Task

To examine the working principle of a potentiometer by means of a model of a potentiometer and subsequently to vary the brightness of a filament lamp by use of a commercially available potentiometer.

Equipment

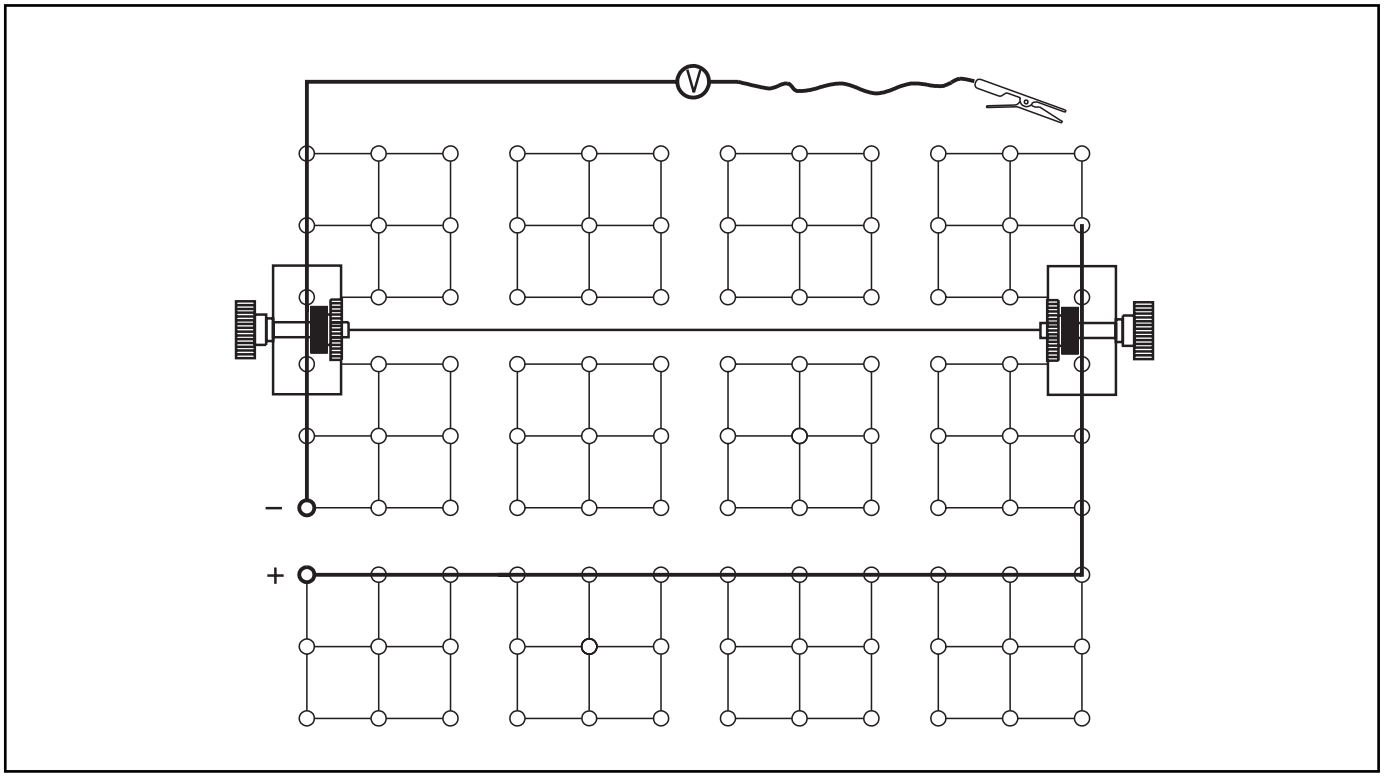
Plug-in board	06033.00	1
Wire building block	39120.00	4
Lamp holder E10	17049.00	1
Potentiometer, 250 Ω	39103.21	1
Universal holder	39115.02	2
Connecting cable, 50 cm, red	07314.01	2
Connecting cable, 50 cm, blue	07314.04	2
Crocodile clips, bare, 1 from 10	07274.03	(1)
Filament lamp, 4V/0.04 A, E10, 1 pc.	06154.03	(1)
Constantan wire, d = 0.2 mm, need approx.. 30 cm	06100.00	(1)
Multi-range meter	07028.01	1
Power supply, 0...12 V-,6 V~, 12 V~	13505.93	1
Ruler		

Set-Up and Procedure

First experiment

— Connect up the circuit as shown in Fig. 1; fix the constantan wire so between the universal holders that it does not sag.
— Connect the crocodile clip on the freely movable wire connected to the voltmeter to the universal holder on the right.
— Select the 1 V- measurement range.
— Set the power supply to 0 V, then switch it on.
— Carefully increase the power supply voltage until the voltmeter shows 1 V.
— Measure the length l of the inserted piece of wire and note the measured value in Table 1.
— Move the crocodile clip to connect the voltmeter successively to different positions on the wire (e.g. about $^3/_4$, $^1/_2$, $^1/_4$ along the length of the wire), measure at each position the length of wire held and the voltage across this length of wire. Note the measured values for l and U in Table 1.
— Set the power supply back to 0 V and switch it off.

