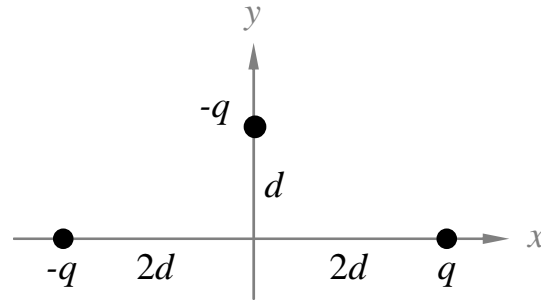


Discussion Question 4C
P212, Week 4
Electric Potential due to a System of Point Charges

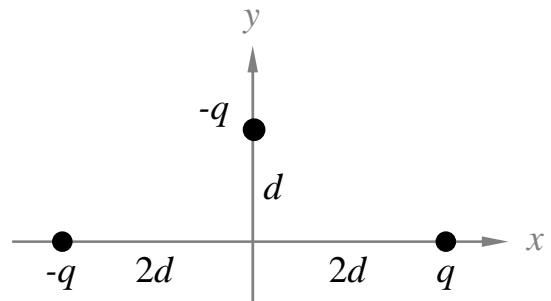
Three point charges are fixed at the positions shown in the figure. We are interested in the electric potential surrounding this system of charges ... we'll set the potential at *infinity* to be zero in all of these problems. Also, we'll work with algebraic answers in this problem, so you can put your calculator away.



(a) What is the electric potential at the origin?

- (i) It is *always* a good idea to anticipate as much of the answer as possible *before* you begin your calculations. In potential problems, the **sign** is particularly important. So, using only your physical intuition, what will be the sign of the electric potential at the origin? (Ask yourself: if I bring in a positive charge from infinity, where the potential is set to zero, will I be pushing it 'uphill' or letting it roll 'downhill'?)
- (ii) Now we're ready to calculate. You *could* do this problem like the last one, using integrals over the electric field. However, we already *know* an expression for the potential due to a point charge. What is this expression? Remember, any formula for potential is only good to within an additive constant ... check your formula: does it set the potential to zero at the location we want?
- (iii) **Superposition** to the rescue! The total potential at the origin is just: the potential due to charge q_1 , plus the potential due to charge q_2 , plus ... you get the idea. Write down the potential V due to each of the three charges.
- (iv) Finally, calculate the net potential at the origin. Is the **sign** correct?

(b) If you placed a negative charge $-Q$ at the origin, what potential energy would it have? What is the maximum speed it would achieve if it was initially at rest and you let it go?



(c) What is the total potential energy of the system of 3 charges?

Let's think for a second ... what does this question mean? The potential energy of the system of 3 charges is equal to the *work it took* to assemble this configuration. When all 3 charges are at infinity, we define them to have zero potential energy. So ... bring in one charge at a time from infinity, and calculate how much work was required at each step ...

Did you check the sign of your result using your physical intuition?