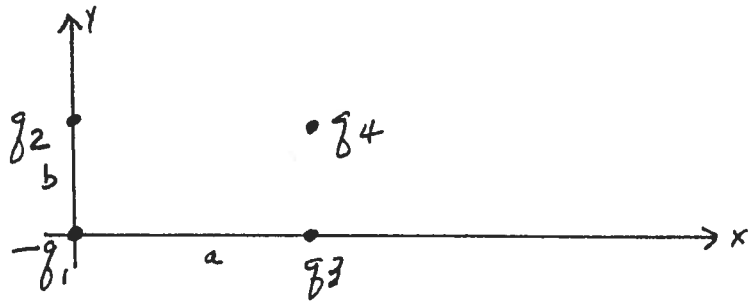
1. (25 points) Three charges are placed as shown.



The distances a and b are known. The charge at the origin is known and negative, $-q_1$. The charge q_2 at $x = 0, y = b$ is unknown. The charge q_3 at $x = a, y = 0$ is unknown. What must be the unknown charges q_2 and q_3 if the electric force on a positive charge q_4 at $x = a, y = b$ is to be zero?

Law

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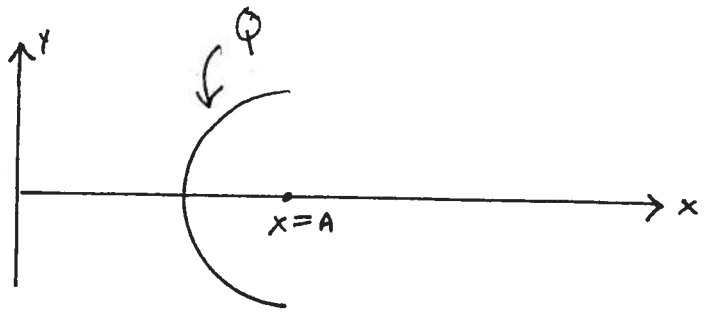
Result

2. (25 points)An amount of charge Q is uniformly distributed along a semi-circle of radius R whose center is a distance A from the origin. What point charge would have to be placed at the origin so that the electric field at the center of the semi-circle would be zero?

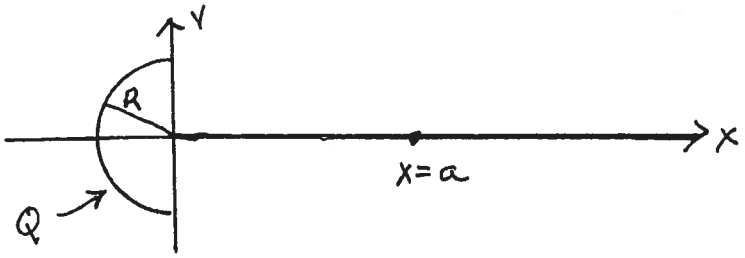


Law

Application

Result

3. (25 points) An amount of charge Q is uniformly distributed along a semi-circle of radius R whose center is at the origin. Find the electric potential function at the point $x = a$ assuming the value of the electric potential at infinity is zero.



Law

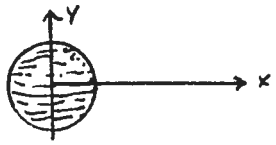
Application

Result What is the value of the electric potential you found above for the special case where $a = 0$?

4. (25 points) Suppose the force exerted on a point test charge q_0 by a point charge Q was given by

$$\vec{F} = C\frac{q_0 Q}{r^6}\hat{r}$$

where, just like in the Coulomb force, r is the distance between the points, $\hat{r}$ is along the line from one point to the other and C is a positive, known constant. The force is repulsive for these two positive charges. Find the flux of $\vec{E}$ corresponding to this force for a surface which is a sphere of radius R with center at the origin. Also find the difference in the electric potential difference between a point 2R from the origin and a point infinitely far from the origin.



Law

Application

Result