**R2024**

No. of Printed Pages : 4

Register Number | | | | | | | |

**12**

## PART – III

## , awgpa y; / PHYSICS

(English Version)

Time Allowed : 3.00 Hours ] [ Maximum Marks : 70

**Instructions :** (1) Check the question paper for fairness of printing. If there is any lack of fairness, inform the Hall Supervisor immediately

(2) Use **Blue** or **Black** ink to write and underline and pencil to draw diagrams.

## PART – I

**Note :** (i) Answer **all** the questions. 15x1=15

(ii) Choose the most appropriate answer from the given **four** alternatives and write the option code and the corresponding answer.

1. Which charge configuration produces a uniform electric field?
   (a) point charge (b) Uniformly charged infinite plane
   (c) Uniformly charged infinite line
   (d) Uniformly charged spherical shell

2. A parallel plate capacitor stores a charge Q at a voltage V. Suppose the area of the parallel plate capacitor and the distance between the plates are each doubled then which is the quantity that will change?
   (a) Capacitance (b) Charge
   (c) Voltage (d) Energy density

3. The internal resistance of a 2.1 V cell which gives a current of 0.2A through a resistance of 10 Ω is :
   (a) 0.2 Ω (b) 0.5 Ω (c) 0.8 Ω (d) 1.0 Ω

4. A wire of length *l* carries a current I along the Y direction and magnetic field is given by $\vec{B} = \frac{\beta}{\sqrt{3}}(\hat{\imath} + \hat{\jmath} + \hat{k})T$. The magnitude of Lorentz force acting on the wire is
   (a) $\sqrt{\frac{2}{\sqrt{3}}}\beta Il$ (b) $\sqrt{\frac{1}{\sqrt{3}}}\beta Il$ (c) $\sqrt{2}\beta Il$ (d) $\sqrt{\frac{1}{\sqrt{2}}}\beta Il$

5. In an oscillating LC circuit, the maximum charge on the capacitor is Q. The charge on the capacitor when the energy is stored equally between the electric and magnetic field is :
   (a) $\frac{Q}{\sqrt{2}}$ (b) $\frac{Q}{\sqrt{3}}$ (c) $\frac{Q}{2}$ (d) Q

[ **Turn Over**

6. Fraunhofer lines are an example of spectrum.
   (a) line emission (b) line absorption
   (c) band emission (d) band absorption
7. Which of the following is an electromagnetic wave?
   (a) $\alpha$ – rays (b) $\beta$ – rays
   (c) $\gamma$ – rays (d) All of the above
8. Stars twinkle due to:
   (a) Reflection (b) Total internal reflection
   (c) Refraction (d) Polarisation
9. In a Young's double slit experiment, the slit separation is doubled. To maintain the same fringe spacing on the screen, the screen-to-slit distance D must be changed to :
   (a) 2D (b) $\frac{D}{2}$ (c) $\sqrt{2}$ D (d) $\frac{D}{\sqrt{2}}$
10. The wavelength $\lambda_e$ of an electron and $\lambda_p$ of a photon of same energy E are related by
   (a) $\lambda_p \propto \lambda_e$ (b) $\lambda_p \propto \sqrt{\lambda_e}$ (c) $\lambda_p \propto \frac{1}{\sqrt{\lambda_e}}$ (d) $\lambda_p \propto \lambda_e^2$
11. Emission of electrons by the absorption of heat energy is called...............emission.
   (a) photoelectric (b) field (c) thermionic (d) secondary
12. The nucleus is approximately spherical in shape. Then the surface area of nucleus having mass number A varies as
   (a) $A^{\frac{2}{3}}$ (b) $A^{\frac{4}{3}}$ (c) $A^{\frac{1}{3}}$ (d) $A^{\frac{5}{3}}$
13. The Zener diode is primarily used as :
   (a) Rectifier (b) Amplifier
   (c) Oscillator (d) Voltage regulator
14. The particle size of ZnO material is 30 nm. Based on the dimension it is classified as:
   (a) Bulk material (b) Nanomaterial
   (c) Soft material (d) Magnetic material
15. The blueprint for making ultra-durable synthetic material is mimicked from:
   (a) Lotus leaf (b) Morpho butterfly
   (c) Parrot fish (d) Peacock feather

## PART – II

**Note** : Answer **any six** questions. Question No. **24** is **compulsory.** **6x2=12**

16. Define electric dipole moment. Give its unit.
17. What is displacement current?
18. State Ampere's circuital law.
19. Mention the ways of producing induced emf.
20. Write the uses of Infra-Red rays.
21. Why does the sky appears blue?
22. What is Peltier effect?
23. Define stopping potential.
24. An ideal transformer has 460 and 40,000 turns in the primary and secondary coils respectively. Find the voltage developed as per turn of the secondary coil if the transformer is connected to a 230V Ac mains.

## PART – III

**Note** : Answer **any six** questions. Question No. **33** is **compulsory.** **6x3=18**

25. Obtain the expression for an energy stored in the parallel plate capacitor.
26. State Kirchoff's current and voltage rule.
27. Mention the various energy losses in a transformer.
28. Derive the relation between f and R for a spherical mirror.
29. Mention the difference between interference and diffraction.
30. Give the uses of polaroid's.
31. List out salient features of magnetic Lorentz force.
32. Give the construction and working of a photo emission cell.
33. Find the impedance of a series RLC circuit, if the inductive reactance, capacitive reactance and resistance are 184 $\Omega$ , 144 $\Omega$ and 30 $\Omega$ respectively. Also calculate the phase angle between voltage and current.

**[ Turn Over**

## PART – IV

**Note :** Answer **all** the questions. **5x5=25**

34. (a) Calculate the electric field due to a dipole on its axial line.

