Physics 217 Practice Midterm Exam

Fall 2002

If this were a real exam, you would be reminded here of the **exam rules**: "You may consult *only* one page of formulas and constants and a calculator while taking this test. You may *not* consult any books, nor each other. All of your work must be written on the attached pages, using the reverse sides if necessary. The final answers, and any formulas you use or derive, must be indicated clearly. Exams are due an hour and fifteen minutes after we start, and will be returned to you during at the next lecture. Good luck."

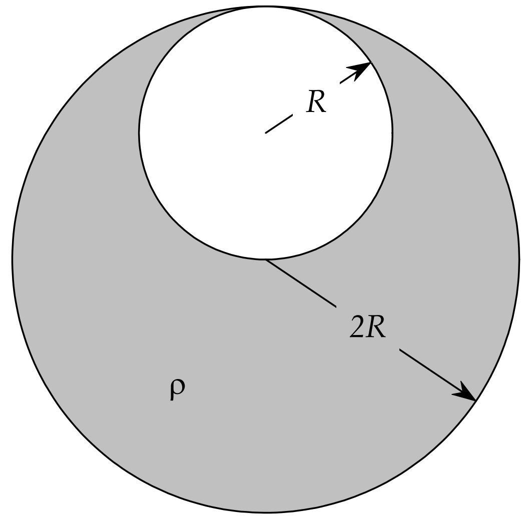
This practice test is meant mostly to illustrate the style, length, variety, and degree of difficulty of the problems on the real exam; not all the topics we have covered are represented here. This is not to say that these topics won't appear on the real exam, or that there will be problems just like the ones here on the real exam! You should expect problems on any topic we have covered in lecture, recitation and on the homework.

For best results please try hard to work out the problems before you look at the solutions.

Name: ______________________

Problem 1 (20 points)

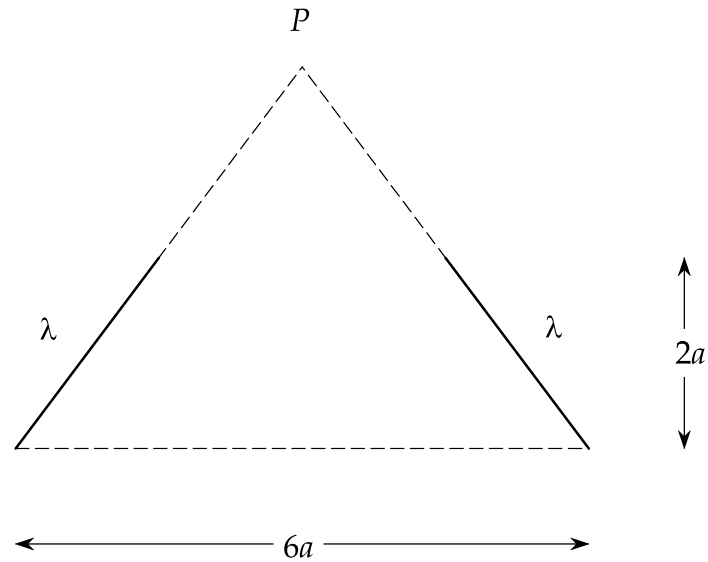
Find a formula for the electric field vector everywhere inside a spherical cavity of radius R, centered a distance R from the center of an otherwise solid sphere of radius $2R$ and uniform charge density ρ. Sketch the lines of $\boldsymbol{E}$ on the accompanying drawing.



Problem 2 (30 points)

