Previous IPE

SOLVED PAPERS

MARCH-2023 (AP)

PREVIOUS PAPERS

IPE: MARCH-2023(AP)

Time : 3 Hours **SR.PHYSICS** Max.Marks : 60

SECTION-A

I. Answer all questions : **10 × 2 = 20**

1. What is the principle of a moving coil galvanometer ?
2. Two lenses of power –1.75 D and +2.25 D respectively are placed in contact. Calculate the focal length of the combination.
3. Define magnetic declination.
4. Magnetic lines form continuous closed loops. Why ?
5. What is transformer ratio ?
6. Give two uses of infrared rays.
7. What are Cathode rays?
8. State Heisenberg's Uncertainty Principle.
9. Draw the circuit symbols for p-n-p and n-p-n transistors.
10. Mention the basic methods of modulation.

BABY BULLET-Q

SECTION-B

II. Answer any six of the following Questions. **6 × 4 = 24**

11. Explain the formation of a mirage.
12. How do you determine the resolving power of your eye?
13. State and explain Coulomb's inverse square law in electricity.
14. Derive an expression for the electric potential due to a point charge.
15. State and explain Ampere's law.
16. Describe the ways in which Eddy currents are used to advantage.
17. Explain the different types of spectral series.
18. Define NAND and NOR gates. Give their truth tables.

SECTION-C

III. Answer any two of the following Questions. **2 × 8 = 16**

19. Explain the formation of stationary waves in stretched string and hence deduce the laws of transverse waves in stretched string.
20. State the working principle of potentiometer. Explain with the help of circuit diagram how the emf of two primary cells are compared by using the potentiometer.

    Find the resistivity of a conductor which carries a current of density of 2.5×10^{6} A when an electric field of 15 Vm^{-1} is applied across it.
21. Explain the principle and working of a nuclear reactor with the help of a labelled diagram.

IPE AP MARCH-2023

SOLUTIONS

SECTION-A

1. What is the principle of a moving coil galvanometer ?

A: 1) Principle of Moving Coil Galvanometer: When a current carrying coil is placed in a uniform magnetic field, it experiences a torque.

2) Here, Current in the coil (i) $\propto$ deflecting angle (θ)

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2. Two lenses of power –1.75 D and +2.25 D respectively are placed in contact. Calculate the focal length of the combination.

Sol: $P_1 = -1.75$ D, $P_2 = +2.25$ D, P = ? , f = ?

Formula for combined power: $P = P_1 + P_2 \Rightarrow P = -1.75 + 2.25 \Rightarrow P = +0.50$ D

Formula for focal length : $f = 1/P \Rightarrow f = 1/0.50 = 2$ m = **200 cm**

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3. Define magnetic declination.

A : Magnetic Declination : At a given place, the angle between the 'geographical meridian' and the 'magnetic meridian' is called Magnetic declination.

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4. Magnetic lines form continuous closed loops. Why ?

A : The magnetic field lines of a magnet or a solenoid form continuous closed loops, because the **magnetic poles N and S always exist together in pairs**.

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5. What is transformer ratio ?

A : 1) Transformer Ratio : Ratio between number of turns in the secondary coil and the number of turns in the primary coil of a transformer is called transformer ratio.

2) Transformer ratio $= \frac{N_s}{N_p} = \frac{V_s}{V_p}$

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6. Give two uses of infrared rays.

A : Infrared rays are used in

1) remote control systems of TV etc.
2) the treatment of skin diseases.
3) taking photographs where there is no visible light.

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7. What are Cathode rays?

A : 1) Cathode Rays: The rays emitted from cathode of a discharge tube, when the gas in it is subjected to low pressure (0.001 mm of Hg) and strong electric field, are called cathode rays.

2) The cathode rays are streams of electrons.

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8. State Heisenberg's Uncertainty Principle.

A : 1) Heisenberg's Uncertainty Principle: It is not possible to measure both the position and momentum of an electron (or any other particle) at the same time exactly.

2) If the uncertainty in position is Δx and uncertainty in momentum is Δp, the product of Δx and Δp is of the order of $\hbar$. Thus $\Delta x\, \Delta p = \hbar$ (where $\hbar = h/2\pi$)

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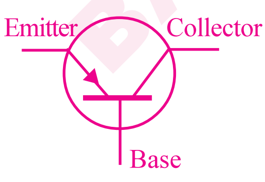
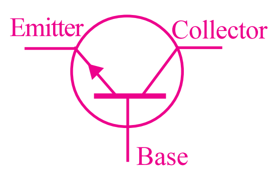
9. Draw the circuit symbols for *p-n-p* and *n-p-n* transistors.

