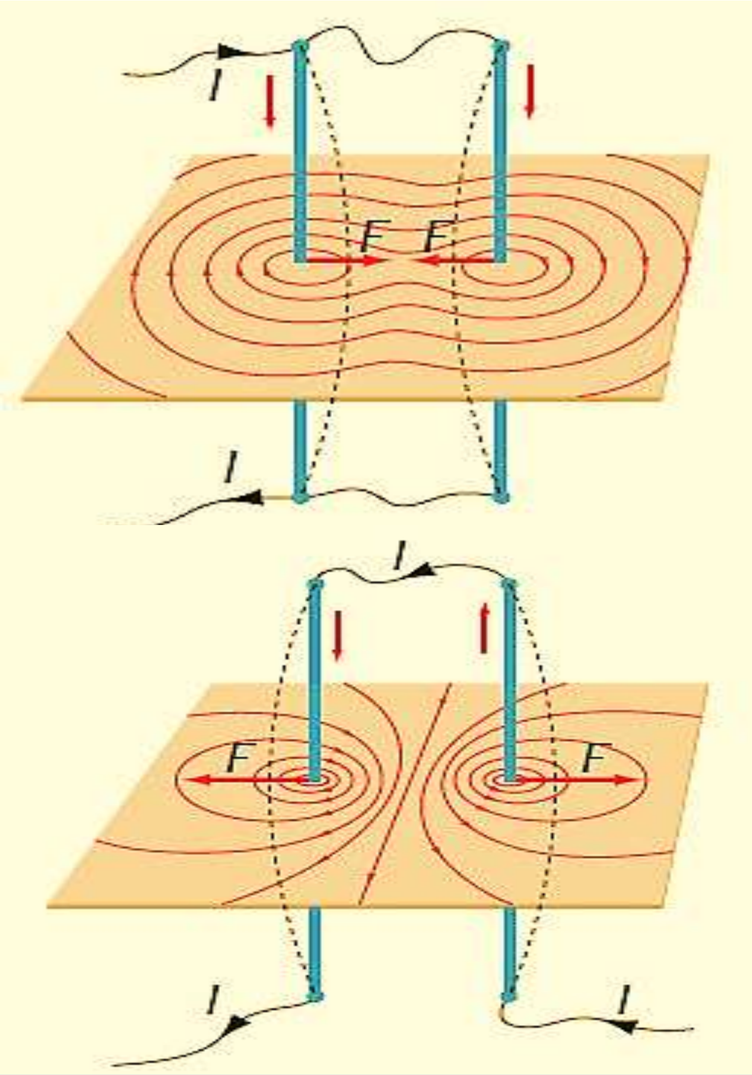
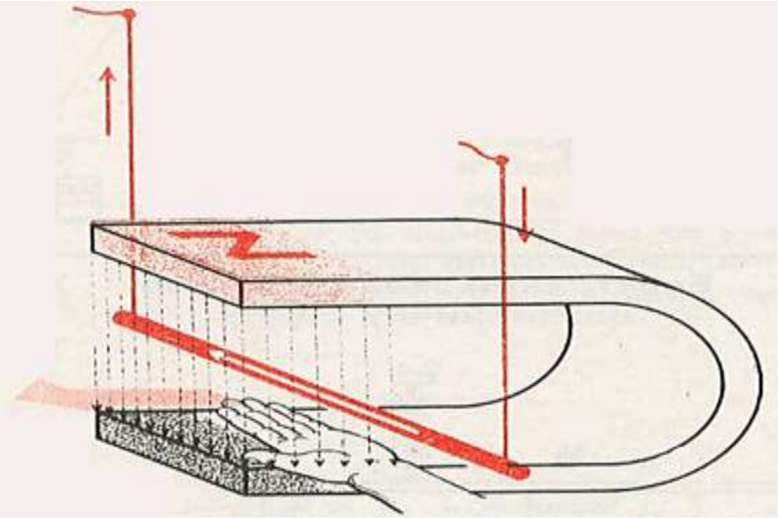


AMPER FORCE

MAGNETIC FORCE ON A CURRENT-CARRYING CONDUCTOR (AMPER FORCE)



picture 1

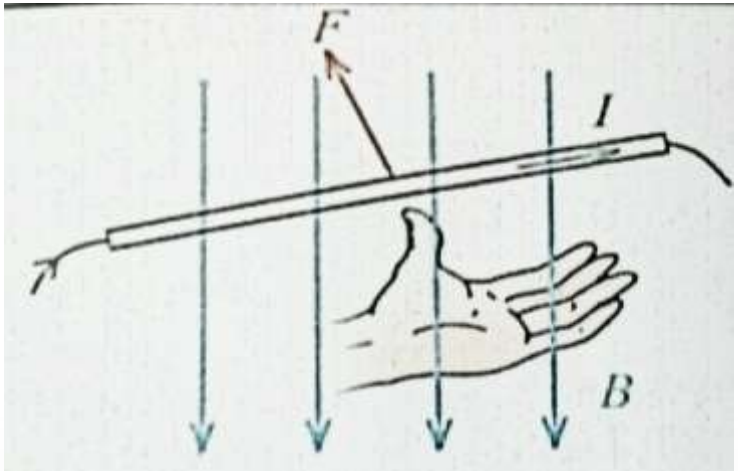
If an aluminium rod is suspended horizontally between the poles of a magnet (picture 1), and current is passed through the wire, then the aluminium rod is displaced. If the direction of current is reversed then the direction of dispalcement is also reversed.

