CBSE Test Paper-05

Class - 12 Physics (Magnetism & Matter)

1. At a certain place, the horizontal component of the earth's magnetic field is B_o and the angle of dip is 45°. The total intensity of the field at that place will be:
   a. $2B_0$
   b. $\sqrt{2}B_0$
   c. B_0
   d. $\frac{B_o}{\sqrt{2}}$
2. A toroidal solenoid with 500 turns is wound on a ring with a mean radius of 2.90 cm. Find the current in the winding that is required to set up a magnetic field of 0.350 T in the ring if the ring is made of annealed iron of relative permeability, $\mu_r = 1400$
   a. 72.5mA
   b. 69.5mA
   c. 79.5mA
   d. 82.5mA
3. A magnet of magnetic moment M is suspended in a uniform magnetic field B. The maximum value of torque acting on the magnet is:
   a. zero
   b. MB
   c. 2MB
   d. $\frac{1}{2}MB$
4. A closely wound solenoid of 2000 turns and area of cross-section $1.6 \times 10^{-4}\mathrm{m}^2$, carrying a current of 4.0 A, is suspended through its centre allowing it to turn in a horizontal plane. If a uniform horizontal magnetic field of 7.5×10^{-2} T is set up at an angle of 30 with the axis of the solenoid,force and torque on the solenoid are
   a. 0.0N,0.048 Nm
   b. 0.5N,0.078 Nm
   c. 0.5N,0.068 Nm
   d. 0.0N,0.058 Nm
5. A long solenoid with 80 turns of wire per centimeter carries a current of 0.15 A. The wire that makes up the solenoid is wrapped around a solid core of silicon steel K_m =

5200 (The wire of the solenoid is jacketed with an insulator so that none of the current flows into the core.) For a point inside the core, find the magnitude of the magnetic field due to the solenoid current;

a. 1.51mT
b. 1.45mT
c. 1.40mT
d. 1.36mT

6. What is the value of the horizontal component of the earth's magnetic field at magnetic poles?
7. Define the term magnetic declination.
8. If a toroid uses bismuth for its core, will the field in the core be (slightly) greater or (slightly) less than when the core is empty?
9. In which direction would a compass free to move in the vertical plane point to, if located right on the geomagnetic north or south pole ?
10. What is the angle of dip at a place where horizontal and vertical components of earth's field are equal?
11. Geologists claim that besides the main magnetic N-S poles, there are several local poles on the earth's surface oriented in different directions. How is such a thing possible at all?
12. Three identical specimens of a magnetic materials nickel, antimony and aluminium are kept in a non-uniform magnetic field. Draw the modification in the field lines in each case. Justify your answer.
13. A magnetic dipole is under the influence of two magnetic fields. The angle between the field directions is 60° and one of the fields has a magnitude of 1.2×10^{-2} tesla. If the dipole comes to stable equilibrium at an angle of 15° with this field. What is the magnitude of the other field?
14. i. How is an electromagnet different from a permanent magnet?
    ii. Write two properties of a material which makes it suitable for making an electromagnet.
15. A monoenergetic (18 keV) electron beam initially in the horizontal direction is subjected to a horizontal magnetic field of 0.40 G normal to the initial direction. Estimate the up or down deflection of the beam over a distance of 30 cm. Given mass of electron $9.11 \times 10^{-31} kg$ and charge on electron $= 1.6 \times 10^{-19} C$.

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Answers

1. b. $\sqrt{2}B_0$

   Explanation: $B_H = Bcos\delta$

   $B = B_H/cos\delta = \frac{B_o}{1/\sqrt{2}} = \sqrt{2}B_o$

2. a. 72.5mA

   Explanation: $B = \frac{\mu_o\mu_r Ni}{2\pi r}$

   $i = \frac{B.2\pi r}{\mu_o\mu_r N}$

   $= \frac{0.35\times0.29\times10^{-2}}{4\pi\times10^{-7}\times1400\times500}$

   $= 72.5 \times 10^{-3}A$

3. b. MB

   Explanation: $\tau = MBsin\theta$

   $\tau_{max} = MBsin90^o = MB$

4. a. 0.0N,0.048 Nm

   Explanation: m = NIA = 1.28 Am^2

   torque = $mBsin\theta = 1.28 \times 7.5 \times 10^{-2} \times 0.5$ = 0.048 Nm

   Since field is uniform, net force = zero

5. a. 1.51mT

   Explanation: $B_O = \mu_o nI$

   $= 4\pi \times 10^{-7} \times 80 \times 10^2 \times 0.15$

   $= 150.72 \times 10^{-5}T \approx 1.51mT$

6. Zero

7. **Magnetic declination:** The angle between the geographical meridian and the magnetic meridian at any place of the earth is known as magnetic declination (α) at that place of the earth.

   it is also defined as the angle between the magnetic north and true north.

