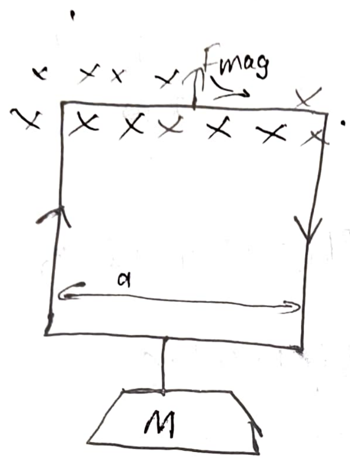
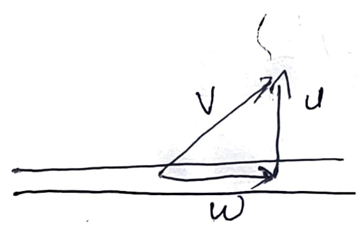
A rectangular loop of wire, supporting a mass m hangs vertically with one end in a uniform magnetic field B which points the page - Find the work done by the magnetic force if the loop rises by a distance h.

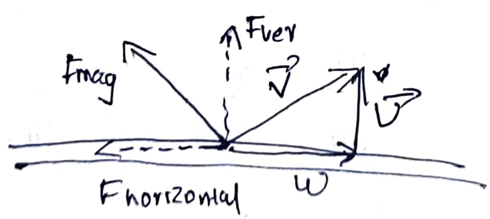


When the loop starts to rise, the charges in the wire are no longer moving horizontally, their velocity acquires an upward u in addition to horizontal component w associated with current $I = \lambda w$.



Since $F = q(\vec{V} \times \vec{B})$

The force acts $\perp$ to the velocity and B



$F_{ver} =$

~~The horizontal component~~ .

$$F_{ver} = IBa = \lambda a w B$$

$$F_{horizontal} = \lambda a u B$$

This horizontal component opposes the flow of current so the battery must do extra amount of work to move these charges against $F_{horizon}$

This work is given by

$$W_{battery} = \lambda a B \int v w \, dt$$ where $w\,dt$ is the distance moved by the charges

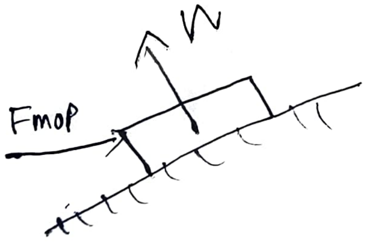
$$W_{battery} = \lambda a B \int v w \, dt = I B a h$$

Here work is indeed done in lifting the loop through a distance h but only by the battery. The role of magnetic force here is to redirect the horizontal force of battery into vertical motion of loop and weight.

$$W_{magnetic\ force} = 0$$

This satisfies the idea that magnetic forces do not work

The mechanical equivalent of this is as follows



Here the normal force do no work because it is $\perp$ to displacement but it does have a vertical component and which is what lifts truck) and a horizontal component (which we overcome by pushing with mop. Here the work is done by us. The normal force plays the same role as magnetic force in while doing no work, it redirects the efforts of the active agent (you) from horizontal to vertical.