Diana Diyab Physics 135-B Midterm 1

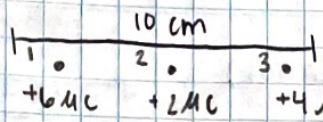
Unit 1:

1. $2.00\ \mu C \times \frac{1\ C}{100\ \mu C} \times \frac{1\ p}{1.6\times10^{-19}\ C} = \boxed{1.25\times10^{13}\text{ excess protons}}$

$50.0\ g \times \frac{1\ mol}{63.5\ g} \times \frac{6.02\times10^{23}}{1\ mol} = 4.74\times10^{23}$ atoms of copper

$4.74\times10^{23} \times \frac{29\ p}{1\ atom\ Cu} = 1.37\times10^{25}\ p$ or e^- $= \frac{1.25\times10^{13}}{1.37\times10^{25}} = \boxed{\frac{9.09\times10^{-13}}{1}}$

2.

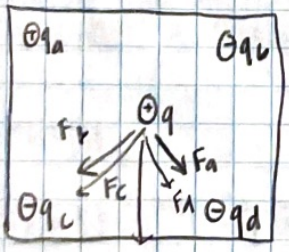


$F_{1,2} = \frac{K|q_1 q_2|}{r^2} = \frac{8.99\times10^9 |6\times10^{-6}\times2\times10^{-6}|}{(0.05)^2} = \boxed{43.152\ N}$ $F_{1,2}$

$F_{2,3} = \frac{8.99\times10^9 |2\times10^{-6}\times4\times10^{-6}|}{(0.05)^2} = \boxed{28.768\ N}$ $F_{2,3}$

$F_{Net} = F_{1,2} - F_{2,3} = (43.152) - (28.76) = \boxed{14.324\ N \text{ away!}}$ to the right

5. Sorry I ran out after 2



$0.05^2 + 0.05^2 = C^2$

$C = 0.07077\ m$

$F = \frac{Kq_1q_2}{r^2} = \frac{8.99\times10^9 (7.5\times10^{-6}\times2\times10^{-6})}{0.07072^2} = 26.97\ N$ F_a

$F_{ay} = 26.97 \cos 45 = 19.07\ N$

$\times\ 4$

$F_T\ 76.3\ N$

3. $\Sigma F_3 = ?$
$\Sigma F_{23} - F_{13} = ?$

$$\frac{K|q_2 q_3|}{r_{2,3}^2} - \frac{K|q_1 q_3|}{r_{1,3}^2}$$

$$\frac{8.99\times10^9 |1\times10^{-4} \times 2\times10^{-6}|}{(0.03)^2} - \frac{8.99\times10^9 |1\times10^{-6} \times 2\times10^{-6}|}{10.05)^2} = \boxed{F_3 = +12.8\ N}$$

4. $$6\left[\frac{5\times10^{-9}}{(0.06)^2} + \frac{1.5\times10^{-6}}{(0.03)^2} + \frac{5\times10^{-9}}{0.03^2} + \frac{1\times10^{-3}}{(0.1)^2}\right] = E_{tot}$$

$$\boxed{E_{tot} = 2.03\times10^5\ N/C}$$

6. $\Delta V = 40\ kV = 40{,}000\ V$

$$\Delta V = \frac{\Delta PE}{qe}$$

$$(40{,}000) = \frac{\Delta PE}{1.6\times10^{-19}}$$

$$\Delta PE = 6.4\times10^{-15}\ J = KE$$

$$KE = \tfrac{1}{2} m v^2$$

$$\sqrt{\frac{2(6.4\times10^{-15}}{9.11\times10^{-31}}} = V$$

$$\boxed{V = 1.18\times10^8\ m/s}$$

7. $V_{AB} = Ed$

$V_{AB} = 7.5\times10^4 (0.04)$

$\boxed{V_{AB} = 3{,}000\ V}$

$\frac{1}{4}(3{,}000) = \boxed{750\ V}$

$V_{AB} = Ed$

$E = V/d$

$E = 0.08/_{9\times10^{-9}} = \boxed{8.89\times10^6\ V/m}$

8. $q = 2(1.6\times10^{-19} C) = \boxed{3.2\times10^{-19}\ C}$

$$E = 32.0\ kV \times \frac{1000\ V}{1\ kV} \times \frac{1.6\times10^{-19}\ J}{1\ eV} = 5.12\times10^{-15}\ J$$

$$\Delta V = \frac{\Delta PE}{q} = \frac{5.12\times10^{-15}}{3.2\times10^{-19}} = 16{,}000\ V$$

