# In-class problems, Mon Feb 10, 2020

## 21.2 21.3 charge quantization, conservation

1. Consider 3 charged objects, A, B and C.
   A and B repel.
   B and C repel.
   Which is true?

   (a) A and C have the same charge.
   (b) A and C have the opposite charge.
   (c) Wait, isn't this a psychology class?

2. Consider 3 charged objects.
   D and E repel.
   E and F attract.
   Which is true?

   (a) D and F have the same charge.
   (b) D and F have the opposite charge.

3. As they fly, honeybees can acquire a charge of about +200pC. Electric forces between charged honeybees and spider webs can make the bees more vulnerable to capture by spiders.

   Assuming that we have instruments and techniques sensitive enough to measure it, will we find the charged honeybee's mass to be greater than, less than, or the same as it was uncharged? Explain your answer.

   *(from Wolfson)*

4. A plastic rod is charged to $-12$nC by rubbing and it easily attracts and repels other charged objects.(The net charge produced by simply rubbing objects is commonly less than 0.1 $\mu$C. )

   (a) Were electrons removed or added to the rod?
   (b) How many electrons?
   (c) We can estimate the number of electrons in a macroscopic object to be about $10^{24}$ (that is about 10 mols). Calculate the change (as a percentage) in the number of electrons of this charged object.

5. Elementary particle theories show that the fundamental charge is actually $\frac{1}{3}e$. Such fractional charges reside on quarks, the building blocks of protons, neutrons and many other particles. Quarks always join to produce particles with integer multiples of the full elementary charge, and it seems impossible to isolate individual quarks.

   The two most common quarks are the $u$ quark, with charge $+\frac{2}{3}e$ and the $d$ quark, with charge $-\frac{1}{3}e$. How could three of these quarks combine to make a proton? A neutron?

   *(Wolfson, Essential University Physics, p 356.)*

# Due Tue Feb 11, 2020, beginning of class

## 21-1 Coulomb's law

1. Read 21-1, just the Coulomb's law section, middle of p613 -p619

2. (a) Write down the most important equation in this section.

   (b) For every term in this equation: give its name and SI unit. If it's a constant, also give its value.

   (c) Write one or two full sentences describing what this equation says.

3. Do problem 21.3. (That is, Chapter 21 problem 3. It's on page 625. It's not in the questions section.)

4. (Review) What is Newton's third law? Provide 1-3 sentences, an equation, and a diagram. Your sentence(s) should refer to the equation and diagram somehow.