Course and Section_____ Names _____

Date_____ _____

COULOMB LAW SIMULATION

Introduction

In class we learned that every material can have a charge. These charges can be either "negative" or "positive". The origin of this charge is the atoms which make up a material. These charges exert forces on one another. In the case of the two points charges q_1 and q_2 at a distance r away from each others, the Coulomb Law gives the force as

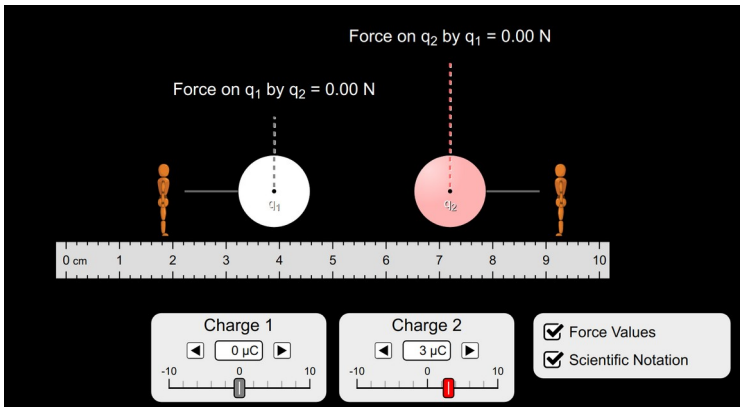
$$F = k\frac{q_1 q_2}{r^2}$$

where $k = 8.99 \times 10^9$ Nm^2/C^2 is the Coulomb constant.

Provide your answers using Blackboard.

1 – Coulomb's Law

Open the simulation and select Macro Scale (https://phet.colorado.edu/sims/html/coulombs-law/latest/coulombs-law_en.html)



For the first six questions only change the value of the charge on each sphere.

Set the charges q_1 = 0 µC and q_2 = 10 µC
1. What is the magnitude of the force on q_1 by q_2? (N)
2. What is the magnitude of the force on q_2 by q_1? (N)

Set the charges to be q_1 = 5 µC and q_2 = 5 µC
3. What is the magnitude of the force on q_1 by q_2? (N)
4. What is the magnitude of the force on q_2 by q_1? (N)

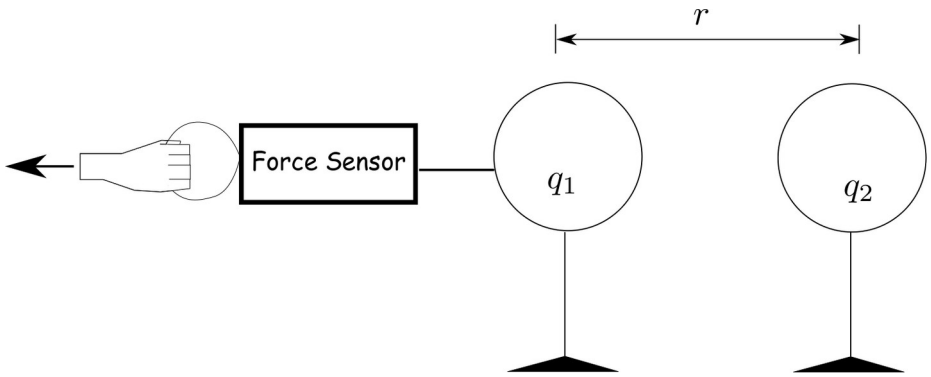
5. Do the two forces have the different directions?
6. Is charge q_1 attracted to q_2 or repelled?

Keep the charges at the same values as the previous question. If you click on either person you can change the distance between them.
7. What happens to the magnitude of the force as the charges are taken further apart?

Leave q_1 at the same charge value but now change the charge $q_2 = -2$ μC
8. Is the force between the charges attractive or repulsive?
9. What happens to the magnitude of the force as the charges are taken further apart?
10. Set the distance between the two charges to 6 cm. What is the magnitude of the force? (N)

2 – The Coulomb Constant

The goal of this experiment is to measure *k*. We could do this hypothetically by attaching a force senors to two large spheres each with a fixed charge on them where we fix the second charge in place but we let the first charge move. If we measure the distance between these two spheres and the force between them then we can determine *k*. This might look something like this



