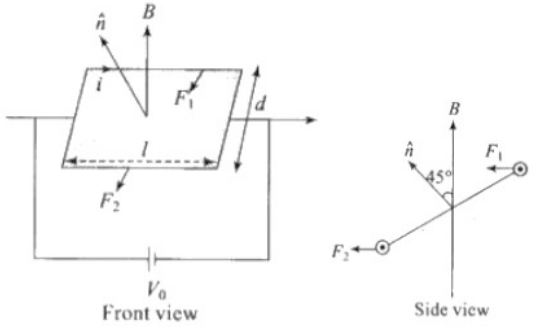
QUES 05:-

A rectangular conducting loop consists of two wires on two opposite sides of length l joined together by rods of length d. The wires are each of the same material but with cross-sections differing by a factor of 2. The thicker wire has a resistance R and the rods are of low resistance, which in turn are connected to a constant voltage source V_0. The loop is placed in uniform a magnetic field B at 45° to its plane. Find τ, the torque exerted by the magnetic field on the loop about an axis through the centres of rods.

Sol. After analyzing the direction of current in both wires magnetic forces and torques need to be calculated for finding the net torque.



Front view

Side view

A_1=A and R_1=2R and A_2=2A and R_2=R

According to the problem, the thicker wire has a resistance R, then the other wire has a resistance 2R as the wires are of the same material so their resistivity remains same.

Now, the force and hence, torque on first wire is given by

$F_i = i_1 lB\sin 90° = \frac{V_0}{2R} lB$

$\tau_1 = \frac{d}{2\sqrt{2}} F_1 = \frac{V_0 lBd}{4\sqrt{2}R}$

Similarly, the force hence torque on other wire is given by

$F_2 = i_2 lB \sin 90° = \frac{V_0}{R_2} lB$

$\tau_2 = \frac{d}{2\sqrt{2}} F_2 = \frac{V_0 ldB}{2\sqrt{2}R}$

So, net torque, $\tau = \tau_2 - \tau_1$ clockwise

$\tau = \frac{1}{4\sqrt{2}} \frac{V_0 AB}{R}$

where A is the area of rectangular coil.