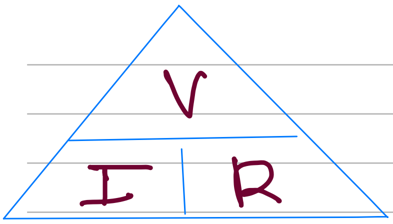
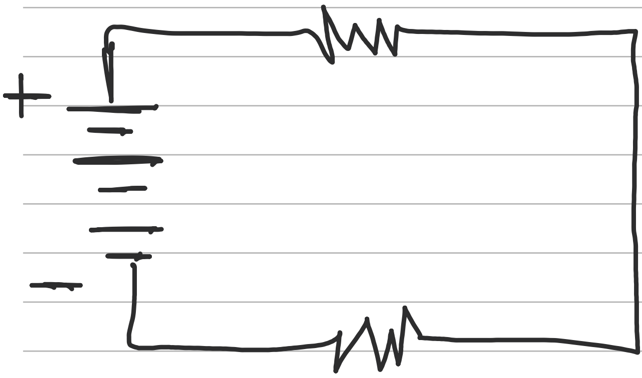
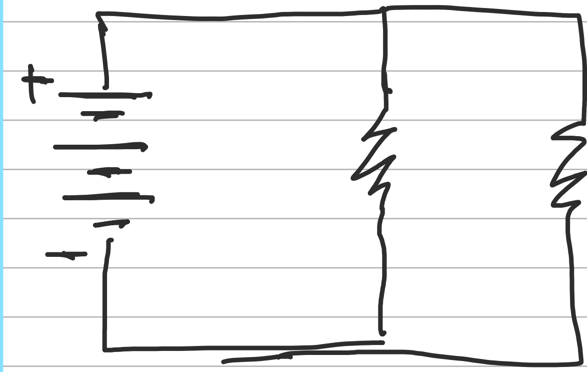
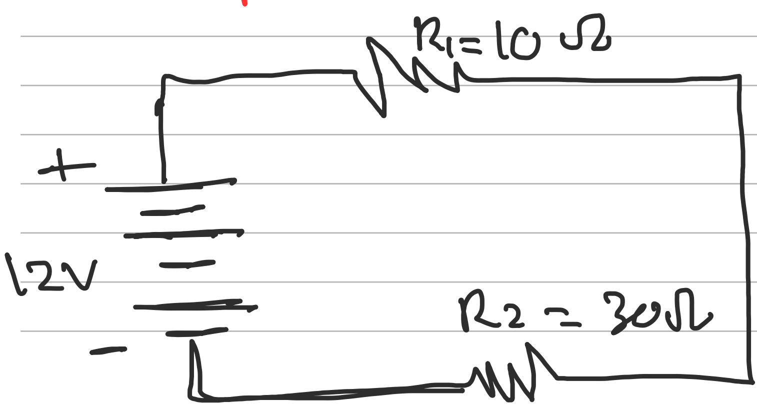


Clo2, part 3, DC circuit

Page 6.1 to 6.13

Series circuit	Parallel circuit
	
$I_t = I_1 = I_2 = I_3$	$I_t = I_1 + I_2 + I_3$
$V_t = V_1 + V_2 + V_3$	$V_t = V_1 = V_2 = V_3$
$R_t = R_1 + R_2 + R_3 \cdots$	$R_t = \dfrac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$ or $\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$
single path	

Example 1. Series circuit.



$V = 12V$

$R_t = ??$

$I_t = ??$

[1] $R_t = ??$

$R_t = R_1 + R_2$

$= 10 + 30$

$R_t = 40\Omega$

[2] $I_t = ??$

$R_t = 40\Omega$

$V = 12V$

$I = ??$

$I_t = \frac{V_t}{R_t}$

$I_t = \frac{12}{40}$

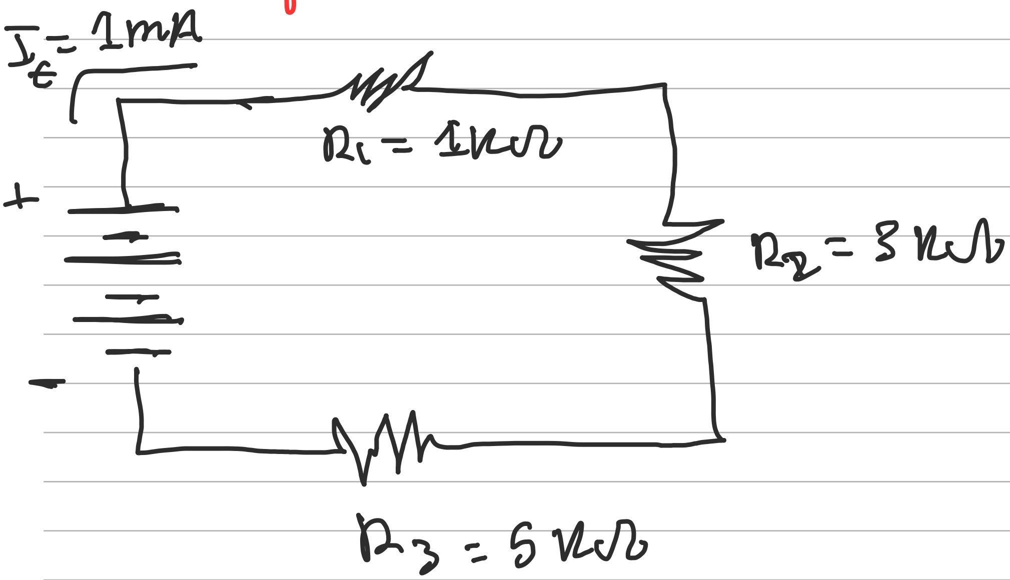
$I_t = 0.3A$

$R_t = 40\Omega$

$I_t = 0.3A$

$V_t = 12V$

Example 2.



