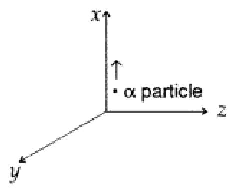
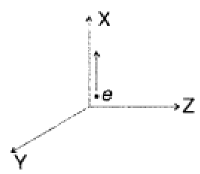
CLASS XII : ASSIGNMENT : CH-4 : MOVING CHARGES AND MAGNETISM : PHYSICS

MAGNETIC LORENTZ FORCE

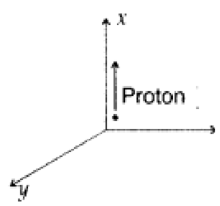
1. How is the magnetic field produced?
2. In what ways are electric and magnetic fields different?
3. Differentiate between electric and magnetic force.http://www.physicsinduction.com
4. In what respect does a wire carrying a current differ from a wire carrying no current?
5. Which quantity has the unit Wb/m^2? Is it a scalar or a vector quantity?
6. Write the relation for the $\vec{F}$ acting on a charge carrier q moving with a velocity $\vec{v}$ through a magnetic field $\vec{B}$ in vector notation. Using this relation, deduce the condition under which this force will be (i) maximum (ii) minimum, and (iii) Show that this force does no work on the charged particle.
7. What is magnetic flux density? Define its units and give its dimension.
8. A charged particle enters a (non-uniform) magnetic field varying from point to point, both in magnitude and direction, with a certain initial velocity. What do you say about the final velocity of the particle when it leaves the field? http://www.physicsinduction.com
9. Describe qualitatively the path of a charged particle moving in a region with uniform electrostatic and magnetic fields parallel to each other, with initial velocity (i) parallel (ii) perpendicular, and (iii) at an arbitrary angle with the common direction of fields. *(Ans (i) F_B = 0, charged particle will move in the same straight line due to $\vec{E}$, (ii) due to $\vec{E}$, parabolic path, due to $\vec{B}$, circular path, (iii)resolve $\vec{v}$ in components, circular and accelerated)*
10. What is the direction of the force acting on a charged particle q, moving with a velocity v in a uniform magnetic field B? *(Ans: F is perpendicular to both v and B)*
11. An electron does not suffer any deflection while passing through a region of uniform magnetic field. What is the direction of the magnetic field? *(Ans: $\vec{v}$ is parallel to $\vec{B}$)*
12. A beam of α particles projected along the +x-axis, experiences a force due to a magnetic field along the +y-axis. What is the direction of the magnetic field? *(Ans: - z axis)* http://www.physicsinduction.com



13. A beam of electrons projected along the +x-axis, experiences a force due to a magnetic field along the +y/-axis. What is the direction of the magnetic field? *(Ans: + z axis)*



14. A beam of protons, projected along the + x-axis, experiences a force due to a magnetic field along the – y-axis. What is the direction of the magnetic field? *(Ans: + z axis)*



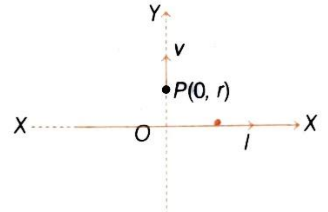
15. Write the condition under which an electron will move undeflected in the presence of crossed electric and magnetic fields. *(Ans : v = E/B)* http://www.physicsinduction.com
16. A particle of mass 'm' and charge 'q' moving with velocity V enters the region of a uniform magnetic field at the right angle to the direction of its motion. How does its kinetic energy get affected? *(Ans: not affected, B provides necessary centripetal force)*
17. (a) Write the expression for the force F acting on a particle of mass m and charge q moving with velocity v in a magnetic field B. Under what conditions will it move in
(i) a circular path and (ii) a helical path?

