# Assignment 1

## Department of Electrical & Computer Engineering

## North South University

### Submitted By


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**Course:** Electrical Circuits (EEE141)

**Section:** 05


### Faculty Advisor

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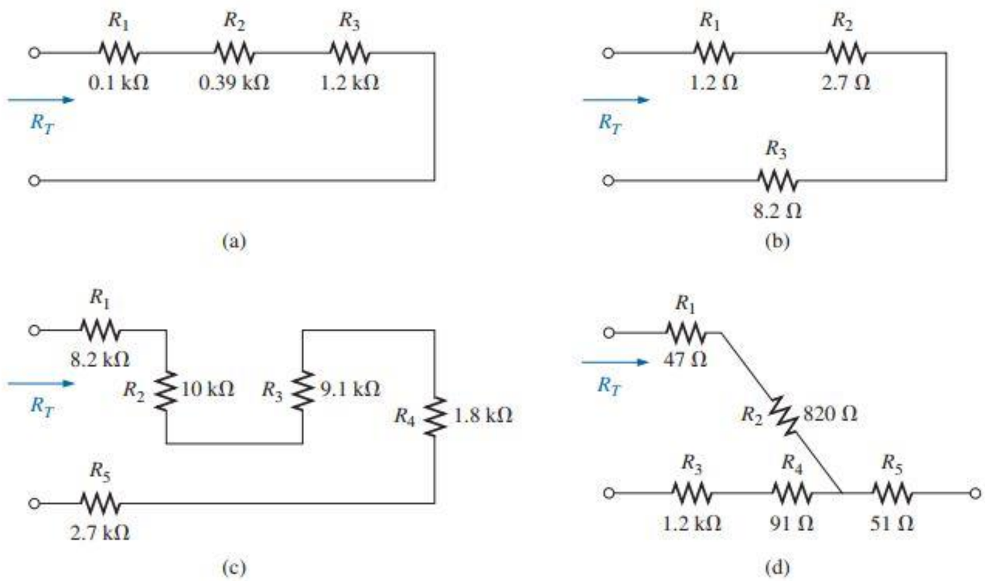
# Question 5.2 (2)

**2.** Find the total resistance $R_T$ for each configuration in Fig. 5.86. Note that only standard resistor values were used.



EEE141. (5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.9)

5.2(2)

~~(a) $R_T = 8.1\,k\Omega + 0$~~

(a) As it's a series circuit,

So total resistance, $R_T = R_1 + R_2 + R_3$.

$= (0.1 + 0.39 + 1.2)\,k\Omega$.

$= 1.69\,k\Omega$.

(b) Since it's series circuit,

So, $R_T = R_1 + R_2 + R_3 = (1.2 + 2.7 + 8.2)\,\Omega = 12.1\,\Omega$.

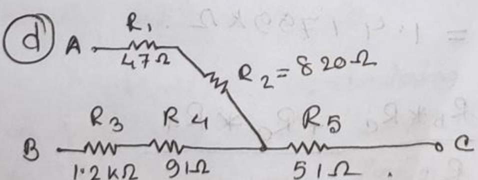
(c) Since it's a series circuit,

So, $R_T = R_1 + R_2 + R_3 + R_4 + R_5$.

$= (8.2 + 10 + 9.1 + 1.8 + 2.7)\,k\Omega$

$= 31.8\,k\Omega$

(d)




Here, $R_1$, $R_2$ are in series.

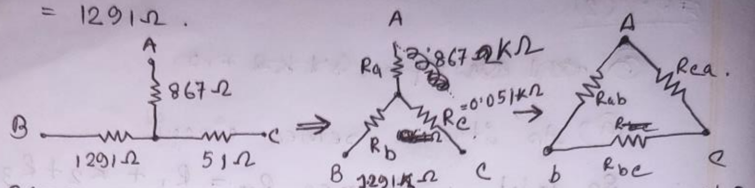
So, $R_{12} = R_1 + R_2 = (47 + 820)\,\Omega = 867\,\Omega$.

Again, $R_3, R_4$ are in series.

$\therefore R_{34} = \cancel{1.2k\Omega = 1.2\times10^3}\ R_3 + R_4 = 1.2\,k\Omega + 91\,\Omega$.

$\Rightarrow R'_{34} = (1.2 \times 10^3)\,\Omega + 91\,\Omega.$ ②

$= 1291\,\Omega.$




$R_a = 867\,\Omega = 0.867\,k\Omega$ ; $R_b = 1291\,\Omega = 1.291\,k\Omega$. ; $R_c = 0.051\,k\Omega$

Here, $R_{ab} = \dfrac{R_a * R_b + R_b * R_c + R_c * R_a}{R_c}$

$= \dfrac{(0.867 \times 1.291) + (1.291 \times 0.051) + (0.051 \times}{0.051}$

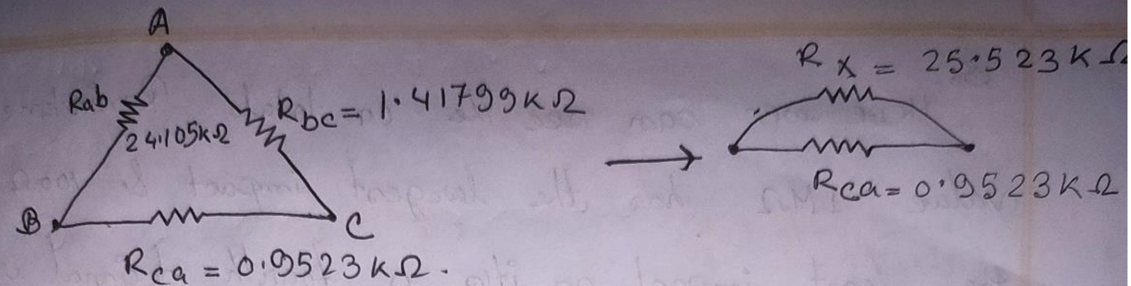
$= \dfrac{1.2294}{0.051}\,k\Omega = 24.105\,k\Omega.$

