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Questions Paper

SERIES: SSJ/1 | CODE : 055/1/4 | SET-4**SUBJECT : PHYSICS****TIME ALLOWED: 90 MINUTES****MAXIMUM MARKS : 35****NOTE**

- (i) Please check that this question paper contains 23 printed pages.
- (ii) Please check that this question paper contains 55 multiple choice questions (MCQs.)
- (iii) QP Code given on the right hand side of the question paper should be written at the appropriate place of the OMR Sheet by the candidates.
- (iv) 20 minute additional time has been allotted to read this question paper prior to actual time of commencement of examination.

GENERAL INSTRUCTIONS:

- (i) This question paper contains 55 questions out of which 45 questions are to be attempted. All questions carry equal marks.
- (ii) The question paper consists of three Sections – Section A, B and C.
- (iii) Section – A contains 25 questions. Attempt any 20 questions from Q. No. 01 to 25.
- (iv) Section – B contains 24 questions. Attempt any 20 questions from Q.No. 26 to 49.
- (v) Section – C contains 6 questions. Attempt any 5 questions from Q.No. 50 to 55.
- (vi) The first 20 Questions attempted in Section – A & Section – B and first 5 questions attempted in Section – C by a candidate will be evaluated.
- (vii) There is only one correct option for every multiple choice question (MCQ). Marks will not be awarded for answering more than one option.
- (viii) There is no negative marking.

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SECTION – A

This Section consists of **25 multiple choice** questions with overall choice to **attempt any 20 questions**. In case more than desirable number of questions are attempted, only first **20 questions** will be considered for evaluation.

1. An electric dipole placed in a non-uniform electric field will experience :
 (a) only a force (b) only a torque
 (c) both force and torque (d) neither force nor torque

Ans. (c)

Sol. both force and torque

2. Let N_1 be the number of electric field lines going out of an imaginary cube of side 'a' that encloses an isolated point charge $2q$ and N_2 be the corresponding number for an imaginary sphere of radius 'a' that encloses an isolated point charge $3q$. Then (N_1/N_2) is

- (a) $\frac{1}{\pi}$ (b) $\frac{2}{3}$ (c) $\frac{9}{4}$ (d) π

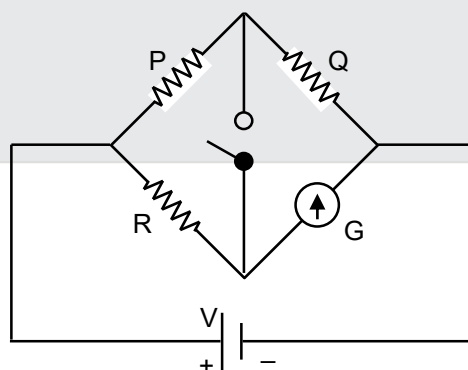
Ans. (b)

Sol. $N_1 = \phi_1 = \frac{2q}{\epsilon_0}$

$N_2 = \phi_2 = \frac{3q}{\epsilon_0}$

$\frac{N_1}{N_2} = \frac{2q}{\epsilon_0} \times \frac{\epsilon_0}{3q} = \frac{2}{3}$

3. In the circuit given below $P \neq R$ and the reading of the galvanometer is same with switch S open or closed. Then :



- (a) $I_Q = I_R$ (b) $I_R = I_G$ (c) $I_P = I_G$ (d) $I_Q = I_G$

Ans. (b)

Sol. Balance wheat stone bridge

Here $I_P = I_Q$

$I_R = I_G$

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4. Two wires A and B of the same material having length in the ratio 1 : 2 and diameter in the ratio 2 : 3 are connected in series with a battery. The ratio of the potential differences (V_A / V_B) across the two wires respectively is :

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

Ans. (d)

Sol. $\frac{\ell_1}{\ell_2} = \frac{1}{2}, \frac{d_1}{d_2} = \frac{2}{3}$

$V_1 = IR_1, V_2 = IR_2$

$\frac{V_1}{V_2} = I \frac{\rho \ell_1}{A_1} \times \frac{A_2}{I \rho \ell_2} = \frac{1}{2} \times \frac{\pi}{4} d_2^2 \times \frac{4}{\pi d_1^2} \Rightarrow \frac{1}{2} \times \frac{9}{4} = \frac{9}{8}$ (In series I = same)

