Practice Problems Section 2 Solutions

1. A 5.00 nC charge is placed at the coordinates (-1.00, 1.00) m. A -1.00 nC is located at (2.00, 0.00) m.
2. Solve for the electric field (expressed in terms of coordinate-axes unit vectors) due to the 5.00 nC charge, at the location of the -1.00 nC charge. (1 nC = C) **Show your work!**

We first have to find the vector that points from the source point (the location of the 5.00 nC charge) to the field point (the location of the -1.00 nC charge). (I will leave the length units off until later).

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Now find the unit vector in the direction of as well as its magnitude .

Now we are ready to find the electric field at the field point due to the source charge.

Plugging everything into a calculator, we find that the electric field at the location of the -1.00 nC charge due to the 5.00 nC charge is equal to

Note that the -1.00 nC charge has nothing to do with this calculation. A charge cannot create an electric field at its own location. In this case, we would call the 5.00 nC charge the “source” charge and the -1.00 nC charge the “test” charge.

1. Solve for the force (expressed in terms of coordinate-axes unit vectors) acting on the -1.00 nC charge. **Show your work!**

Now that we have the electric field at the location of the -1.00 nC charge, it is easy to find the electric force exerted on it.

Coulomb’s Law:

1. A ball of mass 4.00 kg, which contains a charge of -3.00 mC, is placed on a string and hung from a ceiling, as in the picture.

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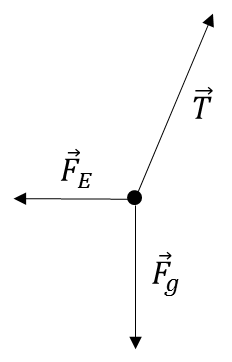
A uniform electric field is applied in the room, which has a magnitude of 4000 N/C and points to the right. Due to the electric field, the string will tilt at some angle with respect to the vertical and the ball will be in equilibrium.

1. Which way will the string tilt, to the right or to the left? **Explain.**

The electric force on a negative charge always points in the opposite direction of the electric field. Since the electric field points to the right, the electric force will point to the left. Thus, the string will tilt left.

1. At what angle with respect to the vertical will the string tilt? **Show your work!**

This is a problem involving forces and equilibrium, which means we must invoke Newton’s 2nd law.



The first step is to draw a force (free-body) diagram. There are three forces acting, the electric force, the gravitational force, and the tension force of the string. A force diagram is shown to the right.

Now we use Newton’s 2nd law. The net force on the ball is zero, as it is in equilibrium.

As usual, we have one equation for the x-direction and one equation for the y-direction. The electric force only has an x-component and the gravitational force only has a y-component. The tension has both x- and y- components. Since the angle we want is with respect to the vertical, we break the tension into components with respect to the vertical axis, and call the angle with respect to the vertical axis .

Therefore, Newton’s law yields

Since our goal is to solve for the angle , we must isolate the terms involving . This yields

Dividing the first equation by the second, we find

Taking the inverse tangent of this yields

Since the electric force in this case is smaller than the gravitational force, the string tilts at an angle less than 45°.