

Lecture 6: Electricity
 Pete Schwartz *Cal Poly Physics*

Motor / Generators (are they different?)
 What is Voltage, Electrical current, and Power
 How does an electric motor work?
 How does an electrical generator?
 Commutator (split ring, DC, AC)
 $V=IR, P=IV=I^2R$

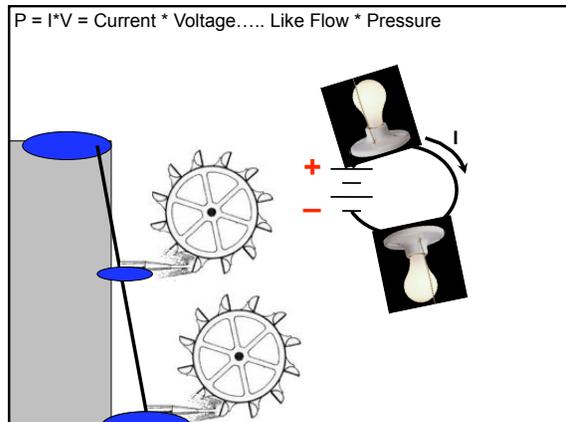
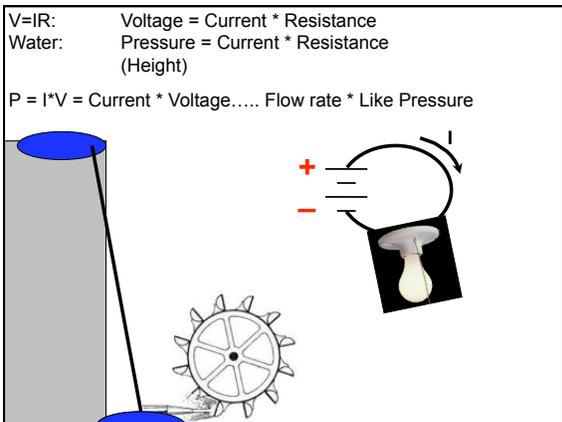
Motors and Generators

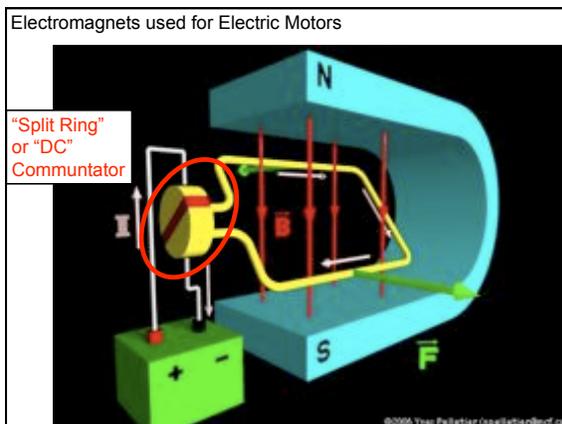
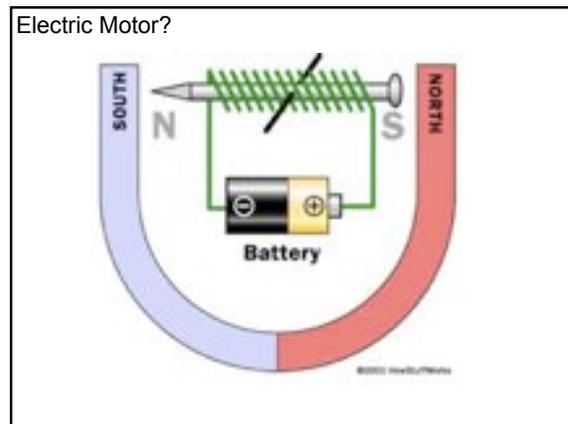
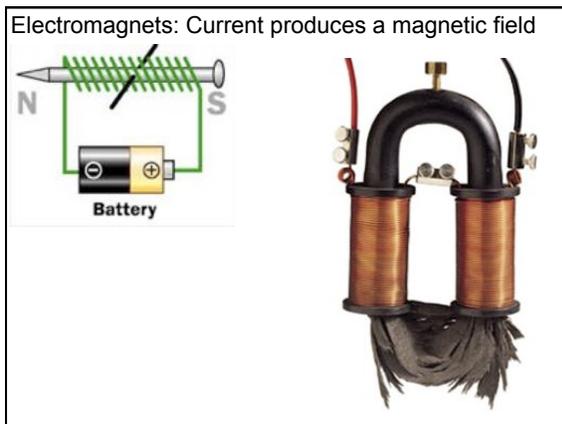
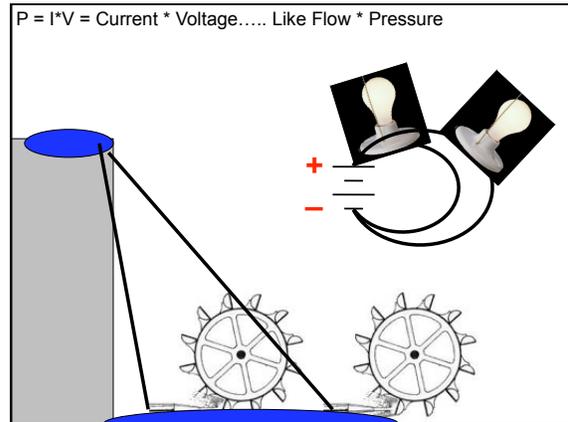
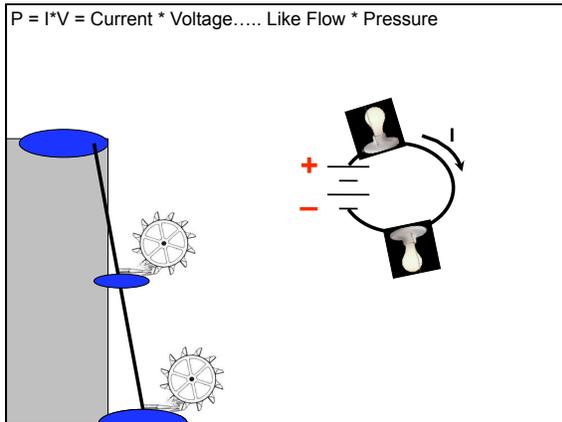
Transducers:
 Between Mechanical Power and Electrical Power

