202: Principles of electrical science  
**Handout 4: Resistors in series**

**Learning outcome**

The learner will:

1. Understand the relationship between resistance, resistivity, voltage, current and power.

**Assessment criteria**

The learner can:

4.5 calculate the values of current, voltage and resistance in parallel and series D.C. circuits.

**Resistors in series**

When there is only one resistance in a circuit, the Ohm’s law calculation is straightforward.

However, when there are two or more resistors in a circuit, the total effective resistance must be calculated first. Resistors can be connected in many configurations:

|  |  |
| --- | --- |
| * series * parallel * series-parallel.   In order to find the total resistance of any series circuit, just add all the resistances together. | series 01.png |

The formula for calculating the total resistance of resistors connected in series is given below:

|  |
| --- |
|  |

**Example 1**

Calculate the total resistance of the circuit shown below:

|  |
| --- |
| series 02.png |

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |
|  |  |  |

**Method of determining current flow in a series circuit**

1. Calculate the total resistance of the circuit, using the series resistor formula.
2. Redraw the circuit diagram, using the equivalent total resistance.
3. Using Ohm’s law, calculate the current flowing.

**Example 2**

Calculate the current that will flow in the circuit shown below:

|  |
| --- |
| series 03.png |

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |
|  |  |  |

**Equivalent circuit**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  | series 04.png |
|  |  |  |
|  |  |  |

The current flowing in any series circuit will be the same wherever you measure it. In other words, the current coming from the supply will flow through resistance 1, then through resistance 2, followed by resistance 3, and so on, until it gets back to the supply terminal.

**It does not matter where you measure the current in the series circuit, as it will always be the same.**

**Voltage drop**

If a current is passed through a resistance then, according to Ohm’s law, a voltage is produced across it, i.e.

This voltage is often referred to as a **voltage drop** but is calculated the same way as any other voltage.

**After you have read a question, the first thing that you do is to draw a diagram relating to the question, with all the information on it.**

**Example 3**

What potential is produced across a resistance of 23Ω if a current of 10 amps is flowing through it?

|  |  |
| --- | --- |
|  | voltage 01.png |

**Kirchoff’s Voltage law**

Kirchhoff's Voltage law states that: **the algebraic sum of the voltages around a circuit is equal to zero** (or the supply voltage).

|  |
| --- |
| voltage 02.png |

Putting Kirchhoff's statement into symbols, we get the formula:

|  |
| --- |
|  |

**Example 4**

Calculate V1, V2, V3, hence proving Kirchhoff's Voltage law.

|  |
| --- |
| voltage 03.png |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | |  |  | | | |
|  | | | | |  |  | | | |
|  | | | | |  |  | | | |
|  | | | | |  |  | | | |
|  | | | | |  |  | | | |
|  | | | | |  |  | | | |
| **Resistor 1** | | | **Resistor 2** | | | | **Resistor 3** | | |
|  |  |  |  |  | |  |  |  |  |
|  |  |  |  |  | |  |  |  |  |
|  |  |  |  |  | |  |  |  |  |

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  | - Kirchhoff’s law is proved. |