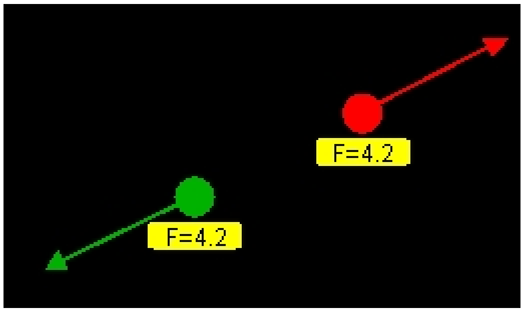

Screen shot of simulation showing force between two charged particles.

Worksheet: Coulomb Force Simulation

Key Topic/Concept: Coulomb's Law and Newton's 3rd Law

Materials:
- One guide sheet for each student
- Computer with simulation downloaded
- Science Notebook

The EJS Coulomb Force simulation can be downloaded from the comPADRE National Digital Library if it not available on the local computer:
< http://www.compadre.org/OSP/items/detail.cfm?ID=9683>

Safety Precautions: No special precautions needed for this lesson.

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Edited by: Mario Belloni and Wolfgang Christian

Physics Classroom Tutorial:

< http://www.compadre.org/classroom/>
Static Electricity- Lesson 3: Electric Force: Coulomb's Law
Static Electricity- Lesson 3: Electric Force: Inverse Square Law
Static Electricity- Lesson 3: Newton's Laws and the Electrical Force

Introduction: Charged Particles

There is a force between charged particles. Describe the force as completely as possible as you understand it. Questions to consider: does it require contact between particles? Are there different types of charge and how do they interact? Does it depend on the distance between charged particles?

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Activity Guide: EJS Coulomb Force Simulation

In this simulation, you can move charged particles around and see the force vector (due to the Coulomb force), change the amount of charge on a particle (the size of the particle changes to show you this) and add charged particles (click on the "Add Charge" button).

1. Run the Applet file on-line OR run the simulation by double-clicking on the ejs_electric_sampler.jar and then navigating to the Coulomb Force simulation and run the simulation by double-clicking on the green arrow.
2. Move the red and green charges around and note what happens to the force arrows and the force. Do these particles have the same charge or opposite charge? How can you tell?

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3. Reset the simulation. Both the red and green charges have the same magnitude (size) charge. How does the force on the red charge compare to the force on the green charge?

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4. Now, use the red slider to change the charge on the red charge (its size changes to remind you that it is a "bigger" charge). What happens to the force on the red charge? The force on the green charge?

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   Sketch your configuration below and record the force on each particle:

5. Which experiences the largest force?

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6. Although many students find this surprising, think back to Newton's 3rd law and use it to explain why they should experience the same force:

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7. Set the red back to $q=1$. If you change the size of the green charge, what do you expect will happen? Why? Try it and explain if you were correct or not.

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8. The interaction you have observed is described by Coulomb's force law. The size of the Coulomb force law is given by $F = kq_1q_2/r^2$ where k is a constant, q_1 and q_2 are the charges of the two interacting particles and r is the distance between the two particles. Explain how this matches what you have observed in the simulation.

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9. What is the direction of the Coulomb force?

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Further Exploration (Vector nature of Coulomb Force):

10. Since force is a vector, if you add a third charge, you should be able to arrange the charges so that the force on one of the charges is zero (no arrow) while the force on the other two is non-zero. Reset the simulation and add another charge. Move the charges around until the red charge has no force on it. Sketch your configuration below:

11. In this configuration, if you increase the charge of the red charge, will it experience a force? Try it and explain.

12. What if you change the green or blue charge, will the force on the red charge remain zero? Try it and explain.

13. Add some more charges and see if you can keep the force on the red charge at zero. Sketch your configuration:

14. What is wrong with the following statement from a student?

"When there are three charges (q=1 for all), the force on all three charges should be bigger than when there were only two charges (q=1 on each) because there is now a bigger total charge and the Coulomb force is proportional to charge."

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