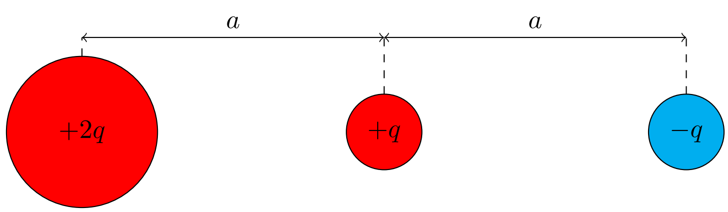
Chapter 21 - Electric Charge and Electric Field Part 1

Physics 207

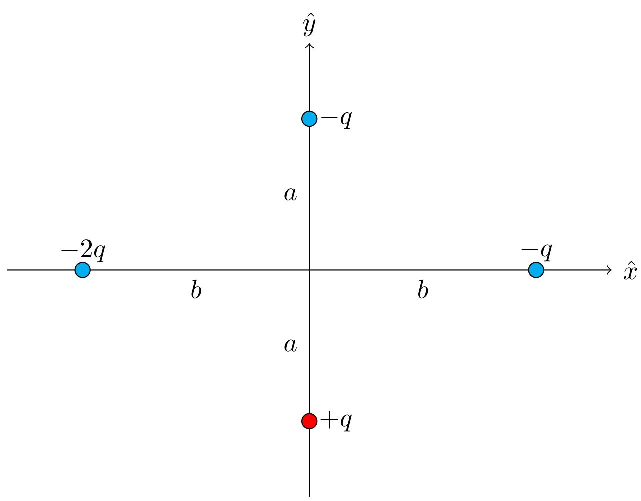
1. Gold-197 is an atomic nucleus with 79 protons and 118 neutrons and has a radius of about 6.98 fm. The electric force that this nucleus exerts on a single electron has a magnitude of 4.40×10^{-14} N.
a) What is the distance between the center of the nucleus and the electron?
b) If this electron is orbiting the nucleus in a uniform circle, what speed must it have?
c) Assuming that the nucleus is spherical, what would the electric force be between a proton on the edge of the sphere and another proton on the exact opposite side of the sphere? Assuming this is the only force, what would the acceleration of these protons be when they are in this position?
d) Since we know protons don't kick each other out of a nucleus, what else must exist so that they don't?

2. Two small spheres are electrically neutral before 8.70×10^9 electrons are transferred from one sphere to the other. The spheres have radii of 0.500 mm.
Part (a) If the magnitude of the force between these two spheres is 3.80×10^{-5} N how far apart are their centers?
Part (b) Is this force attractive or repulsive?
Part (c) Based on what we've learned so far, show that it is impossible for the magnitude of the force to be 9.30×10^{-2} N.

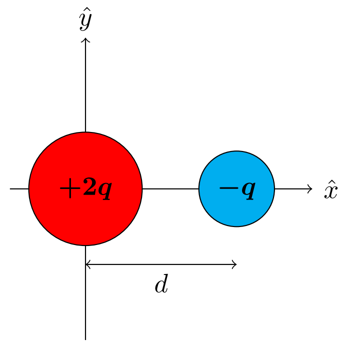
3. Three charges are arranged in the linear, isolated configuration seen below.
a) Find the net electric force vector acting on each charge.
b) Rank these forces from weakest to strongest.



4. An isolated system of charges is in the configuration shown below. All charges are fixed in place. Find the net force vector exerted on the $+q$ charge.

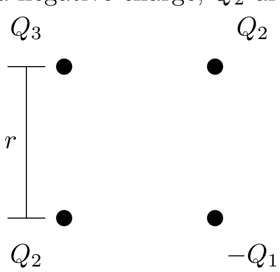


5. A charge of magnitude $+2q$ is fixed at the origin. A second charge, $-q$, is fixed at a distance d away from the origin on the positive x-axis. Find any positions on the x-axis where a charge $+Q$ would feel exactly zero net electric force. Does this change if the charge was $-Q$?



6. **Practice building the $\hat{r}$ vector.** A proton exists at the point (-10.0,17.0) and an electron exists at the point (5.00,-12.0). All positions here are given in mm.
a) What is the vector that points from the proton to the electron?
b) What is the distance between the proton and the electron?
c) What is the unit vector that points from the proton towards the electron?
d) What is the magnitude of the force acting on the electron?
e) What is the force vector that acts on the electron?
f) What is the force vector that acts on the proton?

7. Four charges are on the corners of a square as shown below. The square has sides of length r. What does the relationship between Q_1 and Q_2 have to be so that Q_3 feels zero net force? To be specific here, Q_1 is positive so $-Q_1$ results in a negative charge, Q_2 are positive charges and Q_3 has unknown sign.



8. There exist three charges as shown in the picture below, q_1, q_2 and $-Q$. The charge $-Q$ has a mass m and when it is at the position shown, it has an acceleration straight upwards of magnitude a. What do q_1 and q_2 have to be in order to have this be the case? You should consider gravity to have an impact in this problem and that it acts opposite to the acceleration vector.