B.K. Birla Centre For Education

Date: 15-12-2025 — PRE BOARD EXAMINATION-II — **Duration**: 3 Hrs

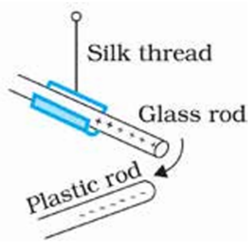
Class: XII — Physics — **Total Marks** : 70

Instructions to the Students

- Write only question numbers clearly outside the margin (1, 2, 3.i, 5.b, 4.c.ii, etc.).
- Do not write questions or any titles. (For ex. - Do not write **II. Answer the following**).
- After every answer, give a one-line space.
- For Multiple choice Questions - Both Option and Answer should be written.
- Bullet points & Sub-points should be written inside the margin.
- Do not fold / staple the paper.

Section A

1. In Figure, a positively charged glass rod is brought near a negatively charged plastic rod. What does the resulting interaction imply about the forces between them? [1]



a) The rods repel, indicating that forces between opposite charges are repulsive.
b) The rods attract, indicating that forces between opposite charges are attractive.
c) The rods do not interact, showing the forces are balanced.
d) The rods rotate, suggesting the presence of a torque but no net force.

Answer

b) The rods attract, indicating that forces between opposite charges are attractive. (1)

2. If R_s and R_p are the equivalent resistances of n resistors, each of value R, in series and parallel combinations respectively, then the value of $(R_s - R_p)$ is : [1]

a) $\left(\frac{n^2-1}{n^2}\right)R$ b) $\left(\frac{n^2+1}{n^2-1}\right)R$ c) $\left(\frac{n^2-1}{n}\right)R$ d) $\frac{(n^2+1)R}{n^2}$

Answer

c) $\left(\frac{n^2-1}{n}\right)R$ (1)

3. A bulb is rated (100 W, 110 V). It is operated by current of 1.0 A supplied by a step down transformer. If the input voltage and efficiency of the transformer are 220 V and 0.9 respectively, the input current drawn from the mains is : [1]

a) $\frac{1}{2}$A b) $\frac{3}{8}$A c) $\frac{5}{9}$A d) $\frac{4}{7}$A

Answer

c) $\frac{5}{9}$A (1)

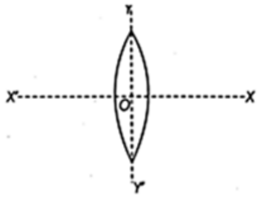
4. Which of the following statement is true for the radio waves and the gamma rays? [1]

a) The energy of gamma rays is lesser than that of the radio waves.
b) The frequency of the radio waves is higher than that of gamma rays.
c) The radio waves and the gamma rays have the same energy.
d) The energy of radio waves is lesser than that of the gamma rays.

Answer

d) The energy of radio waves is lesser than that of the gamma rays. (1)

5. An equiconvex lens of focal length 15 cm is cut into two halves vertically as shown in figure. Find the focal length of each part? [1]

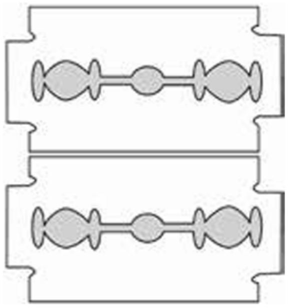


a) -30cm b) -20cm c) 30cm d) -15cm

Answer

c) 30cm (1)

6. Figure shows a method to observe single-slit diffraction using two razor blades. To see a clear pattern, the slit formed by the blades should be held: [1]



a) Perpendicular to the filament of a bulb.
b) Very far away from the eye.
c) Parallel to the filament of a bulb.
d) Very wide (several centimeters).

Answer

c) Parallel to the filament of a bulb. (1)

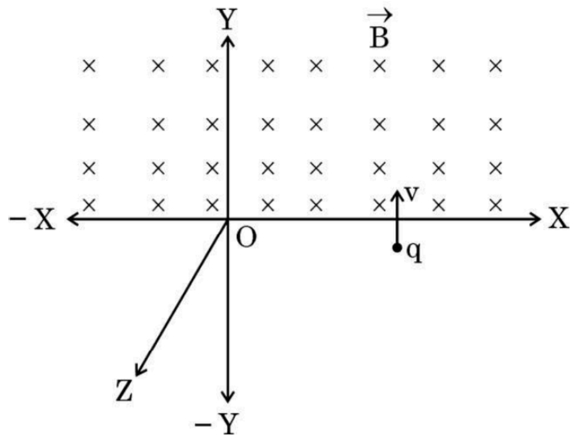
7. The energy of an electron in a hydrogen atom in ground state is -13.6 eV. Its energy in an orbit corresponding to quantum number n is -0.544 eV. The value of n is [1]

a) 2 b) 4 c) 3 d) 5

Answer

d) 5 (1)

8. A particle having charge +q enters a uniform magnetic field $\vec{B}$ as shown in the figure. The particle will describe : [1]



a) a circular path in XZ plane
b) a semicircular path in XY plane
c) a helical path with its axis parallel to Y-axis
d) a semicircular path in YZ plane

Answer ⚩

b) a semicircular path in XY plane (1)

9. A small conducting ring is dropped from rest into a region where there is a uniform magnetic field directed vertically upward. As the ring falls, the magnetic flux through it decreases. The induced current in the ring will be [1]

a) clockwise as seen from above
b) anticlockwise as seen from above
c) zero
d) alternating between clockwise and anticlockwise

Answer ⚩

b) anticlockwise as seen from above (1)

