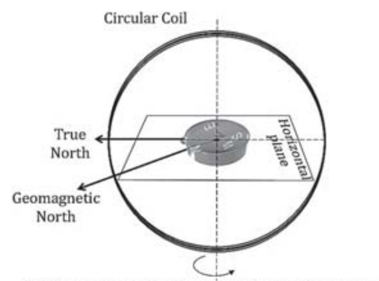
NEUTRAL POINT, TANGENT GALVANOMETER AND MAGNETIC INTENSITY

Neutral Point

- The location where the electric field strength becomes zero is termed as the neutral point in an electric field.
- If two charges have the same type and amount, the neutral point is found at a point along the line connecting them, inside the space between the charges.
- When the charges are identical, the neutral point lies within the line connecting the two charges.
- At a neutral point in an electric field, the resultant electrostatic force becomes zero.

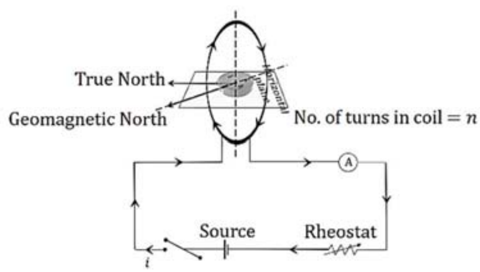
Tangent Galvanometer

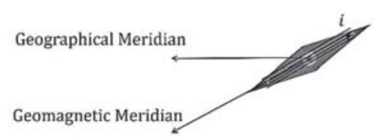
- This instrument is employed to determine the horizontal part of Earth's magnetic field.
- Additionally, it serves to gauge electric current.
- The magnetic needle of the compass can be turned in the horizontal direction, while the circular coil can be turned in the vertical direction around a vertical axis.



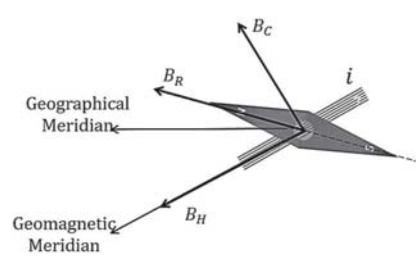
(Coil can be rotated about the vertical axis)

- Initially, the coil is positioned along the geomagnetic meridian before the key K is shut.
- When the key is closed, electricity will pass through the coil, causing it to generate its own magnetic field in the nearby area.





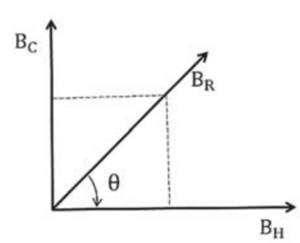
- Depending on the direction of the electric current flowing through the coil, the magnetic field at the center of the coil $\vec{B}_C$ will align with the direction indicated in the diagram.
- Initially, the compass needle was positioned along the 'Geomagnetic meridian', where the Earth's horizontal magnetic field $\vec{B}_H$ operates.
- Due to the interaction between these two magnetic fields, the compass needle rotates to align with the resultant magnetic field $\vec{B}_R$ as depicted in the diagram.



- The strength and direction of the resultant magnetic field $\vec{B}_R$ relative to BH are provided below.

$B_R = \sqrt{(B_C)^2 + (B_H)^2}$ $\qquad$ $\theta = \tan^{-1}\left(\frac{B_C}{B_H}\right)$

(Tangent law of perpendicular fields)



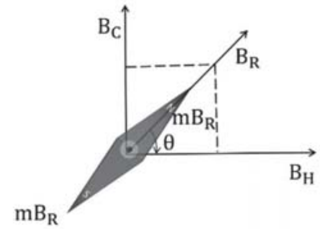
We have:

$\tan\theta = (\frac{B_C}{B_H})$

Assuming the circular coil has n number of turns and radius R, we can write the field due the coil at its centre as,

$B_C = \frac{\mu_0 ni}{2R}$

Substituting the expression of B_C in $\tan\theta$, we get the expression of current i as follows:



$\tan\theta = (\frac{\mu_0 ni}{2R\ _H}) \Rightarrow i = (\frac{2RB_H}{\mu_0 n})\tan\theta$

Since R and n are constants for a particular coil and $\vec{B}_H$ is also constant, the whole term in the parenthesis is a constant. This constant $\frac{2RB_H}{\mu_0 n} = K$ is known as 'Reduction factor. Therefore, the expression of current i becomes:

$i = K\tan\theta$ Since $\tan\theta$ has no units, the unit of 'K' will be same as current i.e., Ampere.

Oscillation Magnetometer

Oscillation magnetometer is used to find the magnetic moment of the bar magnet.

A frame that can rotate in horizontal plane is suspended in a glass box. A bar magnet is attached with the frame. The magnet will orient in North-South direction.

When frame is rotated through small angle, torque due to magnetic moment acts and the frame rotates back. Time period of rotation is found practically

Torque, $\tau = -MB\sin\theta \approx -MB\theta$[$\because \sin\theta$ is very small for small angle]

$$\text{Time period, } T = 2\pi\sqrt{\left\{\frac{I}{MB_H}\right\}}$$

[Time period is calculated experimentally, I = Moment of inertia of magnet]

$$\text{Magnetic moment, } M = \frac{4\pi^2 I}{T^2 B_H}$$