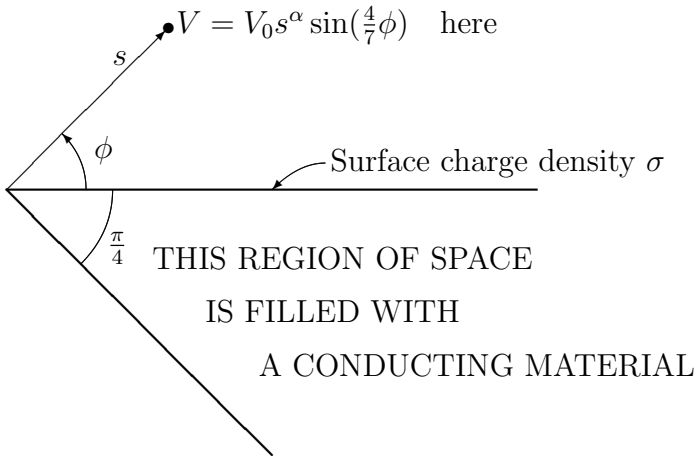
Physics 110A (Electrodynamics) – Midterm Exam / October 7, 2019

Problem 1 (50 points)



An infinite conducting wedge has an opening angle of $\pi/4$.
The conducting wedge occupies the portion of space given, in cylindrical coordinates, by

$$-\infty < z < \infty, \qquad 0 \le s < \infty, \qquad \frac{7\pi}{4} \le \phi \le 2\pi.$$

The remaining portion of space ($0 < \phi < \frac{7\pi}{4}$) has an electric field with a scalar potential given by

$$V = V_0\, s^\alpha \sin(\frac{4}{7}\phi) \qquad \text{for some constants } V_0 \text{ and } \alpha > 0.$$

(a) If the space outside the conductor is free of charges, what is the value of α? **(25 points)**

(b) Find the surface charge density σ on the conductor surface at $\phi = 0$.
The answer should be a function of s and the unknown constants V_0 and α. **(25 points)**

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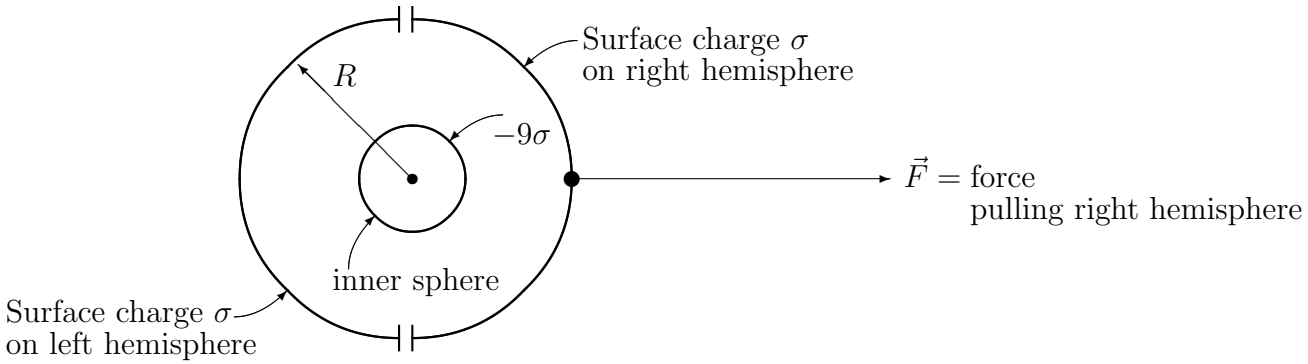
Problem 2 (50 points)



A sphere of radius R is carrying a uniform surface charge density σ. Inside it is an smaller sphere of radius $R/3$ carrying (an oppositely charged) surface charge density -9σ. The outer sphere is cut in half, and the two hemispheres (left and right) are separated, with a very (infinitesimally) thin gap between them.

(a) Calculate the electrostatic energy of this configuration (ignoring the thin gap). **(25 points)**

(b) Calculate the magnitude $|\vec{F}|$ of the force $\vec{F}$ needed to keep the right hemisphere apart from the left one. ($\vec{F}$ must balance the force exerted on the right hemisphere by the inner sphere and the left hemisphere.) **(25 points)**