10. A voltage $v = v_o \sin \omega t$ applied to a circuit drives a current $i = i_o \sin(\omega t + \phi)$ in the circuit. The average power consumed in the circuit over a cycle is [1]

a) Zero b) $i_0 \ \nu_0 cos\phi$ c) $\frac{i_0\nu_0}{2}$ d) $\frac{i_0 v_0}{2} cos\phi$

Answer ⚩

d) $\frac{i_0 v_0}{2} cos\phi$ (1)

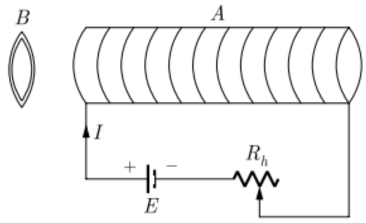
11. Two nuclei have mass numbers in the ratio 1: 2. What is the ratio of their nuclear densities? [1]

a) 1:2 b) 2:1 c) 1:1 d) 4:1

Answer ⚩

c) 1:1 (1)

12. An aluminium ring B faces an electromagnet A. Which of the following statement is correct? [1]



a) If I increases, A will repel B
b) If I decreases, A will repel B
c) If I increases, A will attract B
d) Whether I increases or decreases B will not experience any force

Answer ⚩

a) If I increases, A will repel B (1)

13. Assertion (A): In Bohr model of hydrogen atom, the angular momentum of an electron in nth orbit is proportional to the square root of its orbit radius r [1]

Reason (R) : According to Bohr model, electron can jump to its nearest orbits only.
a) Both (A) and (R) are true and (R) is the correct explanation of (A)
b) Both (A) and (R) are true but (R) is not the correct explanation of (A)
c) (A) is correct but (R) is wrong
d) (A) is wrong but (R) is correct

Answer ⚩

c) (A) is correct but (R) is wrong (1)

14. **Assertion (A):** Although the surfaces of a goggle lens are curved, it does not have any power. [1]
Reason (R): In case of goggles, both the curved surfaces are curved on the same side and have equal radii of curvature.
a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
c) Assertion is true but Reason is false.
d) Both Assertion and Reason are false.

Answer ⚩

a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion. (1)

15. **Assertion(A) :** Thin films such a soap bubble or a thin layer of oil on water show beautiful colours when illuminated by white light. [1]
Reason(R) : It happens due to the interference of light reflected from the upper surface of the thin film
a) Both (A) and (R) are true and (R) is the correct explanation of (A)
b) Both (A) and (R) are true but (R) is not the correct explanation of (A)
c) (A) is correct but (R) is wrong
d) (A) is wrong but (R) is correct

Answer ⚩

c) (A) is correct but (R) is wrong (1)

16. **Assertion (A):** Electric field at a point on the equatorial line of an electric dipole is directed opposite to the dipole moment. [1]
Reason (R): The potential at any point on the equatorial line of a dipole is zero.
a) Both (A) and (R) are true and (R) is the correct explanation of (A)
b) Both (A) and (R) are true but (R) is not the correct explanation of (A)
c) (A) is correct but (R) is wrong
d) (A) is wrong but (R) is correct

Answer ⚩

a) Both (A) and (R) are true and (R) is the correct explanation of (A) (1)

Section B

17. In a plane electromagnetic wave, the electric field oscillates sinusoidally at a frequency of 2.0×10^{10} Hz and amplitude 48 V m^{-1}. [2]

(a) What is the wavelength of the wave?

(b) What is the amplitude of the oscillating magnetic field?

Answer

1) $\lambda = \frac{c}{v}$ (0.5)

2) $= \frac{3 \times 10^8}{2 \times 10^{10}}$ =0.015m (0.5)

3) $B_0 = \frac{E_0}{c}$ (0.5)

4) $= \frac{48}{3 \times 10^8}$ =1.6x10-7T (0.5)

18. A battery that contains emf E and internal resistance r when connected across an external resistance of 12 ohm, produces a current of 0.5 A. When connected [2]
across a resistance of 25 ohm, it produces a current of 0.25 A. Find

(i) internal resistance and

(ii) emf of the cell.

Answer

1) $E = I_1(R_1 + r) = 0.5(12 + r) = 6 + 0.5r = I_2(R_2 + r) = 0.25(25 + r) = 6.25 + 0.25r$ (0.5)

2) $0.25r = 0.25 = 1\Omega$ (0.5)

3) $E = 0.5(12 + 1) = 0.5 \times 13$ (0.5)

4) $E = 6.5V$ (0.5)

19. A charge q is placed inside a sphere of radius r filled with a medium of dielectric constant K_1 , and another charge 2q is placed inside a cube of side 2r in a medium of dielectric constant K_2 . Find the ratio of electric flux linked with the sphere and the cube. [2]

Answer

1) (Using gauss law) $\phi_1 = \frac{q}{\varepsilon_0 K_1}$ (0.5)

2) (Using gauss law) $\phi_2 = \frac{2q}{\varepsilon_0 K_2}$ (0.5)

3) $\frac{\phi_1}{\phi_2} = \frac{\frac{q}{\varepsilon_0 K_1}}{\frac{2q}{\varepsilon_0 K_2}}$ (0.5)

4) $\frac{\phi_1}{\phi_2} = \frac{K_2}{2K_1}$ (0.5)

20.I. Depict the field-line pattern due to a current-carrying solenoid of finite length. [2]

i. In what way do these lines differ from those due to an electric dipole?

ii. Why can't two magnetic field lines intersect each other?