(b) Show that the kinetic energy of the particle moving in a magnetic field remains constant. (Ans: (i) $\vec{v}$ *is perpendicular to* $\vec{B}$) (ii) $\vec{v}$ *is neither parallel nor perpendicular to* $\vec{B}$), (iii) $\vec{F}$ *is perpendicular to* $\vec{v}$ *at all instants*)

18. An α-particle of mass 6.65 x 10^{-27} kg is travelling at right angles to a magnetic field with a speed of 6 x 10^5 m/s. The strength of the magnetic field is 0.2 T. Calculate the force on the α-particle and its acceleration. *(Ans: F = 3.84 x 10^{-14} N, a = 5.77 x 10^{12} m/s)* http://www.physicsinduction.com

19. A charged particle of charge 2 μC moving along X – axis with a speed of 3 x 10^6 m/s enters a magnetic field, $\vec{B} = (0.3\hat{j} + 0.4\hat{k})$ tesla acting in a space. What is the magnitude of magnetic force on the charged particle? *(Ans: 3 N)*

20. An infinite straight conductor is kept along the X'X-axis and carries a current I. A charge q at point P (0. r) starts moving with velocity $\vec{v} = v_0\hat{j}$ as shown in the figure. Find the direction and magnitude of force initially experienced by the charge. *(Ans: $F = \frac{q\mu_0 v_0 I}{2\pi r}\hat{\imath}$)*

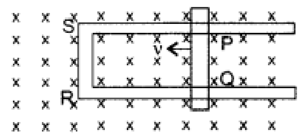


MOTION OF A CHARGED PARTICLE IN A MAGNETIC FIELD

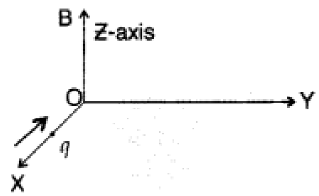
21. Depict the trajectory of a charged particle moving with velocity v as it enters a uniform magnetic field perpendicular to the direction of its motion.

22. A charged particle q moving in a straight line is accelerated by a potential difference V. It enters a uniform magnetic field B perpendicular to its path. Deduce in terms of V an expression for the radius of the circular path in which it travels. (Ans: $r = \sqrt{\frac{2mV}{qB^2}}$) http://www.physicsinduction.com

23. Figure shows a rectangular loop conducting PQRS where the arm PQ is free to move. A uniform magnetic field acts in the direction perpendicular to the plane of the loop. Arm PQ is moved with a velocity v towards the arm RS. Assuming that the arms QR, RS, and SP have negligible resistances and the moving arm PQ has the resistance r, obtain the expression for (i) the current in the loop (ii) the force and (iii) the power required to move the arm PQ. *(Ans: I =Blv/r, F = $B^2l^2v^2$/r, P = B^2l^2v/r)*



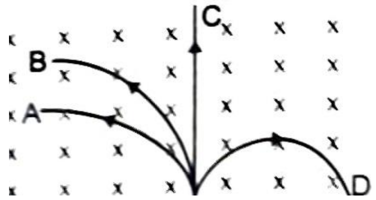
24. A charge 'q' moving B along the X-axis with a velocity v is subjected to a uniform magnetic field B acting along the Z-axis as it crosses the origin O.
(i) Trace its trajectory.
(ii) Does the charge gain kinetic energy as it enters the magnetic field? Justify your answer.



25. A proton and a deuteron, each moving with velocity $\vec{v}$ enter simultaneously in the region of magnetic field $\vec{B}$ acting normal to the direction of velocity. Trace their trajectories establishing the relationship between the two. http://www.physicsinduction.com

26. A proton and an alpha particle having the same kinetic energy are, in turn, passed through a region of uniform magnetic field, acting normal to the plane of the paper and travel in circular paths. Deduce the ratio of the radii of the circular paths described by them. *(Ans: 1:1)*

27. A neutron, a proton, an electron, and an α particle enter a region of constant magnetic field with equal velocities. The magnetic field is along the inward normal to the plane of paper. The tracks of the particle are shown in the figure. Relate the tracks to the particles. Give reasons in support of your answer *(Ans: A-proton, B- α-particle, C- neutron, D- electron)*

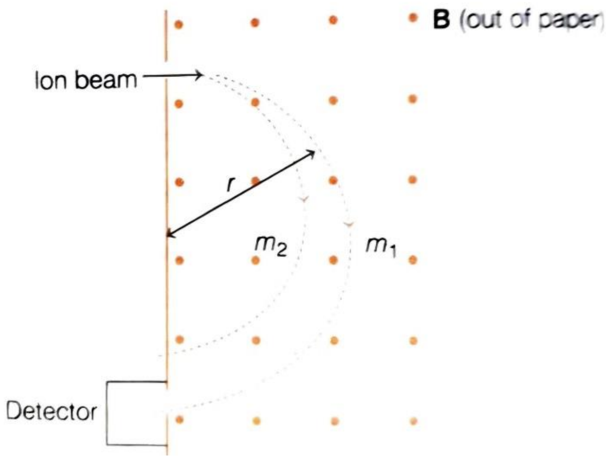


28. A proton and an electron travelling along parallel paths enter a region of uniform magnetic field acting perpendicular to their paths. Which of them will move in a circular path with higher frequency?

