WP-A1) Show that $E(r,t) = \frac{A}{r}\cos(kr - \omega t)$ is a solution to the wave equation.

WP-A2) Suppose that a reflecting surface has a complex reflection coefficient $\rho = \rho_0 \exp(j\delta)$. This means that if a normal incident electric field is given by

$$E_i(z,t) = A\cos(kz - \omega t + \varphi) ,$$

the reflected wave is given by

$$E_r(z,t) = A\rho_0 \cos(kz - \omega t + \varphi + \delta) .$$

Let a plane wave be incident at an angle θ to the normal of a plane reflecting surface. Determine $E_i(z,y,t)$ and $E_r(z,y,t)$, assuming that ρ is not a function of θ. Ignore polarization effects. Show that the total field can be written as

$$\begin{aligned} E_{\text{tot}}(z,y,t) &= A(1-\rho_0)\cos\left[k\left(z\cos\theta + y\sin\theta\right) - \omega t + \varphi\right] \\ &\quad +2\rho_0 A\cos\left(ky\sin\theta - \omega t + \varphi + \delta/2\right)\cos\left(kz\cos\theta - \delta/2\right) . \end{aligned}$$

Interpret this result for the following four cases, which includes finding the visibility, orientation and spatial frequency of the standing wave component:
i) $\theta = 0, \ \ \rho = 1$; ii) $\theta = 0, \ \ \rho = 0.25$; iii) $\theta = 45^\circ, \ \ \rho = 1$; and iv) $\theta = 20^\circ, \ \ \rho = 0.5$

WP-A3) A given argon laser has a cw output of 1 watt. The output beam has a Gaussian amplitude distribution that is truncated at the point where the amplitude falls to 1/e its axial value. The resulting beam diameter is 2 mm.

a) What is the on-axis electric field?
b) What would the on-axis electric field be if we had a uniform amplitude distribution across the beam? (1 watt total power)