PHYSICS 2B QUIZ 2 WINTER QUARTER 2010
PROF. HIRSCH JANUARY 25, 2010

Formulas:

$$\sin 30^\circ = \cos 60^\circ = 1/2, \quad \cos 30^\circ = \sin 60^\circ = \sqrt{3}/2, \quad \sin 45^\circ = \cos 45^\circ = \sqrt{2}/2$$

$F = k\dfrac{q_1 q_2}{r^2}$ Coulomb's law ; $k = 9\times 10^9 \mathrm{N\cdot m^2/C^2}$; $\vec{F}_{12} = \dfrac{kq_1q_2}{|\vec{r}_2-\vec{r}_1|^3}(\vec{r}_2-\vec{r}_1)$

Electric field due to charge q at distance r: $\vec{E} = \dfrac{kq}{r^2}\hat{r}$; Force on charge Q: $\vec{F} = Q\vec{E}$

Electric field of dipole, along dipole axis: $E = \dfrac{2kp}{x^3}$ (p=qd)

Electric field of dipole, along direction perpendicular to dipole axis: $E = \dfrac{kp}{y^3}$

Energy of and torque on dipole in E-field: $U = -\vec{p}\cdot\vec{E}$, $\vec{\tau} = \vec{p}\times\vec{E}$

Linear, surface, volume charge density: $dq = \lambda\, ds$, $dq = \sigma\, dA$, $dq = \rho\, dV$

Electric field of infinite: line of charge: $E = \dfrac{2k\lambda}{r}$; sheet of charge: $E = 2\pi k\sigma = \sigma/(2\varepsilon_0)$

Gauss law: $\Phi = \oint \vec{E}\cdot d\vec{A} = \dfrac{q_{enc}}{\varepsilon_0}$; $\Phi =$ electric flux ; $k = \dfrac{1}{4\pi\varepsilon_0}$; $\varepsilon_0 = 8.85\times 10^{-12} C^2/Nm^2$

$$U_B - U_A = \Delta U_{AB} = -W_{AB} = -\int_A^B \vec{\mathrm{F}}\cdot \vec{dl} = -\int_A^B q\vec{E}\cdot\vec{dl} = q\Delta V_{AB} = q(V_B - V_A) \qquad \mathrm{V=N/C}$$

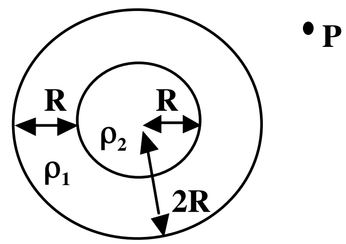
$V = \dfrac{kq}{r}$; $\mathrm{V} = \int \dfrac{kdq}{r}$; $V = \dfrac{kp\cos\theta}{r^2}$ (dipole) ; $E_l = -\dfrac{\partial V}{\partial l}$; $\vec{\mathrm{E}} = -\vec{\nabla}\mathrm{V}$

There are 8 problems in this quiz, all are worth the same. Mark the answer closest to yours. This is Test Form A

Problem 1
A non-conducting sphere of radius R has uniform volume charge density. The electric field at radius r=R/2 (inside the sphere) is 5N/C. What is the electric field at radius r=2R (outside)?
(a) 5N/C ; (b) 2.5N/C ; (c) 10N/C ; (d) 7.5N/C ; (e) 0

Problem 2
For the sphere of problem 1, assume its charge density is positive, and assume a positive charge q is at rest at the sphere's surface. The charge q is released and gains speed as it moves away from the surface of the sphere. At a distance 2R from the center of the sphere the speed of the charge q is v_1, and at a distance 3R from the center of the sphere its speed is v_2, with
(a) $v_2=1.30v_1$; (b) $v_2=v_1$; (c) $v_2=1.41v_1$; (d) $v_2=1.73v_1$; (e) $v_2=1.15v_1$