$R_{bc} = \dfrac{R_a * R_b + R_b * R_c + R_c * R_a}{R_a}$

$= \dfrac{1.2294}{0.867} = 1.41799\,k\Omega.$

$R_{ca} = \dfrac{R_a * R_b + R_b * R_c + R_c * R_a}{R_b}$

$= \dfrac{1.2294}{1.291} = 0.9523\,k\Omega.$




Here, $R_{ab}$, $R_{bc}$ are in Series.

So, $R_{(ab+bc)} = R_x = (24.105\,k\Omega + 1.41799\,k\Omega)$.

$= 25.52299\,k\Omega$.

Again, $R_x$, $R_{ca}$ are in parallel.

So, $R_{xca} = \dfrac{R_x R_{ca}}{R_x + R_{ca}} = \dfrac{(25.523 \times 0.9523)}{25.523 + 0.9523}\,k\Omega$.

$= 0.918\,k\Omega$.

# Question NO: 5.2 (4)

4. For the circuit in Fig. 5.88, composed of standard values:
   a. Which resistor will have the most impact on the total resistance?
   b. On an approximate basis, which resistors can be ignored when determining the total resistance?
   c. Find the total resistance, and comment on your results for parts (a) and (b).

[redacted]

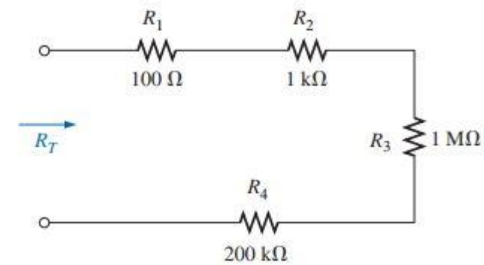
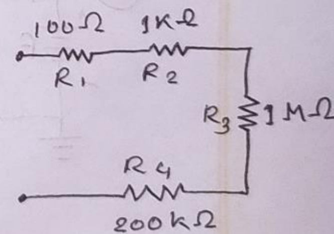



FIG. 5.88

$= 0.918\ k\Omega.$

5.2 (4)

(a) Here,
$R_3$ has the most impact on the total resistance.




(b) When determining total resistance ~~R~~ $R_1$ can be ignored on an approximate basis.

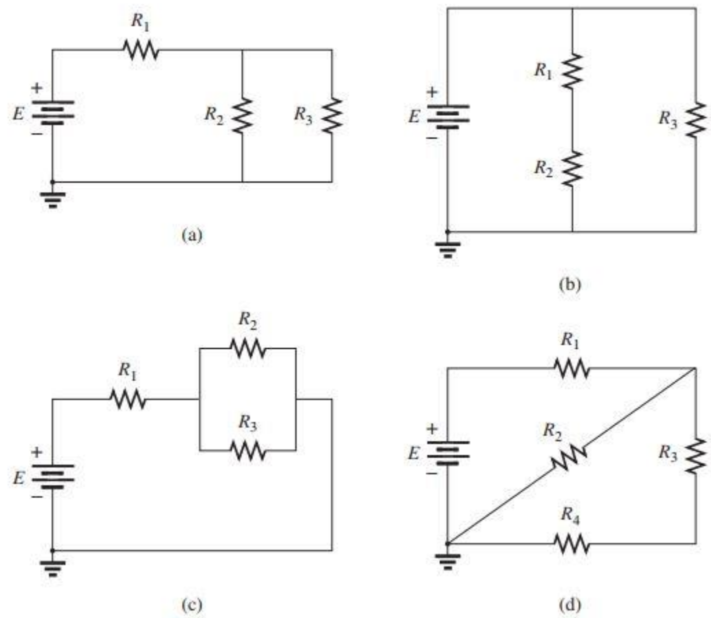
(c) As it's a series circuit,
So, $R_T = R_1 + R_2 + R_3 + R_4 = 100\Omega + 1K\Omega + 1M\Omega + 200k\Omega$

$= 100\times10^{-6}\ M\Omega + 1\times10^{-3}\ M\Omega + 1M\Omega + 200\times10^{-3}\ M\Omega.$
$= 1.2011\ M\Omega.$

So, Here we can see the on total Resistance value $1M\Omega$ has the largest impact & $100\Omega$ has the least impact as it's a fourth decimal value.

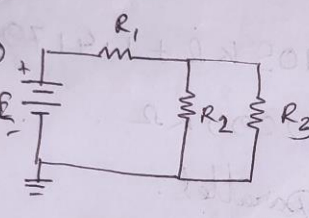
# Question 5.2 (1)

1. For each configuration in Fig. 5.85, find the individual (not combinations of) elements (voltage sources and/or resistors) that are in series. If necessary, use the fact that elements in series have the same current. Simply list those that satisfy the conditions for a series relationship. We will learn more about other combinations later.



