Assignment IV, PHYS 112 (Gerneral Physics II)
Fall 2020
Due via pdf upload to OAKS prior to Friday, September 18th at 10:00 AM

General instructions:
For this, and all other homework assignments, please turn in your solutions with all supporting work; answers without supporting work will not earn credit. You do not need to upload the sheet with the questions on it, but please clearly number your problems and circle or box your final answers. I encourage you to collaborate with classmates to discuss how to approach a particular question, but the mathematical steps to generate your final answer on your submitted work should be your own. If I see the same simple mistake on multiple homework assignments, I will take off more points for that error than I normally would. Please include *words* in your answers. When you get answer keys back from me, you'll see that there are explanations, ideas, commentary, and thought processes included – not just a set of equations one after another. Finally, please ensure that all numerical answers have units.

1. Two protons are held 1 cm apart. One of the protons is "released" (from rest) while the other is held and unable to move. What is the speed of the proton when it is very, very far away from the stationary proton? (E.g. what is the speed of the moving proton as the distance between the two charges goes to infinity?) (If the idea of using infinity bothers you, then find the speed when the protons are separated by 1×10^{10} m instead).

2. A charge of 24.5 μC is located at $(4.40\text{ m})\hat{i} + (6.22\text{ m})\hat{j}$, and a charge of -11.2 μC is located at $(-4.50\text{ m})\hat{i} + (6.75\text{ m})\hat{j}$. What charge must be located at $(2.23\text{ m})\hat{i} - (3.31\text{ m})\hat{j}$ if the electric potential is to be zero at the origin?

3. A particle with charge Q and mass m is moving in the space between two charged parallel plates separated by distance d. The potentials on the plates are V_1 and V_2 with both V_1 and V_2 positive and $V_2 > V_1$. The charged particle starts from rest adjacent to the plate having potential V_1, and – when released from rest – accelerates towards the plate having potential V_2.

   a) Based on the observed motion, is Q a positive or negative charge?

   b) If the plates are very large compared to the particle (e.g. the plates appear to the particle to be effectively infinite plates), how fast is the particle starting from rest near the plate with V_1 moving just before it collides with the plate having potential V_2? (You may assume Q is not so large as to change the electric field between the plates. I'm looking for a symbolic answer here in terms of some subset of V_1, V_2, Q, m, d, and perhaps some fundamental constants.

   c) Based on your answer to part (b) above, how long did it take the particle to go from the plate having potential V_1 to the plate having potential V_2? (Your answer again should be symbolic in terms of some subset of V_1, V_2, Q, m, d, and perhaps some fundamental constants.)

4. Four point charges, each of magnitude q, form the vertices of a square, with the distance between adjacent charges given by d. How much energy did it take to construct this charge alignment? You may assume that the four charges already existed some long distance away from each other, and you need to move them into their desired position. *[If you want to give yourself a challenge, repeat this problem with five point charges of magnitude q at the vertices of a pentagon, with the distance between adjacent charges given by d. I'm not going to grade that one, but I will supply you with an answer to this harder problem when I return your key.]*

5. Some of you have started out struggling a little right out of the gate. Although our semester has been modified substantially by the COVID situation, we have a small enough class that – hopefully – a little one-on-one time targeted to help you could be beneficial. As such, your final graded problem on this homework is to make and keep a 30 minute video-conference appointment with me sometime prior to the due date of this assignment. You can sign up for an "advising/study meeting" slot among the listed available times at http://calendly.com/mikelarsen. During your appointment, we'll either work a problem or two, answer some conceptual questions you have from class, or talk about strategies you could use to make the most of the remainder of your 112 experience. This isn't a test or anything – just a conversation that I'm hoping will have a lasting impact. Your conversation with me isn't likely to be a full half hour, but we'll budget that much time just in case there are a few things we should talk about. If you make and keep the appointment and are generally responsive during our conversation, this will be easy points for you.