LAKSHYA BATCH

Magnetism and Matter
Past Year Questions

[redacted]

Today's GOAL

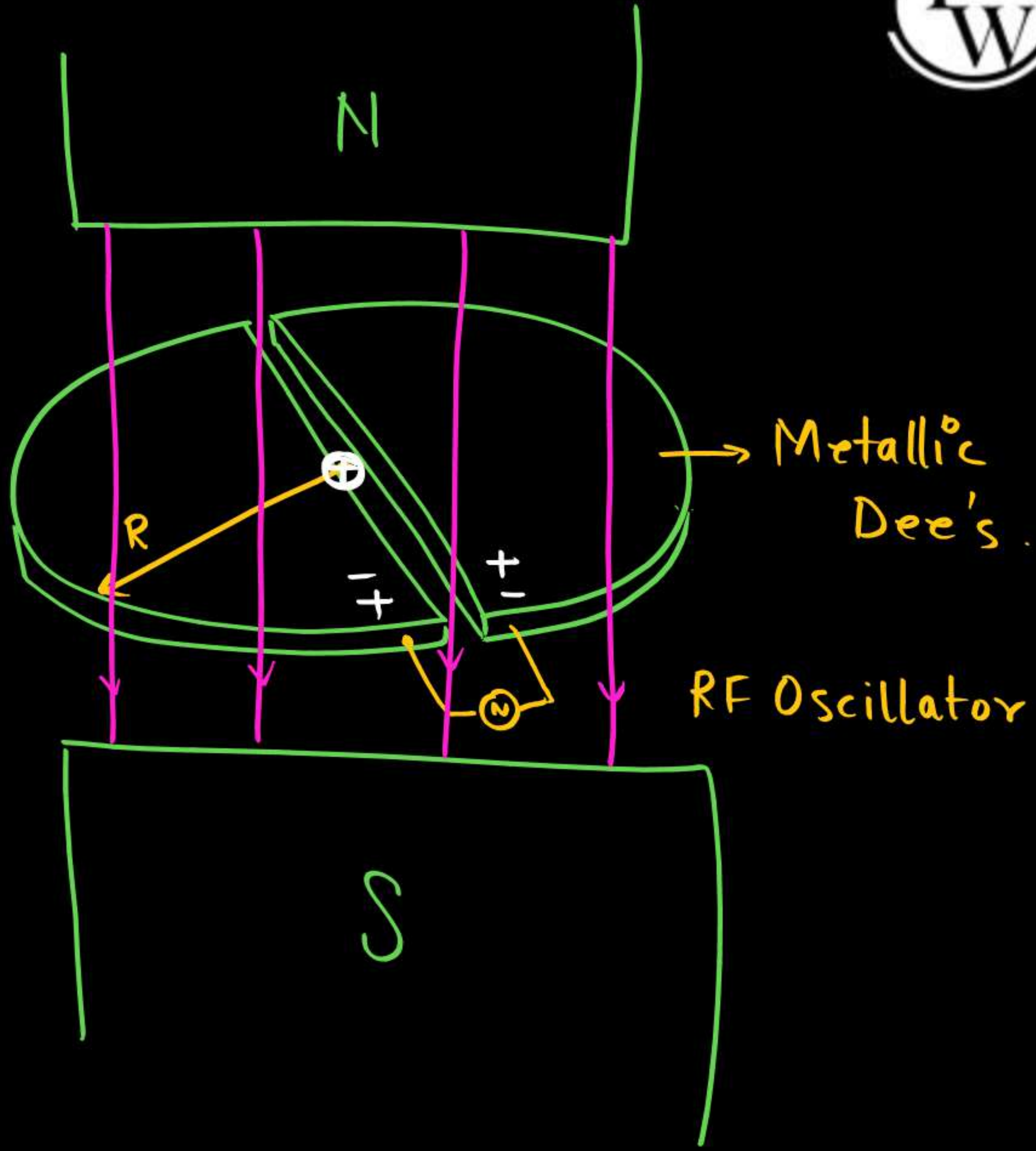
MAGNETISM & MATTER PYQ

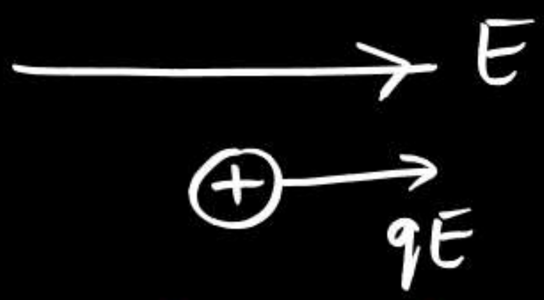
CYCLOTRON:

only used to accelerate (+ve) charge particle.

→ But to accelerate e^- → Betatron.

Working - Simultaneous application of $\vec{E}$ & $\vec{B}$ we can accelerate the ⊕ charge particle.





$acc = \frac{F}{m} = \frac{qE}{m}$

as Soon charge particle Enters Metallic Dee ($E = 0$)

$B = \otimes$

$v = \hat{i}$. Circular Trajectory

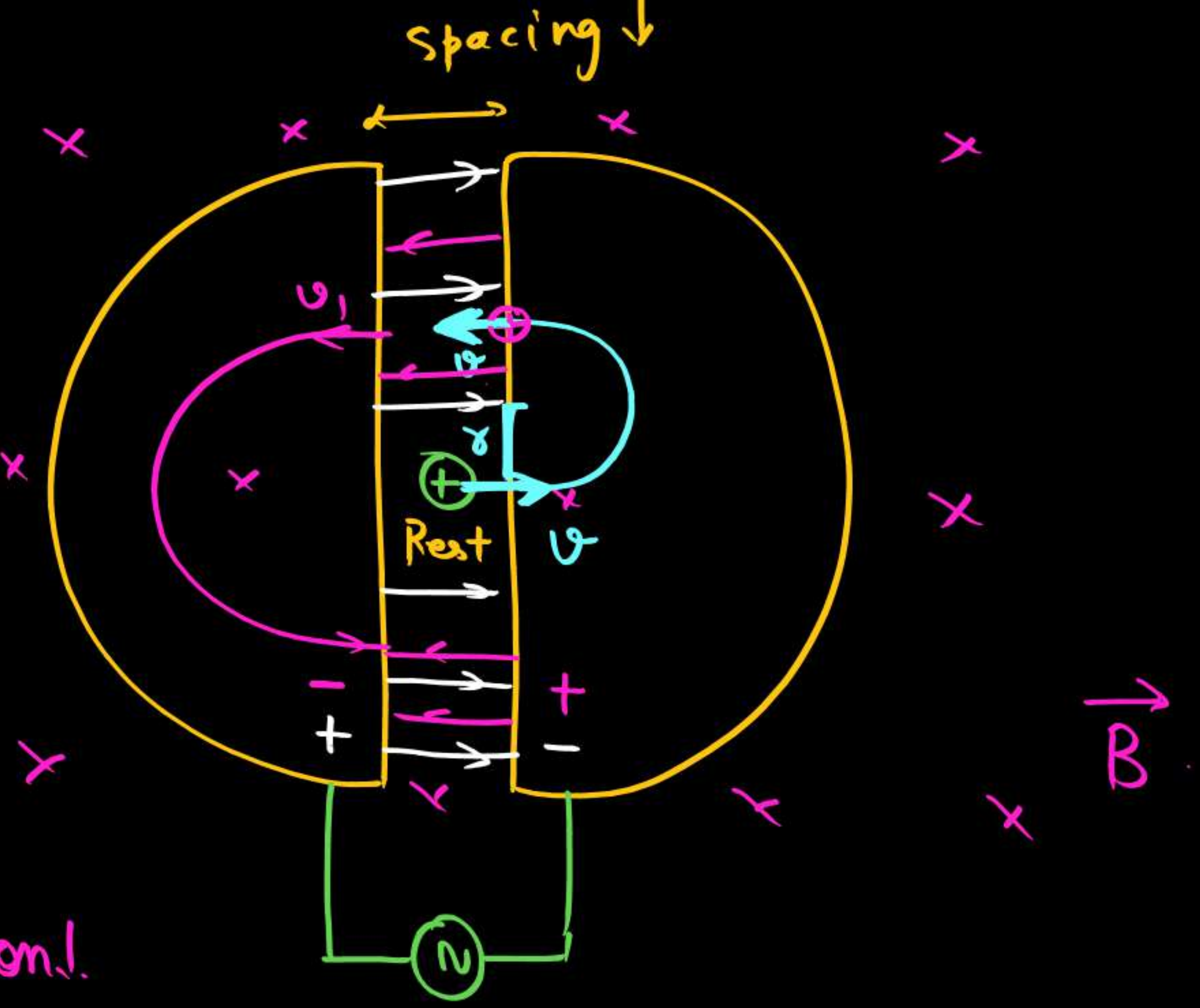
radius of Circular $= r = \frac{mv}{qB}$.

as $v \uparrow$ $r \uparrow$.

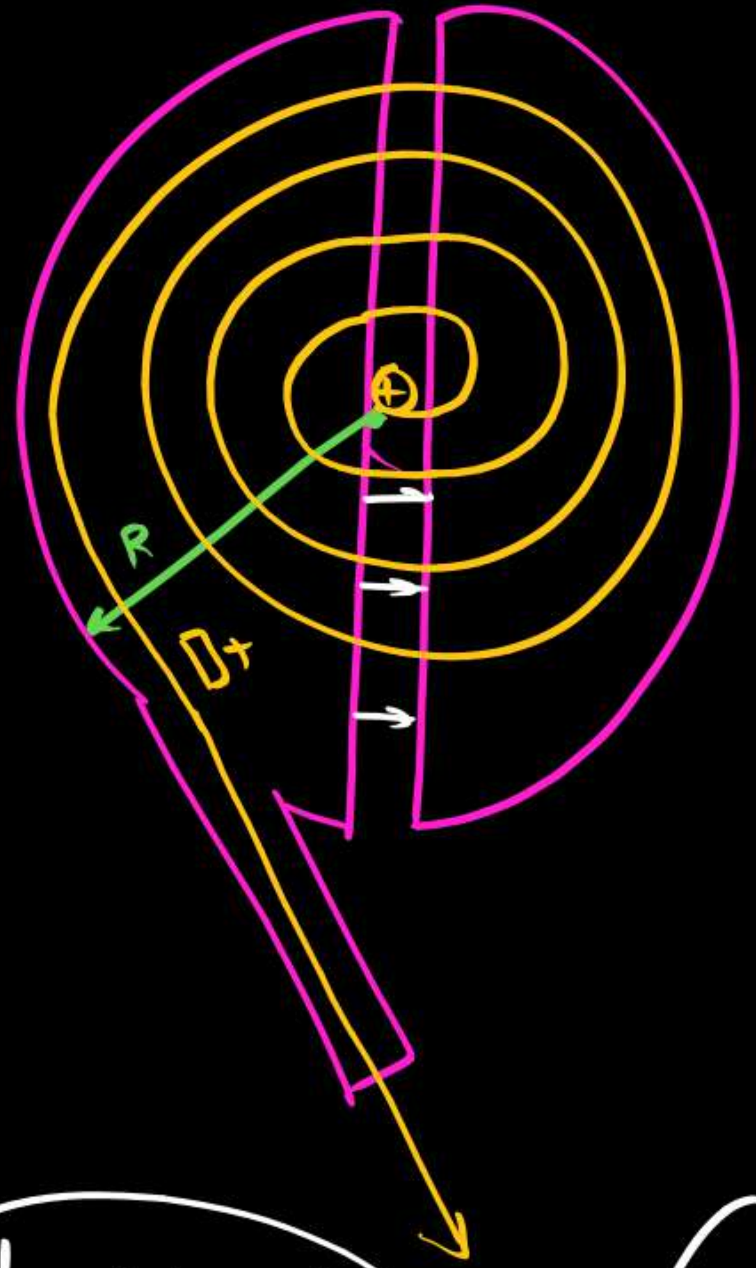
as it goes on..

$R \uparrow$ Speed $\uparrow$.

Top view.



W done by Magnetic field = 0



radius $= r = \dfrac{mv}{qB}$

EF in the gap increases v every time.

When $R \rightarrow$ Maximum "Radius of Dee"

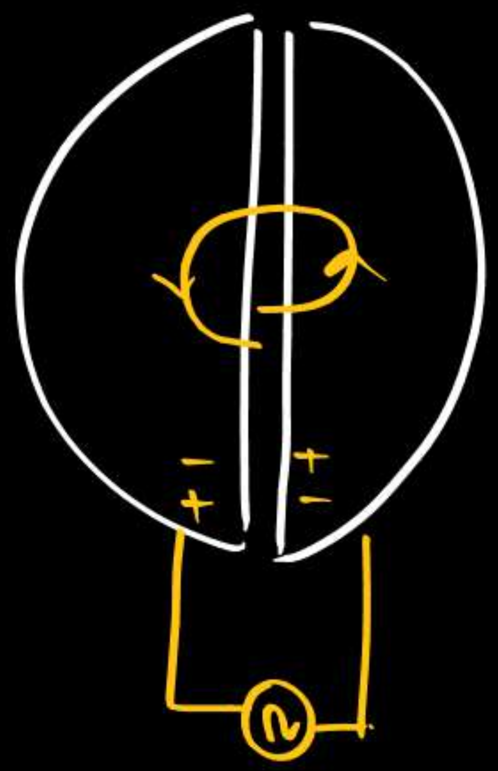
$$R_{max} = R = \frac{m v_{max}}{qB}$$

$$\boxed{v_{max} = \frac{qBR}{m}}$$

$$KE_{max} = \frac{1}{2} m v_{max}^2 = \frac{1}{2} m \frac{q^2B^2R^2}{m^2} = \frac{q^2B^2R^2}{2m}$$

developed by EF

(*) In Complete 1 Rot of charge . The Cycle of (+, -) of RF Oscillator also Completes

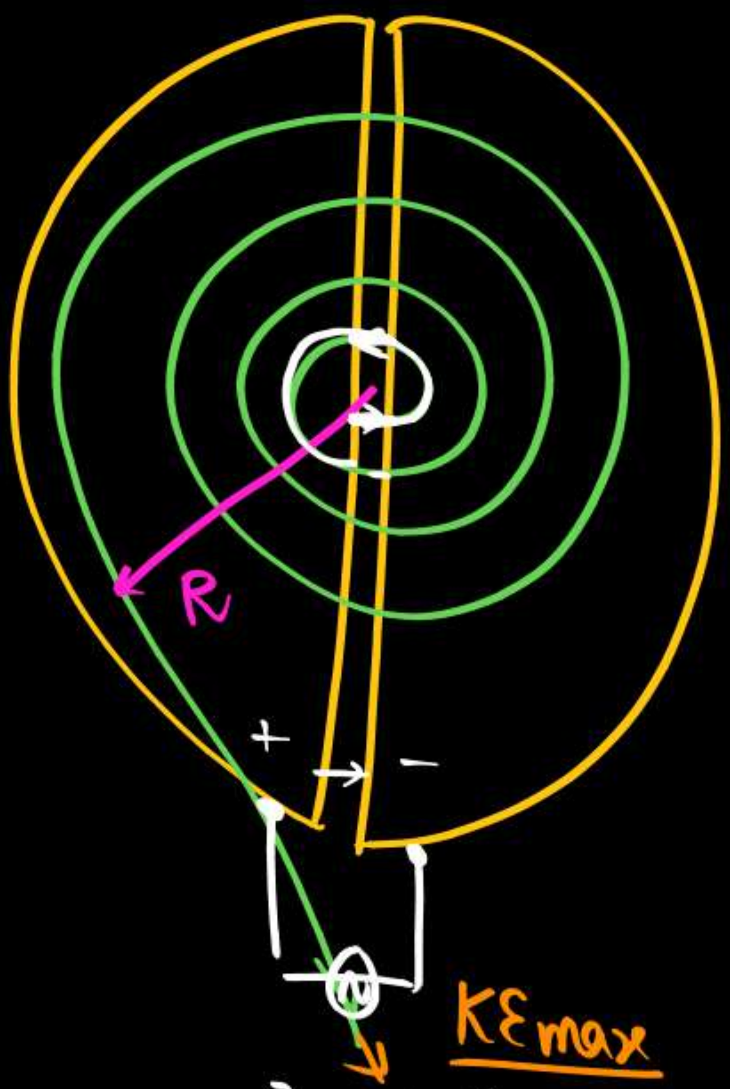


$$T_{RF\ oscillator} = \frac{2\pi m}{qB}$$ → Time period of 1 Rot of charge

$$\nu_{RF} = \nu_{charge\ Rotating}$$

(7) **No of Revolutions Made by charge**

ISRO



Pot diff = ΔV

Work done after passing throug Gap by EF $= q\Delta V$.

In Complete 1 Cycle ⇒ 2 times Cross Gap.

1 Complete Cycle $W_{EF} = 2q\Delta V$.

after N Rotations W_{Total} :- $W_T = 2Nq\Delta V$.

$$W_{T\,EF} = KE$$

$$2Nq\Delta V = \frac{q^2B^2R^2}{2m}$$

$N =$ ______

Drawback

1. We Cannot accelerate, neutral, e^-.

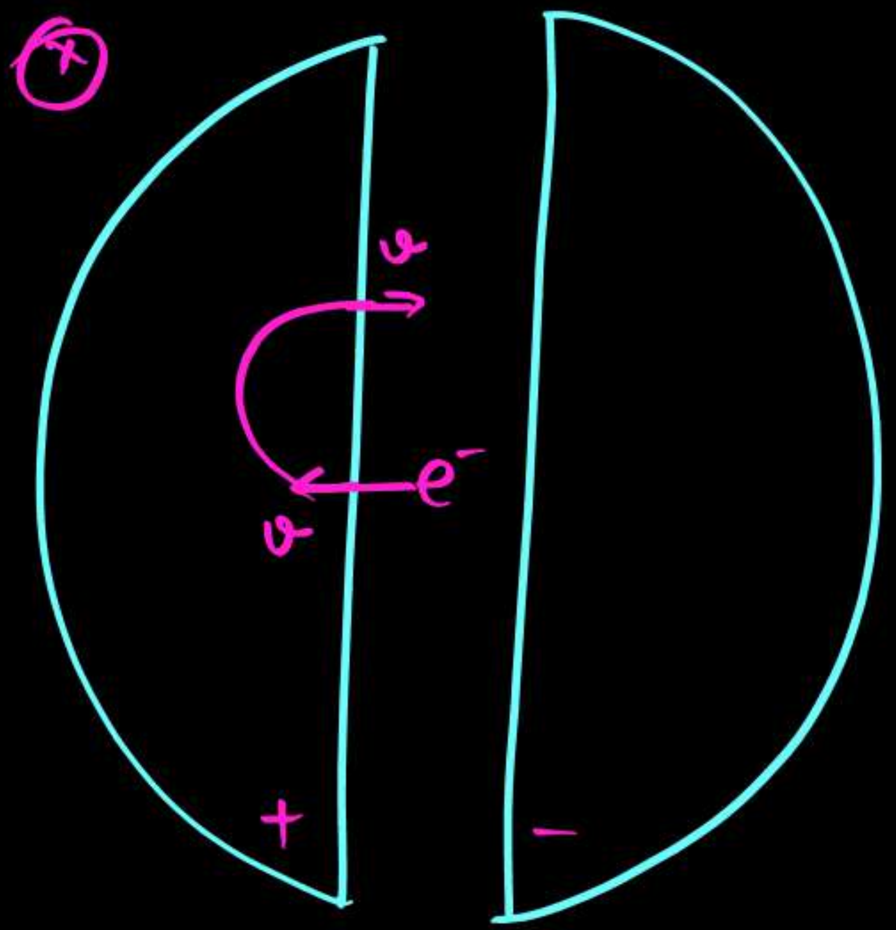
2. $m_e = 9.11 \times 10^{-31}$ Kg.

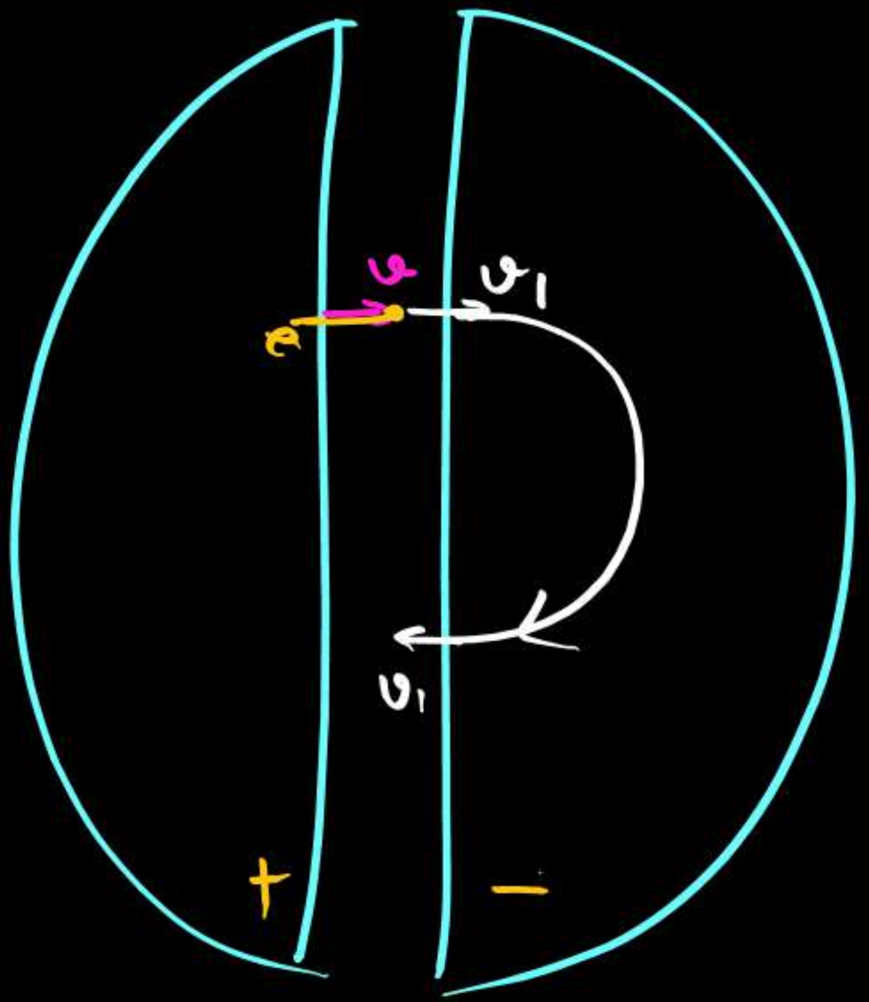
we have a Relativistic Equation of mass — $m_r = \dfrac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$

(mass changes with velocity).

due to very Small mass, accelerate faster, speed Increase ↑

mass Increases Rapidly, hence it damps it motion.





In Case of e^- mass Rapidly vary

$$T = \frac{2\pi m}{qB}$$

The length of a magnet is large compared to its width and breadth. The time period of its oscillation in a vibration is 2s. The magnet is cut along its length into three equal parts and these parts are then placed on each other with their like poles together. The time period of this combination will be

(2004, JEE Mains)

(a) $2\sqrt{3}$ s

(b) 2/3 s

(c) 2 s

(d) $2/\sqrt{3}$ s

Ans (b)

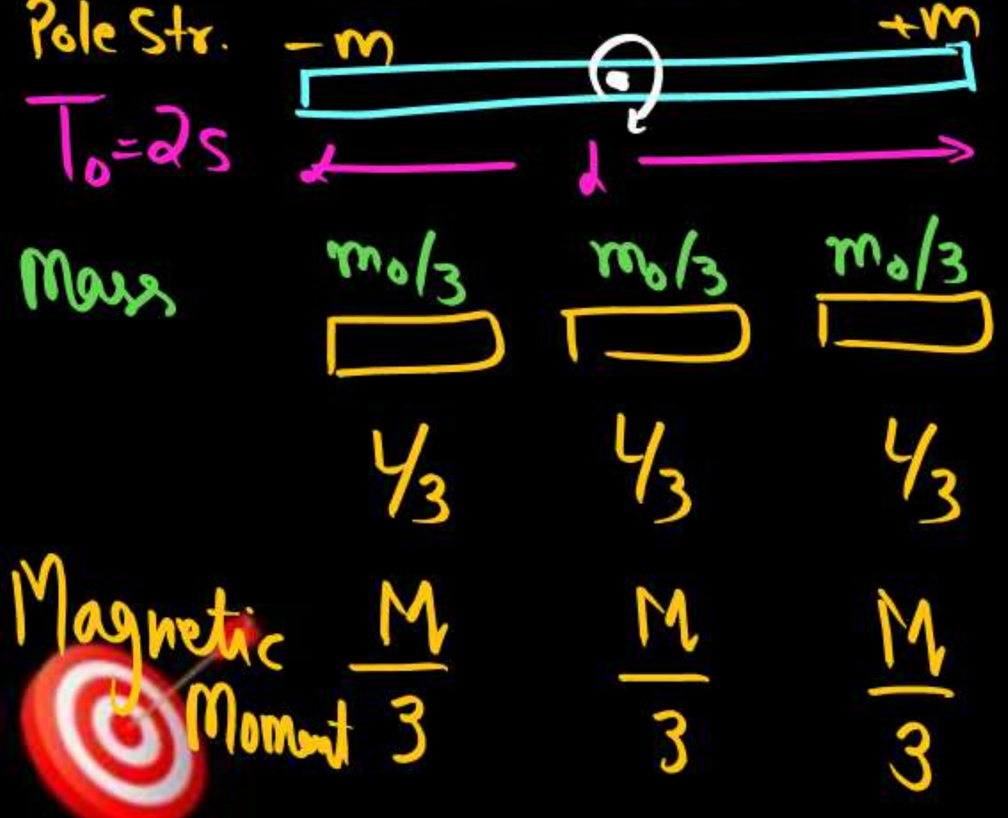
$T \propto \sqrt{I}$

$\frac{T_f}{T_i} = \sqrt{\frac{I_f}{I_i}} = \sqrt{\frac{I_i}{9 I_i}} = \frac{1}{3}$

$T_f = \frac{T_i}{3}$

$T_f = \frac{2}{3}$

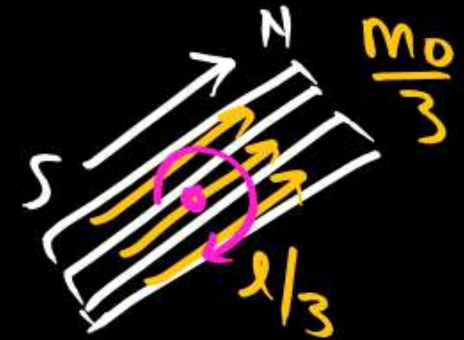
Initial mass = m_0



$T = 2\pi\sqrt{\frac{I}{MB}}$

I = MoI

M = Magnetic Moment.



$\vec{M}_T = 3(\vec{M}_{individual}) = M.$

$I_i = \frac{1}{12} m_0 L^2$

$I_f = 3\left(\frac{1}{12}\frac{m_0}{3}\left(\frac{L}{3}\right)^2\right)$

$= \frac{1}{12} m_0 \left(\frac{L^2}{9}\right) = \frac{I_i}{9}$

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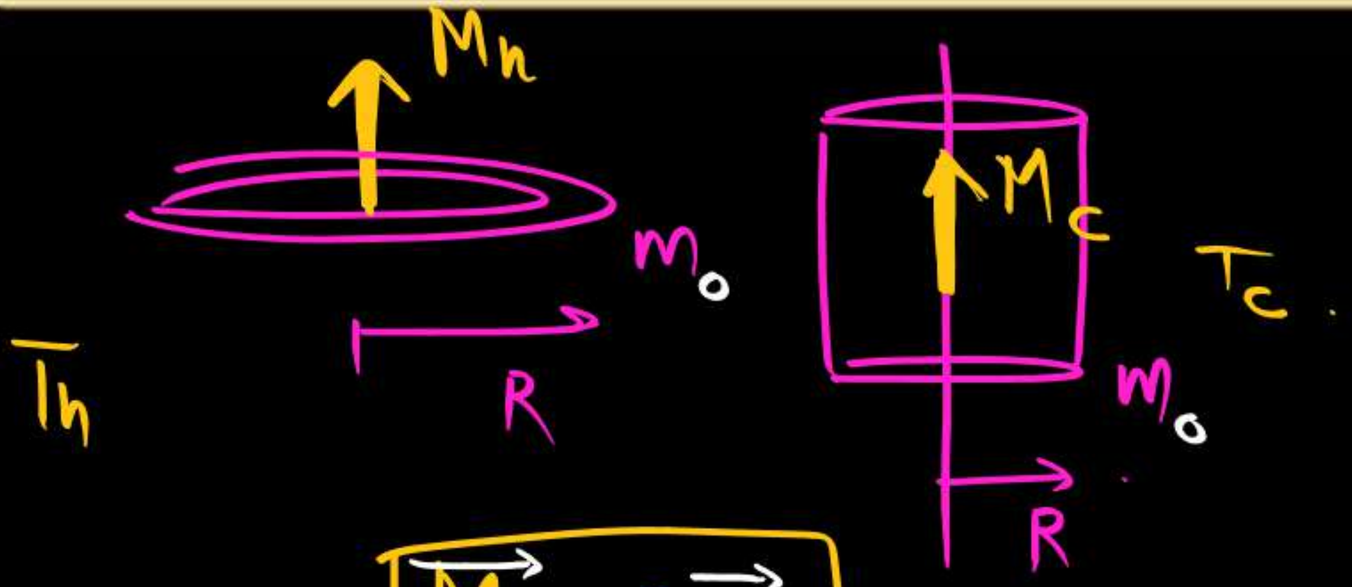
Ring.

A hoop and a solid cylinder of same mass and radius are made of a permanent magnetic moment parallel to their respective axes. But the magnetic moment of hoop is twice of solid cylinder. They are placed in a uniform magnetic field in such a manner that their magnetic moments make a small angle with the field. If the oscillation periods of hoop and cylinder are T_h and T_c respectively. Then:

(2019 JEE Mains)

(a) $T_h = T_c$ Ans
(b) $T_h = 2\,T_c$
(c) $T_h = 1.5\,T_c$
(d) $T_h = 0.5\,T_c$



$\vec{M}_h = 2\vec{M}_c$

$\frac{M_c}{M_h} = \frac{1}{2}$

$T = 2\pi\sqrt{\frac{I}{MB}}$

$I_{Ring} = m_0 R^2$

$I_{cylinder} = \frac{1}{2} m_0 R^2$

$\frac{T_h}{T_c} = \sqrt{\frac{I_h}{M_h}\frac{M_c}{I_c}}$

$= \sqrt{\frac{m_0 R^2}{\frac{1}{2} m_0 R^2}\cdot\frac{1}{2}}$

$T_c = T_h$

A magnetic compass needle oscillates 30 times per minute at a place where the dip is 45°, and 40 times per minute where the dip is 30°. If B_1 and B_2 are respectively the total magnetic field due to the earth and the two places, then the ratio B_1/B_2 is best given by: **(2019 JEE Mains)**

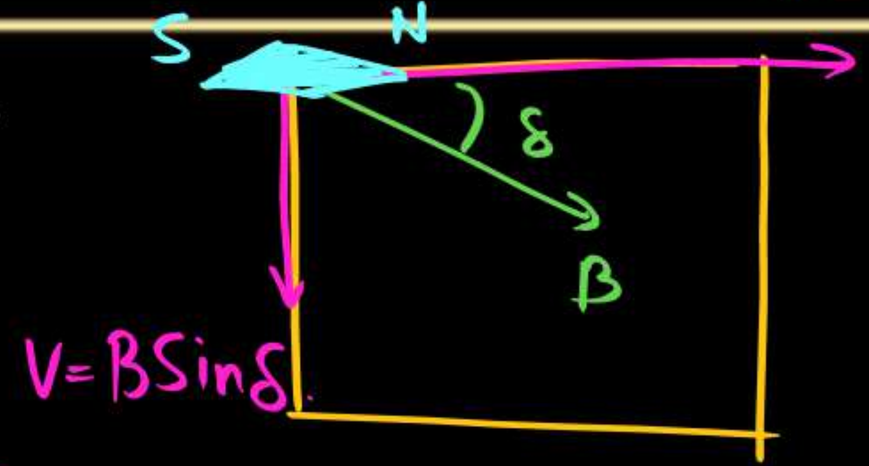
(a) 1.8

(b) 0.7 Ans

(c) 3.6 → rpm, rps, opm, ops

(d) 2.2

$H = B\cos\delta$



$\nu_1 = $ Os per min $= 30$ opm $\quad \delta_1 = 45°$

$\nu_2 = 40$ opm $\quad \delta = 30°$

$\frac{1}{\nu} = T = 2\pi\sqrt{\frac{I}{M(B_H)}}$

$\nu \propto \sqrt{B}$

$\frac{\nu_1}{\nu_2} = \sqrt{\frac{B_{H_1}}{B_{H_2}}}$

$\frac{\nu_1^2}{\nu_2^2} = \frac{B_{H_1}}{B_{H_2}} = \frac{B_1\cos 45}{B_2\cos 30}$

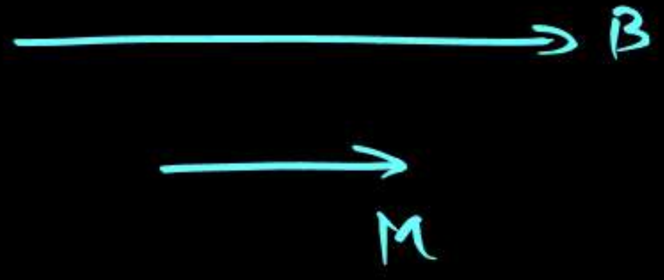
$\frac{B_1}{B_2} = \frac{\cos 30}{\cos 45}\cdot\frac{\nu_1^2}{\nu_2^2}$

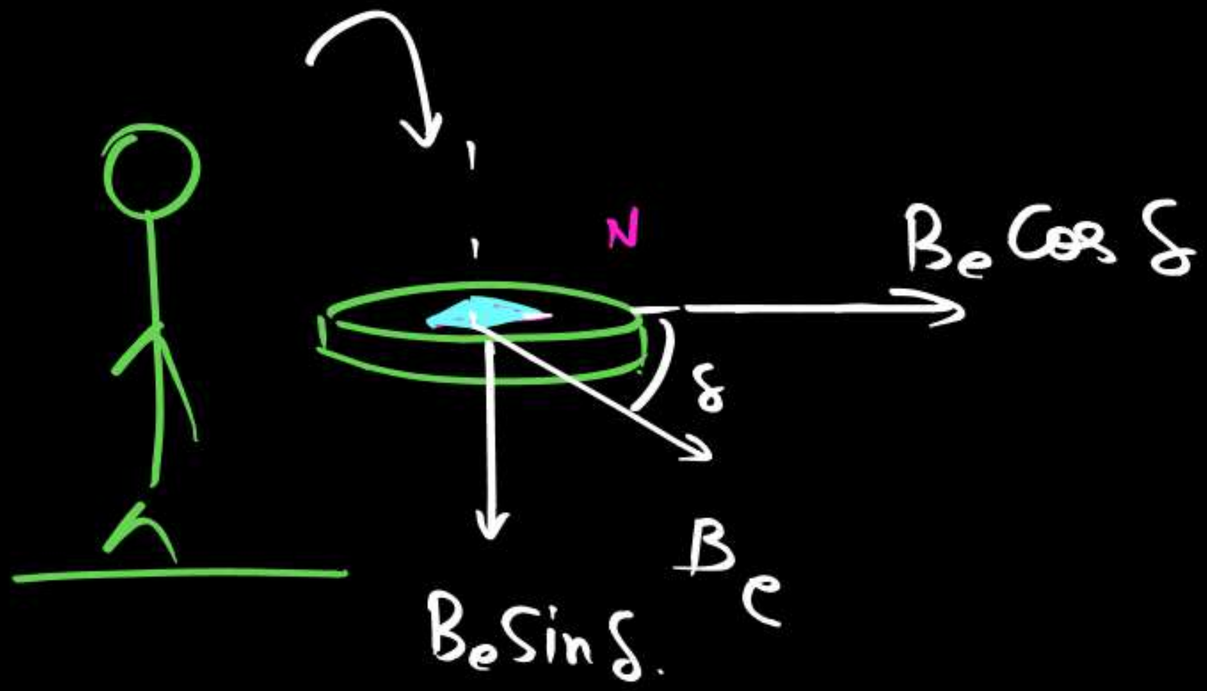
$= \frac{\sqrt{3}\sqrt{2}}{2\times 1}\times\frac{30^2}{40^2}$

$= \frac{\sqrt{6}}{2}\times\frac{900}{1600}$

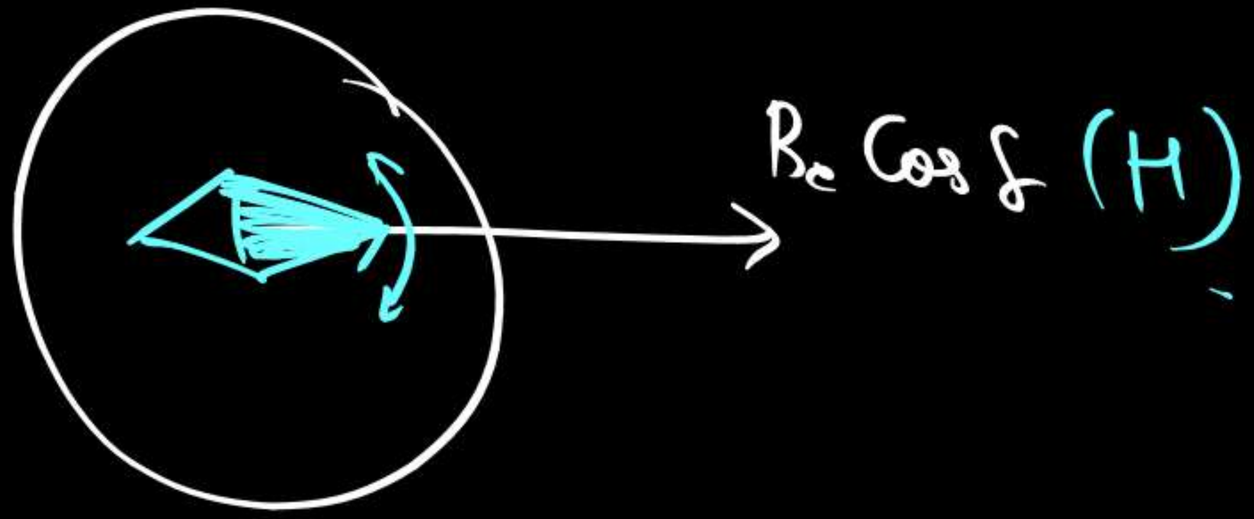
$= 0.688$

Stable Eqn





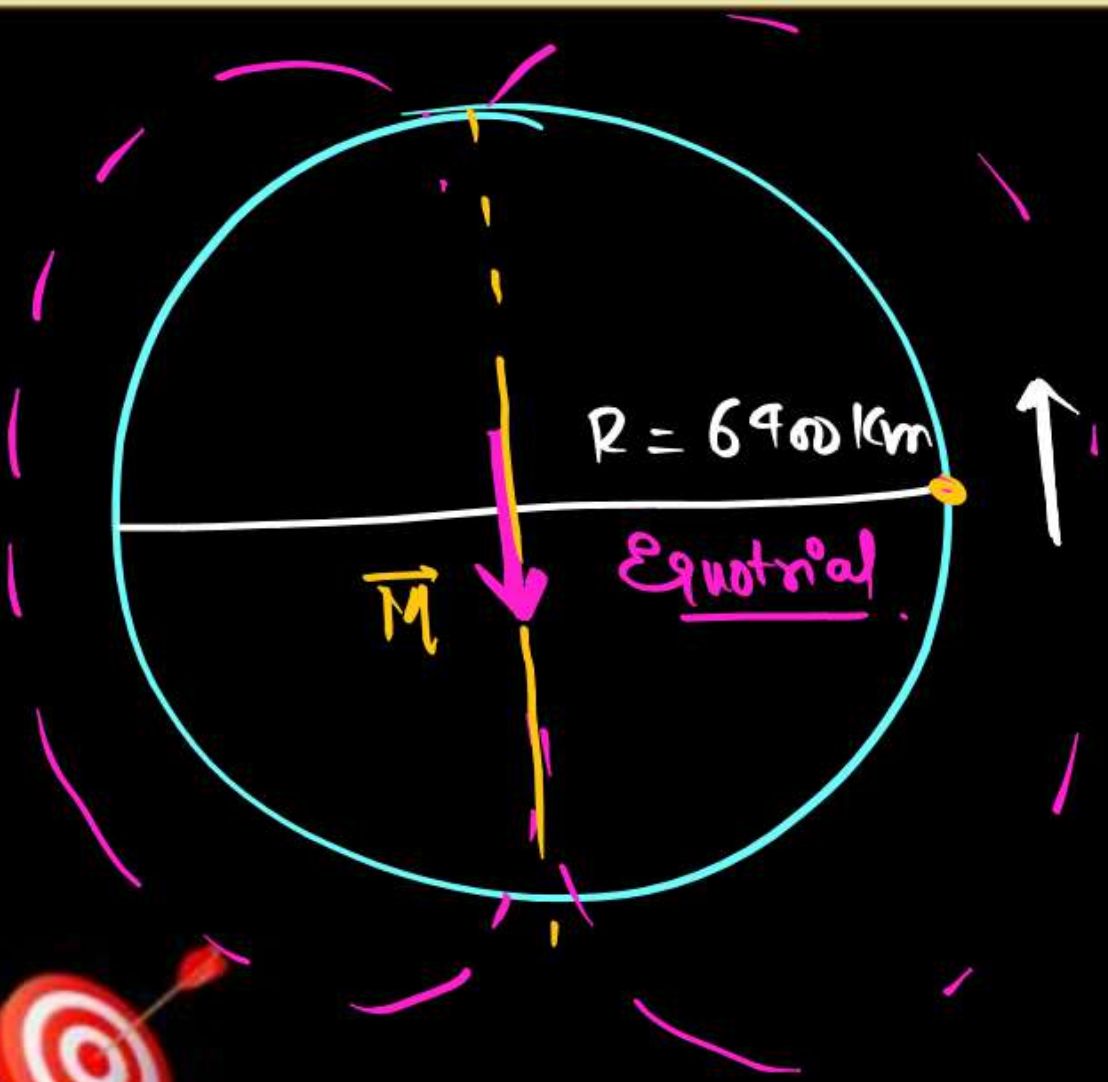
$$PE = -\overline{M}\cdot\overline{B}$$
$$= -MB\cos\theta$$
$$= -ve \text{ (Stable)}$$



The magnetic field of earth at the equator is approximately 4×10^{-5} T. The radius of earth is 6.4×10^{6} m. Then the dipole moment of the earth will be nearly of the order of: (2014 JEE Mains)

(a) 10^{23} A m^2 (b) 10^{20} A m^2

(c) 10^{16} A m^2 (d) 10^{10} A m^2



$B_e = 4 \times 10^{-5}$ T.

$\delta = 0$

$$B = \frac{\mu_0 M}{4\pi r^3}$$

$$B = \frac{10^{-7} \times M}{(6.4 \times 10^{6})^3} = 4 \times 10^{-5} \text{ T}$$

$M =$ ______

The mid points of two small magnetic dipoles of length d in end-on positions, are separated by a distance x, (x >> d). The force between them is proportional to x^{-n} where n is: **(2014 JEE Mains)**

(a) 1 (b) 2

(c) 3 (d) 4 Ans

$f \propto x^{-n}$

$f \propto \frac{1}{x^4} \propto x^{-4}$

$n = 4$ Refer Theory

Two short bar magnets of length 1 cm each have magnetic moments 1.20 Am^2 and 1.00 Am^2 respectively. They are placed on a horizontal table parallel to each other with their N poles pointing towards the South. They have a common magnetic equator and are separated by a distance of 20.0 cm. The value of the result and horizontal magnetic induction at the mid-point O of the line joining their centres is close to (Horizontal component of earth's magnetic induction is 3.6×10^{-5} Wb/m^2)

(2013 JEE Mains)

(a) 3.6×10^{-5} Wb/m^2

(b) 2.56×10^{-4} Wb/m^2 Ans

(c) 3.50×10^{-4} Wb/m^2

(d) 5.80×10^{-4} Wb/m^2

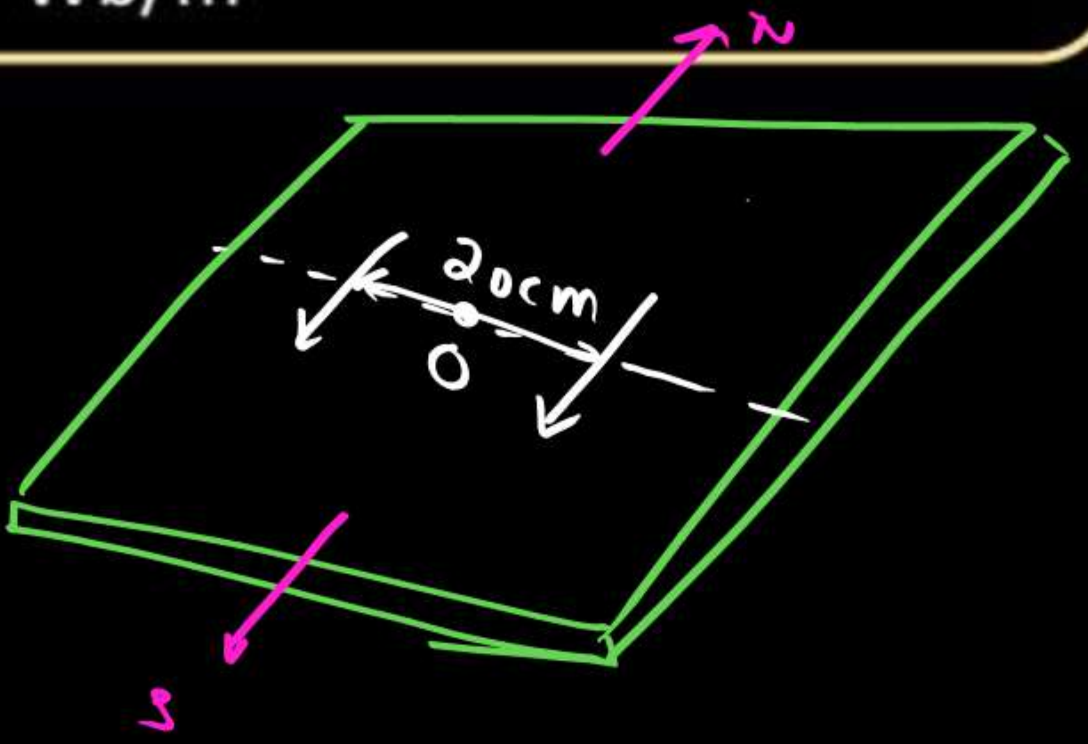
$\phi = B \cdot A$ → wb

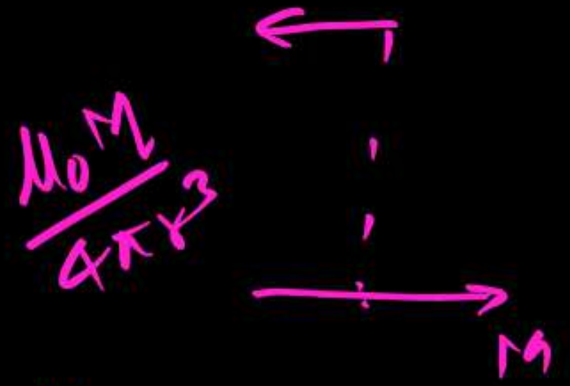
B = Tesla $= \frac{wb}{m^2}$

$\vec{M} = 1.00\ Am^2$

1m

$\vec{M} = 1.20\ Am^2$





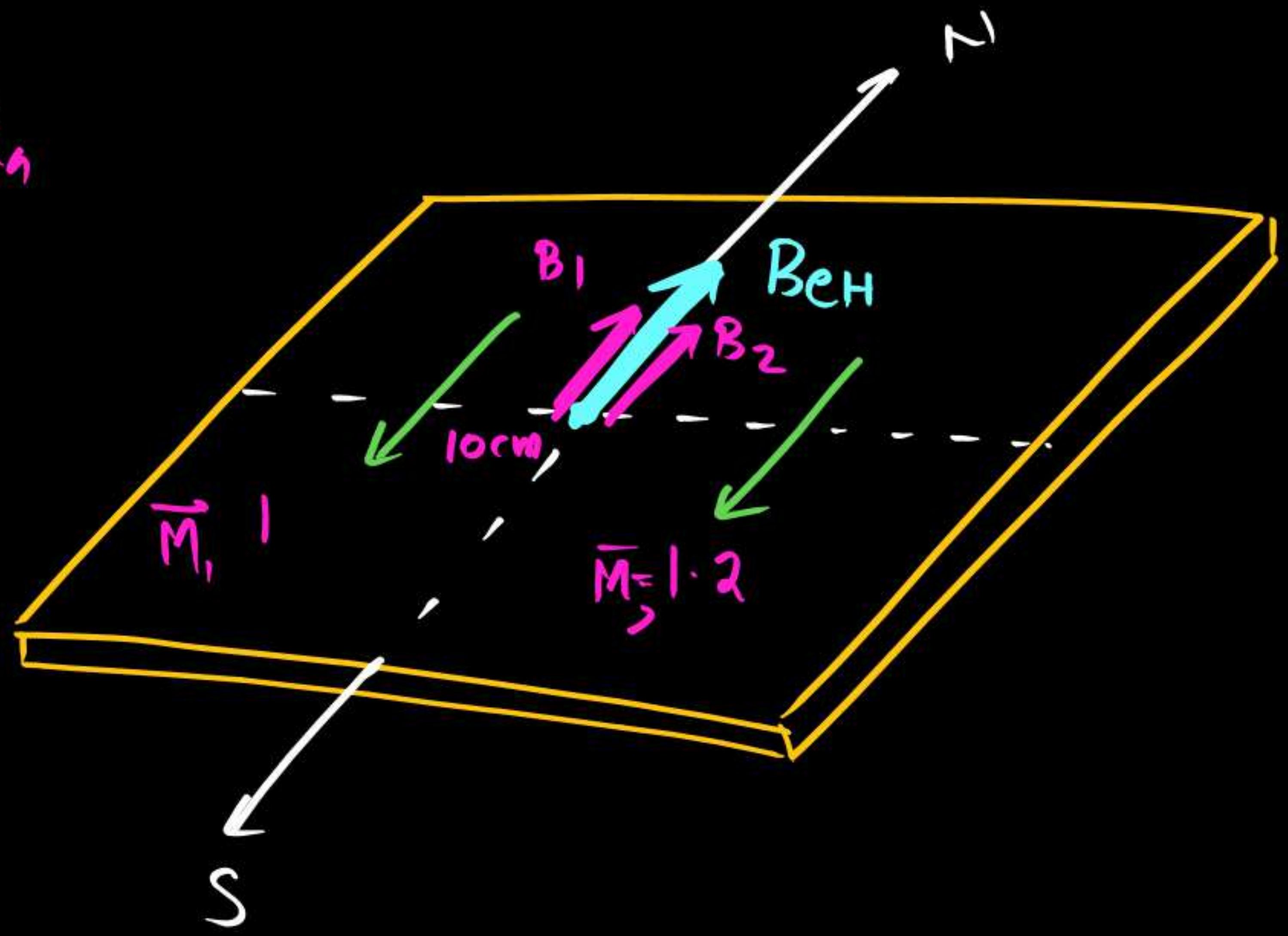
$$B_T = B_{eH} + \frac{\mu_0 M_1}{4\pi r^3} + \frac{\mu_0 M_2}{4\pi r^3}$$

$$= 3.6\times10^{-5} + \left(\frac{10^{-7}}{10^{-3}}(M_1 + M_2)\right)$$

$$= 3.6\times10^{-5} + 10^{-4}(2.2)$$

$$= 0.36\times10^{-4} + 2.20\times10^{-4}$$

$$= 2.56\times10^{-4}.$$



$r = 10\,cm$

$= \frac{10}{100} = (0.1) = 10^{-1}\,m$

At some location on earth the horizontal component of earth's magnetic field is 18×10^{-6} T. At this location, magnetic needle of length 0.12 m and pole strength 1.8 Am is suspended from its midpoint using a thread, it makes 45° angle with horizontal in equilibrium. To keep this needle horizontal, the vertical force that should be applied at one of its ends is: **(2019 JEE Mains)**

(a) 3.6×10^{-5} N (b) 1.8×10^{-5} N

(c) 1.3×10^{-5} N (d) 6.5×10^{-5} N

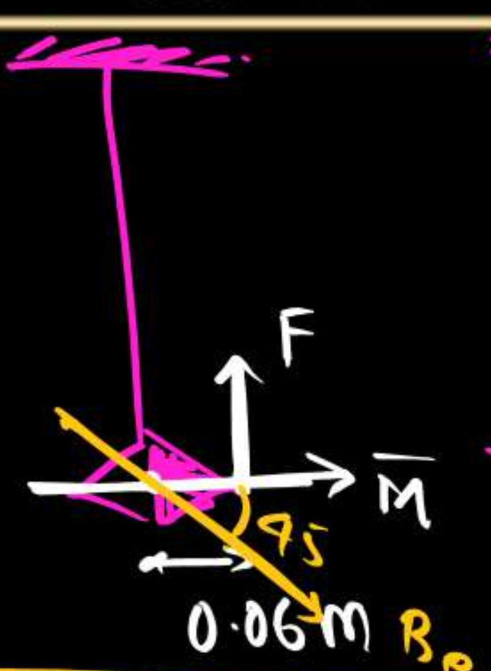
$B_{He} = 18 \times 10^{-6}$ T.

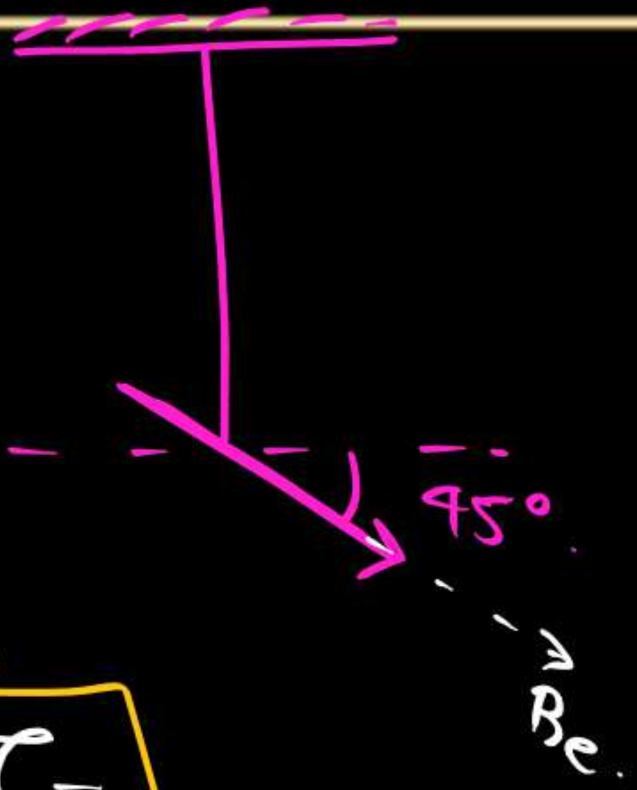
$l = 0.12$ m

$m = 1.8$ Am.

$\vec{M} = m l$

$= 1.8 \times 0.12$.





$\tau_{\text{external force}} = \tau_{\bar{M}}$

$\tau_{ext} = \bar{r} \times \bar{F}$.

$= r F \sin 90$

$\tau_{ext} = 0.06 F \; \hat{k}$.

$\bar{\tau}_M = \bar{M} \times \bar{B}$

$= M B \sin\theta$

$= 1.8 \times 0.12 \times 18 \times 10^{-6} \frac{1}{\sqrt{2}}$.

$(-\hat{k})$

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A 25 cm long solenoid has radius 2 cm and 500 total number of turns. It carries a current of 15 A. If it is equivalent to a magnet of the same size and magnetization $\vec{M}$ (magnetic moment/volume), then $|\vec{M}|$ is: **(2015 JEE Mains)**

$\vec{I}$ Intensity of magnetisation.

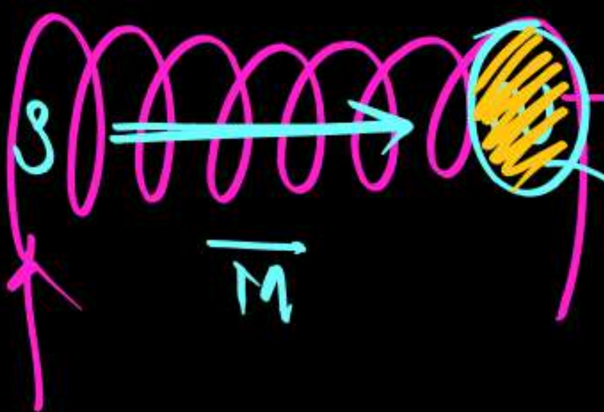
(a) 3000π Am^{-1}

(b) 3π Am^{-1}

(c) 30000 Am^{-1}

(d) 300 Am^{-1} Ans.

$M = I \cdot A$ ← 25 cm → $N = 500$.



=

Pole Strength = m =

Unit (Am)

$$I = \frac{n I A}{A \cdot L} = \frac{500 \times 15}{25} = 300\ \text{A/m}$$

$$I = \frac{\text{Magnetic Moment}}{\text{Volume}} = \frac{\text{Am}^2}{\text{m}^3} = \text{A/m}$$

$$\vec{M} = m(\text{length}) = n I \cdot A$$

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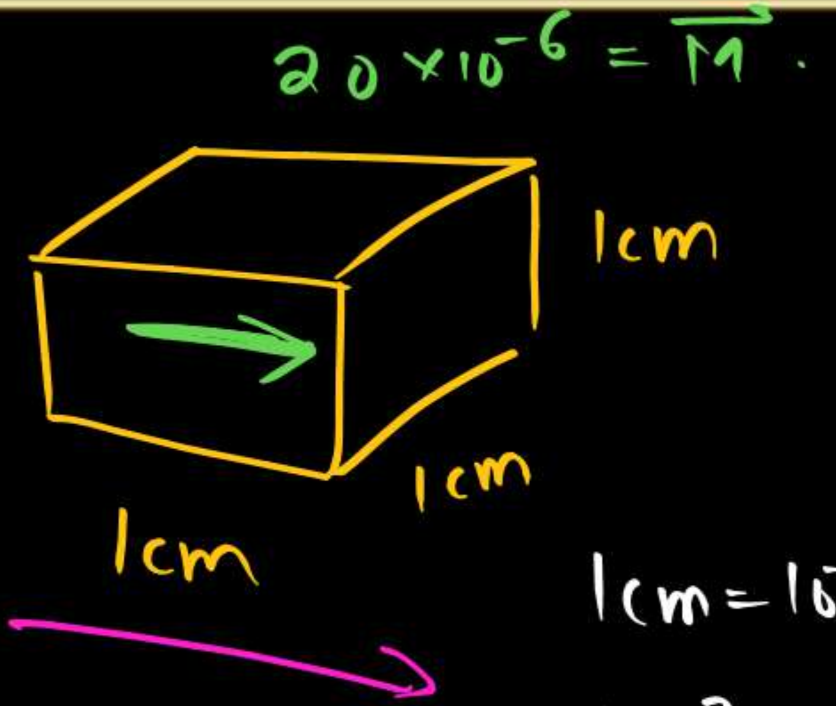
A paramagnetic substance in the form of a cube with sides 1 cm has a magnetic dipole moment of 20×10^{-6} J/T when a magnetic intensity of 60×10^{3} A/m is applied. Its magnetic susceptibility is: **(2019 JEE Mains)**

(a) 3.3×10^{-2} (b) 4.3×10^{-2}

(c) 2.3×10^{-2} (d) 3.3×10^{-4} Ans.



$H = 60 \times 10^{3}$

$1\,cm = 10^{-2}\,m$

$1\,cm^3 = 10^{-6}\,m^3$

$$I = \frac{\text{Magnetic Moment}}{\text{Volume}} = \frac{20 \times 10^{-6}}{10^{-6}} = 20$$

$$\chi = \frac{I}{H} = \frac{20}{60 \times 10^{3}} = \frac{1}{3} \times 10^{-3} = 0.33 \times 10^{-3} = 3.3 \times 10^{-4}$$

A paramagnetic material has 10^{28} atoms/m^3. its magnetic susceptibility at temperature 350 K is 2.8×10^{-4}. Its susceptibility at 300 K is: **(2019 JEE Mains)**

(a) 3.267×10^{-4}
(b) 3.672×10^{-4}
(c) 3.726×10^{-4}
(d) 2.672×10^{-4} Ans

$\chi_{\text{at } T=350K} = 2.8 \times 10^{-4}$

$\chi_{\text{at } 300K} = ?$

Curies Law: $\chi = \frac{C}{T}$

$$\frac{\chi_1}{\chi_2} = \frac{T_1}{T_2}$$

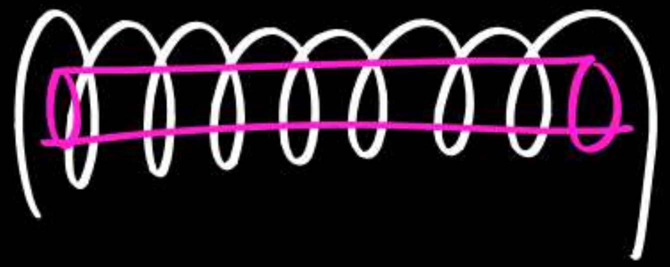
$$\frac{2.8 \times 10^{-4}}{\chi_2} = \frac{350}{300}$$

$$\chi_2 = \frac{30 \times 2.8 \times 10^{-4}}{35} = \frac{16.8}{7} \times 10^{-4}$$

The B-H curve for a ferromagnet is shown in the figure. The ferromagnet is placed inside a long solenoid with 1000 turns/cm. The current that should be passed in the solenoid to demagnetise the ferromagnet completely is: **(2018 JEE Mains)**

(a) 2 mA (b) 1 mA Ans

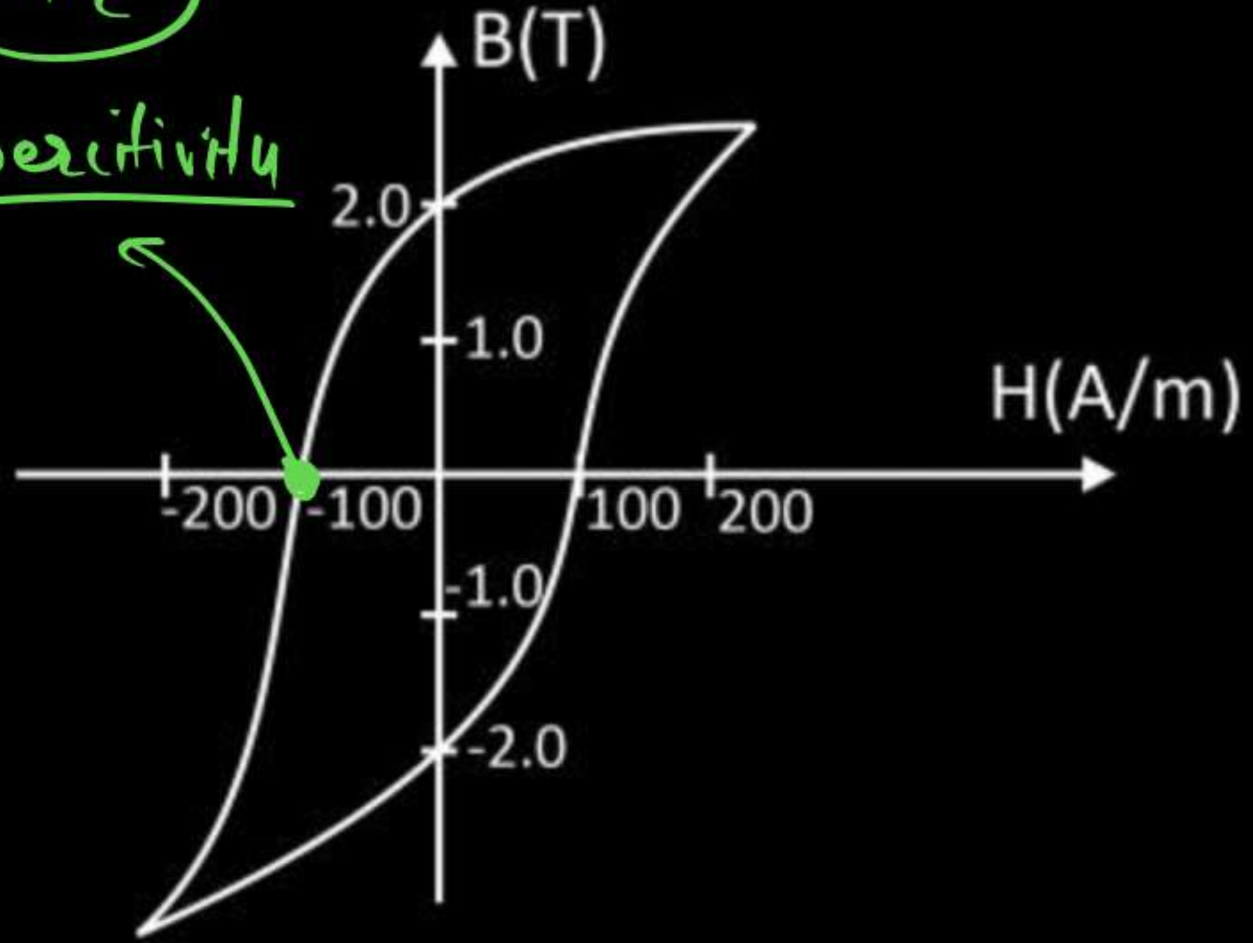
(c) 40 μA (d) 20 μA



$$\frac{N}{L} = 1000 \ \frac{\text{turns}}{\text{cm}}$$

$-H_c$ → Material Normal

Coercitivity



$$H_c = 100 = nI$$

$$100 = \frac{1000}{10^{-2}} I$$

$$\frac{1}{1000} = I$$

$$1 \text{ mA} = I$$

A bar magnet is demagnetized by inserting it inside a solenoid of length 0.2 m, 100 turns, and carrying a current of 5.2 A. The coercivity of the bar magnet is:

(a) 285 A/m
(b) 2600 A/m Ans
(c) 520 A/m
(d) 1200 A/m

(2019 JEE Mains)

$l = 0.2\,m$

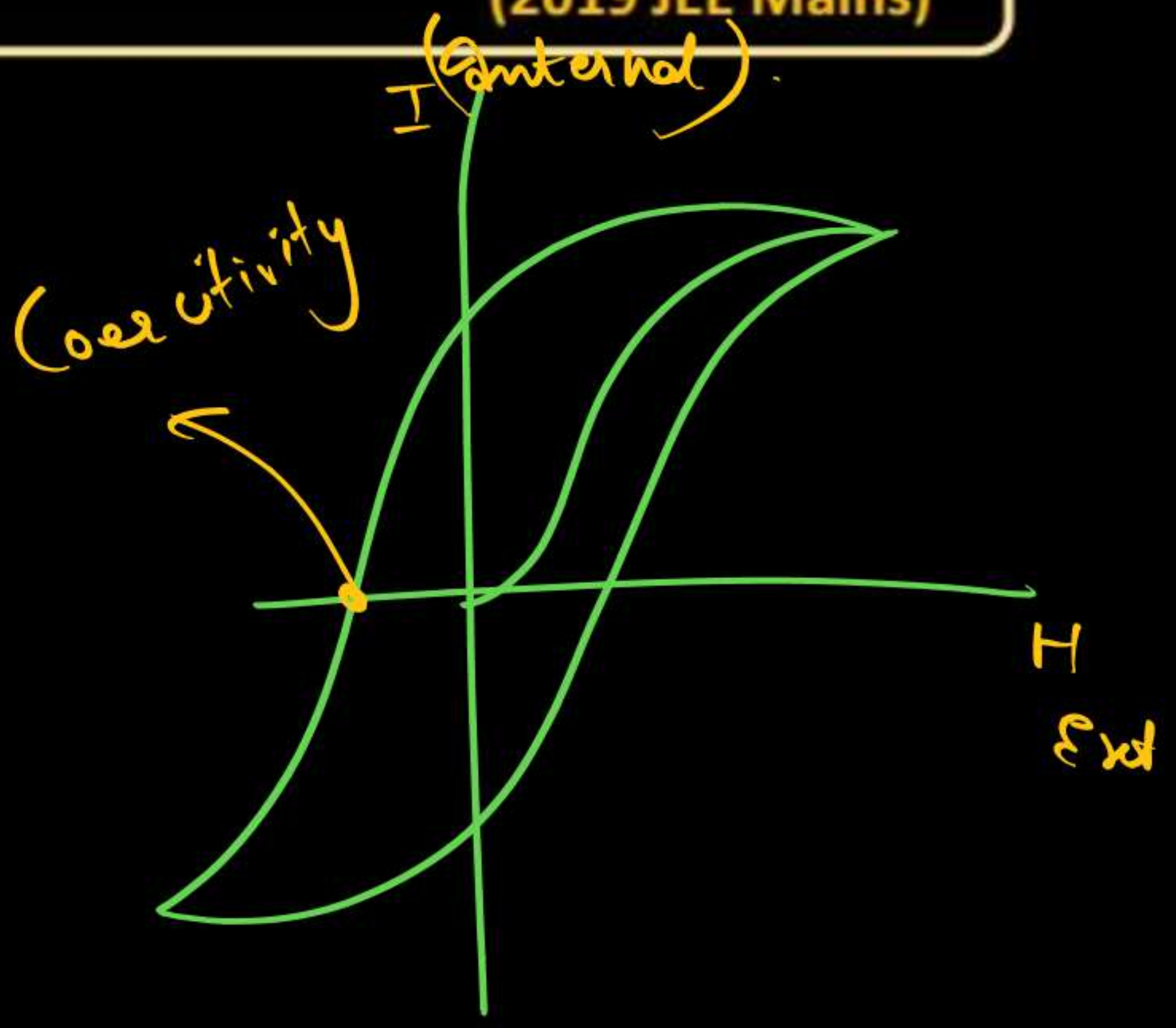
$N = 100$

$I = 5.2A.$

$H_c = nI = \frac{N}{L} I$

$= \frac{100}{2} \times 10 \times 5.2 = 1000 \times 2.6.$

$= 2600$



The coercivity of a small magnet where the ferromagnet gets demagnetized is $3 \times 10^3\ Am^{-1}$. The current required to be passed in a solenoid of length 10 cm and number of turns 100, so that the magnet gets demagnetized when inside the solenoid, is: (2014 JEE Mains)

(a) 30 mA (b) 60 mA

(c) ✓ 3 A Ans (d) 6 A

$H_c = 3 \times 10^3\ (A/m)$

$L = 10\,cm$

$N = 100$

$I = ?$

$H_c = nI$

$3 \times 10^3 = \dfrac{100}{\left(\frac{10}{100}\right)} \cdot I$

$3 \times 10^3 = 10^3\, I$

$I = 3A$

Relative permittivity and permeability of a material ε_r and μ_r, respectively. Which of the following values of these quantities are allowed for a diamagnetic material?

(2008 JEE Mains)

(a) $\varepsilon_r = 0.5, \mu_r = 1.5$

Ans ✓ (b) $\varepsilon_r = 1.5, \mu_r = 0.5$

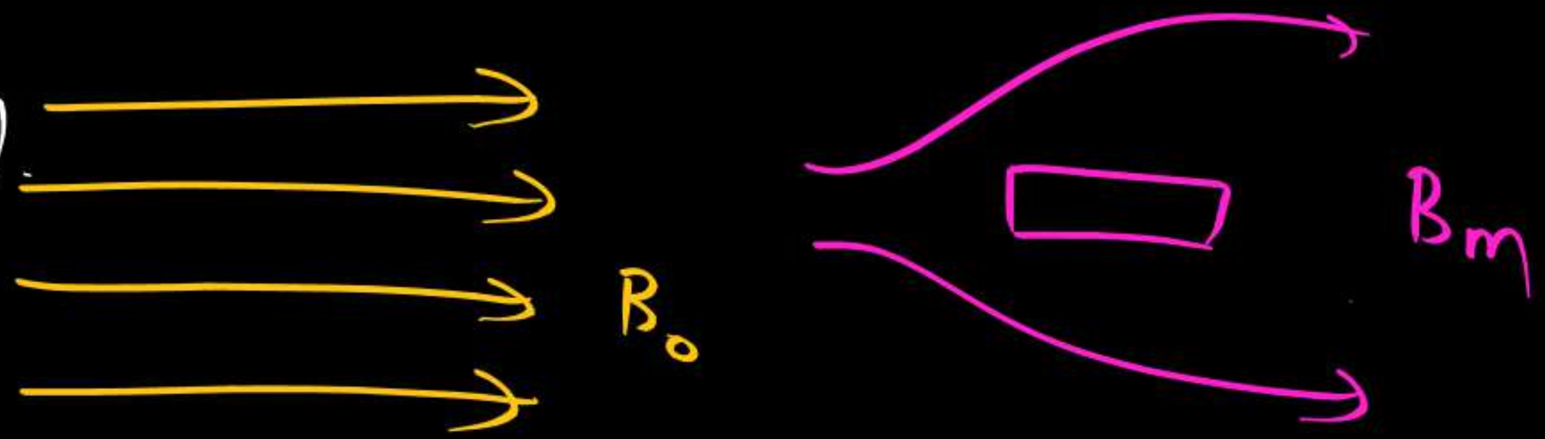
(c) $\varepsilon_r = 0.5, \mu_r = 0.5$

(d) $\varepsilon_r = 1.5, \mu_r = 1.5$

$\varepsilon_r > 1$ for Every medium

diamagnetic

$\mu_r < 1$



$\mu_r = \frac{B_m}{B_0}$ < 1

An example of a perfect diamagnet is a superconductor. This implies that when a superconductor is put in a magnetic field of intensity B, the magnetic field B_s inside the superconductor will be such that: (2014 JEE Mains)

(a) $B_S = -B$

(b) $B_S = 0$ ✓ Ans

(c) $B_S = B$

(d) $B_S < B$ but $B_S \neq 0$

Diamagnetic Substance which Repel External field

Perfectly diamagnetic

$B_i = 0$

$B_S = 0$

Perfect diamagnetic.

$B_i = 0$

Needles N_1, N_2 and N_3 are made of a ferromagnetic, a paramagnetic and a diamagnetic substance respectively. A magnet when brought close to them will

(2006 JEE Mains)

(a) attract N_1 and N_2 strongly but repel N_3

(b) ✓ attract N_1 strongly, N_2 weakly and repel N_3 weakly Ans

(c) attract N_1 strongly, but repel N_2 and N_3 weakly

(d) attract all three of them

$N_1 \rightarrow$ ferro $f_{att} \uparrow$

$N_2 \rightarrow$ Para $f_{att} \downarrow$

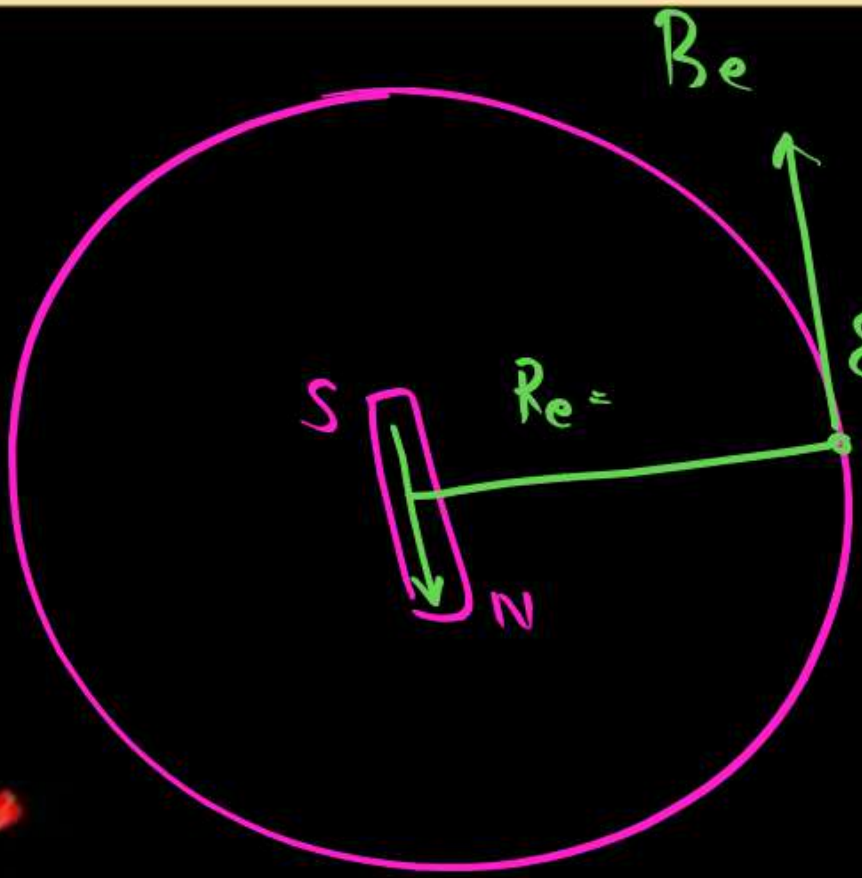
$N_3 \rightarrow$ dia Repel

The earth's magnetic field lines resemble that of a dipole at the centre of the earth. If the magnetic moment of this dipole is close to 8×10^{22} Am^2, the value of earth's magnetic field near the equator is close to (radius of the earth = 6.4×10^6 m)

(2013 JEE Mains)

(a) 0.6 Gauss (b) 1.2 Gauss

(c) 1.8 Gauss (d) 0.32 Gauss



Equitorial Point

$M = 8 \times 10^{22}$.

$$B_e = \frac{\mu_0 M}{4\pi r^3}$$

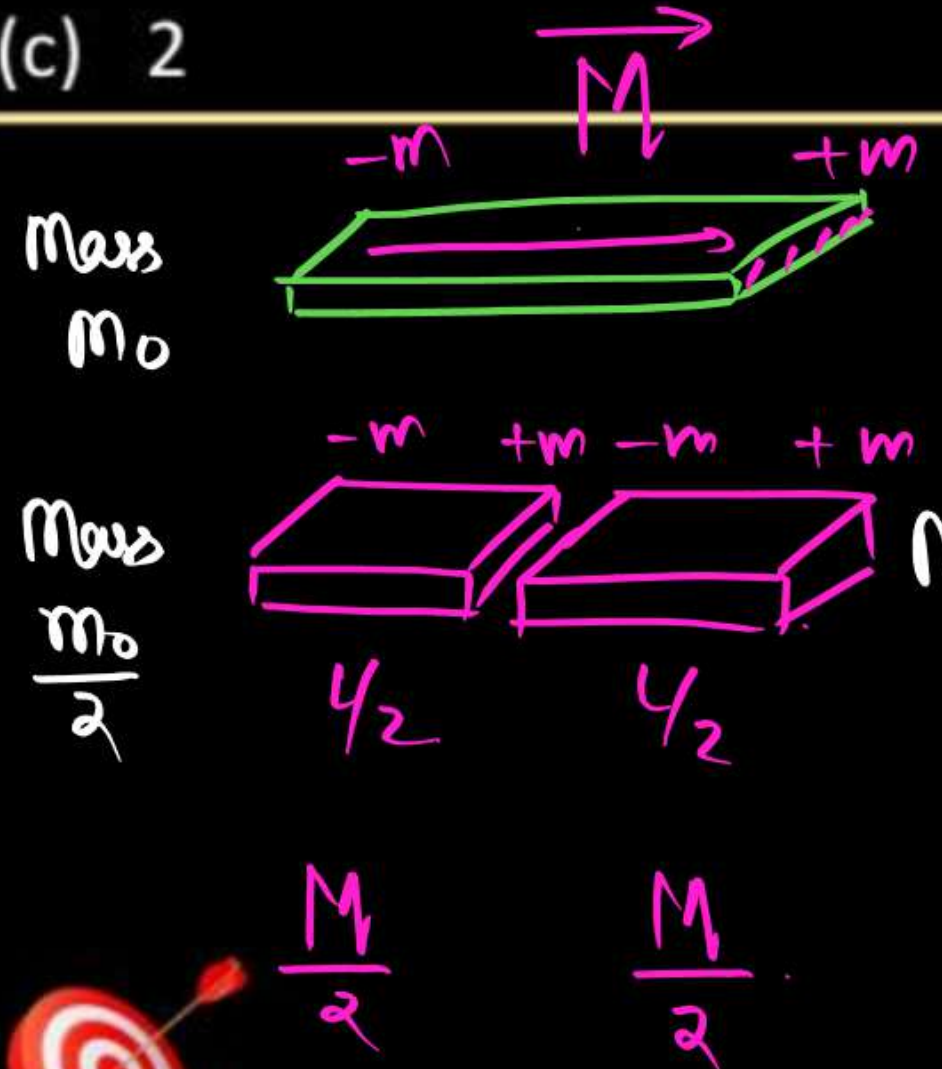
$$B_e = \frac{10^{-7} \times 8 \times 10^{22}}{(6.4 \times 10^6)^3}$$

$1T = 10^4$ Gauss

A thin rectangular magnet suspended freely has a period of oscillation equal to T. Now it is broken into two equal halves (each having half of the original length) and one piece is made to oscillate freely in the same field. If its period of oscillation is T′, the ratio T′/T is - **(2003 JEE Mains)**

(a) $1/2\sqrt{2}$ (b) 1/2 Ans

(c) 2 (d) 1/4



$$T = 2\pi\sqrt{\frac{I}{MB}}$$

$$I_i = \frac{1}{12} M_0 L^2$$

$$\vec{M}_i = M$$

$$I_f = \frac{1}{12}\left(\frac{M_0}{2}\right)\left(\frac{L}{2}\right)^2 = \frac{1}{8}\left(\frac{1}{12} M_0 L^2\right) = \frac{1}{8} I_i$$

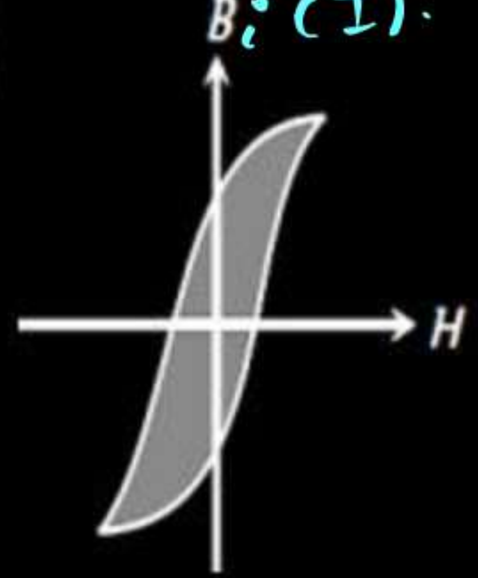
$$M_f = \frac{M}{2}$$

$$\frac{T_f}{T_i} = \sqrt{\frac{I_f M_i}{I_i M_f}} = \sqrt{\frac{I_i}{8 I_i} \times \frac{M \times 2}{M}}$$

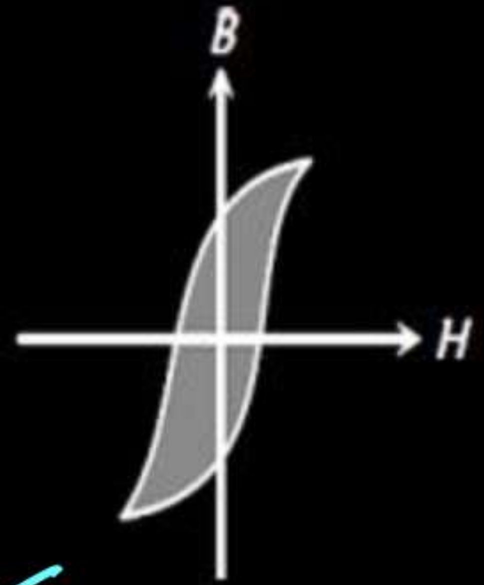
$$\frac{T_f}{T_i} = \frac{1}{2}$$

For substances hysteresis (B – H) curves are given as shown in figure. For making temporary magnet which of the following is best.

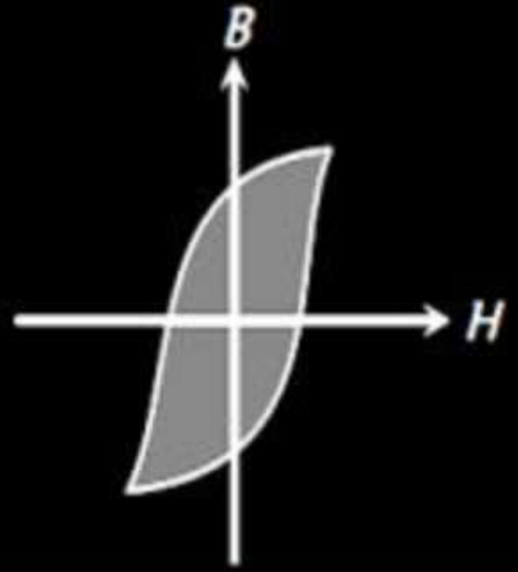
(a)



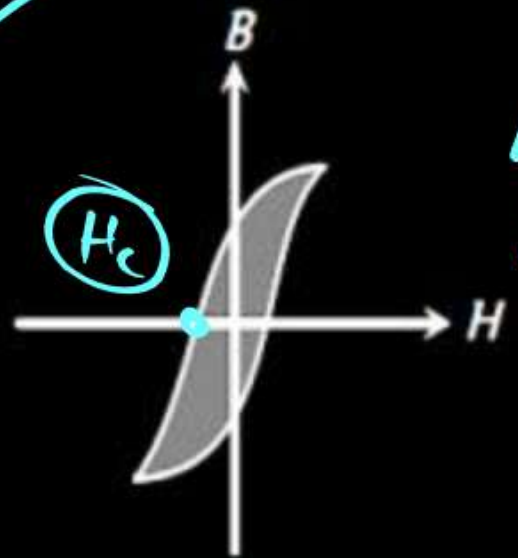
(b)



(c)



✓(d) Ans



Temporary Magnet → Repetetive Magnetisation

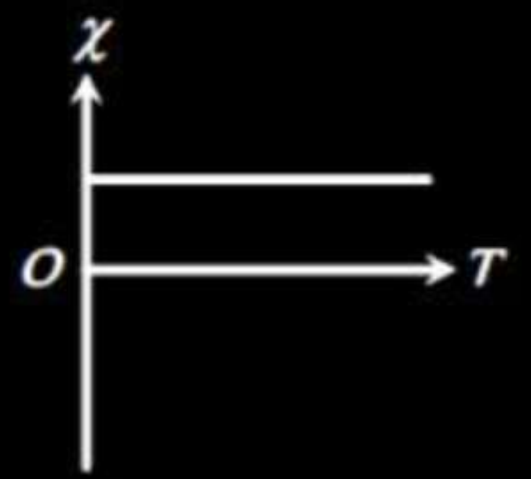
$$\text{Area} = \frac{\text{Energy spent}}{\text{Volume}}$$

Area ↓

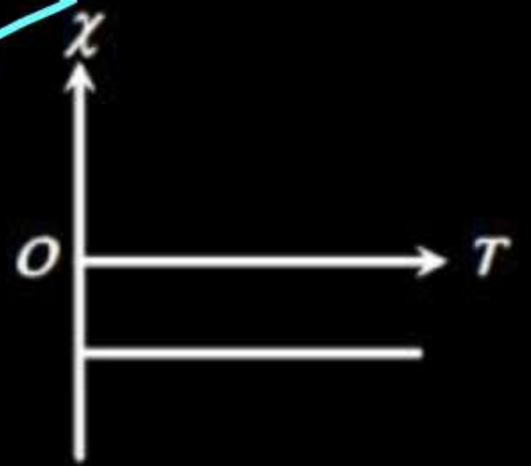
Energy spent in Mag & demagneti per Cycle per unit volume ↓.

The variation of magnetic susceptibility (χ) with temperature for a diamagnetic substance is best represented by

(a)



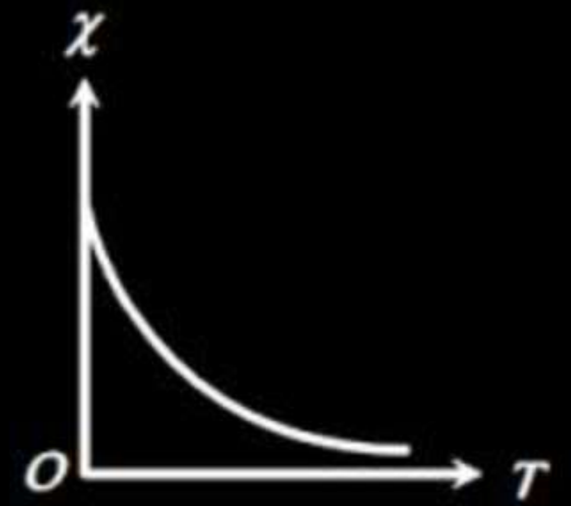
(b) ✓ Ans



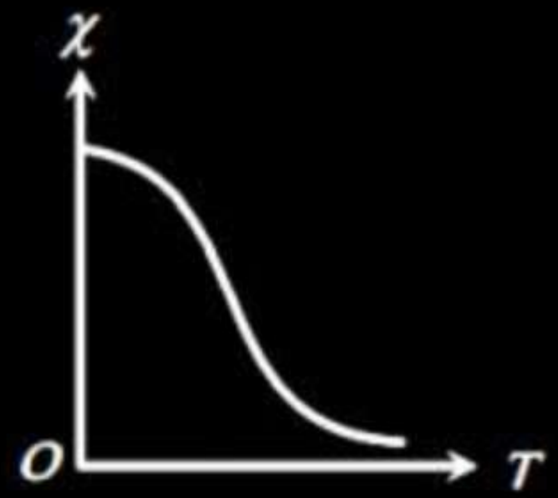
χ = -ve

Independent of Temp

(c)



(d)



Relative permeability of iron is 5500, then its mag susceptibility will be:

(a) 5500×10^{7} (b) 5500×10^{-7}

(c) 5501 (d) 5499 Ans.

$\mu_r = 5500$

$\chi = ?$

$\mu_r = 1 + \chi$

$5500 - 1 = \chi$

$5499 = \chi$

LAKSHYA KO HAR HAAL ME PAANA HAI

Curie temperature is the temperature above which (2003 JEE Mains)

(a) a ferromagnetic material becomes paramagnetic Ans

(b) a paramagnetic material becomes diamagnetic

(c) a ferromagnetic material becomes diamagnetic

(d) a paramagnetic material becomes ferromagnetic

$T_c \uparrow$

Ferro ⟶ Para

The B-H curves S_1 and S_2 in the adjoining figure are associated with :

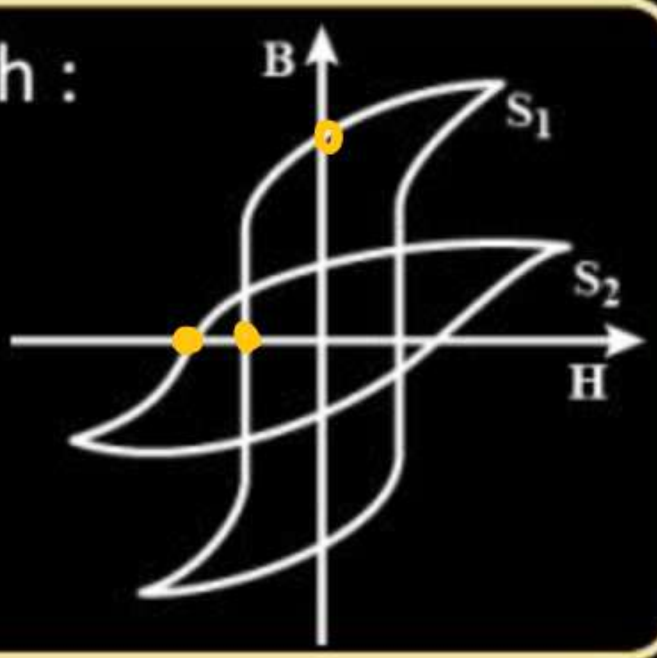
(a) a diagnetic and paramagnetic substances respectively

(b) a paramagnetic and ferromagnetic substances respectively

Temp (Soft). Permanent (Hard)

(c) soft iron and steel respectively

(d) steel and soft iron respectively



Hysterisis → ferromagnetic.

$S_2 \; H_c > S_1 \; H_c$.

$S_1 \; R_1 > S_2 \; R$.

The basic magnetization curve for a ferromagnetic material is shown in figure. Then, the value of relative permeability is highest for the point

(a) P (b) Q Ans

(c) R (d) S

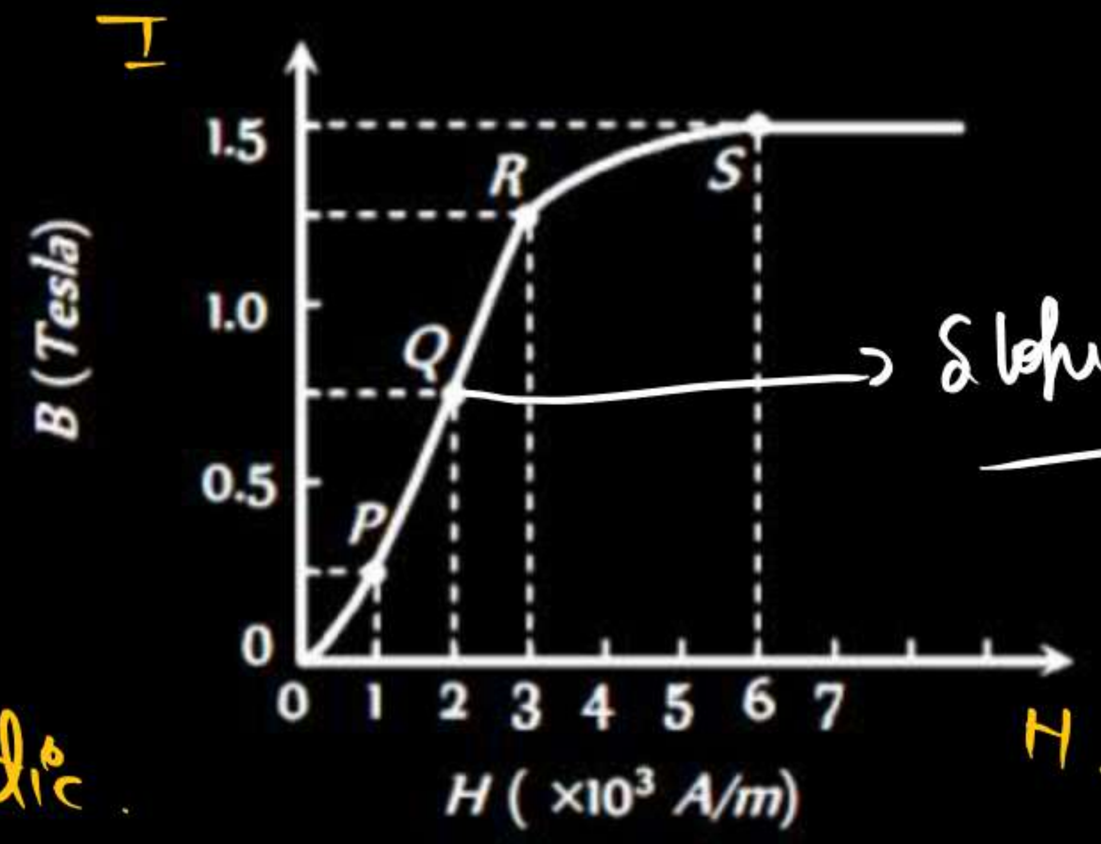
$\mu_r = 1 + \chi$

is always for Every Material

$\chi = \frac{I}{H}$ $I = \chi H$ → Straight → Paramagnetic

directly doesnot hold

for ferro $\chi = \frac{\Delta I}{\Delta H}$ = Slope of I/H.



→ Slope is Max

Slope max → χ_{max} → $\mu_r \uparrow$.

The $\chi - 1/T$ graph for an alloy of paramagnetic nature is shown in figure. The curie constant is, then

Paramagnetic

$\chi = \frac{C}{T}$

$x = \frac{1}{T}$ $\quad \chi = C\left(\frac{1}{T}\right)$

$\chi = y$ $\quad y = mx$

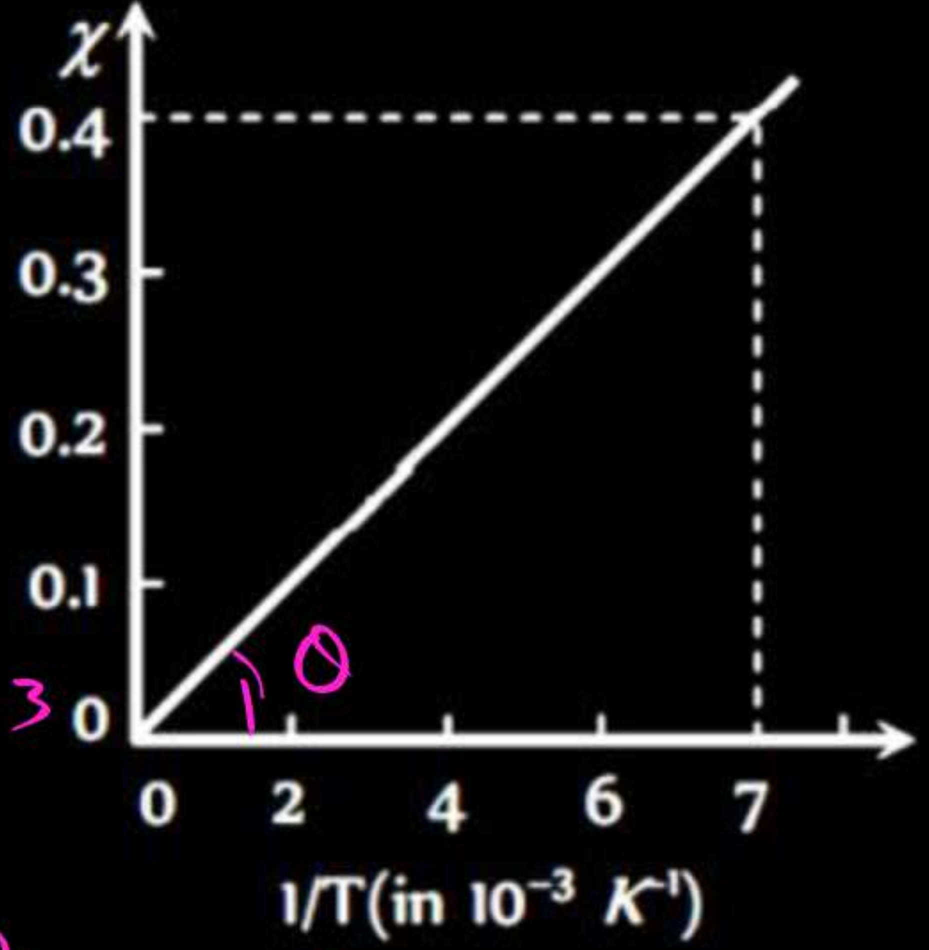
Curies Const = Slope

$\tan\theta = \frac{P}{B}$

$= \frac{0.4}{7\times10^{-3}}$

$= \frac{400}{7}$

$C = 57.$



LAKSHYA KO HAR HAAL ME PAANA HAI

An iron rod is subjected to cycles of magnetisation at the rate of 50 Hz. Given the density of the rod is 8×10^3 kg/m^3 and specific heat is 0.11×10^{-3} cal/kg°C. The rise in temperature per minute, if the area inclosed by the B-H loop corresponds to energy of 10^{-2} J, is: [Assume there is no radiation losses]

(a) 78°C
(b) 88°C
(c) 8.1°C Ans
(d) none of these

$\nu = 50$ Hz
No of cycles per second

$\rho = 8 \times 10^3$ kg/m^3

$s = 0.11 \times 10^{-3} \times 4.2$ J/kg°C

Area $= 10^{-2}$

↳ $\dfrac{\text{Energy spent in 1 Cycle}}{\text{Volume}}$

$E_{\text{Total in 1 sec}} = \left(\dfrac{E_{\text{spent per Cycle}}}{\text{Volume}}\right) \times \text{Volume} \times \text{No of Cycle in 1 sec}$ (Area)

$= 10^{-2} \times V \times 50$

$E_{\text{in 1 Minute}} = 10^{-2} \times V \times 50 \times 60 = m s \Delta T$

$3000 \times 10^{-2} V = \rho V \times s \times \Delta T$

$30 = \rho \cdot s \cdot \Delta T$

$\dfrac{30}{\rho \cdot s} = \Delta T$

$= \dfrac{30}{8 \times 10^3 \times 4.2 \times 0.11 \times 10^{-3}}$

$\Delta T = 8.1$

A bar magnet has coercivity 4×10^3 Am^{-1}. It is desired to demagnetize it by inserting it inside a solenoid 12 cm long and having 60 turns. The current that should be sent through the solenoid is

(a) 2 A
(b) 4 A
(c) 6 A
(d) 8 A

$H_c = 4 \times 10^3$

$l = 12cm$

$N = 60$ turns

$H_c = nI = \frac{N}{L} I$

$$I = \frac{H_c L}{N}$$

$$= \frac{4 \times 10^3 \times \frac{12}{100}}{60}$$

$=$

The figure illustrate how B, the flux density inside a sample of unmagnetised ferromagnetic material varies with B, the magnetic flux density in which the sample is kept. For the sample to be suitable for making a permanent magnet

(a) OQ should be large, OR should be small

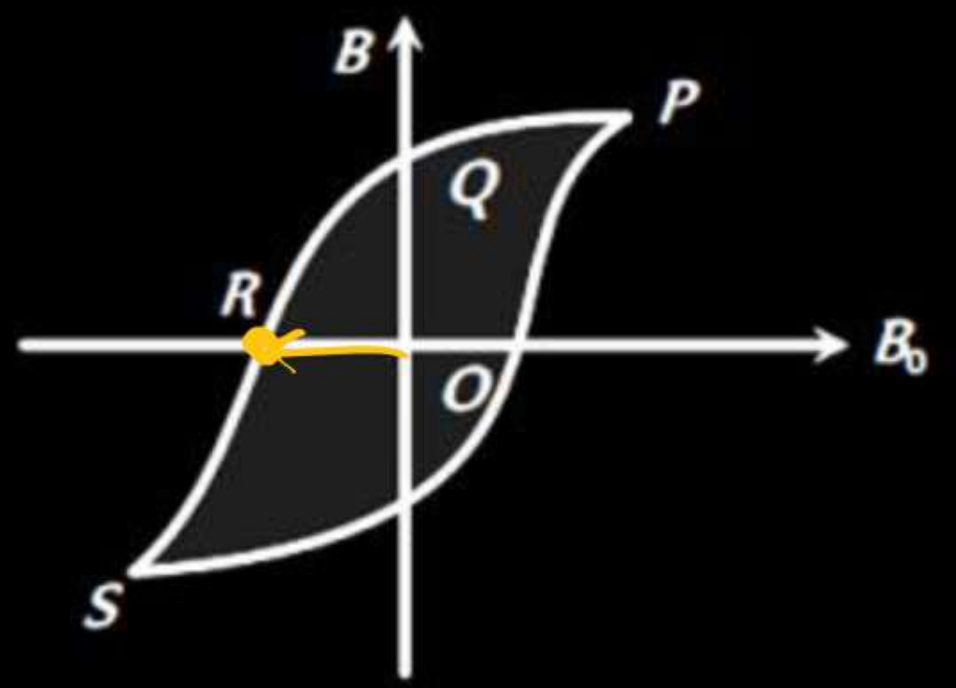
(b) OQ and OR should both be large Ans

(c) OQ should be small and OR should be large

(d) OQ and OR should both be small

OQ → Retentivity → high (Beneficial)

OR → Coercitivity (high)



The variation of the intensity of magnetization (I) with respect to the magnetizing field (H) in a diamagnetic substance is described by the graph

(a) OD

(b) OC Ans

(c) OB

(d) OA

$\chi = \frac{I}{H}$ → Paramagnetic

$-\chi = \frac{I}{H}$ → diamagnetic.

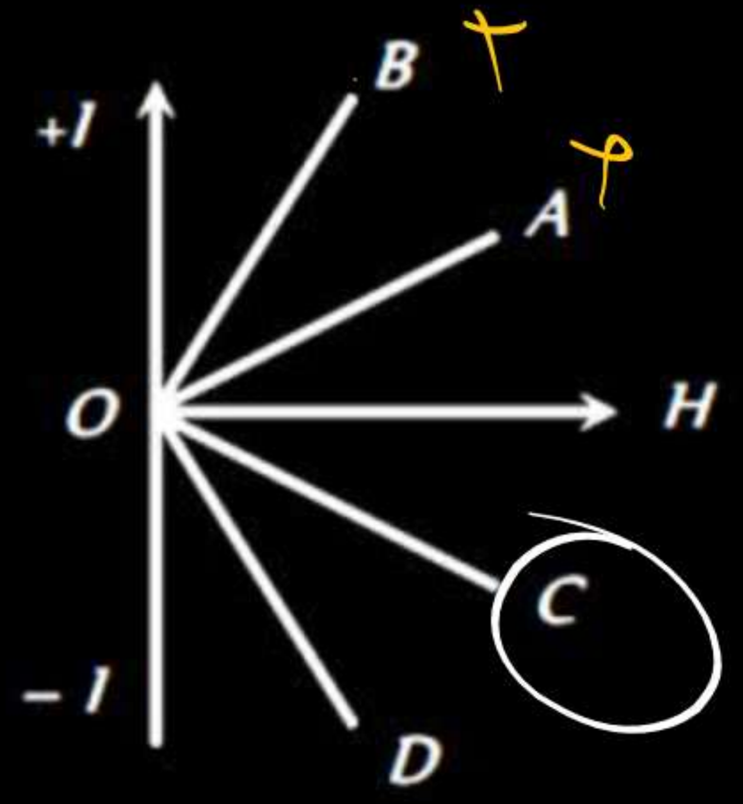
(weakly Repel)

$I = -\chi H$

$y = \text{slope}\, X$

slope = -ve.

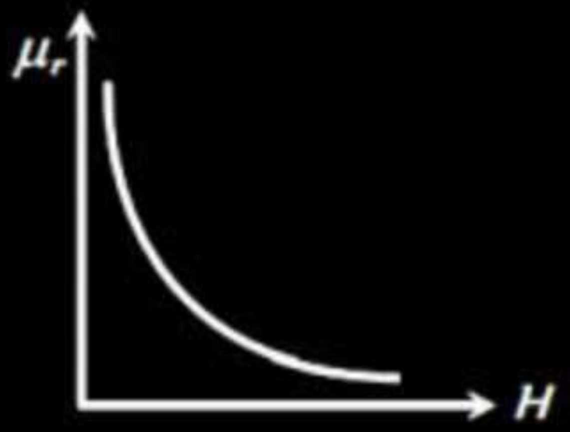
I is opp to External field but small



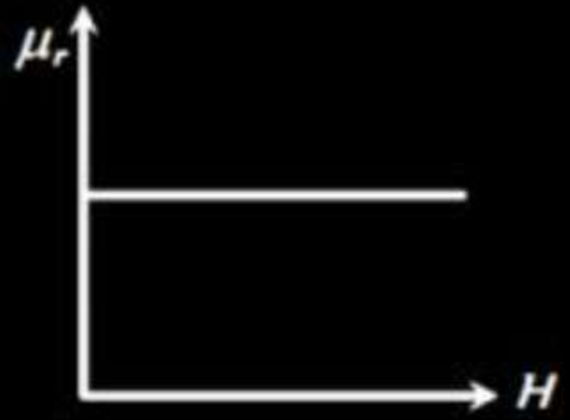
For ferromagnetic material, the relative permeability (μ_r), versus magnetic intensity (H) has the following shape

(a)

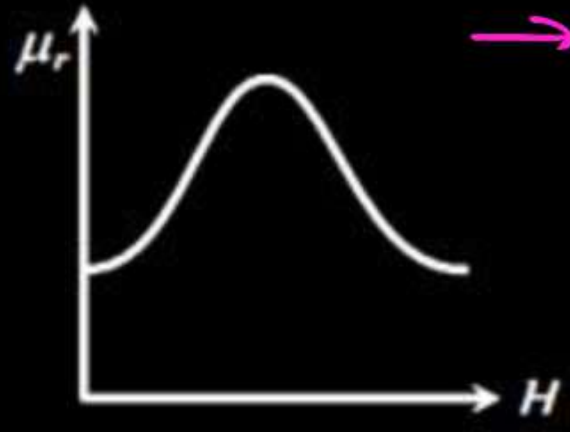
(b)



(c)



(d) Imp.



→ for ferro. χ / H learn

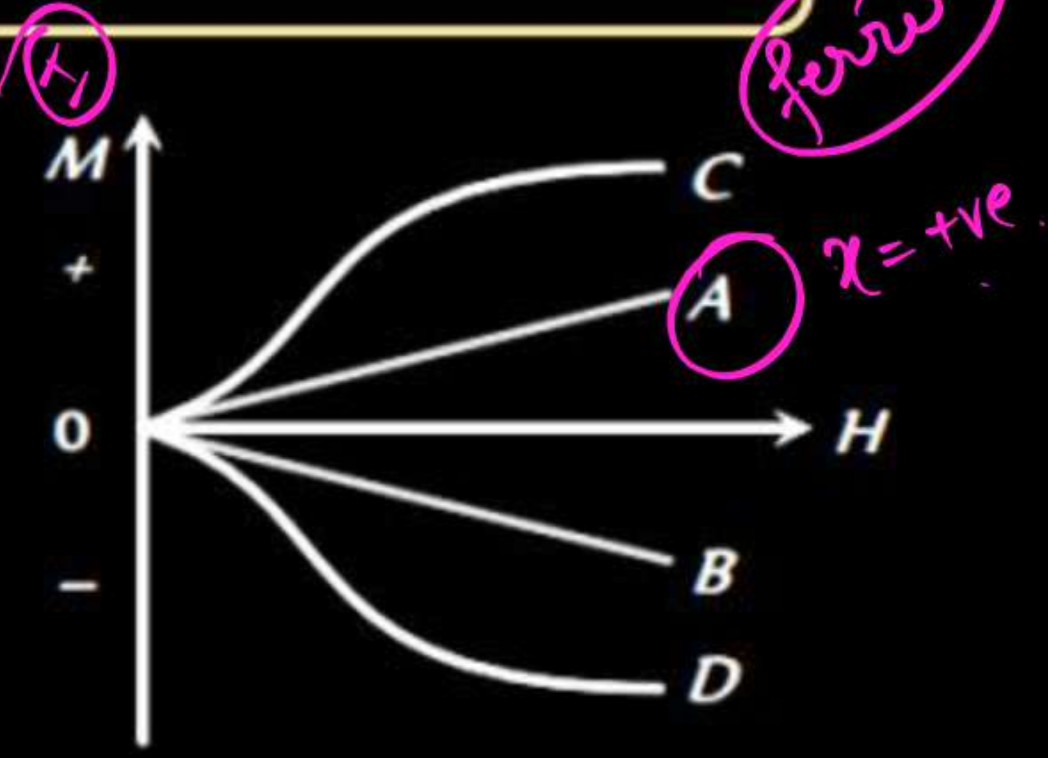
The most appropriate magnetization M versus magnetizing field H curve for a paramagnetic substance is

(a) A Ans
(b) B
(c) C
(d) D

$\chi = \frac{I}{H}$ = Paramagnetic

$\chi = +ve$

$I = \chi H$ → y = slope x



An iron rod of volume 10^{-4} m^3 and relative permeability 1000 is placed inside a long solenoid wound with 5 turns/cm. If a current of 0.5 A is passed through the solenoid, then the magnetic moment of the rod is

(a) 10 Am^2 (b) 15 Am^2

(c) 20 Am^2 (d) 25 Am^2

$V = 10^{-4}\, m^3$.

$\mu_r = 1000$

$n = \frac{5 \text{ turns}}{cm} = \frac{5 \text{ turns}}{10^{-2} m}$

$I = 0.5 A$.

$\mu_r = 1 + \chi$

$1000 = 1 + \frac{M}{10^{-4}(2.5)}$

$M = $ ____

$\chi = \frac{I}{H} = \frac{\text{Magnetic Moment}}{\text{Volume } (H)}$.

$H = nI$

$= \frac{5}{10^{-2}} \times \frac{5}{10}$

$= 25 \times 10^{-1}$

$= 2.5$.

LAKSHYA KO HAR HAAL ME PAANA HAI

A cylindrical rod magnet has a length of 5 cm and a diameter of 1 cm. It has a uniform magnetisation of 5.30×10^3 Amp/m. What its magnetic dipole moment

(a) 1×10^{-2} J/T I

(b) 2.08×10^{-2} J/T

(c) 3.08×10^{-2} J/T

(d) 1.52×10^{-2} J/T

0.5cm

d = 5cm.

$I = \frac{\text{Magnetic Moment}}{\text{Volume}}$.

$I = 5.3 \times 10^3$

$5.3 \times 10^3 = \frac{M}{\pi r^2 L}$.

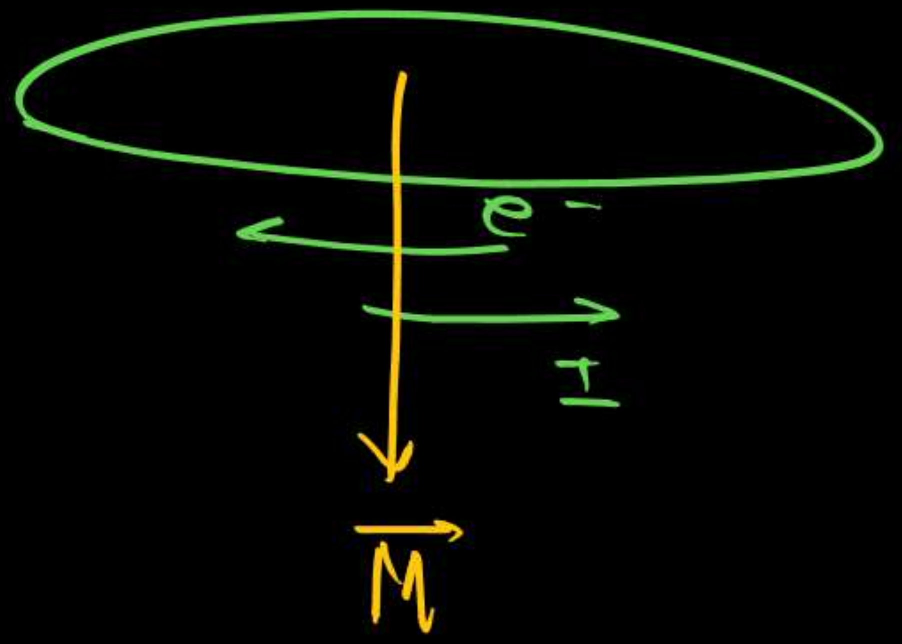
Volume = Area × L

$= (\pi r^2 \times L)$.

An atom is paramagnetic if it has:

(a) an electric dipole moment
(b) no magnetic moment
(c) a magnetic moment Ans
(d) no electric dipole moment

unpaired e^-



The relative permeability is represented by μ_r and susceptibility is denoted by χ for a magnetic substance, then for a paramagnetic substance:

(a) $\mu_r < 1, \chi < 0$

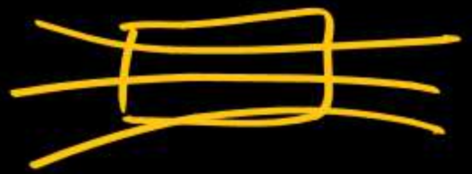
(b) $\mu_r < 1, \chi > 0$

(c) $\mu_r > 1, \chi < 0$

(d) $\mu_r > 1, \chi > 0$ Ans

$\mu_r > 1$

$\chi = +ve > 0$



$\mu_r = 1 + \chi$

$\chi = +ve$

A magnetic dipole is acted upon by two magnetic fields which are inclined to each other at an angle of 75°. One of the fields has a magnitude of 15 mT. The dipole attains stable equilibrium at an angle of 30° with this field. The magnitude of the other field (in mT) is close to: **(2016, JEE Mains)**

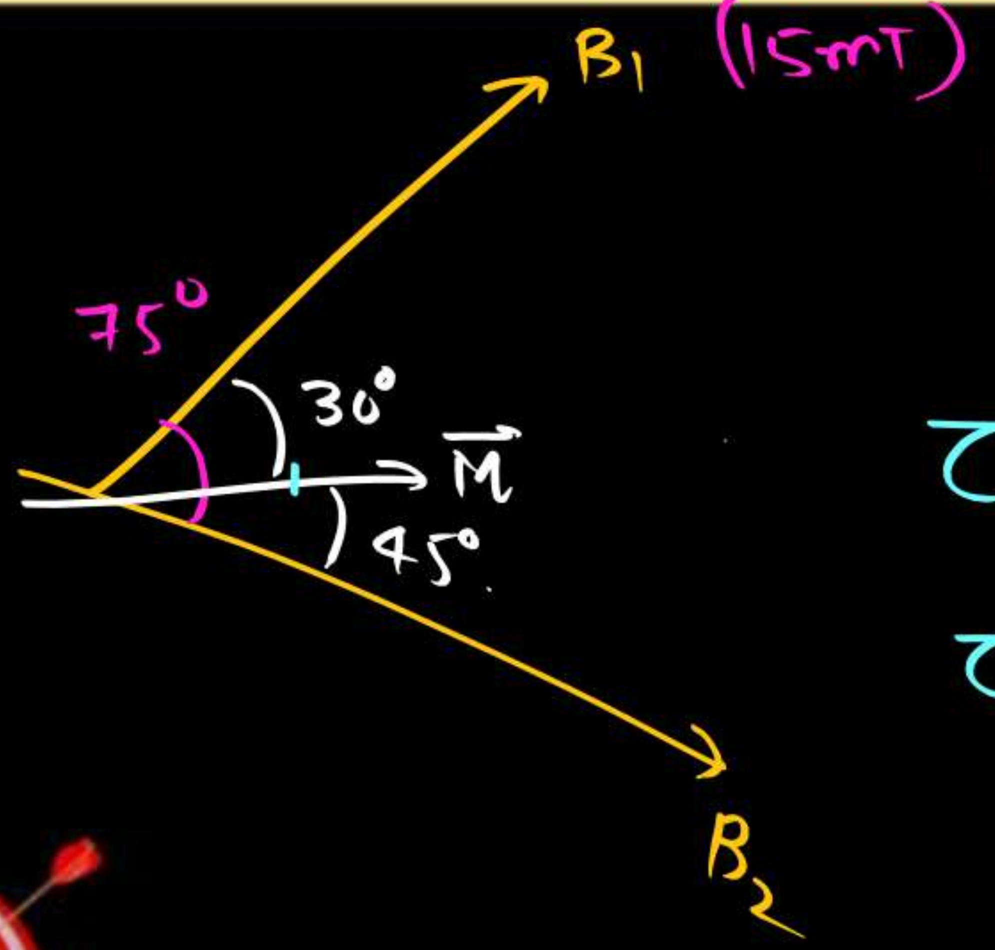
(a) 1

(b) 11 Ans

(c) 36

(d) 1060

$\tau = \vec{m} \times \vec{B}$



$|\tau_{B_1}| = |\tau_{B_2}|$

$\tau_{B_1} = MB_1 \sin 30\, \hat{k}$

$\tau_{B_2} = MB_2 \sin 45\, (-\hat{k})$

$B_1 \sin 30 = B_2 \sin 45$

$15\times10^{-3} \times \frac{1}{2}\sqrt{2} = B_2$

$\frac{15\times10^{-3}}{\sqrt{2}} = B_2$

$= 10.6\,mT = B_2$

Super Conductor

A perfectly diamagnetic sphere has a small spherical cavity at its centre, which is filled with a paramagnetic substance. The whole system is placed in a uniform magnetic field $\vec{B}$. Then the field inside the paramagnetic substance is:

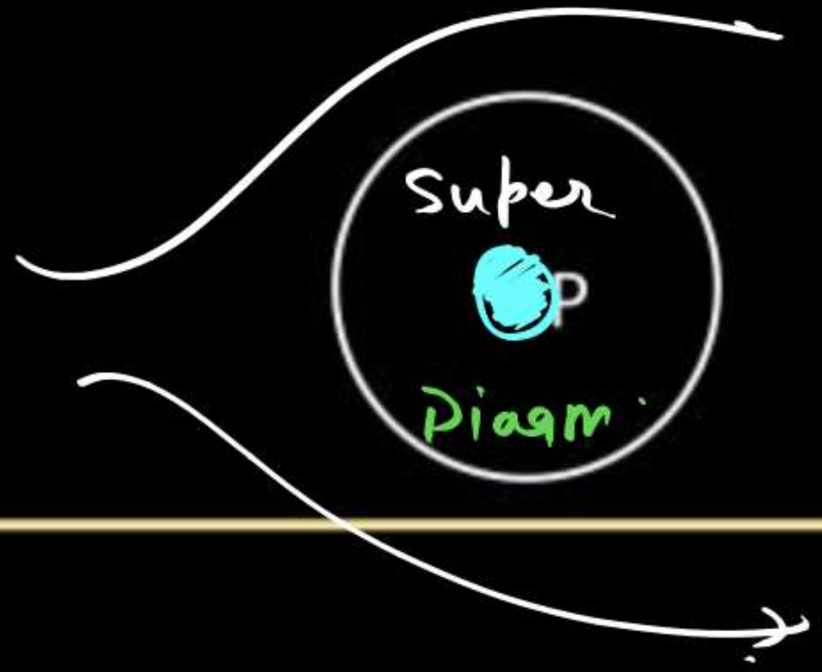
(2020 JEE Mains)

(a) $\vec{B}$

(b) zero Ans

(c) Much large than $|\vec{B}|$ and parallel to $\vec{B}$

(d) Much large than $|\vec{B}|$ but opposite to $\vec{B}$



Since Perfect diamagnetic $B_i = 0$

A soft ferromagnetic material is placed in an external magnetic field. The magnetic domains: **(2021 JEE Mains)**

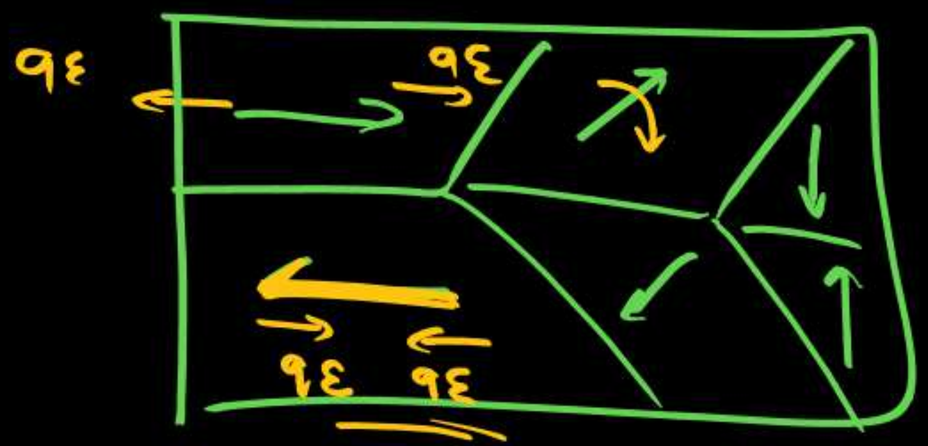
(a) decrease in size and changes orientation.

(b) may increase or decrease in size and change its orientation. Ans

(c) increase in size but no change in orientation.

(d) have no relation with external magnetic field.

⟶ B_{ext}



Size of domains change: parallel Size ↑, Anti Parallel Size ↓.

∠ domains → "Rotate".

In a ferromagnetic material, below the curie temperature, a domain is defined as:

(2021 JEE Mains)

(a) a macroscopic region with consecutive magnetic dipoles oriented in opposite direction.

(b) a macroscopic region with zero magnetization.

(c) a macroscopic region with saturation magnetization. Ans

(d) a macroscopic region with randomly oriented magnetic dipoles.

above T_c Para m

below T_c Ferro.

The materials suitable for making electromagnets should have (2004 JEE Mains)

(a) high retentivity and low coercivity Ans

(b) low retentivity and low coercivity

(c) high retentivity and high coercivity

(d) low retentivity and high coercivity

Electro → Soft Magnets   Coercivity ↓

Retentivity ↑

Area ↓ .

A magnetic needle lying parallel to a magnetic field requires W units of work to turn it through 60°. The torque needed to maintain the needle in this position will be

(2003 JEE Mains)

(a) $\sqrt{3}$ W Ans   (b) W

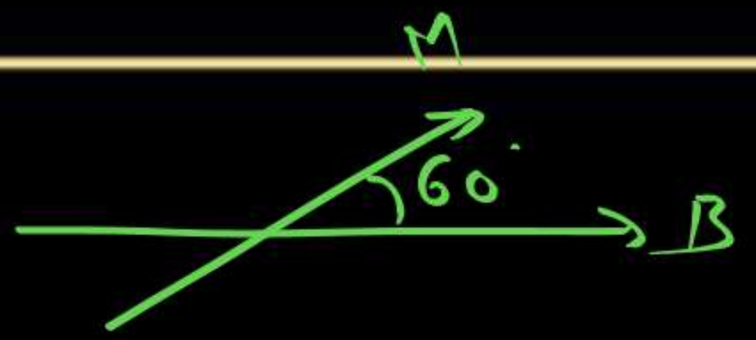
(c) $\sqrt{3}/2$ W   (d) 2 W

$\theta_1 = 0$

$$W = MB(\cos\theta_1 - \cos\theta_2)$$

$$= MB(\cos 0 - \cos 60)$$

$$= MB\left(1 - \tfrac{1}{2}\right) = \frac{MB}{2} = W \Rightarrow MB = 2W$$



$$\tau = MB\sin 60$$

$$= 2W \times \frac{\sqrt{3}}{2}$$

$$= W\sqrt{3}$$

A magnetic needle is kept in a non-uniform magnetic field. It experiences

(2005 JEE Mains)

(a) neither a force nor a torque

(b) a torque but not a force

(c) a force but not a torque

(d) a force and a torque Ans

uniform field

$f = 0$

τ depends on Orientation.

Non uniform field

$f_x = m\frac{dB}{dx}$

τ always.

Which of the following statements are correct?

1. Electric monopoles do not exist whereas magnetic monopoles exist.
2. Magnetic field lines due to a solenoid at its ends and outside cannot be completely straight and confined
3. Magnetic field lines are completely confined within a toroid.
4. Magnetic field lines inside a bar magnet are not parallel.
5. $\chi = -1$ is the condition for a perfect diamagnetic material, where χ is its magnetic susceptibility.

Choose the correct answer from the options given below **(2021 JEE Mains)**

(a) 3 and 5 only
(b) 2 and 4 only
(c) 1 and 2 only
(d) 2 and 3 only

Thank You Lakshyians