بِسْمِ اللهِ الرَّحْمٰنِ الرَّحِيْمِ

বিস্‌মিল্লাহির রাহ্‌মানির রাহীম

# উদ্ভাস

একাডেমিক এন্ড এডমিশন কেয়ার

# Physics

Chapter-12: বিদ্যুতের চৌম্বক ক্রিয়া

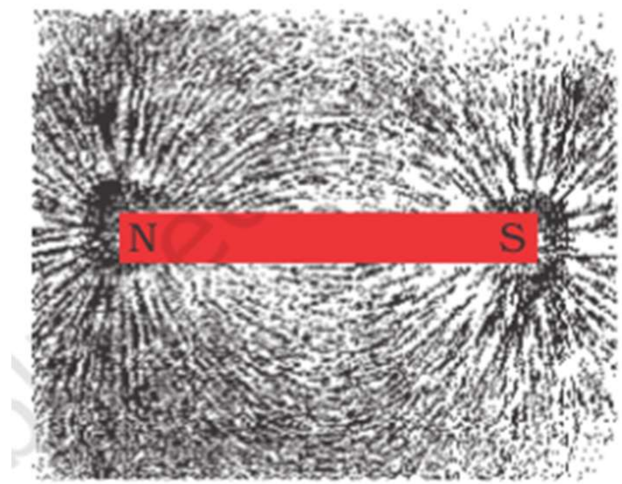
(Magnetic effect of current )

**Lecture-30**

# Magnet

A magnet is a material or object that produces a magnetic field(the region surrounding a magnet, in which the force of the magnet can be detected) .

This magnetic field is *invisible* but is responsible for the most notable property of a magnet: a force (repulsion or attraction) that pulls on other magnetic substance.



# Properties of magnet

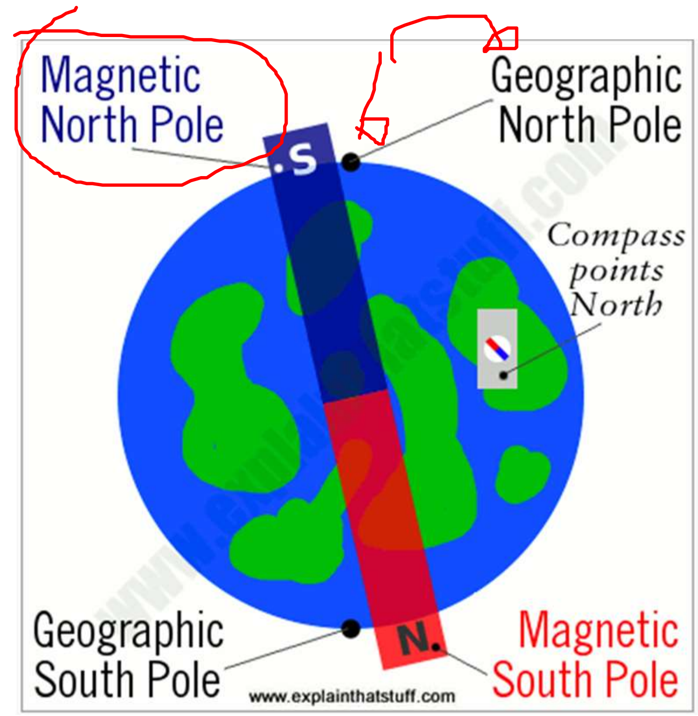
## Magnetic pole :

We are familiar with the fact that a compass needle gets deflected when brought near a bar magnet. A compass needle is, in fact, a small bar magnet. The ends of the compass needle point approximately towards north and south directions. The end pointing towards north is called north seeking or north pole. The other end that points towards south is called south seeking or south pole.

Through various activities we have observed that like poles repel, while unlike poles of magnets attract each other.

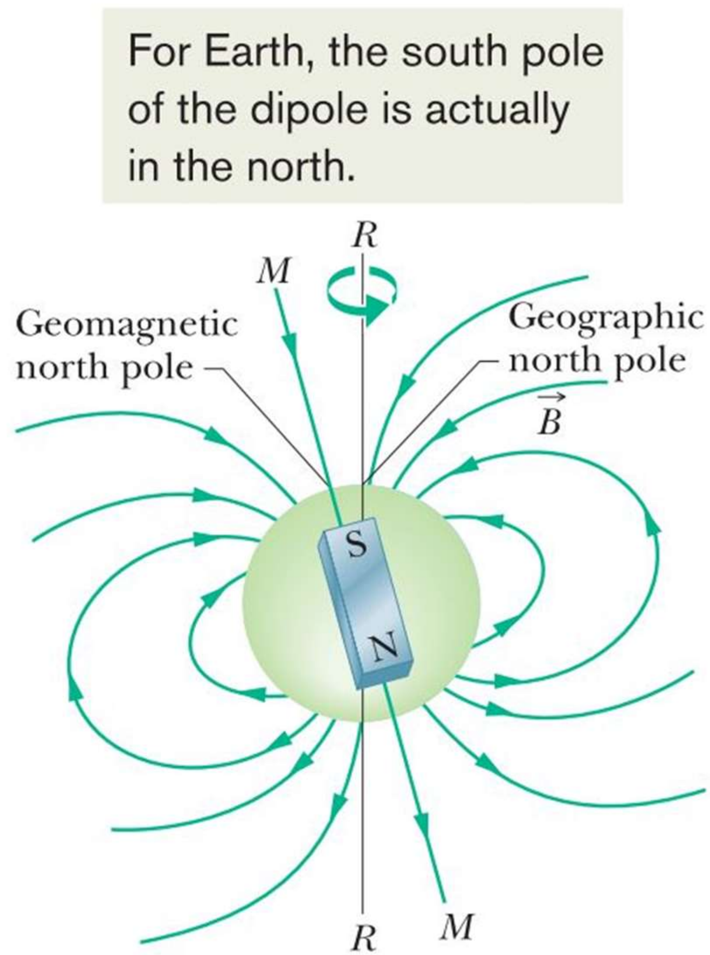
# How do compasses work?

