 2\pi r l$ then

$\phi_E = E\, 2\pi r l$ .... (2)

From Gauss's law $\phi_E = \frac{q}{\varepsilon_0}$ ....(3)

From Eqn. (2) and (3)

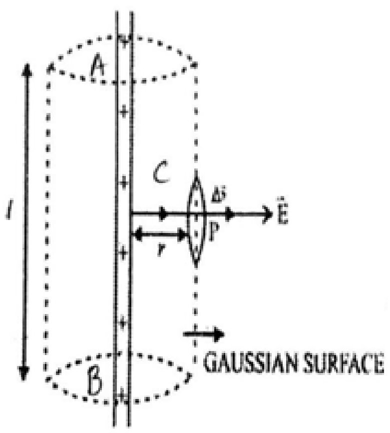
$E\, 2\pi r l = \frac{q}{\varepsilon_0}$

Or $E = \frac{q}{2\pi \varepsilon_0 r l}$

Since $\frac{q}{l} = \lambda$

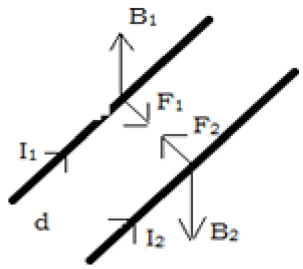
Then $E = \frac{\lambda}{2\pi \varepsilon_0 r}$

In vector form $\vec{E} = \frac{\lambda}{2\pi \varepsilon_0 r}\hat{n}$ ...... (4)



28. Derive an expression for force per unit length between two infinitely long straight parallel current carrying conducting wires. What is the nature of the force if the currents are flowing in opposite directions?

Let P and Q be two conductors of length *l* placed parallel to each other at a distance r apart.
The magnetic field at any point on the conductor Q due to current I_1 in the conductor P.



$$B_1 = \frac{\mu_0}{4\pi}\frac{2I_1}{d}$$

The direction of B_1 is perpendicular to the plane of the conductor and it is acting vertically downward.

The conductor Q carrying current placed in this magnetic field, experience force

$$F_1 = B_1 I_2 l \sin\theta$$

$$F_1 = \left[\frac{\mu_0}{4\pi}\frac{2I_1}{d}\right] I_2 l \sin 90^0 \quad \text{Since} \quad \sin 90^0 = 1$$

There fore $F_1 = \left[\frac{\mu_0}{4\pi}\frac{2I_1}{d}\right] I_2 l$

The conductor Q carrying current will produce magnetic field around P. It is given by

$$B_2 = \frac{\mu_0}{4\pi}\frac{2I_2}{d}$$

The direction of B_2 is perpendicular to the plane of the conductor and it is acting vertically upward.

The conductor P carrying current placed in this magnetic field experience force

$$F_2 = B_2 I_1 l \sin\theta$$

$$F_2 = \left[\frac{\mu_0}{4\pi}\frac{2I_2}{d}\right] I_1 l \sin 90^0 \quad \text{Since} \quad \sin 90^0 = 1$$

There fore $F_2 = \left[\frac{\mu_0}{4\pi}\frac{2I_2}{d}\right] I_1 l$

Since F_1 and F_2 are equal and opposite each other, so these forces pull the two conductors towards each other.

The force per unit length on each conductor is

Therefore $\frac{F}{l} = \frac{\mu_0}{4\pi}\frac{2I_1 I_2}{d}$

Nature of force is repulsive if the currents are flowing in opposite directions.

29. State and explain Faraday's law of electromagnetic induction. Derive an expression for the motional emf induced in a rod which is moving in a plane perpendicular to a uniform magnetic field.

Statement: The magnitude of the induced emf in a circuit is equal to the time rate of change of magnetic flux through the circuit.

