Electric circuit analysis 8th edition by Hayt & Kemmerly chapter3 solutions. Prepared by Ranz.

Exercise 1

A node is a point point at which two or more elements have a common connection.
A branch is a section of a circuit between two nodes.

Now counting, we get:

$\boxed{\text{a) 5 nodes} \quad \text{b) 7 elements} \quad \text{c) 7 branches}}$

(by the definition of a branch, the number of branches is the same as the number of elements, but this only applies when all the elements are active)

a) 5 nodes
b) 7 elements
c) 7 branches

....

Node is a point between two elements. Branch is a section between two nodes. Hence here, the number of elements and branches are essentially same.

Nodes = 5

Elements = Branches = 7

a) 5
b) 7
c) 7

Exercise 2

A node is a point point at which two or more elements have a common connection.
A branch is a section of a circuit between two nodes.

In the given figure we have a 2Ω resistor and a wire in a parallel. This means that there is no current flow in that resistor and the potential on both of it's sides is the same, therefore both sides are a part of the same node, so the number of branches won't be the same as the number of elements (since one element is inactive).

Now we can count:

$\boxed{\text{a) 4 nodes} \quad \text{b) 7 elements (of which one is inactive)} \quad \text{c) 6 branches}}$

a) 4 nodes
b) 7 elements
c) 6 branches

Exercise 3

A node is a point between two or more elements.
If we look at the given figure we get:
$\boxed{\text{a) 4 nodes}}$

If we start at one node and move trough simple elements to get to other nodes and don't encounter any node more than once, then we've formed a path.

b)
Now if we start at point A and move to point B, we've moved to another node and that means we've formed a path, but we visited each node only once so there's no loop.
$\boxed{\text{Path - yes}}$
$\boxed{\text{Loop - no}}$

c)
And we do the same for c) part. After moving from C to F to G, we're still in the same node, therefore:
$\boxed{\text{Path - no}}$
$\boxed{\text{Loop - no}}$

a) 4 nodes
b) Path - yes Loop - no
c) Path - no Loop - no

Exercise 4

1

a)

Number of elements in this circuit is $\boxed{6}$.

2

b)

By moving from B to C, we're now in a new node and from C to D we're in a new node again.

That means we've formed a path.

Since we visited each node only once, we haven't formed a loop.

3

c)

Upon moving from E to D, we're still in the same node, but by moving from D to C to B, we've moved to nodes.

That means we've formed a path.

We visited each node only once, meaning we still haven't formed a loop.

a) 6 elements

b) Path - yes Loop - no

c) Path - yes Loop - no

Exercise 5

1

A node is a point between two or more elements.

a)

By counting, we get that the number of nodes in the circuit is $\boxed{4}$.

2

b)

Number of elements is $\boxed{5}$.
(the 5 resistors)

3

c)

A branch is a section between two nodes.
So the number of branches in the circuit is $\boxed{5}$.
(the same as the number of active elements)

4

d)

(i) $\boxed{\text{neither}}$ we're still in the same node

(ii) $\boxed{\text{only path}}$ we've moved by 3 nodes and visited each only once

(iii) $\boxed{\text{path and loop}}$ we've moved by 4 nodes and closed the loop in node C

(iv) $\boxed{\text{neither}}$ we've visited node C twice, but didn't finish in it

a) 4 nodes
b) 5 elements
c) 5 branches
d) (i) neither (ii) path only (iii) path and loop (iv) neither

Exercise 6

When using the first option, if any of the bulbs fail,
the series is broken and we have an open circuit, meaning,
there is no current flow. In this situation, non of the letters (bulbs) will work.

By using the second option, if a bulb fails, all of the other bulbs keep on working. So using this option is probably better for the owner because if any letter fails, all of the others are unaffected and keep on shining.

2nd option

Exercise 7

1

KCL states that total current entering a node (I_E) must equal the total current leaving the node (I_L).

$$I_E = I_L$$

a)

And now we can calculate:

$$i_B + i_A = i_C + i_D + i_E$$

$$i_B = i_C + i_D + i_E - i_A$$

$$i_B = 3 - 2 + 0 + -1$$

$$\boxed{i_B = 0}$$

2

b)

Again we use:

$$i_B + i_A = i_C + i_D + i_E$$

$$i_E = i_B + i_A - i_C - i_D$$

$$i_E = -1 - 1 + 1 + 1$$

$$\boxed{i_E = 0}$$

a) $i_B = 0$

b) $i_E = 0$

Exercise 8

1

KCL states:

$$I_E = I_L$$

(in a node, entering current must equal leaving current)

a)

So we get:

$$I + 6 = 7$$

$$I = 7 - 6$$

$$\boxed{I = 1\text{A}}$$

2

b)

By the same logic:

$$I + 3 + 3 = 2$$

$$\boxed{I = -4\text{A}}$$

3

c)

The other end of the R_I resistor is not connected to the circuit, so there won't be any current flowing trough.

$$\boxed{I = 0\text{A}}$$

a) $I = 1\text{A}$

b) $I = -4\text{A}$

c) $I = 0\text{A}$

Exercise 9

1

KCL states that:

$$I_E = I_L$$

And with all the other currents known, we get:

$$7\text{A} + 3\text{A} = 1\text{A} + i_2$$

$$i_2 = 7 + 3 - 1$$

$$\boxed{i_2 = 9\text{A}}$$

$i_2 = 9\text{A}$

KCL, total current entering a node = total current leaving a node
Current supplied by source is the current passing through R1. Hence we can use KCL.
7+3 = i2 + 1 ; i2 = 9 A

Exercise 10

1

KCL states:

$$I_E = I_L$$

Now we just apply that rule:

$$1\text{A} = i_2 + (-3\text{A}) + 7\text{A}$$

$$\boxed{i_2 = -3\text{A}}$$

$$i_2 = -3\text{A}$$

....

KCL, total current entering a node = total current leaving a node

Current supplied by source is the current passing through R1. Hence we can use KCL.

1 = i2 - 3 + 7 ; i2 = -3 A

Exercise 11

1

KCL states:

$$I_E = I_L$$

Which gives us:

$$7.6\text{A} + (-1.6\text{A}) = 1.5\text{A} + I_{R_A}$$

(we assumed that current I_{R_A} is leaving the node)

$$I_{R_A} = 7.6 - 1.6 - 1.5$$

$$I_{R_A} = 4.5\text{A}$$

2

Voltage on R_A is $V_{R_A} = 9\text{V}$.
Using Ohm's law we get:

$$R = \frac{U}{I}$$

$$R_A = \frac{9}{4.5}$$

$$\boxed{R_A = 2\Omega}$$

$$R_A = 2\Omega$$

....

KCL, total current entering a node = total current leaving a node

Let current passing through Ra in the downward direction be I

7.6-1.6 = 1.5 + I ; I = 4.5 A

Ra = 9 V / 4.5 A = 2 ohm

Exercise 12

1

KCL states that total current entering a node must equal total current leaving the node.
Meaning:

$$I_B + I_C = I_E$$

We can see that:

$$I_C = 150 \cdot I_B$$

$$\boxed{I_C = 15\text{mA}}$$

Now we can calculate I_E as:

$$I_E = 15 \cdot 10^{-3} + 100 \cdot 10^{-6}$$

$$\boxed{I_E = 15.1\text{mA}}$$

$$I_C = 15\text{mA}$$

$$I_E = 15.1\text{mA}$$

KCL, total current entering a node = total current leaving a node
Ic = 150 x Ib = 150 x 100 uA = 15 mA
Ie = Ic + Ib = 15 mA + 0.1 mA = 15.1 mA

Exercise 13

1

First we calculate V_X by applying Ohm's law:

$$V_X = R \cdot I$$

$$V_X = 4700 \cdot 0.002$$

$$V_X = 9.4\text{V}$$

2

Now we calculate I_3 current. Since it flows in the opposite direction from the current given by the source it will be negative.

$$I_3 = -5V_X$$

$$\boxed{I_3 = -47\text{A}}$$

$$I_3 = -47\text{A}$$

Vx = 2 mA x 4.7 kohm = 9.4 V
I3 = -5 x Vx = -5 x 9.4 = -47 A

Exercise 14

1

Let's take a look at the node between the leftmost resistor and the source. By **KCL** the current leaving that node must equal the current entering it. Meaning, if any current would flow trough the rightmost resistor those values would not be equal.
Therefore $I_X = 0$.

Let's take a look at the node between the leftmost resistor and the source. By **KCL** the current leaving that node must equal the current entering it. Meaning, if any current would flow trough the rightmost resistor those values would not be equal.
Therefore $I_X = 0$.

Let us take the node between the two resistors connected to the source. KCL states that current entering a node should be equal to current leaving a node. Since both resistors are connected to source, current flowing through both should be same. By KCL

I - I + ix =0 ; ix =0

Vx = ix x 0 ; Vx =0 V

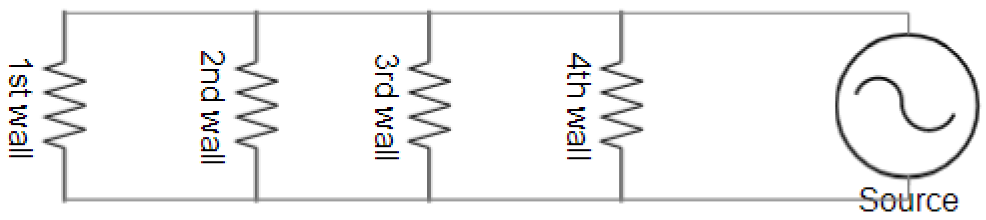
RESULT

Proved in solution

Exercise 15

1

Each resistor is 1Ω.



Open for the result.

Exercise 16
1

For this circuit, by applying the **KVL** we get:
$v_1 - v_2 + v_3 = 0$

a)

$$v_1 = 17 + 0$$

$$\boxed{v_1 = 17\mathrm{V}}$$

b)

$$v_1 = -2 - 2$$

$$\boxed{v_1 = -4\mathrm{V}}$$

c)

$$v_2 = 7 + 9$$

$$\boxed{v_2 = 16\mathrm{V}}$$

d)

$$v_3 = 2.33 - 1.7$$

$$\boxed{v_3 = 0.63\mathrm{V}}$$

a) $v_1 = 17\mathrm{V}$
b) $v_1 = -4\mathrm{V}$
c) $v_2 = 16\mathrm{V}$
d) $v_1 = 0.63\mathrm{V}$

By KVL, V1 + V3 = V2
a) v1 - 17 = 0 ; v1 = 17 V
b) v1 + 2 = -2 ; v1 = -4 V
c) v2 = 7 + 9 = 16 V
d) v3 - 2.33 = -1.7 ; v3 = 0.63 V

RESULT
a) 17 V
b) -4 V
c) 16 V
d) 0.63 V

Exercise 17

1

a)

Apply **KVL** gives us:

$$-9\text{V} - 4\text{V} - v_x = 0$$

$$\boxed{v_x = -13\text{V}}$$

And by using Ohm's law we can calculate i_x:

$$i_x = \frac{v_x}{7\Omega}$$

$$\boxed{i_x = -1.86\text{A}}$$

2

b)

We do the same thing here:

$$-2\text{V} + 7\text{V} - v_x = 0$$

$$\boxed{v_x = 5\text{V}}$$

Again Ohm's law gives us:

$$i_x = \frac{v_x}{8\Omega}$$

$$\boxed{i_x = 0.625\text{A}}$$

a) $v_x = -13\text{V} \quad i_x = -1.86\text{A}$

b) $v_x = 5\text{V} \quad i_x = 0.625\text{A}$

---

a) By KVL, 9 + 4 + vx =0 ; vx = -13 V
ix = vx/ 7 = -13/7 = -1.86 A

b) By KVL, 2 -7 + vx =0 ; vx = 5 V
ix = vx/ 8 = 5/8 = 0.625 A

RESULT

a) -13 V ; -1.86 A
b) 5 V ; 0.625 A

Exercise 18

1

a)

By applying **KVL** we get:

$$1\text{V} - 2\text{V} - V_{2\Omega} + 5\text{V} - V_{10\Omega} = 0$$

By applying Ohm's law we get:

$$1\text{V} - 2\text{V} - 2i + 5\text{V} - 10i = 0$$

And now we can calculate i:

$$12i = 4$$

$$\boxed{i = 0.333\text{A}}$$

2

b)

