Magnetic Effects Of Current And Magnetism JEE Main PYQ - 2

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. A parallel plate capacitor of area $60\,cm^2$ and separation $3\,mm$ is charged initially to $90\,\mu C$. If the medium between the plate gets slightly conducting and the plate loses the charge initially at the rate of $2.5 \times 10^{-8}\,C/s$, then what is the magnetic field between the plates ? **(+4, -1)**

[Online April 23,2013]

a. $2.5 \times 10^{-8}\,T$

b. $2.0 \times 10^{-7}\,T$

c. $1.63 \times 10^{-11}\,T$

d. zero

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2. A particle having the same charge as of electron moves in a circular path of radius $0.5\,cm$ under the influence of a magnetic field of $0.5\,T$. If an electric field of $100\,V/m$ makes it to move in a straight path, then the mass of the particle is (Given charge of electron = $1.6 \times 10^{-19} C$) **(+4, -1)**

[12 April 2019, I]

a. $2.0 \times 10^{-24}\ kg$

b. $1.6 \times 10^{-19}\ kg$

c. $1.6 \times 10^{-27}\ kg$

d. $9.1 \times 10^{-31}\ kg$

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3. A proton and an α-particle (with their masses in the ratio of $1:4$ and charges in the ratio of $1:2$) are accelerated from rest through a potential difference V. If a uniform magnetic field (B) is set up perpendicular to their velocities, the ratio of the radii $r_p : r_\alpha$ of the circular paths described by them will be : **(+4, -1)**

[26-Jun-2022-Shift-1]

a. $1:\sqrt{2}$

b. $1:2$

c. $1:3$

d. $1:\sqrt{3}$

4. A proton (mass m) accelerated by a potential difference V flies through a uniform transverse magnetic field B. The field occupies a region of space by width d. If α be the angle of deviation of proton from initial direction of motion (see figure), the value of $\sin\alpha$ will be : **(+4, -1)**

[Online April 10, 2015]

a. $\frac{B}{2}\sqrt{\frac{qd}{mV}}$

b. $\frac{B}{d}\sqrt{\frac{q}{2mV}}$

c. $Bd\sqrt{\frac{q}{2mV}}$

d. $qV\sqrt{\frac{Bd}{2m}}$

5. An electron , a proton and an alpha particle having the same kinetic energy are moving in circular orbits of radii r_e, r_p, r_α respectively in a uniform magnetic field B. The relation between r_e, r_p, r_α is : **(+4, -1)**

[2018]

a. $r_e > r_p = r_\alpha$

b. $r_e < r_p = r_\alpha$

c. $r_e < r_p < r_\alpha$

d. $r_e < r_\alpha < r_p$

6. An electron, moving along the x-axis with an initial energy of $100\,eV$, enters a region of magnetic field $\vec{B} = (1.5 \times 10^{-3}T)\hat{k}$ at S (See figure). The field extends between $x = 0$ and $x = 2\,cm$. The electron is detected at the point Q on a screen placed $8\,cm$ away from the point S. The distance d between P and Q (on the screen) is : (electron's charge = $1.6 \times 10^{-19}C$. mass of electron = $9.1 \times 10^{-31}kg$) **(+4, -1)**

[12 April 2019, II]

