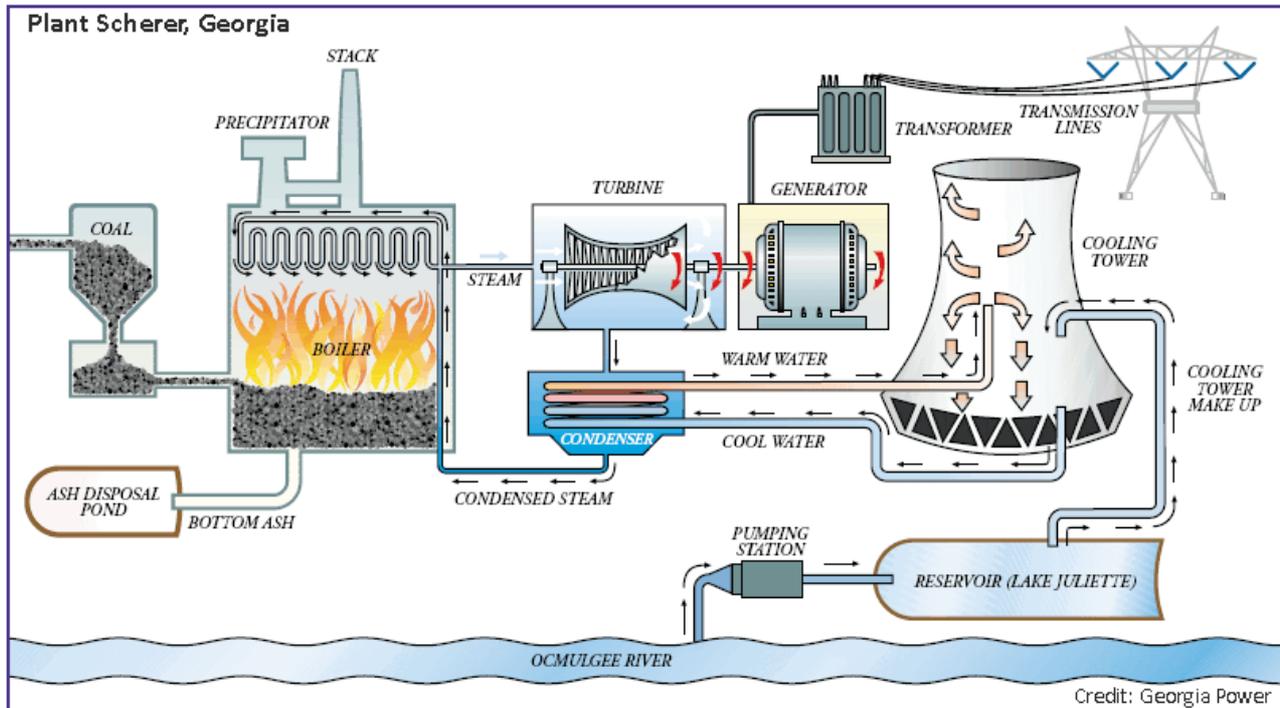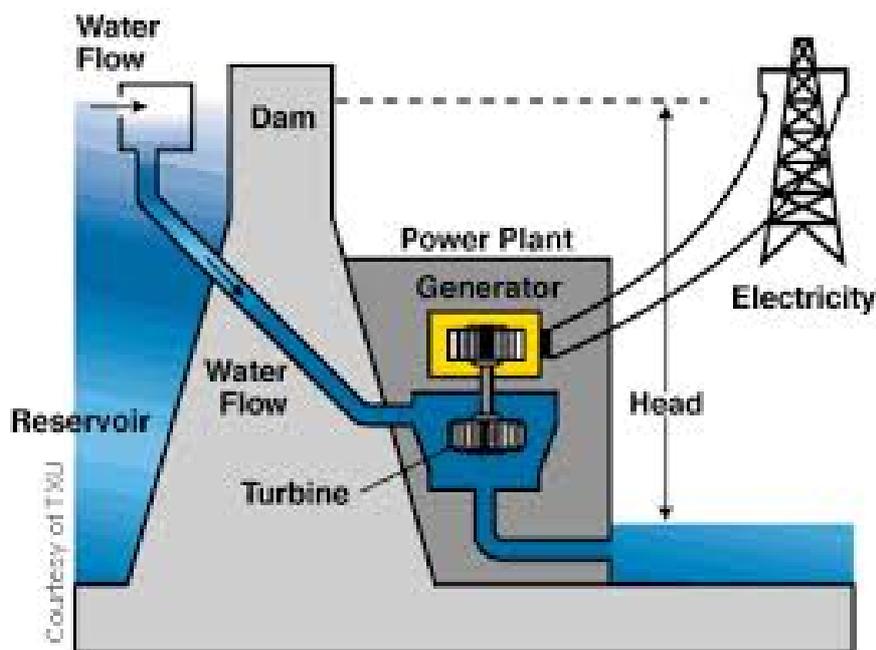# L16 - Motor Effect, Generator