# Moving Charges and Magnetism JEE Main PYQ - 2

**Total Time:** 50 Minute                                          **Total Marks:** 80

## 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.

# Moving Charges and Magnetism

1. Two 10 cm long, straight wires, each carrying a current of 5 A are kept parallel to each other. If each wire experienced a force of $10^{-5}$ N, then separation between the wires is _ _ _ _ _ cm.  (+4, -1)

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2. A charge particle is moving in a uniform field $(2\hat{i} + 3\hat{j})T$. If it has an acceleration of $(\alpha\hat{i} - 4\hat{j})\ m/s^2$, then the value of α will be  (+4, -1)

   a. 3

   b. 6

   c. 12

   d. 2

---

3. A bar magnetic having a magnetic moment of $2.0 \times 10^5$ $JT^{-1}$, is placed along the direction of uniform magnetic field of magnitude $B = 14 \times 10^{-5}$ T. The work done in rotating the magnet slowly through 60° from the direction of field is:  (+4, -1)

   a. 14 J

   b. 8.4 J

   c. 4 J

   d. 1.4 J

---

4. A teacher in his physics laboratory allotted an experiment to determine the resistance (G) of a galvanometer. Students took the observations for $\frac{1}{3}$ deflection in the galvanometer. Which of the below is true for measuring value of G?  (+4, -1)

   a. $\frac{1}{3}$ deflection method cannot be used for determining the resistance of the galvanometer.

   b. $\frac{1}{3}$ deflection method can be used and in this case the G equals to twice the value of shunt resistance(s).

c. $\frac{1}{3}$ deflection method can be used and in this case, the G equals to three times the value of shunt resistance(s).

d. $\frac{1}{3}$ deflection method can be used and in this case the G value equals to the shunt resistance(s).

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5. A charge particle is moving in a uniform magnetic field $(2\hat{i} + 3\hat{j})T$ If it has an acceleration of $(\alpha\hat{i} - 4\hat{j})m/s^2$, then the value of $\alpha$ will be          (+4, −1)

a. 3

b. 6

c. 12

d. 2

---

6. The dimensions of $\left(\frac{B^2}{\mu_0}\right)$ will be :(if $\mu_0$ : permeability of free space andB : magnetic field)          (+4, −1)

a. $\left[ML^2T^{-2}\right]$

b. $\left[MLT^{-2}\right]$

c. $\left[ML^{-1}T^{-2}\right]$

d. $\left[ML^2T^{-2}A^{-1}\right]$

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7. Two charged particles, having same kinetic energy, are allowed to pass through a uniform magnetic field perpendicular to the direction of motion If the ratio of radii of their circular paths is $6 : 5$ and their respective masses ratio is $9 : 4$ Then, the ratio of their charges will be :          (+4, −1)

a. $8 : 5$

b. $5 : 4$

c. $5 : 3$

d. $8:7$

---

8. In a moving coil galvanometer if the number of turns increases by 25%, then change in voltage sensitivity is? **(+4, −1)**

   a. 0

   b. 1%

   c. 25%

   d. 50%

---

9. The characteristics of two coil is given below. If the magnetic moment of both coil A and B are equal then choose the correct relation, **(+4, −1)**

| | Coil A | Coil B |
|---|---|---|
| Radius | $r_A$=10 cm | $r_B$=20 cm |
| Number of turns | $N_A$ | $N_B$ |
| Current | $I_A$ | $I_B$ |

   a. $2N_AI_A = N_BI_B$

   b. $N_AI_A = N_BI_B$

   c. $N_AI_A = 4N_BI_B$

   d. $N_AI_A = 2N_BI_B$

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10. A dipole having dipole moment M is placed in two magnetic fields of strength B1 and B2 respectively. The dipole oscillates 60 times in 20 seconds in the $B_1$ magnetic field and 60 oscillations in 30 seconds in the $B_2$ magnetic field. Then find the $\frac{B_1}{B_2}$ **(+4, −1)**

a. $\frac{3}{2}$

b. $\frac{2}{3}$

c. $\frac{4}{9}$

d. $\frac{9}{4}$

---

11. An electron is moving along positive x direction in xy plane, magnetic field points in negative z direction, then the force due to magnetic field on electron points in the direction

(+4, −1)

a. j

b. −j

c. k

d. −k

---

12. Two identical current carrying coils with same centre are placed with their planes perpendicular to each other. If i = $\sqrt{2}A$ and radius of coil R = 1 m, then magnetic field at centre C is equal to:

