Task

To examine if the the resistance of a wire is dependent on the material from which it is made and on the temperature.

Equipment

Plug-in board	06033.00	1
Wire building block	39120.00	3
Universal holder	39115.02	2
Connecting cable, 25 cm, red	07313.01	1
Connecting cable, 25 cm, blue	07313.04	1
Connecting cable, 50 cm, red	07314.01	2
Connecting cable, 50 cm, blue	07314.04	2
Copper wire, d = 0.2 mm, need approx. 30 cm	06106.00	(1)
Iron wire, d = 0.2 mm, need approx. 30 cm	06104.00	(1)
Constantan wire, d = 0.2 mm, need approx.. 30 cm	06100.00	(1)
Multi-range meter	07028.01	2
Power supply, 0...12 V-,6 V~, 12 V~	13505.93	1
Matches		

Set-Up and Procedure

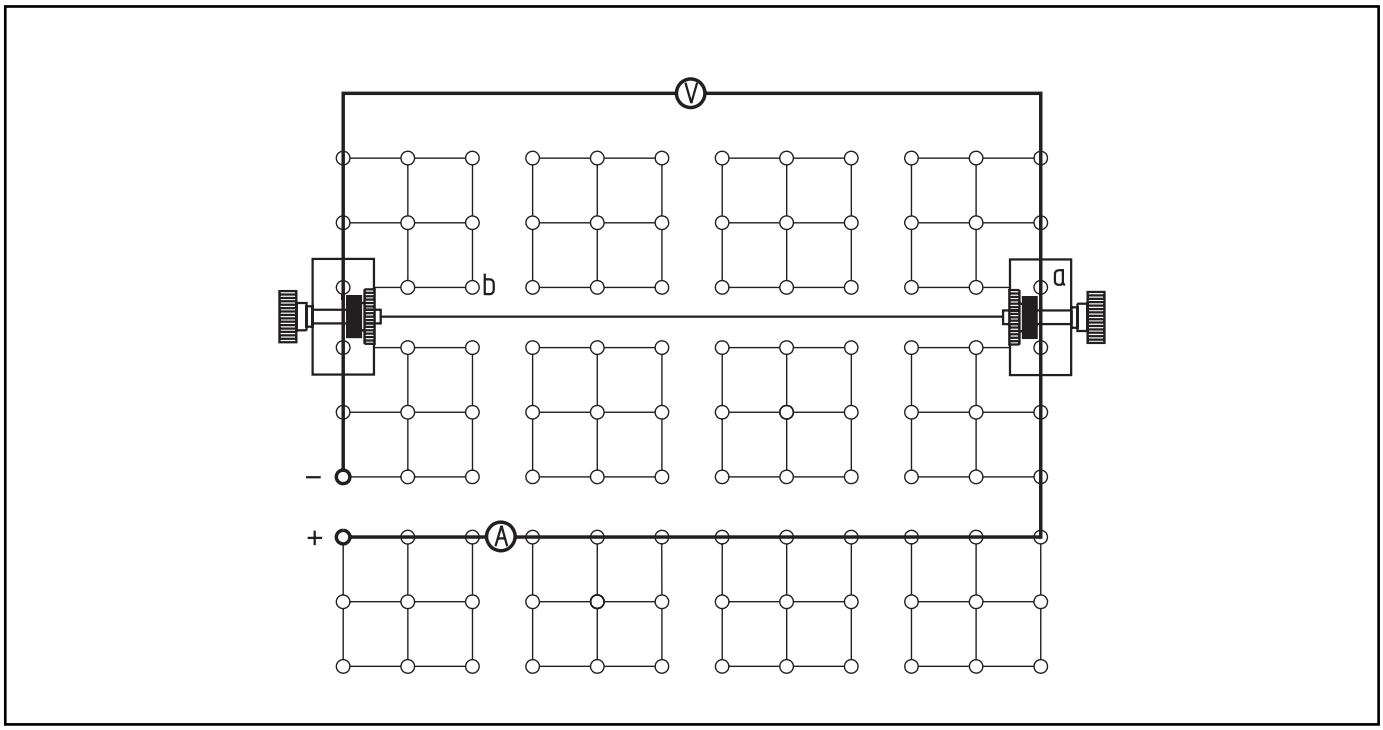
First experiment

— Connect up the circuit as shown in Fig. 1; first fix the copper wire between the universal holders.
— Select the 1 V- and 300 mA- measurement ranges.
— Set the power supply to 0 V, then switch it on.
— Carefully increase the power supply voltage until the ammeter shows 250 mA.
— Read the voltage and note it in Table 1.
— Set the power supply back to 0 V.
— Replace the copper wire between the universal holders with first the iron wire, then the constantan wire. As previously, measure the voltage at 250 mA in each case and note the values in Table 1.
— Switch off the power supply.

Second experiment

— Use a pencil or similar to form coils from the wires used in the first experiment.
— Change the circuit (see Fig. 1) by removing the voltmeter, moving the universal holder on the right from position a to position b, and completing the circuit with the corresponding wire building block.
— To start with, fix the copper wire coil between the universal holders in such a way that the longitudinal axis of the coil is roughly vertical.
— Select the 1 V- and 300 mA- measurement ranges.
— Set the power supply to 0 V, then switch it on.
— Carefully increase the power supply voltage until the ammeter shows 300 mA.
— Light a match and hold it under the coil.
Caution! Avoid melting the wire by using a flame which is not be too large, and by not bringing it too near to the coil
— Observe the ammeter while heating the coil.
— Note your observation under (1).
— Set the power supply back to 0 V.
— Replace the copper wire coil successively with the iron wire coil and the constantan wire coil, and carry out the same procedure with each as with the copper wire coil.
— Note your observations while heating each coil under (1).
— Switch off the power supply.

Fig. 1



Observations and Measurement Results

Table 1

Material	I /A	U/V	R/Ω
Copper	0.25		
Iron	0.25		
Constantan	0.25		

(1) Observations made while heating the wire coils in the second experiment:

Evaluation

1. Calculate the values of the resistances of each of the three wires and enter them in Table 1.
2. Compare the values of the resistances and formulate a statement on their dependence on the material from which the wire is made (for wires of the same length and cross-sectional area).

3. From the observations described in (1), formulate statements on the dependence of the resistance on the temperature.

4. Why is the material (the substance) from which the one wire is made called “constantan”?

(How do the material and the temperature of a wire influence the value of its resistance?)

After the students have established the relationships R ~ I and R ~ 1/A for the resistance of wires, the dependence of their resistance on the substance (material) and temperature are generally treated.
As the experiments are relatively time consuming, we recommend work-sharing. For the same reason, the dependence of the resistance on the temperature should only be qualitatively determined.

Notes on Set-Up and Procedure
The wires should be cut to the 30 cm lengths required prior to the start of the experiment.
Setting up the circuits will not cause the students any problems. When the position of the one universal holder is changed, ensure that the wire building block is correctly replugged.

Observations and Measurement Results
Table 1

Material	I /A	U/V	R/Ω
Copper	0.25	0.030	0.12
Iron	0.25	0.270	1.08
Constantan	0.25	0.835	3.34

1. Observations made while heating the wire coils in the second experiment: A considerable decrease in current is observed on heating the copper wire and iron wire coils, but with the constantan wire coil the current only decreases on very strong heating, and then only a little.

Evaluation
1. Refer to column 4 in Table 1.
2. The values of the resistance of wires of the same length and cross-sectional area are dependent on the material from which they are made. The copper wire has the smallest resistance, and so is the best conductor of electric current. The resistance of the iron wire is far higher than that of the copper wire, but far lower than that of the constantan wire.
3. The resistance of a copper or iron wire is highly dependent on the temperature. The higher the temperature, the higher the resistance. Constantan wires have an almost constant resistance over a large range of temperature.
4. The material is called constantan because wires made of constantan have an almost constant resistance over a large range of temperature.

T	EEP 2.7	The dependence of the resistance of a wire on its material and the temperature	PHYWE

(How do the material and the temperature of a wire influence the value of its resistance?)

Room for notes