5. Two moving coil galvanometers G_1 and G_2 have the following particulars respectively :

$N_1 = 30, A_1 = 3.6 \times 10^{-3} \text{ m}^2, B_1 = 0.25 \text{ T}$

$N_2 = 42, A_2 = 1.8 \times 10^{-3} \text{ m}^2, B_2 = 0.50 \text{ T}$

The spring constant is same for both the galvanometers, The ratio of current sensitivities of G_1 and G_2 is :

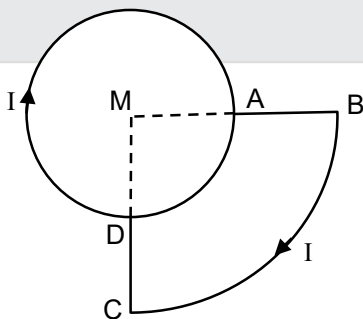
(a) 5 : 7 (b) 7 : 5 (c) 1 : 4 (d) 1 : 1

Ans. (a)

Sol. $S_1 = \frac{\phi}{I} = \frac{BNA}{K} \Rightarrow$

$\frac{(S_1)_1}{(S_1)_2} = \frac{B_1 N_1 A_1}{K_1} \times \frac{K_2}{B_2 N_2 A_2} = \frac{0.25 \times 30 \times 3.6 \times 10^{-3}}{0.50 \times 42 \times 1.8 \times 10^{-3}}$
 $= \frac{30}{42} \Rightarrow \frac{5}{7}$

6. A current I is flowing through the loop as shown in the figure ($MA = R, MB = 2R$). The magnetic field at the centre of the loop is $\frac{\mu_0 I}{R}$ times :



(a) $\frac{5}{16}$, into the plane of the paper (b) $\frac{5}{16}$, out of the plane of the paper
 (c) $\frac{7}{16}$, out of the plane of the paper (d) $\frac{7}{16}$, into the plane of the paper

Ans. (d)

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Sol. $B = B_1 + B_2$

$$= \frac{\mu_0 I}{4\pi R} \times \frac{3\pi}{2} + \frac{\mu_0 I}{4\pi(2R)} \times \frac{\pi}{2}$$

$$= \frac{\mu_0 I}{R} \left(\frac{3}{8} + \frac{1}{16} \right)$$

$$= \frac{\mu_0 I}{R} \left(\frac{6+1}{16} \right)$$

$$B = \frac{\mu_0 I}{R} \left(\frac{7}{16} \right) \text{ into the plane of paper}$$

7. A capacitor and an inductor are connected in two different ac circuits with a bulb glowing in each circuit. The bulb glows more brightly when :

- (a) the number of turns in the inductor is increased
- (b) the separation between the plates of the capacitor is increased
- (c) an iron rod is introduced into the inductor
- (d) a dielectric is introduced into the gap between the plates of the capacitor

Ans. (d)

8. A pure inductor of 318 mH and a pure resistor of 75Ω are connected in series to an ac source of 50 Hz. The voltage across 75Ω resistor is found to be 150 V. The source voltage is :

- (a) 150 V
- (b) 175 V
- (c) 220 V
- (d) 250 V

Ans. (d)

Sol. $L = 318 \text{ mH} = 318 \times 10^{-3} \text{ H}$

$$R = 75 \Omega, V_R = 150 \text{ V}$$

$$f = 50 \text{ Hz}$$

$$I = \frac{V_R}{R} = \frac{150}{75} = 2 \text{ A}$$

$$V = I Z$$

$$= 2 \times (\sqrt{R^2 + X_L^2})$$

$$= 2 \times [\sqrt{(75)^2 + (2\pi fL)^2}]$$

$$V = 250 \text{ V}$$

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9. The electric potential at a point on the axis of a short electric dipole, at a distance x from the mid-point of dipole is proportional to :

(a) $\frac{1}{x^4}$ (b) $\frac{1}{x^{3/2}}$ (c) $\frac{1}{x^3}$ (d) $\frac{1}{x^2}$

Ans. (d)

Sol. $V = \frac{Kp \cos \theta}{x^2} \Rightarrow V \propto \frac{1}{x^2}$

10. Let F_1 be the magnitude of the force between two small spheres, charged to a constant potential in free space and F_2 be the magnitude of the force between them in a medium of dielectric constant k . Then (F_1/F_2) is :

(a) $\frac{1}{k}$ (b) k (c) k^2 (d) $\frac{1}{k^2}$

Ans. (b)

