19. Properties of a Magnetic Field

Let's recall.

1. Where and how are magnets used in our houses and our surroundings?
2. In which direction does a freely suspended magnet settle?
3. What are the names given to the two ends of a magnet? Why are they named thus?
4. Which metals are used for making magnets?
5. What are the characteristics of magnets?

Magnets are made from alloys of iron, cobalt and nickel. Nipermag, an alloy of iron, nickel, aluminium and titanium is used to make magnets. We have also learnt that alnico is a magnetic alloy of aluminium, nickel and cobalt.

Magnetism

Try this. **Apparatus :** Steel bar, bar magnet, iron fillings, thread, etc.

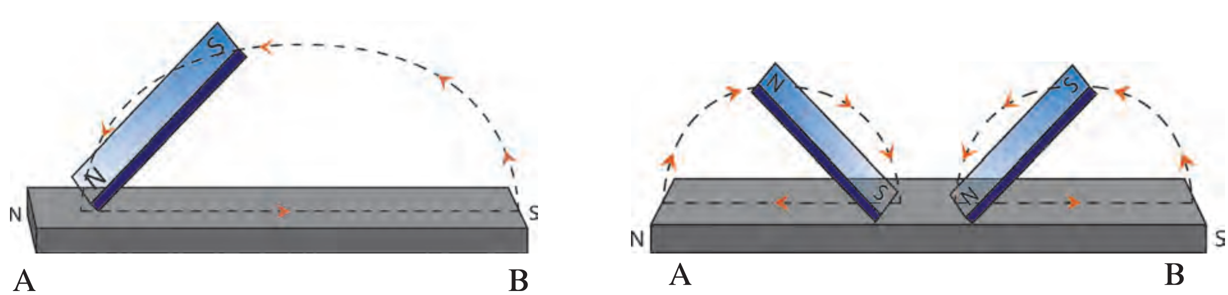
Procedure : Place a steel bar AB, on a table. Take a bar magnet. Place its 'N' pole on the 'A' end of the steel bar and drag it towards the 'B' end. Lift the bar magnet and drag its 'N' pole from the end A to the end B of the steel bar again. Repeat this 15 to 20 times. Now take the steel bar near some iron filings and observe what happens. Hang the bar freely by a thread and observe.

The steel bar will be seen to have developed magnetism. This method of magnetisation is called the single touch method. The magnetism created by this method is of low strength and lasts for a short time.

Procedure : Place a steel bar on a table. Take two bar magnets. Place two opposite poles of the two bar magnets at the centre of the steel bar. Drag these poles apart, one to the 'A' end of the steel bar, and the other to the 'B' end.

Repeat this 15 to 20 times. Now take the steel bar near iron fillings and observe. Hang the steel bar freely and observe.

This method of magnetisation is called the double-touch method. The magnetism generated by this method lasts longer compared to that generated by the single touch method.



19.1 Magnetising a steel bar

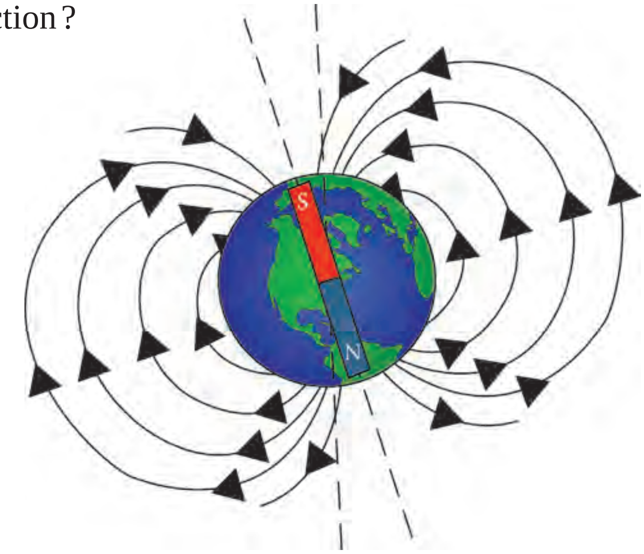
Can you tell ?

Why does a freely suspended magnet always settle in the north-south direction ?

Earth : A gigantic magnet

The scientist William Gilbert gave a scientific explanation, based on experiment, of the observation that a freely suspended magnet always settles in the north-south direction only.

He gave a round shape to a naturally occurring magnetic rock. He suspended this spherical magnet so that it could turn freely and brought the north pole of a bar magnet near it. The south pole of the magnetic sphere was attracted towards it.



19.2 Earth's magnetism

Can you tell ?

