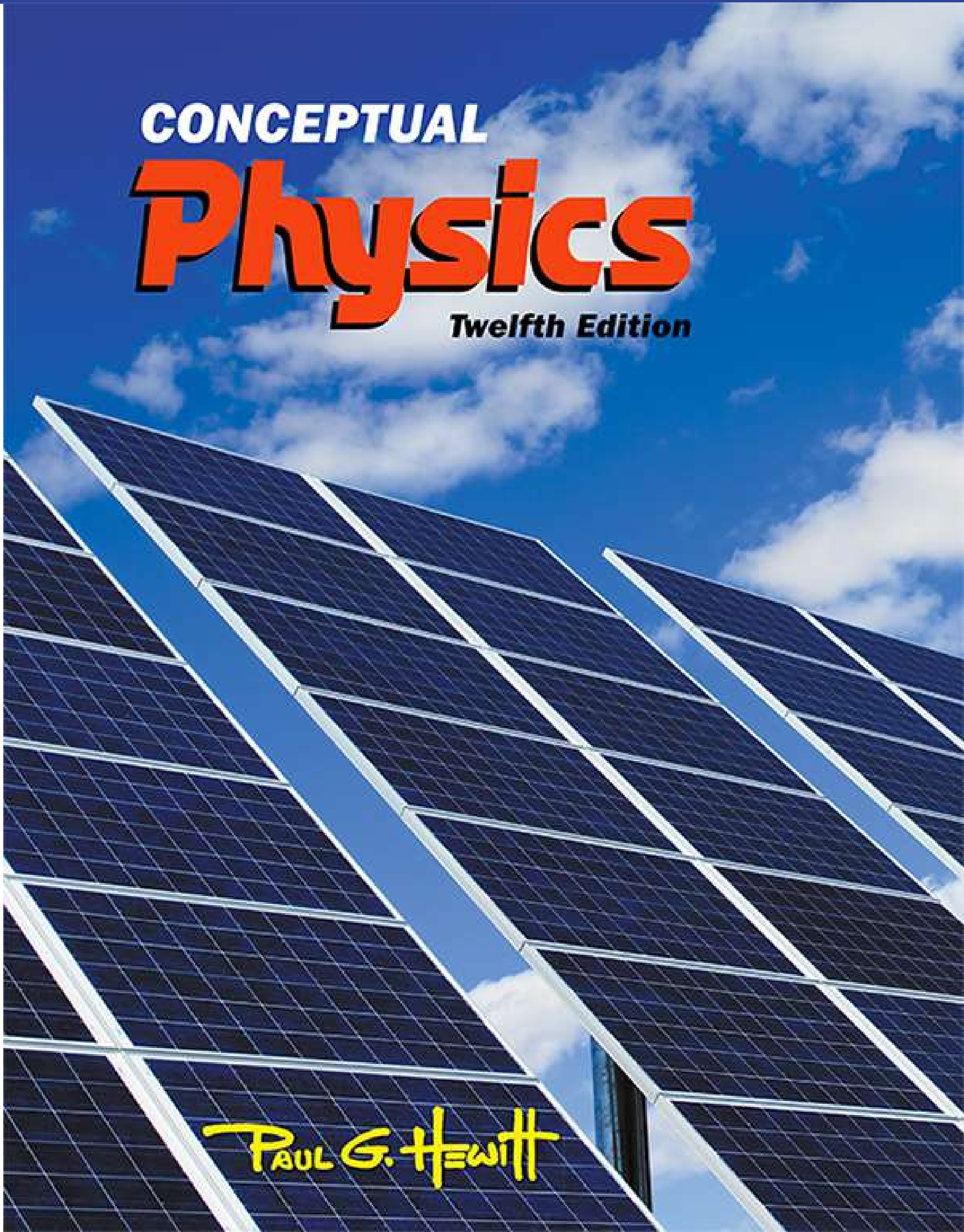


Chapter 22: Electrostatics

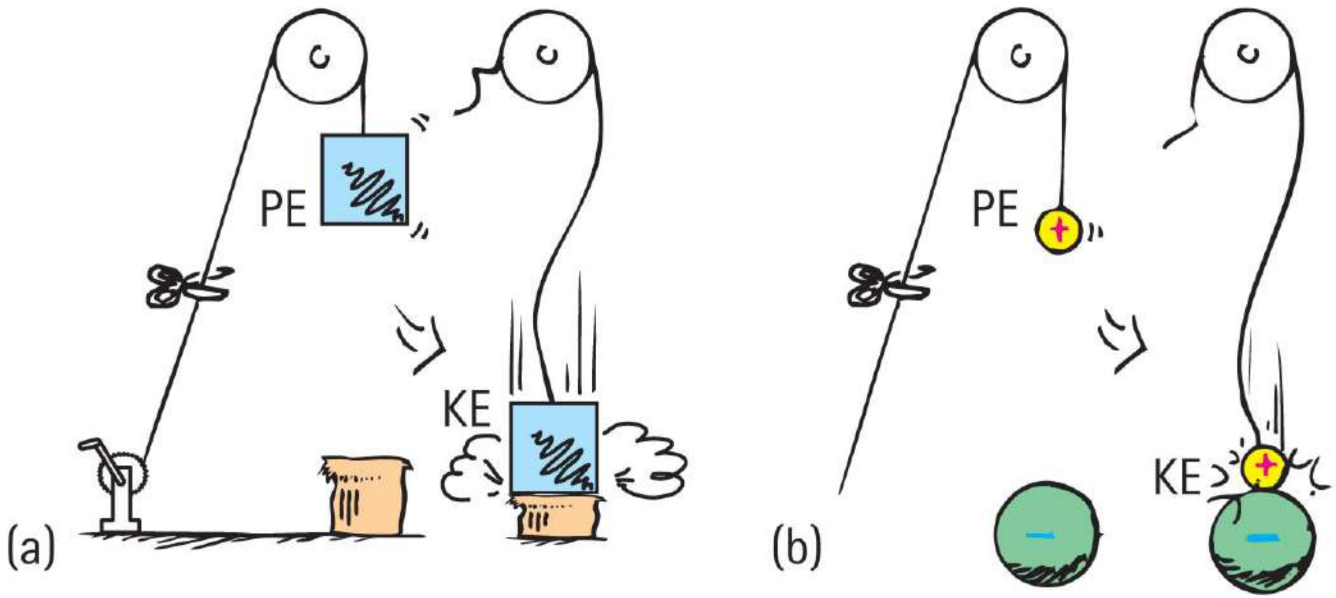
- *Section 9:*
- Electric Potential
- Electric Energy Storage

Don't forget!

Test Thursday on Chapter 22.

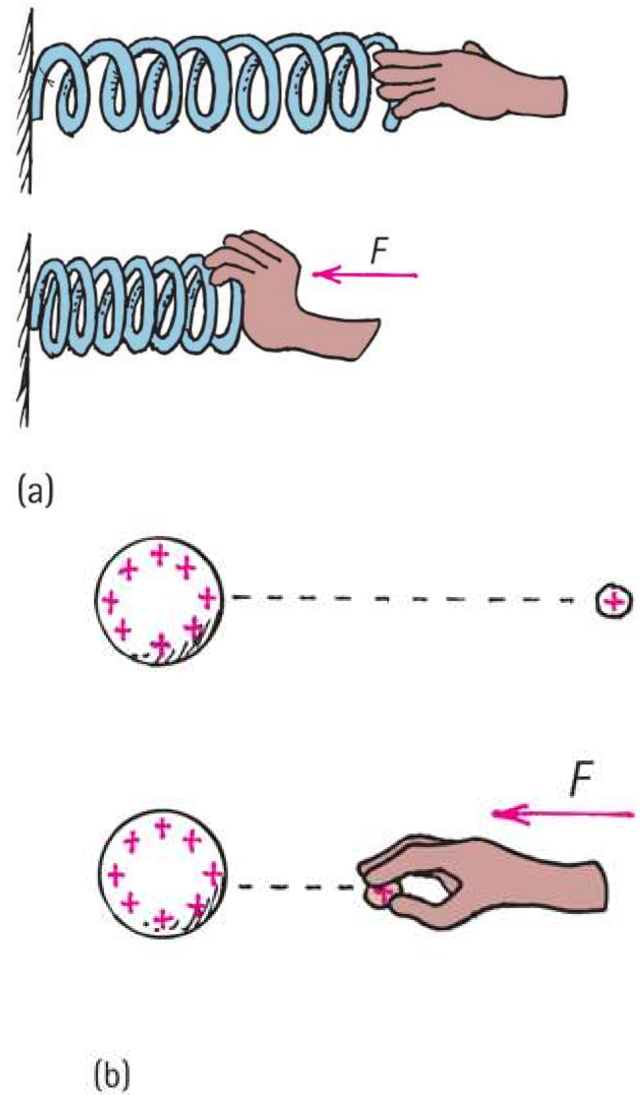
Electric Potential

- Electric potential energy
  - Energy possessed by a charged particle due to its location in an electric field.
  - Work is required to push a charged particle against the electric field of a charged body.
  - This work increases its energy.



