DPP – 2 (Magnetic Field & Force)

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Q 1. A current I flows along the length of an infinitely long, straight and thin-walled hollow pipe. Then

(a) The magnetic field at all points inside the pipe is the same but not zero
(b) The magnetic field at any point inside the pipe is zero
(c) The magnetic field is zero only on the axis of the pipe
(d) The magnetic field is different at different points inside the pipe

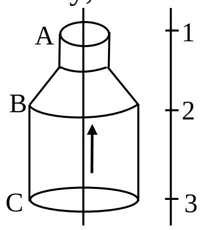
Q 2. A long solenoid of length L has a mean diameter D. It has n layers of windings of N turns each. If it carries a current 'i' the magnetic field at its centre will be

(a) Proportional to D (b) Inversely proportional to D
(c) Independent of D (d) Proportional to L

Q 3. 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, then new value of the magnetic field is -

(a) B (b) 2B
(c) 4B (d) B/2

Q 4. A long, straight, hollow conductor (tube) carrying a current has two sections A and C of unequal cross-sections joined by a conical section B. 1, 2 and 3 are points on a line parallel to the axis of the conductor. The magnetic fields at 1, 2 and 3 have magnitudes B_1, B_2 and B_3 respectively, then :

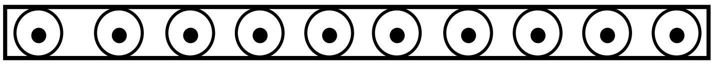


(a) $B_1 = B_2 = B_3$
(b) $B_1 = B_2 \neq B_3$
(c) $B_1 < B_2 < B_3$
(d) B_2 cannot be found unless the dimensions of the section B are known

Q 5. A long wire carries a steady current. It is bent into a circle of one turn and the magnetic field at the centre of the coil is B. It is then bent into a circular loop of n turns. The magnetic field at the centre of the coil will be

(a) nB (b) n^2B
(c) $2nB$ (d) $2n^2B$

Q 6. A large metal sheet carries an electric current along its surface. Current per unit length is λ. Magnetic field near the metal sheet is –

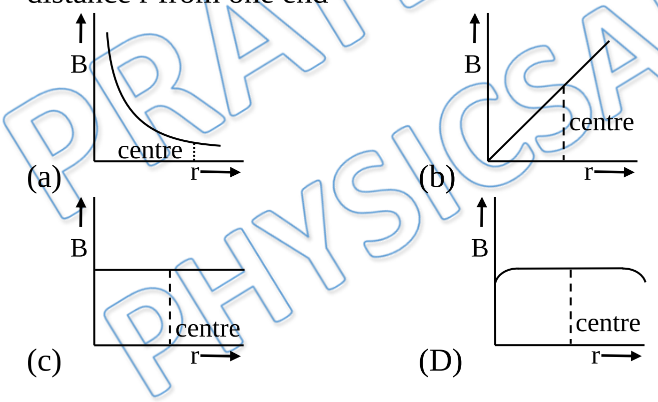


(a) $\frac{1}{2}\mu_0\lambda$ (b) $\frac{\lambda\mu_0}{2\pi}$
(c) $\lambda\mu_0$ (d) $\frac{\mu_0}{2\lambda\pi}$

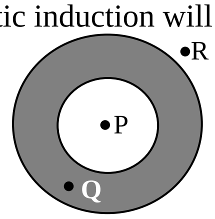
Q 7. The average radius of an air cored made toroid is 0.1 m and it has 500 turns. If it carries 0.5 ampere current, then the magnetic field produced along its circular axis inside the toroid will be:
(a) 5×10^{-4}T (b) Zero
(c) 0.5×10^{-4}T (d) 2×10^{-4}T

Q 8. At the centre of a straight solenoid the magnetic induction is B. If the length of solenoid is reduced to half but to keep the number of turns same, these are wound in two layers, then the magnetic induction at the centre will be -
(a) B/2 (b) 2B
(c) B (d) 4B

Q 9. In a long solenoid the magnetic induction (B) produced due to current is a function of distance r from one end

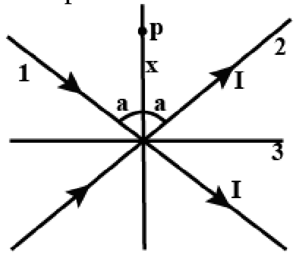


Q 10. Current is flowing through a conducting hollow pipe whose area of cross-section is shown as. The value of magnetic induction will be zero at-



(a) points P, Q and R (b) Point R but not at P and Q
(c) Q but not at P and R (d) P but not at Q and R

Q 11. Three infinite straight current carrying conductors are placed as shown in figure. Two wires carry same current while current in the third wire is unknown. The three are electrically insulated from each other and all of them are in the plane of paper. Which of the following is correct about point P which is also in the same plane?