Earth behaves as though it has a giant bar magnet built inside it. But the magnet is the opposite way around to how you might think, with its south pole up near Earth's actual (geographic) north pole and vice-versa. A compass needle points north because the north pole of the magnet inside it is attracted to the south pole of Earth's built-in magnet. Confusing, eh? Also note that the magnetic north pole and the real north pole don't exactly coincide.



# What causes the Earth to behave as a magnet?

It is not known for sure exactly why the earth itself behaves like a magnetic.



# Magnetic effect of current

Whenever we talk about magnetism ,an image of  a bar magnet pops up in our head. But just as when a charge is kept in a place an electric field is produced around it , moving charge will also create a magnetic field around it .

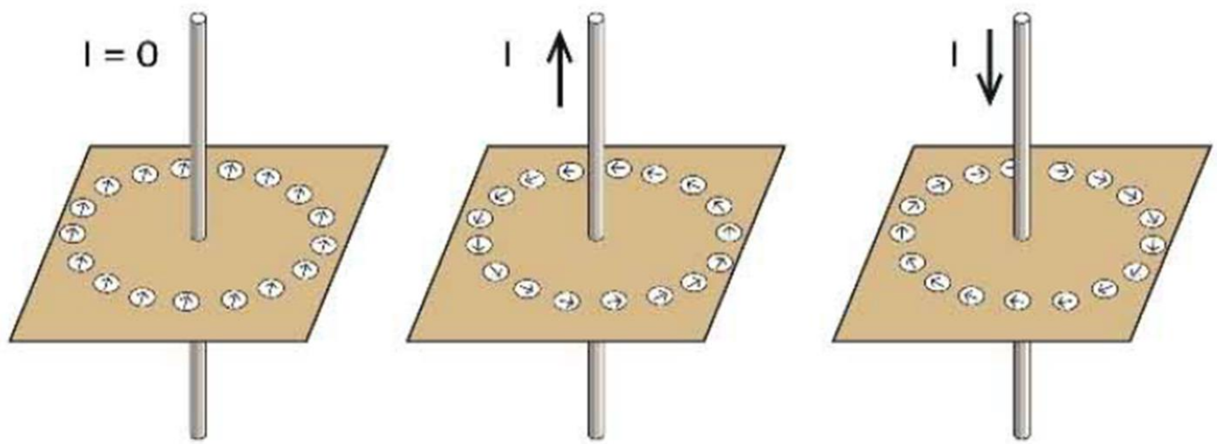
*So what is an electric current ?*

An electric current is nothing but the rate of flow of electric charge past a point or region. Electric charge is carried by charged particles, so an electric current is a flow of charged particles. So an electric current through a metallic conductor produces a magnetic field around it.

Let us discuss the example given in our textbook.

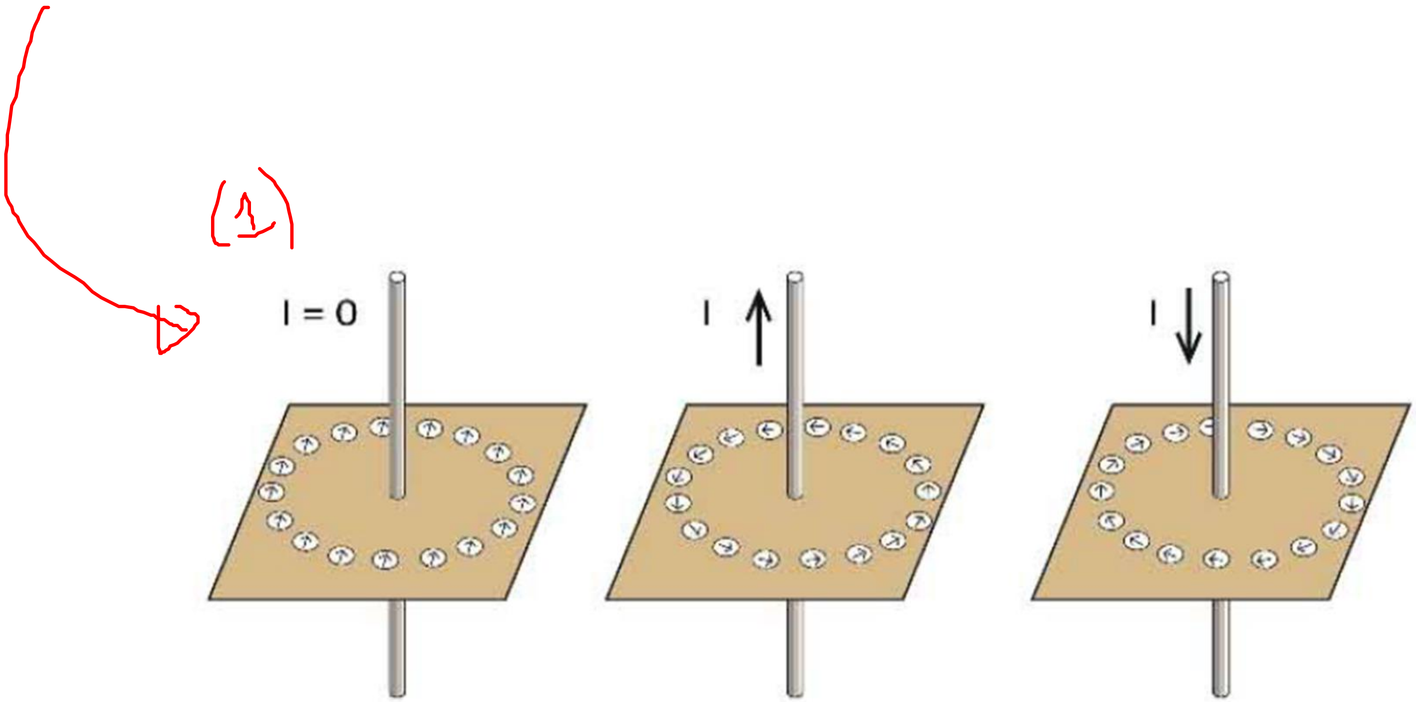
# Magnetic effect of current

Let us discuss the example given in our textbook. Assume that a wire penetrates through the middle of a piece of cardboard and some compasses are placed on carboard around the wire.