8. Slightly less, since bismuth is diamagnetic.

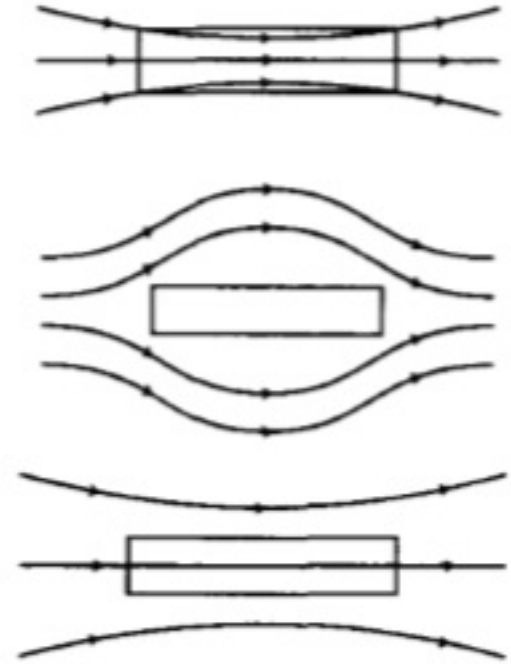
9. A compass is free to move in a horizontal plane, while the earth's field is exactly vertical at the magnetic poles. So the compass can point in any direction there.

10. Here $B_V = B_H$

$$\tan\delta = \frac{B_V}{B_H}$$
$$\tan\delta = \frac{B_H}{B_V} = 1$$
$$\tan\delta = \tan 45^\circ$$
$$\delta = 45^\circ$$

11. The earth's field is only approximately a dipole field. Local N-S poles may arise due to, for instance, magnetized mineral deposits.

12. The modifications are shown in the figure.



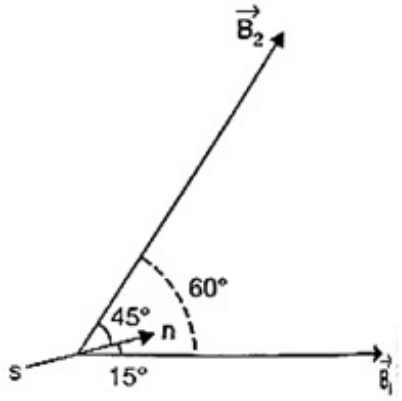
It happens because

i. nickel is a ferromagnetic substance. (as ferromagmefer substance strongly attracts magnetic field lines always)
ii. antimony is a diamagnetic substance.(as diamagnetic substance always feebly repels magnetic field lines)
iii. aluminium is a paramagnetic substance.(as a paramagnetic substance feebly attracts magnetic field lines)

13. Here $\theta = 60^o, B_1 = 1.2 \times 10^{-2}\, tesla$

$\theta_1 = 15^o, \theta_2 = 60^0 - 15^o$ = 45°

In equilibrium torques due to two fields must balance



$\tau_1 = \tau_2$

$MB_1 \sin\theta_1 = MB_2 \sin\theta_2$

$B_2 = \frac{B_1 \sin\theta_1}{\sin\theta_2} = \frac{1.2\times10^{-2}\times\sin 15^o}{sin45^o}$

$B_2 = \frac{1.2\times10^{-2}\times0.2588}{0.7071}$

$= 4.4 \times 10^{-3}\, tesla$

14. i. Electromagnets show magnetism till the current is switched on and as current is switch off, it lost its magnetism while permanent magnet retains its magnetism at room temperature for a long time after being magnetised
    ii. Materials used for making electromagnets must have following properties,
        a. High permeability: get magnetised by applying small external magnetic field.
        b. Low coercivity: to get demagnetised easily by applying small external field in opposite direction.
        c. Low retentivity: Magetisation is lost as soon as current is switched off.

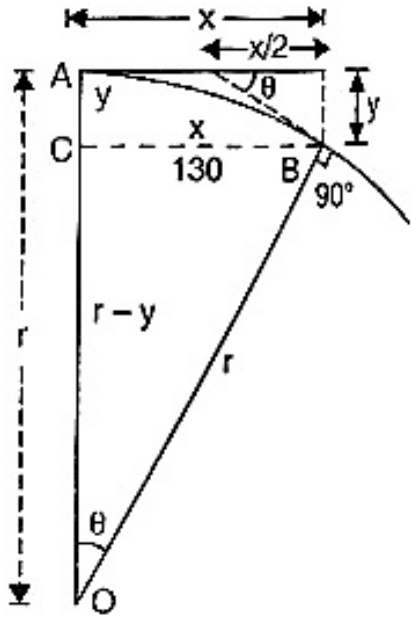
15. Here, energy E = 18 keV $= 18 \times 1.6 \times 10^{-16} J$

    B = 0.40 G $= 0.40 \times 10^{-4} T$

    x = 30 cm = 0.3 m

    As $E = \frac{1}{2}mv^2 \therefore v = \sqrt{2E/m}$

    In a magnetic field electron is deflected along a circular arc of radius r, such that



$Bev = \frac{mv^2}{r} or\ r = \frac{mv}{Be}$

$r = \frac{m}{Be}\sqrt{\frac{2E}{m}} = \frac{1}{Be}\sqrt{2Em}$ = 11.3 m

$\text{Sin}\,\theta = \frac{x}{r}$

$\sin\theta = \frac{0.3}{11.3} = \frac{3}{113}$

y = r - OC

$= r - r\cos\theta$

$= r(1 - \cos\theta)$

$= r\left[1 - \sqrt{1 - \sin^2\theta}\right]$

By x sin g binomial

$y = r\left[1 - \left(1 - \frac{1}{2}\sin^2\theta\right)\right]$

$y = \frac{r}{2} \cdot \sin^2\theta$

$y = \frac{11.3}{2} \times \frac{3\times3}{113\times113\times10} = \frac{9}{2260} = 3.98 \times 10^{-3}$ = 4 mm