**(OR)**

(b) Deduce the relation for the magnetic field at a point due to an infinitely long straight conductor carrying current.

35. (a) Explain the determination of the internal resistance of cell using voltmeter.

**(OR)**

(b) Explain the construction and working of a transformer.

36. (a) Write down Maxwell equations in integral form.

**(OR)**

(b) Obtain lens maker's formula.

37. (a) Describe Davisson-Germer experiment which demonstrated the wave nature of electrons.

**(OR)**

(b) Explain the spectral series of hydrogen atom.

38. (a) What is frequency? List out the advantage and limitations of frequency modulation.

**(OR)**

(b) Explain the construction and working of a full wave rectifier.

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## HIGHER SECONDARY SECOND YEAR REVISION EXAMINATION – JANUARY 2024

## PHYSICS KEY ANSWER

**Note:**

1. Answers written with **Blue** or **Black** ink only to be evaluated.
2. Choose the most suitable answer in Part A, from the given alternatives and write the option code and the corresponding answer.
3. For answers in Part-II, Part-III and Part-IV like reasoning, explanation, narration, description and listing of points, students may write in their own words but without changing the concepts and without skipping any point.
4. In numerical problems, if formula is not written, marks should be given for the remaining correct steps.
5. In graphical representation, physical variables for X-axis and Y-axis should be marked.

### PART – I

**Answer all the questions.** **15x1=15**

| Q. No. | OPTION | ANSWER | Q. No. | OPTION | ANSWER |
|---|---|---|---|---|---|
| 1 | (b) | Uniformly charged infinite plane | 9 | (a) | 2D |
| 2 | (d) | Energy density | 10 | (d) | $\lambda_p \propto \lambda_e^2$ |
| 3 | (b) | 0.5 Ω | 11 | (c) | thermionic |
| 4 | (a) | $\sqrt{\frac{2}{\sqrt{3}}}\beta Il$ | 12 | (a) | $A^{\frac{2}{3}}$ |
| 5 | (c) | $\frac{Q}{\sqrt{2}}$ | 13 | (d) | Voltage regulator |
| 6 | (b) | line absorption | 14 | (b) | Nano material |
| 7 | (c) | γ – rays | 15 | (c) | Parrot fish |
| 8 | (c) | Refraction | | | |

### PART – II

Answer any **six** questions. Question number **24** is compulsory. 6x2=12

| | | | |
|---|---|---|---|
| 16 | **Electric dipole moment and unit**<br>The magnitude of the electric dipole moment ($\boldsymbol{p}$) is equal to the **product of the magnitude of one of the charges** (q) and the distance (2a) between them. (i.e) $\|\vec{p}\|$ = q.2a. Its unit is **Cm.** | 1 ½<br>½ | 2 |

| | | | |
|---|---|---|---|
| 17 | **Displacement current**<br>The displacement current can be defined as **the current which comes into play in the region in which the electric field and the electric flux are changing with time.** That is whenever the change in electric field takes place, displacement current is produced. | 2 | 2 |
| 18 | **Ampere's circuital law**<br>It state that the **line integral of magnetic field over a closed loop** is $\mu_0$ times **net current enclosed by the loop.** $\oint \vec{B}.\vec{dl} = \mu_0 I_0$ | 2 | 2 |
| 19 | **Methods of producing induced emf**<br>By changing the **magnetic field 'B'**<br>By changing the **area 'A' of the coil**<br>By changing the **relative orientation θ** of the coil with magnetic field. | 2 | 2 |
| 20 | **Uses of infra-red rays**<br>(i) Producing **dehydrated fruits**<br>(ii) Green housed to keep the plants warm,<br>(iii) **Heat therapy** for muscular pain or sprain<br>(iv) **TV remote as a signal carrier**, to look through haze off or mist<br>(v) **Night vision** or infrared photography | Any 4<br>4 x ½<br>=2 | 2 |
| 21 | **Sky appears blue colour**<br>According to Rayleigh's scattering, **shorter wavelengths (violet) scattered much more than longer wavelengths (Red)**. As our eyes are more sensitive to blue colour than violet, the sky appears blue during day time. | 2 | 2 |
| 22 | **Peltier effect**<br>When an electric current is passed through a circuit of a **thermocouple, heat is evolved** at one junction and absorbed at the other junction. This is known as Peltier effect.<br>**Peltier effect is reversible.** | 2 | 2 |
| 23 | **Stopping potential**<br>The **negative or retarding potential given to collecting electrode** which is just sufficient to stop the most energetic photoelectrons emitted and make the photo current zero is called stopping potential or cut - off potential. | 2 | 2 |
| 24 | NP = 460 turns; NS = 40,000 turns; VP = 230 V; RS = 104 Ω<br>(i) Secondary voltage, $V_S = \frac{V_P N_S}{N_P}$<br>$= \frac{230 \times 40000}{460}$; $V_S$ = 20000V<br>Secondary voltage per turn, $\frac{V_S}{N_S} = \frac{20000}{40000}$; = 0.5 V | 1<br><br>1 | 2 |

PART – II

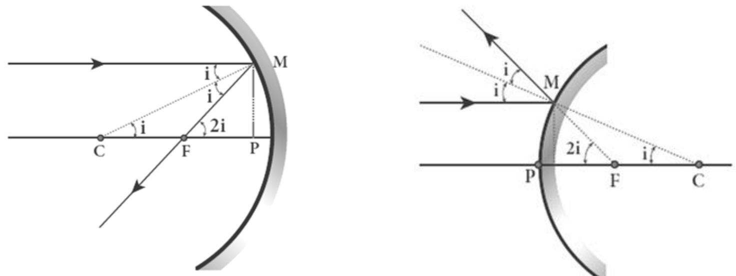
DEPARTMENT OF PHYSICS, SRMHSS, KAVERIYAMPOONDI, TIRUVANNAMALAI.