If ε is the induced emf when the magnetic flux changes by $d\phi_E$ in a time interval dt then from Faraday's law :

$$\varepsilon = -\frac{d\phi_B}{dt}$$ eeee

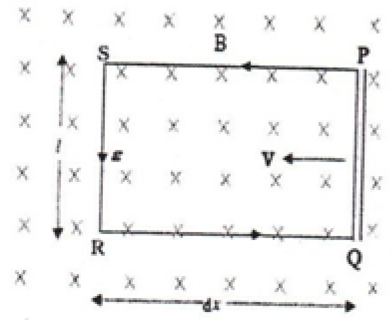
Consider a metallic rod of length l moving in a uniform magnetic field B with a uniform speed v. The direction of the magnetic field is perpendicular to the length of the rod and into the plane of the paper. Let the rod be moved from position PQ to the position RS through a distance dx in a time dt.

The area swept by the rod is:

PQ x QR = $l.\ dx$

The change in the magnetic flux is:

$d\phi_B = B.l.dx$ ....(1)



The rate of change of magnetic flux is:

$\frac{d\phi_B}{dt} = B.l.\frac{dx}{dt}$ ....(2)

From Lenz's law:

$\varepsilon = -\frac{d\phi_B}{dt}$ ....(3)

From equations (2) and (3):

Where $\frac{dx}{dt}$ = v = velocity of the rod.

$\varepsilon = -Blv$ ....(4)

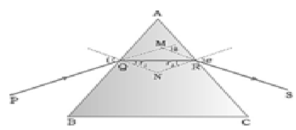
V Answer any two of the following questions: 2 x 5 = 10

30. Derive the expression for refractive index of a prism in terms of angle of the prism and angle of minimum deviation.

ABC is principal section of the prism. i and r_1 are angles of incidence and refraction respectively at the first face AB. r_2 and e are angles of incidence and emergence respectively at the second face AC.

From the cyclic quadrilateral AQNR

$\angle A + \angle QNR = 180^0$ ----------- (1)



From the triangle QNR $r_1 + r_2 + \angle QNR = 180^0$ -------(2)

Comparing (1) & (2) we get

$r_1 + r_2 = A$ ------------------ (3)

Total deviation $\delta = (i - r_1) + (e - r_2)$

$$\delta = (i + e) - A \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

At the minimum deviation

The refracted ray inside the prism becomes parallel to its base.

$\delta = Dm, \; i = e \; \& \; r_1 = r_2 = r$

eqn. (3) becomes $2r = A$ or $r = \frac{A}{2}$

Eqn. (4) becomes $Dm = 2i - A$ or $i = \frac{(A+D_m)}{2}$

Using Snell's law $n = \frac{Sin\, i}{Sin\, r}$

We get

$$n = \frac{Sin\left(\frac{A+D_m}{2}\right)}{Sin\left(\frac{A}{2}\right)}$$

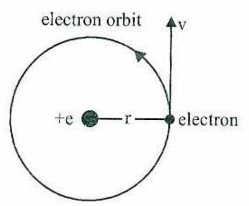
31. Using Bohr's postulates, obtain the expression for radius of nth orbit of electron in hydrogen atom.

Consider electron of charge –*e*, velocity *v* and mass m revolves around the nucleus of charge +*e* of a hydrogen atom in a circular orbit of radius *r*.

The necessary centripetal force is provided by the electrostatic force of attraction between the electron and nucleus. For stability of an atom,

$F_c = F_e$

$$\frac{mv^2}{r} = \frac{1}{4\pi\epsilon_0}\frac{e.e}{r^2}$$



$$mv^2 = \frac{1}{4\pi\epsilon_0}\frac{e^2}{r} \text{ -------------- (1)}$$

From Bohr's quantization condition mvr = $\frac{nh}{2\pi}$

$$v = \frac{nh}{2\pi mr} \text{ ------------------- (2)}$$

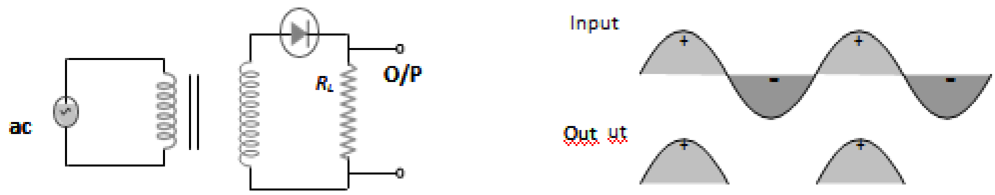
Substitute (2) in (1)

