PHYSICS

BOOKS - MODERN PUBLICATION

MAGNETIC EFFETS OF CURRENT

Example

1. The plane of a circular coil is horizontal. It has 10 turns each of radius 8cm. A current of 2 A flows through it. The current appears to flow

clockwise from a point above the coil. Find the magnitude and direction of magnetic field at the centre of the coil due to the current.

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2. Calculate the magnetic field due to a circular coil of 250 turns and of diameter 0.1m, carrying a current of 7A at the center of the coil .

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3. Calculate the magnetic field due to a circular coil of 250 turns and of diameter 0.1m, carrying a current of 7A at a point on the axis of the coil at a distance 0.12m from the center of the coil.

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4. The radius of the first electron orbit of a hydrogen atom is $0.5\overset{\circ}{A}$. The electron moves in this orbit with a uniform speed of $2.2 \times 10^6 m.\, s^{-1}$. What is the magnetic field

produced at the centre of the nucleus due to the motion of this electron?

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5. Two concentric circular coils X and Y of radii 16 cm and 10 cm, respectively, lie in the same vertical plane containing the north to south direction. Coil X has 20 turns and carries a current of 16 A, coil Y has 25 turns and carries a current of 18 A. The sense of the current in X is anticlockwise, and clockwise in Y, for an

observer looking at the coils facing west. Give the magnitude and direction of the net magnetic field due to the coils at their centre.

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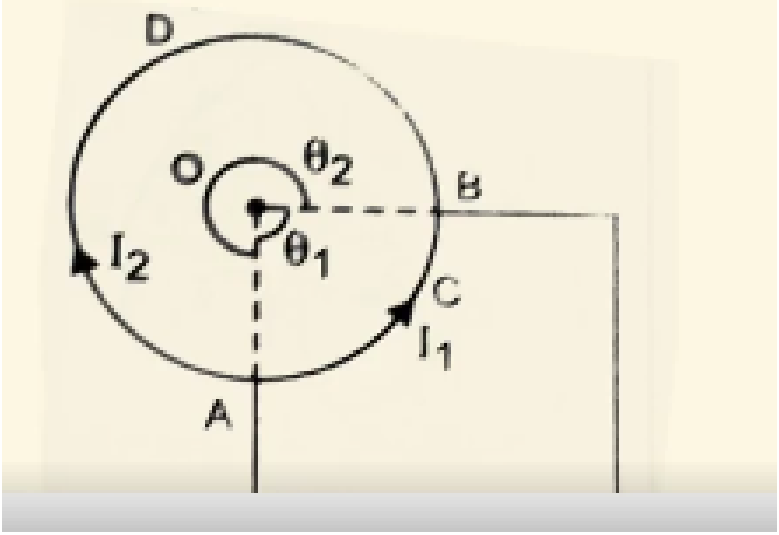
6. As shown in figure a cell is connected across two points A and B of a uniform circular conductor of radius r. Prove that the magnetic

field induction at its centre O will be zero.



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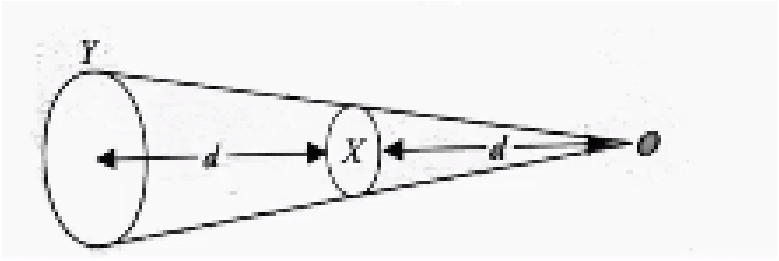
7. Two circular coils X and Y, having equal number of turns and carrying currents in the same sense, subtend same solid angle at point

O. If the smaller coil X is midway between O and Y and if we represent the magnetic induction due to bigger coil Y at O as B_y and the due to smaller coil X at O as B_x, then find the ratio B_x / B_y.



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8. A student records the following data for the magnitudes of the magnetic field at axial

points at different distances x from the centre of a circular coil of radius 'a' carrying a current 'I'. Verfity that these observations are in good agreement with the expected theoreticl variations of B with X.

$X \to x = 0$	$x = a$	$x = 2a$	$x = 3a$
$B \to B_0$	$0.25\sqrt{2}B_0$	$0.039\sqrt{5}B_0$	$0.010\sqrt{10}B_0$

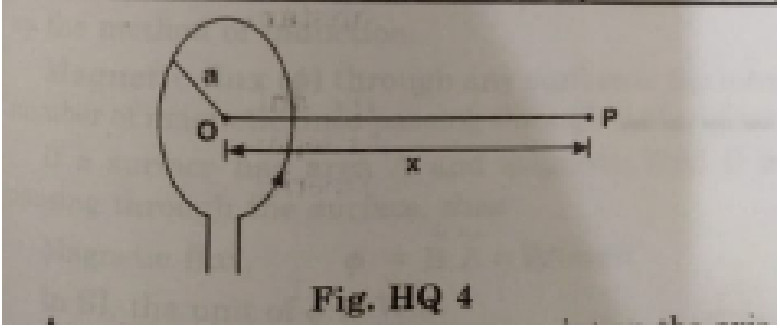

Fig. HQ 4

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9. A long straight solid conductor of radius 5 cm carries a current of 2A, which is uniformly distributed over its circular cross section. Find the magnetic field at a distance of 3 cm from the axis of the conductor.

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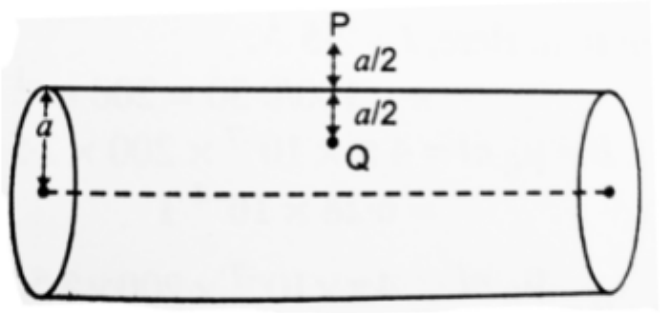
10. A straight thick long wire of uniform cross-section of radius a is carrying a steady current I. Calculate the ratio of magnetic field at a

point $a/2$ above the surface of the wire to that at a point $a/2$ below its surface. What is the maximum value of the field of this wire?