1. Which magnetic poles attract each other ?
2. Which pole of a spherical magnet will get attracted towards the south pole of the bar magnet ?

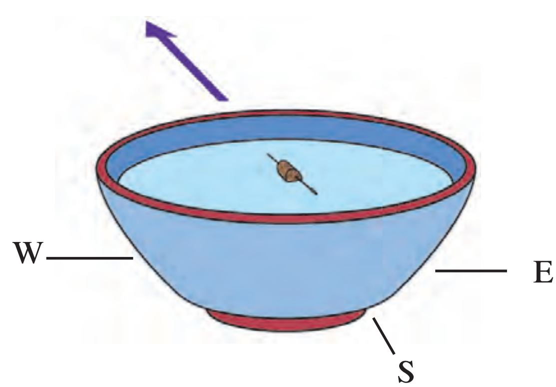
The north pole of a freely suspended magnet settles in the direction of the geographic north pole of the earth. It means that the south pole of some gigantic magnet must be near the geographic north pole of the earth and the north pole of that magnet, near the geographic south pole of the earth. Gilbert inferred from this that the earth itself is a gigantic magnet. However, the south pole of this magnet must be near the geographic north pole of the earth while the magnetic north pole is near the geographic south pole.

Use your brain power !

Which direction will a magnetic needle show on the geographic north pole ?

Magnetic needle

Take a square cardboard and mark the directions on it. Place a pot filled with water at the centre of the cardboard. Take a magnetized needle. Stick it to a small piece of a cardboard by means of a sticking tape. Place the piece of cardboard with the needle, on the surface of water in the pot. In which direction does the magnetized needle point ?



19.3 Magnetic needle

Find out.

In any place, why does the magnetic needle of a compass not settle parallel to the ground but at a an angle to it ?

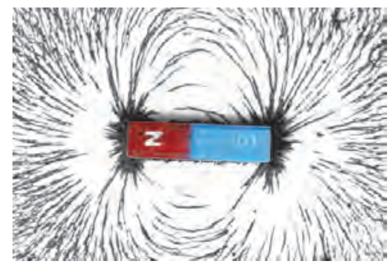
Magnetic field

Try this.

Apparatus : A bar magnet, pins, cardboard, iron filings, plastic bottle, bucket, water.

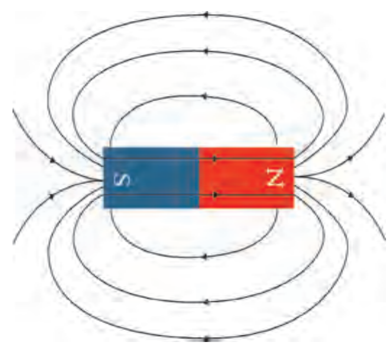
Procedure : Take a bar magnet and some pins. Place them at such a distance from each other that they do not stick to each other. Now slowly move the magnet towards the pins. Observe the pins as they get pulled to the magnet.

The magnet attracts the needles from afar. In other words, a magnet has an effect even at a distance.



Procedure : Take a small cardboard. Place a bar magnet at its centre. Sprinkle iron filings on the cardboard around the magnet. Tap the cardboard gently. Observe the iron filings.

What is the inference from the above experiments? The British researcher Michael Faraday named these lines, going from one end of the bar magnet to the other, 'magnetic lines of force'. The region around a magnet where the magnetic force acts on an object is called a magnetic field. The magnetic field around a magnet can be shown by means of magnetic lines of force. The intensity of the magnetic field at a place can be guaged by the number of lines of force that pass through a unit area at that place, perpendicular to that area. Michael Faraday, imagined that there might be invisible lines of force going from one pole of a magnet to the other, and that magnetic attraction or repulsion might be taking place through the medium of these lines of force. If Faraday's idea is accepted, the intensity of the magnetic field can be obtained from the number of lines of force, as explained above.



19.4 Magnetic field

The intensity of a magnetic field is low where the lines of force are sparse, and the intensity is high where the lines of force are concentrated.

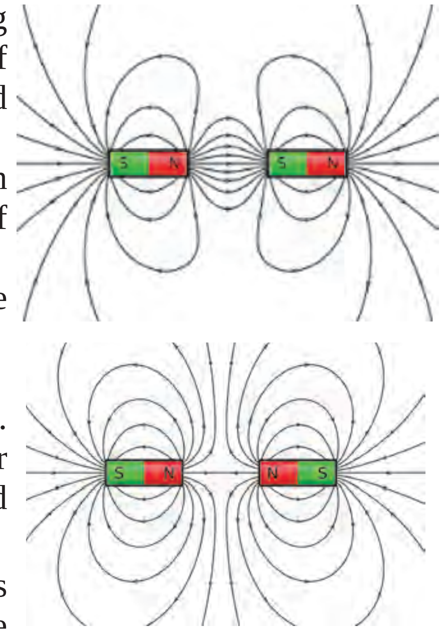
Use your brain power ! Is magnetic force a vector or a scalar quantity?