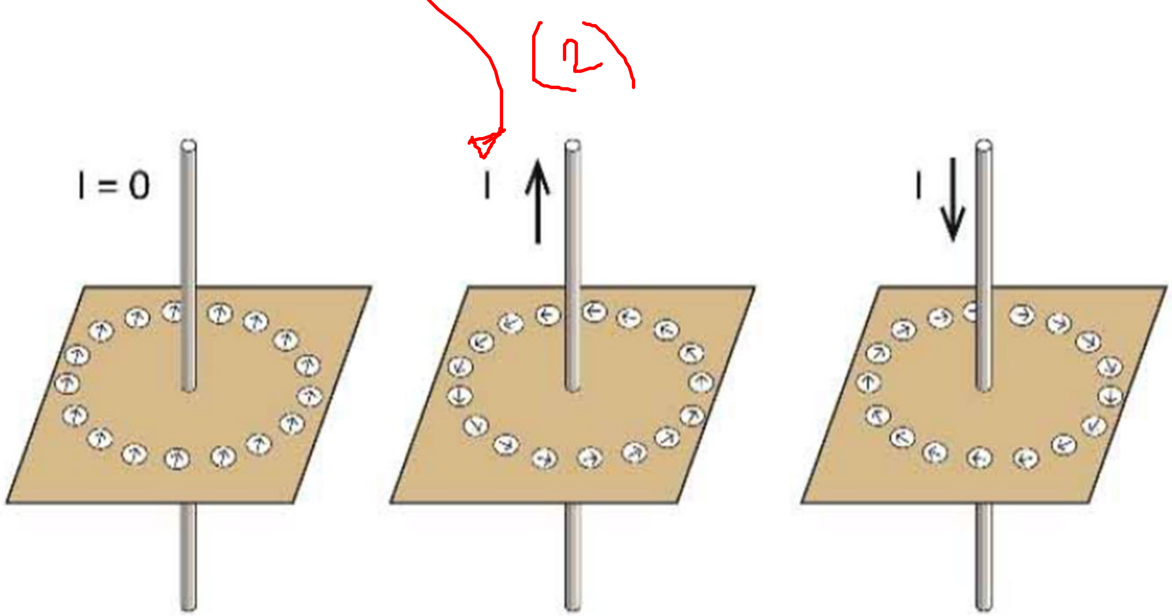
# Magnetic effect of current

Looking at the first diagram (from the left) ,we see if there is no current flowing in wire , compasses will be aligned along the north-south direction.



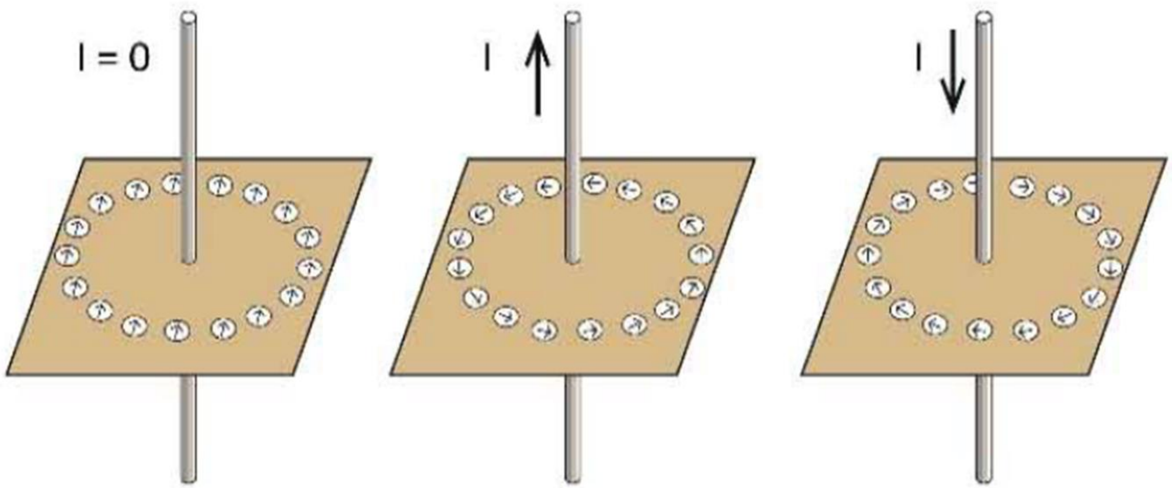
# Magnetic effect of current

Now if a current (moderately strong ) passes through the wire, we will see suddenly the compasses are arranging themselves one after another in a circular manner.



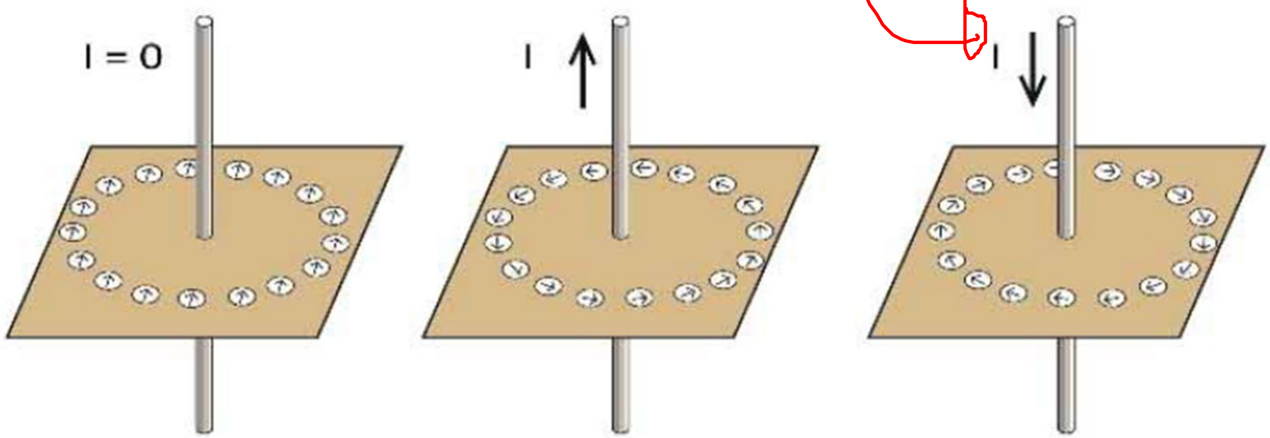
# Magnetic effect of current

If the current is stopped ,then again the compass will align along the north–south direction.