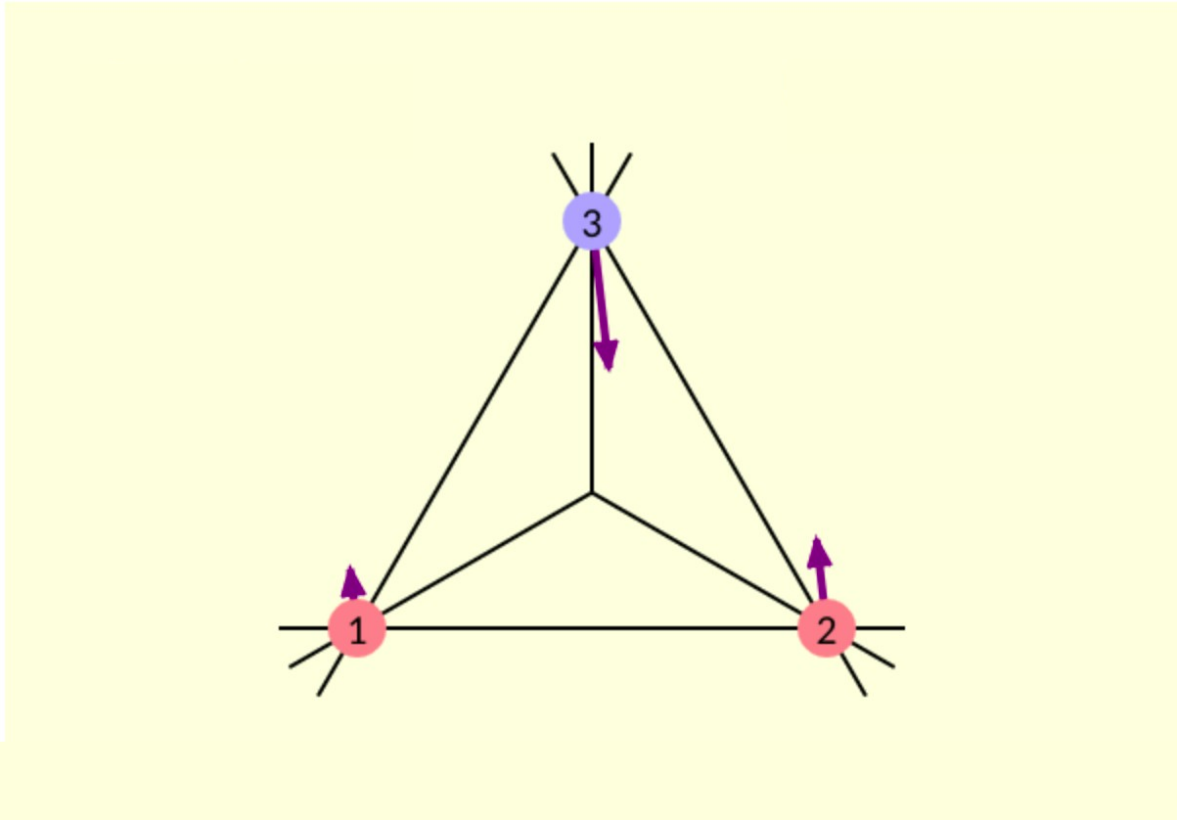
Suppose that you do this experiment in the lab with $q_1 = 5$ μC and $q_2 = 3$ μC you find the following data (where cN is centi-newtons i.e. 10^{-2}N)

r (m)	1	2	3	4	5	6	7	8	9	10
F (cN)	12.48	4.75	1.42	2.43	1.66	0.69	0.55	0.48	0.395	0.38

If we plot this as a function $1/r^2$ then the graph takes the familiar form of a line $y = mx$ where $y = F$ and $x = 1/r^2$. First calculate $1/r^2$ and then make the plot of F vs $1/r^2$. To make the plot use Excel or LibreOffice (free software) or what you prefer.
11. What is the slope *m* of your plot? (Nm^2)
12. What is the experimental value of *k*? (*(*GNm^2/C^2)(use the slope and the values of the given charges) GN- Giga Newtons or 10^9N
13. Find the % error of your result.

3 – Electric Charge Puzzle

The three particle 1,2 and 3 of unknown charge are located at the edges of the triangle shown in the image below.



The arrow on each particle indicates the net force acting on it. To answer the following questions first you need to find the forces acting between each pair of particles. For example the net force acting on particle 1 needs to be decomposed in the force between 1 and 3 and the force between 1 and 2

14. Is the force acting between 1 and 2 repulsive?
15. Is the force acting between 1 and 3 repulsive?
16. Is the force acting between 2 and 3 repulsive?

Assume the electric charge of particle 3 to be negative.
17. Is the charge of particle 1 positive?
18. Is the charge of particle 2 positive?
19. What particle has the smallest (in magnitude) electric charge?
20. What particle has the largest (in magnitude) electric charge?