**ECE 300**
**Spring Semester, 2008**
**HW Set #1**

Desk Copy

**Due: January 22, 2005** Name wlg
wlg Version 2 Print (last, first)

Use engineering paper. Work only on one side of the paper. Use this sheet as your cover sheet, placed on top of your work and stapled in the top left-hand corner. Number the problems at the top of the page, in the center of the sheet. **Do neat work. Underline your answers. Show how you got your equations. Be sure to show how you got your answers.** Each problem counts 10 points.

Work the following problems from the text.

2.37 Ans: R = 2.5 ohms

2.61 Use combinations $R_1$ and $R_2$, $R_1$ and $R_3$, $R_2$ and $R_3$. Answer on your own.

2.74 Ans: $R_1 = 4\ \Omega$, $R_2 = 0.8\ \Omega$, $R_3 = 1.17\ \Omega$

2.80 Ans: 30 W

P.P. 2.6

P.P 2.7

P.P 2.8

P.P 2.9

P.P 2.13

P.P 2.15

2.XX You are given the circuit shown in Figure 2.XX.

(a) Use branch circuit analysis to find the current $I_1$ and $I_2$. Ans: $I_1 = 0.0741$ A, $I_2 = 1.111$ A
(b) Determine the power absorbed by the three resistors. $P_{15} = 21.07$ W, $P_{30} = 0.165$ W $P_{20} = 24.69$ W.
(c) Determine the power supplied by the two sources. $P_{sup\ 20} = 1.482$ W, $P_{sup\ 40} = 44.44$ W
(d) Does power supplied equal to power absorbed? Verify.

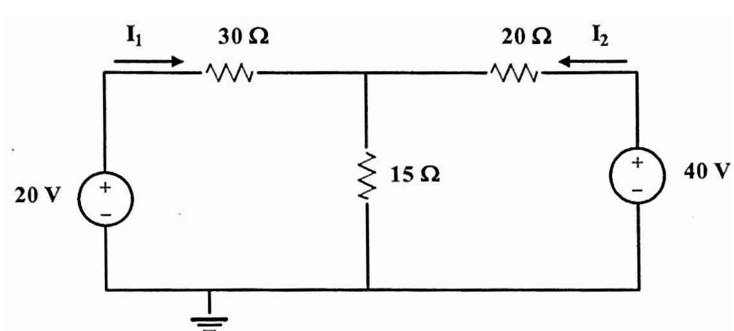


Figure 2.XX: Circuit for problem 2.XX.

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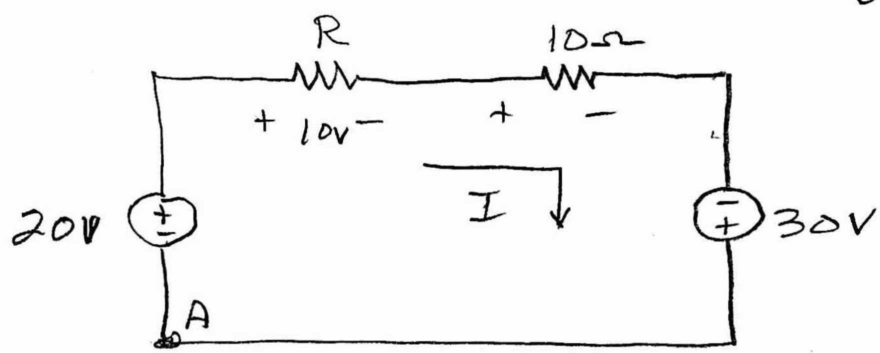
wlg

**2.37** Find R for the following circuit.




$\Sigma$ drops $= 0$, from A, cw

$-20 + 10 + 10I - 30 = 0$

$10I = 40$

$I = 4\,A$

Then the drop across the resistor, being 10V, must equal 4R.

$4R = 10$

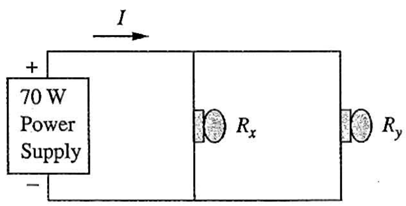
$\boxed{R = 2.5\,\Omega}$

2.61

**2.61** As a design engineer, you are asked to design a lighting system consisting of a 70-W power supply and two lightbulbs as shown in Fig. 2.124. You must select the two bulbs from the following three available bulbs.