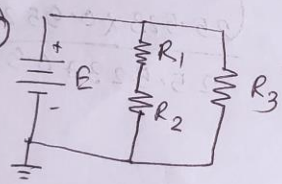
5.2(1)

(a)



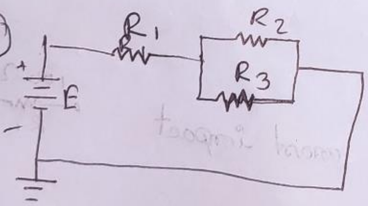

Here, $E$ & $R_1$ are in Series.

(b)



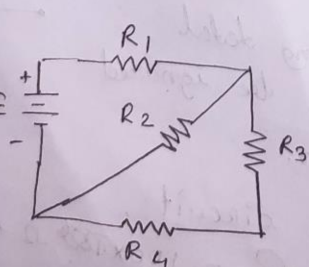

Here, $R_1$ & $R_2$ are in Series.

(c)




Here $E$ & $R_1$ are in Series.

(d)




Here, $E$, $R_1$ are in Series

Again $R_2$, $R_4$ are in Series.

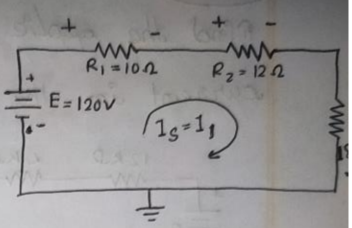
5·3 (7)

For the series configuration, find

(a) Total resistance.

(b) Total Current.

(c) Voltage across each resistive elements




(a) Here, Total Resistance, $R_T = (10 + 12 + 18)\,\Omega = 40\,\Omega$.

(b) As per Ohm's law, Current, $I_S = \frac{E}{R_T} = \frac{120}{40}$ A.

$= 3A$.

(c) ~~Amp~~ Applying Ohm's law in each resistive elements we can obtain voltage across each of them.

So, $V_{R_1} = I_1 R_1 = [(3A)(10\Omega)]\,V = 30V$.

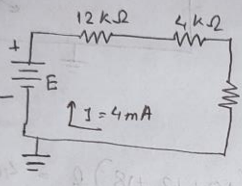
$V_{R_2} = I_1 R_2 = [3A * 12\Omega]\,V = 36V$.

$V_{R_3} = I_1 R_3 = [18\Omega * 3A] = 54V$.

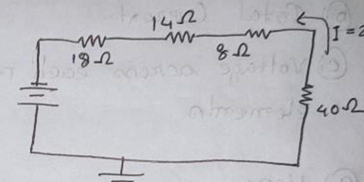
(6)

5.3 (g)

Find the applie voltage necessary to develop the specified current in the following figures.




(a)




(a)

For, figure (a), Total resistance, $R_T = (12 + 4 + 6)$ kΩ

$= 22$ kΩ.

From, Ohm's law we can obtain required voltage. E.

Here, $E = I R_T = \left[(4 \times 10^{-3}) A \times (22 \times 10^{3}) \Omega\right] V$

$= 88 V$.

For, figure (b) Total Resistance, $R_T = (18 + 14 + 8 + 40)\,\Omega$

$= 80\,\Omega$.

Here, $E = I R_T = (250 \times 10^{-3}) A \times 80\,\Omega = 20 V$

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5.3 (10)

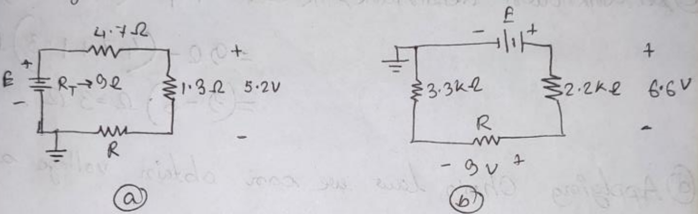
For each network in figure, determine:

(a) The current, I.

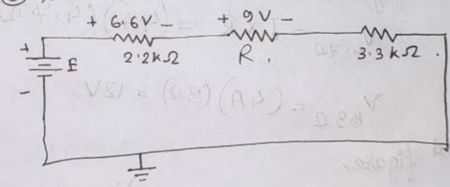
(b) The source Voltage, E

(c) The unknown resistance.

(d) Voltage across each element.




Here, figure (b) can be drawn as:




V = IR.

(a) for figure (a) current, $I = \frac{V_R}{R} = \frac{5.2\ V}{1.3\ \Omega} = 4A$.

& for figure (b) current, $I = \frac{V_R}{R} = \frac{6.6V}{2.2k\Omega} = \frac{6.6V}{2.2\times10^3\ \Omega} = 3\times10^{-3}A$.

(b) for 1st figure, $E = \cancel{\frac{I}{R_T}}\ \cancel{\frac{4A}{9\Omega}}\ IR_T = (4\times9)V = 36V$.

for 2nd figure, unknow Voltage Resistance, $R = \frac{V_{unk}}{I} = \frac{9}{3\times10^{-3}} = 3000\ \Omega = 3k\Omega$

(e)

So, $R_T = 2.2\,k\Omega + 3\,k\Omega + 3.3\,k\Omega$

$= 8.5\,k\Omega$.