Effect, and Mass Spectrometer
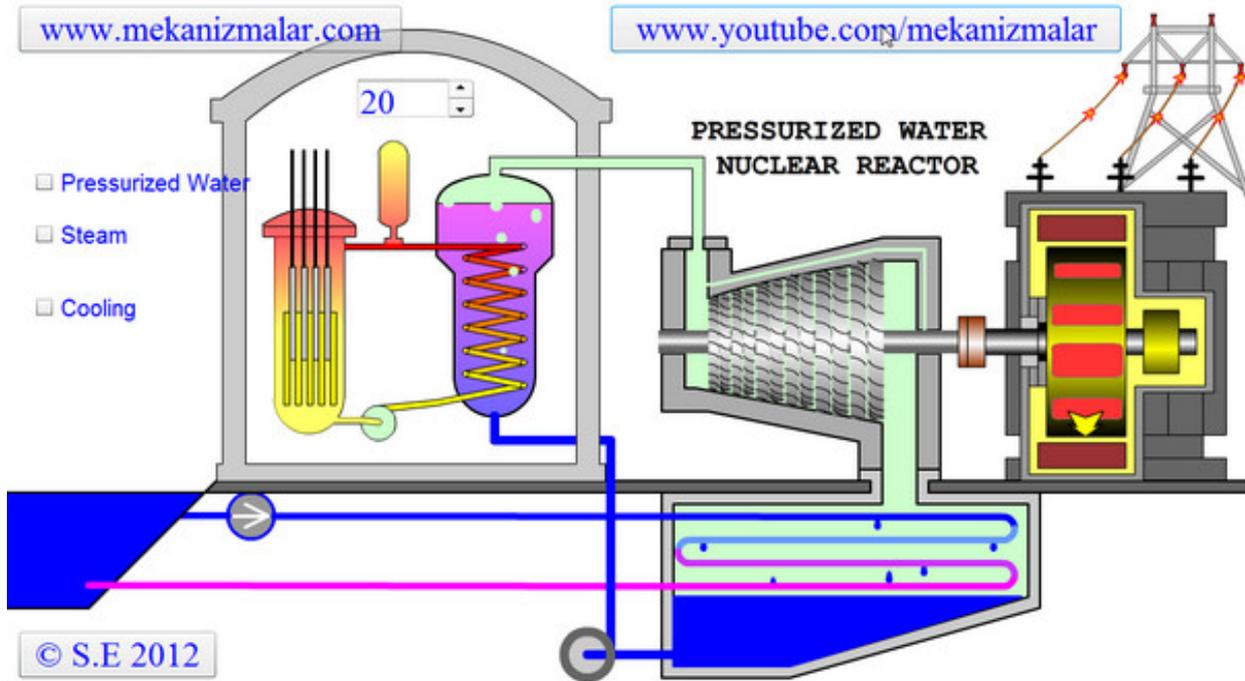
Q1: How do we generate electricity?

