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PHYSICS

BOOKS - NN GHOSH PHYSICS (HINGLISH)

MAGNETIC FIELD AND POTENTIAL

Examples

1. A bar magnet is 0.1m long and has poles of strength 50 Am. What is the magnetic B-field

at a point on its axis 0.15m from its centre. Also calculate the H-field at that point.

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2. The intensities of magnetic field at two points on the axis of a bar magnet at distances of 10 cm and 20 cm from the middle point are in the ratio 18:1. Find the distance between the poles of the magnet.

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3. A neutral point is found on the prolongation of the axis of a bar magnet at a distance of 10 cm from the nearer pole. If the length of the bar be 10 cm and $H = 28Am^{-1}$, find the pole strength of the magnet.

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4. A magnet, whose poles are 10 cm apart is placed in the magnetic meridian. The intensity due to the magnet balances the earth's field

$\left(3.6 \times 10^{-5} T\right)$ at a point 9 cm from either pole. Find the pole strength of the magent.

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5. The magnetic moment of magnet is 1 joule per tesla. How much work is done in turning it through 90° from the magnetic meridian at a place where $B = 1.6 \times 10^{-5} T$?

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6. Find the stable equilibrium position of a magnet in a magnetic field.

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7. Two magnets of magnetic moment m and 3m are mounted so as to cross each other at an angle of 60°. The combination rests on a cork floating on water. Find the angle which the weaker magnet makes with the meridian.

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8. A magnet placed in the north pointing north position, balances the earth's field at a point, which is 27 cm from either pole. If it is broken into three pieces and one such piece is similarly placed, find the position of the neutral point.

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9. Two short magnets of magnetic moment $2Am^2$ and $5Am^2$ are placed along two lines

drawn at right angle to each other on the sheet of paper as shown in the figure. What is the magnetic field at the point of intersection of their axis?

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Exercises A

1. An electron is moving with a velocity of $2 \times 10^6 ms^{-1}$ in the vicinity of a 0.1 m long bar

magnet of pole strength 50 Am in a direction perpendicular to the axis of the magnet at a distance of 0.15 m from the nearer pole. What is the force on the electron ? Charge of electron $= 1.6 \times 10^{-19} C$

[Hint: Calculate B-vector of the field and apply $F = q_0 v B \sin\theta$]

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Exercises

1. A magnetic needle of magnetic moment $0.9Am^2$ and pole strength 5Am is pivoted so that it is free to turn in a horizontal plane at a position where the earth's B-field is 3.6×10^{-5} tesla. It is in equilibrium at an angle 30° from the magnetic meridian when it is pulley by a string attached to its north pole in the easterly direction. what is the tension of the string ?

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2. A magnet of length 0.1 m and pole strength 0.1 Am is freely suspended in a horizontal uniform magnetic field of intensity $0.18 \times 10^{-4} T$. Find the torque tending to restore the magnet to its original position of rest when it is deflected by 30° from that position.

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3. A bar magnet lies in a magnetic field of intensity 0.5×10^{-4} tesla. The torque

required to deflect it through 30° is $2.5 \times 10^{-5} Nm$. Calculate the magnetic moment of the magnet.

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4. A magnet of length 0.2 m balances the earth's horizontal field at a point 0.2 m from the nearer pole. The magnet is placed with its north pole pointing south. Find its magnetic moment. [Horizontal induction of earth's field $= 3.6 \times 10^{-5}$ tesla]

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5. The intensities of magnetic field at two points on the axis of a bar magnet at distances 0.1m and 0.2 m from its middle point are in the ratio 12.5:1. Calculate the distance between the poles of the magnet.

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6. Two magnets of moments m and 2m are mounted to form a cross. The combination

rests horizontally when suspended by a silk fibre. Find the angle which the weaker magnet makes with the meridian.

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7. A short magnet is placed horizontally in the magnetic meridian with its north pole pointing north. It is then found that there is a neutral point 20 cm from the middle of the magnet. If the magnet is turned through 180°, where will the neutral point be?

[Hint: When magne is placed with its north place pointing north, neutral point occurs at the broadside-on position. When it is rotated through 180°, the neutral point will shift to the end-on position.]

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8. The intensities of a magnetic field at two points on the axis of a bar magnet at distance of $0.15m$ and $0.2m$ from its middle point are

in the ratio $75:20$. Find the distance between the poles of the magnet.