(+4, −1)
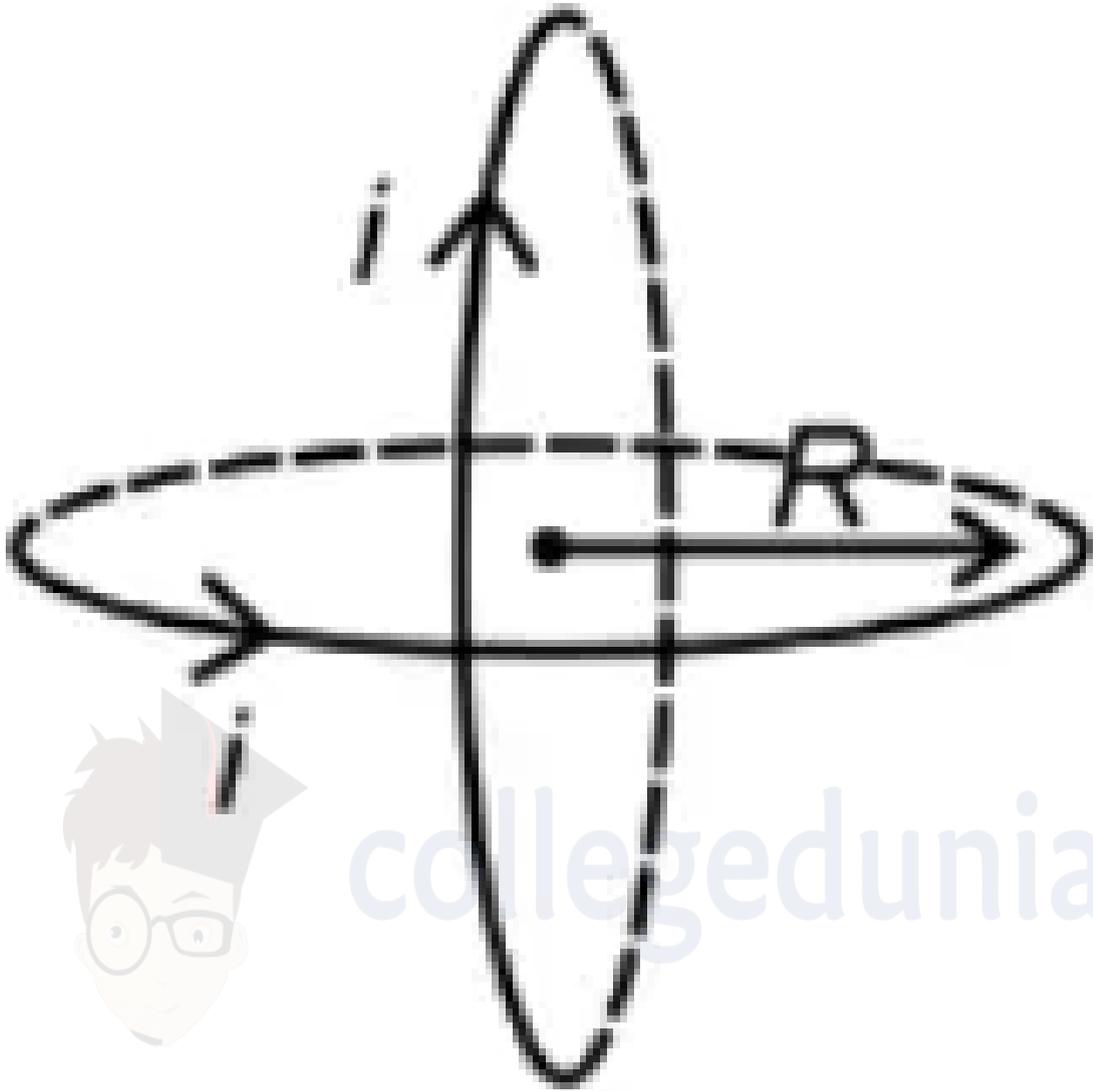
a. $\mu_0$

b. $\frac{\mu_0}{2}$

c. $2\mu_0$

d. $\sqrt{2}\mu_0$

---

13. An electron with energy $01\,keV$ moves at right angle to the earth's magnetic field of $1 \times 10^{-4}Wbm^{-2}$ The frequency of revolution of the electron will be (Take mass of electron $= 90 \times 10^{-31}kg$ )