A :



p-n-p transistor



n-p-n transistor

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10. Mention the basic methods of modulation.

A : Basic Methods of Modulation:

1) Amplitude Modulation (AM)
2) Frequency Modulation (FM)
3) Phase Modulation (PM).

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SECTION-B

11. Explain the formation of a mirage.

A : 1) **Mirage:** Mirage is an optical phenomenon in which light rays are bent to produce a displaced image of distant objects

2) Mirages are formed due to total internal reflection of light.

3) On hot summer days the density of air is less near the ground due to heat.

4) Hotter air is less dense and smaller refractive index than cooler air

5) When the air is stationary, the optical density at different layers of air increases with height.

6) Hence the light rays coming from a tall body such as tree, bends away from normal and under goes total internal reflection.

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12. How do you determine the resolving power of your eye ?

A: 1) Resolving Power of Eye: It is the ability to see the fine details in the viewed objects .

2) We can estimate the resolving power of our eye with a simple experiment.

3) Let us take a pattern of black stripes of equal width (each 5 mm) separated by white stripes of increasing width (0.5mm, 1mm,1.5 mm....)

from left to right as shown in the figure and paste it on a wall of the room.

4) Now, let us watch the pattern with one eye. By moving our eye away or closer to the wall, we have to find the white stripe where we can just see some two black stripes as separate stripes. All the black stripes to the left of white stripe would merge into one another and would not be distinguishable.

5) On the other hand, the black stripes on the right of the white stripe would be more and more clearly visible. If d is the width of the white stripe which separates the two regions and D is the distance between the eye and the wall, the resolving power of the eye is given by d/D.

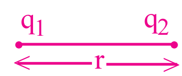
BABY BULLET-Q

13. State and explain Coulomb's law in electricity.

A: 1) Coulomb's Law: The force of attraction or repulsion between two electric charges is directly proportional to product of their charges and is inversely proportional to the square of distance between them and acts along the line joining the charges.

2) Explanation: If F is the force between two charges q_1, q_2 separated by a distance r then

i) $F \propto q_1 q_2$ ....(1) ii) $F \propto \frac{1}{r^2}$ ....(2)



From (1) & (2) $F \propto \frac{q_1 q_2}{r^2} \Rightarrow F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$

where ε_0 is the permittivity of free space and $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \ Nm^2C^{-2}$

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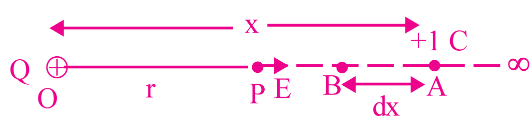
14. Derive an expression for the electric potential due to a point charge. [TS 16][AP 19]

A : Potential due to a Point Charge:

Let us suppose that a point charge Q which is positive is at the origin. P is a point at position vector $\vec{r}$. The work done in bringing a unit positive charge from infinity to the point P is the electric potential at the point P.



The electrostatic force on unit positive charge (+1 C) when it is at an intermediate point A is

$$F = \frac{Q \times 1}{4\pi\varepsilon_0 x^2} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{x^2}$$

If dW is the work done in moving the unit positive charge against the force through a distance dx,

then $dW = -F\,dx \Rightarrow dW = -\frac{1}{4\pi\varepsilon_0}\frac{Q}{x^2}dx$

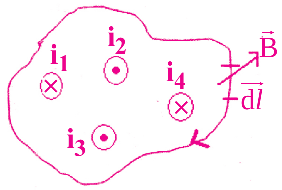
Total work done(W) is obtained by integrating this between the limits from ∞ to r.

$$W = -\int_{\infty}^{r}\frac{1}{4\pi\varepsilon_0}\frac{Q}{x^2}dx \quad \text{or} \quad W = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$$

This is the work done in bringing a unit positive charge from infinity to the point P.
This gives potential at the point.
∴ Electric potential at a distance r from a point charge Q is $V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$

BABY BULLET-Q

15. State and explain Ampere's law.



A: 1) Ampere's Law: The line integral of the intensity of magnetic induction field ($\oint \vec{B}.d\vec{l}$) around a closed curve is equal to μ_0 times the net current (i) bounded by the curve.

2) Thus, $\oint \vec{B}.d\vec{l} = \mu_0 i$

where $\vec{dl}$ = small element of the path, μ_0 = permeability of free space.