Answer **any six** questions. Question number **33 is compulsory.** 6x3=18

| | | | |
|---|---|---|---|
| 25 | **Energy stored in capacitor**<br>Capacitor is a device used to **store charges and energy.**<br>When a battery is connected to the capacitor, electrons of total charge '-Q' are transferred from one plate to other plate. For this work is done by the battery. This work done is stored as electrostatic energy in capacitor.<br>To transfer $'dQ'$ for a potential difference 'V', the work done is<br>$dW = VdQ = \frac{Q}{C} dQ$  $[\because V = \frac{Q}{C}]$<br>The total work done to charge a capacitor,<br>$W = \int_0^Q \frac{Q}{C} dQ ; = \frac{1}{C} \left[\frac{Q^2}{2}\right]_0^Q = \frac{Q^2}{2C}$<br>This work done is stored as electrostatic energy of the capacitor, (i.e)<br>$U_E = \frac{Q^2}{2C} = \frac{1}{2} CV^2$  $[\because Q = CV]$ | 1<br>1<br>1 | 3 |
| 26 | **Kirchhoff's first law (current rule or junction rule)**<br>It states that the **algebraic sum of currents at any junction** in a circuit **is zero.** ($\sum I = 0$). It is a statement of conservation of electric charge.<br>**Kirchhoff's second law (voltage rule or loop rule)**<br>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 ( $\sum IR = \sum \xi$). It is a statement of conservation of energy for an isolated system. | 1<br>2 | 3 |
| 27 | **Energy losses in a transformer**<br>**(i) Core loss or Iron loss:**<br>Hysteresis loss and eddy **current loss** are known as **core loss or Iron loss.** When transformer core is magnetized or demagnetized repeatedly by the alternating voltage applied across primary coil, hysteresis takes place and some energy lost in the form of heat. It is **minimized by using silicone steel in making transformer core.**<br>Alternating magnetic flux in the core induces eddy currents in it. Therefore, there is energy loss due to the flow of eddy current called **eddy current loss.** It is **minimized by using very thin laminations of transformer core.**<br>(ii) Copper loss:<br>The primary and secondary coils in transformer have electrical resistance. When an electric current flows through them, some amount of energy is dissipated due to **Joule's heating** and it is known as **copper loss**. It is **minimized by using wires of larger diameter (thick wire)**<br>(iii) Flux leakage:<br>The magnetic flux linked with primary coil is **not completely linked** with secondary. Energy loss due to this flux leakage is **minimize by winding coils one over the other.** | 1<br>1<br>1 | 3 |

28

**Relation between f and R**




(a) Concave mirror (b) Convex Mirror

½

Let 'C' be the centre of curvature of the mirror.

Consider a light ray parallel to the principal axis and incident at 'M' on the mirror. After reflection, it will pass through principal focus 'F'. The line 'CM' is the normal to the mirror at 'M'.

½

From the figure (a),

Angle of incidence; = $\angle AMC$ Angle of reflection; = $\angle CMF$

By the law of reflection. we have, $\boldsymbol{i} = \boldsymbol{r}$

Thus, , $\angle MCP = i$ & $\angle MFP = 2\,i$

1

From $\Delta MCP$ and $\Delta MFP$

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

As the angles are small, we have $\tan \boldsymbol{i} \approx \boldsymbol{i}$ and $\tan 2\boldsymbol{i} \approx 2\boldsymbol{i}$. So

½

$$\boldsymbol{i} = \frac{\mathbf{PM}}{\mathbf{PC}} \quad ..........(1) \quad ; \quad 2i = \frac{\mathrm{PM}}{\mathrm{PF}} \quad ..........(2)$$

Put equation (1) in equation (2)

$$2\frac{\mathbf{PM}}{\mathbf{PC}} = \frac{\mathbf{PM}}{\mathbf{PF}} \quad \text{(or) } 2\text{ PF} = \text{PC} \quad \text{(or)} \quad 2f = R$$

½

$$\boldsymbol{f} = \frac{\boldsymbol{R}}{\mathbf{2}} \quad ...........(3)$$

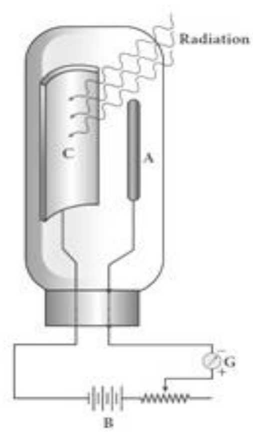
3

29

| Interference | Diffraction |
|---|---|
| Superposition of two waves | Bending of waves around edges |
| Superposition of waves from two Coherent sources. | Superposition wave fronts emitted from various points of the same wave front. |
| **Equally spaced fringes.** | **Unequally spaced fringes** |
| **Intensity of all the bright fringes** is almost same | **Intensity falls rapidly** for higher orders |
| **Large number** of fringes are obtained | **Less number** of fringes are obtained |