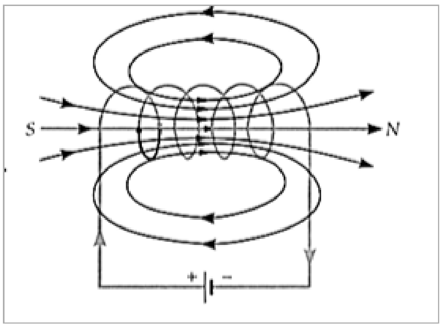


diagram (1)

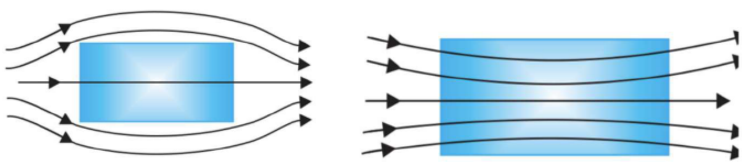
Answer

i. The magnetic lines of force of a solenoid form closed loops while the electric lines of force of an electric dipole start from the positive charge and end at the negative charge. (0.5)

ii. Such curves are called magnetic lines of force. No two such lines of force can intersect. If they do so, then there will be two tangents and hence two directions of the magnetic field at the point of intersection which is impossible (0.5)

(OR)

20.II. A uniform magnetic field gets modified as shown in figure when two specimens A and B are placed in it. [2]



(a) (b)

(i)Identify the specimen A and B.

(ii) How is the magnetic susceptibility of specimen A different from that of specimen B?

Answer

(i) A is diamagnetic and (0.5)

B is ferromagnetic(paramagnetic). (0.5)

(ii) Diamagnetic materials have permeabilities less than 1 (one) and have negative susceptibility. Their atoms and molecules do not have permanent dipole moment. The field lines get expelled in them. (0.5)

Ferromagnetic materials have permeability more than one and susceptibility positive.Their atoms and molecules have permanent dipole moment. So the field lines get concentrated in them. (0.5)

21.I. State Bohr's quantization condition for defining stationary orbits. How does the de Broglie hypothesis explain the stationary orbits? [2]

Answer ⚿

all possible circular orbits allowed by the classical theory, the electrons are permitted to circulate only in those orbits in which the angular momentum of an electron is an integral multiple of h/2π, where h is Plank's constant. (0.5)

Therefore, for any permitted orbit, L=mvr=nh/2π ; n=1,2,3,........ Where L, m, and v are the angular momentum, mass and the speed of the electron respectively. r is the radius of the permitted orbit and n is positive integer called principal quantum number. The above equation is Bohr's famous quantum condition. (0.5)

When an electron of mass m is confined to move on a line of length l with velocity v, the de-Broglie wavelength λ associated with electron is: λ=h/mv=h/P (1)

Where P is Linear momentum

P=hλ=nh/2l

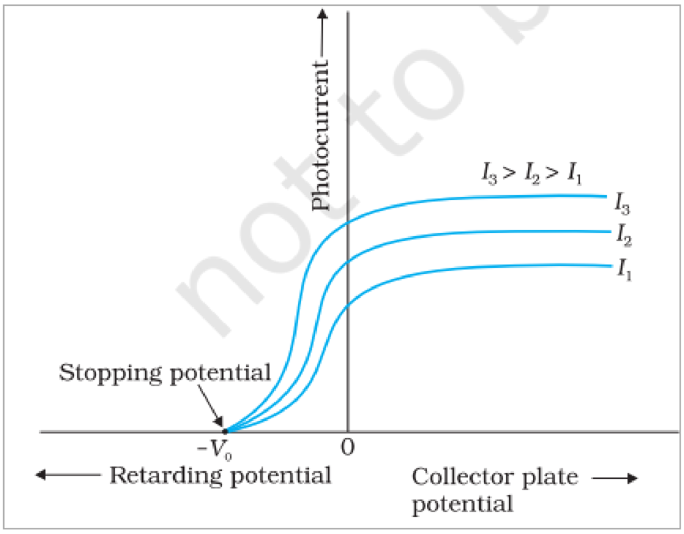
When electron revolves in a circular orbit of radius r then 2l=2πr
Therefore, P=nh/2πr

(OR)

21.II. Draw a graph showing the variation of photoelectric current (I) with collector plate potential (V) for light of a fixed frequency but different intensities I_1 and I_2 ($I_2 > I_1$). Explain how this graph is used to define the saturation current and the stopping potential. [2]

Answer ⚿

he graph of photoelectric current versus collector potential shows that the current increases with potential and becomes constant at high positive potential — this constant value is the saturation current. When the potential is made negative and the current just becomes zero, that potential is called the stopping potential. (1)



X-axis → Collector potential Y-axis → Photoelectric current graph (1)

Section C

22. With the help of circuit diagram, explain the working p-n junction diode as a full wave rectifier. Draw its input and output waveforms. [3]

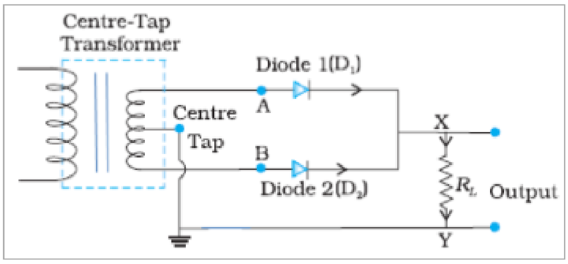


Diagram (1)

Answer

When input voltage to A, with respect to the centre tap at any instant is positive, at that instant voltage at B, being out of phase will be negative, diode D_1 gets forward biased and conducts while D_2 being reverse biased does not conduct. Hence during this half cycle an output current and output voltage across R_L is obtained. (0.5)

During second half of the cycle when voltage at A becomes negative with respect to centre tap, the voltage at B would be positive. Hence D_1 would not conduct but D_2 would be giving an output current and output voltage. Thus output voltage is obtained during both halves of the cycle. (0.5)