Sol. $F_1 = \frac{q_1 q_2}{4\pi\epsilon_0 r^2}, F_2 = \frac{q_1 q_2}{4\pi\epsilon_0 k r^2}$

$$\frac{F_1}{F_2} = \frac{q_1 q_2}{4\pi\epsilon_0 r^2} \times \frac{4\pi\epsilon_0 k r^2}{q_1 q_2} = k$$

11. Infinity resistance in a resistance box has :

(a) a resistance of $10^5 \Omega$.
(b) a resistance of $10^7 \Omega$
(c) a resistance of ∞ resistance
(d) a gap only

Ans. (d)

Sol. (d) a gap only

12. A battery of 15 V and negligible internal resistance is connected across a 50Ω resistor. The amount of energy dissipated as heat in the resistor in one minute is:

(a) 122 J (b) 270 J (c) 420 J (d) 720 J

Ans. (b)

Sol. $H = \frac{V^2 t}{R} = \frac{15 \times 15 \times 60}{50} = 270 \text{ J}$

13. Lenz's law is the consequence of the law of conservation of:

(a) energy (b) charge (c) mass (d) momentum

Ans. (a)

Sol. (a) energy

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14. The vertical component of earth's magnetic field at a place is $\left(\frac{1}{\sqrt{3}}\right)$ times the horizontal component.

The angle of dip at that place is:

- (a) 0° (b) 30° (c) 45° (d) 60°

Ans. (b)

Sol. $B_V = \frac{1}{\sqrt{3}} B_H$

$$\frac{B_V}{B_H} = \frac{1}{\sqrt{3}} = \tan \delta \Rightarrow \delta = 30^\circ$$

15. A long straight wire in the horizontal plane carries a current of 15 A in north to south direction. The magnitude and direction of magnetic field at a point 2.5 m east of the wire respectively are:

- (a) $1.2 \mu\text{T}$, vertically upward (b) $1.2 \mu\text{T}$, vertically downward
(c) $0.6 \mu\text{T}$, vertically upward (d) $0.6 \mu\text{T}$, vertically downward

Ans. (a)

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

$$= \frac{4\pi \times 10^{-7} \times 15}{2\pi \times 2.5} = 12 \times 10^{-7} \text{ T} = 1.2 \mu\text{T} \text{ vertically upward}$$

16. The emf induced in a 10 H inductor in which current changes from 11 A to 2 A in 9×10^{-1} s is:

- (a) 10^4 V (b) 10^3 V (c) 10^2 V (d) 10 V

Ans. (c)

Sol. $\varepsilon = -L \frac{\Delta I}{\Delta t}$

$$= \frac{-10 \times (2 - 11)}{9 \times 10^{-1}} = \frac{90}{9 \times 10^{-1}} = 100 \text{ V} = 10^2 \text{ V}$$

17. A charge Q is placed at the centre of the line joining two charges q and q. The system of the three charges will be in equilibrium if Q is:

- (a) $+\frac{q}{3}$ (b) $-\frac{q}{3}$ (c) $+\frac{q}{4}$ (d) $-\frac{q}{4}$

Ans. (d)

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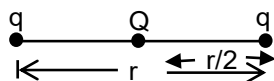
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Sol.



$$\frac{Kq^2}{r^2} = \frac{kQq}{(r/2)^2}$$

$$Q = \frac{q}{r^2} \left(\frac{r}{2} \right)^2 \Rightarrow Q = \frac{q}{r^2} \frac{r^2}{4} = \frac{-q}{4}$$

18. Electric flux of an electric field $\vec{E}$ through an area $d\vec{A}$ is given by:

- (a) $\vec{E} \times d\vec{A}$ (b) $\frac{\vec{E} \times d\vec{A}}{\epsilon_0}$ (c) $\vec{E} \cdot d\vec{A}$ (d) $\frac{\vec{E} \cdot d\vec{A}}{\epsilon_0}$

Ans. (c)

Sol. $\phi = \vec{E} \cdot d\vec{A}$

19. In a potentiometer experiment, the balancing length with a cell is 120 cm. When the cell is shunted by a 1Ω resistance, the balancing length becomes 40 cm. The internal resistance of the cell is:

- (a) 10Ω (b) 7Ω (c) 3Ω (d) 2Ω

Ans. (d)

Sol. $\ell = 120 \text{ cm}$

$$R = 1 \Omega$$

$$\ell_2 = 40 \text{ cm}$$

$$r = \left(\frac{\ell_1 - \ell_2}{\ell_2} \right) R$$

$$r = \left(\frac{120 - 40}{40} \right) \times 1 = \frac{80}{40} = 2 \Omega$$

20. An electron is projected with velocity $\vec{v}$ along the axis of a current carrying long solenoid. Which one of the following statements is true?