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11. A straight wire carries a current of 3 A.Calculate the magnitude of the magnetic field at a point 15cm away from the wire. Draw

a diagram to show tha direction of the magnetic field.

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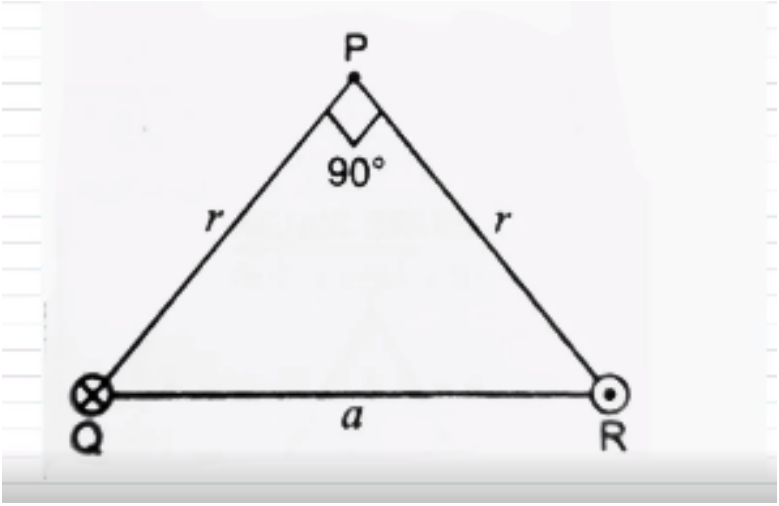
12. Figure shows a right-angled isosceles ΔPQR having its base equal to a. A current of I ampere is passing downwards along a thin straight wire cutting the plane of paper normally as shown at Q. Likewise a similar wire carries an equal current passing normally upwards at R. Find the magnitude and

direction of the magnetic field induction B at P. Assume the wires to be infinity long.



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13. Caculate the magnetic field induction at the centre of a coil bent in the form of a square of side 10 cm carrying current of 10 A.

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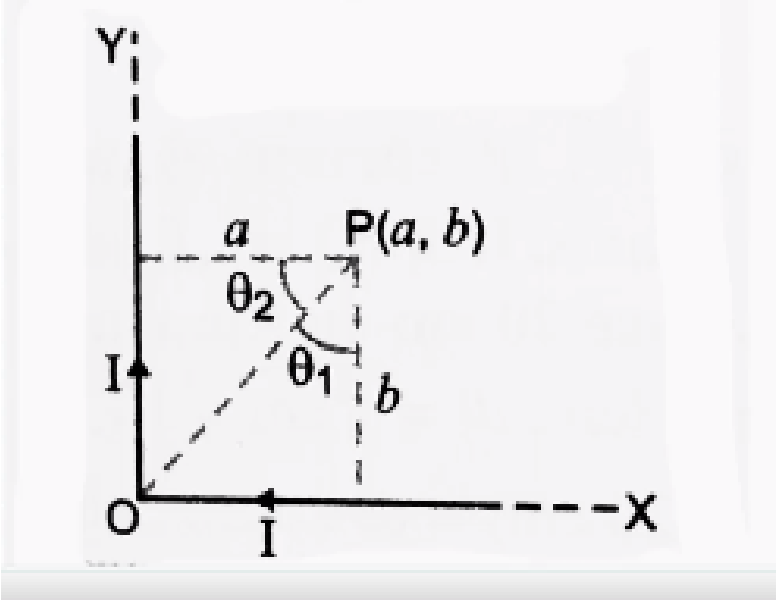
14. Two semi infinitely long straight current carrying conductors are held in the form as shown in figure. One common end of them is at the origin. If both the conductors carry same current I, find the value of the magnetic

field induction at a point (a, b).



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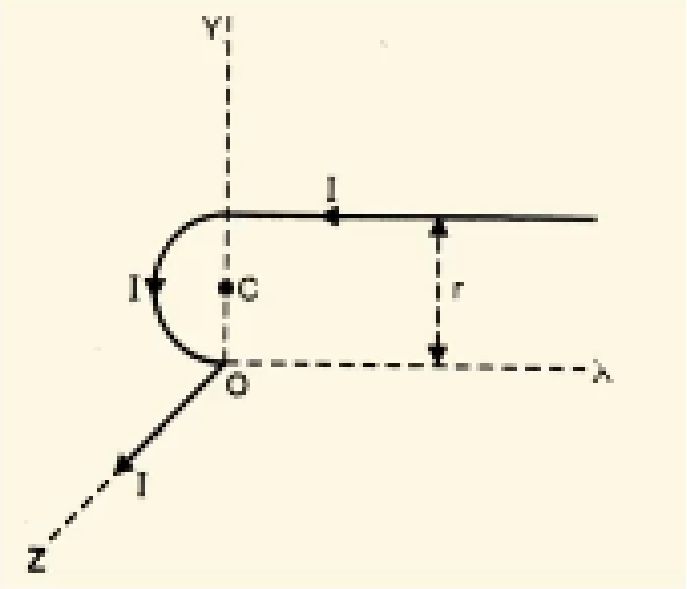
15. An infinitely long conductor as shown in figure, carrying a current I with a semicircular loop on X-Y plane and two straight parts, one

parallel to X-axis and another coinciding with Z-axis. What is the magnetic field induction at the centre C of the semi-circular loop.



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16. A 0.5 m long solenoid has 500 tuns and has a flux density of $2.52 \times 10^{-3} T$ at its centre. Find the current in the solenoid. Given $\mu_0 = 4\pi \times 10^{-7} Hm^{-1}$

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17. A solenoid is 2.0 m long and 3.0 cm in diamter. It has 5 layers of winding of 1,000 turns each an carries a current of 5.0 A. What

is the agnetic field at its centre. ? Use the standard value of μ_0

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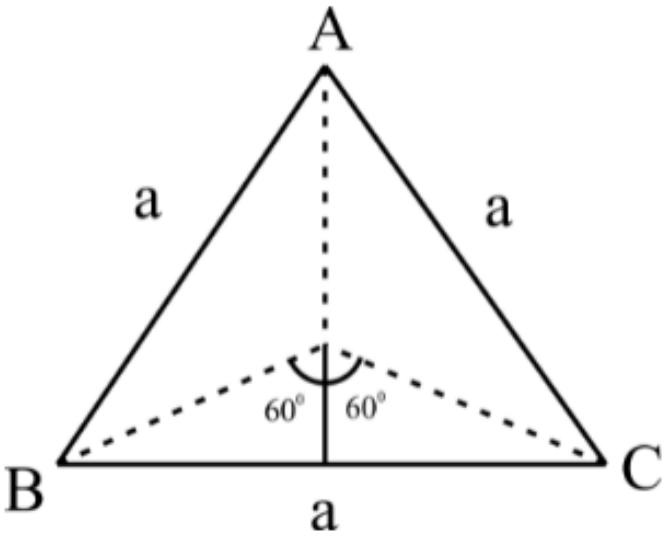
18. A current of 1 A is flowing in the sides of an equilaterial triangles of side 4.5×10^{-2} . Find the magnetic field at the centroid of the

triangle.