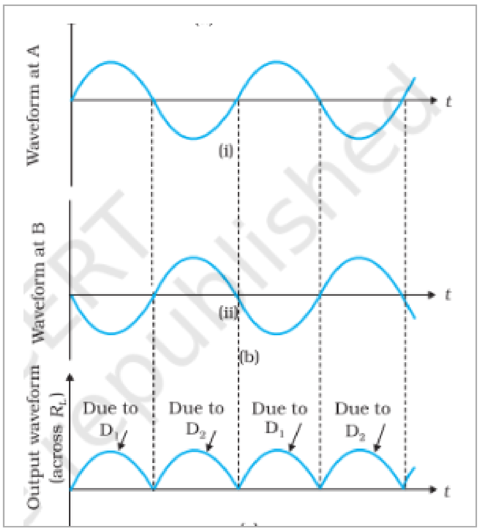


Diagram (1)

23. (i) Write the condition for balance in a Wheatstone bridge. [3]
(ii) In a balanced Wheatstone bridge, if one of the resistances is increased, what happens to the galvanometer deflection?
(iii)Explain how Kichoff's voltage law is consistent with the law of conservation of energy.

Answer ⚩

1) (i)For a balanced Wheatstone bridge, $\frac{P}{Q} = \frac{R}{S}$ (1)

where P,Q,R,S are the four arms of the bridge.

When this condition is satisfied, the potential difference between the points connected to the galvanometer becomes zero, and no current flows through the galvanometer.

2) (ii)If one of the resistances is increased, the balance condition is disturbed. A potential difference now exists between the galvanometer points, causing current to flow through the galvanometer. Hence, the galvanometer shows a deflection indicating that the bridge is no longer balanced. (1)

3) (iii)Kirchhoff's Voltage Law (KVL) states that the algebraic sum of all potential differences around a closed loop is zero:$\sum V=0$ This means the total energy supplied by the sources (like cells) is exactly equal to the total energy used in overcoming resistances or other potential drops in the circuit. Thus, no energy is lost or gained, which verifies the law of conservation of energy. (1)

24. Find the Q value of the following nuclear reaction : [3]
$({}^{12}_{6}\mathrm{C} + {}^{12}_{6}\ \mathrm{C} \rightarrow {}^{20}_{10}\mathrm{Ne} + {}^{4}_{2}\ \mathrm{He})$
Is this reaction exothermic or endothermic ?
Given :

$$\left(\ \mathrm{m}\left({}^{12}_{6}\mathrm{C}\right) = 12 \cdot 000000\ \mathrm{u}\ \ \mathrm{m}\left({}^{20}_{10}\mathrm{Ne}\right) = 19 \cdot 992439\ \mathrm{u}\ \ \mathrm{m}\left({}^{4}_{2}\mathrm{He}\right) = 4 \cdot 002603\ \mathrm{u}\ \ 1\ \mathrm{u} = 931\ \mathrm{MeV} / \mathrm{c}^2 \ \right)$$

Answer ⚩

1) Mass defect Δ m = mass of the reactants – mass of the products (0.5)
2) $\Delta m = 2 \times 12 - 19.992439 - 4.002603$ (0.5)
3) $\Delta m = 0.004958u$ (0.5)
4) $Q = \Delta m \times 931$ (0.5)
5) $4.62MeV$ (0.5)
6) The reaction is exothermic. (0.5)

25. Draw a ray diagram to show the image formation of a distant object by a refracting telescope. Write the expression for its angular magnification in terms of the focal lengths of the lenses used. State the important considerations required to achieve large resolution and their consequent limitations. [3]

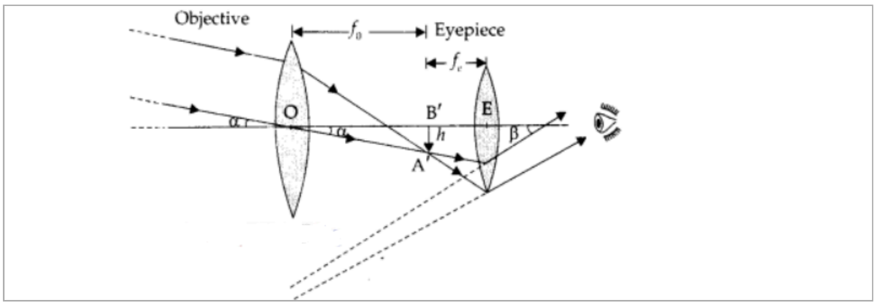


diagram (1)

Answer ⚿

ii) Angular Magnification, m = −f0/fe (1)

(iii) For achieving large resolution, the objective of large aperture is required. (iv) Consequent Limitations : It becomes very heavy and unmanageable, hence difficult to make and support by their edge and also suffers with chromatic aberrations. (1)

26. Using Huygens' principle, explain the refraction of a plane wavefront, propagating in air, at a plane interface between air and glass. Hence verify Snell's law. [3]

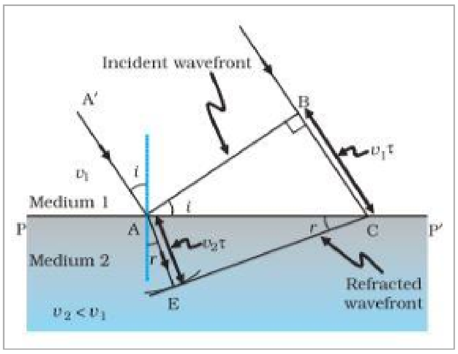


Diagram with labels (1)

Answer ⚿

$$\sin i = \frac{BC}{AC} = \frac{v_1 \tau}{AC}$$ (0.5)

$$\sin r = \frac{AE}{AC} = \frac{v_2 \tau}{AC}$$ (0.5)

$$\frac{\sin i}{\sin r} = \frac{v_1}{v_2} \Rightarrow \frac{\sin i}{\sin r} = \frac{c / n_1}{c / n_2}$$ (0.5)

$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} \textit{ or } n_1 \sin i = n_2 \sin r$$ (0.5)

27.I. (a) A circular coil of 30 turns and radius 8.0 cm carrying a current of 6.0 A is suspended vertically in a uniform horizontal magnetic field of magnitude 1.0 T. The field lines make an angle of 60° with the normal of the coil. Calculate the magnitude of the counter torque that must be applied to prevent the coil from turning. [3]

(b) Would your answer change, if the circular coil in (a) were replaced by a planar coil of some irregular shape that encloses the same area? (All other particulars are also unaltered.)

