

PHYS 114 - Second Homework

1. A long plastic pipe has inner radius a and outer radius b . Electric charge is uniformly distributed over the region $a < r < b$. The amount of charge is λ coulombs per meter of length of pipe. Find the electric field in the regions $r < a$, $a < r < b$, and $r > b$.

(H. C. Ohanian, "Physics," Ch. 24, Pr. 15)

2. According to an old (and erroneous) model due to J. J. Thomson, an atom consists of a cloud of positive charge within which electrons sit like plums in a pudding. The electrons are supposed to emit light when they vibrate about their equilibrium positions in the cloud. Assume that in the case of the hydrogen atom the positive cloud is a sphere of radius $R = 0.5 \text{ \AA}$ with a charge e uniformly distributed over the volume of this sphere. The (pointlike) electron is held at the center of this charge distribution by the electrostatic attraction.

(a) Show that the restoring force on the electron is $e^2 r / (4\pi\epsilon_0 R^3)$ when the electron is at a distance r from the center $r \leq R$.

(b) What is the frequency of small oscillations of the electron moving back and forth along a diameter? Give a *numerical* answer.

(H. C. Ohanian, "Physics," Ch. 24, Pr. 21)

3. A point charge Q is on the positive z axis at the point $z = h$. A point charge $-Q \times R/h$ (where R is a positive length, $0 < R < h$) is on the z axis at the point $z = R^2/h$. Show that the surface of the sphere of radius R about the origin is an equipotential surface.

4. A Point charge $-2Q$ is at the origin of coordinates; two point charges $+Q$ are on the z axis, at $z = \pm l$, respectively.

(a) Show that, for $r \gg l$, the net potential of these charges is approximately

$$V = \frac{2Ql^2}{4\pi\epsilon_0 r^3} \frac{(3 \cos^2 \theta - 1)}{2}$$

(b) Calculate E_x , E_y , and E_z , expressing these in terms of the coordinate x , y , and z

(H. C. Ohanian, "Physics," Ch. 25, Pr. 40)