(+4, −1)

a. $1.6 \times 10^5 Hz$

b. $5.6 \times 10^5 Hz$

c. $2.8 \times 10^6 Hz$

d. $1.8 \times 10^6 Hz$

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14. The electric current in a circular coil of 2 turns produces a magnetic **(+4, -1)**
induction $B_1$ at its centre The coil is unwound and is rewound into a circular
coil of 5 turns and the same current produces a magnetic induction $B_2$ at its
centre The ratio of $\frac{B_2}{B_1}$ is :

a. $\frac{5}{2}$

b. $\frac{25}{4}$

c. $\frac{5}{4}$

d. $\frac{25}{2}$

---

15. Two long parallel wires carrying currents $8A$ and $15A$ in opposite directions are **(+4, -1)**
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
perpendicular to each other The magnitude of magnetic field at $P$ is___$\times 10^{-6}T$
(Given : $\sqrt{2} = 1.4$ )

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16. A charge particle of $2\,\mu C$ accelerated by a potential difference of $100\,V$ enters a **(+4, -1)**
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 _____ $\times 10^{-18} kg$

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17. A solenoid of $1200$ tums is wound uniformly in a single layer on a glass tube **(+4, -1)**
$2\,m$ long and $02\,m$ in diameter The magnetic intensity at the center of the
solenoid when a current of $2A$ flows through it is:

a. $2.4 \times 10^3 Am^{-1}$

b. $1.2 \times 10^3 Am^{-1}$

c. $1 Am^{-1}$

d. $2.4 \times 10^{-3} Am^{-1}$

18. For a moving coil galvanometer, the deflection in the coil is $005$ rad when a **(+4, −1)** current of $10\,mA$ is field is $0,01\,T$ and the number of turns in the coil is $200$, the area of each turn (in $cm^2$) is :

a. 2.0

b. 1.0

c. 1.5

d. 0.5

19. A solenoid of $1200$ turns is wound uniformly in a single layer on a glass tube **(+4, −1)** $2\,m$ long and $02\,m$ in diameter The magnetic intensity at the center of the solenoid when a current of $2A$ flows through it is:

a. $2.4 \times 10^3\,Am^{-1}$

b. $1.2 \times 10^3\,Am^{-1}$

c. $1Am^{-1}$

d. $2.4 \times 10^{-3}\,Am^{-1}$

20. A long solenoid is formed by winding 70 turns/cm. If 2.0 A current flows, then **(+4, −1)** the magnetic field produced inside the solenoid is:

a. $88 \times 10^{-4}T$

b. $123.2 \times 10^{-4}T$

c. $352 \times 10^{-4}T$

d. $176 \times 10^{-4}T$

# Answers

1. **Answer: 5 – 5**

## Explanation:

It should be mentioned, 10 cm wire is part of long wire.
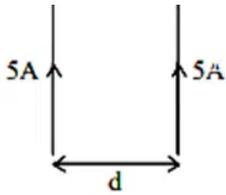Force experienced by unit length of wire



Fig. Force Experienced

$$= \frac{\mu_0 I_1 I_2}{2\pi d} \times 10 \times 10^{-2}$$
$$10^{-5} = \frac{2\times 10 - 7 \times 5 \times 5}{d} \times 10 \times 10 - 2$$
$$d = 50 \times 10^{-3} \ m$$
$$d = 50 \times 10^{-1} \ cm$$

d = 5 cm

## 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,

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

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

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2. **Answer: b**

## Explanation:

As magnetic force is perpendicular to magnetic field.
So, $\vec{F} \cdot \vec{B}$ must be $0$.
So, $2\alpha - 12 = 0$
$2\alpha = 12$
$\alpha = \frac{12}{2}$
$\alpha = 6$

So, the correct option is (B): $6$.

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3. Answer: a

Explanation:

$$U = -\vec{M} \cdot \vec{B}$$

$$So, \; U_f - U_i = -MB(1 - \cos\theta)$$

$$W = 2 \times 10^5 \times 14 \times 10^{-5}(1 - \tfrac{1}{2})$$

$$So, \; W = -\Delta U \; = 14J$$

∴ The correct option is (A): 14 J

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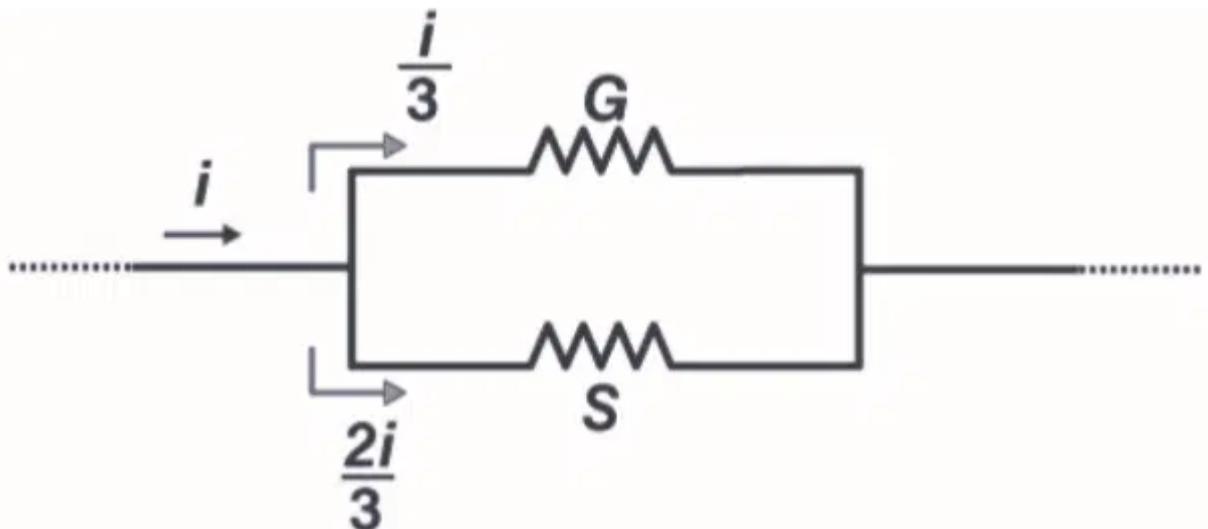
$$F = q\,[\,E\,(r) + v \times B\,(r)\,] \equiv E_{Electric} + F_{magnetic}$$

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

4. **Answer: b**

**Explanation:**

The circuit for the given situation is:

Since *G* and *S* are in parallel,

$\frac{i}{3} \times G = \frac{2i}{3} \times S$

$G = 2S$

So, *G* equals twice the value of shunt resistance.

Hence, the correct option is (B): $\frac{1}{3}$ deflection method can be used and in this case the *G* equals to twice the value of shunt resistance(s).

## Concepts:

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5. **Answer: b**

## Explanation:

The correct option is (B) : 6

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

$\vec{a} = \frac{q}{m}(\vec{v} \times \vec{B})$

So, $\vec{a}$ & $\vec{B}$ are $\perp$ to each other

Hence, $\vec{a}.\vec{B} = 0$

$(\alpha\hat{i} - 4\hat{j}).(2\hat{i} + 3\hat{j}) = 0$

$\alpha(2) + (-4)(3) = 0$

$\alpha = \frac{12}{2}$

$\Rightarrow \alpha = 6$

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6. **Answer: c**

**Explanation:**

From the above correct answer is option (C): $[ML^{-1}T^{-2}]$

**Concepts:**

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7. Answer: b

Explanation:

The correct option is (B)

Concepts:

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8. Answer: a

## Explanation:

The correct option is (A): 0

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9. **Answer: c**

## Explanation:

The correct option is (C): $N_A I_A = 4 N_B I_B$

## Concepts:

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---

## 10. Answer: d

## Explanation:

The time period of oscillation of a dipole in a magnetic field is given by:
$T = 2\pi\sqrt{(\frac{I}{MB})}$
where I is the moment of inertia of the dipole about its axis of rotation.
For a given dipole, the moment of inertia and the dipole moment are constant.
Therefore, the time period of oscillation is directly proportional to the square root of

the magnetic field strength.

Let the time period of oscillation in the $B_1$ magnetic field be $T_1$ and in the $B_2$ magnetic field be $T_2$. Then:

$\frac{T_1}{T_2} = \sqrt{\left(\frac{B_2}{B_1}\right)}$

60 oscillations in 20 seconds in the $B_1$ magnetic field gives:

$T_1 = \frac{20}{60} = \frac{1}{3}\, seconds$

60 oscillations in 30 seconds in the $B_2$ magnetic field gives:

$T_2 = \frac{30}{60} = \frac{1}{2}\, seconds$

Substituting these values in the above equation, we get:

$\frac{\frac{1}{3}}{\frac{1}{2}} = \sqrt{\frac{(B_2)}{(B_1)}}$

$\frac{2}{3} = \sqrt{\frac{B_2}{B_1}}$

Squaring both sides, we get:

$\frac{4}{9} = \frac{B_2}{B_1}$

Therefore, $\frac{B_1}{B_2} = \frac{9}{4}$.

**Answer.** D

## Concepts:

### 1. Torque:

[Torque](#) is a moment of force. Torque is measured as a force that causeque is also defined as the turning effect of force on the axis of rotation. Torque is chs an object to rotate about an axis and is responsible for the angular acceleration. Characterized with "T".

# How is Torque Calculated?

Torque is calculated as the magnitude of the torque vector T for a torque produced by a given force F

T = F. Sin ($\theta$)

Where,

r – length of the moment arm,

$\theta$ – the angle between the force vector and the moment arm.

