Topic 8 The Series Circuit

T8 Series circuits encompassing:

- ☒ circuit diagram of a single-source d.c. ‘series’ circuit.
- ☒ Identification of the major components of a ‘series’ circuit: power supply; loads; connecting leads and switch
- ☒ applications where ‘series’ circuits are used in the Electro technology industry.
- ☒ characteristics of a ‘series’ circuit - connection of loads, current path, voltage drops, power dissipation and effects of an open circuit in a ‘series’ circuit.
- ☒ the voltage, current, resistances or power dissipated from measured or given values of any two of these quantities
- ☒ relationship between voltage drops and resistance in a simple voltage divider network.
- ☒ setting up and connecting a single-source series dc circuit
- ☒ measurement of resistance, voltage and current values in a single source series circuit
- ☒ effect of an open-circuit on a series connected circuit

▼ **Notes**

Below is the growing list of teaching material for this topic

Lesson Plan Week 3 DC ,

Greg Moore

Week 3 Quiz, marked in class and hand back after scanning

TOPIC 8 Series Circuits, KVL (3 hour)

- main ppt and worksheets
- refer to Phillips text pages and see what's there
- my ppt KVL analysis
- Questions to do in class and remainder for homework
- Circuit maker 2000 lab re KVL

TOPIC 4 Introduce Power **** originally not planned (2 hour)

- worksheets and ppt
- Phillips text notes refer to
- Tutorial questions about power

TOPIC 6 EMF sources (1.5 hour)

- main ppt and worksheets
- Lab in class with Vinegar and Salt
- Demo in class about the effects of salt as to conduction in a fluid.
- Tutorial questions about EMF sources.

Additionally, think do breadboard, Fritzing with resistors and wires.
Introduce resistor colour codes, basic identification and measurement.
This is provided have time.

We will do more on power dissipation a little later…. just introduce power here first time in week 2 and 3 of the nine week program.
In class Circuit maker 200 lab for this this topic.
The lab from week 2, with graphs of Vdrop across resistors and current flowing in the circuit more than covers what is here in section 8.
Demonstration of cell voltages reversed (opposing maybe handy here)

