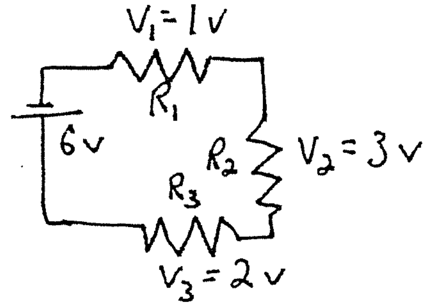
Voltage, Resistance and Current in a Series Circuit

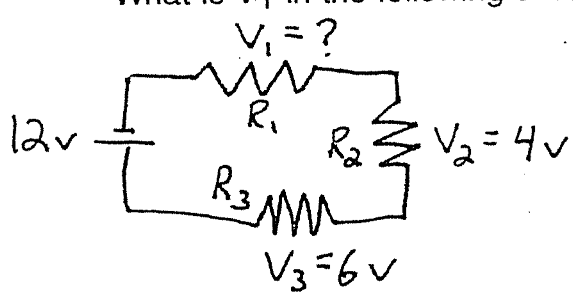
VOLTAGE

From Kirchoffs Law, the total voltage increase is equal to the total voltage decrease. Consider the following circuit.

The voltage increase from the battery is 6 v. The decreases from each of the resistors adds up to 6 v.



What is V_1 in the following circuit?



V_1 =

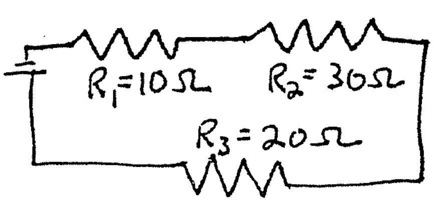
The voltage decrease or voltage drop across each resistor depends on the value of the resistors in the circuit. It is necessary to find the TOTAL RESISTANCE of a circuit.

RESISTANCE

To find the total resistance of a series circuit, sometimes written R_T, you need to add up all the resistors. So

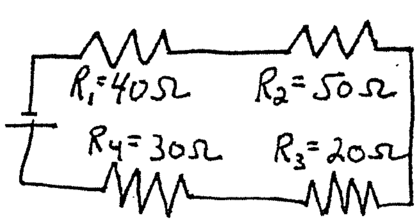
$$R_T = R_1 + R_2 + R_3 + \dots$$

In this circuit the total resistance is 10 Ω + 30 Ω + 20 Ω = 60 Ω



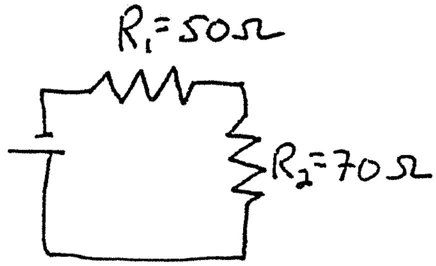
Find R_T for the following circuits

1)



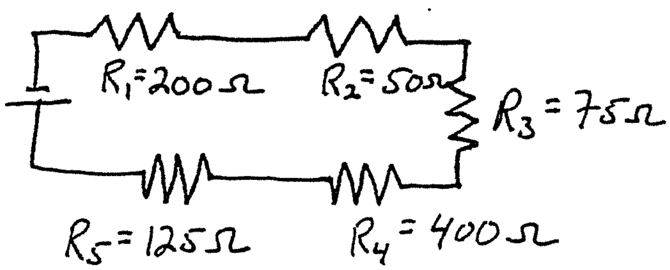
R_T =

2)



RT =

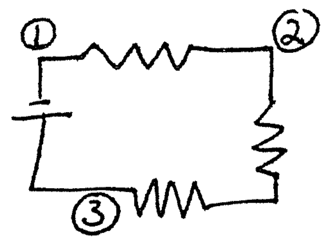
3)



RT =

CURRENT

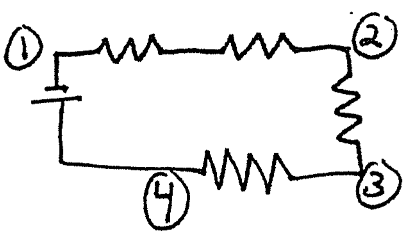
The current in a series circuit is the same throughout the whole circuit, because there are no junctions.