Any 3
3 x 1
= 3

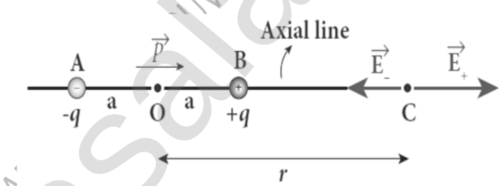
3

| | | | |
|---|---|---|---|
| 30 | **Uses of Polaroid's**<br>Used in goggles and **cameras to avoid glare of light**<br>Used in **holography** (three dimensional motion pictures)<br>Used to improve contrast in **old oil paintings**<br>Used in optical **stress analysis**.<br>Used as window **glasses to control the intensity of incoming light**<br>Polarized needle beam acts as **needle to read / write** in compact discs (CDs)<br>Polaroid produce **polarized lights to be used in liquid crystal display (LCD)** | Any 6<br>6 x ½<br>=3 | 3 |
| 31 | **Properties of Lorentz magnetic force**<br>(i) $\vec{F}_m$ **is directly** proportional to the **magnetic field** ( $\vec{B}$ )<br>(ii) $\vec{F}_m$ **is directly** proportional to the **velocity** ( $\vec{v}$ )<br>(iii) $\vec{F}_m$ is directly proportional to **sine of the angle between the velocity and magnetic field.**<br>(iv) $\vec{F}_m$ is directly proportional to the **magnitude of the charge**<br>(v) The direction of $\vec{F}_m$ is always perpendicular to $\vec{v}$ and $\vec{B}$<br>(vi) The direction of $\vec{F}_m$ on negative charge is opposite to the direction of $\vec{F}_m$ on positive charge<br>(vii) If the of the charge is along the magnetic field, then $\vec{F}_m$ is zero. | Any 6<br>6 x ½<br>=3 | 3 |
| 32 | **Photo emissive cell**<br>It consists of an evacuated glass or quartz bulb in which two metallic electrodes a cathode and an anode are fixed. The **cathode C is semi-cylindrical in shape and is coated with a photo sensitive material.** The anode A is a thin rod or wire kept along the axis of the semi- cylindrical cathode. A potential difference is applied between the anode and the cathode through a galvanometer G.<br><br><br>**Working:**<br>When **cathode is illuminated, electrons are emitted from it.**<br>These **electrons are attracted by anode** and hence a **current is produced** which is measured by the galvanometer. For a given cathode, the magnitude of the current depends on (1) the **intensity to incident radiation** and (2) the **potential difference between anode and cathode.** | 1<br>1<br>1 | 3 |

| | | | |
|---|---|---|---|
| 33 | $X_L = 184\ \Omega$; $X_C = 144\ \Omega$ ; $R = 30\ \Omega$<br>(i ) The impedance is Impedance, $Z = \sqrt{R^2+(X_L-X_C)^2}$<br>$= \sqrt{30^2+(184-144)^2}$ ; $= \sqrt{900+1600}$<br>Impedance, $Z = 50\ \Omega$<br>(ii) Phase angle is $\tan\phi = \frac{X_L-X_C}{R}$ ; $\frac{184-144}{30}$ ; $= 1.33$ ; $\phi = 53.1^0$<br>Since the phase angle is positive, voltage leads current by $53.1^0$ for this inductive circuit. | 1 ½<br><br>1 ½ | 3 |

PART – IV

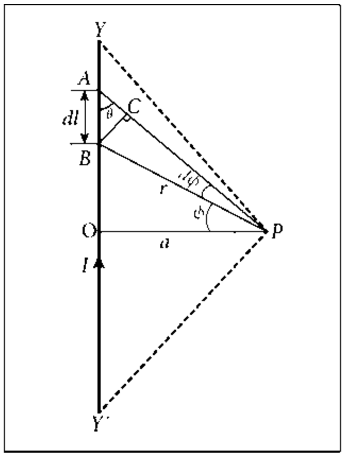
Answer **all** the questions. 5x5=25

| | | | |
|---|---|---|---|
| 34 (a) | **Electric field due to dipole on its axial line**<br>Consider a dipole AB along X - axis. Its dipole moment be $p = 2qa$ and its direction be along – q to + q .<br>Let 'C' be the point at a distance 'r' from the midpoint 'O' on its axial line.<br>**Electric field at C due to +q**<br>$\vec{E}_+ = \frac{1}{4\pi\varepsilon_0}\frac{q}{(r-a)^2}\hat{p}$<br><br>**Electric field at C due to −q**<br>$\vec{E}_- = \frac{1}{4\pi\varepsilon_0}\frac{q}{(r+a)^2}\hat{p}$<br>Since +q is located closer to point 'C' than −q , $\vec{E}_+ > \vec{E}_-$ .<br>By superposition principle, the total electric field at 'C' due to dipole is,<br>$\vec{E}_{tot} = \vec{E}_+ + \vec{E}_-$<br>$\vec{E}_{tot} = \frac{1}{4\pi\varepsilon_0}\frac{q}{(r-a)^2}\hat{p} - \frac{1}{4\pi\varepsilon_0}\frac{q}{(r+a)^2}\hat{p}$<br>$\vec{E}_{tot} = \frac{1}{4\pi\varepsilon_0} q\left[\frac{1}{(r-a)^2} - \frac{1}{(r+a)^2}\right]\hat{p}$ ;<br>$\vec{E}_{tot} = \frac{1}{4\pi\varepsilon_0} q\left[\frac{(r+a)^2-(r-a)^2}{(r-a)^2\ (r+a)^2}\right]\hat{p}$<br>$\vec{E}_{tot} = \frac{1}{4\pi\varepsilon_0} q\left[\frac{r^2+a^2+2ra-r^2-a^2+2ra}{((r-a)\ \ (r+a))^2}\right]\hat{p}$<br>$\vec{E}_{tot} = \frac{1}{4\pi\varepsilon_0} q\left[\frac{4ra}{(r^2-a^2)^2}\right]\hat{p}$<br>Here the direction of total electric field is the dipole moment $\hat{p}$<br>If $r \gg a$ , then neglecting $a^2$. We get $\vec{E}_{tot} = \frac{1}{4\pi\varepsilon_0} q\left[\frac{4ra}{r^4}\right]\hat{p}$ ;<br>$= \frac{1}{4\pi\varepsilon_0} q\left[\frac{4a}{r^3}\right]\hat{p}$<br>$\vec{E}_{tot} = \frac{1}{4\pi\varepsilon_0}\frac{2\vec{p}}{r^3}$ [$q\ 2a\hat{p} = \vec{p}$] | 1<br><br>1<br><br>½<br><br>1<br><br>1<br><br>½ | 5 |

