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Unit 0

Midterm 1

1. $2.00\,\mu C \times \frac{1\,C}{10^6\,\mu C} \times \frac{1\,p}{1.6\times10^{-19}\,C} = 1.25\times10^{13}$ excess protons

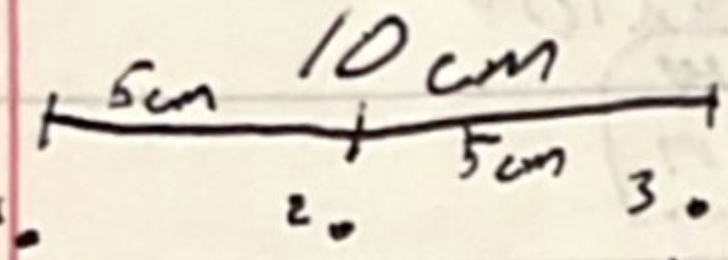
removed electrons

$\frac{e^- \text{ removed}}{\text{total } e^-}$

$50\,g \times \frac{1\,mol}{63.5\,g} \times \frac{6.02\times10^{23}\text{ atoms}}{1\,mol} = 4.74\times10^{23}\text{ atoms Cu} \times \frac{29\,e^-}{1\text{ atom}} = 1.37\times10^{25}$

$\frac{1.25\times10^{13}}{1.37\times10^{25}} = \boxed{\frac{9.09\times10^{-13}}{1}}$

2.



$+6\mu C \quad +2\mu C \quad +4\mu C$

a) $F_{1,2} = \frac{k|q_1 q_2|}{r^2}$

$F_{1,2} = \frac{8.99\times10^9|6\times10^{-6} \cdot 2\times10^{-6}|}{(.05)^2}$

$F_{1,2} = 43.152\,N$

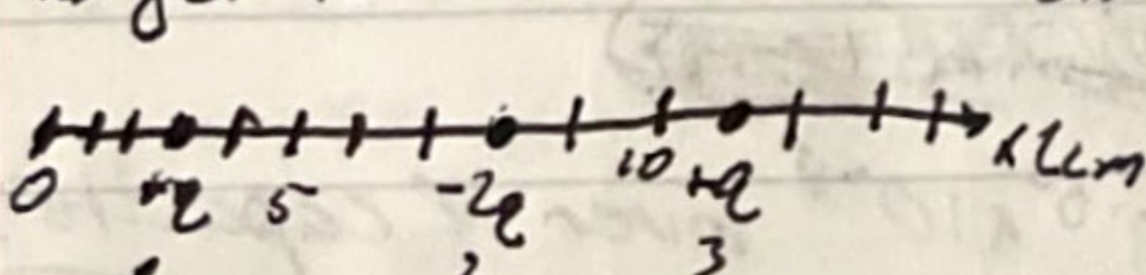
$F_{3,2} = \frac{8.99\times10^9|4\times10^{-6} \cdot 2\times10^{-6}|}{(.05)^2}$

$F_{3,2} = 28.768\,N$

$F_{1,2} - F_{3,2} = 43.152 - 28.788 = \boxed{14.4\,N}$

b) The direction is away from the $+6\mu C$ charge because it produces a larger force on the test charge.

3.

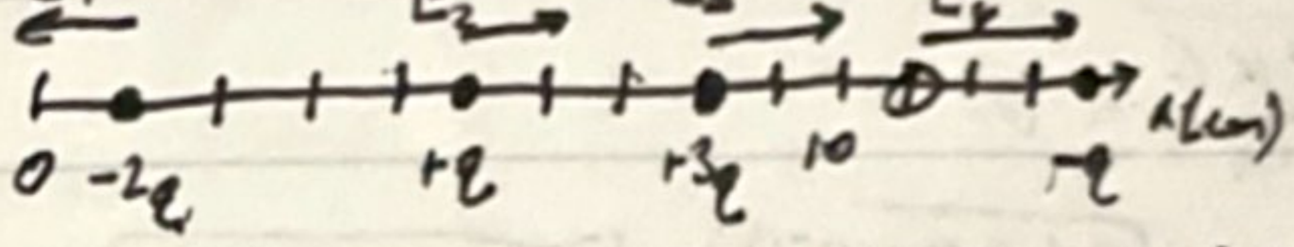


$F_{3,2} = \frac{8.99\times10^9|1\times10^{-6} \cdot -2\times10^{-6}|}{(.03)^2} = 19.978\,N$

$F_{1,2} = \frac{8.99\times10^9|1\times10^{-6} \cdot -2\times10^{-6}|}{(.05)^2} = 7.192\,N$

$F_{3,2} - F_{1,2} = \boxed{12.786\,N}$

4.