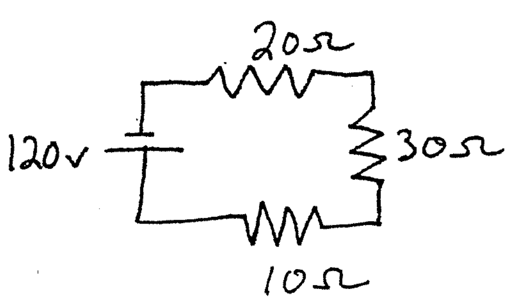
If the current at point 1 is 2 Amps, then the current at point 2 is 2 Amps and at point 3 is 2 Amps.

If the current at point 1 is 50 mA, then

a) what is the current at point 2? ____
b) what is the current at point 3? ____
c) what is the current at point 4? ____



To find the current in a series circuit, use Ohms Law. Remember V = I x R and I = V ÷ R. Consider the following.



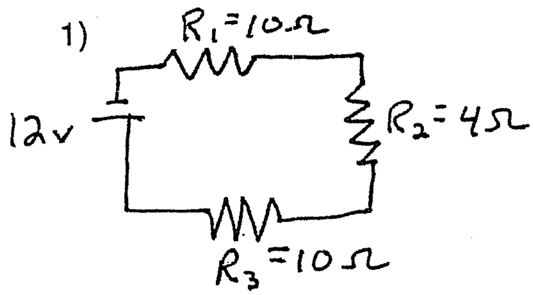
V_T = 120 v (from the battery)

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

So $I_T = V_T \div R_T = 120\text{ v} \div 60\ \Omega = 2\text{ A}$

Find I for each of the following:

1)

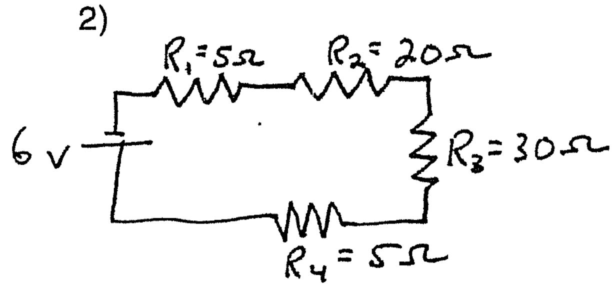


VT =

RT =

IT =

2)

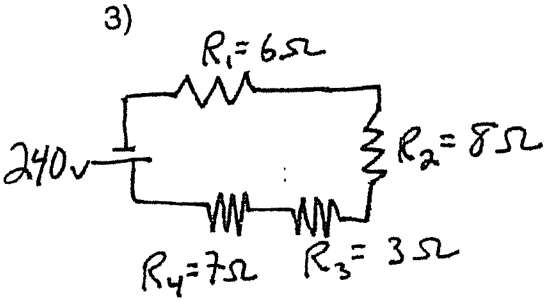


VT =

RT =

IT =

3)



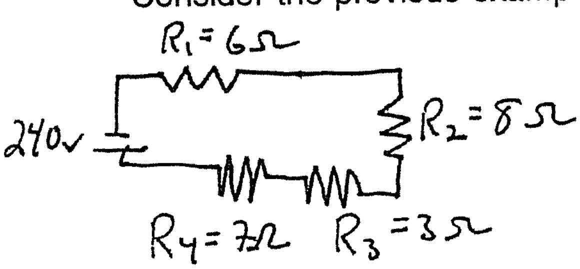
VT =

RT =

IT =

The current which flows in the circuit also flows in each resistor. This is how the **voltage decrease** for each resistor is calculated.

Consider the previous example:



V_T = 240 v, R_T = 24 Ω, I_T = 10 Amps.

The voltage decrease across R1 is determined by Ohms Law, $V_1 = I \times R_1$. The current through R1 is 10 amps and the resistance is 6 Ω so V_1 = 10 a x 6 Ω = 60 v.

