Physics 206b

Homework Assignment IV
due September 17, 2007

***Note that we have an exam on Friday, September 14.
Therefore, I have made the due-date of this assignment the
following Monday.***

Problems #1 and #2 are transferred from the previous assignment.

1. If a refrigerator has a coefficient of performance ("efficiency") of 2.5, how long will it take your refrigerator to cool $1\,\mathrm{L}$ of boiling water to one degree above freezing if the refrigerator draws 1 kW?

2. You see advertised a motor that claims that for every Joule of energy it gets out of burning fuel at $700\,°\mathrm{C}$, given the world average temperature of $15\ °\mathrm{C}$, it can on average do 0.85 Joules of work. Is such a motor feasible?

Reminder: Force is a vector. While I have reminded you to express forces as vectors in some of the problems below, this reminder should not be necessary. If I fail to remind you of this, do not take it as an excuse to leave the vector nature off of you solutions. Vector quantities that are not expressed as vectors (i.e., including both size and direction) are simply wrong and will be graded accordingly.

3. Two charged objects are separated by 1 meter. The net force between them is 2×10^{-3} Newtons and is attractive. The net charge on one of the objects is 7.11×10^{-4} C. What is the other charge?

4. Consider again the two charges in the previous problem. If the distance between the charges is doubled, what then will be the net force between them?

5. Object A has charge of 1.7 C and object B has a charge of 3.1 C. The objects are separated by 2.9 meters. A line drawn between the two makes an angle of 20° relative to the horizontal, as shown. Expressed as a **vector**, what is the force experienced by object B due to object A?
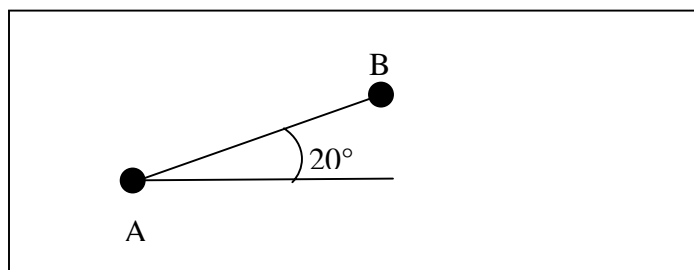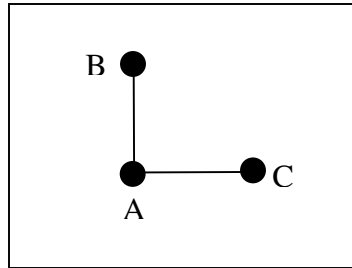
6. Objects A, B, and C sit at the corners of a 45° right triangle as shown. B and C each have a charge of 0.61 C while object A has a charge of -0.7 C. The distance between A and C (which is the same as the distance between A and B) is 13 mm. What is the net force (expressed as a vector!) experienced by object A?

7. Consider once again the charge configuration described in problem #6. What is the total force experienced by object C? What is the total force experienced by object B?

8. An electron sits at each of the corners of a square whose side-length is 17 µm. If no forces other than the Coulomb force act on this system, what is the acceleration experienced by the electron at the top right corner?

9. Consider again the configuration in the previous problem. Replace the electron in the top right corner with a proton. What acceleration does the proton experience?

10. What is the electric field (expressed as a vector!) resulting from a 0.78 C charge at a point 0.9 meters from that charge in the $\hat{x}$ direction?

11. Consider the charge in the previous problem. What is the electric field resulting from that charge at a point 0.9 meters from it in the $\hat{y}$ direction?

12. Two charges lie on the *x* axis, as shown. The one on the right is -0.9 C and the one on the left is 0.7 C. They are separated by 37 cm. What is the electric field (expressed, as always, as a vector!) at the following points:

   a. 10 cm to the right of the charge on the right?

   b. 10 cm to the left of the charge on the left?

   c. The point on the *x* axis midway between the two charges?

   d. The point 12 cm in the $\hat{y}$ direction directly "above" the midpoint between the charges?

d

b   ●- -●   a

.7 C   c   -.9 C
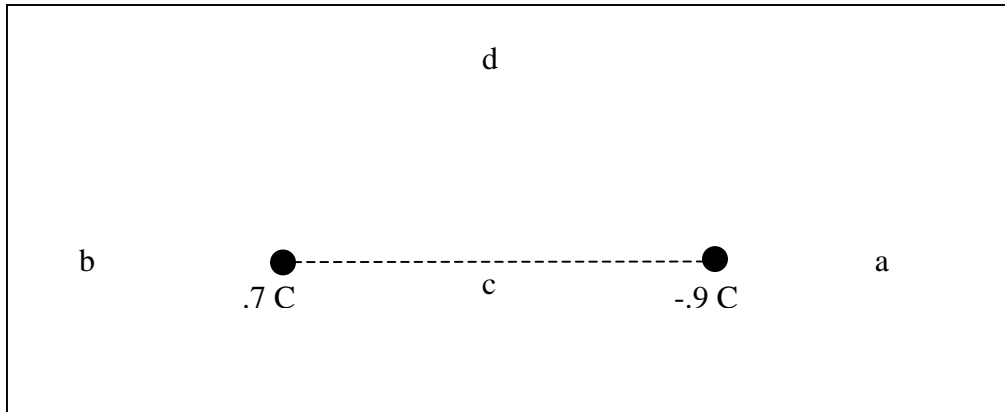
13. For each of the points identified in the previous problem, what is the acceleration which would be experienced by a proton placed at that point?