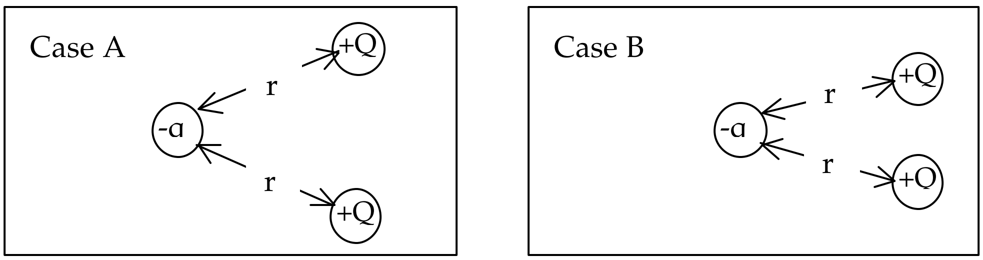
Physics 122, sections 502-4 and 8101 **Assignment 2**
Laura Lising **Due Feb 13, start of class**

Reference: Cutnell & Johnson, 18.1-18.5. (charge, Coulomb's Law, conductors/insulators, induction)

Again and always, please be sure that what you hand in is neat, clean, and easily legible. **If your assignment isn't easily legible, we will not accept it**. And don't forget how we're grading: You must explain your reasoning! You can do that using mathematics or words or diagrams, but I'm asking the TAs to give no credit for answers without explanation, even if the answer is correct.

1) Suppose you have three charged particles arranged as shown in Case A or as shown in Case B. In which case, if either, is there a stronger force on the -q charge?



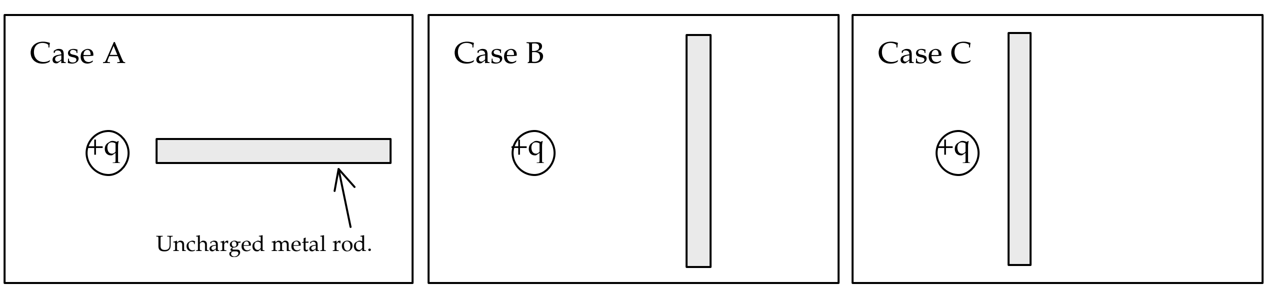
a) First just use your intuition (Maybe think of people pulling with ropes?) to answer the question.

b) Now consider what Coulomb's Law would say.

c) If your answers for a) and b) were contradictory, how can you reconcile them?

2) Let's try that question with some numbers. Suppose Q is 50 μC (that's 50 x 10^{-6} C), –q is 2 μC, and r is 4 cm. And suppose in Case A the two lines are 45 degrees apart, and in Case B they are 30 degrees. Calculate the total force on –q for each.

3) Suppose you have an object with excess charge +q placed near an uncharged metal rod as shown.



a) Consider Case A:

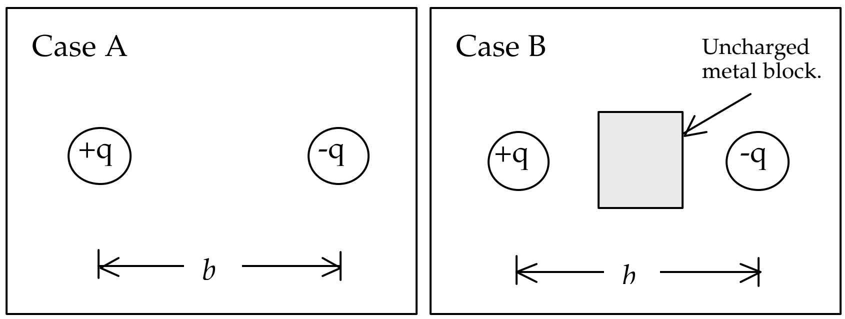
i) Sketch the charge distribution on the rod.

ii) Is there a net electric force on the rod? Explain.

iii) Is there a net electric force on the charged object +q? Explain.

b) Now consider Cases B and C. Which configuration leads to the strongest force on the +q charge: Case A, Case B, or Case C? (This one's hard! Feel free to give an uncertain answer, but try to explain just what it is that makes you uncertain.)