Answer ⚿

Radius of the coil, r = 8.0 c m = 0.08 m (1)

Area of the coil = $\pi r^2 = \pi (0.08)^2 = 0.0201 \text{ m}^2$

The coil experiences a torque in the magneitc field. Hence, it turns. the counter torque applied to prevent the coil form turning is given by the relation, (1)

$T = n I B A \sin\theta \; T$ ...(1)

$= 30 \times 6 \times 1 \times 0.0201 \times \sin 60^\circ = 3.133 \; N m$

b) It can be inferred from relation (i) that the magnitude of the applied torque is not dependent on the shape of the coil. It depends on the area of the coil. (0.5)

Hence, the answer would not change if the circular coil in the above case in replaced by a planar coil of some irrengular shape that enclose the same area. (0.5)

(OR)

27.II. A solenoid has a core of material with relative permeability 250. The windings of the solenoid are insulated from the core and carry a current of 0.5 A. If the number of turns is 2500 per metre, calculate [3]

(A) magnetic intensity,

(B) magnetic field &

(C) magnetisation

Answer ⚿

1) $H = nI = 2500 \times 0.5 = 1250 \text{ A/m}$ (0.5)

2) $\mu = \mu_0 \mu_r = 1.2566370614 \times 10^{-6} \times 150$ (0.5)

3) $B = \mu H = \left(1.2566370614 \times 10^{-6} \times 150\right) \times 1250$ (0.5)

4) $B = 1.2566370614 \times 10^{-6} \times 187500 \approx 0.23524 \text{ T}$ (0.5)

5) $\chi = \mu_r - 1 = 149$ (0.5)

6) $M = \chi H = 149 \times 1250 = 1.8625 \times 10^5 \text{ A/m}$ (0.5)

28. State Lenz's law. A rod MN of length L is rotated about an axis passing through its end M perpendicular to its length, with a constant angular velocity ω in a uniform magnetic field $\vec{B}$ parallel to the axis. Obtain an expression for emf induced between its ends. [3]

Answer

Lenz's law

The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it. (1)

Method 1

$d\mathcal{E} = Bvdr$ (0.5)

$\int_0^L Bvdr$ (0.5)

$\mathcal{E} = \int_0^L B\omega r\, dr$ (0.5)

$\mathcal{E} = \frac{1}{2} BL^2\omega$ (0.5)

Method 2

Area of the sector (QMN) = $\frac{1}{2} L^2\theta$ (0.5)

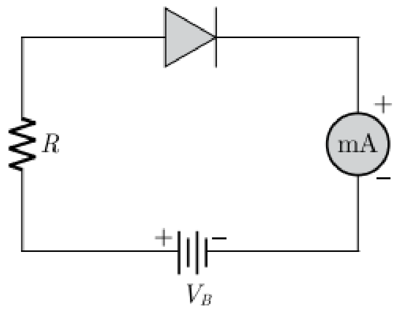
Induced emf is $\mathcal{E} = B \times \frac{d}{\mathrm{d}t}\left(\frac{1}{2} L^2\theta\right)$ (0.5)

$\mathcal{E} = \frac{1}{2} BL^2 \frac{d\theta}{\mathrm{d}t}$ (0.5)

$\mathcal{E} = \frac{1}{2} BL^2\, \omega$ (0.5)

Section D

29. A silicon p-n junction diode is connected to a resistor R and a battery of voltage V_B through milliammeter (mA) as shown in figure. The knee voltage for this junction diode is V_N = 0 7. V. The p-n junction diode requires a minimum current of 1 mA to attain a value higher than the knee point on the I-V characteristics of this junction diode. Assuming that the voltage V across the junction is independent of the current above the knee point. A p-n junction is the basic building block of many semiconductor devices like diodes. Important process occurring during the formation of a p-n junction are diffusion and drift. In an n-type semiconductor concentration of electrons is more as compared to holes. In a p-type semiconductor concentration of holes is more as compared to electrons.



29.I. If V_B = 5 V, the value of R in order to establish a current to 6 mA in the circuit is [1]

a) 833 Ω b) 717 Ω c) 950 Ω d) 733 Ω

Answer

a) 833 Ω (1)

29.II. If V_B = 5 V, the maximum value of R so that the voltage V is above the knee point voltage is [1]

a) 40 kΩ b) 4 3. kΩ c) 5 0. kΩ d) 5 7. kΩ

Answer ⚩

b) 4 3. kΩ (1)

29.III. If V_B = 6 V, the power dissipated in the resistor R, when a current of 6 mA flows in the circuit is [1]

a) 0.36 W b) 36 mW c) 3.6 mW d) 60 mW

Answer ⚩

b) 36 mW (1)