1. Series circuits have only one path for current flow.

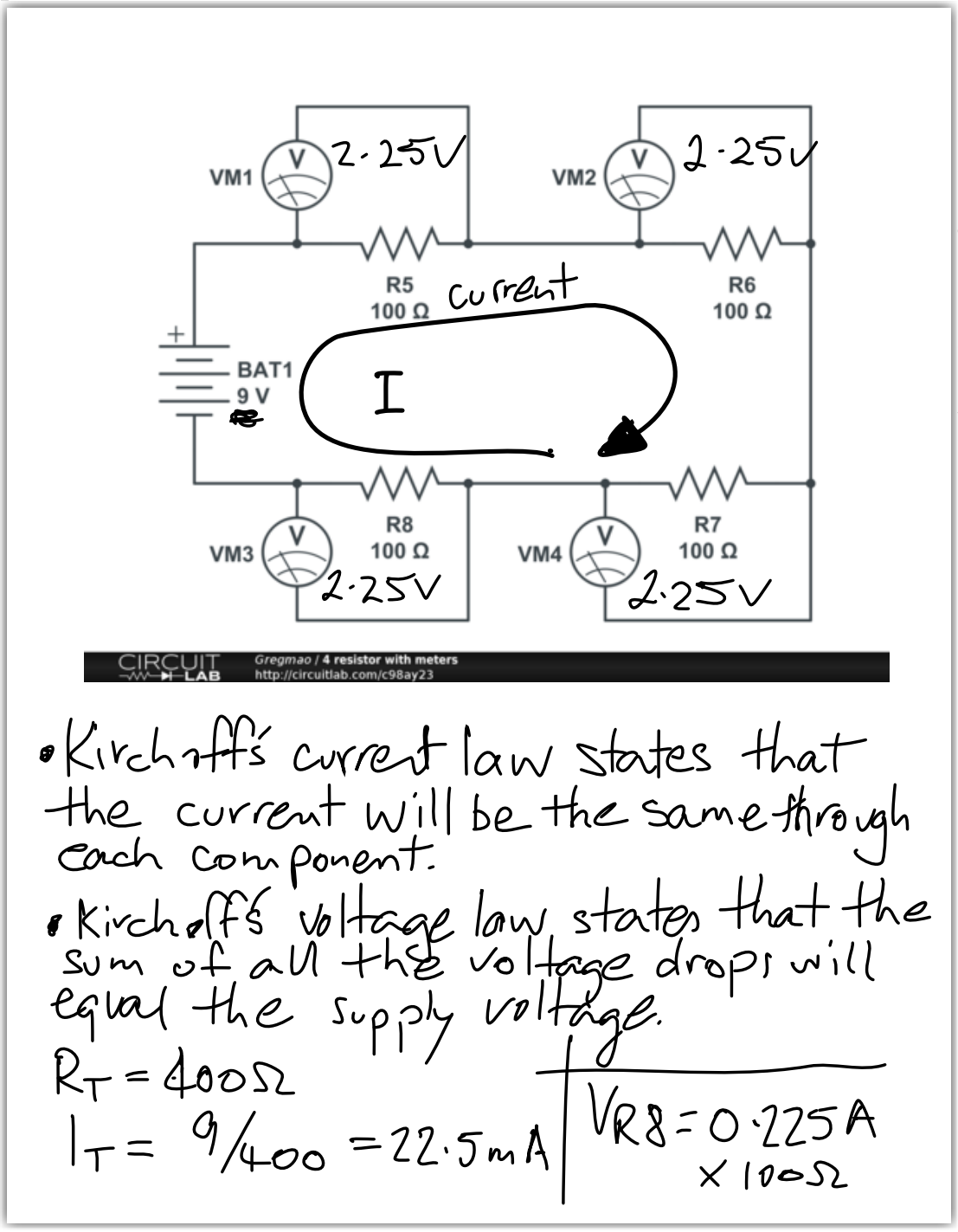
2. The individual voltage drops in a series circuit can be added to equal the applied voltage.

3. The current is the same at any point in a series circuit.

4. The individual resistors can be added to equal the total resistance of the circuit.

5. Fuses and circuit breakers are connected in series with the devices they are intended to protect.

6. The total power in any circuit is equal to the sum of the power dissipated by all parts of the circuit.



KVL 4 resistor cct.pdf

These laws are the basis for all of electrical and electronic theory. Balancing current and voltage conditions is a necessary skill in learning and working with electrical schematics and equipment.

- Kirchoff's current law states that the current will be the same through each component.
- Kirchoff's voltage law states that the sum of all the voltage drops will equal the supply voltage.

