Practice Problems Section 4 Solutions

1. A negative charge is placed 20.0 cm to the left of a positive charge. Each has a magnitude of 4.00 nC.
2. Find the electric potential a distance 10.0 cm to the right of the negative charge. **Show your work!**

10.0 cm to the right of the negative charge is also 10.0 cm to the left of the positive charge. Therefore, the field point is equidistant between the positive and negative charges. Since each source charge has the same magnitude but opposite charge, and the field point is equidistant between them, the electric potential at the field point must be **zero**!

Mathematically, if the positive charge is called charge 1, and the negative charge called charge 2, then

1. How much work (at minimum) must you do against the electric force to bring a third charge ( nC) from “infinity” to the location in part a)? **Show your work and/or explain.**

The external work that must be done against any conservative force in moving a particle from one location to another is

In this case, we are doing the minimum work so . Now, to find the potential energy of a charge configuration, we simply multiply the value of the test charge by the electric potential at that location. Mathematically, .

So this problem amounts to finding the electric potential at the initial and final positions of charge 3. The initial position is infinity, and the electric potential due to the two point charges is zero at infinity.

We also know that the electric potential at the final position is zero, based on our calculation in part a).

Thus, .

This leads to

It takes 0 J of work to move the particle from infinity to the location equidistant between the two charges in part a).

1. Pictured are two parallel plates, kept at 50.0 V and 0 V as shown. An electron located at the 50.0 V plate is initially traveling at a velocity of m/s to the right.

50.0 V

0 V

* 1. On the picture, draw the electric field lines created by the plates.

The electric field always points in the direction of decreasing potential!

* 1. What is the direction of the electric force on the electron? **Explain briefly how you know.**

Since the electric field points to the right, the electric force on a negative charge must point to the left!

* 1. Using only your answer to part b), explain whether the electron will speed up or slow down as it moves towards the 0 V plate. **No numbers to calculate here, just a brief and clear explanation of your choice!**

Newton’s 2nd law says that an object’s acceleration is directly proportional to the net force acting on it. Since the net force acts to the left, the electron will accelerate to the left. Since it was initially moving to the right, it must therefore be **slowing down**.

* 1. Use energy conservation to calculate the speed of the electron at the location of the 0 V plate. Does your answer agree with your qualitative answer in part c? **Show your work!**

We set up energy conservation with kinetic and electric potential energy. The initial speed is m/s and the final speed is unknown. The initial electric potential is 50 V and the final electric potential is 0 V.

Thus,

As expected from the analysis in part c, the electron does indeed end up traveling slower at the 0 V plate compared to its initial speed at the 50 V plate.