- (a) The path of the electron will be circular about the axis
(b) The electron will be accelerated along the axis.
(c) The path of the electron will be helical
(d) The electron will continue to move with the same velocity $\vec{v}$ along the axis of the solenoid.

Ans. (d)

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21. If the speed v of a charged particle moving in a magnetic field $\vec{B}$ ($\vec{v}$ is perpendicular to $\vec{B}$) is halved, then the radius of its path will:

- (a) not change (b) become two times (c) become one-fourth (d) become half

Ans. (d)

Sol. $r = \frac{mv}{qB}$,

$$r' = \frac{r}{2}$$

22. A metal plate is getting heated. Which one of following statements is incorrect?

- (a) It is placed in a space varying magnetic field that does not vary with time.
(b) A direct current is passing through the plate
(c) An alternating current is passing through the plate
(d) It is placed in a time varying magnetic field.

Ans.. (a)

23. In an ac circuit the applied voltage and resultant current are $E = E_0 \sin \omega t$ and $I = I_0 \sin \left(\omega t + \frac{\pi}{2} \right)$ respectively. The average power consumed in the circuit is:

- (a) $E_0 I_0$ (b) $\frac{E_0 I_0}{2}$ (c) $\frac{E_0 I_0}{\sqrt{2}}$ (d) Zero

Ans.. (d)

Sol. Phase difference $(\phi) = \frac{\pi}{2}$

Average power $\langle P \rangle = V_{rms} \cdot I_{rms} \cos \phi$

$$= V_{rms} \cdot I_{rms} \cos \frac{\pi}{2} = 0$$

24. The speed acquired by a free electron when accelerated from rest through a potential difference of 100 V is:

- (a) $6 \times 10^6 \text{ m s}^{-1}$ (b) $3 \times 10^6 \text{ m s}^{-1}$ (c) $4 \times 10^5 \text{ m s}^{-1}$ (d) $2 \times 10^3 \text{ m s}^{-1}$

Ans. (a)

Sol. $\frac{1}{2} mv^2 = qV$

$$v = \sqrt{\frac{2qV}{m}} = 6 \times 10^6 \text{ m/s}$$

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25. Which one of the following is not affected by the presence of a magnetic field?
- (a) A Current carrying conductor
 - (b) A moving charge
 - (c) A stationary charge
 - (d) A rectangular current loop with its plane parallel to the field

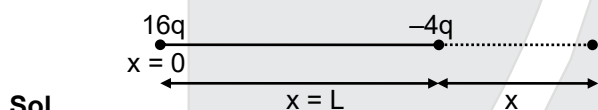
Ans. (c)

SECTION – B

Section-B consists 24 questions. Attempt any 20 questions from this section,
20 Questions attempted first, will only be evaluated.

26. Two point charge $+16q$ and $-4q$ are located at $x = 0$ and $x = L$. The location of the point on x -axis at which the resultant electric field due to these charge is zero, is:
- (a) $8L$
 - (b) $6L$
 - (c) $4L$
 - (d) $2L$

Ans. (d)



$$\frac{K(16q)}{(L+x)^2} = \frac{K(4q)}{x^2}$$

$$4x^2 = (L+x)^2$$

$$2x = (L+x)$$

$$2x = L + x$$

$$x = L \Rightarrow \text{Here } L + L = 2L$$

27. An electric dipole of dipole moment $4 \times 10^{-5} \text{ C-m}$, kept in a uniform electric field of 10^3 NC^{-1} , experiences a torque of $2 \times 10^{-8} \text{ Nm}$. The angle which the dipole makes with the electric field is:
- (a) 30°
 - (b) 45°
 - (c) 60°
 - (d) 90°

Ans. (a)

Sol. $\tau = PE \sin \theta$

$$2 \times 10^{-8} = 4 \times 10^{-5} \times 10^3 \sin \theta$$

$$1/2 = \sin \theta \Rightarrow \theta = 30^\circ$$

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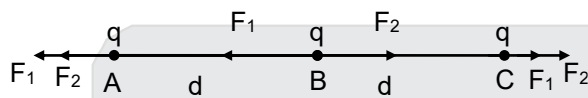
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28. Three identical charges are placed on x-axis from left to right with adjacent charges separated by a distance d . The magnitude of the force on a charge from its nearest neighbour charge is F . Let $\hat{i}$ be the unit vector along + x-axis, then the net force on each charge from left to right is:

