## DAY 10 -- Homework

1. What would be the diameter of a 1 F capacitor if its plates were separated by .1 mm of Strontium Titanate?

2. How much energy is stored in a 100 mF capacitor that has been charged to 6 V? This energy would raise the temperature of 1 mL of water by how much?

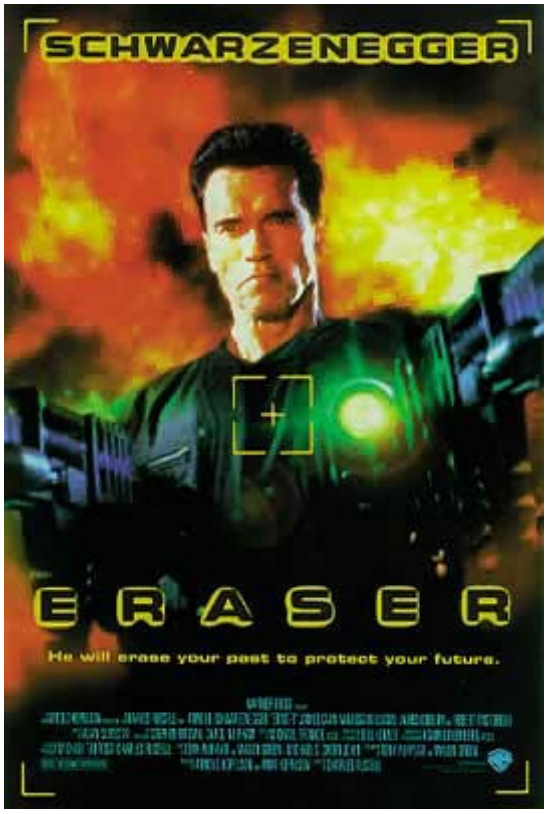
3. Batteries are often rated in "Amp-hours". This is a measure of charge that can be produced.
   I = Q/t
   Q = I t = A x hr



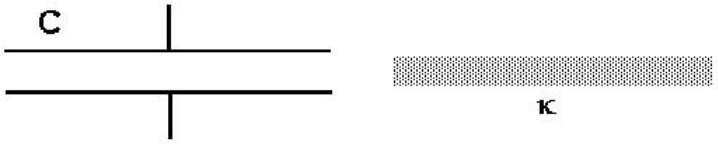
   The DeWalt DC9091 XRP NiCad Pod Style Battery show above (used in battery-powered electric tools) is rated at 2.4 A-hr. Calculate the charge it can generate (in C) and the energy it can produce (in J). How long will it last if it is generating a steady 2 A of current? What will be its power output? How many 1-Farad capacitors could it fully charge?

4. The Schwarzenegger movie "Eraser" features a "rail gun", which supposedly uses the energy stored in a capacitor to launch projectiles at incredible speed. What capacitance capacitor would be needed to store energy sufficient to launch a 100 g bullet at Mach 30 if supplied by 30 3.0 V cells connected in series? What Amp-hour rating would be required of the cells?

   NOTE -- In the movie the bullets are supposed to travel at nearly the speed of light but that concept is just too stupid for a physics problem. Mach 30 is stupid enough.



5. A parallel-plate capacitor has no dielectric. Its capacitance is C. It carries charge Q but is not connected to a voltage source. If a dielectric of constant $\kappa$ is slipped between the plates while it is charged, does the energy stored in the capacitor go up or down? Does this indicate that it takes work to force the dielectric between the plates or does this mean that the dielectric is drawn between the plates?




6. (a) In the above problem, calculate the energy required or released when the dielectric is slipped between the plates.

   (b) Re-work (a), only this time the capacitor is connected to a battery of voltage U.

7. The internal resistance of a battery limits the maximum current the battery can produce. If a battery had no internal resistance, then it would produce near infinite current when its terminals were shorted out. If a 1.5 V AA battery can produce a maximum current of 5 A when shorted as shown in the figure, what is its internal resistance? What power is produced? Where does that power go? If the battery is rated for 500 mA-hrs, how long will the battery last at that rate?