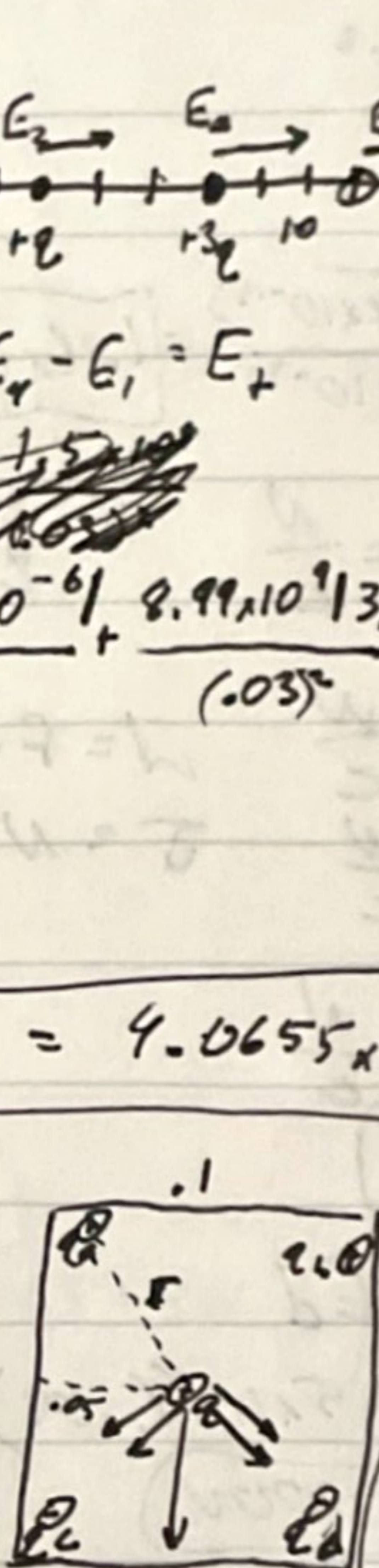


$E_2 + E_3 + E_4 - E_1 = E_T \qquad E = k\frac{|Q|}{r^2}$

$\frac{8.99\times10^9|1\times10^{-6}|}{(.06)^2} + \frac{8.99\times10^9|3\times10^{-6}|}{(.03)^2} + \frac{8.99\times10^9|1\times10^{-6}|}{(.03)^2} - \frac{8.99\times10^9|2\times10^{-6}|}{(.1)^2} =$

$\boxed{E_T = 4.0655\times10^7\,\frac{N}{C}}$

5. a)



x components cancel

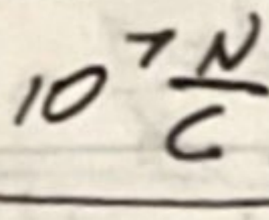
direction of force is directly down

b) $\sqrt{.05^2 + .05^2} = .0707\,m = r$

$F_a = \frac{k q_1 q_2}{r^2}$

$F_a = \frac{8.99\times10^9(7.5\times10^{-6} \cdot 2\times10^{-6})}{(.0707)^2}$

$F_a = 26.97$



$F_{a_y} = 26.97 \cdot \cos(45)$

$F_{a_y} = 19.07\,N$ all equal

$19.07 \cdot 4 = \boxed{76.3\,N}$

Scanned with CamScanner

6. a) $\Delta V = \frac{\Delta PE}{q}$

$40000 = \frac{\Delta PE}{1.6\times10^{-19}}$

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

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

$KE = \frac{1}{2} mv^2$

$\sqrt{\frac{2KE}{m}} = v$

$v = \sqrt{\frac{2(6.4\times10^{-15})}{9.11\times10^{-31}}} = \boxed{1.16\times10^{8} m/s}$