So, $E = I \times R_T = (3 \times 10^{-3} \times 8.5 \times 10^{3})\,V$

$= 25.5\,V$.

(c) Unknown Resistance, $R = R_T - (R_1 + R_2)$

$= 9\,\Omega - (4.7 + 1.3)\,\Omega$

$= (9 - 6)\,\Omega = 3\,\Omega$.

(d) Applying Ohm's law we can obtain voltage across each element.

for 1st figure,

$V_{4.7\Omega} = I \times R = (4A)(4.7\,\Omega) = 18.8\,V$.

$V_{3\Omega} = (4A)(3\,\Omega) = 12\,V$.

for 2nd figure,

$V_{3.3k\Omega} = I \times R = (3 \times 10^{-3})\,A \times (3.3 \times 10^{3})\,\Omega$

$= 9.9\,V$.

# Question 5.4 (12)

12. For the circuit in Fig. 5.96, constructed of standard value resistors:
    a. Find the total resistance, current, and voltage across each element.
    b. Find the power delivered to each resistor.
    c. Calculate the total power delivered to all the resistors.
    d. Find the power delivered by the source.
    e. How does the power delivered by the source compare to that delivered to all the resistors?
    f. Which resistor received the most power? Why?
    g. What happened to all the power delivered to the resistors?
    h. If the resistors are available with wattage ratings of 1/2 W, 1 W, 2 W, and 5 W, what minimum wattage rating can be used for each resistor?

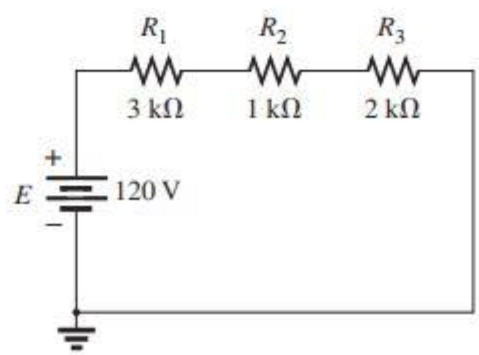
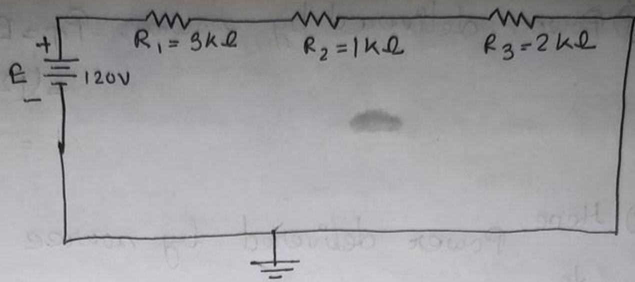



FIG. 5.96

5.4 (12)




(a) Here,
Total resistance, $R_T = (3 + 1 + 2)\,k\Omega$
$= 6\,k\Omega$.

Total current,
$$I_S = \frac{E}{R_T} = \frac{120V}{6k\Omega} = 20\,mA.$$

Voltage across each element is
$$V_{R_1} = (20\,mA)(3k\Omega) = 60V.$$
$$V_{R_2} = (I \cdot R_2) = (20\,mA)(1k\Omega) = 20V.$$
$$V_{R_3} = (I \cdot R_3) = (20\,mA)(2k\Omega) = 40V.$$

(b) As per law,
Power across a element, $P = I^2 R$.

so,
$$P_{R_1} = I_1^2 R_1 = (20\,mA)^2 (3k\Omega) = 1.2W.$$
$$P_{R_2} = I_2^2 R_2 = (20\,mA)^2 (1k\Omega) = 0.4W.$$
$$P_{R_3} = I_3^2 R_3 = (20\,mA)^2 (2k\Omega) = 0.8W.$$

(c) Total Power delivered by ~~source~~ Resistors, $P_T = P_{R_1} + P_{R_2} + P_{R_3}$
$= 1.2W + 0.4W + 0.8W = 2.4W$

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(d) Power delivered by source, $P_T = E \cdot I_S$

$= (120V)(20mA)$

$= 2.4W$

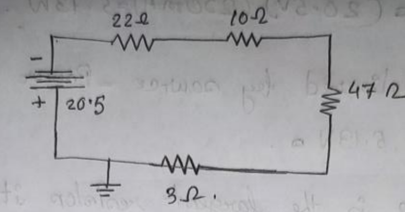
(e) Here, Power delivered by source = Power delivered ~~by~~ to resistors = 2.4W.

(f) Resistor $R_1$ received the most power. As it has the highest resistance therefore it consumed most power.

(g) Power delivered to resistors are dissipated.

(h) If the resistors are available with wattage ratings of ~~R2~~ 0.5W, 1W, 2W & 5W, minimum wattage ratings for each resistor would be, $R_1 = 2W$, $R_2 = 0.5W$, $R_3 = 1W$.

5·4 (13)




(a) Total Resistance, $R_T = (22 + 10 + 47 + 3)\,\Omega = 82\,\Omega$.

Current, $I_S = \frac{E}{R_T} = \frac{20\cdot5V}{82\,\Omega} = 250\,mA$.

Voltage across each element:

$V_{R_1} = I_1 R_1 = (250\,mA)(22\,\Omega) = 5\cdot5\,V$.