Fig. 1



Second experiment

— Set up the experiment as shown in Fig.2; set the rotary knob of the potentiometer to 0; do not insert the filament lamp at first.
— Select the 10 V- measurement range.
— Switch on the power supply and set it to about 4 V.
— Slowly turn the potentiometer knob fully to the end stop and then back to 0; observe the deflection of the voltmeter while doing this.
— Note what you observed under (1).
— Complete the circuit by fitting in the filament lamp.
— Slowly turn the potentiometer knob from the 0 mark to the 10 mark and then back to 0, and observe the lamp while doing so.
— Note what you observed under (1).
— Set the power supply to 0, then switch it off.

(1)

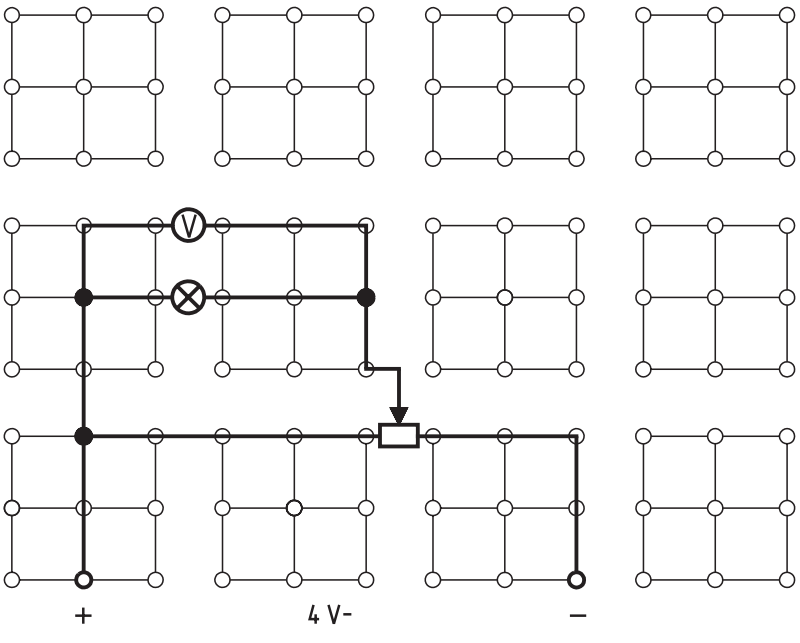
(2)

Observations and Measurement Results

Table 1

$\frac{I}{m}$	$\frac{U}{V}$	$\frac{U/I}{V/m}$
	1.00	

Fig. 2

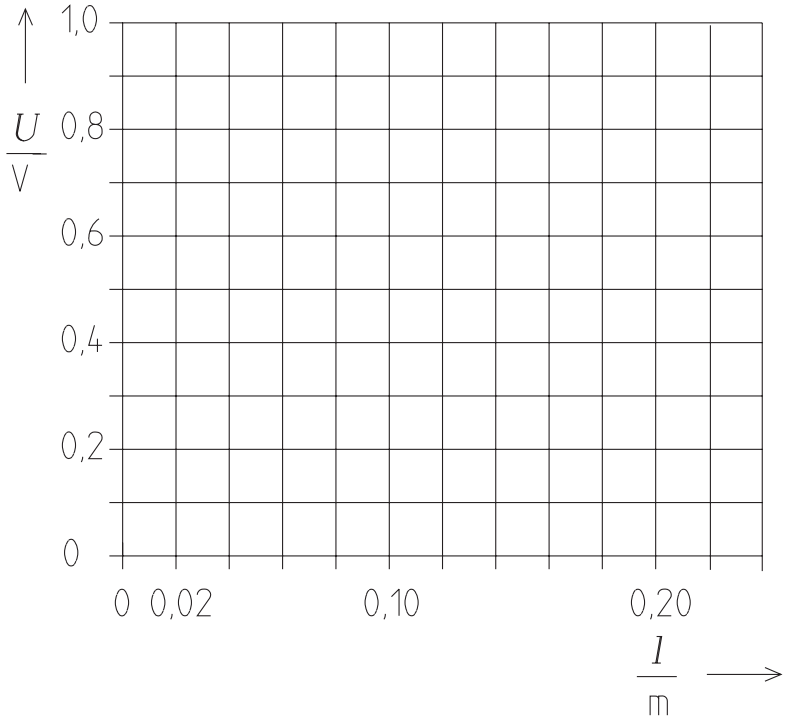


Evaluation

1. Plot a graph showing the dependence of the voltage U on the length of wire held l (Fig. 3). Which relationship between U and l can you derive from Fig. 3?