$R_T = 400\Omega$

$I_T = 9/400 = 22.5mA$

$V_{R8} = 0.225A \times 100\Omega$

Activity for Kirchoffs

$V_S = 50V$

$R_T =$

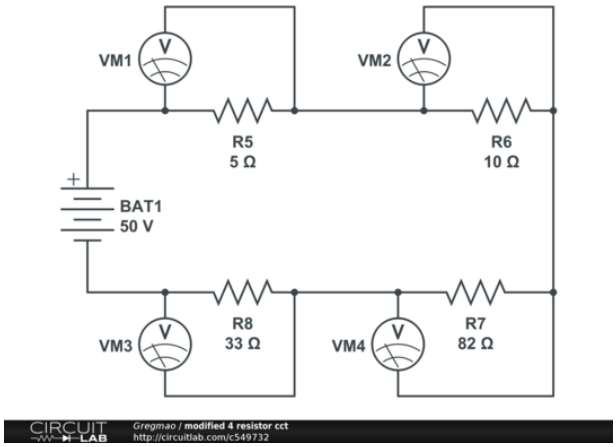
$I_T =$

$V_{R5} =$

$V_{R6} =$

$V_{R7} =$

$V_{R8} =$



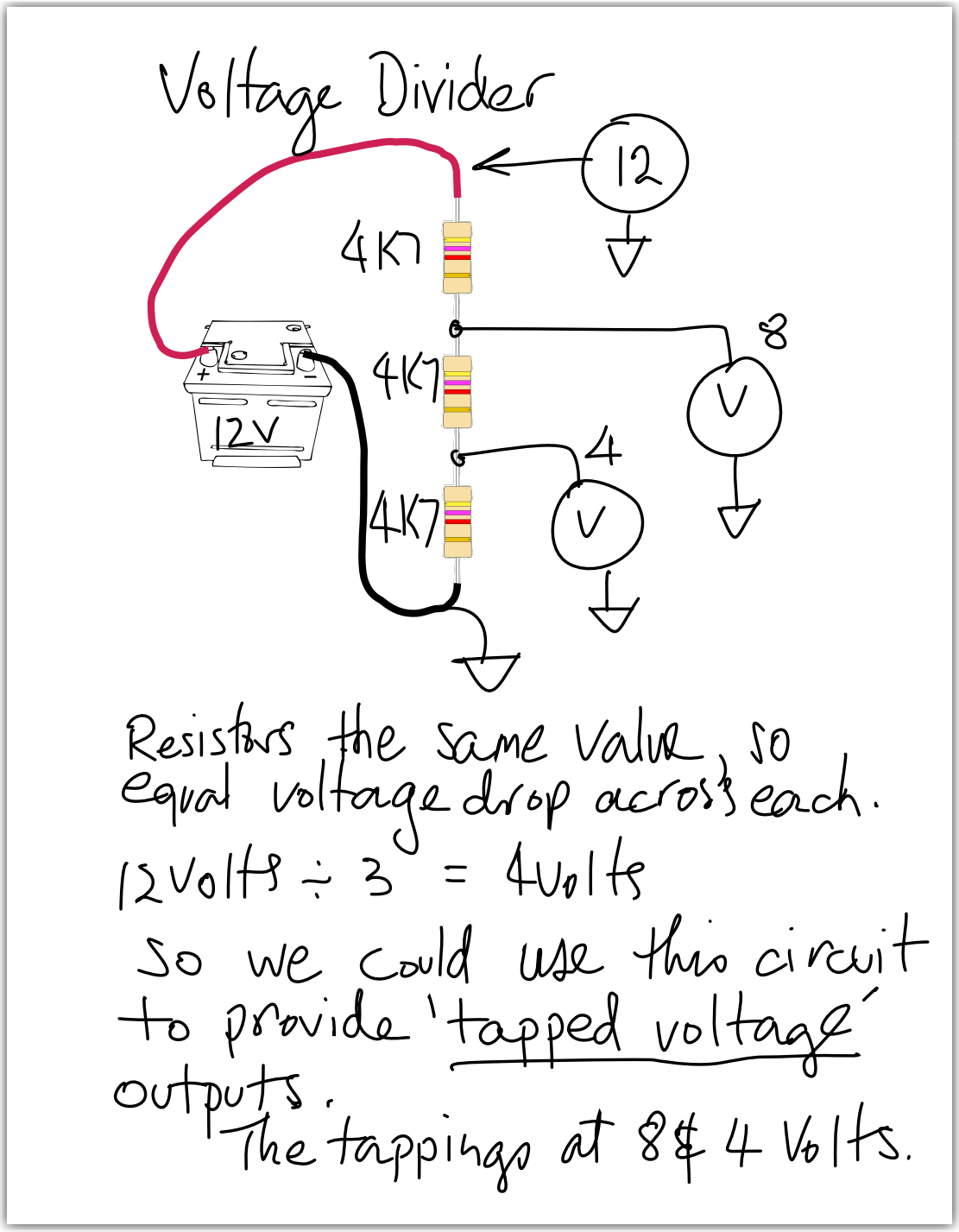
Question

What is the relationship between the voltage drop & the size of the resistor?

GM2014

activity for kirchoffs.pdf
This is a class activity. There is a definite relationship between the resistor size and the voltage developed across it.

