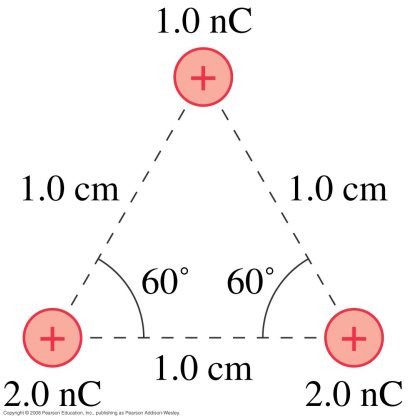
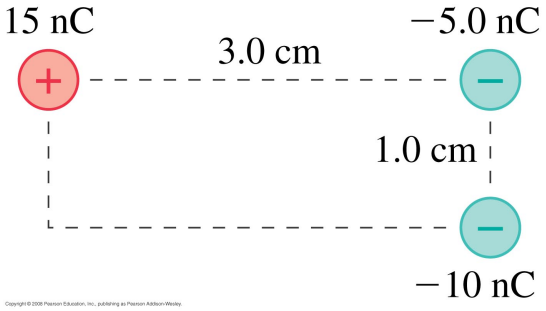
PHYS 1004
INTRODUCTORY ELECTROMAGNETISM AND WAVE MOTION
2013 Winter Term

Tutorial #2: Assigned Problems

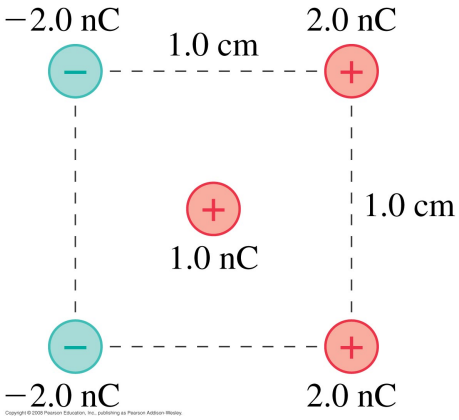
1. What is the force $\vec{F}$ on the 1.0 nC charge in the FIGURE? Give your answer as a magnitude and a direction.



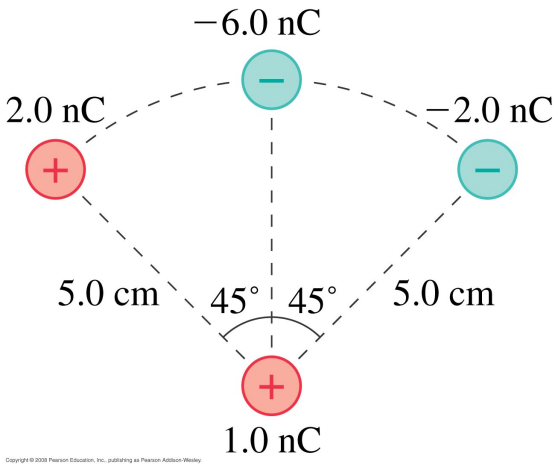
2. What is the force $\vec{F}$ on the -10 nC charge in the FIGURE? Give your answer as a magnitude and an angle measured cw or ccw (specify which) from the $+x$-axis.



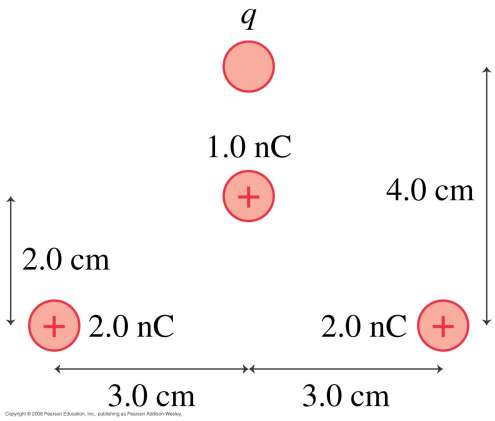
3. What is the force $\vec{F}$ on the 1.0 nC charge in the middle of the FIGURE due to the four other charges? Give your answer in component form.



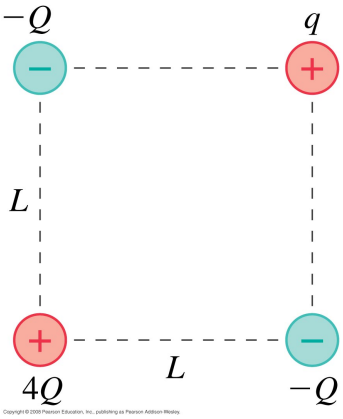
4. What is the force $\vec{F}$ on the 1.0 nC charge at the bottom in the FIGURE? Give your answer in component form.



5. The net force on the 1.0 nC charge in the FIGURE is zero. What is q?



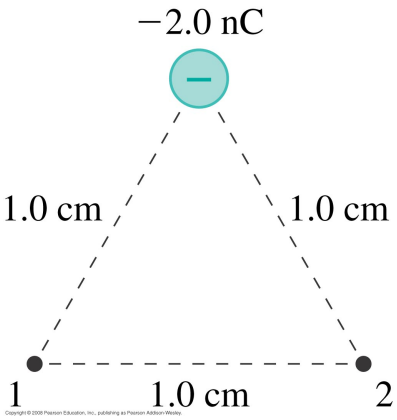
6. The FIGURE shows four charges at the corners of a square of side L. What is the magnitude of the net force on q?



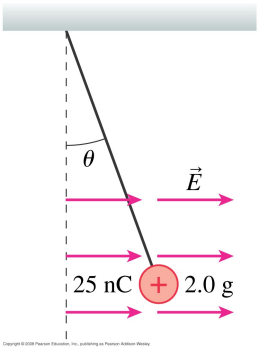
7. Two positive point charges q and $4q$ are at $x = 0$ and $x = L$, respectively, and free to move. A third charge is placed so that the entire three-charge system is in static equilibrium. What are the magnitude, sign, and x-coordinate of the third charge?

8. You have a lightweight spring whose unstretched length is 4.0 cm. First, you attach one end of the spring to the ceiling and hang a 1.0 g mass from it. This stretches the spring to a length of 5.0 cm. You then attach two small plastic beads to the opposite ends of the spring, lay the spring on a frictionless table, and give each plastic bead the same charge. This stretches the spring to a length of 4.5 cm. What is the magnitude of the charge (in nC) on each bead?

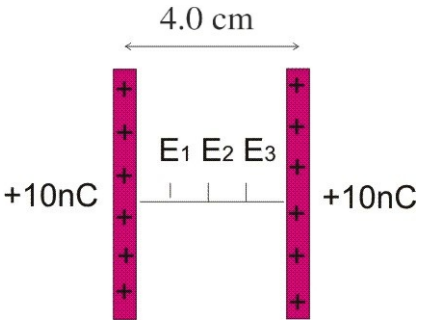
9. What are the electric fields at points 1 and 2 in the FIGURE? Give your answer as a magnitude and direction.



10. An electric field $\vec{E} = 200{,}000\ \hat{i}$ N/C causes the point charge in the FIGURE to hang at an angle. What is θ?



11. Two 10-cm-long thin glass rods uniformly charged to +10 nC are placed vertically side by side, 4.0 cm apart, as shown in the figure below. What are the electric field strengths E_1, E_2 and E_3 at distances 1.0 cm, 2.0 cm, and 3.0 cm, respectively, to the right of the rod on the left along the line (x-axis) connecting the midpoints of the two rods?



12. Two 10-cm-diameter charged rings face each other, 20 cm apart. The left ring is charged to -20 nC and the right ring is charged to $+20$ nC.

    a. What is the electric field $\vec{E}$, both magnitude and direction, at the midpoint between the two rings?

    b. What is the force $\vec{F}$ on a -1.0 nC charge placed at the midpoint?

13. Two 10-cm-diameter charged disks face each other, 20 cm apart. The left disk is charged to -50 nC and the right disk is charged to $+50$ nC.

