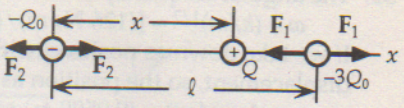
48. Because the charges have the same sign, they repel each other. The force from the third charge must balance the repulsive force for each charge, so the third charge must be positive and between the two negative charges. For each of the negative charges, we have



Q_0: $kQ_0Q/x^2 = kQ_0(3Q_0)/\ell^2$, or $\ell^2 Q = 3x^2Q_0$;

$3Q_0$: $k3Q_0Q/(\ell - x)^2 = kQ_0(3Q_0)/\ell^2$, or $\ell^2Q = (\ell - x)^2Q_0$.

Thus we have

$3x^2 = (\ell - x)^2$, which gives $x = -1.37\ell, + 0.366\ell$.

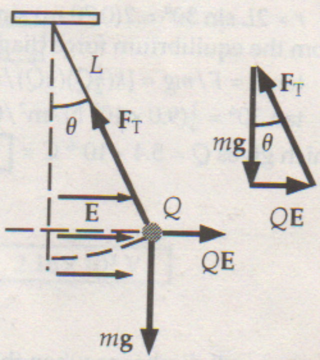
Because the positive charge must be between the charges, it must be 0.366ℓ from Q_0. When we use this value in one of the force equations, we get

$Q = 3(0.366\ell)^2Q_0/\ell^2 = 0.402Q_0$.

Thus we place a charge of $0.402Q_0$ 0.366ℓ from Q_0.

Note that the force on the middle charge is also zero.

49. Because the charge moves in the direction of the electric field, it must be positive.



We find the angle of the string from the dimensions:

$\cos\theta = (0.49\text{ m})/(0.50\text{ m}) = 0.98$, or $\theta = 11.5°$.

Because the charge is in equilibrium, the resultant force is zero.

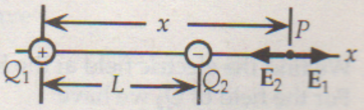
We see from the force diagram that

$\tan\theta = QE/mg$;

$\tan 11.5° = Q(9200\text{ N/C})/(1.0 \times 10^{-3}\text{ kg})(9.80\text{ m/s}^2)$,

which gives $Q =$ 2.2×10^{-7} C.

50. Because the charges have opposite signs, the location where the electric field is zero must be outside the two charges, as shown.



The fields from the two charges must balance:

$kQ_1/x^2 = kQ_2/(L - x)^2$;

$(2.5 \times 10^{-5}\text{ C})/x^2 = (5.0 \times 10^{-6}\text{ C})/(2.0\text{ m} - x)^2$,

which gives $x = 1.4$ m, 3.6 m.

Because 1.4 m is between the charges, the location is

3.6 m from the positive charge, and 1.6 m from the negative charge.

51. (*a*) The force is opposite to the direction of the electron. We find the acceleration produced by the electric field:

$-qE = ma$;

$-(1.60 \times 10^{-19}\text{ C})(7.7 \times 10^3\text{ N/C}) = (9.11 \times 10^{-31}\text{ kg})a$, which gives $a = -1.35 \times 10^{15}\text{ m/s}^2$.

Because the field is constant, the acceleration is constant, so we find the distance from

$v^2 = v_0^2 + 2ax$;

$0 = (1.5 \times 10^6\text{ m/s})^2 + 2(-1.35 \times 10^{15}\text{ m/s}^2)x$, which gives $x = 8.3 \times 10^{-4}\text{ m} =$ 0.83 mm.

(*b*) We find the time from

$x = v_0t + \frac{1}{2}at^2$;

$0 = (1.5 \times 10^6\text{ m/s})t + \frac{1}{2}(-1.35 \times 10^{15}\text{ m/s}^2)t^2$,

which gives $t = 0$ (the starting time), and $2.2 \times 10^{-9}\text{ s} =$ 2.2 ns.