Homework 3

This homework is due Monday, 2 Feb, at 3 PM. Please **staple** your homework together.

Problems marked with a **W** are to be submitted through WebAssign. Problems marked with a **C** are to be turned in in class with complete write-ups. Some problems will be both done on WebAssign and then turned in. For problems that get turned in, start each by starting what general principle(s) you'll be using (eg, "conservation of energy"). If it's a calculation problem, also state clearly what fundamental equation(s) you're going to use. (That is, probably equations you'll find in the equation sheet or in the end of chapter review.)

Although much of your solutions will be mathematical in nature, your write-up should be as much text as equations/mathematics (perhaps more). Correct answers, poorly justified, will not be worth many points. Things you should explain include: where you found a given equation, which law (eg, "Newton's Second Law") you are using, what mathematical steps you are following, and what assumptions you are making. Also note that your solutions will be easier to follow (and less prone to errors) if you work in analytic equations for as long as possible before you plug in any numbers given in the problem. (This has the added benefit of being generalized so you can plug in new numbers easily if you need to.)

A note on collaboration/help/references: please cite any source (this includes the text, although you can just say, '...Equation 10 in Mazur...') you use as well as acknowledging any help you may have received from the tutors or John. I encourage you to work with buddies, but you must acknowledge their assistance. Furthermore, your write-up must be your own and you must understand everything in it. Failure to acknowledge or cite a source of help is a form of academic dishonesty and will be dealt with accordingly. Also note that looking up solutions (either using previous years' solutions, a previous year's student's solutions, or finding textbook solutions) is strictly forbidden. These problems were designed to aid you in your education. To avoid them is doing yourself a disservice.

Many problems will be based on Mazur originals.

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0. Feedback (**C, 2 pts**)
   Estimate how long both the daily and weekly homeworks took you as well as the reading and notes. Provide any feedback you wish to offer.
1. WebAssignCalcPhys1 24.P.001(Problem 1 on WebAssign) (**W, 4 pts**)
   A flat rectangular surface ($a = 4.2$ mm and $b = 4.0$ mm) lies in the horizontal plane in a region of a uniform electric field of 1400 N/C. The electric field makes an angle $\alpha = 42.0°$ with the horizontal. For simplicity, only one field line is shown in the diagram one WebAssign. A rectangle of length a and width b is on the horizontal plane. A dashed horizontal line lies along the horizontal plane. An arrow representing the electric field vector E is at an angle α above the dashed horizontal line.
   a) What is the electric flux through the surface if the normal to the surface is directed vertically up?(**2 pts**)
   b) What is the electric flux through the surface if the normal to the surface is directed vertically down?(**2 pts**)
2. WebAssignCalcPhys1 24.P.003(Problem 2 on WebAssign) (**W, 6 pts**)
   A circular disk of radius 15.9 cm is oriented at an angle $\alpha = 31.0°$ to the positive x-axis. The diagram on WebAssign shows the edge view of the disc. A straight line representing the edge view of the disc is at an angle α counterclockwise to the positive x axis.

a) What angle does the area vector make with the positive x axis? Enter the smallest value as measured counterclockwise from the positive x axis.(**1 pts**)
b) The electric flux through the disc is zero at this orientation. What is the smallest possible angle, measured counterclockwise from the positive x axis, that the electric field vector makes with the positive x axis in order for this to be true?(**1 pts**)
c) Now the disc is rotated until the flux through it has a maximum positive value of 5.04×10^5 N · m²/C. Determine the magnitude of the electric field producing this flux. (**4 pts**)

3. WebAssignCalcPhys1 24.P.004(Problem 3 on WebAssign) (**CW, 12 pts**)
The diagram on WebAssign shows a closed triangular prism situated in a region of uniform electric field $\boldsymbol{E} = (6.84 \times 10^4 \text{ N/C}\hat{\boldsymbol{j}}$. A triangular prism made up of 5 faces is in the horizontal plane; it has a bottom face that is a horizontal rectangle of width d and length a; joined to the left edge of width d of the bottom face is a vertical rectangular face of the same width d and height b perpendicular to the bottom face; a vertical right triangle of height b and length a forms the front face; a vertical right triangle of height b and length a forms the back face; a top slanting rectangular face with left edge attached to the top edge of the vertical face and the right edge attached to the right edge of the bottom face. Arrows labeled E directed vertically up go through the triangular prism. The dimensions of the triangular prism are $a = 16.4$ cm, $b = 10.0$ cm, and $d = 30.8$ cm. Note that the diagram is not to scale.
   a) What is the flux through the bottom face of the triangular prism?(**2 pts**)
   b) What is the flux through the slanted face of the triangular prism?(**2 pts**)
   c) What is the flux through the front triangular face of the triangular prism?(**2 pts**)
   d) What is the flux through the back triangular face of the triangular prism?(**2 pts**)
   e) What is the flux through the vertical rectangular face of the triangular prism?(**2 pts**)
   f) What is the net flux through the triangular prism? (**2 pts**)

   Valuable Bonus Clue for people who read this first: You really only have to do one — very easy — calculation amid all of this *if you think about what you're doing first.* If you don't think ahead, good luck to you...
4. WebAssignCalcPhys1 24.P.007(Problem 4 on WebAssign) (**W, 2 pts**)
A cylinder of diameter 1.72 m is in a region where the electric field is as shown in the figure below. If $E_1 = 38.6$ N/C and $E_2 = 24.0$ N/C, what is the net flux through the two end faces of the cylinder? Note that the diagram is not to scale.
5. WebAssignCalcPhys1 24.P.012(Problem 5 on WebAssign) (**CW, 2 pts**)
Consider the three charges $q_1 = q_2 = 4q$ and $q_3 = -q$. Which of the following configurations will result in an electric flux of $3q/\epsilon_0$ through the enclosed surface? Select all that apply.
6. WebAssignCalcPhys1 24.P.013(Problem 6 on WebAssign) (**W, 6 pts**)
Consider the three charges, q_1, q_2, and q_3. The flux through the three surfaces S_1, S_2, and S_3 shown in the diagram below are $-6q/\epsilon_0$, $-14q/\epsilon_0$, and $-4q/\epsilon_0$, respectively. If $q = 3.5$ μC, determine the values (magnitude and sign) of the three charges q_1, q_2, and q_3.
7. WebAssignCalcPhys1 24.P.014(Problem 7 on WebAssign) (**W, 6 pts**)
What is the net electric flux through a closed surface that encloses the following four charges: $q_1 = -2.50$ $-\mu$C, $q_2 = +3.7$ μC, $q_3 = -24.0$ μC, and $q_4 = +45.0$ μC?
8. Field Line Drawings (**C, 4 pts**)
Cauchy and Lagrange are drawing field lines from a $+q$ charge to a $-2q$ charge. Cauchy draws 12 lines emerging from the positive and 24 lines entering the negative. Lagrange draws 8 lines emerging from the positive and 16 lines entering the negative. Whose drawing is correct? Explain, of course.

9. Sphere to Cube (**C, 4 pts**)
   When a charged particle is placed at the center of a sphere, the flux through the sphere is Φ. When the sphere is replaced by a cube (also centered on the charge), what is the flux through *any one* of the faces of the cube?