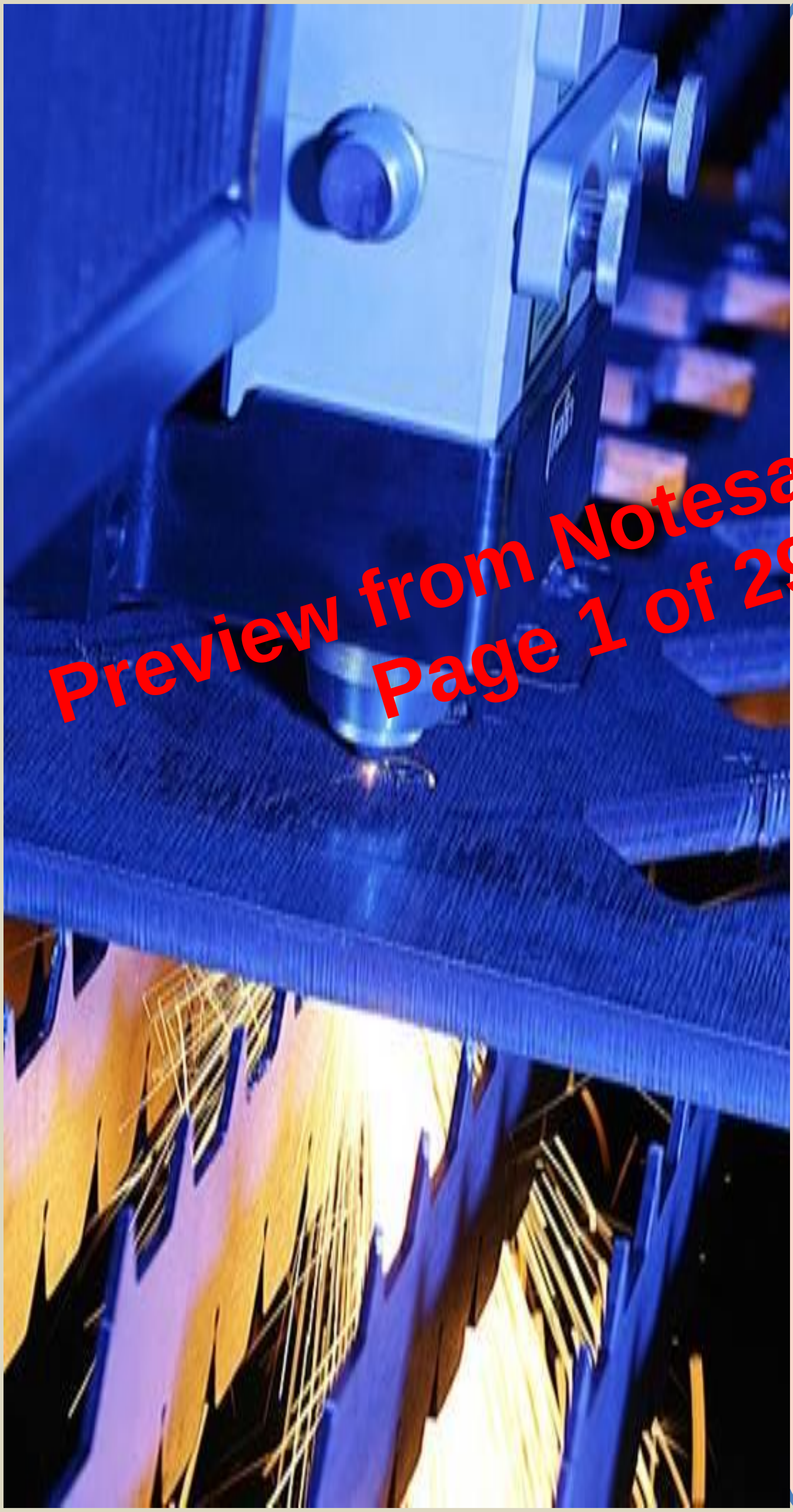
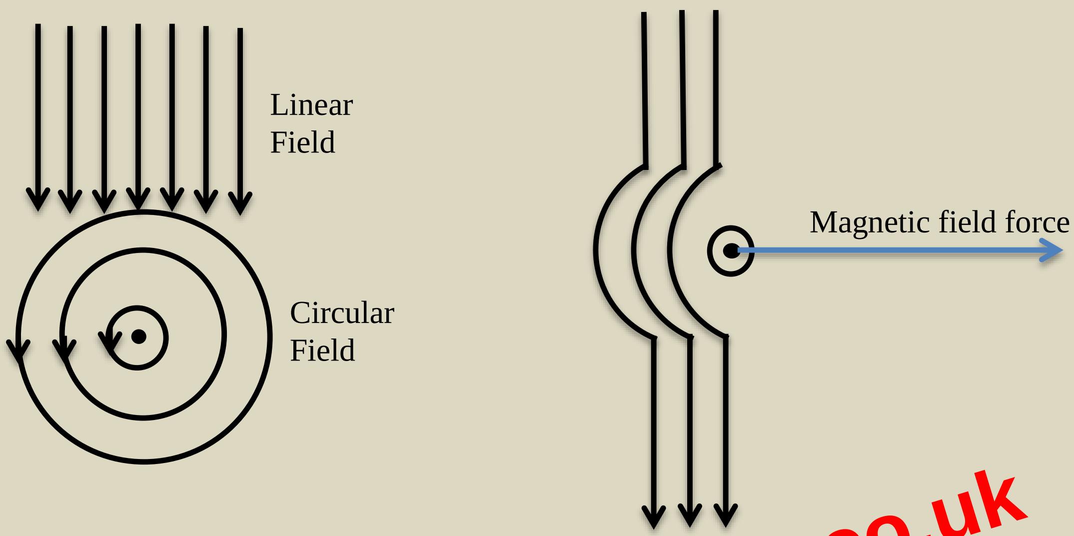
7