3) Explanation:

i) Consider a closed curve as shown in the figure. d*l* is a small length element on the curve.

ii) Let B is the resultant magnetic field of the position of d*l*.

iii) Currents i_1, i_4 are directed into the plane of paper and are positive.

iv) Currents i_2, i_3 are directed outward to the plane of paper and are negative.

v) So, the total current crossing the area bounded by the closed curve is $i = i_1 - i_2 - i_3 + i_4$

Hence, $\oint \vec{B}.d\vec{l} = \mu_0 (i_1 - i_2 - i_3 + i_4)$ $\quad \therefore \oint \vec{B}.d\vec{l} = \mu_0 i$

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16. Describe the ways in which Eddy currents are used to advantage.

A : 1) Eddy Currents : When large pieces of conductors are subjected to changing magnetic fluxes, induced currents are produced in them. Such induced currents are called eddy currents

2) Advantages of Eddy Currents :

i) Magnetic Brakes to Trains: When the strong electromagnets are activated, the eddy currents induced in the rails oppose the motion of the train. As a result, **smooth braking effect** comes into play.

ii) Electromagnetic Damping: In galvanometers, electromagnetic damping brings the coil to rest quickly. This happens due to eddy currents produced in the core.

iii) Induction Furnace : A high frequency alternating current is passed through a coil which surrounds the metals to be melted. Then the eddy currents generated in the metals produce high temperatures.

iv) Electric power meters: The shiny **metal disc** in the 'electric power meter' **rotates** due to eddy currents.

BABY BULLET-Q

17. Explain the different types of spectral series of hydrogen atom

A : Hydrogen atom consists of five spectral series. They are

1) Lyman series 2) Balmer series 3) Paschen series 4) Brackett series 5) Pfund series.

1) **Lyman series:** When an electron jumps from any outer orbits to the first orbit, we get Lyman series. It is observed in the **UV** region. Here n_1=1 and n_2=2,3,4,5....

$$\therefore \nu = R\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right] = R\left[\frac{1}{1^2}-\frac{1}{n_2^2}\right]$$

2) **Balmer Series:** When an electron jumps from any outer orbits to the second orbit, we get Balmer series. It is observed in the **Visible** region. Here n_1=2 and n_2=3,4,5....

$$\therefore \nu = R\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right] = R\left[\frac{1}{2^2}-\frac{1}{n_2^2}\right]$$

3) **Paschen Series :** When an electron jumps from any outer orbits to the third orbit, we get Paschen series. It is observed in the **near infrared** region. Here n_1=3 and n_2=4,5,6,........

$$\therefore \nu = R\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right] = R\left[\frac{1}{3^2}-\frac{1}{n_2^2}\right]$$

4) **Brackett Series :** When an electron jumps from any outer orbits to the fourth orbit, we get Brackett series. It is observed in the **infrared** region. Here n_1=4 and n_2=5,6,7,..........

$$\therefore \nu = R\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right] = R\left[\frac{1}{4^2}-\frac{1}{n_2^2}\right]$$

5) **Pfund Series :** When an electron jumps from any outer orbits to the fifth orbit, we get Pfund series. It is observed in the **far infrared** region. Here n_1=5 and n_2=6,7,8,..........

$$\therefore \nu = R\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right] = R\left[\frac{1}{5^2}-\frac{1}{n_2^2}\right]$$

BABY BULLET-Q

18. Define NAND and NOR gates. Give their truth tables.

A : 1) NAND gate: NAND gate is the AND gate followed by NOT gate.

2) The output of AND gate is connected to the input of NOT gate.

3) In NAND gate, the output becomes 0 only when both the inputs are 1.

4) The symbol of NAND gate: A B  $Y = \overline{A.B}$

NAND gate-Truth Table

Input		Output
A	B	$Y = \overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

1) NOR gate: NOR gate is the OR gate followed by NOT gate.

2) The output of OR-gate is connected to the input of NOT gate.

3) In NOR gate, the output becomes 1 only when both the inputs are 0.

4) The symbol of NOR gate: A B  $Y=\overline{A+B}$

NOR gate-Truth Table

Input		Output
A	B	$Y=\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

BABY BULLET-Q

SECTION-C

19. Explain the formation of stationary waves in stretched strings and hence deduce the laws of transverse waves in stretched strings.

A: 1) **Stretched String:** When a stretched string is plucked and released at the middle, transverse waves are generated. They reflect back at its ends.

2) **Formation of Stationary Waves :** When two reflected waves travelling in opposite directions along the string super impose each other to produce stationary waves.

3) Nodes(N) are formed at the ends.

