The fixed points of the Celsius (centigrade) temperature scale are the melting point of ice and the boiling point of water. The scale is equally subdivided between these points. This process is carried out in this experiment. Several measurements are made with the self-calibrated thermometer and the values obtained are compared with those displayed by a measuring instrument with a NiCr-Ni temperature probe.

**Materials**

| | | |
|---|---|---|
| Demo-Board Physics | 02150.00 | 1 |
| Shaft with magnetic base | 02151.02 | 1 |
| Rule for demo-board | 02153.00 | 1 |
| Pointer for demo-board, 4 pcs | 02154.01 | 1 |
| Point markers for demo-board, 24 pcs | 02154.02 | 1 |
| Holder for hand-held measuring instruments, magnetic | 02161.00 | 1 |
| Holder for burner, with magnetic base | 02162.00 | 1 |
| Holder for wire gauze, with magnetic base | 02163.00 | 1 |
| Wire gauze square, ceramic centre | 33287.01 | 1 |
| Non graduated thermometer | 04256.00 | 1 |
| Beaker, 100 ml, low form, plastic | 36011.01 | 1 |
| Glass beaker, short, 250 ml | 36013.00 | 1 |
| Immersion probe NiCr-Ni, 50/1000 C | 13615.03 | 1 |
| Hand-held measuring instrument 2xNiCr-Ni | 07140.00 | 1 |
| Digital large-scale display | 07157.93 | 1 |
| Data cable RS 232, SUB-D/USB | 07157.01 | 1 |
| Butane burner, Labogaz 206 | 32178.00 | 1 |
| Butane cartridge C 206 | 47535.00 | 1 |
| Boiling stones, 200 g | 36937.00 | 1 |
| Ice (hammer, cloth) | | |
| Water soluble pen for overheads | | |
| Right-angled triangle | | |
| Matches | | |

**Experimental set-up**

— Position the holder for the burner at the bottom of the board.
— When a butane burner is to be used, position the holder for the wire gauze on the board at the marked height 240 and place the wire gauze on it (when a bunsen burner is to be used, select height 180).
— Wrap the ice in the cloth and break into as small pieces as possible with the hammer.
— Fill the glass beaker up to the 200 ml mark with ice, add two boiling stones and pour in cold water until the ice is just covered.
— Place the glass beaker on the wire gauze.
— Position the shaft with magnetic base on the board some way above the beaker.
— Hang the non-graduated thermometer from the shaft and lower the it until the thermometer dips about 2 cm into the iced water.

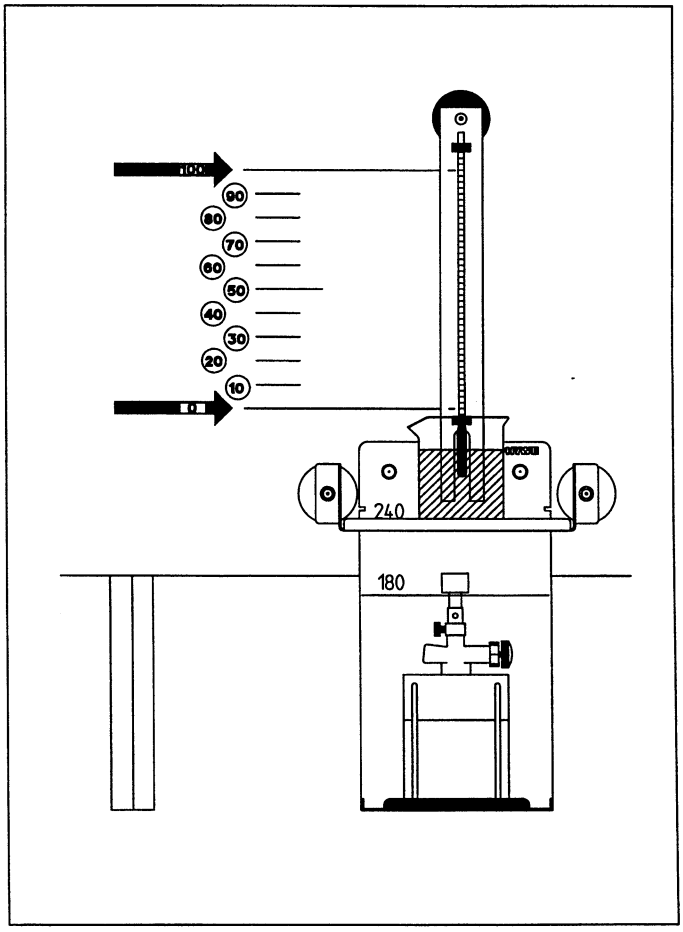
*Calibration of the NiCr-Ni temperature probe:*

