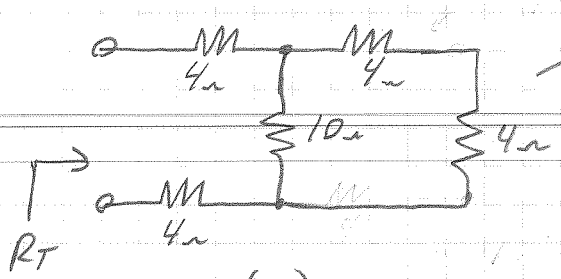
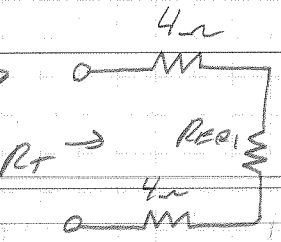
~~(2)~~ DETERMINE R_T

(3)



(a)

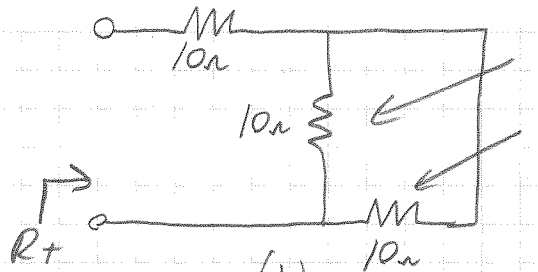


$R_{EQ1} = 10\Omega \,//\, 8\Omega$
$= 4.44\Omega$

$\therefore R_T = 4\Omega + 4.44\Omega + 4\Omega$

OR

$\boxed{R_T = 12.44\Omega}$



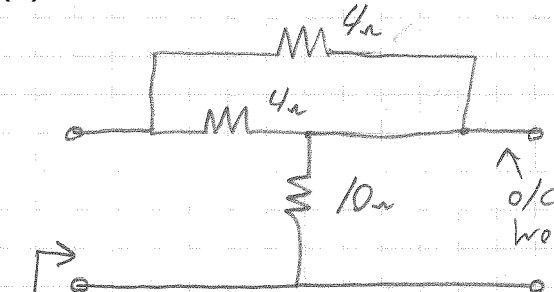
(b)

$R_T = 10\Omega + (10\Omega \,//\, 10\Omega)$

$= 10\Omega + 5\Omega$

$\boxed{R_T = 15\Omega}$

(4)

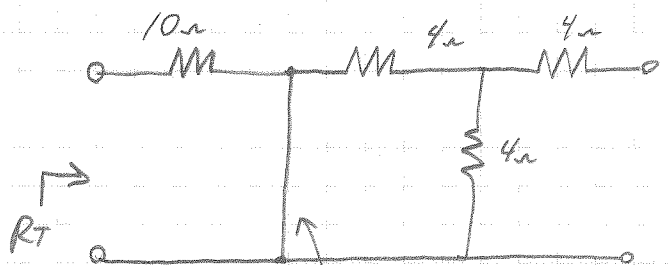


~~(c)~~ (a)

$R_T = (4\Omega \,//\, 4\Omega) + 10\Omega$

$= 2\Omega + 10\Omega$

$\boxed{R_T = 12\Omega}$

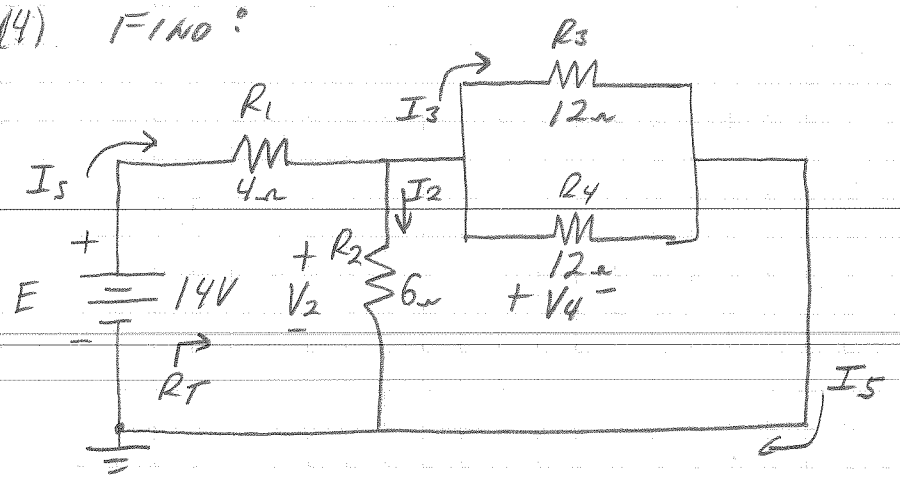


~~(d)~~ (b)

$R_T = 10\Omega + \underbrace{0\Omega \,//\, (4\Omega + 4\Omega)}_{0\Omega}$

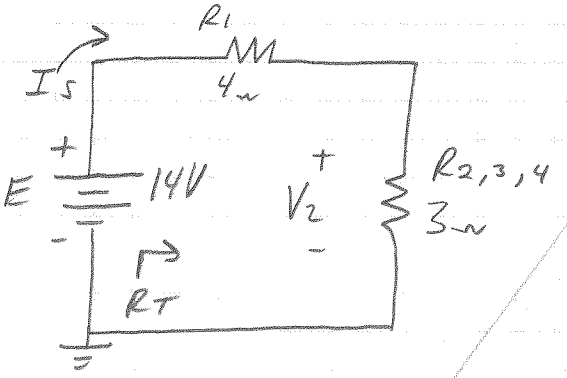
$\therefore \boxed{R_T = 10\Omega}$

(4) FIND:



(a) R_T

- COMBINE R_3 & R_4 (IN PARALLEL) W/ R_2 (ALSO IN PARALLEL) & REDRAW



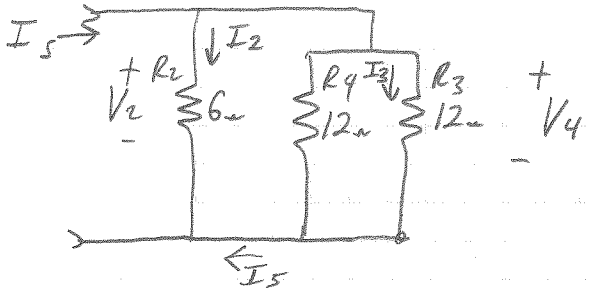
$$R_{2,3,4} = (R_3 // R_4) // R_2$$
$$= 12\Omega // 12\Omega // 6\Omega$$
$$= \underline{\underline{3\Omega}}$$

$$R_T = R_1 + R_{2,3,4} = \boxed{7\Omega}$$

(b) I_5, I_2, I_3

$$I_5 = \frac{E}{R_T} = \frac{14V}{7\Omega} = \boxed{2A}$$

- REDRAW TO CLEARLY SEE I_2, I_3



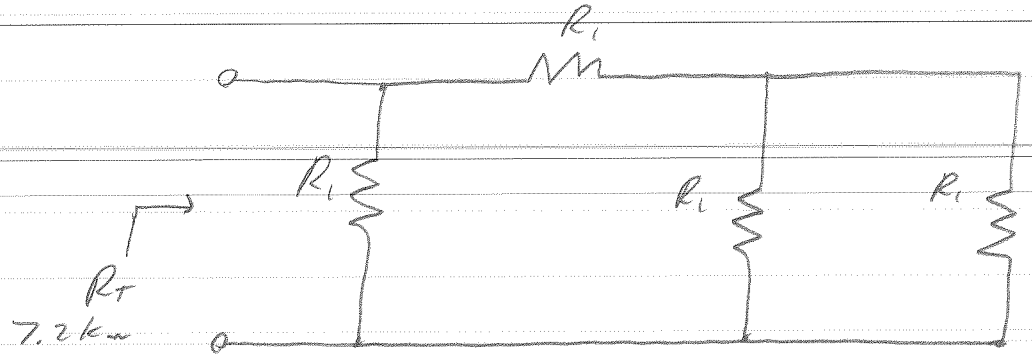
$$I_2 = \frac{V_2}{R_2} \quad \text{BUT FROM (a)}$$

$$V_2 = E\left(\frac{R_{2,3,4}}{R_T}\right)$$
$$= 14V\left(\frac{3\Omega}{7\Omega}\right) = \underline{6V}$$

$$\therefore I_2 = \frac{6V}{6\Omega} = \boxed{1A}$$

~~(a)~~ $R_T = 7.2\,k\Omega$, FIND R_1

(6)



$$R_T = (R_1 // R_1 + R_1) // R_1$$

$$= \left(\frac{R_1 \cdot R_1}{R_1 + R_1} + R_1\right) // R_1$$

$$\therefore R_T = \frac{\left(\frac{R_1^2}{2R_1} + R_1\right)(R_1)}{\left(\frac{R_1^2}{2R_1} + R_1\right) + R_1} = \frac{\left(\frac{1}{2}R_1 + R_1\right)(R_1)}{\left(\frac{1}{2}R_1 + R_1\right) + R_1}$$

