PHYS 112 HW2

Garrett Haldeman

No.

Date

Problems: 2, 4, 7, 11, 15, 16, 22, 23, 30, 32, 36, 39

2) a) $\mathcal{E} = 40 N/C \quad e_A = 1.6e{-}19 C$

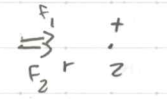
$F = \mathcal{E} \cdot q \quad F = 40 N/C \cdot 1.6e{-}19 C = 6.41e{-}18 C$

c) $F = 6.41e{-}18 N$

b) $\mathcal{E}_b = \mathcal{E}_A / 2$

$\mathcal{E}_b = 20 N/C$

4) $q_1 = -2e{-}7 C \quad q_2 = 2e{-}7 C \quad r = \frac{21-6}{2} = 7.5$



$\mathcal{E}_1 + \mathcal{E}_2 = \mathcal{E}_{net}$

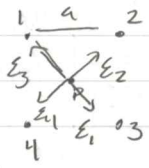
$\mathcal{E}_1 = k\frac{q_1}{r^2} \cdot \cos(0) = k\frac{2e{-}7C}{0.075^2} \cdot 1 = 319{,}644.44 N/C\hat{i}$

$\mathcal{E}_2 = k\frac{q_2}{r^2} \cdot \cos(0) = k\frac{2e{-}7C}{0.075^2} \cdot 1 = 319{,}644.44 N/C\hat{i}$

$\vec{\mathcal{E}}_{net} = (6.39e5 \frac{N}{C}\hat{i} + 0\hat{j})$

7) $q_1 = 10nC \quad q_2 = -20nC \quad q_3 = 20nC \quad q_4 = -10nC$

$a = 5.00cm$



$r = \frac{\sqrt{2a^2}}{2} = \frac{a\sqrt{2}}{2}$

$r^2 = \frac{a^2}{2}$

x-axis

$\mathcal{E}_x = \mathcal{E}_{3x} - \mathcal{E}_{4x} + \mathcal{E}_{2x} + \mathcal{E}_{1x}$

$\mathcal{E}_x = 0 N/C\hat{i}$

$\mathcal{E}_{3x} = \mathcal{E}_{2x}$

$\mathcal{E}_{4x} = \mathcal{E}_{1x}$

y axis

$\mathcal{E}_y = \mathcal{E}_{3y} + \mathcal{E}_{2y} - \mathcal{E}_{4y} - \mathcal{E}_{1y}$

$\mathcal{E}_y = 2\mathcal{E}_{3y} - 2\mathcal{E}_{1y}$

$\mathcal{E}_y = 2(101{,}710 N/C) - 2(50{,}855 N/C)$

$\mathcal{E}_y = 101{,}710.23 N/C\hat{j}$

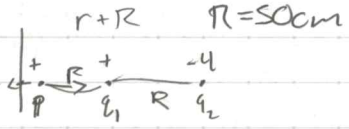
$\mathcal{E}_{3y} = \mathcal{E}_{2y} \quad \mathcal{E}_{1y} = \mathcal{E}_{4y}$

$\mathcal{E}_{3y} = k\frac{q_3 \sin 45}{r^2 \sin 45} = k\frac{20nC \sin 45}{0.05^2} = 101{,}710.24 N/C$

$\mathcal{E}_{1y} = k\frac{q_1}{r^2} = k\frac{10nC \sin 45}{\frac{0.05^2}{2}} = 50{,}855.12 N/C$

$\vec{\mathcal{E}}_{net} = (0\hat{i} + 101{,}710.24\hat{j})$

11) $q_1 = 2.1e{-}8C \quad q_2 = -4q_1 \quad x_1 = 20cm \quad x_2 = 70cm$

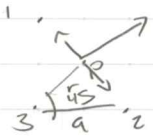


$\mathcal{E}_2 - \mathcal{E}_1 = 0 \quad \mathcal{E}_2 = \mathcal{E}_1 \quad k\frac{4q_1}{(R+r)^2} = k\frac{q_1}{r^2}$

