NCERT Physics Class 12 Exemplar Ch 5 Magnetism and Matter Part 7 (For CBSE, ICSE, IAS, NET, NRA 2022)

Q. 23 Assume the dipole model for earth's magnetic field B which is given by B_V = vertical component of magnetic field = $\frac{\mu_0}{4\pi}\frac{2m\cos\theta}{r^3}$ B_H = Horizontal component of magnetic field

= $\frac{\mu_0}{4\pi}\frac{2m\sin\theta}{r^3}$ $\theta = 90°$ – lattitude as measured from magnetic equator. Find loci of points for which (i) $|B|$ is minimum; (ii) dip angle is zero; and (iii) dip angle is $\pm 45°$.

Solution:

(I) $|B| = \frac{\mu_0}{4\pi}\frac{m}{R^3}\left(4\cos^2\theta + \sin^2\theta\right)^{\frac{1}{2}}$

$\frac{|B|^2}{\left(\frac{\mu_0}{4\pi R^3}\right)^2 m^2} = 3\cos^2\theta + 1$, minimum at $\theta = \frac{\pi}{2}$

$|B|$ is minimum at magnetic equator.

(ii) $\tan$ (dip angle) $= \frac{B_V}{B_H} = 2\cot$

At $\theta = \frac{\pi}{2}$ dip angle vanishes. Magnetic equator is again the locus.

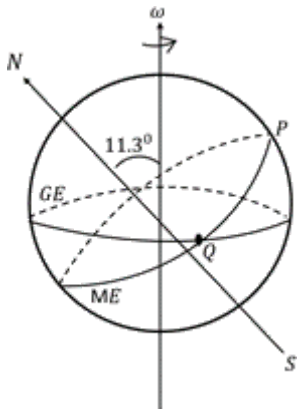
(iii) Dip angle is $\pm 45°$ when $\left|\frac{B_V}{B_H}\right| = 1$

$2\cot\theta = 1$

$\theta = \tan^{-1}2$ is the locus.

Q. 24 Consider the plane S formed by the dipole axis and the axis of earth. Let P be point on the magnetic equator and in S . Let Q be the point of intersection of the geographical and magnetic equators. Obtain the declination and dip angles at P and Q .

Solution:



Refer to the adjacent Fig.

1. P is in S (needle will point both north) Declination $= 0$

P is also on magnetic equator.

$\therefore$ dip $= 0$

2. Q is on magnetic equator.

$\therefore$ dip $= 0$

But declination $= 11.3°$.

Q. 25 There are two current carrying planar coils made each from identical wires of length L . C_1 is circular (radius R) and C_2 is square (side a) . They are so constructed that they have same frequency of oscillation when they are placed in the same uniform B and carry the same current. Find a in terms of R .

Solution:

$$n_1 = \frac{L}{2\pi R} n_2 = \frac{L}{4a}$$

$$m_1 = n_1 \, \mathrm{IA}_1 \;\; m_2 = n_2 \, \mathrm{IA}_2$$

$$= \frac{L}{2\pi R} I\pi R = \frac{L}{4a} \mathrm{Ia}^2 = \frac{L}{4} \mathrm{Ia}$$

$I_1 = \frac{\mathrm{MR}^2}{2}$ (Moment of inertia about an axis through the diameter)

$$I_2 = \frac{Ma^2}{12}$$

$$\omega_1^2 = \frac{m_1 B}{I_1} \omega_2^2 = \frac{m_2 B}{I_2}$$

$$\frac{m_1}{I_1} = \frac{m_2}{I_2}$$

$$\frac{L}{2} \times \frac{R}{\pi} \frac{I}{\frac{MR^2}{2}} = \frac{\frac{L}{4} Ia}{\frac{Ma^2}{12}} \Rightarrow \frac{3\pi}{4} R$$

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