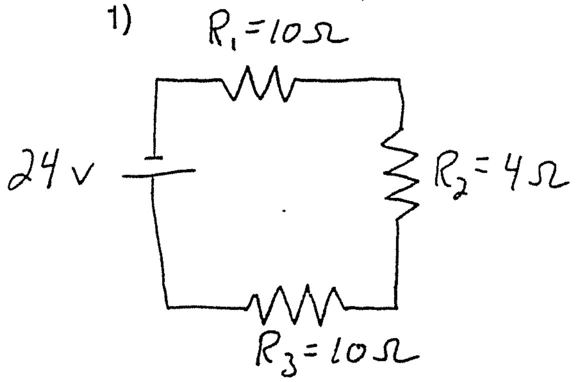
Similarly the voltage decrease across R2 will be

	V_2= 10 amps x 8 Ω = 80 v,
for R3	V_3= 10 amps x 3Ω = 30 v,
for R4	V_4= 10 amps x 7 Ω = 70 v.

If these voltage decreases are added up, the total is 60 v + 80 v + 30 v + 70 v = 240 v, which is the same as the voltage increase or the voltage of the battery. This is a way to check to make sure you did it right.

Find the voltage decreases for the following circuits.

1)



$V_T =$ $R_T =$ $I_T =$

Voltage decrease for R_1, $V_1 =$

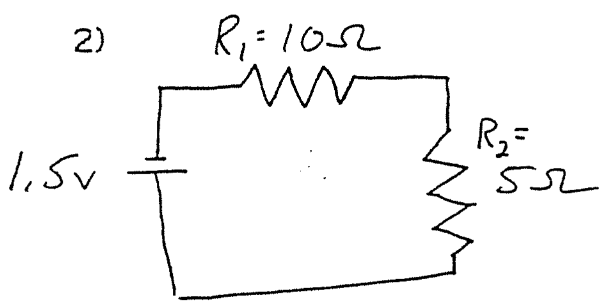
(Remember V = I x R)

Voltage decrease for R_2, $V_2 =$

Voltage decrease for R_3, $V_3 =$

Total of all Voltage decreases ___

2)



$V_T =$ $R_T =$ $I_T =$

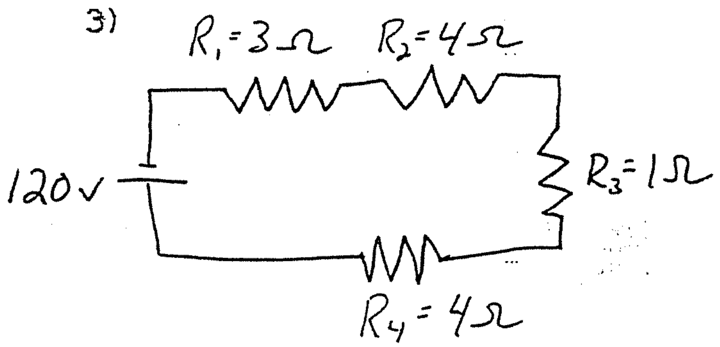
Voltage decrease for R_1, $V_1 =$

(Remember V = I x R)

Voltage decrease for R_2, $V_2 =$

Total of all Voltage decreases ___

3)



$V_T =$ $R_T =$ $I_T =$

Voltage decrease for R_1, $V_1 =$

(Remember V = I x R)

