# CUET (UG) Exam Paper 2025

## National Testing Agency

## PHYSICS

## (Solved)

*[This includes Questions pertaining to Domain Specific Subject only]*

**Time Allowed: 60 Minutes** **Maximum Marks: 250**

***General Instructions :***

*(i)* *This Test contains 50 questions.*
*(ii)* *Five (5) marks will be given for each correct answer.*
*(iii)* *One (1) mark will be deducted for each incorrect answer.*
*(iv)* *If more than one option is chosen, then it will be considered as an incorrect answer.*
*(v)* *Unanswered questions will be given no mark.*

**1.** The drift velocity for electrons in a conductor is '$v_d$' when a current '$i$' flows through it. If the area of the cross-section of the conductor is reduced to half of its initial value, then the drift velocity will be:

**(1)** $\frac{v_d}{2}$ **(2)** $v_d$

**(3)** $2v_d$ **(4)** $4v_d$

**Ans. Option (3) is correct.**

***Explanation:*** The electric current is given by $i = Anev_d \Rightarrow v_d = \frac{i}{Ane}$

where $v_d$ is the drift velocity of the free electrons inside the conductor.

Given, $A' = \frac{A}{2}$

So, $v'_d = \frac{i}{\frac{A}{2}ne} = \frac{2i}{Ane} = 2v_d$

**2.** A monochromatic source emitting light of wavelength 600 nm has a power output of 66 W. The number of photons emitted by the source in 2 minutes is: (Given $h = 6.6 \times 10^{-34}$ J s)

**(1)** $1.2 \times 10^{22}$
**(2)** $2.4 \times 10^{22}$
**(3)** $12 \times 10^{22}$
**(4)** $24 \times 10^{22}$

**Ans. Option (2) is correct.**

***Explanation:*** Given $\lambda = 600$ nm $= 600 \times 10^{-9}$ m

The energy of a single photon

$$E = \frac{hc}{\lambda}$$

$$E = \frac{(6.6 \times 10^{-34}\,\text{Js})(3 \times 10^{8}\,\text{m/s})}{600 \times 10^{-9}\,\text{m}}$$

$$E = \frac{1.98 \times 10^{-25}}{600 \times 10^{-9}}$$

$$E = 3.3 \times 10^{-19}\,\text{J}$$

The power output of the source is given as 66 W, which means it emits 66 J of energy per second.

So, the total energy = Power × Time
= 66 W × 120 s
= 7920 J

Now, the number of photons emitted

$$N = \frac{\text{Total Energy}}{E} = \frac{7920}{3.3 \times 10^{-19}}$$

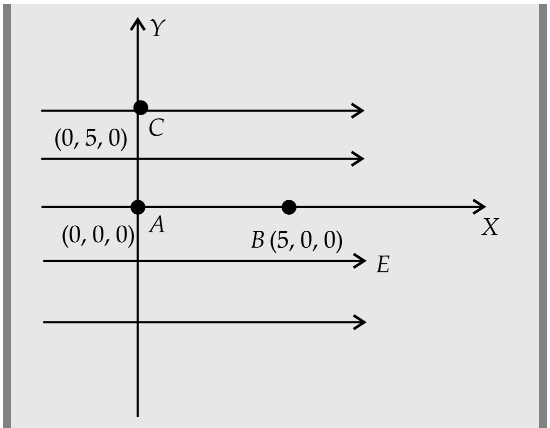
$$N \approx 2.4 \times 10^{22}\ \text{photons}$$

**3.** In a certain region, a uniform electric field exists in the positive $x$-direction. Let $V_A$ = electric potential at point (0, 0, 0) cm, $V_B$ = electric potential at point (5, 0, 0) cm and $V_C$ = electric potential at point (0, 5, 0) cm. The correct relationship between them is

**(1)** $V_A < V_C$ and $V_A = V_B$
**(2)** $V_A = V_C$ and $V_A > V_B$
**(3)** $V_A > V_C$ and $V_A = V_B$
**(4)** $V_A = V_C$ and $V_A < V_B$

**Ans. Option (2) is correct.**

***Explanation:*** Potential decreases in the direction of electric field. Here points $A$ and $C$ are on the same equipotential surface.




$\therefore V_A = V_C$ and $V_A > V_B$

**4.** A negatively charged object A is repelled by another charged object B. However, an object C is attracted to object B. Which of the following is the most probable for the charge of object C?

**(1)** neutral or negatively charged
**(2)** negatively charged only
**(3)** neutral or positively charged
**(4)** positively charged only

**Ans. Option (3) is correct.**

***Explanation:*** Object A is negatively charged and repels object B. According to the laws of electrostatics, object B must also be negatively charged.
Object C is attracted to the negatively charged object B, which implies that C can either be positively charged or neutral.
**Note:** Neutral objects are attracted to the charged objects by electrostatic induction method.

**5.** A current of 15 A flows in a wire of cross-sectional area 5 mm$^2$ with a drift velocity of $3 \times 10^{-3}$ m/s. The electron density in the wire will be

**(1)** $489 \times 10^{25}$ m$^{-3}$ **(2)** $546 \times 10^{25}$ m$^{-3}$
**(3)** $725 \times 10^{23}$ m$^{-3}$ **(4)** $625 \times 10^{25}$ m$^{-3}$

**Ans. Option (4) is correct.**

***Explanation:*** Given $I = 15$ A
$A = 5$ mm$^2$ $= 5 \times 10^{-6}$ m$^2$
$v_d = 3 \times 10^{-3}$ ms$^{-1}$
We have $I = Anev_d$

$$\Rightarrow n = \frac{1}{Aev_d}$$

$$\Rightarrow n = \frac{15}{5\times10^{-6}\times1.6\times10^{-19}\times3\times10^{-3}}$$

$$\Rightarrow n = \frac{15}{15\times1.6\times10^{-28}}$$

$\Rightarrow n = 0.625 \times 10^{28}$
$\therefore$ Electron density $n = 625\times 10^{25}$ m$^{-3}$

**6.** The external diameter of a 5 m long hollow copper tube is 10 cm and the thickness of its wall is 5 mm. If the specific resistance of copper is $1.7 \times 10^{-8}$ Ωm, then the resistance of the tube will be:

**(1)** $7.45 \times 10^{-4}$ Ω **(2)** $14.9 \times 10^{-4}$ Ω
**(3)** $5.7 \times 10^{-5}$ Ω **(4)** $5.7 \times 10^{5}$ Ω