Electromagnetism



You need to cut up some chunks of steel. Mechanical tools are prone to wearing out and lasers are just too expensive, so what do you use? Fast cutting electromagnetic pulses and what else? Researchers have figured out that they can modify existing electromagnetic pulse technology and use it to cut hard steels about seven times faster than with a laser and at only a fraction of the cost of other methods. That's not even the crazy part though. The impact pressure [of the pulse] on the steel is approximately 3,500 bar, which equates to the weight of three small cars on a single finger nail .Three cars on a single fingernail. Three cars. One fingernail. Forget cool buzzing sounds from mechanical tools and the pewpewpew of lasers. That description alone makes this the coolest cutting method. In this Chapter we will try to reconnoiter the basics of this wonderful idea, The ELECTROMAGNETISM

If you see the interaction as given, you can draw the fields as given below. Current seems to be coming out of board if seen from one side. Use grip rule to draw circular magnetic field pattern.



Look at the diagram carefully. At left hand side of wire the direction of magnetic field (circular) is the same as the direction of linear magnetic field whereas on right hand side it has opposite direction. Now nature's basic tendency activates. "Nature avoids disturbance and supports equilibrium".
So the field lines always avoid interaction or intersection so all field lines are collected on right hand side. Strictly speaking there is no field line on right hand side of wire.

In this arrangement a force is introduced on the wire pushing the wire towards right and hence wire is kicked out of linear magnetic field. Wire moves out but returns to the field due to one component of its weight but there it is not allowed to enter in the region of linear magnetic field.
Check it by reversing the direction of current. Now you will observe that wire is moving towards left.

7.4.1 Factors Affecting Magnetic Field Force

Following factors affect the magnitude of magnetic field force acting on the wire.

A. Length Of Wire (Exposed)

Magnetic field force is proportional to the length of wire because with this factor number of concentric circles of circular magnetic field increase so more force is exerted on the wire.

