

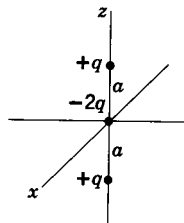
Multipole Expansion of Scalar Potential

1. For a source charge distribution consisting of a charge of q placed at $(0, a, 0)$ and a charge of $-q$ placed at $(0, -a, 0)$, the first term in the multipole expansion (the dipole term) is

$$V(x, y, z) \approx \frac{qay}{2\pi\epsilon_0 r^3}$$

We did this calculation in class. Now show that, in the limit $r \gg a$, the exact potential has the form given by the first term in the multipole expansion.

2. (a) Find the monopole, dipole and quadrupole moments of the charge distribution shown below using cartesian co-ordinates.



- (b) Calculate the approximate scalar potential using the multipole expansion.
- (c) Show that in the limit

$$r = \sqrt{x^2 + y^2 + z^2} \gg a$$

that the exact potential reduces to the first term of the multipole expansion given in (b).