$V_{AB} = Ed$

$E = V/d = 1.6\times10^4/_{0.02} = \boxed{8.0\times10^5\ V/m}$

9. $q = 3.2 \times 10^{-19} C$

$E = 5 MeV \times \frac{1 eV}{1 MeV} \times \frac{1.6 \times 10^{-19} J}{1 eV} = 8 \times 10^{-13} J$

$\Delta V = \frac{\Delta PE}{q}$

$\Delta V = \frac{8 \times 10^{-13}}{3.2 \times 10^{-19}} = 2.5 \times 10^{6} V$

$V = \frac{kq}{r}$

$r = \frac{kq}{V} = \frac{9 \times 10^{9}(1.264 \times 10^{-17})}{2.5 \times 10^{6}} = \boxed{4.55 \times 10^{-14} m}$

Unit 1:

1. $C = q/V$

$C = \frac{3 \times 10^{-6}}{120} = \boxed{2.50 \times 10^{-8} F}$

2. $E = \frac{CV^2}{2}$

$E = \frac{(10 \times 10^{-6})(9 \times 10^{3})^2}{2} = \boxed{405 J}$

3. $C = \frac{Q}{4V}$

$= \frac{3.00 \times 10^{-3} C}{4(9.00 \times 10^{3} V)} = \boxed{8.33 \times 10^{-8} F}$

$E_{cap} = \frac{CV^2}{2}$

$C = q/V$

$V = \sqrt{\frac{2E}{C}} = \sqrt{\frac{2(40)}{8 \times 10^{-6}}} = \boxed{3.16 \times 10^{3} V}$

Connecting the capacitors in series would create a shock

4. $R = \rho \times L/A$

$r = d/2 = \frac{1 \times 10^{-3}}{2} = 5 \times 10^{-4} m$

$A = \pi (5 \times 10^{-4})^2$

$= 7.85 \times 10^{-7} m^2$

$L = \frac{25 \times 7.25 \times 10^{-8}}{1.68 \times 10^{-8} \Omega m} = \frac{15.7 \times 10^{-8} m^2}{1.68 \times 10^{-8}} = \boxed{9.345 m}$

max length = 1.0 m
$R = 25 \Omega$ @ 20°C
approx = 9.35 m

5. $V = IV$

$P = 2.99 \times 10^{-3} \times 3.0 V$

$\boxed{P = 3.97 mW}$

$I = \frac{3.0 V}{1003 \Omega} = 2.99 mA$

$Q = I \times t$

$t = 600 s$

$\boxed{I = 2.99 \times 10^{-3} A}$

$Q = 2.99 \times 10^{-3} \times 600$

$\boxed{Q = 1794 C}$

Unit 2:

1. $1/R_{tot} = 1/R_1 + 1/R_2 + 1/R_3$

$1/R_3 = 1/2000 - 3/100000$

$R_3 = \frac{10000}{5}\ \Omega = \boxed{2000\ \Omega}$

$\Delta V = I \times R_{tot}$

$I = \frac{12V}{2000\ \Omega}$

$\boxed{I = 6 \times 10^{-3} A}$

$I_1 = \frac{\Delta V}{R_1}$

$I_1 = \frac{12}{10 \times 10^3\ \Omega} = \boxed{1.2\ mA}$

$I_3 = \frac{12}{2000} = \boxed{6\ mA}$

$I_2 = \frac{12}{5 \times 10^3} = \boxed{2.4\ mA}$

2. $V_{tot} = n \times 1.5V$ $\quad V_{tot} = 3V$

$I = \frac{V_{tot}}{R}$

$I_t = \frac{3(1.58) + 1.53}{3(0.02) + 0.1 + 10}$

$\boxed{I_t = 0.617 A}$

3. $P_L = I_L^2 R_L$

$P_L = (0.617)^2 (10)$

$\boxed{P_L = 3.81\ W}$

$P_L = I_L^2 R$

$(0.5) = I_L^2 (10)$

$\boxed{I_L = 0.224 A}$

4. $\frac{72\ rmcs}{1\ min} = \frac{0.015\ mn}{vrat} \times \frac{60\ sec}{1\ min} = \frac{0.83\ s}{vrat}$

