Unit 0

1. $2.00\,\mu s\left(\frac{1\,C}{10^6\,\mu C}\right)\left(\frac{1\,p}{1.6\times10^{-19}}\right) = 1.25\times10^{13}$ $50.0\,g\left(\frac{1\,mol}{63.5g}\right)\left(\frac{6.02\times10^{23}}{1\,mol}\right) = 4.7\times10^{23}$

$4.74\times10^{23}\left(\frac{2\,qp}{1}\right) = \boxed{1.37\times10^{25}\,e}$

2. 10cm, 2mC, 4μC

$F_{1,2} = \frac{k|q_1q_2|}{r^2}$ $F_{1,2} = \frac{8.99\times10^{9}\,|6\times10^{-6}\times2\times10^{-6}|}{(0.05)^2}$

$\boxed{F_{1,2} = 43.152\,N}$ $F_{2,3} = \frac{k|q_2q_3|}{r^2}$ $F_{2,3} = \frac{8.99\times10^{9}\,|2\times10^{-6}\times4\times10^{-6}|}{(0.05)^2}$

$F_{2,3} = 28.768\,N$ $\Sigma F = F_{1,2} - F_{2,3} = 43.152 - 28.768 =$ $\boxed{14.4\,N}$

3. a) F_{23}, F_{13}

0 +q 5 -2q 10 +q x

$F_{23} = F_{13} = \frac{k|q_2q_3|}{r_{23}^2} - \frac{k|q_1q_2|}{r_{12}^2} = \frac{8.99\times10^{9}\,|1\times10^{-6}\times2\times10^{-6}|}{0.03^2} - \frac{8.99\times10^{9}\,|1\times10^{-6}\times2\times10^{-6}|}{0.05^2} = \boxed{F_3 = 12.8\,N}$ (Away)

0 2q 5 +q 10 3q x

4. $F_3 - F_1 - F_2 = F_1$ (1m)

$\frac{k|q_3|}{r_3^2} - \frac{k|q_1|}{r_1^2} - \frac{k|q_2|}{r_2^2} = k\left[\frac{3\times10^{-9}}{0.13^2} - \frac{5\times10^{-9}}{0.04^2} - \frac{1.5\times10^{-9}}{.07^2}\right] = \boxed{-53\times10^{9}\,\frac{N}{C}}$

5. $\sqrt{c^2} = \sqrt{0.05^2 + 0.05^2}$ $c = 0.0707\,m$ $F = \frac{kq_1q_2}{r^2}$

$F = \frac{8.99\times10^{9}\,(7.5\times10^{-6}\times2\times10^{-6})}{(0.0707)^2}$ $\boxed{F_q = 26.97\,N}$

$F_{qy} = 26.97\cos(45) = \boxed{19.07\,N}$ $\boxed{F_T = 26.3\,N}$

6. $V = 40{,}000\,V$ $\Delta V = \frac{\Delta PE}{q_e}$ $40{,}000 = \frac{\Delta PE}{1.6\times10^{-19}}$ $\boxed{\Delta PE = 6.4\times10^{-15}\,J}$

$KE = 6.4\times10^{-15}\,J$ $KE = \frac{1}{2}mv^2$ $v = \sqrt{\frac{2KE}{m}}$ $v = \sqrt{\frac{2(6.4\times10^{-15})}{9.11\times10^{-31}}} = \boxed{1.18\times10^{8}\,\frac{m}{s}}$

7. $V_{1,2} = Ed$ $V_{1,2} = 2.25\times10^{4}\,(0.09)$ $\boxed{V_{1,2} = 3{,}000\,V}$ $\frac{1}{4}(3000) = \boxed{750\,V}$

8. $q = 2(1.6\times10^{-19}\,C) = 3.2\times10^{-19}\,C$ $V = 1.6\times10^{-19}\,J$ $E = 32.0\,keV\left(\frac{1000\,eV}{1\,keV}\right)\left(\frac{1.6\times10^{-19}\,J}{1\,eV}\right) =$