The force exerted by the magnetic field on the current-carrying conductor is called magnetic force (Amper force).

The Amper force is given by equation**:**

$$\vec{F}_A = \mathrm{I}\vec{l}x\vec{B}$$

Where $\vec{F}_A$ is the Amper force vector, $\vec{l}$ is *a length vector* with a magnitude I and directed along the direction of the electric current, and $\vec{B}$ is the magnetic field vector.



picture 2

The direction of the force can be determined by left hand rule (picture 2).
The fore fingers shows the direction of the electric current, magnetic field lines passes throught open slape of left hand and the thumb shows the direction of the Amper force.

The implications of this expression include:

- The Amper force is perpendicular to both the conductor L directed along the direction of the electric current and the magnetic field B.
- The magnitude of the Amper force is $\boldsymbol{F_A = IlBsin\theta}$ where θ is the angle < 180 degrees between the conductor L and the magnetic field B. This implies that the Amper force is zero if the conductor is placed parallel to the magnetic field and force is maximum when the conductor is placed at right angle to a magnetic field.

It follows from the equation $F = IlB$ for B that:

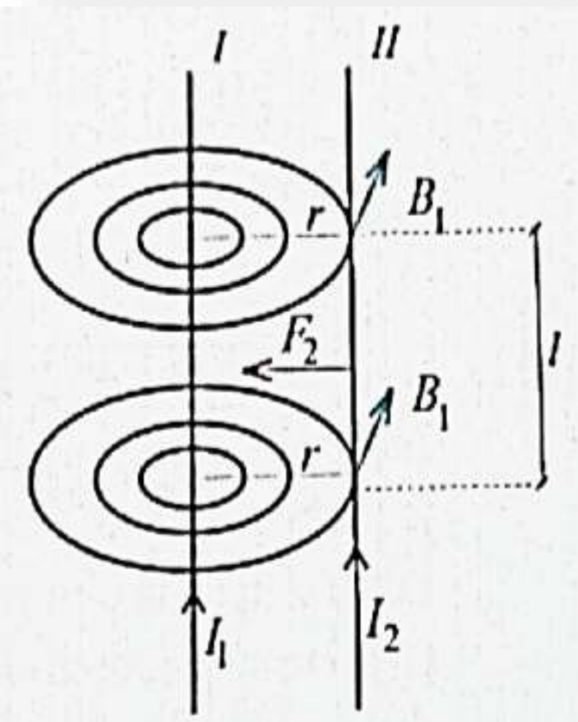
$$B = \frac{F}{Il}$$

$$1T = 1\frac{N}{Am}$$

The strength of magnetic field is 1 T, when a conductor carrying a current of 1 A placed at right angles to the magnetic field experiences a force of 1 N per metre of its length.

MAGNETIC FORCE BETWEEN TWO PARALLEL CONDUCTORS

Because a conductor carrying a current creates a magnetic field around itself, it is easy to understand that two current-carrying wires placed close together exert magnetic forces on each other.



picture 3

Consider two long, straight, parallel conductors separated by the distance *r* and carrying currents I_1 and I_2 in the same direction, as shown in picture 3. We are finding the force on conductor 2 due to the magnetic field of conductor 1. The current I_1 sets up magnetic field $\vec{B}_1$ at conductor 2. The direction of $\vec{B}_1$ is perpendicular to the conductor. We find that the magnitude of this magnetic field is

$$B_1 = \mu_0 \frac{I_1}{2\pi r}$$

The magnitude of the magnetic force on conductor 2 in the presence of field $\vec{B}_1$ due to I_1 is:

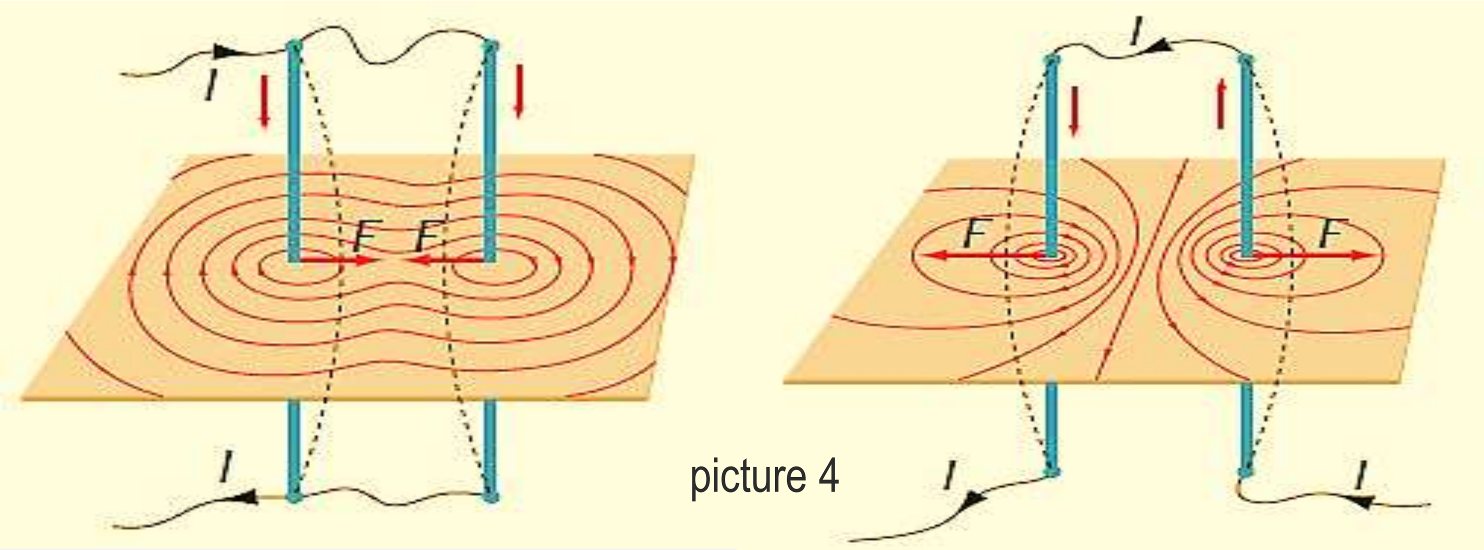
$$F_2 = I_2 l B_1 = \mu_0 \frac{I_1 I_2}{2\pi r} l$$

The direction of $\vec{F}_2$ is toward conductor 1, as indicated by left-hand rule. This calculation is completely symmetric, which means that the force $\vec{F}_1$ on conductor 2 is equal to and opposite $\vec{F}_2$, as expected from Newton's third law of action–reaction.

The force between two parallel currents I1 and I2 separated by a distance r, has a magnitude per unit length given by:

$$\frac{F}{l} = \mu_0 \frac{I_1 I_2}{2\pi r} l$$

Picture 4:
The force is attractive if the currents are in the same direction and repulsive if they are in opposite directions



picture 4

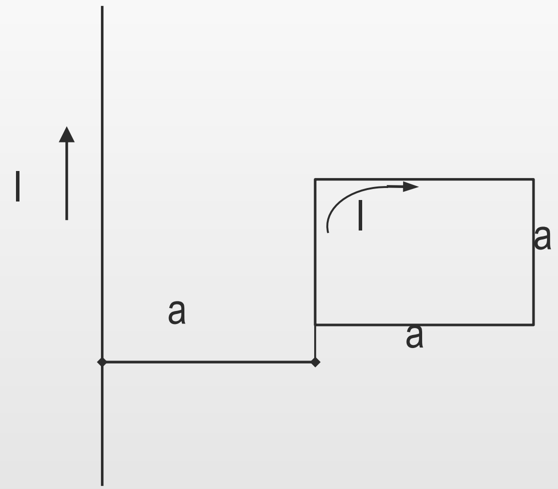
The force between two parallel conductors carrying a current is used to define the SI unit of current, the **ampere** (A), as follows:

If two long, parallel conductors 1 m apart carry the same current and the magnetic force per unit length on each wire is $2 \cdot 10^{-7}\, N/m$, the current is defined to be 1 A.

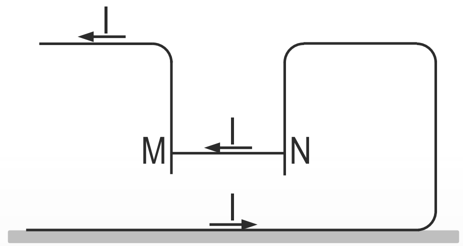
PROBLEMS

1. A 0,8m long straight conductor moves in a magnetic field of induction 50mT. The current in the conductor is 15A. The conductor is at an angle 30º with the magnetic induction vector. Find the magnitude of Amper force acting on the conductor?

2. A square frame with side a and a long straight wire (throught the wire and frame flows I=10A currents) are located in the same plane as shown in the picture. Find the resultant Amper force acting on the frame?



3. A long bent conducting wire is placed as shown in the figure. An MN wire is connected to it (that wire) through sliding contacts. What is the current intensity if the wire stands at a height of 36mm. The MN wire has a mass per unit length of 2g/m.



4.An MN wire of length 30cm and mass of 30g is suspended from two conducting threads and placed in a homogeneous magnetic field that is directed vertically upward. Determine the angle of deflection (measured from the vertical) if the current of 1A is passed through the conductor. The induction of the magnetic field is 0.5T.