March 3, 2020

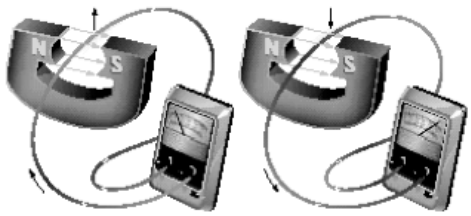
Electromagnetic Induction

Why will moving a wire through a magnetic field induce a potential difference and a current in the wire?

moving a wire through a magnetic field generates a magnetic force on the electrons in the wire and causes them to flow through the wire

emf (electromotive force):

potential difference



Maximum emf (and current) is induced when . . .

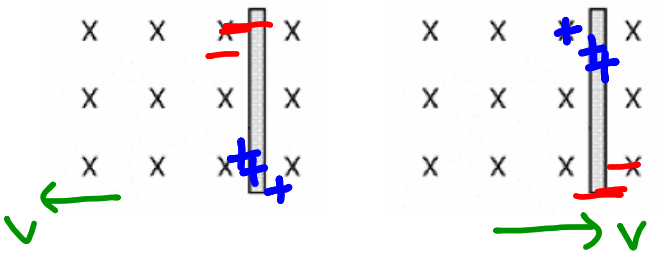
$v_\perp B_\perp \ell$

Induced EMF:

$\mathcal{E} = \vec{B} \times \vec{\ell} \cdot \vec{v}$

Variable:	$\mathcal{E}$	$\vec{B}$	$\vec{\ell}$	$\vec{v}$
Quantity:	EMF	mag field	length of wire	velocity
Units:	[V]	[T]	[m]	[m/s]
Type:	scalar	vector	vector	vector

$\frac{N}{C \cdot m/s} \cdot m/s \cdot m = \frac{J}{C}$

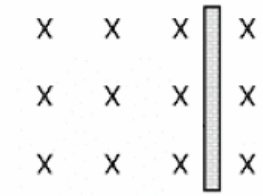


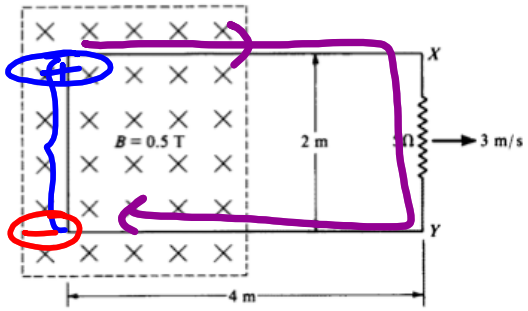
1. What is the potential difference induced in a 1.5 meter length of wire moving perpendicular to a 0.4 T magnetic field at a speed of 2.1 m/s?

$\mathcal{E} = B\ell v = .4\,T \cdot 1.5\,m \cdot 2.1\,m/s$

$= 1.3\,V$

2. In which direction should the wire be moved to induce the most potential difference?





3. A wire loop as shown is pulled to the right at a constant speed of 3 m/s.

a) Determine the induced potential difference between points X and Y.

$\mathcal{E} = B\ell v = .5\,T \cdot 2\,m\ 3\,m/s = 3\,V$

b) Determine the magnitude of the induced current.

$I = \mathcal{E}/R = 3\,V/5\,\Omega = .6\,A$

c) Which way will the current flow?