Class XII Academic Program-2020

PHYSICS 2ND PAPER

Lecture : P-11

Chapter 04 : Magnetic effects of current and magnetism

Today's Topics:

- Hall Effect
- Hall Experiment
- Torque on Loop of conducting wire due to magnetic field
- Electron revolving on orbit
- Spin of electron
- Terrestrial Magnetism

Hall Effect and Eperiment

The Hall effect is the production of a voltage difference (the Hall voltage) across an electrical conductor, **transverse** to an electric current in the conductor and to an applied magnetic field **perpendicular** to the current. It was discovered by **Edwin Hall** in 1879.

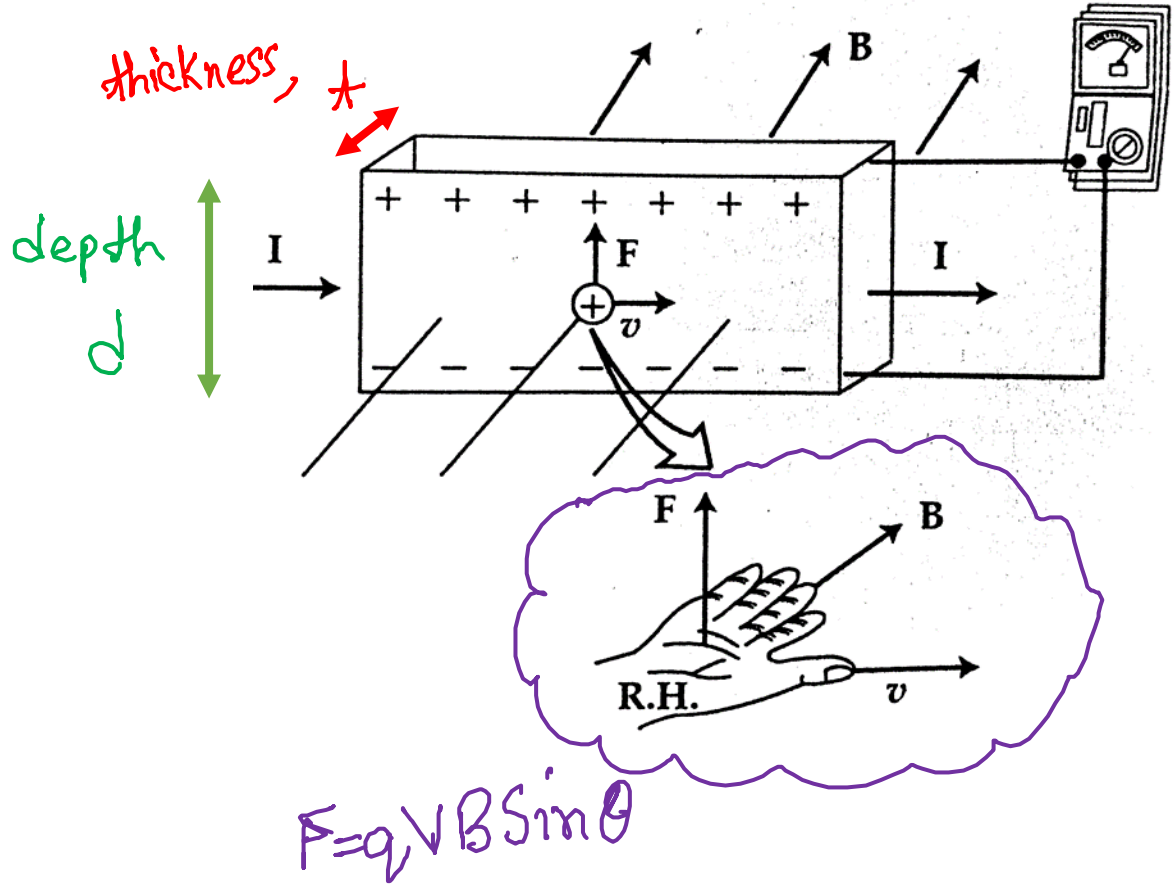
$V = Ed$ --- (9-10)

1. $V_H = Ed$ --- (11-12)

2. $V_H = \frac{BI}{ntq}$; q = charge, n = no of charge per unit volume

$V_H \propto \frac{1}{n}$ mcq

$I = nAve$



$F = qvB\sin\theta$

POLL QUESTION 01

What is the outcome of Hall's experiment?

$V_H = \frac{BI}{nstq}$

(a) Type of charge (q)

(b) Hall voltage (V_H)

(c) Amount of charge per unit volume (n)

~~(d)~~ All of above

1) conductor (e^-)
2) Semiconductor (hole)

→ Carrier

MATH 01

A metal plate of 0.02m width is placed perpendicularly to a magnetic field which has flux density of 6T. If the drift velocity in the plate is 4×10^{-3}m/s find out Hall voltage.

