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Physics 253
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Midterm 1 Work Units 0-3

- Unit 0: Electrostatics I & II

1) 29_p, atom = 63.5 $\quad 2.00\,\mu C \times 1C/10^6\,\mu C \times 1p/1.6\times10^{-19}C = \boxed{1.25\times10^{13}\,p \text{ removed}}$

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

$50g \times 1\,mol/63.5g \times 6.02\times60^{23}\,atoms/1\,mol = \boxed{4.74\times10^{25}\,atoms \times 29p/1\,atom}$

2) $F_{1,2} = K|q_1q_2|/r^2 = 8.99\times10^4\,|6\times10^{-6}\times2\times10^{-6}|/(0.05^2)$

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

$F_{2,3} = K|q_2q_3|/r^2 = 8.99\times10^4\,|2\times10^{-6}\times4\times10^{-6}|/(0.05^2)$

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

$\Sigma F = F_{1,2} - F_{2,3}$

$= 43.152N - 28.768N = \boxed{14.4N}$

3) $x = 6.00cm$ $\quad \Sigma F_3 = ?$

$q = 1.00\mu C$ $\quad F_{23} - F_{13}$

$K|q_2q_3|/r_{23}^2 - K|q_1q_2|/r_{13}^2$

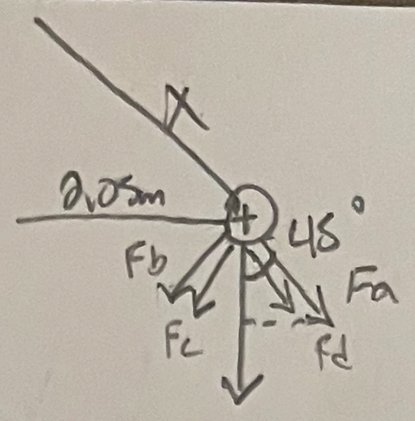
$8.99\times10^9\,|1\times10^{-6}\times2\times10^{-6}|/2.03^2 - 8.99\times10^9\,|1\times10^{-6}\times2\times10^{-6}|/0.05^2$

$\boxed{F_3 = +12.8N}$

4) $x = 11.0cm$ $\quad E_3 - E_1 - E_2 = E_T$ $\quad K|q_2|/r_3^2 - K|q_1|/r_1^2 - K|q_2|/r_2^2$

$K[5\times10^{-9}/0.13^2 - 5\times10^{-9}/0.04^2 - 1.5\times10^{-8}/007^2]$

$\boxed{= 5.30\times10^4\,N/C}$



5) $\sqrt{0.05^2 + 0.05^2} = \sqrt{c^2}$

$c^2 = 0.0707\,m$

$F_a = kq_1q_2/r^2$

$F_a = 8.99\times10^9\,(7.5\times10^{-6}\times2\times10^{-6})/0.0707^2$

$F_a = 26.97\,N$

$F_{ay} = 26.97\cos(45)$

$= 19.07\,(4)$

$F_T = 76.3\,N$

6) $\Delta V = 40kV$

$\Delta V = 40{,}000\,V$

$\Delta V = \Delta PE/q_e$

$40{,}000 = \Delta PE/1.6\times10^{-19}$

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

$KE = 1/2\,mv^2$

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

$v = \sqrt{2(6.4\times10^{-15}/9.11\times10^{-31}} = 1.18\times10^8\,m/s$

7) $A = Ov$

$B = 3{,}000$

$0.04m$

$E = 7.5\times10^4\,v/m$

$V_{AB} = ?$

$V_{AB} = Ed$

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

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

$1/4\,(3000)$

$= 750V$

8) $1ev = 1.6\times10^{-19}J$

32.0kev

2.00cm

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

$E = 32.0\cancel{kev} \times 1000\cancel{ev}/1\cancel{kev} \times 1.6\times10^{-19}J/1\cancel{ev} = \boxed{5.12\times10^{-15}J}$

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

$V_{AB} = Ed$ $\quad E = V/d = 1.6\times10^{4}/0.02$

$\boxed{E = 8.0\times10^{5}V/m}$

9) $79_p = 1.264\times10^{-17}C$ $\quad E = 5MeV \times 10^{6}eV/1MeV \times 1.6\times10^{-19}J/1eV = \boxed{8\times10^{-13}J}$