Practical use of a Series Cct. Power supply voltage divider. Current bleeder across high voltage source.



voltage divider.pdf
Very important concept. We will explore this more and learn the voltage divider equation.

Even though the voltage divider shown can deliver the 4 Volts and 8 Volts as tapped voltages, there is a lot more to know about how to use a circuit such as this. If we connect another circuit to one of these points, we draw extra current and change the balance of the circuit. We must understand a '**stiff voltage divider**' concept, and understand that we can only draw 10% of the total current flowing throughout the voltage divider main circuit. Used in biasing of solid state components and vacuum tube technology.

SERIES CIRCUITS

PURPOSE:

This section introduces the series circuit and the basic laws applicable to series circuits.

TO ACHIEVE THE PURPOSE OF THIS SECTION:

At the end of this section the student will be able to:

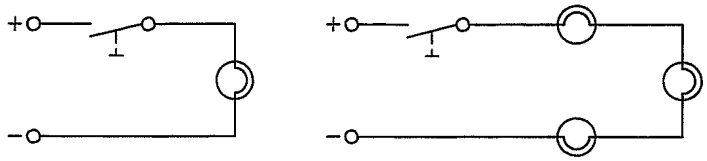
- Define what is meant by the term series circuit and draw circuit diagrams of series connected components.
- State the basic laws related to current, voltage, power and equivalent resistance for series connected resistive circuits.
- Simplify a series circuit to one containing a single equivalent resistance.
- Calculate circuit current, applied voltage, equivalent resistance and total power dissipation for a series circuit.
- Calculate the voltage drop, current and power dissipation for each resistor in a series circuit.
- List the affects of an open circuit and a short circuit on the current flowing in a series circuit.

REFERENCES:

Floyd Chapter 4

1. WHAT IS A SERIES CIRCUIT?

Series circuit - a circuit in which all components are connected so as to allow only one path for current to flow.



Switch and lamp in series | Lamps in series

Figure 1

2. CURRENT FLOW IN A SERIES CIRCUIT

A series circuit has only one current path, therefore there is only _____.

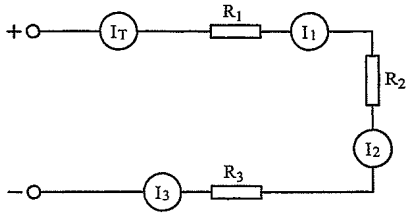


Figure 2

Therefore, the basic rule relating to current in a series circuit states -

> The current in a series circuit is the _____ in all parts of the circuit.

Based on the arrangement shown in figure 2, the current in various parts of a series circuit may be expressed mathematically as -

where: I_T = supply current
I_1 = current through resistor R_1
I_2 = current through resistor R_2
I_3 = current through resistor R_3

3. RESISTANCE OF A SERIES CIRCUIT

Consider three resistors connected in series.

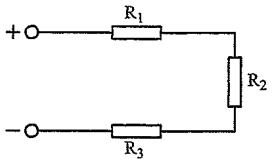


Figure 3

As current flows through the circuit it passes through each resistor in turn. That is, the total resistance seen by the power supply will be the combination of all resistances.

Therefore, the basic rule relating to resistance in a series circuit states -

The equivalent or total resistance is equal to the _____ of the individual resistances.

This statement may be expressed mathematically as -

where: R_T = total circuit resistance
R_1 = resistance of resistor R_1
R_2 = resistance of resistor R_2
R_3 = resistance of resistor R_3

Example: 1

Three resistors having resistances of 5Ω, 4Ω and 11Ω are connected in series. Calculate the total resistance of the circuit.

_____

_____

Example: 2

Determine the resistance of the resistor R_2 in the circuit of figure 4.

_____ $R_T = 75\Omega$

_____

_____

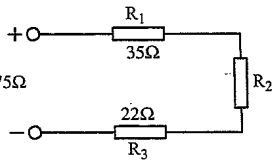


Figure 4

4. OHM'S LAW and THE SERIES CIRCUIT

As seen previously, values of voltage, current and resistance may be determined by the application of Ohm's law. The three equations associated with Ohm's law are -

As is the case with the basic electric circuit, Ohm's law may be applied to a series circuit to determine values of voltage, current and resistance.

