1) Jackson, problem 1.7.

Two long, cylindrical conductors of radii \(a_1\) and \(a_2\) are parallel and separated by a distance \(d\), which is large compared with either radius. Show that the capacitance per unit length is given approximately by

\[ C \approx \pi \varepsilon_0 \left( \ln \frac{d}{a} \right)^{-1} \]

where \(a\) is the geometrical mean of the two radii.

Approximately what gauge wire (state diameter in millimeters) would be necessary to make a two-wire transmission line with a capacitance of \(1.2 \times 10^{-11}\) F/m if the separation of the wires was 0.5 cm? 1.5 cm? 5.0 cm?

2) Jackson, problem 2.1.

A point charge \(q\) is brought to a position a distance \(d\) away from an infinite plane conductor held at zero potential. Using the method of images, find:

(a) the surface-charge density induced on the plane, and plot it;

(b) the force between the plane and the charge by using Coulomb’s law for the force between the charge and its image;

(c) the total force acting on the plane by integrating \(\sigma^2/2\varepsilon_0\) over the whole plane;

(d) the work necessary to remove the charge \(q\) from its position to infinity;

(e) the potential energy between the charge \(q\) and its image [compare the answer to part d and discuss];

(f) Find the answer to part d in electron volts for an electron originally one angstrom from the surface.
3) Jackson, problem 2.9.

An insulated, spherical, conducting shell or radius $a$ is in a uniform electric field $E_0$. If the sphere is cut into two hemispheres by a plane perpendicular to the field, find the force required to prevent the hemispheres from separating

(a) if the shell is uncharged;

(b) if the total charge on the shell is $Q$. 