Electrostatics: Verifying Coulomb’s Law – PhET Simulation Lab

*First of all, my things to Matthew Leach of Douglas County High School, author of “Coulomb’s Law Activity”, for posting his work in the teachers resources section of the PhET website! Much of this activity is pilfered with permission from this source.*

**Objectives:**

* Determine the relationship between types of charges exerting forces on each other and the direction of force
* Verify Coulomb’s Law and use it to calculate forces between charged particles

**Procedure:**

1. Go to the PhET page with electricity and magnetism simulations:

https://phet.colorado.edu/en/simulations/category/physics/electricity-magnets-and-circuits

1. Click on the simulation “Coulomb’s Law”
2. Click on the play icon to run the simulation
3. Choose “Macro Scale”
4. Investigate **Type of Charge and Direction of Force:** Objects can be positively or negatively charged. Vary the charges of the two objects and record whether the resulting force is attractive or repulsive in Table 1:

Table 1:

|  |  |  |
| --- | --- | --- |
| **Left Charge** | **Right Charge** | **Direction of Force** |
| Positive | Positive |  |
| Positive | Negative |  |
| Negative | Positive |  |
| Negative | Negative |  |

1. Investigate **Magnitude of Charge and Resulting Force:** Place the left charge at the 0 cm position and the right one at the 2 cm position. Vary the left and right charge to the values provided below and record the resulting forces in Table 2.

Table 2:

|  |  |  |
| --- | --- | --- |
| **Left Charge** | **Right Charge** | **Resulting force (N)** |
| 1 μC | 4 μC |  |
| 4 μC | 1 μC |  |
| 2 μC | 2 μC |  |
| 1 μC | 2 μC |  |
| 1 μC | 8 μC |  |
| 2 μC | 8 μC |  |

1. Investigate **Distance and Resulting Force:** Set the charge for both object to 5μC. Place the left object at 0 cm. Move the right object to the locations before and record the resulting forces in Table 3.

Table 3:

|  |  |
| --- | --- |
| Distance (cm) | Resulting Force (N) |
| 2 |  |
| 4 |  |
| 6 |  |
| 8 |  |
| 10 |  |

**Analysis Questions:**

1. Based on your results in Table 1, what seems to be the rule regarding whether electrical forces are attractive or repulsive?
2. Compare the force on the left charge and the force on the right charge in each case. What Law of physics, learned in the first trimester, explains this observation?
3. Based on your results in Table 2, what can you conclude about the relationship of the 2 charges to the resulting force? (Hint: is it about the Sum? Difference? Product? Factor?)
4. When the magnitude of one of the charges doubles, by what factor does force change?
5. When the magnitude of both of the charges doubles, by what factor does the force change?
6. Does the proportionality between magnitude of force and magnitude of either charge seem to be direct, inverse, or inverse-square?
7. Based on your results in Table 3, what happened to the force when the distance doubled? By what factor did it change?
8. What about when the distance tripled?
9. Quadrupled?
10. Does the proportionality between magnitude of force and distance between charges seem to be direct, inverse, or inverse-square?
11. Write a proportionality statement relating the magnitude of electrical force *F* between two charges *q1* and *q2* distance *d* apart.
12. Re-write your relationship as a statement of equality instead of a statement of proportionality. What did you have to include?
13. Use data from one of your trials of this simulation to calculate the value of the constant you included in your answer to #12.
14. What equation or law of physics, learned in the first trimester, is mathematically similar to the equation you determined in #12?
15. What are two fundamental differences between the forces described by your answers to #12 and #14? (Hint: Consider your answers to #1 and #13)

Now that we are at the end, with no explanation or context, and out of nowhere, here is Galactic Emperor Palpatine:



Thank goodness *that’s* never happened before!