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19. A toroid has a core of inner radius 20cm and outer radius 22cm around which 4200 turns of a wire are wound. If the current in the

wire is 10A, what is the magnetic field inside the core of toroid.

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20. A toroid has a core of inner radius 20cm and outer radius 22cm around which 4200 turns of a wire are wound. If the current in the wire is 10A, what is the magnetic field outside the toroid.

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21. A toroid has a core (non-ferromagnetic) of inner radius 25 cm and outer radius 26 cm, around which 3500 turns of a wire are wound. If the current in the wire is 11 A, what is the magnetic field in the empty space surrounded by the toroid.

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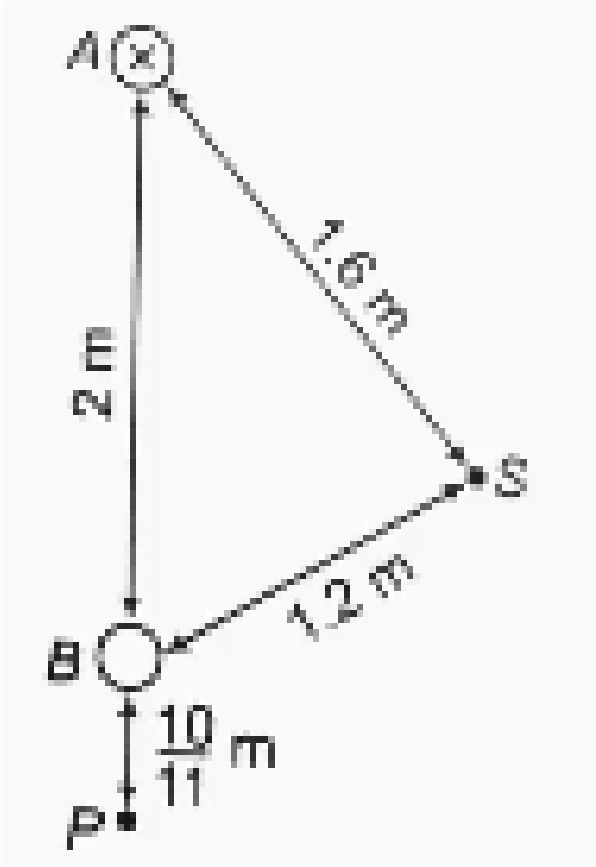
22. Two long straight parallel wieres are 2m apart, perpendicular to the plane of the paper. The wire A carries a current of 9.6 A, directed

into the plane of the paper. The wire B carries a current such that the magnetic field of induction at the point P, at a distance of 10/11 m from the wire B, is zero. find the magnitude

and directiion of the current in B.



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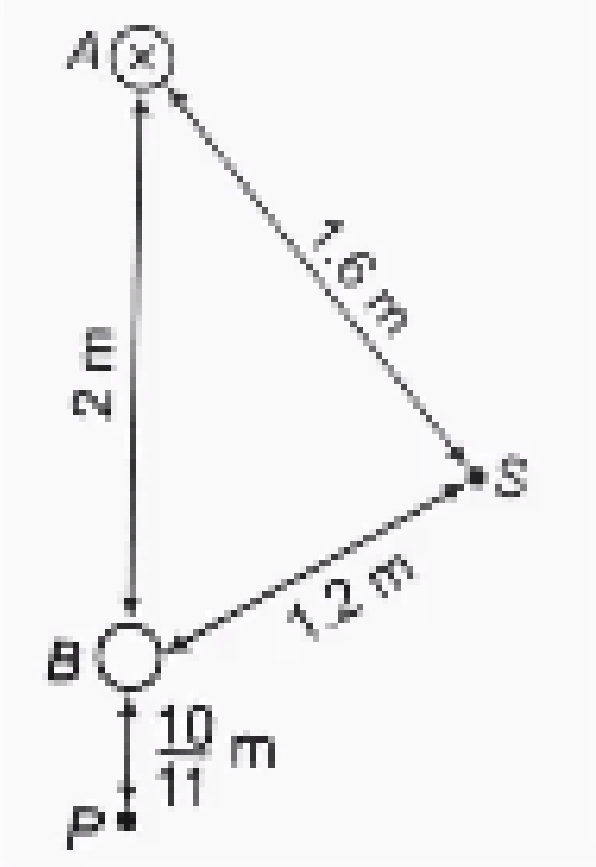
the magnitude of the magnetic field of

induction of the pont S.



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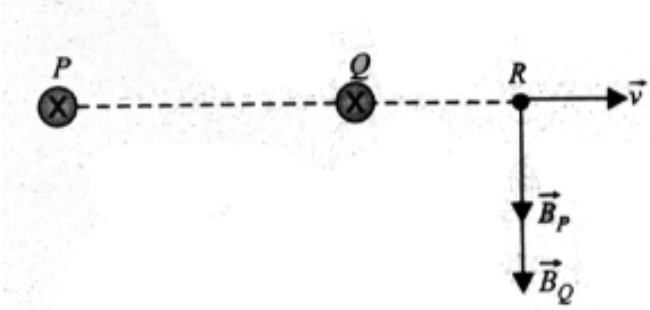
24. Two long parallel wires carrying current 2.5 amperes and I ampere in the same Idirection (directed into the plane of the paper) are held at P and Q respectively such that they are perpendicular to the plane of paper. The points P and Q are located at a distance of 5 metres and 2 metres respectively from a collinear point R (see figure)

An electron moving with a velocity of $4 \times 10^5 m/s$ along the positive x- direction experiences a force of magnitude $3.2 \times 10^{-20} N$ at the point R. Find the value of

I.