**Read More:** [Torque](#)

# Types of Torque

Torque is of two types:

1. Static torque
2. Dynamic torque

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## 11. Answer: b

### Explanation:

The power dissipated across a resistor is given by the formula:

$$P = \frac{V^2}{R},$$

where $P$ is the power, $V$ is the potential difference, and $R$ is the resistance. If the potential difference $V$ is doubled, the new potential difference is $2V$. The new power $P'$ is:

$$P' = \frac{(2V)^2}{R} = \frac{4V^2}{R} = 4P.$$

Thus, the power dissipated becomes four times when the potential difference is doubled. Hence, the correct answer is $\boxed{(2)}$.

### Concepts:

### 1. Biot Savart Law:

Biot-Savart's law is an equation that gives the magnetic field produced due to a current-carrying segment. This segment is taken as a vector quantity known as the current element. In other words, Biot-Savart Law states that if a current carrying **conductor** of length dl produces a **magnetic field** dB, the force on another similar current-carrying conductor depends upon the size, orientation and length of the first current carrying element.

The equation of **Biot-Savart law** is given by,

$$dB = \frac{\mu_0}{4\pi} \frac{Idl\sin\theta}{r^2}$$
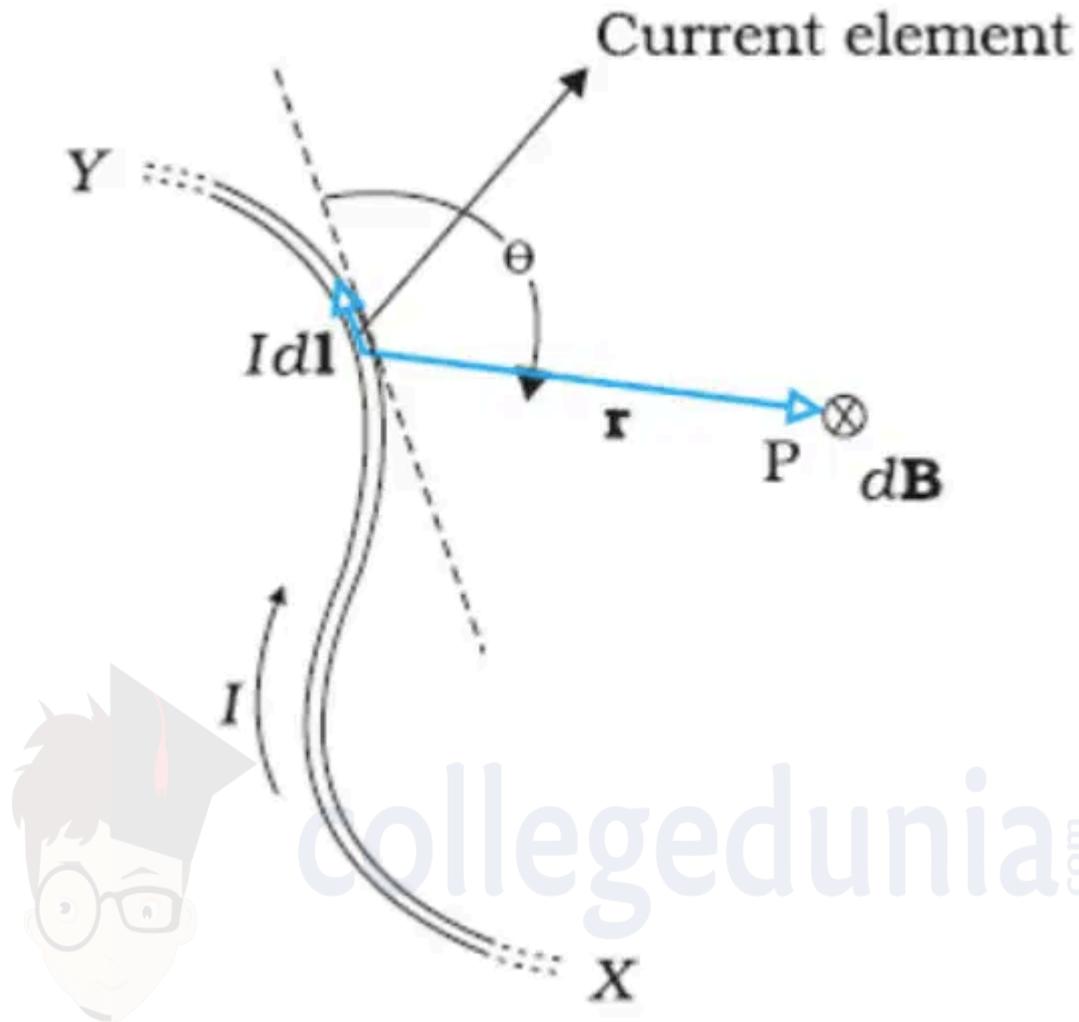
## Application of Biot Savart law

- Biot Savart law is used to evaluate magnetic response at the molecular or atomic level.
- It is used to assess the velocity in aerodynamic theory induced by the vortex line.