$d = 0.02\,m$

$B = 6\,T$

$V = 4 \times 10^{-3}\,m/s$

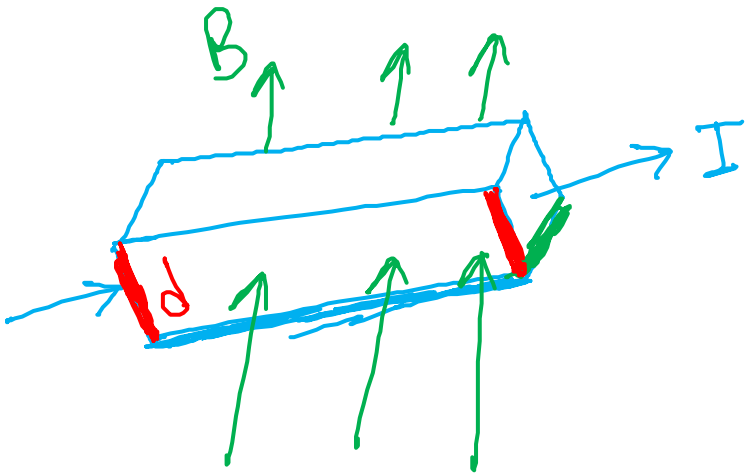
$V_H = ?$

(3) $V_H = BdV$

$= 6 \times 0.02 \times 4 \times 10^{-3}$

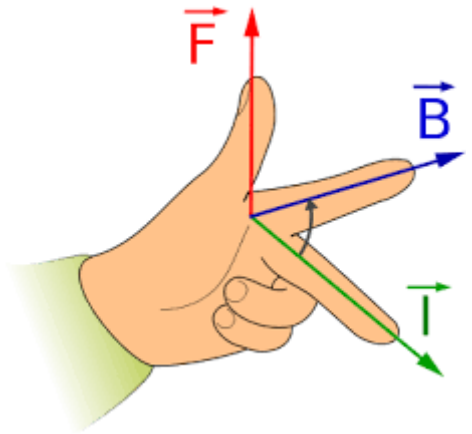
$V_H = 4.8 \times 10^{-4}$ Volts

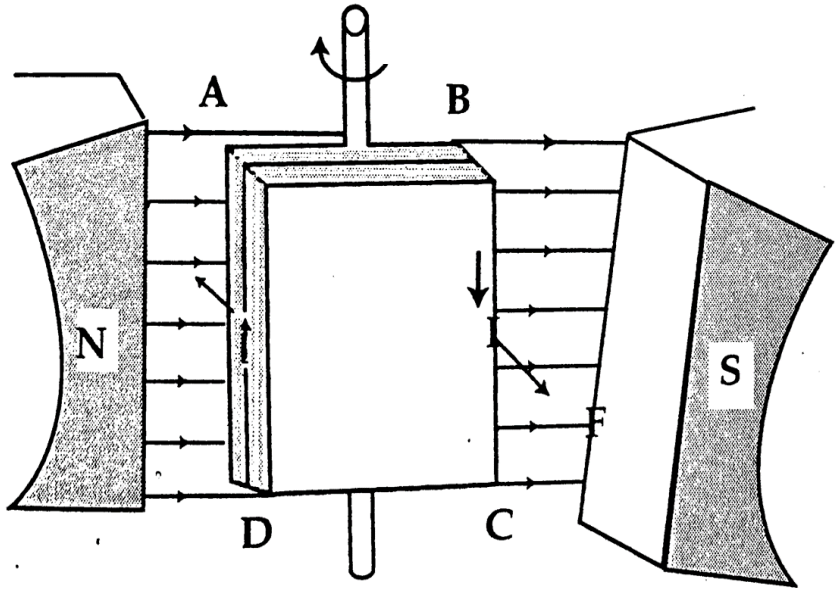
(Ans)