$I_t = 1mA$ or 1×10^{-3}

$R_1 = 1k\Omega$ or 1×10^{3}

$R_2 = 3k\Omega$ or 1×10^{3}

$R_3 = 5k\Omega$ or 1×10^{3}

[1] $R_t = ??$

$R_t = R_1 + R_2 + R_3$

$1\times10^3 + 3\times10^3 + 5\times10^3$

$= 9k\Omega$ or 9×10^3

[2] $V_t = ??$

$I_t = 1\times10^{-3}$

$R_t = 9\times10^{3}$

$V_t = I_t \times R_t$

$= 1\times10^{-3} \times 9\times10^{3}$

$V_t = 9V$

$V_t = ??$

add

$V_t = 9V \Rightarrow V_1 + V_2 + V_3$

add

$R_t = 9\,k\Omega$ or $9 \times 10^3 =$

$I = 1 \times 10^{-3}$

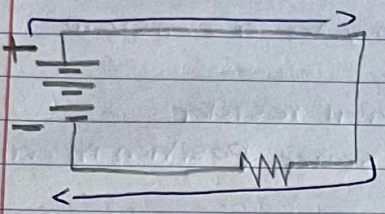
(ii)

in three R are

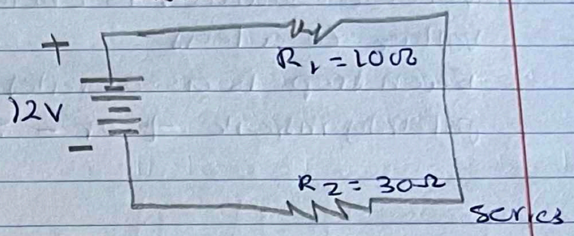
same

Part 3, DC circuits

Simple ~~Series~~ circuit

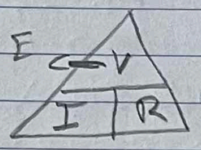


simple DC circuit with additional resistor.



we will use Ohm's law

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



$V = 12V$
$R = 40$
$I_t = ??$

$I = \frac{12}{40}$

$I = 0.3A$

$R_t = ??$

$R_t = R_1 + R_2 + R_3 ---$

$R_t = R_1 + R_2$

$= 10 + 30$

$R_t = 40\Omega$

$I_t = I_1 = I_2 = I_3$

Ohm's Law :-

* describe the relationship between the variables of V, I and R that is linear.

$R_t =$ doubled

effect of $I_t = ??$

$R_t = 40 \times 2 = 80\Omega$

$I = \frac{12}{80}$

$I = 0.15A$

we conclude that we $R \uparrow$, $I \downarrow$

when R double, I reduce by half

* if R_t Reduced to half

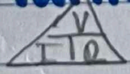
$R_t = 40 \div 2 = 20\Omega$

$I = \frac{12}{20}$

$R \downarrow \ I \uparrow$

$I = 0.6A$

Voltage Drop and further Application Ohm's law



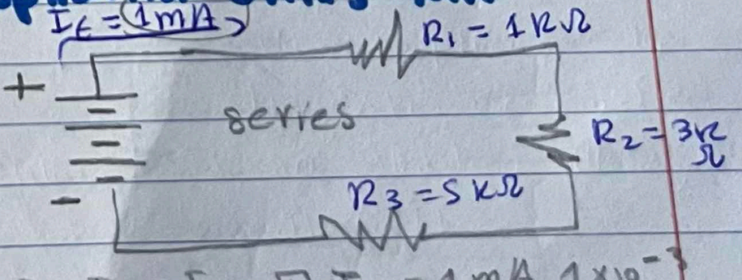
Voltage Drop:-

→ refers to The loss in electrical pressure or

→ EMF caused by forcing electrons through resistor.

amount of electrical pressured required to force given number of electron through resistor

∝ to the size of resistor.



$I_t = I_1 = I_2 = I_3$

$V_t = V_1 + V_2 + V_3$

$R_t = R_1 + R_2 + R_3$

1) $I_t = 1mA \ 1 \times 10^{-3}$

$R_t = 1 + 3 + 5$

$R_t = 9k\Omega$ or $9 \times 10^3 \Omega$

$V_t = ??$

$V_t = I \times R$

$= 1 \times 10^{-3} \times 9 \times 10^3$

$V_t = 9V$

$V_{R_1} = 1 \times 10^{-3} \times 1 \times 10^3$

$V_{R_1} = 1V$

$V_{R_3} = 1 \times 10^{-3} \times 5 \times 10^3$

$V_{R_3} = 5V$

$V_{R_2} = 1 \times 10^{-3} \times 3 \times 10^3$

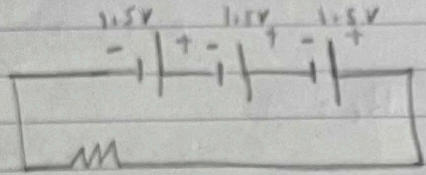
$V_{R_2} = 3V$

Voltage Sources in series

Voltage Sources: is energy source that provides a constant voltage to a load

Each drop is associated with each individual resistor

polarity indicate + or - sign depending on source position in circuit



$V_t = V_1 + V_2 + V_3$ ---

$I_t = I_1 = I_2 = I_3$

$R = R_1 + R_2 + R_3$

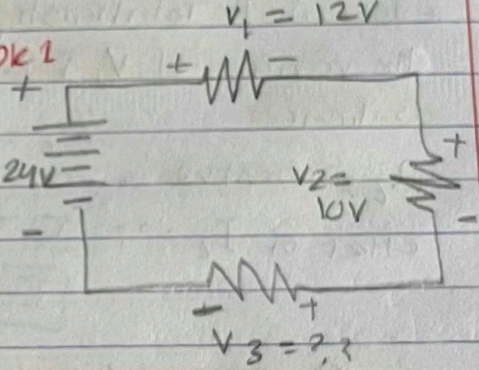
$E = V_t = 1.5 + 1.5 + 1.5$

[redacted] 4.5V

$E \overset{\text{are the same}}{=} V$

Kirchhoff's Voltage Law

Example 1



- analysis of electron circuit
- sum of all V around closed path or loop is 0
- sum of V drops = total source V
- $V_s = V_1 + V_2 + V_3$ ---