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25. Two long parallel wires carrying current 2.5 amperes and I ampere in the same Idirection (directed into the plane of the paper) are held at P and Q respectively such that they are perpendicular to the plane of paper. The

points P and Q are located at a distance of 5 metres and 2 metres respectively from a collinear point R (see figure)

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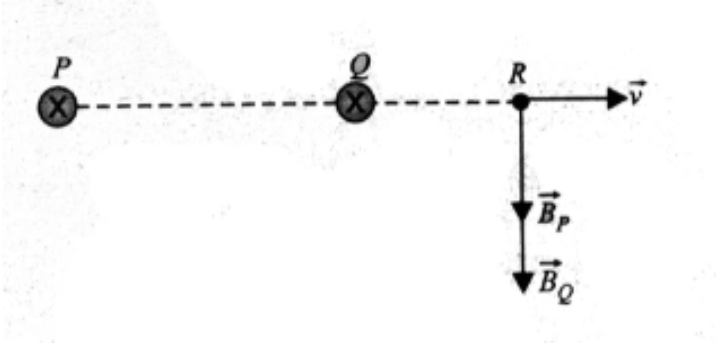

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26. Is the source a magnetic field analogue to the source of electric field?

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27. State Biot-Savert's law.

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28. A conductor carrying current is placed somewhere. What is the magntiude and direction of the field due to a small part of the conductor at a point near it?

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29. Write Biot Savart expression for the magnetic field due to a current element in vector form.

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30. The SI unit of permeability is:

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31. What is the value of constant $\frac{\mu_0}{4\pi}$?

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32. Write the dimensional formula of μ_0

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33. State the rule that is used to find the direction of field acting at a point near a current carrying straight conductor.

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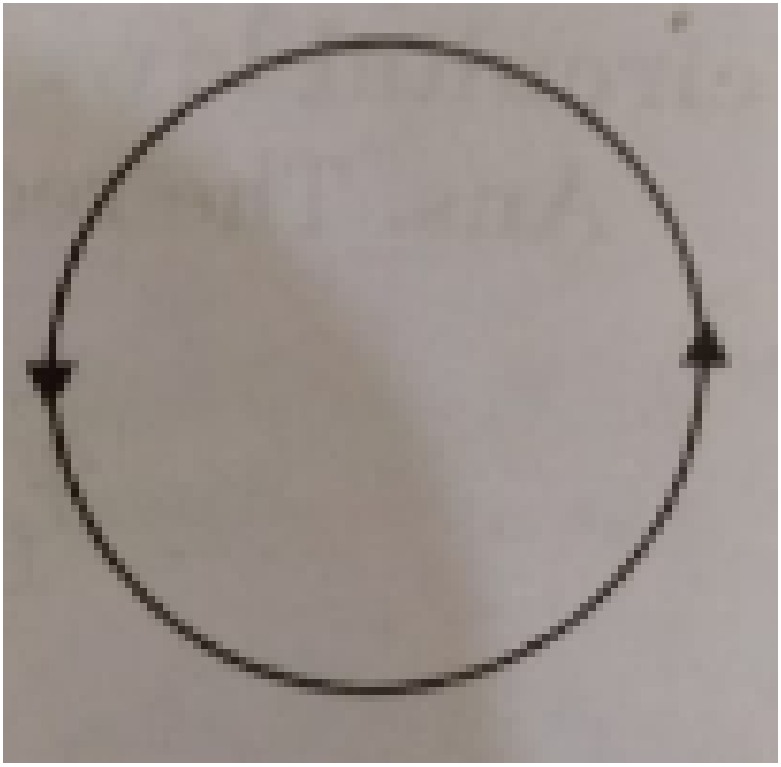
34. In the diagram below is shown a circular loop carrying current I. show that the direction of magnetic field with the help of

lines of force.



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35. Does a current carrying circular coil produce uniform magnetic field?

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36. What is the effect of increasing the number of turns on magnetic field produced due to a circular coil?

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37. Looking at a ciruclar coil, the current found to be flowing in anticlockwise diretion. Predict the direction of magnetic field produced at a

point on the axis of the coil on the same side as the observer

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38. State Ampere's circuital law.

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39. State Ampere's circuital law.

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40. Write an expression for the magnetic field produced by an infinitely long straight wire carrying a current I, at a short perpendicular distance a from itself.

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41. What kind of magnetic field is produced by an infinitely long current carrying conductor?

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42. The magnetic lines of force around an infinitely long conductor carrying current are:

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43. What is the solenoid? Give magnitude of magnetic of magnetic field is applied on it?

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44. Write down an expression for the flux density B inside a long straight solenoid, explaining the symbols used.

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45. How much is the flux density B at the centre of a long solenoid?

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46. What is the nature of magnetic field produced by straight solenoid?

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47. What is a toroid?

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48. Magnetic field lines can be entirely confined within the core of a toroid, but not

within a straight solenoid. Why?

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49. What is the basic difference between magnetic field and electric field?

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50. In what way is an electric field different from a magnetic field?

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51. In what respect does a wire carrying a current differ from a wire, which carries no current?

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52. Give two similarities between Biot Savart's law for magnetic fields and Coulomb's law for electrostatic fields.

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53. Give two differences between Biot Savart's law for magnetic fields and Coulomb's law for electrostaic fields.

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54. State any rule that relates the direction of electric current and the direction of accompaying magnetic field?

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55. Assuming that the earth's magnetic field is due to large circular loop of current in the interior of the earth, what is the plane of the loop and what is the direction of current around it?

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56. How will the magnetic field intensity at the centre of a circular coil carrying current

change, if the current through the coil is doubled and the radius of the coil is halved?

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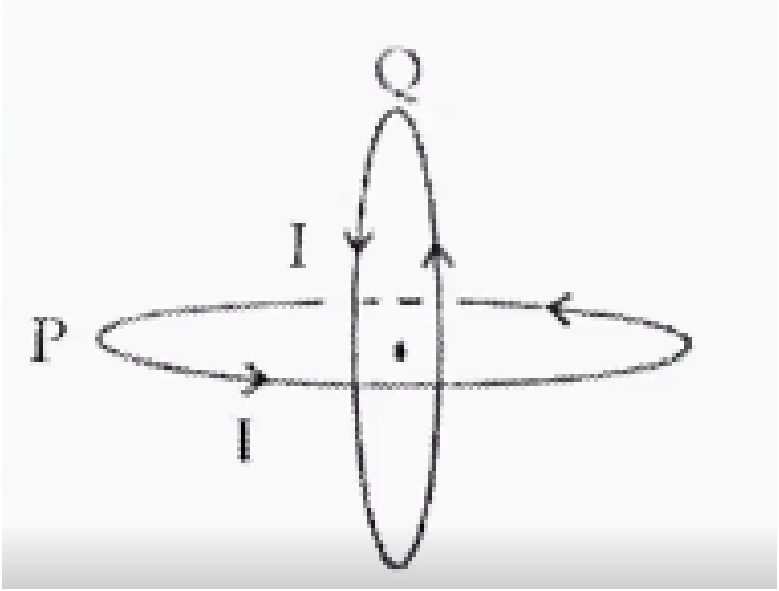
57. Two identical circular wires P and Q each of radius R and carrying current 'I' are kept in perpendicular planes such that they have a common centre as shown in the figure. Find the magnitude and direction of the net magnetic field at the common centre of the

two coils.



