Homework 1: Point charges

1. Particles of charge +75 μC, +48 μC and -85 μC are placed in a line. The center one is 0.35 m from each of the others. Calculate the net force on each charge due to the other two.

2. Three positive particles of equal charge, +11 μC are located at the corners of an equilateral triangle of side 0.15 m. Calculate the magnitude and direction of the net force on each particle.

3. A charge of 6 mC is placed at each corner of a square of side 0.1 m. Determine the magnitude and direction of the force on each charge.

4. Repeat previous problem for the case when two of the positive charges, on opposite corners, are replaced by negative charges of the same magnitude.

5. Three charged particles are placed at the corners of an equilateral triangle of side 1.2 m. The charges are +4 μC, -8 μC and -6 μC. Calculate the magnitude and direction of the net force on each due to the other two.

6. Two charges, $-Q_0$ and $-3Q_0$, are a distance *l* apart. These two charges are free to move but do not because there is a third charge nearby. What must be the charge and placement of the third charge for the first two to be in pseudo-equilibrium?

7. Two identical point charges $+Q$ are located on the y-axis at $y = +d/2$ and $y = -d/2$. A third charge q is placed on the x-axis. At what distance from the origin is the net force on q a maximum?

8. Two $2.0\ g$ balls hang from lightweight insulating threads $50\ cm$ long from a common support point as shown in the Figure. When equal charges Q are place on each ball they are repelled, each making an angle of 10 degrees with the vertical. What is the magnitude of Q, in μC?

9. Two identical point charges $+Q$ are located on the $y - axis$ at $y = +d/2$ and $y = -d/2$ and a third charge $-2Q$ is located at the origin. The three charged $+Q, +Q$, and $-2Q$ form an electrically neutral system called an *electric quadrupole*. A charge q is placed on the $x - axis$ a distance $x = d$ from the quadrupole.

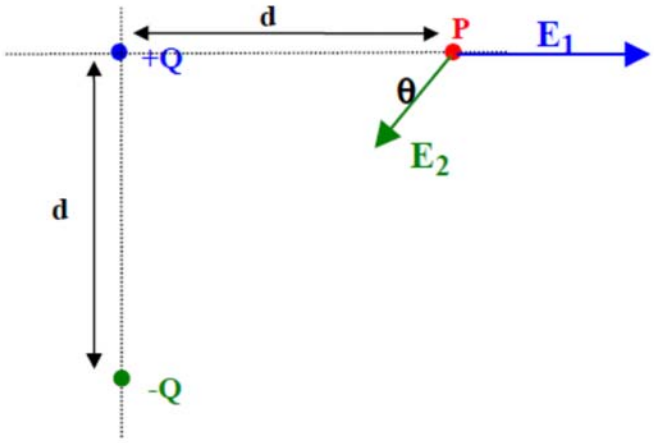
(a) What is the net force on q due to the quadrupole?

(b) What is the magnitude of force on the charge q when x becomes very large compared to the quadrupole separation d.

(***Hint***: take the limit of the quadrupole force on q when $x \gg d$.)

10. Two charges $Q1$ and $Q2$ are separated by distance L and lie on the $x - axis$ with $Q1$ at the origin. At a point P on the $x - axis$ a distance $L/3$ from $Q1$ the *net* electric field is zero. What is the ratio $Q1/Q2$?

11. An electric dipole is placed on the $y-axis$ with $+Q$ at $y=0$ and $-Q$ at $y=-d$. What is the magnitude of the electric field at a point P located at $x=d$ on the $x-axis$?



12. As shown in the figure, a ball of mass $M=2\ kg$ and charge $Q=3\ C$ is suspended on a string of negligible mass and length L=1 m in *a non uniform* electric field $E(x)=ax\hat{x}$, where $a=13.07\ N/(Cm)$ is a constant. If the ball hangs at a non-zero θ from the vertical, what is θ? (Hint: gravity pulls the ball down with acceleration $g=9.8\ m/s^2$.)