

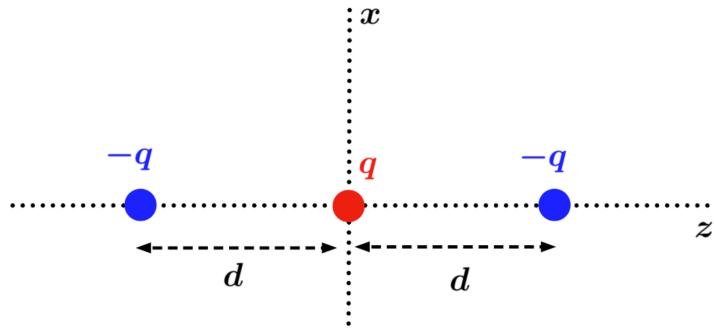
# PHYS UN1602 Recitation Week 2 Worksheet

TA: Nitya Nigam

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## Problem 1

Three charged particles with charges  $\{-q, q, -q\}$  are placed on the  $z$  axis at  $z = \{-d, 0, d\}$ , as shown in the diagram below.



- a) List the symmetries associated with this arrangement of charges.
- b) Calculate the electric field on the  $x$  axis,  $\vec{E}(x, 0, 0)$ .
- c) Evaluate the electric potential on the  $x$  axis,  $\phi(x, 0, 0)$ .
- d) Show that  $E_x = -\frac{\partial \phi}{\partial x}$
- e) What is  $\vec{E}(x, 0, 0)$  in the limit  $x \gg d$  to zeroth order in  $d/x$ ?
- f) What is  $\phi(x, 0, 0)$  in the limit  $x \gg d$  to zeroth order in  $d/x$ ?

## Problem 2

A spherical volume of radius  $a$  is filled with charge of uniform density  $\rho$ . We want to know the potential  $U$  of this sphere of charge. (*Hint: this is essentially the work required to assemble this sphere.*) Express your final result in terms of the total charge  $Q$  in the sphere.

- a) Take a sphere of initial radius  $r$  and find the work required to add a point charge  $q$  to the sphere.
- b) Write the charge of the sphere as a function of the radius.
- c) Solve for total energy by building the sphere up layer by layer.
- d) Why are we allowed to do what we did in step c)?