step 1

[1] series

$V_t = V_1 + V_2 + V_3$

[2] find V_3

[2] $V_t = 24$

$V_1 = 12$

$V_2 = 10$

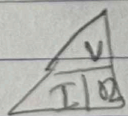
$V_3 = ??$

$V_t = V_1 + V_2 + V_3$

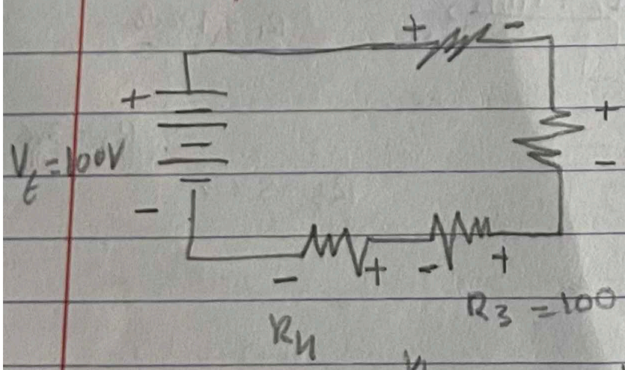
$V_t - V_1 - V_2 = V_3$

$24 - 12 - 10 = V_3$

$V_3 = 2V$



Example 2



[1] Series [2] $R_4 = 340\Omega$ [3] $V_4 = 68V$

[1] $I = 200mA \times 10^{-3}$

$V = 100V$

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

$= \frac{100}{200 \times 10^{-3}}$

$R_t = 500$

$R_4 = ??$

$R_t = R_1 + R_2 + R_3 + R_4$

$500 = 10 + 50 + 100 + R_4$

$500 - 100 - 50 - 10 = R_4$

$R_4 = 340\Omega$

$V_{R_1} = ??$

$I = 200 \times 10^{-3}$

$R_1 = 10$

V_1

$V_1 = I \times R$

$= 200 \times 10^{-3} \times 10$

$V_1 = 2$

V_2

$= 200 \times 10^{-3} \times 50$

$V_2 = 10V$

V_3

$= 200 \times 10^{-3} \times 100$

$V_3 = 20$

$V_t = V_1 + V_2 + V_3 + V_4$

$100 = 2 + 10 + 20 + V_4$

$100 - 20 - 10 - 2 = V_4$

$V_4 = 68V$

voltage divider

* are devices that make it possible to obtain more than one V from single power source
* consist of :
-> resistor
-> resistor connected in series, with fixed or movable contacts and two fixed terminal contacts

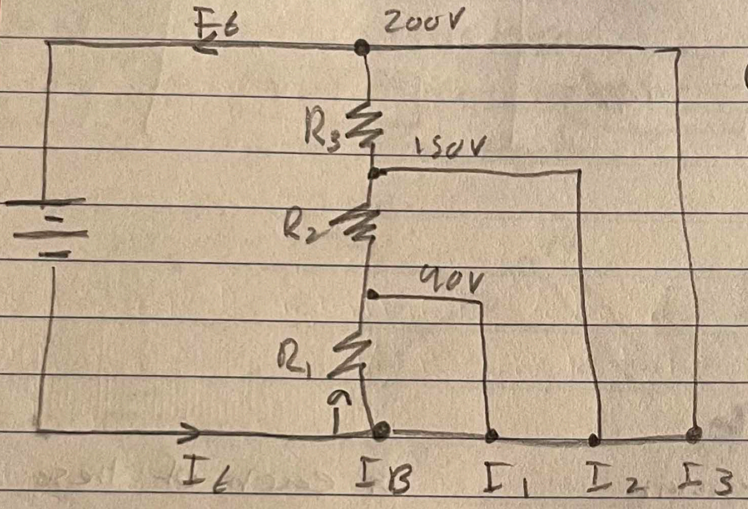
* voltage drops are proportional to the ohmic value of consistment resistors

* as current flow through resistor, different v can be obtained between the contacts.

* I not given

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

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



$R_1 \Rightarrow I_B$

$R_2 \Rightarrow I_B + I_1$

$R_3 \Rightarrow I_B + I_1 + I_2$

$V_{out} = \frac{R_2}{R_1 + R_2} \times V_{in}$

$R_1 = 90$
$R_2 = 60$
$R_3 = 50$

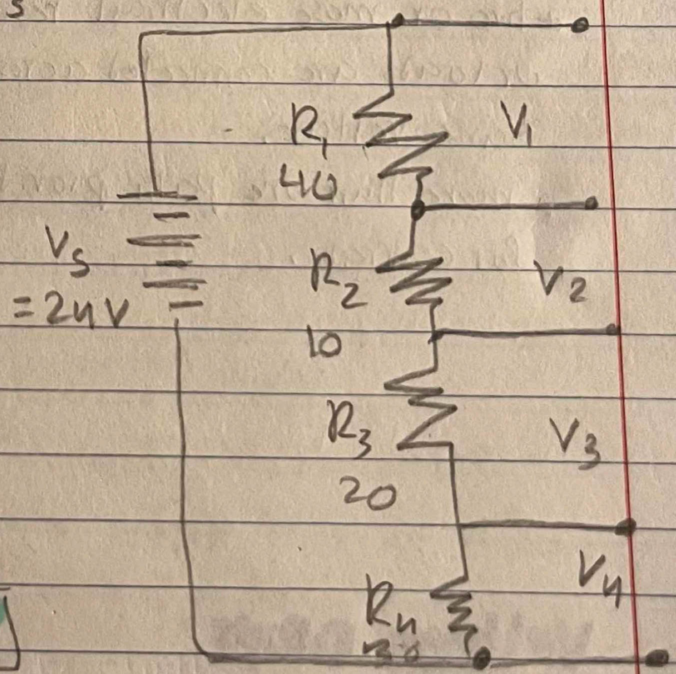
* Ohm's law

$V_3 = I(R_3)$ $\quad I = \frac{V_S}{R_t}$

$V_3 = \frac{V_3}{R_t}(R_3)$

$V_3 = \frac{R_3}{R_t}(V_3)$

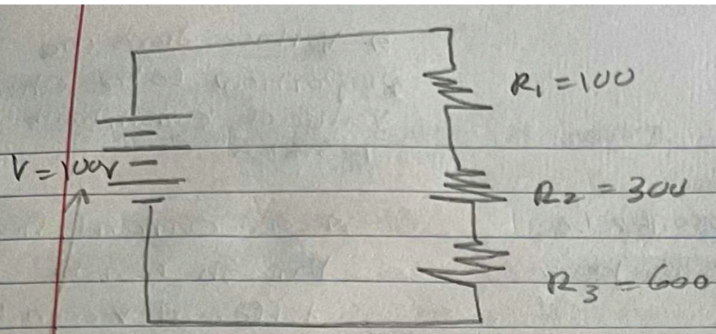
find voltage divider ??



1. $R_t = R_1 + R_2 + R_3 + R_4$

$40 + 10 + 20 + 3 = 100\Omega$

$V_1 = \frac{R_1}{R_t} V_S$	$V_2 = \frac{R_2}{R_t} V_S$	$V_3 = \frac{R_3}{R_t} V_S$	$V_4 = \frac{R_4}{R_t} V_S$
$= \frac{40}{100} \times 24$	$\frac{10}{100} \times 24$	$= \frac{20}{100} \times 24$	$\frac{30}{100} \times 24$
$= 9.6V$	$= 2.4V$	$= 4.8V$	$= 7.2V$



Voltage divider $V_x = \frac{R_x}{R_t} V_t$

$R_t = R_1 + R_2 + R_3$
$= 100 + 300 + 600$
$= 1000\,\Omega$

$V_1 = \frac{R_1}{R_t} V_t$
$= \frac{100}{1000} \times 100$
$= 10V$

$V_2 = \frac{R_2}{R_t} V_t$
$\frac{300}{1000} \times 100$
$= 30V$

$V_3 = \frac{R_3}{R_t} V_t$
$\frac{600}{1000} \times 100$
$= 60V$

check:
$V_1 + V_2 + V_3$
$= 10 + 30 + 60$
$= 100\,V$

parallel DC circuit

- two or more electrical resistance or loads are connected across the same voltage.
- more than one path provided for current.
- each of these parallel path called branch
- minimum requirements for parallel circuit are:
  - power source
  - conductors
  - resistance or load for each current path
  - two or more paths for current flow