34 (b)

**Magnetic field due to long straight current carrying conductor**

Consider a long straight wire $YY'$ carrying a current I




Let P be a point at a distance 'a' from 'O'

Consider an **element of length '$dl$'** of the wire at a distance '$l$' from point 'O' Let $\vec{r}$ be the vector joining the element '$dl$' with the point 'P' and '$\theta$' be the **angle between $\vec{r}$ and $\vec{dl}$.** Then the 1

magnetic field at 'P' due to the element is, ½

$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2}\hat{n} ------ (1)$$

Where, $\hat{n}$ – unit vector normal to both $I\,\vec{dl}$ and $\vec{r}$

To apply trigonometry, draw a perpendicular AC to the line BP

In triangle Δ ABC, $\sin\theta = \frac{AC}{AB} \Rightarrow \mathbf{AC = AB\sin\theta}$

But AB = dl $\Rightarrow \mathbf{AC = dl\sin\theta}$ ½

Let $d\phi$ be the angle subtended between AP and BP

i.e. $\angle APB = \angle BPC = d\phi$

In triangle Δ APC, $\sin(d\phi) = \frac{AC}{AP}$; since, $d\phi$ is very small, $\sin(d\phi) \simeq d\phi$ ½

But AP = r $\Rightarrow AC = rd\phi$ $\therefore$ **$AC = dl\sin\theta = rd\phi$**

$\therefore d\vec{B} = \frac{\mu_0}{4\pi}\frac{Idl}{r^2}(rd\phi)\,\hat{n}$ ; = $\frac{\mu_0}{4\pi}\frac{Id\phi}{r}\,\hat{n}$ 5

Let $\phi$ be the angle between BP and OP

In a Δ OPA, $\cos\phi = \frac{OP}{BP} = \frac{a}{r}$ ; $\Rightarrow r = \frac{a}{\cos\phi}$ ; $d\vec{B} = \frac{\mu_0}{4\pi}\frac{I}{\frac{a}{\cos\phi}}d\phi\,\hat{n}$

$\vec{dB} = \frac{\mu_0 I}{4\pi a}\cos\phi d\phi.\,\hat{n}$ 1

The total magnetic field at P due to the conductor $YY'$ is $\vec{B} = \int_{-\phi1}^{\phi2} d\vec{B}$

$= \int_{-\phi1}^{\phi2}\frac{\mu_0 I}{4\pi a}\cos\phi d\phi.\,\hat{n}$ ;

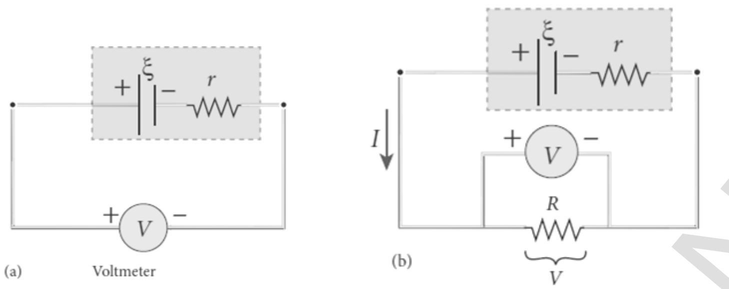
$\frac{\mu_0 I}{4\pi a}[\sin\phi]_{-\phi1}^{\phi2}\,\hat{n}$

$\vec{B} = \frac{\mu_0 I}{4\pi a}(\sin\phi + \sin\phi)\,\hat{n}$ 1

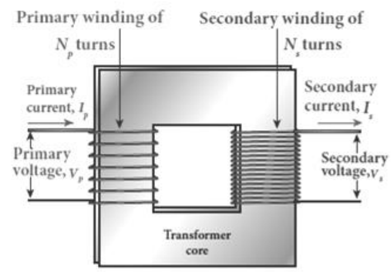
For infinitely long conductor , $\mathbf{\phi_1 = \phi_2 = 90^0}$

$\vec{B} = \frac{\mu_0}{4\pi}\frac{I}{a}[2]\,\hat{n}$ ;