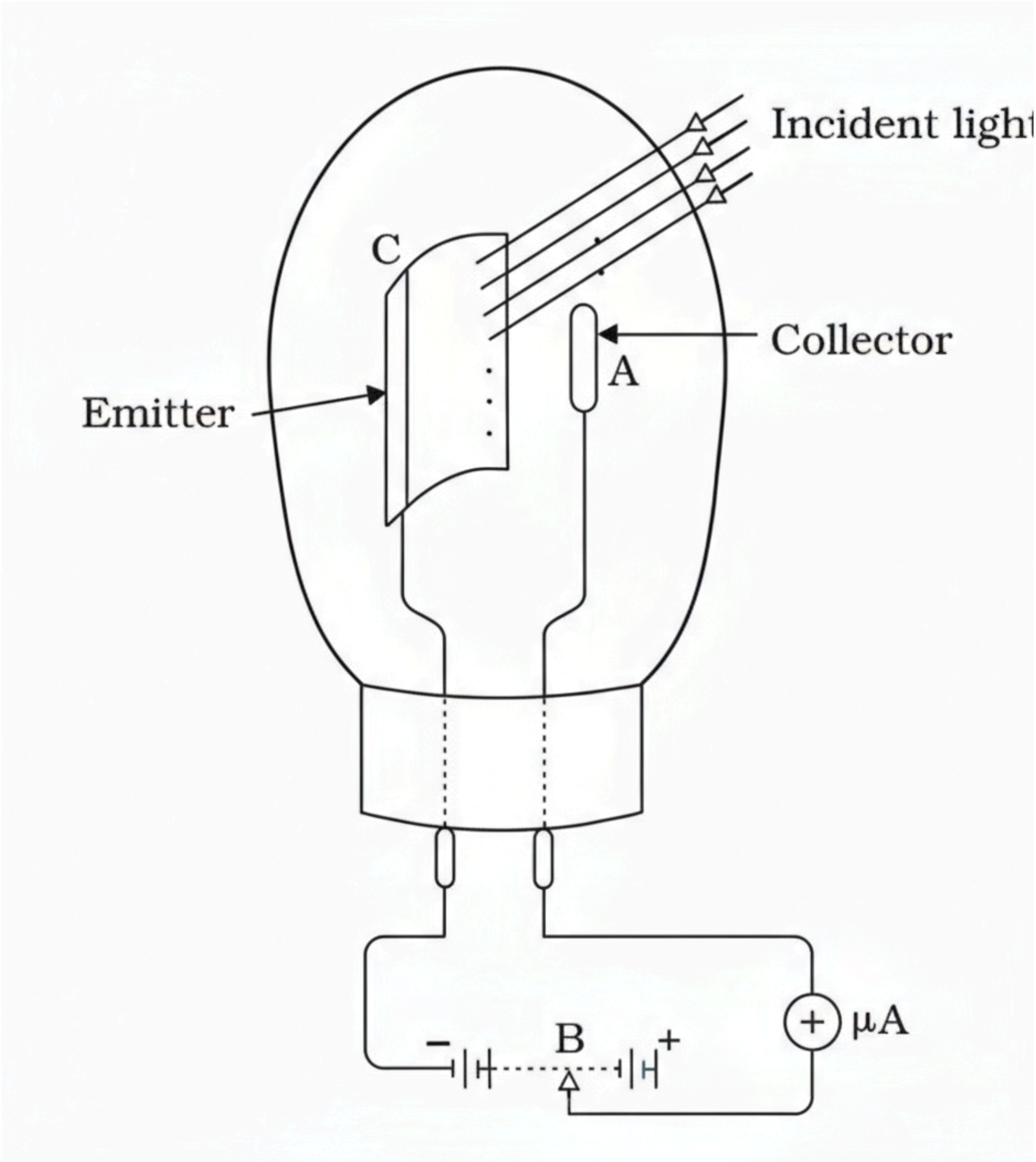
29.IV. When the diode is reverse biased with a voltage of 6 V and V_{bi} = 0 63 V . Calculate the total potential [1]

a) 9.27 V b) 6.63 V c) 5.27 V d) 0.63 V

Answer ⚩

b) 6.63 V (1)

30. The photoelectric effect is the phenomenon in which electrons are ejected from the surface of a metal when light of suitable frequency falls on it. In the given device, when light of appropriate wavelength strikes the emitter C, photoelectrons are emitted and collected by the collector A, producing a measurable photoelectric current. This current is sensitive to changes in the intensity of illumination, allowing the device to convert variations in light into electrical signals. Such a current can be used to operate control systems or in light-sensing instruments. The emitter is usually made of metals with low work functions, which facilitates the easy emission of electrons when exposed to light of suitable frequency.The devices are made up of metals with low ionization enthalpies, for example platinum whose work function is 2.28 eV



30.I. If a retarding potential is applied by moving the terminal B towards the left, how will it affect the microammeter reading? [1]

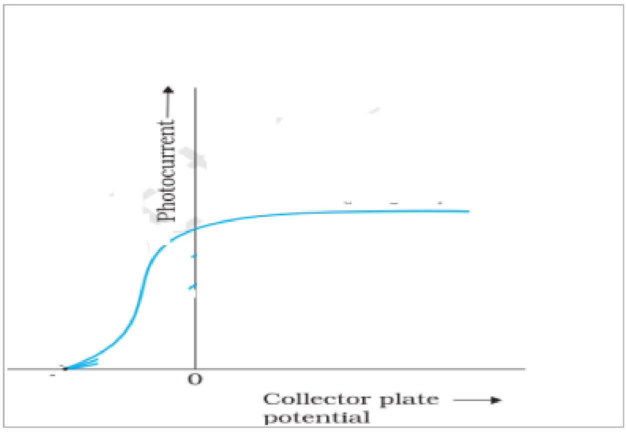
Answer ⚿

Moving B left applies a retarding voltage, reducing the current. (0.5)

Microammeter reading decreases; if voltage exceeds stopping potential, current becomes zero. (0.5)