29. A charged particle moving in a uniform magnetic field penetrates a layer of lead and thereby loses ½ of its kinetic energy how does the time period of revolution of the particle change? Give a reason in support of your answer. *(Ans: No change)* http://www.physicsinduction.com

30. A charged particle moving in a uniform magnetic field penetrates a layer of lead and thereby loses ½ of its kinetic energy how does the radius of curvature of its path change? *(Ans: 1/√2 times)*

31. A stream of singly-charged particles of mass m_1 = 0.8 x 10^{-26} kg accelerated through a potential difference V are projected in uniform magnetic field B_1 = 0.2 T. The stream deflects along a curved path under the effect of a magnetic field and strikes the detector.



Another stream of singly-charged particles of mass m_2 = 0.2 x 10^{-26} kg, projected through the same accelerating potential and into the same magnetic field B_1 failed to reach the detector. To what value should the magnetic field be changed so that this stream of particles strikes the detector? *(Ans: 0.1 T)*

32. A uniform magnetic field B directed along the negative z-axis and of value 2 x 10^{-3}T extends through 1 m along the X-axis beyond which it becomes non-uniform. A single charged ion of mass 1.6 x 10^{-26} kg is projected along the positive X-axis into the magnetic field. http://www.physicsinduction.com
What should be the maximum velocity v of projection of the ion such that it just fails to enter the non-uniform part of the magnetic field region but instead emerges out of the uniform magnetic field region with a velocity v along the negative X-axis? *(Ans: $v \leq 2 \times 10^4$ m/s)*

FORCE ON A CURRENT-CARRYING CONDUCTOR IN A MAGNETIC FIELD

33. In which orientation is the force experienced by a current-carrying conductor placed in a magnetic field (i) minimum (ii) maximum? *(Ans: 0^o or 180^o,90^o)*

34. A straight wire of mass 200g and length 1.5 m carries a current of 2A. It is suspended in mid-air by a uniform horizontal magnetic field what is the magnitude of the magnetic field? *(Ans: 0.65 T)* http://www.physicsinduction.com

35. The horizontal component of the earth's magnetic field at a certain place is 3 x 10^{-5} N and the direction of the field is from the geographic south to the geographic north. A very long straight conductor carries a steady current of 1 A., What is the force per unit length on it when it is placed on a horizontal table and the direction of current is (i) east to West, (ii) South to north? *(Ans: (i) 3 x 10^{-5} N/m (ii) zero)*

36. A straight horizontal conducting rod of length 0.60 m and mass 60 g is suspended by two vertical wires at its ends a current of 5 A is set up in the rod through the wire.

(i) What magnetic field should be set up normally to the conductor so that the tension in the wire is 0

(ii) What will be the total tension in the wires, if the direction of current is reversed keeping the magnetic field the same as before (ignore the mass of the wire), take g = 10m/s^2 *(Ans: (i) 0.20 T (ii) 1.2 N)* http://www.physicsinduction.com

37. A rotating table of diameter 0.5 m has a wire stretched across its surface passing through its centre. An electric current of 0.25 A flows through the wire and a magnetic field of 0.8 T is applied in the plane of the rotating table.

(i) Does the magnetic force acting on the wire depend on the angle between the wire and the magnetic field?

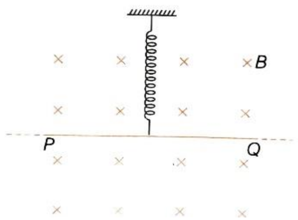
(ii) Find the angle between the wire and the magnetic field such that the magnetic force on the wire is equal to 0.05 N. http://www.physicsinduction.com

(iii) What is the effect on the magnetic force in case the magnetic field is applied perpendicular to the plane of the table? Give a reason for your answer. *(Ans: 30^0)*

38. A uniform magnetic field B = 0.002 T acts on a 2 cm long section PQ of an insulated wire. The wire is attached to a spring of spring constant 0.8 N/m as shown in the figure.