# Magnetic effect of current

If the direction of current is changed ,you will find that the compasses will arrange themselves again ,but now the direction of the compasses in the circle will be reversed.

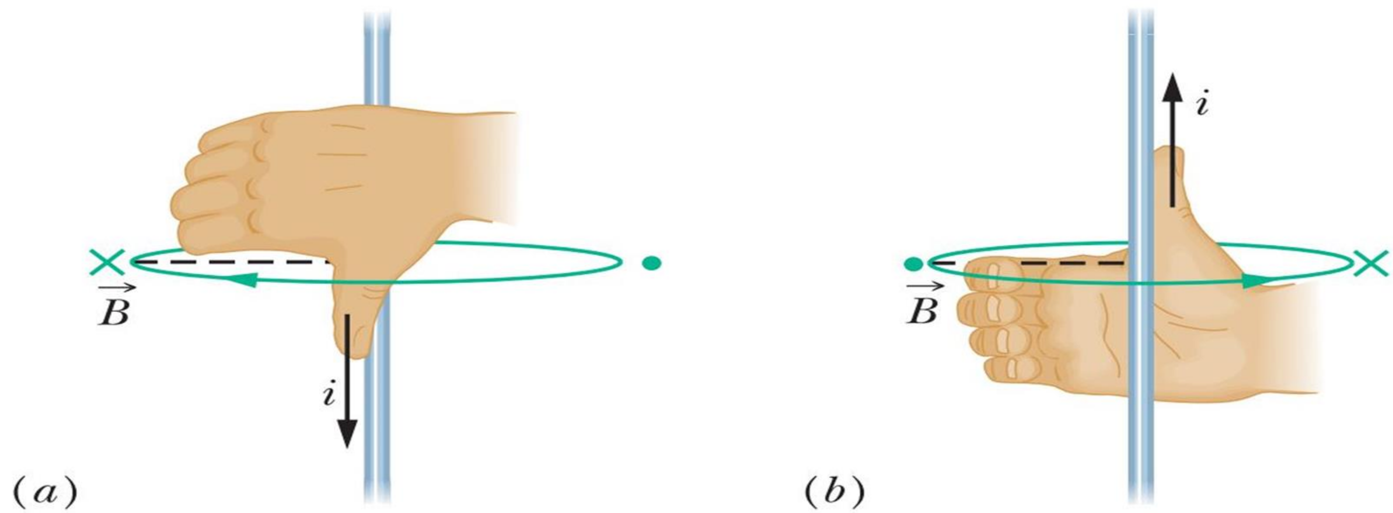


# Magnetic effect of current

If you sprinkle some iron powders around the current carrying wire, you can actually see the pattern without any compass.

# Direction of magnetic field

A convenient way of finding the direction of magnetic field associated with a current-carrying conductor is given in figure below. It's also known as *right thumb rule*.



# Poll 1

A current flows in a straight wire to the right, as shown below.


At which point is the magnetic field stronger?

a) A

b) B

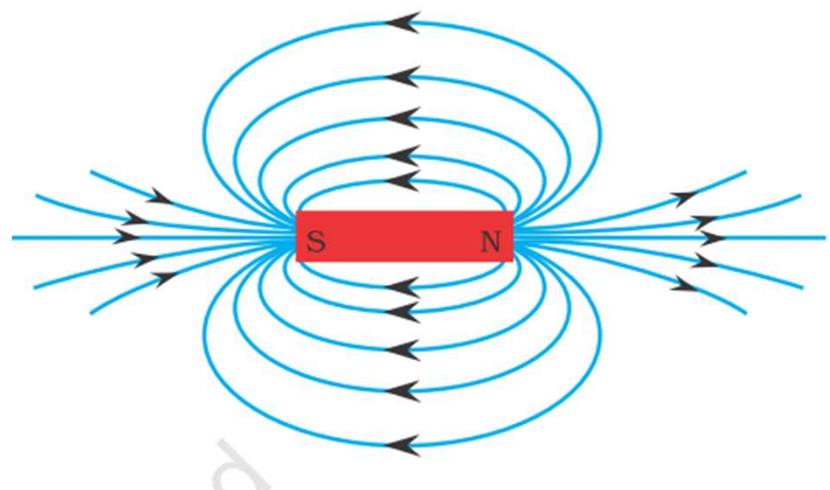
c) Same

d) Not enough information

# Magnetic lines of force

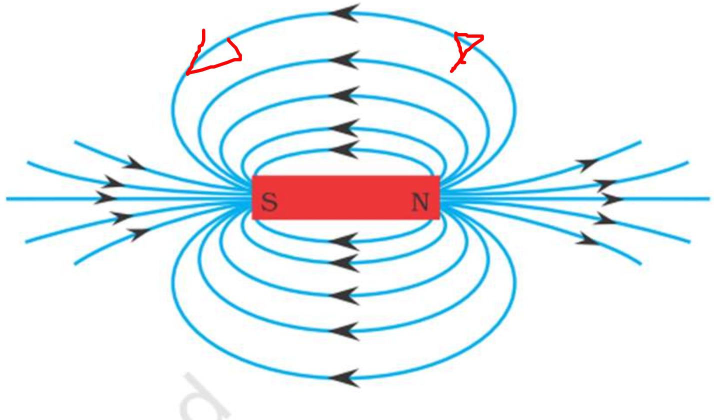
Magnetic field is a quantity that has both direction and magnitude. But it's invisible so to understand it better physicist introduced Magnetic Lines of Force .

Magnetic Lines of Force is a an *imaginary* line representing the direction of magnetic field such that the *tangent at any point* is the *direction of the field* vector at that point.