**Ans. Option (3) is correct.**

***Explanation:*** Given length of the hollow copper tube = 5 m.
External diameter =10 cm.
So, the external radius $r_2$ = 5 cm = 0.05 m.
Thickness of the tube = 5 mm = 0.005 m.
So, the internal radius $r_1$ = 0.05 – 0.005 = 0 .045 m.
Area of cross-section of tube,

$$A = \pi(r_2^2 - r_1^2)$$
$$= 3.14[(0.05)^2 - (0.045)^2]$$
$$= 14.91 \times 10^{-4} \text{ m}^2$$

Thus, $$R = \frac{\rho l}{A} = \frac{1.7\times10^{-8}\times5}{14.91\times10^{-4}}$$
$$= 5.7 \times 10^{-5}\ \Omega$$

**7.** In a plane electromagnetic wave, the electric field varies as $E_z = 90 \sin(500x + 20 \times 10^{10} t)$ V/m. The expression of its magnetic field variation is:

**(1)** $27 \times 10^{-7} \sin(500x + 20 \times 10^{10} t)$ T
**(2)** $3.3 \times 10^{6} \sin(500x + 20 \times 10^{10} t)$ T
**(3)** $27 \times 10^{8} \sin(500x + 20 \times 10^{10} t)$ T
**(4)** $3 \times 10^{-7} \sin(500x + 20 \times 10^{10} t)$ T

**Ans. Option (4) is correct.**

***Explanation:*** The electric field variation is given by $E_z = 90 \sin(500x + 20 \times 10^{10} t)$ V/m.
So, the amplitude of electric field is $E_0 = 90$ V/m.

So, $B_0 = \dfrac{90}{3\times10^8} = 30 \times 10^{-8} = 3 \times 10^{-7}$ T.

In a plane electromagnetic wave, the electric and magnetic fields are in phase.
So, $B = 3 \times 10^{-7} \sin(500x + 20 \times 10^{10} t)$ T.

**8.** If we double the number of turns of coil in a moving coil galvanometer, its voltage sensitivity will:

**(1)** reduce to half **(2)** remain unchanged
**(3)** increase to twice **(4)** increase to 4 times

**Ans. Option (2) is correct.**

***Explanation:*** Voltage sensitivity of a moving coil galvanometer is given by

$$V_s = \frac{NBA}{kR}$$

where $k$ is the torsional constant.
If the number of turns of the coil is doubled, then the resistance will also get doubled. So, the voltage sensitivity of the galvanometer will remain unchanged.

**9.** An iron ring of relative permeability $\mu_r$ is introduced inside a toroidal solenoid having $n$ turns per meter. If the current in the solenoid is $I$, then the magnetic field in the ring is:

**(1)** $\dfrac{\mu_0\mu_r I}{\sqrt{n}}$ **(2)** $\dfrac{\mu_0\mu_r I}{n^2}$
**(3)** $\mu_0\mu_r n^2 I$ **(4)** $\mu_0\mu_r nI$

**Ans. Option (4) is correct.**

*Explanation:* Magnetic field inside a toroidal solenoid is given by

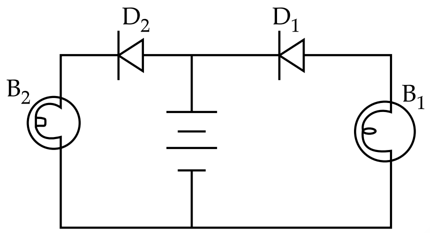
$$B = \frac{\mu_0 NI}{2\pi r}$$

If an iron ring of relative permeability $\mu_r$ is introduced inside the solenoid, then the magnetic field will be,

$$B = \mu_0\mu_r nI$$

where, $n = \frac{N}{2\pi r}$ is the number of turns per unit length of the solenoid.

**10.** In the circuit diagram, the battery, diodes $D_1$ and $D_2$, bulbs $B_1$ and $B_2$ are connected as shown. Which of the following statements is true regarding bulbs $B_1$ and $B_2$?




**(1)** Only $B_1$ will glow

**(2)** $B_1$ and $B_2$ both will glow

**(3)** Only $B_2$ will glow

**(4)** Both $B_1$ and $B_2$ will not glow

**Ans. Option (3) is correct.**

*Explanation:* Here the diode $D_2$ is forward-biased and $D_1$ is reverse-biased. So, only $B_2$ will glow.

**11.** Light of wavelength 300 nm is used in an experiment on photoelectric effect with lithium having a work function of 2.7 eV. The maximum kinetic energy of ejected photo-electrons will be:

**(1)** 1.60 eV **(2)** 1.90 eV

**(3)** 1.75 eV **(4)** 1.44 eV

**Ans. Option (4) is correct.**

*Explanation:* Given $\lambda = 300 \text{ nm} = 300 \times 10^{-9}$ m

Work function of lithium $\phi = 2.7$ eV

Frequency of the light used $v = \frac{c}{\lambda} = \frac{3\times10^{8}}{3\times10^{-7}}$

$= 10^{15}$ Hz

Energy of incident photons $E = hv$

$\Rightarrow \quad E = 6.63 \times 10^{-34} \times 10^{15}$

$\Rightarrow \quad E = 6.63 \times 10^{-19}$ J

$\Rightarrow \quad E = \frac{6.63\times10^{-19}}{1.6\times10^{-19}} \text{eV} = 4.14 \text{ eV}$

Using the photoelectric equation $K_{max} = E - \phi$

$\Rightarrow \quad K_{max} = 4.14 - 2.7 = 1.44$ eV

**12.** A cell of e.m.f. $E$ is connected across an external resistance $R$. When a current '$I$' is drawn from the cell, the potential difference across the electrodes of the cell drops to '$V$'. The internal resistance '$r$' of the cell is

**(1)** $\left[\frac{E-V}{E}\right]R$ **(2)** $\left[\frac{E-V}{R}\right]$

**(3)** $\left[\frac{E-V}{I}\right]R$ **(4)** $\left[\frac{E-V}{V}\right]R$

**Ans. Option (4) is correct.**

*Explanation:* Current in the circuit $I = \frac{V}{R}$

Across the cell, $V = E - Ir$

$$r = \frac{E-V}{I}$$

$$r = \frac{E-V}{\frac{V}{R}}$$

$$r = \left(\frac{E-V}{V}\right)R$$

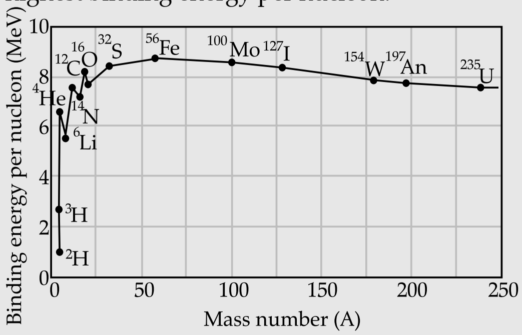
**13.** The element having the highest binding energy per nucleon among the following is:

**(1)** $^{6}Li$ **(2)** $^{14}N$

**(3)** $^{12}C$ **(4)** $^{16}O$

**Ans. Option (4) is correct.**

*Explanation:* Binding energy per nucleon of $^{56}Fe$ is maximum. As the mass number decreases, the binding energy per nucleon decreases. So, among the given nuclei, $^{16}O$ is closest to $^{56}Fe$ given in the graph below. Hence, $^{16}O$ has the highest binding energy per nucleon.




**14.** Three resistors of resistance 15 Ω each are to be connected in combination. The ratio of maximum equivalent resistance to the minimum equivalent resistance is:

**(1)** 3 : 1 **(2)** 6 : 1

**(3)** 9 : 1 **(4)** 12 : 1

**Ans. Option (3) is correct.**

*Explanation:* The maximum equivalent resistance is when the resistors are connected in series.

So, $\quad R_s = R_1 + R_2 + R_3$

$\Rightarrow \quad R_s = 15 + 15 + 15 = 45\ \Omega$

The minimum equivalent resistance is when the resistors are connected in parallel.

So, $\quad \frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$$\Rightarrow \quad \frac{1}{R_p} = \frac{1}{15}+\frac{1}{15}+\frac{1}{15}$$

$$\Rightarrow \quad \frac{1}{R_p} = \frac{3}{15} = \frac{1}{5}$$

$$R_p = 5\Omega$$

Therefore, $\frac{R_s}{R_p} = \frac{45}{5} = 9:1$

**15.** A symmetrical double convex lens is cut into two equal parts by a plane containing the principal axis.

The power of the divided lens is:

**(1)** half of the original lens
**(2)** equal to that of the original lens
**(3)** double of the original lens
**(4)** four times of the original lens

**Ans. Option (2) is correct.**

***Explanation:*** If a symmetric double convex lens is cut in half along a plane containing the principal axis, the power of each resulting piece will be equal to the power of the original lens. Cutting the lens along the principal axis divides it into two identical halves, each with the same curvature and refractive index as the original lens.

**16.** The atomic hydrogen emits a line spectrum consisting of different series. The ratio of frequencies of the first line in Lyman and Balmer series is:

**(1)** 3 : 5 **(2)** 9 : 5
**(3)** 27 : 5 **(4)** 5 : 27

**Ans. Option (4) is correct.**

***Explanation:*** For Lyman series
(transition from $n = 2$ to $n = 1$):

$$\frac{1}{\lambda_L} = R\left(\frac{1}{1^2}-\frac{1}{2^2}\right)$$

$$= R\left(1-\frac{1}{4}\right) = R\left(\frac{3}{4}\right)$$

Thus,

$$\lambda_L = \frac{4}{3R}$$

For Balmer series (transition from $n = 3$ to $n = 2$):
Substituting these values into the formula:

$$\frac{1}{\lambda_B} = R\left(\frac{1}{2^2}-\frac{1}{3^2}\right)$$

$$\frac{1}{\lambda_B} = R\left(\frac{9-4}{36}\right)$$

$$= R\left(\frac{5}{36}\right)$$

Thus,

$$\lambda_B = \frac{36}{5R}$$

$$\frac{\lambda_L}{\lambda_B} = \frac{\frac{4}{3R}}{\frac{36}{5R}}$$

$$= \frac{4}{3R}\times\frac{5R}{36} = \frac{5}{27}$$

**17.** A charging capacitor has

**(1)** Only conduction current present in connecting wire
**(2)** Only displacement current present in the space between plates
**(3)** Both displacement and conduction currents present
**(4)** No current present in different regions of space

**Ans. Option (3) is correct.**

***Explanation:*** During the charging process of a capacitor, the displacement current in the gap between the plates is equal to the conduction current flowing in the wires. This ensures the continuity of the total current in the circuit.

**18.** A long wire is bent into a circular coil of one turn and then into a circular coil of smaller radius having $n$ turns. If the same current passes in both the cases, then the ratio of the magnetic fields produced at the centres in two cases will be:

**(1)** $1 : n^2$ **(2)** $1 : n$
**(3)** $\sqrt{n} : 1$ **(4)** $1 : n^3$

**Ans. Option (1) is correct.**

***Explanation:*** In the first case, let the radius of the coil be $R_1$.
The magnetic field at its centre

$$B_1 = \frac{\mu I}{2R_1} \quad ...(1)$$

In the second case, for $n$ turns, let the radius of the coil be $R_2$.
The magnetic field at its centre

$$B_2 = \frac{\mu n I}{2R_2} \quad ...(2)$$

Now, for the first case, $L = 2\pi R_1$ and for the second case, $L = n \times 2\pi R_2$

$\Rightarrow \quad 2\pi R_1 = n \times 2\pi R_2$

$\Rightarrow \quad R_1 = nR_2$

Dividing Eq. (1) by Eq. (2), $\frac{\mu n I}{2R_2}$

$$\frac{B_1}{B_2} = \frac{R_2}{nR_1}$$

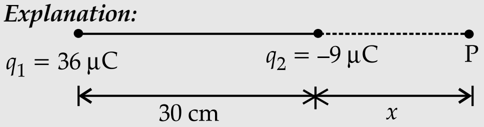
$$\Rightarrow \quad \frac{B_1}{B_2} = \frac{R_2}{n^2R_2} = \frac{1}{n^2}$$

**19.** Two point charges, $q_1 = 36\ \mu C$ and $q_2 = -9\ \mu C$ are placed at a distance of 30 cm. The distance from $q_1$, where the net electric field is zero, will be

**(1)** 10 cm **(2)** 20 cm
**(3)** 60 cm **(4)** 30 cm

**Ans. Option (3) is correct.**

***Explanation:***




At point $P$,

$$E_1 = \frac{1}{4\pi\varepsilon_0}\frac{36\times10^{-6}}{(30+x)^2}$$

$$E_2 = \frac{1}{4\pi\varepsilon_0}\frac{9\times10^{-6}}{x^2}$$

As at point $P$, the net electric field is zero, so

$$\frac{1}{4\pi\varepsilon_0}\frac{36\times10^{-6}}{(30+x)^2} = \frac{1}{4\pi\varepsilon_0}\frac{9\times10^{-6}}{x^2}$$

$$\frac{4}{(30+x)^2} = \frac{1}{x^2}$$

$$\frac{2}{30+x} = \frac{1}{x}$$

$$2x = 30 + x$$

$$x = 30 \text{ cm}$$

Therefore, the distance of $P$ from the charge $q_1$ is $30 + 30 = 60$ cm.