Alberta - Coal Power Plant

British Columbia - Hydroelectric Power Plant (i.e. "Dam")

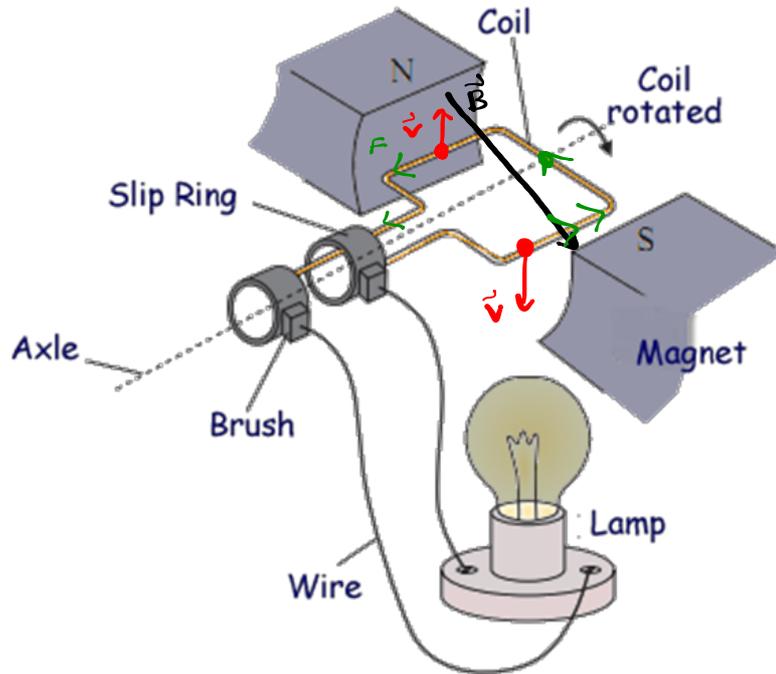*Springfield – Nuclear Power Plant*

Camping – Hand-Crank Flashlight
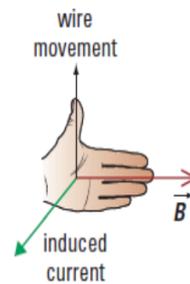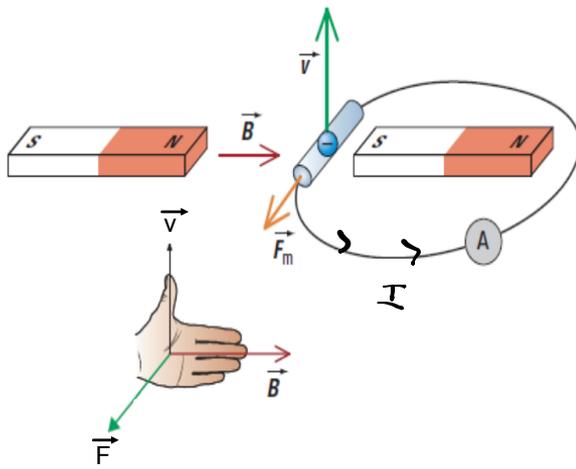
Generator Diagram

DEMO

Coil

N

$\vec{B}$

$\vec{v}$

F

Coil
rotated
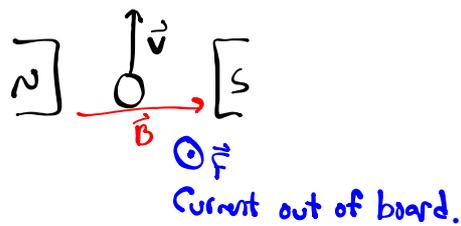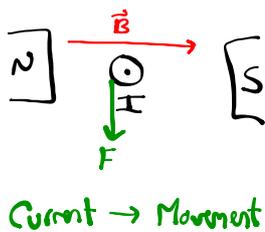
Slip Ring

$\vec{v}$

S

Axle

Magnet

Brush

Lamp

Wire

Q2: Using the Motor Effect, what is the direction of the current induced?

$\vec{v}$

$\vec{B}$

S   N

S   N

$\vec{v}$

$\vec{F}_m$

A

I

$\vec{B}$

$\vec{F}$

wire
movement

$\vec{B}$

induced
current

Q3: What is the difference between the Motor Effect and the Generator Effect?

Electricity → | Motor | → Movement

Movement → | Generator | ← Electricity   DEMO

$\vec{B}$

N] ⊙ I [S

F

Current → Movement

$\vec{v}$

N] ○ [S

$\vec{B}$

⊙ $\vec{F}$

Current out of board.