$I_t = \frac{V_t}{R_t} = \frac{3(1.58) + 1.53}{3(0.02) + r + 10}$

$\boxed{r = 18.05\ \Omega}$

$\tau = R \cdot C$

$0.833 = R(25 \times 10^{-9})$

$\boxed{R = 3.33 \times 10^7\ \Omega}$

$C = \tau / R$

$\frac{1 \times 10^{-4}}{1 \times 10^3} = C$

$\boxed{C = 1 \times 10^{-7} F}$ $\quad \boxed{C < 1 \times 10^{-17} F}$

Unit 3: Magnetism 1

1. $F_L = q(v \times B)$

case	v dir	B dir	F dir
A	$\hat{j}$	$\hat{i}$	out of page
B	$\hat{i}$	$\hat{j}$	out of page
C	$\hat{i}$	$\hat{k}$	up (+) direction
D	$\hat{j}$	$\hat{k}$	left (−) $\hat{i}$ direction

2. $F = qvB\sin\theta$

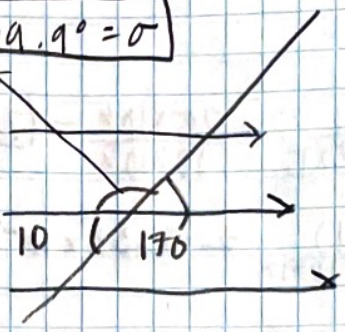
$\sin\theta = F/qvB$

$\frac{1.4\times10^{-16}}{(1.6\times10^{-19})(4\times10^{3})(1.25)} = \sin\theta$

$\sin^{-1}(0.175) = \sin(5)\sin^{-1}$

$\theta = 10.1°$

log. $9° = \theta$



3. $r = \frac{mv}{|q|B}$

$q = \frac{(2.66\times10^{-26})(5\times10^{6})}{0.25(1.20)}$

$q = 4.80\times10^{-19}\ C$

$\frac{m_{16}}{m_{16}} = \frac{m_{16}}{16/1\text{ amu}} = 16/16 = 9/8$

$\frac{m_{16}}{2} = 9/8 = \frac{Bq_{16}}{2}$ $\quad 9/8 = \frac{Bq}{2} \rightarrow$ $r = 9/8 \times 2/B$

4. $F = I\ell B\sin\theta$

$F = 100\times0.25\times2\times\sin(90)$

$F = 50\ N$

5. $\tau = NIAB\sin\theta$

$B = \frac{300}{200(25)(0.2^2)(\sin90)}$

$B = 1.50\ T$

6.

case	B-direction
a	$\vec{B} = -\hat{i}$
b	
c	

7. $B = \frac{\mu_0 I}{2\pi r}$

$I = \frac{450 \times 10^6}{300{,}000}$

$B = \frac{4\pi \times 10^{-7}(1500)}{2\pi(120)}$

$\boxed{B = 1.50 \times 10^{-5}\,T}$

8. $B = \frac{\mu_0 N I}{2\pi r}$

$N = \frac{2\pi r B}{\mu_0 I}$

$N = \frac{2\pi \times 5 \times 1}{4\pi \times 10^{-7} \times I} = \frac{25 \times 10^6}{10 \times 10^6} = \boxed{2.5 \approx 3}$

$I = \frac{(2\pi)(5)(1)}{3 \times 4\pi \times 10^{-7}} = 3.33 \times 10^{-7}\,A$

$\frac{F}{2\pi m} = \frac{(1.602 \times 10^{-19})(1.0)}{2\pi(1.673 \times 10^{-27}\,kg)} = 15.24 \times 10^6 \approx \boxed{15.24\,MHz}$