Voltage Drops

- voltage across any branch = voltage across all of other branches

Total Parallel R

-> $R_t \downarrow$ when connected to parallel
-> $R_t <$ smallest R in circuit
-> I has several resistors
-> $I = I_1 + I_2 + I_3$

formula of R: reciprocal

$$R_t = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \cdots}$$

Current source :-

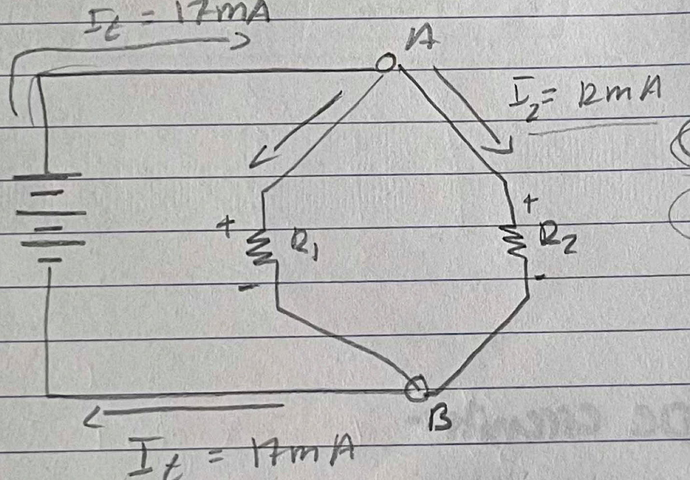
- is an energy source that provide constant value of I to load even when load changes in resistive value

- general rule:
  → I_t produced by current source in parallel $= I_1 + I_2 + I_3$
  $I_t = I_1 + I_2 + I_3 ...$

Kirchhoff current law

- sum of I into junction or node = sum of current flowing out that junction or node
- A junction can be defined as point in circuit where two or more circuit path comes together

- it is the point in circuit where the information branches form
  $I_t = I_1 + I_2 + I_3 ...$
- current going in = current going out
  $I_{in} = I_{out}$



$I_1 = 5mA$

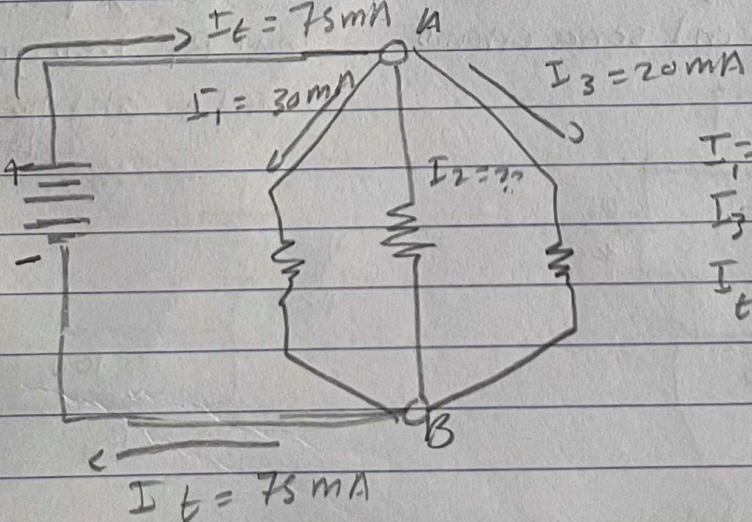
$I_2 = 12\ mA$

$I_t = I_1 + I_2$

$17 - 12$

$I = 5\ mA$

$I_t = 5mA + 12mA$
$= 17mA$



$I_1 = 30$

$I_3 = 20$

$I_t = 75$

$I_t = I_1 + I_2 + I_3$

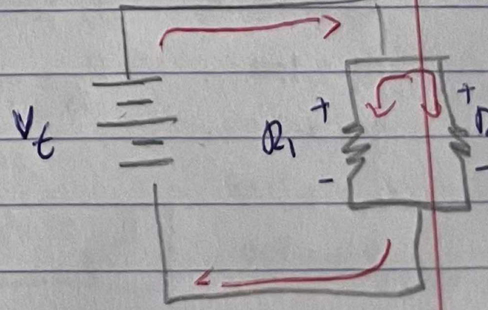
$75 = 30 + I + 20$

$75 - 30 - 20$

$I_2 = 25\ mA$

Current divider :-

- parallel circuit is current divider
- there is current through each two resistor
- V are same across both resistor.
- I inversely proportional to the ohmic value of R



Branches — higher R have less I than those with lower R

Ohm's Law

$I_{\square} = \frac{V_t}{R_{\square}}$

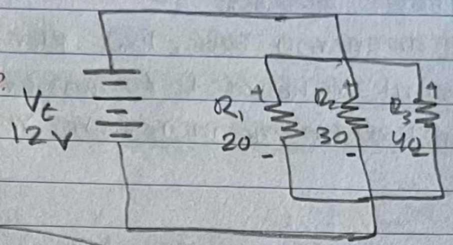
$V_t = I_t (R_t)$

$I_{\square} = \frac{R_t}{R_{\square}} I_t$

↓ current divider

Example:

Determine I_1, I_2, I_3 ??



[1] find R_t

$R_t = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$

$= \frac{1}{\frac{1}{20} + \frac{1}{30} + \frac{1}{40}}$

$R_t = 9.2\,\Omega$

[2] $I_t = ??$

$I_t = \frac{V_t}{R_t}$

$= \frac{12}{9.2}$

$I_t = 1.3\,A$

[3] $I_1 = \frac{R_t}{R_1} \times I_t$

$= \frac{9.2}{20} \times 1.3$

$I_1 = 0.6\,A$

$I_2 = \frac{R_t}{R_2} \times I_t$

$= \frac{9.2}{30} \times 1.3$

$I_2 = 0.4\,A$

$I_3 = \frac{R_t}{R_3} \times I_t$

$= \frac{9.2}{40} \times 1.3$

$I_3 = 0.3\,A$

Final answer

$R_t = 9.2\,\Omega$

$I_t = 1.3\,A$

$I_1 = 0.6\,A$, $I_2 = 0.4\,A$

$I_3 = 0.3\,A$

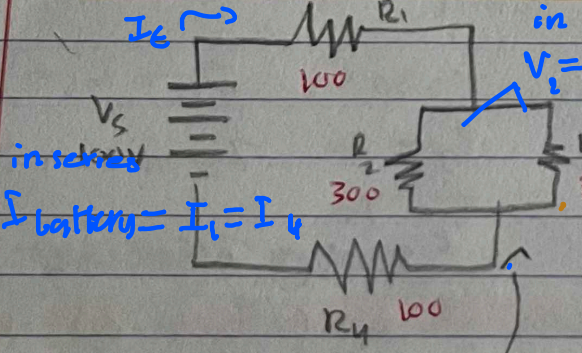
check:

$I_t = 0.6 + 0.4 + 0.3$

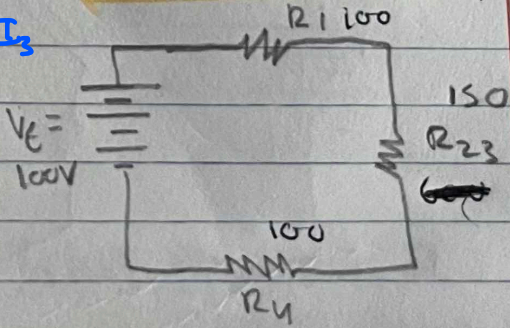
$I_t = 1.3\,A$

Series parallel DC circuits:-

- circuit are usually combination of both, parallel and series circuits



- the voltage provide current out R_1, then group of R_2 and 3 and then R_4.



determine R_t

$V_t = 100\,V$

$R_1 = 100$

$R_2 = 300$

$R_3 = 300$

$R_4 = 100$

[1] parallel

$R_{23} = \frac{1}{\frac{1}{300} + \frac{1}{300}}$

$R_{23} = 150\,\Omega$

[2] series

$R_t = R_1 + R_{23} + R_4$

$= 100 + 150 + 100$

$R_t = 350\,\Omega$

[3] $I_T = ??$

$V = 100\,V$

$R_t = 350$

$I_t = \frac{V}{R} = \frac{100}{350}$

$I_t = 0.286\,A$

[redacted]

[redacted]

$V_{23} = I_t \times R_{23}$

$= 0.286 \times 150$

$= 42.9$

So the voltage in I_2 and I_3 are 42.9V because are parallel

$\Rightarrow$

$I_2 = \frac{V_2}{R_2}$

$= \frac{42.9}{300}$

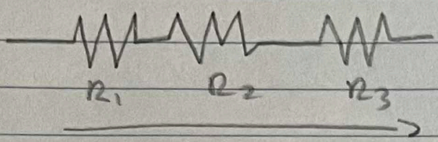
$I_2 = 0.143$

$I_3 = \frac{V_3}{R_3}$

$= \frac{42.9}{300}$

$I_2 = 0.143A$

Series resistor

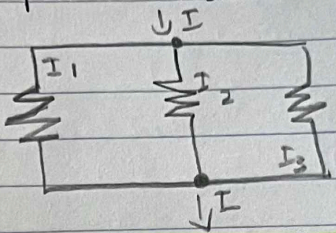


$I_t = I_1 = I_2 = I_3$

$V_t = V_1 + V_2 + V_3$ ---

$R_t = R_1 + R_2 + R_3$

parallel resistor



$I_t = I_1 + I_2 + I_3$ --

$V_t = V_1 = V_2 \pm V_3$ --

$R_t = \dfrac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$ ---

Question:-

1. for resistance in series circuit, the total tolerance is equal to sum of individual resistors in the circuit

2. What's Ohm's law?

$V = I \times R$ -> Resistor
Voltage, current
or
$E = I \times R$

are same $V = E$

Q3. The source voltage = the sum of voltage drops this is known as

Kirchhoff's voltage law

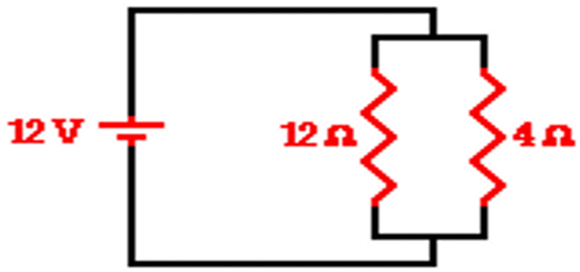
4. What is the primary different between series and parallel circuit
Series: only one path for current
parall: more then one path for current to follow.

5. The total tolerance in parallel circuit always less than value of the smallest resistor in the circuit
$T_{total} < R_{smallest}$

6. The total current produced by current sources in parallel is equal to the algebraic sum of individual source

7. A circuit that is combination a series circuit and one or more parallel circuit is knowns
series parallel circuit or combination circuit.

A 12-V battery , a 12-ohm resistor and a 4-ohm resistor are connected as shown. The voltage drop across the 12-ohm resistor is _____ that across the 4-ohm resistor.



a. 1/3

b. 1/2

c. 2/3

d. the same as

e. 1.5 times

f. twice

g. three times

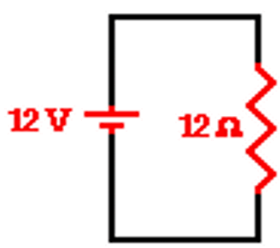
h. four times

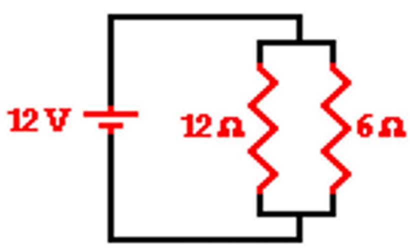
Because it's Voltage drops

9/27/24

A 12-V battery and a 12-ohm resistor are connected as shown in circuit.
A 6-ohm resistor is added to the 12-ohm resistor to create circuit Y as shown.

The voltage drop across the 6-ohm resistor in circuit Y is _____ that across the resistor in X.





a. larger than

b. smaller than

c. the same as

لأن parallel عشانجي يكون نفس

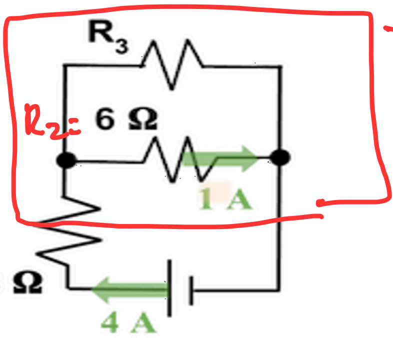
إيمي

For the circuit shown, the current out of the battery is **4 A** and the current that passes through the **6 Ω** resistor is **1 A**

$I_{battery}$

combination circuit:

series and parallel circuit



→ parallel:

$V_{battery} = V_1 = V_2 = V_3$

$I_{battery} = I_1 + I_2 + I_3$

$R_t = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$

What is the current that passes through R_3?

What is the resistance of R_3?