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9. A short bar magnet is placed horizontally in the magnetic meridian with its north pole pointing north and the neutral points are found 0.15m from the centre of the magnet. Find the distance between the neutral points if the magnet is reversed.

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10. A neutral point is found on the prolongation of the axis of a bar magnet at a distance of 0.1 m from the nearest pole. If the length of the bar be 0.1m and the B-field of earth $= 0.36 \times 10^{-4}$ tesla, find the pole strength of the magnet.

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11. A magnet whose poles are 12 cm apart is placed in the magnetic meridian. The field due

to this magnet counterbalances the earth's horizontal field $\left(H = 30Am^{-1}\right)$ at a point 10 cm from each pole. Find the pole strength of the magnet.

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12. A uniformly magnetized bar of brittle steel is broken into two pieces, one twice as long as the other, and the pieces are fastend together at right angles to each other. How would the combination thus formed set itself under the

action of the earth's magnetic force, if made to float on water ?

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13. Calculate the moment of a magnet, which when placed at right angles to the horizontal magnetic field of the earth of intensity $30Am^{-1}$ experiences a couple of 3×10^{-4} newton metre.

[Hint: $B_0 = \mu_0 H_0 = 4\pi \times 10^{-7} \times 30$tesla and $\tau = mB_0 \sin\theta$]

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14. A neutral point is found on the prolongation of the axis of a bar magnet of length 10 cm at 10 cm from the nearer pole. How has the magnet been placed with respect to the magnetic meridian ? Calculate the magnetic moment of the magnetic given that B-vector of earth's field along the horizontal $= 3.6 \times 10^{-5}$ tesla. Also calculate the torque required to deflect it through 30° from the magnetic meridian.

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15. A bar magnet whose poles are 10 cm apart in the magnetic meridian with its north pole pointing south. The neutral point is at a distance of 20 cm from the nearest pole. Find the intensity of the resultant field at a point on the perpendicular magnet. (B-vector of earth's field along the horizontal $= 4 \times 10^{-5}$ tesla)

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16. A long, vertical magnet is placed at a perpendicular distance of 0.8m from the centre of a horizontal magnetic needle of length 0.12 m ad pole strength 0.6Am. If the moment of the couple acting upon the needle is $72 \times 10^{-7} Nm$, Find the pole strength of the long magnet.

[Hint: Since the magnet is long, the effect of the distance pole may be neglected.]

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17. A magnet placed in the magnetic merdian with its north pole pointing north of the earth produces a neutral point at a distance 0.15 m from either pole. It is then broken into two equal pieces and one such piece is placed in a similar position. Calculate the position of the neutral point. where will the neutral point be if the other piece is placed over the previous one with like poles together ?

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18. Two short magnets of the same type, but of moments m and 2m are mounted on a frame so as to form a cross. If the combination is suspended at the centre with a vertical fibre, find the direction in which it will set in the earth's magnetic field. Calculate also the magnetic B-field at a distance d from the centre of the cross on the prolongation of one of the arms.

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19. Assuming $\theta = \pi/2$ as the zero-energy position of a magnet in a magnetic field, show that the potential energy of a magent can be written as $u = -\vec{B}.\vec{m}$. Hence find the stable equilibrium position of a magnet in a magnet in a magnetic field.

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20. Show that the force of attraction between two short magnets of moment m and m' with their centres d distance apart and their axes in

the same direction along the same lines is $\frac{\mu_0}{4\pi}\frac{6mm'}{d^4}$

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21. A bar magnet of moment $m = 4.0Am^2$ lies on a table horizontally in the earth's magnetic field $H = 30Am^{-1}$. A student turns it and holds it erect on the table. What is the work done by the student.

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22. Find the force between two small circular coils of radii $r_1 = 1cm, r_2 = 2cm$ and currents $I_1 = 1A$ and $I_2 = 2A$ placed at $d = 20cm$ apart with their planes parallel to each other.

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Exercises B

1. Two bar magnets of length 0.1m and poles strength 75m each, are placed on the same

line. The distance between their centres is 0.2 m. what is the reultant force due to one on the other when (i) the north pole of one faces the south pole of the other, (ii) the north pole of one faces the north pole of the other ?

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