

SET 1–DUE 21 JANUARY

“The world of our imagination is narrower and more special in its logical structure than the world of physical things.” (Max Born)

1) [10 points] Jackson 9.3. In CGS, the discontinuity in $E \cdot \hat{n}$ across a conductor is $4\pi\sigma$ where σ is the surface charge density. Or, just do the problems in MKS and let us deal with the units...

2) [20 points] Consider an array of $2N + 1$ dipoles. Each has a time-dependent dipole moment $\vec{p}(t) = \hat{z}pe^{-i\omega t}$, and they are spaced a distance D apart along the \hat{z} axis, centered on the origin. What is the resulting antenna pattern? Explicitly work out what happens at θ (the polar angle measured with respect to the \hat{z} axis) near $\pi/2$.

3) (a) [15 points] The surface of a charge distribution of uniform density is almost a sphere: the radius as a function of the polar angle is $R(\theta) = R_0(1 + \gamma \cos \theta)$. The quantity γ oscillates in time with frequency ω , so we are describing something like surface waves on a water balloon. Working to lowest nontrivial order in the small parameter γ , and in the long wavelength limit, find an expression for the antenna pattern of emitted radiation and the total power radiated. (b) [5 points] Part (a) is a variation of Jackson 9.12, except in that problem $R(\theta) = R_0(1 + \beta P_2(\cos \theta))$. What is the leading multipole behavior of the radiation in that case? Why?