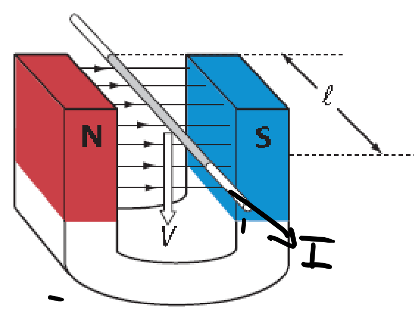
Lesson 8.1 – Induced EMF

Unit 8: Electromagnetic Induction

You know that when electric charges move, they produce a magnetic field. In addition, a magnetic field will exert a force on moving charges.
Consider the following question: ***If a current produces magnetism, could magnetism produce a current?*** Explain.

A **current** in circuit can be **induced** if a length of wire, ***l***, is made to **move** through a **perpendicular** magnetic field.

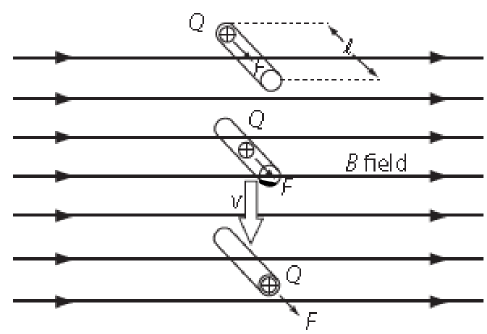


Why is current induced?

The force from the magnetic field pushes charge through the wire.

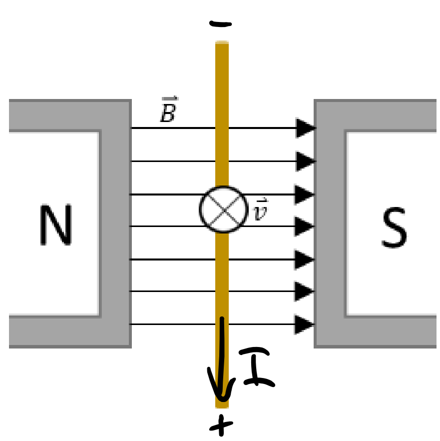
Direction of current: use the 2nd right-hand rule

- Thumb in direction the wire is moving
- Fingers extend with the external magnetic field
- Palm faces direction of force and gives direction of conventional current

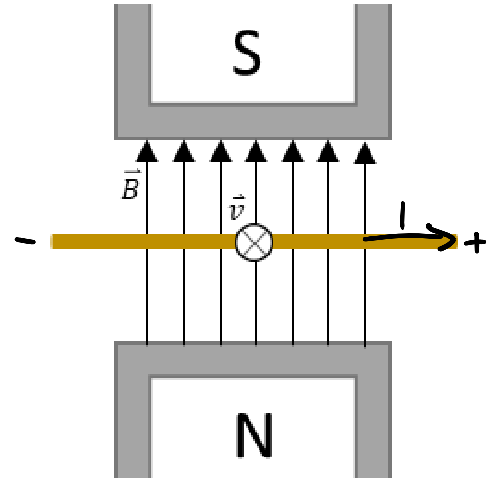


(b)

Example 1: Indicate the direction of current if the motion of the wire is into the page.



Example 2: Indicate the direction of conventional current



Defining EFM:

Induced Electromotive Force (Induced EMF) – A **voltage** created when a magnetic field changes around a conductor.

- ❖ Since force on each charge causes movement, work is done:

Force on a charge: $\vec{F} = \vec{B}Q\vec{v}$

Charges move so work is done: $W = F \cdot d$

$W = \vec{B}Q\vec{v}l$

Work done → charges gain potential energy: $\cancel{Q}V = \vec{B}\cancel{Q}\vec{v}l$

The gain in E_p per unit charge is induced EMF ($\mathcal{E}$)

$$\boxed{\mathcal{E} = \vec{B}\vec{v}l}$$

If the wire is at an angle θ to $\vec{B}$, use:

$$\boxed{\mathcal{E} = \vec{B}\vec{v}l\sin\theta}$$

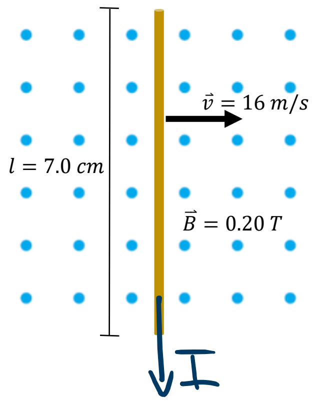
$\mathcal{E}$ = Induced EMF (V)
$\vec{B}$ = Magnetic Field Intensity (T)
$\vec{v}$ = velocity of conductor (m/s)
l = length of conductor in external $\vec{B}$-field (m)

Units of Induced EMF are volts:

Consider

$$\mathcal{E} = \vec{B}\vec{v}l = T \cdot \frac{m}{s} \cdot m = \frac{N}{A \cdot \cancel{m}} \cdot \frac{\cancel{m}}{s} \cdot m = \frac{Nm}{As} = \frac{J}{C} = V$$

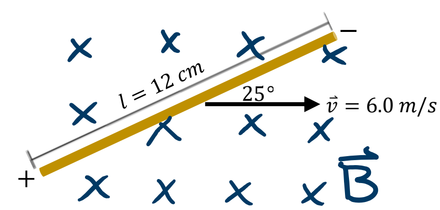
Example 3: Calculate the induced EMF in the wire shown and label the direction of conventional current.



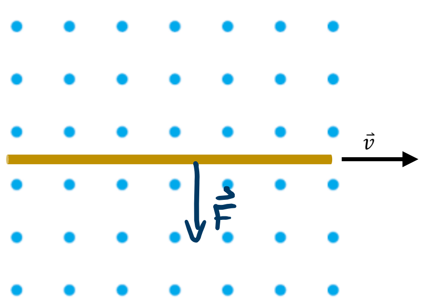
$$\varepsilon = \vec{B}\vec{v}l$$
$$= (0.20T)(16m/s)(0.07m)$$
$$\boxed{= 0.224V}$$

Example 4: Given that the wire shown experiences an induced EMF of 1.2 V, determine the magnetic field (magnitude and direction).

$$\varepsilon = \vec{B}\vec{v}l\sin\theta$$
$$\vec{B} = \frac{\varepsilon}{\vec{v}l\sin\theta}$$
$$= \frac{1.2V}{(6.0m/s)(0.12m)\sin 25}$$
$$= 3.94T \otimes$$



Determine the outcome of the following scenario:



*Force is down ↓

↳ No current

↳ $\varepsilon = 0V$

Assignment: BC Physics 12 Pg. 250 # 1-3 and Pg. 257 # 1-2