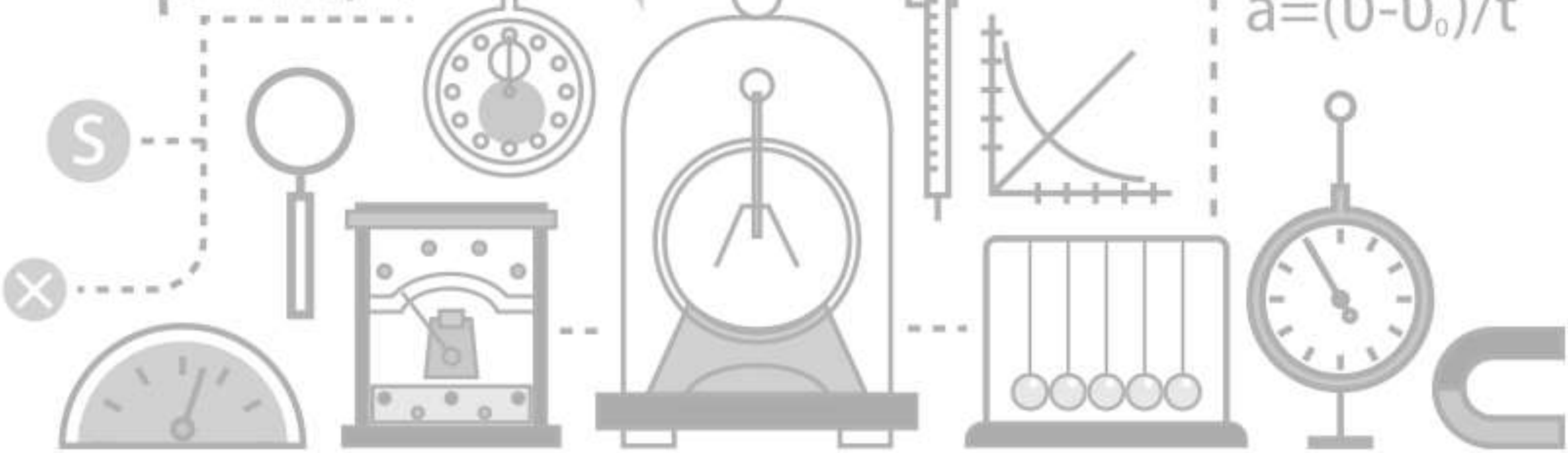
PHYSICS



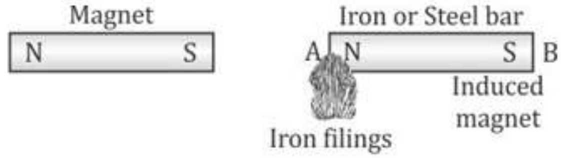
Magnetism

Introduction

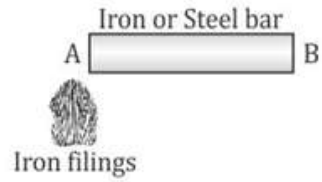
- The magnets found in nature are called **natural magnets**.
- An artificial magnet is a magnetised piece of iron or any other magnetic material.
- Some forms of artificial magnets are bar magnet, horseshoe magnet, magnetic needle, magnetic compass, etc.
- If a magnet is suspended with a silk thread such that it is free to rotate in a horizontal plane, it always sets itself pointing in the geographic north–south direction.
- Two like poles repel each other, while two unlike poles attract each other.

Induced Magnetism

- The bar of a magnetic material behaves as a magnet so long it is kept near or kept in contact with a magnet.
- This type of magnetism is called **induced magnetism**.
- The process in which a piece of magnetic material acquires magnetic properties temporarily in the presence of another magnet is called **magnetic induction**.



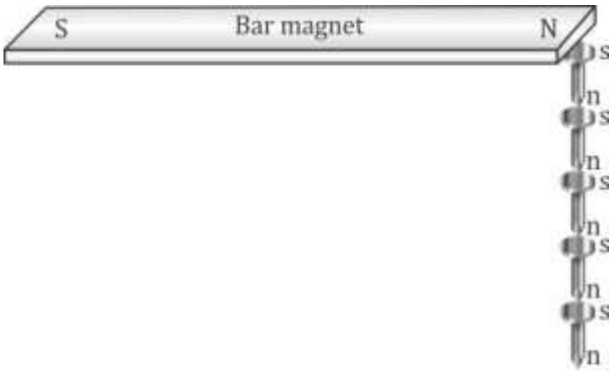
(a) Iron filings attracted by the iron bar in the presence of magnet.