(i) What value of current should flow through PQ such that the spring is stretched by 2 x 10^{-4} m?

(ii) Identify the possible direction of current through the section PQ. *(Ans: 4A, Q to P)*



BIOT SAVART'S LAW

39. State Biot-Savart's law and express this law in vector form. http://www.physicsinduction.com

40. Where is the magnetic field of the current element (i) minimum (ii) maximum?

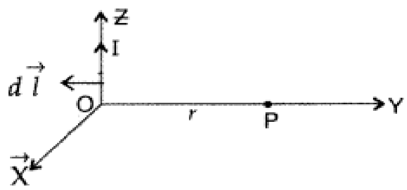
41. Compare the electrostatic field given by Coulomb's law and the magnetic field given by Biot Savart's law.

42. What is the nature of the magnetic field associated with the current in a straight conductor?

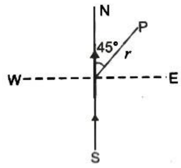
43. The net charge in a current-carrying conductor is zero, even then it experiences a force in a magnetic field, Why?

44. A closed circuit is in the form of a regular hexagon of side r. If the circuit carries current I, what is the magnetic field induction at the centre of the hexagon? *(Ans: $\frac{\sqrt{3}\mu_0 I}{\pi r}$)*http://www.physicsinduction.com

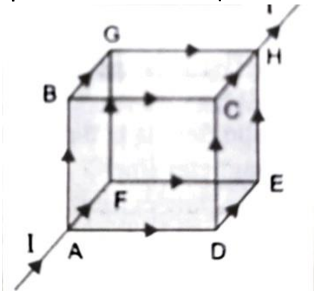
45. A current I flow in a conductor placed perpendicular to the plane of the paper. Indicate the direction of the magnetic field due to a small element $\vec{dl}$ at point P situated at a distance r from the element as shown in the figure. *(Ans: -ve X direction)*



46. A current of 5 A is flowing from south to north in a straight wire. Find the magnetic field due to a 1 cm piece of wire at a point 1m from the north-east from the piece of wire. *(Ans: 3.54 x 10^{-9}T, vertically downwards)*



47. Figure shows a cube made from twelve uniform wires. Find the magnetic field at the centre of the cube, if a battery is connected between points A and H. *(Ans: zero)* http://www.physicsinduction.com



48. Find the expression for the magnetic field at the centre, O of a coil bent in the form of a square of side 2a, carrying current, I. *(Ans:* $\frac{\sqrt{2}\mu_0 I}{\pi a}$*, vertically downwards)*

49. An element $\vec{dl} = dx\hat{\imath}$ (where, dx = 1 cm) is placed at the origin and carries a large current of I = 10A. what is the magnetic field on the Y-axis at a distance of 0.5 m? *(Ans: 4×10^{-8} T $\hat{k}$)*

50. A current element 3 dl is at (0, 0, 0) along the Y-axis. If dl = 1 cm. find the magnetic field at a distance of 20 cm on the X-axis. *(Ans: - (7.5×10^{-8} T) $\hat{k}$)*http://www.physicsinduction.com

MAGNETIC FIELD ON THE AXIS OF A CIRCULAR CURRENT LOOP

51. How does a circular loop behave like a bar magnet?

52. What do you understand by the magnetic dipole moment of the current loop?

53. What will be the change in the magnetic field strength at the centre of the circular coil?

54. Consider a loop carrying current I, Show the direction of the magnetic field with the help of lines of force.

55. What will be the change in the magnetic field strength at the centre of the circular coil carrying current? If the current through the coil is doubled and the radius of the coil is halved? *(Ans: 3B)*

56. What is the magnetic moment of an electron orbiting in a circular orbit of radius, r with a speed, v? *(Ans: evr/2)* http://www.physicsinduction.com

57. A long wire carries a steady current I. First, it is bent into a circular coil of one turn when the magnetic field induction at the centre is B_o. Then the same wire is bent to form a circular coil of a smaller radius but n turns then find the magnetic field induction at the centre of the circular coil. *(Ans: n^2B_o)*

