DPP - Daily Practice Problems

Name :

Date :

Start Time :

End Time :

PHYSICS 39

SYLLABUS : MAGNETIC EFFECTS OF CURRENT-1 (Magnetic field due to current carrying wires, Biot savart law)

Max. Marks : 108 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 27 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.19) : There are 19 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

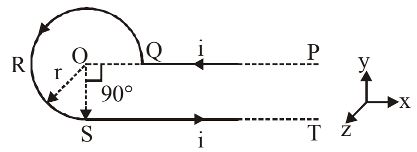
Q.1 The magnitude of magnetic field at a point having perpendicular distance 50 mm from a long straight conducting wire carrying a current of 3A is

(a) 0.12 G (b) 1.2 G
(c) 12 G (d) 0.012 G

Q.2 A circular arc of wire of radius of curvature r subtends an angle of $\pi/4$ radian at its centre. If i current is flowing in it then the magnetic induction at its centre is -

(a) $\frac{\mu_0 i}{8r}$ (b) $\frac{\mu_0 i}{4r}$
(c) $\frac{\mu_0 i}{16r}$ (d) 0

Q.3 A current i is flowing in a conductor PQRST shaped as shown in the figure. The radius of curved part QRS is r and length of straight portions PQ and ST is very large. The magnetic field at the centre O of the curved part is -



(a) $\frac{\mu_0 i}{4\pi r}\left[\frac{3\pi}{2}+1\right]\hat{k}$ (b) $\frac{\mu_0 i}{4\pi r}\left[\frac{3\pi}{2}-1\right]\hat{k}$

(c) $\frac{\mu_0 i}{4\pi r}\left[\frac{3\pi}{2}+1\right](-\hat{k})$ (d) $\frac{\mu_0 i}{4\pi r}\left[\frac{3\pi}{2}-1\right](-\hat{k})$

RESPONSE GRID 1. ⓐⓑⓒⓓ 2. ⓐⓑⓒⓓ 3. ⓐⓑⓒⓓ

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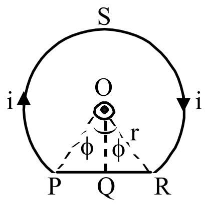
Q.4 Consider the loop PQRSP, carrying clockwise current i, shown in the figure. The magnitude of magnetic field at the centre O of the curved portion is



(a) $\frac{\mu_0 i}{2\pi r}[\pi - \phi + \tan\phi]$

(b) $\frac{\mu_0 i}{2\pi r}$

(c) 0

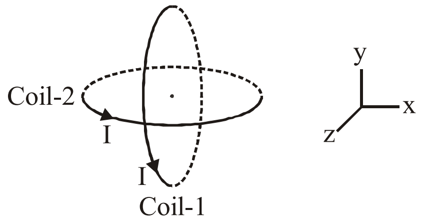
(d) $\frac{\mu_0 i}{2\pi r}[\pi - \phi + \tan\phi]$

Q.5 A circular coil of 0.2 m diameter has 100 turns and carries a current of 0.1 ampere. The intensity of magnetic field at the centre of the coil is -

(a) 6.28×10^{-4} N/A.m (b) 62.8×10^{-4} N/A.m

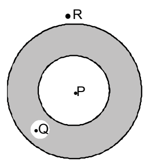
(c) 6.28×10^{-5} N/A.m (d) 62.8×10^{-5} N/A.m

Q.6 For the arrangement of two current carrying identical coils shown in the figure, the magnetic field at the center O is (N and a represent number of turns and radius of each coil)-



(a) $\frac{\mu_0 NI}{\sqrt{2}a}$ (b) $\frac{\mu_0 NI}{2\sqrt{2}a}$ (c) $\frac{\mu_0 NI}{2}$ (d) $\frac{\mu_0 NI}{2a}$

Q.7 A current is flowing through a conducting hollow pipe whose area of cross-section is shown in the fig. The value of magnetic induction will be zero at-



(a) Point P, Q and R

(b) Point R but not at P and Q

(c) Point Q but not at P and R

(d) Point P but not at Q and R

Q.8 Dimensional formula of μ_0 is-

(a) $MLT^{-2}A^{-2}$ (b) $MLT^{-2}A^{-2}$

(c) $MLT^{-2}A^{2}$ (d) $MLT^{2}A^{2}$

Q.9 A current of 1.0 ampere is flowing in the sides of an equilateral triangle of side 4.5×10^{-2} m. Find the magnetic field at the centroid of the triangle.
(Permeability constant $\mu_0 = 4\pi \times 10^{-7}$ V-s/A-m).

(a) 4.0×10^{-5} weber/m^2 (b) 6.0×10^{-8} weber/m^2

(c) 2.0×10^{-5} weber/m^2 (d) 7.0×10^{-12} weber/m^2

Q.10 An air-solenoid has 500 turns of wire in its 40 cm length. If the current in the wire be 1.0 ampere then the magnetic field on the axis inside the solenoid is -

(a) 15.7 gauss (b) 1.57 gauss

(c) 0.157 gauss (d) 0.0157 gauss

Q.11 A solenoid of length 0.2m has 500 turns on it. If 8.71×10^{-6} Weber/m^2 be the magnetic field at an end of the solenoid, then the current flowing in the solenoid is –

(a) $\frac{0.174}{\pi}$A (b) $\frac{0.0174}{\pi}$A (c) $\frac{17.4}{\pi}$A (d) $\frac{174}{\pi}$A

Q.12 A circular current carrying coil has a radius R. The distance from the centre of the coil on the axis where the magnetic induction will be $\frac{1}{8}th$ to its value at the centre of the coil, is

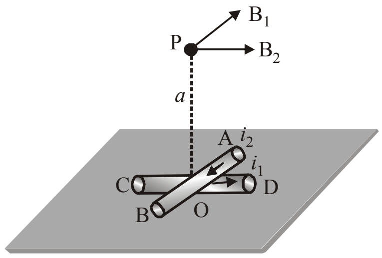
(a) $\frac{R}{\sqrt{3}}$ (b) $R\sqrt{3}$ (c) $2\sqrt{3}R$ (d) $\frac{2}{\sqrt{3}}R$

Q.13 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 inside it is :

(a) 5×10^{-4} tesla (b) 5×10^{-3} tesla

(c) 5×10^{-2} tesla (d) 2×10^{-3} tesla

Q.14 The straight long conductors AOB and COD are perpendicular to each other and carry current i_1 and i_2. The magnitude of the magnetic induction at point P at a distance a from the point O in a direction perpendicular to the plane ACBD is



(a) $\frac{\mu_0}{2\pi a}(i_1 + i_2)$

(b) $\frac{\mu_0}{2\pi a}(i_1 - i_2)$

(c) $\frac{\mu_0}{2\pi a}(i_1^2 + i_2^2)^{1/2}$

(d) $\frac{\mu_0}{2\pi a}\frac{i_1 i_2}{(i_1 + i_2)}$

RESPONSE GRID	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ
	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ
	14. ⓐⓑⓒⓓ				

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Q.15 A conducting circular loop of radius r carries a constant current i. It is placed in a uniform magnetic field $\vec{B}$, such that $\vec{B}$ is perpendicular to the plane of the loop. The magnetic force acting on the loop is

(a) $ir\vec{B}$ (b) $2\pi ri\vec{B}$ (c) zero (d) $\pi ri\vec{B}$

Q.16 The radius of a circular loop is *r* and a current *i* is flowing in it. The equivalent magnetic moment will be

(a) ir (b) $2\pi ir$ (c) $i\pi r^2$ (d) $\frac{1}{r^2}$

Q.17 A current of 30 A is flowing in a vertical straight wire. If the horizontal component of earth's magnetic field is 2×10^{-5} tesla then the distance of null point from wire is -

(a) 0.9 m (b) 0.3 mm (c) 0.3 cm (d) 0.3 m

Q.18 A charged particle is released from rest in a region of steady uniform electric and magnetic fields which are parallel to each other. The particle will move in a

(a) Straight line (b) Circle
(c) Helix (d) Cycloid

Q.19 A 6.28m long wire is turned into a coil of diameter 0.2m and a current of 1 amp is passed in it. The magnetic induction at its centre will be -

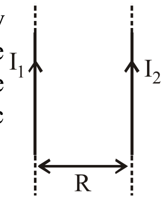
(a) 6.28×10^{-5} T (b) 0 T
(c) 6.28 T (d) 6.28×10^{-3} T

DIRECTIONS (Q.20-Q.21) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct
(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.20 Two long straight parallel wires carry currents I_1 and I_2 respectively, in the same direction (as shown). The distance between the wires is R. The magnetic field at the centre of the two wires will be-



(1) $\frac{\mu_0 (I_1 - I_2)}{\pi R}$ into the plane of paper (If $I_1 > I_2$)

(2) $\frac{\mu_0 (I_2 - I_1)}{\pi R}$ out of the plane of paper (if $I_2 > I_1$)

(3) $\frac{\mu_0 (I_1 - I_2)}{\pi R^2}$ out of the plane of paper (if $I_2 > I_1$)

(4) $\frac{\mu_0 (I_2 - I_1)}{\pi R^2}$ into the plane of paper (if $I_1 > I_2$)

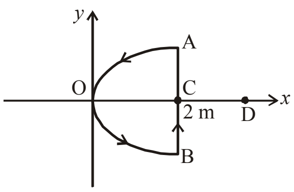
Q.21 A wire of length L carrying current I is bent into a circle of one turn. The field at the center of the coil is B_1. A similar wire of length L carrying current I is bent into a square of one turn. The field at its center is B_2. Then

(1) $B_1 > B_2$ (2) $B_1 = B_2$ (3) $\frac{B_1}{B_2} = 2$ (4) $B_1 < B_2$

DIRECTIONS (Q.22-Q.24) : Read the passage given below and answer the questions that follows :

A conducting wire is bent into a loop as shown in the figure. The segment AOB is parabolic given by the equation $y^2 = 2x$ while segment BA is a straight line parallel to the *y*-axis.

The magnetic field in the region is $\vec{B} = -8\hat{k}$ and the current in the wire is 2A.



Q.22 The torque on the loop will be

(a) $16\sqrt{2}$ Nm (b) 16 Nm
(c) $18\sqrt{2}$ Nm (d) Zero

Q.23 The field created by the current in the loop at point C will be

(a) $-\frac{\mu_0}{4\pi}\hat{k}$ (b) $-\frac{\mu_0}{2\pi}\hat{k}$

(c) $-\frac{\mu_0\sqrt{2}}{\pi}\hat{k}$ (d) None of these

RESPONSE GRID					
	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ
	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	

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Q.24 Magnetic field at point D due to segment AO of the loop is directed parallel to

(a) $\hat{k}$ (b) $-\hat{k}$ (c) $\hat{i}$ (d) $\hat{j}$

DIRECTIONS (Q. 25-Q.27) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is] the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(c) Statement-1 is False, Statement-2 is True.

(d) Statement -1 is True, Statement-2 is False.

Q.25 Statement -1: Cyclotron does not accelerate electron.
Statement-2: Mass of the electron is very small.

Q.26 Statement-1: The ion cannot move with a speed beyond a certain limit in a cyclotron.
Statement-2: As velocity increases time taken by ion increases.

Q.27 Statement-1: If an electron, while coming vertically from outerspace, enter the earth's magnetic field, it is deflected towards west.
Statement-2: Electron has negative charge.

RESPONSE GRID	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 39 - PHYSICS			
Total Questions	27	Total Marks	108
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	28	Qualifying Score	44
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

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DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

39

(1) (a) We know magnetic field due to a long straight current carrying wire

$$B = \frac{\mu_0 i}{2\pi r} = \frac{4\pi \times 10^{-7} \times 3}{2\pi \times 50 \times 10^{-3}}$$

(Note that $\mu_0 = 4\pi \times 10^{-7}$ in SI system)

$= 1.20 \times 10^{-5}$ Tesla = 0.12 G.

[As 1 Gauss = 10^{-4} Tesla]

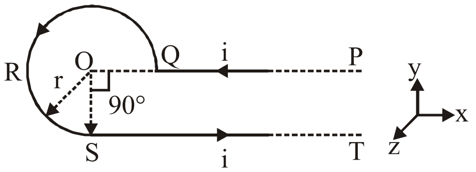
(2) (c) The magnetic induction produced due to a current carrying arc at its centre of curvature is

$$B = \frac{\mu_0 i\alpha}{4\pi r} \quad \text{.......... (a)}$$

(subtending angle α at the centre of curvature)

$$\Rightarrow \quad B = \frac{\mu_0 i\pi}{4\pi r} \times \frac{\pi}{4} = \frac{\mu_0 i}{16r}$$

(3) (a)



$$\vec{B}_O = \vec{B}_{QRS} + \vec{B}_{ST}.$$

$$\vec{B}_{PQ} = \text{zero}, \vec{B}_{QRS} = \frac{3}{4} \times \frac{\mu_0 i}{2r}\hat{k}, \vec{B}_{ST} = \frac{\mu_0 i}{4\pi r}\hat{k}$$

$$\Rightarrow \quad \vec{B}_O = \frac{\mu_0 i}{4\pi r}\hat{k} + \frac{3}{4}\frac{3\mu_0 i}{2r}\hat{k} = \frac{\mu_0 i}{4\pi r}\left[\frac{3\pi}{2} + 1\right]\hat{k}$$

(4) (a). $\vec{B}_O = \vec{B}_{PSR} + \vec{B}_{PQR}$ .... (a)

$$\vec{B}_{PSR} = \frac{\mu_0 i}{4\pi}\left[\frac{2\pi - 2\phi}{r}\right] = \frac{\mu_0 i}{2\pi r}[\pi - \phi](-\hat{k}) \quad \text{.... (b)}$$

$$\vec{B}_{PQR} = \frac{\mu_0 i}{4\pi} \cdot \frac{2\sin\phi}{OQ}(-\hat{k}) = \frac{\mu_0 i}{4\pi} \cdot \frac{2\sin\phi}{r\cos\phi} = \frac{\mu_0 i}{2\pi r}\tan\phi\,(-\hat{k}) \quad \text{.... (c)}$$

From eqs. (a), (b) and (c)

$$\vec{B} = \frac{\mu_0 i}{2\pi r}[\pi - \phi](-\hat{k}) + \frac{\mu_0 i}{2\pi r}\tan\phi\,(-\hat{k})$$

$$= \frac{\mu_0 i}{2\pi r}[\pi - \phi + \tan\phi](-\hat{k})$$

(5) (a). The rotating rod is a current-loop whose radius a = 0.6m. The magnetic field due to this current-loop at a point on its axis at a distance x from its centre is given by

$$B = \frac{\mu_0 i a^2}{2(a^2 + x^2)^{3/2}} \quad \text{...(i)}$$

Let T be the period of rotation of the rod. Then

$$i = \frac{q}{T} = \frac{q\omega}{2\pi} = \frac{1 \text{ colulomb} \times 10^4 \pi / \text{sec}}{2\pi}$$

$= 5 \times 10^3$ amp.

Now, a = 0.6 m, x = 0.8 m and $\mu_0 = 4\pi \times 10^{-7}$ V-s/A-m.

Substituting these values in eq. (i) we get

$$B = \frac{(4\pi \times 10^{-7} \text{V} - \text{s}/\text{A} - \text{m})(5 \times 10^3 \text{A})(0.6\text{m})^2}{2(0.36 + 0.64)^{3/2}\text{m}^3}$$

$= 0.36\pi \times 10^{-3} = 1.13 \times 10^{-3}$ tesla

In the second case the current remains the same because the rotating charge and the angular frequency are the same. However, the radius of the loop becomes half (a = 0.3 m) and the distance x is now 0.4 m.

$$\therefore \quad B = \frac{\mu_0 i a^2}{2(a^2 + x^2)^{3/2}}$$

$$= \frac{(4\pi \times 10^{-7} \text{V} - \text{s}/\text{A} - \text{m})(5 \times 10^3 \text{A})(0.3\text{m})^2}{2(0.09 + 0.16)^{3/2}\text{m}^3}$$

$$= \frac{4\pi \times 10^{-7} \times 5 \times 10^3 \times 0.09}{2 \times 0.25 \times 0.5} \text{ tesla}$$

$= 0.72 \times 10^{-3}\,\pi = 2.26 \times 10^{-3}$ tesla.

(6) (a) The magnetic field at the centre of a current carrying coil having n turns is given by

$$B = \frac{\mu_0 n i}{2r} \text{ N/A.m}$$

where i, is the current in the coil and r is the radius of the coil.

Here i = 0.1 A, n = 1000 and r = 0.1 m.

$$\therefore \quad B = \frac{(4\pi \times 10^{-7}) \times 1000 \times 0.1}{2 \times 0.1} = 6.28 \times 10^{-4} \text{ N/A.m}$$

(7) (a). The two coils are perpendicular to each other. Coil 1 produces field along X axis and coil 2 produces field along Y axis. Thus the resultant field will be-

$$B = \sqrt{B_1^2 + B_2^2} \text{ making an angle}$$

$$\theta = \tan^{-1}\left(\frac{B_2}{B_1}\right) \text{ with x axis}$$

$$\text{As } B_1 = B_2 = \frac{\mu_0 NI}{2a}$$

$$\Rightarrow B = \sqrt{2} = \left(\frac{\mu_0 NI}{2a}\right) = \frac{\mu_0 NI}{\sqrt{2}a} \text{ and } \theta = 45°.$$

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(8) (d) Applying ampere's law at P, Q and R respectively, we find that there is no current enclosed by the circle of P. So magnetic induction at P is zero while that at Q and R is non- zero.

(9) (a). For a current carrying coil

$B = \frac{\mu_0 i}{2R}$ at centre and force on a current carrying conductor ie

$$F = i\ell B \Rightarrow F = \frac{\mu_0 i^2 \ell}{2R}$$

$$\Rightarrow [MLT^{-2}] = \frac{[\mu_0][A^2][L]}{[L]}$$

$$\Rightarrow [\mu_0] = [MLT^{-2} A^{-2}]$$

(10) (c) By Biat Savart Law,

$$\delta B = \frac{\mu_0}{4\pi} \frac{i\delta\ell \sin\theta}{r^2}$$

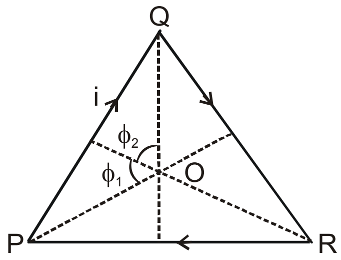
When $\theta = 90°$, then $\sin 90° = 1$ = maximum

$$\therefore \delta B = \frac{\mu_0 i\delta\ell}{4\pi r^2} = \text{maximum}$$

(11) (a) The magnitude of the magnetic field at the centroid O of the triangle due to a side PQ (say) is

$$\frac{\mu_0}{4\pi}\frac{i}{r}(\sin\phi_1 + \sin\phi_2)$$

Where r is the perpendicular distance of PQ from O, and ϕ_1, ϕ_2 the angles as shown. The field is perpendicular to the plane of paper and is directed into plane of paper. Since the magnetic field due to each of the three sides is the same in magnitude and direction, the magnitude of the resultant field at O is



$$B = 3\frac{\mu_0}{4\pi}\frac{i}{r}(\sin\phi_1 + \sin\phi_2)$$

Here i = 1 ampere, $\phi_1 = \phi_2 = 60°$

and $r = \frac{l}{2}\cot 60° = \frac{l}{2} \times \frac{1}{\sqrt{3}}$

and ℓ is the side of the triangle ($= 4.5 \times 10^{-2}$ meter).

$$\therefore B = \frac{3\times10^{-7}\times1.0}{\left(\frac{1}{2}\times4.5\times10^{-2}\right)\times\left(\frac{1}{\sqrt{3}}\right)}\left(\frac{\sqrt{3}}{2}+\frac{\sqrt{3}}{2}\right)$$

$$= \frac{3\times10^{-7}\times2\times3}{4.5\times10^{-2}} = 4.0\times10^{-5} \text{ weber/m}^2.$$

(12) (a). The magnetic field inside (near centre) a current carrying solenoid having n turns per unit length is given by
$B = \mu_0 ni$ newton/(ampere-meter),
where i (ampere) is the current in the solenoid and
$\mu_0 = 4\pi \times 10^{-7}$ newton/ampere^2.
Here n = 500/0.40 = 1250 per meter, i = 1.0 amp.
$\therefore B = (4 \times 3.14 \times 10^{-7}) \times 1250 \times 1.0$
$= 15.7 \times 10^{-4}$ newton/(ampere-meter) = 15.7 gauss.

(13) (b) We know, $B_{end} = \frac{\mu_0 ni}{2}$

Here $n = \frac{500}{0.2} = 2500$/metre,

$$\therefore \quad i = \frac{2B_{end}}{\mu_0 n} = \frac{2\times8.71\times10^{-6}}{4\pi\times10^{-7}\times2500}$$

$$= \frac{17.42\times10^{-3}}{\pi} = \frac{0.01742}{\pi}\text{amp} \text{ amp.}$$

(14) (b) $\frac{B_{centre}}{B_{axis}} = \left(1\times\frac{x^2}{R^2}\right)^{3/2}$, also $B_{axis} = \frac{1}{8}B_{centre}$

$$\Rightarrow \quad \frac{8}{1} = \left(1\times\frac{x^2}{R^2}\right)^{3/2} \Rightarrow \quad 2 = \left(1\times\frac{x^2}{R^2}\right)^{1/2}$$

$$\Rightarrow \quad 4 = 1 + \frac{x^2}{R^2} \Rightarrow 3 = \frac{x^2}{R^2} \Rightarrow x^2 = 3R^2 \Rightarrow 3R^2$$

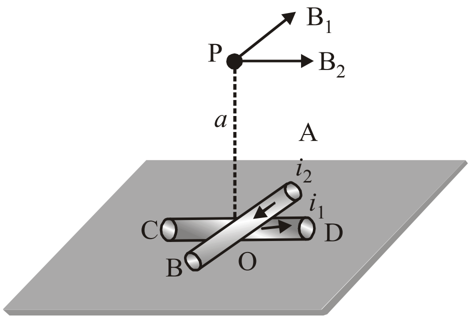
$$\Rightarrow x = \sqrt{3}R$$

(15) (a) $B_0 = \mu_0 \frac{Ni}{2\pi R}$

$$= \frac{4\pi\times10^{-7}\times500\times0.5}{2\pi\times0.1} = 5\times10^{-4} \text{ tesla}$$

(16) (c) At P : $B_{net} = \sqrt{B_1^2 + B_2^2}$

$$= \sqrt{\left(\frac{\mu_0}{4\pi}\frac{2i_1}{a}\right)^2 + \left(\frac{\mu_0}{4\pi}\frac{2i_2}{a}\right)^2}$$



$$= \frac{\mu_0}{2\pi a}\left(i_1^2 + i_2^2\right)^{1/2}$$

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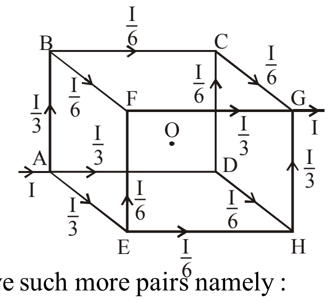
(17) (d)

(18) (b) Current distribution in the network is as shown.
Now, consider the pair of wires AB and GH. As current in these wires produce equal but opposite magnetic fields at centre O of the cube, resultant field due to the pair is zero.



We can see five such more pairs namely :
(i) AE, CG
(ii) AD, FI
(iii) BC, EH
(iv) EF, DC
(v) BF, OH
Magnetic field due to each of these pairs is zero.
Therefore, resultant magnetic field at centre O is zero.

(19) (a) Magnetic field inside a solid cylinder of current is

$$B_{inside} = \frac{\mu_0 ir}{2\pi R^2}$$

$$\Rightarrow \quad B_0 = \frac{\mu_0 i \frac{R}{2}}{2\pi R^2}$$ (as per given information)

$$\Rightarrow \quad i = \frac{4B_0 \pi R}{\mu_0}$$

Magnetic field outside a solid cylinder of current is

$$B_{outside} = \frac{\mu_0 i}{2\pi r}$$

$$\Rightarrow \quad B_{outside} \text{ at a distance } 2R = \frac{\mu_0\left(\frac{4B_0\pi R}{\mu_0}\right)}{2\pi(2R)} = B_0$$

(20) (d) As per sense of transversal,
$i_{crossing} = I_1 - I_2 - I_3$

By Ampere's law, $\oint \vec{B}.d\vec{\ell} = \mu_0\, i_{crossing}$

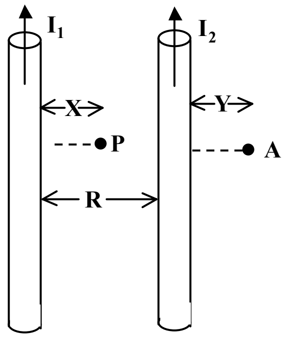
$$\Rightarrow \oint \vec{B}.d\vec{\ell} = \mu_0 (I_2 - I_1 - I_3)$$

(21) (a) $\ell = (2\pi r)\,n$ or $\quad n = \frac{\ell}{2\pi r}$

$$B = \frac{\mu_0 ni}{2r} = \frac{\mu_0 i\ell}{4\pi r^2}$$

or $$B = \frac{4\pi\times10^{-7}\times6.28\times1}{2\times2\times\pi\times(0.10)^2} = 6.28\times10^{-5}\text{ Tesla.}$$

(22) (b). The arrangement is shown in fig.



The magnetic field at a point P in between the two wires is

$\vec{B} = \vec{B}_1 + \vec{B}_2$. The field B_1 (due to current I_1) points down ward while B_2 (due to current I_2) points upwards. Thus field at point P is-

$$B = \frac{\mu_0}{2\pi}\left[\frac{I_1}{x} - \frac{I_2}{R-x}\right] \text{ in to the plane of paper.}$$

At $x = R/2$,

$$B = \frac{\mu_0 (I_1 - I_2)}{\pi R} \text{ into the plane of paper, } (\text{if } I_1 > I_2)$$

or $$B = \frac{\mu_0 (I_2 - I_1)}{\pi R} \text{ out of the plane of paper } (\text{if } I_2 > I_1)$$

(23) (d) (i) Fields due to both coils are in the same direction

$$\Rightarrow B = \frac{\mu_0 N_1 I_1}{2R_1} + \frac{\mu_0 N_2 I_2}{2R_2}$$

If $I_1 = I_2 = I,\ N_1 = N_2 = N,$

$$B = \frac{\mu_0 NI(R_1 + R_2)}{2R_1R_2}$$

(ii) Fields due to the two coils are in opposite direction,

$$\Rightarrow B = \frac{\mu_0 N_1 I_1}{2R_1} - \frac{\mu_0 N_2 I_2}{2R_2}$$

If $I_1 = I_2 = I,\ N_1 = N_2 = N,$

$$B = \frac{\mu_0 NI(R_2 - R_1)}{2R_1R_2}$$

(24) (a). For circular coil $B_1 = \frac{\mu_0 I}{2r}$
Circumference of the coil $= 2\pi r = L$.
Thus $B_1 = \pi\mu_0\, I/L = 3.14\,\mu_0\, I/L$
For square loop $B_2 = 2\sqrt{2}\,\mu_0\, I/L = 3.60\,\mu_0\, I/L$
Thus $B_1 < B_2$.

25. (d) Since $\vec{M} \parallel \vec{B}$ $\therefore$ Torque $= \vec{M}\times\vec{B}$ is zero.

26. (d) The field must be in $+\hat{k}$ direction.

27. (a)

28. (b) The statements are independently correct.

29. (d) $\vec{\tau} = \vec{m}\times\vec{B} \Rightarrow \vec{\tau} = 0$ for $\theta = 0°, 180°$.

30. (b)

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