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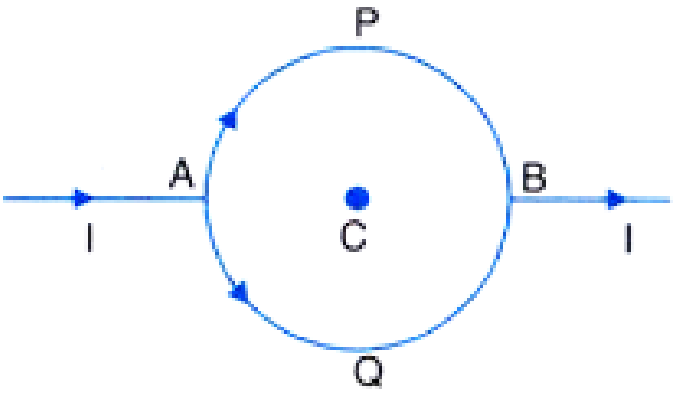
58. Consider the circuit as shown in the figure. Where APB and AQB are semi-cricles. What will be the magnetic field at the centre C of the

circular loop?



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59. Derive an expression for magnetic field at the centre of circular current carrying coil.

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60. An electron revolves in a circular orbit of radius r with uniform angular speed ω. From the expression for magnetic field due to current carrying circular conductor, deduce the expression for magnetic field at the center of electron orbit.

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61. A horizontal overhead power line carries a current of 90 A in east to west direction. What is the magnitude and direction of the

magnetic field due to the current 1.5 m below the line?

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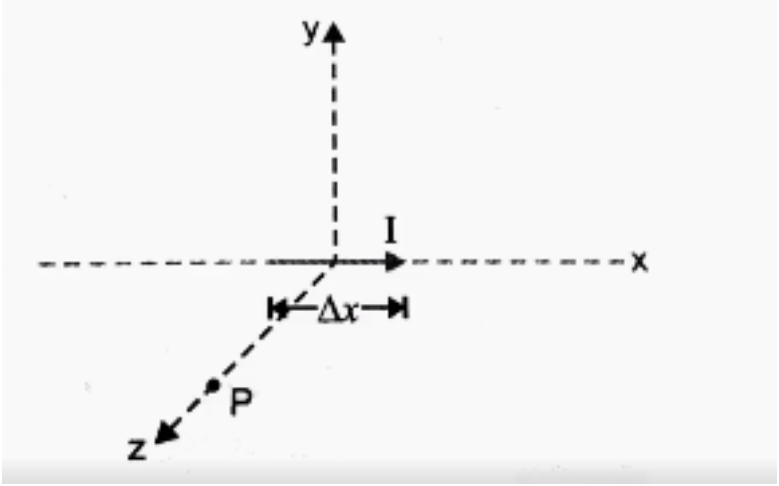
62. An element $\Delta \vec{l} = \Delta x \hat{i}$ is placed at the origin as shown in figure and carries a current I=2A. Find out the magnetic field at a point P on the Z-axis at a distance of 1.0m due to the element $\Delta x = 1cm$. Give also the direction

of the field produced.



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63. An air-core solenoid having N turns and length l is carrying a current I ampere Sketch the pattern of magnetic lines of force in the solenoid.

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64. An air-core solenoid having N turns and length l is carrying a current I ampere . If an iron core is inserted in it, how is its field modified?

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65. A solenoid of length 'l' having n turns carries current 'I'. Deduce the expression for

the magnetic field in the interrior of the solenoid.

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66. The magnetic field at the point near the centre but outside a current carrying solenoid is zero. Why?

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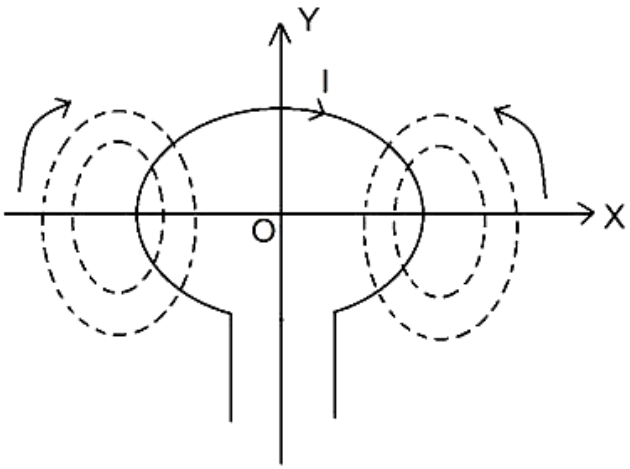
67. A circular loop of radius R, carrying current I, lies in x-y plane with its center at origin. The total magnetic flux through x-y plane?



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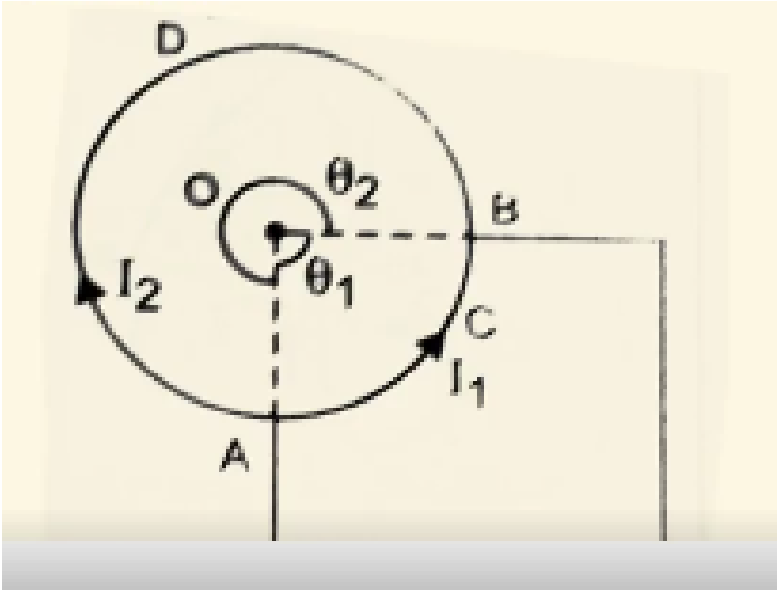
68. A circular branching made from a uniform conductor is connected to a battery as shown in the figure. What force will the magnetic field of the currents in the branching exert on the agnetic pole placed at its centre O? Deduce the resutl qualtatively.



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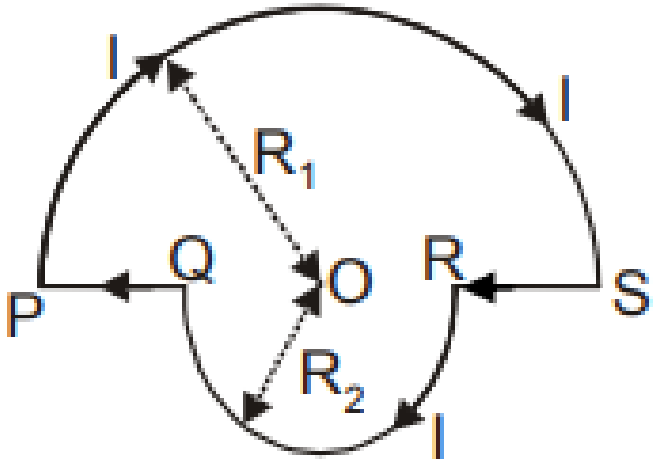
69. A wire loop is formed by joining two semicircular wires of radii r_1 and r_2 as shown in the figure . The loop carries a current I, find the magnetic field at the centre O.



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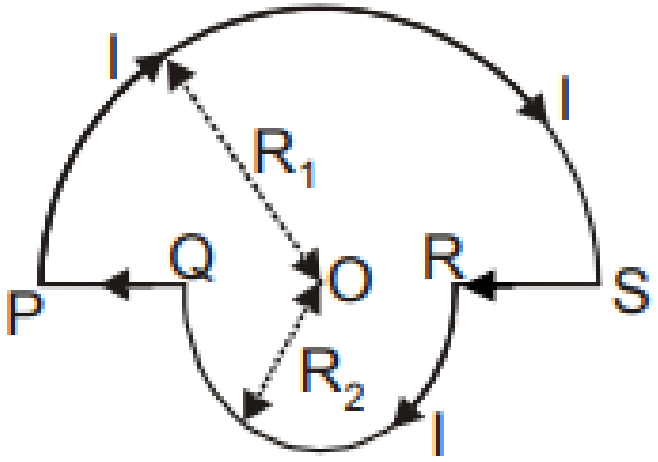
70. A wire loop is formed by joining two semicircular wires of radii r_1 and r_2 as shown in the figure . The loop carries a current I, find the magnetic field at the centre O.



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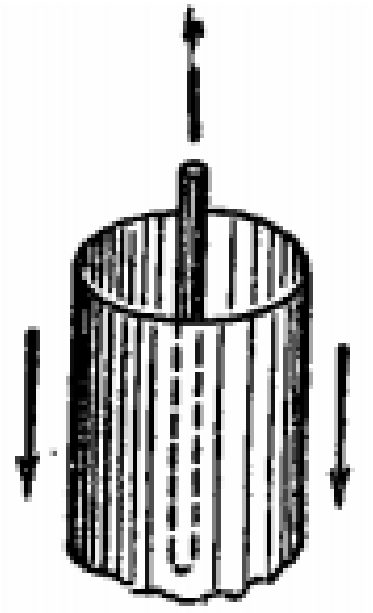
71. a current I flows upwards along the inner conductor of a co-axial cable and returns down along the external shel of the cable shown in the figure what is the intensity of the magnitude field at points inside the cable?



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72. A mettalic wire is bent into a square of each side a. If a current I is passed through the wire, what is the magnetic field at the centre of the square?

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73. A long wire is first bent into a circular coil of one turn and then into a circular coil of

smaller radius, having n identical turns. If the same current passes in both the cases, find the ratio of the magnetic fields produced at the centre in the two cases.

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74. What is the dimensional formula for ε_0?

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75. Write the dimensional formula of μ_0

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76. Calculate the current in a circular coil of radius 5 cm and 100 turns to produce a field of 2×10^{-5} T at its centre.

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77. The electron moves around the ucelus in a hydrogen atom of radis $0.51\overset{\circ}{A}$, with a speed of $2 \times 10^{5} ms^{-1}$. Calculate the following:

The equivalent current due to orbit motion of electron.

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78. The radius of the first electron orbit of a hydrogen atom is $0.5\overset{\circ}{A}$. The electron moves in this orbit with a uniform speed of $2.2 \times 10^6 m.\, s^{-1}$. What is the magnetic field produced at the centre of the nucleus due to the motion of this electron?

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79. The electron moves around the ucelus in a hydrogen atom of radis $0.51\overset{\circ}{A}$, with a speed of $2 \times 10^5 ms^{-1}$. Calculate the following:

The magnetic moent associated with the electron take $e = 1.6 \times 10^{-19} C$ and $\mu_0 = 4\pi \times 10^{-7}$ SI units.

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80. Calculate the strength of magnetic field due to an electron revolving in a circle of radius 2×10^{-10} m with a speed of $5 \times 10^{6} ms^{-1}$ at its centre.

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81. In Bohr model of hydrogen atom , the electron circulates around the nucelus in a path of raidus 5.1×10^{-11} m at a frequency of $6.8 \times 10^{15} Hz$. What is the value of

magnetic field set up at the centre of the orbit?

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82. In a hydrogen atom, electron moves in an orbit of radius $5 \times 10^{-11} m$with a speed of $2.2 \times 10^{6} \frac{m}{s}$. Calculate the equivalent current.

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83. Two similar coils each of radius R and no. of turns N are lying concentrically with their planes at right angle to each other. The currents following in them are 1 A and $\sqrt{3}A$ respectively. What is the magnetic field at centre of the coils ?

