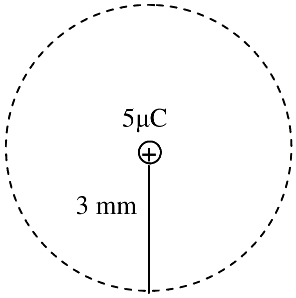
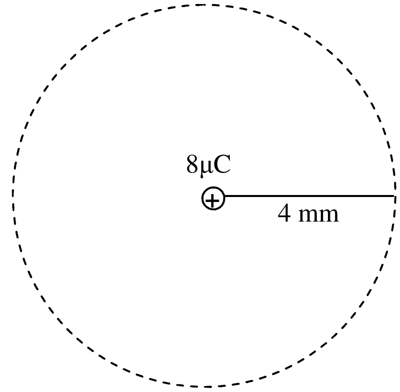
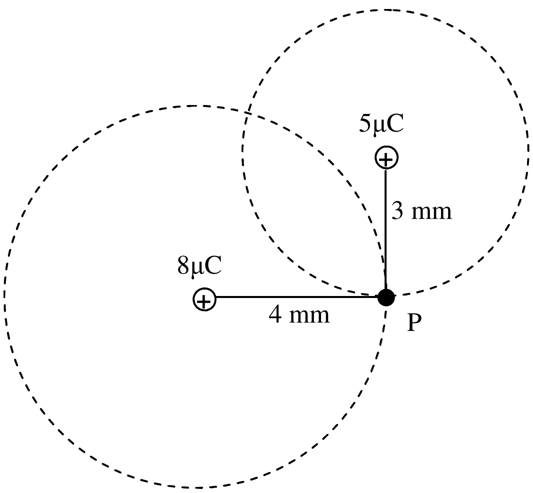
Calculating net E, F, PE, and V p 2



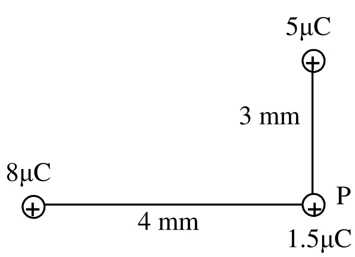
1. Calculate the four electrostatic quantities (E, F, PE, and V) 3 mm from a 5μC charge, as shown in the diagram. Be sure to give direction, if necessary. Some may be zero. Notice, keeping r constant produces a sphere that is 3 mm away from the 5μC charge. This means E, F, PE, and V will have particular values everywhere on that sphere.



2. Calculate the four electrostatic quantities 4 mm from an 8μC charge, as shown in the second diagram. Again, everywhere equidistant from the charge will have the same E, F, PE, and V.



3. The two charges are then brought close to each other. Obviously, their spheres intersect at a few points (two should be obvious). Each of these points is 3 mm from one and 4 mm from the other. We will call one of these intersections points P. Using the numbers you found in Q1 and 2, calculate the net E, F, PE, and V at point P due to both charges. Again, some may be zero.



4. A 1.5μC charge is then brought to point P from infinity. The spheres have been removed to make the diagram easier to read.
   A. Again, using your previous numbers, calculate the four electrostatic quantities for this charge at point P.
   B. How much work was done to move the charge to point P from infinity?
   C. If released from rest, which way will the 1.5μC move?
   D. If a negative charge was put at P, which way would it move?

5. The 1.5μC charge is then replaced with a 3μC charge.
   A. How would the electric field at P change?
   B. How would the force at P change?
   C. How would the electric potential (V) at P change?
   D. How would the potential energy at P change?

6. The 1.5μC is returned and the 5μC charge is changed to a −5μC charge. Describe any changes that will occur on the charge at P.

Name: ____________________

Period: ____________________

Calculating net E, F, PE, and V page 2

9E9

$\vec{E} = \frac{k(5\mu C)}{(3mm)^2} = 5\times10^9$ N/c down ($\times10^{-6}$, $\times10^{-3}$)

$\vec{F} = \frac{kqq}{r^2} = 0N$ (only 1 q)

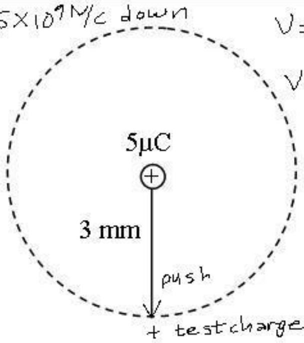
$V = \frac{kq}{r} = \vec{E}r$

$V = 5\times10^9(3mm)$

$= 15\times10^6$ J/c

$= 1.5\times10^7$ J/c (no direction)

PE = 0 J (only 1 q)



1. Calculate the four electrostatic quantities (E, F, PE, and V) 3 mm from a 5µC charge, as shown in the diagram. Be sure to give direction, if necessary. Some may be zero. Notice, keeping r constant produces a sphere that is 3 mm away from the 5µC charge. This means E, F, PE, and V will have particular values everywhere on that sphere.

