Typical Homework Question with Answers
Hot Dryer
As freshly laundered clothes tumble about in a hot dryer, they rub against one another. Sliding friction transfers electric charges from one piece of clothing to the other so that some items become positively charged and others negatively charged. These charge accumulations produce static cling. Fabric softener is a soap-like chemical that binds to wet fabric fibers and lubricates them. This lubrication is what softens the clothes. But fabric softener also attracts moisture, which in turn reduces static cling.

a. As you unload the dryer you find several socks clinging to a shirt. How do the charges on the socks and shirt compare to one another?

Key: The shirt attracts each sock, so therefore each sock must be the opposite charge as the shirt (and the same as each other) because opposite charges attract. Note, from this information you cannot tell whether the shirt is positively charged and the socks negative or vice versa.

b. As you pull socks off the shirt, you do work on the socks. Into what form is your energy being transformed?

Key: The mechanical work you do on the socks is converted into voltage, or electric potential energy stored in the electric field between the shirt and the socks.

c. Suppose that your socks are covered with positive charge. As you pull them away from the shirt, what happens to the voltage of the charges on the socks?

Key: The voltage of the socks becomes more positive as you move them away from the shirt. The shirt must be negatively charged (see a) so you are moving electric charges in the opposite direction that the electric field points (i.e. towards the negative charge)

d. The farther each sock is from the shirt, the less that sock and shirt attract one another. Explain.

Key: The socks and shirt attract each other less because the electric force between two charges is proportional to the inverse square of the distance between them, as equation 8.1.1 declares. Although the charges are distributed over irregular sock- and shirt-shaped regions, which means that the force will not precisely fall off like the inverse square of the distance, the distances between each little charge on the shirt and each little charge on the sock are all increasing, which means that the force will always decrease.

e. After removing them from the shirt, you find that the socks repel one another. Explain.

Key: Since every sock was attracted to the shirt, each sock must be the opposite charge as the shirt, and therefore the same charge as each other. Like charges repel one another, so the socks repel.

f. The next time you do your clothes you decide to add fabric softener. Your clothes emerge from the dryer with a thin layer of moisture on them, and this moisture permits charge to move freely about the clothes. Why does this mobility prevent the build-up of separated charge?

Key: Imagine pulling apart a fabric-softened shirt and sock. They have somehow been oppositely charged. Those opposite charges are attracted to each other, and since the charges are now free to move about due to the fabric softener, charge flows from one to the other until both have the same net charge. No differential charge can be built up because the individual charges cannot be made to stay on one article of clothing.