Ampere's Circuital Law and Applications

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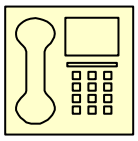

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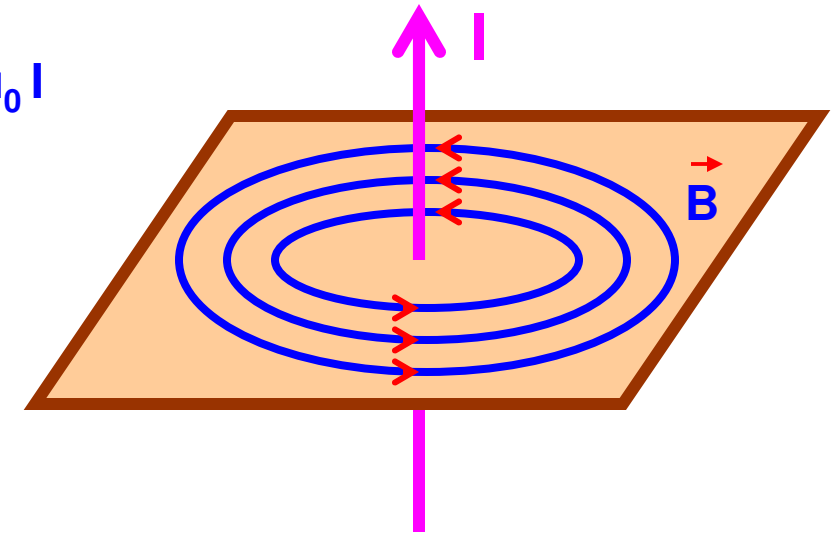
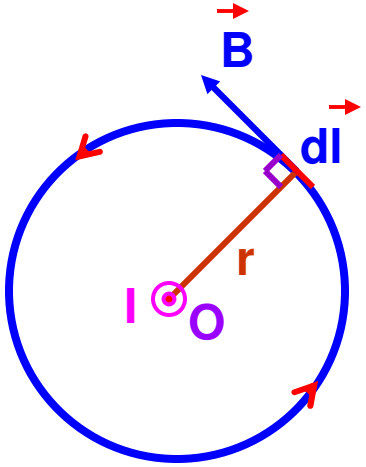
Ampere's Circuital Law:

The line integral $\oint \vec{B} \cdot d\vec{l}$ for a closed curve is equal to μ_0 times the net current I threading through the area bounded by the curve.