$\frac{4}{(r+R)^2} = \frac{1}{r^2} \quad 2 = \frac{r}{r} + \frac{R}{r} \quad 1 = \frac{R}{r} \quad r = R \quad r = 50cm \quad 20 - 50 = -30cm$

$x = -30cm$

15) $q_1 = q_2 = +e$ $q_3 = +2e$ $a = 6\mu m$



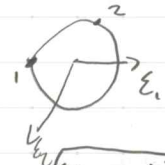
$\mathcal{E}_1 - \mathcal{E}_2 = 0$ $r = \frac{a\sqrt{2}}{2}$ $r^2 = \frac{a^2}{2}$

$\mathcal{E}_3 = k\frac{2e}{\frac{a^2}{2}} = 4k\frac{1.6e-19}{6\mu m^2} = 160.04 N/C$

a) 160.04 N/C

b) 45° from +x

16) $r = 50cm$ $q_1 = 2\mu C$ $q_2 = 6\mu C$



$\mathcal{E}_{net} = 2eSN/C = \vec{\mathcal{E}}_1 + \vec{\mathcal{E}}_2$

$\mathcal{E}_1 = k\frac{2\mu C}{0.5^2} = 71{,}920 N/C$

$\mathcal{E}_2 = k\frac{6\mu C}{0.5^2} = 215{,}760 N/C$

$\mathcal{E}_{net} = \sqrt{(\mathcal{E}_1 - \mathcal{E}_{2x})^2 + \mathcal{E}_{2y}^2}$

$(2eS)^2 = (7.2e4 - 2.16eScos(x))^2 + (2.16eSsin(x))^2$

$\cos^2 - 1$

$4e10 = 5.17e9 - 3.1e10\cos(x) + 4.66e10\cos^2 x + 4.66e10\sin^2 x$

$3.48e10 = -3.1e10\cos(x) + 4.66e10\cos^2(x) + 4.66e10\cos^3(x) - 4.66e10$

$0 = 9.31e10\cos^2 x - 3.1e10\cos(x) - 8.13e10$

$x = 67.8°$

67.8°

22) a) $q = -300e$ $r = 4cm$ $\theta = 40°$ $2\pi r \cdot \left(\frac{40}{360}\right) = 2\cdot\pi\cdot 0.04\cdot\frac{1}{9} = 2.79cm$ arc

$\lambda = \frac{q}{L} = \frac{-300e}{2.79cm} = -1.72e-15 C/m$

a) $\lambda = -1.72e-15 C/m$

b) $q = -300e$ $r = 2cm$ $A = \pi r^2$ $A = \pi 0.02^2 = 1.26e-3 m^2$

$\sigma = \frac{q}{A} = \frac{-300e}{1.260-3m} = -3.82e-14 C/m^2$

$\sigma = -3.82e-14 C/m^2$

c) $q = -300e$ $r = 2cm$ $A = 4\pi r^2 = 4\cdot\pi\cdot 0.02^2 = 5.03e-3 m^2$

$\sigma = \frac{q}{A} = \frac{-300e}{5.03e-3m} = -9.56e-15 C/m^2$

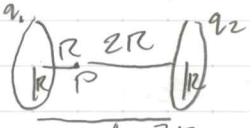
$\sigma = -9.56e-15 C/m^2$

d) $q = -300e$ $r = 2cm$ $V = \frac{4}{3}\pi r^3 = \frac{4}{3}\cdot\pi\cdot 0.02^3 = 3.35e-5 m^3$

$\rho = \frac{q}{V} = \frac{-300e}{3.35e-5m^3} = -1.43e-12 C/m^3$

$\rho = -1.43e-12 C/m^3$

23)



$\mathcal{E}_1 = k\frac{q_1 R}{2\sqrt{2}R^3}$ $\mathcal{E}_2 = k\frac{q_2 2R}{5\sqrt{5}R^3}$

$\mathcal{E}_P = 0$ $\mathcal{E}_P = \mathcal{E}_1 - \mathcal{E}_2$ $R^2 + 4R^2$ $(5R^2)^{3/2}$ $5\sqrt{5}R^3$

$k\frac{q_1 R}{2\sqrt{2}R^3} = k\frac{q_2 2R}{5\sqrt{5}R^3}$

$\frac{q_1}{2\sqrt{2}} = \frac{2q_2}{5\sqrt{5}}$ $\frac{q_1}{q_2} = \frac{4\sqrt{2}}{5\sqrt{5}} =$

$\frac{q_1}{q_2} = 0.506$

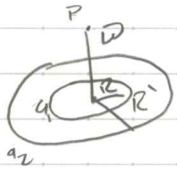
Phys 112 HW 2 cont

Garrett Haldup

No.

