Electrostatics Problem Set

2. You are given an apple and an orange. The apple has a net charge of $+3\times10^{-17}$ C. The orange has a net charge of -3×10^{-17} C. With only this information, can you determine which one has more total electrons? Explain.

No. Net charge tells you the difference between the number of protons and neutrons, not how many are there. I could have something with a charge of +2e with 2 protons and no electrons, 16 protons and 11 electrons, or even 50002 protons and 50000 electrons.

3. An electron has a mass of 9.11×10^{-31} kg. What is the charge of 1.00 grams of pure electrons?

First we need to find out how many electrons are in 1 gram of electrons. So we need to convert 1g into electrons.

$$1\text{g}\left(\frac{1\text{ kg}}{10^3\text{ g}}\right)\left(\frac{1\text{ electron}}{9.11\times10^{-31}\text{ kg}}\right) = 1.10\times10^{27}\text{ electrons}$$

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1/(10^3)/9.11E-31
  1.097694841E27
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Now we need to figure out the charge of this many electrons.
1 electron has a charge of 1.602×10^{-19}C,
so we multiply this by the number of electrons.

$$q=ne=(1.10\times10^{27})*(1.602\times10^{-19}C)=\boxed{1.76\times10^{8}C}$$

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1/(10^3)/9.11E-31
  1.097694841E27
Ans*1.602E-19
     175850713.5
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4. The nucleus of a helium atom contains two protons, two neutrons, and no electrons. Neutrons have no net charge. What is the charge of the nucleus?

the charge is +2e and $e=1.602\times10^{-19}$ C, so the charge is $\boxed{3.204\times10^{-19}\text{ C}}$

5. Two scientists are locked in a bitter dispute about the charge on a particularly famous particle of dust. Maria claims it has a charge of 2.40×10^{-19} C. Richard disagrees; he thinks its charge is 3.20×10^{-19} C. Which scientist should you believe? Explain

You should believe Richard. Charge is quantized, which means that it only comes in multiples of e. You can't have half an electron or .24 of a proton.
$e=1.60\times10^{-19}$ C, so 3.20×10^{-19} C is a multiple of e and 2.40×10^{-19} C is not a multiple of e.

6. A positively charged eraser is placed near the "0 cm" end of a 10 cm metal ruler. As a result of the induced charge effect, which end of the ruler becomes positively charged: the "0 cm" end, or the "10 cm" end?

The positively charged eraser will draw electrons to it, making the 0cm end negative.

7. In an experiment, a particle called a pion (π) is observed to decay into two other particles, a muon and a neutrino. The muon then decays into an electron and two more neutrinos. Neutrinos are electrically neutral. (a) What is the charge of a muon? (b) Pions come in three types: π^+ has a charge of $+1.60\times10^{-19}$, π^- has a charge of -1.60×10^{-19}, and π^0 is electrically neutral. What kind of pion could decay as described in this experiment?

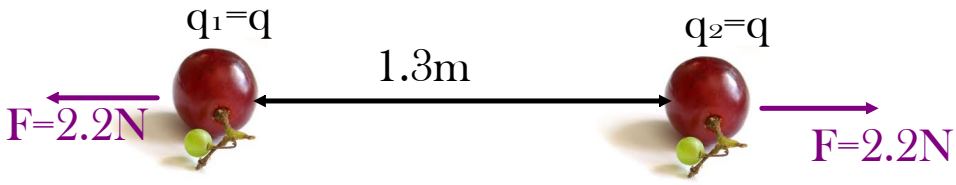
a) The net charge of everything that is produced is -e. Charge is conserved so, so the muon must have a charge of -e or $-1.60\times10^{-19}C$

b) the muon and the pion have the same charge, so the pion must be a π^-

8. Three indistinguishable balloons are given charges of $-1.1\ \mu C$, $-2.5\ \mu C$, and $+2.0\ \mu C$ respectively. You are given two of them at random, and you observe that they repel each other. Find the total charge of the balloons you have been handed.

Like charges repel, so the two charges we have been handed are the -1.1 μC and the -2.5 μC. The total charge of these two is -3.6 μC.

9. Two grapes are given equal charges and held apart at a distance of 1.3 m. They experience a repulsive force of 2.2 N. Find the magnitude of the charge on each grape.



$q_1=q_2=q$
$r=1.3m$
$F=2.2N$
$k=8.99\times10^9\ Nm^2/C^2$

$$F=\frac{kq_1q_2}{r^2}$$

$$2.2=\frac{8.99\times10^9\,q^2}{(1.3)^2}$$

$$2.2=5.3195\times10^9\,q^2$$

$$q^2=4.136\times10^{-10}$$

$$\boxed{q=2.0\times10^{-5}\,C}$$

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8.99E9/(1.3^2)
        5319526627
2.2/Ans
  4.13570634E-10
√Ans
  2.033643612E-5
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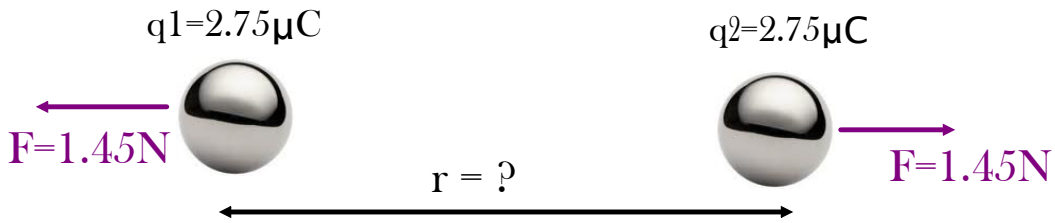
10. Two steel juggling balls each carry a charge of 2.75 μC. There is a repulsive force between them of 1.45 N. What is the distance between the centers of the two balls?



3 sig fig

$q_1=q_2=2.75$ μC
r=?
F=1.45N
$k=8.99\times10^9$ Nm^2/C^2

We need to start by converting the micro-Coulombs to Coulombs

$\mu=10^{-6}$
so
$q_1=q_2=2.75$ μC$=2.75\times10^{-6}$C

$$F=\frac{kq_1q_2}{r^2}$$

$$1.45=\frac{8.99\times10^9(2.75\times10^{-6})(2.75\times10^{-6})}{r^2}$$

$$r^2(1.45)=\left(\frac{.06798}{r^2}\right)r^2$$

$$\frac{1.45r^2}{1.45}=\frac{.06798}{1.45}$$

$$r^2=.04688$$

$$r=.217\text{ m}$$