$\vec{B} = \frac{\mu_0}{2\pi}\frac{I}{a}\,\hat{n}$ --------- (3) ½

| Q.No | Answer | Mark | Total |
|---|---|---|---|
| 35<br>(a) | **<u>Internal resistance of a cell</u>**<br>A real battery is made of electrodes and electrolyte. There is resistance to the flow of charges within the battery and this resistance is called internal resistance (r)<br>The **emf of the cell** is measured by **connecting high resistance** voltmeter across it without connecting the external resistance R. This circuit may be considered as open, the voltmeter reading gives the emf ($\xi$) of the cell. Then external resistance is included in the circuit and current 'I' is established in the circuit.<br><br>This circuit is then considered as close, the voltmeter reading gives the potential difference (V) across 'R'<br>By Ohm's law, = IR (or) $I = \frac{V}{R}$ ..........(1)<br>Due to internal resistance of the cell, the voltmeter reads the value "V" which is less than the emf ($\xi$). It is because, certain amount of voltage (Ir) has dropped across the internal resistance 'r'. Hence<br>$V = \xi - Ir$ $----$ (2) (or) $Ir = \xi - V$<br>$\therefore$ $r = \frac{\xi - V}{I}$ ; $= \left[\frac{\xi - V}{V}\right]R$<br>Since $\xi$, V and R are known, internal resistance 'r' and total current 'I' can be determined.<br>The power delivered to the circuit is, $I = I\,\xi$ ; $= I\,(V + Ir)$; $= I\,(IR + Ir)$<br>$P = I^2R + I^2r$<br>where, $I^2R \rightarrow$ power delivered to R<br>$I^2r \rightarrow$ power delivered to $r$ | 1<br><br>1<br><br>½<br><br>1 ½<br><br>1 | 5 |
| 35<br>(b) | **Transformer:**<br>It is a stationary device used to transform electrical power from one circuit to another without changing its frequency. It is done with either increasing or decreasing the applied alternating voltage with corresponding decrease or increase of current in the circuit.<br>If the transformer **converts an alternating current with low voltage in to an alternating current with high voltage,** it is called **step-up transformer**. If the transformer converts an alternating current with high voltage in to an alternating current with low voltage, it is called step-down transformer.<br>**Principle:**<br>**Mutual induction between two coils.** | ½ | 5 |

**Construction:**




It consists of two coils of high mutual inductance wound over the same transformer core made up of silicone steel. To avoid eddy current loss, the core is generally laminated. The alternating voltage is applied across primary coil (P), and the output is taken across secondary coil (S) 1

The assembled core and coils are kept in a container which is filled with suitable medium for better insulation and cooling purpose.

**Working:**

The **alternating voltage given to the primary coil**, set up an **alternating magnetic flux in the laminated core**. As the result of **flux change**, emf is induced in both primary and secondary coils. 1

The emf induced in the primary coil '$\in_P$' is almost equal and opposite to the applied voltage '$VP$' and is given by, $V_P = \in_P = -N_P \frac{d\phi_B}{dt}$ --------- (1)

The frequency of alternating magnetic flux is same as the frequency of applied voltage. Therefore induced in secondary will also have same frequency as that of applied voltage, The emf induced in the secondary coil ½

'$\in_S$' is, $V_S = \in_S = -N_S \frac{d\phi_B}{dt}$ --------- (2)

Dividing equating (1) by (2), $\frac{V_S}{V_P} = \frac{N_S}{N_P}$ --------- (3)

Where, K → Transformation ratio ½

For an **ideal transformer, Input Power = Output Power**

$V_P i_P = V_S i_S$ ; $\frac{V_S}{V_P} = \frac{i_P}{i_S}$ --------- (4)

From equation (3) and (4), we have

$\frac{V_S}{V_P} = \frac{N_S}{N_P} = \frac{i_P}{i_S}$ = K --------- (5) 1

(i) If K > 1 (or) $N_S > N_P$, then $V_S > V_P$ and $i_S < i_P$

This is **step up transformer** in which **voltage increased** and the corresponding **current is decreased**. ½

(ii) If K < 1 (or) $N_S < N_P$, then $V_S < V_P$ and $i_S > i_P$

This is **step down transformer** in which **voltage decreased** and the corresponding **current is increased**.

**Efficiency of a transformer:**

The efficiency ($\eta$) of a transformer is defined as the ratio of the useful output power to the input power.

$$\eta = \frac{\text{Output Power}}{\text{Input Power}} \times 100\%$$

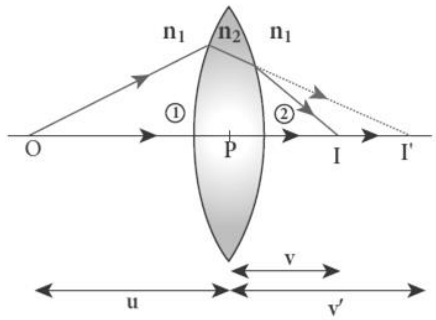
| | | | |
|---|---|---|---|
| 36<br>(a) | **Maxwell equations - Integral form:**<br>Electrodynamics can be summarized into four basic equations, known as Maxwell's equations. Maxwell's equations completely explain the behaviour of charges, currents and properties of electric and magnetic fields.<br>This equation ensures the existence of electromagnetic waves.<br>**Equation - 1 :** It is nothing but Gauss's law<br>It relates the net electric flu to net electric charge enclosed in a surface.<br>Mathematically, **Gauss law is expressed as,** $\oint \vec{\mathbf{E}}.\vec{\mathbf{dA}} = \frac{\mathbf{Q_{Closed}}}{\boldsymbol{\varepsilon_0}}$ ........(1)<br>Here, $\vec{E}$ → Electric field, $Q_{Closed}$ → Charge enclosed<br>This equation is true for either discrete or continuous distribution of charges. It also indicates that the electric field lines start from positive change and terminate at negative charge.<br>The electric field lines do not form a continuous closed path (i.e.) isolated positive or negative charges can exist. | 1 | 5 |
| | **Equation - 2 :**<br>It has no name. But **this law of similar to Gauss law in electrostatics.** Hence this law can be called as **Gauss's law in magnetism**. According to this law, the surface integral of magnetic field over a closed surface is zero.<br>**Mathematically, this law can be expressed as,** $\oint \vec{\mathbf{B}}.\vec{\mathbf{dA}} = \mathbf{0}$ ........(2)<br>$\vec{B}$ → Magnetic field.<br>This equation implies that the magnetic field lines form a continuous closed path. (i.e.) no isolated magnetic monopole exists | 1 | |
| | **Equation - 3 :**<br>This is Faraday's laws of electromagnetic induction. This law relates **electric field with the changing magnetic flux**. This equation implies that, the **line integral of the electric field around any closed path is equal to the rate of change of magnetic flux through the closed path bounded by the surface**.<br>**Mathematically it is expressed as,** $\oint \vec{E}.\vec{dl} = \frac{d\phi_B}{dt}$ ...............(3)<br>$\vec{E}$ → Electric field<br>The electrical energy supplied to our houses from electricity board by using Faraday's law of induction. | 1 ½ | |
| | **Equation - 4 :**<br>It is **modified Ampere's circuital law** and also **called as Ampere - Maxwell's law.** This law relates the magnetic field around any closed path to the conduction current and displacement current through that path.<br>Mathematically, $\oint \vec{B}.\vec{dl} = \mu_0(I_C + I_D)$ (or)<br>$\oint \vec{B}.\vec{dl} = \mu_0 I_C + \mu_0\varepsilon_0 \frac{d}{dt}\int \vec{E}.\vec{dA}$. Here, $\vec{B}$ → Magnetic field.<br>It implies that **both conduction and displacement current produces magnetic field.** | 1 ½ | |