Voltage decrease for R_2, $V_2 =$

Voltage decrease for R_3, $V_3 =$

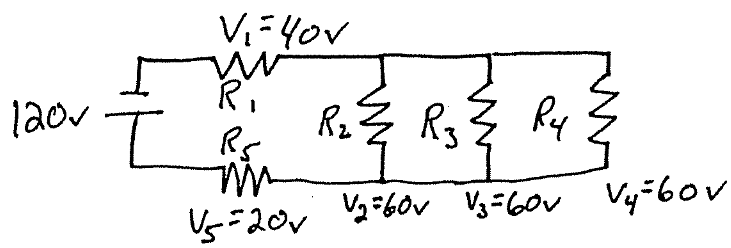
Voltage decrease for R_4, $V_4 =$

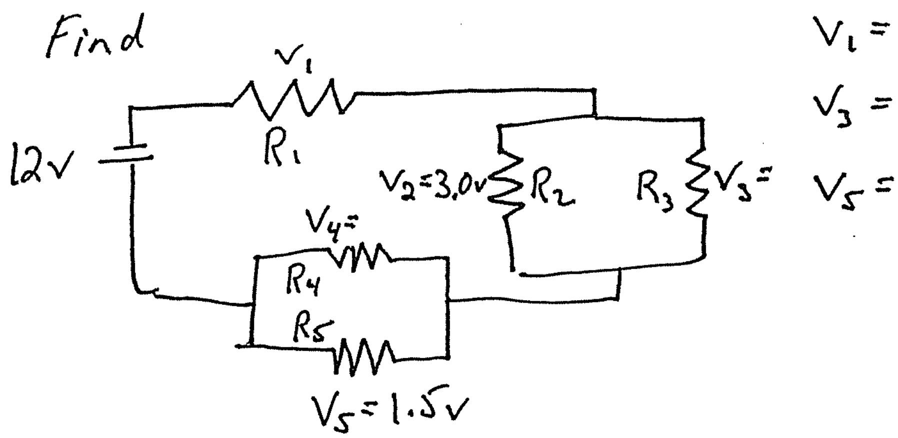
Total of all Voltage decreases ___

Voltage, Current and Resistance in a Parallel Circuit

VOLTAGE

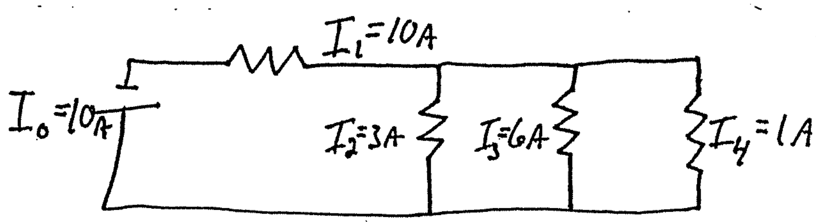
From Kirchoffs Law, the voltage increase in a circuit is equal to the voltage decreases for a complete path.



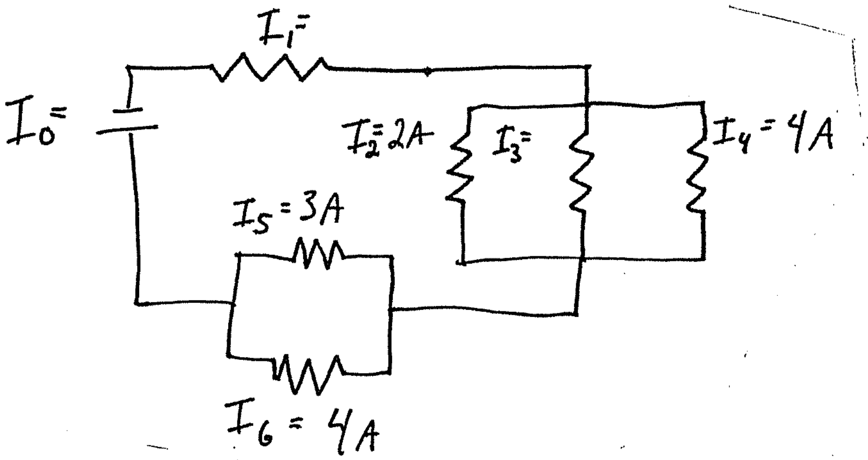


CURRENT

Again Kirchoffs Laws are used. The current entering a junction must equal the current in the junction and exiting it.



Find the current in the following parts of the circuit.



$I_0 =$

$I_1 =$

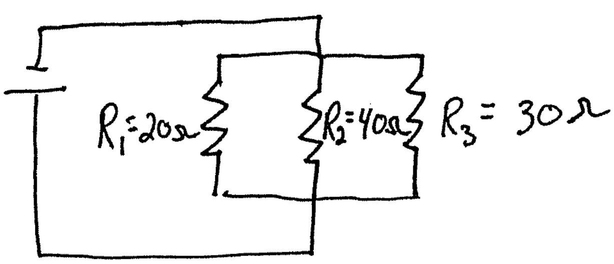
$I_2 =$

RESISTANCE

To find the total resistance, R_T, in a parallel circuit use the following equation.

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

This is a tough equation to use. Please follow the outline shown below.