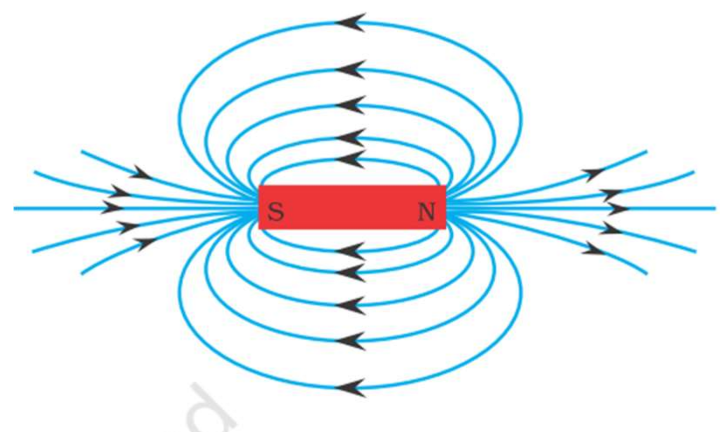
# Properties of magnetic lines of force

- It is taken by convention that the field lines emerge from north pole and merge at the south pole.(note the arrows marked on the field lines in figure).
- They are continuous through the body of magnet.
- Two magnetic lines of force can not intersect each other.



# Properties of magnetic lines of force

- The relative strength of the magnetic field is shown by *the degree of closeness* of the field lines. The field is stronger, that is, the force acting on the pole of another magnet placed is greater where the field lines are crowded .
- The direction of the magnetic field is taken to be the direction in which a north pole of the compass needle moves inside it.



# Poll 2

Complete the following statement about magnetic field lines.

**Magnetic field lines _____.**

a) intersect when two magnets are brought close together.

b) intersect inside a magnet.

c) don't intersect because the north and the south poles are always found together.

d) don't intersect because a compass needle at the point of intersection can't point in two directions.

# Cross & Dot Convention

## Cross & Dot Convention

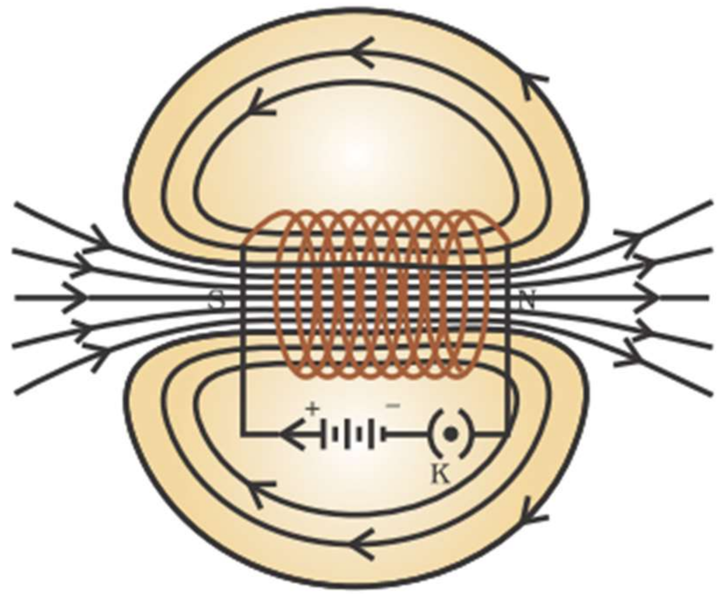
Current INTO the plane of paper

Current Coming Out of the plane of paper

*Current carrying conductor is represented by small circle

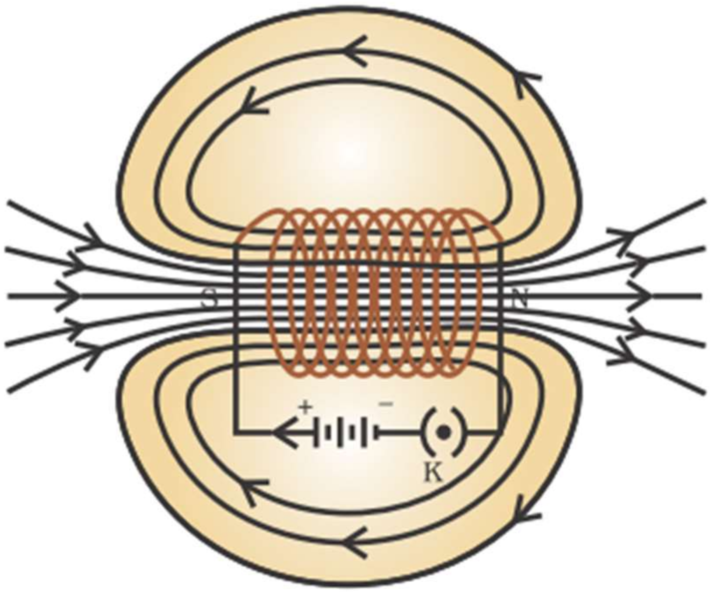
# Solenoid

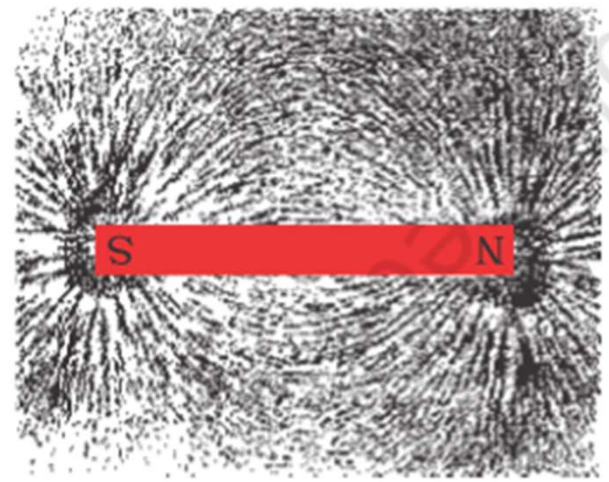
A coil of many circular turns of insulated copper wire wrapped closely in the shape of a cylinder is called a solenoid.