36 (b)

**Lens maker's formula**

A thin lens of refractive index $n_2$ is placed in a medium of refractive index $n_1$. Let $R_1$ and $R_2$ be radii of curvature of two spherical surfaces ① and ② respectively

Let P be pole of the lens and O be the Point object.




Here $I'$ be the image to be formed due the refraction at the surface ① and $I$ be the final image obtained due the refraction at the surface ② — 1

We know that, equation for single spherical surface

$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

For refracting surface ①, the light goes from $n_1$ to $n_2$, Hence

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

For refracting surface ②, the light goes from $n_2$ to $n_1$, Hence

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

Adding equation (1) and (2), we get,

$$\frac{n_2}{v'} - \frac{n_1}{u} + \frac{n_1}{v} - \frac{n_2}{v'} = \frac{n_2 - n_1}{R_1} + \frac{n_1 - n_2}{R_2}$$ — 1 — 5

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

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

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

If the object is at infinity, the image is formed at the focus of the lens. Thus, $u = \infty, v = f$ — 1

Then equation becomes, $\frac{1}{f} - \frac{1}{\infty} = \left(\frac{n_2}{n_1} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$$\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right] \quad \text{..............(4)}$$ — 1

Here first medium is air and hence $n_1 = 1$ and let the refractive index of second medium be $n_2 = n$. Therefore $\frac{1}{f} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$..............(5)

The above equation is called lens maker's formula.

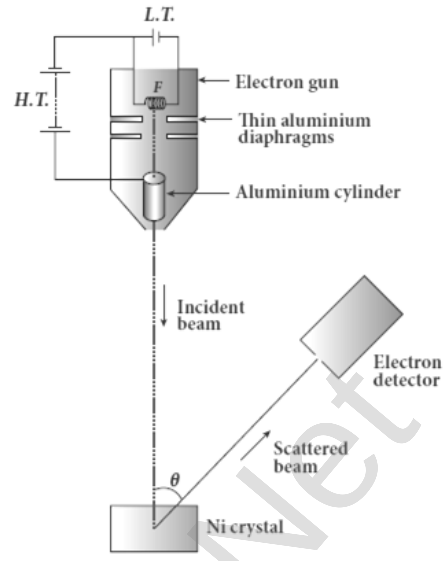
By comparing equation (3) and (4) $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

This equation is known as lens equation.

37(a)

**Davisson - Gerner experiment:**

De Broglie hypothesis of matter waves was experimentally confirmed by Clinton Davisson and Lester **Germer in 1927**. They demonstrated that **electron beams are diffracted when they fall on crystalline solids.** Since crystal can act as a three-dimensional diffraction grating for matter waves, the electron waves incident on crystals are diffracted off in certain specific directions. 1

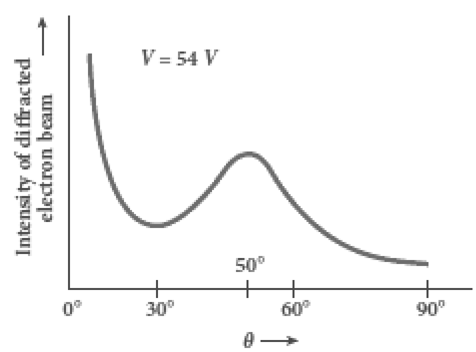



The **filament F is heated by a low tension (L.T.)** battery so that electrons are emitted from the **hot filament by thermionic emission.** They are then accelerated due to the potential difference between the filament and the anode aluminium cylinder by a high tension (H.T.) battery. 1

Electron beam is collimated by using two thin aluminium diaphragms and is allowed to strike a single crystal of Nickel. The electrons scattered by **Ni atoms in different directions are received by the electron detector which measures the intensity of scattered electron beam.**

The detector is rotatable in the plane of the paper so that the angle $\theta$ between the incident beam and the scattered beam can be changed at our will. **The intensity of the scattered electron beam is measured as a function of the angle θ.** 1 5

The graph shows the variation of intensity of the scattered electrons with the angle θ for the **accelerating voltage of 54V.** For a given accelerating voltage V, the scattered wave shows a peak or **maximum at an angle of 50⁰** to the incident electron beam. This peak in intensity is attributed to the constructive interference of electrons diffracted from various atomic layers of the target material. 1




From the known value of inter planar spacing of Nickel, the wavelength of the electron wave has been experimentally calculated as **1.65Å. The wavelength can also be calculated from de Broglie relation for V = 54 V** 1

**as** $\lambda = \frac{12.27}{\sqrt{V}}\,\text{Å} = \frac{12.27}{\sqrt{54}}\,\text{Å}$ **= 1.67** Å

This value agrees well with the experimentally observed wavelength of 1.65Å. Thus this experiment directly verifies de Broglie's hypothesis of the wave nature of moving particles.

