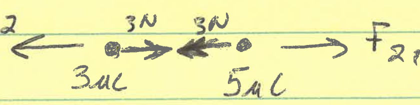
Ch5 solutions

44) a) $N_{p+excess} = 0.300\cdot10^{-12}\,C \,/\, 1.602\cdot10^{-19}\,C/proton = \boxed{1.873\cdot10^{6}}$ excess protons

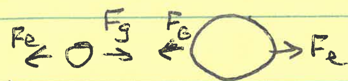
b) $1.873\cdot10^{6} \,/\, 1.00\cdot10^{16} = \boxed{1.873\cdot10^{-10}}$

48) a)



b) $F = 3N = k\frac{q_1q_2}{r^2} \Rightarrow r = \sqrt{\frac{kq_1q_2}{3N}} = \boxed{0.21\,m}$

52)



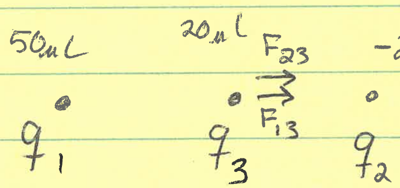
a) $\frac{Gm_1m_2}{r^2} = \frac{kQ^2}{r^2} \Rightarrow Q = \sqrt{\frac{Gm_1m_2}{k}} =$

$$= \sqrt{\frac{6.67\cdot10^{-11}\frac{m^3}{kg\,s^2}\;7.34\cdot10^{22}\,kg\;5.97\cdot10^{24}\,kg}{8.99\cdot10^{9}\,\frac{Nm^2}{C^2}}} = \boxed{5.70\cdot10^{13}\,C}$$

b) No - the factors of r^2 cancel

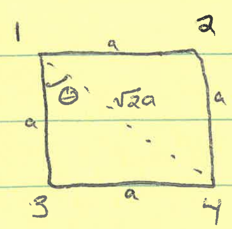
c) $5.70\cdot10^{13}\,C \,/\, 1.602\cdot10^{-19}\,C/e^- = \boxed{3.56\cdot10^{32}\,e^-}$ per object

53)



$\vec{F}_{total} = \vec{F}_{23} + \vec{F}_{13} = \frac{k|q_3|}{r^2}\left(|q_1| + |q_2|\right)\hat{\imath} = \boxed{53.94\,N\,\hat{\imath}}$

63)



$F_{14,x} = \frac{kq^2}{2a^2}\sin\theta\,(+\hat{\imath})$ $\quad F_{14,y} = \frac{kq^2}{2a^2}\cos\theta\,(-\hat{\jmath})$

$F_{24,y} = \frac{kq^2}{a^2}(-\hat{\jmath})$ $\quad F_{34,x} = \frac{kq^2}{a^2}(+\hat{\imath})$

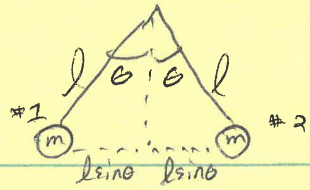
$\cos\theta = \sin\theta = \frac{1}{\sqrt{2}} \Rightarrow \boxed{\vec{F}_{net} = \frac{kq^2}{a^2}\left(1 + \frac{1}{2}\frac{1}{\sqrt{2}}\right)\hat{\imath} - \frac{kq^2}{a^2}\left(1 + \frac{1}{2}\frac{1}{\sqrt{2}}\right)\hat{\jmath}}$

66)

$\vec{F}_g = mg(-\hat{\jmath}) = 19.6\cdot10^{-18}\,N(-\hat{\jmath})$ $\quad \vec{F}_E = qE(+\hat{\jmath}) = 16.0\cdot10^{-18}\,N(+\hat{\jmath})$

$\vec{F}_{net} = \vec{F}_g + \vec{F}_E = 3.6\cdot10^{-18}\,N(-\hat{\jmath})$ $\quad \left(\frac{F_g}{F_E}\right) = 1.23$