b) $\frac{V}{m} = \frac{N}{C}$ $\quad V = \frac{E}{q} = \frac{J}{C}$

$\frac{J/C}{m} = \frac{N}{C}$ $\quad W = F\cdot d$

$\frac{J}{C\cdot m} = \frac{N}{C}$ $\quad J = N\cdot m$

$\frac{N\cdot \cancel{m}}{C\cdot \cancel{m}} = \frac{N}{C}$

$\boxed{\frac{N}{C} = \frac{N}{C}}$

7. a) $V = Ed$

$V = 7.5\times10^{4}(.04)$

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

b) $\frac{1}{4}(3000) = \boxed{750 V}$

c) $V = Ed$

$E = \frac{V}{d}$

$E = \frac{.08}{9\times10^{-9}}$

$\boxed{E = 8.89\times10^{6} \frac{V}{m}}$

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

$E = 32 keV \times \frac{1000 eV}{1 keV} \cdot \frac{1.6\times10^{-19} J}{1 eV} = 5.12\times10^{-15} J$

$V = \frac{\Delta PE}{q} = \frac{5.12\times10^{-15}}{3.2\times10^{-19}} = 1.6\times10^{4} V \rightarrow E = \frac{V}{d} = \frac{1.6\times10^{4}}{.02} = \boxed{8.0\times10^{5} \frac{V}{m}}$

9. $79 \cdot 1.6\times10^{-19} = 1.264\times10^{-17} C$ (gold)

$2 \cdot 1.6\times10^{-19} = 3.2\times10^{-19} C$

$5 MeV \cdot \frac{10^6 eV}{1 MeV} = \frac{1.6\times10^{-19} J}{1 eV} = 8\times10^{-13} J$

$\Delta V = \frac{\Delta PE}{q} = \frac{8\times10^{-13}}{3.2\times10^{-19}} = 2.5\times10^{6} V$

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

$r = \frac{kq}{V} = \frac{9\times10^{9}(1.264\times10^{-17})}{2.5\times10^{6}}$

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

Unit 1

1. $C = \frac{q}{V}$

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

2. a) $E = \frac{CV^2}{2} = \frac{10\times10^{-6}(9\times10^{3})^2}{2} = \boxed{405 J}$

b) $q = CV = 10\times10^{-6}(9\times10^{3}) = \boxed{.09 C}$

c) $V = \sqrt{\frac{2E}{C}}$

$V = \sqrt{\frac{2(40)}{(8\times10^{-6})}} = \boxed{3.16\times10^{3} V}$

d) $q = CV = (8\times10^{-6})(3.16\times10^{3}) = \boxed{.0253 C}$

3. $C = 2.5\times10^{-8}$ over 4 capacitors

$C_{cap} = \frac{2.5\times10^{-8}}{4} = \boxed{6.25\times10^{-9} F}$

Capacitors in parallel result in additive values while in series results in diminished values, and could end up burning the skin.

4. $A = \pi r^2$

$A = \pi(.5\times10^{-3})^2$

$A = 2.5\times10^{-7}\pi\ m^2$

~~[illegible]~~ $R = 2\Omega$

$\rho = 1.72\times10^{-8}\ \Omega\cdot m$

$R = \frac{\rho\cdot L}{A}$

$L = \frac{RA}{\rho} = \frac{2(2.5\times10^{-7}\pi)}{1.72\times10^{-8}}$

$\boxed{L = 45.663\,m}$

5. a) $V = IR$

$I = \frac{V}{R}$

$I = \frac{3}{1000+3}$

$\boxed{I = .00299\,A}$

b) $P = IV$

$P = (.00299)(3)$

$\boxed{P = .00897\,W}$

c) $1A = 1\,C/s$

$60s \cdot \frac{10\,min}{1\,min} = 600s$

.00299 A for 600s

$.00299 \cdot 600 = \boxed{1.794\,C}$

Unit ~~3~~ 2

1. a) $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$\frac{1}{2000} = \frac{1}{10000} + \frac{1}{5000} + \frac{1}{R_3}$

