Magnetic Field JEE Main PYQ - 3

Total Time: 1 Hour **Total Marks:** 100

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 Field

1. The magnetic field at the centre of a circular coil of radius r, due to current I flowing through it, is B. The magnetic field at a point along the axis at a distance $\frac{r}{2}$ from the centre is : **(+4, -1)**

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

   b. 2B

   c. $(\frac{2}{\sqrt{5}})^{3B}$

   d. $(\frac{2}{\sqrt{3}})^{3B}$

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2. A long solenoid carrying a current produces a magnetic field *B* along its axis. If the current is doubled and the number of turns per cm is halved, the new value of magnetic field will be equal to **(+4, -1)**

   a. B

   b. 2B

   c. 4B

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

---

3. Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R). **(+4, -1)**
   Assertion (A): In an uniform magnetic field, speed and energy remains the same for a moving charged particle.
   Reason (R): Moving charged particle experiences magnetic force perpendicular to its direction of motion.

   a. Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**.

   b. Both **(A)** and **(R)** are true but **(R)** is NOT the correct explanation of **(A)**

   c. **(A)** is true but **(R)** is false

d. **(A)** is false but **(R)** is true

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4. B_X and B_Y are the magnetic field at the centre of two coils of two coils X and Y respectively, each carrying equal current If coil X has 200 turns and $20\,cm$ radius and coil Y has 400 turns and $20\,cm$ radius, the ratio of B_X and B_Y is **(+4, -1)**

a. $1:1$

b. $1:2$

c. $2:1$

d. $4:1$

---

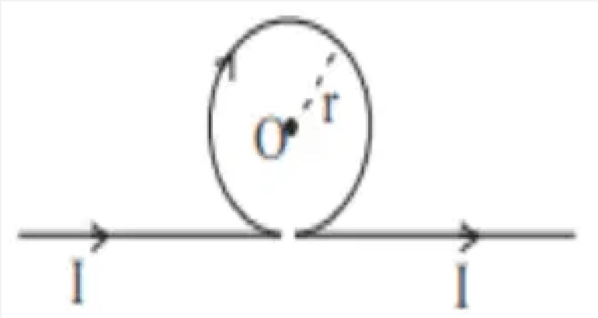
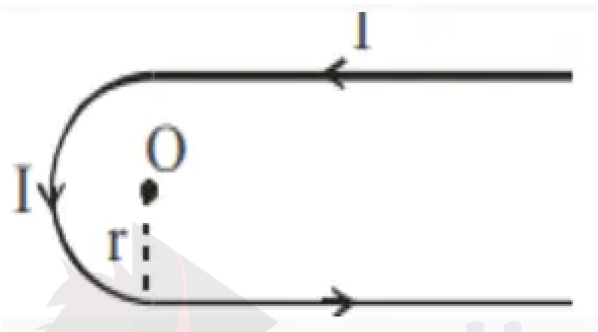
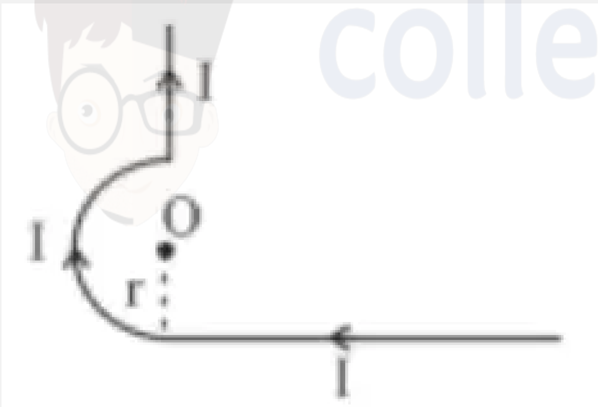
5. Match **List I** with **List II** **(+4, -1)**

a. A-III, B-IV, C-I, D-II

b. A-I, B-III, C-IV, D-II

c. A-III, B-I, C-IV, D-II

d. A-II, B-I, C-IV, D-III

List I (Current configuration)		List II(Magnetic field at point O)	
A		i	$B_0 = \frac{\mu_0 I}{4\pi r}[\pi + 2]$
B		ii	$B_0 = \frac{\mu_0}{4}\frac{I}{r}$
C		iii	$B_0 = \frac{\mu_0 I}{2\pi r}[\pi - 1]$
D		iv	$B_0 = \frac{\mu_0 I}{4\pi r}[\pi + 1]$

6. The electric field part of an electromagnetic wave in a medium is represented by = 0 = 25–cos[(2 10^6 —) − (10^{-2} —)] = 0. The wave is: **(+4, -1)**

a. (A) Moving along y-direction with frequency $2\pi \times 10^6$ Hz and wavelength 200 m

b. (B) Moving along x-direction with frequency 10^6 Hz and wavelength 100 m

c. (C) Moving along x-direction with frequency 10^6 Hz and wavelength 200 m

d. (D) Moving along y-direction with frequency 10^6 Hz and wavelength 400 m

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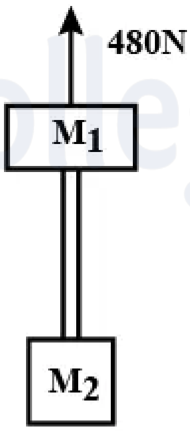
7. Two blocks of mass $_1 = 20$ and $_2 = 12$ are connected by a metal rod of mass 8 . The system is pulled vertically up by applying a force of 480 as shown. The tension at the mid-point of the rod is: **(+4, -1)**



a. (A) 144

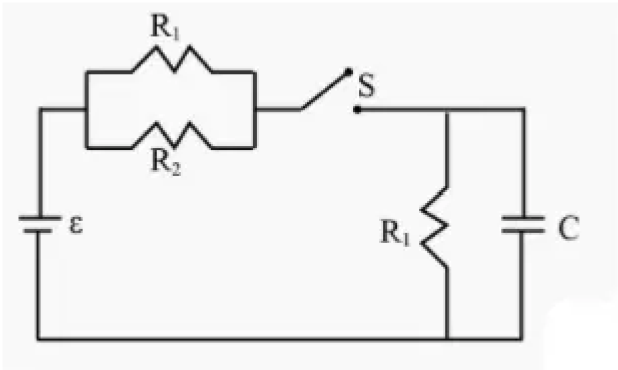
b. (B) 96

c. (C) 240

d. (D) 192

---

8. The circuit shown in the figure consists of a battery of emf = 10 V; a capacitor of capacitance = 1.0 and three resistor of values $_1 = 2\Omega$, $_2 = 2\Omega$ and $_3 = 1\Omega$. Initially the capacitor is completely uncharged and the switch is open. The switch is closed at = 0. **(+4, -1)**



a. (A) The current through resistor $_3$ at the moment the switch closed is zero

b. (B) The current through resistor $_3$ a long time after the switch closed is 5

c. (C) The ratio of current through $_1$ and $_2$ is always constant

d. (D) The maximum charge on the capacitor during the operation is 5

---

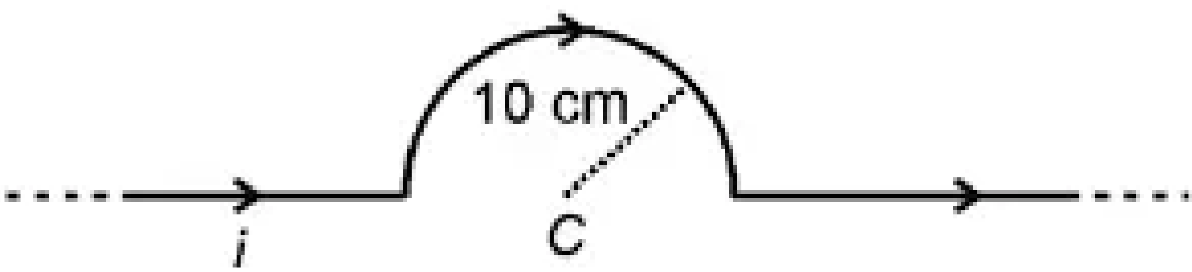
9. In the Bohr model of the hydrogen atom, let R, V and E represent the radius of the orbit, speed of the electron and total energy of the electron respectively. Which of the following quantity is proportional to the quantum number n ? **(+4, -1)**

a. (A) /

b. (B) /

c. (C)

d. (D)



10. **(+4, -1)**

An infinitely-long conductor has a current of 14A flowing as shown in the figure. Find the magnetic field at center C.

a. $88 \mu T$

b. $44 \mu T$

c. $10 \mu T$

d. $120 \mu T$

---

11. A uniform current carrying cylindrical wire carries current I having radius 'a'. Magnetic field with distance x varies with relation given: **(+4, -1)**

a. $B \propto x$, for $x < a$
$B \propto \frac{1}{x}$, for $x > a$

b. $B \propto x$, for $x < a$
B is constant, for $x > a$

c. B is constant, for $x < a$
$B \propto \frac{1}{x}$, for $x > a$

d. $B \propto \frac{1}{x}$, for $x < a$
$B \propto x$, for $x > a$

---

12. $E = E_0 \sin(\omega t - kx)$ **(+4, -1)**
$B = B_0 \sin(\omega t - kx)$, then ratio of energy density of electric field to magnetic field is :

a. 1:1

b. 1:3

c. 1:2

d. 2:1

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13. In which condition EMF will be induced in loop. (+4, -1)

Situation-S_1: A loop is moving with uniform velocity in a uniform magnetic field perpendicular
to its plane.

Situation-S_2: A loop is moving with non-uniform velocity in a uniform magnetic field
perpendicular to its plane.

Situation-S_3: A loop is rotating about its diameter in a uniform magnetic field.

Situation-S_4: Area of loop is changing in a uniform magnetic field.

a. S_2,S_3

b. S_1,S_3

c. S_2,S_4

d. S_3,S_4

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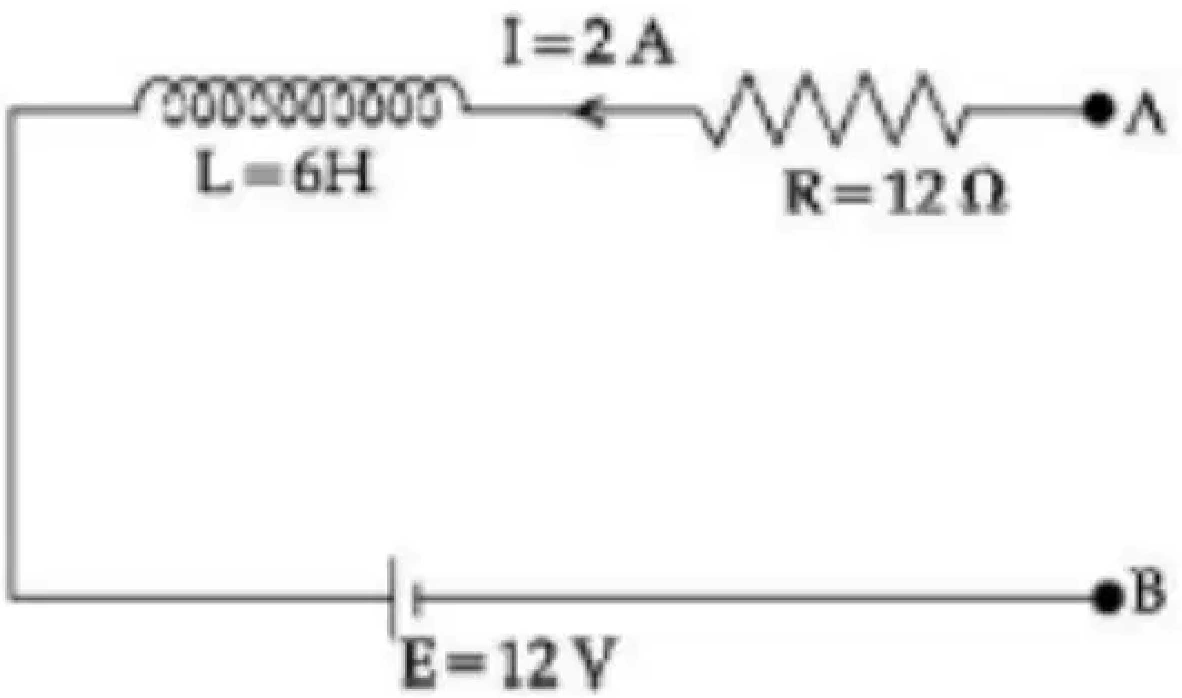
14. As per the given figure, if $\frac{dI}{dt} = -1A/$ s then the value of V_{AB} at this instant will be ______V (+4, -1)



15. A circular loop of radius r is carrying current IA The ratio of magnetic field at the center of circular loop and at a distance r from the center of the loop on its axis is: **(+4, -1)**

a. $1 : 3\sqrt{2}$

b. $2\sqrt{2} : 1$

c. $3\sqrt{2} : 2$

d. $1 : \sqrt{2}$

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16. **A long conducting wire having a current I flowing through it, is bent into a circular coil of N turns .Then it is bent into a circular coil of n turns. The magnetic field is calculated at the centre of coils in both the cases. The ratio of the magnetic field in first case to that of second case is :** **(+4, -1)**

a. $n : N$

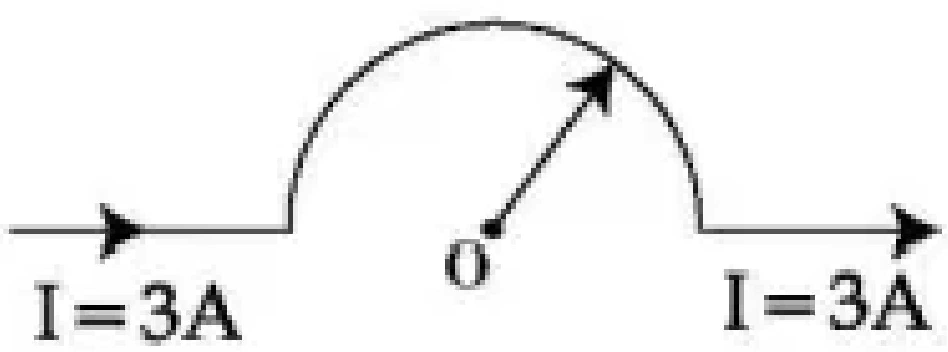
b. $N : n$

c. $N^2 : n^2$

d. $n^2 : N^2$

---

17. As shown in the figure, a long straight conductor with semi-circular are of radius $\frac{\pi}{10}m$ is carrying current $I = 3A$. The magnitude of the magnetic field at the center O of the arc is :(The permeability of the vacuum $= 4\pi \times 10^{-7} NA^{-2}$) **(+4, -1)**



a. $6\mu T$

b. $4\mu T$

c. $3\mu T$

d. $1\mu T$

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18. A coil is placed in magnetic field such that plane of coil is perpendicular to the direction of magnetic field. The magnetic flux through a coil can be changed : **(+4, -1)**

A. By changing the magnitude of the magnetic field within the coil
B. By changing the area of coil within the magnetic field
C. By changing the angle between the direction of magnetic field and the plane of the coil
D. By reversing the magnetic field direction abruptly without changing its magnitude.

Choose the most appropriate answer from the options given below :

a. A and C only

b. A, B and C only

c. A, B and D only

d. A and B only

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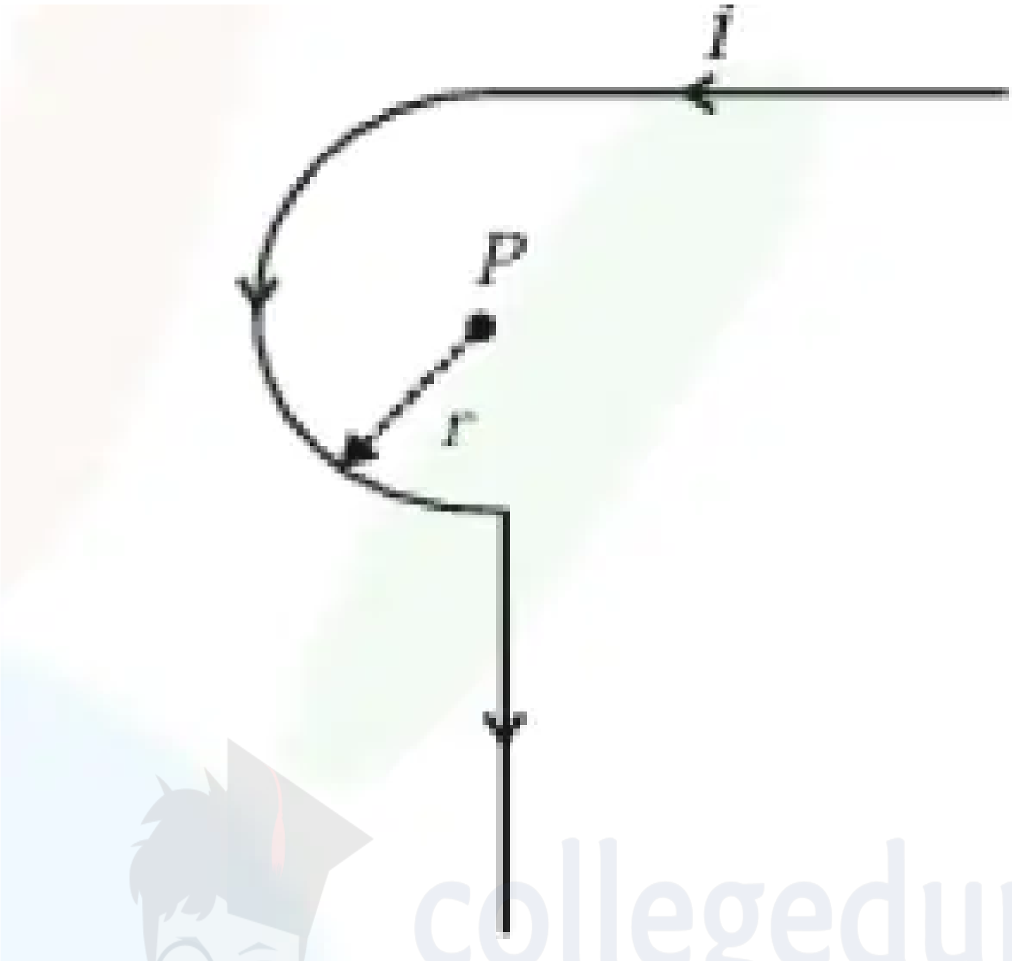
19. Find the magnetic field at the point P in figure. The curved portion is a semicircle connected to two long straight wires **(+4, -1)**



a. $\frac{\mu_0 i}{2r}\left(1+\frac{1}{\pi}\right)$

b. $\frac{\mu_0 i}{2r}\left(1+\frac{2}{\pi}\right)$

c. $\frac{\mu_0 i}{2r}\left(\frac{1}{2}+\frac{1}{\pi}\right)$

d. $\frac{\mu_0 i}{2r}\left(\frac{1}{2}+\frac{1}{2\pi}\right)$

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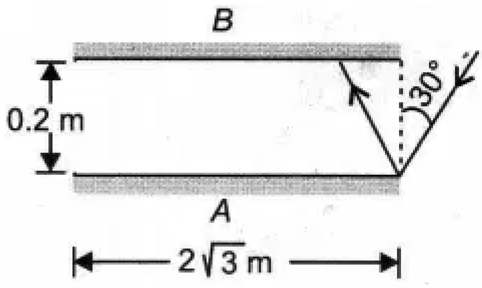
20. Two plane mirrors and are aligned parallel to each other as shown in the figure. A light ray is incident at an angle 30 at a point just inside one end of . The plane of incidence coincides with the plane of the figure. The maximum number of times the ray undergoes reflections (including the first one), before it emerges out, is: **(+4, -1)**



a. (A) 28

b. (B) 30

c. (C) 321

d. (D) 34

21. Barn is a unit of which physical quantity? **(+4, -1)**

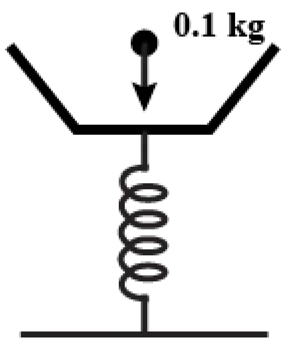
a. (A) Area

b. (B) Time

c. (C) Distance

d. (D) Speed

22. A massless platform is kept on a light elastic spring, as shown in the figure. When a particle of mass 0.1 kg is dropped on the pan from a height of 0.24 m, the particle strikes the pan, and the spring is compressed by 0.01 m. From what height should the particle be dropped to cause a compression of 0.04 m? **(+4, -1)**



a. (A) 0.96 m

b. (B) 2.96 m

c. (C) 3.96 m

d. (D) 0.48 m

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23. A circular coil of radius 10 , 500 turns and resistance 2Ω is placed with its plane perpendicular to the horizontal component of the earth's magnetic field. It is rotated about its vertical diameter through 180 in 0.25 . The current induced in the coil is:(Horizontal component of the earth's magnetic field at the place is 3.0×10^{-5}) **(+4, -1)**

a. (A) 1.9×10^{-3}

b. (B) 2.9×10^{-3}

c. (C) 3.9×10^{-3}

d. (D) 4.9×10^{-3}

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24. A circular loop of radius r, carrying current I, lies in the x-y plane with its centre at the origin. The total magnetic flux through x-y plane is: **(+4, -1)**

a. (A) Directly proportional to I

b. (B) Directly proportional to R

c. (C) Inversely proportional to R

d. (D) Zero

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25. In the formula, $= 3 \ ^2$, and have dimensions of capacitance and magnetic field respectively. What are the dimensions of Y in the MKSQ system? **(+4, -1)**

a. (A) $[M^{-3} L^{-1} T^{3} Q^{4}]$

b. (B) $[M^{-3} L^{-2} T^{4} Q^{4}$

c. (C) $[M^{-2} \quad ^{-2} T^{4} Q^{4}]$

d. (D) $[M^{-3} L^{-2} T^{4} Q]$

Answers

1. **Answer: c**

Explanation:

B= $\frac{\mu_0 l}{2r}$

$B_a = \frac{\mu_0 l r^2}{2(r^2+\frac{r}{4})}$

$\Rightarrow \frac{B_a}{B} = (\frac{2}{\sqrt{5}})^3$

$\Rightarrow B_a = (\frac{2}{\sqrt{5}})^{3B}$

The correct option is (C) : $(\frac{2}{\sqrt{5}})^{3B}$

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.
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2. **Answer: a**

Explanation:

The correct option is(A): B

B = $\mu_0 ni$

Now $i \rightarrow 2i$

And

$n \rightarrow \frac{n}{2}$

$B' = \mu_0 \frac{n}{2} \times 2i = \mu_0 ni = B$

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3. **Answer: a**

Explanation:

Magnetic force
$\vec{F} \perp \vec{V}$
$\Rightarrow W_b = 0$
$\Rightarrow \Delta_{KE} = 0$ and speed remains constant.
The correct option is (A): Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**.

Concepts:

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4. **Answer: b**

Explanation:

Therefore, the correct option is (B): 1 : 2

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5. **Answer: c**

Explanation:

1. Configuration A: - Using Biot-Savart's law, the magnetic field at point O is:

$$B = \frac{\mu_0 I}{4\pi r}[\pi + 2].$$

2. Configuration B: - The magnetic field at O is:

$$B = \frac{\mu_0 I}{4\pi r}[2\pi - 1].$$

3. Configuration C: - The magnetic field at O is:

$$B = \frac{\mu_0 I}{4\pi r}[\pi - 1].$$

4. Configuration D: - The magnetic field at O is:

$$B = \frac{\mu_0 I}{4\pi r}[2\pi + 1].$$

Thus, the correct match is: **A-III, B-I, C-IV, D-II**. The magnetic field at a point due to a current configuration is calculated using Biot-Savart's law or Ampère's circuital law.

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---

6. **Answer: c**

Explanation:

Explanation:
Given:The electric field part of the electromagnetic wave is
= 25–cos[(2 10^{6} —) –(10^{-2} —)].....(i) = = 0Let be the frequency and be the wavelength of the wave. The given equation is similar to the wave equation, which propagates along the positive direction of -axis: = $_{0}$cos(–).....
(ii)whereω: angular frequencyk: wave numberT: time periodComparing equation (i) and (ii), we get = 2 ×10^{6} / 2 = 2 ×10^{6} / [since = 2] = 10^{6}
This represents the frequency of the electromagnetic waves.Also, = 10^{-2} /
2 = .10^{-2} / [since = 2] = 200This represents the wavelength of the electromagnetic wave.Therefore, the wave is moving along -axis with frequency 10^{6} and wavelength 200 m.Hence, the correct option is (C).

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7. Answer: d

Explanation:

Explanation:

The total mass of the system = 20 + 12 + 8 = 40 .The gravitational force ′g′ = 10 / 2
= − 40 = 480 − 40 × 10 = 2 / 2 At the midpoint of the rod, half of the rod and
2 are below, having a total mass of 4 + 12 = 16 .Therefore, Tension
= (+) = 16(10 + 2) = 192 Hence, the correct option is (D).

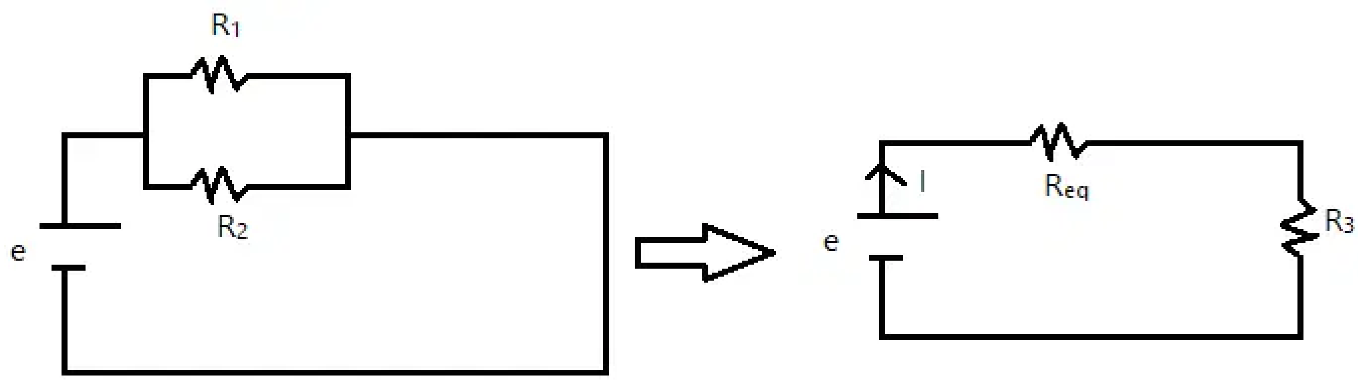
---

8. Answer: d

Explanation:

Explanation:

When the switch is just closed, the capacitor will start charging through resistors
1 , 2 and no current will pass through resistor 3 .The current through 1 is
1 = 10 − / 1 and current through 2 is 2 = 20 − / 2 As
1 = 2 = 2, 10 = 20 = 10 / 2 = 5 and 1 = 2 = 2Thus the ratio (1 / 2) is always
constant.After switch closed long time the charging of capacitor will stop and the
circuit will treat as shown in figure below.



= $\frac{2\times2}{2+2}$ = 1ΩCurrent through 3 is = $\frac{10}{1+1}$ = 5 The capacitor charged maximum
when potential across is = 3 = 3 = 5 Thus, max charge on is = = 5
Hence, the correct option is (D).

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9. Answer: c

Explanation:

Explanation:
Given:Radius of the orbit is RVelocity of the electron is VTotal energy of the electron is EVelocity of an electron in the n^{th} orbit of Bohr's model of an atom is given byV $\frac{1}{}$...... (i)The radius of the orbit is given byR ^{2} ...... (ii)The energy of an electron in the nth orbit is given byE ^{2} .... (iii)A. For option (A)E/V = $\frac{}{2}$ = $\frac{1}{}$Option 'A' is incorrect.B. For option (B)R/E = n^4Option 'B' is incorrect. C. For option (C)V.R = $\frac{2}{}$ = Option 'C' is correct.D. For option (D)R.E = $\frac{2}{2}$ = 1Option 'D' is incorrect.Hence, the correct option is (C).

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10. **Answer: b**

Explanation:

The correct option is (B): $44\mu T$

$B = \frac{\mu_0 i}{4R}$

$= \frac{4\pi\times10^{-7}\times14}{4\times0.1}$ T

$= \frac{22}{7}\times10^{-7}\times\times140$ T

$= 44\mu$T

Concepts:

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---

11. **Answer: a**

Explanation:

B is directly proportional to 'x', for when the 'x' is lesser than 'a'
The B is inversely proportional to 'x', for when the 'x' is greater than 'a'.

So, the correct option is (A)

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12. **Answer: a**

Explanation:

In the EM wave,
$(\text{The energy density})_{\text{magnetic field}} = (\text{The energy density})_{\text{electric field}}$

So, the correct answer is (A): 1:1

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.

---

13. **Answer: d**

Explanation:

$S_1, S_2 \rightarrow$ The Flux remains constant

$S_3 \rightarrow \Phi = BA \cos\theta$ [Here, θ is changing]

$S_4 \rightarrow$ The area is changing $\rightarrow$ The EMF induces

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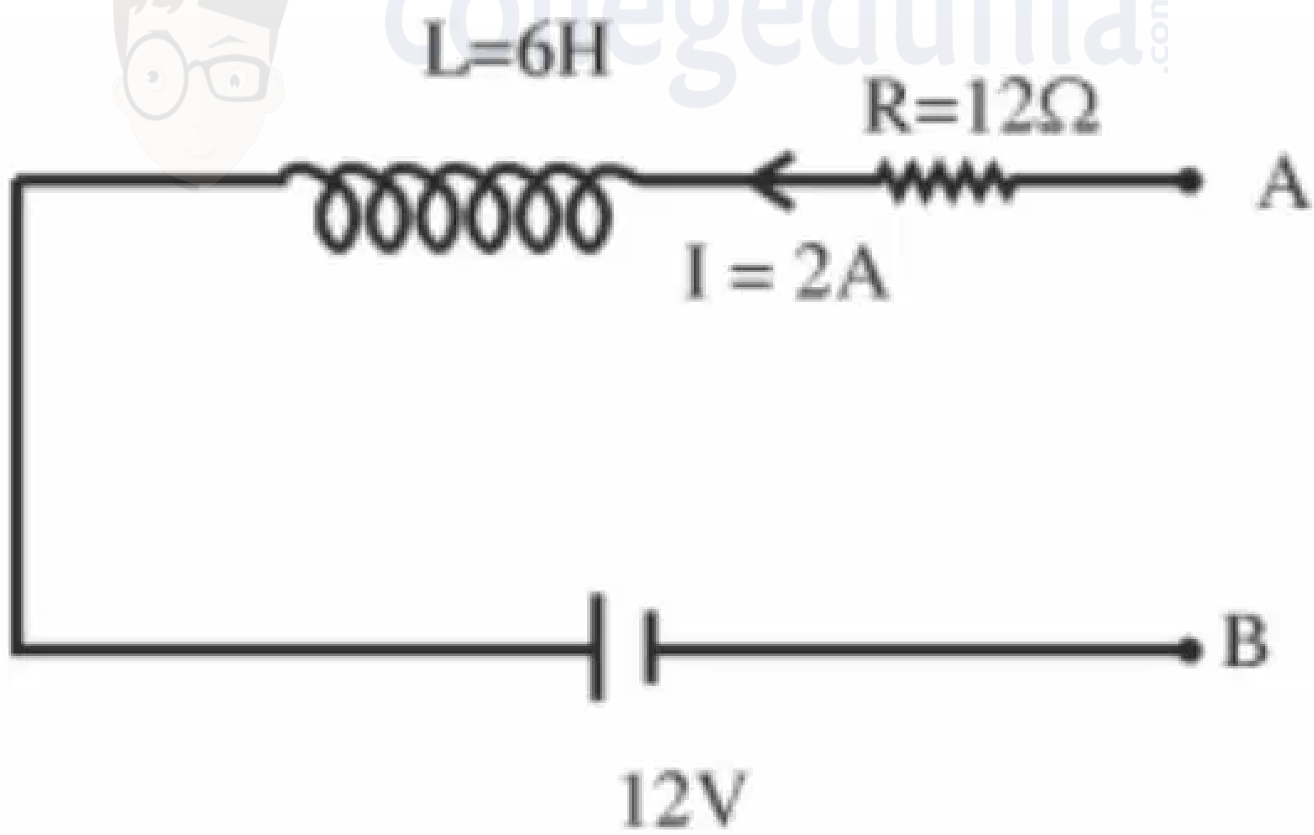
14. **Answer: 30 - 30**

Explanation:

The correct answer is 30.



Applying Kirchhoff's Voltage Law (KVL):

The differential equation for the circuit is given by:

$$\frac{dI}{dt} = -1 \text{ A/sec}$$

The equation for the potential difference across the circuit is:

$$V_A - IR - L\frac{dI}{dt} - 12 = V_B$$

Substituting Known Values:

Substitute $I = 2$ A, $R = 12\ \Omega$, $L = 6$ H, and $\frac{dI}{dt} = -1$:

$$V_A - 2 \times 12 - 6(-1) - 12 = V_B$$

Simplify the equation:

$$V_A - V_B = 36 - 6 = 30 \text{ volts}$$

Final Answer:

$V_A - V_B = 30$ volts

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15. **Answer: b**

Explanation:

The magnetic field due to a current-carrying circular loop on its axis is given as:

$$B_{\text{axis}} = \frac{\mu_0 I r^2}{2(r^2 + x^2)^{3/2}}$$

At the center of the loop $(x = 0)$:

$$B_{\text{center}} = \frac{\mu_0 I}{2r}$$

At a distance r on the axis $(x = r)$:

$$B_{\text{axis}} = \frac{\mu_0 I}{2 \cdot 2\sqrt{2}r}$$

The ratio of magnetic fields is:

$$\frac{B_{\text{center}}}{B_{\text{axis}}} = \frac{\frac{\mu_0 I}{2r}}{\frac{\mu_0 I}{2\cdot 2\sqrt{2}r}} = 2\sqrt{2}$$

Thus, the ratio $B_{\text{center}} : B_{\text{axis}} = 2\sqrt{2} : 1$.

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:

- 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.

---

16. **Answer: c**

Explanation:

$I = (2\pi\ r)n$
$r \propto (\frac{I}{n})$
$B = n(\frac{\mu_0 i}{2r}) \propto (\frac{\mu_0 i}{2L})n^2$
$\frac{B_1}{B_2} = (\frac{N^2}{n^2})$
So, the correct answer is (C) : $N^2 : n^2$

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---

17. **Answer: c**

Explanation:

Step 1: Determine the Magnetic Field Due to the Semicircular Arc

The magnetic field at the center of a circular arc of radius R carrying current I is given by:

$B_c = \frac{\mu_0 I}{4\pi R}\theta$

where μ_0 is the permeability of free space, and θ is the angle subtended by the arc at the center in radians. For a semicircular arc, $\theta = \pi$.

$B_c = \frac{\mu_0 I}{4R}$

Step 2: Substitute the Given Values

Given $I = 3\,\mathrm{A},\ R = \frac{\pi}{10}\,\mathrm{m},\ \text{and}\ \mu_0 = 4\pi \times 10^{-7}\,\mathrm{N\,A^{-2}}$, we have:

$B_c = \frac{(4\pi \times 10^{-7})(3)}{4\left(\frac{\pi}{10}\right)}$

$B_c = \frac{4\pi \times 10^{-7} \times 3 \times 10}{4\pi}$

$B_c = 3 \times 10^{-6}\,\text{T} = 3\,\mu\text{T}$

Step 3: Consider the Magnetic Field Due to the Straight Wires

The straight portions of the wire do not contribute to the magnetic field at point O. This is because the magnetic field lines due to an infinitely long straight wire form concentric circles around the wire. At the center of the semicircle, the straight sections are radial, so the magnetic field produced by them at point O will be perpendicular to the plane of the semicircle and thus won't affect the field in the plane caused by the semicircular section.

Conclusion: The magnitude of the magnetic field at the center O is $3\,\mu\text{T}$ (**Option 3**).

Concepts:

1. Moving Charges and Magnetism:

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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.

---

18. Answer: b

Explanation:

Step 1: Recall the Formula for Magnetic Flux

The magnetic flux (Φ) through a coil is given by:

$$\Phi = \vec{B} \cdot \vec{A} = BA\cos\theta$$

where B is the magnetic field strength, A is the area of the coil, and θ is the angle between the magnetic field vector and the area vector (which is perpendicular to the plane of the coil).

Step 2: Analyze Each Option

A: Changing the magnitude of the magnetic field (B) directly affects the magnetic flux (Φ). So, A is correct.

B: Changing the area of the coil (A) within the magnetic field also directly affects the magnetic flux (Φ). So, B is correct.

C: Changing the angle (θ) between the magnetic field and the plane of the coil changes $\cos\theta$ and thus the magnetic flux (Φ). So, C is correct.

D: Reversing the magnetic field direction means changing the direction of $\vec{B}$ by 180 degrees. This means that θ becomes $\theta + 180^\circ$.

$$\cos(\theta + 180^\circ) = -\cos\theta,$$

meaning the flux reverses sign, but its magnitude changes. So, D is a way to change the flux.

Conclusion: Options A, B, and C are correct ways to change the magnetic flux, and D is also a way to change the magnetic flux. Because the question asks for the most appropriate answer, and D implies a change in magnitude, ABC is slightly preferred. So, option (2) is the most appropriate answer.

Concepts:

1. Electromagnetic Induction:

Electromagnetic Induction is a current produced by the voltage production due to a changing magnetic field. This happens in one of the two conditions:-

1. When we place the conductor in a changing magnetic field.
2. When the conductor constantly moves in a stationary field.

Formula:

The electromagnetic induction is mathematically represented as:-

e=N × dØ.dt

Where

- e = induced voltage
- N = number of turns in the coil
- Φ = Magnetic flux (This is the amount of magnetic field present on the surface)
- t = time

Applications of Electromagnetic Induction

1. Electromagnetic induction in AC generator
2. Electrical Transformers
3. Magnetic Flow Meter

---

19. Answer: d

Explanation:

Applying Biot-Savart's Law:

$$B_p = \left(\frac{\mu_0 I}{4r} + \frac{\mu_0 I}{4\pi r}\right) = \frac{\mu_0 I}{2r}\left(\frac{1}{2} + \frac{1}{2\pi}\right)$$

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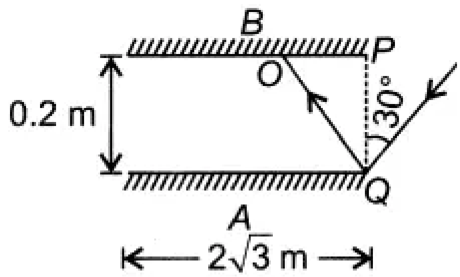
---

20. Answer: b

Explanation:

Explanation:



According to laws of reflection, = So, = 30 Given, = 0.2 tan30 = — $\frac{1}{\sqrt{3}} = \frac{}{0.2}$ = $\frac{0.2}{\sqrt{3}}$ OP is distance covered by the ray in one reflection. Number of times the ray undergoes reflections, before it emerges out: = $\frac{2\sqrt{3}}{} = \frac{2\sqrt{3}}{\frac{0.2}{\sqrt{3}}} = \frac{6}{0.2}$ = 30Hence, the correct option is (B).

---

21. Answer: a

Explanation:

Explanation:
Barn is a unit of area.A barn is a unit of area. It is represented by the “symbol b”.Originally it was used in nuclear physics for expressing the cross-sectional area of nuclei and nuclear reactions, nowadays it is used in all fields of high energy physics to express the cross-sections of any scattering.The nuclear cross-section is measured in barn, it is equal to 10-28m^2 (100 fm^2).Nuclear reactions typically have cross-sections in the range 0.1 to 10 barns, though cross sections from 10⁸ to 10^6 barns are known.Hence, the correct option is (A).

---

22. Answer: c

Explanation:

Explanation:
Given:Mass of the particle, = 0.1 Height, = 0.24 Compression, = 0.01 Loss in potential energy = (+)Elastic potential energy = $\frac{1}{2}$ ^{2} According to the conservation of mechanical energy,Loss in PE of the particle = Gain in elastic potential energy of the spring (+) = $\frac{1}{2}$ ^{2} Also ($'$ + $'$) = $\frac{1}{2}$ $'^2$ On dividing: $\frac{+}{' + '} = \frac{^2}{'^2}$ $\frac{0.24 + 0.01}{+ 0.04} = (\frac{0.01}{0.04})^2$ On solving: = 3.96 Hence, the correct option is (C).

---

23. Answer: a

Explanation:

Explanation:
Initial magnetic flux through the coil, = cos = $3.0 \times 10^{-5} \times (\times 10^{-2}) \times \cos 0$

$= 3 \times 10^{-7}$ Final magnetic flux after the rotation, $= 3.0 \times 10^{-5} \times (\times 10^{-2}) \times \cos 180$ $= -3 \times 10^{-7}$ Induced emf, $= - \, — = - \frac{(-)}{} = - \frac{500(-3 \times 10^{-7} - 3 \times 10^{-7})}{0.25}$ $= \frac{500 \times (6 \times 10^{-7})}{0.25} = 3.8 \times 10^{-3}$ $= - = \frac{3.8 \times 10^{-3}}{2\Omega} = 1.9 \times 10^{-3}$ Hence, the correct option is (A).

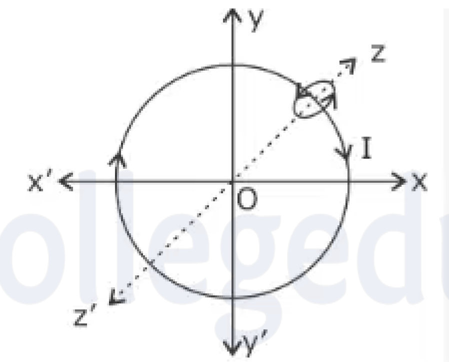
---

24. Answer: d

Explanation:

Explanation:

Since the current loop is in the x-y plane, the magnetic lines of force will be perpendicular to the x-y plane i.e. in the z-direction.



Magnetic flux is given by $= \cdot$ The number of magnetic lines of force going towards the positive z-direction through the circular loop is equal to the number of magnetic lines of force going towards the negative z-direction through the x-y plane outside the circular loop. This is true because the magnetic lines of forces form a closed loop. Thus, the net magnetic flux through the x-y plane is zero.Hence, the correct option is (D).

---

25. Answer: b

Explanation:

Explanation:

The magnetic force (F) experienced by a moving charged particle(q) in a uniform magnetic field (B) is given by $= \sin$ $= \frac{}{\sin}$ where, is angle between the magnetic field and the velocity of the particle.The dimensions of charge, force and velocity are[ ] = [ ][ ] = [$^{-2}$][v] = [LT^{-1}]sin is a dimensionless quantity. Now, the dimension of magnetic field is[ ] = $\frac{[\ ]}{|\ \ |\ \ \sin\ ]}$ = $\frac{[\ \ ^{-2}]}{[\ ][\ \ ^{-1}]}$ = [$^{-1}$ $^{-1}$]The energy stored in a capacitor is given by = $\frac{^2}{2}$where, is capacitance.The dimension of energy is [ ] = [^{2} $^{-2}$]Thus, the dimension of capacitance is[ ] = $\frac{[\ ^2]}{[\ ]}$ [ ] = $\frac{[\ ^2]}{[\ \ ^2\ ^{-2}]}$ [ ] = [$^{-1}$ $^{-2}$ ^{2} ^{2}]Given: X = 3YZ^2 where, X and Z have the dimensions of capacitance and magnetic field respectively. Thus, [ ] = [ ] = [$^{-1}$ $^{-2}$ ^{2} ^{2} [ ] = [ ] = [$^{-1}$ $^{-1}$]Therefore, the dimension of is [ ] = $\frac{[\ ]}{[\ ]^2}$ [ ] = $\frac{[M^{-1}\ L^{-2}\ T^{2}\ \ ^{2}]}{[MT^{-1}\ Q^{-1}]^{2}}$ [ ] = $\frac{[\ ^{-1}\ ^{-2}\ ^{2}\ ^{2}]}{|\ ^{2}\ ^{-2}\ ^{-2}|}$ [ ] = [$^{-3}$ $^{-2}$ ^{4} ^{4}]Hence, the correct option is (B).