CW

Jan 12, 201

3. What is a parallel circuit?

- What is a parallel universe?
- How would this apply to a circuit?
- How are V, I and R calculated for a series circuit?

What is a parallel universe? A parallel universe is a hypothetical self-contained reality co-existing with one's own. A specific group of parallel universes are called a "multiverse", although this term can also be used to describe the possible parallel universes that constitute

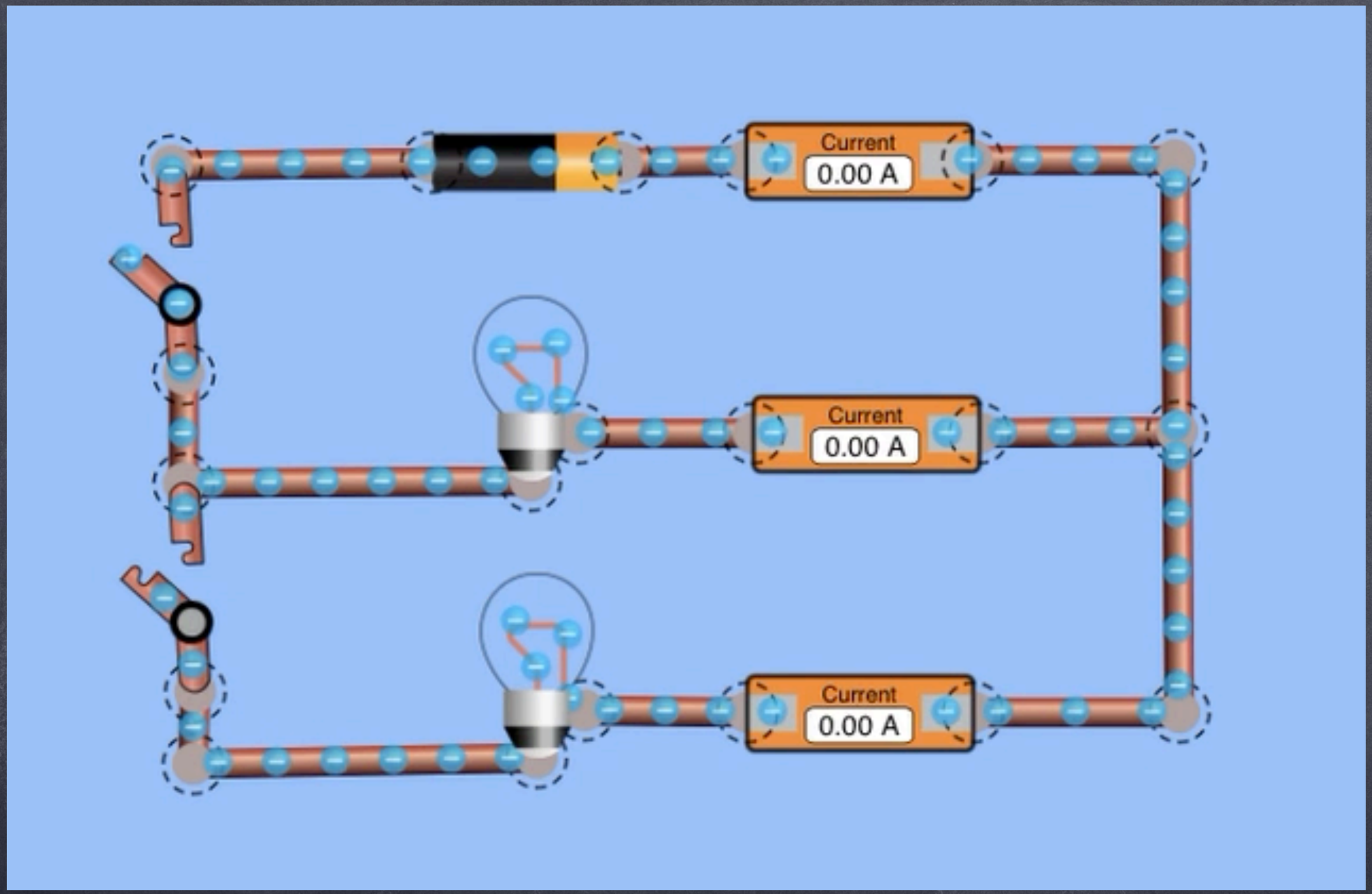
How would this apply to a circuit? There must be multiple pathways for the current.

How are V, I and R calculated for a series circuit? $V_T = V_1 + V_2 + V_3...$, $I_T = I_1 = I_2 = I_3...$ and $R_T = R_1 + R_2 + R_3...$

The true science of parallel universes

Learning objectives

- State that, for a parallel circuit, the current from the source is larger than the current in each branch.
- Recall and use the fact that the current from the source is the sum of the currents in the separate branches of a parallel circuit.
- State that the combined resistance of two resistors in parallel is less than that of either resistor by itself.
- Calculate the combined resistance of two resistors in parallel.
- State the advantages of connecting lamps in parallel in a circuit.



What is a parallel circuit?

What can we say about the current in a parallel circuit?

Write an equation to describe this

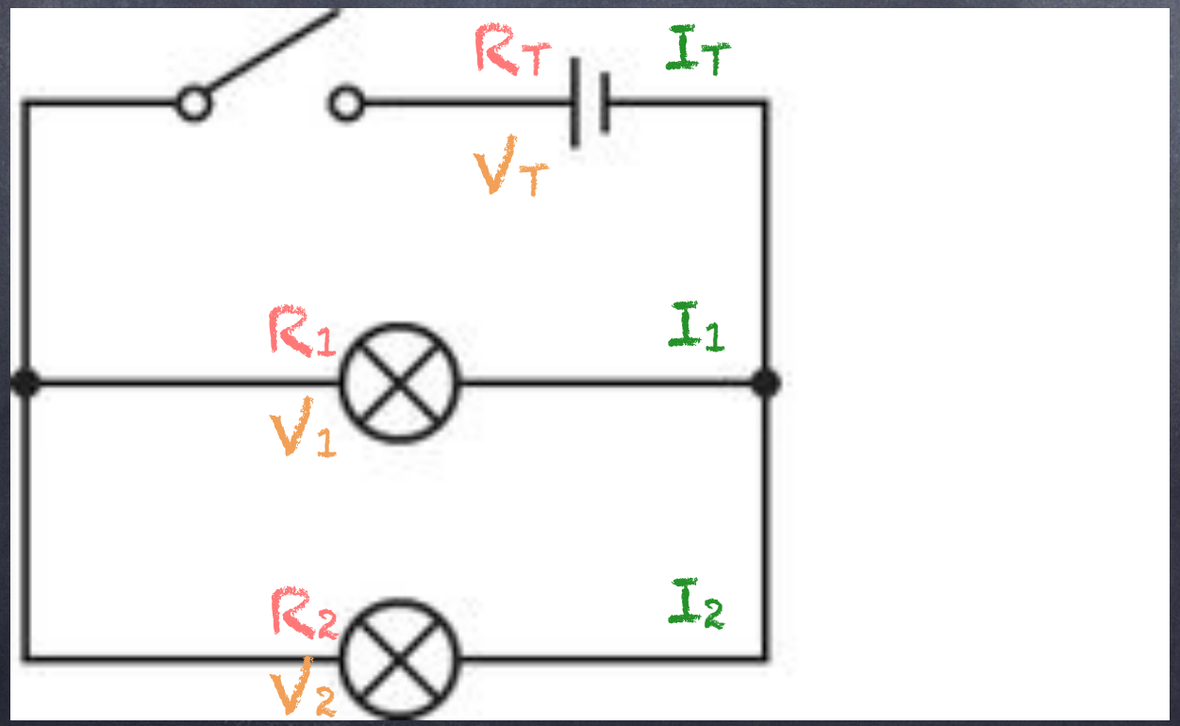
- What is a parallel circuit? A circuit with more than one loop/ branch/path.