$\frac{1}{2000} - \frac{1}{10000} - \frac{1}{5000} = \frac{1}{R_3}$

$\frac{1}{R_3} = \frac{1}{5000}$

$\boxed{R_3 = 5000\,\Omega}$

b) $V = IR$

$I = \frac{R}{V}$

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

$\boxed{I = 166.67\,A}$

c) $I_1 = \frac{R_1}{V}$

$I_1 = \frac{10000}{12}$

$\boxed{I_1 = 833.33\,A}$

$I_2 = \frac{R_2}{V}$

$I_2 = \frac{5000}{12}$

$\boxed{I_2 = 416.67\,A}$

$I_3 = \frac{R_3}{V}$

$I_3 = \frac{5000}{12}$

$\boxed{I_3 = 416.67\,A}$

2. a) $1.5 + 1.5 = 3V$

$I = \frac{R}{V}$

$I = \frac{500}{3}$

$\boxed{I = 166.67\,A}$

$I = \frac{500}{3}$

~~$I = 333.33\,A$~~

$\boxed{I = 166.67\,A}$

b) $I = \frac{R}{V}$

$I = \frac{505}{3} = \cancel{42.08\,A}$

$\boxed{I = 168.33\,A}$

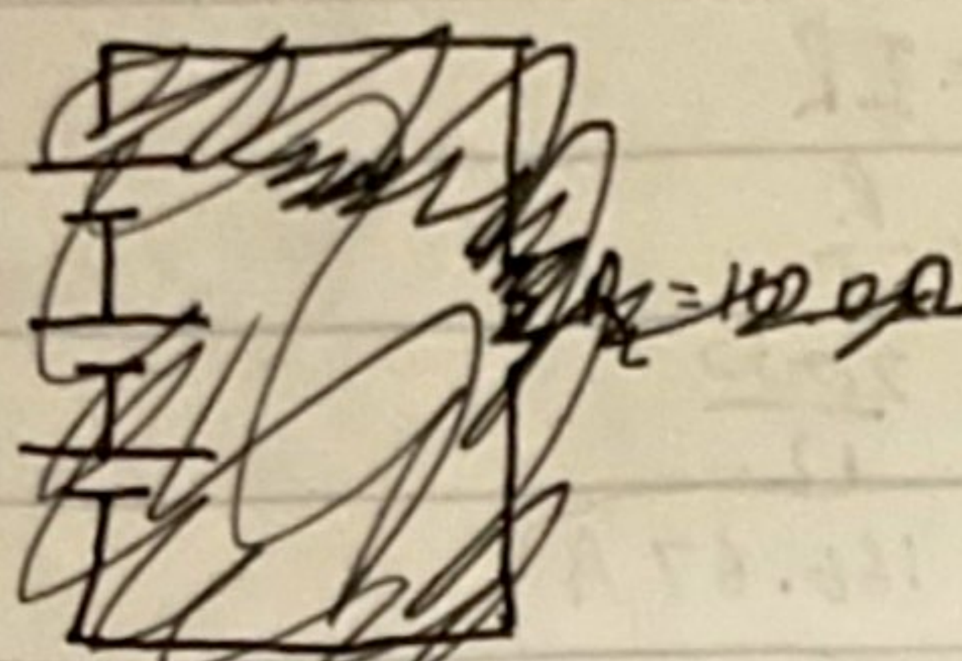
$I = \frac{R}{V}$

$I = \frac{505}{3}$

~~$I = 336$~~

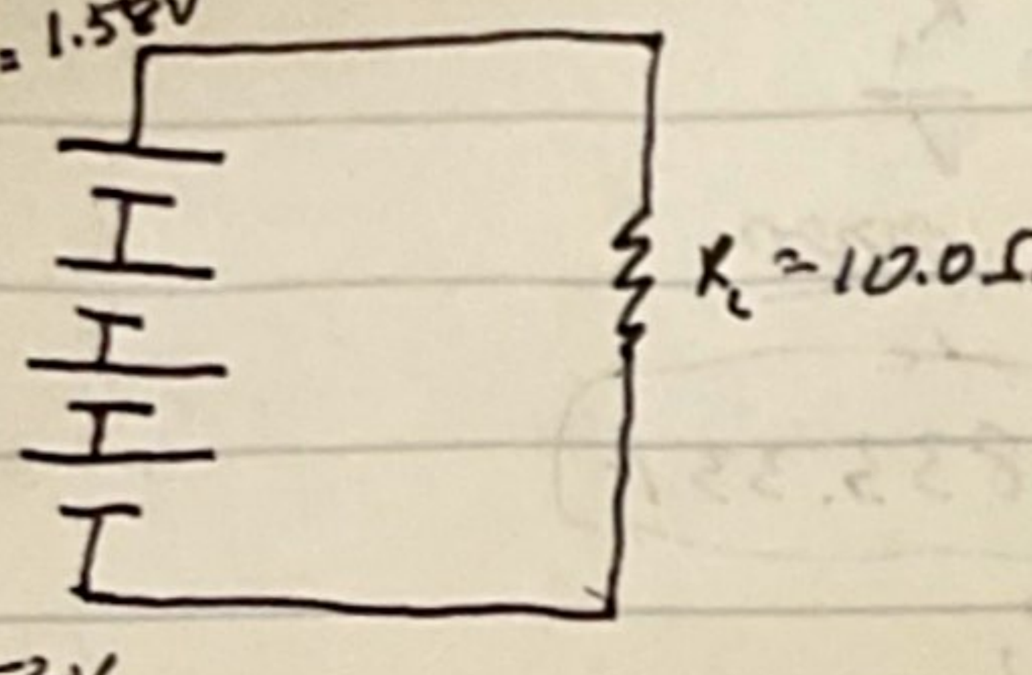
$\boxed{I = 168.33\,A}$

3. a)



$r = .02\Omega$

EMF = 1.58V



EMF = 1.53V

$r = .01\Omega$

b) $I_T = \frac{V_T}{R_T}$

$I_T = \frac{3(1.58)+(1.53)}{3(.02)+.1+10}$

$\boxed{I_T = .617A}$

c) $P_L = (I_L)^2 R_L$

$P_L = (.617)^2(10)$