**20.** The smallest wavelength in the spectral lines of the Paschen series in the hydrogen atoms is: (R is the Rydberg's constant in Å)

**(1)** $\frac{9}{R}$Å **(2)** $\frac{R}{9}$Å

**(3)** $\frac{9R}{21}$Å **(4)** $\frac{21}{R}$Å

**Ans. Option (1) is correct.**

***Explanation:*** We have $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right)$

for the shortest wavelength of the Paschen series $n_1 = 3$ and $n_2 = \infty$

So, $$\frac{1}{\lambda} = R\left(\frac{1}{9}-\frac{1}{\infty}\right)$$

$\Rightarrow$ $$\lambda = \frac{9}{R}\text{Å}$$

**21.** A short bar magnet of magnetic moment $5.25 \times 10^{-2}$ J/T is placed with its axis perpendicular to earth's magnetic field direction. The distance of the point from the centre of magnet on its perpendicular bisector, where the resultant field is 45° to the earth's field will be: (Earth's field at that place is 0.42 G)

**(1)** $6.3 \times 10^{-2}$ m **(2)** $5 \times 10^{-2}$ m

**(3)** $6.3 \times 10^{-3}$ m **(4)** $5 \times 10^{-3}$ m

**Ans. Option (2) is correct.**

***Explanation:*** Given $M = 5.25 \times 10^{-2}$ J/T

Earth's field $B_H = 0.42\ G = 0.42 \times 10^{-4}$ T

The magnetic field on the perpendicular bisector of a short bar magnet is

$$B_e = \frac{\mu_0}{4\pi}\frac{M}{r^3}$$

The angle θ between the resultant field and the Earth's field is 45°.

$$\tan\theta = \frac{B_e}{B_H}$$

$\Rightarrow$ $$\tan 45° = \frac{B_e}{B_H}$$

$\Rightarrow$ $$B_e = B_H$$

So, $$\frac{\mu_0}{4\pi}\frac{M}{r^3} = 0.42 \times 10^{-4}$$

$\Rightarrow$ $$r^3 = \frac{\mu_0}{4\pi}\times\frac{M}{0.42\times10^{-4}}$$

Upon solving, $r = 5 \times 10^{-2}$ m.

**22.** The electric field in a region is given by $\vec{E} = (6\hat{i}+3\hat{j}+5\hat{k})$ N/C. The electric flux due to this electric field through an area 100 cm$^2$ lying in the $XY$ plane is:

**(1)** $5 \times 10^{2}$ Nm$^2$/C **(2)** $5 \times 10^{1}$ Nm$^2$/C

**(3)** $5 \times 10^{-1}$ Nm$^2$/C **(4)** $5 \times 10^{-2}$ Nm$^2$/C

**Ans. Option (4) is correct.**

***Explanation:*** Given $\vec{E} = (6\hat{i}+3\hat{j}+5\hat{k})$ N/C

Area = 100 cm$^2$ = 0.01 m$^2$, lying in the $XY$-plane

So, the area vector $\vec{A} = 0.01\hat{k}$ m$^2$

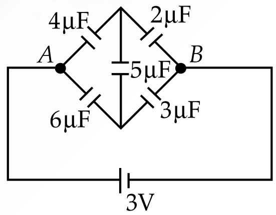
Now electric flux, $\phi = \vec{E}\cdot\vec{A}$

$\Rightarrow$ $$\phi = (6\hat{i}+3\hat{j}+5\hat{k})\cdot(0.01\hat{k})$$

$\Rightarrow$ $$\phi = 0.05 \text{ Nm}^2/\text{C}$$

Or, $$\phi = 5 \times 10^{-2} \text{ Nm}^2/\text{C}$$

**23.** A network of five capacitors is shown in the figure. The total charge stored in the network connected between $A$ and $B$ is:




**(1)** 8 μC **(2)** 10 μC

**(3)** 9 mC **(4)** 10 mC

**Ans. Option (2) is correct.**

***Explanation:*** The figure shows a balanced Wheatstone bridge.

So, $$\frac{1}{C_{s_1}} = \frac{1}{4}+\frac{1}{2} = \frac{1+2}{4} = \frac{3}{4}$$

$\Rightarrow$ $$C_{s_1} = \frac{4}{3}\mu F$$

and $$\frac{1}{C_{s_2}} = \frac{1}{6}+\frac{1}{3}$$

$$= \frac{1+2}{6} = \frac{3}{6} = \frac{1}{2}$$

$\Rightarrow$ $$C_{s_2} = 2\mu F$$

Now the net capacitance $C = C_{s_1} + C_{s_2}$

$$\Rightarrow \quad C = \frac{4}{3} + 2$$

$$\Rightarrow \quad C = \frac{10}{3}\ \mu F$$

Potential difference $V = 3$ V

We have $\quad C = \frac{Q}{V}$

$$\Rightarrow \quad Q = CV$$

$$\Rightarrow \quad Q = \frac{10}{3} \times 3 = 10\ \mu C$$

**24.** The mutual inductance of two co-axial coils is 2 H. If the current in one coil changes uniformly from zero to 1.0 A in 100 ms, the emf induced in the other coil is

**(1)** 10 V **(2)** 20 V
**(3)** –10 V **(4)** –20 V

**Ans. Option (4) is correct.**

***Explanation:*** Induced emf in the second coil

$$\varepsilon = -M\frac{\Delta I}{\Delta t} = -2 \times \frac{1}{0.1} = -20 \text{ V}$$

**25.** If the ratio of mass number of two nuclei is 8:27, then the ratio of the volumes of their nuclei is:

**(1)** 8:27 **(2)** 4:9
**(3)** 2:3 **(4)** 1:1

**Ans. Option (1) is correct.**

***Explanation:*** The volume of a nucleus $V = \frac{4}{3}\pi R_3$

$$\Rightarrow \quad V = \frac{4}{3}\pi\left(R_0 A^{1/3}\right)^3$$

$$\Rightarrow \quad V = \frac{4}{3}\pi R_0^3 A$$

i.e., $V \propto A$

So, $\quad \frac{V_1}{V_2} = \frac{A_1}{A_2}$

$$\Rightarrow \quad \frac{V_1}{V_2} = \frac{8}{27}$$

**26.** A long solenoid with 30 turns/cm has a small loop of area 3 cm$^2$ placed inside it normal to its axis. If the current carried by the solenoid changes steadily from 3.0 A to 6.0 A in 0.1 s, the induced emf in the loop is