NiCr-Ni thermoelements have an accuracy of approx. 3% when used to measure absolute temperatures, whereas they measure relative temperature changes with an accuracy of 0.1°C .

The temperatures measured with the self-calibrated thermometer are subsequently to be compared with those displayed by a measuring instrument for NiCr-Ni thermoelements. It is therefore necessary to also check the temperature display of the NiCr-Ni immersion probe by dipping it in iced water, and to adjust it to 0°C if required (refer also to the operating instructions for the hand-held measuring instrument 07140.00).

— Press the <HOLD> key (until HOLD appears in the display)
— Press the <Δ> key (CAL appears in the display)
— Press the <HOLD> key (SET appears in the display)
— Use key <Δ> or <∇> to adjust the value in the large digital display ($t_1$) to 0°C.
— Press the <CAL> key. A second temperature value ($t_2$) appears in the large digital display, but this value is of no interest.
— Press the <CAL> key. The temperatures are saved and the display returns to the normal measuring mode.

Fig. 1



# Preparation of a thermometer scale

## Procedure

— Stir the iced water and wait until the column of liquid in the thermometer no longer moves.
— Mark the height of the column with a pen, first on the metal plate, then demonstratively on the board, and indicate the mark here with a blue pointer.
Note: The liquid column can be particularly well seen, when the plate is perpendicular to the line of sight.
— Heat the iced water for one to two minutes and then extinguish the burner again.
— Stir the iced water and observe the liquid column of the thermometer.
— Again heat the iced water, until the ice has completely melted.
— Observe the liquid column while heating further.
— Allow the water to boil for a few minutes, until the level of the liquid column no longer changes.
— Mark the height of the liquid column with a pen, first on the metal plate, then demonstratively on the board, and indicate the mark here with a red pointer.
— Extinguish the burner.
— Divide the distance between the marks on the metal plate and on the board into 10 equal divisions.
— Mark the 10 degree subdivisions additionally on the board with labelled point markers (Fig. 1).
— Fix the hand-held measuring instrument to the board with the magnetic holder and connect it to the large-scale display.
— Successively make water baths of various temperatures by mixing in cold water.
— Measure the various temperatures, both with the self-calibrated thermometer and with the immersion probe, and compare the two values with each other.

## Results

1. Observation of the liquid column in iced water:
When the iced water had only been heated for one to two minutes, there was still sufficient ice in the beaker, so that after careful stirring the level of the liquid column was still at the zero mark (and the digital measuring instrument showed 0°C). When only a few pieces of ice were left in the water, however, the water temperature increased a little.
2. Observation on heating the water:
When the water had been heated for 1 minute, the level of the liquid column moved up about 2 cm.
3. Observation when the water boiled:
When the water began to boil, the level of the liquid column first moved up a little and then stopped at a value which was marked as 100°C.
4. The temperatures of the various water baths

| Self-calibrated thermometer | NiCr-Ni immersion probe |
|---|---|
| 80 °C | 81.0 °C |
| 60 °C | 60.8 °C |
| 40 °C | 40.5 °C |