



P 2.1.3

Thermal anomaly of water

P 2.1.3.1 Investigating the density maximum of water

Investigating the density maximum of water (P 2.1.3.1 b)

Cat. No.	Description	P 2.1.3.1 (a)	P 2.1.3.1 (b)
667 505	Device for demonstrating the anomaly of water	1	1
382 36	Thermometer, -10° to + 40 °C	1	
666 190	Digital thermometer with 1 input		1
666 193	Temperature sensor NiCr-Ni		1
666 845	Magnetic stirrer, 0...2000 rpm	1	1
664 195	Glass tank, 300 x 200 x 150 mm	1	1
665 008	Funnel, 50 mm dia., plastic	1	1
307 66	Rubber tubing, i. d. 8 mm	1	1
300 02	Stand base, V-shape, 20 cm	1	1
300 42	Stand rod, 47 cm	1	1
301 01	Leybold multiclamp	1	1
301 10	Clamp with ring	1	1
666 555	Universal Bunsen clamp S	1	1

When heated from a starting temperature of 0 °C, water demonstrates a critical anomaly: it has a negative volumetric expansion coefficient up to 4 °C, i.e. it contracts when heated. After reaching zero at 4 °C, the volumetric expansion coefficient takes on a positive value. As the density corresponds to the reciprocal of the volume of a quantity of matter, water has a density maximum at 4 °C.

This experiment verifies the density maximum of water by measuring the expansion in a vessel with riser tube. Starting at room temperature, the complete setup is cooled in a constantly stirred water bath to about 1 °C, or alternatively allowed to gradually reach the ambient temperature after cooling in an ice chest or refrigerator. The rise height h is measured as a function of the temperature ϑ . As the change in volume is very slight in relation to the total volume V_0 , we obtain the density

$$\rho(\vartheta) = \rho(0\text{ °C}) \cdot \left(1 - \frac{A}{V_0} \cdot h(\vartheta)\right)$$

A: cross-section of riser tube