Thermal behaviour of bodies
Solid bodies

Linear expansion of tubes when the temperature rises - Linear expansion apparatus D

Object of the experiment

1. Investigating the longitudinal expansion of copper, steel and glass tubes when they are warmed

Setup

Safety note:

When exchanging the hot expansion tubes, touch them with a piece of cloth.

Apparatus

1 Longitudinal expansion apparatus D	381 341
1 Erlenmeyer flask, Boro 3.3, 500 ml, narrow neck	664 251
1 Petri dish, 120 mm	602 740
1 Rubber stopper, one 7-mm hole, 28/34 mm Ø	667 265
1 Connector, straight, 8 mm diam., 10 pieces	665 222ET2
1 Silicone tubing, 7 mm diam., 1 m	604 433
1 Stand base, V-shape, large	300 01
1 Stand rod, 75 cm, 12 mm diam.	300 43
2 Leybold multiclamps	301 01
1 Universal clamp	666 555
1 Stand ring with stem, 100 mm diam.	666 573
1 Wire gauze, 120 x 120 mm	608 120
1 Butane gas burner	666 711
1 Butane cartridge, 190 g, set of 3	666 712ET3

Carrying out the experiment

- Fill approx. 300 ml of water into the Erlenmeyer flask and close the flask with the stopper.
- Put the copper tube into the expansion apparatus, and connect it to the Erlenmeyer flask via the tubing.
- Fasten the copper tube in the spring clip so that the groove on the tube rests on the blade of the pointer.
- Shift the expansion tube until the pointer points to the zero of the scale.
- Use the cartridge burner to warm the water in the flask until it boils.
- Observe the pointer deflection, and take the value read from the scale down.
- Repeat the procedure with the steel and the glass tube.

Measuring example

Material	Value read from the scale	*change in length $\Delta\ell$ in mm
Copper	3.4	0.68
Steel	2.2	0.44
Glass	1.8	0.36

*The full-scale value of 5 corresponds to a change in the length of the expansion tube of 1 mm.

Evaluation

The change in the length of tubes when their temperature rises depends on the material.

In the case of a copper tube the change in length is greater than in the case of steel or glass tubes.

Remark:

From the length changes obtained in this experiment the linear expansion coefficients α of the materials copper, steel, and glass can be determined: $\alpha = \frac{\Delta\ell}{\ell \cdot \Delta\vartheta}$

$\Delta\ell$: change in the length of the expansion tube

ℓ: initial length of the expansion tube

$\Delta\vartheta$: difference between the temperature of the warmed tube ϑ_2 (ϑ_2 = 100 °C) and the room temperature ϑ_1

Table values for the materials used in the experiment:

Copper: $\alpha = 17 \cdot 10^{-6} \frac{1}{K}$

Steel: $\alpha = 11 \cdot 10^{-6} \frac{1}{K}$

Glass: $\alpha = 9 \cdot 10^{-6} \frac{1}{K}$

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