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84. A semicircular arc of radius 20 cm carries a current of 10 A. Calculate the magnitude of

magnetic field at the center of the arc.

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85. Magnetic field B on the axis of a circular coil and far away distance x from the centre of the coil are related as:

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86. A long straight solid metal wire of radius R carries a current I, uniformly distributed over

its circular cross-section. Find the magnetic field at a distance r from axis of wire inside the wire

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87. A long straight solid metal wire of radius R carries a current I, uniformly distributed over its circular cross-section. Find the magnetic field at a distance r from axis of wire outside the wire.

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88. A current of 5 A is flowing south to north in a wire kept along north-south direction . Find the magnitude of magnetic field due to a 1 cm piece of the wire at a point 2 m north-east from the piece of wire.

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89. Calculate the magnetic field at a distance of 5 m from an infinite straight conductor carrying a current of 100 A.

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90. A current of 10A is flowing east to west in a long wire kept in the east-west direction. Find magnetic field in a horizontal plane at a distance of 10cm north.

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91. A current of 10A is flowing east to west in a long wire kept in the east-west direction. Find

magnetic field in a horizontal plane at a distance of 20cm south from the wire

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92. A current of 5 A is flowing east to west in an infinitely long wire kept along east-west direction. Find magnetic field in a vertical plane at a distance 50 cm below the wire

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93. A current of 5 A is flowing east to west in an infinitely long wire kept along east-west direction. Find magnetic field in a vertical plane at a distance 40 cm above the wire.

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94. Earth's magnetic field is 5×10^{-5}T. A cable is 10 m above the ground. Calculate the current in the cable, so that it may produce a

neutral point with earths' magnetic field on the surface of the earth just below it.

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95. Two straight long conductors AOB and COD are perpendicular to each other and carry currents I_1 annd I_2 respectively. Find the magnitude of magnetic field at a point P at a distance a from the point O to a direction perpendicular to the plane ABCD.

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96. Caculate the magnetic field induction at the centre of a coil bent in the form of a square of side 10 cm carrying current of 10 A.

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97. A rectangular loop of metallic wire is of length a and breadth b and carries a current I. Find the magnitude of magnetic field at the centre O of the loop.

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98. A hexagonal loop of a metallic wire is of each side a and carries a current I. Find the magnitude of magnetic field at the centre of the loop.

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99. Length of solenoid is 0.2 m and it has 120 turns. Find the magnetic field in its interiro, if

a current of 2.5 A is flowing through it. Given $\mu_0 = 4\pi \times 10^{-7}$ SI units.

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100. A solenoid 50 cm long has 4 layers of winding of 350 turns each. If the current carried is 6.0 A, estimate the amgntiude of magnetic field near the centre of the solenoid on its axis

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101. A solenoid 50 cm long has 4 layers of winding of 350 turns each. If the current carried is 6.0 A, estimate the amgntiude of magnetic field near the ends on its axis.

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102. A closely wound solenoid 80 cm long has 5 layers of windings of 400 turns each. The diameter of the solenoid is 1.8 cm. If the current carried is 8.0 A. estimate the

magnitude of B inside the solenoid near its centre.

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103. A solenoid of length 1 m and 3 cm in diameter has five layers of winding of 850 turns each and carries a current of 5 A. What is the magnetic field thorugh a cross-sectional end of the solenoid of the solenoid at its centre.

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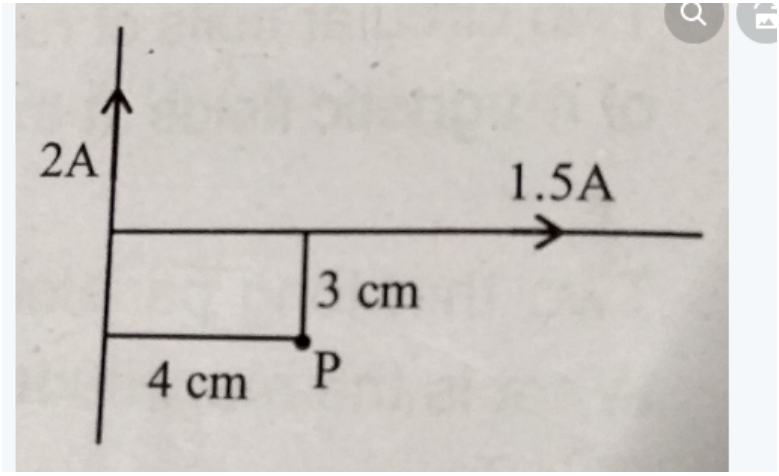
104. Two insulating infinitely long wires are lying mutually perpendicular to each other as shown in the figure. If the two wires carry currenst I_1 and I_2 as shown in the figure, find the magnetic field at point P (A,b).



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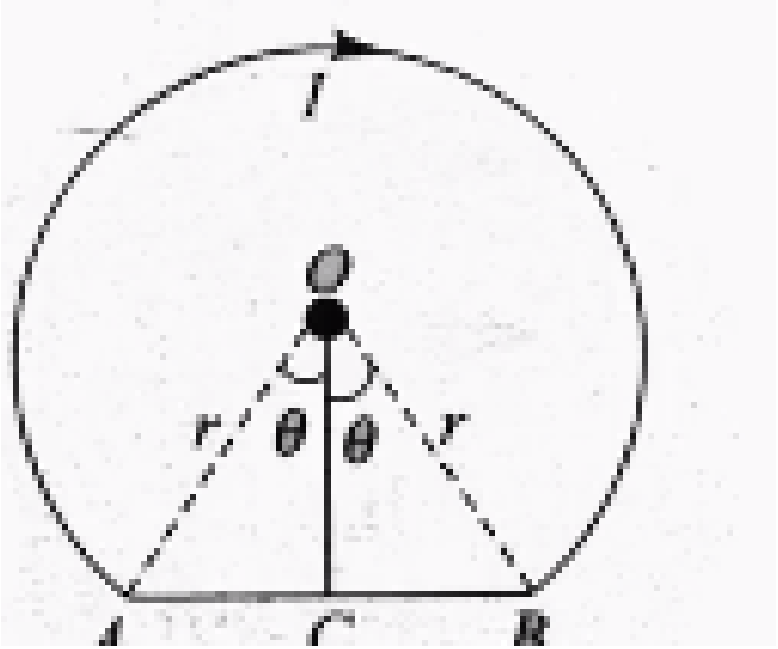
105. A metallic wire carrying a current I is bent into the form as shown in the figure. The circular portion ABC of the wire is of radius r and the straight portion AC subtends an angle 2θ at the centre O. Find the magnetic field due to the conductor at point O. If the radius of the curved path is r, find the magnetic field at

the centre O.