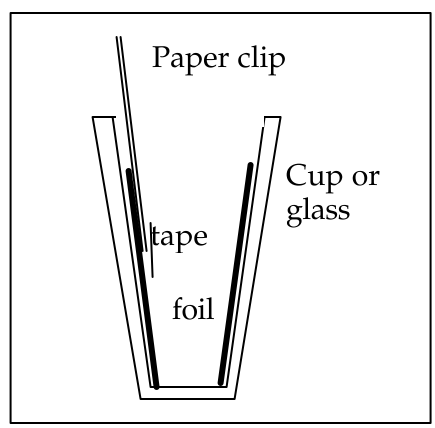
4) Suppose that you have two charged objects separated by a distance *b*. In Case A there is a force between these two objects. Case B shows the two objects, but now an uncharged block of metal has been placed between them.



a) In Case B, after the block has been placed between the charged objects, is the force on the positively charged object (labeled +q) *greater than, less than,* or *equal to* the force on that object in Case A with no metal block?

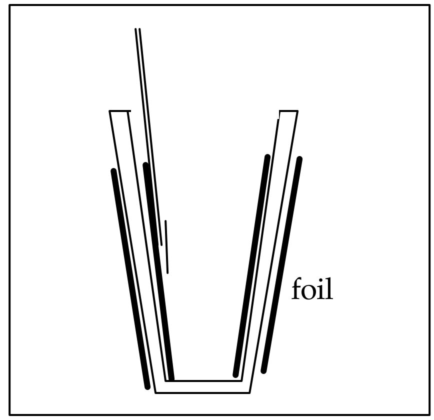
b) A reasonable person could have the intuition that it "putting an object in the way shields the electric force." Compare that bit of common-sense thinking to the model, and explain in what way, if any, it would need to be refined to agree with our basic model of two charges and Coulomb's Law.

5) This problem is about a device for storing charge. You could actually build one and try it—that would be great—or you could just think through what should happen according to the basic model. (Just don't make it too big! A device like this the size of a large bucket could kill you! And don't even make a little one if you wear a pace-maker!)



Get a plastic or Styrofoam cup or a glass cup or jar and line the inside with aluminum foil. Unfold a paper clip and tape one end to the aluminum foil inside so that the other end sticks out of the cup.

a) Now go build up a net charge on yourself by shuffling around in your socks, maybe, so that if you were to touch something you'd get a shock. Suppose you have a net negative charge on you and you touch the end of the paper clip. Does the inside of the cup (the foil) now have a charge?



b) If you were now to go shuffle around some more, come back and touch the paper clip again, explain why you won't be able to put much more negative charge on the foil inside.

c) Here's a way to solve the problem: Add a wrapping of aluminum foil to the *outside* of the cup, without letting it touch the inside layer or the paper clip. And use another paper clip or other foil to connect the foil on the outside to some other large, conducting object—the best thing would be to a metal water pipe. If you put negative charge on the inside foil, what charge would you expect on the outside foil?

d) Explain why that outside foil will make it easier to add more negative charge to the inside foil.

e) If you do this for a while—shuffle, touch the clip, shuffle, touch the clip—you can end up with a lot of charge stored! When you get tired of it, disconnect the outside foil from that water pipe (or whatever you used). Now try touching the outside foil with one hand and the inside foil (or the paper clip) with the other. What should happen?

6) Here's another device to think about. Two metal plates, held apart by some insulating material, start with opposite charges. And then someone runs a wire, as shown from one plate to the other. Draw two more sketches to show what happens, one to show how the charges end up, and another to show the intermediate state, after you connect the wire but before the charges have stopped moving.