$R_1 = 80\ \Omega$, cost = \$0.60 (standard size)
$R_2 = 90\ \Omega$, cost = \$0.90 (standard size)
$R_3 = 100\ \Omega$, cost = \$0.75 (nonstandard size)

The system should be designed for minimum cost such that lies within the range $I = 1.2\text{ A} \pm 5$ percent.




CASE I

With: $R_1 = 80\,\Omega$, $R_2 = 90\,\Omega$

$$R_{eq} = \frac{80 \times 90}{80 + 90} = 42.35\,\Omega$$

$$P = I^2 R_{eq}$$

$$I = \sqrt{\frac{70}{42.35}} = 1.28\text{ A}$$

$$5\% \times 1.2 = .06$$

$I_{accept} = 1.28 - .06 = 1.22\text{ A}$ (out of Range)

$\#$

CASE II

$R_1$ & $R_3$

$$R_{eq} = \frac{80 \times 100}{80 + 100} = 44.44$$

$$I = \sqrt{\frac{70}{44}} = 1.255$$

$I_{accept} = 1.2 + .06 = 1.26$ OK

Cost = \$0.6 + \$0.75 = \$1.35

2.61 (continued) 

With $R_2$ & $R_3$

Case III

$$R_{eq} = \frac{90 \times 100}{90 + 100} = 47.368\ \Omega$$

$$I = \sqrt{\frac{70}{47.368}} = 1.2156\ A$$

$$I_{Accept} = 1.2 + .06 = 1.26\ A$$

Since 1.2156 A is less than 1.26 A this is acceptable.

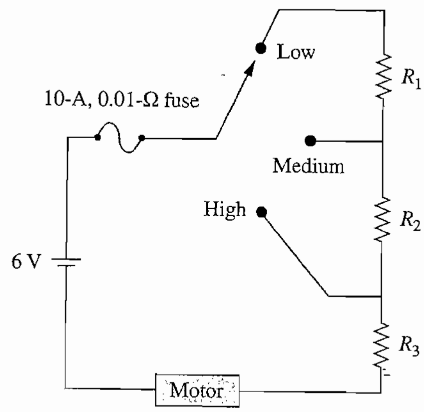
Cost

Cost = \$.9 + .75 = \$1.65

Case II is best; **$R_1$ & $R_3$** bulbs

2.74

**2.74** The circuit in Fig. 2.134 is to control the speed of a motor such that the motor draws currents 5 A, 3 A, and 1 A when the switch is at high, medium, and low positions, respectively. The motor can be modeled as a load resistance of 20 mΩ. Determine the series dropping resistances $R_1$, $R_2$, and $R_3$.




Start with the switch set on high, $R_3$ in the circuit. We have

$$-6 + (.01 + .02) \times 5 + 5R_3 = 0$$

$$5R_3 = 6 - 5 \times .03 = 5.85$$

$$R_3 = 1.17\,\Omega$$

With $R_2$ and $R_3$ in the circuit;

$$-6 + .03 \times 3 + 3(1.17) + 3R_2 = 0$$

$$3R_2 = 2.5$$

$$R_2 = 0.8\,A$$

With $R_1$, $R_2$ and $R_3$ in the circuit

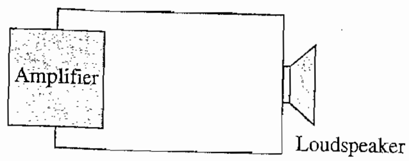
$$-6 + .03 \times 1 + 1(1.17 + .8) + 1 \times R_1 = 0$$

$$R_1 = 6 - .03 - 1.97 = 4\,\Omega$$

$$R_1 \simeq 4\,\Omega$$

2.80

**2.80** A loudspeaker is connected to an amplifier as shown in Fig. 2.139. If a 10-Ω loudspeaker draws the maximum power of 12 W from the amplifier, determine the maximum power a 4-Ω loudspeaker will draw.




