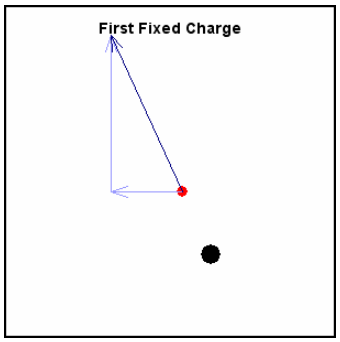
Worksheets for Exploration 22.1: Equilibrium



Two fixed charges and a dragable test charge are placed as shown **(position is given in meters and force is given in newtons)**. The blue arrow represents the force on the red test charge. The forces on the fixed charges are not shown. You can examine the forces with the first fixed charge, with the second fixed charge, or with both fixed charges in place. Notice that the net force on the test charge is displayed in the yellow message box when you have only one charge present, but not when you have both charges present.

Answer the following questions with both fixed charges in place.

a. Determine the net force on the test charge at the point (3 m,4 m).
   i. To do this first determine the force due to the "first" charge alone (magnitude and direction).
      $F_{red,\ first}$=_____, direction=_____
   ii. Next do the same for the "second" charge.
      $F_{red,\ second}$=_____, direction=_____
   iii. Now sketch the two vectors represented by the forces in the usual "head to tail" vector addition picture. And then give the resultant net force (work this out analytically).

b. Determine the net force on the test charge at a point midway between the two charges.
   i. First you will need to determine where the midpoint is.
      x_{mid}=_____ y_{mid}=_____
   ii. As in part a you will need to measure the magnitude of force due to each charge (first and second) and also consider the directions.

c. Is (are) there any point(s) where the net force on the test charge is zero? If so, find those points.
   i. Check this by moving the charge, but also think about it. How many such points are possible? And where should such "equilibrium" points be located when the charges are the same, opposite?

x_{equil}=_____ y_{equil}=_____

d. What is the ratio of the charges? (First charge is lower right)
   i. To find the ratio you will need to use Coulomb's law and also determine the distance to the equilibrium point from each charge. Also what is the net force and force due to each charge at that point (on the test charge)?

$$\frac{q_{first}}{q_{second}} = \_\_\_\_\_$$

e. Throughout the problem did you need to consider the force of the first charge on the second (or vice versa)?