## Importance of Biot-Savart Law

- Biot-Savart Law is exactly similar to Coulomb's law in electrostatics.
- Biot-Savart Law is relevant for very small conductors to carry current,
- For symmetrical current distribution, Biot-Savart Law is applicable.

For detailed derivation on Biot Savart Law, read more.

## 12. Answer: a

### Explanation:

$$B_0 = \sqrt{B_1^2 + B_2^2}$$
$$B_0 = \sqrt{2}B$$
$$B_0 = \sqrt{2}\frac{\mu_0 I}{2R} = \sqrt{2}\frac{\mu_0 \times \sqrt{2}}{2 \times 1} = \mu_0$$

So, the correct answer is (A): $\mu_0$

### Concepts:

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## Magnetism:

- The relationship between a Moving Charge and Magnetism is that Magnetism is produced by the movement of charges.
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$$F = q \left[ E\,(r) + v \times B\,(r) \right] \equiv E_{Electric} + F_{magnetic}$$

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

## 13. Answer: c

**Explanation:**

$$f = \frac{1}{T} = \frac{eB}{2\pi m}$$
$$= \frac{1.6 \times 10^{-19} \times 10^{-4}}{2\pi \times 9 \times 10^{-31}} = 2.8 \times 10^6 Hz$$

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## 14. Answer: b

## Explanation:

$B = \frac{N\mu_0 i}{2R}$

$B_1 = \frac{N_1\mu_0 i}{2R_1}$

For $N_2 = 5$

Radius of coil $= R_2 = \frac{N_1 \times R_1}{N_2}$

$B_2 = \frac{N_2\mu_0 i}{R_2}$

$\frac{B_2}{B_1} = \frac{N_2}{N_1} \cdot \frac{R_1}{R_2} = \frac{N_2}{N_1} \times \frac{N_2}{N_1}; \frac{B_2}{B_1} = \frac{25}{4}$

## Concepts:

### 1. Moving Charges and Magnetism:

Moving charges generate an electric field and the rate of flow of charge is known as current. 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,
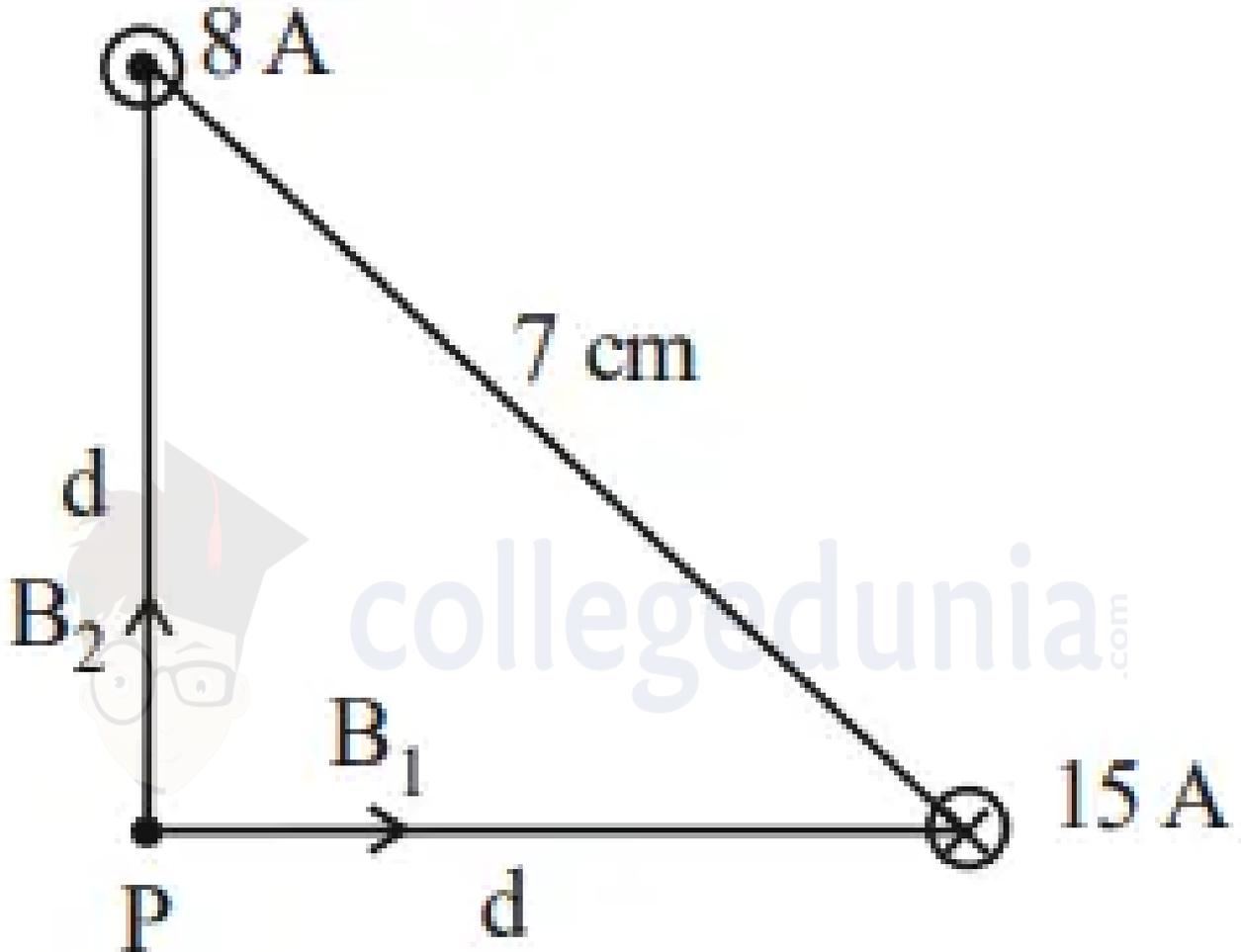
$$F = q \left[ E (r) + v \times B (r) \right] \equiv E_{Electric} + F_{magnetic}$$

