AP Physics II Assignment #3

- For this assignment, you must submit your final answers on the answer sheet provided with this packet.
- For full credit, you must explain your reasoning, and your reasoning must be correct. Reasoning can be explained in sentence form, or math calculation form, or a combination of both as applicable.
- When showing calculations, draw a box around your final answer
- Your grade is assessed based on what you wrote, not what you meant to write
- Points may be deducted for explanations that are
  a. overly wordy, vague, tautologus, *etc.*
  b. highly fractured, scattered, poorly organized or incohesive.
  c. rife with spelling or stylistic errors such as sentence fragments.
  d. irrelevant or beyond the scope of AP Physics 1 (vortices in the space-time continuum, a quantum theory of supergravity, anti-deSitter space, *etc.*)

1. A rubber balloon has a single point charge in its interior. Does the electric flux through the balloon depend on whether or not it is fully inflated? Explain your reasoning.

2. A spherical Gaussian surface encloses a point charge *Q*.
   a. Does the electric field at a point on the surface change when the point charge is moved from the center of the sphere to a point away from the center? Explain.
   b. Does the total flux through the Gaussian surface change when the charge is moved? Explain.

3. A certain region of space bounded by an imaginary closed surface contains no charge. Is the electric field always zero everywhere on the surface? Is any violation of Gauss's law possible in this situation? (Fully explained counterexamples may work well for this question).
4. A solid conductor has a cavity in its interior.
   a. Would the presence of a point charge inside the cavity affect the electric field outside the conductor? Why or why not.

   b. Would the presence of a point charge outside the conductor affect the electric field inside the cavity? Again, why or why not. Although Faraday Cages are applicable to this question, No credit is awarded for stating Faraday Cage as a final answer. More detail must be given.

5. A student claimed that in order to create a Faraday Cage (*e.g.* a region where the electric field is zero despite the fact that there is an electric charge nearby), you don't need a hollow conductor. One can arbitrarily draw a Gaussian surface around a region and this intangible "Gaussian Surface" can be your Faraday Cage. Explain why the student is wrong. NOTE: Counterexamples and *reductio ad absurdum* arguments are worth full credit if made correctly. No points will be awarded for tautological answers (*e.g.* The student is wrong because a Faraday Cage needs to be made of something).

6. Use Gauss's law to derive the equation for the electric field outside of an:
    a. infinitely long line of positive charge, with a linear charge density of λ.
    b. infinitely large sheet of positive charge, with a surface charge density of σ.

7. A hollow, conducting metal shell of inner radius R and outer radius 3R has a charge of $+Q$ on it. Which of the following graphs (Figure 1 A - E below) correctly represents the electric field as a function of r, the distance from the center of the sphere. State the correct graph, and justify your answer by explaining (graph by graph) what is wrong with the others. Each incorrect graph should have a two or three sentence explanation of why it isn't the right graph. No tautological answers (*e.g.* this graph is wrong because it disobeys the laws of electrostatics).

8. A solid insulating shell of radius $3R$ has a charge of $+Q$ on it. Which of the following graphs (Figures 1 A - E below) correctly represents the electric field as a function of r, the distance from the center of the sphere. State the correct graph, and justify your answer by explaining (graph by graph) what is wrong with the others. Each incorrect graph should have a two or three sentence explanation of why it isn't the right graph.

    Note: An alternative approach to this that is worth full credit is to use Gauss's law to derive an equation (piecewise if necessary) for the electric field at all points in space, and then simply state which graph matches up with the equation you have.

Figure 1 “A”

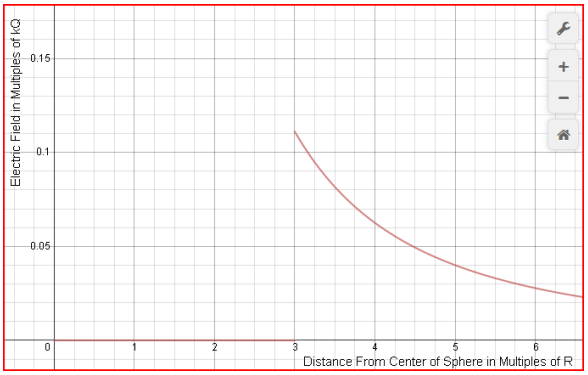


Figure 1 “B”