Properties of magnetic lines of force

While proposing the concept of lines of force, Michael Faraday argued that, if all observed effects are to be explained satisfactorily, then the lines of force must have certain properties.

Michael Faraday

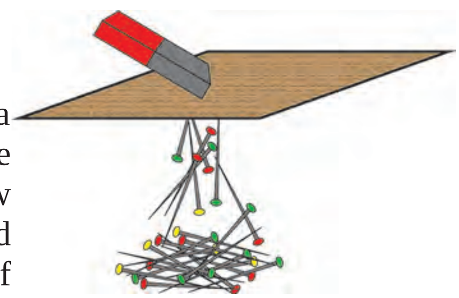
1. Magnetic lines of force are imaginary connecting lines and Faraday introduced the concept of lines of force in order to explain magnetic attraction and repulsion.
2. Magnetic lines of force always run from the north pole to the south pole. The south pole may be of the same magnet or a different one.
3. Magnetic lines of force are in a state of tension like a stretched spring.
4. Magnetic lines of force repel each other.
5. Magnetic lines of force do not intersect each other.
6. The number of the magnetic lines force at a particular point determines the strength of the magnetic field there.



19.5 Properties of magnetic lines of force

You can now see from the figure, how the properties given above help to explain the repulsion between like poles and attraction between opposite poles. According to the third property, the lines of force joining the north and south poles of a magnet, being in a stretched state like a spring, pull the two opposite poles towards each other. By the fourth property they give rise to repulsion between like poles.

Penetrating ability of the magnetic field


19.6 Penetrating ability of magnetic field

Procedure : Spread some pins on a table. Hold a cardboard at a small distance above these pins. Place a bar magnet on the cardboard and observe. Now move the magnet slowly over the cardboard and observe. Repeat this procedure, increasing the layers of cardboard, and observe.

Procedure : Fill water in a plastic bottle. Drop a few pins in the water. Take a bar magnet near the bottle and observe. Move the magnet through a small distance near the bottle and observe.

From the above observations, we see that a magnetic field can pass through a cardboard, a bottle or water. However, in each case, the intensity of the magnetic field is found to decrease.

Procedure : Take water in a big basin. Place a bar magnet on a plastic lid and float it on the surface of the water. Magnetise a needle or pin. Stick this needle firmly to a small piece of thick cardboard by means of a sticking tape.

Place the magnetized needle stuck to the cardboard, in the water near the magnet. Observe the direction in which the needle moves. Repeat this, placing the magnet at difference places around the magnet and observe.


Use your brain power !

1. What is meant by magnetic force ?
2. How does a magnetic force act without direct contact ?
3. What is the difference between gravitational force and magnetic force ?

Can you tell ?

1. What is an electromagnet?
2. How can an electromagnet be made?

Metal detectors

The function of these machines is based on electromagnets. Metal detectors are used in very important places like an airport, bus station, certain temples and buildings. They are used for inspection of persons entering these places. Metal detectors are used to detect very precious articles and also in the food-processing industry to detect any iron/steel objects mixed unknowingly in foodstuff as these would be harmful to health. In geology, these machines are used to detect the presence and quantity of metals.

19.3 Metal detectors

Use your brain power!

1. Why is repulsion the real test for identifying a magnet?
2. How will you find a magnet from among the various articles given to you ?

Exercise

1. Write the appropriate term in the blanks.

(a) The alloys called ………… and …………… are used for making industrial magnets.

(b) A magnetic field can pass through ……… and ……….. .

(c) The intensity of a magnetic field is indicated by the lines of ....

(d) The real test of a magnet is ....

2. With whom should I pair up?

Group 'A'	Group 'B'
(a) Compass	1. The highest magnetic force
(b) Door of a cupboard	2. Like poles
(c) Repulsion	3. A magnet
(d) Magnetic pole	4. A magnetic needle

3. Write answers to the following questions:

(a) Distinguish between the two methods of making artificial magnets.

(b) Which substances are used for making electromagnets?

(c) Write a note on 'magnetic field'.

(d) Why is a magnetic needle used in a compass?

(e) Explain with the help of a diagram how the intensity and direction of the magnetic field of a bar magnet can be determined.

4. Give detailed information about how the merchants of olden times used a magnet while travelling.

Project :

Obtain information about the function of metal detectors.

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