(b) Iron filings fall from the bar on removal of the magnet

Induced Magnetism is Temporary

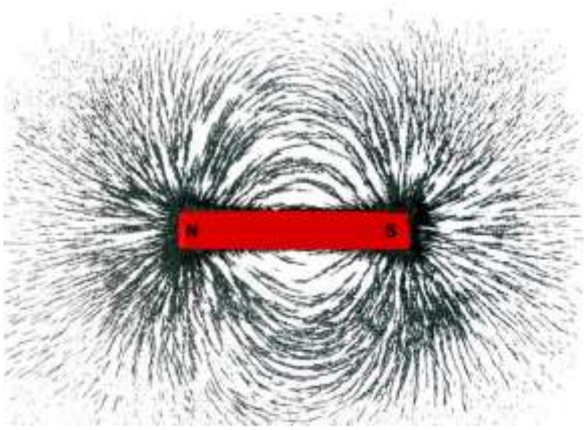
- The magnetism acquired by induction is temporary.



- The bar magnet induces magnetism in an iron nail which gets attracted by the magnet and clings to it. This magnetised nail magnetises the other nail near it by magnetic induction and attracts it.
- When the magnet is removed, the uppermost nail loses its magnetism first, and hence, all other nails lose their magnetism and fall down.

Magnetic Field Lines

- The space around a magnet in which the needle of a compass rests in a direction other than the geographic north–south direction is called the **magnetic field**.
- The direction of magnetic field at a point is the direction in which the needle of the compass rests when it is placed at that point. It is represented by drawing a line from the South Pole of the needle to its North Pole.



- A line of magnetic field is a continuous curve in the magnetic field such that the tangent at any point of it gives the direction of the magnetic field at that point.

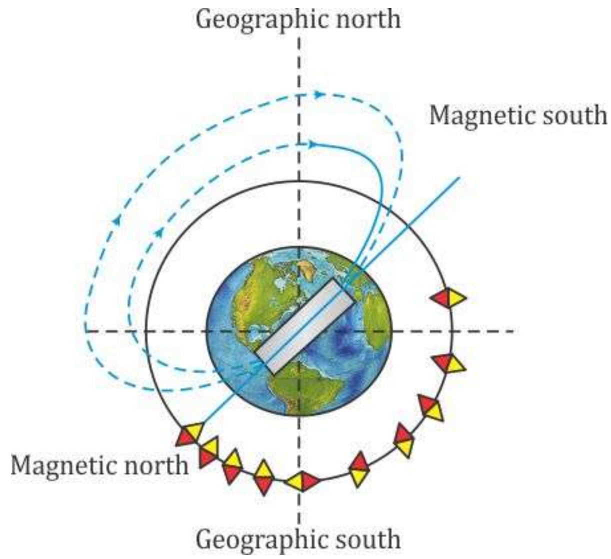
Properties of Magnetic Field Lines

The magnetic field lines have the following properties:
- They are closed and continuous curves.
- They are directed from the North Pole towards the South Pole of the magnet.
- The tangent at any point on a field line gives the direction of the magnetic field at that point.
- They never intersect with one another.
- They are crowded near the poles of the magnet and are separated near the middle of the magnet.
- Parallel and equidistant field lines represent a uniform magnetic field.

Magnetic Field of the Earth

Our Earth has a magnetic field associated with it, and it behaves like a magnet. The existence of the Earth's magnetic field is based on the following facts:

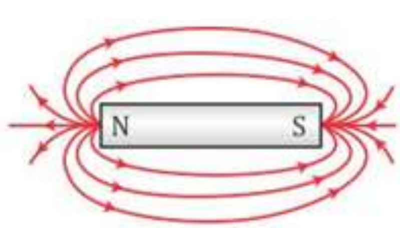
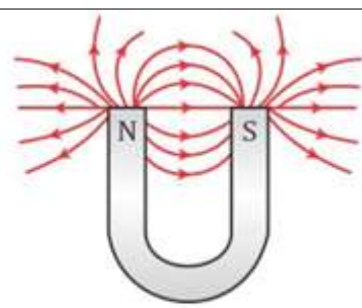
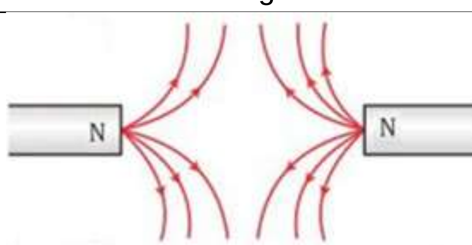
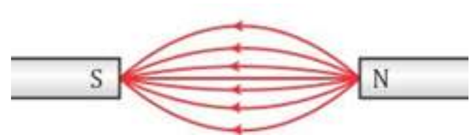
- A freely suspended magnetic needle always rests in the geographic North–South direction.
- An iron rod buried inside the Earth along the North–South direction becomes a magnet.
- Neutral points are obtained on plotting the field lines of a magnet.
- A magnetic needle rests making different angles with the horizontal when suspended at different places of the Earth.