Similarly as in a), we get:

$$-10\text{V} - 2i + 1.5\text{V} + 1.5\text{V} - 2i - 2i - 2\text{V} + 1\text{V} - 2i = 0$$

$$8i = -8$$

$$\boxed{i = -1\text{A}}$$

a) $i = 0.333\text{A}$

b) $i = -1\text{A}$

Exercise 19

1

KVL gives us:

$$v_R - 12\text{V} - v_3 + v_2 + 1.5\text{V} - v_1 = 0$$

and

$$-4\text{V} + 23\text{V} - v_R = 0$$

2

Now it's easy to calculate v_R:

$$\boxed{v_R = 19\text{V}}$$

And now for v_2:

$$19\text{V} - 12\text{V} - 1.5\text{V} + v_2 + 1.5\text{V} - 3\text{V} = 0$$

$$\boxed{v_2 = -4\text{V}}$$

$$v_R = 19\text{V}$$

$$v_2 = -4\text{V}$$

Exercise 20

1

The voltage difference between points a and b is:

$$v_x = v_R - 12\text{V} - v_3$$

First we need to find the unknown values.
We use **KVL** and get:

$$v_R - 23\text{V} + 4\text{V} = 0$$

$$v_R = 19\text{V}$$

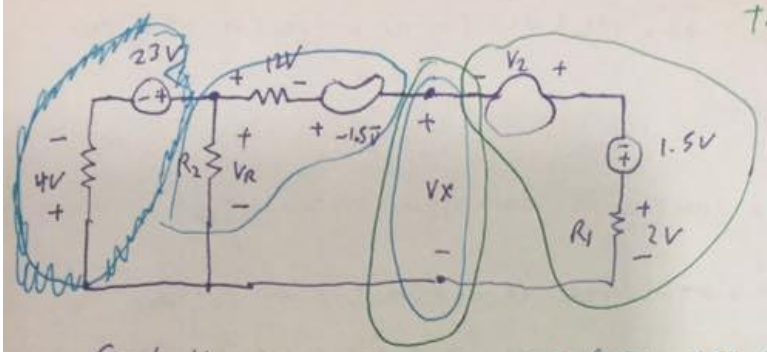
And now we can calculate v_x as:

$$v_x = v_R - 12\text{V} - v_3$$

$$\boxed{v_x = 8.5\text{V}}$$

$$v_x = 8.5\text{V}$$

this system is equal to V_x



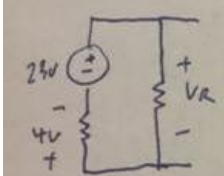
find V_x

$V_x = V_R - 12V + 1.5V$

as you can see ~~theses~~ Two systems are accross the same node pair and thus have the same voltage drop

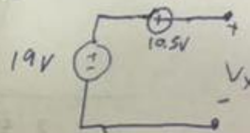
$-V_2 - 1.5 + 2 = V_x$

$-V_2 = 8.5 - .5 = 8 = -V_2 \quad V_2 = -8V$



$V_x = -4 + 23 = 19V$

(not all are V sorces)



$$\boxed{+19V - 10.5 = V_x = 8.5V}$$

Exercise 21

1

Here we use both **KVL** and **KCL** and also Ohm's law. We can calculate $v_{7.3\Omega}$ as:

$$v_{7.3\Omega} = 7.3 \cdot 0.5$$

$$v_{7.3\Omega} = 3.65\text{V}$$

2

Using KVL we get can get $v_{1\Omega}$:

$$v_{1\Omega} = -3.65 + 2.3$$

$$v_{1\Omega} = -1.35\text{V}$$

3

Let's call the voltage on left 2Ω resistor $v_{2\Omega a}$ and on the right one $v_{2\Omega b}$. Since we know $v_{1\Omega}$ we can calculate $i_{1\Omega}$:

$$i_{1\Omega} = \frac{-1.35}{1}$$

$$i_{1\Omega} = -1.35\text{A}$$

4

KCL tells us that:

$$-1.35\text{A} + i_{2\Omega a} = 0.5\text{A}$$

And we get:

$$i_{2\Omega a} = 1.85\text{A}$$

5

Applying Ohm's law gives us:

$$v_{2\Omega a} = 1.85\text{A} \cdot 2\Omega$$

$$v_{2\Omega a} = 3.7\text{V}$$

6

To get $v_{2\Omega b}$ we apply KVL once again:

$$v_{2\Omega b} = -1.35\text{V} - 3.7\text{V}$$

$$v_{2\Omega b} = -5.05\text{V}$$

And by KVL $v_{2\Omega b}$ must equal v_x.
So in the end we get:

$$\boxed{v_x = -5.05\text{V}}$$

$$v_x = -5.05\text{V}$$

Exercise 22

1

KLV gives us:

$$V_S - V_1 - V_2 = 0$$

2

a)

Since I is the same everywhere in circuit because of Ohm's law:

$$\frac{V_2}{R_2} = \frac{V_S}{R_1 + R_2}$$

and we get:

$$V_2 = V_S \frac{R_2}{R_1 + R_2}$$

$$V_1 = V_S - V_S \frac{R_2}{R_1 + R_2}$$

We write that as:

$$V_1 = V_S \frac{R_1 + R_2 - R_2}{R_1 + R_2}$$

$$\boxed{V_1 = V_S \frac{R_1}{R_1 + R_2}}$$

3

b)

Since I is the same everywhere in circuit because of Ohm's law:

$$\frac{V_1}{R_1} = \frac{V_S}{R_1 + R_2}$$

and we get:

$$V_1 = V_S \frac{R_1}{R_1 + R_2}$$

$$V_2 = V_S - V_S \frac{R_1}{R_1 + R_2}$$

$$\boxed{V_2 = V_S \frac{R_2}{R_1 + R_2}}$$

a) $V_1 = V_S \dfrac{R_1}{R_1 + R_2}$

b) $V_2 = V_S \dfrac{R_2}{R_1 + R_2}$

Exercise23

1

a)

Here we'll be applying **KCL**, **KVL** and **Ohm's law**.

First, we have:

$$\boxed{v_1 = 2\text{V}}$$

$$\boxed{v_2 = 2\text{V}}$$

And we can calculate i_2 using Ohm's law as:

$$i_2 = \frac{2}{6}$$

$$\boxed{i_2 = 0.333\text{A}}$$

2

For i_3 we have the expression:

$$i_3 = 5v_1$$

Giving us:

$$\boxed{i_3 = 10\text{A}}$$

Also, by applying KCL, now we can determine i_1 as:

$$i_1 = i_2 + i_3$$

$$\boxed{i_1 = 10.333\text{A}}$$

3

We are give the expression for v_4 too:

$$i_4 = 5i_2$$

$$\boxed{v_4 = 1.667\text{V}}$$

And since $v_4 = v_5$:

$$\boxed{v_5 = 1.667\text{V}}$$

By applying Ohm's law we calculate i_5:

$$i_5 = \frac{v_5}{i_5}$$

$$\boxed{i_5 = 0.333\text{A}}$$

And again, applying KCL gives us:

$$i_3 = i_4 + i_5$$

$$\boxed{i_4 = 9.667\text{A}}$$

4

Finally we can determine v_3 as:

$$-v_2 + v_3 + v_4 = 0$$

$$\boxed{v_3 = 0.333\text{V}}$$

5

b)

Now to calculate the power absorbed by each element we use, but we also take into account into which terminal the current flows (positive or negative):

$$P_i = u_i \cdot i_i$$

And we get the following:

$$P_1 = -10.333\text{A} \cdot 2\text{V} = \boxed{-20.667\text{W}}$$
$$\boxed{P_2 = 0.667\text{W}}$$
$$\boxed{P_3 = 3.333\text{W}}$$
$$\boxed{P_4 = 16.111\text{W}}$$
$$\boxed{P_5 = 0.556\text{W}}$$

And the sum checks to be zero:

$$-20.667 + 0.667 + 3.333 + 16.111 + 0.556 = 0$$

a)

$$i_1 = 10.333\text{A} \quad v_1 = 2\text{V}$$
$$i_2 = 0.333\text{A} \quad v_2 = 2\text{V}$$
$$i_3 = 10\text{A} \quad v_3 = 0.333\text{V}$$
$$i_4 = 9.667\text{A} \quad v_4 = 1.667\text{V}$$
$$i_5 = 0.333\text{A} \quad v_5 = 1.667\text{V}$$

b)

$$P_1 = -20.667\text{W}$$
$$P_2 = 0.667\text{W}$$
$$P_3 = 3.333\text{W}$$
$$P_4 = 16.111\text{W}$$
$$P_1 = 0.556\text{W}$$

$$-20.667 + 0.667 + 3.333 + 16.111 + 0.556 = 0$$

Exercise24

1

Since no current flows into the "-" terminal of the amp, the same current flows trough 100Ω and 470Ω resistors. By applying **KVL** we get:

$$5\text{V} - 100I - 470I - V_{out} = 0$$

We can apply KVL one more time and since $V_d = 0$ we get:

$$5\text{V} - 100I = 0$$

2

Now we can calculate I as:

$$I = 0.05\text{A}$$

And use it to get V_{out}:

$$V_{out} = 5 - 5 - 23.5$$

$$\boxed{V_{out} = -23.5\text{V}}$$

$$V_{out} = -23.5\text{V}$$

Exercise25

1

First we calculate the current as:

$$I = \frac{U}{R}$$

$$I = \frac{v_{s1} - v_{s2}}{R_1 + R_2} = -4.21\text{A}$$

2

And now to get the power absorbed by each element we'll use:

$$P = UI = I^2R$$

$$P_{v_s1} = -8 \cdot 4.21 = \boxed{-33.68\text{W}}$$

$$P_{v_s2} = 16 \cdot -4.21 = \boxed{-67.36\text{W}}$$

$$P_{R_1} = (-4.21)^2 \cdot 1 = \boxed{17.72\text{W}}$$

$$P_{R_2} = (-4.21)^2 \cdot 4.7 = \boxed{83.3\text{W}}$$

$$P_{v_s1} = -33.68\text{W}$$

$$P_{v_s2} = -67.36\text{W}$$

$$P_{R_1} = 17.72\text{W}$$

$$P_{R_2} = 83.3\text{W}$$

We must first calculate the current using:

$$\frac{-v_2 - v_1)}{R_1 + R_2} = \frac{-16 + 8}{1 + 4.7} = -4.2$$

The power absorbed can be calculated respectively as:

v1: $v_1(I) = -8(4.2) = -33.6$
v2: $v_2(I) = 16(-4.2) = 67.2$
R1: $R_1(I^2) = 4.2^2 = 17.6$
R2: $r_2(I^2) = 4.7(4.2)^2 = 82.9$

Exercise26

1

Let's number the devices by numbers from left to right.
We can get the current in the circuit as:

$$i = -\frac{v_A}{5\Omega}$$

Now we get the expression for the voltage in element 3:

$$8v_A = -40i$$

Applying **KVL** gives us:

$$4.5 - 2i - 8v_A + v_A = 0$$

$$4.5 - 2i + 40i - 5i = 0$$

$$i = -\frac{4.5}{33} = -0.136\text{A}$$

$$v_A = -0.136 \cdot \frac{-40}{8} = -0.682\text{V}$$

2

Now we're able to calculate the power absorbed by each element:

$$P = VI = I^2R$$

$$P_1 = 4.5 \cdot 0.136 = \boxed{0.612\text{W}}$$

$$P_2 = 0.136^2 \cdot 2 = \boxed{0.037\text{W}}$$

$$P_3 = 8 \cdot (-0.682) \cdot 0.136 = \boxed{-0.742\text{W}}$$

$$P_4 = 0.136^2 \cdot 5 = \boxed{0.092\text{W}}$$

$$P_1 = 0.612\text{W}$$
$$P_2 = 0.037\text{W}$$
$$P_3 = -0.742\text{W}$$
$$P_4 = 0.092\text{W}$$

Let current flowing through circuit be i.
Va = -5i
8Va = -40i
By KVL,
4.5 = 2i + 8Va +5i = 7i - 40 i = -33i
i = -4.5/33 = -0.136 A
Let us number the devices from left to right as 1,2,3,4. Power absorbed by
1 : 4.5 x 0.136 = 0.6136 W
2 : 0.136 x 0.136 x 2 = 0.0369 W
3: -40 x 0.136 x 0.136 = -0.743 W
4 : 0.136 x 0.136 x 5 = 0.0925 W