- What can we say about the current in a series circuit? It is larger at the source than in the branches

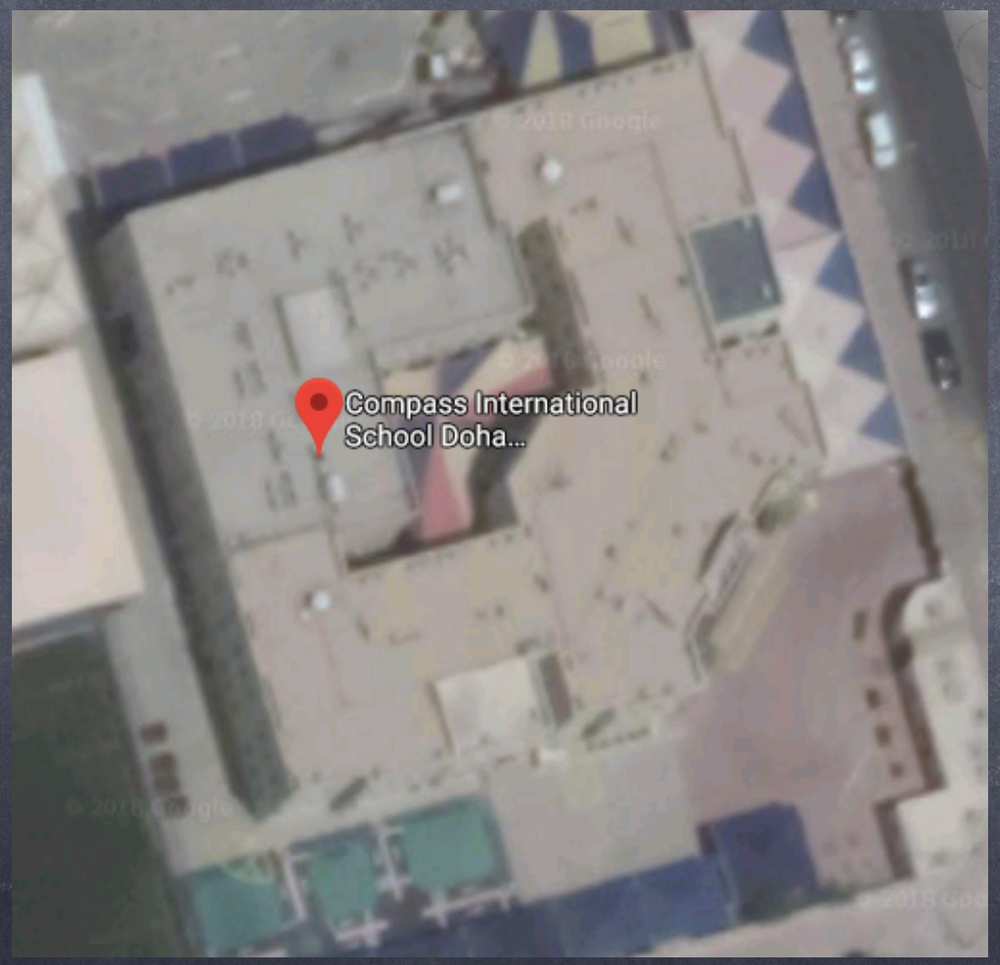
- Write an equation to describe this. $I_T = I_1 + I_2 + I_3 \ldots$

$I_T = I_1 + I_2 + I_3$

- For a parallel circuit, the current from the source is larger than the current in each branch.

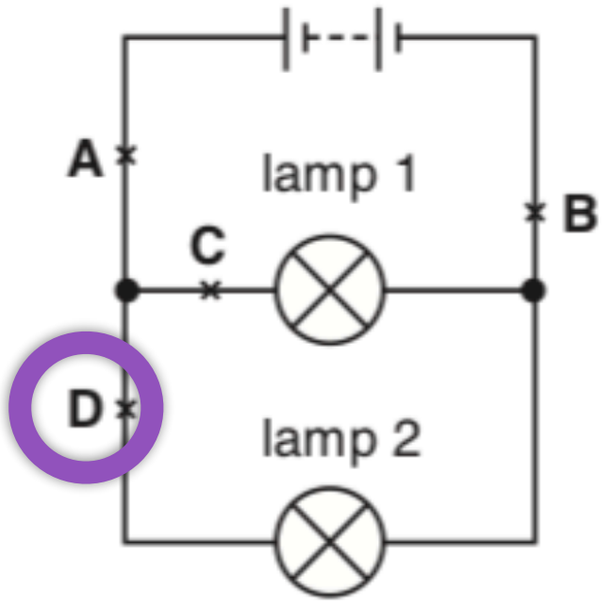


Why is the current different?



Think back to the last fire drill. Why do we use multiple exits?