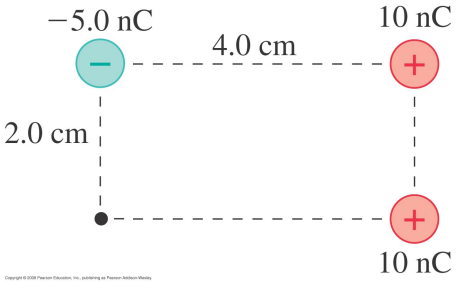
    a. What is the electric field $\vec{E}$, both magnitude and direction, at the midpoint between the two disks?

    b. What is the force $\vec{F}$ on a -1.0 nC charge placed at the midpoint?

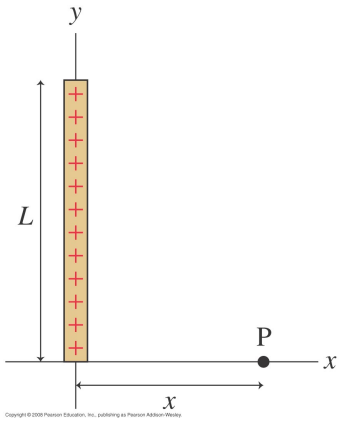
14. Two circular disks spaced 0.50 mm apart form a parallel-plate capacitor. Transferring 3.0×10^9 electrons from one disk to the other causes the electric field strength to be 2.0×10^5 N/C. What are the diameters of the disks?

15. The permanent electric dipole moment of the water molecule (H_2O) is 6.2×10^{-30} C m. What is the maximum possible torque on a water molecule in a 5.0×10^8 N/C electric field?

16. What are the strength and direction of the electric field at the position indicated by the dot in the figure below? Give your answer (a) in component form and (b) as a magnitude and angle measured cw or ccw (specify which) from the positive x-axis.



17. The figure below shows a thin rod of length L with total charge Q. Find an expression for the electric field $\vec{E}$ at point P. Give your answer in component form.



18. An electron is launched at a 45° angle and a speed of $v_o = 5.0 \times 10^6$ m/s from the positive plate of the parallel-plate capacitor shown in the figure below. The electron lands 4.0 cm away.

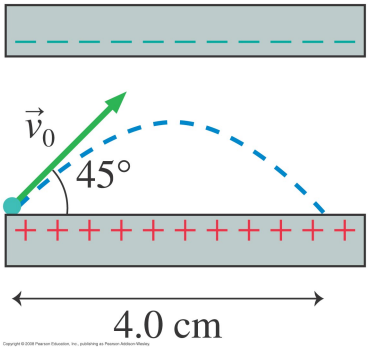
a. What is the electric field strength inside the capacitor?

b. What is the smallest possible spacing between the plates?

Hint: For projectile motion under the force of gravity (represented here by the acceleration due to gravity, g):

$$Range = |v_0| \cos\theta \times 2\,|v_0| \sin\theta / g$$
$$Height = (vertical\ velocity)^2 / 2g = (|v_0| \sin\theta)^2 / 2g$$

Note to change to the electrostatic calculation, replace g with the acceleration due to an electric field E acting on an object with mass m and electric charge e.

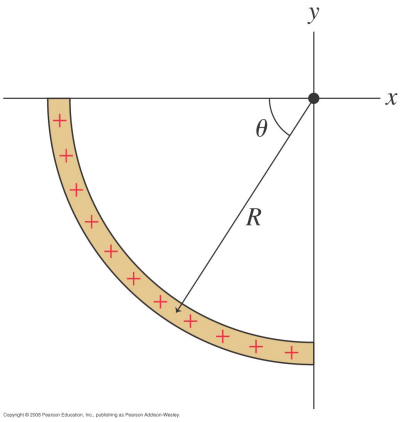


19. A plastic rod with linear charge density λ is bent into the quarter circle shown in the figure below. We want to find the electric field at the origin.

a. Write expressions for the x- and y-components of the electric field at the origin due to a small piece of charge at angle θ.

b. Write, but do not evaluate, definite integrals for the x- and y-components of the net electric field at the origin.

c. Evaluate the integrals and write $\vec{E}_{net}$ in component form.



20. Two 2.0-cm-diameter insulating spheres have a 6.0 cm space between them. One sphere is charged to +10 nC, the other to −15 nC. What is the electric field strength at the midpoint between the two spheres?