With 10 Ω

$$P_{10} = 12 = \frac{V_{source}^2}{10}$$

$$V_{source}^2 = 120$$

$$V_{source} = 10.954 \text{ V}$$

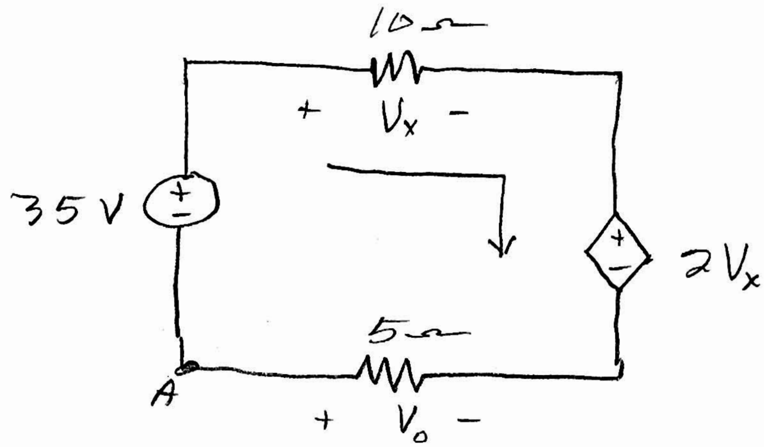
With 4 Ω

$$P_4 = \frac{V_{source}^2}{4} = \frac{120}{4}$$

$$P_4 = 30 \text{ W}$$

# PP 2.6

Find $V_x$ and $V_o$ in the following circuit.




Assume I as shown. Write KVL, drops, cw, A

$$-35 + 10I + 2V_x + 5I = 0$$

but $V_x = 10I$, so

$$-35 + 10I + 20I + 5I = 0$$

$$35I = 35$$

$$I = 1\,A$$

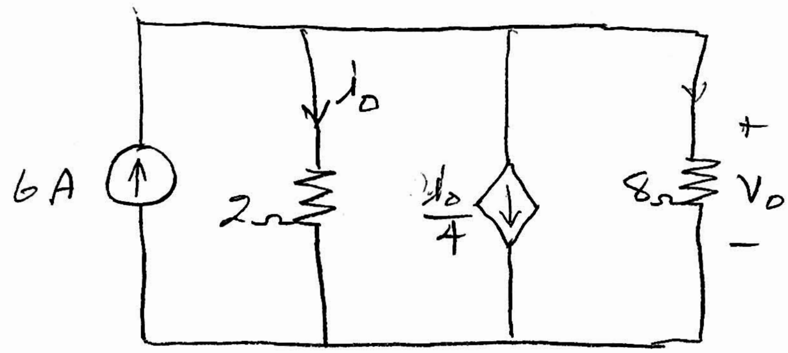
∴

$$\underline{V_x = 10I = 10V}$$

$$\underline{V_o = -5I = -5V}$$

PP 2.7

Find $V_o$ and $i_o$ in the following circuit.




$$V_o = 2 i_o$$

so

$$6 = i_o + \frac{i_o}{4} + \frac{V_o}{8}$$

$$6 = i_o + \frac{i_o}{4} + \frac{2 i_o}{8}$$

$$6 = i_o + 0.5 i_o$$

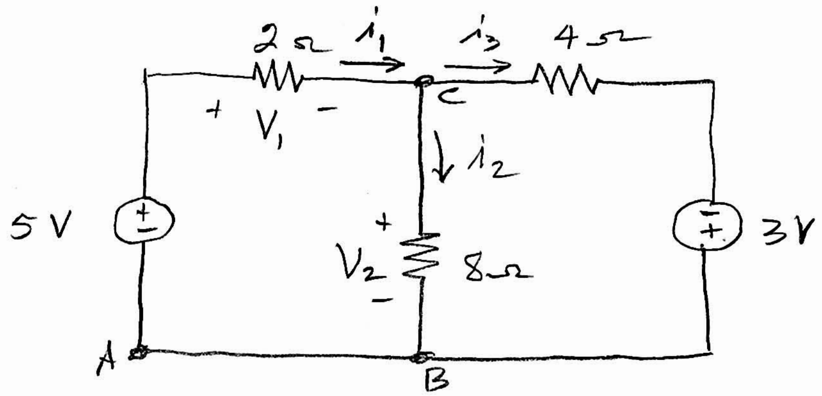
$$\underline{i_o = 4\,A}$$

$$V_o = 2 i_o = 8\,V$$

$$\underline{V_o = 8\,V}$$

## PP 2.8

Find the indicated voltages and currents in the following circuit.




Start at A, cw, Σ drops = 0

$$-5 + 2i_1 + 8i_2 + 0i_3 = 0$$

$$\boxed{2i_1 + 8i_2 + 0i_3 = 5}$$

Start at B, cw, Σ drops = 0

$$-8i_2 + 4i_3 - 3 = 0$$

$$\boxed{0i_0 - 8i_2 + 4i_3 = 3}$$

KCL @ C

$$\boxed{i_1 - i_2 - i_3 = 0}$$

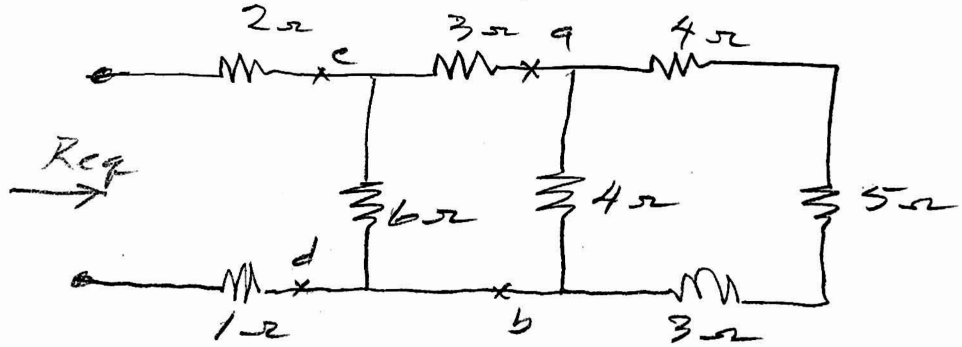
$$\begin{bmatrix} 2 & 8 & 0 \\ 0 & -8 & 4 \\ 1 & -1 & -1 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 5 \\ 3 \\ 0 \end{bmatrix}$$

$\underline{i_1 = 1.5A}$, $\underline{i_2 = 0.25A}$, $\underline{i_3 = 1.25A}$

$\underline{V_1 = 2i_1 = 3V}$ ; $\underline{V_2 = 8i_2 = 2V}$ ; $\underline{V_3 = 4i_3 = 5V}$

PP 2.9

By combination of resistors, find $R_{eq}$ for the following circuit.




$$R_{ab} = 4 \parallel (4+5+3) = \frac{4 \times 12}{4+4+5+3} = 3\,\Omega$$

$$R_{cd} = 6 \parallel (3 + R_{ab}) = \frac{6(3+3)}{3+3+6} = 3\,\Omega$$

$$R_{eq} = 2 + R_{cd} + 1 = (2 + 3 + 1)\,\Omega$$

$$R_{eq} = 6\,\Omega$$

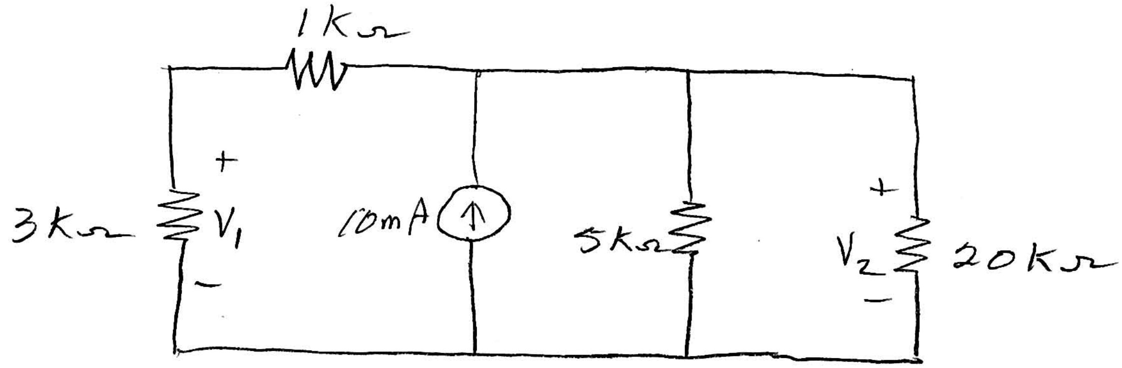
PP 2.13

For the following circuit find:

(a) $V_1$ and $V_2$

(b) P dissipated in 3kΩ & 20kΩ resistors

(c) $P_{supplied}$ by current source.