$\boxed{\Delta PE = 5.12\times10^{-15}\,J}$

$\Delta V = \frac{\Delta PE}{q} = \frac{5.12\times10^{-15}}{3.2\times10^{-19}} = \boxed{1.6\times10^{4}\,V}$

$V_{1,2} = Ed$ $E = \frac{V}{d} = \frac{1.6\times10^{4}}{0.02} = \boxed{8.0\times10^{5}\,\frac{V}{m}}$

9. $E = 5\,MeV\left(\frac{10^6\,eV}{1\,MeV}\right)\left(\frac{1.6\times10^{-19}\,J}{1\,eV}\right) = 8\times10^{-13}\,J$ $q = 3.2\times10^{-19}$ $\Delta V = \frac{\Delta PE}{q} = \frac{8\times10^{-13}}{3.2\times10^{-19}}$

$\Delta V = 2.5\times10^{6}\,V$ $V = \frac{kq}{r}$ $r = \frac{kq}{V}$ $r = \frac{9\times10^{9}\,(1.269\times10^{-19})}{2.5\times10^{6}}$

$\boxed{r = 4.55\times10^{-14}\,m}$

Unit 7

1. $C = \frac{q}{V} = \frac{3\times10^{-6}}{120} = \boxed{2.5\times10^{-8}\ F}$

2. $E = \frac{CV^2}{2} = \frac{10\times10^{-6}(9\times10^3)^2}{2} = \boxed{405\ J}$ b) $C = \frac{2}{V}$ $q = CV = 10\times10^{-6}(9\times10^3) = \boxed{0.09\ C}$

$\frac{E_{cc}}{C} = \frac{1}{2}V^2$ $V = \sqrt{\frac{2(E)}{C}}$ $V = \sqrt{\frac{2(400)}{8\times10^{-6}}}$ $\boxed{V = 3.16\times10^3\ V}$

$q = CV = 8\times10^{-6}(3.16\times10^3) = 0.0253C$

3. $C = \frac{Q_T}{V} = \frac{0.0253}{4} = 7.03\times10^{-7}C$

$C = \frac{Q}{V} = \frac{0.025}{4} = 0.0063C$

The voltage would need to be higher since the total voltage is divided with capacitors.

4. $R = \frac{\rho L}{A}$ $A = \frac{\pi(1\times10^{-3})^2}{4} = 7.85\times10^{-7}$ $L = \frac{2(7.85\times10^{-7})}{1.68\times10^{-8}} = 93.45$

5. a) $I_1 = \frac{V}{R} = \frac{3V}{3000\Omega} = 0.003$ $I_L = \frac{V}{R} = \frac{3V}{3\Omega} = 1 + 0.003 = \boxed{1.003\ C}$

b) $P = I_L V = 1\cdot3 = \boxed{3W}$ c) $10\ min\left(\frac{360\ s}{1\ min}\right) = 600s$ $Q = I_L \times t = 1\cdot600 = \boxed{600\ C}$

Unit 2

1. $\frac{1}{2} = \frac{1}{10} + \frac{1}{5} + \frac{1}{R_3} = \frac{1}{5}$ $R_3 = 5\ k\Omega$ $I = \frac{V}{R}$ $I = \frac{12}{2000} = 0.006\ C$

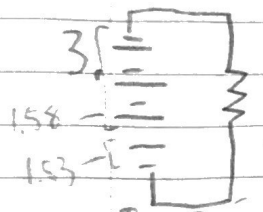
$I_1 = \frac{12}{10,000} = 0.0012\ C$ $I_2 = \frac{12}{5000} = 0.0024\ C$ $I_3 = \frac{12}{5000} = 0.0024\ C$

2. $I = \frac{V}{R}$ series $I = \frac{3}{500} = 0.006\ C$ $P = IV$ $P = (0.006)(3) = 0.18\ W$

parallel $I = \frac{V}{R} = \frac{3}{500} = 0.006$ $P = nIV$ $P = 2(0.006)(3) = 0.036\ W$

series $R = 500 + 2(5) = 510$ $I = \frac{3}{510} = 0.0059$ $P = 0.0059(3) = 0.0176$ parallel $I = \frac{3}{500} = 0.0059\ C$

$P = 2(.0059)(3) = 0.0356\ W$

3. 

