Coulomb's Law Activity

When charged particles are brought near each other, they interact and result in attraction or repulsion. We can see this in action.

1. Balloon: Take a balloon and rub it on a shirt or hair. Place the balloon against an object and observe the interaction.
   a. What happens to the balloon?

      It should stick

   b. Can you come up with an explanation for why this interaction occurs?

2. Sticky Tape: Take a piece of tape and place most of it onto a desk or binder (keep one end off the surface so it can peeled off easily). Quickly peel the tape off.
   a. When the tape is brought near your finger, what happens? Why do you think this happens?

      It should be attracted

   b. When the tape is brought near another piece of tape, also peeled from a surface what happens? Why do you think this interaction occurs?

      It should repel

3. Coulomb's Law PhET

   So clearly there are forces being exerted on this electrically charged objects. The question is what variables affect that force. To determine that answer, we will be using a PhET simulation. Grab a chromebook, get onto PhET, select Physics, Electricity, and then Coulomb's Law and select Macro Scale.

   a. **Type of Charge:** Objects can be positively or negatively charged. Vary the charges of the two objects and determine a rule for when the force is attractive or repulsive.

b. **Magnitude of Charge:** Place the left charge at the 2 cm position and the right one at the 4 cm position. Vary the left and right charge to the values provided below and record the resulting forces.

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	

I. How do the forces that each charged object feels compare to each other? What Law explains this observation?

Same, Newton's 3rd Law

II. Look how the forces changed when you changed the charges. What can you conclude about the relationship of the 2 charges to the resulting force? (Hint: is it about the Sum? Difference? Product? Factor?)

the force changes w/ the product of the two charges

c. **Distance:** 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.

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

I. What happened to the force when the distance doubled? By what factor did it change? 1/4

II. What about when the distance tripled? 1/9

III. Quadrupled? 1/16

IV. Can you arrive at a rule for how the distance between the charged objects relates to the resulting force?

∴ inverse square relationship

Look up at the board and see if your rules for the b and c agree with the equation on the board. Does the format of this equation look similar to any other equation you have seen before? Maybe another Force that was described by Sir Isaac Newton? Compare the two equations below.

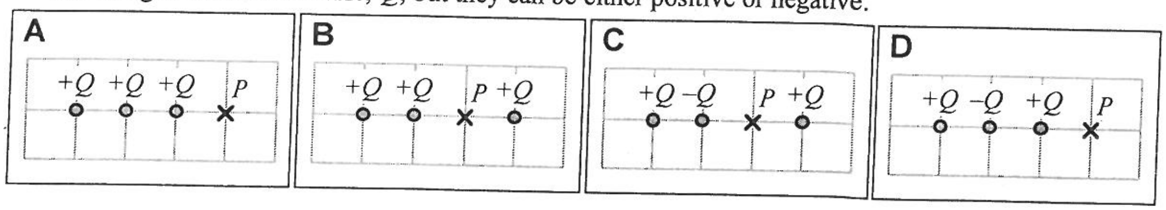
Coulomb's Law Problems

1. What is the magnitude of the electric force of attraction between an iron nucleus (q = +26e) and its closest electron if the distance between them is $1.5*10^{-13}$ m? **(0.27 N)**

$q_1 = 26e = 26 \cdot 1.602 \times 10^{-19}$ C

$q_2 = -e = -1.602 \times 10^{-19}$ C

2. In each figure, three charges are fixed in place on a grid, and a point near those particles is labeled *P*. All of the charges are the same size, *Q*, but they can be either positive or negative.



Rank the strength (magnitude) of the net electric force on a charge +*q* that is placed at point *P*.

C	A	D	B	OR			
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.

A: $\frac{kQq}{1^2} + \frac{kQq}{2^2} + \frac{kQq}{3^2}$ $= kQq(1 + \frac{1}{4} + \frac{1}{9})$ $= 1.361\, kQq$

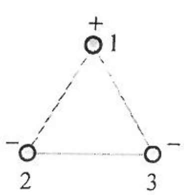
B: $\frac{kQq}{1^2} - \frac{kQq}{1^2} + \frac{kQq}{2^2}$ $= 0.25\, kQq$

C: $\frac{kQq}{1^2} + \frac{kQq}{1^2} - \frac{kQq}{2^2}$ $= 1.75\, kQq$

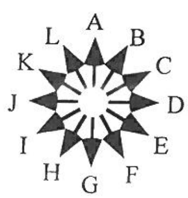
D: $\frac{kQq}{1^2} - \frac{kQq}{2^2} + \frac{kQq}{3^2}$ $= 0.861\, kQq$

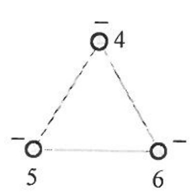
3. Three charges are fixed at the vertices of each equilateral triangle shown below. All charges have the same magnitude. Only charge 1 is positive.

Determine the direction of the net electric force acting on each charge due to the other two charges in the same triangle. Answer by using letters A through L representing directions from the choices below.



	Net Force Direction
Charge 1	G
Charge 2	K
Charge 3	C





	Net Force Direction
Charge 4	A
Charge 5	I
Charge 6	E

4. A small object with positive charge +*Q* is fixed in place. A small bead with positive charge +*q* is released from rest from the position shown above. In the absence of forces other than the electric force, draw what the graph for the acceleration as a function of distance would look like for the +q charge.