58. Deduce the expression for the magnetic field induction at the center of a circular electron orbit of radius r, and angular velocity of the orbiting electron, ω. *(Ans:* $\frac{\mu_0 e\omega}{4\pi r}$*)*

59. A wire of length L metre carrying a current of I A is bent in the form of a circle. Find its magnetic moment. *(Ans: $IL^2 \,/\, 4\pi$)* http://www.physicsinduction.com

60. A circular coil of N turns and diameter d carries a current I. it is unwound and rewound to make another coil of diameter 2d, current I remaining the same. Calculate the ratio of the magnetic moments of the new coil and the original coil. *(Ans: 2)*

61. Magnetic field at the centre of a circular loop of area A carrying current I is B. What is the magnetic moment of this loop? *(Ans:* $\frac{2BA}{\mu_0}\sqrt{\frac{A}{\pi}}$*)*

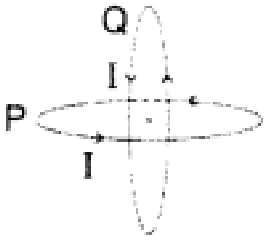
62. An electron moves around the nucleus in a hydrogen atom of radius 0.51 A°, with a velocity of 2×10^5 m/s. Calculate the following:
(i) the equivalent current due to the orbital motion of the electron

(ii) the magnetic field produced at the centre of the nucleus

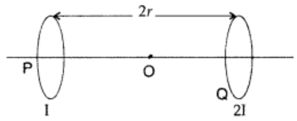
(iii) the magnetic moment associated with the electron. http://www.physicsinduction.com

63. Two identical circular coils, P and Q each of radius R, carrying currents 1 A and √3 A respectively, are placed concentrically and perpendicular to each other lying in the XY and YZ planes. Find the magnitude and direction of the net magnetic field at the centre of the coils. *(Ans: μ_o/R, 60^o)*

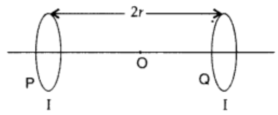
64. Two identical circular wires P and Q each of radius R and carrying current 'I' are kept in perpendicular planes such that they have a common centre as shown in the figure. Find the magnitude and direction of the net magnetic field at the common centre of the two coils. *(Ans: $\frac{\mu_0 NI}{\sqrt{2}R}$, 45^0)*



65. Two identical circular loops, P and Q, each of radius r and carrying current I and 2I respectively are lying in parallel planes such that they have a common axis. The direction of current in both the loops is clockwise as seen from O which is equidistant from both the loops. Find the magnitude of the net magnetic field at point O. *(Ans: $\frac{\mu_0 I}{4\sqrt{2}r}$, towards the coil Q)* http://www.physicsinduction.com



66. Two identical circular loops, P and Q, each of radius r and carrying equal currents are kept in the parallel planes having a common axis passing through O. The direction of current in P is clockwise and in Q is anti-clockwise as seen from O which is equidistant from the loops P and Q. Find the magnitude of the net magnetic field at O. *(Ans: $\frac{\mu_0 I}{2\sqrt{2}r}$, towards the coil P)*



AMPERE'S CIRCUITAL LAW, STRAIGHT CONDUCTOR

67. State Ampere's circuital law, expressing it in the integral form.

68. Compare Gauss's law and Ampere's law. http://www.physicsinduction.com

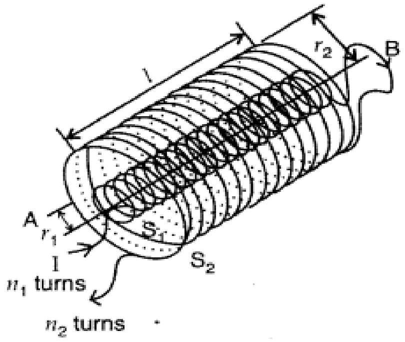
69. A current is set up in a long copper pipe. Is there a magnetic field (i) inside (ii) outside the pipe? *(Ans: Inside: 0, outside: Finite)*

70. A long straight wire of a circular cross-section 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 in the region for (i) r < a, and (ii) r > a. *(Ans: $\mu_o Ir/2\pi a^2$, $\mu_o I/2\pi r$)*