$$R_T = \frac{1.5R_1^2}{2.5R_1} = \frac{1.5R_1}{2.5} = \underline{0.6R_1}$$

$$\therefore R_T = 7.2\,k\Omega = 0.6R_1$$

OR

$$\boxed{R_1 = 12\,k\Omega}$$

(4) (b) CONTINUED

$I_3 = \frac{V_4}{R_3}$, BUT $V_4 = V_2$ SINCE R_4 & R_2 ARE IN PARALLEL

$\therefore I_3 = \frac{V_2}{R_3} = \frac{6V}{12\Omega} = \boxed{0.5A}$

(c) FIND I_5

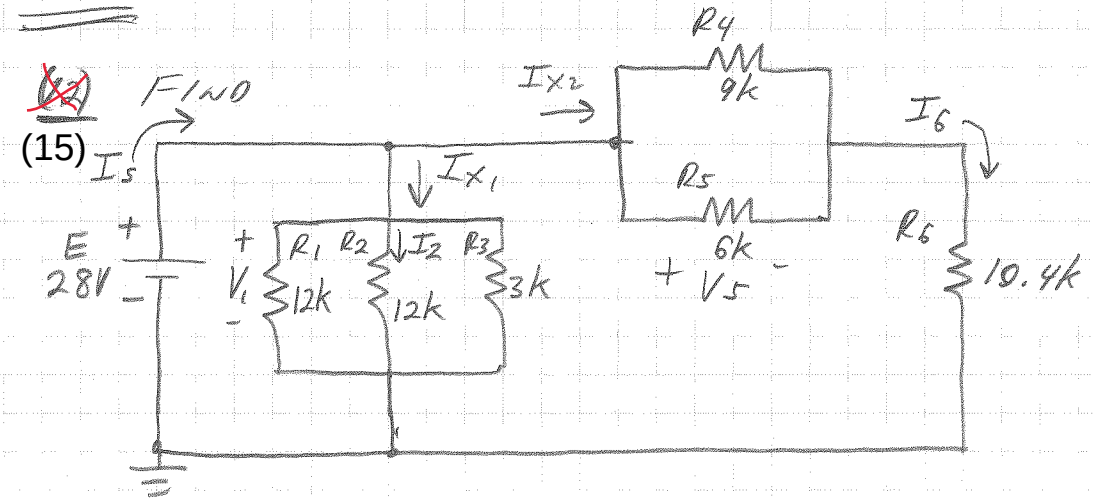
- SEE THE SCHEMATIC FROM PART (b)

$I_5 = \frac{V_4}{R_4 // R_3} = \frac{6V}{6\Omega} = \boxed{1A}$

(d) FIND V_2 & V_4

- DONE IN (b) $\boxed{V_2 = V_4 = 6V}$

(15) FIND



a) I_5, I_2, I_6

- SIMPLIFY THE CIRCUIT & REDRAW

$R_{1,2,3} = R_1 // R_2 // R_3 = 12k // 12k // 3k = 2k\Omega$

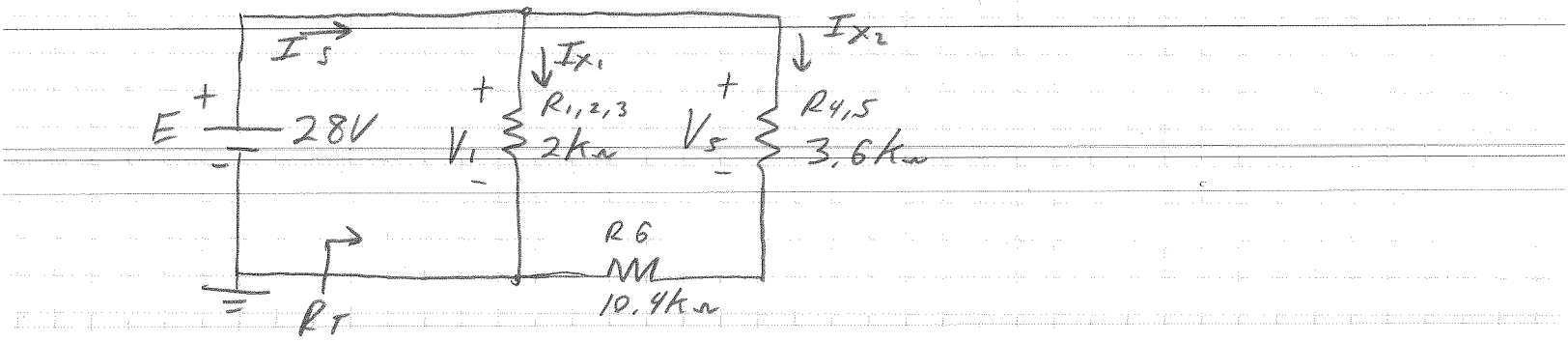
$R_{4,5} = R_4 // R_5 = 9k // 6k = 3.6k\Omega$

- FIND I_{x1} & I_{x2}, USE THIS TO FIND I_2 & I_6

~~(A)~~ CONTINUED

(15)

a) REDRAWN:



I_S] $I_S = \frac{E}{R_T}$, $R_T = R_{1,2,3} // (R_{4,5} + R_6)$

$= 2k\Omega // 14k\Omega$

$\underline{R_T = 1.75k\Omega}$

$\therefore I_S = \frac{28V}{1.75k\Omega} = \boxed{16mA}$

I_2] $I_2 = I_{X_1}\left(\frac{R_{1,2,3}}{R_2}\right)$, CURRENT DIVIDER REF TO THE ORIGINAL SCHEMATIC

$I_{X_1} = \frac{E}{R_{1,2,3}} = \frac{28V}{2k\Omega} = \underline{14mA}$

$\therefore I_2 = 14mA\left(\frac{2k\Omega}{12k\Omega}\right) = \boxed{2.33\,mA}$

I_6] $-I_6 = I_{X_2}$

KCL: $I_S - I_{X_1} - I_{X_2} = 0$

OR

$I_S = I_{X_1} + I_{X_2}$ BUT $I_S = 16mA$, $I_{X_1} = 14mA$, $I_{X_2} = I_6$

WE HAVE: $I_6 = I_S - I_{X_1}$

$= 16mA - 14mA$

$\boxed{I_6 = 2mA}$

(15) ~~(12)~~ CONTINUED

b) V_1, V_5

$V_1 = E = \boxed{28V}$

- FOR V_5, USE VOLTAGE DIVIDER & THE SIMPLIFIED SCHEMATIC

$$V_5 = E\left(\frac{R_{4,5}}{R_{4,5}+R_6}\right) = 28V\left(\frac{3.6k\Omega}{14k\Omega}\right)$$