a. 12.87 cm

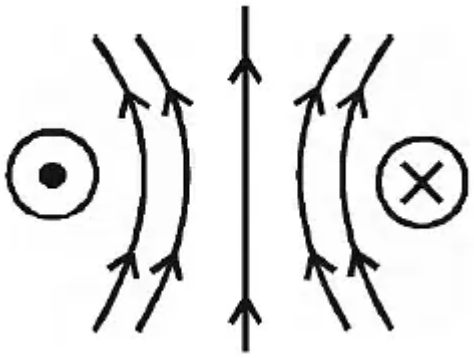
b. 1.22 cm

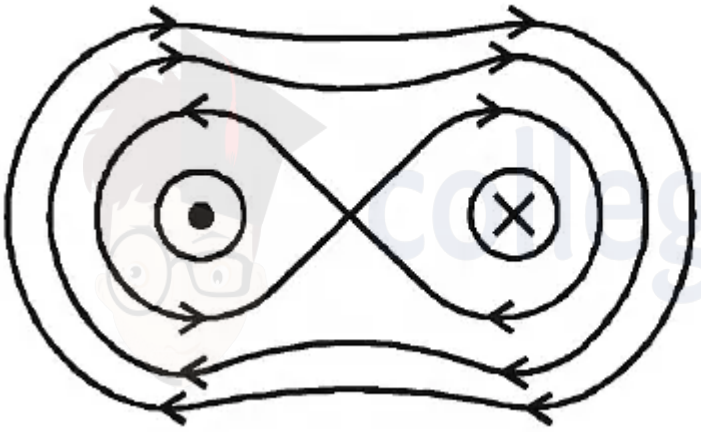
c. 11.65 cm

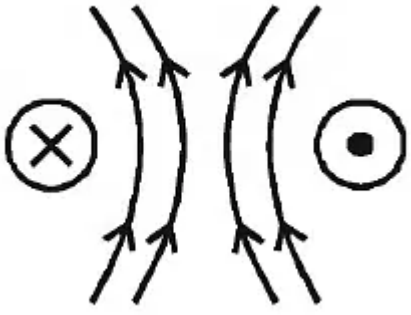
d. 2.25 cm

7. Choose the correct sketch of the magnetic field lines of a circular current loop shown by the dot ? and the cross ?. **(+4, -1)**

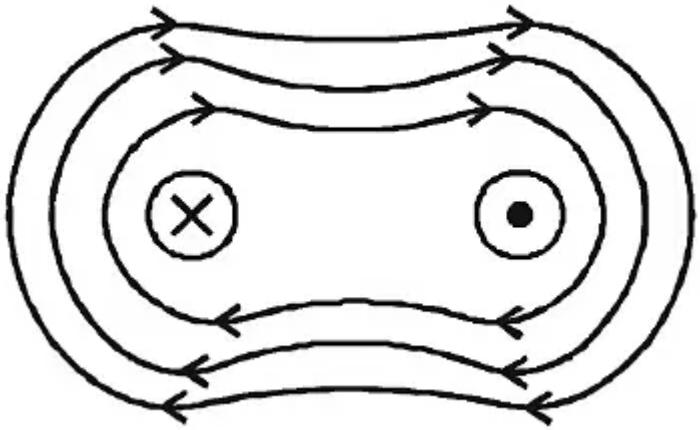
[Online April 22, 2013]

a. 

b. 

c. 

d.



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8. Find the magnetic field at point P due to a straight line segment AB of length $6\,cm$ carrying a current of $5\,A$. (See figure) $(\mu_0 = 4\pi \times 10^{-7}\,N - A^{-2})$ **(+4, -1)**

[1-Feb-2023 Shift 1]

a. $3.0 \times 10^{-5} T$

b. $2.5 \times 10^{-5} T$

c. $2.0 \times 10^{-5} T$

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

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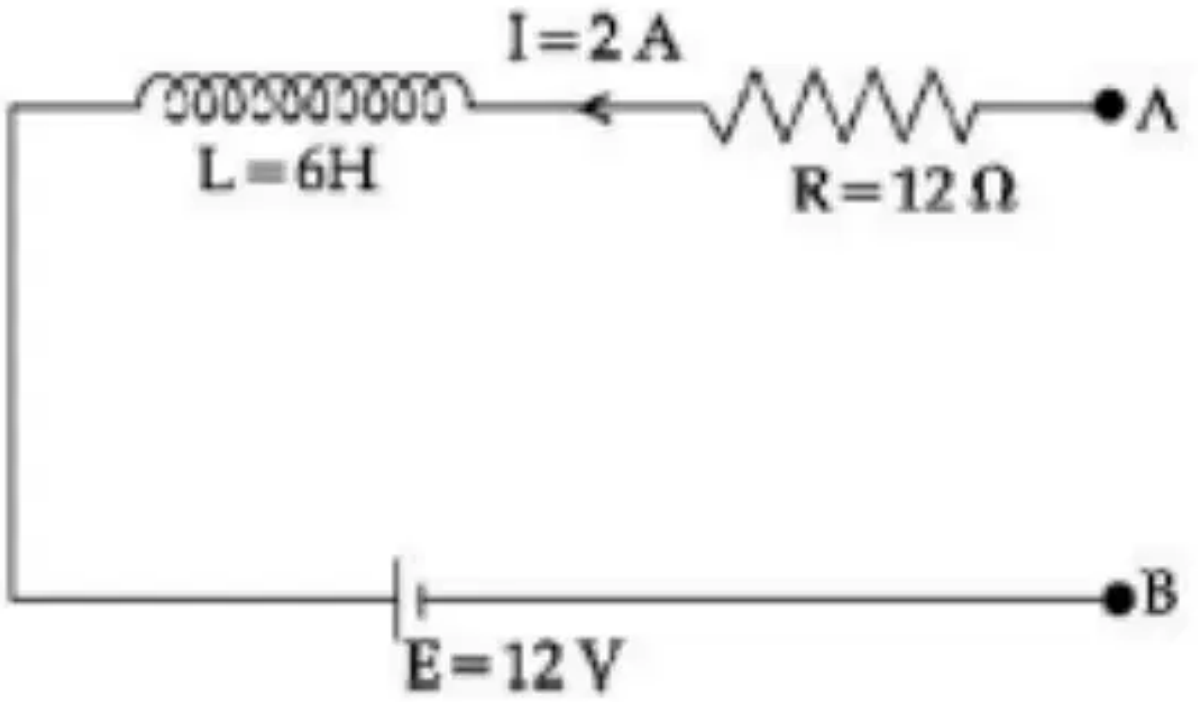
9. As per the given figure, if $\frac{dI}{dt} = -1A/$ s then the value of V_{AB} at this instant will be _____V **(+4, -1)**