The two places where the magnetic needle becomes vertical are called the **magnetic poles**, and the line joining the two places where the magnetic needle becomes horizontal is called the **magnetic equator**.

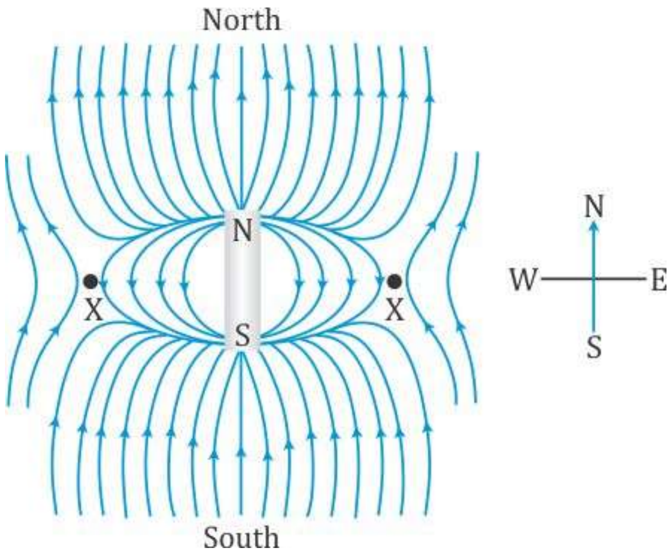
Plotting the Non-Uniform Magnetic Field of a Strong Bar Magnet and Neutral Points

The figures below show non-uniform magnetic field lines.

	
Bar magnet	Horseshoe magnet
	
Two like poles facing each other	Two unlike poles facing each other

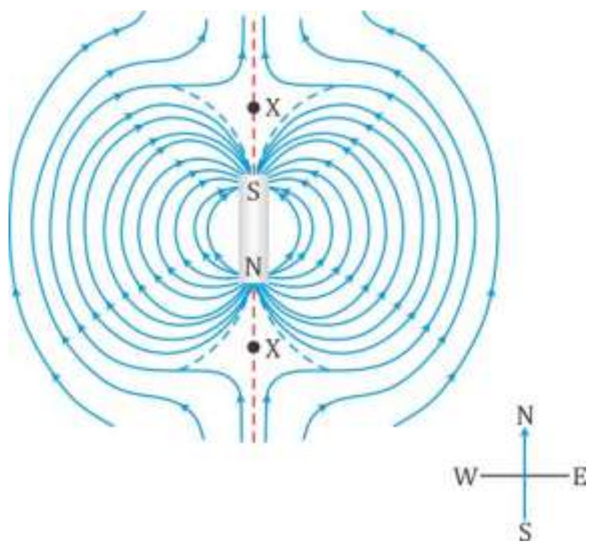
When The Given Magnet Is Placed With Its North Pole Pointing Towards North:

The magnetic field lines obtained in this position are shown in the figure below which are due to the combined effect of the magnetic field of the magnet and the Earth's magnetic field.



When The Given Magnet Is Placed With Its South Pole Pointing Towards North:

The magnetic field lines obtained in this position are shown in the figure below which are due to the combined effect of the magnetic field of the magnet and the Earth's magnetic field.



From the above figures, we can conclude that (for both the positions)

- The magnetic field lines near the magnet are curved, and they are mainly due to the magnetic field of the magnet which is much stronger than the magnetic field of the Earth. The magnetic field lines at distant points are parallel to each other and are mainly due to the Earth's magnetic field.
- There are two points equidistant from the centre of the magnet where the magnetic field of the magnet and the horizontal component of the Earth's magnetic field neutralise each other. These are the neutral points.

Neutral Points

- Neutral points are the points where the magnetic field of a magnet is equal in magnitude to the Earth's horizontal magnetic field, but it is in the opposite direction. Thus, the resultant magnetic field at the neutral points is zero.
- When the North Pole of the magnet faces the geographic North: The neutral points are situated symmetrically on either side of the magnet at equal distances from the centre in the east–west direction.
- When the South Pole of the magnet faces the geographic North: The neutral points are situated symmetrically on either side of the magnet at equal distances from the centre in the North–South direction.