Physics 132, Midterm Exam #2, May 18, 2010 Page Score _____

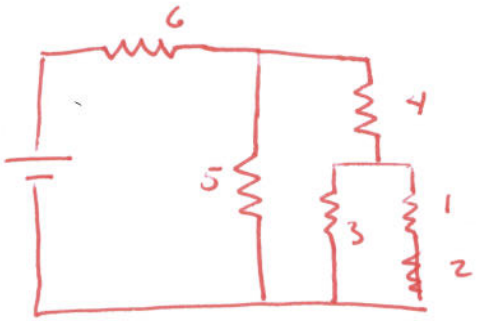
Name: _____

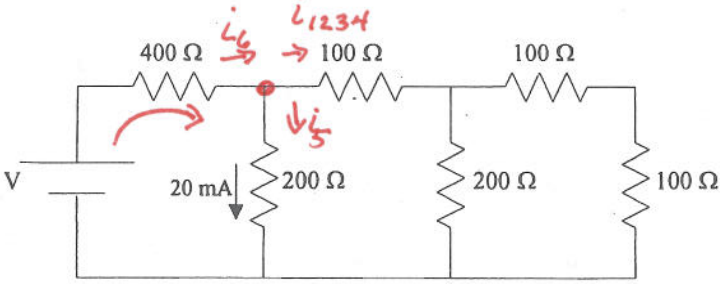
Recitation Instructor: Draskovic Helal Ruggiero Wolfe

Problem 1 [25 points]. The current through the leftmost 200Ω resistor is 20 mA.

(a) [10 points]. Find the equivalent resistance of the resistors in the circuit.

(b) [15 points]. What is the battery voltage, V?





$R_{12} = R_1 + R_2 = 200\,\Omega$

$R_{123} = \left(\frac{1}{R_{12}} + \frac{1}{R_3}\right)^{-1} = 100\,\Omega$

$R_{1234} = R_{123} + R_4 = 200\,\Omega$

$R_{12345} = \left(\frac{1}{R_{1234}} + \frac{1}{R_5}\right)^{-1} = 100\,\Omega$

$R_{eq} = R_6 + R_{12345} = \boxed{500\,\Omega}$

$V - i_6 R_6 - i_5 R_5 = 0$

$V = i_6 R_6 + i_5 R_5$

$i_5 = 20\,mA$

R_5 is $\|$ to R_{1234}

since $R_5 = R_{1234}$

$i_{1234} = 20\,mA$

node rule

$i_6 = 40\,mA$

$V = (.04\,A)400\,\Omega + (.02\,A)200\,\Omega$

$\boxed{= 20V}$

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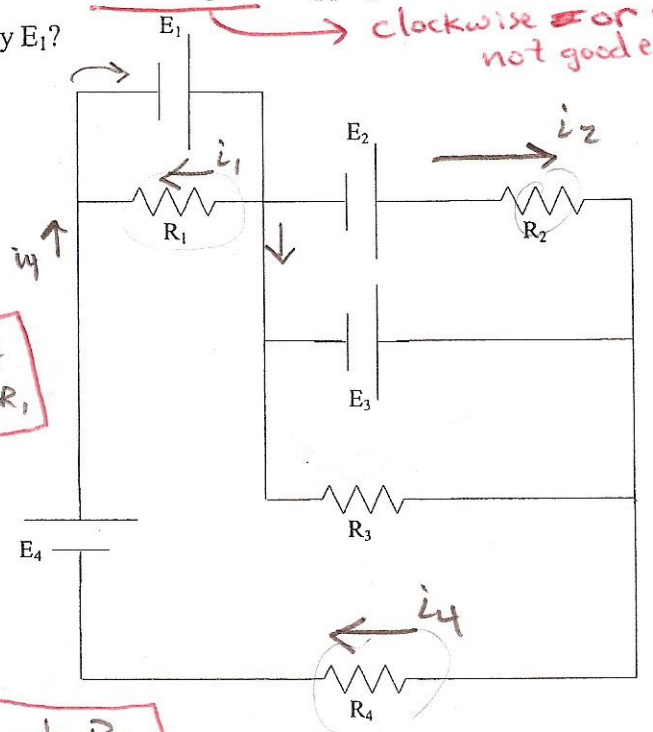
Problem 2 [25 points]. $E_1 = 20V$, $E_2 = 10V$, $E_3 = 5.0V$, $E_4 = 5.0V$ and $R_1 = R_2 = R_3 = R_4 = 1000\ \Omega$.
I am only asking questions about selected components. Read each question carefully so you solve for the correct quantity.

(a) [18 points] What is the current magnitude and direction through resistors R_1, R_2, and R_4.
Label your answers clearly, specifying the direction as either "left" or "right", as appropriate.

(b) [7 points] How much power is being supplied by battery E_1?

clockwise or ccw not good enough.

4 pts for current
2 pts for each direction



(a) $E_1 - i_1 R_1 = 0$

$i_1 = \frac{E_1}{R_1} = \frac{20\,V}{1000\,\Omega}$ = 0.02 A left through R_1

$E_3 - i_2 R_2 - E_2 = 0$

$i_2 = \frac{E_3 - E_2}{R_2} = -\frac{5\,V}{1000\,\Omega}$

= 0.005 A right trough R_2

$E_4 + E_1 + E_3 - i_4 R_4 = 0$

$i_4 = \frac{E_4 + E_1 + E_3}{R_4} = \frac{30\,V}{1000\,\Omega}$ = 0.03 A left through R_4

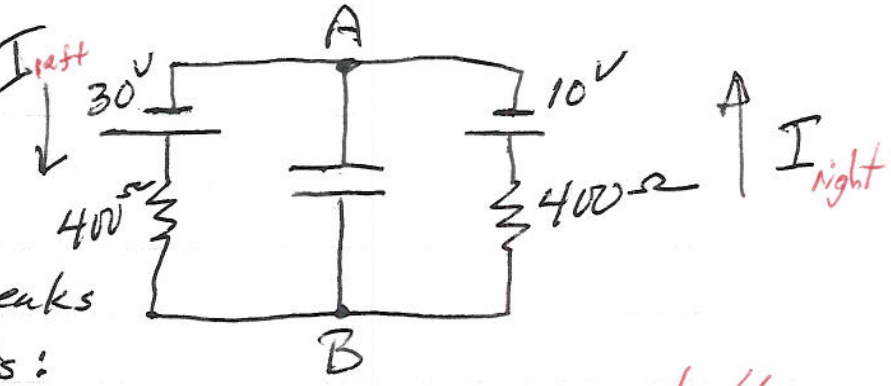
(b) $i_{E_1} = i_1 + i_4 = 0.05\,A$ (in the natural direction for a battery supplying power)

$P_{E_1} = i_{E_1} E_1 = (0.05\,A)(20\,V) =$ 1 W

No more than 1 point total was taken off for units

0 pts if you set i_{E_1} = current through any resistor (must use angle)

$U = \frac{1}{2} C_{Eq} V_{AB}^2$



the problem breaks into Two Parts:

1) Find C_{Eq} 2) Find V_{AB} so we can get U.

(1) parallel : $5\mu F + 10\mu F = 15\mu F$

parallel : $7\mu F + 13\mu F = 20\mu F$

Series : $1/15\mu F + 1/20\mu F = 7/60\mu F$

$\rightarrow \boxed{C_{Eq} = \frac{60}{7}\mu F = 8.571\mu F}$

5 Points

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(2) "Long Time" $\Rightarrow \boxed{I_{CAP} = 0}$ 5 points

Outside Loop (Counter clock wise current)

$30^V - I_{Left} \cdot 400\Omega - I_{Right} \cdot 400\Omega - 10^V = 0$

Node B: $I_{Left} = I_{Right} + I_{CAP} = I_{Right} + 0$

$I_{left} = I_{right} = I_0$

$\rightarrow I = \frac{30-10}{400+400} = \boxed{1/40 \text{ Amp} = 0.025 \text{ Amps}}$ 5 points

Walk from A to B:

Left Branch: $V_{AB} = 30 - (0.025)\,400$

Right Branch: $V_{AB} = 10 + (0.025)\,400$

$\boxed{= 20^V = 20^V}$ 5 Point

Note: You go from A to B through R_{Right} Against the current

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$U = \frac{1}{2}\left(\frac{60}{7} \times 10^{-6} F\right)(20^V)^2 = \boxed{1.71 \times 10^{-3} \text{ Joule}}$

5 Points

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Multiple Choice Section. Circle the best answer to each question.

Problem 5 [15 points]. Three large, equally spaced, conducting plates are connected to batteries or ground as shown in cross-section in the figure. The plates are not directly connected to each other. An x-axis is given, as well. Note carefully the orientation and voltage of the batteries.

(a) [5 points]. The charge on the right side of the middle plate is: **positive** **zero** **negative**
(Hint: You might want to sketch the charge on the other plates, first.)

(b) [10 points]. Circle the graph which best represents E_x along the x-axis. The shaded regions of the graphs indicate where the conducting plates are.

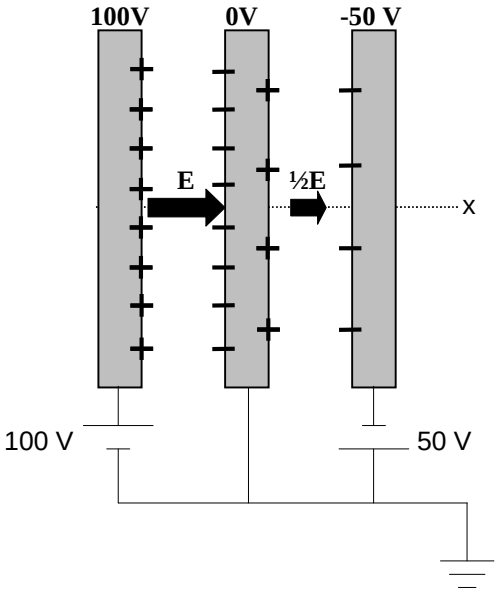
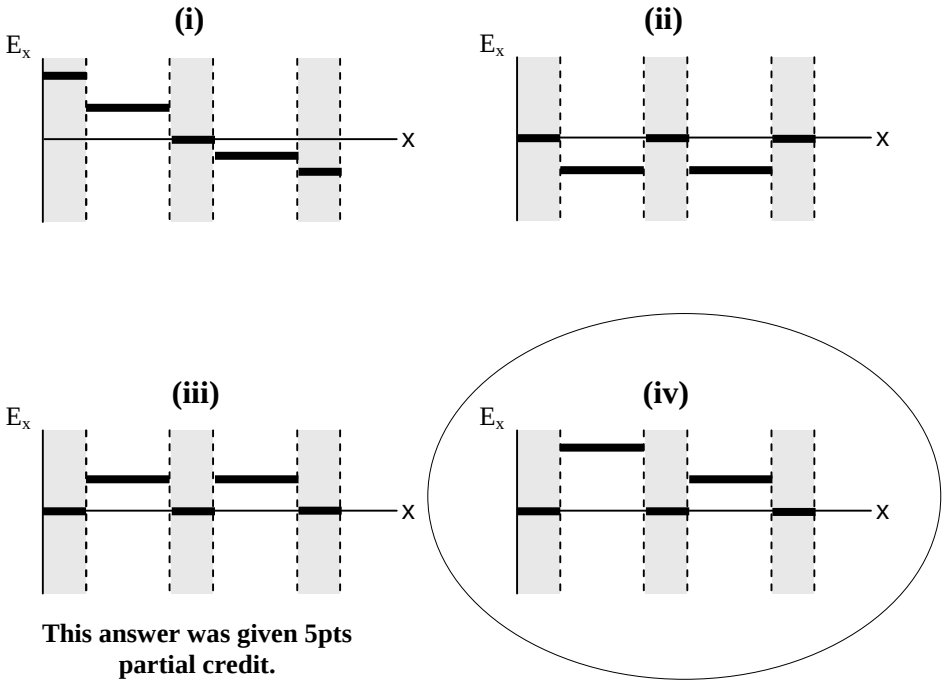


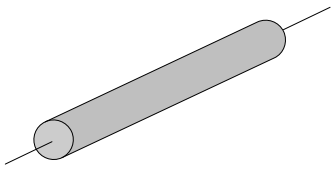
Figure showing the conducting plates (big grey rectangles).



This answer was given 5pts partial credit.

Problem 6 [5 points]. Resistors A and B are both made of aluminum and in the shape of a cylinder. Resister A is 100 Ω. Resister B has twice the radius and twice the length of A. Its resistance is:

(a) 25 Ω **(a)** 50 Ω **(a)** 100 Ω **(a)** 200 Ω **(a)** 400 Ω



$R_A = \rho L/A = 100\ \Omega$

$R_B = \rho(2L)/(4A) = ½\ R = 50\Omega$

Problem 7 [5 points]. Circle each statement that is true for typical experience. More than one statement might be true, or none of them might be true.

"1 Ω is a small resistance."

"1 F is a small capacitance."

"1 V/m is a small electric field."