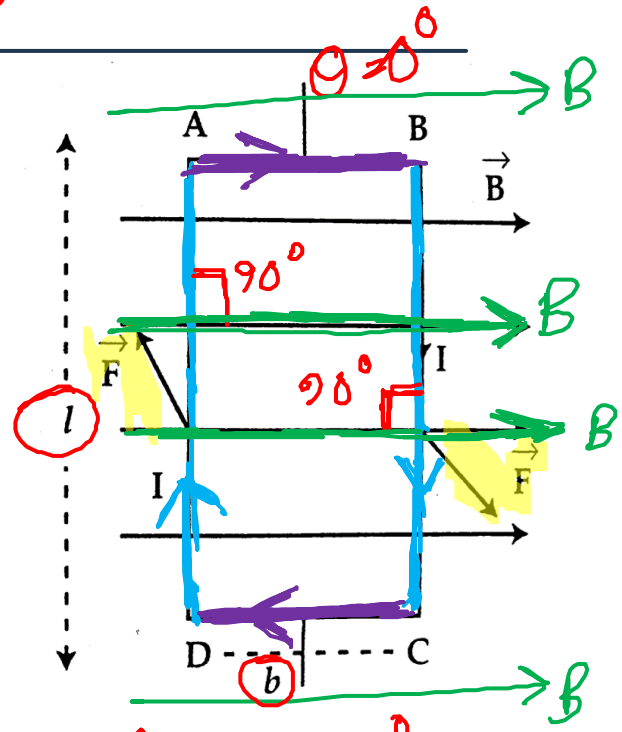


Torque on Loop of conducting wire due to magnetic field

$F = ILB \sin\theta$







AD

$F = IlB$

BC

$F = IlB$

AB

$F = IbB\sin 0^\circ = 0$

CD

$F = IbB\sin 180^\circ = 0$

$\theta = 90^\circ$ AD

$\theta = 180^\circ$ BC

$\theta = 90^\circ$ BC

Torque on Loop of conducting wire due to magnetic field

τ= NIAB

torque, τ = force × arm length

$= F \times \frac{b}{2} + F \times \frac{b}{2}$

$= Fb$

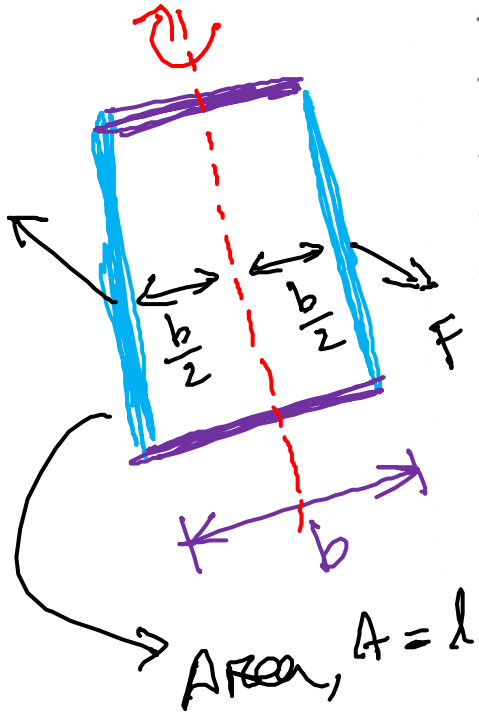
$= IlBb$

$= IB(lb)$

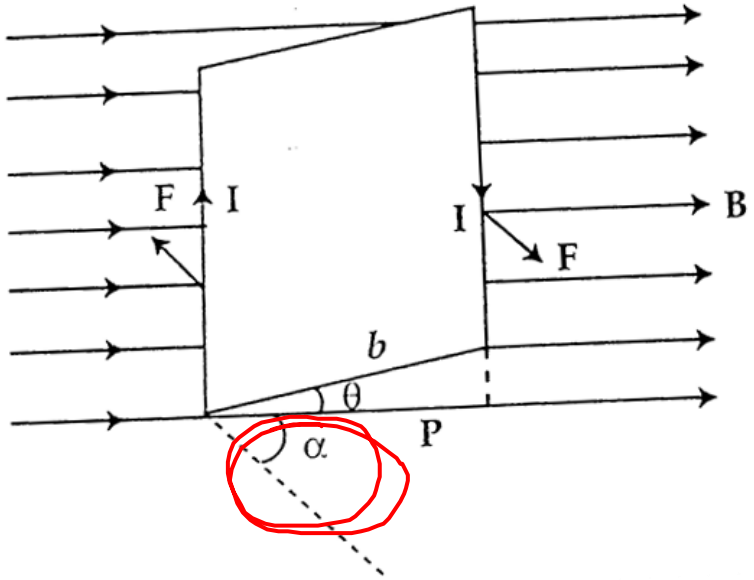
$= IBA$

$\tau = NIAB$

$\tau = NIAB\sin\alpha$



Area, $A = lb$



α = Area যে perpendicular যে সাথে B যে কোণ

MATH 02

Rectangular shaft is placed parallelly with magnetic field of 5×10^{-3} T intensity. Shaft's length and width are 15cm and 10cm which is conducting 5 amp current and number of turns is 500. Calculate torque.

$B = 5 \times 10^{-3}$ T

$l = 15\text{cm} = 0.15\text{ m}$

$b = 10\text{cm} = 0.1\text{ m}$

$I = 5$ amp

$N = 500$

$T = ?$

$\alpha = 90^\circ - \text{Question's angle}$

$= 90^\circ - 0^\circ$

$\alpha = 90^\circ$

"প্রশ্নে perpendicular এর সাথের angle বলা থাকলে সেটাই α হবে"

$T = NAIB\sin\alpha$

$= 500 \times 0.15 \times 0.1 \times 5 \times 5 \times 10^{-3} \times \sin 90^\circ$

$T = 0.1875$ Nm

POLL QUESTION 02

অথবা 1 Bohr Magneton = ?

When an electron is revolving on the orbit of hydrogen atom calculate magnetic moment of electron?