$\boxed{q = 3.2\times10^{-19}C}$

$r = kq/V$

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

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

$\Delta V = \Delta PE/q$

$\Delta V = 8\times10^{-13}/3.2\times10^{-19}$

$\boxed{\Delta V = 2.5\times10^{6}V}$

- Unit 1: Capacitors, Current, & DC circuits

1) $q = 3\times10^{-6}C$ $\quad C = q/V$

$V = 120V$

$C = 3\times10^{-6}/120$

$\boxed{C = 2.50\times10^{-8}F}$

2) $C = 10 \times 10^{-6} F$

$V = 9 \times 10^3 V$

a) $E = CV^2/2$

$E = 10 \times 10^{-6} \cdot (9 \times 10^3)^2/2$

$\boxed{E = 405 J}$

b) $C = q/V$

$q = C \cdot V$

$q = 10 \times 10^{-6}(9 \times 10^3) = \boxed{0.09000 C}$

c) $\sqrt{2(E_{cap})/C} = \sqrt{V^2}$

$V = \sqrt{2(E)/C}$

$V = \sqrt{2(40)/8 \times 10^{-6}}$

$\boxed{V = 3.16 \times 10^3 V}$

d) $q = 8 \times 10^{-6}(3.16 \times 10^3)$

$\boxed{q = 0.02536}$

3) $C = Q/V$

$0.02536/3.16 \times 10^3$

$\boxed{C = 8.02}$

It would be too much power

4) $R = \rho(L/A)$

$\frac{2\Omega}{1.72 \times 10^{-8}} = 1.72 \times 10^{-8}(L/0.7854)$

$1.16 \times 10^{-26} \cdot 0.7824$

$\boxed{L = 9.13 \times 10^{-27}}$

5) 1kΩ
3.0V

$R = (V_S - V_{LED} / I_{LED})$

$3k\Omega\ (V_S - 3 / I_{LED})$

I'm not sure):

Unit 2: DC circuits with resistors in series & parallel, RC circuits

1) $V = IR$

$R_1 = 10k\Omega$

$R_2 = 5k\Omega$

$R_{tot} = 2k\Omega$

$\Delta V = 12$

$1/2 = 1/10 + 1/5 + 1/x$

$5/10 = 1/10 + 2/10 + 3/10$

$R_3 = 3k\Omega$

$12 = I(2)\ \ 12/2$ $I = 6$

$12 = I(10) = I_1 = 1.2$

$12 = I(5) = I_2 = 2.4$

$12 = I(3) = I_3 = 4$

2) $R = 0.5k\Omega$
1.5V
3V

$R_{tot} = R_1 + R_2 + R_3$

a) $R_{tot} = 0.5k\Omega + 0.5k\Omega$

$0.001k\Omega$

b) $R_{tot} = 5k\Omega = 0.01k\Omega$

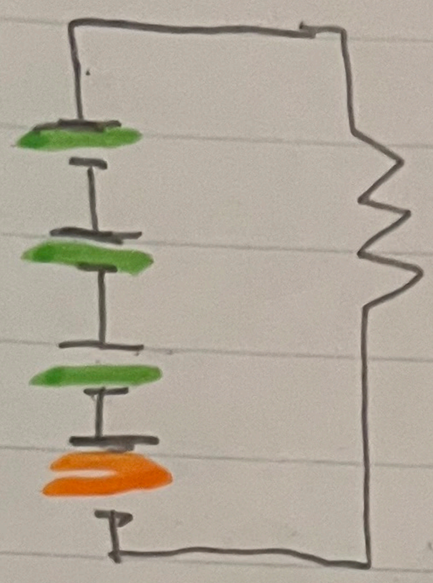
$1/R_{tot} = 1/R_1 + 1/R_2 + 1/R_3$

$1/R_{tot} = 1/0.5k\Omega + 1/0.5k\Omega$

$0.003k\Omega$

$R_{tot} = 5k\Omega = 0.0025k\Omega$

3)



