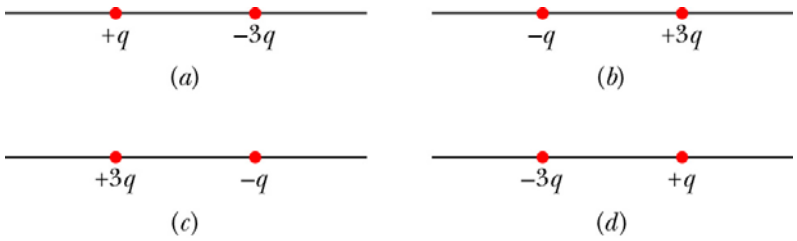
Chapter 20: Electric Fields & Forces
Example Questions & Problems

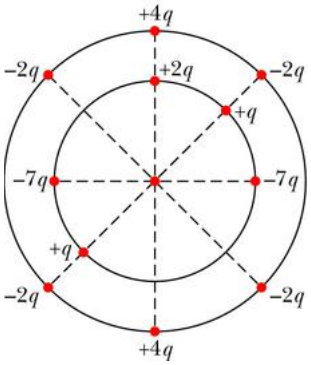
$$F_E = \frac{kq_1q_2}{r^2} \qquad k = 8.99\times10^9 N\cdot m^2/C^2 \qquad F_E = qE$$

$$e = 1.6\times10^{-19} C$$

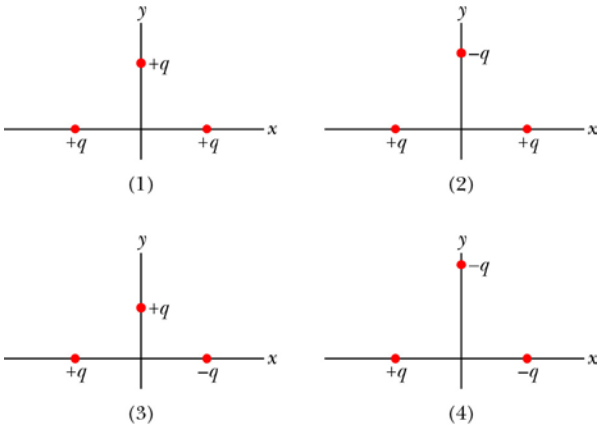
Question 20-1
The figure below shows four situations in which charged particles are fixed in place on an axis. In which situation(s) is there a point to the left of the particle where an electron will be in equilibrium?



Question 20-2
In the figure to the right, a central particle of charge -q is surrounded by two circular rings of charged particles, of radii r and R, with R > r. What are the magnitude and direction of the net electrostatic force on the central particle due to the other particles?



Question 20-3
The figure to the right shows four situations in which particles of charge +*q* or –*q* are fixed in place. In each, the particles on the x-axis are equidistant from the y-axis. What is the direction of the net force on the middle particle in each case?



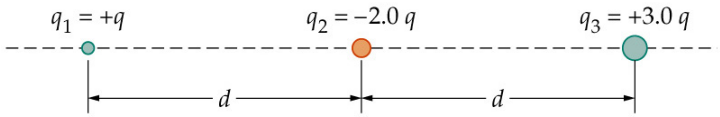
Example 20.1
Two identical metal spheres A and B are connected by a metal rod. Both are initially neutral. 1.0×10^{12} electrons are added to sphere A, then the connecting rod is removed. Afterward, what is the charge of A and the charge of B?

Example 20.2
A plastic rod that has been charged to -15.0 nC touches a metal sphere. Afterward, the rod's charge is -10.0 nC.
a. What kind of charged particle was transferred between the rod and the sphere, and in which direction?
b. How many charged particles were transferred?

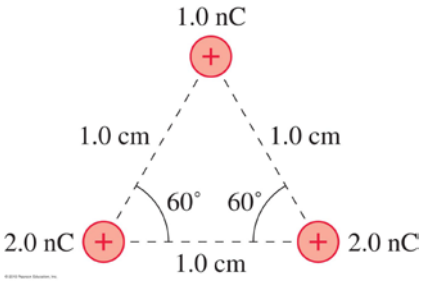
Example 20.3
Two small plastic spheres each have a mass of 2.0 g and a charge of −50.0 nC. They are placed 2.0 cm apart.
a. What is the magnitude of the electric force between the spheres?
b. By what factor is the electric force on a sphere larger than its weight?

Example 20.4
A small plastic sphere with a charge of −5.0 nC is near another small plastic sphere with a charge of −12 nC. If the spheres repel one another with a force of magnitude 8.2×10^{-4}N, what is the distance between the spheres?

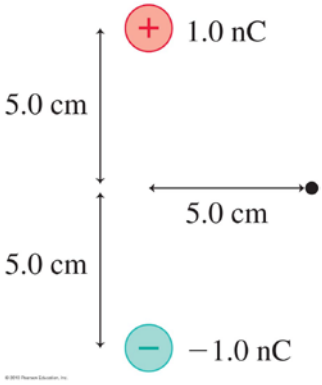
Example 20.5
Given that q = +12 uC and d = 16 cm, find the direction and magnitude of the net electrostatic force exerted on charge q_1 in the figure below.



Example 20.6
What is the force on the 1.0 nC charge in the figure below. Give your answer as a magnitude and a direction.

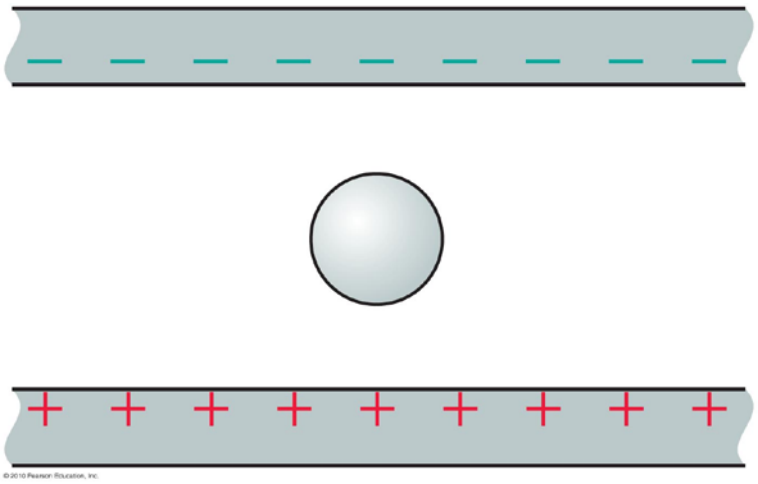


Example 20.7
What are the strength and direction of the electric field at the position indicated by the dot in the figure below. Specify the direction as an angle above or below the horizontal.



Example 20.8

a. A +10 nC charge is located at the origin. (i) Draw the field diagram showing the E-field vectors at these positions (cm): (x, y) = (5.0, 0), (–5.0, 5.0) and (–5.0, –5.0). (ii) What are the strengths of the E-fields at the positions?
b. A –10 nC charge is located at the origin. (i) Draw the field diagram showing the E-field vectors at these positions (cm): (x, y) = (0, 5.0), (–5.0, 5.0) and (–5.0, –5.0). (ii) What are the strengths of the E-fields at the positions?

Example 20-9
A 0.10 g plastic bead is charged by the addition of $1.0 * 10^{10}$ excess electrons. What electric field **E** (strength and direction) will cause the bead to hang suspended in the air?

Example 20-10
A neutral conducting sphere is between two parallel charged plates, as shown in the Figure below. Sketch the electric field lines in the region between the plates. Be sure to include the effect of the conducting sphere.