71. A wire of radius 0.8 cm carries a current of 100 A which is uniformly distributed over its cross section. Find the magnetic field (i) at 0.2 cm from the axis of the wire (ii) at the surface of the wire and (iii) at a point outside the wire 0.4 cm from the surface of the wire. Neglect the permeability of the wire. *(Ans: 6.25×10^{-4} T, 2.5×10^{-3} T, 1.67×10^{-3} T)* http://www.physicsinduction.com

72. Two long coaxial insulated solenoids, S_1 and S_2 of equal lengths are wound one over the other as shown in the figure. A steady current "I" flows through the inner solenoid S_1 to the other end B, which is connected to the outer solenoid S_2 through which the same current "I" flows in the opposite direction so as to come out at end A. If n_1 and n_2 are the number of turns per unit length, find the magnitude and direction of the net magnetic field at a point http://www.physicsinduction.com

(i) inside on the axis and (ii) outside the combined system.



SOLENOID AND TOROID

73. What is the difference between a toroid and a solenoid?http://www.physicsinduction.com

74. How is the magnetic field inside the solenoid made strong?

75. In a solenoid carrying current, where is the magnetic field (i) maximum (ii) minimum, and (iii) half of the maximum value?

76. The magnetic field at a point near the centre but outside a current-carrying a long solenoid is zero. Explain why? http://www.physicsinduction.com

77. A solenoid of length 0.5 m has a radius of 1 cm and is made up of 500 turns. It carries a current of 5A. What is the magnitude of the magnetic field inside the solenoid? *(Ans: 6.28 x 10^{-3} T)*

78. A solenoid of length 50 cm, having 100 turns carries a current of 2.5 A. Find the magnetic field (i) in the interior of the solenoid (ii) at one end of the solenoid. *(Ans: 6.28 x 10^{-4} T, 3.14 x 10^{-4} T)*

79. A copper wire having a resistance of 0.015 Ω per meter is used to wind a 500 turns solenoid of radius 1 cm and length 22 cm. if the emf of the battery used is 6 V, then find the magnetic field near the centre of the solenoid. *(Ans: 3.64 x 10^{-2}T)*http://www.physicsinduction.com

80. A toroid has a core of an inner radius of 20 cm and an outer radius of 22 cm around which 4200 turns of a wire are wound. If the current in the wire is 10 A, what is the magnetic field (i) inside the core of the toroid (ii) outside the toroid (iii) in the empty space surrounded by the toroid? *(Ans: 0.04 T, zero, zero)*

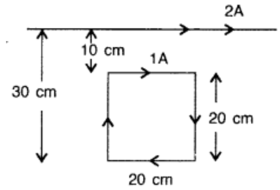
81. A closely wound solenoid of 2000 turns and cross-sectional area 1.6 × 10^{-4} m^2 carrying a current of 4.0 A is suspended through its centre allowing it to turn in a horizontal plane. Find
(i) the magnetic moment associated with the solenoid,
(ii) magnitude and direction of the torque on the solenoid if a horizontal magnetic field of 7.5 × 10^{-2} T is set up at an angle of 30° with the axis of the solenoid.

PARALLEL CURRENTS

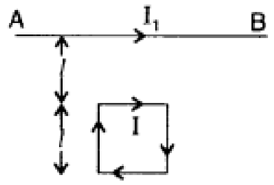
82. Using the concept of force between two infinitely long parallel current-carrying conductors, define one ampere of current. http://www.physicsinduction.com

83. If the distance between the two parallel current-carrying wires is doubled, what is the force between them?

84. A square loop of side 20 cm carrying a current of 1A is kept near an infinite long straight wire carrying a current of 2A in the same plane as shown in the figure. Calculate the magnitude and direction of the net force exerted on the loop due to the current-carrying conductor. http://www.physicsinduction.com



85. Write the expression for the magnetic moment due to a planar square loop of side 'l' carrying a steady current I in a vector form. In the given figure this loop is placed in a horizontal plane near a long straight conductor carrying a steady current I, at a distance l as shown. Give reasons to explain that the loop will experience a net force but no torque. Write the expression for this force acting on the loop.



