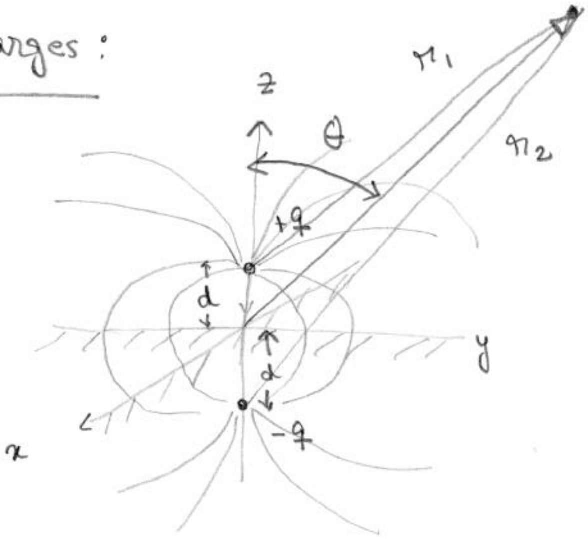
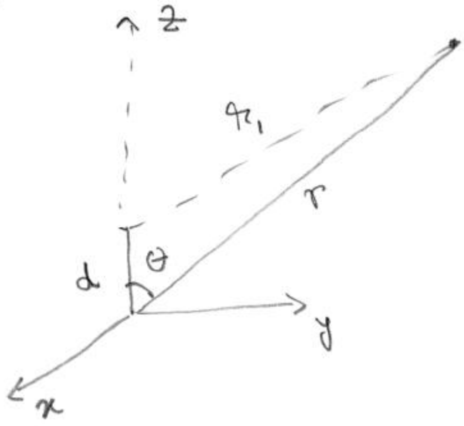
Problem set II

Image charges:





$$\phi(r,\theta) = \frac{1}{4\pi\epsilon_0}\left(\frac{q}{r_1} - \frac{q}{r_2}\right)$$

$$r_1^2 = r^2 + d^2 - 2dr\cos\theta$$

$$r_2^2 = r^2 + d^2 + 2dr\cos\theta$$

- Using the cartesian coordinate system as drawn above and the expression for the potential give above write down

  $\phi(x, y, z)$

- Calculate the electric field by taking gradient of the potential

  $$\vec{E}(x, y, z) = -\nabla\phi$$

- In the expression of the electric field set $z=0$ to obtain the electric field at any point on the x-y plane. Show that the same field (on the x-y plane) could be found easily by Coulomb's law.

- Using the expression for the electric field calculate the surface density of induced charge $\sigma(x, y)$ on the x-y plane.

- Find the total induced charge

$$q_{in} = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} \sigma(x, y)\, dx\, dy$$

by doing the above integral.
You already knew the result, did you not?