39 The diagram shows a circuit, with four possible positions to place a switch.

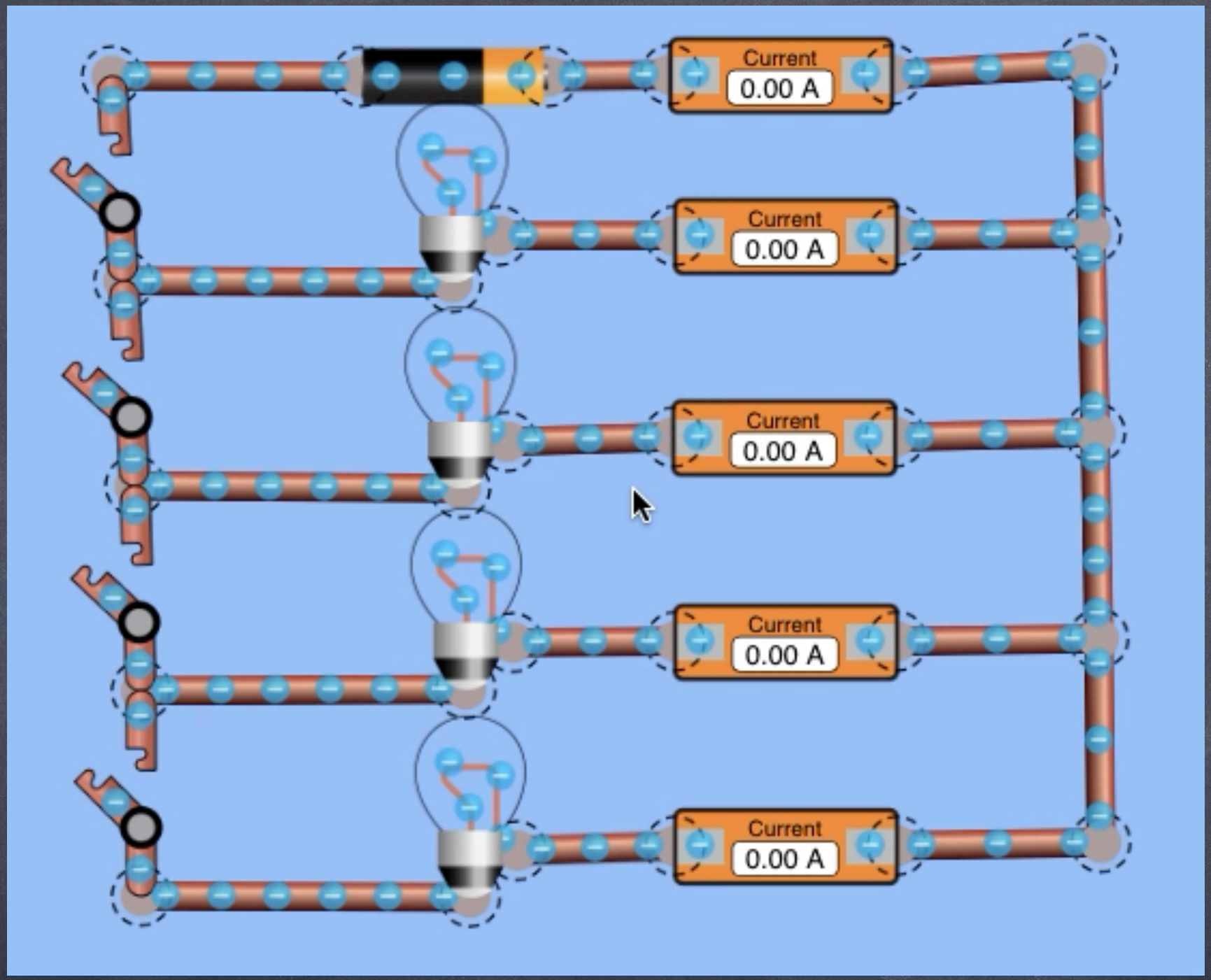


At which labelled point should a switch be placed so that lamp 1 remains on all the time and lamp 2 can be switched on and off?

What is the answer?

Give your reasons.

How is this different for a series circuit?



What happens to current as the number of lamps increases?

What happens to the resistance as the number of lamps increases?

Explain your answers.

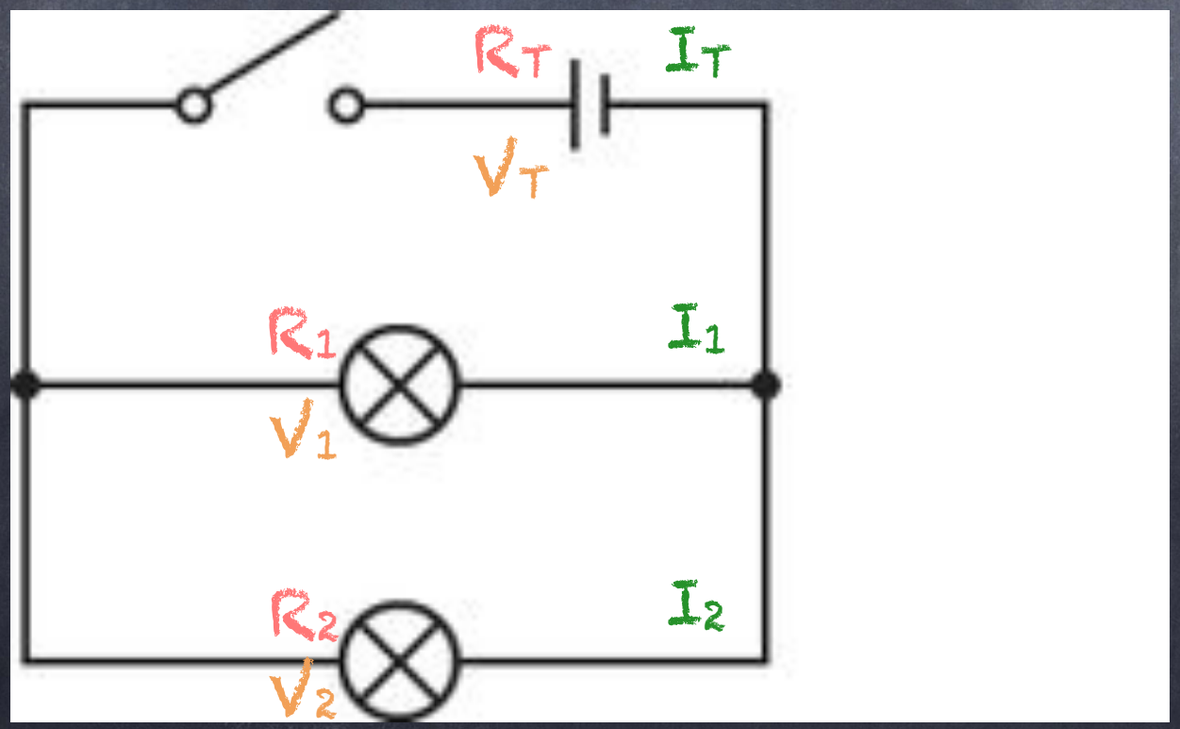
- What happens to current as the number of lamps increases? Increases.

- What happens to the resistance as the number of lamps increases? Decreases.

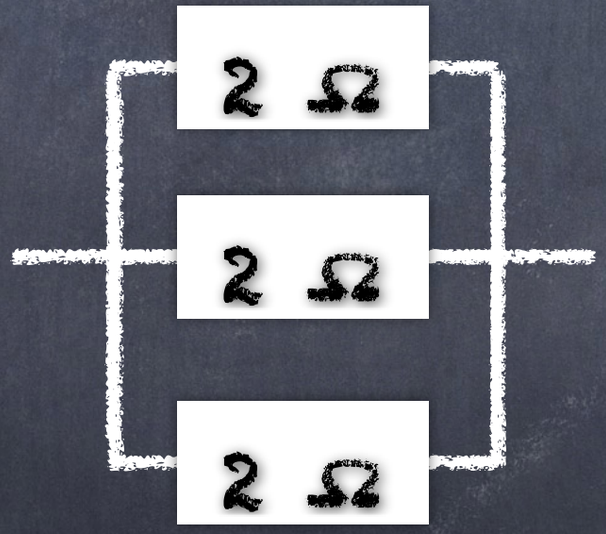
- Explain your answers. As the number of lamps increases, the resistance decreases: it is easier for the current to flow.

$1/R_T = 1/R_1 + 1/R_2 + 1/R_3...$

- The reciprocal of the total resistance is equal to the sum of the reciprocals of the individual resistances



Worked example: What is the combined resistance of three 2 ohm resistors?



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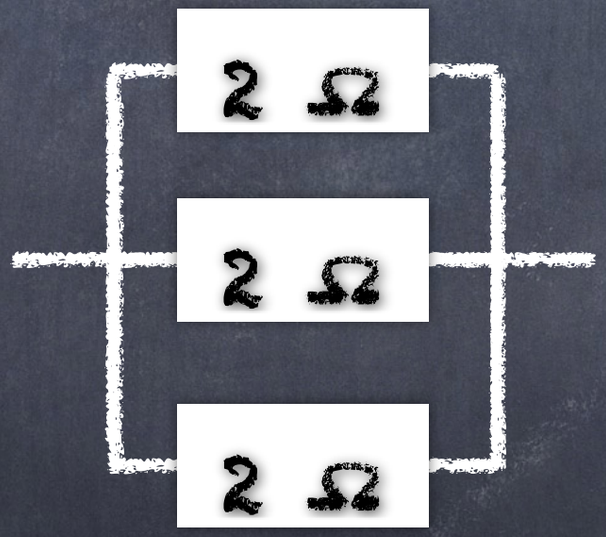


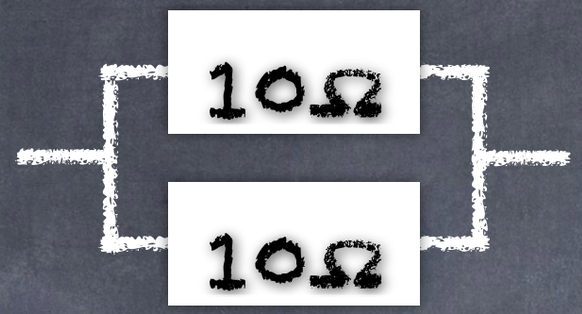
$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_T} = \frac{1}{2\Omega} + \frac{1}{2\Omega} + \frac{1}{2\Omega}$$

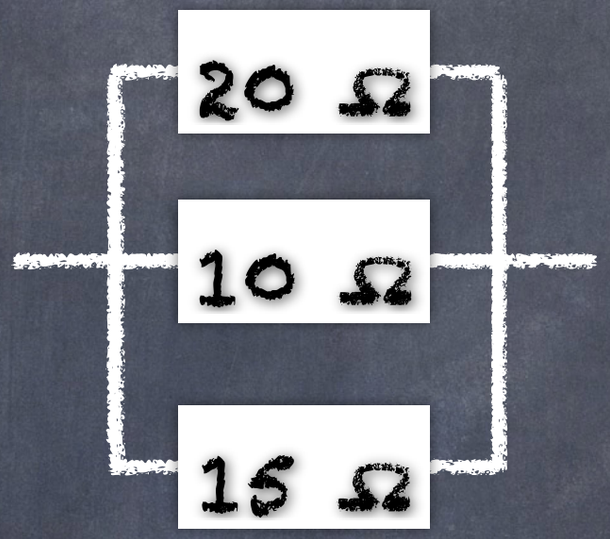
$$\frac{1}{R_T} = \frac{3}{2\Omega}$$

$$R_T = \frac{2}{3}\Omega = 0.67\Omega$$

Do NOT leave as fractions



What is the sum of the resistors?



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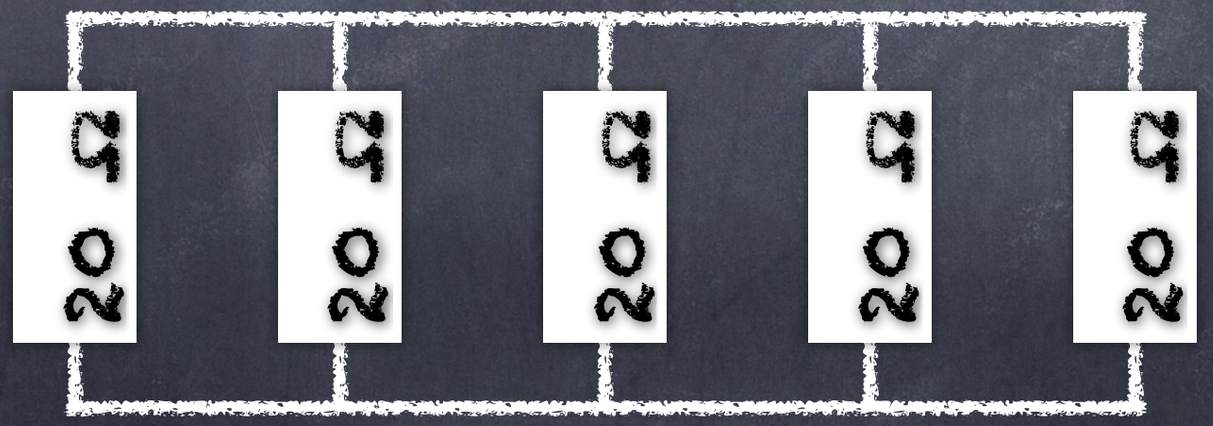
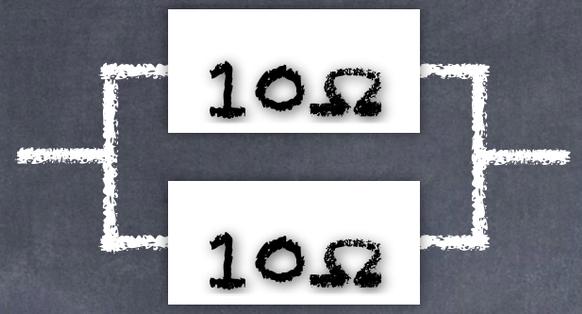
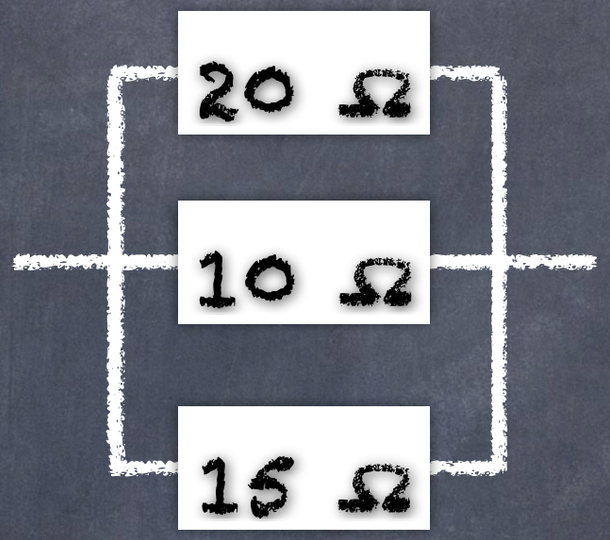


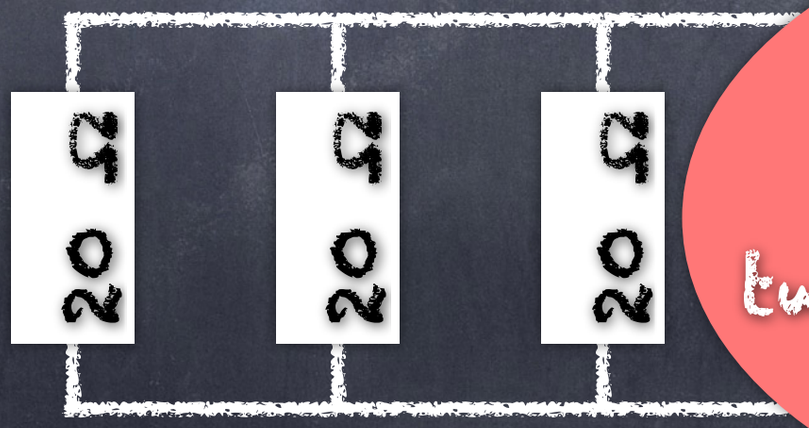
What is the sum of the resistors?



What is the sum of the resistors? 5 Ω



What is the sum of the resistors? 4.6 Ω



You only need to combine two resistors in your exam!

What is the sum of the resistors? 4 Ω

Copy and complete using the words below

Copy and complete without looking at the words below

Rewrite the sentence in your own words

- When adding up resistors in _____ to determine the _____ resistance, the total resistance is always _____ than the _____ resistors resistance.

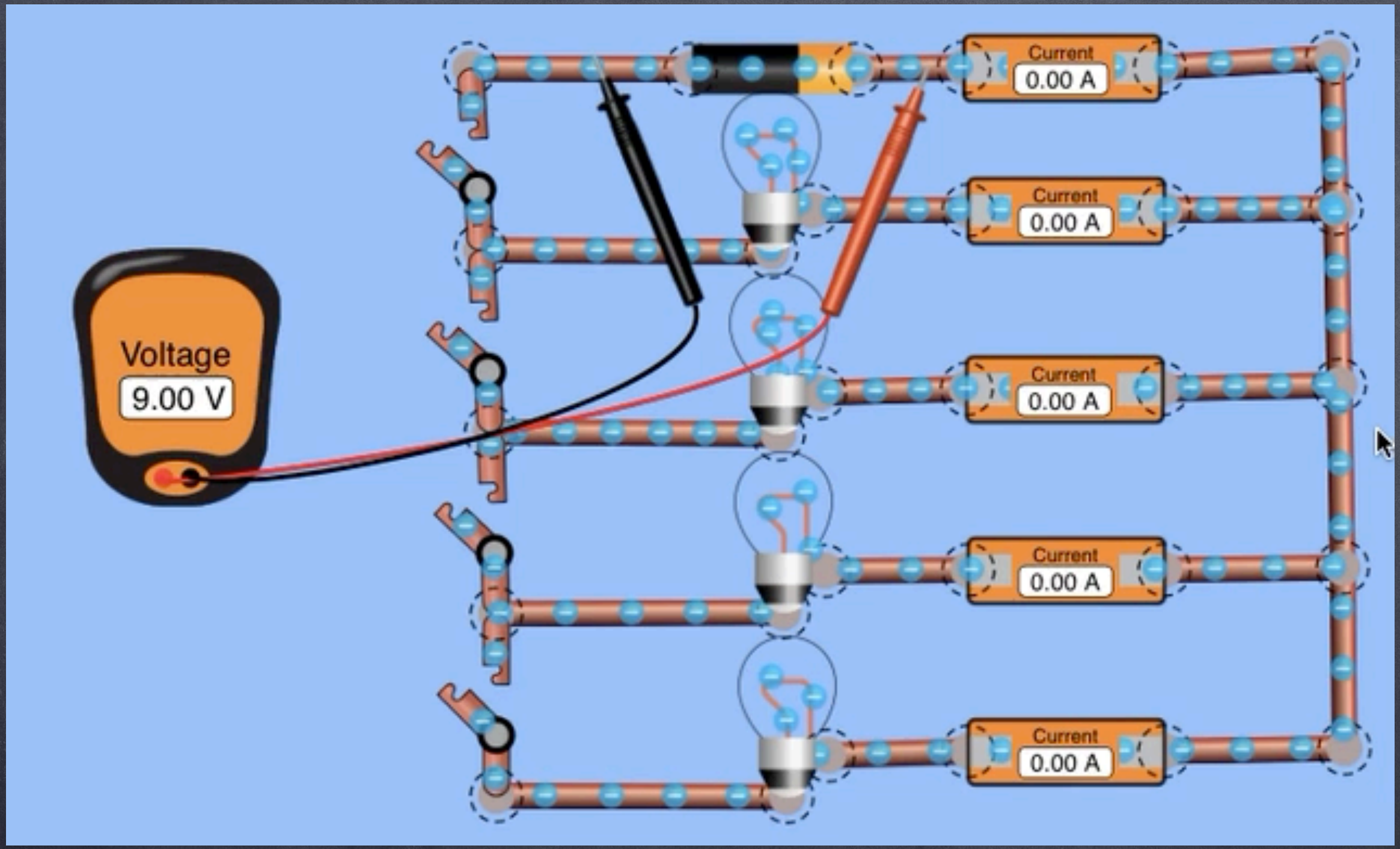
smaller, parallel, smallest, total

Copy and complete using the words below

Copy and complete without looking at the words below

Rewrite the sentence in your own words

- When adding up resistors in parallel to determine the total resistance, the total resistance is always smaller than the smallest resistors resistance.



