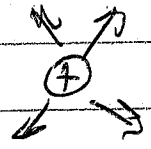
Phys 1402 2017-10-12 Lec 12

So far...

- Electric Field ($\vec{E}$)
  - Generated by charge (q)
  - Causes force on charge (F_E)
  - Is Voltage (V) per distance; $\vec{E}$ points "downhill" toward low V.
  - Voltage causes current.
  - Voltage is energy per charge.



- Magnetic Field ($\vec{B}$)
  - Generated by moving charge ($q\vec{v}$ or I)
  - Circulates instead of being "emitted".
  - Causes force (F_B) on moving charges.
  - Deflects objects/charges, doesn't make them go faster or slower.

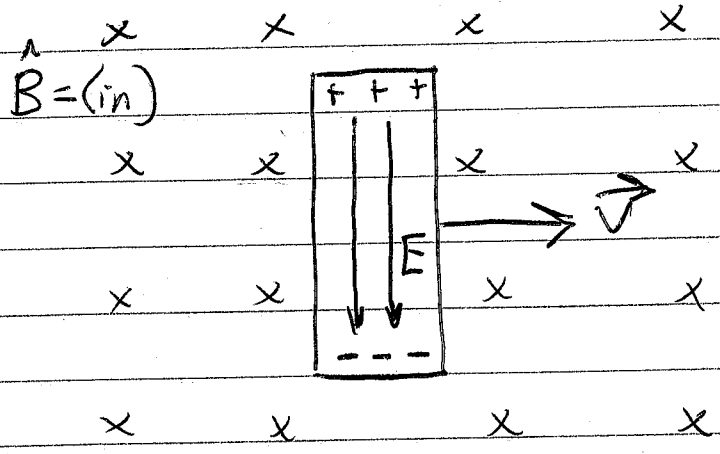
- Electromagnetism
  - Fluctuating $\vec{E}$ generates $\vec{B}$
  - Fluctuating $\vec{B}$ generates $\vec{E}$

Results:

- Electromagnetic Induction (B generates voltage)
- Electromagnetic Waves (Radio, Light)

(2)

Motional EMF - Voltage generated by moving a conductor in a B field.



- Metal block made of ⊕ and ⊖.
- F_B direction: Up on ⊕
  Down on ⊖
- Charges gather @ ends of bar.
- They stop building when $F_E = F_B$.
  & $E = \ell v B$
- Induced E in the bar.
- This is a voltage from one end to the other:

$$E = \frac{-\Delta V}{\Delta x} \Rightarrow \Delta V = -E\,\Delta x$$

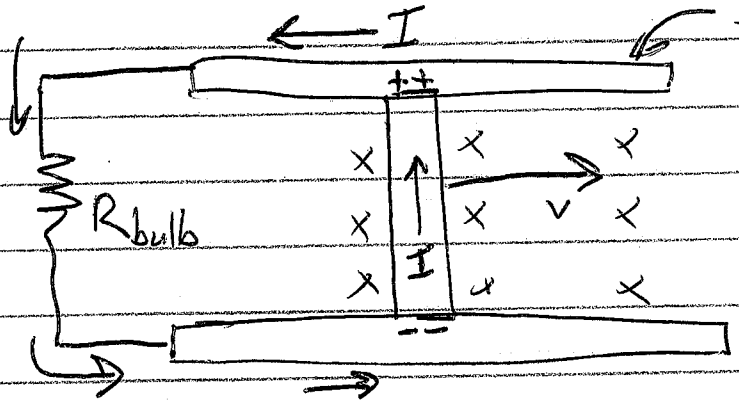
$$|\Delta V| = |E|\,|d| \quad = \ell$$

d = length of bar.

Result: $|\Delta V| = \mathcal{E} = vB\ell$

(3)

Using Motional EMF to power a bulb:



EMF

Generated Voltage: $\mathcal{E} = vBl$

Generated Current: $I = \mathcal{E}/R_{bulb}$

Side-effect: Magnetic Force $= F_B = IlB$

Magnetic force is to the left.

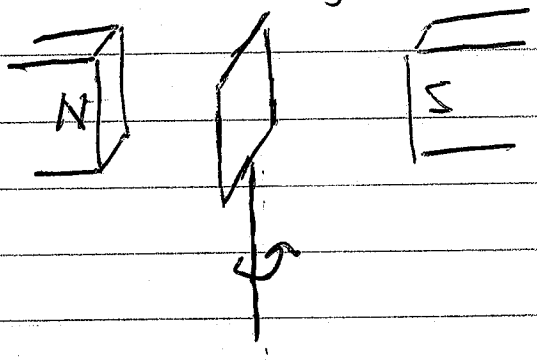
Velocity is to the right.

To keep the bar moving, we must pull the bar to the right.

Mechanical Power input: $P = F \cdot v$
$= IlBv$

Electric Power output: $P = \mathcal{E} I$
$= vBl I$

$\mathcal{E}$ From rotating a coil:



Maximum $\mathcal{E} = NBA\omega$ (Generator)

ω ← rotational speed in rad/s

Recall: Max $\tau = NBA I$ (Motor)

Torque of a generator: opposes motion and makes it hard to spin it, but only when we use it (i.e. draw I).

$\mathcal{E}$ of a motor: opposes current, reducing the motor current, but only once the motor spins freely.