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I$$

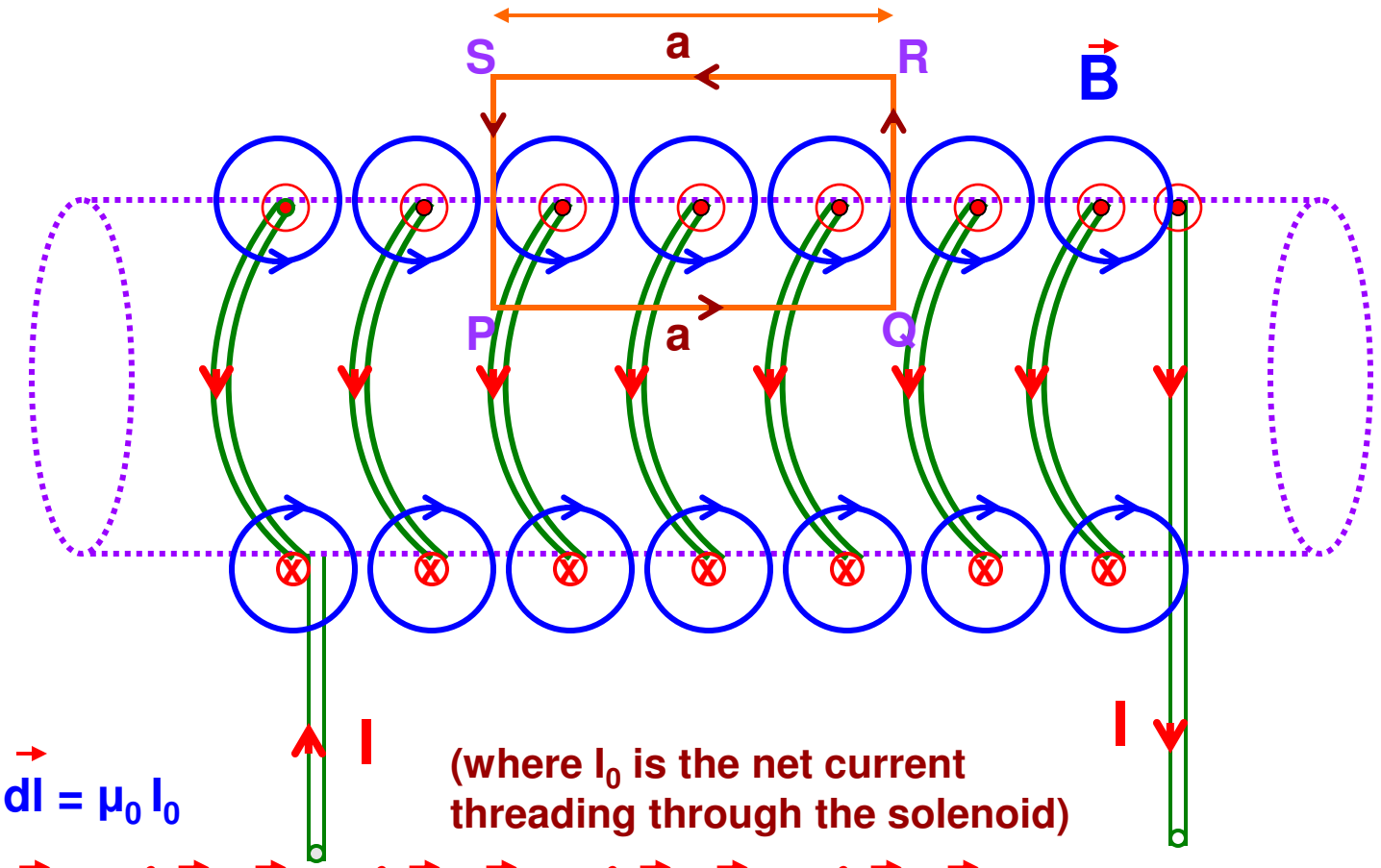




Current is emerging out and the magnetic field is anticlockwise.

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I$$

Magnetic Field at the centre of a Straight Solenoid:



$\oint \vec{B} \cdot \vec{dl} = \mu_0 I_0$ (where I_0 is the net current threading through the solenoid)

$$\oint \vec{B} \cdot \vec{dl} = \int_{PQ} \vec{B} \cdot \vec{dl} + \int_{QR} \vec{B} \cdot \vec{dl} + \int_{RS} \vec{B} \cdot \vec{dl} + \int_{SP} \vec{B} \cdot \vec{dl}$$

$$= \int B \cdot dl \cos 0° + \int B \cdot dl \cos 90° + \int 0 \cdot dl \cos 0° + \int B \cdot dl \cos 90°$$

$$= B \oint dl = B.a \quad \text{and} \quad \mu_0 I_0 = \mu_0 n a I \quad \therefore \quad \boxed{B = \mu_0 n I}$$

(where **n** is no. of turns per unit length, **a** is the length of the path and **I** is the current passing through the lead of the solenoid)

Magnetic Field due to Toroidal Solenoid (Toroid):

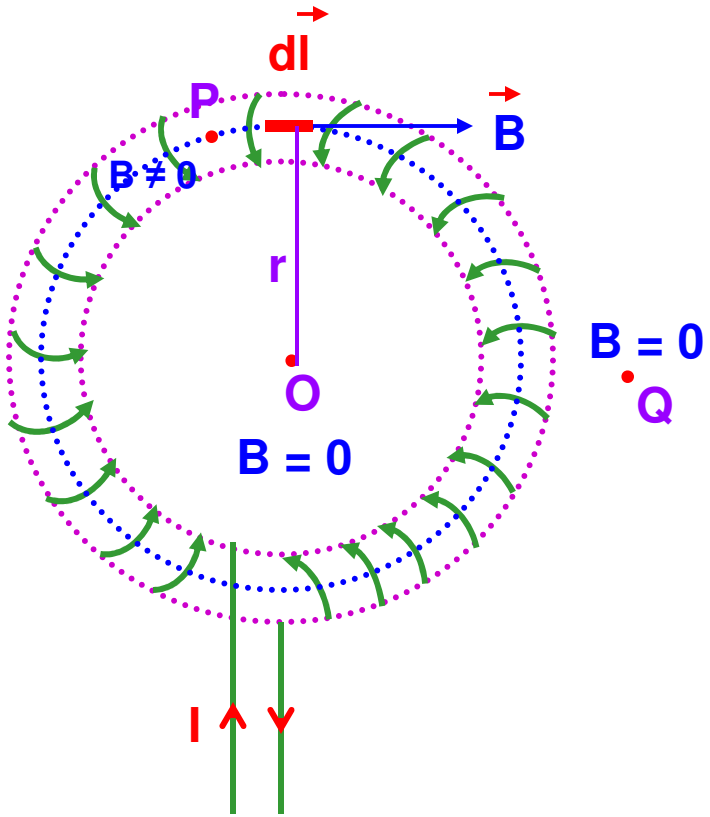
$$\oint \vec{B} \cdot \vec{dl} = \mu_0 I_0$$

$$\oint \vec{B} \cdot \vec{dl} = \oint B \cdot dl \cos 0°$$

$$= B \oint dl = B\,(2\pi r)$$

And $\mu_0 I_0 = \mu_0 n\,(2\pi r)\, I$

$$\therefore \quad \boxed{B = \mu_0 n I}$$



NOTE:

The magnetic field exists only in the tubular area bound by the coil and it does not exist in the area inside and outside the toroid.

i.e. B is zero at O and Q and non-zero at P.

End of Magnetic Effect of Current !