Electrical Power = $I \cdot V$, Current * Voltage
 Mechanical Power = $F \cdot v$, Force * speed
 = $\tau \cdot \omega$, Torque * rotation rate

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Generator, spinning speed (ω) => Voltage
 If you draw current, then it will get harder to push, so Torque (τ) => current





$V = IR, I = V/R$ Voltage Produces Current

Electromagnet: Current produces magnetic field

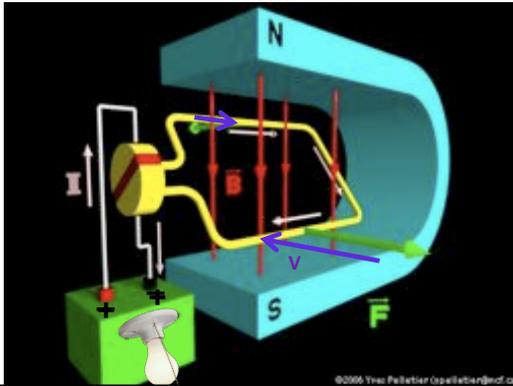
Electric Motor: Current and magnetic field make motion
Electrical Energy \Rightarrow Kinetic energy

Voltage? Batteries = Chemical Energy

Motion + Magnets \Rightarrow Voltage ???

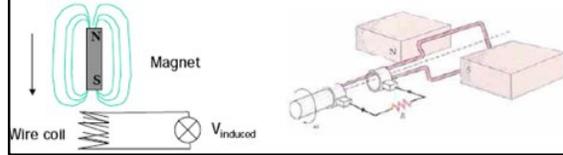
Kinetic Energy \Rightarrow Electrical Energy

Magnets used to generate voltage and current



Every Electric Generator is also a Motor!

- The change in magnetic field produces voltage
Spin faster => more voltage
- If no current => no force on the motor
- If current is drawn => motor pushes *opposite* way
Work in = Electrical Work Out



Wire coil $V_{induced}$

AC: Alternating Current
DC Direct Current

Alternating Current

• Single phase transmission:

$$v = v_m \sin(\omega t); i = i_m \sin(\omega t - \phi)$$

for $\omega = 2\pi f$ (radians/sec), $T = 1/f$

Faraday's Law

- Changing the magnetic field around a conductor will induce an electromotive force (emf, measured in volts).
- Possible sources of change: move the conductor, move the magnet, rotate a coil of wire in a magnetic field
- Faraday's Law - an emf will be created by a coil of wire with N turns when the magnetic field, Φ , that it encloses changes, $e = N \times d\Phi/dt$

Lens Law: Oppose Change! You don't get something for nothing

Wire coil $V_{induced}$