(a) 9.27×10^{-24} Wb ✗

(b) 9.27×10^{-27} Am

(c) 9.27×10^{-24} Am^2

(d) 9.27×10^{-27} Wb ✗

flux, ϕ → unit Wb

magnetic moment, $\mu = IA$

unit Am^2

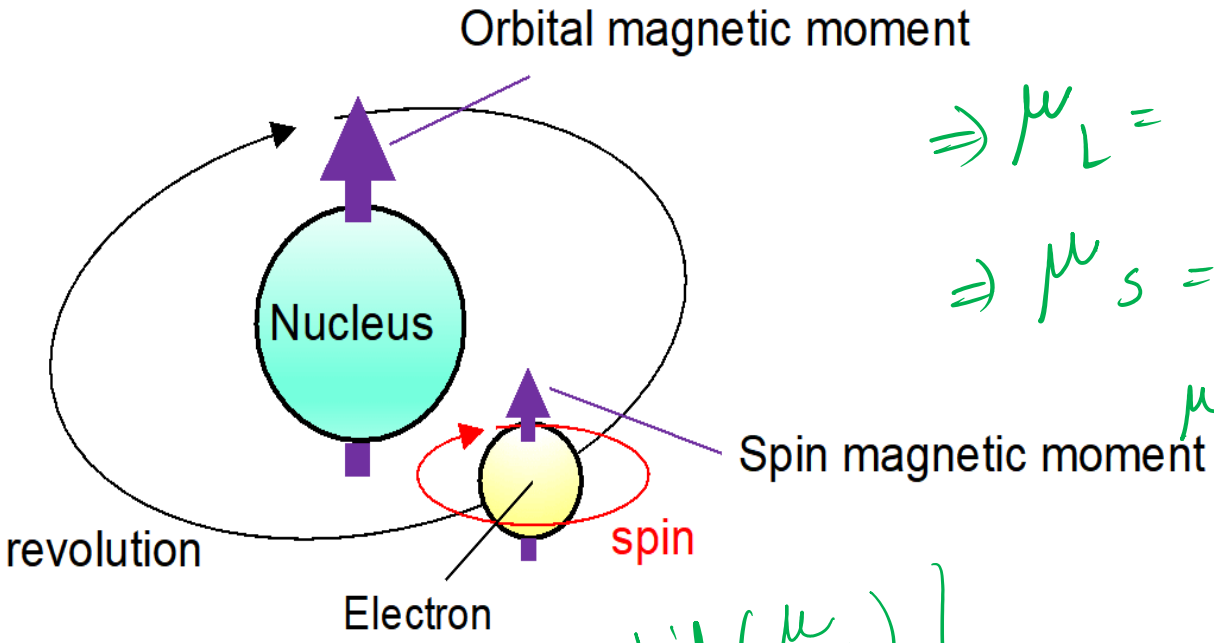
$$\mu_L = \frac{neh}{4\pi m} \Rightarrow (\mu_L)_{min} = \frac{eh}{4\pi m}$$

$= 9.27 \times 10^{-24}\ Am^2$

$= 1$ B.M.

Revolving electron and spin

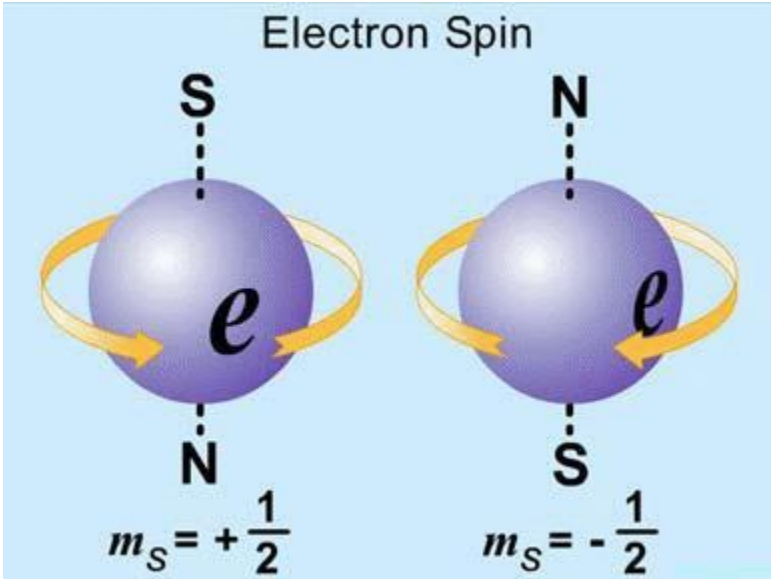
* **Orbital magnetic moment ≠ axial magnetic moment**



$$\Rightarrow \mu_L = \left(\frac{e}{2m}\right) L$$

$$\Rightarrow \mu_s = \left(\frac{e}{2m}\right)(2s)$$

$$\mu_s = \frac{e}{m}(s)$$



magnetic moment → orbit (μ_L), spin (μ_s)

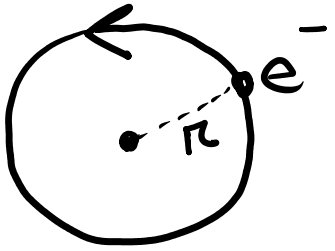
$$\mu = \mu_L + \mu_s$$

$$\mu = \frac{e}{2m}(L + 2s)$$

Revolving electron and spin

* Minimum value of **Orbital magnetic moment is 1 Bohr magneton.**

- **1 Bohr magneton=** 9.27×10^{-24} A m^2



Orbital magnetic moment, $\mu_L = IA$

$= \frac{q}{t}\pi r^2$

$= \frac{e\pi r^2}{\frac{2\pi r}{v}}$

$I = \frac{q}{t}$, $t = \frac{2\pi r}{v}$

$$\mu_L = \frac{evr}{2} \quad (1)$$

angular momentum, $L = mvr = \frac{nh}{2\pi}$

$\Rightarrow vr = \frac{L}{m}$ or $vr = \frac{nh}{2\pi m}$

So $\mu_L = \left(\frac{e}{2m}\right)L$ (II) or $\mu_L = \frac{enh}{4\pi m}$ (III)

n = 1 -- minimum

$(\mu_L)_{min} = \frac{eh}{4\pi m}$ = 1 Bohr Magneton

POLL QUESTION 03

At what angle is the geomagnetic axis with the geographical axis?