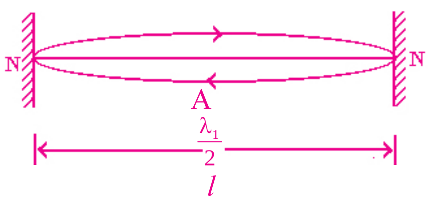
4) **Notation:** l= length of the string, T= Tension in the string, μ = Linear density of the string and V= Velocity of the transverse wave.

$\lambda_1, \lambda_2, \lambda_3$ are the wave lengths of waves in respective harmonics.

Modes of vibration in a stretched string:

5) **First harmonic :** Here, the string vibrates in a single loop

From the fig., $l = \frac{\lambda_1}{2} \Rightarrow \lambda_1 = 2l$. Here , $n_1 = \frac{V}{\lambda_1} = \frac{V}{2l}$



We know, velocity of transverse wave is $V = \sqrt{\frac{T}{\mu}}$

From the above two equations, we get $n_1 = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$

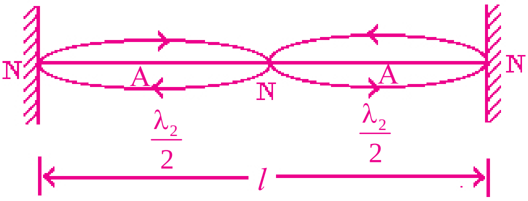
This frequency is called First harmonic (or Fundamental frequency).

6) **Second harmonic:** Here, the string vibrates in two loops:

From the fig., $l = \frac{\lambda_2}{2} + \frac{\lambda_2}{2} = \lambda_2 \Rightarrow \lambda_2 = l$

Here $n_2 = \frac{V}{\lambda_2} = \frac{V}{l}$. But $V = \sqrt{\frac{T}{\mu}}$

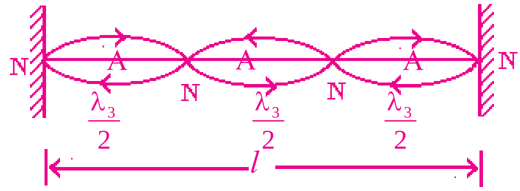
$\therefore \quad n_2 = \frac{1}{l}\sqrt{\frac{T}{\mu}} = 2 \times \frac{1}{2l}\sqrt{\frac{T}{\mu}} = 2n_1$



This frequency is called second harmonic (or first overtone).

7) Third harmonic: Here, the string vibrates in three loops:

From the fig, $l = \frac{\lambda_3}{2} + \frac{\lambda_3}{2} + \frac{\lambda_3}{2} = \frac{3\lambda_3}{2} \Rightarrow \lambda_3 = \frac{2l}{3}$



Here $V = n_3\lambda_3 \quad \Rightarrow n_3 = \frac{V}{\lambda_3} = \frac{V}{\left(\frac{2l}{3}\right)} = \frac{3V}{2l}$

$\therefore n_3 = \frac{3}{2l}\sqrt{\frac{T}{\mu}} = 3n_1 \qquad \left[\because V = \sqrt{\frac{T}{\mu}}\right]$

This frequency is called Third harmonic (or Second overtone).

8) Deduction of Laws of transverse waves:

The fundamental frequency is given by $n_1 = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$

i) First law: The fundamental frequency(first harmonic) of a vibrating string is inversely proportional to its length (l) when tension(T) and linear density(μ) are kept constants.

Thus, $n \propto \frac{1}{l}$ ($\because T, \mu$ are constants)

ii) Second law: The fundamental frequency of a vibrating string is directly proportional to square root of its tension (T) when length(l) and linear density(μ) are kept constants.

Thus, $n \propto \sqrt{T}$ ($\because l, \mu$ are constants)

iii) Third law: The fundamental frequency of vibrating string is inversely proportional to square root of its linear density (μ) when length(l) and tension (T) are kept constants.

Thus, $n \propto \frac{1}{\sqrt{\mu}}$ ($\because l$, T are constants)

BABY BULLET-Q

20. State the working principle of potentiometer. Explain with the help of circuit diagram how the emf of two primary cells are compared by using the potentiometer.

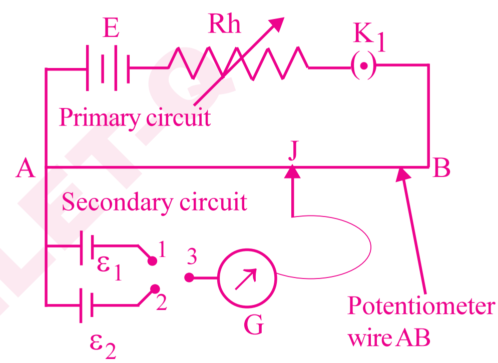
A : 1) Potentiometer : Potentiometer is a device used to measure emf of a cell.