Exercise27

1

Applying **KVL** gives us:

$$500i - 2\text{V} + 1000i - 3v_x + 2200i = 0$$

And in the given diagram we can see that:

$$v_x = i \cdot 500\Omega$$

2

Now we can calculate i as:

$$500i - 2 + 1000i - 1500i + 2200i = 0$$
$$i = \frac{2}{2200}$$
$$i = 9.09 \cdot 10^{-4}\text{A}$$

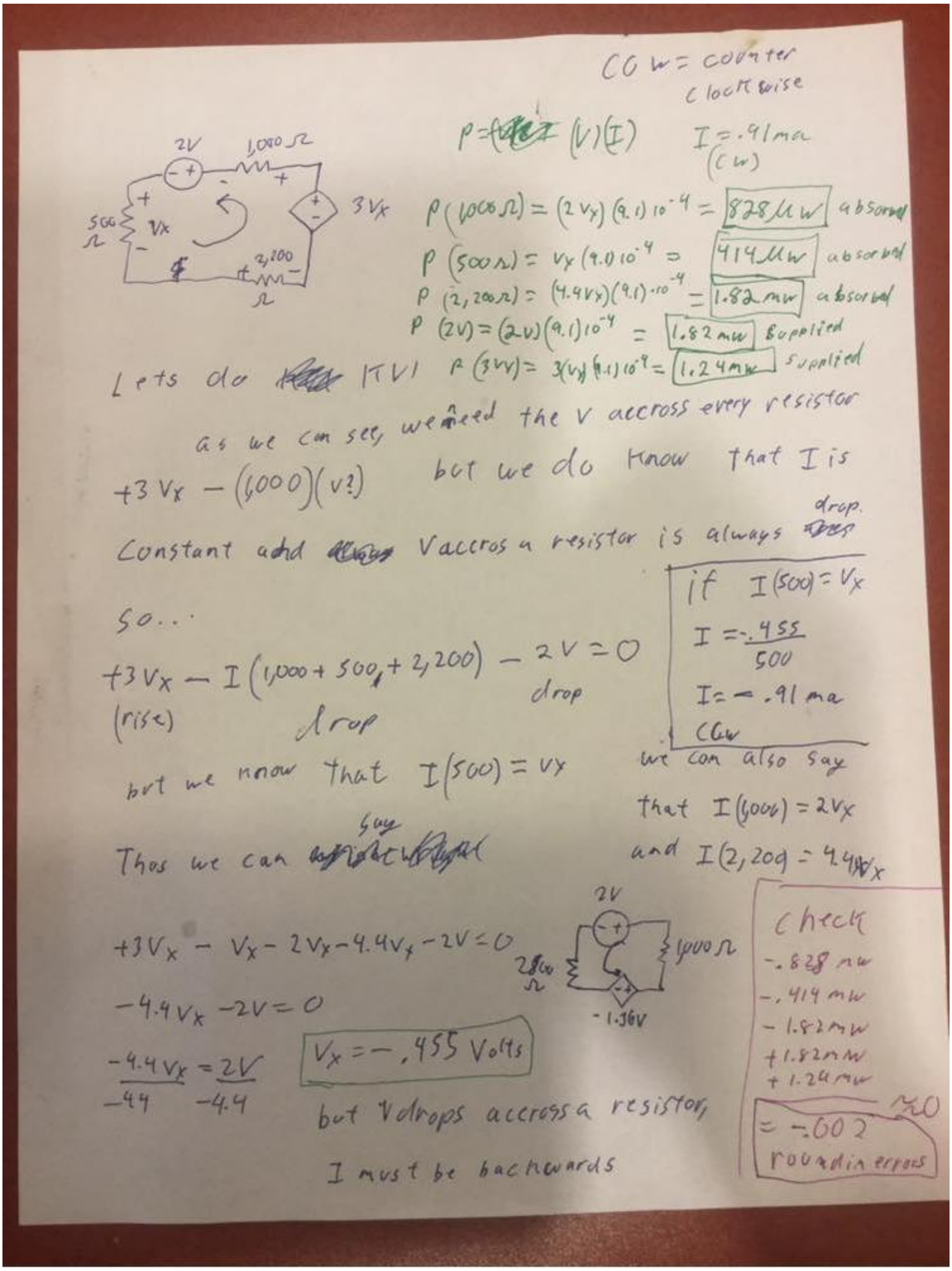
3

We can calculate the power absorbed by each element as:

$$P = VI = I^2R$$

$$P_{500\Omega} = (9.09 \cdot 10^{-4})^2 \cdot 500 = \boxed{413.14\mu\text{A}}$$
$$P_{2\text{V}} = 2 \cdot -9.09 \cdot 10^{-4} = \boxed{-1.818\text{mA}}$$
$$P_{1\text{k}\Omega} = (9.09 \cdot 10^{-4})^2 \cdot 1000 = \boxed{826.28\mu\text{A}}$$
$$P_{3v_x} = -3 \cdot 500 \cdot i \cdot -9.09 \cdot 10^{-4} = \boxed{-1.240\text{mA}}$$
$$P_{2.2\text{k}\Omega} = (9.09 \cdot 10^{-4})^2 \cdot 2200 = \boxed{1.818\text{mA}}$$

$$P_{500\Omega} = 413.14\mu\text{A}$$
$$P_{2\text{V}} = -1.818\text{mA}$$
$$P_{1\text{k}\Omega} = 826.28\mu\text{A}$$
$$P_{3v_x} = -1.240\text{mA}$$
$$P_{2.2\text{k}\Omega} = 1.818\text{mA}$$


CCW = counter clockwise

P = (V)(I) I = .91 ma (CW)

P(1000 Ω) = (2 Vx)(9.1) 10^-4 = $\boxed{828\ \mu W}$ absorbed

P (500 Ω) = Vx (9.1) 10^-4 = $\boxed{414\ \mu W}$ absorbed

P (2,200 Ω) = (4.4Vx)(9.1)·10^-4 = $\boxed{1.82\ mW}$ absorbed

P (2V) = (2V)(9.1)10^-4 = $\boxed{1.82\ mW}$ Supplied

Lets do ~~KVL~~ KVL P(3Vx) = 3(Vx)(9.1)10^-4 = $\boxed{1.24\ mW}$ supplied

as we can see, we need the V accross every resistor

+3 Vx − (1,000)(V?) but we do know that I is

Constant and ~~always~~ V accros a resistor is always ~~drop~~ drop.

so...

+3 Vx − I (1,000 + 500 + 2,200) − 2 V = 0
(rise) drop drop

but we know that I(500) = Vx

Thus we can ~~~~ say

if I(500) = Vx
I = −.455 / 500
I = − .91 ma
CCW

we can also say that I(1,000) = 2Vx
and I(2,200) = 4.4Vx

+3Vx − Vx − 2Vx − 4.4Vx − 2V = 0

−4.4 Vx − 2V = 0

−4.4 Vx / −4.4 = 2V / −4.4

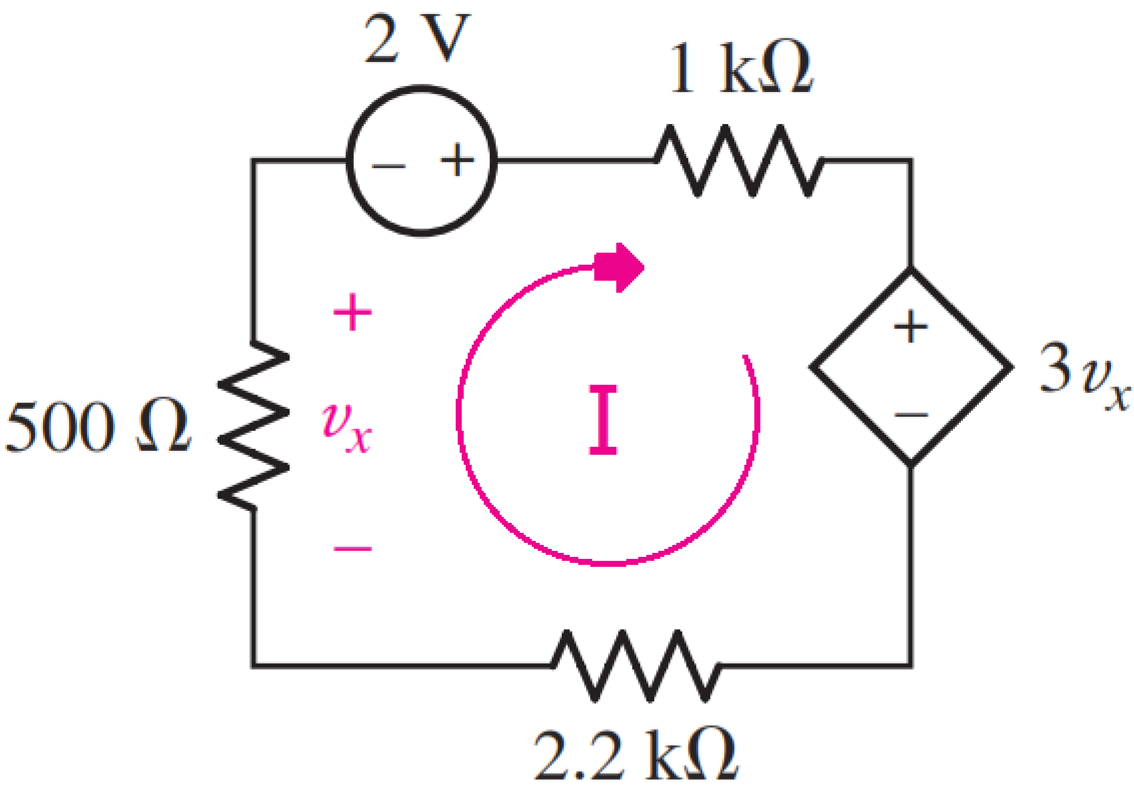
$\boxed{V_x = -.455\ \text{Volts}}$

but V drops accross a resistor, I must be backwards

2V 1,000 Ω 2,200 Ω −1.36V

check
−.828 mW
−.414 mW
−1.82 mW
+1.82 mW
+1.24 mW
= −.002 ≈ 0
rounding errors

1



We have our circuit, and we have to calculate the power absorbed by every element. Let's find the current in order to do it.

2

$$2V + I(1000 + 2200 + 500)\Omega - 3V_x = 0$$

Apply Kirchhoff voltage law to find current.

3

$$V_x = I(500\Omega)$$

V_x can be calculated by the current and resistance

4

$$2V + I(1000 + 2200 + 500)\Omega - 3(500I\Omega) = 0$$

$$I = -\frac{2V}{2.2k\Omega} = 0.9091mA$$

Calculate the current

5

$$P_{500} = (0.0009091A)^2(500\Omega) = 0.413mW$$
$$P_{2200} = (0.0009091A)^2(2200\Omega) = 1.818mW$$
$$P_{1000} = (0.0009091A)^2(1000\Omega) = 0.8264W$$
$$P_{S1} = (0.0009091A)(2V) = 1.8182mW$$
$$P_{S2} = (0.0009091A)^2(500\Omega) = 0.413mW$$

Calculate each power

$$P_{500} = 0.413mW$$
$$P_{2200} = 1.818mW$$
$$P_{1000} = 0.8264W$$
$$P_{S1} = 1.8182mW$$
$$P_{S2} = 0.413mW$$

Exercise28

1

a)

First we need to find the current i_x and for that we use **KVL** and **Ohm's law**:

$$12\text{V} - 27 \cdot i_x - 33 \cdot i_x - 13 \cdot i_x - 2\text{V} - 19 \cdot i_x = 0$$
$$10 = 92 \cdot i_x$$
$$i_x = 0.1087\text{A}$$

Now we can calculate absorbed power as:

$$P = IV = I^2R$$

(Since i_x is flowing into the negative terminal of 12V source, $P_{12\text{V}}$ will be negative.)

$$P_{12\text{V}} = -0.1087 \cdot 12 = \boxed{-1.304\text{W}}$$
$$P_{27\Omega} = 0.1087^2 \cdot 27 = \boxed{0.319\text{W}}$$
$$P_{33\Omega} = 0.1087^2 \cdot 33 = \boxed{0.3899\text{W}}$$
$$P_X = 0.1087^2 \cdot 13 = \boxed{0.1536\text{W}}$$
$$P_{2\text{V}} = 0.1087 \cdot 2 = \boxed{0.2174\text{W}}$$
$$P_{19\Omega} = 0.1087^2 \cdot 19 = \boxed{0.2245\text{W}}$$