[24-Jan-2023 Shift 2]



10. A single turn current loop in the shape of a right angle triangle with sides 5cm, 12cm, 13cm is carrying a current of 2A. The loop is in a uniform magnetic field of magnitude 0.75T whose direction is parallel to the current in the 13 cm side of the loop. The magnitude of the magnetic force on the 5 cm side will be $\frac{x}{130}N$. The value of x is _____ **(+4, -1)**

Answers

1. **Answer: d**

Explanation:

Magnetic field between the plates in this case is zero.

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,

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

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

2. **Answer: a**

Explanation:

$\frac{mv^2}{R} = qvB$
$mv = qBR$ ....(i)
Path is straight line
it $qE = qvB$
$E = vB$ ....(ii)
From equation (i) & (ii)
$m = \frac{qB^2R}{E}$
$m = 2.0 \times 10^{-24} kg$

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3. **Answer: a**

Explanation:

The correct option is(A): $1:\sqrt{2}$

$KE = q\Delta V$
$r = \frac{\sqrt{2mq\Delta V}}{qB}$
$r \propto \sqrt{\frac{m}{q}}$
$\frac{r_p}{r_\infty}\sqrt{\frac{1}{4}\times\frac{2}{1}} = \frac{1}{\sqrt{2}}$

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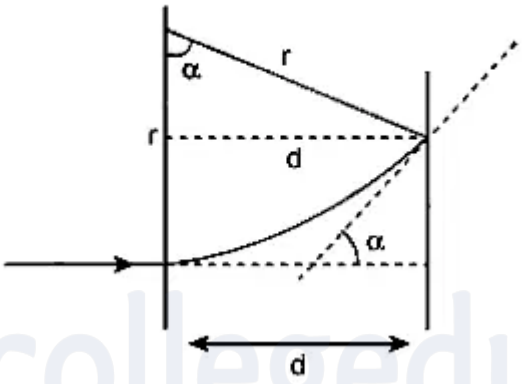
4. **Answer: c**

Explanation:



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5. Answer: b

Explanation:

$r = \frac{\sqrt{2mk}}{qB}$

$\frac{r_\alpha}{r_p} = \frac{\sqrt{2m_\alpha}}{q_\alpha} \times \frac{q_p}{\sqrt{2m_p}}$

$\begin{bmatrix} m_\alpha = 4m_p \\ q_\alpha = 2q_p \end{bmatrix}$

$= 1$

Mass of electron is least and charge $q_e = e$

So, $r_e < r_p = r_\alpha$

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6. **Answer: a**

Explanation:

$R = \frac{mv}{qB}$

$= \frac{\sqrt{2m(K.E.)}}{qB}$

$R = \frac{\sqrt{2\times9.1\times10^{-31}\times(100\times1.6\times10^{-19}}}{1.6\times10^{-19}\times1.5\times10^{-3}}$

$R = 2.248$ cm

$sin\theta = \frac{2}{2.248}$

$tan\theta = \frac{QU}{TU}$

$\frac{2}{1.026} = \frac{QU}{6}$

$QU = 11.69$

$PU = R(1 - cos\theta)$

$= 1.22$

$d = QU + PU$

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7. **Answer: a**

Explanation:

If magnetic field is perpendicular and into the plane of the paper, it is represented by cross ⊗ and if the direction of the magnetic field is perpendicular out of the plane of the paper it is represented by dot ?.