[1] $I_{battery} = 4A$

[2] parallel

9/27/24

[3] $I_{battery} = I_1 + I_3$

$4 = 1 + I_3$

$-1 \quad -1$

$3 = I_3$

$R_2 = 6\Omega$

$I_2 = 1A$

$V_2 = I \times R$

$= 6 \times 1$

$= 6V$

$V_2 = V_3$

so $V_3 = 6V$

$R_3 = ??$

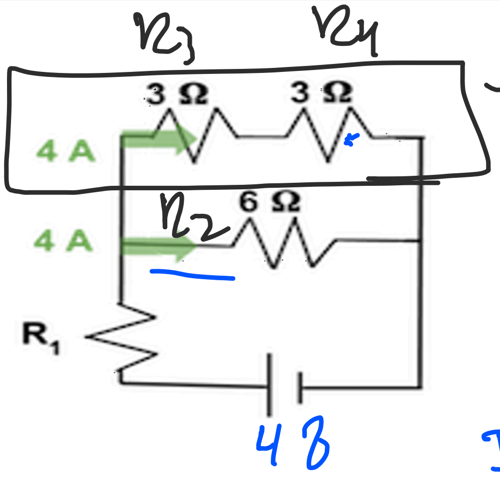
$V_3 = 6V$

$I_3 = 3$

$R_3 = \frac{V_3}{I_3}$

$= \frac{6}{3}$

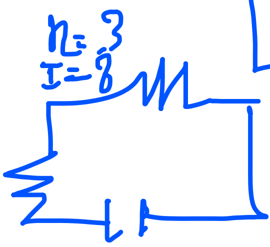
$R_3 = 2\Omega$



$\rightarrow I_{34} = 4$ So parallel

$I_2 = 4$ $I_t = 4 + 4$

$I_t = 8$



$\Rightarrow$ series

so $I_t = I_1 = I_2 = \ldots$

What is the current that passes through R_1?

If the battery voltage is 48 V, what is resistance of R_1?

7/24

[1] $R_1 = ??$

$R_{34} = R_3 + R_4$

$= 3 + 3$

$R_{34} = 6\,\Omega$

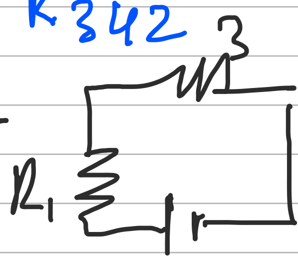
I_1 is also 8 because I_{342} is 8 so I_1 also

$I_1 = 8\,A$

[2] parallel so R_{342}

$$R_{342} = \frac{1}{\frac{1}{6} + \frac{1}{6}}$$

$= 3\,\Omega$



[4] $V_{R_1} = 24$

$R_1 = ??$ $R_1 = \frac{24}{8}$

$I = 8$

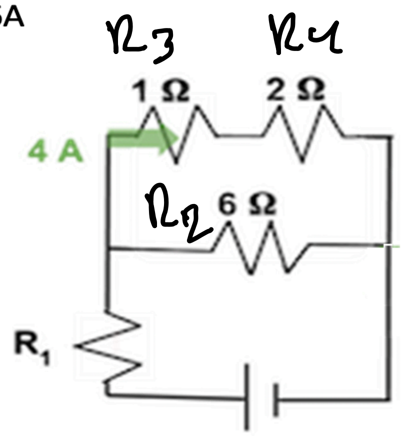
$= 3$

3 $V_{R342} = 3 \times 8 = 24$ ⟹ $V_t = 48$ $48 - 24 = 24$

$R_{342} = 3$ $V_{R342} = 24$

$I = 8$

For the circuit shown, the current through the branch with the 1Ω and 2Ω resistors is 4 A, and the current out of the node is 6A



$I = 4$

$R_{34} = 3$

$V_{34} = 12$

$= V_{R2}$

What is the current that passes through the 6Ω resistor?

If the battery voltage is 24 V, what is resistance of R_1?

1

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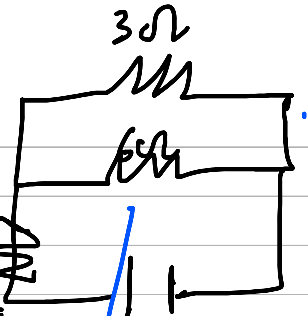
$R_3 = 1\Omega$