(a) Magnetic field intensity at P is zero for all values of x, whatever is the current in the third wire.

(b) If the current in the third wire is $\frac{2I}{\sin a}$ (left to right), then magnetic field will be zero at P for all values of x.

(c) If the current in the third wire is $\frac{2I}{\sin a}$ (right to left), then magnetic field will be zero at P for all values of x.

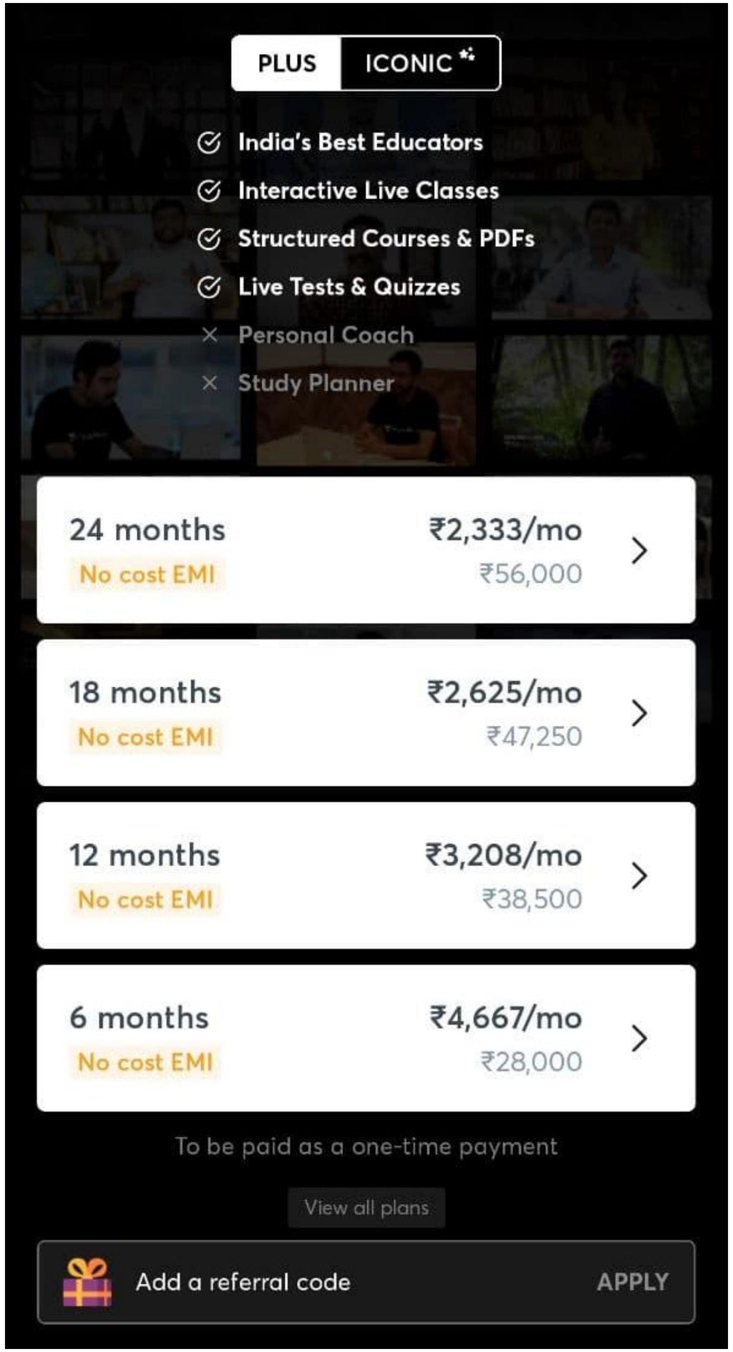
(d) none of these

Q 12. A hollow cylindrical conductor of inner radius a and outer radius b carries a current I uniformly spread over its cross-section. Find the magnetic field induction at a point inside the body of the conductor at a distance r [where a<r<b] from the axis of the cylinder-

(a) $\frac{\mu_0 I}{2\pi r}\frac{(r^2-a^2)}{(b^2-a^2)}$
(b) $\frac{\mu_0 I}{2\pi}\frac{(r^2-a^2)}{(b^2-a^2)}$
(c) $\frac{\mu_0 I}{2\pi}\frac{(b^2-a^2)}{(r^2-a^2)}$
(d) $\frac{\mu_0 I}{2r}\frac{(r^2-a^2)}{(b^2-a^2)}$

Answer Key

Q.1 b	**Q.2 c**	**Q.3 a**	**Q.4 a**	**Q.5 b**
Q.6 a	**Q.7 a**	**Q.8 b**	**Q.9 d**	**Q.10 d**
Q.11 c	**Q.12 a**			



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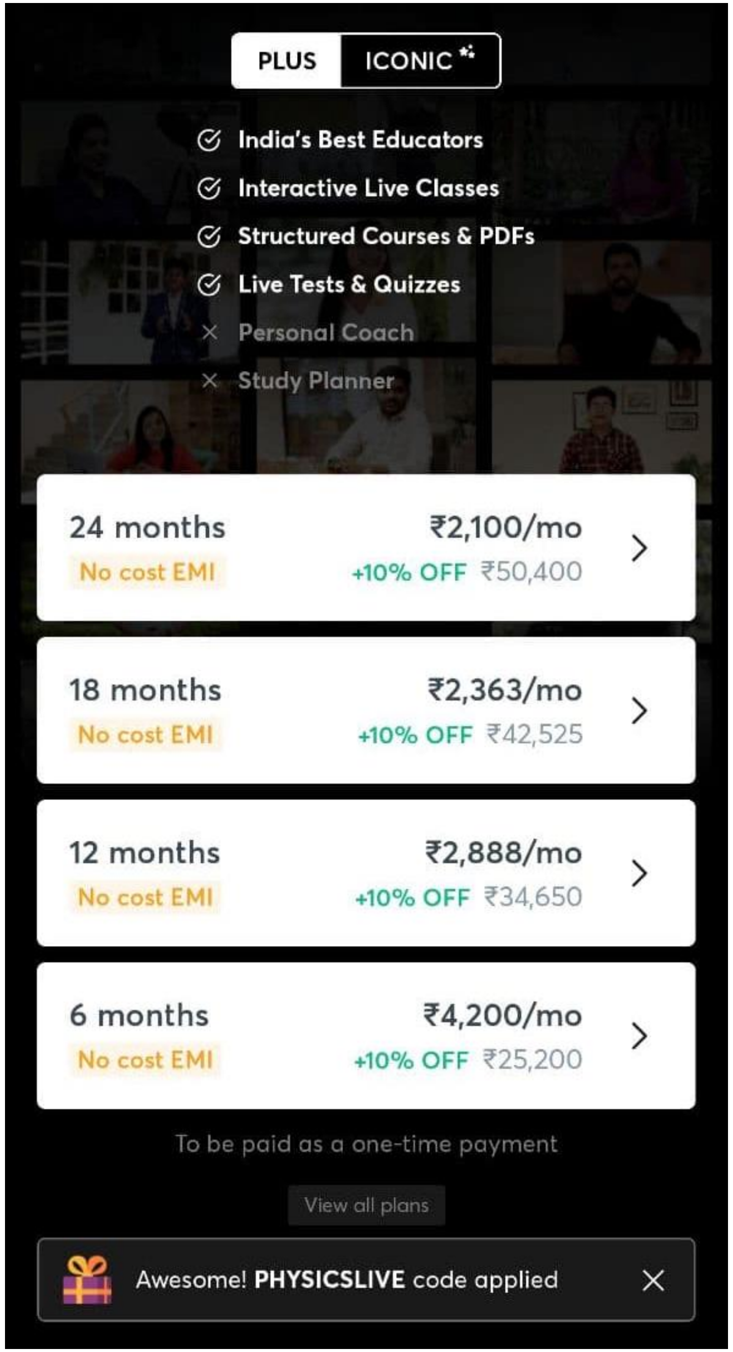
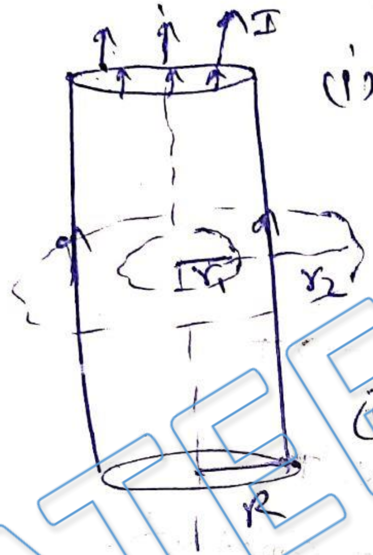


Written Solution

DPP- 2 Amperes law , Solenoid and Toroid

By Physicsaholics Team

Solution: 1



(i) at $r < R$ (inside the pipe)

$$\oint B \cdot dl = \mu_0 \Sigma I \to 0$$

$$\boxed{B = 0} \quad \text{--- (1)}$$

(ii) at $r > R$ (outside the pipe)

$$\oint B \cdot dl = \mu_0 \Sigma I$$

$$B \cdot (2\pi r) = \mu_0 I$$

$$\boxed{B = \frac{\mu_0 I}{2\pi r}} \quad \text{--- (2)}$$

Hence, from eq^n (1)

field at any point inside the pipe is zero.

Ans. b

Solution: 2

$$B = \mu_0 n_0 I$$

n_0 = no. of turns per unit length $= \frac{N}{L}$

$$B = \frac{\mu_0 N I}{L}$$

Layers of windings = n

$$B_{net} = n\left(\frac{\mu_0 N I}{L}\right)$$

$$B_{net} \propto \frac{1}{L}$$

& does not depend on diameter 'D'.

Ans. c

Solution: 3

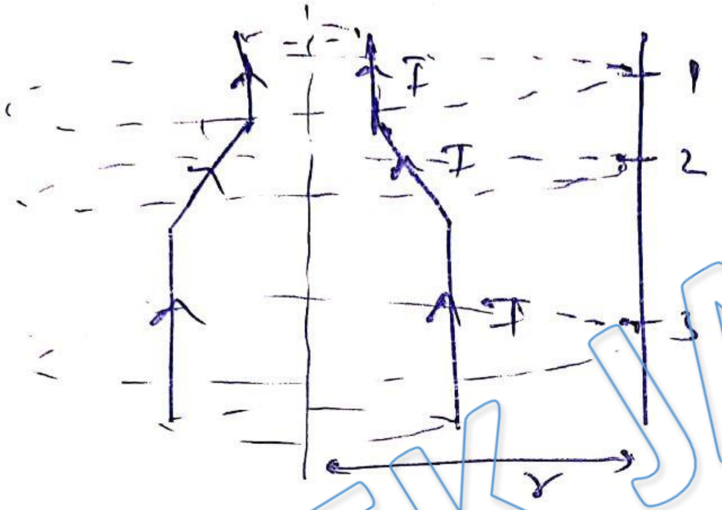
Sol.[A]

$$B = \mu_0 n i$$

$$B' = \mu_0 \left(\frac{n}{2}\right)(2i) = B$$

Ans. a

Solution: 4



for magnetic field

$$\oint B \cdot dl = \mu_0 \Sigma I$$

$\therefore \Sigma I = I$ for all points 1, 2 & 3

and distance '(r)' from axis of conductor is ~~same~~ also same for all points.

$\therefore B = \text{constant}$

$$B_1 = B_2 = B_3$$

Ans. a

Solution: 5

Case - 1

$$B_1 = \frac{\mu_0 I}{2R} = B$$

Let length of the wire = l

$\therefore$ $2\pi R = l$

$$R = \frac{l}{2\pi}$$

$$B_1 = B = \frac{\mu_0 I}{2\frac{l}{2\pi}}$$

$$\boxed{B_0 = \frac{\mu_0 \pi I}{l}} \quad \text{—(1)}$$

Case - 2

Now it is bent in the loop of n turns

Let radius of loops = r

$$n \times 2\pi r = l$$

$$r = \frac{l}{2\pi n}$$

$$B_2 = n\left(\frac{\mu_0 I}{2r}\right)$$

$$B_2 = n\frac{\mu_0 I}{2\left(\frac{l}{2\pi n}\right)} = n^2\frac{\mu_0 \pi I}{l}$$

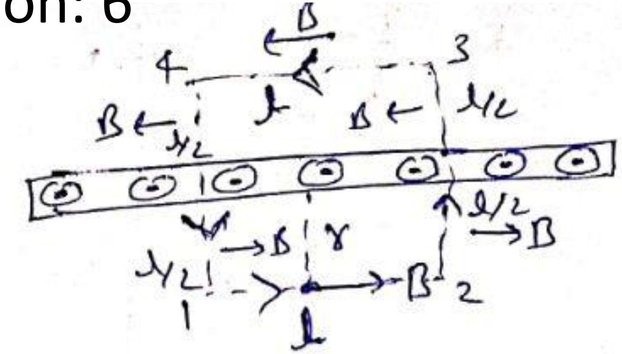
$$\boxed{B_2 = n^2\frac{\mu_0 \pi I}{l}} \quad \text{—(2)}$$

from eq (1) + (2)

$$\boxed{B_2 = n^2 B}$$

Ans. b

Solution: 6



$\oint B \cdot dl = \mu_0 \Sigma I$

for part 1 – 2

(B = constant ; as r = constant)

$\therefore \oint B \cdot dl = B \cdot l$ (as $B \parallel l$)

for part 2 – 3

$B \perp l$

$\therefore \oint B \cdot dl = 0$

for part 3 – 4

$\oint B \cdot dl = B \cdot l$ (as $B \parallel l$)

for part 4 – 1

$B \perp l$

$\therefore \oint B \cdot dl = 0$

$\therefore \oint B \cdot dl = \mu_0 \Sigma I$

$\oint_{1-2} B \cdot dl + \oint_{2-3} B \cdot dl + \oint_{3-4} B \cdot dl + \oint_{4-1} B \cdot dl = \mu_0 \Sigma I$

$Bl + 0 + Bl + 0 = \mu_0 (d l)$

$2Bl = \mu_0 d l$

$$\boxed{B = \frac{\mu_0 d}{2}}$$

Ans. a

Solution: 7

$$B = \mu_0 n I$$

$$B = \frac{\mu_0 N I}{2\pi r}$$

$$B = \frac{4\pi \times 10^{-7} \times 500 \times 0.5}{2\pi \times 0.1}$$

$$= \frac{1000 \times 0.5 \times 10^{-7}}{0.1}$$

$$\boxed{B = 5 \times 10^{-4}\ T}$$

Ans. a

Solution: 8

$B_1 = \mu_0 n I = B$

let ~~total~~ number of turns $= N$

then; $n = \frac{N}{l}$

$\therefore B = \frac{\mu_0 N I}{l}$

Now $l' = l/2$

& $N' = N$

$\therefore n' = \frac{N}{l/2} = \frac{2N}{l}$

$B_2 = \mu_0 n' I$

$B_2 = \mu_0 \left(\frac{2N}{l}\right) I$

$B_2 = 2\left(\frac{\mu_0 N I}{l}\right)$

$\boxed{B_2 = 2B}$

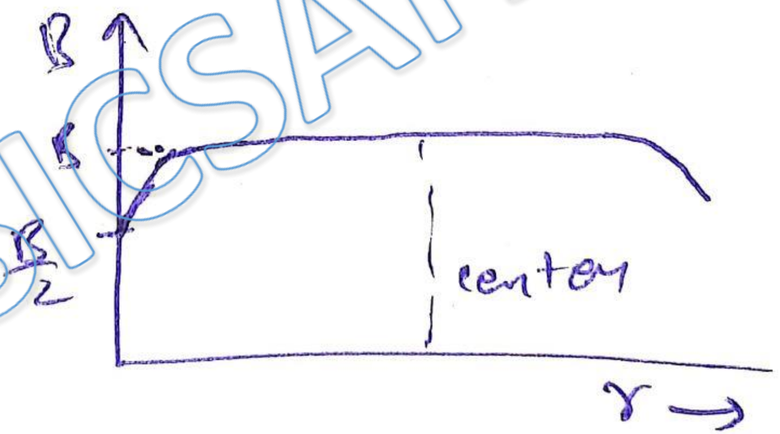
Ans. b

Solution: 9

for. Solenoid

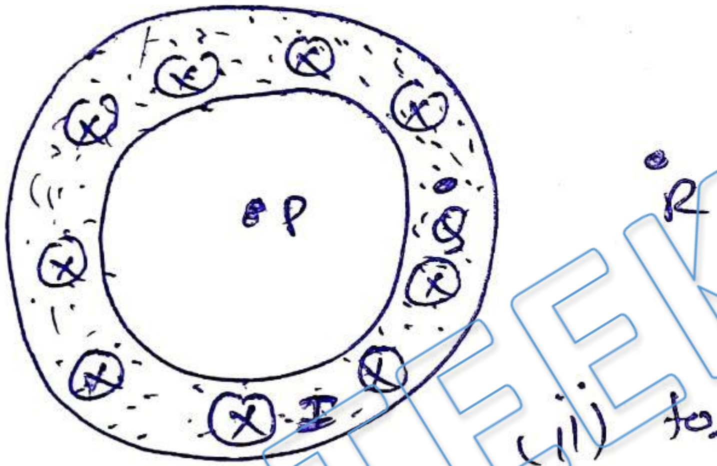
$B_{(inside)} = \mu_0 n I$ (constant)

$B_{(ends)} = \frac{\mu_0 n I}{2}$



Ans. d

Solution: 10



(i) for P

$\oint B \cdot dl = \mu \Sigma I \to 0$

$B_P = 0$

(ii) for Q

$\oint B \cdot dl = \mu_0 \Sigma I$

$\because \Sigma I \neq 0$

$\therefore B \neq 0$

(iii) for R

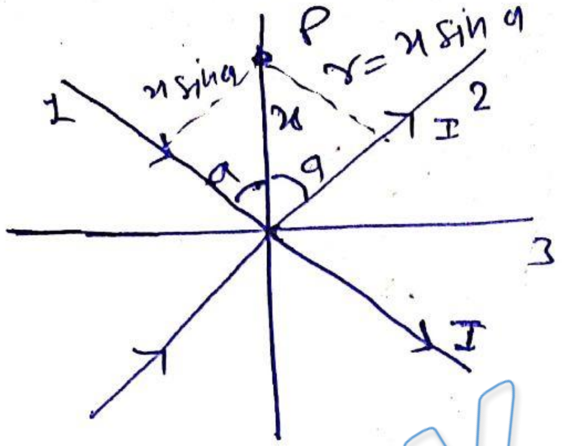
$\oint B \cdot dl = \mu_0 \Sigma I$

$\Sigma I \neq 0$

$\therefore B \neq 0$

Ans. d

Solution: 11



$B_p = 0 = B_1 + B_2 + B_3$

$$\left(\frac{\mu_0 I}{2\pi (x \sin a)} \odot\right) + \left(\frac{\mu_0 I}{2\pi (x \sin a)} \odot\right) + \left(\frac{\mu_0 I'}{2\pi x} \otimes\right) = 0$$

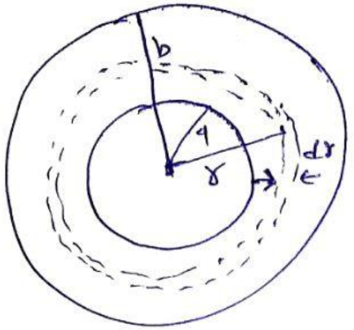
to make zero magnetic field at (p) current should be in direction right to left.

$$\frac{\mu_0 I'}{2\pi x} = \frac{2\mu_0 I}{2\pi x \sin a}$$

$$\boxed{I' = \frac{2I}{\sin a}}$$

Ans. c

Solution: 12



$$dA = 2\pi r\,dr$$

$$dI = \frac{I}{\pi(b^2-a^2)}(2\pi r\,dr)$$

$$\int_0^{i} dI = \int_a^{r} \frac{I}{\pi(b^2-a^2)} \times 2\pi \times r\,dr$$

$$i = \frac{I \times 2\pi}{\pi(b^2-a^2)}\left[\frac{r^2}{2}\right]_a^r$$

$$i = \frac{2\pi I}{\pi(b^2-a^2)}\,\frac{(r^2-a^2)}{2}$$

$$i = \frac{I(r^2-a^2)}{b^2-a^2}$$

$$\oint B\cdot dl = \mu_0 \Sigma I$$

$$B\cdot 2\pi r = \mu_0 \frac{I(r^2-a^2)}{(b^2-a^2)}$$

$$B = \frac{\mu_0 I}{2\pi r}\,\frac{(r^2-a^2)}{(b^2-a^2)}$$

Ans. a

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Chalo Niklo