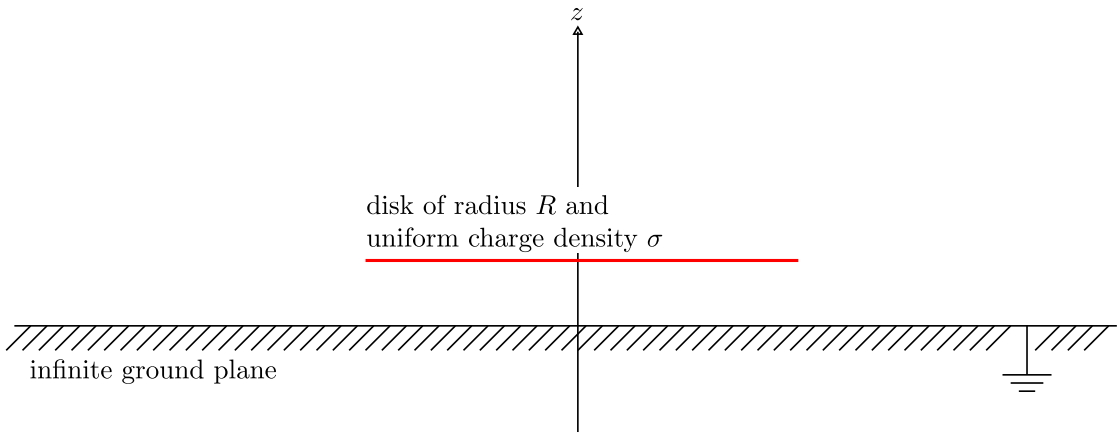
PHYSICS 301 Tutorial #6 – quiz Name: Solns
Oct. 31, 2024 Student Number:

(2pts) **1.** The figure below shows a side view of a circular disk of radius R a distance $z = a$ above an infinite ground plane that lies in the xy-plane. The disk is parallel to the plane and $R \gg a$. The disk carries a uniform charge per unit area $\sigma > 0$.

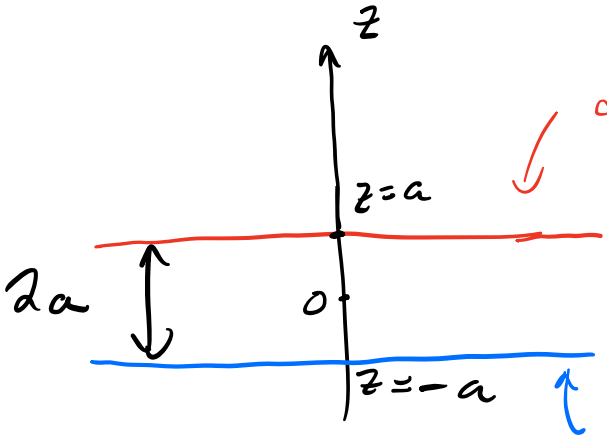


(a) Using the method of images, draw an equivalent geometry of charge distributions that would give the same $V(x, y, z)$ in the region $z > 0$. (**1 mark**)

(b) What kind of familiar structure does the equivalent charge distribution of (a) produce? (**1 mark**)

BONUS: For a point P on the z-axis at $z = a/2$ (half way between the disk and the ground plane), what is the direction and magnitude of the electric field? (**1 mark**)

(a)



disk of radius R & charge density +σ

disk of radius R & charge density −σ

(image charge dist'n.)

(b) This structure is a parallel-plate capacitor.

2 pts

(c) For a parallel-plate capacitor,

$$C = \frac{Q}{\Delta V} = \varepsilon_0 \frac{A}{d}$$

In our case, $d = 2a$

$$\therefore \Delta V = \frac{(Q/A)d}{\varepsilon_0} = \frac{\sigma}{\varepsilon_0} d$$

We also know that

$$|\Delta V| = \int \vec{E} \cdot d\vec{l} = Ed \quad \text{for a const. } \vec{E}$$

$$\therefore E \cancel{d} = \frac{\sigma}{\varepsilon_0} \cancel{d}$$

$$\therefore \vec{E} = -\frac{\sigma}{\varepsilon_0} \hat{z}$$

$\vec{E}$ points from pos. plate to neg. plate.