Magnetic Effects Of Current And Magnetism JEE Main PYQ - 1

Total Time: 25 Minute **Total Marks:** 40

Instructions

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1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Magnetic Effects Of Current And Magnetism

1. One of the two identical conducting wires of length L is bent in the form of a circular loop and the other one into a circular coil of N identical turns. If the same current is passed in both, the ratio of the magnetic field at the central of the loop (B_L) to that at the centre of the coil (B_C) , i.e., $R\frac{B_L}{B_C}$ will be **(+4, -1)**

[9 Jan 2019, II]

a. $\frac{1}{N}$

b. N^2

c. $\frac{1}{N^2}$

d. N

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2. A circular coil having N turns and radius r carries a current I. It is held in the XZ plane in a magnetic field $B\hat{i}$. The torque on the coil due to the magnetic field is : **(+4, -1)**

[8 April 2019 I]

a. $B\pi r^2 IN$

b. $\frac{Br^2 I}{\pi N}$

c. Zero

d. $\frac{B\pi r^2 I}{N}$

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3. Two very long, straight, and insulated wires are kept at 90° angle from each other in xy - plane as shown in the figure. These wires carry currents of equal magnitude I, whose directions are shown in the figure. The net magnetic field at point P will be : **(+4, -1)**

[12 April 2019, I]

a. $Zero$

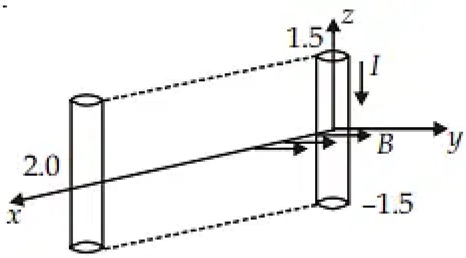
b. $\frac{+\mu_0 I}{\pi d}(\hat{z})$

c. $-\frac{\mu_0 I}{2\pi d}(\hat{x}+\hat{y})$

d. $\frac{\mu_0 I}{2\pi d}(\hat{x}+\hat{y})$

4. A conductor lies along the z -axis at $-1.5 \leq z < 1.5\,m$ and carries a fixed current of $10.0A$ in $-\hat{a}_z$ direction (see figure). For a field $\vec{B} = 3.0 \times 10^{-4} e^{-0.2x} \hat{a}_y T$, find the power required to move the conductor at constant speed to $x = 2.0m, y = 0\,m$ in $5 \times 10^{-3}\,s$. Assume parallel motion along the x -axis **(+4, -1)**

[2014]



a. 1.57 W

b. 2.97 W

c. 14.85 W

d. 29.7 W

5. A current loop, having two circular arcs joined by two radial lines is shown in the figure. It carries a current of $10\,A$. The magnetic field at point O will be close to : **(+4, -1)**

[9 Jan. 2019 I]

a. $1.0 \times 10^{-5} T$

b. $1.5 \times 10^{-5} T$

c. $1.0 \times 10^{-7} T$

d. $1.5 \times 10^{-7} T$

6. A galvanometer having a coil resistance of $100\,\Omega$ gives a full scale deflection, when a current of $1\,mA$ is passed through it. The value of the resistance, which can convert this galvanometer into ammeter giving a full scale deflection for a current of $10\,A$ is : **(+4, -1)**

[8 Jan 2019, II]

a. $0.01\,\Omega$

b. $2\,\Omega$

c. $0.1\,\Omega$

d. $3\,\Omega$

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7. A galvanometer of resistance G is converted into a voltmeter of range $0-1V$ by connecting a resistance R_1 in series with it. The additional resistance that should be connected in series with R_1 to increase the range of the voltmeter to $-2V$ will be : **(+4, -1)**

[Sep. 05, 2020 (I)]

a. R_1

b. R_1+G

c. R_1-G

d. G

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8. A galvanometer, whose resistance is $50\,ohm$, has 25 divisions in it. When a current of 4×10^{-4} A passes through it, its needle (pointer) deflects by one division. To use this galvanometer as a voltmeter of range $2.5\,V$, it should be connected to a resistance of: **(+4, -1)**

a. 6250 ohm

[12 Jan 2019, II]

b. 250 ohm

c. 200 ohm

d. 6200 ohm

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9. A charge particle of $2\,\mu C$ accelerated by a potential difference of $100\,V$ enters a region of uniform magnetic field of magnitude $4\,mT$ at right angle to the direction of field The charge particle completes semicircle of radius $3\,cm$ inside magnetic field The mass of the charge particle is _______ $\times10^{-18}kg$ **(+4, -1)**

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10. Two long parallel wires carrying currents $8A$ and $15A$ in opposite directions are placed at a distance of $7cm$ from each other A point P is at equidistant from both the wires such that the lines joining the point P to the wires are **(+4, -1)**