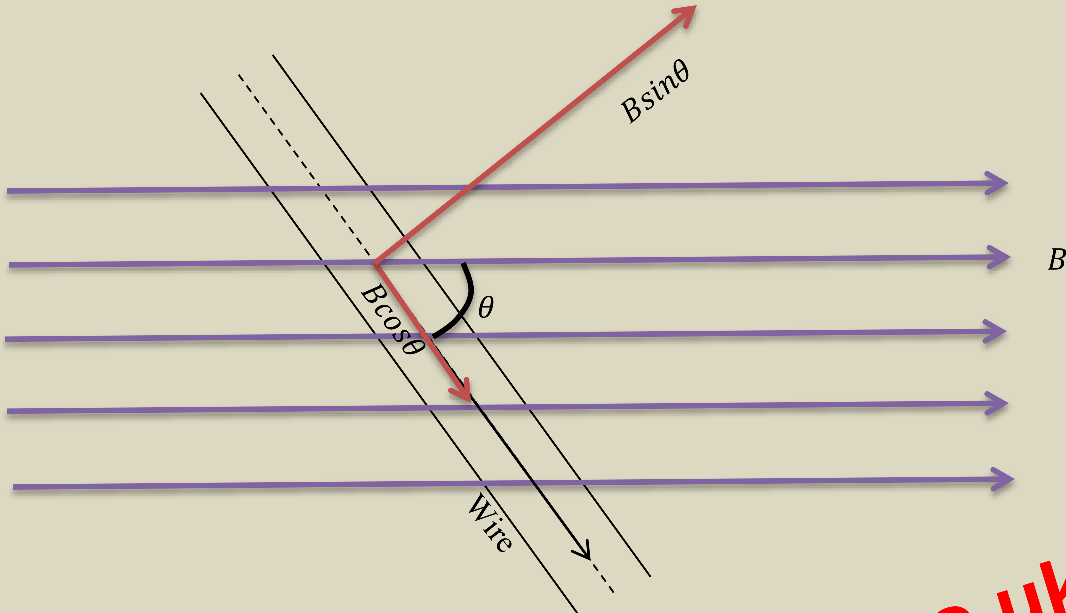
Mathematically $F_M \propto L \quad \rightarrow (1)$

B. Magnitude Of Electric Current:

With increase in current the strength of circular magnetic field increases hence more interaction causes more magnetic field force.

Mathematically $F_M \propto I \quad \rightarrow (2)$

Consider if field lines are making certain angle with current then the situation is as follows.



Now the force is exerted due to $B\sin\theta$ as $B\cos\theta$ is parallel to current. So

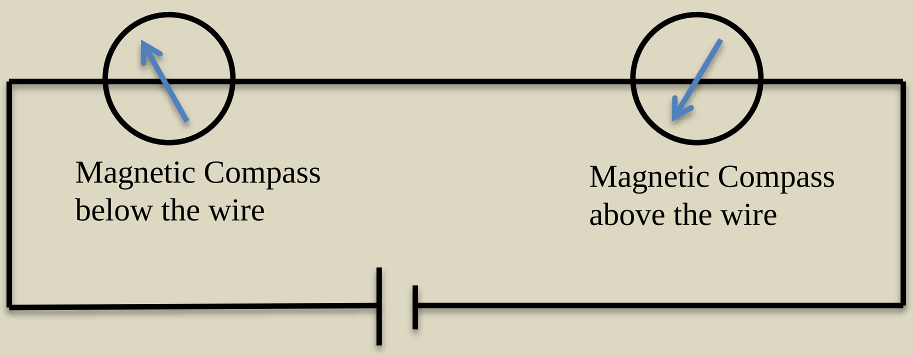
$$F_M = (B\sin\theta)IL$$
$$= BIL\sin\theta$$

If $\theta = 0, \sin 0 = 0$, so $F_M = 0$ i.e. when field lines are parallel to current

If $\theta = 90^0, \sin 90^0 = 1$, so $F_M = BIL$, which is maximum as field lines are perpendicular to current

7.6 Ampere's Swimming Rule

This rule is helpful in determining the nature of circular magnetic fields.