What happens to the total voltage as you add lamps?

What happens to the voltage on each lamp as the number of lamps increases?

Write an equation to show this.

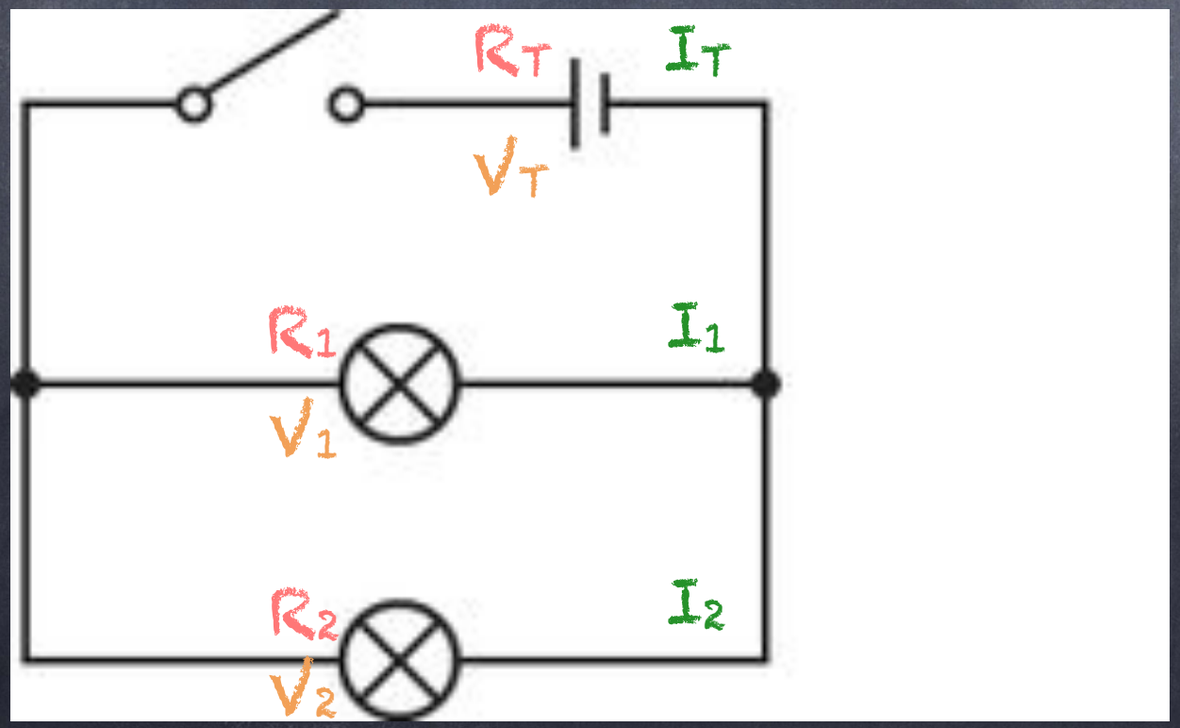
- What happens to the total voltage as you add lamps? Nothing. It stays constant. Whatever energy goes into the circuit, has to come out.

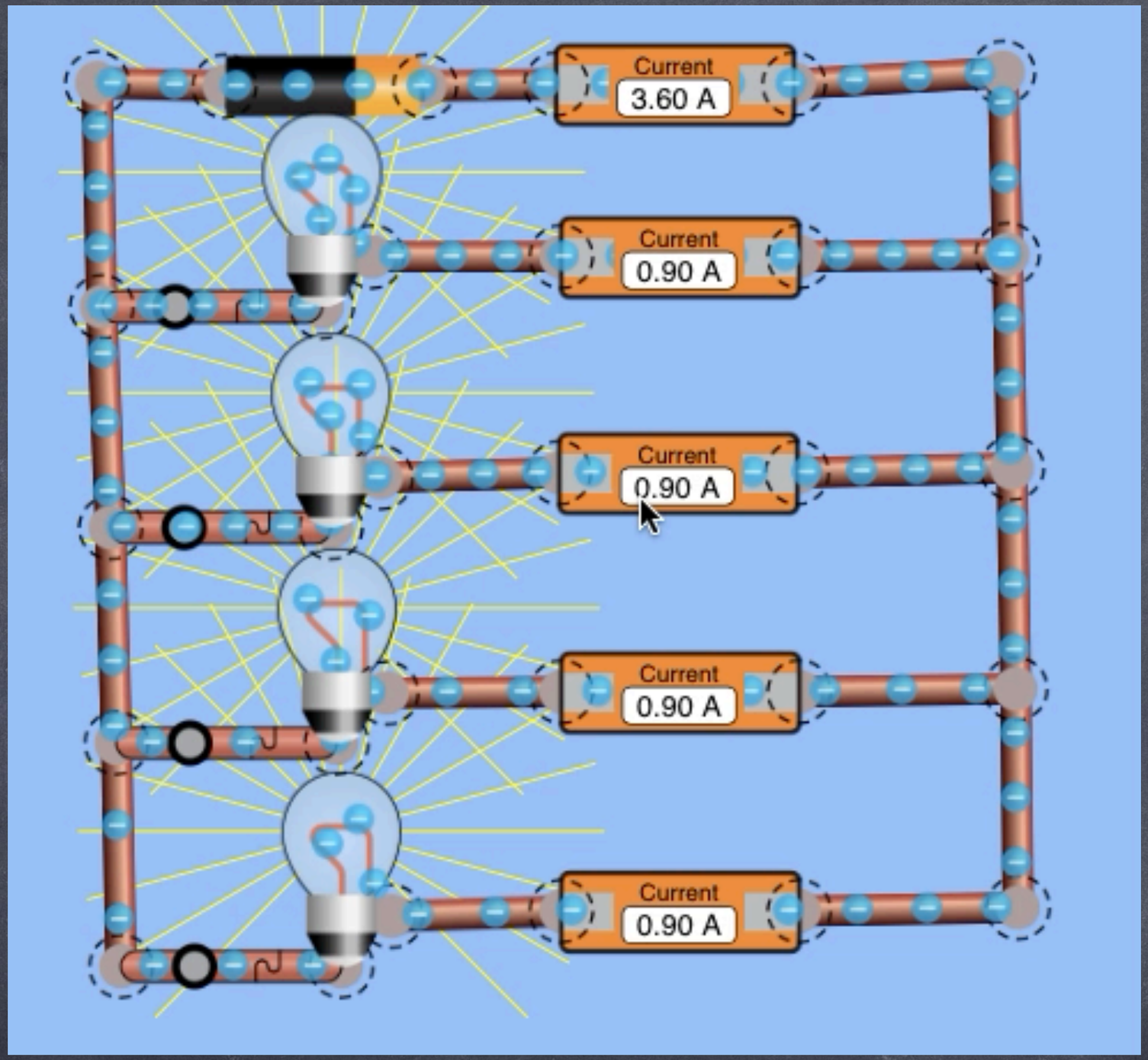
- What happens to the voltage on each lamp as the number of lamps increases? It remains constant, independent of the number of lamps.