2. Form the quotient U /l for each pair of measured values obtained and enter these in column 3 of Table 1. Formulate the relationship between U and l mathematically.

Fig. 3



3. The function of a potentiometer is given from the relationship determined under 2 and the observations noted under (1) and (2). Describe what a potentiometer can be used for.

4. Give examples of where a potentiometer is used in practice.

(How does a potentiometer function?)

The students should first recognize from a model that a given voltage can be divided with a potentiometer (voltage divider) and that the dividing function is based on the law for the series connection of resistances $U_1/R_1 = U_2/R_2 = ... = U_n/R_n$.
For a homogen wire is $l_1/R_1 = l_2/R_2 = ... = l_n/R_n$.
The potentiometer must hereby not be under load.
Subsequently to this, the students should vividly experience the functioning of an actual potentiometer by working with it.

Notes on Set-Up and Procedure
In the first experiment, the lengths l can be freely chosen. The measured values for l and U can be best compared with each other, however, when the wire lengths are in the ratio of approximately 4:3:2:1.
In the second experiment it must be ensured that the preset power supply voltage does not exceed 5 V, because of the load-carrying ability of the lamp.

Observations and Measurement Results
Table 1

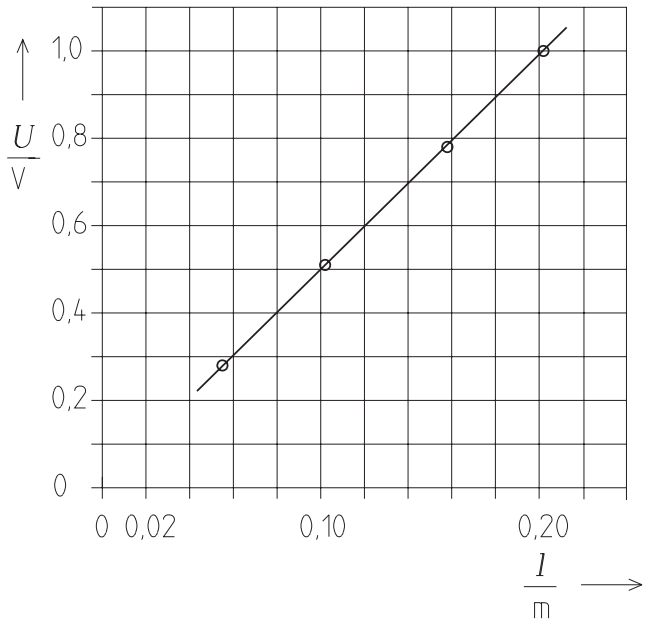
$\frac{l}{m}$	$\frac{U}{V}$	$\frac{U/I}{V/m}$
0.202	1.00	5.0
0.158	0.78	4.9
0.102	0.51	5.0
0.055	0.28	5.1

(1) During the turning of the knob from the 0 mark up to the stop, the voltage increases from 0 V to a maximum value; during turning back, it decreases again back down to 0 V.
(2) During the turning of the knob from the 0 mark up to the stop, the lamp starts to glow feebly, becomes continually brighter and attains its maximum brightness when the potentiometer knob reaches its stop; during turning back, the brightness of the lamp gets slowly less and less until the lamp goes out.

Evaluation
1. Refer to Fig. 3. The lengths of wire used l and the corresponding voltages U are directly proportional to each other, as the points lie on a straight line.
2. Refer to column 3 of Table 1.
   U / I = constant. It follows from this that:
   $U \sim I$ or $U_1/I_1 = U_2/I_2 = ... = U_n/I_n$.
3. A potentiometer can be used to divide a given voltage into smaller voltages as required.
4. Potentiometers are used in electronic devices as components for the adjustment of loudness and brightness. The power supply also has a potentiometer for the adjustment of the output voltage.

Remarks
Potentiometers of low load have a carbon layer instead of a resistor wire.
You should also use the clarifying term voltage divider during your introduction to the potentiometer.
When the sliding contact of the potentiometer is connected to the end of a resistor path, then the potentiometer can be used as a component for changing resistance.

Fig. 3



(How does a potentiometer function?)

Room for notes