Physics 301/571: Electromagnetic Theory I

Read: Griffiths chapter 2.4-2.5, 3.2

“G” refers to Griffiths’ book.
Problems with stars are not for credit and will NOT be graded.

Homework 5

Exercise 1
Eight particles of mass \( m \) and electric charge \(-q\) each are placed in corners of a cube and released. Find the velocity of each charge at infinity. The length of the edge of the cube is \( a \).

Exercise 2 (G 2.35)
A metal sphere of radius \( R \), carrying charge \( q \), is surrounded by a thick concentric metal shell (inner radius \( a \), outer radius \( b \)). The shell carries no net charge.

a) Find the surface charge density \( \sigma \) at \( R \), at \( a \), and at \( b \).

b) Find the potential at the center, using infinity as the reference point.

c) Now the outer surface is touched to a grounding wire, which lowers its potential to zero (same as infinity). How do your answers to (a) and (b) change?

Exercise 3 (G 2.38)
A metal sphere of radius \( R \) carries a total charge \( Q \). What is the force of repulsion between the “northern” and “southern” hemisphere?

*Exercise 4 (G 2.39)
Find the capacitance per unit length of two coaxial (very long) metal cylindrical tubes, of radii \( a \) and \( b \).
Exercise 5

What is the minimal work required to move a point charge $q$ from the center of a thick concentric metal shell (inner radius $a$, outer radius $b$) to infinity. Assume that there is a small hole in the shell.

Exercise 6 (2d electron gas)

Two electrons are confined to a two-dimensional $xy$ plane (can freely move along the plane, but have a fixed coordinate $z = 0$). There is an infinite conducting plane (gate) parallel to the $xy$ plane at the distance $a$ from the latter ($z = a$). Find the “effective” force between electrons at distances $r \gg a$. Take into account the “screening” by image charges.