Electric Potential, Continued

- (a) The spring has more mechanical PE when compressed.
- (b) The charged particle similarly has more electric PE when pushed closer to the charged sphere.
- → In both cases, the increased PE is the result of work input.



Electric Potential, Continued-1

- Electric potential (voltage)
  - Energy *per charge* possessed by a charged particle due to its location
  - May be called *voltage*—potential energy per charge
  - In equation form:

$$\text{Electric potential} = \frac{\text{electric potential energy}}{\text{amount of charge}}$$

Electric Potential units:

$$\text{electric potential} = \frac{\textit{electric potential energy}}{\textit{charge}}$$

- Units: $$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}}$$

Ex. It takes 6 joules of energy to move 4 coulombs of charge. What is the electric potential?

$$\text{electric potential} = \frac{\textit{electric potential energy}}{\textit{charge}}$$

$$\text{electric potential} = \frac{6\,J}{4\,C} = 1.5 \text{ J/C} = 1.5 \text{ V}$$

→ Because it's units are volts, electric potential is often called the ***voltage***.

Ex: car battery

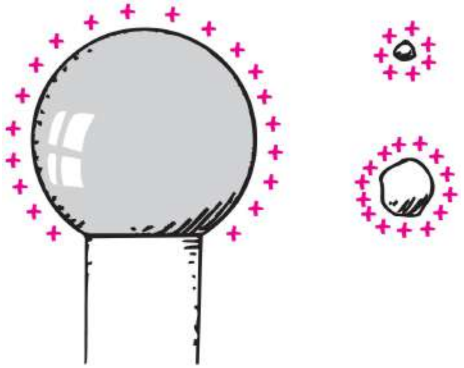
How much energy is given to each coulomb of charge that flows through a 12 V batter?

12 J!

That's what **12 V** means: 12 J per coulomb or 12 J/C

→ the energy is used to do electrical work on the car's solenoid, starter, radio, etc.

– Example:
  - Twice the charge in same location has twice the electric potential energy but the same electric potential.



electric potential = $$\frac{\textit{electric potential energy}}{\textit{charge}}$$

new electric potential =

$$\frac{\textit{2x electric potential energy}}{\textit{2x charge}}$$

= same as old elec. potent.

- 3 times the charge in same location has 3 times the electric potential energy but the same electric potential ($2\ E/2\ q = 3\ E/3\ q = V$)

Electric Potential

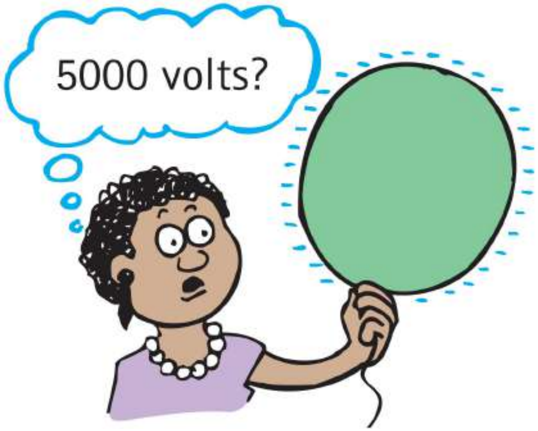
electric potential = $\dfrac{\textit{electric potential energy}}{\textit{charge}}$

– High voltage can occur at low electric potential energy for a small amount of charge.

$$\text{electric potential} = \frac{6\,J}{0.0012\,C} = 5000\,V$$

– High voltage at high electric potential energy occurs for lots of charge.

$$\text{electric potential} = \frac{6000\,J}{12\,C} = 5000\,V$$



Electric Potential
CHECK YOUR NEIGHBOR

Electric potential energy is measured in joules. Electric potential, on the other hand (electric potential energy per charge), is measured

A. in volts.
B. in watts.
C. in amperes.
D. also in joules.

Electric Potential
CHECK YOUR ANSWER

Electric potential energy is measured in joules. Electric potential, on the other hand (electric potential energy per charge), is measured