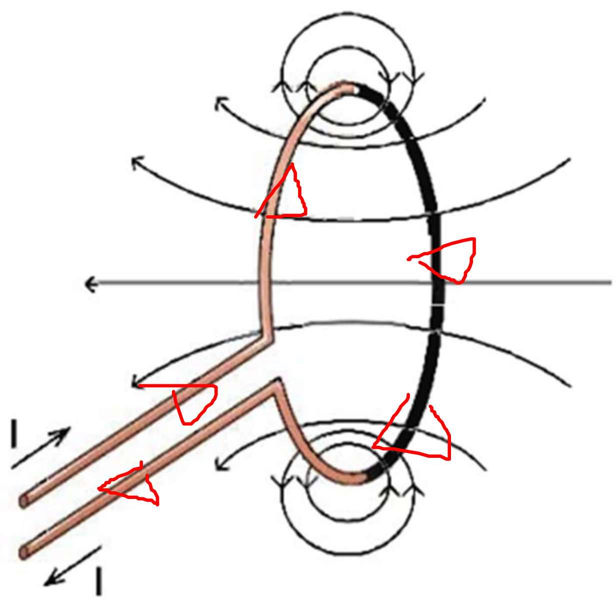
# Solenoid

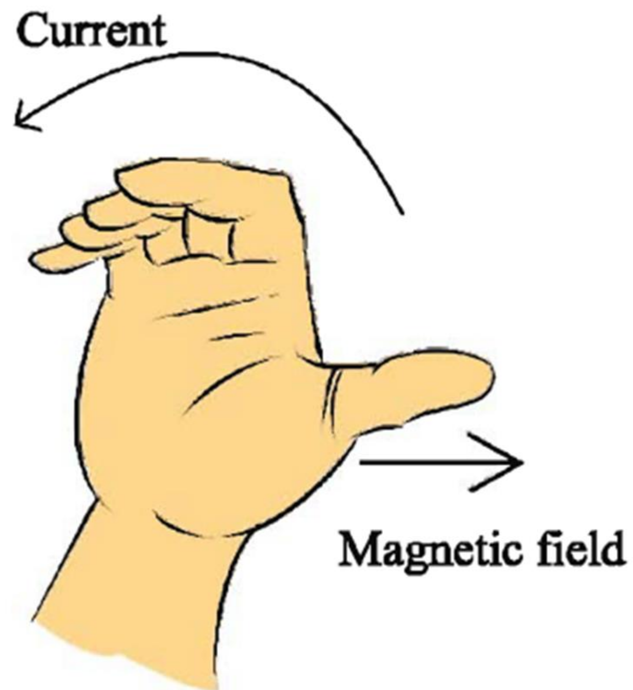
A coil of many circular turns of insulated copper wire wrapped closely in the shape of a cylinder is called a solenoid.



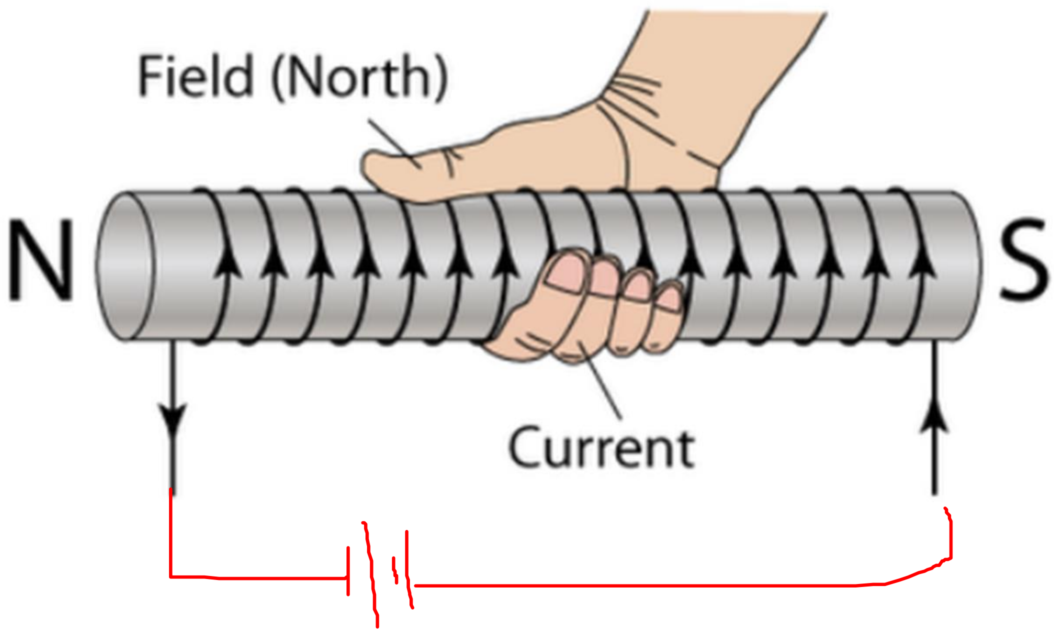



# Direction of magnetic field of a circular loop



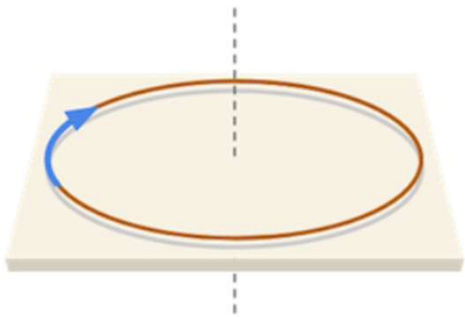



# Direction of magnetic field of a solenoid



# Poll 3

A current flows in a circular loop in the clockwise direction. Where is the north pole of the magnetic field produced by this current?