(a) 9°

(b) 15°

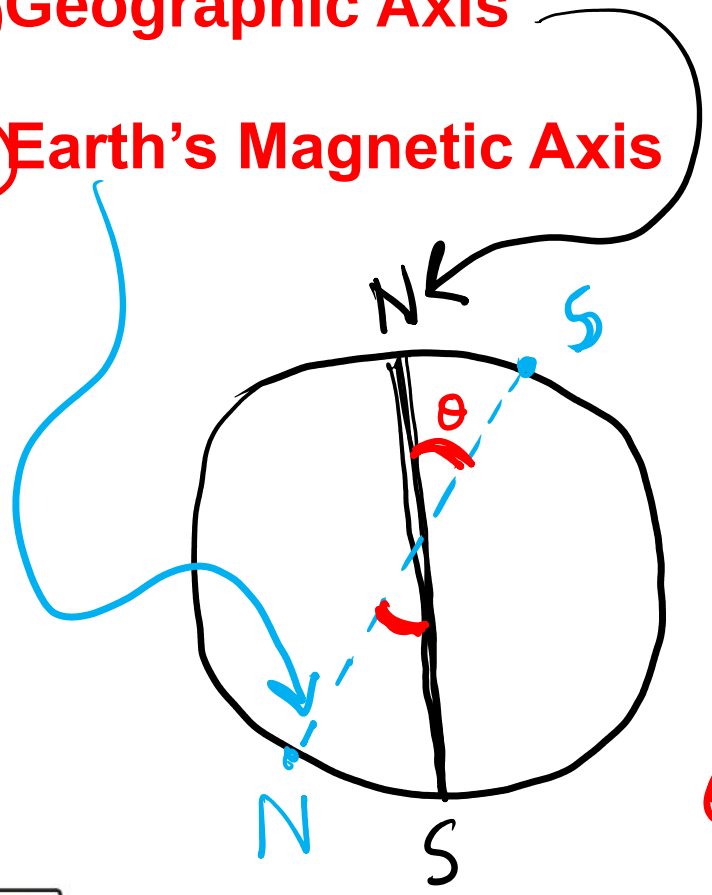
(c) 18° (Prof. Ishaq sir)

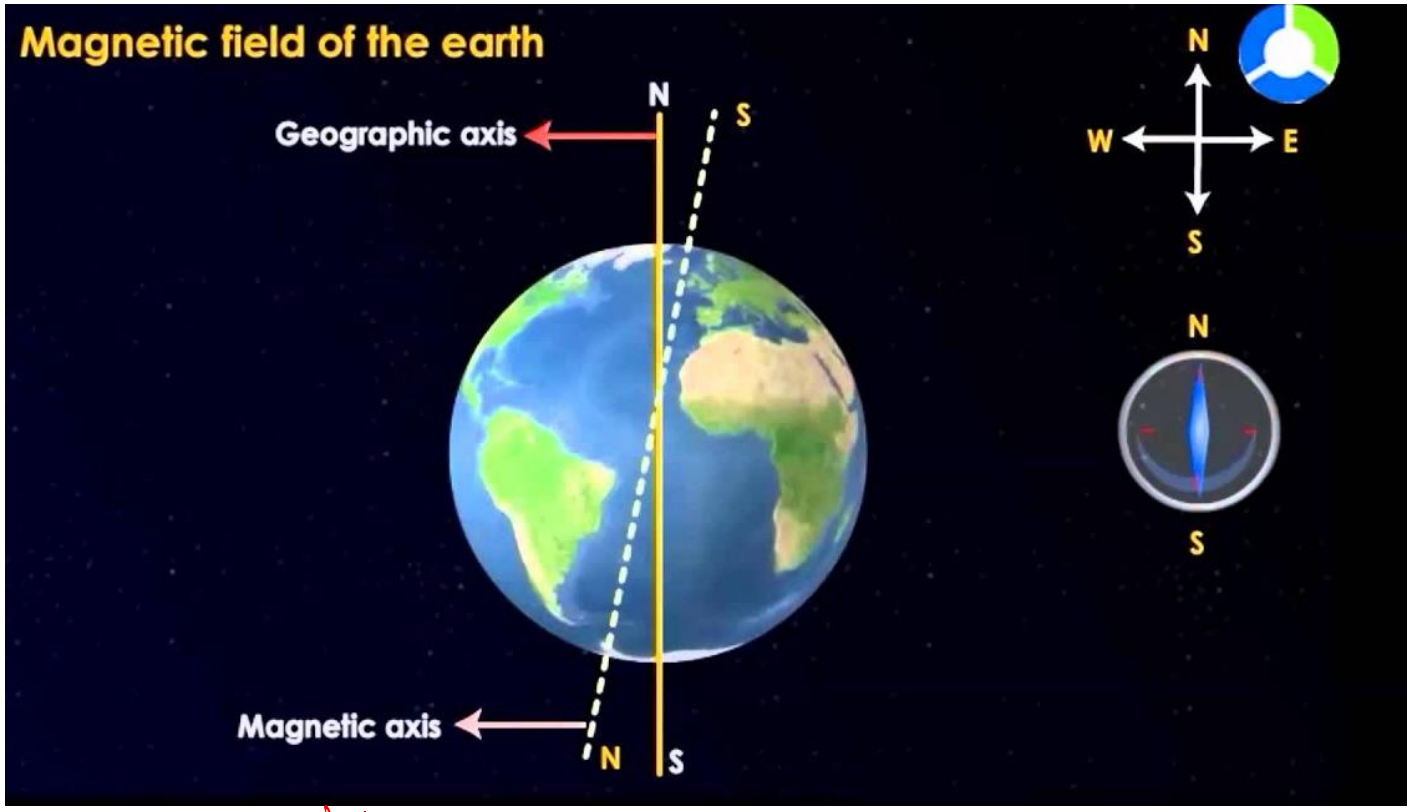
(d) 30° 11°5 (Prof. Shahjahan Sir)

