

DEPARTMENT OF PHYSICS
INDIAN INSTITUTE OF TECHNOLOGY, MADRAS

PH1020 Physics II

Tutorial 1 (22.1.2018)

1. Consider an infinite uniformly-charged plate occupying the xoy plane, carrying a surface charge density σ , with a circular hole of radius a centered at the origin. Find the force on a charge Q lying on the z -axis. If the charge is negative, (i.e., $Q < 0$), discuss the force on it when released at a distance x close to the origin (i.e., $z \ll a$).
2. Determine the electric field at the center of a sphere of radius R that carries a charge on its surface with charge density $\sigma = \vec{k} \cdot \vec{r}$, where \vec{k} is a constant vector.
3. A fixed charge $+q$ at a point O is surrounded by a continuous distribution of charge whose density $\rho (< 0)$ is a function only of the distance r from O. The total negative charge *exceeds* q in magnitude. A point charge $+q'$, with a mass m , is free to move on a line passing through O. (a) Obtain the condition for $+q'$ to be in equilibrium at a distance r_0 from O. (b) If q' is released at a point very close to r_0 , find the force acting on it.
4. Evaluate the electrostatic energy W of a charge distribution in the form of a uniform charge density within a sphere of radius a and total charge Q . Express the answer in terms of ϵ_0 , a , and Q .
5. Verify if $\vec{E} = \frac{a}{\rho^2} [\hat{e}_\rho (1 + \cos \phi) + \hat{e}_\phi \sin \phi]$ can be a electric field and if so find the volume charge density that creates it. Note: (ρ, ϕ, z) represent the cylindrical polar co-ordinates.
6. A hemisphere of radius R has a uniformly distributed surface charge with total charge Q . Find the potential at any position along the z axis due to the entire hemisphere of surface charge?