30.II. Sketch or describe the variation of microammeter current with applied voltage when B is moved from left to right. [1]

Answer 🔑



GRAPH (1)

30.III. A photoelectric cell has a sodium emitter (work function ϕ=2.28 eV) and a collector connected to a microammeter. If violet light of wavelength 400 nm falls on the emitter, determine the maximum kinetic energy of the emitted electrons and the microammeter reading. [2]

Answer 🔑

1) $E = \dfrac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{4 \times 10^{-7}} = 4.9725 \times 10^{-19}$ J (0.5)

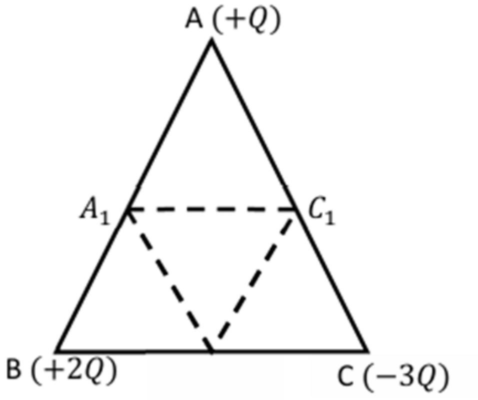
2) $E = \dfrac{4.9725 \times 10^{-19}}{1.6 \times 10^{-19}} = 3.11\text{eV}$ (0.5)

3) $K_{\max} = E - \phi = 3.11 - 2.28 = 0.83\text{eV}$ (0.5)

4) Since $E > \phi$, photoelectrons are emitted, so the microammeter shows non-zero current. (0.5)

Section E

31.I.A. Three-point charges, +Q,+2Q and −3Q are placed at the vertices of an equilateral triangle ABC of side l. If these charges are displaced to the mid-points A_1, B_1 and C_1 respectively, find the amount of the work done in shifting the charges to the new locations. [3]



Answer

1) $U_i = \frac{2kQ^2}{l} - \frac{3kQ^2}{l} - \frac{6kQ^2}{l}$ (0.5)

2) $U_i = -\frac{7kQ^2}{l}$ (0.5)

3) $U_f = \frac{4kQ^2}{l} - \frac{6kQ^2}{l} - \frac{12kQ^2}{l}$ (0.5)

4) $U_f = -\frac{14kQ^2}{l}$ (0.5)

5) $W = U_f - U_i$ (0.5)

6) $= -\frac{14kQ^2}{l} - \left(-\frac{7kQ^2}{l}\right) = -\frac{7kQ^2}{l}$ (0.5)

31.I.B. A parallel plate capacitor C with a dielectric in between the plates is charged to a potential V by connecting it to a battery. The capacitor is then isolated. If the dielectric is withdrawn from the capacitor, [2]

(a) Will the energy stored in the capacitor increase or decrease?

(b)Will the potential difference across the capacitor plates increase or decrease ? Give an explanation.

Answer

(1)

(i) The capacitance of capacitor increases to K times (since $C = (K\varepsilon_0 A)/d \propto K$)

(ii) The potential difference between the plates becomes 1/K times. (1)
Reason: V = Q/C;Q same, increases to K times ∴ V' = V/K As E = V/d = and V is decreased; therefore, electric field decreases to 1/K times.

(OR)

31.II.A. (i) How does the distance between equipotential surfaces vary with the strength of the electric field? Give reason [3]

(ii) What happens to stored energy in a capacitor when its plates are separated farther after disconnecting the battery.

(iii) If the charge on a body and the distance of a point from it are both doubled, what will be the effect on the electric potential at that point?

Answer

i)

As the electric field strength increases, the distance between equipotential surfaces decreases. Reason: Electric field is equal to the rate of change of potential with distance (E = –dV/dr), so stronger field means potentials change rapidly → surfaces are closer. (1)

(ii)

The stored energy in the capacitor increases. (0.5)

Reason: When the battery is disconnected, charge remains constant. Increasing plate separation increases capacitance denominator (C decreases), so energy $U = \frac{Q^2}{2C}$ increases (0.5)

iii)

The electric potential remains the same. (0.5)

Because potential V= r kq , and doubling both q → 2q and r → 2r gives: (0.5)

$$V' = \frac{k(2q)}{2r} = \frac{kq}{r} = V$$

So, no change in potential.

31.II.B. Two capacitors 16 micro farads develops a charge of 200 micro coulomb and if capacitor C is connected to the same battery, the charge developed is 100 micro couloumb Calculate the value of C . [2]

Answer

$$V = \frac{Q}{C} = \frac{200 \times 10^{-6}}{16 \times 10^{-6}} = 12.5V$$ (1)

$$C = \frac{Q}{V} = \frac{100 \times 10^{-6}}{12.5} = 8\, micro\, farads\ or\ 8 \times 10^{-6} F$$ (1)

32. (i) Draw a ray diagram showing refraction of a ray of light through a triangular glass prism. Hence, obtain the relation for the refractive index (u) in terms of angle of prism (A) and angle of minimum deviation (δ_m). [5]

(ii) The radii of curvature of the two surfaces of a concave lens are 20 cm each. Find the refractive index of the material of the lens if its power is -5.0 D.

i.