$$\bar{\mu} = \left(\frac{-e}{2m}\right)\left[\bar{L} + 2\bar{S}\right]$$

Terrestrial Magnetism

- Geographic Axis
- Earth's Magnetic Axis

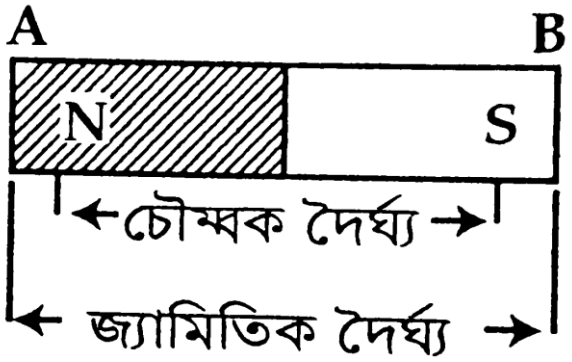


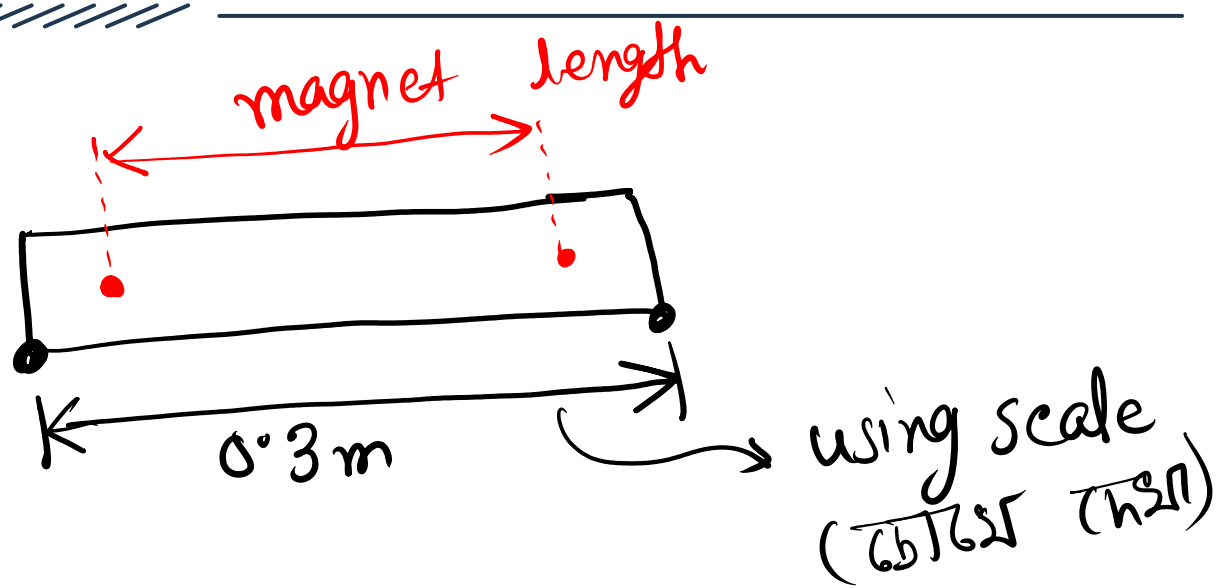


$\theta = 18^\circ$ (P. Ishaq Sir)

$\theta = 11.5^\circ$ (Prof. Shahjahan Sir)

