FORCE BETWEEN TWO PARALLEL CURRENTS

THE AMPERE

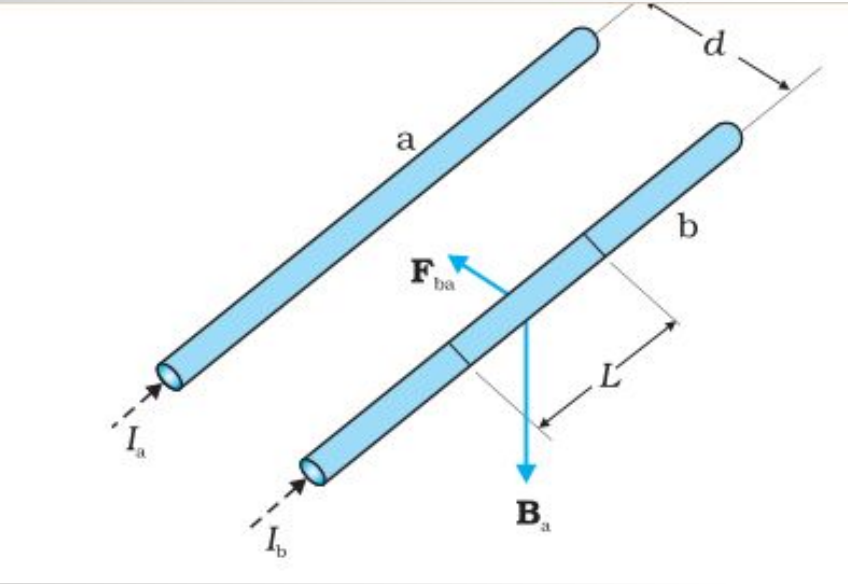

Figure shows two long parallel conductors a and b separated by a distance d and carrying currents $\mathbf{I_a}$ and $\mathbf{I_b}$, respectively. The conductor ‘**a**’ currents $\mathbf{I_a}$ and $\mathbf{I_b}$ and separated by a distance **d**.

The conductor ‘**a**’ produces, the same magnetic field $\mathbf{B_a}$ at all points along the conductor ‘**b**’.

The right-hand rule tells us that thedirection of this field is downwards (when the conductors are placed horizontally).

Its magnitude is given by Ampere’s circuital law

$$B_a = \frac{\mu_0 I_a}{2\pi d}$$

The conductor ‘b’ carrying a current I_b will experience a sideways force due to the field B_a. The direction of this force is towards the conductor ‘a’

The force on a segment L of ‘b’ due to ‘a’

$$F_{ba} = I_b \, L \, B_a$$

$$= \frac{\mu_0 \, I_a \, I_b}{2 \pi d} L$$

From considerations similar to above we can find the force F_{ab}, on a segment of length L of ‘a’ due to the current in ‘b’.

It is equal in magnitude to Fba, and directed towards ‘b’. Thus,

$$\mathbf{F_{ba} = -F_{ab}}$$

This is consistent with Newton’s third Law. Thus, at least for parallel conductors and steady currents, we have shown that the Biot-Savart law and the Lorentz force yield results in accordance with Newton’s third Law

Parallel currents attract, and antiparallel currents repel.

If $I_a = I< =1$ Amp

and $d = 1$m

then $F = 2 \times 10^{-7}$ N/m

Definition of Ampere

The ampere is the value of that steady current which, when maintained in each of the two very long, straight, parallel conductors of negligible cross-section, and placed one metre apart in vacuum, would produce on each of these conductors a force equal to

2×10^{-7} newtons per metre of length.