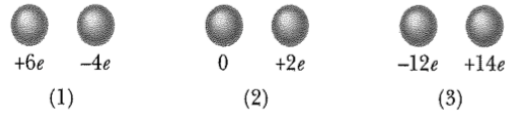
In-class problems, Thu Feb 13, 2020

21.1 Coulomb's law

1. The figure below shows three pairs of identical spheres that are to be touched together and then separated. The initla charges on them are indicated. Rank the pairs according to (a) the magnitude of the charge transferred during the touch and (b) the charge left on the positively charged sphere, from largest to smallest.



(HRW 11th ed, q21.2)

2. Charged rod A is brought near suspended object B.

   (a) They repel. What can we conclude about B's charge?
   (b) They attract. What can we conclude about B's charge?

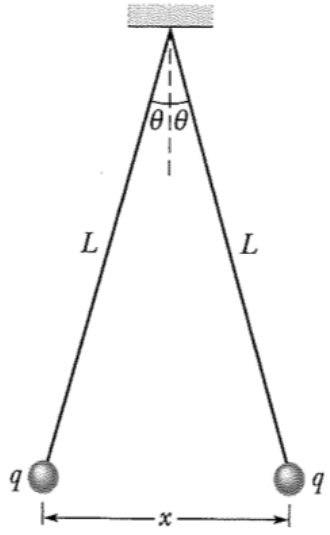
3. Let's estimate that a penny is completely made of copper (the atomic number, or number of protons, in copper is $Z = 29$ protons/atom), and its mass is 3.11g.

   (a) Calculate the amount of total positive charge in this penny.

   (b) Assuming that it's electrically neutral, what is the total negative charge on the penny?

   You'll need to use Avogadro's number (in atoms/mol), the molar mass of copper (in g/mol), and some dimensional analysis. *(Final answer* $1.5 \times 10^5\, C$*)*

4. Two identical spheres hang in equilibrium. The angle θ, length L and mass m can be easily measured. We know that they have the same charge. Calculate the magnitude of charge q in terms of the easily measurable quantities.



(answer: $|q| = 2L\sin\theta\sqrt{\frac{mg\tan\theta}{k}}$*)*

Due, Mon Feb 16, 2020

22.1, 22.2 Electric fields

Read 22.1 The electric field, and 22.2 the electric field due to a point charge.

1. The text gives examples of a temperature field and a pressure field as a *scalar field*. It says the electric field is a *vector field*.

   Give another example of a scalar field. Give another example of a vector field.

2. Write the equation that relates the electric field $\vec{E}$ to the electrostatic force $\vec{F}$ acting on a test charge q_o

3. (a) Draw the electric field of a negative point charge.

   (b) If you were to put a tiny positive particle near this negative point charge, what would be the direction of the force on the tiny positive particle? Sketch it... include the negative point charge, the tiny positive particle, and the force. Try at least 4 different positions. (You can answer this question without even thinking about the electric field... just think of Coulomb's law.)

   (c) Draw the electric field of a positive point charge. (This isn't obviously in your text, but Fig 22-3 and 22-5 are helpful. Or just look it up elsewhere.)

4. Do problem 22.5