**(1)** $3\pi \times 10^{-7}$ V **(2)** $9\pi \times 10^{-7}$ V
**(3)** $18\pi \times 10^{-7}$ V **(4)** $108\pi \times 10^{-7}$ V

**Ans. Option (4) is correct.**

***Explanation:*** Given, $n$ = 30 turns/cm = 3000 turns/m.

Area of the small loop $A$ = 3 cm$^2$
$= 3 \times 10^{-4}$ m$^2$

Induced emf $|\varepsilon| = \frac{d\phi}{dt}|\varepsilon| = \frac{d}{dt}A(BA)$

$$|\varepsilon| = A\mu_0 n\frac{dI}{dt}$$

$$|\varepsilon| = 3\times10^{-4} \times 4\pi \times 10^{-7} \times 3000 \times \frac{3}{0.1}$$

$$|\varepsilon| = 108\pi \times 10^{-7} \text{ V}$$

**27.** Match **List-I** with **List-II**.

| | List-I | | List-II |
|---|---|---|---|
| **A.** | $E$ is independent of $r$ | **I.** | For a point charge |
| **B.** | $E \propto \frac{1}{r}$ | **II.** | For a short dipole |
| **C.** | $E \propto \frac{1}{r^2}$ | **III.** | For a linear charge distribution |
| **D.** | $E \propto \frac{1}{r^3}$ | **IV.** | For a surface charge distribution on an infinite plane sheet |

Choose the **correct** answer from the options given below:

**(1)** (A)–(I), (B)–(II), (C)–(III), (D)–(IV)
**(2)** (A)–(II), (B)–(IV), (C)–(I), (D)–(III)
**(3)** (A)–(IV), (B)–(III), (C)–(I), (D)–(II)
**(4)** (A)–(IV), (B)–(III), (C)–(II), (D)–(I)

**Ans. Option (3) is correct.**

***Explanation:*** For a point charge, $E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$

For a short dipole:

(i) at an axial point, $E = \frac{1}{4\pi\varepsilon_0}\frac{2P}{r^3}$

(ii) at an equatorial point, $E = \frac{1}{4\pi\varepsilon_0}\frac{P}{r^3}$

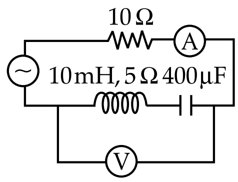
For a linear charge distribution,

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

For a surface charge distribution on an infinite plane sheet,

$$E = \frac{\sigma}{2\varepsilon_0}$$

**28.** In the circuit shown in the figure, the ac source gives a voltage of $V = 10\cos(500t)$. The ammeter reading will be:




**(1)** $\frac{2\sqrt{2}}{3}$ A **(2)** $\frac{3\sqrt{2}}{3}$ A
**(3)** $\frac{\sqrt{2}}{3}$ A **(4)** $\sqrt{2}$ A

**Ans. Option (3) is correct.**

*Explanation:* Given, $R = 15\ \Omega$

$X_L = \omega L = 500 \times 10 \times 10^{-3} = 5\ \Omega$

$$X_C = \frac{1}{\omega C} = \frac{1}{500 \times 400 \times 10^{-6}}$$

$$= \frac{1}{2 \times 10^5 \times 10^{-6}} = 5\Omega$$

So, $$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{225} = 15\Omega$$

$$I_0 = \frac{V_0}{Z} = \frac{10}{15} = \frac{2}{3}\text{A}$$

$$I_{rms} = \frac{2}{3\sqrt{2}}\text{ A} = \frac{\sqrt{2}}{3}\text{ A}$$

**29.** A long straight wire of radius '$a$' carries a steady current '$I$'. The current is uniformly distributed across its area of cross-section. The ratio of magnitude of magnetic fields $B_1$ at a distance $\frac{a}{2}$ and $B_2$ at a distance $2a$ from the axis of the wire.

**(1)** 1 : 2 **(2)** 1 : 1

**(3)** 2 : 1 **(4)** 4 : 1

**Ans. Option (2) is correct.**

*Explanation:* For points inside the wire,

$$B_1 = \frac{\mu_0 I r}{2\pi R^2}$$

or, $$B_1 = \frac{\mu_0 I\left(\frac{a}{2}\right)}{2\pi a^2} = \frac{\mu_0 I a}{4\pi a^2}$$

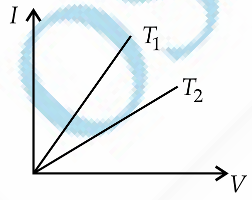
For points outside the wire

$$B_2 = \frac{\mu_0 I}{2\pi r}$$

or, $$B_2 = \frac{\mu_0 I}{2\pi \times 2a} = \frac{\mu_0 I}{4\pi a}$$

So, $$\frac{B_1}{B_2} = \frac{\mu_0 I a}{4\pi a^2} \times \frac{4\pi a}{\mu_0 I} \Rightarrow \frac{B_1}{B_2} = 1:1$$

**30.** The current–voltage graphs for a given metallic wire at two different temperatures, $T_1$ and $T_2$ are shown in the figure. The correct relation of temperatures and resistances will be:




**(1)** $R_{T_1} = R_{T_1}, T_1 > T_2$ **(2)** $R_{T_2} < R_{T_1}, T_1 > T_2$

**(3)** $R_{T_2} > R_{T_1}, T_2 > T_1$ **(4)** $R_{T_2} < R_{T_1}, T_2 > T_1$

**Ans. Option (3) is correct.**

*Explanation:* From the graph, slope of $T_1$ > Slope of $T_2$.

$$\Rightarrow \frac{1}{R_{T_1}} > \frac{1}{R_{T_2}}$$

$$\Rightarrow R_{T_1} < R_{T_2}$$

For metallic wires, resistance increases with an increase in temperature.

Since $R_{T_1} < R_{T_2}$, it follows that $T_1 < T_2$.