$r = 0.02\Omega$

EMF = 1.58V

EMF = 1.53V

$I_T = V_b / R_T$

$R_L = 12.0\Omega$

$I_L = 0.224A$

$P_L = 0.5$

$0.224 = 3(1.58) + 1.53 / 3(0.02) + r + 10$

$6.27 / 0.224 \sim 10.06$

$\boxed{r = 18\Omega}$

4) $72 beats / 1 min = 0.0139 min/beat \times 60s/1 min$

$= \boxed{0.833 s/beat}$

$T = R \cdot C$

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

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

5) $T = 1 \times 10^{-4} s$

$R < 1 \times 10^3 \Omega$

$T / R = C$

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

$T = RC$

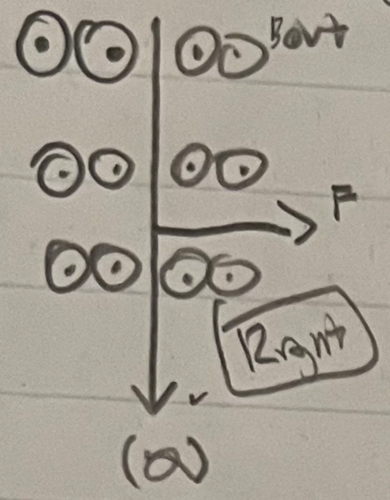
1×10^{-4}

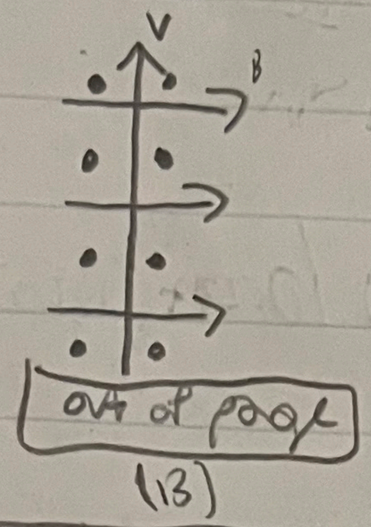
1×10^5

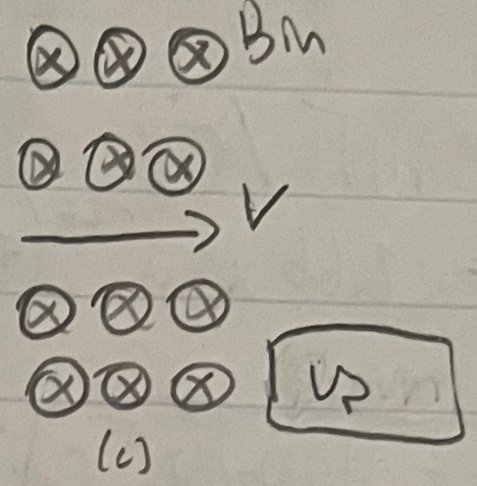
$\boxed{C < 1 \times 10^{-7} F}$

- Unit 3: Magnetism I

1)







Case	V direction	B direction	F direction
a	down	out	$\hat{i}$
b	up	right	$\hat{k}$
c	right	in	$\hat{j}$

2) $F = qvB\sin\theta$

$1.40\times10^{-16} = (1.6\times10^{-19})(4\times10^{3})(1.75)\sin\theta$

$\sin^{-1}(0.75)$

$10.1° = \theta$

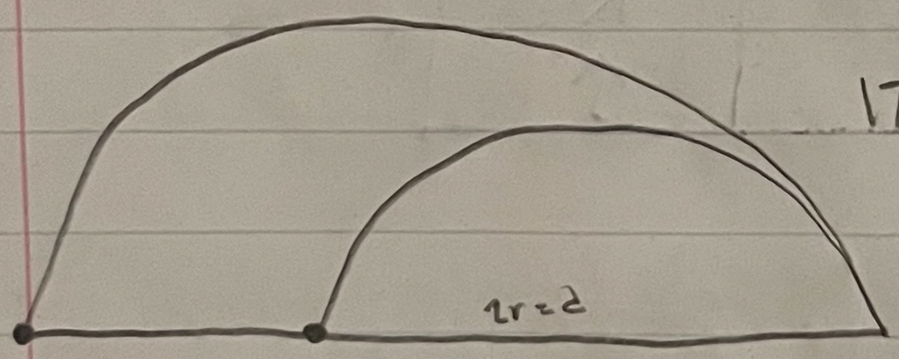
$169.9° = \theta$

3) $4.60 \times 10^{-19} C / 1.6 \times 10^{-19} C = \boxed{3}$

$q_v = mvT / rB$

$q = 2.66 \times 10^{-26} (5 \times 10^6) / 0.231 (1.20)$

$\boxed{q = 4.60 \times 10^{-14} C}$



$2(0.774) - 2(0.693)$

$17.3cm \simeq \boxed{0.173m}$

$r_{16} = 0.693m$

$r_{18} = 0.779m$

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

$F = 100(0.25)(2)\sin(90)$

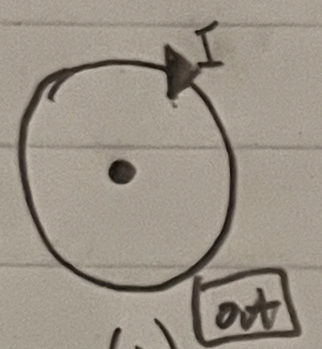
$\boxed{F = 50.0N}$

5) $T / NIA \sin\theta = B$

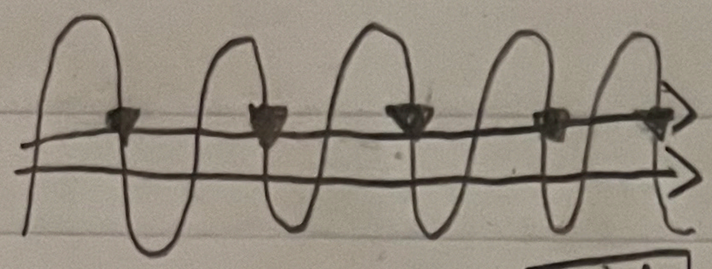
$300 / 200(25)(0.2^2)\sin(90) = B$

$\boxed{B = 1.50T}$

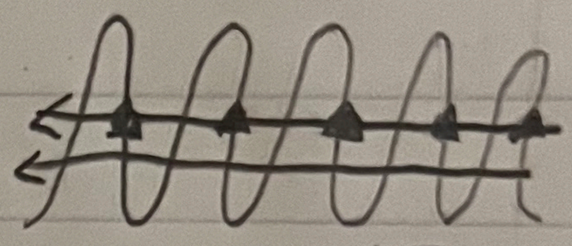
6)



(a) out



(b) right



(c) up

case	B direction
a	$\hat{k}$
b	$\hat{i}$
c	$\hat{j}$

7) $P/V = I \quad (450 \times 10^6 / 300{,}000) = I$

$B = \mu_0 I / 2\pi r$

$B = 4\pi \times 10^{-7} (1500) / 2\pi (20)$

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

8) I'm not sure if im suppose to use my own #'s):