- Write an equation to show this. $V_T = V_1 = V_2 = V_3 \ldots$

$V_T = V_1 = V_2 = V_3 ...$

- The total potential difference in a parallel circuit is the same across all components.





What are the advantages of using parallel circuits?

What are the disadvantages?

State some example of series and parallel circuits.

- What are the advantages of using parallel circuits? The individual branches can be controlled. Not affected by one lamp blowing. Voltages are the same as the source.

- What are the disadvantages? Source uses energy far faster, energy is not free! More connecting wires are required. Greater complexity of circuit.

- State some example of series and parallel circuits. Series: Flashlight, Christmas tree lights (in the past). Parallel: house lighting system, almost every other circuit.

This is what you could change. You can only change one.

This is a prediction.

What do you need to investigate?

What are the dangers?

What did you find out?

Experiment: What factors affect the potential difference in a c

What are the variables?

Current, power pack, type of wire, number of lamps, length of wire, thickness of wire.

Independent variabl

Number of lamp

Dependent variable:

Potential difference across each lamp / V

Hypothesis

If I increase/decrease ~~XXXX~~ Lamps, then the p.d. ~~XXXXXXXXXX~~ will increase/ decrease/stay the same ~~XXXXXXXXXX~~

Graph prediction

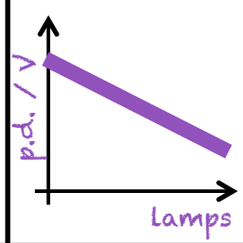


Table of results

Lamps /	p.d. / V /

Equipment:

- Lamps
- Power pack at 6 V
- Digital multimeter
- Connecting wires
-

Method:

1. Set up a circuit with a two lamp.
2. Set the power pack to 6 V.
3. Record the p.d. across each lamp.
4. Repeat with more lamps.
5. What pattern do you notice?

Risk assessment

Avoid short circuits. Do not exceed 6 V. Avoid any liquids near the work area.

Evaluation

Conclusion:

Explanation:

Alternative experiment:

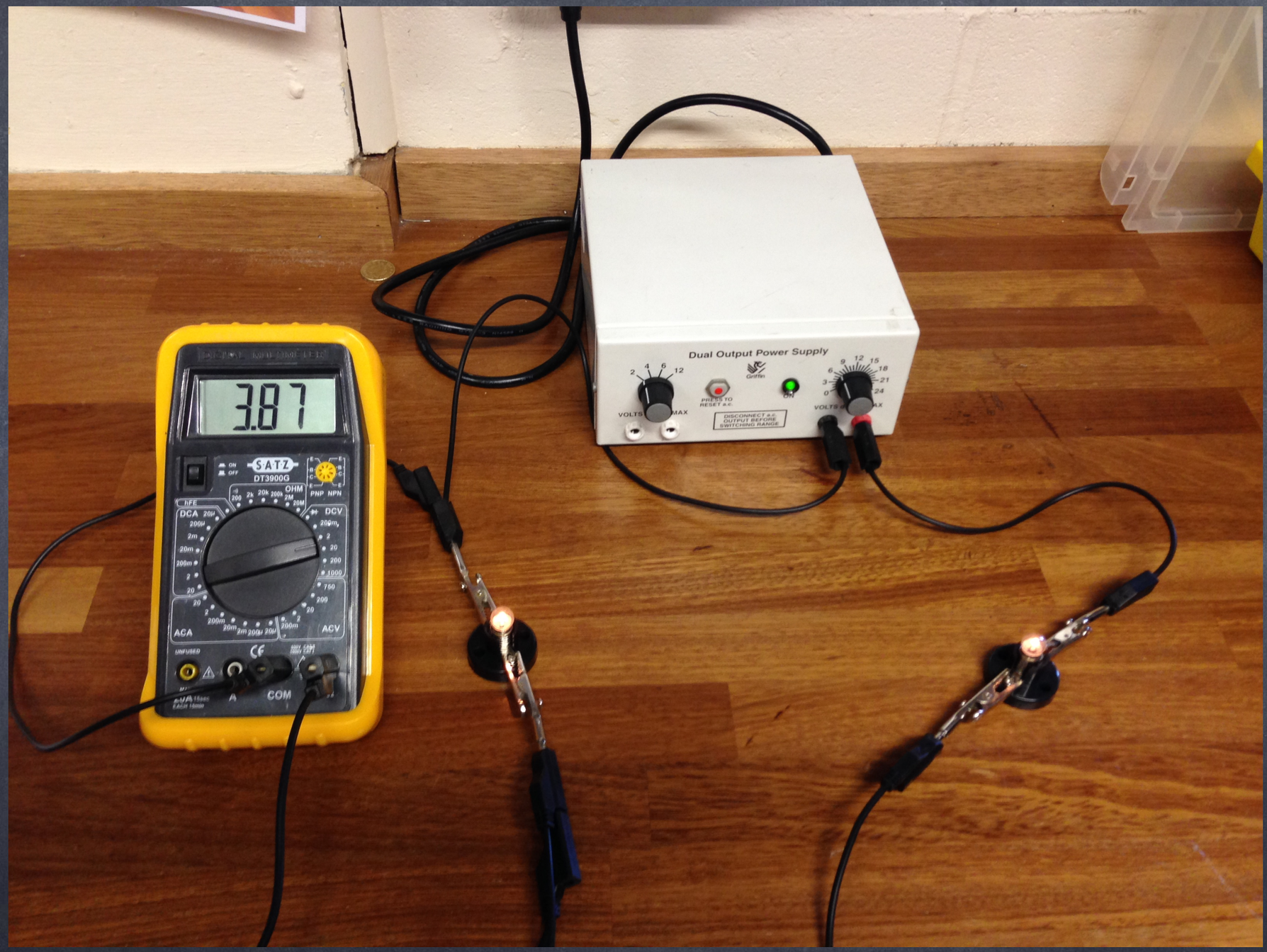
Investigating p.d. using two DMM's, a lamp, a rheostat.

This is what you measure

How will you carry out your investigation.

What could you do better?

Why did this happen?