$\boxed{P_L = 3.81\ W}$

d) $P_L = I_L^2 R_L$

$.5 = I_L^2(10)$

$I_L = .224\ A$

$I_T = \frac{V_T}{R_T}$

$I_T = \frac{3(1.58)+1.53}{3(.02)+r+10}$

$.224 = \frac{3(1.58)+1.53}{3(.02)+r+10}$

$.224 = \frac{6.27}{10.06+r}$

$r = \frac{6.27}{.224} - 10.06$

$\boxed{r = 18.0\Omega}$

4. $\frac{72\ \text{beats}}{1\text{min}} \quad \frac{1\text{min}}{72\ \text{beats}} = .0139\ \frac{\text{min}}{\text{beat}} \cdot \frac{60s}{1\text{min}} = .833\frac{s}{\text{beat}}$

$\tau = R \cdot C$

$.833 = R(25\times10^{-9})$

$\boxed{R = 3.33\times10^{7}\Omega}$

5. a) $\tau = 1\times10^{-4}s$

$R = 1\times10^{3}\Omega$

$\frac{\tau}{R} = C$

$\frac{1\times10^{-4}}{1\times10^{3}} = C$

$\boxed{C = 1\times10^{-7}F}$

b) It would not be difficult to limit the capacitance to less than the value in a) because the capacitance in practice must be less than that number.

Unit 3

1.

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

only 3? Just A B C no D?

2. $F = qvB\sin\theta$

$\frac{F}{qvB} = \sin\theta$

$\frac{1.40\times10^{-16}}{(1.6\times10^{-19})(4\times10^{3})(1.25)} = \sin\theta$