A. in volts.

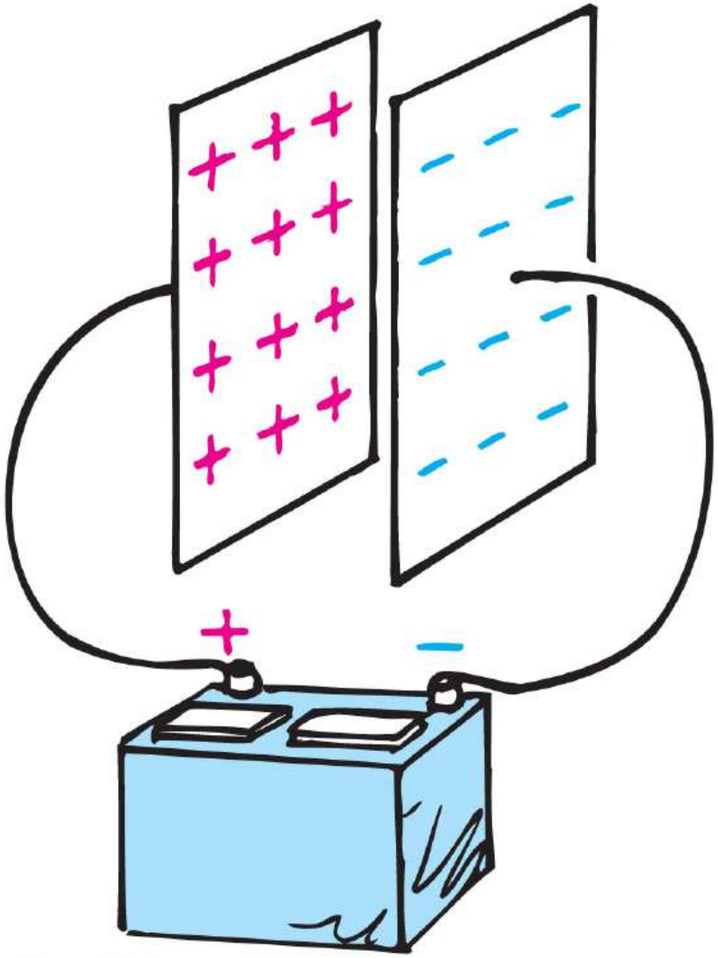
Classwork. Take a sheet of paper out. Put name at top. Number your problems:

28. How much energy is given to each coulomb of charge that flows through a 1.5-V battery?

29. A balloon may easily be charged to several thousand volts. Does that mean it has several thousand joules of energy? Explain.

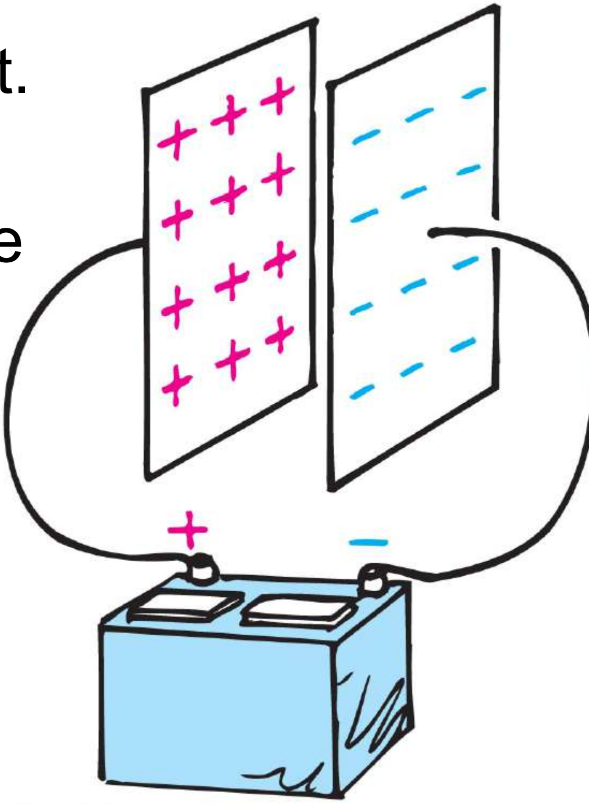
Electric Energy Storage

- Electrical energy can be stored in a common device called a **capacitor.**
- The simplest capacitor is a pair of conducting plates separated by a small distance, but not touching each other.
- When the plates are connected to a charging device, such as the battery, electrons are transferred from one plate to the other.



