Problems

1) $1.602 \times 10^{-19} C \times 6.022 \times 10^{23}$

$= \boxed{9.65 \times 10^{4} C}$

2) $\frac{1.00 \times 10^{-9} C}{1.602 \times 10^{-19} C} = \boxed{6.24 \times 10^{9}}$

5) $\boxed{9.65 \times 10^{4} C}$ (from 1)

9) a) $F = \frac{k|q_1||q_2|}{r^2} = \frac{(9 \times 10^{9} \frac{Nm^2}{C^2})(79)(2)(1.602 \times 10^{-19})^2}{(1 \times 10^{-14} m)^2}$

$= \boxed{365 N}$

b) $F = \boxed{365 N}$

13) $F_g = \frac{G m M}{r^2}$ $F_e = \frac{k q Q}{r^2}$

$\frac{kqQ}{\cancel{r^2}} = \frac{GmM}{\cancel{r^2}}$ $Q = q$

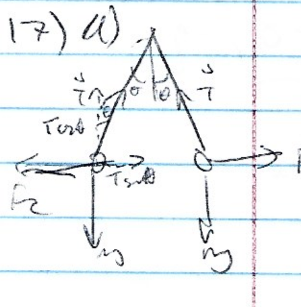
$\cancel{Q = \frac{GMm}{kq}}$

$q^2 = \frac{GMm}{k}$

$q = \sqrt{\frac{GMm}{k}} = \sqrt{\frac{(6.67 \times 10^{-11})(1.99 \times 10^{30} kg)(5.97 e 24 kg)}{(9 \times 10^{9} \frac{Nm^2}{C^2})}}$

$= \boxed{2.97 \times 10^{17} C}$

17) a)



F_G is negligible

$T\cos\theta = mg$

$T\sin\theta = F_e = \frac{kqq}{r^2}$

$T = \frac{mg}{\cos\theta}$

$\sin\theta = \frac{r}{2l}$

$r = 2l\sin\theta$

$q^2 = \frac{T\sin\theta r^2}{k} = \frac{r^2 mg\tan\theta}{k}$

$q^2 = \frac{4l^2 \sin^2\theta \, mg\tan\theta}{k}$

$q = 2l\sin\theta \sqrt{\frac{mg\tan\theta}{k}}$

$= 2l\sin\theta \sqrt{4\pi\varepsilon_0 mg\tan\theta}$

c) $q = 2(0.500 m)\sin(15)\sqrt{\frac{(0.015 kg)(9.8 \frac{m}{s^2})\tan(15)}{(9 \times 10^{9} \frac{Nm^2}{C^2})}}$

$= \boxed{4.42 \times 10^{-7} C}$

d) $\frac{4.47 \times 10^{-7} C}{1.602 \times 10^{-19} C} = \boxed{2.76 \times 10^{12}}$

21) $x_{cm} = \frac{m_1 x_1 + m_2 x_2 + \ldots}{M_{total}}$

$x_{cq} = \frac{q_1 x_1 + q_2 x_2 + \ldots}{q_{total}}$

Would be undefined if $q_{total} = 0$ or if the charges are ~~canceling~~ for another.

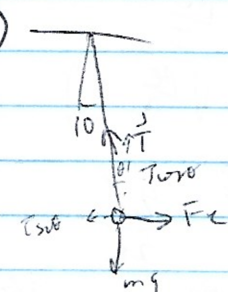
25) $F = qE$

$q = \frac{F}{E} = \frac{6.0 N}{500 N/C} = \boxed{-1.2 \times 10^{-2} C}$

since it's opposite direction.

29)

b)



a) negative charge

$T\cos\theta = mg$

$T = \frac{mg}{\cos\theta}$

$qE = T\sin\theta$

$q = \frac{mg\tan\theta}{E} = \frac{(0.02 kg)(9.8 \frac{m}{s^2})\tan(10)}{(100 N/C)}$

$= \boxed{3.46 \times 10^{-4} C}$

33) 1st charge: + strongest
2nd charge: − 2nd strongest
3rd charge: − weakest

37) It has linear geometry?

41) a) $F_e = qE = (-2e)\left(\frac{-kP}{y^3}\right)$

$= \frac{2(1.602\times10^{-19}C)(9\times10^9 \frac{Nm^2}{C^2})(6e^{-30}C\cdot m)}{(10\times10^{-9}m)^3}$

$= \boxed{1.73\times10^{-14} N}$

b) $\tau = pE\sin\theta = p\cdot\frac{kq}{r^2}\sin\theta$

$= \frac{(6e^{-30}C\cdot m)(9e9 \frac{Nm^2}{C^2})(2)(1.602e^{-19}C)\sin(90)}{(10\times10^{-9}m)^2}$