- (a) $(2F\hat{i}, -2F\hat{i}, 2F\hat{i})$ (b) $(F\hat{i}, 0\hat{i}, F\hat{i})$ (c) $(-\frac{5}{4}F\hat{i}, 0, \frac{5}{4}F\hat{i})$ (d) $(2F\hat{i}, 0\hat{i}, 2F\hat{i})$

Ans. (c)

Sol.



$$\text{Force on A : } F = \frac{Kq^2}{d^2} + \frac{Kq^2}{(2d)^2} = \frac{Kq^2}{d^2} \left[1 + \frac{1}{4} \right]$$

$$F = \frac{5Kq^2}{4d^2}$$

$$\vec{F} = -\frac{5Kq^2}{4d^2} \hat{i}$$

$$\text{Force on B : } F = 0$$

$$\text{Force on C : } F = \frac{Kq^2}{d^2} + \frac{Kq^2}{(2d)^2} = \frac{Kq^2}{d^2} \left[1 + \frac{1}{4} \right]$$

$$F = \frac{5Kq^2}{4d^2}$$

29. The students A and B calculate the charge flowing through a circuit. A concludes that 300 C of charge flows in 1 minutes. B concludes that 3.125×10^{19} electrons flow in 1 second. If the current measured in the circuit is 5 A, then the correct calculation is done by:

- (a) A (b) B (c) both A and B (d) neither A nor B

Ans. (c)

$$\text{Sol. } (I)_A = \frac{Q}{t} = \frac{300}{60} = 5A$$

$$(I)_B = \frac{Q}{t} = \frac{ne}{t} = \frac{3.125 \times 10^{19} \times 1.6 \times 10^{-19}}{1} = 5A$$

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30. The resistances of two wires having same length and same area of cross-section are 2Ω and 8Ω respectively. If the resistivity of 2Ω wire is $2.65 \times 10^{-8} \Omega\text{-m}$ then the resistivity of 8Ω wire is:

- (a) $10.60 \times 10^{-8} \Omega\text{-m}$ (b) $8.32 \times 10^{-8} \Omega\text{-m}$
(c) $7.61 \times 10^{-8} \Omega\text{-m}$ (d) $5.45 \times 10^{-8} \Omega\text{-m}$

Ans. (a)

Sol. $R_1 = \frac{\rho_1 \ell}{A}$

$$R_2 = \frac{\rho_2 \ell}{A}$$

$$\frac{R_1}{R_2} = \frac{\rho_1}{\rho_2}$$

$$\frac{2}{8} = \frac{2.65 \times 10^{-8}}{\rho_2}$$

$$\rho_2 = 10.60 \times 10^{-8} \Omega\text{m}$$

31. In a certain region electric field $\vec{E}$ and magnetic field $\vec{B}$ are perpendicular to each other. An electron enters the region perpendicular to the direction of both $\vec{E}$ and $\vec{B}$ and moves undeflected. The speed of the electron is:

- (a) $\vec{E} \cdot \vec{B}$ (b) $|\vec{E} \times \vec{B}|$ (c) $\frac{|\vec{E}|}{|\vec{B}|}$ (d) $\frac{|\vec{B}|}{|\vec{E}|}$

Ans. (c)

Sol. $qE = qvB$

$$v = \frac{|\vec{E}|}{|\vec{B}|}$$

32. A test charge of $1.6 \times 10^{-19} \text{ C}$ is moving with a velocity $\vec{v} = (4\hat{i} + 3\hat{k}) \text{ ms}^{-1}$ in a magnetic field $\vec{B} = (3\hat{k} + 4\hat{i})$ T. The force on this test charge is:

- (a) $24\hat{j} \text{ N}$ (b) $-24\hat{i} \text{ N}$ (c) $24\hat{k} \text{ N}$ (d) 0

Ans. (d)