[25-Jan-2023 Shift2]

perpendicular to each other The magnitude of magnetic field at P is___ $\times 10^{-6} T$
(Given : $\sqrt{2}=1.4$)

Answers

1. **Answer: c**

Explanation:

$L = 2\pi R \ L = N \times 2\pi r$

$R = Nr$

$B_L = \frac{\mu_0 i}{2R}$

Concepts:

1. Moving Charges and Magnetism:

Moving charges generate an electric field and the rate of flow of charge is known as c urrent. This is the basic concept in Electrostatics. Another important concept related to moving electric charges is the magnetic effect of current. Magnetism is caused by the current.

Magnetism:

- The relationship between a Moving Charge and Magnetism is that Magnetism is produced by the movement of charges.
- And Magnetism is a property that is displayed by Magnets and produced by moving charges, which results in objects being attracted or pushed away.

Magnetic Field:

Region in space around a magnet where the Magnet has its Magnetic effect is called the Magnetic field of the Magnet. Let us suppose that there is a point charge q (moving with a velocity v and, located at r at a given time t) in presence of both the electric field E (r) and the magnetic field B (r). The force on an electric charge q due to both of them can be written as,

$$F = q [E (r) + v \times B (r)] \equiv E_{Electric} + F_{magnetic}$$

This force was based on the extensive experiments of Ampere and others. It is called the Lorentz force.

2. **Answer: a**

Explanation:

Magnetic moment of coil = $NIA\hat{j}$
$= NI(\pi r^2)\hat{j}$
Torque on loop (coil) = $\vec{M} \times \vec{B}$
$= NI(\pi r^2)B\sin 90^\circ(-\hat{k})$
$= NI\pi r^2 B(-\hat{k})$

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Explanation:

Magnetic field at point P

$\vec{B}_{net} = \frac{\mu_0 i}{2\pi d}\left(-\hat{k}\right) + \frac{\mu_0 i}{2\pi d}\left(\hat{k}\right) = 0$

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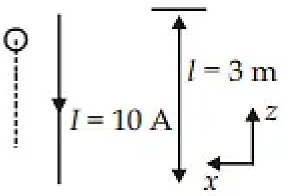
4. **Answer: b**

Explanation:

$$\text{Average Power} = \frac{\text{work}}{\text{time}}$$
$$W = \int_0^2 F dx$$
$$= \int_0^2 3.0 \times 10^{-4} e^{-0.2x} \times 10 \times 3\, dx$$
$$= 9 \times 10^{-3} \int_0^2 e^{-0.2x}\, dx$$
$$= \frac{9\times10^{-3}}{0.2}\left[-e^{-0.2\times2} + 1\right]$$
$$B = 3.0 \times 10^{-4} e^{-0.2x}$$



$$= \frac{9\times10^{-3}}{0.2} \times \left[1 - e^{-0.4}\right]$$
$$= 9 \times 10^{-3} \times (0.33)$$
$$= 2.97 \times 10^{-3}\, J$$
$$P = \frac{2.97\times10^{-3}}{(0.2)\times5\times10^{-3}}$$
$$= 2.97\, W$$

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5. **Answer: a**

Explanation:

$$\vec{B} = \frac{\mu_0 i}{4\pi}\theta\left[\frac{1}{r_1} - \frac{1}{r_2}\right]\hat{k}$$
$$r_1 = 3\,cm = 3 \times 10^{-2}m$$
$$r_2 = 5\,cm = 5 \times 10^{-2}m$$
$$\theta = \frac{\pi}{4}, i = 10A$$
$$\Rightarrow \vec{B} = \frac{4\pi \times 10^{-7}}{16} \times 10\left[\frac{1}{3\times10^{-2}} - \frac{1}{5\times10^{-2}}\right]\hat{k}$$
$$\Rightarrow \left|\vec{B}\right| = \frac{\pi}{3} \times 10^{-5}T$$
$$\approx 1 \times 10^{-5}T$$

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6. **Answer: a**

Explanation:

Maximum voltage that can be applied across the galvanometer coil $= 100\,\Omega \times 10^{-3} A = 0.1\,V$.
If R_s is the shunt resistance :
$R_S \times 10A = 0.1V$
$\Rightarrow\ R_S = 0.01\Omega$

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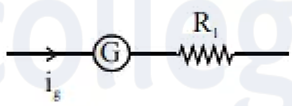
7. **Answer: b**

Explanation:



$\Rightarrow 1 = i_g(G + R_1) \quad \ldots (1)$

$\Rightarrow 2 = i_g\,(R_1 + R_2 + G)\ldots(2)$

(1) $\%(2)$

$\Rightarrow \frac{1}{2} = \frac{G+R_1}{G+R_1+R_2}$

$G + R_1 + R_2 = 2G + 2h_1$

$(R_2 = G + R_1)$

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8. **Answer: c**

Explanation:

$$I_g = 4 \times 10^{-4} \times 25 = 10^{-2} A$$
$$2.5 = (50 + R)10^{-2} \;\therefore\; R = 200\Omega$$

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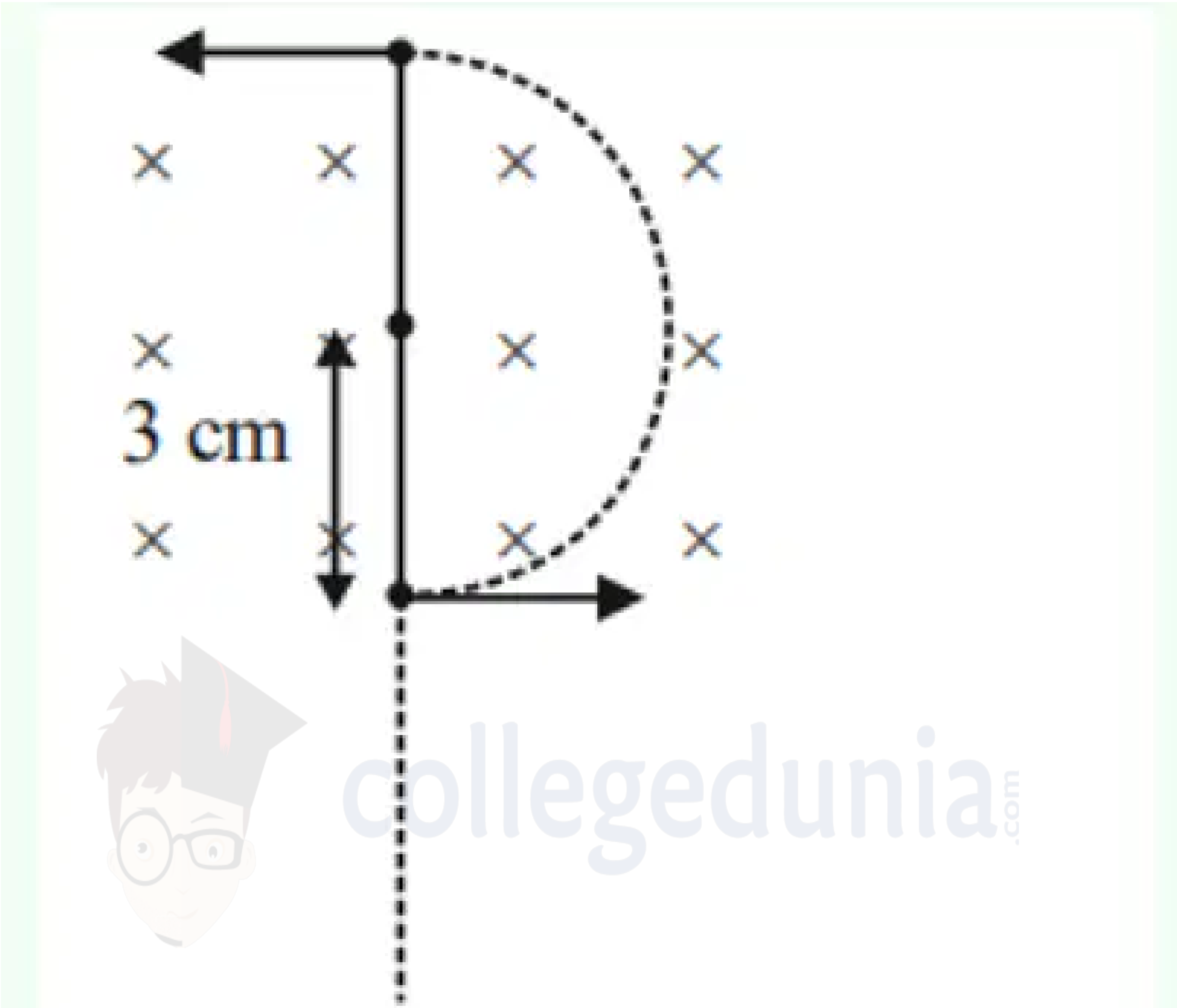
9. **Answer: 144 - 144**

Explanation:

The correct answer is 144.



$$r = \frac{mvqB}{=} \frac{2km}{qB}, m = \frac{r^2q^2B^2}{2k}$$
$$m = \frac{\frac{1}{100} \times \frac{3}{100} \times 2 \times 2 \times 4 \times 10^{-3} \times 4 \times 10^{-3} \times 10^{-12}}{2 \times (100) \times 10^{-16}}$$

