Assignment 1
Introduction to Electricity and Magnetism

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To be submitted by 15/01/2015(Thursday),midnight

1. Two charges $+Q$ and $-Q$ are placed on the x-axis at distances $x = +a$ and $x = -a$ respectively. A charge $+q$ is placed on the y-axis at distance y from the origin. The force $\vec{F}$ on the charge q is

   (a) $\frac{Qq}{4\pi\epsilon_0} \frac{2y}{(y^2 + a^2)^{3/2}} \hat{y}$

   (b) $-\frac{Qq}{4\pi\epsilon_0} \frac{2a}{(y^2 + a^2)^{3/2}} \hat{x}$

   (c) $-\frac{Qq}{4\pi\epsilon_0} \frac{2a}{(y^2 + a^2)} \hat{y}$

   (d) $\frac{Qq}{4\pi\epsilon_0} \frac{2y}{(y^2 + a^2)^{3/2}} \hat{x}$

2. Twelve charges of the same sign and magnitude Q are placed on a ring of radius R at equal distances. The axis of the ring is taken to be along the z-axis. A charge q is placed at a height of z on the axis of the ring. The force on the charge q is

   (a) $\frac{Qq}{4\pi\epsilon_0} \frac{6R}{(z^2 + R^2)^{3/2}} \hat{z}$

   (b) $\frac{Qq}{4\pi\epsilon_0} \frac{12R}{(z^2 + R^2)^{3/2}} \hat{z}$

   (c) $\frac{Qq}{4\pi\epsilon_0} \frac{12}{(z^2 + R^2)^{3/2}} \vec{z}$

   (d) $\frac{Qq}{4\pi\epsilon_0} \frac{6}{(z^2 + R^2)^{3/2}} \vec{z}$

3. A thin disc of radius R is placed in the xy-plane with its centre at the origin. The disc carries surface charge $\sigma = \frac{\sigma_0}{r}$, where r is the distance from the centre. Axis of the disc is taken along z-axis. A point charge q is placed on the axis of the ring at a height of z. The force on the point charge q is

   (a) ∞

   (b) $\frac{q\sigma_0 R}{2\epsilon_0 z(R^2+z^2)^{1/2}}\hat{z}$

   (c) $\frac{q\sigma_0}{\epsilon_0 R(R^2+z^2)^{1/2}}\vec{z}$

   (d) $\frac{q\sigma_0}{2\epsilon_0 R(R^2+z^2)^{1/2}}\vec{z}$

4. Take two infinitely long overlapping cylinders each of radius R. One cylinder has the charge density ρ and the other one has $-\rho$. The distance between the axes of the two cylinders is a ($a < 2R$). The magnitude of the electric field in the overlapping region is

   (a) $\frac{a\rho}{2\epsilon_0}$

   (b) $\frac{a\rho}{3\epsilon_0}$

   (c) $\frac{a\rho}{\epsilon_0}$

   (d) $\frac{a\rho}{4\epsilon_0}$

5. Divergence of the vector field described by the function $\vec{f}(x,y,z) = x^2\hat{x} + 6xyz\hat{y} + z^2x\hat{z}$ is

   (a) $3x$

   (b) $2x + 8xz$

   (c) $x + 6xz$

   (d) $xyz + z$

6. If divergence of the vector field $\vec{A}(x,y,z) = 2\alpha x\hat{x} + \beta y\hat{y} - 3\gamma z\hat{z}$ is zero then

   (a) $\alpha + \frac{\beta}{6} - \gamma = 0$

   (b) $\frac{\alpha}{2} + \beta - \frac{\gamma}{2} = 0$

(c) $\frac{\alpha}{3} + \frac{\beta}{6} - \frac{\gamma}{2} = 0$

(d) $\frac{2}{\alpha} + \frac{1}{\beta} - \frac{3}{\gamma} = 0$

7. Electric field for a charge distribution is given as $\vec{E}$(r)= $C\frac{e^{-\lambda r}}{r^3}\ \vec{r}$, where C is a constant and r is the distance from the origin. If we take a very small sphere of radius ϵ around the origin, the charge enclosed by this sphere in the limit of $\epsilon \to 0$ is given by

   (a) 0

   (b) $4\pi\epsilon_0 C$

   (c) $4\epsilon_0 C$

   (d) $\epsilon_0 C$

8. For the electric field $\vec{E}(r)$= $C\frac{e^{-\lambda r}}{r^3}\ \vec{r}$, the flux through a shell of radius R and infinitesimal thickness dR (centre of the shell is at the origin) is given by

   (a) $C\lambda e^{-\lambda R} dR$

   (b) $4\pi C\lambda e^{-\lambda R} dR$

   (c) $-4\pi C\lambda e^{-\lambda R} dR$

   (d) $-C\lambda e^{-\lambda R} dR$

9. The charge density $\rho(r)$ for $\vec{E}(r)$= $C\frac{e^{-\lambda r}}{r^3}\ \vec{r}$ is

   (a) $4\pi C\epsilon_0 \delta(\vec{r}) - C\epsilon_0\lambda\frac{e^{-\lambda r}}{r^2}$

   (b) $\frac{C\delta(\vec{r})}{\epsilon_0}$

   (c) $4\pi C\epsilon_0 \delta(\vec{r}) + \epsilon_0 C\lambda\frac{e^{-\lambda r}}{r^2}$

   (d) $\frac{-\epsilon_0 C\lambda e^{-\lambda r}}{r^2}$