1) Write out the equation above, substituting in the values for R_1, R_2, R_3, etc. So:

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

2) Convert the fractions to decimals. So: $\frac{1}{R_T} = \frac{1}{20} + \frac{1}{40} + \frac{1}{30}$ becomes

$$\frac{1}{R_T} = 0.05 + 0.025 + 0.0\overline{3}$$

3) Add up the decimal numbers, so: 0.05 + 0.025 + 0.033 = 0.108

This is **NOT** the final answer!!

$$\frac{1}{R_T} = 0.108$$

4) Take the reciprocal of both sides.

$$\frac{R_T}{1} = \frac{1}{0.108}$$

5) Divide the fraction (1 ÷ 0.108 = 9.26)

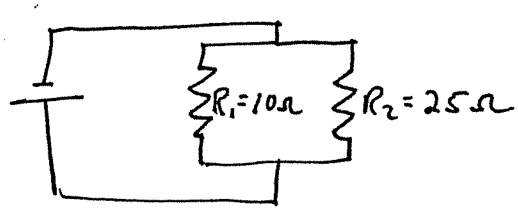
This **IS** the answer. $R_T = 9.26\ \Omega$

There are other ways of doing this, but this method is the simplest.

Questions:

1) Find the total resistance in the following parallel circuits.

a)



Step 1) $\frac{1}{R_T} = \frac{1}{\ } + \frac{1}{\ }$

2) $\frac{1}{R_T} = 0. \quad + 0.$

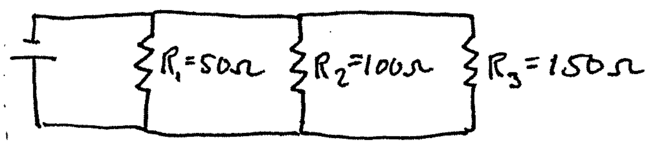
3) $\frac{1}{R_T} = 0.$

4) $\frac{R_T}{1} = \frac{1}{0.}$

5) $R_T = \quad \Omega$

b) 

RT =

c) 

RT =

d) a circuit with a 20 Ω, 40 Ω, 60 Ω and 80 Ω resistors all in parallel.

RT =

e) a circuit with a 25 Ω, 50 Ω, 75 Ω, 100 Ω and 200 Ω resistors all in parallel.

RT =

f) Calculate the total resistance of

i) 2, 50 Ω resistors in parallel. RT =

ii) 3, 50 Ω resistors in parallel. RT =

iii) 4, 50 Ω resistors in parallel. RT =

Series Circuit Worksheet

Name: ___________

1) Unit Conversion: Amps to milliAmps etc.

Remember 1000 mA = 1 A   1000 mV = 1V

1 mA = 0.001 A   1 mV = 0.001 V

a) 2 A = ______ mA   b) 0.2 A = ______ mA

c) 15 A = ______ mA   d) 0.007 A = ______ mA

e) 6000 mA = ______ A   f) 750 mA = ______ A

g) 19 mA = ______ A   h) 4 mA = ______ A

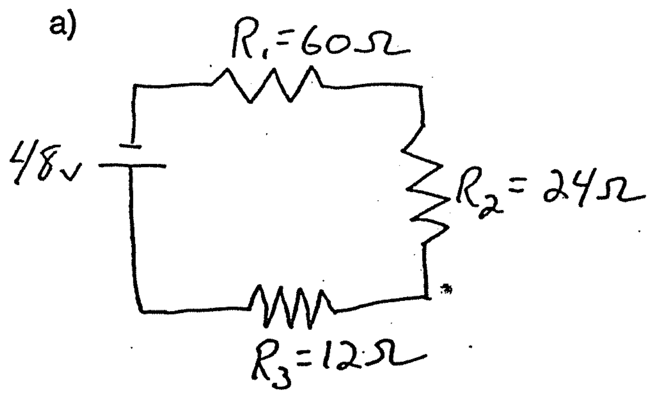
i) 27 mV = ______ V   j) 980 mV = ______ V

k) 6527 mV = ______ V   l) 0.2 V = ______ mV

m) 6 V = ______ mV   n) 15.5 V = ______ mV

2) Solve for the unknowns in each circuit.

a)