$=144\times10^{-18}$kg

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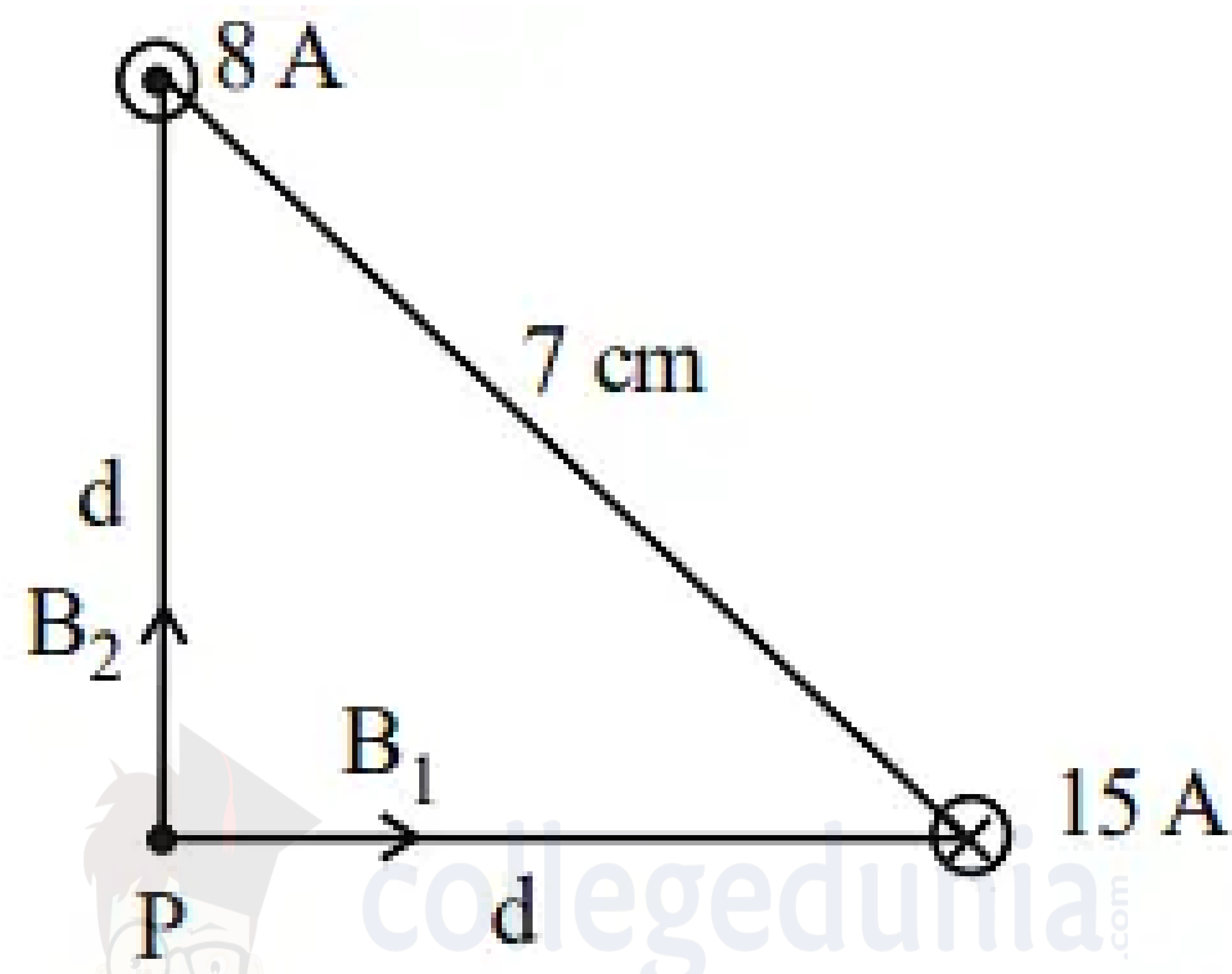
10. **Answer: 68 - 68**

Explanation:

The correct answer is 68



Magnetic fields due to both wires will be perpendicular to each other.

$B_1 = \frac{\mu_0 i_1}{2\pi d} B_2 = \frac{\mu_0 i_2}{2\pi d}$

$B_{net} = \sqrt{B_1^2 + B_2^2} \Rightarrow \frac{\mu_0}{2\pi d}\sqrt{i_1^2 + i_2^2}$

$\Rightarrow \frac{4\pi \times 10^{-7}}{2\pi \times (7/\sqrt{2}) \times 10^{-2}} \times \sqrt{8^2 + 15^2} \left(d = \frac{7}{\sqrt{2}} cm\right)$

$\Rightarrow 68 \times 10^{-6} T$

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