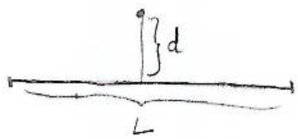
PHY 1304 Test #1 9-18-08 Name:

1) A 10 km non-conducting wire of essentially no thickness has 50C placed uniformly on it. What is the strength of the E field 1cm from the wire near the center of its length? [10 pts]



$$\lambda = \frac{Q}{L} = \frac{50\,C}{10\times10^{3}\,m} = 5\times10^{-3}\ C/m$$

$$E = \frac{2k\lambda}{d} = \frac{2.(9\times10^{9}).(5\times10^{-3})}{0.01}$$

$$\boxed{E = 9\times10^{9}\ N/C}$$

2) A large (100m by 100m) plate has 10 C uniformly distributed over its surface. What is the difference in electric potential when moving from a distance of 1 cm above the center of the plate to 10 cm? [10 pts]

$$\sigma = \frac{Q}{A} = \frac{10\,C}{100\,m\times100\,m} = 10^{-3}$$

$$E = \frac{\sigma}{2\varepsilon_0} = \frac{10^{-3}}{2\times(8.85\times10^{-12})} = 0.0565\times10^{9} = 5.65\times10^{7}$$

$$\Delta V = -\int\vec{E}.d\vec{s} = -\vec{E}.\int d\vec{s} = -E.(d_f - d_i) = -(5.65\times10^{7}).(0.1-0.01)$$

$$\boxed{\Delta V = -5.08\times10^{6}}$$

3) A disk of radius 1m is cut out of the charged plate in Problem 2 above and carried far away. What is the electric potential at a perpendicular distance of 10 cm along the disk axis? [10 pts]

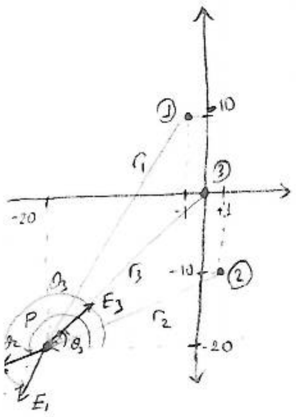
$$V = 2\pi k\sigma\left[(R^2+x^2)^{1/2}-x\right]$$

$$= 2\pi\,(9.10^{9})\,(10^{-3})\,\left[(1^2+0.1)^{1/2}-0.1\right]$$

$$= 5.11\times10^{7}$$

$$E = \frac{kq}{r^2}, \quad r = \sqrt{\Delta x^2 + \Delta y^2}, \quad \theta = \tan^{-1}\left(\frac{\Delta y}{\Delta x}\right)$$

4) Two 5 mC charges are at (x,y) = (-1cm, +10cm) and (+1cm, -10cm), and one charge is at (0cm, 0cm) with -15 mC. What is the E field at the point (-20cm, -20cm)? [10 pts]



$$r_1 = \sqrt{(-20-(-1))^2 + (-20-10)^2} = \sqrt{(-19)^2 + (-30)^2} = 0,355\,m, \quad \theta_1 = \tan^{-1}\left(\frac{-30}{-19}\right) = 57,7° \text{ or } \boxed{237,7°}$$

$$r_2 = \sqrt{(-20-1)^2 + (-20-(-10))^2} = \sqrt{(-21)^2 + (-10)^2} = 0,233\,m, \quad \theta_2 = \tan^{-1}\left(\frac{-10}{-21}\right) = 25,5° \text{ or } \boxed{205,5°}$$

$$r_3 = \sqrt{(-20-0)^2 + (-20-0)^2} = \sqrt{(-20)^2 + (-20)^2} = 0,283\,m, \quad \theta_3 = \tan^{-1}\left(\frac{-20}{-20}\right) = \boxed{45°}$$

$$E_1 = \frac{(9\times10^9)(5\times10^{-3})}{(0,355)^2} = 3,57\times10^8; \quad E_2 = \frac{(9\times10^9)(5\times10^{-3})}{(0,233)^2} = 8,29\times10^8; \quad E_3 = \frac{(9\times10^9)(15\times10^{-3})}{(0,283)^2} = 16,9\times10$$

$$E_x = E_1\cos\theta_1 + E_2\cos\theta_2 + E_3\cos\theta_3 = 2,56\times10^8; \quad E_y = E_1\sin\theta_1 + E_2\sin\theta_2 + E_3\sin\theta_3 = 5,36\times10^8$$

$$E = \sqrt{E_x^2 + E_y^2} \Rightarrow \boxed{E = 5,94\times10^8\ N/m} \quad \theta = \tan^{-1}\left(\frac{E_y}{E_x}\right) \Rightarrow \boxed{\theta = 64,5°}$$

5) A thin hoop has a total of 1mC distributed evenly over its circumference. Its radius is 0.5m. A tiny charged pellet is placed along the axis of the hoop 5m from the plane of the hoop. What force is felt by the pellet? [10 pts]

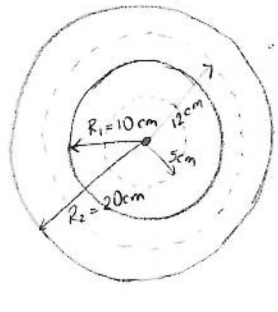
$$E = \frac{k x Q}{(a^2+x^2)^{3/2}} = \frac{(9\times10^9)(5m)(1\times10^{-3}C)}{(0,5m^2 + 5^2)^{3/2}} = 3,55\times10^5$$

$$F = q_{pellet}\cdot E$$

$$F = 3,55\times10^5\, q_{pellet}\ N/C$$

6) A thick shell has 6mC uniformly distributed thru its volume. Its inner radius is 10cm and its outer radius is 20cm. (Note: There is no charge inside the inner radius.) What is the E field for radius = 5cm? Please document the Gaussian surface you used. What is the E field for radius of 12 cm? [10 pts]

$$q_{in} = \rho \cdot V_{in} = \frac{Q}{\frac{4\pi}{3}(R_{out}^3 - R_{in}^3)} \cdot \frac{4\pi}{3}(r^3 - R_{in}^3) = Q\cdot\left(\frac{r^3 - R_{in}^3}{R_{out}^3 - R_{in}^3}\right) = 6,24\times10^{-4}$$



$$\oint \vec{E}\cdot d\vec{a} = \frac{q_{in}}{\varepsilon_0}$$

$r = 5\,cm \Rightarrow q_{in} = 0 \Rightarrow E = 0$

$r = 12\,cm \Rightarrow E\cdot 4\pi r^2 = \frac{q_{in}}{\varepsilon_0} \Rightarrow E = \frac{q_{in}}{4\pi\varepsilon_0 r^2}$

$$E = \frac{(9\times10^9)(6,24\times10^{-4})}{(0,12)^2}$$

$$\boxed{E = 3,9\times10^8\ N/C}$$