Problem Set 1
Due: 9/8/09, Tuesday

Chapter 21: Electric Charge
Exercises & Problems:  8, 12, 15, 20, 26, 39, 52

Chapter 21 Even Answers
2.25 \times 10^{20}; -2.83, not possible; +16e; 1.92 \text{ cm}, decreased; 1.25 \times 10^{13}e

Question A
When a charged ruler attracts small pieces of paper, sometimes a piece jumps quickly away after touching the ruler. Explain.

Question B
Your clothing tends to cling together after going through the dryer. Why? Would you expect more or less clinging if all your clothing is made of the same material (say, cotton) than if you dry different kinds of clothing together? Again, why? (You may want to experiment with your next load of laundry.)

Question C
Plastic food wrap can be used to cover a container by stretching the material across the top and pressing the overhanging material against the sides. What makes it stick? (Hint: The answer involves the electric force.) Does the food wrap stick to itself with equal tenacity? Why or why not? Does it work with metallic containers? Again, why or why not?

Question D
Why are the tires for trucks carrying gasoline and other flammable fluids manufactured to be electrically conducting?

Problem 21.8
In Fig. 21-23, four particles form a square. The charges are q_1 = q_4 = Q and q_2 = q_3 = q. (a) What is Q/q if the net electrostatic force on particles 1 and 4 is zero? (b) Is there any value of q that makes the net electrostatic force on each of the four particles zero? Explain.

Problem 21.12
Figure 21-25 shows four identical conducting spheres that are actually well separated from one another. Sphere W (with an initial charge of zero) is touched to sphere A and then they are separated. Next, sphere W is touched to sphere B (with an initial charge of $-32e$) and then they are separated. Finally, sphere W is touched to sphere C (with an initial charge of $+48e$), and then they are separated. The final charge on sphere W is $+18e$. What was the initial charge on sphere A?
Problem 21.15
In Fig. 21-28, particle 1 of charge +1.0 μC and particle 2 of charge −3.0 μC are held at separation L = 10.0 cm on an x axis. If particle 3 of unknown charge q_3 is to be located such that the net electrostatic force on it from particles 1 and 2 is zero, what must be the (a) x and (b) y coordinates of particle 3?

Problem 21.20
Figure 21-30 shows an arrangement of four charged particles, with angle θ = 30.00° and distance d = 2.00 cm. Particle 2 has charge q_2 = +8.00 × 10^{-19} C; particles 3 and 4 have charges q_3 = q_4 = −1.60 × 10^{-19} C. (a) What is distance D between the origin and particle 2 if the net electrostatic force on particle 1 due to the other particles is zero? (b) If particles 3 and 4 were moved closer to the x axis but maintained their symmetry about that axis, would the required value of D be greater than, less than, or the same as in part (a)? Explain your answer using short concise sentences.

Problem 21.26
A current of 0.300 A through your chest can send your heart into fibrillation, ruining the normal rhythm of heartbeat and disrupting the flow of blood (and thus oxygen) to your brain. If that current persists for 2.00 min, how many conduction electrons pass through your chest?

Problem 21.39
In Fig. 21-38, particle 1 of charge +4e is above a floor by distance d_1 = 2.00 mm and particle 2 of charge +6e is on the floor, at distance d_2 = 6.00 mm horizontally from particle 1. What is the x component of the electrostatic force on particle 2 due to particle 1? SSM

Problem 21.52
If a cat repeatedly rubs against your cotton slacks on a dry day, the charge transfer between the cat hair and the cotton can leave you with an excess charge of −2.0 μC. (a) How many electrons are transferred between you and the cat? You will gradually discharge via the floor, but if instead of waiting, you immediately reach toward a faucet, a painful spark can suddenly appear as your fingers near the faucet, (b) In that spark, do electrons flow from you to the faucet or vice versa? (c) Just before the spark appears, do you induce positive or negative charge in the faucet? (d) If, instead, the cat reaches a paw toward the faucet, which way do electrons flow in the resulting spark? (e) If you stroke a cat with a bare hand on a dry day, you should take care not to bring your fingers near the cat's nose or you will hurt it with a spark. Considering that cat hair is an insulator, explain how the spark can appear.