Ohm's law may be applied to -

- an entire series circuit - using total circuit values, for example, $R_T = \frac{V_T}{I_T}$
- any individual section of a series circuit - using section values, for example, $R_1 = \frac{V_1}{I_1}$.

Example: 3

For the circuit of figure 5, determine -

(a) total circuit resistance

(b) circuit current

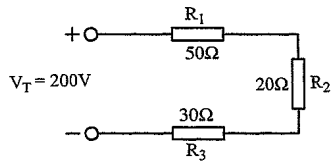


Figure 5

Example: 4

Determine the voltage across resistor R_2 in the circuit of figure 6.

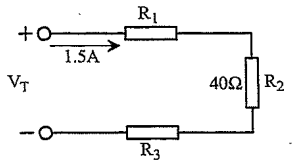


Figure 6

5. VOLTAGES IN A SERIES CIRCUIT

Consider the circuit shown in figure 7.

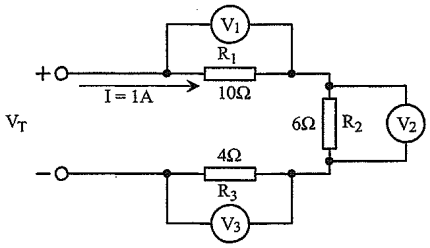


Figure 7

Assuming the current flowing in the circuit and the value of the individual resistances are known, the voltages across each resistor may be determined.

These voltages are known as the circuit _____.

The circuit voltage drops may be determined by applying Ohm's law to each resistor individually.

The voltage drop across the resistor R_1 is determined by applying Ohm's law using only values associated with R_1 -

The voltage drop across the resistor R_2 is determined by applying Ohm's law using only values associated with R_2 -

The voltage drop across R_3 is determined in the same way, but using only values associated with R_3 -

If each of the individual voltage drops are known, the applied voltage may be determined.

The rule for voltages in a series circuit, known as Kirchhoff's voltage law, is -

The applied voltage is equal to the _____ of the individual voltage drops.

This statement may be expressed mathematically as -

where: V_T = the applied voltage
V_1 = the voltage drop across resistor R_1
V_2 = the voltage drop across resistor R_2
V_3 = the voltage drop across resistor R_3

Example: 5

For the series circuit shown in figure 8, determine -

(a) total circuit resistance
(b) the voltage drop across each resistor
(c) the supply voltage.

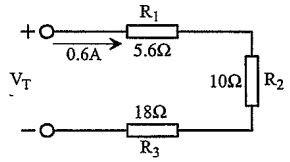


Figure 8

Example: 6

Determine the voltage drop across the resistor R_3 in the circuit of figure 9.

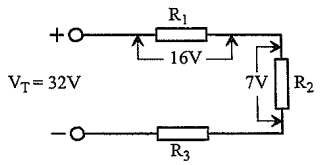


Figure 9

6. VOLTAGE DIVIDER CIRCUIT

The voltage drop across a particular resistor in a series circuit may be determined using the voltage divider. The advantage of the voltage divider is that voltage drops may be determined without knowing the circuit current. The basic arrangement for the voltage divider is shown in figure 10.

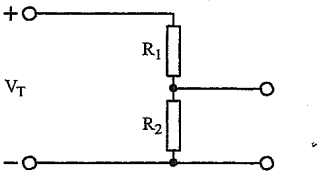


Figure 10

Example: 7

For the circuit of figure 10, assume the supply voltage is 10V, R_1 has a value of 1kΩ and R_2 a value of 3kΩ. Determine the voltage drop across the resistor R_2.

7. POWER IN A SERIES CIRCUIT

Each component in a series circuit dissipates power and the total power delivered to a circuit is supplied by the circuit power supply. Therefore, it can be stated -

> The total power supplied to a series circuit is equal to the _____ of the powers dissipated by each component.

