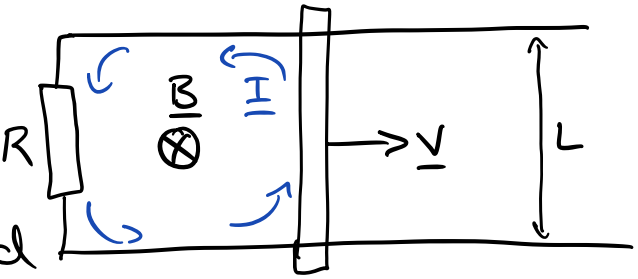
Slidewire Generator



Consider a current moving in 3 wires and a movable rod moving at velocity v under a constant magnetic field $\underline{B}$.

The area changes $\frac{dA}{dt} = vL$

The change in flux through the area will be

$$\frac{d\Phi}{dt} = \underline{B} \cdot \frac{dA}{dt} = -BvL$$

(due to anticlockwise current)

The EMF will be $\mathcal{E} = -\frac{d\Phi}{dt} = +BvL$. This drives a current in the anticlockwise sense.

$$I = \frac{BvL}{R}$$

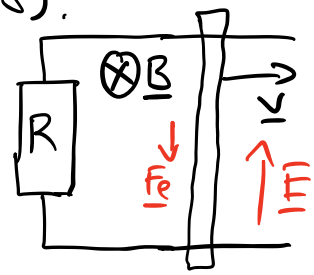
Power: $P = I^2R = \frac{B^2v^2L^2}{R^2} \cdot R = \frac{B^2v^2L^2}{R}$

Where does this power come from? We have to push the rod. The rod will experience the lorentz force, $F = I\underline{L} \times \underline{B}$ to the left. $F = \frac{BvL}{R} \cdot \underline{L} \times \underline{B} = \frac{B^2vL^2}{R}$; $P = Fv = \frac{Bv^2L^2}{R}$

Motional Electric Field

Let's now consider the charges in the rod as it moves, the electrons will undergo the lorentz force $F = q(\underline{E} + \underline{v} \times \underline{B})$

$F_e = qE$ will point downwards (E points upwards).



✡ The electrons get deflected, like in the Hall effect, until the induced electric field is equal and opposite to E. $E_i = -v \times B$ which points down.

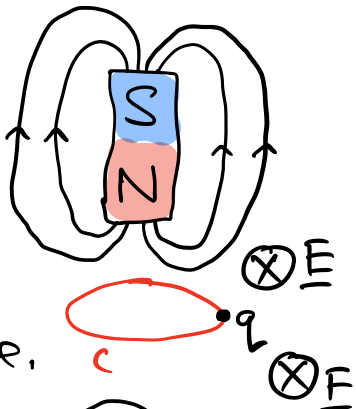
✡ The potential along the rod will be $\mathcal{E} = EL = vBL$, this will drive a current $I = \frac{BvL}{R}$ around the circuit.

These are <u>not</u> separate phenomenon but different ways of doing the same problem.

Frame Transformations

Let's consider two cases: a moving magnet w. stationary charge and a stationary magnet w. moving charge.

① magnet moves down whilst charge stationary. Around C (no wire), $|B|$ increases so $\oint B \cdot dr$ increases. ∴ There is an electric field. At q this points points into the page.



② magnet stationary, moving charge ∴ no electric field. Particle experences Lorentz's force $F = qv \times B$ which is into page.