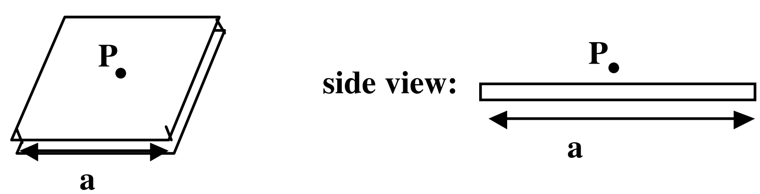
Problem 3



The figure shows a spherical non-conducting shell of inner radius R and thickness R (i.e. outer radius 2R) and volume charge density ρ_1, and a concentric inner non-conducting sphere of radius R and volume charge density ρ_2.
The electric field at a point P outside the spherical shell is zero when
(a) $\rho_2=-\rho_1$; (b) $\rho_2=-4\rho_1$; (c) $\rho_2=-7\rho_1$; (d) $\rho_2=-3\rho_1$; (e) $\rho_2=-2\rho_1$

Problem 4
Same as problem 2 except that the figure now shows a cross section of a very long outer cylindrical shell and an inner cylinder, both with the same axis oriented perpendicular to the paper. The electric field at a point P outside is zero when
(a) $\rho_2=-\rho_1$; (b) $\rho_2=-4\rho_1$; (c) $\rho_2=-7\rho_1$; (d) $\rho_2=-3\rho_1$; (e) $\rho_2=-2\rho_1$

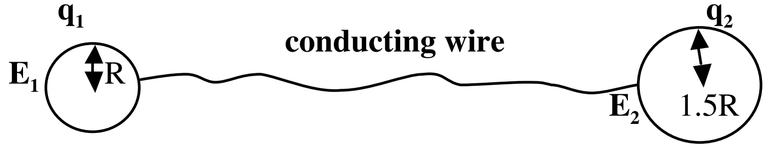
Problem 5



The thin non-conducting square plate in the figure has side length a and thickness a/100. It has total charge q which is uniformly distributed. The electric field at a point P that is at a distance a/100 above the center of the plate has magnitude
(a) $q/(2\pi\varepsilon_0 a^2)$; (b) $q/(2\pi\varepsilon_0(a/100)^2)$; (c) $q/(2\varepsilon_0 a^2)$; (d) $q/(\varepsilon_0 a^2)$; (e) $q/(4\pi\varepsilon_0 a^2)$

Problem 6
Same as problem 5 assuming the plate is conducting rather than non-conducting.
(a) $q/(2\pi\varepsilon_0 a^2)$; (b) $q/(2\pi\varepsilon_0(a/100)^2)$; (c) $q/(2\varepsilon_0 a^2)$; (d) $q/(\varepsilon_0 a^2)$; (e) $q/(4\pi\varepsilon_0 a^2)$

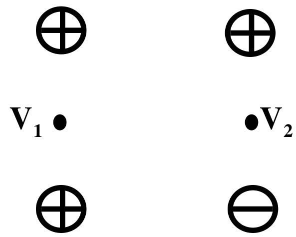
Problem 7



The two conducting spheres of radii R and 1.5R are far away from each other, are connected by a conducting wire, and have charges q_1 and q_2 respectively. The electric field right

outside the surface of the smaller sphere is E_1, and the electric field right outside the surface of the larger sphere is E_2, with
(a) $E_2=0.67E_1$; (b) $E_2=2.25E_1$; (c) $E_2=0.33E_1$; (d) $E_2=1.5E_1$; (e) $E_2=0.5E_1$

Problem 8



In the square arrangement in the figure, the charges are q or -q, with the sign indicated. The electric potential is defined so that it is zero at points infinitely far away. At the points shown at the center of the vertical edges the electric potential is V_1 and V_2, with
(a) $V_2=0.75V_1$; (b) $V_2=1.5V_1$; (c) $V_2=0.60V_1$; (d) $V_2=0.25V_1$; (e) $V_2=0.45V_1$