2

b)

We do the same as in part **a)**:

$$12\text{V} - 27 \cdot i_x - 33 \cdot i_x - 4v_1 - 2\text{V} - 19 \cdot i_x = 0$$

$$4v_1 = 4 \cdot 33 \cdot i_x$$
$$12\text{V} - 27 \cdot i_x - 33 \cdot i_x - 4 \cdot 33 \cdot i_x - 2\text{V} - 19 \cdot i_x = 0$$
$$10 = 211 \cdot i_x$$
$$i_x = 0.0474\text{A}$$

$$P_{12\text{V}} = -0.0474 \cdot 12 = \boxed{-0.5687\text{W}}$$
$$P_{27\Omega} = 0.0474^2 \cdot 27 = \boxed{0.0606\text{W}}$$
$$P_{33\Omega} = 0.0474^2 \cdot 33 = \boxed{0.0741\text{W}}$$
$$P_X = 0.0474^2 \cdot 4 \cdot 33 = \boxed{0.2964\text{W}}$$
$$P_{2\text{V}} = 0.0474 \cdot 2 = \boxed{0.0948\text{W}}$$
$$P_{19\Omega} = 0.0474^2 \cdot 19 = \boxed{0.0427\text{W}}$$

3

c)

We do the same as in part **a)**:

$$12\text{V} - 27 \cdot i_x - 33 \cdot i_x - 4i_x - 2\text{V} - 19 \cdot i_x = 0$$

$$10 = 83 \cdot i_x$$
$$i_x = 0.1205\text{A}$$

$$P_{12\text{V}} = -0.1205 \cdot 12 = \boxed{-1.446\text{W}}$$
$$P_{27\Omega} = 0.1205^2 \cdot 27 = \boxed{0.392\text{W}}$$
$$P_{33\Omega} = 0.1205^2 \cdot 33 = \boxed{0.4792\text{W}}$$
$$P_X = 0.1205^2 \cdot 4 = \boxed{0.0581\text{W}}$$
$$P_{2\text{V}} = 0.1205 \cdot 2 = \boxed{0.241\text{W}}$$
$$P_{19\Omega} = 0.1205^2 \cdot 19 = \boxed{0.2759\text{W}}$$

a)

$$\begin{aligned}
P_{12\mathrm{V}} &= -1.304\mathrm{W} \\
P_{27\Omega} &= 0.319\mathrm{W} \\
P_{33\Omega} &= 0.3899\mathrm{W} \\
P_X &= 0.1536\mathrm{W} \\
P_{2\mathrm{V}} &= 0.2174\mathrm{W} \\
P_{19\Omega} &= 0.2245\mathrm{W}
\end{aligned}$$

b)

$$\begin{aligned}
P_{12\mathrm{V}} &= -0.5687\mathrm{W} \\
P_{27\Omega} &= 0.0606\mathrm{W} \\
P_{33\Omega} &= 0.0741\mathrm{W} \\
P_X &= 0.2964\mathrm{W} \\
P_{2\mathrm{V}} &= 0.0948\mathrm{W} \\
P_{19\Omega} &= 0.0427\mathrm{W}
\end{aligned}$$

c)

$$\begin{aligned}
P_{12\mathrm{V}} &= -1.446\mathrm{W} \\
P_{27\Omega} &= 0.392\mathrm{W} \\
P_{33\Omega} &= 0.4792\mathrm{W} \\
P_X &= 0.0581\mathrm{W} \\
P_{2\mathrm{V}} &= 0.241\mathrm{W} \\
P_{19\Omega} &= 0.2759\mathrm{W}
\end{aligned}$$

Exercise29

1

Applying **KVL** gives us:

$$3 - 100 \cdot I_D - V_D = 0$$

We'll replace I_D with the right side of the equation

$$I_D = I_S \cdot (e^{\frac{V_D}{V_T}} - 1)$$

and we'll get:

$$V_D = 3 - 100 \cdot I_S \cdot (e^{\frac{V_D}{V_T}} - 1)$$

$$V_D = 3 - 100 \cdot 29 \cdot 10^{-12} \cdot (e^{\frac{V_D}{27 \cdot 10^{-3}}} - 1)$$

We can calculate V_D using scientific calculator.

$$\boxed{V_D = 0.5549\text{V}}$$

$$V_D = 0.5549\text{V}$$

Exercise30

1

a)

Applying **KCL** gives the following expression:

$$3\text{A} = i_1 + 7\text{A} + i_2$$

Since elements are in a parallel the voltage drop on each element is the same.

$$v = 4 \cdot i_1 = 2 \cdot i_2$$

Which means that:

$$i_2 = 2 \cdot i_1$$

Now we're able to calculate i_1 and i_2.

$$3\text{A} = i_1 + 7\text{A} + 2 \cdot i_1$$

$$\boxed{i_1 = -\frac{4}{3}\text{A}}$$

$$\boxed{i_2 = -\frac{8}{3}\text{A}}$$

2

b)

$$v = -4 \cdot \frac{4}{3} = -\frac{16}{3}\text{V}$$

To calculate the power absorbed by each element we use:

$$P = IV = I^2R$$

$$P_{3\text{A}} = -3 \cdot \left(-\frac{16}{3}\right) = \boxed{16\text{W}}$$

$$P_1 = 4 \cdot \left(-\frac{4}{3}\right)^2 = \boxed{7.11\text{W}}$$

$$P_{7\text{A}} = 7 \cdot \left(-\frac{16}{3}\right) = \boxed{-37.33\text{W}}$$

$$P_2 = 2 \cdot \left(-\frac{8}{3}\right)^2 = \boxed{14.22\text{W}}$$

a)

$$i_1 = -1.333\text{A}$$

$$i_2 = -2.667\text{A}$$

b)

$$P_{3\text{A}} = 16\text{W}$$

$$P_1 = 7.11\text{W}$$

$$P_{7\text{A}} = -37.33\text{W}$$

$$P_2 = 14.22\text{W}$$

Exercise31

1

Applying **KCL** gives the following expression:

$$-2\text{A} = i_1 + 3\text{A} + i_2$$

Since elements are in a parallel the voltage drop on each element is the same.

$$v = 10 \cdot i_1 = 6 \cdot i_2$$

Which means that:

$$i_1 = 1.6 \cdot i_2$$

Now we're able to calculate i_1 and i_2.

$$-2\text{A} = 0.6 \cdot i_2 + 3\text{A} + i_2$$

$$\boxed{i_2 = -3.125\text{A}}$$

$$\boxed{i_1 = -1.875\text{A}}$$

2

$$v = 10 \cdot i_1 = -18.75\text{V}$$

To calculate the power supplied by the sources:

$$P = IV$$

$$P_{2\text{A}} = (-2) \cdot (-18.75) = \boxed{37.5\text{W}}$$

$$P_{3\text{A}} = -(3) \cdot (-18.75) = \boxed{56.25\text{W}}$$

$$i_1 = -1.875\text{A}$$

$$i_2 = -3.125\text{A}$$

$$P_{2\text{A}} = 37.5\text{W}$$

$$P_{3\text{A}} = 56.25\text{W}$$

1

-2 = v/10 + 3 + v/6 ; v = -18.75 V

Power supplied by -2A source = 2 x 18.75 = 37.5 W

Power supplied by 3A source = 3 x 18.75 = 56.25 W

RESULT

v = -18.75 V

Power supplied by -2A source = 37.5 W

Power supplied by 3A source = 56.25 W

Exercise32

1

Applying **KCL** gives the following expression:

$$1\text{A} + 2\text{A} = \frac{v}{5} + 5\text{A} + \frac{v}{5}$$

$$2 \cdot v = -10$$

$$\boxed{v = -5\text{V}}$$

$$v = -5\text{V}$$

1 = v/5 + 5 + v/5 - 2 ; v = -5 V

Exercise33

1

Applying **KCL** gives the following expression:

$$2\text{A} + 3 \cdot i_x = i_{3\Omega} + i_{1\Omega}$$

(because of the given voltage we'll assume that the current flowing trough resistors are flowing downwards)

We can see that:

$$i_{3\Omega} = -i_x$$

And also:

$$v = 3 \cdot i_{3\Omega} = 1 \cdot i_{1\Omega}$$

This give us:

$$i_{1\Omega} = -3 \cdot i_x$$

Now we can calculate the currents flowing trough the resistors.

$$2\text{A} + 3 \cdot i_x = -i_x - 3 \cdot i_x$$

$$i_x = -\frac{2}{7}$$

$$v = 3 \cdot i_{3\Omega} = 3 \cdot -i_x = \boxed{\frac{6}{7}\text{V} = 0.8571\text{V}}$$

2

For calculating supplied power we use:

$$P = IV$$

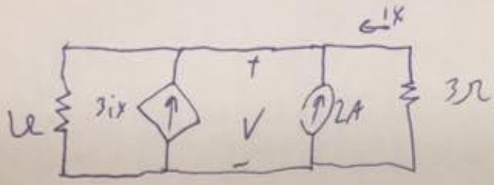
$$P_{3i_x} = 3 \cdot \frac{6}{7} \cdot \left(-\frac{2}{7}\right) = \boxed{-0.7347\text{W}}$$

$$P_{2\text{A}} = 2 \cdot \frac{6}{7} = \boxed{1.7143\text{W}}$$

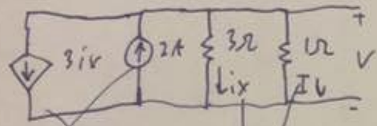
$$v = 0.8571\text{V}$$

$$P_{3i_x} = -0.7347\text{W}$$

$$P_{2\text{A}} = 1.7143\text{W}$$



first lets switch ix becase the direction is wrong



V is constant across all elements so V=IR applies

thus $(1\Omega) I = 3\Omega\, i_x$

$V = (3\Omega)(i_x)$, $V = (1\Omega)(I)$

Current rises are equall to the drops

$+2A - 3i_x - (3)(i_x) - i_x = 0$ $\qquad 2A = (3+3+1)\, i_x$

$\boxed{\frac{2}{7} A = i_x}$

as $V = (3)\, i_x$

$V = \frac{(3)\,2}{7}$ $\boxed{= \frac{6}{7} V}$ $= .85V$

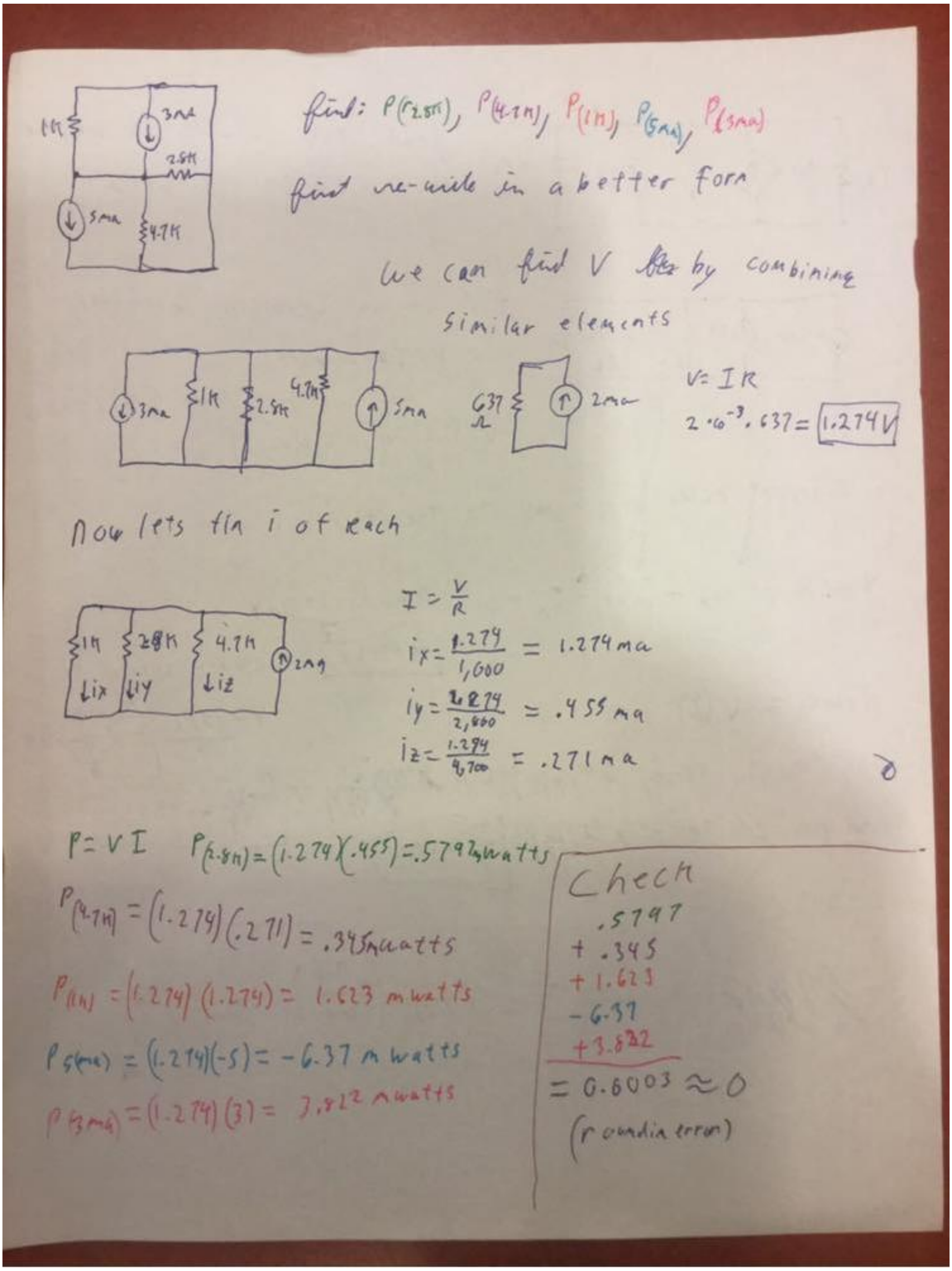
Power = V(I)