AC and DC Generators

Metal Brush

Rotating Split-Ring

Lead to External Circuit
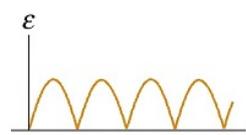

Brush

N

S

Commutator

Armature

ε
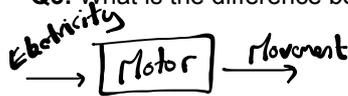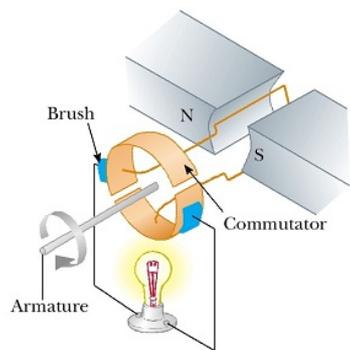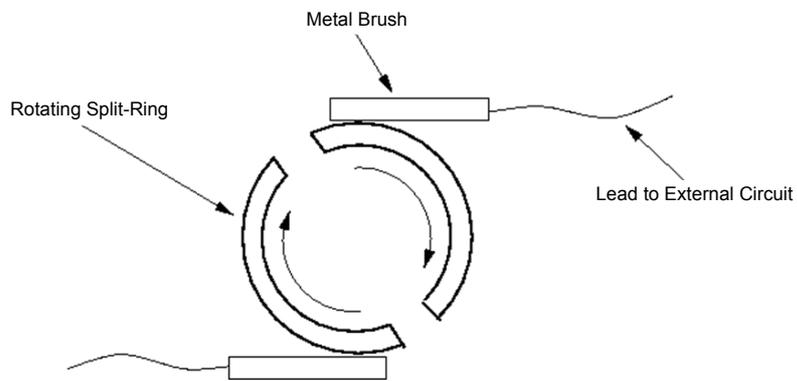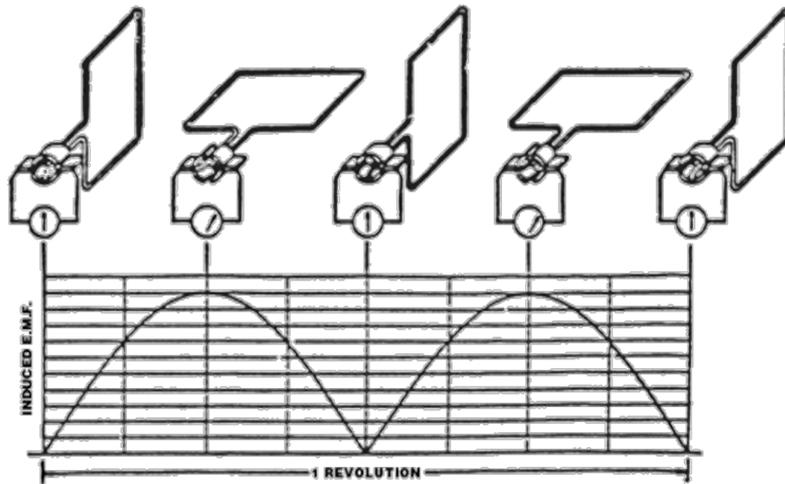
(a)   (b)

Figure 31.21 (a) Schematic diagram of a dc generator. (b) The magnitude of the emf varies in time but the polarity never changes.

Lenz's Law

Lenz's law: In a solenoid, a current will be produced that opposes the motion of the magnet

Q4: Why is the motion of the magnet opposed?

Cannot gain unlimited free energy!