$I = \frac{V}{R} = \frac{3(1.58) + 1.53}{3(.02)(.1) + 10} = 0.617\ A$

$P = I^2 R = (.617)^2 (10) = 3.81\ W$

$I^2 = \frac{P}{R}$ $I = \sqrt{(.05)(10)}$ $I = 0.224\ A$

$I_T = \frac{V_T}{R_T} = 0.224 = \frac{3(1.58) + 1.53}{3(.02) + r + 10} = 0.06 + r = \frac{.27}{.224}$ $r = 18\ \Omega$

4. $\frac{72}{1\ min}\left(\frac{1\ min}{72\ beats}\right) = 0.0139\ \frac{min}{beat}\left(\frac{60\ sec}{1\ min}\right) = 0.833\ \frac{sec}{beats}$

$R = \frac{T}{L} = \frac{.833}{25 \times 10^{-9}}$ $R = 3.33 \times 10^7\ \Omega$

5. $C = \frac{\tau}{R} = \frac{1 \times 10^{-4}}{1 \times 10^3}$ $C = 1 \times 10^{-7}\ F$ No because too small

Unit 3

1.

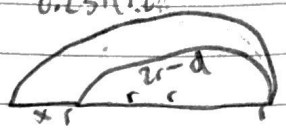
Case	v direction	B direction	F direction
(a)	$-\hat{j}$	$\hat{k}$	$\hat{i}$
(b)	$\hat{j}$	$\hat{i}$	$-\hat{k}$
(c)	$-\hat{i}$	$-\hat{k}$	$-\hat{j}$
(d)			

2. $\frac{F}{qvB} = \sin\theta \quad \frac{1.4\times10^{-16}}{(1.6\times10^{-19})(4\times10^{3})(.125)} = \sin\theta \quad \sin^{-1}\theta = (.174)\sin^{-1} \quad \theta = 10.1$

$180 - 10.1 = \boxed{169.9 = \theta}$

3. $r = \frac{mv}{qB} \quad q = \frac{mv}{rB} = \frac{2.66\times10^{-26}(5\times10^{6})}{0.231(1.2)} = \boxed{4.8\times10^{-19}\,C} \quad \frac{4.8\times10^{-19}}{1.6\times10^{-19}} = 3$

Discrete values



$\boxed{2r = d}$

4. $F = IlB\sin\theta \quad F = 100(.25)(2)\sin 90) \quad \boxed{F = 50\ N}$

5. $(.2)^2 = A = 0.04 \quad B = \frac{T}{NAI\sin\theta} \quad B = \frac{300\ Nm}{200(.04)25} = \boxed{1.5\ T}$

6.

Case	B direction
(a)	$\hat{k}$
(b)	$\hat{j}$
(c)	$-\hat{i}$

7. $B = \frac{\mu I}{2\pi r} \quad R = \frac{v^2}{P} = \frac{300{,}000}{450\times166\,W} = 6.66\times10^{7} \quad I = \frac{300{,}000}{6.66\times10^{7}} = 4.5\times10^{11}$

$B = \frac{4\pi\times10^{-7}(4.5\times10^{11})}{2\pi(20)} = \boxed{4500\ T}$

8. $B = \frac{\mu NI}{2\pi r} \quad NI = \frac{B\cdot2\pi r}{\mu} \quad NI = \frac{(1T)(2\pi)(5m)}{4\pi\times10^{-7}\frac{Tm}{A}} = \boxed{2.5\times10^{7}}$

$f = \frac{qB}{2\pi m} \quad f = \frac{1.602\times10^{-19}(2.5\times10^{7})}{2\pi(1.67\times10^{-27})} = \boxed{3.81\times10^{14}\ Hz}$