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

15. Answer: 68 - 68

Explanation:

The correct answer is 68



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

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

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

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

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

## Concepts:

### 1. Moving Charges and Magnetism:

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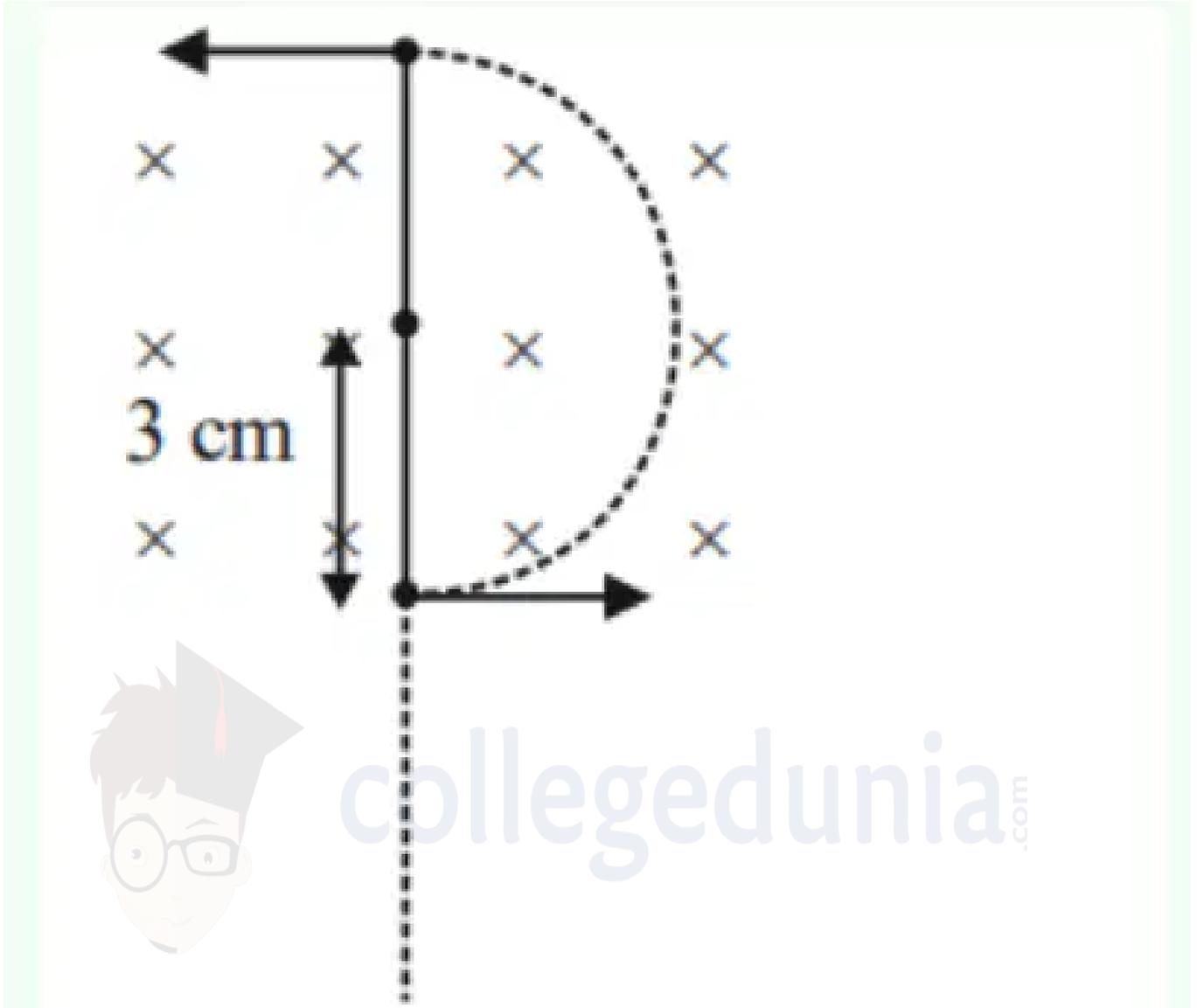
$$F = q [ E (r) + v \times B (r)] \equiv E_{Electric} + F_{magnetic}$$