$\vec{a} = \frac{\vec{F}_{net}}{m} = \boxed{1.8\,\frac{m}{s^2}\,(-\hat{\jmath})}$



68) $\sum F_{x \text{ on } 2} = 0 \Rightarrow \frac{kq^2}{4l^2 \sin^2\theta} = T\sin\theta$

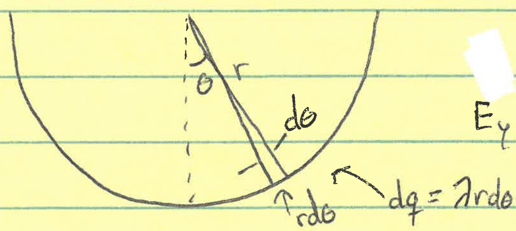
$\sum F_{y \text{ on } 2} = 0 \Rightarrow mg = T\cos\theta$

$\Rightarrow$ divide these 2 equations: $\frac{mg}{kq^2} 4l^2 \sin^2\theta = \frac{1}{\tan\theta} \Rightarrow \boxed{\tan\theta \sin^2\theta = \frac{1}{4\pi\epsilon_0} \frac{q^2}{mg 4l^2}}$

75) a) $E = \frac{kq}{r}$ and $q = 8q_p \Rightarrow \boxed{\vec{E} = 1.15 \cdot 10^{12} \frac{N}{C} (+\hat{r})}$

b) $|\vec{F}_E| = |q\vec{E}| \Rightarrow \boxed{F_E = 1.48 \cdot 10^{-6}\ N}$

84)

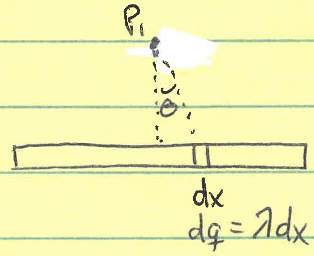


$E_x = \int dE_x = 0$

$E_y = \int dE_y = \int \frac{k\,dq \cos\theta}{r^2} = \frac{k}{r^2} \lambda r \int_{-\pi/2}^{+\pi/2} \cos\theta\, d\theta$

$= \frac{k\lambda}{r} \sin\theta \Big|_{-\pi/2}^{+\pi/2} = \boxed{\frac{2k\lambda}{r} \hat{j}}$

87) a)



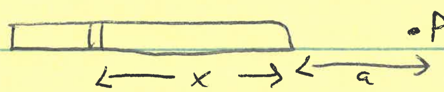
$E_x = 0$

$E_y = \int dE_y = \int \frac{k\,dq \cos\theta}{r^2} = k\lambda \int \frac{\frac{y\,dx}{\sqrt{x^2+y^2}}}{x^2+y^2}$

$= 2k\lambda y \int_0^{L/2} \frac{dx}{(x^2+y^2)^{3/2}} = 2k\lambda y \frac{x}{y^2\sqrt{x^2+y^2}} \Big|_0^{L/2}$

$= 2k\lambda y \frac{\frac{L}{2}}{y^2 \sqrt{\frac{L^2}{4}+y^2}} = 2k \frac{q}{L} \frac{a}{2} \frac{L/2}{\frac{a^2}{4}\left(\frac{L^2}{4}+\frac{a^2}{4}\right)^{1/2}} = \boxed{\frac{4kq}{a\sqrt{L^2+a^2}} (+\hat{j})}$

b)



$E_y = 0$

$E_x = \int dE_x = \int_0^L \frac{k\,dq}{(x+a)^2} = k\lambda \int_0^L \frac{dx}{(x+a)^2} = -k\lambda \left(\frac{1}{x+a}\right)\Big|_0^L = -k\lambda \left(\frac{1}{L+a} - \frac{1}{a}\right)$

$= k\lambda \frac{L}{a(L+a)} = \boxed{\frac{kq}{a(L+a)} (+\hat{x})}$