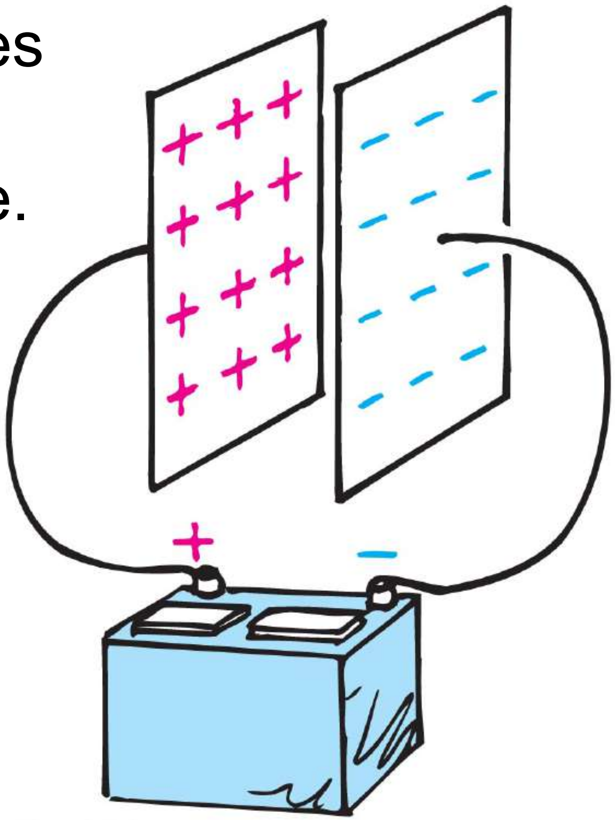
Electric Energy Storage, Continued

- This occurs as the positive battery terminal pulls electrons from the plate connected to it.
- These electrons, in effect, are pumped through the battery and through the negative terminal to the opposite plate.
- The capacitor plates then have equal and opposite charges:
  - The positive plate connected to the positive battery terminal, and
  - The negative plate connected to the negative terminal.
  - What is the net charge on a capacitor?
  - 0!



Electric Energy Storage, Continued-1

- The charging process is complete when the potential difference between the plates equals the potential difference between the battery terminals—the battery voltage.
- The greater the battery voltage, and the larger and closer the plates, the greater the charge that can be stored.
- The energy stored in a capacitor comes from the work required to charge it.
- The energy is stored in the electric field



30. Where is the energy stored in a capacitor?

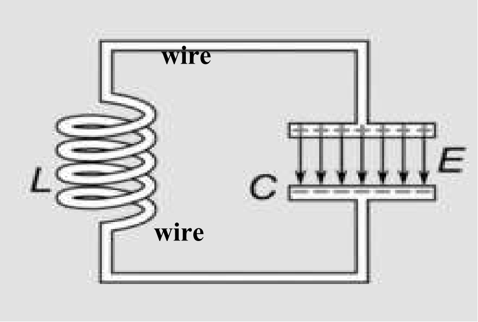
Where are capicitors found?

Power supplies: The energy is stored even after you unplug it.

