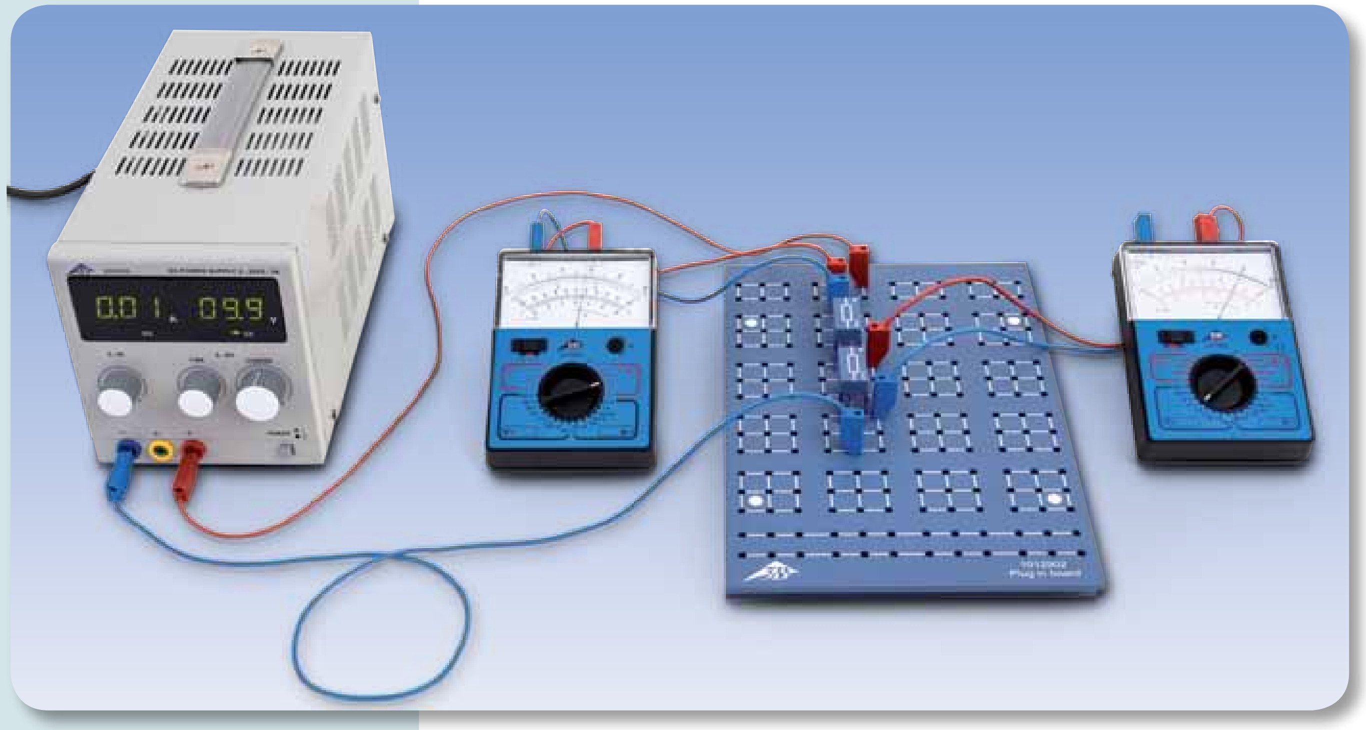
UE3020340

VOLTAGE DIVIDERS



EXPERIMENT PROCEDURE

- **Measure voltage and current for a voltage divider with no load as a function of the resistance R_2.**
- **Measure voltage and current for a voltage divider with no load for a constant overall resistance $R_1 + R_2$.**
- **Measure voltage and current for a voltage divider with a load as a function of the load resistance R_L.**

OBJECTIVE

Measure the voltage and current for a voltage divider with and without a load

SUMMARY

A voltage divider in its simplest form consists of a pair of resistors connected in series, whereby the total voltage across the two of them is divided into two parts. A voltage divider is considered to be loaded when a further resistance is connected in parallel with one of the pair. The current and voltage in each part of the circuit are calculated as in any other series or parallel circuit using Kirchhoff's laws. When there is no load on the divider, the portions of the voltage can vary between 0 volts and the total voltage, depending on the individual resistors. There is a marked difference, however, when the circuit is loaded with very small loads. Then the voltage across the part of the circuit including the load will be very small regardless of the resistors in the divider.

REQUIRED APPARATUS

Quantity	Description	Number
1	Plug-In Board for Components	**1012902**
1	Resistor 47 Ω, 2 W, P2W19	**1012908**
2	Resistor 100 Ω, 2 W, P2W19	**1012910**
1	Resistor 150 Ω, 2 W, P2W19	**1012911**
1	Resistor 470 Ω, 2 W, P2W19	**1012914**
1	Potentiometer 220 Ω, 3 W, P4W50	**1012934**
1	DC Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)	**1003312 or**
	DC Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)	**1003311**
2	Analogue Multimeter AM50	**1003073**
1	Set of 15 Experiment Leads, 75 cm 1 mm²	**1002840**

BASIC PRINCIPLES

A voltage divider in its simplest form consists of a pair of resistors connected in series, whereby the total voltage across the two of them is divided into two parts. A voltage divider is considered to be loaded when a further resistance is connected in parallel with one of the pair. The current and voltage in each part of the circuit are calculated as in any other series or parallel circuit using Kirchhoff's laws

When there is no load on the divider, the overall resistance is given by the following equation (see Fig. 1)

(1) $$R = R_1 + R_2$$

The same current flows through both resistors

(2) $$I = \frac{U}{R_1 + R_2}$$

U: Overall voltage

Therefore the voltage across R_2 is given by the following:

(3) $$U_2 = I \cdot R_2 = U \cdot \frac{R_2}{R_1 + R_2}$$

When the divider is loaded, the load resistance R_L also needs to be taken into account (see Fig. 2), whereby the value of R_2 in the above equation is replaced by the following expression:

(4) $$R_P = \frac{R_2 \cdot R_L}{R_2 + R_L}$$

Thus the voltage U_2 in that part of the circuit is now given by

(5) $$U_2 = I \cdot R_P = U \cdot \frac{R_P}{R_1 + R_P}$$

In this experiment, an unloaded voltage divider is assembled using two discrete resistors R_1 and R_2 with resistors of various different values being used as R_2. Alternatively, a potentiometer can be used, in which case the total resistance $R_1 + R_2$ is inherently constant and the value of R_2 depends on the position of potentiometer's sliding contact. The voltage source supplies a constant value U, which remains unchanged for the whole experiment. In each case the voltage and the current is measured for each section of the circuit.

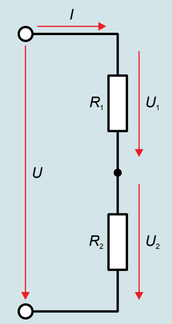


Fig. 1: Circuit diagram of a voltage divider with no load

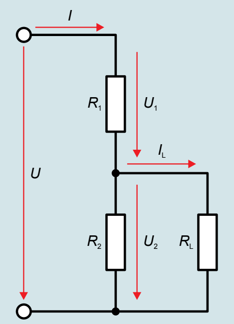


Fig. 2: Circuit diagram of a voltage divider with a load

EVALUATION

In a voltage divider without a load, the voltage U_2 corresponds to the overall voltage U, if R_2 is very much larger than R_1 but is close to zero if R_2 is very small in comparison.

For a voltage divider with a load of comparatively large magnitude, the resistance of the parallel section effectively equates to $R_P = R_2$ and the voltage in the section U_2 is then given by equation (3). The situation is very different if the load resistance is very small. In that case $R_P = R_L$, since most of the current flows through the load. The voltage U_2 then becomes very small regardless of the value of R_2.

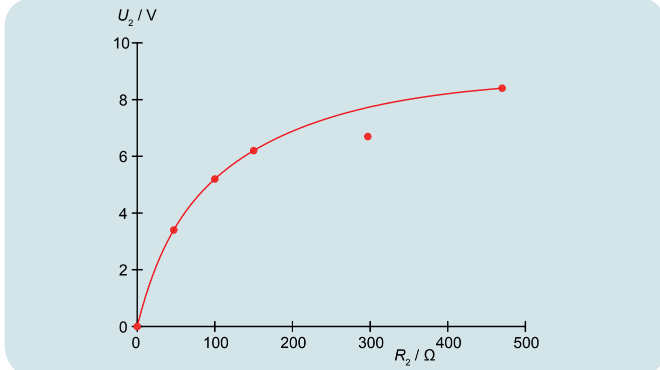


Fig. 3: Voltage U_2 as a function of resistance R_2 in a voltage divider with no load

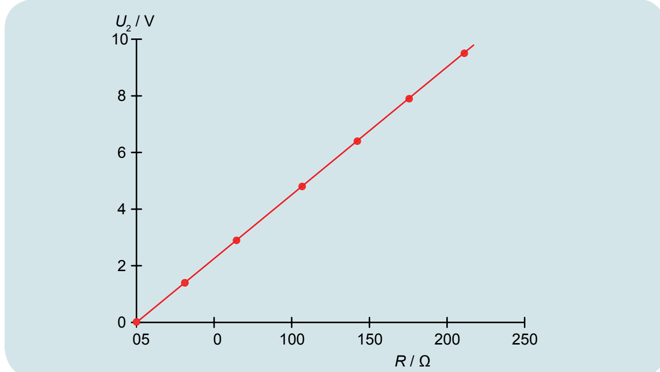


Fig. 4: Voltage U_2 as a function of resistance R_2 in a voltage divider with no load and a constant overall resistance $R_1 + R_2$

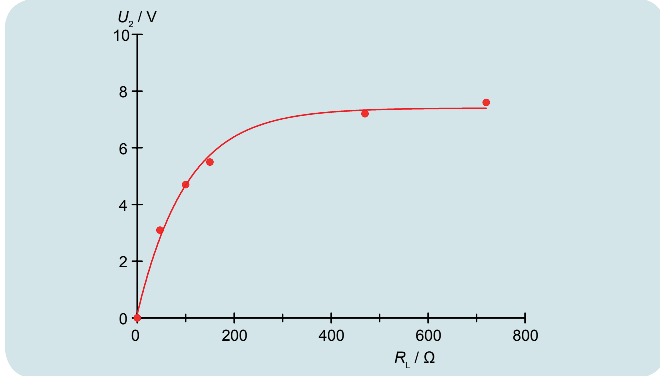


Fig. 5: Voltage U_2 as a function of resistance R_2 in a voltage divider with a load