$\boxed{V_5 = 7.2V}$

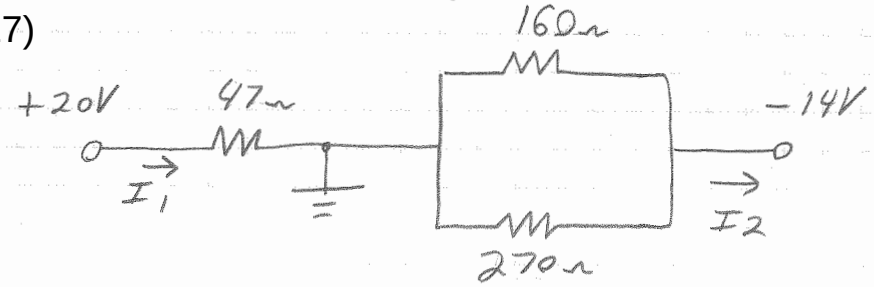
c) P_{R_3}

$$P_{R_3} = \frac{(V_{R_3})^2}{R_3},$$

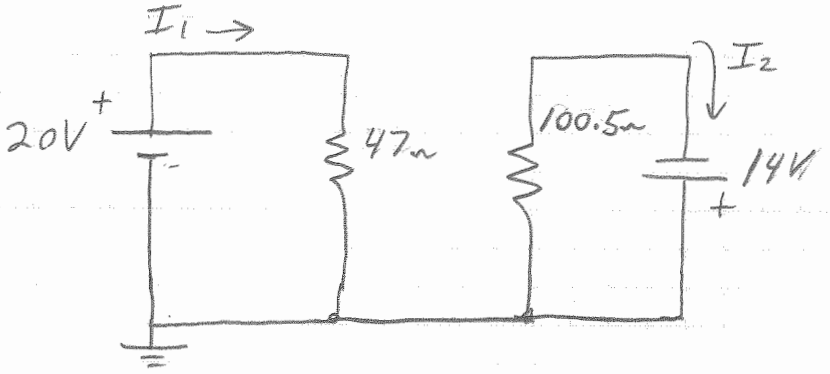
$$= \frac{(V_1)^2}{R_3} = \frac{(28V)^2}{3k\Omega} = \boxed{261.3\,mW}$$

~~(14)~~ FIND I_1 & I_2

(17)



- REDRAW THE CIRCUIT SHOWING THE SUPPLIES & COMBINING THE PARALLEL RESISTORS



$160\Omega \,//\, 270\Omega = \underline{100.5\Omega}$

$$I_1 = \frac{20V}{47\Omega} = \boxed{425.5\,mA}$$

$$I_2 = \frac{14V}{100.5\Omega} = \boxed{139.3\,mA}$$

Question 7-19

For the network in Fig. 7.82:
a. Determine the current I_1

$$I_1 = (E_1 - E_2)/R_1$$
$$I_1 = (20V - 15V)/3 = \boxed{1.67A}$$

b. Calculate the currents I_2 and I_3

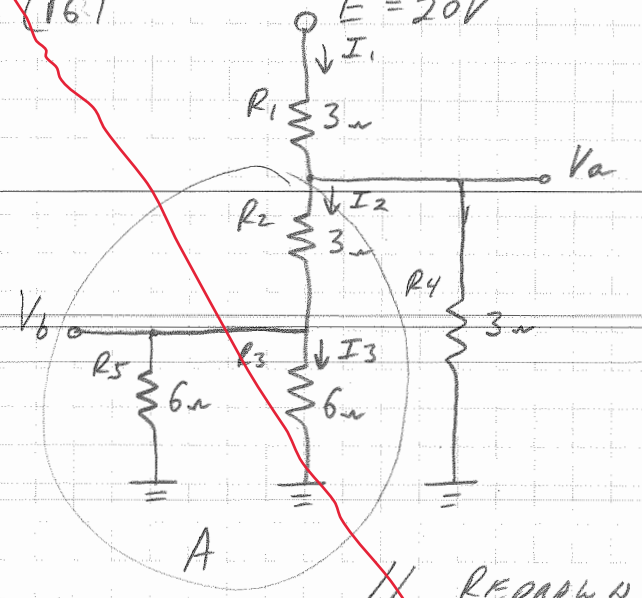
$$I_2 = (E_2)/R_T$$
$$R_T = R_2 + (R_5 \| R_3)$$
$$R_T = 3 + (6 \cdot 6)/(6 + 6) = 6\Omega$$
$$I_2 = 15V/6\Omega = \boxed{2.5A}$$

$$I_3 = \tfrac{1}{2} \cdot I_2 = \tfrac{1}{2} \cdot 2.5 = \boxed{1.25A}$$

c. Determine the voltage level V_a

$$V_a = E_2 \cdot \tfrac{(R_5 \| R_3)}{(R_5 \| R_3) + R_2}$$
$$V_a = 15 \cdot \tfrac{3}{3+3} = \boxed{7.5V}$$

1. (16)