3.87
SATZ
DT3900G
Dual Output Power Supply
VOLTS
MAX
PRESS TO RESET a.c.
ON
DISCONNECT a.c. OUTPUT BEFORE SWITCHING RANGE
DCA
ACA
DCV
ACV
OHM
PNP NPN
hFE
UNFUSED
A
COM

Number of lamps	p.d. across first lamp	p.d. across second lamp	p.d. across third lamp	p.d. across fourth lamp	p.d. across fifth lamp	p.d. across sixth lamp
2						
3						
4						
5						
6						

Complete the table up to three lamps.

Complete the table up to five lamps.

Complete the table up to six lamps.

Number of lamps	p.d. across first lamp	p.d. across second lamp	p.d. across third lamp	p.d. across fourth lamp	p.d. across fifth lamp	p.d. across sixth lamp
2	3	3				
3	2	2	2			
4	1.5	1.5	1.5	1.5		
5	1.2	1.2	1.2	1.2	1.2	
6	1	1	1	1	1	1

State a conclusion to the experiment.

Evaluate the experiment.

Explain your results.

Learning objectives

- State that, for a parallel circuit, the current from the source is larger than the current in each branch.
- Recall and use the fact that the current from the source is the sum of the currents in the separate branches of a parallel circuit.
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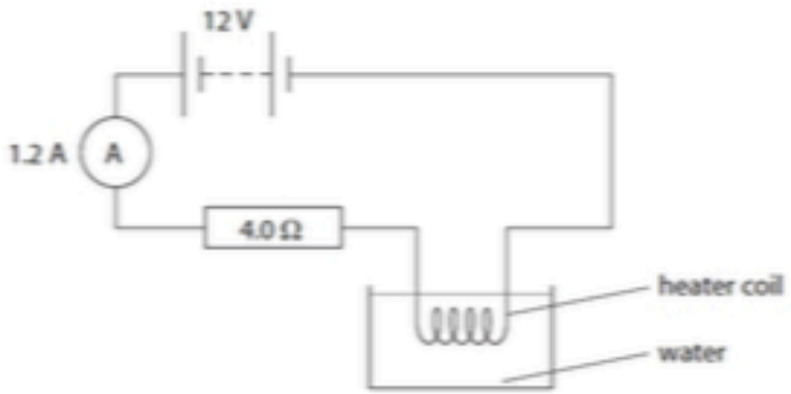
Questions

Q1.

The diagram shows a heater coil and a resistor connected to a 12 V battery and an ammeter.
The ammeter reading is 1.2 A.



(a) (i) State the equation linking voltage, current and resistance.

(1)

(ii) Calculate the voltage across the 4.0 Ω resistor.

(2)

Voltage = ... V

(iii) Show that the voltage across the heater coil is about 7 V.

(2)

(iv) Calculate the energy transferred to the heater coil in 5.0 minutes.

(3)

Energy transferred = ... J

(v) At first, the temperature of the water increases.

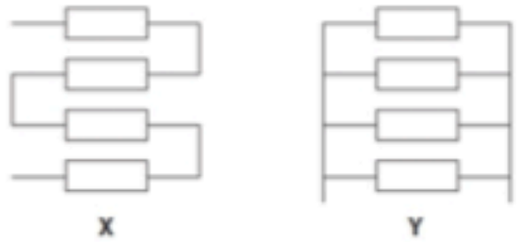
After a while, the temperature reaches a steady value below the boiling point of water.

Explain why the temperature reaches a steady value.

(2)

.....
.....
.....
.....

(b) Resistors can be used as heating elements in the rear windows of cars.
The diagram shows two possible designs.



(i) Complete the table by placing a tick (✓) in the correct boxes.

(1)

Design	Series	Parallel
X		
Y		

(ii) Describe the advantages and disadvantages of design **X** when used as a heater in a car window.

(3)

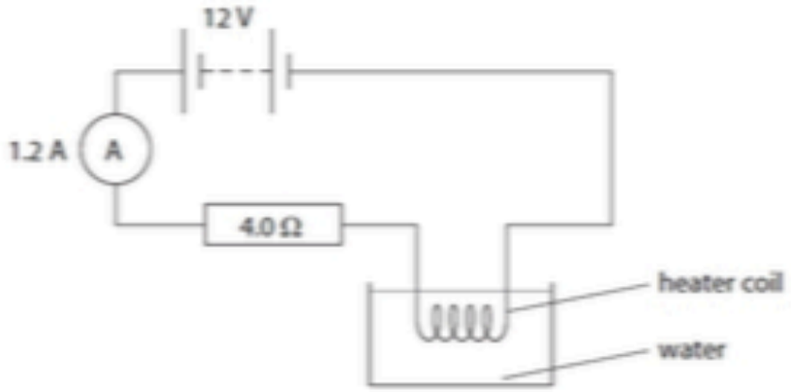
.....
.....
.....
.....
.....
.....
.....

(Total for question = 14 marks)

Questions

Q1.

The diagram shows a heater coil and a resistor connected to a 12 V battery and an ammeter. The ammeter reading is 1.2 A.



(a) (i) State the equation linking voltage, current and resistance. (1)

$V = IR$

(ii) Calculate the voltage across the 4.0 Ω resistor. (2)

$V = 1.2\ A \times 4.0\ V = 4.8\ V$

Voltage = ... V

(iii) Show that the voltage across the heater coil is about 7 V. (2)

$V_T = V_1 + V_2$

$12\ V = 4.8\ V + V$

$V = 7.2\ V$

(iv) Calculate the energy transferred to the heater coil in 5.0 minutes. (3)

$E = IVt = 1.2\ A \times 7.2\ V \times (5.0 \times 60)$

$E = 2600\ J$

Energy transferred = ... J

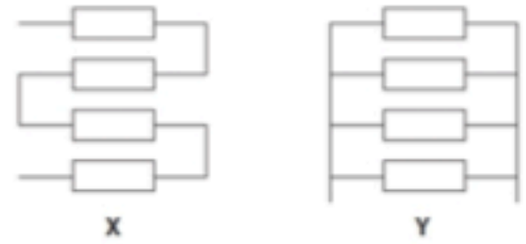
(v) At first, the temperature of the water increases.

After a while, the temperature reaches a steady value below the boiling point of water.

Explain why the temperature reaches a steady value. (2)

Rate of energy loss is equal to rate of energy gain

(b) Resistors can be used as heating elements in the rear windows of cars.
The diagram shows two possible designs.



(i) Complete the table by placing a tick (✓) in the correct boxes. (1)

Design	Series	Parallel
X	✓	
Y		✓

(ii) Describe the advantages and disadvantages of design **X** when used as a heater in a car window. (3)

Fewer wires

One component fails, circuit fails

(Total for question = 14 marks)

What is a parallel circuit?

Answer this in as much detail, and as fully as you can. This will determine whether or not you have achieved the learning objective and the level to which you have achieved it.

Think about what you have learned and how it relates to what you already know.