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8. **Answer: d**

Explanation:

$b = \frac{\mu_0 I}{4\pi d} 2sin\theta$
d = 4 cm
$sin\theta = \frac{3}{5}$

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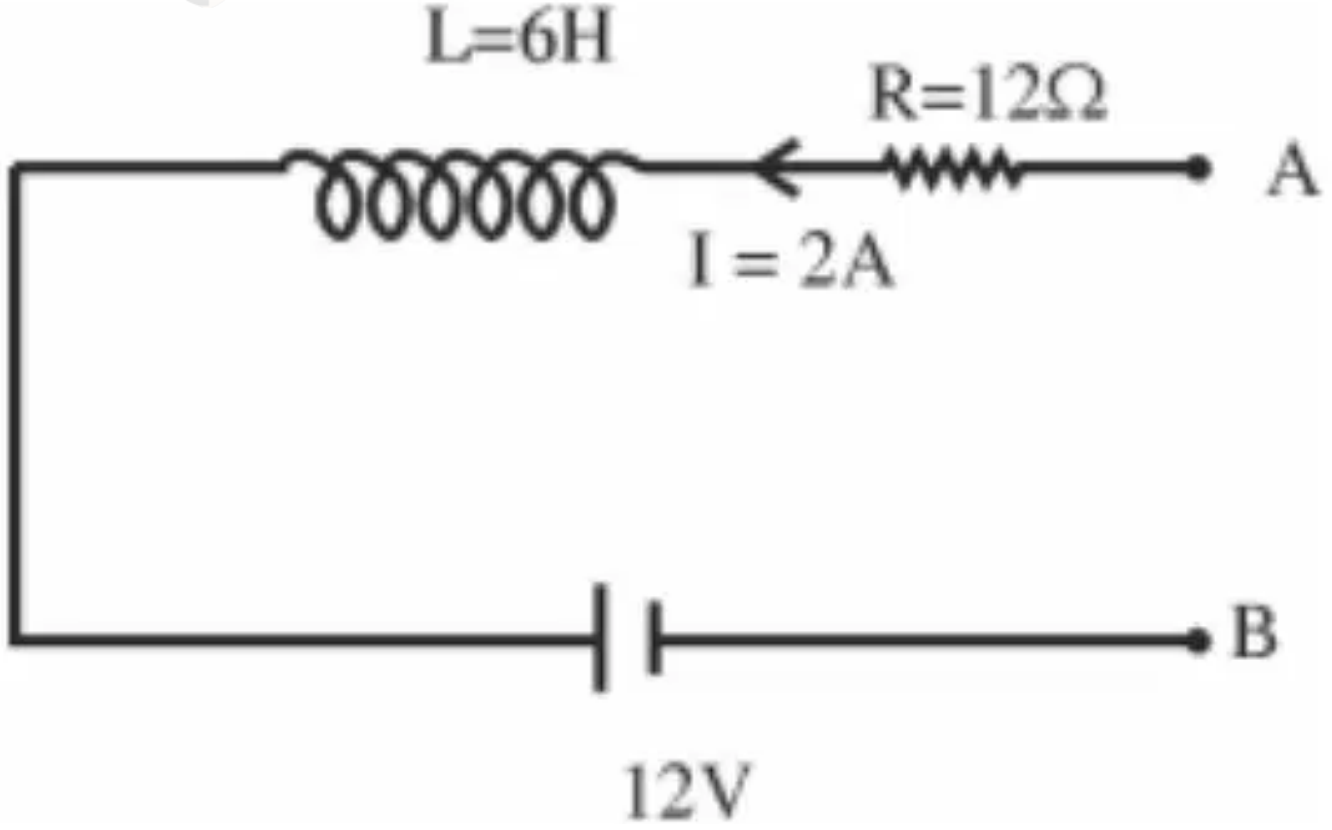
9. **Answer: 30 - 30**

Explanation:

The correct answer is 30.



$\frac{dI}{dt} = -1 \frac{A}{\text{sec}}$
$V_A - IR - L\frac{dI}{dt} - 12 = V_B$
$V_A - 2 \times 12 - 6(-1) - 12 = V_B$
$V_A - V_B = 36 - 6 = 30$ volt

Concepts:

1. Magnetic Field:

The magnetic field is a field created by moving electric charges. It is a force field that exerts a force on materials such as iron when they are placed in its vicinity. Magnetic fields do not require a medium to propagate; they can even propagate in a vacuum. Magnetic field also referred to as a vector field, describes the magnetic influence on moving electric charges, magnetic materials, and electric currents.