$.175 = \sin\theta$

$\sin^{-1}(.175) = \theta$

$\boxed{\theta = 10.1°}$ or $\boxed{\sim 170.0°}$

3. a) $r = \frac{m v_T}{|q| B}$

$q = \frac{m v_T}{r B}$

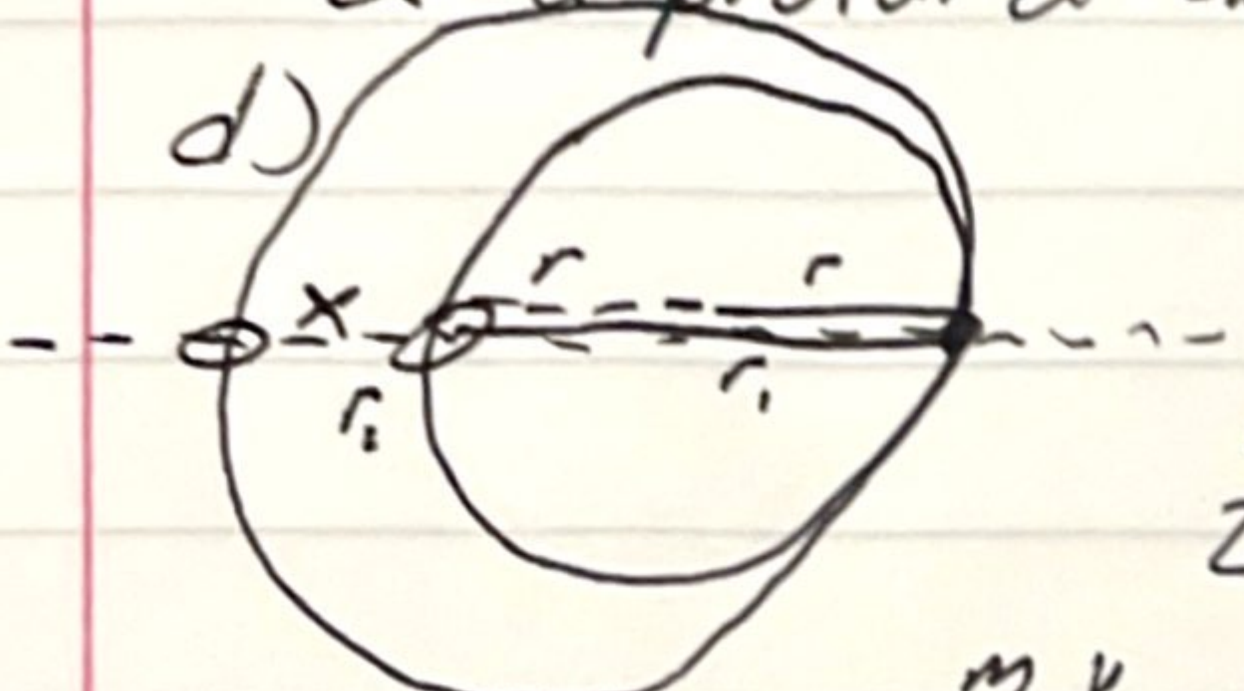
$q = \frac{(2.66\times10^{-26})(5\times10^{6})}{.231(1.2)}$

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

b) $\frac{4.8\times10^{-19}}{1.6\times10^{-19}} = \boxed{3}$

c) It is not possible to have fractional amounts of a proton or electron.

d)



$2r = d$

$2r_1 = d_1$

$d_1 - d = x$

$2r_1 - 2r = x$

$\frac{16}{18} = \frac{2.66\times10^{-26}}{m_1}$

$m_1 = 2.99\times10^{-26}$

$r = \frac{mv}{qB}$

$r = \frac{2.66\times10^{-26}(5\times10^{6})}{(1.6\times10^{-19})(1.2)}$

$r = .693 m$

$r_1 = \frac{m_1 v_1}{q_1 B_1} = \frac{(2.99\times10^{-26})(5\times10^{6})}{(1.6\times10^{-19})(1.2)} = .779m$

$2(.779m) - 2(.693) = \boxed{.173m}$

4. $F = ILB\sin\theta$

$F = 100(.25)(2)\sin(90)$

$\boxed{F = 50N}$

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

$\frac{\tau}{NIA\sin\theta} = B$

$B = \frac{300}{200(25)(.2^2)(\sin 90)}$

$\boxed{B = 1.5 T}$

6.

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

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

$I = \frac{P}{V}$

$I = \frac{450\times10^{6}}{300000} = 1500$

$B = \frac{4\pi\times10^{-7}(1500)}{2\pi(20)}$

$\boxed{B = 1.5\times10^{-5} T}$

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

$1 = \frac{(4\pi\times10^{-7})(NI)}{2\pi(5)}$

$\frac{10\pi}{4\pi\times10^{-7}} = NI$

$25000000 = NI$

$I = 45955$

$N = 550$

b) $v = c/2\pi R$ c=speed of light

$v = \frac{3\times10^{8}}{2\pi(5)}$

$\boxed{v = 9.54\times10^{6} m/s}$