Q5: In the diagram below, in what direction is the current travelling at *Point P*?
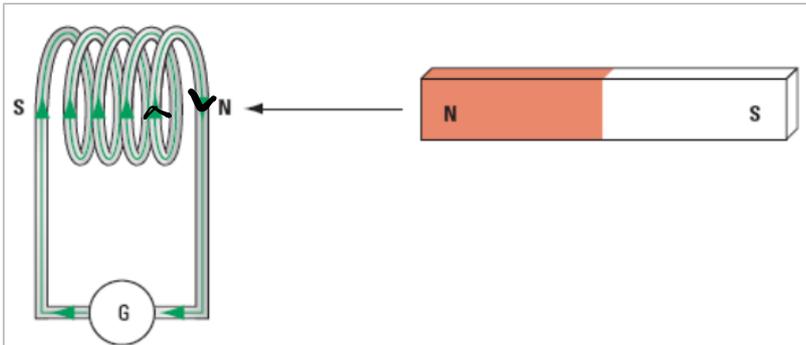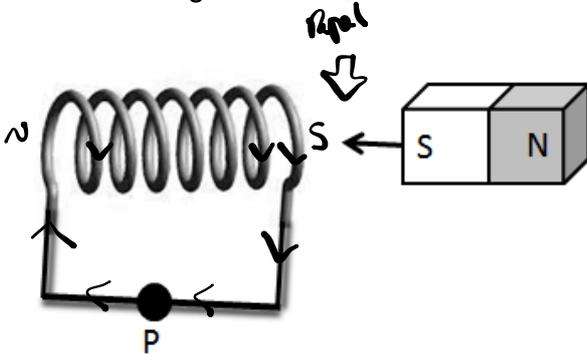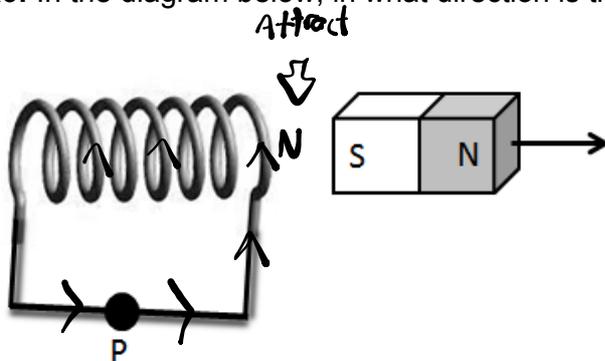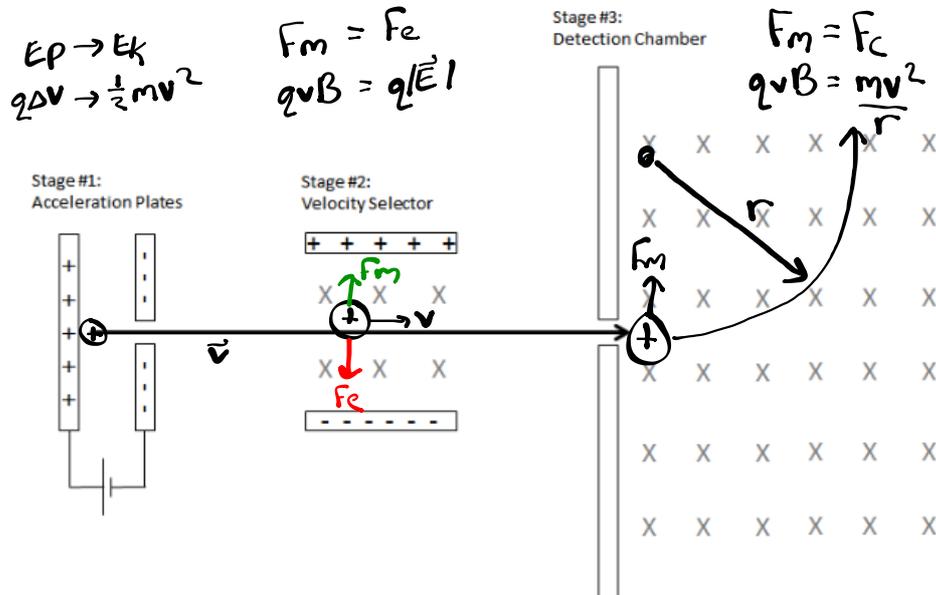
Repel

Q6: In the diagram below, in what direction is the current travelling at *Point P*?

Attract

Mass Spectrometer

$$EP \rightarrow Ek$$
$$q\Delta V \rightarrow \tfrac{1}{2}mv^2$$

$$F_m = F_e$$
$$qvB = q|\vec{E}|$$

Stage #3:
Detection Chamber

$$F_m = F_c$$
$$qvB = \frac{mv^2}{r}$$

Stage #1:
Acceleration Plates

Stage #2:
Velocity Selector

Stage #1: Acceleration Plates

- Concept: Potential energy transforms to kinetic energy.
- Strategy: Set $E_p = E_k$.
- Equations: $\Delta V = \frac{\Delta E_p}{q}$ and $E_k = \frac{1}{2}mv^2$
- Set-up: $q\Delta V = \frac{1}{2}mv^2$ and solve for v.

Step #2: Velocity Selector

- Concept: Particles with the correct speed can make it through undeflected. All other speeds are deflected and don't make it into the detection chamber.
- Strategy: Set $F_{magneetic} = F_{electrostatic}$.
- Equations: $|\vec{F_m}| = qv|\vec{B}|$ and $\vec{E} = \frac{\vec{F_e}}{q}$
- Set-up: $qv|\vec{B}| = q|\vec{E}|$ and solve for v.

Step #3: Detection Chamber

- Concept: Unbalanced $F_{magnetic}$ acts as centripetal force and causes circular motion.
- Strategy: Set $F_{magnetic} = F_{centripetal}$
- Equations: $|\vec{F_m}| = qv|\vec{B}|$ and $|\vec{a_c}| = \frac{v^2}{r}$, with $|\vec{F_c}| = \frac{mv^2}{r}$ being implied.
- Set-up: $qv|\vec{B}| = \frac{mv^2}{r}$ and solve for the unknown variable.