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

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16. **Answer: 144 – 144**

## Explanation:

The correct answer is 144.

$$r = \frac{mvqB}{=} \frac{2km}{qB}, m = \frac{r^2 q^2 B^2}{2k}$$

$$m = \frac{\frac{1}{100} \times \frac{3}{100} \times 2 \times 2 \times 4 \times 10^{-3} \times 4 \times 10^{-3} \times 10^{-12}}{2 \times (100) \times 10^{-16}}$$

=144×10$^{-18}$kg

## Concepts:

### 1. Moving Charges and Magnetism:

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# Magnetism:

- The relationship between a <u>Moving Charge and Magnetism</u> 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.

---

17. Answer: b

Explanation:

1. The magnetic intensity $H$ inside a solenoid is given by:

$$H = nI,$$

where $n$ is the number of turns per unit length and $I$ is the current.
2. Calculate $n$:

$$n = \frac{\text{Total number of turns}}{\text{Length of solenoid}} = \frac{1200}{2} = 600 \,\text{turns/m}.$$

3. Substituting $n = 600 \,\text{turns/m}$ and $I = 2 \,\text{A}$:

$$H = nI = 600 \times 2 = 1200 \,\text{A m}^{-1}.$$

Thus, the magnetic intensity is $\mathbf{1.2 \times 10^3 \,A\, m^{-1}}$.
The magnetic intensity depends on the number of turns per unit length and the current flowing through the solenoid.

## Concepts:

### 1. Moving Charges and Magnetism:

Moving charges generate an electric field and the rate of flow of charge is known as current. 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:

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# Magnetic Field:

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

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## 18. Answer: b

## Explanation:

The correct answer is (B) : 1.0

$\tau = K\theta$

$NiAB = K\theta$

$A = \frac{K\theta}{NiB} = \frac{4 \times 10^{-5} \times 0.05}{200 \times 10 \times 10^{-3} \times 0.01}$

On solving $A = 10^{-4} m^2 = 1 cm^2$

## Concepts:

### 1. Moving Charges and Magnetism:

Moving charges generate an electric field and the rate of flow of charge is known as current. 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.

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# Magnetic Field:

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

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

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## 19. Answer: b

## Explanation:

Magnetic field at centre inside the solenoid is given by
$B = \mu_0 nI$
So magnetic intensity at centre
$H = \frac{B}{\mu_0} = nI = \left(\frac{1200}{2}\right)(2)$
$H = 1.2 \times 10^3\, Am^{-1}$

## Concepts:

### 1. Moving Charges and Magnetism:

Moving charges generate an electric field and the rate of flow of charge is known as current. 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:

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# Magnetic Field:

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

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

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## 20. Answer: d

## Explanation:

The magnetic field inside a long solenoid is given by:

$$B = \mu_0 n I$$

where:

- $\mu_0 = 4\pi \times 10^{-7}$ Tm/A (permeability of free space),
- $n = \frac{70}{\text{cm}} = 70 \times 10^2$ turns/m,
- $I = 2.0$ A (current).

Substitute the values:

$$B = (4\pi \times 10^{-7}) \cdot (70 \times 10^2) \cdot 2$$

$$B = 176 \times 10^{-4} \text{ T}$$

Thus, the magnetic field produced inside the solenoid is $176 \times 10^{-4}$ T.

## Concepts:

### 1. Moving Charges and Magnetism:

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

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