Department of Physics

Electrodynamics and Optics (PHN-005)

Tutorial 2 (August 26 , 2019)

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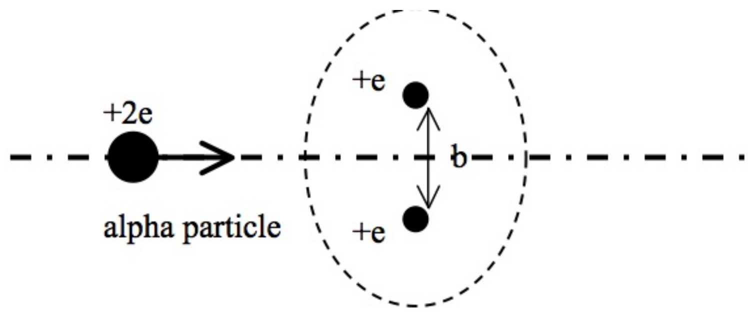
(1) Consider two positive charges ($+e$) separeted by a distance of b. An alpha particle passes on a line perpendicular to the inter-charge axis as shown in following figure. Where on its path does the alpha particle experience the greatest force? Assume that the charges remain stationary during the passage of the alpha particle (The assumption is valid because of the high speed of the alpha particle.)

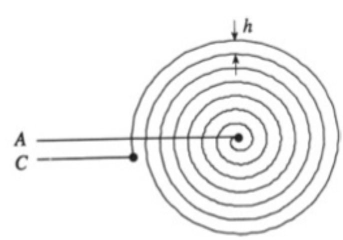


(2) Calculate the electric field at the surface of following three objects a) Sphere of radius R with ρ volume charge density b) Cylinder with radius R and infinite length ρ volume charge density c) Infinite 2D sheet with $2R$ thickness having ρ volume charge density.

(3) An electric charge distribution produces electric field $\mathbf{E}= (1 - e^{-\alpha r})\frac{\hat{\mathbf{r}}}{\mathbf{r^2}}$ where α is a constant. Find charge density and total charge enclosed by sphere of radius $r = 1/\alpha$.

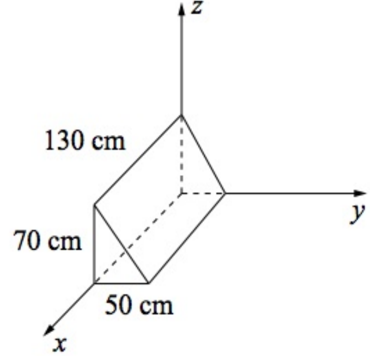
(4) An electric field is give by $\mathbf{E} = ax^3\hat{i}$V/m from $x \geq 0$ to ≤ 5 m and $\mathbf{E} = b\hat{i}$ V/m for $x > 5$ m. Calculate electrical charge density at $x = 3$ m and $x = 8$ m

(5) If there are N turns in a metal spiral as shown in following figure. A time varying magnetic field $B_0\cos(\omega t)$ is applied perpendicular to the plane of spiral. Calculate emf generated between A and C.



(6) Calculate the flux of $\mathbf{B}= 0.002\hat{i} + 0.003\hat{j}$T through all five surfaces . Also calculate total flux.

(7) Which one can not be a magnetic field?
(a) $\mathbf{B}_1(r, \phi, z) = \frac{a}{r}\cos^2(\phi)\hat{r}$
(b)$\mathbf{B}_2(r, \phi, z) = \frac{a}{r^2}\cos^2(\phi)\hat{r}$



(8) A square of metal wire has sides of length L. This square rotates in constant magnetic field with magnitude B. Angle between normal to the plane and magnetic field is $\theta(t) = \theta_0(t/t_0)$. Calculate generated emf in the loop.

(9) Consider a sphere of radius R with uniform volume charge density ρ. If a spherical cavity of radius r is carved out at an arbitrary location inside the sphere, then calculate electric field inside the cavity.

(10) A steady current I flows down a long cylinder wire of radius R. Find the magnetic field inside and outside of the wire, if a) current is uniformly distributed over outside surface of he wire b) Current is distributed in such a way that J (current density) is proportional to r (distance from axis). Griffith 5.13 problem.