37 (b)

**Spectral series of hydrogen atom:**

When an electron jumps from $n^{th}$ orbit to nth orbit, a spectral line was obtained whose wave number (i.e.) reciprocal of wave length is,

$\bar{\upsilon} = \frac{1}{\lambda} = R\left[\frac{1}{n^2} - \frac{1}{m^2}\right]$. Here, R →Rydberg Constant

(R = 1.097 x $10^7$ $ms^{-1}$)

From m>n, various spectral series are obtained.

**(1) Lyman Series:**

n = 1 and m = 2, 3, 4, .....

Hence the wave number, $\bar{\upsilon} = \frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{m^2}\right]$ 1

They lie in **ultra violet** region.

**(2) Balmer Series:**

n = 2 and m = 3, 4, 5, .....

Hence the wave number, $\bar{\upsilon} = \frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{m^2}\right]$

They lie in **visible** region. 1

5

**(3) Paschen Series:**

n = 3 and m = 4, 5, 6,..... 1

Hence the wave number, $\bar{\upsilon} = \frac{1}{\lambda} = R\left[\frac{1}{3^2} - \frac{1}{m^2}\right]$

They lie in **infra-red** region.

**(4) Brackett Series:**

n = 4 and m = 5, 6, 7,.....

Hence the wave number, $\bar{\upsilon} = \frac{1}{\lambda} = R\left[\frac{1}{4^2} - \frac{1}{m^2}\right]$ 1

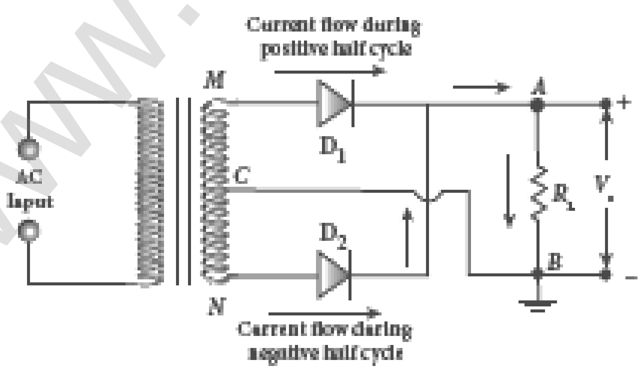
They lie in **middle infra-red** region.

**(5) Pfund Series:**

n = 5 and m = 6, 7, 8,..... 1

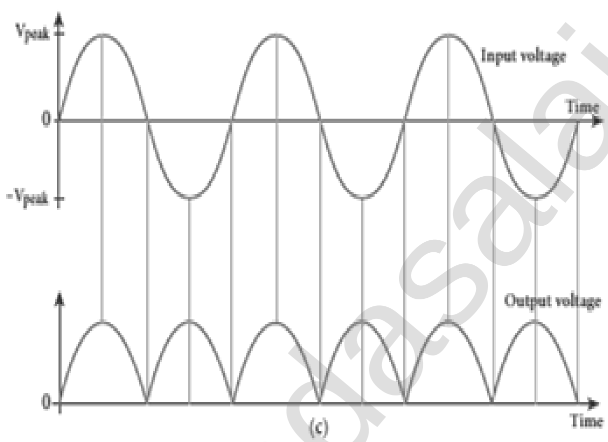
Hence the wave number, $\bar{\upsilon} = \frac{1}{\lambda} = R\left[\frac{1}{4^2} - \frac{1}{m^2}\right]$

They lie in **far infra-red** region.

| | | | |
|---|---|---|---|
| 38 (a) | Frequency definition states that it is the number of complete cycles of waves passing a point in unit time. The SI unit of frequency is Hertz(Hz).<br><br>**Advantages of FM :**<br>Large decrease in noise. This leads to an increase in signal-noise ratio.<br>The operating range is quite large.<br>The transmission efficiency is very high as all the transmitted power is useful.<br>FM bandwidth covers the entire frequency range which humans can hear. Due to this,<br>FM radio has better quality compared to AM radio.<br><br>**Limitations of FM :**<br>FM requires a much wider channel.<br>FM transmitters and receivers are more complex and costly.<br>In FM reception, less area is covered compared to AM. | 1<br><br>2<br><br>2 | 5 |
| 38 (b) | **Full wave rectifier:**<br>**The positive and negative half cycles of the AC input signal pass through this circuit and hence it** is called the full wave rectifier.<br>It consists of two P-N junction diodes, a center tapped transformer, and a load resistor ($R_L$).<br>The centre (C) is usually taken as the ground or zero voltage reference point. Due to the centre tap transformer, the output voltage rectified by each diode is only one half of the total secondary voltage.<br> | ½<br><br>1 | 5 |

| **During positive half cycle of input AC** | **During negative half cycle of input AC** |
|---|---|
| Terminal M is positive, G is at zero potential and N is at negative potential. | Terminal M is negative, G is at zero potential and N is at positive potential. |
| Diode $D_1$ is forward biased. Diode $D_2$ is reverse biased. | Diode $D_1$ is reverse biased. Diode $D_2$ is forward biased. |
| $D_1$ conducts and current flows along the path $MD_1AGC$ | $D_2$ conducts and current flows along the path $ND_2BGC$ |
| The voltage appears across $R_L$ in the direction G to C | The voltage appears across $R_L$ in the same direction G to C |

2




1

Hence in a full wave rectifier both positive and negative half cycles of the input signal pass through the circuit in the same direction. The output waveform is shown below.

Though both positive and negative half cycles of ac input are rectified, the output is still pulsating in nature. The efficiency (η) of full wave rectifier is twice that of a **half wave rectifier and is found to be 81.2 %.** ½