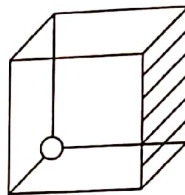


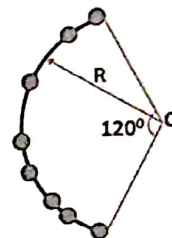
Quiz -1 (Introductory Electricity and Magnetism- PH1213)

Total marks 15; time 1 hr.

1. (a) If two charges kept in 'air' at a certain separation, are now kept at the same separation in 'water' of dielectric constant 80, then what happens to the force between them? (1 no.)
  - (b) What is the net force on an electric dipole placed in a uniform electric field? (1 no.)
  - (c) Consider a dipole in an external electric field  $\vec{E} = E_0 \hat{y}$  where  $E_0$  is a constant. A dipole  $\vec{p} = p \hat{y}$  ( $p$  is the magnitude of the dipole moment) is placed in that electric field. Find the potential energy of the dipole in this external field. (1 no.)
2. (a) Can this be a possible electric field  $\vec{E} = c[(xy)\hat{i} + (2yz)\hat{j} + (3xz)\hat{k}]$ , where  $c$  is some constant and  $\hat{i}, \hat{j}, \hat{k}$  are three unit vectors along  $x, y$  and  $z$  axis. Establish your answer with suitable arguments and calculation. (2 no.)
  - (b) A charge  $q$  sits at the back corner of a cube. What is the flux of  $\vec{E}$  through the shaded area? (2 no.)



3. 8 electrons of charge  $-e$  are placed non-uniformly along an arc of a circle of radius  $R$ . With this information can you find the potential at the center  $C$ ? If yes, then please write down the potential. (2 no.)



4. A sphere of radius  $R$  carries a polarization  $\vec{P}(\vec{r}) = k\vec{r}$  where  $k$  is a constant and  $\vec{r}$  is the vector from the center.
  - (a) Calculate the bound charge  $\sigma_b$  and  $\rho_b$ . (2 no.)
  - (b) Find the electric field inside the sphere at distance  $r$  ( $< R$ )
 {Hint: radial component of  $\vec{\nabla} \cdot \vec{a} = \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 a_r)$ } (2 no.)

5. Consider an air-filled parallel-plate capacitor with one plate connected to a spring having a force constant  $k$ , and another plate held fixed. The system rests on a frictionless table top as shown in the figure below. If we place  $+Q$  and  $-Q$  charges on plates  $a$  and  $b$ , respectively, how much does the spring expand? (2 no.)

