Wheatstone Bridge

Apparatus

a Wheatstone bridge circuit (see below, with a variable resistor such as a decade box that the resistance can be read off), low voltage power supply, voltmeter, unknown resistor, resistor colour code chart

Note – the bridge circuit can be wired in advance, or the students can wire it themselves, however this may take a long time.

Action.

The students find an expression for the unknown resistor in terms of the known resistances when the bridge is balanced. They then balance the bridge by adjusting the variable resistor until there is no potential difference between points **a** and **b** - this is the balance condition (see diagram below). When the bridge is balanced they read off the value of the variable resistor, and find the value of the unknown resistor. If a resistor colour chart is available they can then check their measurement.

The Physics

When there is no potential difference between points **a** and **b** there is no current flow between these points. Hence all of current I_1 flows through R_1 and into R_3, and all of current I_2 flows through R_2 and into R_x. As there is no potential difference between points **a** and **b**, we also know that the potential difference across R_1, must be equal to the potential difference across R_2., i.e. that $V_1 = I_1 R_1 = I_2 R_2$. The potential differences across R_3 and into R_x must also be equal, giving $I_1 R_3 = I_2 R_x$. We can now divide the second equation by the first to give $R_3 / R_1 = R_x/R_2$, and rearrange to obtain an expression for R_x. : $R_x = (R_2 R_3)/ R_1$.

Wheatstone bridges have many applications, for example they are used in many gauges where one element of the Wheatstone bridge is a resistance which varies with some physical property, such as temperature or stress. Hence they can be used to measure properties such as mass by measuring small changes in resistance.
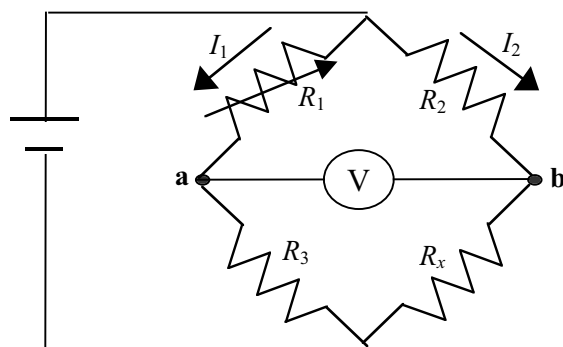
Accompanying sheet

> ## Wheatstone Bridge
>
> Explain how this circuit works.
>
> Find an expression for R_x, the unknown resistor, when the bridge is "balanced".
>
> Balance the bridge to find the value of the unknown resistor.
> Use the chart to check your measurement.