$\vec{E} = \frac{k(8\mu C)}{(4mm)^2}$

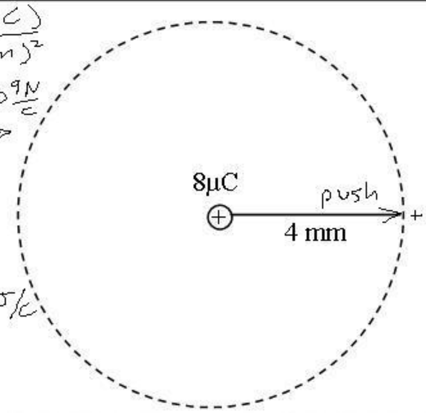
$= 4.5\times10^9$ N/c to R →

$\vec{F} = 0N$ (only 1 q)

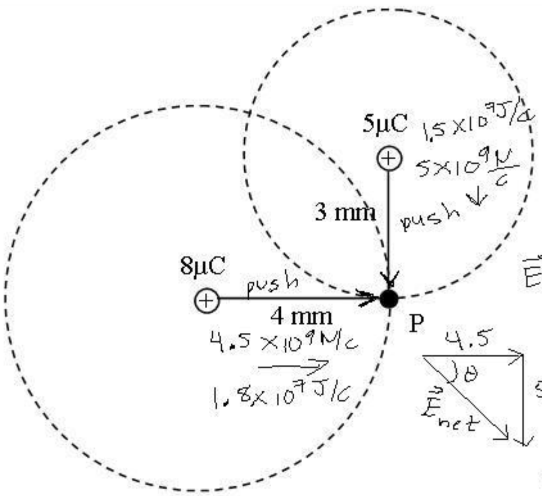
$V = Er$

$= 1.8\times10^7$ J/c

PE = 0 J



2. Calculate the four electrostatic quantities 4 mm from an 8µC charge, as shown in the second diagram. Again, everywhere equidistant from the charge will have the same E, F, PE, and V.



obviously $\vec{F}$ and PE are still 0, since there is no q at Point P.

V_{net} is scalar, so just add $= (1.8+1.5)10^7$

$= 3.3\times10^7$ J/c

$\vec{E}_{net}$ is a vector, so

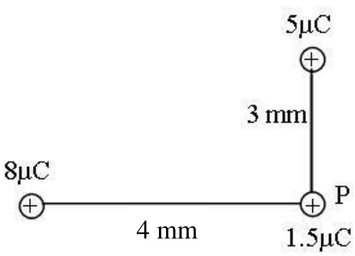
$\vec{E}_{net} = \sqrt{5^2+4.5^2}$

$= 6.7\times10^9$ N/c

$\theta = \tan^{-1}\left(\frac{-5}{4.5}\right) = -48°$

and since x and y are almost = θ must be close to 45°.

3. The two charges are then brought close to each other. Obviously, their spheres intersect at a few points (two should be obvious). Each of these points is 3 mm from one and 4 mm from the other. We will call one of these intersections points P. Using the numbers you found in Q1 and 2, calculate the net E, F, PE, and V at point P due to both charges. Again, some may be zero.



4. A 1.5µC charge is then brought to point P from infinity. The spheres have been removed, only to make the diagram cleaner.

   A. Again, using your previous numbers, calculate the four electrostatic quantities for this charge at point P.

$\vec{E}_{net} = 6.7\times10^9 \frac{N}{c}$

mult. by c to get N: so $\vec{F} = q\vec{E}$

$\left(\frac{6.7\times10^9 N}{1c}\right)\frac{1.5\mu c}{1} = 1.005\times10^4$ N at −48°

$PE = qV = 3.3\times10^7 \frac{J}{c}(1.5\mu c)$

PE = 49.5 J (V still $= 3.3\times10^7$ J/c)

B. How much work was done to move the charge to point P from infinity?

49.5 J (and will have 49.5 J of KE after it is released)

C. If released from rest, which way will the 1.5µC move?

+ charges go the direction of E (-48°), since we used a + test charge

D. If a negative charge was put at P, which way would it move?

- charges go the opposite direction of E (toward the 2nd Q)

5. The 1.5µC charge is then replaced with a 3µC charge.

   A. How would the electric field at P change?

   No Δ, since the 8µC + 5µC haven't changed

   B. How would the force at P change?

   doubles: F = qE and q doubled

   C. How would the electric potential (V) at P change?

   no Δ

   D. How would the potential energy at P change?

   doubles

6. The 5µC charge is changed to a −5µC charge. Describe any changes that will occur on the charge at P.

$\vec{E}$ has same mag, but toward 1st Q.

$\vec{F}$ is same mag (same $\vec{E}$) at +48°

V in Q1 is now neg, so

$V_{net} = (-1.5\times10^7)+(1.8\times10^7) = 3\times10^6$ J/c

so $PE = qV = 1.5\mu C(3\times10^6) = 4.5$ J