Writing this statement in the form of an equation gives -

where: P_T = total power dissipated
P_1 = power dissipated by component 1
P_2 = power dissipated by component 2
P_3 = power dissipated by component 3

Example: 8

For the circuit shown in figure 11, calculate the -

(a) circuit current
(b) total circuit resistance
(c) voltage drop across R_1
(d) applied voltage
(e) power dissipated by each resistor
(f) total power dissipated

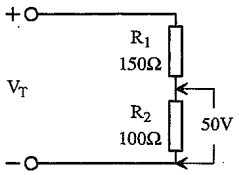


Figure 11

8. EFFECT OF AN OPEN CIRCUIT IN A SERIES CIRCUIT

Consider three lamps connected in series, as shown in figure 12. What would be the effect on the circuit of say lamp 2 going open circuit?

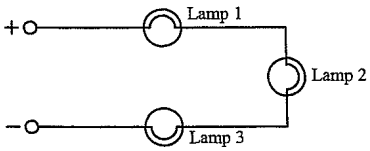


Figure 13

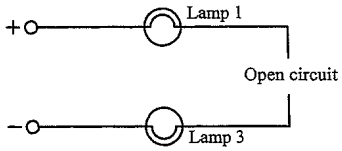


Figure 14

The open circuit would cause the circuit current to _____.

The effects of an open circuit in any part of a series circuit are -

- circuit current is _____
- the resistance of the circuit is _____
- the voltage across the open circuit equals the _____
- the voltage across all other components equals _____
- all components in the circuit _____ working.

9. EFFECT OF A SHORT CIRCUIT IN A SERIES CIRCUIT

Consider three lamps connected in series, as shown in figure 14. What would be the effect on the circuit of say lamp 3 going short circuit?

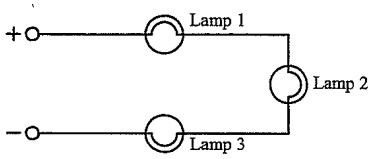


Figure 14

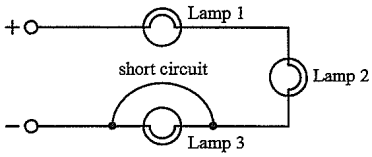


Figure 15

The short circuit would cause the circuit current to _____.

The effects of a short circuit in any part of a series circuit are -

- circuit current is _____
- the resistance of the circuit is _____
- the voltage across the short circuit equals _____
- the voltage across all other components _____
- all components in the rest of the circuit work _____ because of the increased voltage drop across them.

NOTES:

Tutorial questions for Series Circuits

1. A series circuit has individual resistor values of 200 ohms, 86 ohms, 91 ohms, 180 ohms, and 150 ohms. What is the total resistance of the circuit?

2. A series circuit contains four resistors. The total resistance of the circuit is 360 ohms. Three of the resistors have values of 56 ohms, 110 ohms, and 75 ohms. What is the value of the fourth resistor?

3. A series circuit contains five resistors. The total voltage applied to the circuit is 120 V. Four resistors have voltage drops of 35 V, 28 V, 22 V, and 15 V. What is the voltage drop of the fifth resistor?

4. A circuit has three resistors connected in series. The resistance of resistor r2 is 220 ohms, and it has a voltage drop of 44 V. What is the current flow through resistor r3?

5. A circuit has four resistors connected in series. if each resistor has a voltage drop of 60 V, what is the voltage applied to the circuit?

6. Define a series circuit.

7. State the three rules for series circuits.

8. A series circuit has resistance values of 160 ohms, 100 ohms, 82 ohms, and 120 ohms. What is the total resistance of this circuit?

9. if a voltage of 24 V is applied to the circuit in question 8, what will be the total amount of current flow in the circuit?

10. What will be the voltage drop across each of the resistors? A. 160 ohms_____V
B. 100 ohms_____V
C. 82 ohms_____V
D. 120 ohms_____V

11. Find all the values in this circuit by analysis and fill in the blanks neatly.

You will need to use your new Power equations and Ohms law equations.
This circuit is really as hard as it gets in Series single path.
Show all working: