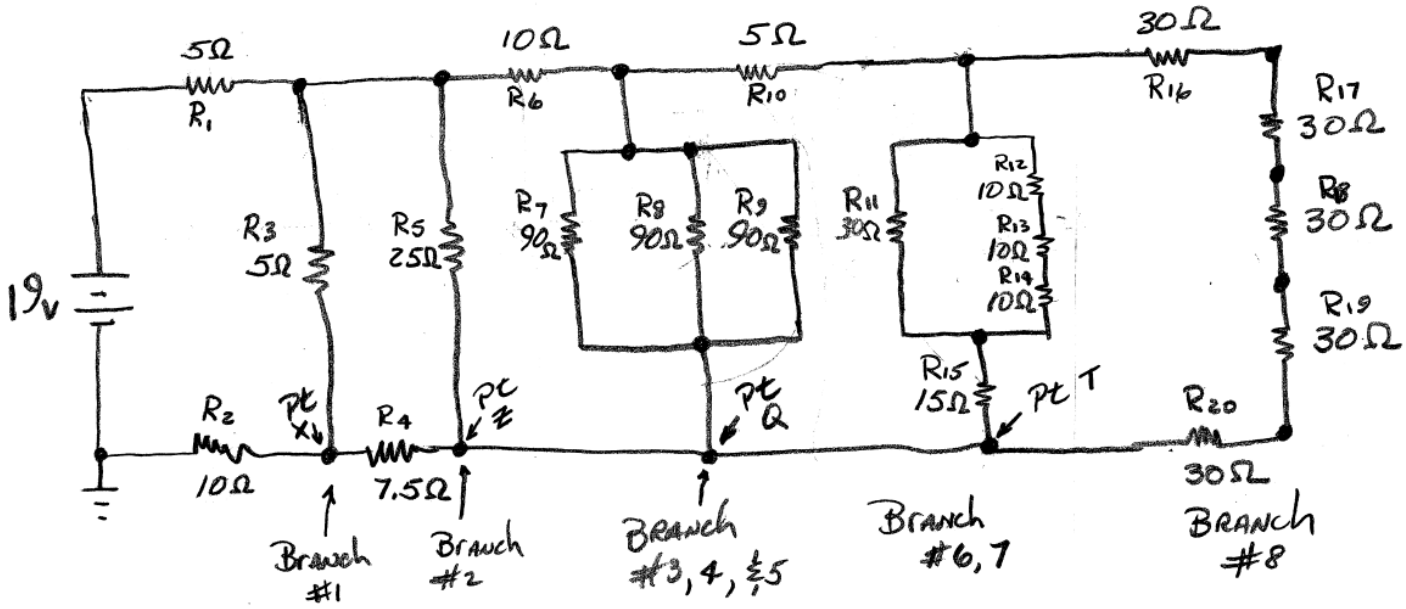
Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4

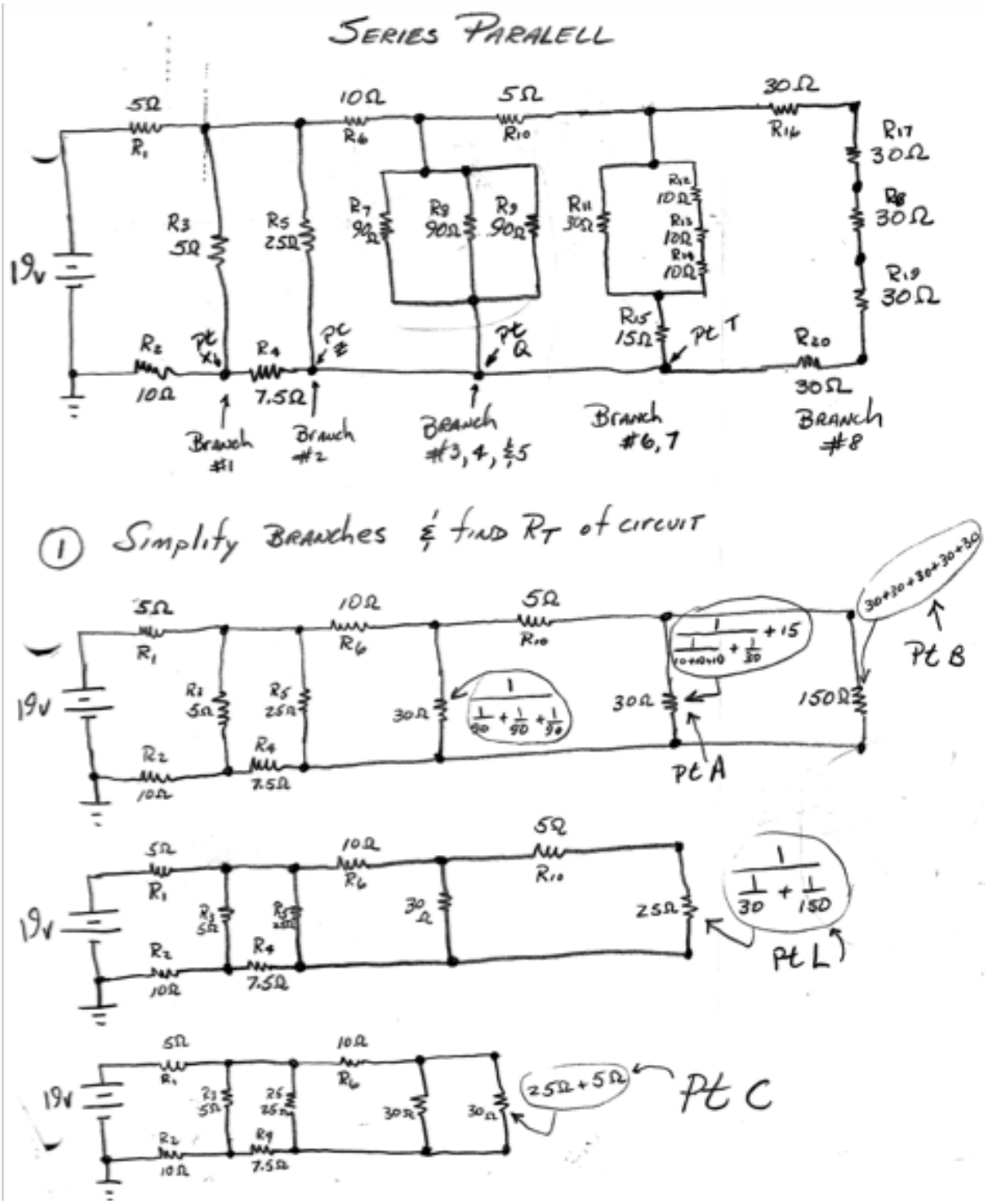
Instructions: Solve the following circuit.



Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

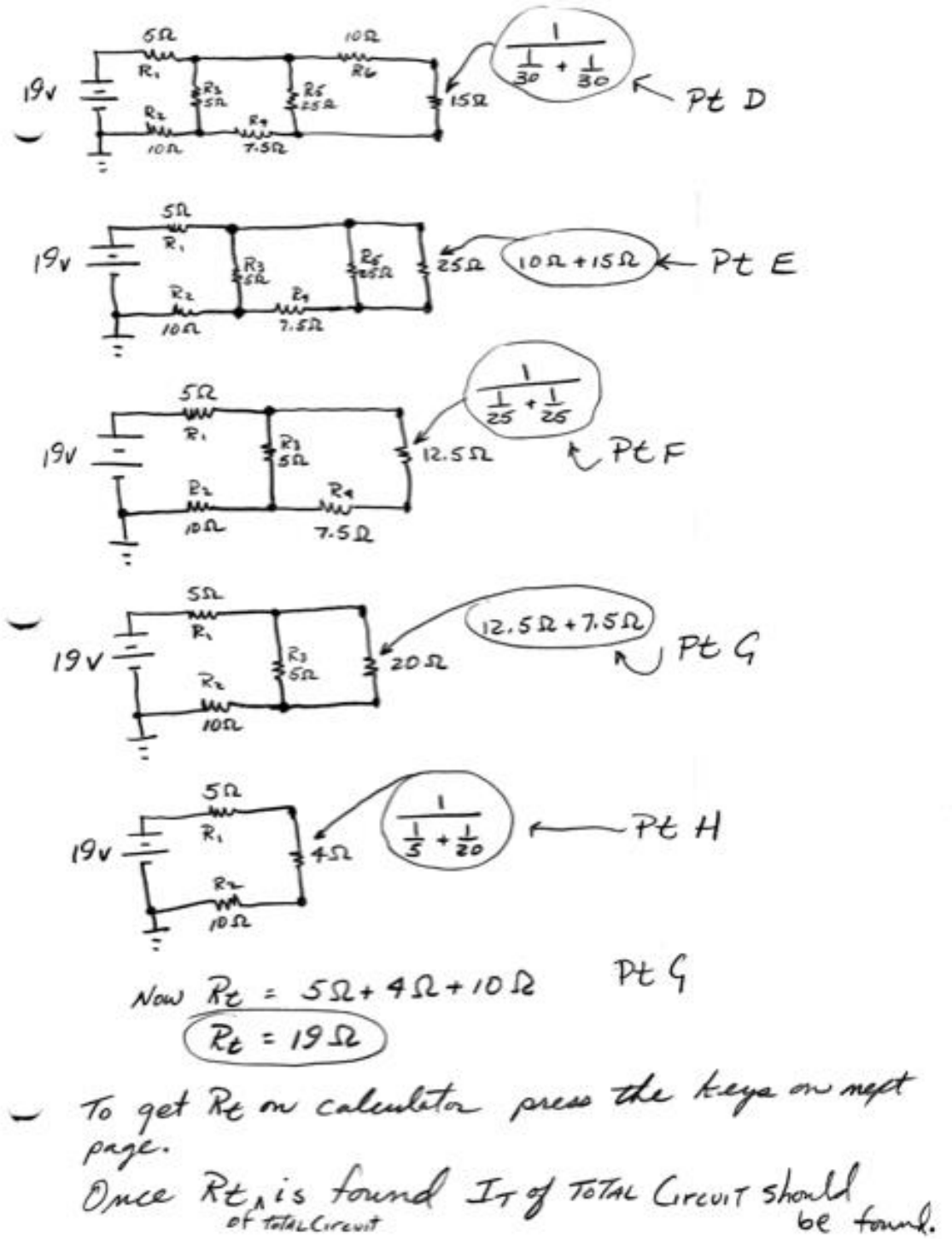
Homework 4

Solution:



Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4



Now $R_t = 5\Omega + 4\Omega + 10\Omega$ Pt G

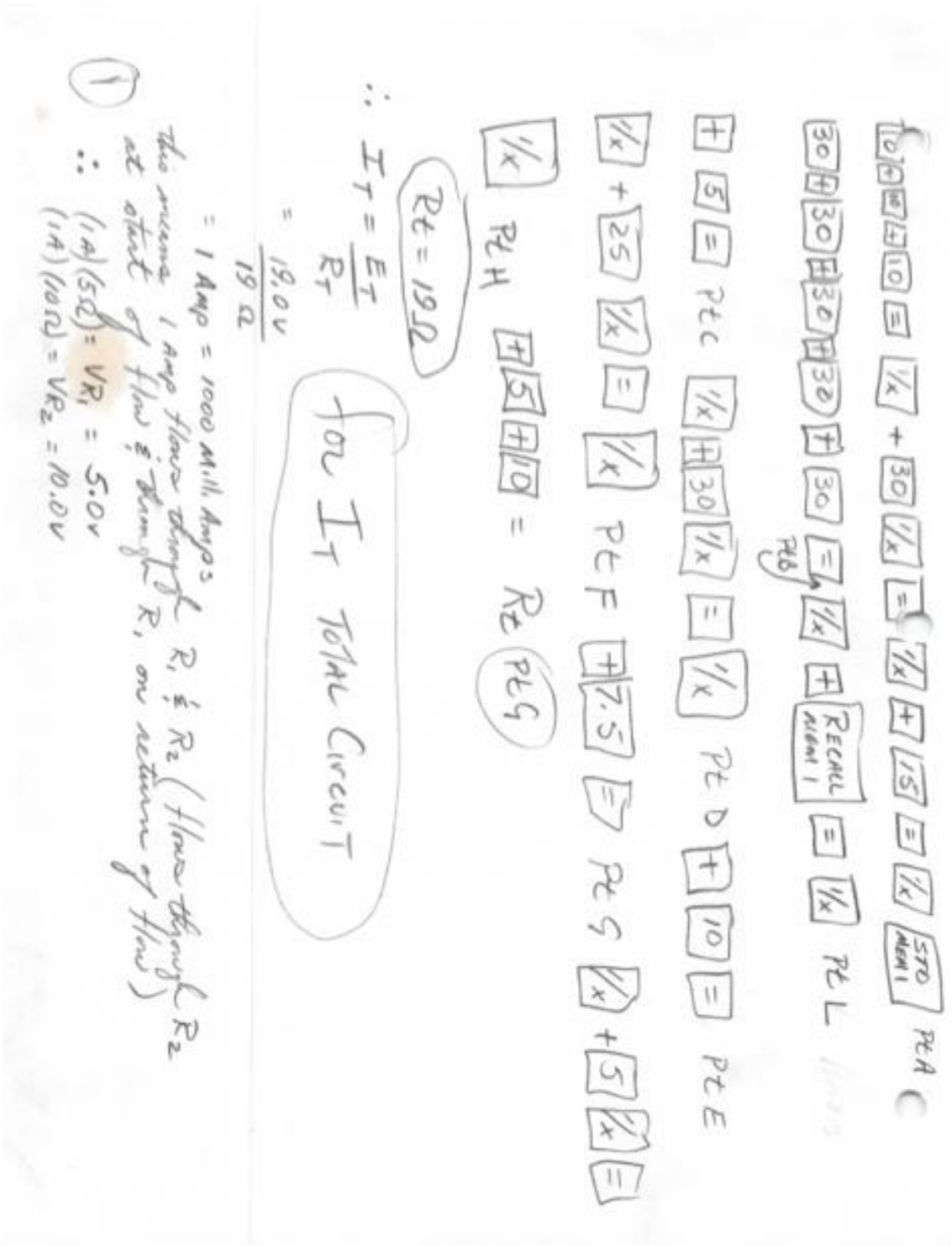
$R_t = 19\Omega$

To get R_t on calculator press the keys on next page.

Once R_t of Total Circuit is found I_T of Total Circuit should be found.

Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4



Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4

Since these voltages are dropped across R_1 & R_2 Subtract from Supply.

(2) $V_{R_3} = V_T - V_{R_1} - V_{R_2} = 19v - 5v - 10v = 4.0v$

(3) Since R_3 in parallel with supply 4.0v across R_3

$I_{R_3} = \frac{V_{R_3}}{R_3} = \frac{4.0v}{5\Omega} = .8A = 800ma$

current out of pt X = current into pt X.
↓
= 1 Amp (from step 1)

since part of this 1 Amp flows through R_3 & some through R_4 (see circuit) we know 800ma goes through R_3 the rest goes through R_4.

$\therefore I_{R_4} = I_{R_2} - I_{R_3} =$
$= 1000ma - 800ma$
$= 200ma$

$V_{R_4} = (I_{R_4})(R_4)$
$= (200ma)(7.5\Omega)$
$= 1.5v$

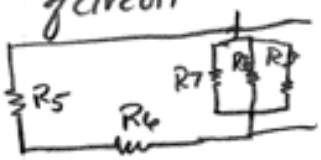
(4) $V_{R_5} = V_{R_3} - V_{R_4} = V_{\text{branch previous}} - V_{\text{series drop}}$
$= 4.0v - 1.5v$
$= 2.5v$

$I_{R_5} = \frac{V_{R_5}}{R_5} = \frac{2.5v}{25\Omega} = .1A = 100ma$

Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4

current into pt Z = current out of pt Z.
Can treat R_6 like it is at bottom of circuit



$\therefore I_{R_6} = I_{R_4} - I_{R_5}$

$= 200ma - 100ma$

(5) $= 100\,ma$

$V_{R_6} = (100\,ma)(10\,\Omega)$
$= (.1)(10\,\Omega)$
$= 1.0\,v$

(6) Since R_7, R_8 & R_9 are all in parallel all have the same voltage across them.

$V_{R_7} = V_{R_8} = V_{R_9} = V_{R_5} - V_{R_6} = V_{Branch\ previous} - V_{series\ drop}$

$= 1.5\,v$

$I_{R_7} = I_{R_8} = I_{R_9}$ is equal in value since they are same value resistors.

$I_{R_7} = I_{R_8} = I_{R_9} = \frac{E_{R_7}, E_{R_8} \text{ & } E_{R_9}}{R_7, R_8 \text{ & } R_9}$

$= \frac{1.5\,v}{90\,v}$

$= .016666666\,A$
$= 17\,ma$ through R_7, R_8 & R_9

Note: ALL 3 R's HAVE 1.5V across them & 17ma of current through them

Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4

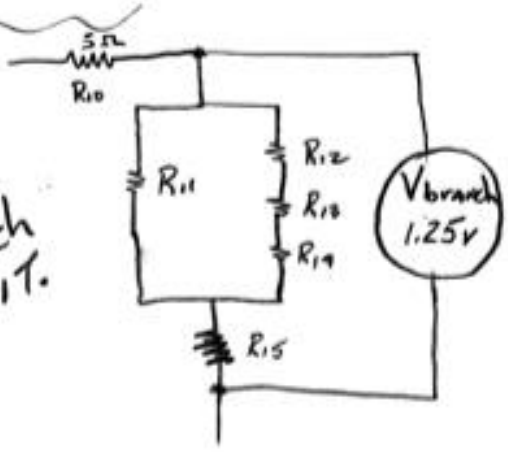
(7) Do like R_4, R_6

current into pt Q = current out of pt Q

$$\therefore I_{R_{10}} = I_{R_6} - I_{R_7} - I_{R_8} - I_{R_9}$$
$$= .1 - .016666666 - .016666666 - .016666666$$
$$= 100\,ma - 17\,ma - 17\,ma - 17\,ma$$
$$= .05\,A$$
$$= 50\,ma$$

$$V_{R_{10}} = (I_{R_{10}})(R_{10})$$
$$= (50\,ma)(5\,\Omega)$$
$$= (.05)(5\,\Omega)$$
$$= .25\,V$$

(8) Next: CALCULATE THIS BRANCH OF CIRCUIT.



$$V_{BRANCH} = V_{Branch\ Previous} - V_{R_{10}} =$$
$$= 1.5V - .25V$$
$$= 1.25V$$

Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4

Since this branch is a series parallel branch need to find Rt of the branch

$$\therefore R_t = \frac{1}{\frac{1}{10\Omega + 10\Omega + 10\Omega} + \frac{1}{30\Omega}} + 15\Omega$$

10 + 10 + 10 = 1/x + 30 1/x = 1/x

+ 15 =

$= 30\Omega$

$$I_{branch} = \frac{V_{BRANCH}}{R_{T\ branch}}$$

$$= \frac{1.25V}{30\Omega}$$

$= .041666666\ A$

$= 41.7ma$

this current all flows through R_{15} (series)

$\therefore I_{R15} = 41.7ma$

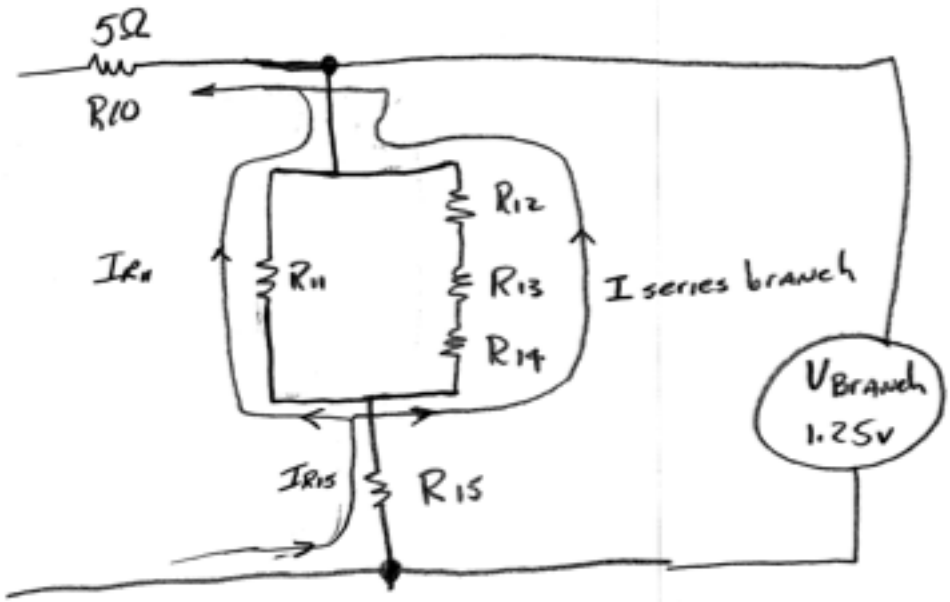
this is split 2 ways half through R_{11} the other half through the 3 series resistors R_{12}, R_{13}, R_{14} it splits in half since both branch R_t's $= 30\Omega$

$\therefore I_{R11} = .020833333\ A = I_{12} = I_{13} = I_{14}$

$= 20.8ma$

Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4



$I_{R15} = 41.7\,ma$

$I_{R11} = 20.8\,ma$

$I_{R12} = 20.8\,ma$

$I_{R13} = 20.8\,ma$

$I_{R14} = 20.8\,ma$

VOLTAGES $V = I \times R$

$V_{R15} = (I_{R15})(R_{15}) = (41.7\,ma)(15\Omega) = .615v = 615\,mV$

$V_{R11} = (I_{R11})(R_{11}) = (20.8\,ma)(30\Omega) = .624v = 624\,mV$

$V_{R12} = (I_{R12})(R_{12}) = (\,''\,)(10\Omega) = .208v = 208\,mV$

$V_{R13} = (I_{R13})(R_{13}) = (\,''\,)(10\Omega) = .208v = 208\,mV$

$V_{R14} = (I_{R14})(R_{14}) = (\,''\,)(10\Omega) = .208v = 208\,mV$

$V_{R12} + V_{R13} + V_{R14}$ should $= V_{R11}$

& $V_{R11} + V_{R15} = V_{branch} = V_{R12} + V_{R13} + V_{R14} + V_{R15}$

Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4

(9) the rest of the resistors are in series with each other but in parallel with the circuit.

$\therefore V_{\text{across Remaining R's}} = V_{\text{across previous branch}}$

$= 1.25\text{v}$

R_t of remaining branch

$R_t = 30\Omega + 30\Omega + 30\Omega + 30\Omega + 30\Omega$

$= 150\Omega$

$I_{\text{remaining branch}} = \frac{V_{\text{remaining branch}}}{R_{t\ \text{remaining branch}}}$

$= \frac{1.25\text{v}}{150\Omega}$

$= .008333333\ A$

$= 8.33\ ma$

$V_{R16} = (I_{R16})(R_{16}) = (8.33\text{ma})(30\Omega) = .25\text{v}$

$V_{R17} = (I_{R17})(R_{17}) = (\ \text{"}\ )(30\Omega) = .25\text{v}$

$V_{R18} = (I_{R18})(R_{18}) = (\ \text{"}\ )(30\Omega) = .25\text{v}$

$V_{R19} = (I_{R19})(R_{19}) = (\ \text{"}\ )(30\Omega) = .25\text{v}$

$V_{R20} = (I_{R20})(R_{20}) = (\ \text{"}\ )(30\Omega) = .25\text{v}$

Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4

IF CIRCUIT IS SOLVED CORRECTLY ALL VOLTAGE DROPS AROUND OUTSIDE OF CIRCUIT WILL EQUAL SUPPLY VOLTAGE.

$\therefore V_{R_1} + V_{R_6} + V_{R_{10}} + V_{R_{16}} + V_{R_{17}} + V_{R_{18}} + V_{R_{19}} + V_{R_{20}} + V_{R_4} + V_{R_2} = V_{TOT}$

$5V + 1.0V + .25V + .25V + .25V + .25V + .25V + .25V + 1.5V + 10.0V = 19V$

$V_{TOTAL} = 19V$

Sum of OUTSIDE VOLTAGE DROPS $= 19V$

ALSO the currents through the PARALELL BRANCHES WILL EQUAL I_{TOTAL} of CIRCUIT.

$I_{BRANCH_1} + I_{BRANCH_2} + I_{BRANCH_3} + I_{BRANCH_4} + I_{BRANCH_5} + I_{BRANCH_6} + I_{BRANCH_7} + I_{BRANCH_8}$

should EQUAL I_{TOTAL}

$I_{TOTAL} = 1 AMP$

$I_{B_1} + I_{B_2} + I_{B_3} + I_{B_4} + I_{B_5} + I_{B_6} + I_{B_7} + I_{B_8} \stackrel{?}{=} 1 AMP$

$.8A + .1A + .017A + .017A + .017 + .0417 + (\text{NOT USED}) + .00833A =$

NOTE I_{B7} NOT USED
SINCE I flow in branch 6, 7 all goes through R_{15} USE THAT VALUE

TOTAL BRANCH currents $= 1.00103 A$

I_{TOTAL} of CIRCUIT $= 1 Amp$

Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4

Note if ACTUAL CALCULATOR VALUES USED IT WORKS EXACT.

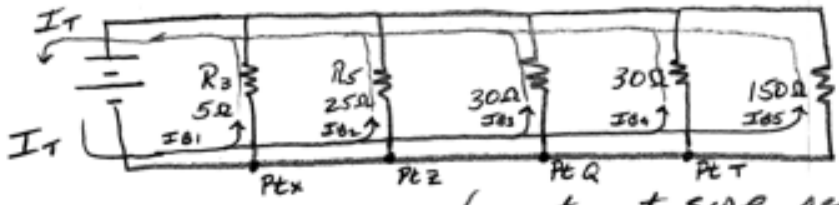
TO SEE:

$$IB_1 = \frac{V_{R3}}{R_3} \qquad I_{B2} = \frac{V_{R5}}{R_5} \qquad I_{B3} \frac{V_{R\,B3}}{R_{T\,B3}}$$

$$I_{B4} = \frac{V_{R\,B4}}{R_{T\,B4}} \qquad I_{B5} = \frac{V_{R\,B5}}{R_{T\,B5}}$$

$$I_{B1} = \frac{4.0V}{5\Omega} \qquad I_{B2} = \frac{2.5V}{25\Omega} \qquad I_{B3} = \frac{1.5V}{30\Omega}$$

$$I_{B4} = \frac{1.25V}{30\Omega} \qquad I_{B5} = \frac{1.25}{150\Omega}$$



What was done. forget out side resistors make EQUIVELANT CIRCUIT of INSIDE branches

$$I_{B1} + I_{B2} + I_{B3} + I_{B4} + I_{B5}$$

$$.8A + .1A + .05A + .041666666 + .008333333$$

$$= 1 \text{ Amp}$$

∴ Correct

Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4

Power can also be calculated.

The power delivered by the supply

$P = I \times E$

$= (1\text{ Amp})(19\text{ v})$

$= 19$ watts

This ALSO EQUALS the power consumed by the LOAD OR CIRCUIT.

The power dissipated IS EQUAL TO the power consumed by the LOAD

Power dissipated by a resistor

$P = I^2 R$

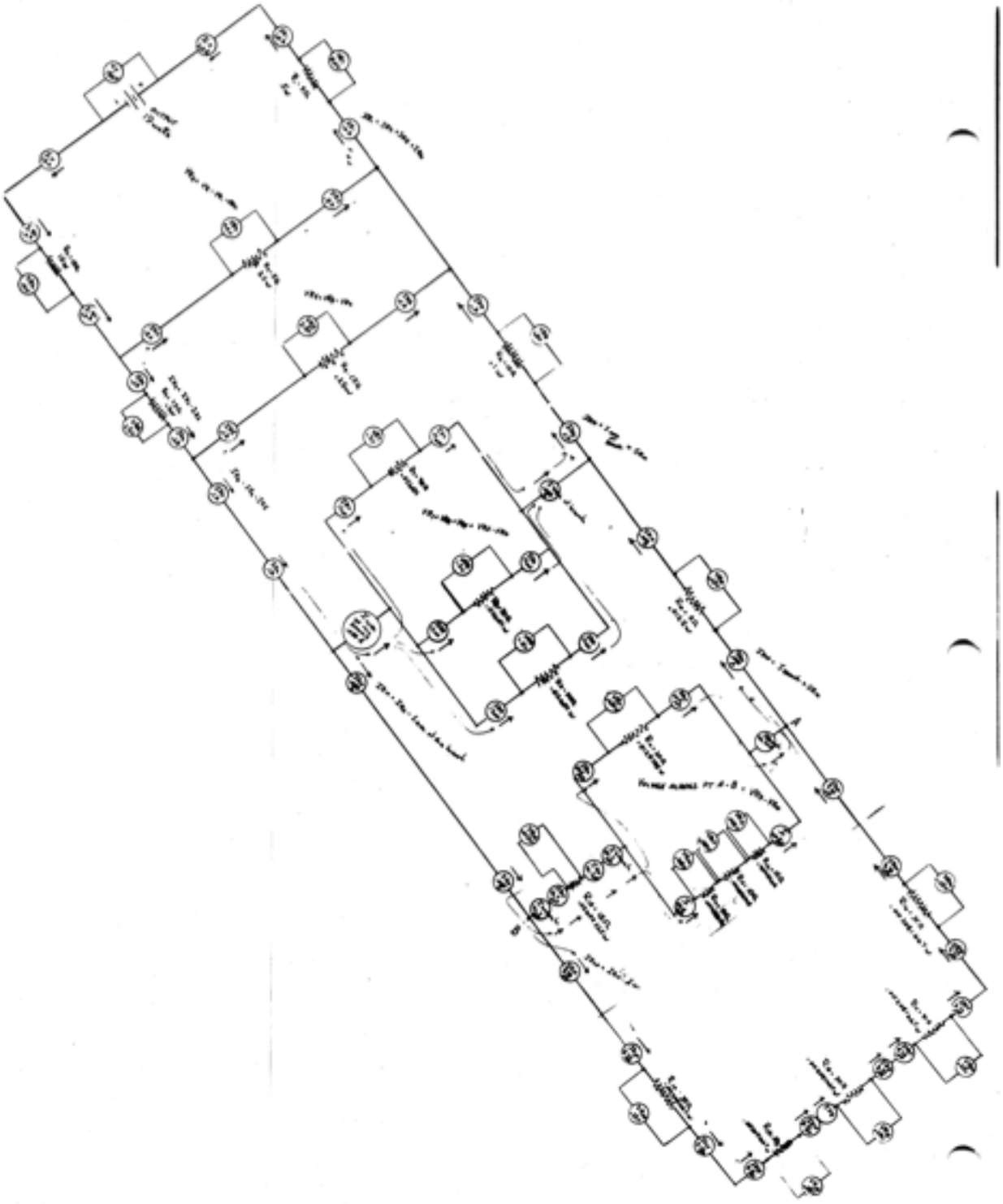
$(I_1)^2 R_1 = (1A)^2(5\Omega) = 5w$
$(I_2)^2 R_2 = (1A)^2(10\Omega) = 10w$
$(I_3)^2 R_3 = (.8A)^2(5\Omega) = 3.2w$
$(I_4)^2 R_4 = (.2A)^2(7.5\Omega) = .3w$
$(I_5)^2 R_5 = (.1A)^2(25\Omega) = .25w$
$(I_6)^2 R_6 = (.1A)^2(10\Omega) = .1w$
$(I_7)^2 R_7 = (.017A)^2(90\Omega) = .02601w$
$(I_8)^2 R_8 = (.017)^2(90\Omega) = .02601w$
$(I_9)^2 R_9 = (.017)^2(90\Omega) = .02601w$
$(I_{10})^2 R_{10} = (.050A)^2(5\Omega) = .0125w$
$(I_{11})^2 R_{11} = (.0208)^2(30\Omega) = .0129792w$
$(I_{12})^2 R_{12} = (.0208A)^2(10\Omega) = .0043264w$

$(I_{13})^2 R_{13} = (.0208A)^2(10\Omega) = .0043264w$
$(I_{14})^2 R_{14} = (.0208A)^2(10\Omega) = .0043264w$
$(I_{15})^2 R_{15} = (.0417A)^2(15\Omega) = .02608335w$
$(I_{16})^2 R_{16} = (.00833A)^2(30\Omega) = .002081667w$
$(I_{17})^2 R_{17} =$ " " = " w
$(I_{18})^2 R_{18} =$ " " = " w
$(I_{19})^2 R_{19} =$ " " = " w
$(I_{20})^2 R_{20} =$ " " = " w

TOTAL of ALL
$= 19.002600614\text{ W}$
WOULD COME OUT EXACT IF EXACT I VALUES WERE USED.

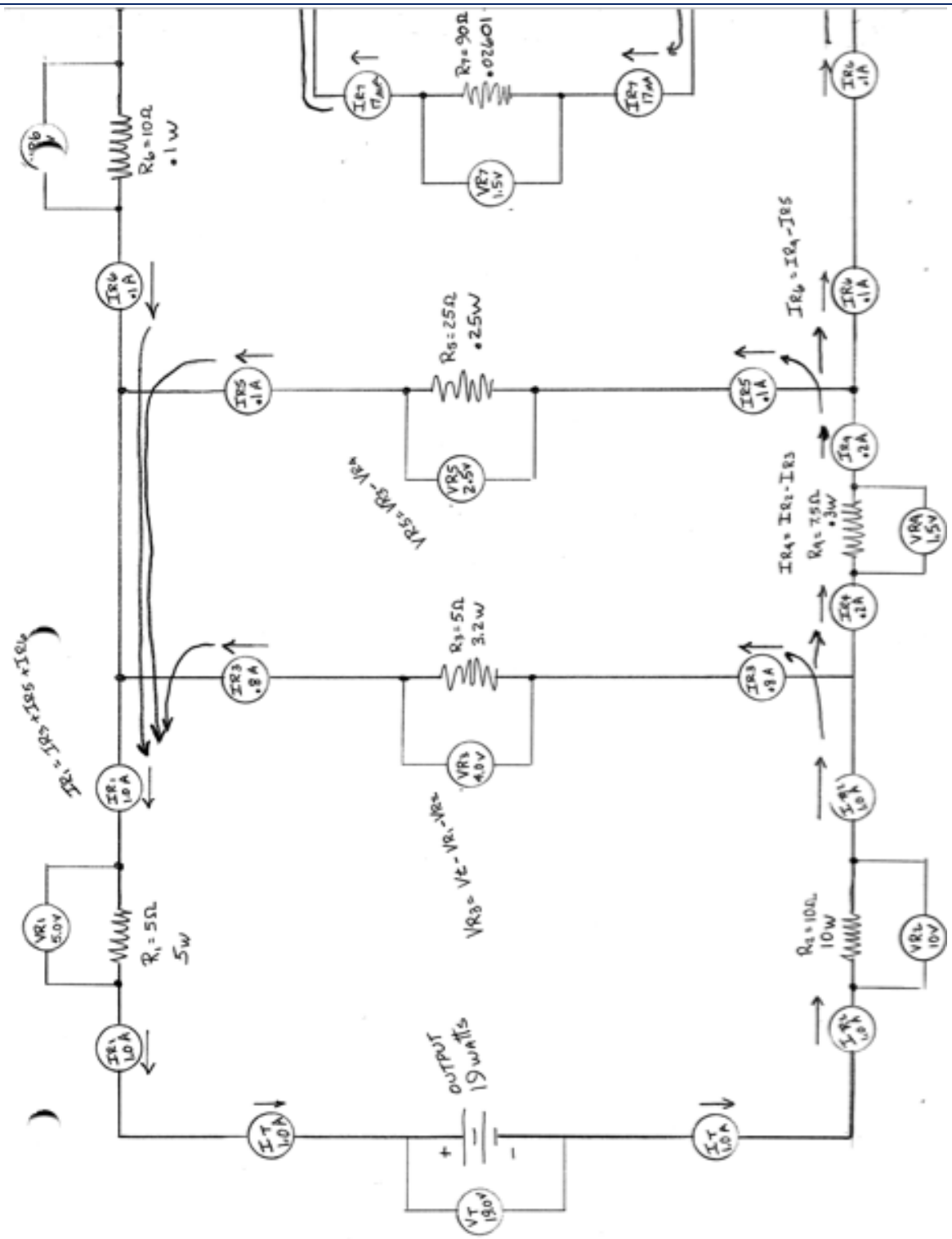
Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4



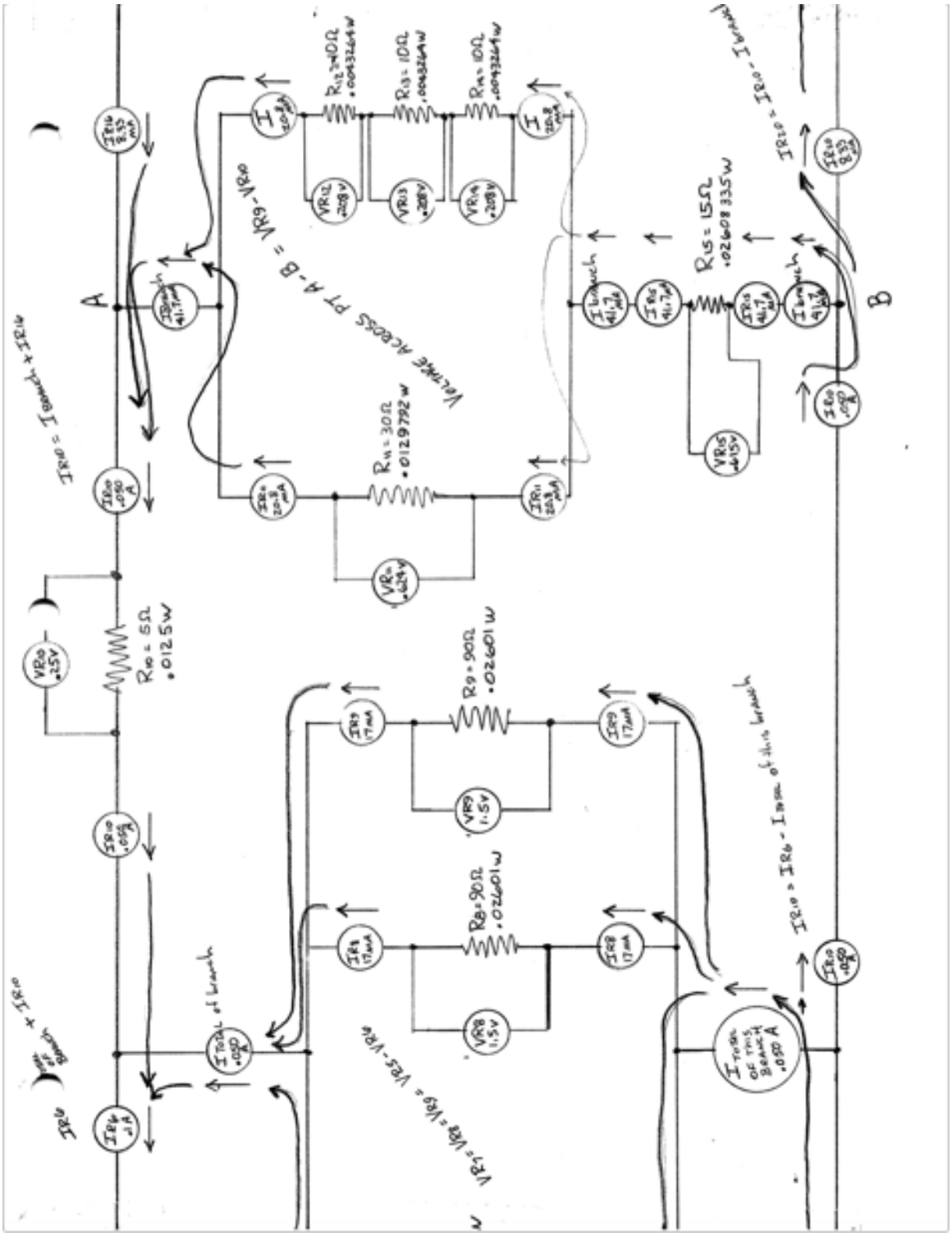
Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4



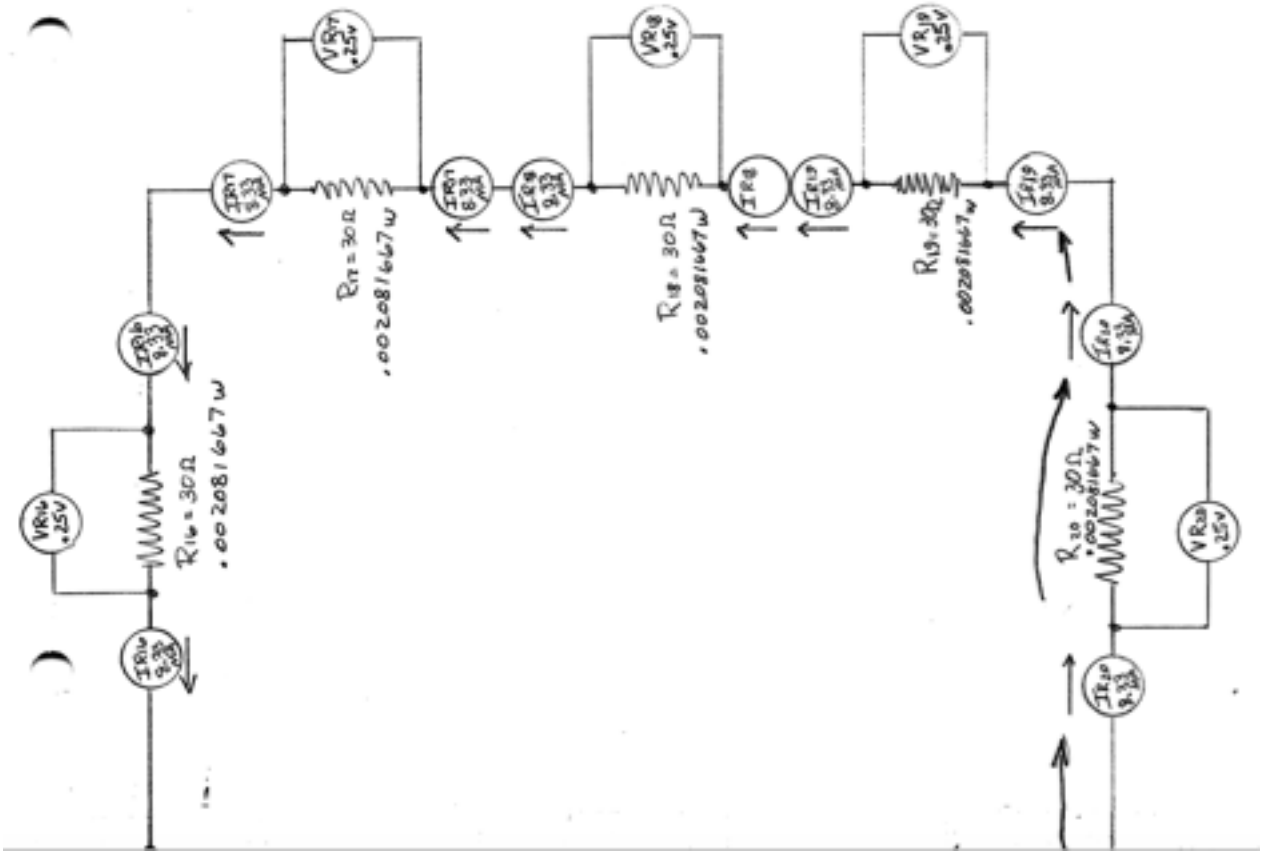
Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4



Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4



Basic Electricity – Unit 6: Other Basic Circuit Fundamentals

Homework 4

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