**31.** An infinitely long line charge distribution produces a field of $9 \times 10^4$ NC$^{-1}$ at a distance of 2 cm. The linear charge density of the distribution is:

**(1)** 0.01 μC m$^{-1}$ **(2)** 0.1 μC m$^{-1}$

**(3)** 1 μC m$^{-1}$ **(4)** 2 μC m$^{-1}$

**Ans. Option (2) is correct.**

*Explanation:* For an infinitely long line charge distribution,

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

$\Rightarrow \lambda = E \times 2\pi\varepsilon_0 r$

$\Rightarrow \lambda = 9 \times 10^4 \times 2 \times 3.14 \times 8.85 \times 10^{-12} \times 2 \times 10^{-2}$

$\Rightarrow \lambda = 10^{-7}\ \text{C m}^{-1}$

$\Rightarrow \lambda = 0.1\ \mu\text{C m}^{-1}$

**32.** A coil having area $A_0$ is placed in a magnetic field. The magnetic field is perpendicular to the plane of the coil. When the magnetic field changes from $B_0$ to $4B_0$ in a time interval $t$, the magnitude of emf induced in the coil will be:

**(1)** $\frac{3A_0B_0}{t}$ **(2)** $\frac{4A_0B_0}{t}$

**(3)** $\frac{3B_0}{A_0 t}$ **(4)** $\frac{4B_0}{A_0 t}$

**Ans. Option (1) is correct.**

*Explanation:* Initial magnetic flux $\phi_i = B_0A_0$.

Final magnetic flux $\phi_f = 4B_0A_0$.

So, the change in magnetic flux $\Delta\phi = 3B_0A_0$.

Magnitude of induced emf is

$$|\varepsilon| = \frac{\Delta\phi}{t}$$

$$|\varepsilon| = \frac{3A_0B_0}{t}$$

**33.** If $n_i$ is the concentration of intrinsic charge carriers in a pure semiconductor and $n_e$ and $n_h$ are the concentrations of electrons and holes, respectively after the semiconductor is doped, then at thermal equilibrium.

**(1)** $n_e\, n_h = n_i$ **(2)** $n_e\, n_h = n_i^2$

**(3)** $\frac{n_e}{n_h} = n_i^2$ **(4)** $\frac{n_h}{n_e} = n_i^2$

**Ans. Option (2) is correct.**

*Explanation:* Even after doping, the law of mass action holds true at thermal equilibrium, i.e.,

$$n_e \times n_h = n_i^2$$

**34.** A ray of light from air passes through an equilateral triangular glass prism and undergoes minimum deviation when the angle of incidence is $\frac{3}{4}$ of the angle of the prism. The speed of light in prism is

**(1)** $1.15 \times 10^8$ m/s **(2)** $2.12 \times 10^8$ m/s

**(3)** $2.78 \times 10^8$ m/s **(4)** $3 \times 10^8$ m/s

**Ans. Option (2) is correct.**

> ***Explanation:*** The angle of the prism $A = 60°$.
>
> The angle of incidence $i = \frac{3}{4} \times A$
>
> $= \frac{3}{4} \times 60° = 45°$
>
> for minimum deviation, $r = \frac{A}{2} = 30°$
>
> From Snell's law of refraction, $\mu = \frac{\sin 45°}{\sin 30°}$
>
> $\Rightarrow \quad \mu = \frac{\frac{1}{\sqrt{2}}}{\frac{1}{2}} = \sqrt{2}$
>
> So, from the relation $\mu = \frac{c}{v}$, we have
>
> $v = \frac{c}{\mu}$
>
> $\Rightarrow \quad v = \frac{3 \times 10^8}{\sqrt{2}}$
>
> $\approx 2.12 \times 10^8 \text{ ms}^{-1}$

**35.** Match **List-I** with **List-II**.

| **List-I** | | **List-II** | |
|---|---|---|---|
| **(AC circuit)** | | **(Feature)** | |
| **A.** | Only resistor in a circuit | **I.** | Current leads or lags the voltage |
| **B.** | Only capacitor in a circuit | **II.** | Voltage and current are in phase |
| **C.** | Only inductor in a circuit | **III.** | The current lags the voltage by $\frac{\pi}{2}$ |
| **D.** | Series LCR circuit $X_C \neq X_L$ and $R \neq 0$ | **IV.** | The current leads the voltage by $\frac{\pi}{2}$ |

Choose the **correct** answer from the options given below :

**(1)** (A)–(IV), (B)–(III), (C)–(II), (D)–(I)
**(2)** (A)–(II), (B)–(IV), (C)–(III), (D)–(I)
**(3)** (A)–(III), (B)–(II), (C)–(IV), (D)–(I)
**(4)** (A)–(IV), (B)–(II), (C)–(III), (D)–(I)

**Ans. Option (2) is correct.**

> ***Explanation:*** In a circuit containing only resistance, the current and the voltage are in phase.
> In a purely capacitive circuit, the current leads the voltage by $\frac{\pi}{2}$.
>
> In a purely inductive circuit, the current lags the voltage by $\frac{\pi}{2}$.
>
> In a series LCR circuit with non-zero resistance and unequal inductive and capacitive reactance ($X_C \neq X_L$), the circuit is not in resonance.
> In this case, the current will either lead or lag the voltage, depending on whether the circuit is predominantly capacitive ($X_C > X_L$, current leads voltage) or predominantly inductive ($X_L > X_C$, voltage leads current).
> The phase difference between the voltage and current is given by $\tan \phi = \frac{X_L - X_C}{R}$.

**36.** Young's double slit experiment is carried out by using green, yellow, red and blue lights one by one. Arrange the expected values of fringe width ($\beta$) in increasing order.

**(A)** $\beta_{Green}$ **(B)** $\beta_{Yellow}$
**(C)** $\beta_{Blue}$ **(D)** $\beta_{Red}$

Choose the **correct** answer from the options given below:

**(1)** (B), (C), (D), (A)
**(2)** (A), (C), (D), (B)
**(3)** (C), (A), (B), (D)
**(4)** (C), (A), (D), (B)

**Ans. Option (3) is correct.**

> ***Explanation:*** In Young's double slit experiment, the fringe width is directly proportional to the wavelength,
>
> i.e., $\beta = \frac{\lambda D}{d}$
>
> Since $\lambda_{Red} > \lambda_{Yellow} > \lambda_{Green} > \lambda_{Blue}$
> So, the values of fringe widths in increasing order is
> $\beta_{Blue} < \beta_{Green} < \beta_{Yellow} < \beta_{Red}$

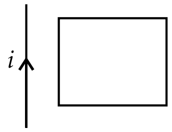
**37.** Interference fringes may be observed due to the superposition of two light waves represented by:

**(1)** $y_1 = a \sin \omega t$ and $y_2 = a \sin 2\omega t$
**(2)** $y_1 = a \sin \omega t$ and $y_2 = 2a \sin(2\omega t + \delta)$
**(3)** $y_1 = 2a \sin 2\omega t$ and $y_2 = 2a \sin 2(\omega t + \delta)$
**(4)** $y_1 = 2a \sin \omega t$ and $y_2 = 2a \sin(2\omega t + \delta)$

**Ans. Option (3) are correct.**

> ***Explanation:*** For $y_1 = 2a \sin 2\omega t$ and $y_2 = 2a \sin 2(\omega t + \delta)$, they have the same angular frequency ($2\omega$).
> They have the same amplitude and also have a constant phase difference.
> Therefore, these two waves are coherent and will produce observable interference fringes.