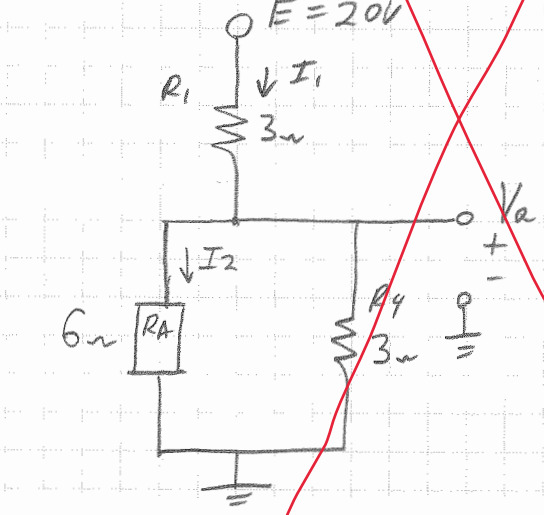
STRATEGY

- REDRAW THE NETWORK, COMBINING ELEMENTS TO GET TO A SIMPLE SERIES - PARALLEL CIRCUIT

$R_A = R_5 // R_3 + R_2$

$= 3\Omega + 3\Omega = 6\Omega$

REDRAWN



a) FIND I_1

$I_1 = \frac{E}{R_T}$, $R_T = R_A // R_4 + R_1$

$= 2\Omega + 3\Omega$

$R_T = 5\Omega$

$I_1 = \frac{20V}{5\Omega} = \boxed{4A}$

b) FIND I_2 & I_3

$I_2 = I_1 \underbrace{\left(\frac{R_A // R_4}{R_A}\right)}_{\text{CURRENT DIVIDER (SIMPLIFIED CIRCUIT)}} = 4A\left(\frac{2\Omega}{6\Omega}\right) = \boxed{1.33A}$

(16) CONTINUED - b) FIND I_3

- SEE THE ORIGINAL SCHEMATIC & USE CURRENT DIVIDER

$$I_3 = I_2 \left(\frac{R_3 // R_5}{R_3} \right)$$

$$I_3 = 1.33A \left(\frac{3\Omega}{6\Omega} \right) = \boxed{666.7\,mA}$$

c) FIND V_a & V_b

$$V_a = I_2 \cdot R_4 = (1.33A)(6\Omega) = \boxed{8V}$$

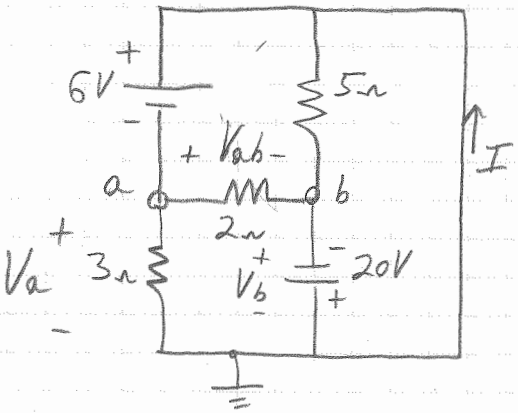
$$V_b = I_3 \cdot R_3 = (667.7mA)(6\Omega) = \boxed{4V}$$

REDUCED CIRCUIT

ORIGINAL CIRCUIT

~~(21)~~

(23)



a) FIND V_{ab}

KVL: $+V_a + 6V = 0$

$\underline{V_a = -6V}$

KVL: $-20V - V_b = 0$

$\underline{V_b = -20V}$

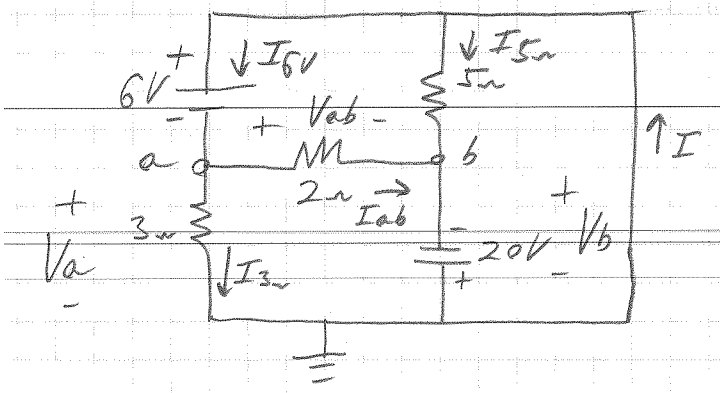
$\therefore V_{ab} = V_a - V_b = -6V - (-20V) = \boxed{14V}$

b) CALCULATE I

REDRAW THE CIRCUIT W/ THE KNOWNS & BRANCH CURRENTS

~~(11)~~ CONTINUED b) FIND "I"

(23)



$V_a = -6V$

$V_b = -20V$

$V_{ab} = 14V$

KCL

$I = I_{6V} + I_{5\Omega}$

$I_{6V} = I_{ab} + I_{3\Omega}$, $I_{ab} = \frac{V_{ab}}{2\Omega} = \frac{14V}{2\Omega} = \underline{7A}$