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Sol. $F = q(\vec{v} \times \vec{B})$

$$F = 1.6 \times 10^{-19} [(4\hat{j} + 3\hat{k}) \times (3\hat{k} + 4\hat{i})]$$

$$F = 1.6 \times 10^{-19} [-12\hat{j} + 0 + 0 + 12\hat{j}]$$

$$F = 0$$

33. In a series LCR circuit, at resonance the current is equal to:

- (a) $\frac{V}{R}$ (b) $\frac{V}{X_C}$ (c) $\frac{V}{X_L - X_C}$ (d) $\frac{V}{\sqrt{R^2 + (X_L - X_C)^2}}$

Ans. (a)

Sol. $I = \frac{V}{Z} = \frac{V}{R}$; At Resonance ($Z = R$)

34. The frequency of an ac source for which a $10\mu\text{F}$ capacitor has a reactance of 1000Ω is:

- (a) $\frac{1000}{\pi}$ Hz (b) 50 Hz (c) $\frac{50}{\pi}$ Hz (d) $\frac{100}{\pi}$ Hz

Ans. (c)

Sol. $X_C = 1000\Omega$

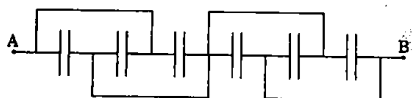
$$C = 10\mu\text{F} = 10 \times 10^{-6}\text{F}$$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

$$f = \frac{1}{2\pi C X_C} = \frac{1}{2\pi \times 10 \times 10^{-6} \times 1000}$$

$$f = \frac{50}{\pi} \text{ Hz}$$

35. In the given network all capacitors used are identical and each one is of capacitance C . Which of the following is the equivalent capacitance between the point A and B ?



- (a) $6C$ (b) $\frac{5}{2}C$ (c) $\frac{3}{2}C$ (d) $\frac{5}{6}C$

Ans. (c)

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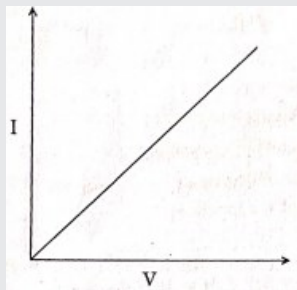
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Sol. $\frac{1}{C_{\text{net}}} = \frac{1}{3C} + \frac{1}{3C}$

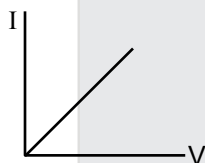
$\Rightarrow C_{\text{net}} = \frac{3C}{2}$

36. The given figure shows I – V graph of a copper wire whose length and area of cross-section are L and A respectively. The slope of this curve becomes:



- (a) less if the length of the wire is increased
(b) more if the length of the wire is increased
(c) more if a wire of steel of same dimension is used
(d) more if the temperature of wire is increased

Ans. (a)



Sol.

Slope of I-V graph = $1/R = A/\rho\ell$

37. When a potential difference V is applied across a conductor at temperature T, the drift velocity of the electrons is proportional to:

- (a) T (b) $\sqrt{T}$ (c) V (d) $\sqrt{V}$

Ans. (c)

Sol. $V_d = \frac{eE\tau}{m}$

$V_d \propto E \propto V$ (Potential)

$V_d \propto V$

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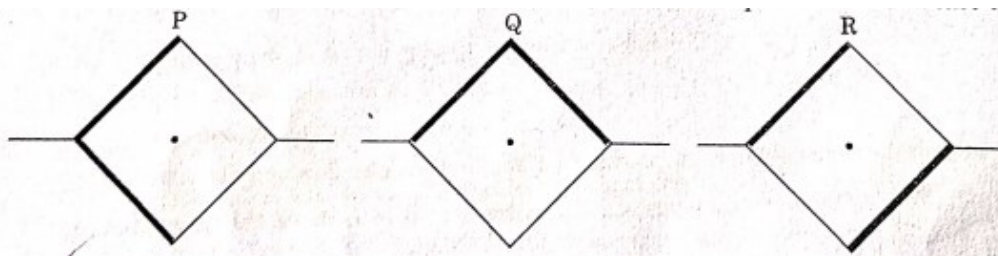
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38. Two identical thick wires and two identical thin wires, all of the same material and the same length form a square in three different ways P, Q and R as shown. Due to the current in these loops the magnetic field at the centre of the loop will be zero in case of:



- (a) P and R only (b) Q and R only (c) P and Q only (d) P, Q and R

Ans. (a)

Sol. P and R only

39. A circular current carrying coil produces a magnetic field B_0 at its centre. The coil is rewound so as to have three turns and the same current is passed through it. The new magnetic field at the centre is:

- (a) $3 B_0$ (b) $\frac{B_0}{3}$ (c) $\frac{B_0}{9}$ (d) $9 B_0$

Ans. (d)

Sol. $B' = n^2 B$

$B' = 9B$

40. Which one of the following statements is true?
- (a) An inductor has infinite resistance in a dc circuit.
(b) An inductor and a capacitor both cannot conduct in a dc circuit.
(c) A capacitor can conduct in a dc circuit but not an inductor
(d) An inductor can conduct in a dc circuit but not a capacitor

Ans. (d)

41. The magnetic flux linked with a coil is given by $\phi = 5t^2 + 3t + 16$, where ϕ is in webers and t in seconds. The induced emf in the coil at $t = 5$ s will be:

- (a) 53 V (b) 43 V (c) 10 V (d) 6 V

Ans. (a)

Sol. $\varepsilon = \frac{d\phi}{dt}$

$$\varepsilon = 10t + 3$$

$$(\varepsilon)_{t=5} = 53V$$

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42. If a charge is moved against a coulomb force of an electric field, then the
- intensity of the electric field increases
 - intensity of the electric field decreases
 - work is done by the electric field
 - work is done by the external source

Ans. (d)

43. A charge Q is located at the centre of a radius r . The work done in moving a test charge q_0 from point A to point B (at opposite ends of diameter AB) so as to complete a semicircle is $\left[k = \frac{1}{(4\pi\epsilon_0)} \right]$

- $k \frac{q_0 Q}{r}$
- $k \frac{Qq_0}{r^2}$
- $K q_0 Q r$
- Zero

Ans. (d)

44. A long solenoid carrying current produces a magnetic field B along its axis. If the number of turns in the solenoid is halved and current in it is doubled, the new magnetic field will be

- $\frac{B}{2}$
- B
- $2B$
- $4B$

Ans. (b)

Sol. $B = \frac{\mu_0 NI}{\ell}$, $B' = \frac{\mu_0 N \times 2I}{2\ell} = \frac{\mu_0 NI}{\ell}$
 $B = B'$

Question Nos. 45 to 49 are Assertion (A) and Reason (R) type questions. Given below are two statements labelled as Assertion (A) and Reason (R). Select the most appropriate answer from the options given below.

- Both Assertion (A) and Reason (R) are True and Reason (R) is the correct explanation of Assertion (A).
- Both Assertion (A) and Reason (R) are True, but Reason (R) is NOT the correct explanation of Assertion (A).
- Assertion (A) is True, but Reason (R) is False.
- Assertion (A) is False, but Reason (R) is True.

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45. Assertion (A) : A bar magnet experiences a torque, when placed in a magnetic field.

Reason (R) : A bar magnet exerts a torque on itself due to its own magnetic field.

Ans. (c)

46. Assertion (A) : In a series LCR circuit connected to an AC source, resonance can take place.

Reason (R) : At resonance, $X_L = X_C$.

Ans. (b)

47. Assertion (A) : When a charged particle moves with a velocity $\vec{v}$ in a magnetic field $\vec{B}$ ($\vec{v} \perp \vec{B}$), the force on the particle does no work.

Reason (R) : The magnetic force is perpendicular to the velocity of the particle.

Ans. (a)

48. Assertion (A) : Induced emf in two coils made of wire of the same length and the same thickness, one of copper and another of aluminium is same. The current in the copper coil is more than the aluminium coil.

Reason (R) : Resistance of aluminium coil is more than that of copper coil.

Ans. (a)

49. Assertion (A) : A transformer is used to increase or decrease AC voltage only.

Reason (R) : A transformer works on the basis of mutual induction.

Ans. (a)

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SECTION – C

Section-C consists 6 questions. Attempt any 5 questions from this section.

50. Two charged spheres A and B having their radii in the ratio 1 : 2 are connected together with a conducting wire. The ratio of their surface charge densities $\left(\frac{\sigma_A}{\sigma_B}\right)$ will be :

- (a) $\frac{1}{2}$ (b) 2 (c) $\frac{1}{4}$ (d) 4

Ans. (b)

Sol. $V_1 = V_2$

$$\frac{kQ_1}{R_1} = \frac{kQ_2}{R_2} \quad \therefore \quad \frac{R_1}{R_2} = \frac{1}{2}$$