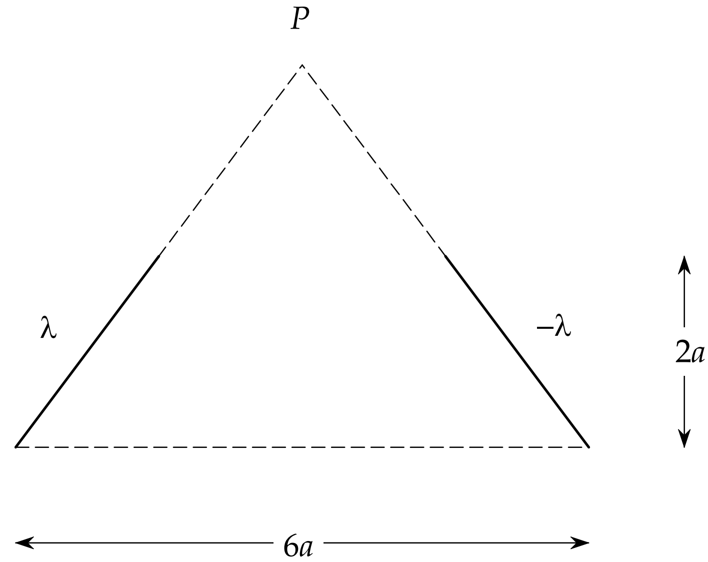
The oblique sides of a trapezoid of height $2a$ and width $6a$, made from an isosceles triangle of height $4a$, are uniformly charged. Compute the electric field vector at the vertex P at which the oblique sides converge, if…

a. both sides have charge per unit length λ, and if…



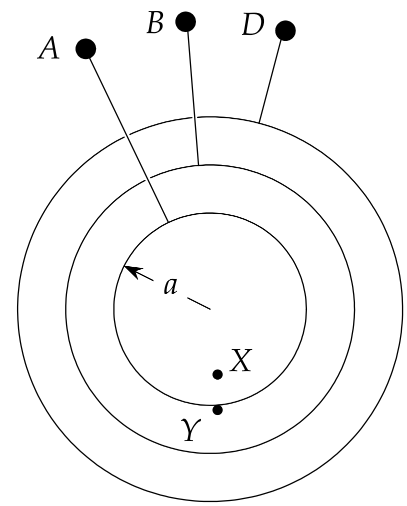
Problem 2 (continued)

b. one side has charge per unit length -λ and the other has charge per unit length λ.



Problem 3 (20 points)

Three concentric, conducting spheres are initially uncharged and initially not connected to any constant potentials.



a. A very small conductor with charge Q is placed at the center. What is the charge density on the outer surface of the inner sphere?

b. Move the charge from the center to point X. What happens to the charge density at point Y on the outer surface of the inner sphere? Why?

c. Touch the charged conductor to the inner surface of the inner sphere. Now what are the charge densities on both surfaces of the inner sphere?

Problem 3 (continued)

d. Then, ground terminal D. What is the charge density on the outer surface of the outer sphere?

e. And *then*, ground terminal B, and set terminal A to potential V_0. What is the charge on the inner surface of the middle sphere?

Problem 4 (10 points)

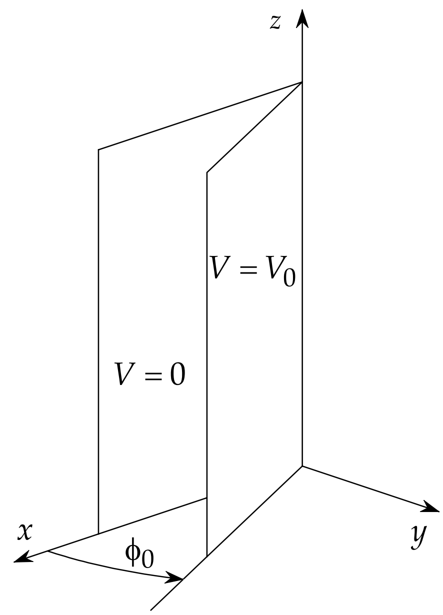
A vector field is given in cylindrical coordinates as

$$\boldsymbol{F} = As\hat{\boldsymbol{\varphi}} + Bz\hat{\mathbf{z}} \quad ,$$

where A and B are constants. Could $\boldsymbol{F}$ be an electrostatic field? Why or why not?

Problem 5 (20 points)

Two semi-infinite conducting planes meet in the shape of a wedge, with an angle ϕ_0 between them. They are insulated from one another, and one is grounded, while the other is held at potential V_0. We wish to compute the electric potential everywhere between the planes.



a. Write down Laplace's equation in the coordinate system appropriate to this geometry, and indicate which two of the terms drop out because of the independence of the potential on the corresponding coordinate.

Problem 5 (continued)

b. Solve the resulting equation for the electric potential between the planes, subject to the boundary conditions, and compute the electric field vector from the potential.