

Image charges

1. For the first image charge problem that we did in class, of a charge located near a metal plate, from the electric field at the plate calculate the surface charge density, and by direct integration find the total charge on the surface of the plate.
2. A conductor has a spherical cavity of radius R inside it. Inside this sphere there is a charge $+Q$ located at a distance d from its centre, where $d < R$. Find the potential inside the cavity, and the charge density on its walls.
3. A charge $+Q$ at the origin is located between two metal plates which occupy the planes $z=+a$ and $z=-a$.
 - a. Find the images charges. (Hint: imagine you are looking at your reflection when standing between two parallel mirrors. What do you see? Looking at it a different way, each image charge has its own image charge.)
 - b. Find an expression for the potential at points along the z axis and between the two plates.
 - c. Plot the answer to the previous question.
 - d. (Optional) Can you plot the potential $V(x,0,z)$ and check that the two plates are equipotentials? (This is a good check that you have the answer to question 3a correct.)

Complex functions

4. For each of the following analytic functions find the equipotentials and electric field lines, and describe the physical situation(s) that relate to it.
 - a. $f(z) = z$
 - b. $f(z) = \ln(z)$