$R_4 = 2\Omega$

$R_{34} = R_3 + R_4$

$= 1 + 2$

$R_{34} = 3\Omega$



1 $R_2 = 6\Omega$

$V_2 = 12$

$I_2 = \frac{12}{6}$

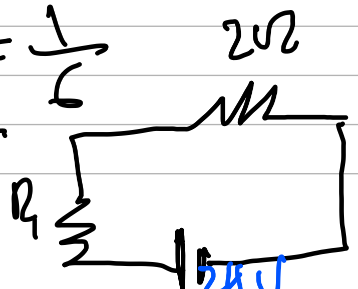
$I_2 = 2A$

2

parallel so R_{342}

$$R_{342} = \frac{1}{\frac{1}{3} + \frac{1}{6}}$$

$R_{342} = 2\Omega$



8) $I_{342} = ??$

$R_{342} = 2\Omega$

$V_{342} = 12$

$I_{342} = \frac{V}{R}$

$= \frac{12}{2}$

$I_{342} = 6\Omega$

so if I_{342} is 6 also $I_{R_1} = 6$ because it's series

$R_1 = ??$

$V_1 = 12$

$I_1 = 6$

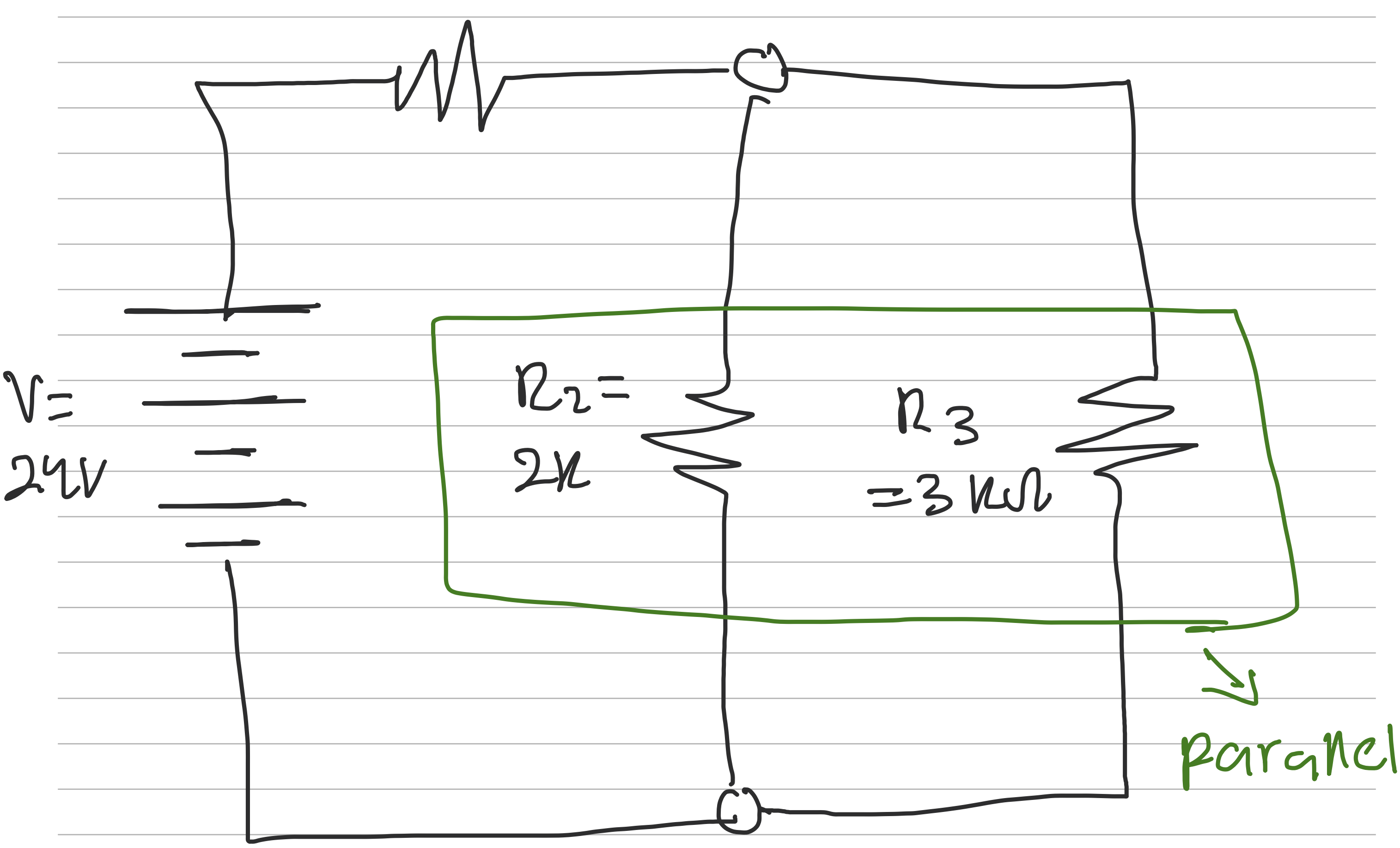
$R_1 = \frac{V_1}{I_1}$

$= \frac{12}{6}$

$R_1 = 2\Omega$

Extra examples

Find I_2 and I_3



1) Combination circuit

2) $R_{23} = ??$

$$R_{23} = \frac{1}{\frac{1}{2\times10^3} + \frac{1}{3\times10^3}}$$

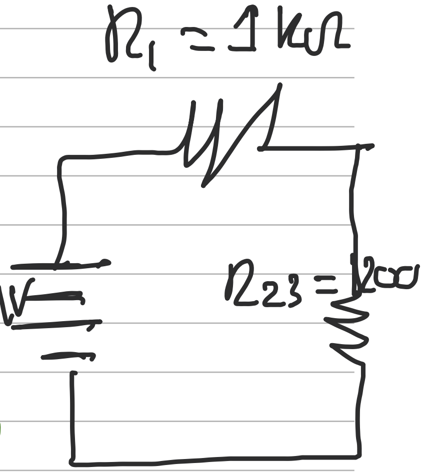
$R_{23} = 1200\Omega$

3) $Rt =$

$R_t = R_1 + R_{23}$

$= 1\times10^3 + 1200$

$R_t = 2200\Omega$



4) $I_t = ??$

$V_s = 24$

5) $V_{R23} = ??$

$V_{R23} = It \times R_{23}$

$R_t = 2200$

$I_t = \frac{24}{2200}$

$= 0.01 A$

$= 0.01 \times 1200$

$V_{R_{23}} = 12V$

so $V_{R_2} = 12$ and

$V_{R_3} = 12 V$

6) I_2 and $I_3 = ??$

$I_2 = \frac{V_2}{R_2}$

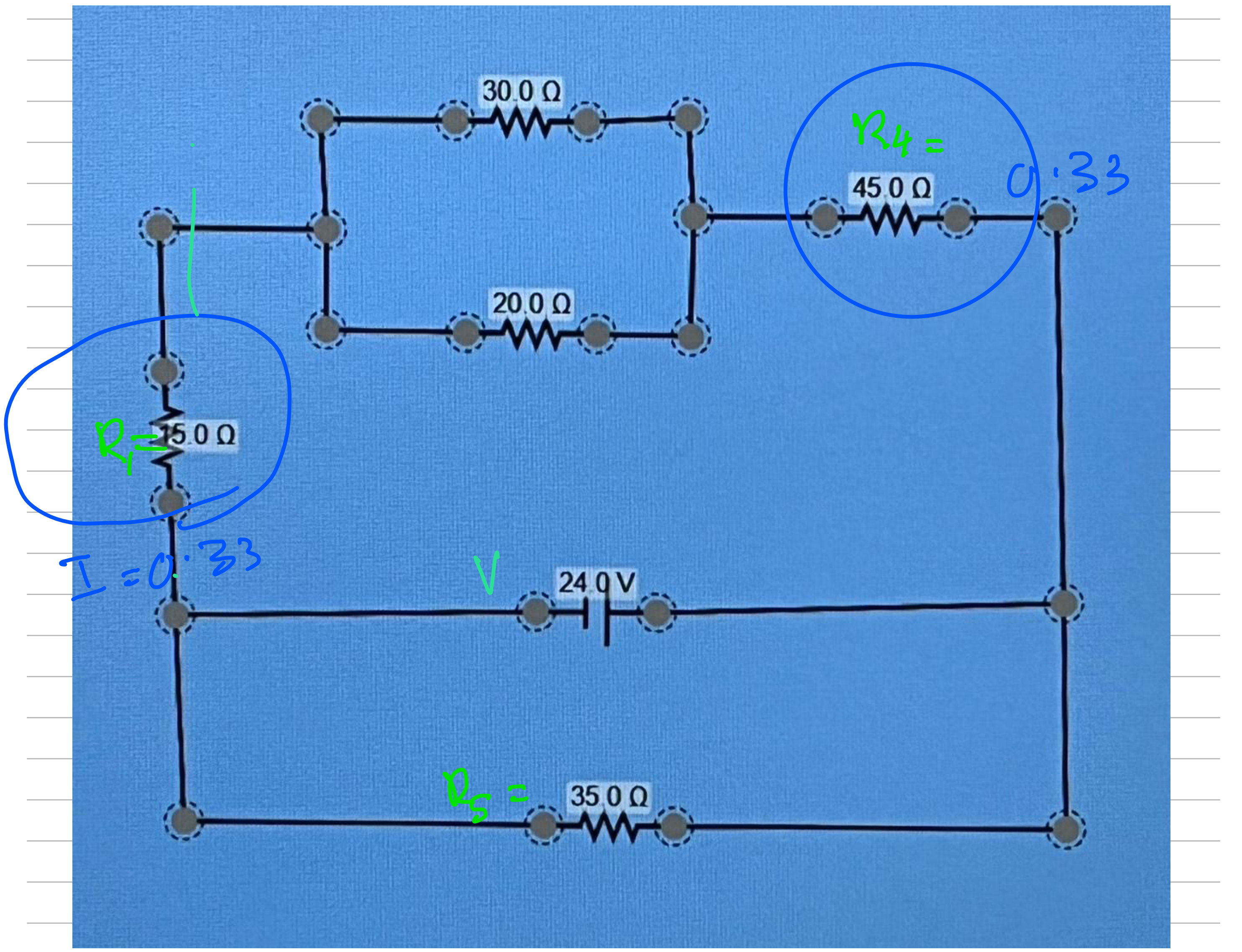
$= \frac{12}{2 \times 10^3}$

$= 6 \times 10^{-3} A$

$I_3 = \frac{V_3}{R_3}$

$= \frac{12}{3 \times 10^3}$

$= 4 \times 10^{-3} A$



:Questions

.Calculate the total resistance of the circuit Rt .1

.Find the total current supplied by the battery It .2

