Name, Surname:	Signature:
Exam Room:	Student ID Number:

PHYS 102 General Physics II – Midterm 1

24 October, 2019 Thursday 19:00 -20:40

Please read!

- Count to make sure that there are 5 pages in the question booklet
- Check your name and surname on front page, and student ID number on each page, and sign each page.
- This examination is conducted with closed books and notes.
- Put all your personal belongings underneath your seat and make sure that pages of books or notebooks are not open.
- Absolutely no talking or exchanging anything (like rulers, erasers) during the exam.
- You must show all your work to get credit; you will not be given any points unless you show the details of your work (this applies even if your final answer is correct!).
- Write neatly and clearly; unreadable answers will not be given any credit.
- If you need more writing space, use the backs of the question pages and put down the appropriate pointer marks.
- Make sure that you include units in your results.
- Make sure that you label the axis and have units in your plots.
- You are not allowed to use calculators during this exam.
- Only the answers in the boxes will be graded and NO partial credit will be given. No points will be given to unjustified answers. Incomplete calculations will not be graded

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1	2	3	4	TOTAL

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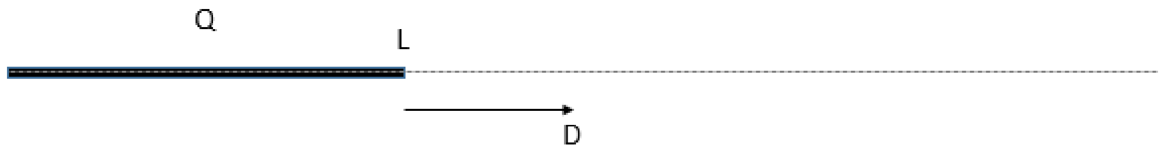
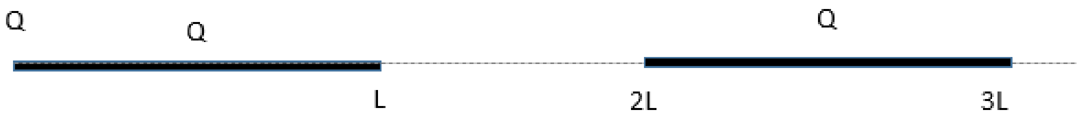
1- (25 pts) As shown in the figure a positive charge Q is uniformly distributed along a thin rod of length L.

a) Calculate the electric field vector produced by a charged rod at a distance D.



b) The second uniformly charged rod is placed on the x axis (see the figure). The second rod also has positive charge Q distributed uniformly. Calculate the magnitude of the electrostatic force applied on the second rod.



 Solution continues on the back side of the page **Yes** ◻ **No** ◻

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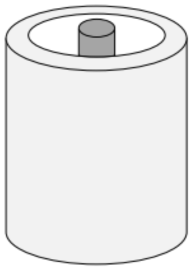
2- (25 pts) Consider a coaxial cable with an inner conductor shielded by a conductor layer. Assume the inner conductor is an infinite line charge of uniform density λ, while the surrounding conductor is a neutral hollow cylindrical shell with inner Radius R_1 and outer radius R_2 (see the figure).



(a) Find an expression for the electric field strength *E* everywhere, that is in the regions $0 < r < R_1$, $R_1 < r < R_2$ and $R_2 < r < \infty$, as a function of *r*, the perpendicular distance from the line charge.

(b) Find the surface charge density on the inner and the outer surfaces of the cylindrical shell.

 Solution continues on the back side of the page **Yes** □ **No** □

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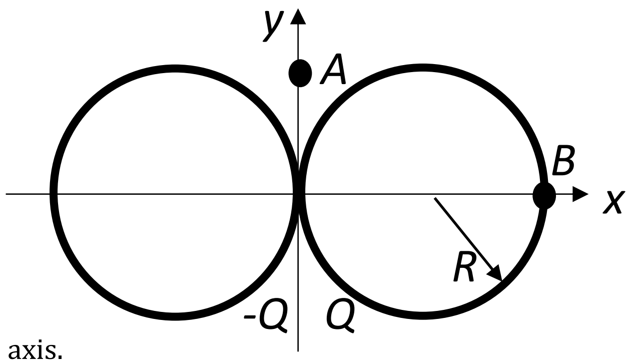
3- (25 pts) Two empty spherical shells of radius R are centered symmetrically around the origin, and have uniform charges $\pm Q$ as in the figure.



a) Find the electrical potential for all the points on the x axis.

b) Draw one equipotential surface for this charge configuration, and explain your reasoning.

c) How much work do we have to do to move a point charge q from point A at $(0, R)$ to point B at $(2R, 0)$?

Solution continues on the back side of the page **Yes** □ **No** □

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4- (25 pts) A parallel plate capacitor is filled with a nonuniform dielectric characterized by a dielectric constant $\kappa(x) = k/x^n$, where *k* and *n* are positive constants (k has dimensions to make sure that the dielectric constant is dimensionless) and *x* is the distance from one plate. The distance between the capacitor plates and the area of each plate are denoted by *d* and *A*, respectively.

(i) Use the Gauss law for dielectrics to find the electric field between the plates if the plates have charges +Q and -Q.

(ii) Find the voltage difference between the plates.

(iii) Calculate the capacitance of the system by dividing the dielectric to many thin layers and using capacitor connection rules for the equivalent capacitance. Compare your result with the capacitance calculation based upon the results in (i) and (ii).

Solution continues on the back side of the page **Yes** □ **No** □