Coulomb’s Law: Lab #4
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Objective: to become familiar with, to predict, and to simulate the behavior of electrically charged objects.

Equipment: balloon, paper bits, pith ball on a stand, electroscope, Styrofoam cup, silk, dull transparent tape, computer with Internet access

Definitions, in words and/or equations:
Electric charges:

Magnetic poles:

Charging by rubbing:

Charging by induction:

Coulomb’s law:

Electric field:

Electric dipole:

Proportional thinking:

Background: What are some of the variables which might affect the forces between electrically charged objects?

Procedure (real balloons, real sticky tapes, computer illustrations):
1. Balloon
   Blow up the balloon and tie it off.
   Rub the balloon on a wool sweater or on your hair.
   Bring it near the pith ball. Describe what happened.

   Bring it near the electroscope. Describe what happened.

   Draw a picture of the charges and forces in the electroscope.
Rub the Styrofoam cup with the silk and repeat the activities with the pith ball and electroscope. Describe what happened.

2. Transparent tapes
Cut two 6-inch pieces of transparent tape. Mark one T1 and the other B1.
Put the sticky side of T1 on top of the nonsticky side of B1.
Pull them apart briskly.
Do they attract each other or repel each other?
Is either one attracted to your finger?

Stick the ends of the tapes to the edge of a table. Prepare another set marked T2 and B2. Record how they interact with each other in pairs:

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T1</th>
<th>T1</th>
<th>T2</th>
<th>T2</th>
<th>B1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repel or attract?</td>
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</tbody>
</table>

What can you conclude from this experiment?

If the balloon is negatively charged, what can you conclude about the tapes?

3. Computer illustrations and simulations (with only one partner)
It is sometimes difficult to do experiments with electrically charged objects in damp weather because the charge leaks off the objects onto water droplets in the air fairly quickly. A computer program does not have this problem.

Go to phet.colorado.edu
Click on “Play with sims”
Select Physics
Select Electricity, Magnets & Circuits

A. Select John Travoltage, Run Now!
Predict what will happen when his foot rubs the carpet and his hand touches the doorknob:

With the mouse, rub his foot on the carpet.
How did your prediction hold up?
Close this window.

B. Go back to Electricity, Magnets & Circuits
Select Balloons and Static Electricity, Run Now!
See that these items are checked: Show all charges, Ignore initial balloon charge, Wall.
Predict what will happen if you rub the balloon on the neutral sweater:

Try it, and comment on your prediction:
Place the balloon vertical again and let go. Explain what happened:

Predict what will happen if you place the balloon near the neutral wall:
Try it, and comment on your prediction:

Predict what will happen if you rub two balloons on the sweater:
Try it, and comment on your prediction:

C. A worked example of electric changes in only one dimension, using proportional thinking.
Go to physics.bu.edu/~duffy/semester2/c01_Coulomb1D.html
Read and discuss the example, then minimize the window so you cannot see it.
Explain the example in your own words in three sentences or less:

D. Four worked examples of Coulomb’s Law
Go to physics.bu.edu/~duffy/semester2/c01_magnitude.html
Read and discuss these examples until you both understand them.

E. Worked examples of Coulomb’s Law in two dimensions
Go to physics.bu.edu/~duffy/semester2/c01_Coulomb2D.html
Read and discuss these examples until you both understand them.

F. Interactive plot of Coulomb forces
Go to www.hep.uiuc.edu/home/mats/flash/coulomb_plot.html
Are these two objects charged ++, or --, or + -?
Explain why you think this:

Move the smaller object directly away from the larger object and describe the change in the force on it from the larger object as the separation increases:
(Use words like increase, decrease, monotonic, linear, inverse)
If the smaller object ran in from the left side of the screen, somewhat above the larger object’s position, what do you think its path would look like?

G. **Superposition of forces** (vector addition)
   Go to www.hep.uiuc.edu/home/mats/flash/Super.html
   Draw the diagram and explain the vector addition in words:

   How should you move the objects so that the force on the top one drops to zero?
   Try moving them, and comment on your prediction:

   Now click to have only two charges. Move them to be three spaces apart vertically.
   Write down the force value __________

   Where should you move the top one to have the force drop to one quarter its value?
   (Use proportional thinking.)

   Try moving it, and comment on your prediction:

   **Conclusions:**

   **Future work:**