Week 6 Challenge Homework

Electric Potential

Submission Details | Submit a digital copy (PDF, jpg, etc.) to Canvas. Include solutions to the metacognitive exercise and each question. Please use the interface to associate each page of your submission with the assignment. It makes grading much easier. Please clearly indicate which question is being solved. If data is needed to complete a problem, be sure to cite the source you've acquired your data from. Typed work will not receive credit. See the course website for further details.

Group Submissions | You may submit a group collaboration to Canvas. Add each group member to the submission. Each group member should contribute to the work. Clearly indicate which part of the submission is written by each member (color or labels are preferable).

Sensemaking | You will be asked to apply sensemaking in some problems. More information about sense-making can be found on the BoxSand Sensemaking page, which is linked on the Canvas homepage.

Metacognitive Exercise

Each week will feature a metacognitive exercise, followed by one or two challenge problems to solve. The metacognitive exercise will usually ask you to reflect on your solution to the previous week's challenge problems.

Review your solution to the Week 5 Challenge Homework. If you do not have a copy of it anymore, you can find it on Canvas or Gradescope, under the Week 5 Challenge Homework assignment. Also, review the solution which has been posted to the BoxSand solutions archive (click here for a link). Solutions are posted a few days after the assignment is due.

(a) After you have reviewed your own work and the provided solutions from last week, create some form of a concept map for the charges and forces (CF), electric field (EF), and electric potential and potential energy (EP) portions of this course. Examples of concept maps can be found in the "where to find things" page on Canvas. Get creative and have fun. The goal should be to create something that will help you study/prepare and/or take the upcoming midterm.

Question 1

In 1911, Ernest Rutherford and his assistants Geiger and Marsden conducted an experiment in which they scattered alpha particles (nuclei of helium atoms) from thin sheets of gold. An alpha particle, having charge $+2e$ and mass 6.64×10^{-27} kg, is a product of certain radioactive decays. The results of the experiment led Rutherford to the idea that most of the atom's mass is in a very small nucleus, with electrons in orbit around it. This is the nuclear, or planetary, model of an atom. Assume an alpha particle, initially very far from a stationary gold nucleus, is fired with a velocity of 2.00×10^{7} m/s directly toward the nucleus (charge $+79e$).

(a) To start the process of dimensionality sensemaking, make a prediction for the units or dimensions you expect your answer to have in part (b).

(b) What is the smallest distance between the alpha particle and the nucleus before the alpha particle reverses direction? Assume the gold nucleus remains stationary.

(c) How might your answer change if the gold nucleus was allowed to move? Explain your answer qualitatively! There is no need to perform any calculations. (Hint: think a little about energy and/or momentum conservation!)

(d) Use dimensionality sensemaking to show that the units or dimensions of your solution to part (b) match your prediction in part (a). Note: if you included units in each step of your calculations for part (b), you have completed this process, except to state here that the found units (hopefully) match your prediction!