a)Above the loop

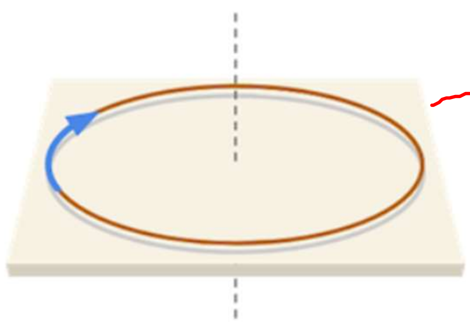
b)Below the loop

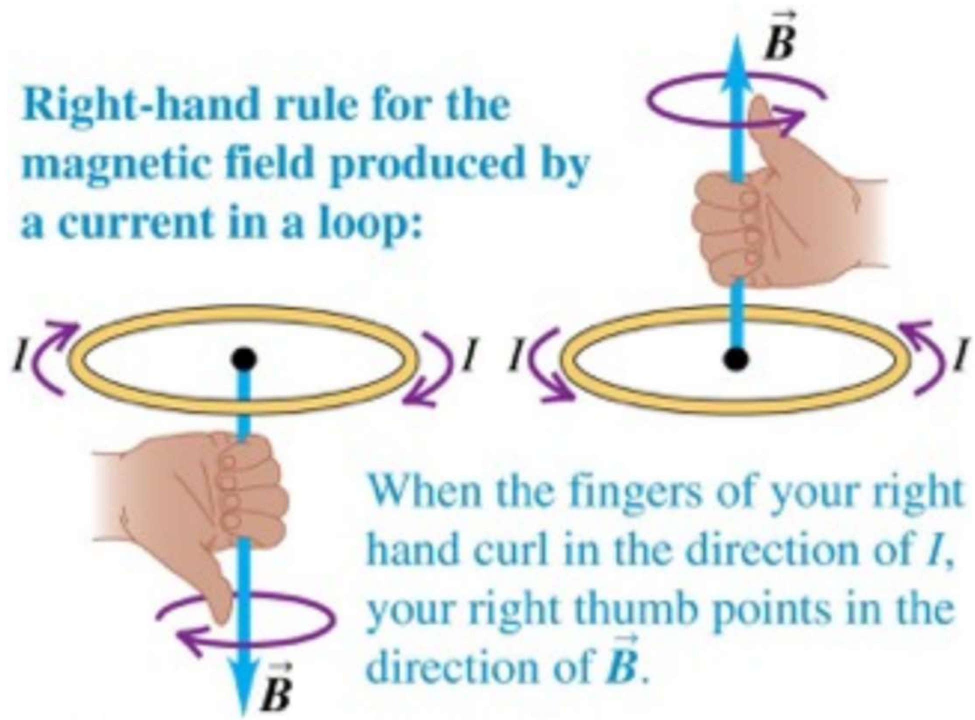
c) A current-carrying loop does not have magnetic poles.

d) None

# Poll 3

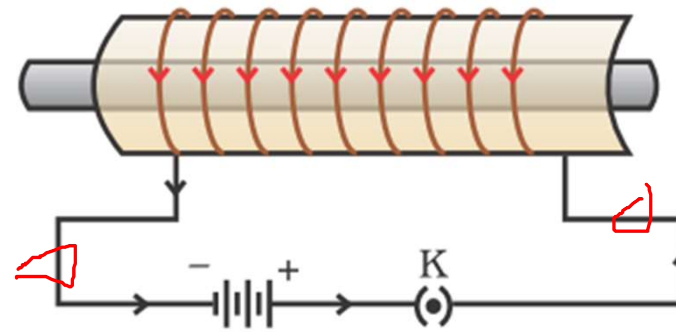
A current flows in a circular loop in the clockwise direction. Where is the north pole of the magnetic field produced by this current?





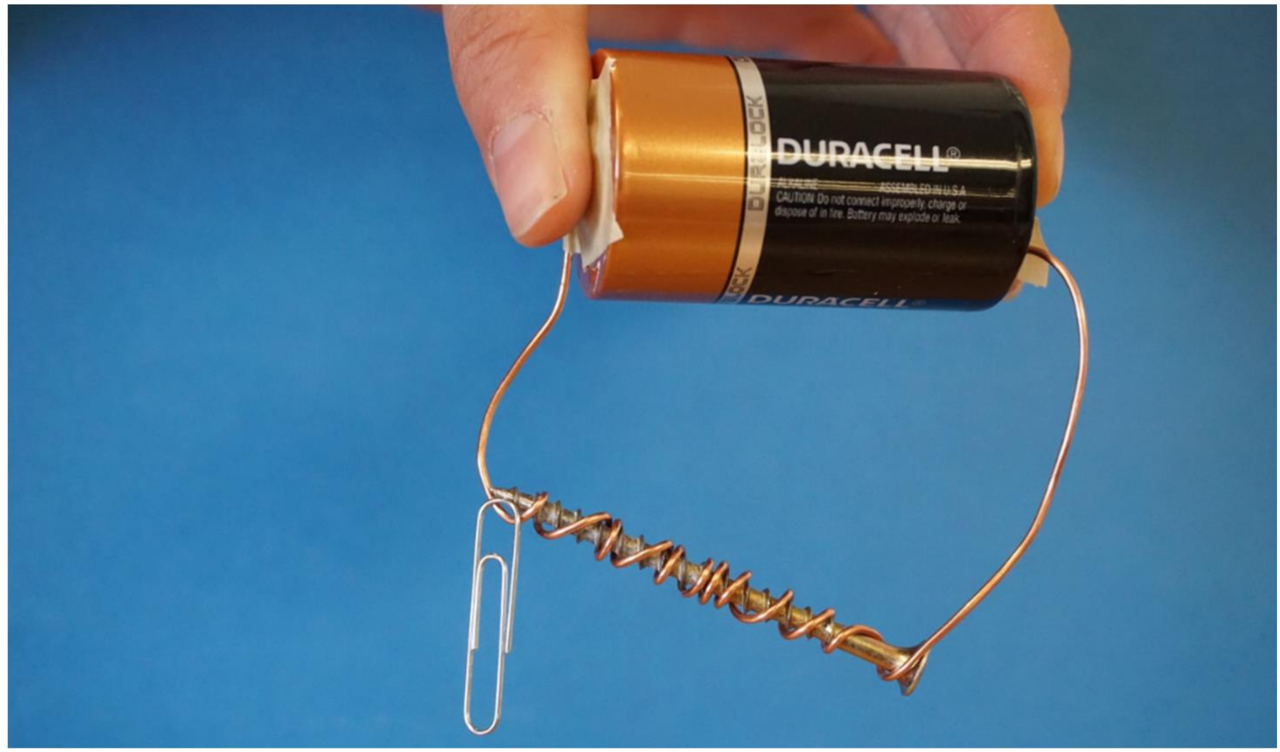
# How to increase the intensity of magnetic field?

