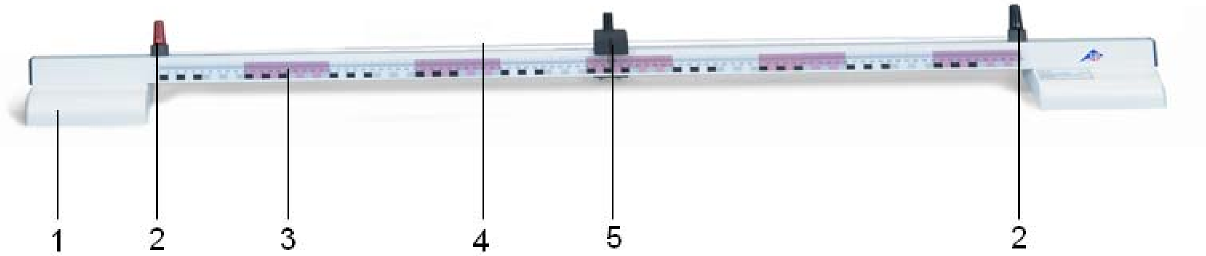
3B SCIENTIFIC® PHYSICS

...going one step further

Resistance Bridge 1009885

Instruction sheet

01/13 ALF



1 Plastic base
2 Connection sockets
3 Rail with scale
4 Resistance wire
5 Slide contact with pointer

1. Safety instructions

- Do not exceed a maximum permissible voltage of 8 V.
- Do not exceed a maximum permissible current of 1.5 A.

2. Description

The resistance bridge is used in determining the resistance in bridge circuits as well as in investigating the voltage drop along a wire.

The device consists of a rail with scale mounted on two bases with a resistance wire. A slide contact, is attached on top of the resistance wire. This defines the resistances R_1 and R_2 (see Fig. 1).

3. Technical data

Dimensions:	approx. 1300x100x90 mm³
Rail:	approx. 30x30 mm²
Scale:	0 – 1000 mm
Scale divisions:	mm
Resistance wire:	1 m, 0.5 mm diam.
Material:	NiCr
Resistance:	5.3 Ω
Connection:	4 mm safety jacks
Maximum voltage:	8 V
Maximum current:	1.5 A

4. Operating principle

In order to determine a resistance a Wheatstone bridge circuit is set up (see Fig. 1).

To do this a resistance wire of length $l = l_1 + l_2$ and with specific resistivity ρ (Ωm) is connected into a circuit consisting of the resistor R_X to be measured and a known resistor R_0. A DC voltage U is applied to this circuit. The ammeter is used to measure the current flowing between the point D and the moveable tapping point C located on the resistance wire.

The partial resistances of the wire R_1 and R_2 can be varied using the slide contact on the resistance wire.

Now it is important to calibrate the measurement bridge, i.e. to adjust the slide contact so that there is no voltage between points C and D and thus a current no longer flows. The partial resistances are:

$$R_1 = \rho \cdot \frac{l_1}{F} \text{ and } R_2 = \rho \cdot \frac{l_2}{F}$$

whereby F is the cross-sectional area of the wire.

For the resistance ratios the following then holds true:

$$\frac{R_X}{R_0} = \frac{R_1}{R_2} = \frac{l_1}{l_2}$$

From this we can deductively compute the unknown resistance:

$$R_X = R_0 \cdot \frac{l_1}{l_2}$$

The resistor R_0 should be selected so that upon calibration of the bridge l_1 and l_2 are approximately equal, in order to keep the error to a minimum.

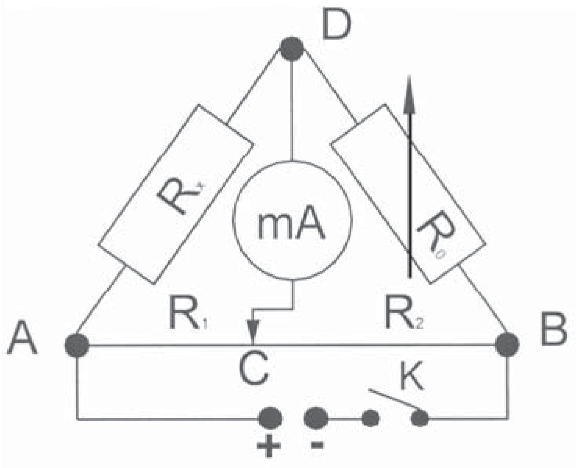


Fig. 1

5. Sample experiments

5.1 Determining resistance in a Wheatstone bridge circuit

Additionally required:

1 AC/DC Power Supply 12 V, 3 A (230 V, 50/60 Hz) 1002776
or
1 AC/DC Power Supply 12 V, 3 A (115 V, 50/60 Hz) 1002775

1 Zero Galvanometer CA 403 1002726

1 Resistance Decade 1 Ω 1002730
or
1 Resistance Decade 10 Ω 1002731
or
1 Resistance Decade 100 Ω 1002732

1 Incandescent lamp with socket

8 Experiment cables (500 mm)

1 Switch (optional)

- Connect up the experiment setup as illustrated (see Fig. 1).
- An incandescent lamp is used as the unknown resistance.
- A voltage of 4 to 6 V is applied.
- Close switch K and slowly move the slide contact from A to B to A again.
- At the same time observe the deflection of the ammeter. When the pointer deflection in the proximity of point A is zero, this means that the value of R_0 is very high and that it must be reduced. If the zero value is in the proximity of point B, then the value of R_0 is too low and must be increased.
- Select the R_0 value so that when the power is switched on again the pointer of the ammeter does not deflect when the slide contact is in the middle of the wire, i.e. the measurement bridge is calibrated.
- If there is no appropriate resistance available, use a resistor R_0, for which the pointer's deflection is smallest and then carry out the calibration.
- Obtain readings of partial lengths of the resistance wire.
- Repeat the experiment with varied voltage levels, enter your findings in a table and compute the resistance R_X.

5.2 Determine the specific resistivity ρ of a wire

- Experiment set-up according to Fig. 1, but this time use a resistance wire with a length from 1 to 3 m instead of the incandescent lamp.

- Measure the length l and diameter d of the wire used and from this compute the cross-sectional area F.
- Determine the resistance R_X as described under 5.1.
- For computed resistance R_X the following is true:

$$R_X = \rho \cdot \frac{l}{F}$$

Whereby ρ is the specific resistivity, l is the length of the wire in m and F is its cross-sectional area in m^2.

- The following is true for its specific resistance:

$$\rho = R_X \cdot \frac{F}{l}$$

- Repeat the experiment with various voltages and wires of varying lengths, enter the data into a table and work out the mean value.

Fig. 2 Determining resistance in a Wheatstone bridge circuit