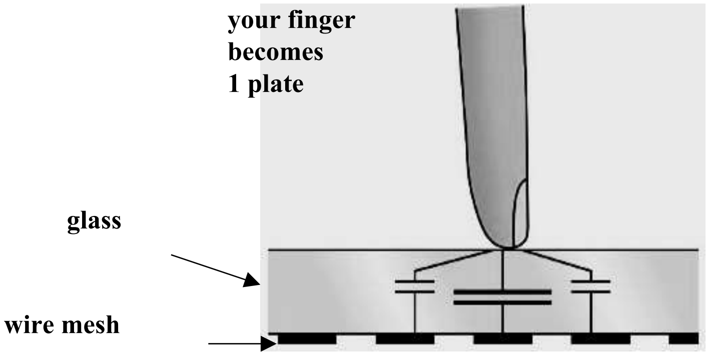
Photoflash units

Defibrillators→

Radios



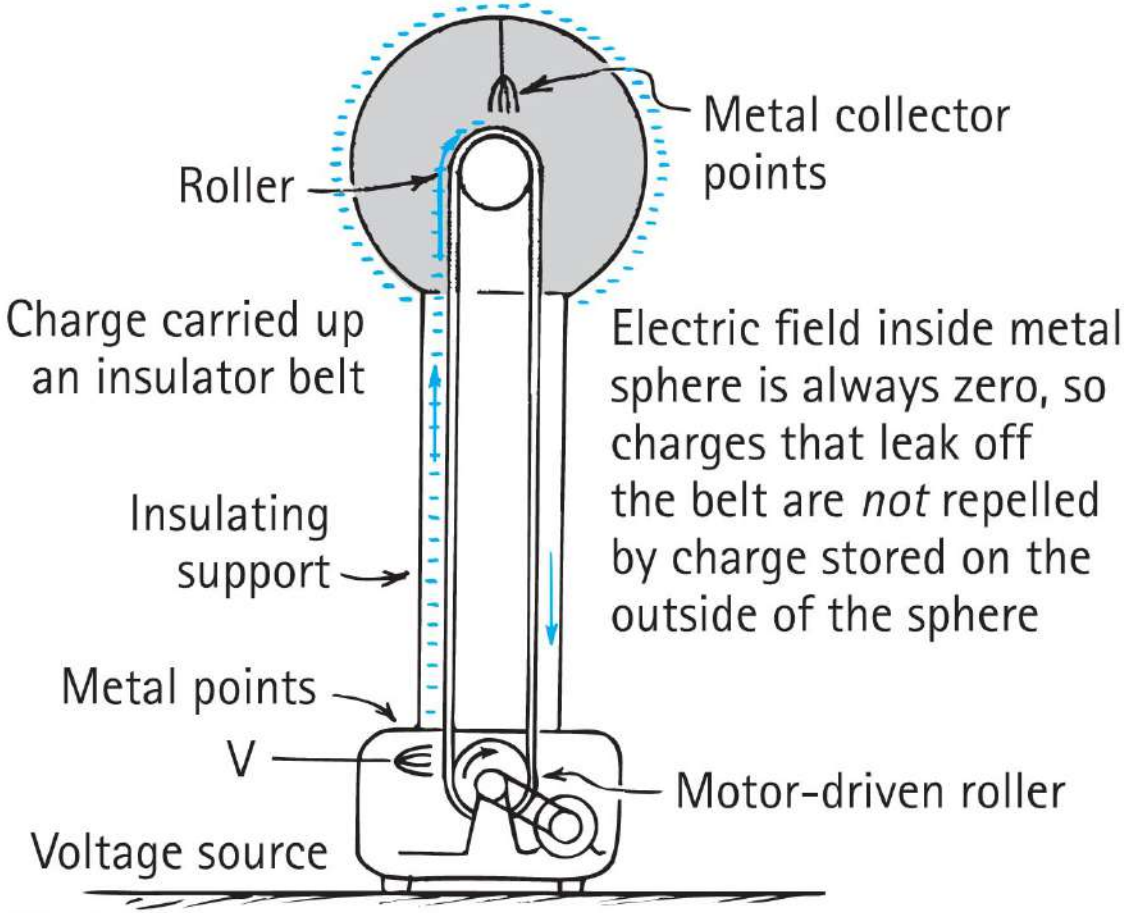
Touchscreens:



→ Discharging a charged capacitor can be a *shocking* experience if you happen to be the conducting path.

Electric Energy Storage, Continued-2

- A common laboratory device for producing high voltages and creating static electricity is the *Van de Graaff generator*.



Van de Graaff's are *atom smashers*

They accelerate charge particles to high speeds and smash them into target atoms.   Along with x-rays and gamma rays, new particles can be created.

Boston Museum of Science.

A hair raising experiment

- The dome is charged up while you put your hand on it, so you are charged by contact.
- Your hairs become charged—all the same charge, and repel each other!

81. If you place a free electron and a free proton in the same electric field, how will the forces acting on them compare?

89. If you expend 10 J of work to push a 1-C charge against an electric field, what is its change of voltage?

36. Two point charges are separated by 6 cm. The attractive force between them is 20 N. Find the force between them when they are separated by 12 cm. (Why can you solve this problem without knowing the magnitudes of the charges?)

46. The three pairs of metal, same-size spheres have different charges on their surfaces, as indicated. Each pair is brought together, allowed to touch, and then separated. Rank, from greatest to least, the total amounts of charge on the pairs of spheres after separation.