- increasing the number of turns on the coil per unit length
- increasing the current of wire I ↑
- A strong magnetic field produced inside a solenoid can be used to magnetize a piece of magnetic material, like soft iron,when placed inside the coil. The magnet so formed is called an electromagnet.



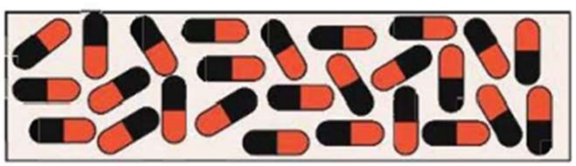
# Electromagnet

You can build an electromagnet yourself.

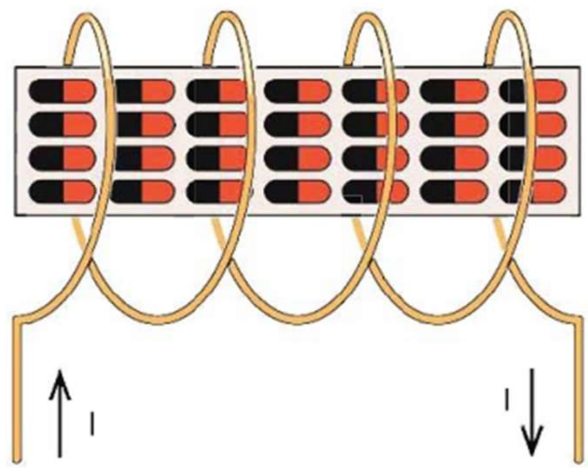


# Electromagnet

Without any external magnetic field

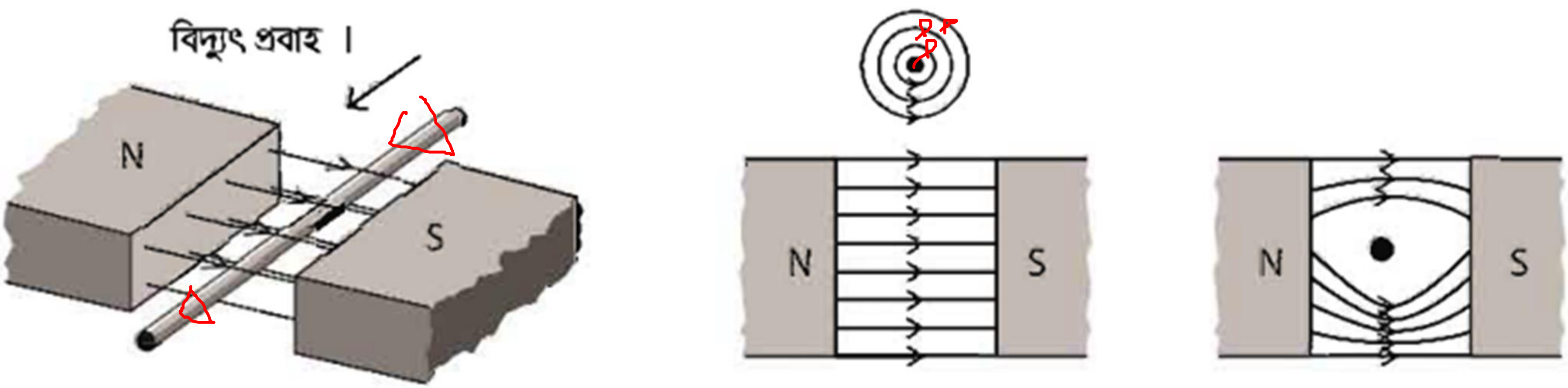


After applying an external magnetic field



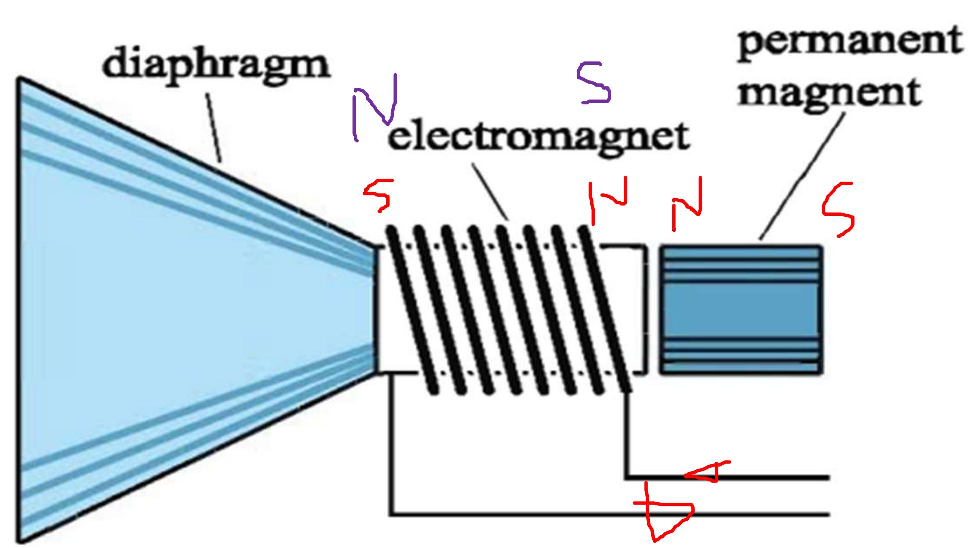
# Effect of a magnet on a current-carrying wire

An electric current flowing through a conductor produces a magnetic field. The field so produced exerts a force on a magnet placed in the vicinity of the conductor.



# Effect of a magnet on a current-carrying wire

A practical example (although it is over-simplified)



লেগে থাকো সৎভাবে,
স্বপ্ন জয় তোমারই হবে

উদ্ভাস-উন্মেষ শিক্ষা পরিবার