Terrestrial Magnetism





$$\frac{\text{magnet length}}{\text{geometric length}} = 0{\cdot}85$$

So, magnet length $= 0{\cdot}85 \times 0{\cdot}3$

$= 0{\cdot}255$ m

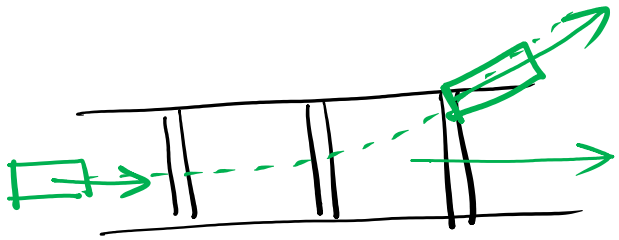
Geomagnetism

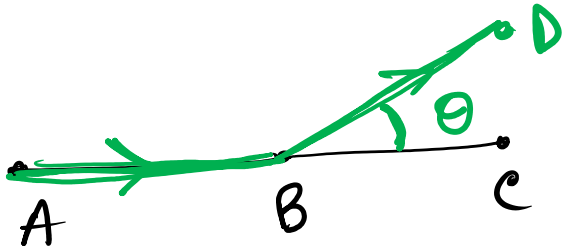
1. Declination(θ)

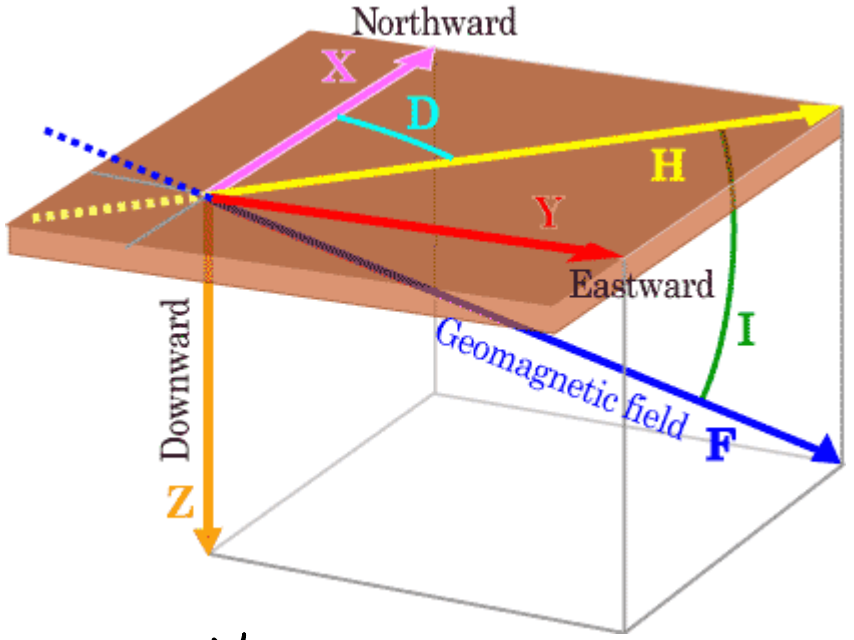
2. Inclination or Dip(δ)