V_T = R_T = I_T =

Voltage decrease for R_1, V_1 =

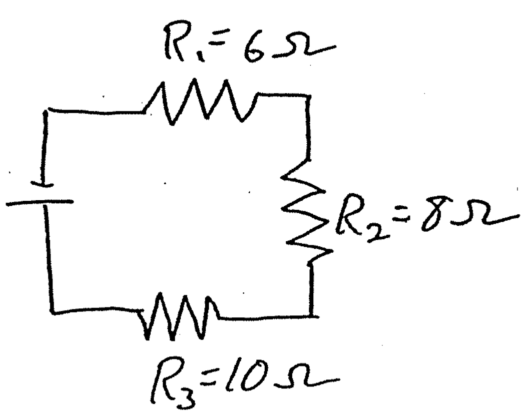
(Remember V = I x R)

Voltage decrease for R_2, V_2 =

Voltage decrease for R_3, V_3 =

Total of all Voltage decreases ___

b)



V_T = R_T = I_T = 0.2 Amps

Voltage decrease for R_1, V_1 =

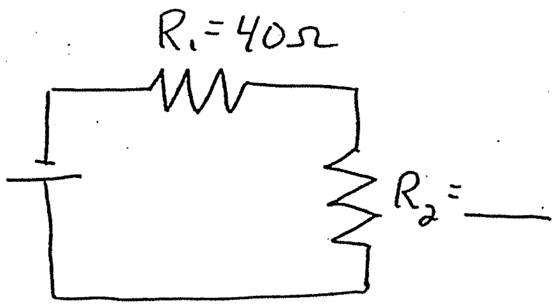
(Remember V = I x R)

Voltage decrease for R_2, V_2 =

Voltage decrease for R_3, V_3 =

Total of all Voltage decreases ___

c)



$V_T =$ $R_T =$ $I_T = 3.0$ Amps

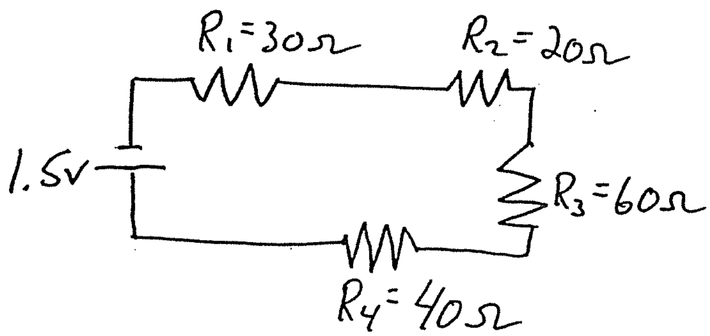
Voltage decrease for R_1, $V_1 =$

(Remember $V = I \times R$)

Voltage decrease for R_2, $V_2 =$ 20.0 v

Total of all Voltage decreases ___

d)



$V_T =$ $R_T =$ $I_T =$

Voltage decrease for R_1, $V_1 =$

(Remember $V = I \times R$)

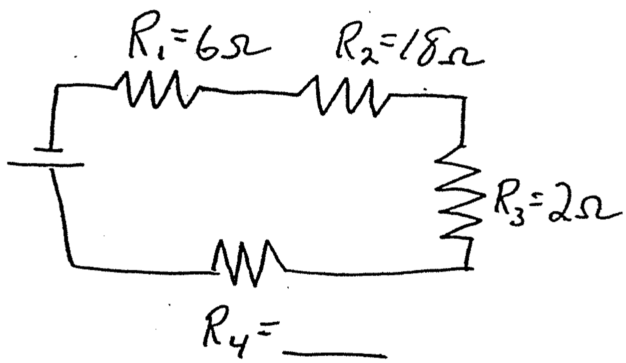
Voltage decrease for R_2, $V_2 =$

Voltage decrease for R_3, $V_3 =$

Voltage decrease for R_4, $V_4 =$

Total of all Voltage decreases ___

e)



$V_T =$ $R_T =$ $I_T = 2.0$ amps

Voltage decrease for R_1, $V_1 =$

(Remember $V = I \times R$)

Voltage decrease for R_2, $V_2 =$

Voltage decrease for R_3, $V_3 =$

Voltage decrease for R_4, $V_4 =$

Total of all Voltage decreases = 60 v