So, for 3ix sorce, $(-3i_x)\,\frac{6}{7} = P$ $\cancel{(3)(\ldots)}$ $\left(\frac{6}{7}\right)\left(\frac{6}{7}\right) = P$ $\boxed{= \frac{-36}{49} \text{ watts}}$

and for 2A source, $(2)\left(\frac{6}{7}\right) = \boxed{\frac{12}{7} \text{ watts}}$

$$\boxed{V = \frac{6}{7} \quad P_{(3i_x)} = \left(\frac{-36}{49}\right) \quad P_{(2A)} = \left(\frac{12}{7}\right)}$$

Exercise34



find: $P_{(2.8k)}$, $P_{(4.7k)}$, $P_{(1k)}$, $P_{(5ma)}$, $P_{(3ma)}$

first re-write in a better form

we can find V by combining similar elements

$V = IR$

$2 \cdot 10^{-3} \cdot 637 = \boxed{1.274V}$

now lets fin i of each

$I = \frac{V}{R}$

$i_x = \frac{1.274}{1{,}000} = 1.274\text{ma}$

$i_y = \frac{1.274}{2{,}800} = .455\text{ma}$

$i_z = \frac{1.274}{4{,}700} = .271\text{ma}$

$P = VI$ $\quad P_{(2.8k)} = (1.274)(.455) = .5797$ mwatts

$P_{(4.7k)} = (1.274)(.271) = .345$ mwatts

$P_{(1k)} = (1.274)(1.274) = 1.623$ mwatts

$P_{5(ma)} = (1.274)(-5) = -6.37$ mwatts

$P_{(3ma)} = (1.274)(3) = 3.822$ mwatts

Check

$.5797$
$+ .345$
$+ 1.623$
$- 6.37$
$+ 3.822$

$= 0.0003 \approx 0$

(rounding error)

Exercise35

1

On the figure to the right we can see that the lower terminal is the negative one and the upper one is positive.
From that we can deduce the expression for V_{eq}:

$$V_{eq} = -V_3 + V_2 + V_1$$

a)

$$V_{eq} = -3 - 3 + 0 = \boxed{-6\text{V}}$$

b)

$$V_{eq} = -1 + 1 + 1 = \boxed{1\text{V}}$$

c)

$$V_{eq} = -1 + 4.5 - 9 = \boxed{-5.5\text{V}}$$

a) $V_{eq} = -6\text{V}$
b) $V_{eq} = 1\text{V}$
c) $V_{eq} = -5.5\text{V}$

Exercise36

1

i_{eq} is the sum of all the other currents (taking the directions into consideration):

$$i_{eq} = i_1 - i_2 + i_3$$

a)

$$i_{eq} = 0 + 3 + 3 = \boxed{6\text{A}}$$

b)

$$i_{eq} = 1 - 1 + 1 = \boxed{1\text{A}}$$

c)

$$i_{eq} = -9 - 4.5 + 1 = \boxed{12.5\text{A}}$$

a) $i_{eq} = 6\text{A}$
b) $i_{eq} = 1\text{A}$
c) $i_{eq} = 12.5\text{A}$

Exercise37

1

The sources in the figure are in a series and may be replaced by one voltage source:

$$V_{eq} = -2 + 2 - 12 + 6 = -6\text{V}$$

Now by applying **Ohm's law** we can calculate the current:

$$i = \frac{-6}{1000} = \boxed{-6\text{mA}}$$

$$i = -6\text{mA}$$

Exercise38

1

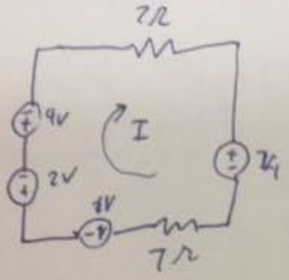
Since the current in the circuit is zero, we can just remove the resistors. Now the sum of voltage sources must be zero and we get:

$$v_1 + 4\text{V} + 2\text{V} + 1\text{V} = 0$$

$$\boxed{v_1 = -7\text{V}}$$

$$v_1 = -7\text{V}$$

find V1 so that $I=0$

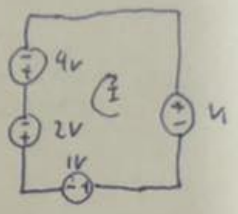


by $I=\frac{V}{R}$ either $V=0$ or $R=\infty$

as $R<\infty$ we must make $V=0$

if $I=0$ the Vdrop accros the resistors is zero and can be ignored

giving this circuit



now for KVL

$+V_1+1+2+4=0-V_1$

$-V_1$

$7=-V_1$

$\boxed{V_1=-7V}$

1

i is 0 when Veq is 0.

Veq = v1 + 1 + 2 + 4 = 0 ; v1 = -7 V

RESULT

-7 V

Exercise39

1

a)

Combining all sources into one comes down to summing their currents. The new source is:

$$i_{eq} = -5 - 8 + 7 = -6\text{A}$$

To callculate the voltage we'll apply **KCL**:

$$-6 = \frac{v}{2} + \frac{v}{3}$$

$$v = -\frac{36}{5} = \boxed{-7.2\text{V}}$$

2

b)

To calculate supplied power we use:

$$P = V \cdot I$$

Summing supplied power of the three sources:

$$-7.2 \cdot 7 - 7.2 \cdot (-5) - 7.2 \cdot (-8) = 43.2\text{W}$$

And for the one source:

$$-7.2 \cdot (-6) = 43.2\text{W}$$

And so, it is proved.

$$v = -7.2\text{V}$$

Exercise40

1

Ieq = 0 will result in a 0 voltage v.
Ieq = 1.28 - Is - 2.57 = 0; Is = -1.29 A

RESULT

-1.29 A

Exercise41

1

$V_y = 3$ and $I_x = 3$

Part A

2

Parallel voltage sources will always have the same voltage, therefore they will also have the same current.

Part B

3

We are only interested in the voltage going across the 1ohm resister. Therefore the drawing is simplified to the resister and the 4V source which is parallel to it. The other voltages have not effect on the voltage across the resister in question.

Part C

RESULT

See Solutions

Exercise42

1

For calculating equivalent resistance we use the following expressions:

Series $(R_1 + R_2)$

$$R_{eq} = R_1 + R_2$$

Parallel $(R_1||R_2)$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

Giving us:

$$R_{eq} = \frac{R_1 \cdot R_2}{R_1 + R_2}$$

Now we can calculate the equivalences as:

a)

$$R_{eq} = 1\Omega + 2\Omega||2\Omega$$

$$R_{eq} = 1\Omega + \frac{2\Omega \cdot 2\Omega}{2\Omega + 2\Omega}$$

$$R_{eq} = 1\Omega + 1\Omega$$

$$\boxed{R_{eq} = 2\Omega}$$

2

b)

$$R_{eq} = 4\Omega + \frac{1\Omega \cdot 2\Omega}{1\Omega + 2\Omega} + 3\Omega$$

$$\boxed{R_{eq} = 7.667\Omega}$$

a) $R_{eq} = 2\Omega$

b) $R_{eq} = 7.667\Omega$

1

a) Req = 1 + 2 x 2 /(2 + 2) = 1 + 1 = 2 ohms
b) Req = 4 + 3 + 1 x 2/(1+2) = 7 + 0.67 = 7.67 ohms

RESULT

a) 2 ohms
b) 7.67 ohms

Exercise43

1

For calculating equivalent resistance we use the following expressions:

Series $(R_1 + R_2)$

$$R_{eq} = R_1 + R_2$$

Parallel $(R_1 || R_2)$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

Giving us:

$$R_{eq} = \frac{R_1 \cdot R_2}{R_1 + R_2}$$

Now we can calculate the equivalences as:

a)

$$R_{eq} = 2\Omega || 4\Omega + 1\Omega$$

$$R_{eq} = \frac{2\Omega \cdot 4\Omega}{2\Omega + 4\Omega} + 1\Omega$$

$$R_{eq} = \frac{8}{6}\Omega + 1\Omega$$

$$\boxed{R_{eq} = 2.333\Omega}$$

2

b)

In this case, we can solve the problem by first finding the equivalent of first two resistors and then the equivalent of the third one and the new one.

$$R_{eq} = (1\Omega||4\Omega)||3\Omega$$

$$R_{eq} = \frac{1\Omega \cdot 4\Omega}{1\Omega + 4\Omega}||3\Omega$$

$$R_{eq} = \frac{4}{5}\Omega||3\Omega$$

$$R_{eq} = \frac{\frac{4}{5}\Omega \cdot 3\Omega}{\frac{4}{5}\Omega + 3\Omega}$$

$$\boxed{R_{eq} = 0.632\Omega}$$

a) $R_{eq} = 2.333\Omega$

b) $R_{eq} = 0.632\Omega$

1

a) Req = 1 + 2 x 4/(2+4) = 1 + 1.33 = 2.33 ohms
b) Req = 1 x 4 x 3 / (1 x 4 + 4 x 3 + 1 x 3) = 12/19 = 0.63 ohms

RESULT

a) 2.33 ohms
b) 0.63 ohms

Exercise44

1

a)

We can simplify the circuit as to only have one voltage source and one resistor in it.

$$V_{eq} = 3V - 1V = \boxed{2V}$$

$$R_{eq} = 2\Omega + 7\Omega + 5\Omega + 1\Omega = \boxed{15\Omega}$$

2

b)

By **Ohm's law**:

$$i = \frac{V_{eq}}{R_{eq}}$$

$$\boxed{i = 0.1333\text{A}}$$

3

c)

For i to be zero, the voltage source $V_{1\text{V}}$ should be changed to:

$$3 - V_{1\text{V}} = 0$$

$$\boxed{V_{1\text{V}} = 3\text{V}}$$

So electric potential is the same everywhere in the circuit.

4

d)

To calculate absorbed power we use:

$$P = I^2 \cdot R$$

$$P_{5\Omega} = 0.1333^2 \cdot 5 = \boxed{0.0889\text{W}}$$

a) $V_{eq} = 2\text{V} \quad R_{eq} = 15\Omega$

b) $i = 0.1333\text{A}$

c) $V_{1\text{V}} = 3\text{V}$

d) $P_{5\Omega} = 0.0889\text{W}$

Exercise45

1

a)

The we can make a simpler equivalent of the circuit with just one current source and one resistor. We get the current source equivalent by summing the three original currents:

$$i_{eq} = -2\text{A} + 5\text{A} + 1\text{A}$$

$$\boxed{i_{eq} = 4\text{A}}$$

And since the resistors are in parallel the equivalent is:

$$R_{eq} = 5\Omega || 5\Omega$$

$$R_{eq} = \frac{5\Omega \cdot 5\Omega}{5\Omega + 5\Omega}$$

$$\boxed{R_{eq} = 2.5\Omega}$$

2

b)

To calculate the voltage we apply **Ohm's law**:

$$v = i_{eq} \cdot R_{eq}$$

$$v = 4\text{A} \cdot 2.5\Omega$$

$$\boxed{v = 10\text{V}}$$

3

c)

To calculate the provided power we use:

$$P = I \cdot V$$

$$P_{2\text{A}} = -2\text{A} \cdot 10\text{V}$$

$$\boxed{P_{2\text{A}} = -20\text{W}}$$

a) $i_{eq} = 4\text{A}$ $R_{eq} = 2.5\Omega$

b) $v = 10\text{V}$

c) $P_{2\text{A}} = -20\text{W}$

1

Ieq = -2 + 5 + 1 = 4 A
Req = 5 x 5/(5 + 5) = 2.5 ohms
v = Ieq x Req = 10 V

Power provided by 2 A source = -2 x 10 = -20 W; Power is absorbed by 2 A source.

RESULT

a) Ieq = 4 A ; Req = 2.5 ohms

b) v = 10 V

c) -20 W

Exercise46

1

Firstly, let's replace all the resistors with an equivalent.
We'll calculate the value of the resistors in the rightmost branch.

$$3\Omega||9\Omega + 3\Omega + 5\Omega + 3\Omega||6\Omega = 12.25\Omega$$

So R_{eq} will be:

$$R_{eq} = 3\Omega||5\Omega||12.25\Omega$$

$$R_{eq} = 1.875\Omega||12.25\Omega$$

$$R_{eq} = \frac{1.875\Omega \cdot 12.25\Omega}{1.875\Omega + 12.25\Omega}$$

$$R_{eq} = 1.6261\Omega$$

2

Now we're able to calculate voltage v:

$$V = I \cdot R$$

$$v = 1\text{A} \cdot 1.6261\Omega$$

$$v = 1.6261\text{V}$$

3

And since v is the voltage on the 3Ω resistor, now we're able to calculate i_3:

$$i_3 = \frac{v}{3\Omega}$$

$$i_3 = \frac{1.6261\text{V}}{3\Omega}$$

$$\boxed{i_3 = 0.542\text{A}}$$

4

To get the power supplied by the source we use:

$$P = I \cdot V$$

$$P_{1\text{A}} = 1\text{A} \cdot 1.6261\text{V}$$

$$\boxed{P_{1\text{A}} = 1.6261\text{W}}$$

$$i_3 = 0.542\text{A}$$

$$P_{1\text{A}} = 1.6261\text{W}$$

1

Req = 3 x 5 x ($\frac{3\times 9}{3+9}$ +3 +5 + $\frac{3\times 6}{3+6}$)/(3 x 5 + 3 x ($\frac{3\times 9}{3+9}$ +3 +5 + $\frac{3\times 6}{3+6}$)
+ 5 x ($\frac{3\times 9}{3+9}$ +3 +5 + $\frac{3\times 6}{3+6}$)) = 1.63 ohms
Vx = 1 x 1.63 = 1.63 V
i3 = Vx/3 = 0.54 A
Power provided = 1 x 1.63 = 1.63 W

RESULT

i3 = 0.54 A
Power provided = 1.63 W

Exercise47

1

The equivalent current source in this circuit would be:

$$I = 2\text{A} - 4 \cdot i$$

We can calculate R_{eq} as:

$$R_{eq} = 3\Omega||15\Omega||(9\Omega + 6\Omega||6\Omega)$$

$$R_{eq} = 3\Omega||15\Omega||12\Omega$$

$$R_{eq} = 15\Omega||2.4\Omega$$

This means that now we have two resistors in parallel.

2

The sum of the two currents flowing trough these resistors must equal I.
And the voltage on both resistors is v_x.
This give us the expression:

$$v_x = v_x$$

$$i \cdot 15\Omega = (2 - 4 \cdot i - i) \cdot 2.4\Omega$$

And we get:

$$i = 0.1778\text{A}$$

3

Since $v_x = i \cdot 15\Omega$ we get:

$$v_x = 0.1778\text{A} \cdot 15\Omega$$

$$\boxed{v_x = 2.667\text{V}}$$

$$v_x = 2.667\text{V}$$

1

Vx=2.07(2-4i)
Vx=15*i
2.07(2-4i)=15i
i=.178A

Vx=15i=15*.178=2.67

RESULT
Vx=2.67V

Exercise48

1

First, we'll simplify the circuit by calculating source and resistor equivalences.

$$i_{eq} = 4 - 2i + 3 - 9 = -2 - 2i$$

$$R_{eq} = (6 + 3||15)||6||6$$

$$R_{eq} = 8.5||3 = 2.2174\Omega$$

2

Now we can calculate voltage v as:

$$v = i_{eq} \cdot R_{eq}$$

$$v = (-2 - 2i) \cdot 2.2174\Omega$$

And from the diagram we can see that:

$$v = 6i$$

$$6i = (-2 - 2i) \cdot 2.2174$$

$$10.4348 \cdot i = -4.4348$$

$$i = -0.425\text{A}$$

$$v = -2.55\text{V}$$

3

To get the power consumed by the 15Ω resistor we'll need the voltage on that resistor too.

$$P = \frac{V^2}{R}$$

$$P_{15\Omega} = \frac{v_{15\Omega}^2}{15\Omega}$$

$$v_{15\Omega} = \frac{6}{6+2.5} \cdot v$$

$$v_{15\Omega} = 1.8\text{V}$$

4

And the power is:

$$P_{15\Omega} = \frac{1.8^2}{15\Omega}$$

$$\boxed{P_{15\Omega} = 0.216\text{W}}$$

$$P_{15\Omega} = 0.216\text{W}$$

Exercise49

1

We'll start from the right end. As we can see, on the right end, we have $R_8 + R_{10}||R_{10} + R_9$ connected to the ends of R_7 resistor (meaning it's in parallel) and we continue with:

$$(R_8 + R_{10}||R_{10} + R_9)||R_7 + R_5 + R_6$$

Next step:

$$((R_8 + R_{10}||R_{10} + R_9)||R_7 + R_5 + R_6)||R_4 + R_2 + R_3$$

And in the end we get:

$$(((R_8 + R_{10}||R_{10} + R_9)||R_7 + R_5 + R_6)||R_4 + R_2 + R_3)||R_1 = R_{eq}$$

2

$R_1 = 11 \cdot R_{11} = 11 \cdot 3\Omega$ and $R_n = \frac{R_1}{n}$ is given.
So now we can calculate R_{eq}.

$$R_{eq} = ((9.363||\frac{33}{7} + 12.1)||8.25 + 27.5)||33$$

$$R_{eq} = (15.236||8.25 + 27.5)||33$$

$$R_{eq} = 32.852||33$$

$$\boxed{R_{eq} = 16.463\Omega}$$

$$R_{eq} = 16.463\Omega$$

Exercise50

1

$$100||100||100||100$$

Part A

2

$$((100||100) + 100)||100$$

Part B

3

$$(100 + 100)||100||100$$

Part C

RESULT

See Solutions

Exercise51

1

a)

We can see that:

$$v = v_1 + v_2$$

Giving us:

$$v_2 = 9.2 - 3$$

$$\boxed{v_2 = 6.2\text{V}}$$

2

b)

Again as in part a):

$$v_1 = 2 - 1$$

$$\boxed{v_1 = 1\text{V}}$$

3

c)

And again:

$$v = 3 + 6$$
$$\boxed{v = 9\text{V}}$$

4

d)

Since the current is the same in both resistor, for $v_1 = v_2$ to be true the resistors must be the same:

$$R_1 = R_2$$

Giving us:

$$\boxed{\frac{R_1}{R_2} = 1}$$

5

e)

Since the same current flows trough both resistors we have:

$$\frac{v_1}{R_1} = \frac{v_2}{R_2}$$

Giving us:

$$\frac{v_1}{2} = v_2$$

And because of $v = v_1 + v_2$, now we have:

$$\frac{v - v_2}{2} = v_2$$
$$3 \cdot v_2 = v$$
$$v_2 = \frac{3.5}{3}$$
$$\boxed{v_2 = 1.167\text{V}}$$

6

f)

From

$$\frac{v_1}{R_1} = \frac{v_2}{R_2}$$

and

$$\frac{v_1}{2} = v_2$$

we get:

$$v_1 = \frac{v - v_1}{4.7}$$
$$5.7 \cdot v_1 = 1.8$$
$$\boxed{v_1 = 0.316\text{V}}$$

a) $v_2 = 6.2\text{V}$

b) $v_1 = 1\text{V}$

c) $v = 9\text{V}$

d) $\frac{R_1}{R_2} = 1$

e) $v_2 = 1.167\text{V}$

f) $v_1 = 0.316\text{V}$

Exercise52

1

a)

KCL gives us:

$$i = i_1 + i_2$$

$$i_1 = i - i_2$$

$$i_1 = 8 - 1$$

$$\boxed{i_1 = 7\text{A}}$$

2

b)

We have two resistors in parallel and applying **Ohm's law** gives us:

$$v = i \cdot (R_1 || R_2)$$

$$v = 10\text{mA} \cdot 50\text{k}\Omega$$

$$\boxed{v = 50\text{V}}$$

3

c)

We'll use the fact that the voltage is the same on both resistors:

$$v_1 = v_2$$

$$i_1 \cdot R_1 = i_2 \cdot R_2$$

Also:

$$i_1 = i - i_2$$

$$i - i_2 = 4i_2$$

$$i_2 = \frac{i}{5}$$

$$\boxed{i_2 = 4\text{mA}}$$

4

d)

Since R_1 and R_2 are the same and the voltage is the same on both of them, i_1 and i_2 will be the same too.

$$i = i_1 + i_2$$

$$i = i_1 + i_1$$

$$i = 2i_1$$

$$\boxed{i_1 = 5\text{A}}$$

5

e)

Again as in part c) we have:

$$i_1 \cdot R_1 = i_2 \cdot R_2$$

$$(i - i_2) \cdot 1000 \cdot 10^6 = i_2$$

$$(1000 \cdot 10^6 + 1) \cdot i_2 = (1000 \cdot 10^6) \cdot i$$

$$i_2 = \frac{10 \cdot 1000 \cdot 10^6}{1000 \cdot 10^6 + 1}$$

$$\boxed{i_2 = 10\text{A}}$$

a)

$$i_1 = 7\text{A}$$

b)

$$v = 50\text{V}$$

c)

$$i_2 = 4\text{mA}$$

d)

$$i_1 = 5\text{A}$$

e)

$$i_2 = 10\text{A}$$

Exercise53

1

$$R_1 = \frac{V}{I_1} = \frac{2}{1} = 2$$
$$R_1$$

2

$$R_2 = \frac{V}{I_2} = \frac{2}{1.2} = 1.66$$
$$R_2$$

3

$$R_3 = \frac{V}{I_3} = \frac{2}{8} = 0.25$$
$$R_3$$

4

$$R_4 = \frac{V}{I_4} = \frac{2}{3.1} = 0.64$$
$$R_4$$

5

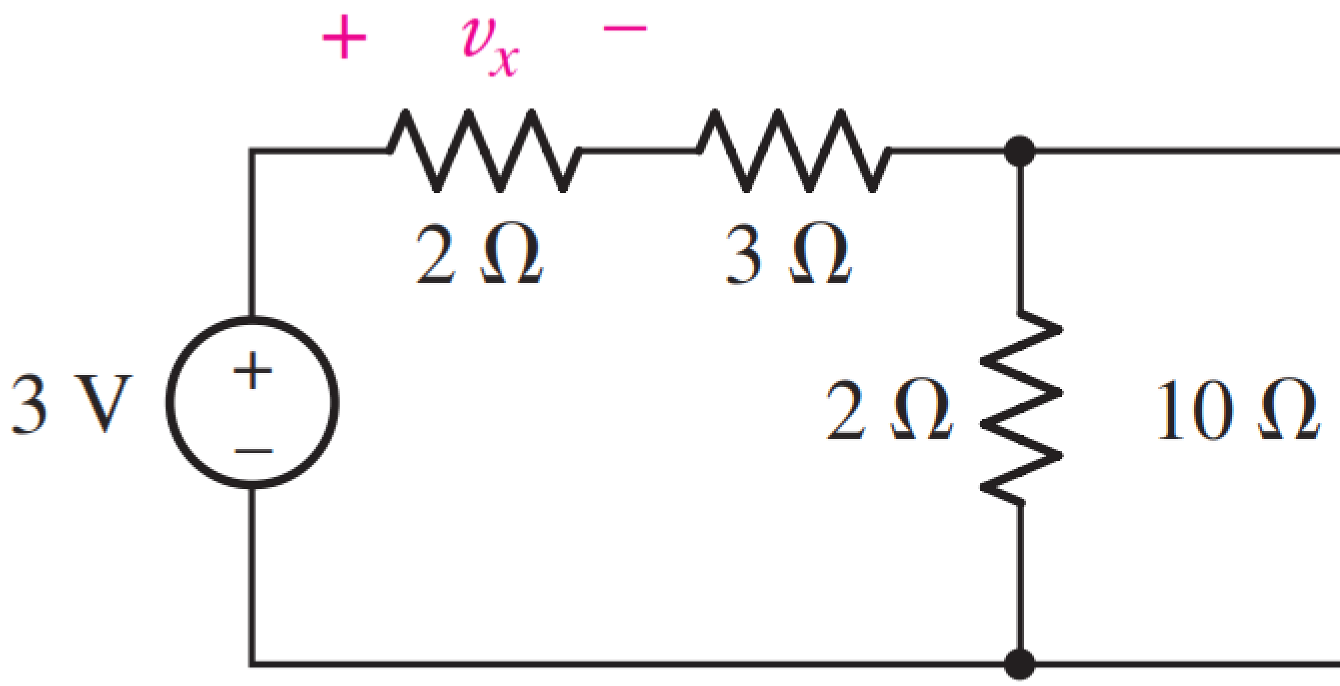
Please note there are many solutions to this problem as long as you choose a v that is NOT zero and is less than 2.5 your answer will be correct

