Physics 1B - Winter 2007

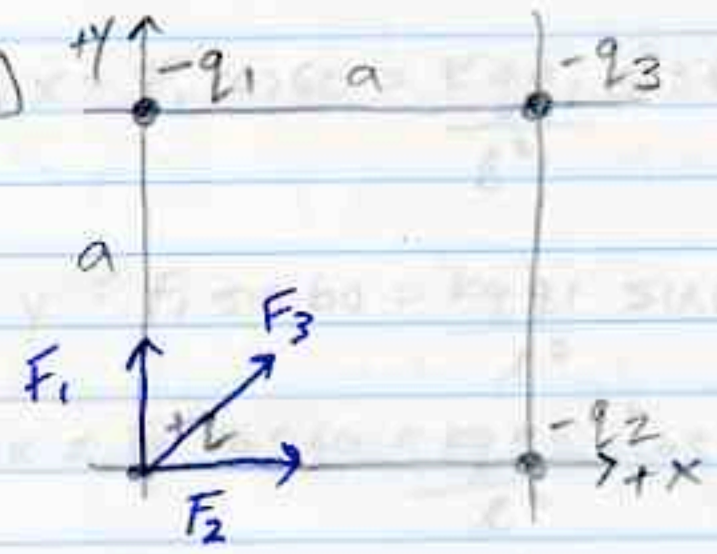
Final Review Problems

★ email mjbrown@ucsd.edu w/ error concerns

15 : 4, 13, 27, 39
16 : 6, 18, 34
17 : 9, 18, 35
18 : 8, 11, 22, 50
19 : 8, 23, 39, 70
20 : 17, 20, 32, 42

CHAP 15

4



Forces

$F_1 = \frac{kq^2}{a^2}\ (+y)$

$F_2 = \frac{kq^2}{a^2}\ (+x)$

$F_3 = \frac{kq^2}{(a\sqrt{2})^2}\ (\hat{x}+\hat{y})$

$F_{3x} = F_3 \cos 45$

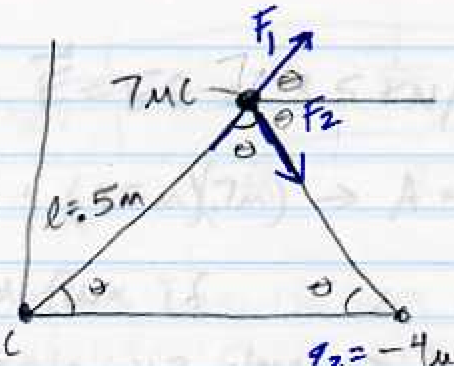
$F_{3y} = F_3 \sin 45$

$F_{Net\,x} = F_2 + F_3 \cos 45° = kq^2\left(\frac{1}{a^2} + \frac{\cos 45}{2a^2}\right) = \frac{1.35\,kq^2}{a^2}\hat{x}$

$F_{Net\,y} = F_1 + F_3 \sin 45° = kq^2\left(\frac{1}{a^2} + \frac{\sin 45}{2a^2}\right) = \frac{1.35\,kq^2}{a^2}\hat{y}$

$F_{TOT} = \sqrt{F_x^2 + F_y^2} = \frac{1.91\,kq^2}{a^2}$ pointing 45° above $+\hat{x}$

15-13



$\theta = 60°$

☆ Find Force on 7μC charge

$F_1 x = F_1 \cos 60 = \frac{kqq_1}{l^2}\cos 60 = .252\,N$

$F_1 y = F_1 \sin 60 = \frac{kqq_1}{l^2}\sin 60 = .436\,N$

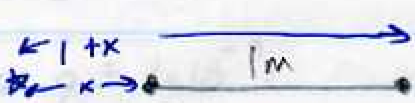
$F_2 x = F_2 \cos 60 = \frac{kqq_2}{l^2}\cos 60 = .504\,N$

$F_2 y = -F_2 \sin 60 = -\frac{kqq_2}{l^2}\sin 60 = -.873\,N$

$F_{Net}\,x = .756\,N$ $F_{Net}\,y = -.437\,N$

$|F_{TOT}| = .87\,N$ $\theta' = \tan^{-1}\left|\frac{F_y}{F_x}\right| = 30°$

15-27



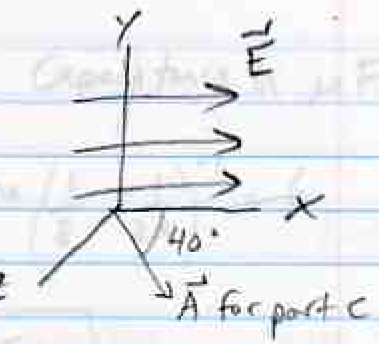
☆ Find spot where E=0

$E_1 = (\text{right})\,\frac{kq_1}{x^2}$; $E_2 = \text{left}\,\frac{kq_2}{(1+x)^2}$; Require $|E_1| = |E_2|$

$\frac{kq_1}{x^2} = \frac{kq_2}{(x+1)^2} \Rightarrow \frac{\sqrt{q_1}}{x} = \frac{\sqrt{q_2}}{x+1} \Rightarrow \sqrt{q_1}(x+1) = \sqrt{q_2}\,x$

$x(\sqrt{q_1} - \sqrt{q_2}) = -\sqrt{q_1}$

15-[39] $\vec{E} = E\hat{x} = 3.5\ kN/C$



Rect: $(.35m)(.7m) \rightarrow A = .245m^2$

Find flux if

(a) loop in yz plane $\rightarrow \theta = 0°$

Flux = $BA\cos\theta = BA =$ **860 Nm²/C = flux**

(b) loop in xy plane $\rightarrow \theta = 90°$

$\cos\theta = 0 \rightarrow$ **Flux = 0**

(c) loop has $\vec{A}$ vector 40° from x axis $\rightarrow \theta = 40°$

Flux = $BA\cos 40°$ = **Flux = 660 Nm²/C**

CHAP 16: [6] 12 V Battery

$Q = 3.6 \times 10^5\ C$ moved from (-) → (+) (pushed up "potential" hill)

Work done = $Q\Delta V = 4.32 \times 10^6\ J$

16-[18] e^- at rest outside sphere

sphere $q_s = 1 \times 10^{-9}\ C$

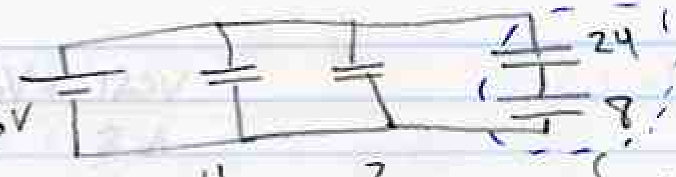
e^- gains KE = −PE as it approaches sphere: $\Delta PE = kqq_s\left(\frac{1}{r_f} - \frac{1}{r_i}\right) = keq_s\left(\frac{1}{.02m} - \frac{1}{.03m}\right)$

$\Delta PE = -2.4 \times 10^{-17}\ J$

$\Delta KE = \frac{1}{2}mv^2 \rightarrow v = \sqrt{\frac{2\Delta KE}{m_e}} = \sqrt{\frac{-2\Delta PE}{m_e}} =$ **$7.26 \times 10^6\ m/s = V_f$**

Q=CV

16-[34]



Capacitance in μF

combine $\left(\frac{1}{8}+\frac{1}{24}\right)^{-1}=6$

(a) Combine resultant 3 cap in parallel: $C_{eq} = 4+2+6 = $ **12 μF = Ceq**

(b) Find Q on each: every parallel branch has full 36 volts across it so:

4μF cap: $Q = C\Delta V = (4\mu F)(36V) =$ **144 μC**

2μF cap: $Q = C\Delta V =$ **72 μC**

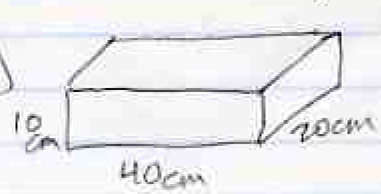
Now the 24 and 8 μF had eq cap of 6μF so that is how much charge they get
$Q = C\Delta V = (6\mu F)(36V) =$ **216 μC** → since they are in series, both get this amount of charge

CHAP 17 [9] Double current, Then

(a) charge carrier density is unchanged b/c that is a property of the material

(b) electron drift velocity must double to account for the increased current b/c $I = nqv_dA$ & nqA are all constant.

17-[18]



(a) $I_{max} = \frac{V}{R_{min}} = \frac{V}{\rho}\frac{A_{max}}{l_{min}} = \frac{V}{\rho}\frac{(.4m)(.2m)}{(.1m)}$

(b) $I_{min} = \frac{V}{...}$ [illegible]

17- [35] $\Delta V = 120V$

$I = 2A$

$m = .5kg\ H_2O$

$\Delta T = 23°C \rightarrow 100°C = 77°C$

Water takes 4.184J / g°C → Heat needed = $(500g)(77°C)\left(\frac{4.184J}{g°C}\right) = 1.61 \times 10^5 J$

Power output = IV; $P = E/t \rightarrow t = \frac{E}{P} = \frac{1.61 \times 10^5 J}{IV}$

time needed = 671 seconds ≈ 11.2 min

CHAP 18

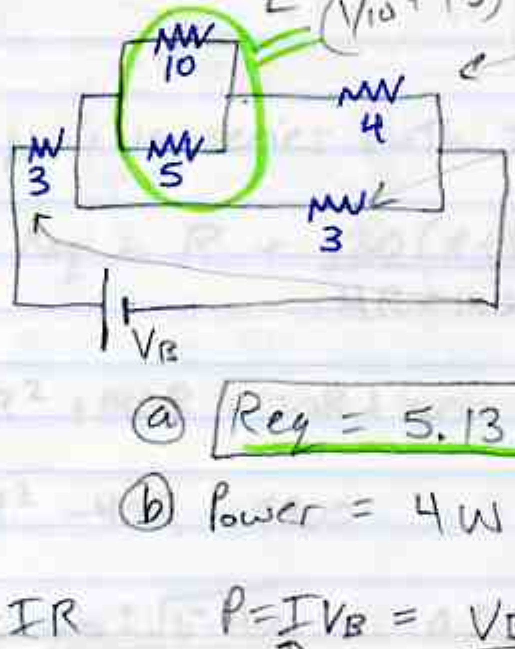
[8] ⓐ Find R_{eq}

$(1/10 + 1/5)^{-1} = 3.3$ → combine series with $4\Omega = 7.3\Omega$

combine in // with 3Ω

$\left(\frac{1}{7.3} + \frac{1}{3}\right)^{-1} = 2.13\Omega$

combine series w/ $3\Omega \rightarrow 5.13\Omega$

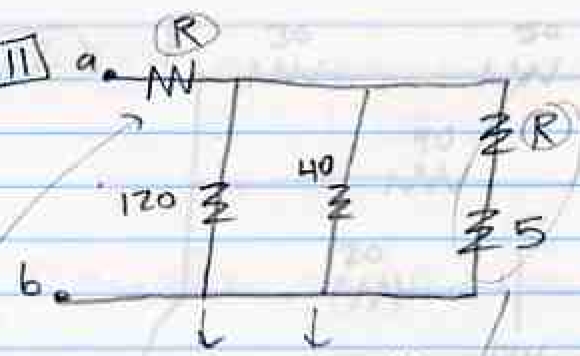


ⓐ **$R_{eq} = 5.13\Omega$**

ⓑ Power = 4W, find $V_{Battery}$

$V = IR$, $I = \frac{V}{R}$ → $P = IV_B = \frac{V_B^2}{R} \rightarrow V_B = \sqrt{P \cdot R} =$ **4.53V**

18 - [11]



$R_{ab} = 75\,\Omega$; Find (R)

Just use algebra

$120 \,//\, 40 \,//\, R+5 \rightarrow \left(\frac{1}{120} + \frac{1}{40} + \frac{1}{R+5}\right)^{-1}$

$= \left(\frac{R+5}{(120)(R+5)} + \frac{3(R+5)}{120(R+5)} + \frac{120}{120(R+5)}\right)^{-1}$

$= \left(\frac{4R+140}{120(R+5)}\right)^{-1} = \frac{120(R+5)}{4R+140}$

Now in series with the final R:

$R_{eq} = R + \frac{120(R+5)}{4R+140} \rightarrow \frac{(4R+140)R + 120(R+5)}{4R+140} - R_{eq} = 0$

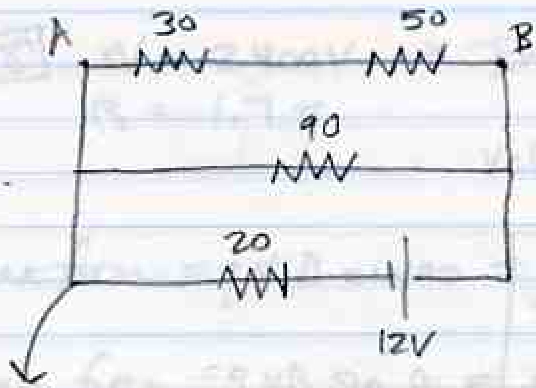
$4R^2 + 140R + 120R + 600 - 75(4R+140) = 0$ (we ignore denominator)

$4R^2 - 40R - 9900$

$R = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{40 \pm \sqrt{40^2 - 4 \cdot 4 \cdot (-9900)}}{8} = \frac{40 \pm 400}{8} = \begin{matrix} +55\,\Omega \\ -45\,\Omega \end{matrix}$

Just take pos solution $\rightarrow$ $\boxed{R = +55\,\Omega}$

19 - 22



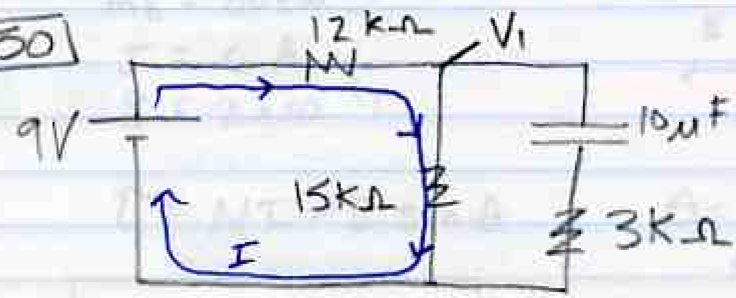
Find power to 50 Ω Resistor

$R_{eq} = 62.4 \rightarrow I = .1925 A$

$V_1 = (+I)(20\,\Omega) = 3.85V \rightarrow \Delta V_{AB} = 12 - 3.85 = 8.15V$

$I_{AB} = \frac{8.15V}{80\,\Omega} = .102 A \rightarrow$ **Power (50) = I^2R = .52W**

19 - 50



Cap fully charged → all current follows blue path

$I = \frac{V}{R_{eq}} = \frac{9V}{27K\Omega} =$ **.33 mA = I**

$V_1 = 9V - I(12\,k\Omega) = 5V$

$I_{R3} = 0$

$V_{cap} = V_1$ b/c No current goes thru 3KΩ resistor so, it has $\Delta V = IR = 0$

$Q_{cap} = CV_{cap} = CV_1 = (10\,\mu F)(5V) =$ **50 μC = Q_{cap}**

CHAP 19: [8] $\Delta V = 2400V \rightarrow$ Energy $= q\Delta V = |e|\Delta V = \underline{3.84\times10^{-16}\text{ J}}$

$B = 1.7T$

$V_{el} = \sqrt{\frac{2E}{m}} = 2.9\times10^{7}\text{ m/s}$

(a) max force $= qVB\sin 90 =$ $\boxed{7.9\times10^{-12}\text{ N} = F_{max}}$

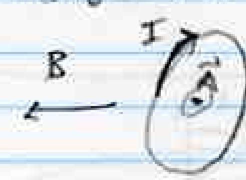
(b) min force $= qVB\sin 0 =$ $\boxed{0 = F_{min}}$

19 - [23] $N = 8$

$m_a = 40\text{cm}$, $m_b = 30\text{cm}$ } area $= \pi m_a m_b = .377\text{ m}^2$

$I = 6\text{ A}$

$B = 2\times10^{-4}\text{T}$



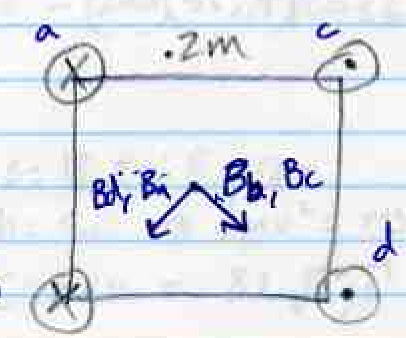
$\tau = NIAB\sin\theta$

$\theta = 90°$ b/c area vector points into page & B points left

$\boxed{\tau = .0036\text{ Nm}}$

(left side out of page, right side into page)

19 - [39]



B_d and B_a both point in the same way and same for B_b and B_c

$|B|$ magnitude $= \frac{\mu_0 I}{2\pi\left(\frac{.2}{2}\sqrt{2}\right)} = 7.07\ \mu T$

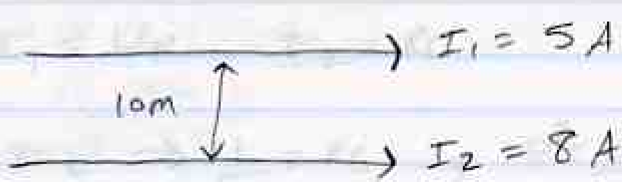
$I = 5A$

Horizontal components cancel.

Vertical components add as

[illegible]

19- [70]



(a) $B(\text{at } 2) = \frac{\mu_0 I_1}{2\pi d} = 1\times10^{-7}\,T$

(b) $\frac{\text{Force}}{l} = I_2 B = 8\times10^{-7}\,\frac{N}{m}$

(c) $B(\text{at } 1) = \frac{\mu_0 I_2}{2\pi d} = 1.6\times10^{-7}\,T$

(d) $\frac{\text{Force}}{l} = I_1 B = 8\times10^{-7}\,\frac{N}{m}$

– Note force is same even though B fields differ

CHAP 20 [17]

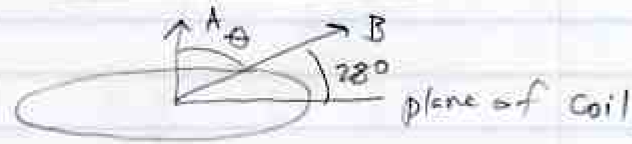
$N = 200$

$dA = 39\ cm^2$

$B = 50\,\mu T$

$\theta = 90 - 28 = 62°$

$ds = 1.8s$



$$\mathcal{E} = -N\frac{d\Phi}{dt} = -NB\cos 62°\,\frac{dA}{dt}$$

$$\mathcal{E} = -(200)(50\,\mu T)(\cos 62°)\left(\frac{39\ cm^2}{1.8s}\right)\left(\frac{m}{100\,cm}\right)^2 = 1.02\times10^{-5}\,V$$

20- [26] $B = 18\,\mu T$; $l = 12m$

$h = 9m \rightarrow \frac{1}{2}mv^2 = mgh \rightarrow v_f = \sqrt{2gh}$

$\mathcal{E} = Blv = Bl\sqrt{2gh} = 2.9\ mV = \mathcal{E}$

20- [32] $R = 30\,\Omega$ (a) $I_{(0)} = V/R$ (Back emf = 0) $= 8.0$ Amps $= I(0)$

$V = 240V$ (b) $I(\infty) = (V - \mathcal{E}_{back})/R = 3.2$ Amps $= I(\infty)$