**38.** A square loop is placed near a long straight current carrying wire as shown in the figure. If the loop is moved away from the wire:




**(1)** Induced current in loop will be anti-clockwise.
**(2)** Wire will exert net attractive force on the loop.
**(3)** Wire will exert net repulsive force on the loop.
**(4)** No current is induced in the loop.

**Ans. Option (2) is correct.**

*Explanation:* Even if the loop is moved away from the wire, the side of the loop closer to the wire will have a current in the upward direction, for which the force will be attractive; and for the side of the loop which is at the farthest distance from the wire will have a current in the downward direction, for which the force will be repulsive.
So, the loop will experience a net attractive force.

**39.** Match **List-I** with **List-II**.

| | List-I Motion of a charge particle | | List-II Path |
|---|---|---|---|
| **A.** | Initial velocity of charge particle parallel to B | **I.** | Circular path |
| **B.** | Initial velocity of charge particle perpendicular to B | **II.** | Helical path |
| **C.** | Initial velocity of charge particle inclined to B | **III.** | Straight path |
| **D.** | Initial velocity of charge particle perpendicular to E | **IV.** | Parabolic path |

Choose the **correct** answer from the options given below :

**(1)** (A)–(I), (B)–(II), (C)–(III), (D)–(IV)
**(2)** (A)–(IV), (B)–(III), (C)–(II), (D)–(I)
**(3)** (A)–(III), (B)–(I), (C)–(II), (D)–(IV)
**(4)** (A)–(III), (B)–(I), (C)–(IV), (D)–(II)

**Ans. Option (3) is correct.**

*Explanation:* Motion of a charged particle
**Parallel to the magnetic field (B):** No magnetic force acts on the particle, so it continues in a straight line.
**Perpendicular to the magnetic field (B):** The magnetic force acts as a centripetal force, causing the particle to move in a circular path.
**Inclined to the magnetic field (B):** The velocity component parallel to the field causes straight line motion, while the perpendicular component causes circular motion. The combination of these results in a helical path.
**Perpendicular to the electric field (E):** The electric force is constant in magnitude and direction, causing the particle to accelerate and follow a parabolic path.

**40.** From the following diagram, determine the direction of propagation of an electromagnetic wave.


**(1)** In the direction of electric field
**(2)** In the direction of magnetic field
**(3)** Inward to the plane of paper
**(4)** Outward from the plane of paper

**Ans. Option (3) is correct.**

*Explanation:* The direction of propagation of an electromagnetic wave can be determined by determining the direction of $\vec{E}\times\vec{B}$.

Here, $\vec{E}\times\vec{B} = \hat{j}\times\hat{i} = -\hat{k}$, which is into the plane of the paper.

**41.** Match **List-I** with **List-II**.

| | List-I (Potential difference across the terminal of a battery) | | List-II (Situations) |
|---|---|---|---|
| **A.** | $V = E$ | **I.** | Cell is being charged |
| **B.** | $V = 0$ | **II.** | The internal resistance of a cell is zero. |
| **C.** | $V = E - Ir$ | **III.** | Cell is short-circuited. |
| **D.** | $V = E + Ir$ | **IV.** | Current is being drawn from a cell. |

Choose the **correct** answer from the options given below:

**(1)** (A)–(II), (B)–(III), (C)–(I), (D)–(IV)
**(2)** (A)–(II), (B)–(III), (C)–(IV), (D)–(I)
**(3)** (A)–(III), (B)–(II), (C)–(I), (D)–(IV)
**(4)** (A)–(III), (B)–(II), (C)–(IV), (D)–(I)

**Ans. Option (2) is correct.**

*Explanation:* **(A)** V = E: This occurs when the potential difference across the battery terminals equals its electromotive force (EMF). This happens when no current is drawn from or flowing into the cell. This is equivalent to a situation where the internal resistance of the cell is zero.
**(B)** $V = 0$: This indicates that the potential difference across the battery terminals is zero. This happens when the battery is short-circuited.
**(C)** $V = E - Ir$: This equation represents the terminal potential difference when a current ($I$) is drawn from the cell, where $E$ is the EMF and $r$ is the internal resistance. The potential difference is less than the EMF due to the voltage drop across the internal resistance.
**(D)** $V = E + Ir$: This equation represents the terminal potential difference when the cell is being charged. The current ($I$) flows into the positive terminal of the battery, increasing the potential difference across the terminals compared to the EMF.

**42.** The magnifying power of a compound microscope is high, if

**(1)** objective has long focal length and eyepiece has short focal length
**(2)** objective has short focal length and eyepiece has long focal length
**(3)** Both objective and eyepiece have short focal length
**(4)** Both objective and eyepiece have long focal length

**Ans. Option (3) is correct.**

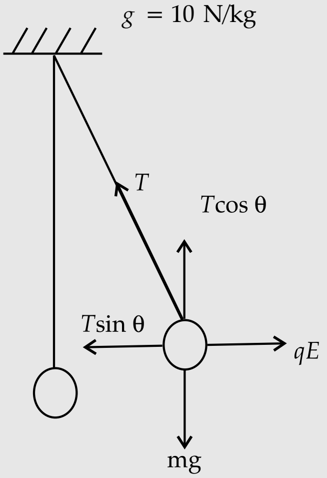
*Explanation:* A compound microscope uses an objective lens and an eyepiece to magnify an object in two stages. The overall magnification is the product of the magnification of the objective and the eyepiece.
The magnification of a lens is inversely proportional to its focal length.
Therefore, to achieve a high magnifying power, both the objective and the eyepiece should have short focal lengths, which leads to increased magnification by both lenses.