$I_{3\Omega} = \frac{V_a}{3\Omega} = \frac{-6V}{3\Omega} = \underline{-2A}$

$\therefore I_{6V} = \underline{5A}$

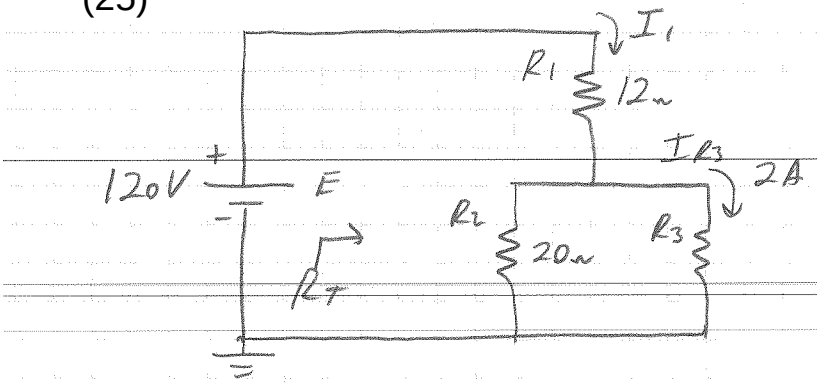
$I_{5\Omega} = -\frac{V_b}{5\Omega} = \frac{-(-20V)}{5\Omega} = \underline{4A}$

HENCE $I = 5A + 4A$

$\boxed{I = 9A}$

~~(23)~~ FIND R_3 IF $I_{R_3} = 2A$

(25)



KCL: $I_{R_3} = I_1 \left(\frac{R_3 // R_2}{R_3} \right)$

$\therefore I_1 = I_{R_3} \left(\frac{R_3}{R_2 // R_3} \right)$

OR $I_1 = 2A \left(\frac{R_3}{R_2 // R_3} \right)$ (1)

BUT, $I_1 = \frac{E}{R_T}$

$R_T = R_1 + R_2 // R_3$

OR $I_1 = \frac{120V}{R_T} = \frac{120V}{12 + R_2 // R_3}$ (2)

EQUATING (1) & (2): $\frac{2R_3}{R_2 // R_3} = \frac{120}{12 + R_2 // R_3}$, $R_2 // R_3 = \frac{R_2 R_3}{R_2 + R_3} = \frac{20R_3}{20 + R_3}$

CROSS MULTIPLY: $24R_3 + 2R_3 (R_2 // R_3) = 120 (R_2 // R_3)$

COMMON DENOMINATOR: $24R_3 + \frac{40R_3^2}{20 + R_3} - \frac{2400R_3}{20 + R_3} = 0$

$\frac{24R_3(20 + R_3) + 40R_3^2 - 2400R_3}{20 + R_3} = 0$

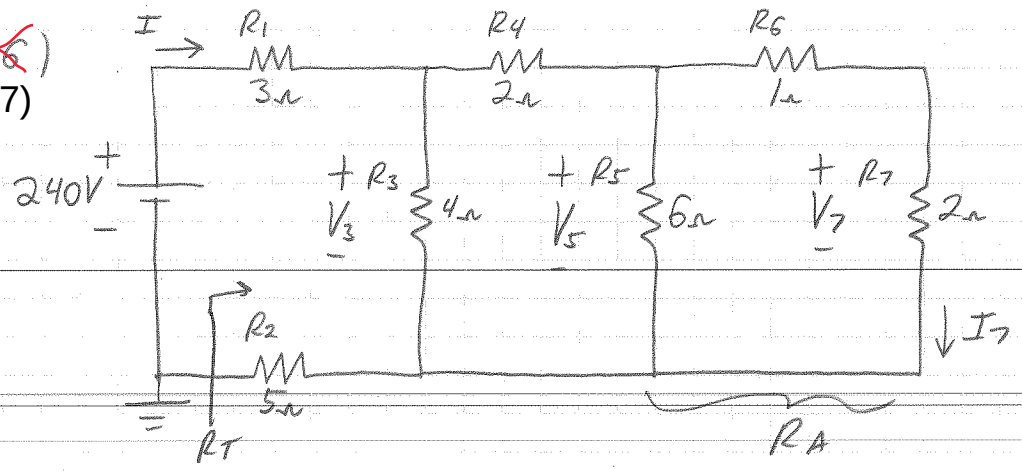
$480R_3 + 24R_3^2 + 40R_3^2 - 2400R_3 = 0$

COLLECT TERMS: $64R_3^2 - 1,920R_3 + 0 = 0$ ← QUADRATIC EQUATION

$\boxed{R_3 = 30\Omega}$

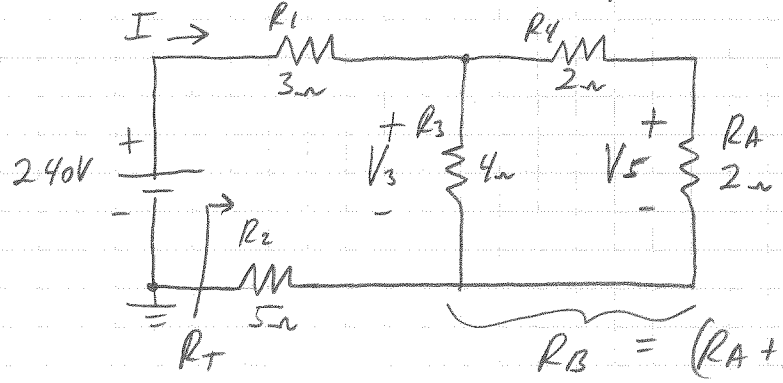
$\left(aX^2 + bX + c = 0 \quad X = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \right)$

~~(26)~~
(27)

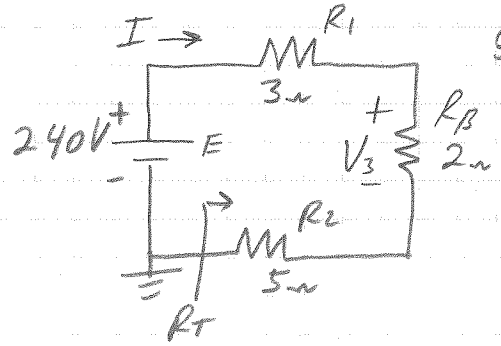


a) FIND I - REDUCE (SIMILIRY) THE NETWORK TOWARDS THE SOURCE TO FIND R_T & HENCE I.

$$R_A = (R_6 + R_7) \,//\, R_5 = 2\Omega$$



$$R_B = (R_A + R_4) \,//\, R_3 = 2\Omega$$



$$R_T = R_1 + R_2 + R_B$$

$$R_T = 10\Omega$$

$$\therefore I = \frac{E}{R_T} = \frac{240V}{10\Omega} = \boxed{24A}$$

b) FIND I_7 - FIND V_3, V_5, V_7, USE OHM'S LAW

$$V_3 = E\,\frac{R_B}{R_T} = 240V\left(\frac{2\Omega}{10\Omega}\right) = 48V \quad \text{, CKT II}$$

$$V_5 = V_3\,\frac{R_A}{R_A + R_4} = 48V\left(\frac{2\Omega}{4\Omega}\right) = 24V \text{, CKT I}$$

$$V_7 = V_5\,\frac{R_7}{R_7 + R_6} = 24V\left(\frac{2\Omega}{3\Omega}\right) = 16V \text{, ORIG}$$

$$I_7 = \frac{V_7}{R_7} = \frac{16V}{2\Omega} = \boxed{8A}$$

~~(26)~~ CONTINUED

(27)

c) DETERMINE V_3, V_5, V_7

- SEE b)

$V_3 = 48V$

$V_5 = 24V$

$V_7 = 16V$

d) FIND P_{R7}, COMPARE TO P_{SOURCE}

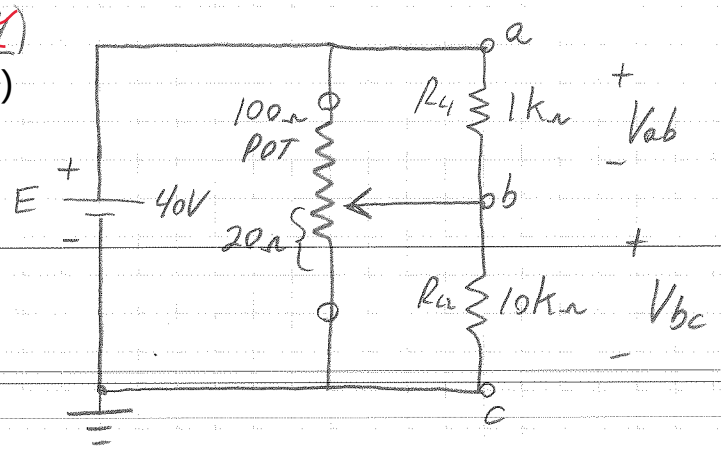
$$P_{R7} = \frac{(V_7)^2}{R_7} = \frac{(16V)^2}{2\Omega} = 128W$$

COMPARE

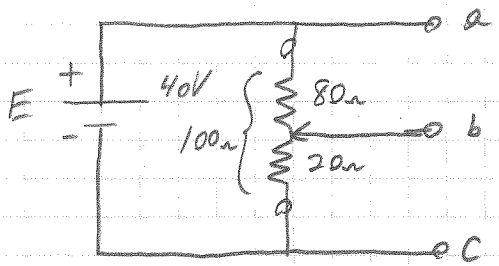
$$P_{SOURCE} = (E)(I) = (240V)(24A) = 5,760W$$

$P_{R7} \approx 2.2\%$ OF P_{SOURCE}

~~(34)~~
(33)



a) FIND Vab & Vbc W/ NO LOAD APPLIED



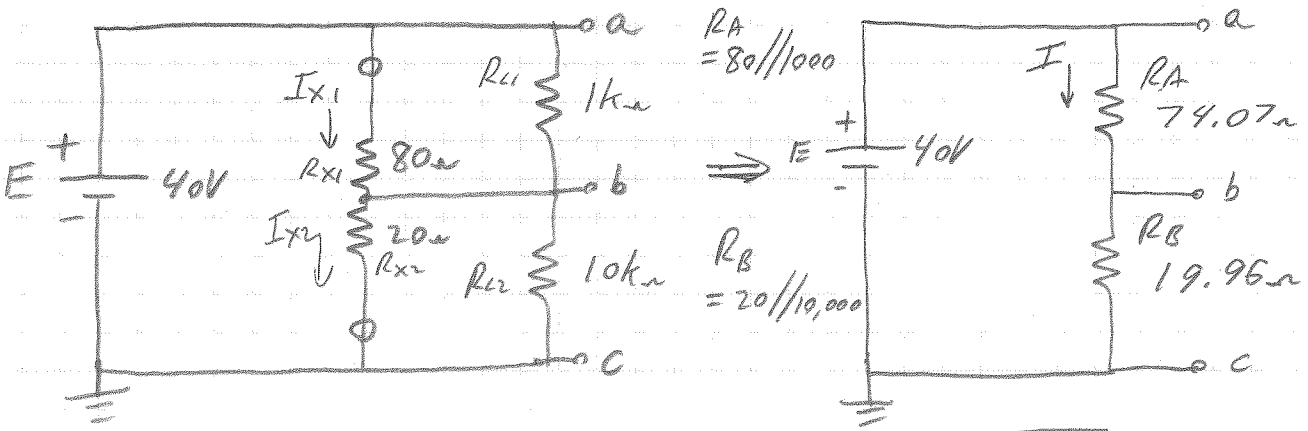
$$V_{ab} = E\,\frac{R_{ab}}{R_T} = 40V\left(\frac{80\Omega}{100\Omega}\right)$$

$$\boxed{V_{ab} = 32V}$$

$$V_{bc} = E\,\frac{R_{bc}}{R_T} = 40V\left(\frac{20\Omega}{100\Omega}\right)$$

$$\boxed{V_{bc} = 8V}$$

b) FIND Vab & Vbc W/ THE INDICATED LOADS APPLIED



$$V_{ab} = E\left(\frac{R_{ab}}{R_T}\right) = 40V\left(\frac{74.07\Omega}{94.03\Omega}\right) = \boxed{31.51V}$$

KVL: $V_{bc} = E - V_{ab} = 40V - 31.51V = \boxed{8.49V}$

~~(34)~~ (33) CONTINUED

c) FIND $P_{potentiometer}$ UNDER LOADED CONDITIONS

- SEE THE SCHEMATICS IN b)

$$I = \frac{E}{R_T} = \frac{40V}{94.03\Omega} = \underline{425.4\,mA}$$

$$I_{x1} = I\left(\frac{80\Omega // 1k\Omega}{80\Omega}\right) = 425.4\,mA\left(\frac{74.07\Omega}{80\Omega}\right)$$

$$\underline{I_{x1} = 393.9\,mA}$$

$$I_{x2} = 425.4\,mA\left(\frac{20\Omega // 10k\Omega}{20\Omega}\right) = \underline{424.6\,mA}$$

$$P_{pot} = (I_{x1})^2 R_{x1} + (I_{x2})^2 R_{x2}$$

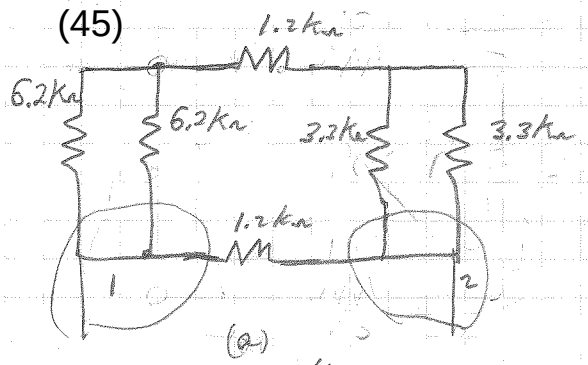
$$= 12.41W + 3.61W = \boxed{16.02W}$$

~SAME

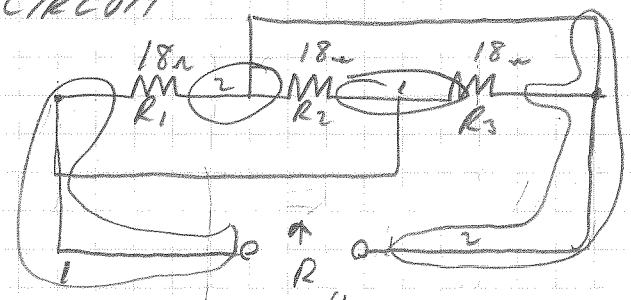
d) FIND P_{pot} W/ NO LOAD

$$P_{pot} = \frac{V^2}{R_{pot}} = \frac{(40V)^2}{100\Omega} = \boxed{16.00W}$$

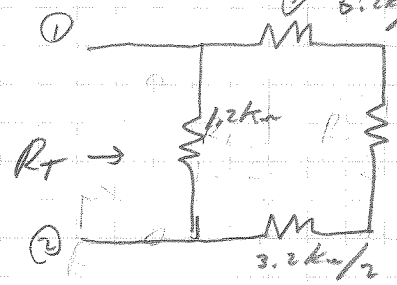
~~(42)~~ (45) FIND R FOR EACH CIRCUIT



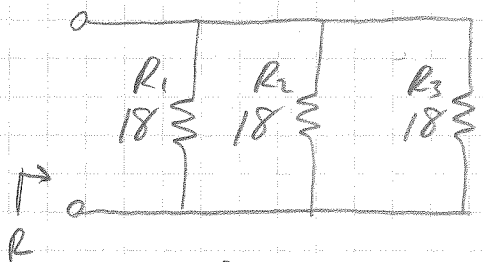
(a)



(b)



$$R = 1.2k\Omega // 5.9k\Omega = \boxed{997.2\Omega}$$



$$R = \frac{18\Omega}{3} = \boxed{6\Omega}$$