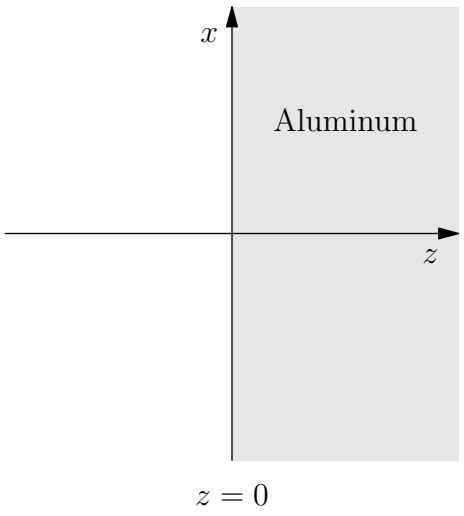
J03E.1—Waves in Aluminum

Problem

A plane wave at 90 GHz is normally incident on aluminum, a very good conductor, that fills the space with $z > 0$ as shown in the figure. Most, but not all, of the field is reflected from the surface. Aluminum has a magnetic permeability equal to that of free space and a conductivity of $\sigma = 3.5 \times 10^{17}$ s^{-1} or 3.5×10^{7} Ω^{-1}m^{-1}.



a) Assume the wave inside the aluminum has the form

$$\vec{E} = E_0 \exp(ikx - i\omega t)\hat{e}_x.$$

What is the dispersion relation, $k(\omega)$, in the aluminum?

b) What fraction of the incident power is reflected?

c) What is the numerical value of the normal emissivity ϵ? Recall that ϵ = (the power emitted)/(the power emitted by a perfect radiator at the same temperature).