$V_{R_2} = I_2 R_2 = (250\,mA)(10\,\Omega) = 2\cdot5V$.

$V_{R_3} = I_3 R_3 = (250\,mA)(47\,\Omega) = 11\cdot75V$.

$V_{R_4} = I_4 R_4 = (250mA)(3\,\Omega) = 0\cdot75V$.

(b) $P_{R_1} = I_1^2 R_1 = (250\,mA)^2 \cdot 22\,\Omega = 1\cdot38W$.

$P_{R_2} = I_2^2 R_2 = (250mA)^2 \, (10\,\Omega) = 625\,mW$.

$P_{R_3} = I_3^2 R_3 \, (250\,mA)^2 \, (47\,\Omega) = 2\cdot94W$.

$P_{R_4} = I_4^2 R_4 = (250mA)^2 \cdot (3\,\Omega) = 187\cdot5\,mW$

(c) $P_T = P_{R_1} + P_{R_2}' + P_{R_3} + P_{R_4} = 1\cdot38W + 625\,mW + 2\cdot9W + 187\cdot5\,mW$

$= 5\cdot13W$

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(d) $P = EI_s = (20.5V)(250mA) = 5.13W$.

(e) Power delivered by source = Power received by resistor = 5.13W.

(f) As $47\Omega$ is the largest resistor it received the most power.

(g) Power delivered to resistor are dissipated.

(h) If the resistors are available with wattage rating of 1/2 W, 1 W, 2 W & 5W minimum wattage for each resistor would be:

$R_1 \to 2W$

$R_2 \to 1/2 W$

$R_3 \to 5W$

$R_4 \to 1/2 W$

## Question No 5.4 (15)

**15.** Eight holiday lights are connected in series as shown in Fig. 5.99.

**a.** If the set is connected to a 120 V source, what is the current through the bulbs if each bulb has an internal resistance of $28\frac{1}{8}\ \Omega$?

**b.** Determine the power delivered to each bulb.

**c.** Calculate the voltage drop across each bulb.

**d.** If one bulb burns out (that is, the filament opens), what is the effect on the remaining bulbs? Why?

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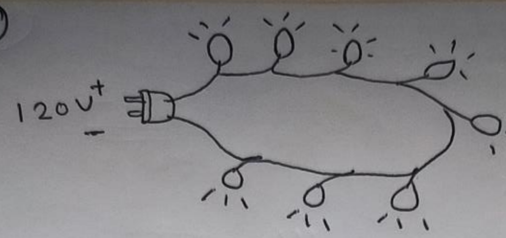
5.4 (15)




ⓐ Here, Total resistance, $R_T = NR_1 = 8\left(28\frac{1}{8}\,\Omega\right) = 225\,\Omega$.

So, current, $I = E/R_T = 120\,V/225\,\Omega = 0.53\,A$.

ⓑ Here, $P = I^2R = \cancel{\left(\frac{8}{15}\right)}\,(0.53)^2\left(28\frac{1}{8}\right) = 8\,W$.

ⓒ Voltage drop across each bulb,

$$V = IR = (0.53)\left(\frac{225\,\Omega}{8}\right) = 15\,V.$$

ⓓ If one bulb burns out remaining bulbs will be turned off as the circuit would be opened in place of burned bulb.

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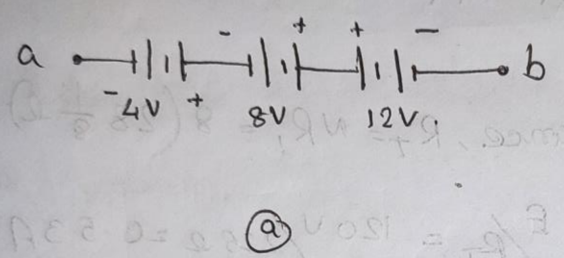
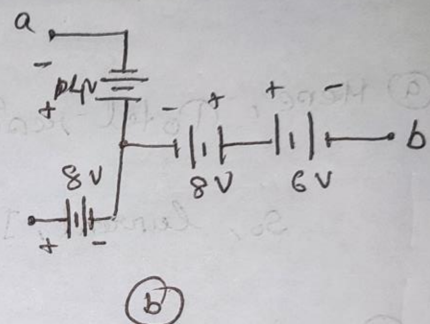
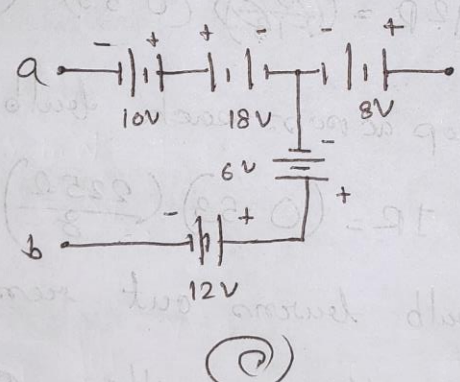
5.5 (17)

Combine the series voltage source into a single voltage source between points a & b.