$$V_2 = 10mA \times R_{eq}$$

$$R_{eq} = 4K \parallel (5K \parallel 20K)$$

$$= 4K \parallel \frac{(5K \times 20K)}{5K + 20K} = 4K \parallel 4K = 2K\Omega$$

$$\underline{V_2} = (10K^{-1})(2K) = 20V$$

by voltage division;

$$V_1 = \frac{V_2 \times 3K}{3K + 1K} = \frac{20 \times 3}{4} = 15V$$

$$\underline{V_1 = 15V}$$

PP 2.13 continued

(b)

$$P_{3k} = \frac{V_1^2}{3k} = \frac{15^2}{3k} = 75\ mW$$

$$P_{3k} = 75\ mW$$

$$P_{20k} = \frac{V_2^2}{20k} = \frac{20^2}{20k} = 20\ mW$$

$$P_{5k} = \frac{V_2^2}{5k} = \frac{20^2}{5k} = 80\ mW$$

$$V_{1k} = \frac{20 \times 1k}{4k} = 5\ V$$

$$P_{1k} = \frac{5^2}{1k} = 25\ mW$$

$$\Sigma P_{dissipated} = (75 + 20 + 80 + 25)\ mW$$

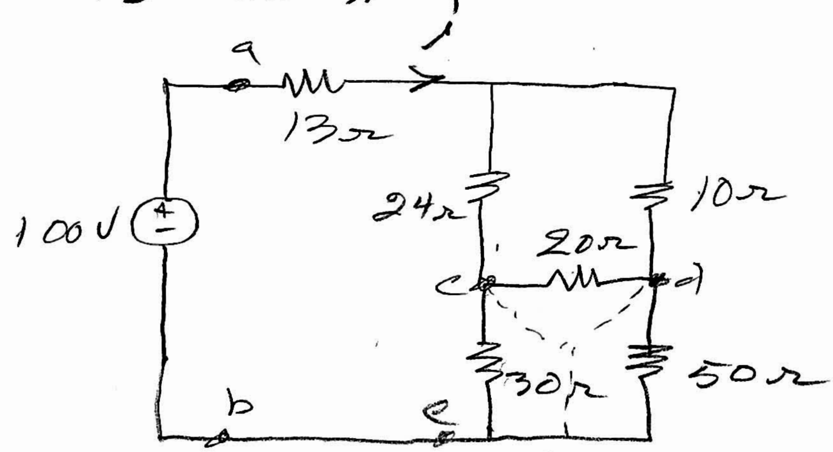
$$\Sigma P_{dissipated} = 200\ mW = P_{sup\ 10mA}$$

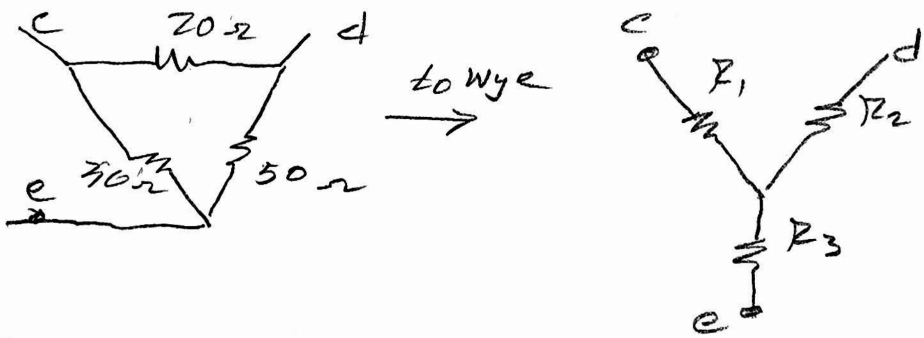
$$P_{10mA\ supplied} = (10k^{-1})V_2 = 10k^{-1} \times 20$$

