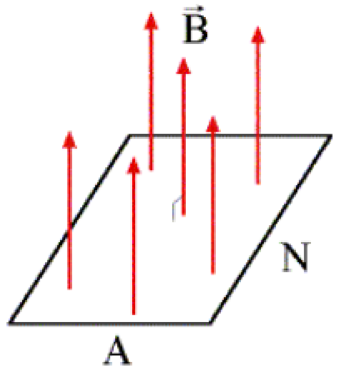
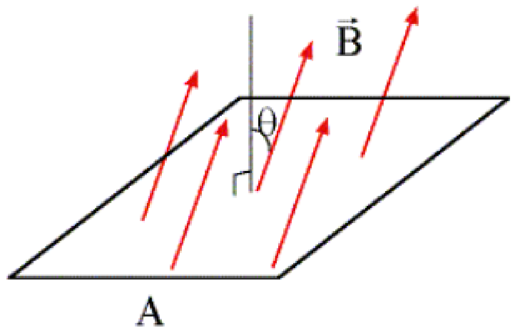
Review from yesterday: Magnetic Flux

$$\Phi_B \equiv B \perp A = BA\cos\theta$$





Faraday's Law of Induction

If a circuit contains a number "N" of tightly wound loops and the magnetic flux through each loop changes over a time interval, we can calculate and average emf induced

$$\mathcal{E} = -N\frac{\Delta\Phi_B}{\Delta t}$$

What causes the change in the flux?

Since: $\Phi_B = BA\cos\theta$

Anyone of A, B, or the angle can cause a change in flux

What about the magnitude of the induced emf?

$$|\mathcal{E}| = \frac{|\Delta\Phi_B|}{\Delta t} = \frac{|\Delta(B\cos\theta)|A}{\Delta t}$$ If magnetic field is changing

$$|\mathcal{E}| = \frac{|\Delta\Phi_B|}{\Delta t} = \frac{|\Delta(A\cos\theta)|B}{\Delta t}$$ If area of coil is changing

A rectangular coil is located in a uniform magnetic field of magnitude 0.30 T directed perpendicular to the plane of the coil. If the area of the coil increases at the rate of 5.0 x 10^-3 m^2/s, what is the magnitude of the emf induced in the coil?

$$\mathcal{E} = \frac{\Delta \Phi_B}{\Delta t} = \frac{B\,\Delta A}{\Delta t}$$

$$= (0.30\,T)(5.0 \times 10^{-3}\,m^2/s)$$

$$= 1.5 \times 10^{-3}\,V = 1.5\,mV$$

A wire loop of radius 0.30m lies so that an external magnetic field of magnitude 0.30T is perpendicular to the loop. The field reverses its direction, and its magnitude changes to 0.20T in 1.5s. Find the magnitude of the average induced emf in the loop during this time.

$$|\varepsilon| = \frac{|\Delta \Phi_B|}{\Delta t} = \frac{|\Delta B \cos\theta| A}{\Delta t}$$

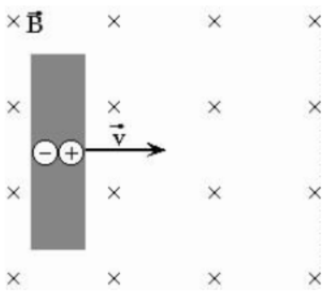
$$\frac{|0.20T\cos 180^\circ - 0.30T\cos 0|\pi(0.3m)^2}{1.5s}$$

$$9.4\times 10^{-2}\,V$$

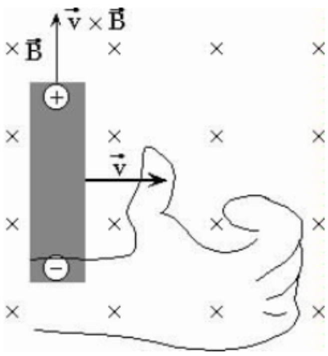
Motional EMF

A conducting bar is comprised of charge that can move in the bar. If it moves through a magnetic field, the qvB magnetic force will cause a separation of positive and negative charges. For a magnetic field pointing into the screen and a bar moving to the right, in what direction will the positive conduction charges move?

up or down?



up



Quantifying it...

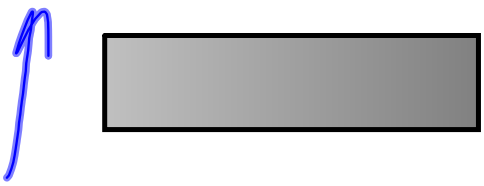
What does it depend on?

We have a uniform magnetic field (B)

We have a conductor of some length (l)

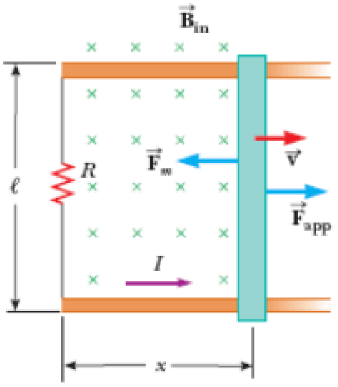
And that conductor is moving at some speed (v)

$$\cancel{q}E = \cancel{q}vB$$



$$\Delta V = El = Blv$$

Faraday's Law?



$$\mathcal{E} = \frac{\Delta \Phi_B}{\Delta t}$$

$$\mathcal{E} = \frac{\Delta BA\cos\theta}{\Delta t}$$

$$\mathcal{E} = \frac{\Delta BA}{\Delta t}$$

$$\mathcal{E} = \frac{B\Delta A}{\Delta t} = \frac{B\,\Delta \ell w}{\Delta t}$$

$$= B\ell\frac{\Delta x}{\Delta t}$$

$$\mathcal{E} = B\ell v$$

A pickup truck has a width of 79.8 inches. If it is traveling north at 37 m/s through a magnetic field with vertical component of 35 uT, what magnitude emf is induced between the driver and passenger sides of the truck?

$$\mathcal{E} = Bl v = (35\times10^{-6}\,T)(79.8\,in)(37\,m/s)\left(\frac{1\,m}{39.37\,in}\right)$$

$$\mathcal{E} = 2.6\,mV$$