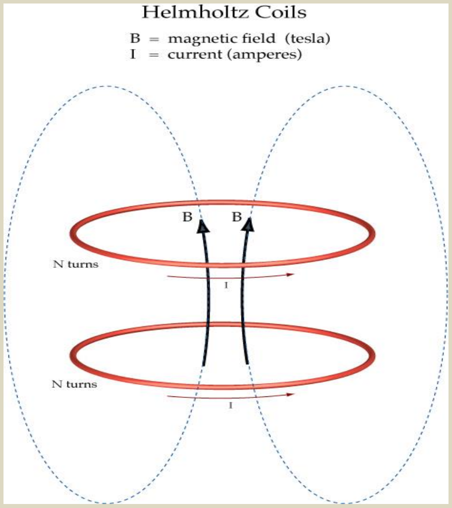


Before stating this rule looks at the diagram carefully. One magnetic compass is placed below the wire and the other is above the wire.

Statement Of The Rule:

"**If a person swims in the direction of flow of current facing the magnetic compass then north pole of the compass is on his left hand side**".

For the case when compass is above the wire, rule is still valid but now the person is considered to swim on his back.



7.10 Field Formula

7.10.1 Solenoid

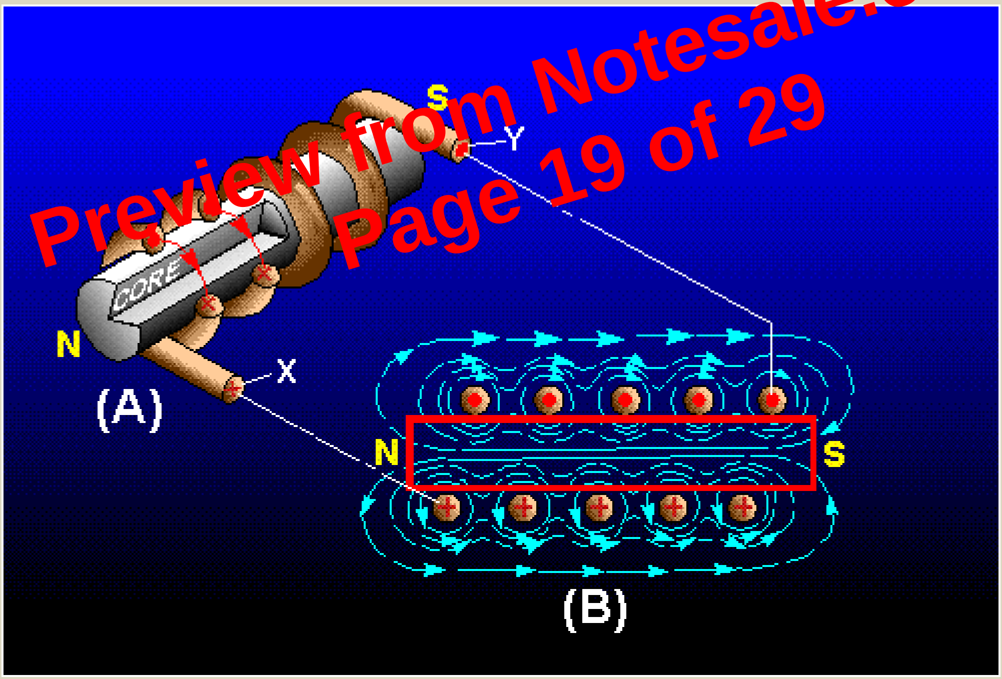


Figure 1-5 illustrates that when a straight wire is wound around a core, it forms a coil and that the magnetic field about the core assumes a different shape. Figure 1-5(A) is actually a partial cutaway view showing the construction of a simple coil. Figure 1-5(B) shows a cross-sectional view of the same coil. Notice that the two ends of the coil are identified as X and Y. When current is passed through the coil, the magnetic field about each turn of wire links with the fields of the adjacent turns. The combined influence of all the turns produces a two-pole field similar to that of a simple bar magnet. One end of the coil is a