Date

30)



$R' = 3R \quad D = 2R \quad q_1 = +Q \quad E_p = 0 = E_1 - E_2$

$E_1 = E_2$

$E_1 = k\frac{2Rq_1}{(2R)^2+R^2)^{3/2}} = k\frac{2Rq_1}{5\sqrt{5}R^3}$

$E_2 = k\frac{2Rq_2}{(2R)^2+(3R)^2)^{3/2}} = k\frac{2Rq_2}{11\sqrt{11}R^3}$

$k\frac{2Rq_1}{5\sqrt{5}R^3} = k\frac{2Rq_2}{11\sqrt{11}R^3}$

$\frac{q_1}{5\sqrt{5}} = \frac{-q_2}{11\sqrt{11}}$

$\frac{q_1}{q_2} = \frac{-5\sqrt{5}}{11\sqrt{11}}$

$q_2 = +Q\cdot\frac{11\sqrt{11}}{-5\sqrt{5}}$

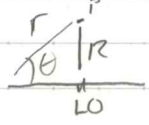
$q_2 = -3.26Q$

$\boxed{q_2 = -3.26Q}$

32) $q = 7.81\,pC \quad L = 14.5\,cm \quad R = 6.00\,cm$

x cancels out so just y

$E_y = 2\int_0^{\frac{L}{2}} k\frac{\lambda}{r^2}\sin\theta\,dx$



$r = \sqrt{R^2+x^2}$

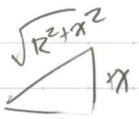
$\sin\theta = \frac{R}{r} =$

$E_y = 2k\int_0^{\frac{L}{2}} \frac{\lambda}{R^2+(\frac{L}{2}-x)^2}\cdot\frac{R}{\sqrt{R^2+(\frac{L}{2}-x)^2}}\,dx$

$E_y = 2k\lambda R\int_0^{\frac{L}{2}} \frac{1}{0.06^2+(0.0725-x)^2}\cdot\frac{L}{\sqrt{0.06^2+(0.0725-x)^2}}$

this sub

$= \frac{1}{(R^2+x^2)^{\frac{3}{2}}}\,dx$



$x = R\tan\theta$

$dx = R\sec^2\theta$

$\theta = \arctan\left(\frac{x}{R}\right)$

$\sin\theta = \frac{x}{\sqrt{R^2+x^2}}$

$= \frac{R\sec^2\theta}{(R^2+R^2\tan^2\theta)^{\frac{3}{2}}}d\theta$

$= \int\frac{R\sec^2\theta}{R^2(1+\tan^2\theta)}d\theta \quad \sec^2$

$= \frac{2k\lambda}{R}\int\cos\theta\,d\theta = \sin\theta = \frac{x}{\sqrt{R^2+x^2}}\Big|_0^{0.0725}\cdot\frac{2k\lambda}{R}$

$= 12.4\,N/C$

$\boxed{a)\ 12.4\,N/C}$

$\boxed{b)\ 90^\circ}$

36) $R = 2\,cm \quad r = 0.5\,cm \quad Q = +2e^6\cdot e \quad \omega = 30\,\mu m$

$\sigma = \frac{Q}{A} \quad A_f = \pi R^2 = 0.0013\,m^2 \quad \sigma = 2.55e{-}10\,C/m^2$

$A_r = \pi(r+\omega)^2 - \pi r^2 = 6.45e{-}7\,m^2 \quad Q_r = \sigma\cdot A = 2.41e{-}16\,C$