$$m\left(\frac{nh}{2\pi mr}\right)^2 = \frac{1}{4\pi\epsilon_0}\frac{e^2}{r}$$

$$\frac{mn^2h^2}{4\pi^2m^2r^2} = \frac{1}{4\pi\epsilon_0}\frac{e^2}{r}$$

$$r_n = \frac{n^2h^2\epsilon_0}{\pi me^2}$$

32. What is rectification? With the help of a neat circuit diagram explain the working of half wave rectifier.



The process of conversion of AC into Pulsating DC is called rectification.

Working:

A Half wave rectifier consists of a diode connected across the end of secondary winding of a centre tapped step down transformer. The load resistance R_L is connected across secondary winding and the diode D shown in the circuit.

During positive half cycle of input ac the point A is positive with respect to the point B

then the diodes is forward biased hence the current flows through R_L as output.

During the half cycle of input ac the point A is negative with respect to the point B then the diode is reversed biased hence the current do not flows through R_L

The diode allows only positive half cycles of ac through R_L from output hence the diode acts as half wave rectifier.

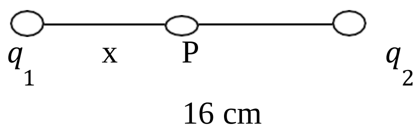
VI Answer any three of the following questions: 3 x 5 = 15

33. Two charges 5×10^{-8} C and -3×10^{-8} C are located 16 cm apart. At what points on the linejoining the two charges is the electric potential zero? Take the potential at infinity to be zero.

Case I: Position between the charges:

Let p be a point at a distance x from the charge q_1.

Electric potential $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ $\quad since \; V_1 = V_2 \; at \; P$



$$There\,fore \quad \frac{1}{4\pi\varepsilon_0}\frac{q_1}{x} = \frac{1}{4\pi\varepsilon_0}\frac{q_2}{16-x} \quad => 9\,X\,10^9\left[\frac{5\,X\,10^{-8}}{x}\right] = 9\,X\,10^9\left[\frac{3\,X\,10^{-8}}{16-x}\right]$$

$3x = 80 - 5x \quad Or \quad 8x = 80$

$x = 10\ cm$

Case II: Position beyond the charges:
Let p be a point at a distance x beyond the charge q_2. q_1 16 cm q_2 x P

Electric potential $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ since $V_1 = V_2$ at P

$$There\ fore \quad \frac{1}{4\pi\varepsilon_0}\frac{q_1}{16+x} = \frac{1}{4\pi\varepsilon_0}\frac{q_2}{x} \quad => 9\ X\ 10^9 \left[\frac{5\ X\ 10^{-8}}{16+x}\right] = 9\ X\ 10^9 \left[\frac{3\ X\ 10^{-8}}{x}\right]$$

$5x = 48 + 3x \quad Or \quad 2x = 48$

$x = 24\ cm$

34. A wire of length 2m, area of cross-section0.5 mm2and resistivity 1.5× 10^{-6} Ωm is connectedin series with a cell of emf 4 V. If the current through the wire is 0.5 A, calculate: (a) the internal resistance of the cell and (b) the rate of energy dissipated by the wire.