86. A wire AB is carrying a steady current of 12A and is lying on the table. Another wire CD carrying 5A is held directly above AB at a height of 1 mm. Find the mass per unit length of the wire CD so that it remains suspended at its position when left free. Give the direction of the current flowing in CD with respect to that in AB. [Take the value of g = 10 ms^{-2}] *(Ans: 1.2 x 10^{-3} kg/m, direction of CD must be opposite to AB)* http://www.physicsinduction.com

TORQUE

87. A square-shaped plane coil of area 100 cm2 of 200 turns carries a steady current of 5A. It is placed in a uniform magnetic field of 0.2 T acting perpendicular to the plane of the coil. Calculate the torque on the coil when its plane makes an angle of 60° with the direction of the field. In which orientation will the coil be in stable equilibrium?

88. A circular coil of 200 turns and a radius 10 cm is placed in a uniform magnetic field of 0.5 T, normal to the plane of the coil. If the current in the coil is 3.0 A, calculate the (a) total torque on the coil, (b) total force on the coil. http://www.physicsinduction.com
(c) Average force on each electron in the coil, due to the magnetic field.
Assume the area of the cross-section of the wire is 10^{-5} m^2 and the free electron density is $10^{29}/m^3$.

MOVING COIL GALVANOMETER

89. Write the underlying principle of a moving coil galvanometer.

90. Why should the spring/suspension wire in a moving coil galvanometer have a low torsional constant?

91. (a) Define the current sensitivity of a galvanometer.
(b) The coil area of a galvanometer is 16 × 10^{-4} m^2. It consists of 200 turns of a wire and is in a magnetic field of 0.2 T. The restoring torque constant of the suspension fibre is 10^{-6} Nm per degree. Assuming the magnetic field to be radial, calculate the maximum current that can be measured by the galvanometer if the scale can accommodate 30° deflection.

92. Describe the working principle of a moving coil galvanometer. Why is it necessary to use
(i) a radial magnetic field and
(ii) a cylindrical soft iron core in a galvanometer? http://www.physicsinduction.com
Can a galvanometer as such be used for measuring the current? Explain.

93. (a) Why is the magnetic field radial in a moving coil galvanometer? Explain how it is achieved.
(b) A galvanometer of resistance 'G' can be converted into a voltmeter of range (0 – V) volts by connecting a resistance 'R' in series with it. How much resistance will be required to change its range from 0 to V/2?

94. A current of 300 μA deflects a coil of a moving coil galvanometer through 30°. What should be the current to cause the rotation through π/5 radians? What is the current sensitivity of the galvanometer? If the resistance of the galvanometer is 50Ω, find its voltage sensitivity. *(Ans: 360μA, 0.1 degree/μA, 2000 degree/volt)*http://www.physicsinduction.com

95. The current sensitivity of the moving coil galvanometer increases by 20% when its resistance is increased by a factor of 2. Calculate by what factor the voltage sensitivity changes. *(Ans: 40%)*

96. A current of 500 μA deflects the coil of a moving coil galvanometer through 60°. what should be the current to cause the rotation through π/5 radian? What is the current sensitivity of the galvanometer? *(Ans: 300 μA, 0.12 degree/μA)*

SHUNT, CONVERSION OF GALVANOMETER INTO AN AMMETER AND VOLTMETER

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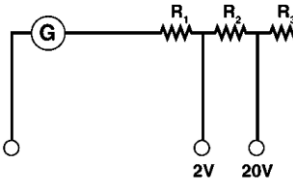
97. A galvanometer with a scale divided into 100 equal divisions has a current sensitivity of 10 divisions per mA and a voltage sensitivity of 2 divisions per mV. What adoptions are required to read (i) 5A for full scale and (ii) 1 division per volt? *(Ans: 5/499 Ω, 9995Ω)*

98. A resistance of 1980 Ω is connected in series with a voltmeter, after which the scale division becomes 100 times larger. Find the resistance of the voltmeter. *(Ans: 20Ω)*

99. A multirange voltmeter can be constructed by using a galvanometer circuit, as shown in the figure. We want to construct a voltmeter that can measure 2V, 20V, and 200V using a galvanometer of resistance 10Ω and produce maximum deflection for a current of 1 mA. Find R_1, R_2, and R_3 that have to be used. http://www.physicsinduction.com



100. An ammeter of resistance 0.6 Ω can measure current upto 1.0 A. Calculate

(i) The shunt resistance required to enable the ammeter to measure current upto 5.0 A

(ii) The combined resistance of the ammeter and the shunt. http://www.physicsinduction.com