A magnetic field can be presented in two ways.

- **Magnetic Field Vector:** The magnetic field is described mathematically as a *vector field*. This vector field can be plotted directly as a set of many vectors drawn on a grid. Each vector points in the direction that a compass would point and has length dependent on the strength of the magnetic force.
- **Magnetic Field Lines:** An alternative way to represent the information contained within a vector field is with the use of *field lines*. Here we dispense with the grid pattern and connect the vectors with smooth lines.

Properties of Magnetic Field Lines

- Magnetic field lines never cross each other
- The density of the field lines indicates the strength of the field
- Magnetic field lines always make closed-loops
- Magnetic field lines always emerge or start from the north pole and terminate at the south pole.

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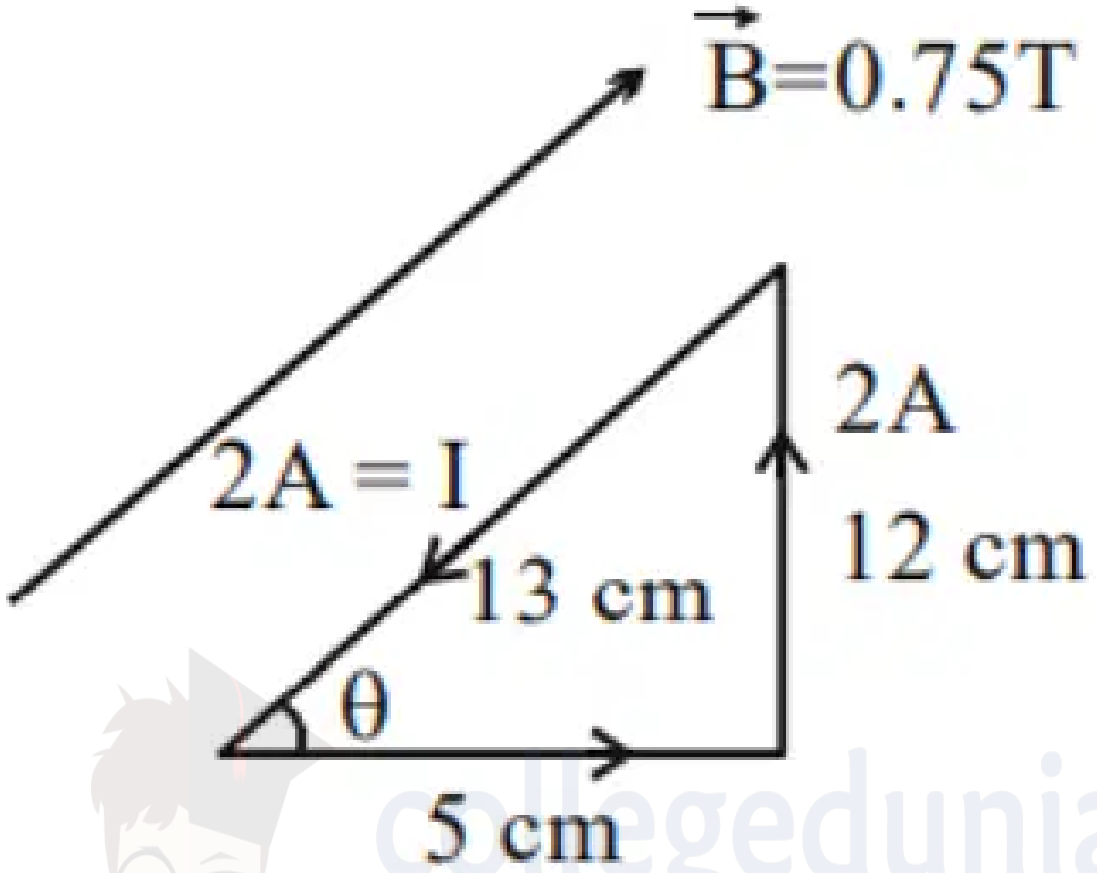
10. **Answer: 9 - 9**

Explanation:



Force on $5\,cm$ side is

$|\vec{F}| = \text{ ILB } \sin\theta$

$= (2)\left(5 \times 10^{-2}\right) \times \frac{3}{4} \times \frac{12}{13} = \frac{9}{130} N$

So, $x = 9$

Hence, The correct answer is 9.

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