2) Construction: Potentiometer consists of a wooden board on which a uniform manganin wire of length 4 m is fixed in parallel rows between two binding screws A and C, by the side of a metre scale. A jockey is provided to make a contact at any point of the wire.

3) Principle: The potential difference (E) between any 2 points of the wire is directly proportional to the length l of the wire between the two points. $\varepsilon \propto l \Rightarrow \varepsilon = \phi l$

Here, ϕ is potential drop per unit length of the wire.

4) Comparison of emfs of two cells:



Let ε_1 & ε_2 be the emf's of two cells under comparison.

The primary circuit consists of a cell of emf E, a rheostat Rh, a plug key K_1 .

The secondary circuit consists of a two way key, two cells of emf ε_1 & ε_2 and a galvanometer G as shown in the diagram.

In the first position of the key, 1,3 points are connected. Then cell ε_1 gets connected to Galvanometer (G).Now, the balancing length l_1 of the wire is found by adjusting the position of its jockey for 'null deflection' of the galvanometer G..

Then emf of the first cell $\varepsilon_1 = \phi l_1$ ......(1)

In the second position of the key, 2,3 points are connected. Now the cell ε_2 gets connected to Galvanometer (G). Now its balancing length l_2 is noted.

Then emf of the second cell $\varepsilon_2 = \phi\, l_2$ ...(2)

Dividing equation (1) by equation (2), we get, $\dfrac{\varepsilon_1}{\varepsilon_2} = \dfrac{l_1}{l_2}$

By using this equation the emfs of the given cells can be compared.

b) Find the resistivity of a conductor which carries a current of density of 2.5 x 10 ^{6} A when an electric field of 15 Vm^{-1} is applied across it.

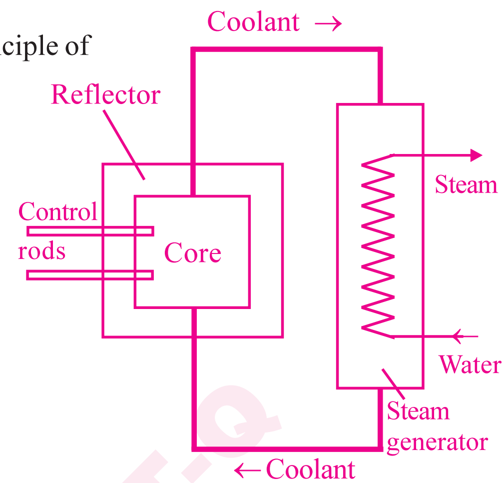
Sol: $j = 2.5 \times 10^6\ A/m^2$, $E = 15\ V/m$, $\rho = ?$

Resistivity $\rho = \dfrac{E}{j} \Rightarrow \rho = \dfrac{15}{2.5\text{x}10^6} = \mathbf{6 \text{ x } 10^{-6}\ \Omega m}$

BABY BULLET-Q

21. Explain the principle and working of a nuclear reactor with the help of a labelled diagram.

A: **1) Principle:** Nuclear reactor works on the principle of **controlled chain reaction.**



Nuclear Reactor

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Be Clear with Nuclear

2) Main parts of Nuclear reactor:

(i) Fuel

(ii) Moderator

(iii) Control rods

(iv) Protective Sheilding

(v) Coolant

3) Fuel: The material which undergoes fission is called fuel. **Ex:** U^{235} .

4) Moderator: The material which slows down the fast moving neutrons is called moderator. **Ex:** D_2O, Graphite

5) Control rods: The rods which absorb neutrons to control the chain reaction are called control rods.

Ex: Cd, B

6) Protective Shielding: The construction with cement and lead(Pb) around the reactor which protects from harmful radiations is called protective shielding.

7) Coolant: The liquid which removes the heat generated by the reactor is called circulating coolant. **Ex:** Water at high pressure, molten sodium.

8) Working:

i) Uranium fuel rods are arranged in the A*l* cylinders.

ii) The graphite moderator is placed in between the fuel cylinders.

iii) When U^{235} undergo fission, fast neutrons are released.

iv) These neutrons pass through the surrounding graphite moderator and loose their energy.

v) The heat generated here is used to produce steam.

vi) This steam is used to rotate steam turbine then electric power is produced.

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