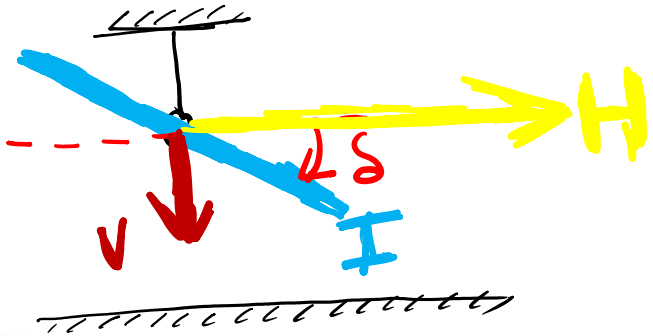
$$\tan\delta = \frac{V}{H}$$

3. Horizontal Intensity of earth's magnetic field(H)





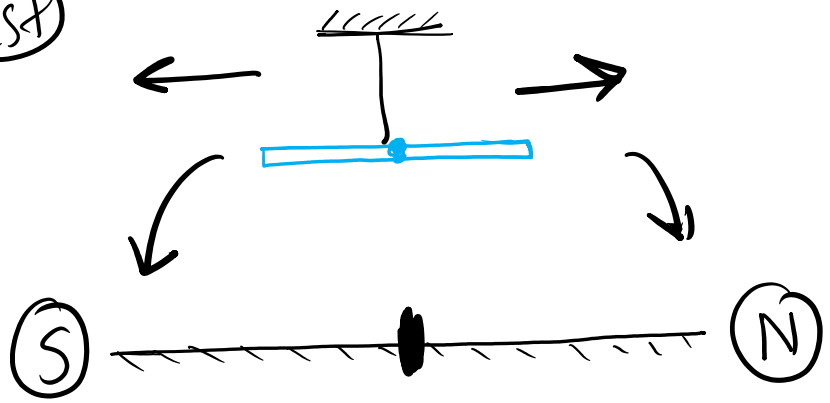


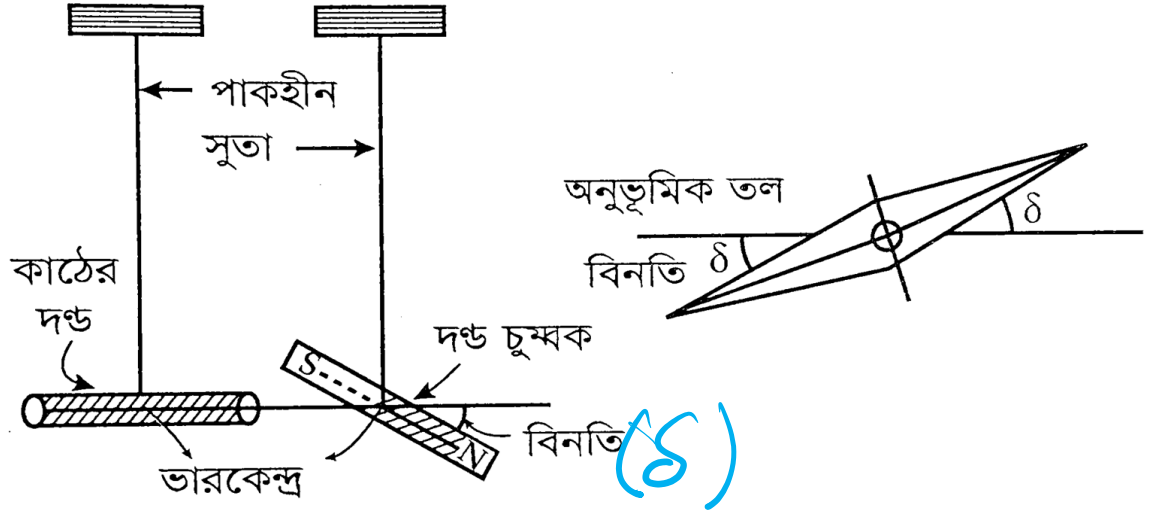


$$\left.\begin{aligned} H &= I\cos\delta \\ V &= I\sin\delta \end{aligned}\right\} \tan\delta = \frac{V}{H}$$

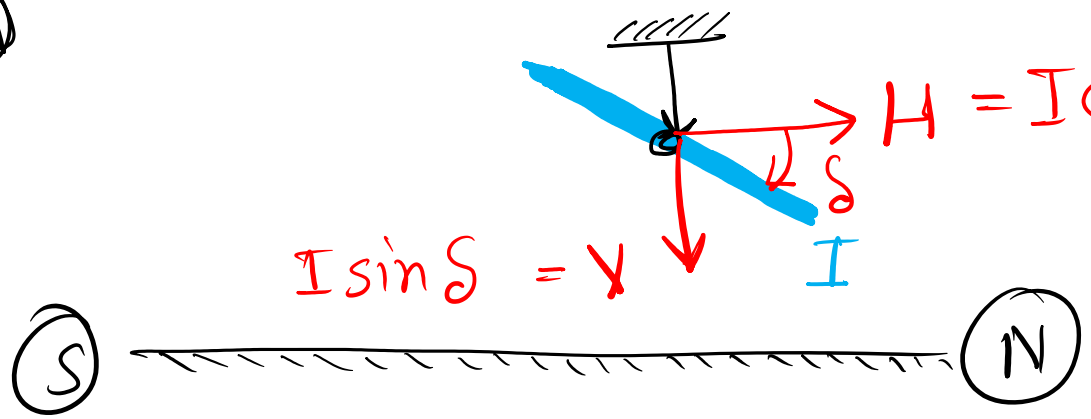
Geomagnetism

1st





2nd



I ⇒ intensity

POLL QUESTION 04

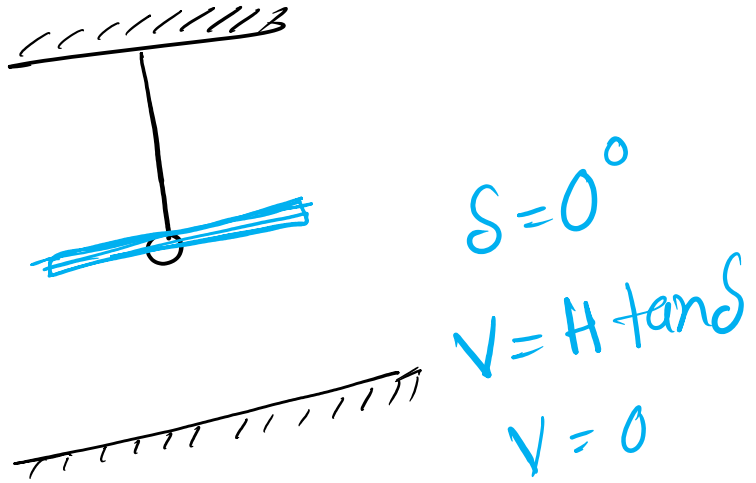
A magnet is hanged using thread. If that stays horizontal which one is correct for vertical component of magnetic field intensity?

(a) Max

(b) Min

(c) Zero

(d) Clue missing to solve



না বুঝে মুখস্থ করার অভ্যাস প্রতিভাকে ধ্বংস করে।