$$P_{10mA\ supplied} = 200\ mW$$ checks

## PP 2.15

For the bridge network below, find $R_{ab}$ and $i$

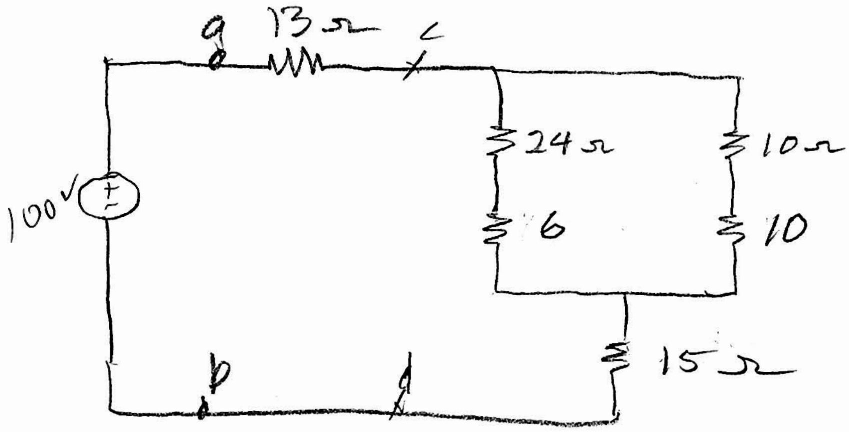



$$R_1 = \frac{20 \times 30}{20+30+50} = 6\,\Omega$$

$$R_2 = \frac{20 \times 50}{100} = 10\,\Omega$$

$$R_3 = \frac{30 \times 50}{100} = 15\,\Omega$$



## PP 2.15

$$R_{cd} = 30 \| 20 + 15 = 12 + 15$$

$$R_{cd} = 27\,\Omega$$

$$R_{ab} = 13\,\Omega + 27\,\Omega$$

$$R_{ab} = 40\,\Omega$$

$$i = \frac{100}{40} = 2.5\,A$$

2.XX You are given the circuit shown in Figure 2.XX.

(a) Use branch circuit analysis to find the current $I_1$ and $I_2$. Ans: $I_1 = 0.0741$ A, $I_2 = 1.111$ A
(b) Determine the power absorbed by the three resistors. $P_{15} = 21.07$ W, $P_{30} = 0.165$ W $P_{20} = 24.69$ W.
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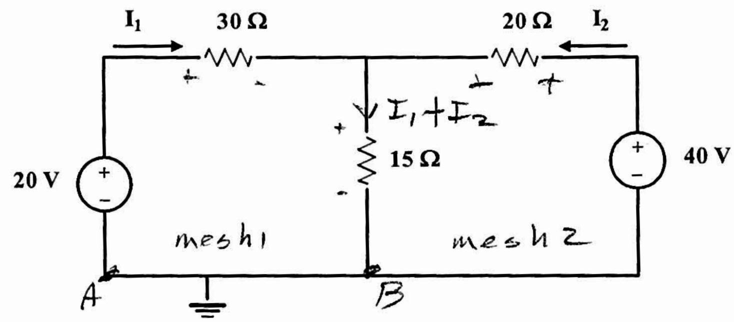


Figure 2.XX: Circuit for problem 2.XX.

(a) Around mesh 1: Start at A, cw, Σ drops = 0

$$-20 + 30I_1 + 15(I_1 + I_2) = 0$$

$$45I_1 + 15I_2 = 20$$

Around mesh 2: Start at B, cw, Σ drops = 0

$$-15(I_1 + I_2) - 20I_2 + 40 = 0$$

$$-15I_1 - 35I_2 = -40$$

$$\begin{bmatrix} 45 & 15 \\ 15 & 35 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 20 \\ 40 \end{bmatrix}$$

$I_1 = 0.07407$ A $\quad I_2 = 1.111$ A

2.XX continued

(b)

$$P_{30} = I_1^2 \times 30 = (.07407)^2 \times 30$$

$$P_{30} = 0.16459\ W = .165\ W$$

$$\underline{P_{30} = 0.165\ W}$$

$$P_{20} = I_2^2 \times 20 = 24.67\ W$$

$$\underline{P_{20} = 24.69\ W}$$

$$P_{15} = (I_1 + I_2)^2 \times 15 = (1.185)^2 \times 15$$

$$P_{15} = 21.06\ W$$

$$\Sigma P_{abs} = (0.165 + 24.69 + 21.06)\ W$$

$$\boxed{\Sigma P_{abs} = 45.92\ W}$$

$$P_{sup_{20}} = 20 \times I_1 = 1.482\ W$$

$$P_{sup_{40}} = 40 \times I_2 = 44.44$$

$$\Sigma P_{sup} = 1.482 + 44.44$$

$$\boxed{\Sigma P_{sup} = 45.92\ W}$$

checks