1. A rod is charged to -30 nC by rubbing.
   (a) Have electrons been added to or removed from the rod?
   (b) Have protons been added to or removed from the rod?
   (c) How many electrons/protons have been added or removed?

2. What would be the electrostatic force between two 1.00 C charges separated by a distance of
   (a) 1.00 m and
   (b) 1.00 km if such a configuration could be set up?

3. What must be the distance between point charge q1 = 26.0 μC and point charge q2 = -47.0 μC
   for the electrostatic force between them to have a magnitude of 5.70 N?

4. Two equally charged particles, held 3.2 × 10^{-3} m apart, are released from rest. The initial
   acceleration of the first particle is observed to be 7.0 m/s^2 and that of the second to be 9.0 m/s^2.
   The mass of the first particle is 6.3 × 10^{-7} kg.
   (a) What is the mass of the second particle?
   (b) What is the magnitude of the charge of each particle?

5. The figure below shows two charges, q1 and q2, held a fixed distance d apart.
   (a) What is the magnitude of the electrostatic force that acts on q1? Assume that q1 = q2 = 20.0 μC and d = 1.5m.
   (b) A third charge q3 = 20.0 μC is brought in and placed as shown below. What now is the
       magnitude of the electrostatic force on q1?

   \[\text{Figure 1: For Problem 4}\]

6. In the figure below, what are the horizontal and vertical components of the resultant
   electrostatic force on the charge in the lower left corner of the square if q = 1.0 × 10^{-7} C and a = 5.0 cm?
7. Two fixed particles, of charges $q_1 = +1.0 \ \mu\text{C}$ and $q_2 = -3.0 \ \mu\text{C}$ are 10 cm apart. How far from each should a third charge be located so that no net electrostatic force acts on it?

8. (a) What equal positive charges would have to be placed on Earth and on the Moon to neutralize their gravitational attraction? Do you need to know the lunar distance to solve this problem? Why or why not?  
   b) How many thousand kilograms of hydrogen would be needed to provide the positive charge calculated in part (a)?

9. In the figure below, two tiny conducting balls of identical mass $m$ and identical charge $q$ hang from non-conducting threads of length $L = 25\text{cm}$ at an angle of $\theta = 15^\circ$. What is $q$?

10. What magnitude charge creates a 1 N/C electric field at a point 1.0 m away?

11. (a) What is the strength of the electric field that will balance the weight of a 1.0 gram plastic sphere charged to $-4 \ \text{nC}$?  
   b) What is the direction of this electric field?

12. Large electric fields in cell membranes cause ions to move through the cell wall. The field strength in a typical membrane is $1.0 \times 10^7 \ \text{N/C}$. What is the magnitude of the force on a calcium ion with charge $+e$?
13. A parallel-plate capacitor is formed from two 1.0 cm × 1.0 cm electrodes spaced 3.0 mm apart. The electric field strength inside the capacitor is $1.0 \times 10^6$ N/C. What is the charge on each of the parallel plates?

14. Which vector best represents the direction of the electric field vector at the position of the dot?