**43.** A body of 20 g and +50 μC charge is suspended from the ceiling by a string. If a horizontal electric field of 10 kV/m is applied, the angle between the string and vertical direction is: (Take $g$ = 10 N/kg)

**(1)** $\tan^{-1}(2.50)$ **(2)** $\tan^{-1}(3.00)$
**(3)** $\tan^{-1}(3.50)$ **(4)** $\sin^{-1}(2.50)$

**Ans. Option (1) is correct.**

*Explanation:* Given $m = 20 \text{ g} = 20 \times 10^{-3}$ kg
$q = 50\ \mu\text{C} = 50 \times 10^{-6}$ C
$E = 10$ kV/m $= 10^4$ V/m
$g = 10$ N/kg




At equilibrium, $T\cos\theta = mg$
$T\sin\theta = qE$

So, $$\tan\theta = \frac{qE}{mg}$$

$$\Rightarrow \quad \theta = \tan^{-1}\left(\frac{qE}{mg}\right)$$

$$\Rightarrow \quad \theta = \tan^{-1}\left(\frac{50\times10^{-6}\times10^{4}}{20\times10^{-3}\times10}\right)$$

$$\Rightarrow \quad \theta = \tan^{-1}\left(\frac{50\times10^{-2}}{20\times10^{-2}}\right)$$

$$= \tan^{-1}(2.5)$$

**44.** In a series LCR circuit $C = 5\ \mu$F and $\omega = 1000$ rads$^{-1}$. The value of inductance $L$ for which the current is maximum in this circuit will be

**(1)** 100 mH **(2)** 10 mH
**(3)** 50 mH **(4)** 200 mH

**Ans. Option (4) is correct.**

*Explanation:* Current will be maximum at the resonance condition, i.e.,

$$X_C = X_L$$

$$\Rightarrow \quad \frac{1}{\omega C} = \omega L$$

$$\Rightarrow \quad \frac{1}{1000\times5\times10^{-6}} = 1000 \times L$$

$$\Rightarrow \quad L = 0.2 \text{ H} = 200 \text{ mH}$$

**45.** When white light consisting of wavelengths ranging from 400 nm to 700 nm passes through water $\left(\mu = \frac{4}{3}\right)$, then the wavelength range in water will be:

**(1)** 300 nm – 525 nm **(2)** 500 nm – 700 nm
**(3)** 700 nm – 850 nm **(4)** 450 Å – 750 Å

**Ans. Option (1) is correct.**

*Explanation:* When light travels from one medium to another, its wavelength $\lambda' = \frac{\lambda}{\mu}$

So, $$\lambda'_{min} = \frac{400}{\frac{4}{3}} = 300 \text{ nm}$$

$$\lambda'_{max} = \frac{700}{\frac{4}{3}} = 525 \text{ nm}$$

**46.** In an intrinsic semiconductor at room temperature

**(1)** the number of free electrons are much larger than the number of holes
**(2)** the number of holes are much larger than the number of free electrons
**(3)** the number of free electrons and the number of holes are equal and non-zero
**(4)** the number of free electrons and the number of holes are zero

**Ans. Option (3) is correct.**

*Explanation:* In an intrinsic semiconductor at room temperature, the number of free electrons and holes are equal and non-zero. This is because:

- Thermal Energy: Room temperature provides enough thermal energy to break some atomic bonds in the pure semiconductor material.
- Electron–Hole Pairs: When a bond breaks, a free electron is released, leaving behind a 'hole' (a missing electron).
- Equal Creation: For each free electron created, a corresponding hole is created simultaneously.

**47.** Two Polaroids are placed in such a way that their axes make an angle of 60° with each other. If an unpolarised light is incident on a system of these Polaroids, the fraction of transmitted light to the incident light will be

**(1)** zero **(2)** $\frac{1}{8}$
**(3)** $\frac{3}{8}$ **(4)** $\frac{5}{8}$

**Ans. Option (2) is correct.**

***Explanation:*** Intensity of emergent light from the first polaroid is

$$I_1 = \frac{I_0}{2}$$

Intensity of light from the second polaroid is

$$I_2 = I_1 \cos^2\theta$$

$$I_2 = \left(\frac{I_0}{2}\right)\times\left(\frac{1}{4}\right) = \frac{I_0}{8} = \frac{1}{8}\times I_0$$

**48.** If $h$ is the Planck's constant, then the momentum of the photon having frequency $v$ is represented by

**(1)** $hc\nu$ **(2)** $\frac{h\nu}{c}$

**(3)** $\frac{hc}{\nu}$ **(4)** $\frac{h}{c\nu}$

**Ans. Option (2) is correct.**

***Explanation:*** The energy of a photon is given by

$$E = h\nu$$

Again $E = pc$, where $p$ = momentum and $c$ = speed of light.

So, $h\nu = pc$

$\Rightarrow$ $p = \frac{h\nu}{c}$

**49.** The current sensitivity of a galvanometer increases by 10%. If its resistance also increases by 20%, the voltage sensitivity will

**(1)** decrease by 8.3% **(2)** increase by 8.3%

**(3)** decrease by 21.5% **(4)** remain unaffected

**Ans. Option (1) is correct.**

***Explanation:*** Voltage sensitivity

$$= \frac{\text{Current sensitivity}}{R}$$

i.e., $V_s = \frac{I_s}{R}$

Now $I'_s = I_s + \frac{10}{100}I_s = 1.1\, I_s$

$$R' = R + \frac{20}{100}R = 1.2\,R$$

So, $V_s = \frac{1.1\, I_s}{1.2\, R} = 0.917\, V_s$

Therefore, the % decrease in voltage sensitivity

$$\frac{V_S - 0.917V_S}{V_S}\times 100 = 0.083 \times 100$$

$$= 8.3\%$$

**50.** An equiconvex lens has a focal length $\frac{2}{3}$ times the radius of curvature of either surface. The refractive index of the material of the lens is:

**(1)** 1.29 **(2)** 1.52

**(3)** 1.63 **(4)** 1.75

**Ans. Option (4) is correct.**

***Explanation:*** From the lens maker's formula,

$$\frac{1}{f} = (\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

we have, $\frac{1}{f} = (\mu-1)\left(\frac{1}{R}+\frac{1}{R}\right)$

[$\because R_1 = R$ and $R_2 = -R$]

$$\frac{1}{f} = (\mu-1)\left(\frac{2}{R}\right)$$

According to the question,

$$\frac{1}{\left(\frac{2}{3}\right)R} = (\mu-1)\left(\frac{2}{R}\right)$$

$$\frac{3}{2R} = (\mu-1)\left(\frac{2}{R}\right)$$

$$\mu - 1 = \frac{3}{2R}\times\frac{R}{2} = \frac{3}{4}$$

$$\mu = \frac{3}{4}+1 = \frac{3+4}{4} = \frac{7}{4} = 1.75$$

◆◆◆