for figure ⓐ,

$$v_{ab} = -4V - 8V + 12V = 0.$$

for figure ⓑ

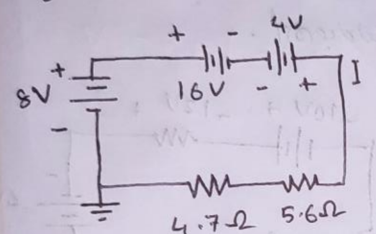
$$v_{ab} = -4V - 8V + 6V = -6V.$$

for figure ⓒ

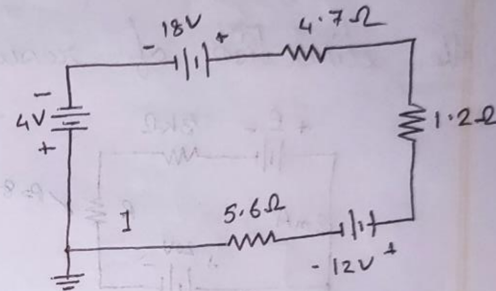
$$v_{ab} = -10V + 18V - 6V + 12V = 14V.$$

## 5.5 (18)

Determine the current I & it's direction for following figure. Before solving for I, redraw each figure with a single voltage source.



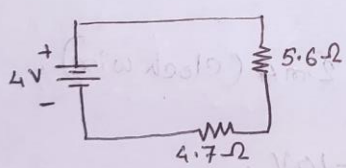

(a)



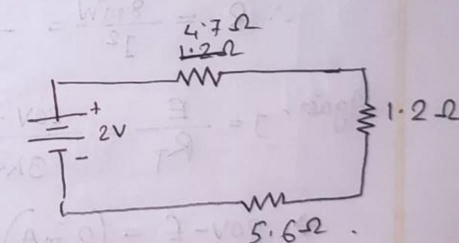

(b)

for, (a) $E_T = 16V - 4V - 8V = 4V$.

& for (b) $E_T = -4V + 18V - 12V = 2V$.




a redrawn




b redrawn.

for, (a) redrawn, $R_T = 5.6 + 4.7 = 10.3\Omega$.

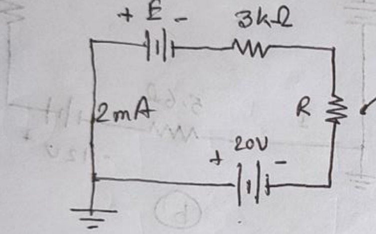
so, $I = \frac{4V}{10.3\Omega} = 388.35\ mA$ (counter clock-wise)

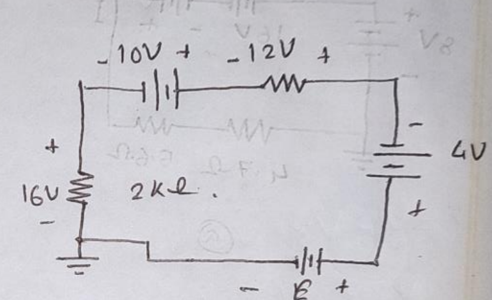
for (b) redrawn, $R_T = (4.7 + 1.2 + 5.6) = 11.5\Omega$.

so, $I = \frac{2V}{11.5\Omega} = 173.91\ mA$ (clock-wise)

5.5 (19)

Find the unknown voltage source & resistor for the networks in following figures. First, combine series voltage sources into a single source. Indicate the direction of resulting current.




(a) Here,

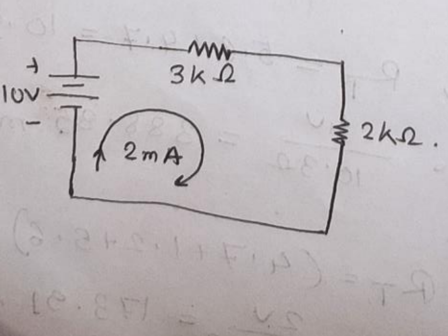
$P = 8\,mW = I^2 R$.

$\therefore R = \dfrac{8mW}{I^2} = \dfrac{8mW}{(2mA)^2} = 2k\Omega$

Again, $I = \dfrac{E}{R_T} = \dfrac{20V - E}{3k\Omega + 2k\Omega} = 2mA$ (Clock wise).

$\Rightarrow 20V - E = (2mA)(5k\Omega) = 10V$.

$\therefore E = 20V - 10V = 10V$.



(b) Here,

$$I = \frac{16V}{2k\Omega} = 8\,mA.$$

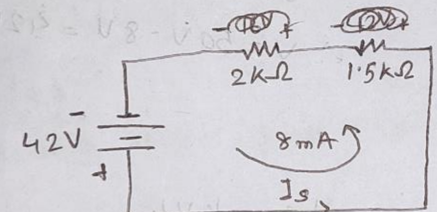
$$R = \frac{V}{I} = \frac{12V}{8\,mA} = 1.5k\Omega.$$

$$I_s = \frac{E}{R_T} = \frac{E-4-10V}{2k\Omega+1.5k\Omega} = \frac{E-14V}{3.5k\Omega} = 8\,mA$$

(Counter Clock wise).

$$\therefore\ E - 14 = (8\,mA)(3.5k\Omega)$$

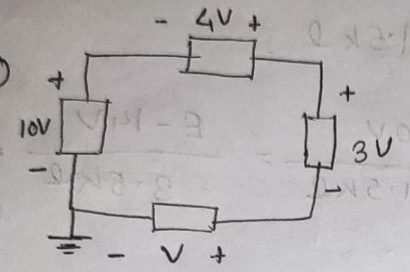
$$\therefore\ E = 42\,V.$$



5.6 (20)

Using Kirchhoff's voltage law, find the unknown voltages

(a)

