Name __________________________ Date _________

Partners ____________________________________________________________

**Coulomb's Law with Interactive Physics: Lab #4**

D. Hamden, M.L. West

**Objective:** to become familiar with the Interactive Physics computer application and to predict and simulate the behavior of electrically charged objects.

**Equipment:** Interactive Physics on a computer

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

Force:

Coulomb's law:

Electric field:

Electric dipole:

**Background:** It is often difficult to do experiments with electrically charged objects in damp weather because the charge leaks off the objects onto water droplets in the air. A computer simulation has no such problems.

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

**Procedure:**

1. Turn on the computer and open **Start, All Programs, Interactive Physics 3.0.**

2. Getting organized: Pull down

**World, Gravity, None, OK**
**World, Electrostatics, On, OK**
**View, Workspace, Navigation, Grid Lines, XY Axes.** Leave everything else as it is. **Close.**
Slide the scroll bars to their centers to see X = 0, Y = 0 (the solid lines).

**3. Placing two objects:**
On the side tool bar, click once on the circle icon. (It should turn light grey.)
Position the cursor at x = -2, y = 0, and click once, move slightly, then click again. The small dark grey circle will be your first charged object, Q1.

(If something goes wrong and you get huge moving circles, try <Ctrl>, or <Ctrl>Z. If these do not work then you must quit the program using <Ctrl> <Alt> <Delete> End Task Now, and restart Interactive Physics.)
Double click in the small circle to open the Properties window. Check that Q1 is at the proper coordinates, or type them in. The charge on Q1 is ____________________, and its mass is ________________.

Similarly place your second charged object, Q2, at x = 2, y = 0. Make the charge and mass the same as those for Q1.
Pull down Measure, Total Force, and drag the measuring box to the upper left of the workspace. Close the properties windows now.
Select Q1 again, and open a total force measuring box for it, and put it near the one for Q1.

**4. Simulating the passage of time:**
Predict what will happen if these two charged objects are free to move:

Now on the top menu bar click RUN. STOP. Click RESET and observe (RUN) again, then describe the motion:

Here is another way to observe this motion. From the top menu bar select World, Tracking Every 2 Frames.
RUN, STOP. To erase the tracks use WORLD, ERASE TRACK, or <Control> e.
Try again at every 4 frames, or 8 frames. Sketch the resulting display:

Which tracking display gave you the clearest idea of this motion? __________________

**5. Different masses:** Make the mass of Q1 at least three times larger than the mass of Q2. Predict what their motion will be:

Try it. How did your prediction hold up?

**6. Forces:** Try the motion again and watch the force meters. How does the force change with time?

Why?

Let's record some measurements and compare them with calculations from Coulomb's law:
We will keep the charges the same and equal, but the masses unequal, and the distances as variables.

Use RUN, then click STOP as quickly as you can. (I hope you have a quick reaction time!) Use the bottom scroll bar to look leftwards to locate Q1. Move the cursor to its center point and read its X coordinate from the lower left of the screen. Move the scroll bar to the right to find Q2 and record its X coordinate also.
Record coordinates from four different runs. Stop and reset between each trial.

| Q1 | Q2 | X1 | X2 | F, meter | F, calculated | % difference |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

7. **Negative Charge:** Predict the motion if Q1 were negatively charged:

Try it, and describe the results.

**8. Using a test charge as a probe:** From the side tool bar select the little anchor and click on the center of Q1 and also Q2 to anchor them in place so that they cannot move.
Choose the circle tool and place another charged circle, Q3, at x = 0, y = 0. Make the charge on Q3 be 1 x 10^-6 C. Make the other two charges both positive at 1 x 10^-4 C.
Predict the motion of Q3:

Try it, and comment.

Move Q3 to x = 0, y = .5 and predict its motion:

Try it, and comment.

9. **Map the force field** on the test probe Q3 when it is at various positions around Q1 and Q2, when all have the same sign charge. Use World, Tracking every frame. You can hold and drag Q3 to new positions. Sketch its motion for at least 15 positions:

Q1 Q2

Predict what will happen when Q3 is put at x = .5, y = 0:

Try it and describe: (Try with World, Tracking Off.)

**Conclusions:**

**Discussion of errors:**

**Future work in this field:**