RESULT

See Solutions

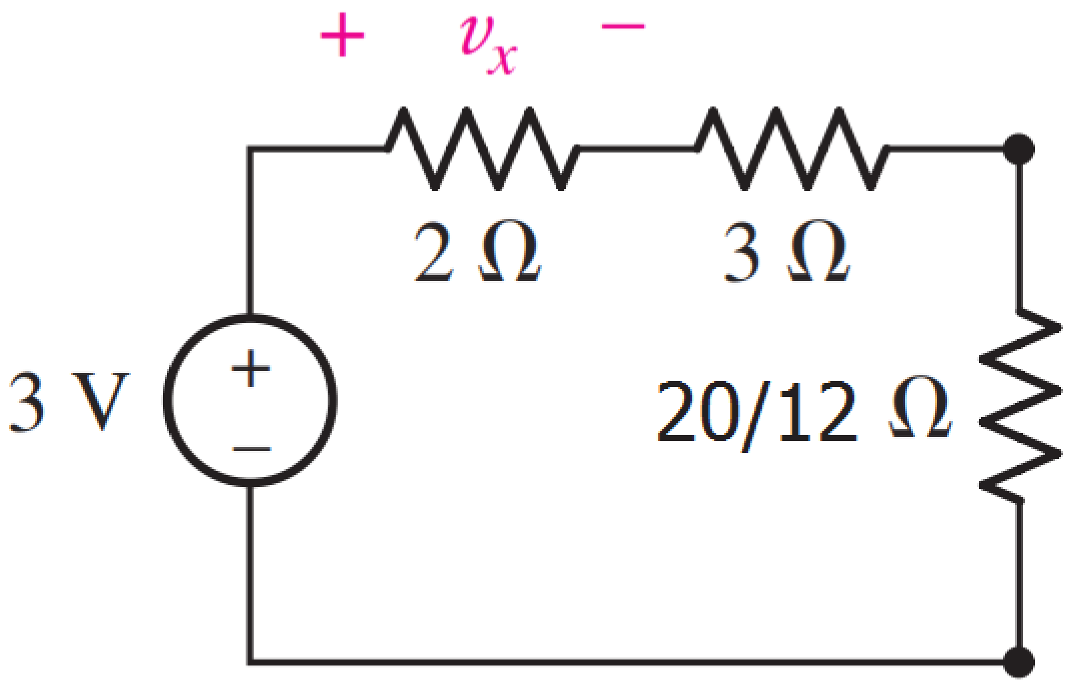
Exercise54

1



We have our circuit and we have to find the drop voltage V_x by voltage division.

2



Simplify the resistance in parallel

3

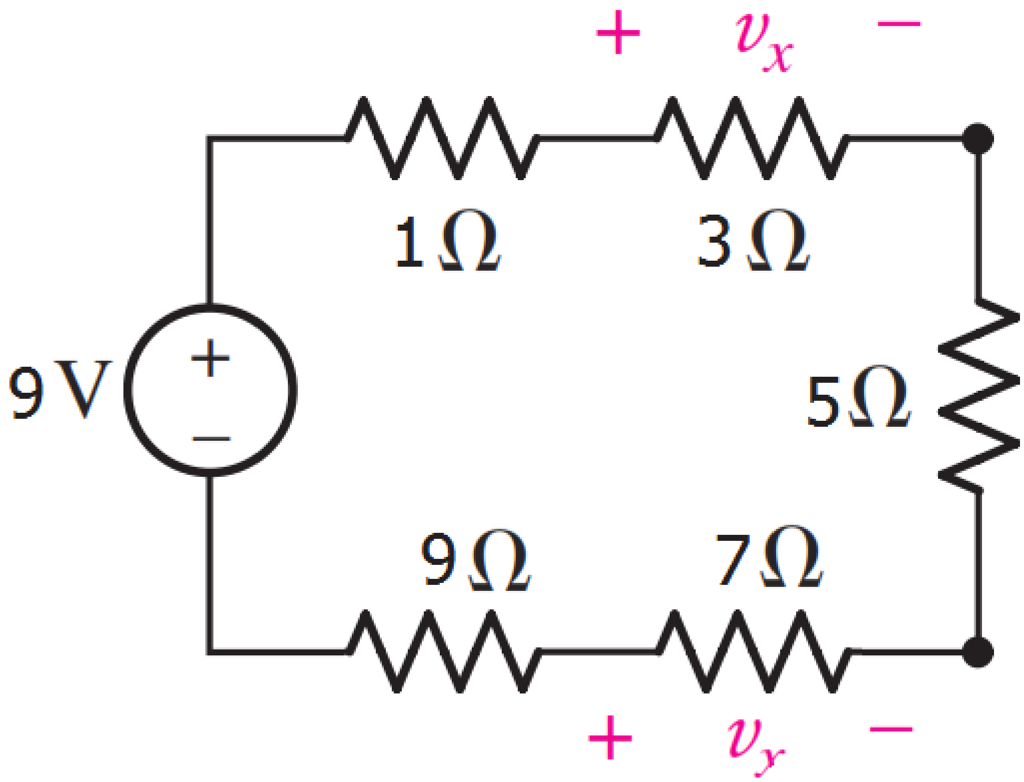
$$V_x = \frac{(3V)(2\Omega)}{(3+2+20/12)\Omega} = 0.9V$$

Then apply voltage division formula

$V_x = 0.9V$

Exercise55

1



We have our circuit, and we have to find the drop voltage indicated by voltage division.

2

$$a)V_x = \frac{(9V)(3\Omega)}{(1+3+5+7+9)\Omega} = 1.08V$$

Use the voltage division formula

3

$$a)V_y = \frac{(9V)(7\Omega)}{(1+3+5+7+9)\Omega} = 2.52V$$

Repeat the same process

$$a)V_x = 1.08V$$
$$b)V_y = 2.52V$$

Exercise56

1

Firs, let's find the resistor equivalent to everything right of the 1Ω resistor and call it R_A.

$$R_A = (((4+4)||4)+5)||2$$

$$R_A = 7.67||2$$

$$R_A = 1.59\Omega$$

And we calculate i_1 as:

$$(i - i_1) \cdot 1\Omega = R_A \cdot i_1$$

$$2.59 \cdot i_1 = 25$$

$$\boxed{i_1 = 9.67\text{A}}$$

2

For calculating i_2 we'll need the resistor equivalent to everything right of 2Ω resistor, call it R_B.

$$R_B = ((4+4)||4)+5$$

$$R_B = 7.67\Omega$$

And we calculate i_2 as:

$$(i_1 - i_2) \cdot 2\Omega = R_B \cdot i_2$$

$$9.67 \cdot i_2 = 2 \cdot i_1$$

$$\boxed{i_2 = 2\text{A}}$$

3

We could have also calculated i_2 much easier as:

$$i_2 = i - i_1$$

(But by doing it the harder way we showed another example of resistance combination and current division.)

4

i_2 is split between the two rightmost branches. Meaning:

$$i_{v3} \cdot (4\Omega + 4\Omega) = (i_2 - i_{v3}) \cdot 4\Omega$$

$$12 \cdot i_{v3} = 8$$

$$i_{v3} = 0.67\text{A}$$

Giving us:

$$v_3 = 4 \cdot 0.67$$

$$\boxed{v_3 = 2.67\text{V}}$$

$$i_1 = 9.67\text{A}$$

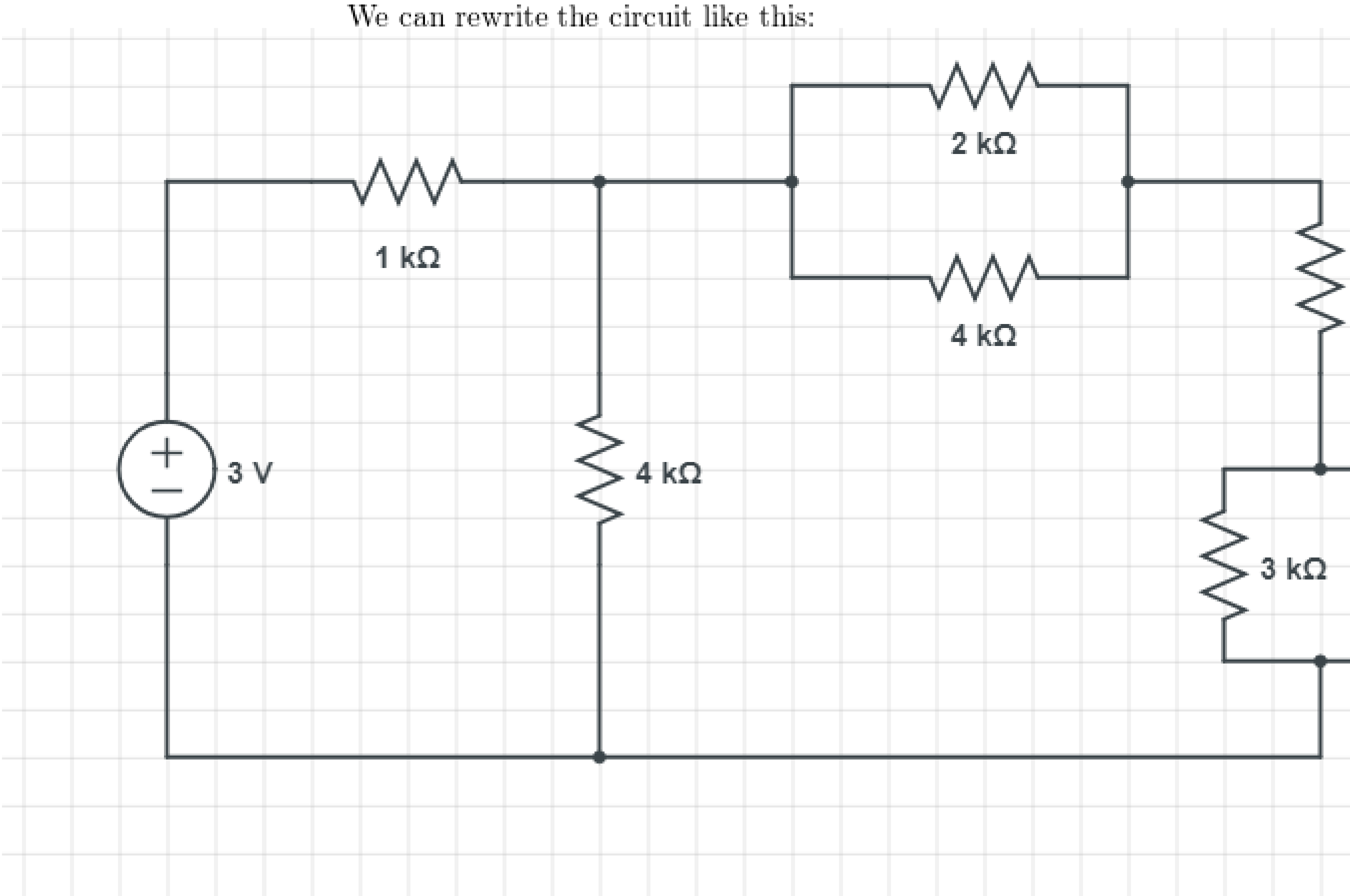
$$i_2 = 2\text{A}$$

$$v_3 = 2.67\text{V}$$

Exercise57

1

We can rewrite the circuit like this:



2

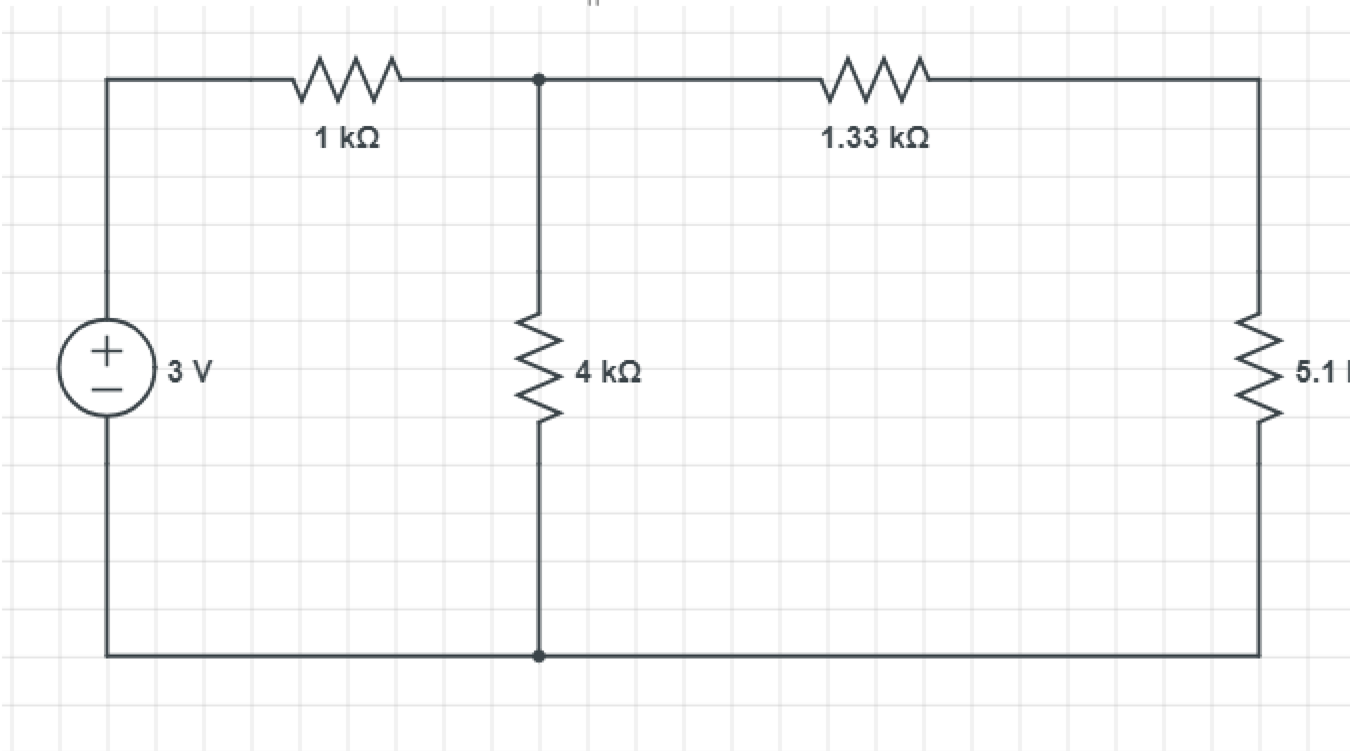
The resistance in the circuit after $1\text{k}\Omega$ resistor is:

$$R_{eq} = 4\text{k}\Omega||(2\text{k}\Omega||4\text{k}\Omega + 3\text{k}\Omega + 3\text{k}\Omega||7\text{k}\Omega) = 2.466\text{k}\Omega$$

And:

$$2\text{k}\Omega||4\text{k}\Omega = 1.33\text{k}\Omega$$

$$3\text{k}\Omega||7\text{k}\Omega = 5.1\text{k}\Omega$$



3

Now we can determine the voltage right of the 1Ω resistor using voltage division.

$$3\text{V} \cdot \frac{R_{eq}}{R_{eq}+1} = 2.134\text{V}$$

And again using voltage division, we can calculate v_x:

$$v_x = 2.134\text{V} \cdot \frac{2.1\text{k}\Omega}{2.1\text{k}\Omega + 3\text{k}\Omega + 1.33\text{k}\Omega}$$

$$\boxed{v_x = 0.697\text{V}}$$

$$v_x = 0.697\text{V}$$

Exercise58

1

In order for us to be able to use voltage division, the same current must be running trough both resistors.
Because:

$$i_1 = i_2$$
$$\frac{v_1}{R_1} = \frac{v_2}{R_2}$$

Here, we'd be able to use voltage division if $i_1 = 0$.

In order for us to be able to use voltage division, the same current must be running trough both resistors.
Here, we'd be able to use voltage division if $i_1 = 0$.

Exercise 59

1

$$v_\pi = \frac{12\cos 1000t(15000)}{15000 + 30} = 12\cos 1000t$$

Let $R_1 = 15000$ and $R_2 = 30$ We can thus solve for v_π from:

$$v_\pi = \frac{VR_1}{R_1 + R_2}$$

2

$$10000||1000 = 909$$

We now need to determine the resistance on the right side of the circuit

3

$$v_{out} = (-0.0012)12\cos(1000t)(909) = -13\cos 1000t$$

We can now find v_{out} using:

$$v_{out} = -\tfrac{1.2}{1000}v_\pi(909)$$

RESULT $-13\cos 1000t\text{mV}$

Exercise 60

1

$$15||3 = 2.5$$

Combine the resisters in parallel

2

$$v_\pi = 6\times10^{-6}\cos 2300t(\frac{2.5}{2.5+1}V = 4.3\times10^{-6}\cos 2300t$$

Solve for $v\pi$ using voltage division:

3

$$v_{out} = -3300(\frac{322}{1000})(4.3\times10^{-6}\cos 2300t)$$
$$= -4.5\times10^{-3}\cos 2300t\text{V}$$

We can find v_{out} from:

$$v_{out} = -Rg_m v\pi$$

RESULT$-4.5 \times 10^{-3} \cos 2300t\text{V}$

Exercise 61

1

a)

First, let's find resistance equivalent to everything right of the 20Ω resistor and we'll call it R_{eq}.

$$R_{eq} = 10||10||(40 + 50||(20+4))$$
$$R_{eq} = 5||(40 + 16.22)$$
$$R_{eq} = 4.59\Omega$$

The voltage on 10Ω resistors is:

$$V_{10\Omega} = 2\text{V} \cdot \frac{4.59\Omega}{4.59\Omega + 20\Omega}$$

$$\boxed{V_{10\Omega} = 0.3734\text{V}}$$

2

b)

To determine the power dissipated on 4Ω resistor we'll first need to determine the voltage on the resistor. By voltage division we get:

$$V_{4\Omega} = V_{10\Omega} \cdot \frac{16.22}{40 + 16.22} \cdot \frac{4}{20+4}$$
$$V_{4\Omega} = 0.01795\text{V}$$

And to get the power we use:

$$P = \frac{V^2}{R}$$

$$P_{4\Omega} = \frac{0.01795^2}{4}$$

$$\boxed{P_{4\Omega} = 80.59\mu\text{W}}$$

a) $V_{10\Omega} = 0.3734\text{V}$

b) $P_{4\Omega} = 80.59\mu\text{W}$

Exercise 62

1

a)

First, we'll determine the current given by the source. So let's find the equivalence of all the resistors in the circuit:

$$R_{eq} = 20 + 10||(40 + 50||(20 + 4))$$

$$R_{eq} = 20 + 10||56.2$$

$$R_{eq} = 20 + 8.49$$

$$R_{eq} = 28.49\Omega$$

2

By applying **Ohm's law** we'll determine the current:

$$I = \frac{2\text{V}}{R_{eq}}$$

$$I = 0.0702\text{A}$$

Current division gives us the value of the current in 40Ω resistor:

$$I_{40\Omega} = I \cdot \frac{10}{10 + 56.22}$$

$$\boxed{I_{40\Omega} = 0.0106\text{A}}$$

3

b)

To calculate the power supplied by the source we'll use the following expression:

$$P = V \cdot I$$

This gives us:

$$P_{2\text{V}} = 2\text{V} \cdot 0.0702\text{A}$$

$$\boxed{P_{2\text{V}} = 0.1404\text{W}}$$

4

c)

For determining the power dissipated by 4Ω resistor, we'll first calculate the current running trough it, by applying current division.

$$I_{4\Omega} = I_{40\Omega} \cdot \frac{50}{50+24}$$

$$I_{4\Omega} = 0.0474\text{A}$$

And to get the power we use the expression:

$$P = I^2 \cdot R$$

$$P_{4\Omega} = I_{4\Omega}^2 \cdot 4\Omega$$

$$\boxed{P_{4\Omega} = 0.205\text{mW}}$$

a) $I_{40\Omega} = 0.0106\text{A}$
b) $P_{2\text{V}} = 0.1404\text{W}$
c) $P_{4\Omega} = 0.205\text{mW}$

Exercise 63

1

a)

By examining the given figure we get:

$$\begin{aligned} \text{nodes} &= 5 \\ \text{loops} &= 6 \\ \text{branches} &= 7 \end{aligned}$$

2

b)

We can see that $I_{2\Omega\text{left}}$ is the same as the current provided by the source. So:

$$\boxed{I_{2\Omega\text{left}} = 2\text{A}}$$

To get $I_{5\Omega\text{left}}$ we'll use current division and find the equivalent resistance of everything right of the that resistor (R_{eq}):

$$R_{eq} = 5 + 2 + 2||1$$
$$R_{eq} = 7 + 0.67$$
$$R_{eq} = 7.67\Omega$$

$$I_{5\Omega\text{left}} = I \cdot \frac{7.67}{5 + 7.67}$$
$$\boxed{I_{5\Omega\text{left}} = 1.21\text{A}}$$

Since $I = I_{5\Omega\text{left}} + I_{5\Omega\text{right}}$ we get:

$$I_{5\Omega\text{right}} = 2 - 1.21$$
$$\boxed{I_{5\Omega\text{right}} = 0.79\text{A}}$$

Because $I_{5\Omega\text{right}}$ and $I_{2\Omega\text{right}}$ are on the same branch:

$$I_{2\Omega\text{right}} = I_{5\Omega\text{right}}$$
$$\boxed{I_{5\Omega\text{right}} = 0.79\text{A}}$$

And also $I_{5\Omega\text{right}} = I_{2\Omega\text{middle}} + I_{1\Omega}$. So current division gives us:

$$I_{2\Omega\text{middle}} = I_{2\Omega\text{right}} \cdot \frac{1}{2+1}$$
$$\boxed{I_{2\Omega\text{middle}} = 0.263\text{A}}$$

And finally $I_{5\Omega\text{right}} = I_{2\Omega\text{middle}} + I_{1\Omega}$. So we have:

$$I_{1\Omega} = 0.79 - 0.263$$
$$\boxed{I_{1\Omega} = 0.527\text{A}}$$

3

c)

Ohm's law states:

$$V = I \cdot R$$

So in this case:

$$V = -2\text{A} \cdot (2\Omega + 7.67\Omega)$$
$$\boxed{V = -19.34\text{V}}$$

a)

$$\text{nodes} = 5$$
$$\text{loops} = 6$$
$$\text{branches} = 7$$

b)

$$I_{2\Omega\text{left}} = 2\text{A}$$
$$I_{5\Omega\text{left}} = 1.21\text{A}$$
$$I_{5\Omega\text{right}} = 0.79\text{A}$$
$$I_{2\Omega\text{right}} = 0.79\text{A}$$
$$I_{2\Omega\text{middle}} = 0.263\text{A}$$
$$I_{1\Omega} = 0.527\text{A}$$

c)

$$V = -19.34\text{V}$$