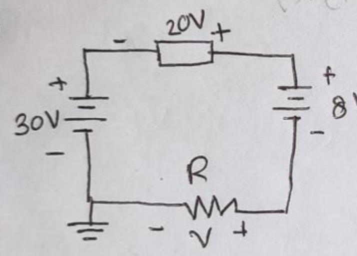



Here, applying KVL,

$+10V + 4V - 3V - V = 0.$

$\therefore V = 14V - 3V = 11V.$

(b)

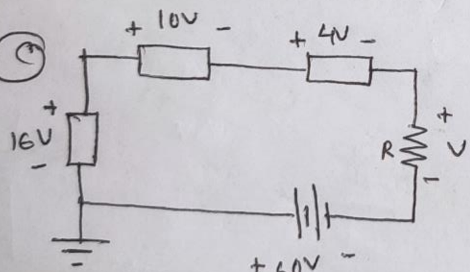



applying KVL,

$+30V + 20V - 8V - V = 0.$

$\therefore V = 50V - 8V = 42V.$

(c)




Applying KVL,

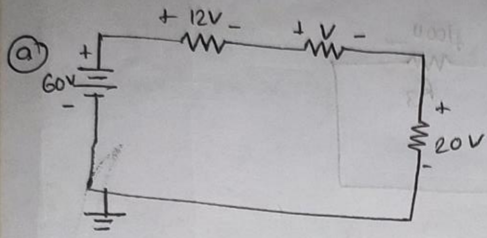
$+16V - 10V - 4V - V + 60V = 0.$

$\therefore V = 76V - 14V = 62V.$

## 5.6(21)

Using KVL, find the unknown Voltage:

(a)

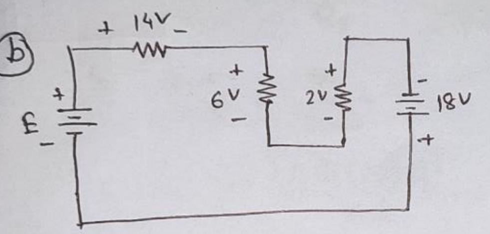



Applying KVL,

$+60V - 12V - V - 20V = 0$

$\therefore V = 60V - 32V = 28V.$

(b)




Applying KVL,

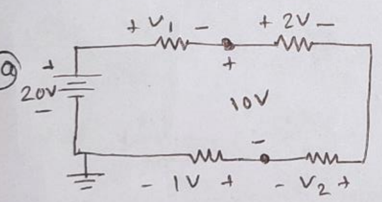
$+E - 14V - 6V - 2V + 18V = 0$

$\therefore E = 22V - 18V = 4V.$

## 5.6(23)

Using KVL, find the unknown voltage.

(a)




Applying KVL,

$\cancel{x} + 20V - V_1 - \overset{10V}{\cancel{2V}} - 1V = 0.$

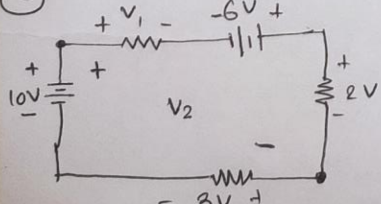
$\therefore V_1 = 9V.$

Again,

$+10V - 2V - V_2 = 0.$

$\therefore V_2 = 8V$

(b)




Applying KVL,

$+10V - V_1 + 6V - 2V - 3V = 0.$

$\therefore V_1 = 11V.$

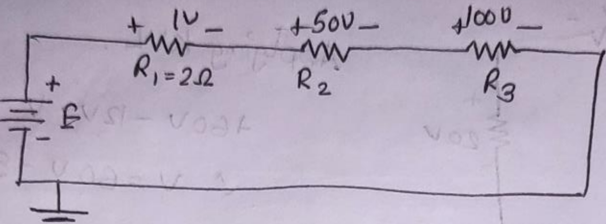
Again,

$+10V - V_2 - 3V = 0$

$\therefore V_2 = 7V.$

5.7 (24)

Determine the values of unknown resistors.




Here,
$$\frac{V_1}{R_1} = \frac{V_2}{R_2}$$

$$\Rightarrow \frac{1V}{2\Omega} = \frac{50V}{R_2}$$

$$\therefore R_2 = \frac{(50V)(2\Omega)}{1V} = 100\Omega.$$

Again,
$$\frac{V_1}{R_1} = \frac{V_3}{R_3}$$

$$\Rightarrow \frac{1V}{2\Omega} = \frac{100V}{R_3}$$

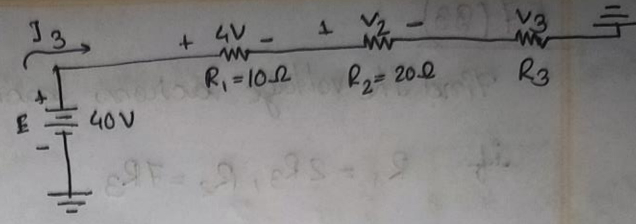
$$\therefore R_3 = \frac{(100V)(2\Omega)}{1V} = 200\Omega.$$

5.7 (30)

(a) Determine $V_2$.

(b) Calculate $V_3$.

