Physics 515, Spring Quarter 2018
Electrodynamics: Homework Assignment 1
Due May 6, either 11:00am in class or 10:45am in the instructor's mailbox.

1. Consider a circular aperture in a perfectly-absorbing screen. Plane waves are incident normally on the screen. In the scalar-diffraction model, show that along the axis in the limit where the size of the aperture is infinite, the result for the diffraction is sensible, that is there is no scattered wave and there's a plane wave at observation points along the axis. (This also will justify the factor of ik/2π from lecture.)

2. Consider an aperture consisting of a long slit of width D and length L (L>>D) in a perfectly-absorbing screen. Plane waves are incident normally on the screen. In the Fraunhofer (far) region, show that the scalar-diffraction model yields the single-slit diffraction result from first-year physics $I = I_0 \left(\frac{\sin\theta}{\theta}\right)^2$. (Working in the Fraunhofer region may simplify the Green's-function integration.)

3. Consider the example of long-wavelength scattering off a *conducting* sphere. Find the equivalent of Jackson equations 10.15 where the polarization basis is circular polarization. (The unpolarized cross section remains Jackson equation 10.16 regardless of the polarization basis.) This is presented in several texts.

4. When a plane wave is incident on a scatterer, it may be some incident power is absorbed instead of being radiated. Suppose a plane wave is incident on an Ohmic sphere, where some heating arises due to $\mathbf{J}\cdot\mathbf{E}$ effects within the sphere. A sensible definition of the "absorption cross" section, the cross section area of the incident wave that goes into heating, is
$\sigma_{\text{abs}} = \iiint \mathbf{J}\cdot\mathbf{E}\, dV / |\langle \mathbf{S} \rangle|$, where $|\langle \mathbf{S} \rangle|$ is the magnitude of the time-average incident Poynting vector.

a. Suppose the sphere is a poor but finite conductor. Find the approximate induced electric dipole moment of the sphere. (Because the sphere is a poor conductor the skin depth is large. This is similar to the situation in Jackson figure 4.8.
b. Find the resulting absorption cross section of the sphere. This is presented in several texts.

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