$Given: l = 2\ m \quad A = 0.5\ X\ 10^{-6}\ m^2 \quad \rho = 1.5\ X\ 10^{-6}\ \Omega\, m \quad E = 4\ V \quad I = 0.5\ A \quad r = ?\ P = ?$

Resistance of the wire $R = \rho \frac{l}{A}$

$$R = 1.5\ X\ 10^{-6}\ X \frac{2}{0.5\ X\ 10^{-6}} \qquad R = 6\ \Omega$$

$$I = \frac{E}{R + r} \qquad 0.5 = \frac{4}{6 + r} \quad => \quad 6 + r = \frac{4}{0.5}$$

$Or \quad r = 2\ \Omega$

$P = I^2R \qquad P = (0.5)^2\ X\ 6 \qquad P = 1.5\ W$

35. Calculate the resonant frequency of a series LCR circuit with L= 2.0 H, C= 32 µF and R= 10 Ω. What is the Q-value of this circuit?

$L = 2.0\ H \quad C = 32\ \mu F \quad R = 10\ \Omega \quad \omega_0 = ?\ Q = ?$

Resonant frequency

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2.0\ X\ 32\ X 10^{-6}}} = 0.125\ X\ 10^3\ Or \quad \omega_0 = 125\ rad\ s^{-1}$$

Quality factor

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

$$Q = \frac{1}{10}\sqrt{\frac{2}{32\ X\ 10^{-6}}}$$

$Q = \frac{1}{10}\sqrt{0.0625\ X\ 10^6} \quad Q = 0.005\ X\ 10^3$

$Q = 25$

36. **In a Young's double slit experiment setup with monochromatic light, fringes are obtained on a screen placed at a certain distance from the slits. If the screen is moved by 5cm towards the slits, the change in fringe width is 20 µm. Given the distance between two slits to be1.2mm, calculate the wavelength of the light used.**

$\beta^1 = \beta - 20 X 10^{-6}$ $d = 0.0012\ m$ $D^1 = D - 0.05$ $\lambda = ?$

Fringe width

$\beta = \frac{\lambda D}{d}$...... (1) and $\beta^1 = \frac{\lambda D^1}{d}$ ..... (2)

Subtract Eqn. (2) from Eqn.(1)

$$\beta - (\beta - 20 X 10^{-6}) = \frac{\lambda D}{d} - [\frac{\lambda}{d}(D - 0.05)]$$

$$20 X 10^{-6} = \frac{\lambda}{d}(0.05)$$

$$\lambda = \frac{20 X 10^{-6}}{0.05} X 0.0012$$

$$\lambda = 0.48 X 10^{-6}$$

$$\lambda = 480\ nm$$

37. Light of frequency 7.21 × 10^{14} Hz is incident on a metal surface. The cut-off wavelength forphotoelectric emission from the metal surface is 540 nm. Determine the maximum speed ofthe photoelectrons emitted from the surface(Given: h= 6.63 × 10^{-34} Js, m = 9.1 X 10^{-31} kg)

Energy of the photon is

$$E = \frac{h\nu}{e} = \frac{6.63 \times 10^{-34} X 7.21 \times 10^{14}}{1.6 X 10^{-19}}$$

$$E = 2.99\ eV$$

$$\phi_0 = \frac{hc}{e\lambda_0} = \frac{6.63 \times 10^{-34} X 3 \times 10^{8}}{1.6 X 10^{-19} X 540 X 10^{-9}}$$

$$\phi_0 = 2.3\ eV$$

Maximum kinetic energy

$$K_{max} = E - \phi_0 = 2.99 - 2.3 = 0.69\ eV$$

$$K_{max} = 0.69 X 1.6 X 10^{-19} = 1.104 X 10^{-19}\ J$$

Maximum velocity

$$v_{max} = \sqrt{\frac{2 X K_{max}}{m}} = \sqrt{\frac{2 X 1.10 X 10^{-19}}{9.1 X 10^{-31}}} = 0.491 X 10^{6}$$

$$v_{max} = 4.91 X 10^{5}\ m/s$$