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Exercise

1. State and explain Biot-Savart's theorem for a current carrying finite conductor.

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2. A current 'I' flows in a conductor placed perpendicular to the plane of paper. Indicate the direction of the magnetic field due to a small element $d\vec{l}$ at a point P situated at a distance $\vec{r}$ from the element as shown in the

figure HQ 1.

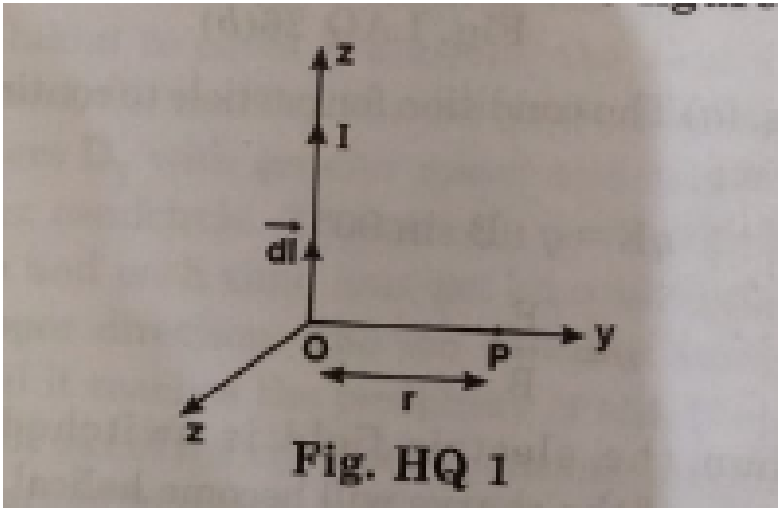

Fig. HQ 1

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3. Explain Biot-Savart law for the magnetic field produced at a point due to the current flowing in a current element. How will you determine the direction of the field?

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4. Explain Biot-Savart law for the magnetic field produced at a point due to the current flowing in a current element. How will you determine the direction of the field?

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5. Derive an expression for magnetic field at the centre of circular current carrying coil.

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6. Using Biot-Savart's law, derive an expression for magnetic field at the centre of a current carrying circular coil. What will be the direction of this magnetic field?

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7. Using Biot-Savart's law, derive an expression for magnetic field at the centre of a current

carrying circular coil. What will be the direction of this magnetic field?

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8. Derive an expression for magnetic field at the centre of circular current carrying coil.

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9. Using Biot-Savart's law, derive an expression for magnetic field at the centre of a current

carrying circular coil. What will be the direction of this magnetic field?

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10. Using Biot-Savart's law, derive an expression for magnetic field at the centre of a current carrying circular coil. What will be the direction of this magnetic field?

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11. State Biot-Savart law. Using Biot-Savart law find the magnitude and direction of magnetic field at a point on the axis of a circular coil of radius 'r', distant 'x' from the center having number of turns N carrying current 'I'.

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12. State Biot-Savert's law. Use this law to find the magnetic field at a point on the axis of a circular coil carrying current.

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13. Derive an expression for magnetic field at the centre of circular current carrying coil.

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14. How will the magnetic field at the centre of a circular coil carrying current change, if the diameter as well as number of turns in the coil is tripled?

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15. State Ampere's circuital law.

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16. What is Maxwell's modification of Ampere's circuital law?

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17. State Ampere's circuital law. By using it derive an expression for magnetic field intensity at a point due to a straight current carrying conductor.

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18. State Ampere's circuital law.

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19. Using Ampere's circuital theorem, calculate the magnetic field due to an infinitely long wire carrying current I.

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20. State Ampere's circuital law. By using it derive an expression for magnetic field intensity at a point due to a straight current carrying conductor.

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21. A long straight wire of circular cross-sectional of radius a carries a steady current I. The current is uniformly distributed across the cross-section. Apply Ampere's circuital law to calculate the magnetic field at a point r in the region $r < a$

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22. A long straight wire of circular cross-sectional of radius a carries a steady current I.

The current is uniformly distributed across the cross-section. Apply Ampere's circuital law to calculate the magnetic field at a point r in the region r > a

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23. Using Ampere's circuital law, obtain an expression for the magnetic field along the axis of a current carrying solenoid of lenth l and having N number of turns.

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24. Using Ampere's circuital law, obtain an expression for the magnetic field along the axis of a current carrying solenoid of lenth l and having N number of turns.

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25. Using Ampere's circuital law, derive an expression for the magnetic field along the axis of a toroidal solenoid.

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26. Applying Ampere's circuital law, find magnetic field

due to toroidal solenoid.

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27. State the Biot-Savart's law for the magnetic field due to a current carrying element. Use this law to obtain a formula for magnetic field at athe centre of circular loop of radius r

carrying steady current I. Sketch the magnetic field lines for a current loop clearly indicating the direction of the field.

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28. Derive an expression for magnetic field at the centre of circular current carrying coil.

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29. Derive an expression for magnetic field at the centre of circular current carrying coil.

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30. State Biot-Savart's law, giving the mathematical expression for it. Use this law to derive the expression for the magnetic field due to a circular coil carrying current at a point along its axis. How does a circular loop carrying current behave as a magnet?

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31. State the Biot-Savart's law for the magnetic field due to a current carrying element. Use this law to obtain a formula for magnetic field at athe centre of circular loop of radius r carrying steady current I. Sketch the magnetic field lines for a current loop clearly indicating the direction of the field.

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32. Derive an expression for magnetic field at the centre of circular current carrying coil.

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33. Derive an expression for magnetic field at the centre of circular current carrying coil.

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34. State the Biot-Savart's law for the magnetic field due to a current carrying element. Use this law to obtain a formula for magnetic field at athe centre of circular loop of radius r carrying steady current I. Sketch the magnetic field lines for a current loop clearly indicating the direction of the field.

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35. Derive an expression for magnetic field at the centre of circular current carrying coil.

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36. State Ampere's circuital law. By using it derive an expression for magnetic field intensity at a point due to a straight current carrying conductor.

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37. What does a toroid consist of ? Find out the expression for the magnetic field inside a toriod for N turns of the coil having an average radius r and carrying current I. show that the magnetic field in the open space inside and outside the torroid is zero.

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