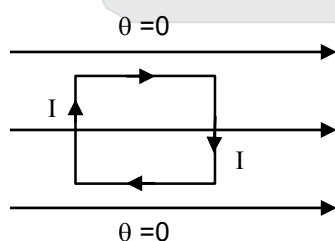
$$\begin{aligned} \frac{\sigma_A}{\sigma_B} &= \frac{q_1}{4\pi R_1^2} \times \frac{4\pi R_2^2}{q_2} = \frac{q_1}{q_2} \times \frac{R_2^2}{R_1^2} \\ &= \frac{R_1}{R_2} \times \frac{R_2^2}{R_1^2} \\ &= \frac{R_2}{R_1} = \frac{2}{1} \end{aligned}$$

51. A current carrying square loop is suspended in a uniform magnetic field acting in the plane of the loop. If the force on one arm of the loop is $\vec{F}$, the net force on the remaining three arms of the loop will be :

- (a) $3\vec{F}$ (b) $-3\vec{F}$ (c) $\vec{F}$ (d) $-\vec{F}$

Ans. (d)

Sol.



$$\vec{F} = I(\vec{\ell} \times \vec{B})$$

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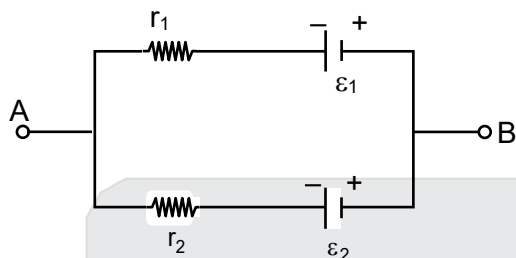
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Case Study

A battery is a combination of two or more cells. In the following figure, a single battery is represented in which two cells of emf ε_1 & ε_2 and internal resistance r_1 & r_2 respectively are connected.



Answer the following questions :

52. The equivalent emf of this combination is :

- (a) $\frac{\varepsilon_1 r_1 + \varepsilon_2 r_2}{r_1 + r_2}$ (b) $\frac{\varepsilon_1 r_1 - \varepsilon_2 r_2}{r_1 + r_2}$ (c) $\frac{\varepsilon_1 r_2 - \varepsilon_2 r_1}{r_1 + r_2}$ (d) $\varepsilon_1 - \varepsilon_2$

Ans. (c)

53. For terminal B to be negative :

- (a) $\varepsilon_1 r_2 > \varepsilon_2 r_1$ (b) $\varepsilon_1 r_2 < \varepsilon_2 r_1$ (c) $\varepsilon_1 r_1 > \varepsilon_2 r_2$ (d) $\varepsilon_2 r_2 = \varepsilon_1 r_1$

Ans. (b)

Sol. $\varepsilon_B - \varepsilon_A = \frac{\varepsilon_1 r_2 - \varepsilon_2 r_1}{r_1 + r_2}$

for negative potential.

$$\varepsilon_B - \varepsilon_A \leq 0$$

So $\frac{\varepsilon_1 r_2 - \varepsilon_2 r_1}{r_1 + r_2} < 0$

$$\varepsilon_1 r_2 \leq \varepsilon_2 r_1$$

54. The current in the internal circuit is :

- (a) $\frac{\varepsilon_1 + \varepsilon_2}{r_1 + r_2}$ (b) $\frac{\varepsilon_2 - \varepsilon_1}{r_1 + r_2}$ (c) $\frac{\varepsilon_1}{r_1} - \frac{\varepsilon_2}{r_2}$ (d) $\frac{\varepsilon_1}{r_2} - \frac{\varepsilon_2}{r_1}$

Ans. (c)

Sol. $I = \frac{\varepsilon_{eq}}{r_{eq}} = \frac{\frac{\varepsilon_1 r_2 - \varepsilon_2 r_1}{r_1 + r_2}}{\frac{r_1 r_2}{r_1 + r_2}} = \frac{\varepsilon_1 r_2 - \varepsilon_2 r_1}{r_1 r_2} \times \frac{r_1 + r_2}{r_1 + r_2} = \frac{\varepsilon_1}{r_1} - \frac{\varepsilon_2}{r_2}$

55. The equivalent internal resistance of the combination is :

- (a) $\frac{r_1 + r_2}{r_1 r_2}$ (b) $r_1 + r_2$ (c) $\frac{r_1 r_2}{r_1 + r_2}$ (d) $r_1 - r_2$

Ans. (c)

Sol. $\frac{r_1 r_2}{r_1 + r_2}$

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