PH631 Electromagnetic Theory I
Fall 2014

Midterm Exam 10:00-10:50 am,

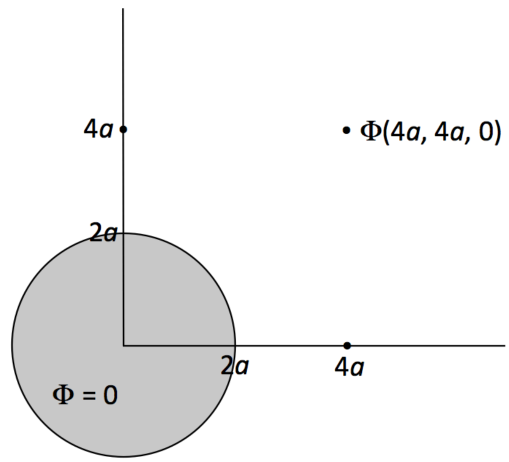
Show your working unless the problem states otherwise.

You may use any information on your cheat sheet (single sided 8.5 x 11 page). You may also use a calculator. Otherwise, the exam is closed book.

You may ask me any questions you wish. I may or may not answer.

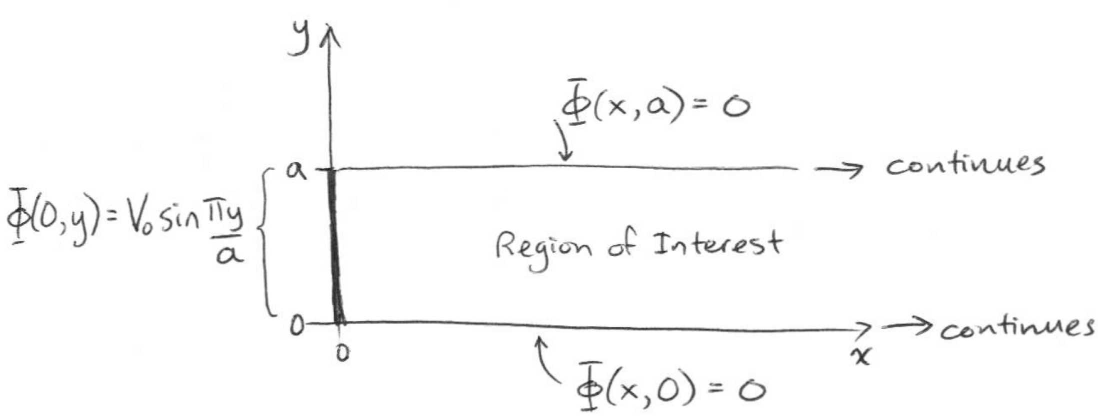
Q1 (10pts)	Q2 (10pts)	Q3 (15pts)	Q4 (15pts)	Total (50pts)

Question 1 (10 pts)



A grounded metal sphere of radius $2a$ is centered at the origin. Two point charges are placed near the sphere. There is nothing else in the universe. Charge q is placed on the y-axis at $y = 4a$. An identical charge is placed on the x-axis at $x = 4a$. Find Φ at the point $x = 4a$, $y = 4a$, $z = 0$.

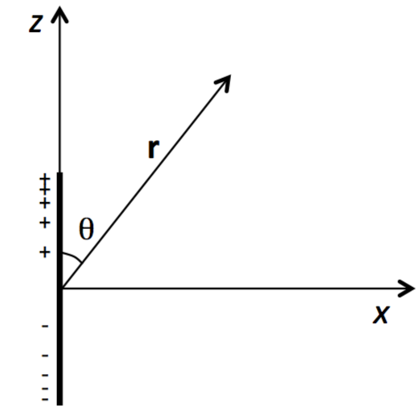
Question 2 (10 pts)



The figure above illustrates the boundary conditions for an electrostatics problem in the x-y plane. Translational symmetry in the z-direction ensures that Φ has no z dependence. Inside the region of interest is empty space.

Find the electric potential, $\Phi(x,y)$, in the region of interest.

Question 3 (15 pts)



$\lambda(z) = \lambda_0 \sin(\pi z/2a)$ for $-a < z < a$

A rod of length $2a$ points along the z direction and is centered at the origin. The charge per unit length on the rod is given by $\lambda(z) = \lambda_0 \sin(\pi z/2a)$. Find the electric potential in the space around the rod in terms of the coordinates r and θ. Express your answer as a definite integral that could be handed over to a mathematician (the variables in the integrand must either r, θ, or a variable of integration).

Question 4 (15 pts)

A spherical party balloon of radius a is covered by a charge density $\sigma(\theta)$. The charge distribution has azimuthal symmetry (no ϕ dependence). The electric potential inside and outside the balloon is measured to be

$$\Phi_{out} = \frac{V_0 a^3}{r^3} P_2(\cos\theta), \quad r > a$$

$$\Phi_{in} = \frac{V_0 r^2}{a^2} P_2(\cos\theta), \quad r < a$$

Find $\sigma(\theta)$.