$= 7.31\times10^{-23} N\cdot m$

45) $\tau = I\alpha = pE\sin\theta$ $\quad \nu = f$

$\omega = 2\pi f$

$\alpha = \frac{pE}{I}$ $\quad \omega_f = \omega_0 + \alpha t$

$\omega_f^2 = \cancel{\omega_0^2} + 2\alpha\Delta\theta$

$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$ $\quad 4\pi^2 f^2 = \frac{2pE}{I}\theta$

but, 2θ is negligible (small angle)

so $4\pi^2 f^2 = \frac{pE}{I}$

$\boxed{f = \frac{1}{2\pi}\sqrt{\frac{pE}{I}}}$

49) $E = \frac{\sigma}{2\varepsilon_0}$ $\quad F_e = mg = qE = \frac{q\sigma}{2\varepsilon_0}$

$\sigma = \frac{2\varepsilon_0 mg}{q} = \frac{2(8.85\times10^{-12} F/m)(0.0048)(9.81)}{(3\times10^{-6}C)}$

$= \boxed{1.16\times10^{-7} \frac{C}{m^2}}$

53) $\lambda = \frac{Q}{\pi R} = \frac{Q}{l}$ $\quad E = k$

$Q = \lambda l$ $\quad l = \pi r$

$dQ = \lambda dl$ $\quad r = \frac{l}{\pi}$

$dE = k\frac{dq}{r^2}$

$= \frac{k\pi^2 dq}{l^2} = \frac{k\pi^2\lambda dl}{l^2} = k\pi^2 Q\cdot\frac{dl}{l^3}$

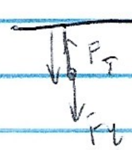
$E = k\pi^2 Q\int_0^l \frac{dl}{l^3}$

$= \frac{-k\pi^2 Q}{2l^2}\Big|_0^l$

$= \frac{-(9e9 \frac{Nm^2}{C^2})(\pi^2)(-8\times10^{-9}C)}{2(0.5m)^2}$

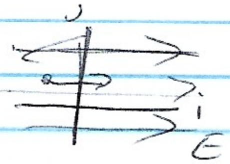
$= \boxed{1.42\times10^3 \frac{N}{C}}$ $\quad \overleftarrow{E}$

57) a) $+\sigma, +q$ or $-\sigma, -q$



$f = \frac{1}{2\pi}\sqrt{\frac{q\sigma}{2\varepsilon_0 m l}}$

(61) a) parallel b)



c) $F_E = ma = qE$

thus

$$a = \frac{qE}{m} = \frac{-(1.602\times10^{-19}C)(100\,N/C)}{9.11\times10^{-31}\,kg}$$

$$= -1.76\times10^{13}\,m/s^2$$

d) $v_f^2 = v_0^2 + 2a\Delta x$

$\Delta x = v_0 t + \frac{1}{2}at^2$ $\quad \cancel{v_f} = v_0 + at$

$$t = \frac{-v_0}{a} = \frac{-(5.00\times10^6\,m/s)}{-1.76\times10^{13}\,m/s^2}$$

$$= \boxed{2.84\times10^{-7}\,s}$$

e) $\Delta x = v_0 t + \frac{1}{2}at^2$

$$= (5.00\times10^6\,m/s)(2.84\times10^{-7}\,s) + \frac{1}{2}(-1.76\times10^{13}\,m/s^2)(2.84\times10^{-7}\,s)^2$$

$$= \boxed{0.71\,m}$$

f) no, it will accelerate the way it came and gain more speed.

(65) from above, $\Delta x = v_0 t + \frac{1}{2}at^2$

$$t = \frac{-v_0}{a} = \frac{-v_0 m}{qE}$$

$$\Delta x = \frac{-v_0^2 m}{qE} + \frac{1}{2}\cdot\frac{qE}{m}\cdot\frac{v_0^2 m^2}{q^2E^2}$$

$$= \frac{-v_0^2 m}{qE} + \frac{1}{2}\frac{v_0^2 m}{qE} = -\frac{1}{2}\frac{v_0^2 m}{qE}$$

$$= -\frac{1}{2}\frac{(5.00\times10^6\,m/s)^2(9.11\times10^{-31}\,kg)}{(-1.602\times10^{-19}\,C)(500\,N/C)}$$

$$= \boxed{0.14\,m}$$

69) $\Phi = 0$ since Q_{enc} adds up to 0

73) $\Phi = 0$ b/c it isn't enclosed?

79) $\oint E\cdot dS = \frac{Q_{enc}}{\varepsilon_0}$

$$Q_{enc} = Q\cdot\frac{r}{R} = \frac{er}{R}$$

$$S = 4\pi R^2$$

$$E\cdot 4\pi R^2 = \frac{er}{R\varepsilon_0}$$

$$E = \frac{1}{4\pi\varepsilon_0}\cdot\frac{er}{R^3} = \frac{k\,er}{R^3}$$

b) $\frac{d^2r}{dt^2} + \omega^2 r = 0\,m/s^2$

$$\omega = \sqrt{\frac{ke^2}{R^3 m}}$$

c) $$\omega = \sqrt{\frac{(9\times10^9\,Nm^2/C^2)(1.602\times10^{-19}\,C)^2}{(1\times10^{-10}\,m)^3(9.11\times10^{-31}\,kg)}}$$

$$= 1.59\times10^{16}\,Hz$$