.Determine the voltage across R1 (VR1) .3

.Calculate the current through each resistor (I2, I3, I4, 15) .4

R1 = 15

R2 = 30

R3 = 20

R4 = 45

R5 = 35

Battery voltage V = 24

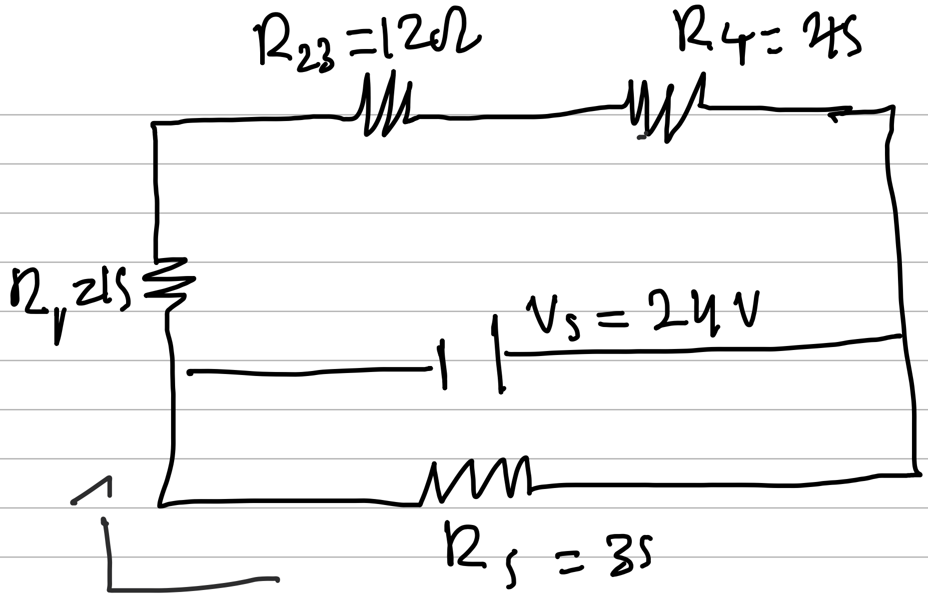
parallel

1 $R_2 = 30$

$R_3 = 20$

$$R_{23} = \frac{1}{\frac{1}{30} + \frac{1}{20}}$$

$R_{23} = 12\,\Omega$

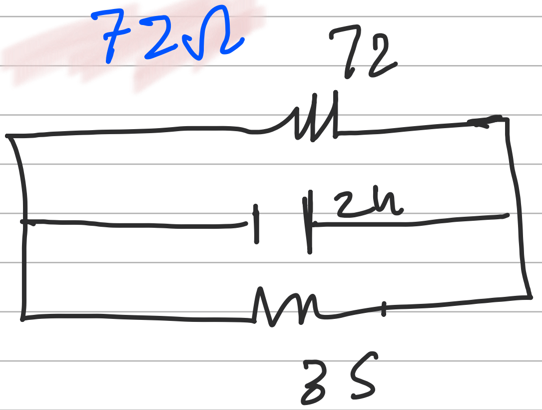


$I_t = 1.019$

2 $R_1 + R_{23} + R_4$

$R_{1234} = 15 + 12 + 45$

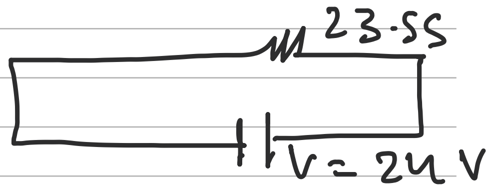
$R_{1234} = 72\,\Omega$



3 $$R_t = \frac{1}{\frac{1}{R_{1234}} + \frac{1}{R_5}}$$

$$= \frac{1}{\frac{1}{72} + \frac{1}{35}}$$

$R_t = 23.55\,\Omega$



4 $I_t = ??$

$R_t = 23.55\,\Omega$

$V_s = 24V$

$$I_t = \frac{V}{R} = \frac{24}{23.55}$$

$I_t = 1.019A$

5 $R_{1234} = 72$

$V = 24$

$$I = \frac{V}{R} = \frac{24}{72}$$

$I_1 = 0.33A$

6 $I_1 = 0.33$

$I_4 = 0.33A$

$R_1 = 15$

$V_{R_1} = 4.95\ V$

7 $I_s = ??$

$R_s = 35$ $I_s = \frac{24}{35}$

$V = 24$

because its parallel

$I_s = 0.685$

$I_{23} = 0.33A$

because it is series

8 $R_{23} = 12$

$V_{23} = ??$

$I_{23} = 0.33$

$V_{23} = I_{23} \times R_{23}$

$= 0.33 \times 12$

$V_{23} = 3.96$

9 I_2 and I_3

$R_2 = 30$

$V_2 = 3.96$

$I_2 = \frac{V}{R}$

$= \frac{3.96}{30}$

$I_2 = 0.132A$

$R_3 = 20$

$V_3 = 3.96$

$I_3 = \frac{V}{R}$

$= \frac{3.96}{20}$

$I_3 = 0.198A$

Note if we add I_2 and I_3

$I_{23} = 0.33\ A$ => $0.132 + 0.198$