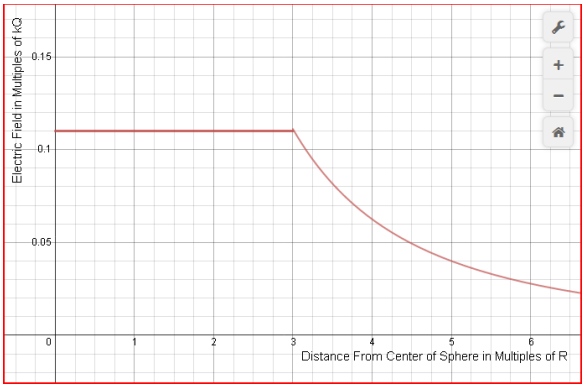


Figure 1 “C”

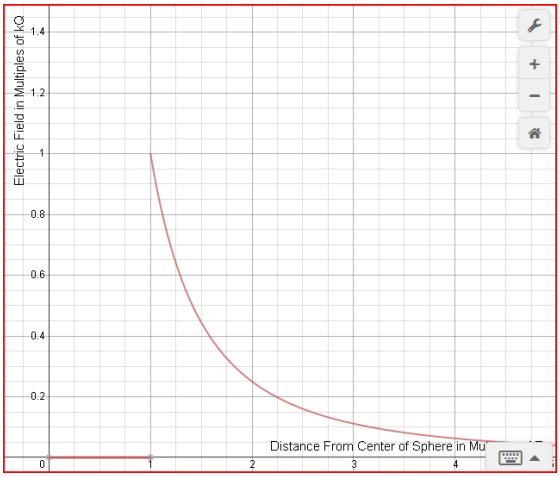


Figure 1 “D”

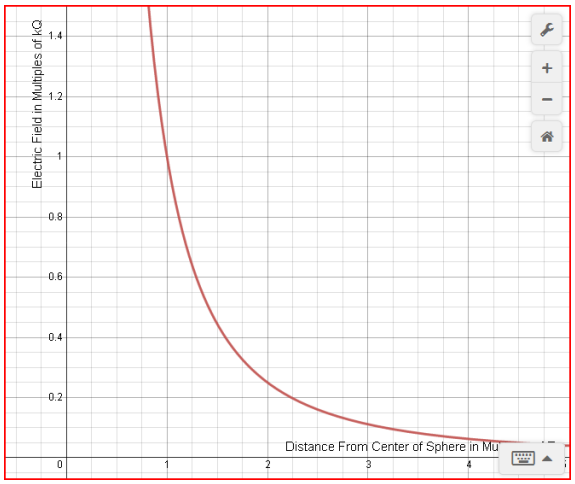
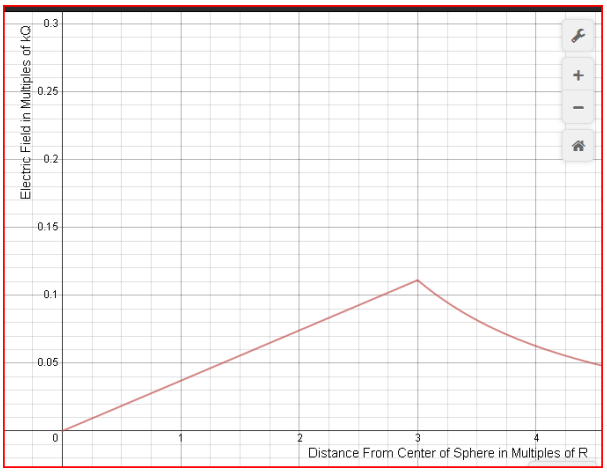


Figure 1 “E”



Answer Sheet for AP Physics II Writing Assignment #3

Name: _____ Date: _____ Period: _____

Due Date: _____

1. _____
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_____

2.
   a. _____
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   b. _____
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3. _____
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4.
   a. _____
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_____
_____

b. _____

5. _____

6. Show your derivations to parts “a” and “b” in the spaces provide.
   a.

   b.

Note: for this problem, you need only give explanations for the *incorrect* graphs. If you think that a particular graph is correct, simply state that it is, and no further explanation is necessary.

7. Graph A is (circle one) correct / incorrect because:

_____
_____
_____
_____
_

Graph B is (circle one) correct / incorrect because:

_____
_____
_____
_____
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Graph C is (circle one) correct / incorrect because:

_____
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_____
_

Graph D is (circle one) correct / incorrect because:

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Graph E is (circle one) correct / incorrect because:

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8. Graph A is (circle one) correct / incorrect because:

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Graph B is (circle one) correct / incorrect because:

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_____
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Graph C is (circle one) correct / incorrect because:

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_____
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_____
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Graph D is (circle one) correct / incorrect because:

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_____
_____

Graph E is (circle one) correct / incorrect because:

_____
_____
_____
_____
_____