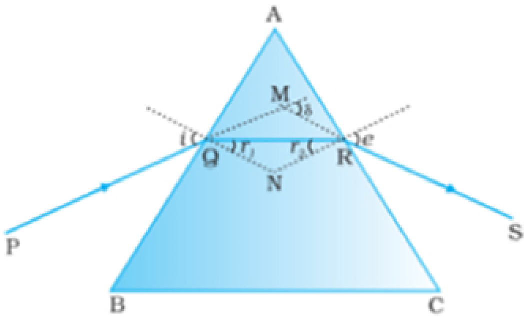


DIAGRAM (0.5)

Answer

In the quadrilateral AQNR, two of the angles (at the vertices Q and R) are right angles. Therefore, the sum of the other angles of the quadrilateral is 180^o. (0.5)

From the triangle QNR, $r_1 + r_2 + QNR = 180^o$ (0.5)

Comparing these two equations, we get $r_1 + r_2 = A$ ...(i)

The total deviation is the sum of deviations at the two faces, = $(i - r_1) + (e - r_2)$ that is, (0.5)

$\delta = i + e - A$ ...(ii)

When $\delta = \delta m$ $i = e$ & $r_1 = r_2$

From (i); 2r = A or r =A/2 (0.5)

From (ii) A 2 δm = 2i - A or i = $\frac{A+\delta_m}{2}$

$$\mu = \frac{sin\ i}{sin\ r} = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$ (0.5)

hence, this is the relation of angle of prism (A) and angle of minimum deviation

ii. Given; P = -5D

f (in cm) = $\frac{100}{(-5)}$ = -20 cm

Using Lens Maker's formula; $\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$\frac{1}{(-20)} = (\mu - 1)\left[\frac{1}{(-20)} - \frac{1}{(+20)}\right]$

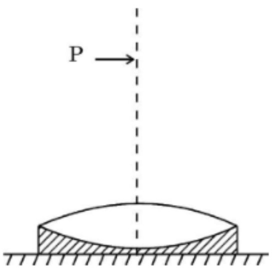
$\frac{1}{(-20)} = (\mu - 1)\left[-\frac{1}{10}\right]$; $\mu - 1 = \frac{1}{2}$

$\Rightarrow \mu = \frac{3}{2}$ = 1.5

DIAGRAM (0.5)

(OR)

32.I.A. The figure below shows an equiconvex lens (of refractive index 1.50) in contact with a liquid layer on top of a plane mirror. A small needle with its tip on the principal axis is moved along the axis until its inverted image is found at the position of the needle. The distance of the needle from the lens is measured to be 45.0 cm. When the liquid is removed and the experiment is repeated, the new distance is 30.0 cm. Find the refractive index of the liquid. [3]



Answer

$$\frac{1}{f} = (\mu - 1)[\frac{1}{R1} - \frac{1}{R2}]$$ (0.5)

R = 30 cm (0.5)

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$ (0.5)

$$f_2 = -90\ cm$$ (0.5)

$$\frac{1}{-90} = (\mu 1 - 1)[\frac{1}{-30} - \frac{1}{\infty}]$$ (0.5)

$\mu 1 = \frac{4}{3}$ (0.5)

32.I.B. (i) State the principle on which the working of an optical fiber is based. [2]
(ii) What are the necessary conditions for this phenomenon to occur?

Answer

i) Working of an optical fibre is based on the principle of total internal reflection (1)

(ii) (a) Light should travel from a denser to rarer medium. (b) Angle of incidence should be more than critical angle given by ic = sin-1(1/μ) (1)

33.I.A. (i) A galvanometer of resistance R_g =50Ω has a full-scale deflection current of I_g =1mA. What series resistance should be connected to convert it into a voltmeter of range 10 V? [3]
(ii) How should this series resistance be connected to the galvanometer?

Answer

Rs= $\frac{V}{I_g}$ −Rg= $\frac{10}{0.001}$ −50=10000−50 (1)

R_s=9950Ω (1)

(ii) The series resistance R_s should be connected in series with the galvanometer to convert it into a voltmeter. (1)

33.I.B. Why is the magnetic field radial in a moving coil galvanometer? Explain how it is achieved? [2]

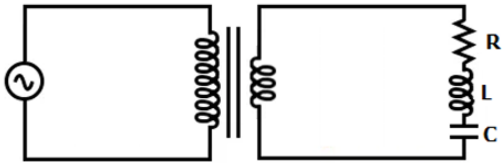
Answer ⚿

(a)Galvanometer is a very sensitive device. It gives a full scale deflection for a small value of current. (1)

(b)The galvanometer has to be connected in series for measuring currents and as it has a large resistance, this will change the value of the current in the circuit. (1)

(OR)

33.II.A. An ideal transformer has 800 turns in the primary coil and 200 turns in the secondary coil. The primary is connected to an AC supply of V in =240 sin 200π t V. The secondary is connected to a series load consisting of R=8Ω, X_L =6Ω, and X_C =2Ω. [3]



Find:

(i) The voltage across the load

(ii) The current through the load

(iii) The power consumed by the load

Answer ⚿

1) $\Rightarrow V_s = V_p \cdot \frac{N_s}{N_p} = 240 \cdot \frac{200}{800} = 60 \text{ V}$ (0.5)

2) $Z = R + j\,(X_L - X_C) = 8 + j(6-2) = 8 + j4\Omega$ (0.5)

3) $|Z| = \sqrt{8^2+4^2} = \sqrt{64+16} = \sqrt{80} \approx 8.944\Omega$ (0.5)

4) $I = \frac{V_s}{|Z|} = \frac{60}{8.944} \approx 6.71 \text{ A}$ (0.5)

5) $P = I^2R = (6.71)^2 \cdot 8 \approx 359.7 \text{ W} \approx 360 \text{ W}$ (1)

33.II.B. Explain the working principle of a transformer and how it helps in long-distance power transmission. [2]

Answer ⚿

Principle: Electromagnetic induction – alternating current in the primary produces a changing magnetic flux, which induces EMF in the secondary. (1)

Importance in power transfer: Step-up voltage → reduces current → minimizes transmission losses Step-down voltage → safe for domestic/industrial use Essential for efficient long-distance AC power transmission (1)