(c) Determine $R_3$




(a) Here,

$$\frac{V_1}{R_1} = \frac{V_2}{R_2}$$

$$\Rightarrow \frac{4V}{10\Omega} = \frac{V_2}{20\Omega}$$

$$\therefore V_2 = \frac{(4V)(20\Omega)}{10\Omega} = 8V.$$

(b) Here,

$$V_3 = E - V_1 - V_2 = 40V - 4V - 8V = 28V.$$

(c)

$$\frac{V_1}{R_1} = \frac{V_3}{R_3}$$

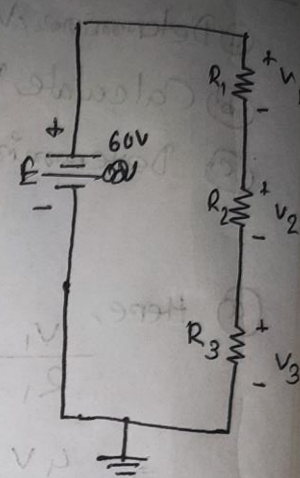
$$\Rightarrow \frac{4V}{10\Omega} = \frac{28V}{R_3}$$

$$\Rightarrow R_3 = \frac{(28V)(10\Omega)}{4V} = 70\Omega.$$

5.7 (33)

Find the voltage across each resistor.

if $R_1 = 2R_3$, $R_2 = 7R_3$.




Here, Total Resistance, $R_T = R_1 + R_2 + R_3$

$$= 2R_3 + 7R_3 + R_3$$

$$= 10R_3.$$

Again,

$$\frac{V_{R_3}}{R_3} = \frac{V_{total}}{R_{total}}$$

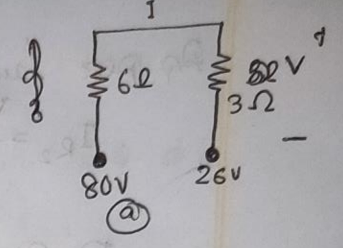
$$= V_{R_3} = \frac{V_{total}}{R_{total}} \times R_3 = \frac{60V}{10R_3}(R_3) = 6V.$$

$$V_{R_1} = 2V_{R_3} = 2(6V) = 12V.$$

$$V_{R_2} = 7V_{R_3} = (7 \times 6)V = 42V.$$

5.9 (36)

Determine current I (with direction) & voltage V (with polarity) for the following figure.



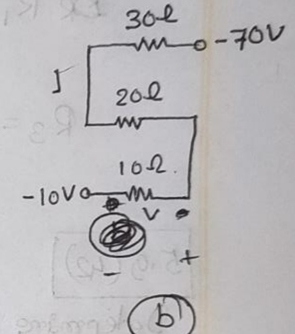

for figure ⓐ,

Here, $V = 80V - 26V = 54V$.

& $R_T = 6\Omega + 3\Omega = 9\Omega$.

$\therefore I = \frac{54V}{9\Omega} = 6A$. & $V = IR = (6A)(3\Omega) = 18V$

The direction would be Clock wise as $80V > 26V$.




for figure ⓑ. $E = +70V - 10V = 60V$.

$R_T = 10\Omega + 20\Omega + 30\Omega = 60\Omega$.

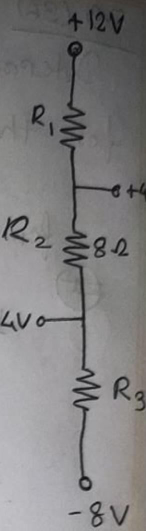
$\therefore I = \frac{E}{R_T} = \frac{60V}{60\Omega} = 1A$.

Direction is clock-wise (

Again, $V = IR = (1A)(10\Omega) = 10V$.

## 5.9 (39)

Find the level of Resistance $R_1$ & $R_3$




As per law,

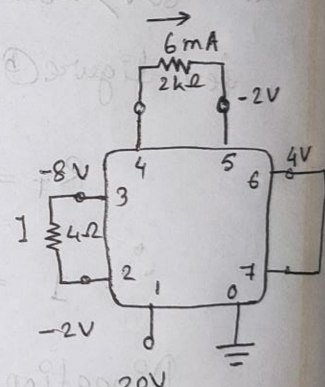
$$I_{R_2} = \frac{V_{R_1} - V_{R_2}}{R_2} = \frac{4-(-4)}{8\Omega} = \frac{8V}{8\Omega} = 1A.$$

$$R_1 = \frac{V_{R_1}}{I} = \frac{12V - 4V}{1A} = \frac{8V}{1A} = 8\Omega.$$

$$R_3 = \frac{V_{R_3}}{I} = \frac{8V - 4V}{1A} = \frac{4V}{1A} = 4\Omega.$$

## $\boxed{5.9 (42)}$

Determine $V_0, V_4, V_7, V_{10}, V_{23}, V_{30}$, $V_{67}$, $V_{56}$ and $I$ (magnitude & direction)




Here, $V_0 = 0V$ (ground).

$V_4 = -V_1 - 2V$

$= -(6mA \times 2k\Omega) - 2V$

$= 12V - 2$

$= 10V$.

$V_7 = 4V$

$V_{10} = 20V - 0V = 20V$.

$V_{23} = -2V + 8V = 6V$.

$V_{30} = -8V - 0V = -8V$

$V_{67} = 4V - 0V = 4V$

$V_{56} = -2V - 4V = -6V.$

Here, current, $I = \frac{V_{23}}{4\Omega} = \frac{6V}{4\Omega} = 1.5A$

& the direction is clock-wise (↑).