B1.4 HISTORY NOTE A: CELSIUS AND THE REVERSE SCALE

The **Celsius temperature scale** dates back to 1742, when the Swedish astronomer **Anders Celsius** published a paper entitled 'Observations on two persistent degrees on a thermometer'.

After providing background on the various ways that temperature could be expressed at that time, the paper presents an account of Celsius' experiments with two fixed points for a temperature scale:

- The temperature of thawing snow or ice
- The temperature of boiling water

The idea of using the **freezing point of water** as a temperature calibration point had already been suggested by **Reaumur** and **Newton**. Celsius' approach was different. He wanted to use the point at which snow or ice thaw, rather than the point at which water freezes; the **melting point** of water, rather than the **freezing point**. In his paper, Celsius described an experiment which involved placing a thermometer in thawing snow. 'I have repeated this experiment many times over two years in all winter months...' he wrote, 'through different barometric changes, and always found precisely the same point on the thermometer... When it was strong winter I took the cold snow into my room and put it in front of the fire until it began to thaw...'

The second calibration point was more complicated. 'As far as the second fixed point is concerned,' Celsius wrote, 'it is well known that once water has begun to boil, it will not take up any considerable degree of heat even if one continues the boiling for long; thus the mercury in the thermometer will end at the same point.'

The intensity of the boiling might, however, affect the calibration point to a certain degree. Celsius proposed a standardised method for determination. He noted that when the thermometer is taken out of the boiling water the mercury level rises somewhat before it retracts. The explanation, Celsius suggests, is that the glass tube contracts before the mercury starts to cool off.

The second factor that affects the boiling point of water is the air pressure. This was already observed by Fahrenheit, and Celsius reports a series of experiments confirming this observation. His conclusion is that 'the height of the thermometer in boiling water is always proportional to the height of the barometer, thus eight "points" on the thermometer I use correspond to a change of one inch in the barometer reading; a thermometer which is somewhat more sensitive or has large degrees can be used as a barometer when put into boiling water, and would be easier to bring along when travelling at sea or land, especially on high mountains.'

Celsius proposed a standardised procedure for the calibration of a thermometer:

1. Put the cylinder AB of the thermometer (i.e. the bulb) in thawing snow. Mark the freezing point of water C. This should be at such a height over the cylinder at A that the distance AC is half the distance between C and the water boiling point marked D.
2. Mark the boiling point of water D at a pressure of approximately 755 mm.
3. Divide the distance in 100 equal parts or degrees; so that 0 degree corresponds to the boiling point of water, D, and 100 to the freezing point of water, C. When the same degrees have been continued below C all the way down to A the thermometer is ready.

Celsius thus put the boiling point at 0 degrees and the freezing point at 100. This is, of course, the reverse of the Celsius scale as we now know it.

It is often claimed that Carl von Linné (Carolus Linnaeus) instigated the reversal, but it appears more likely that the responsible person was Daniel Ekström, who manufactured most of the scientific instruments, including thermometers, used by both Celsius and Linné.

B1.4 HISTORY NOTE B: LORD KELVIN; THE IRISH CONNECTION

In 1848 the Irish-born scientist, **William Thomson**, formulated a temperature scale that was **independent of all thermometric properties**.

He proposed that the temperature at which all movement ceases (no heat energy available) should be called **'the absolute'** temperature. While the existence of a very low temperature was acknowledged, at the time it was Thomson who actually determined its value of approximately **minus 237.15°C**. He called the value the 'absolute zero' to distinguish it from zero degrees on the Celsius scale, which by then referred to the freezing point of water. Because minuses have a habit of getting lost, the Kelvin scale replaces −273.15°C with zero. The divisions on the **Kelvin scale** are the same as those of the Celsius scale.

Figure 8: William Thomson

According to the Kelvin scale:

− 273.15°C = 0 K

0°C = 273.15 K

This makes it easier to convert readings on the Celsius scale to the equivalent on the Kelvin scale.

The Kelvin is one of the seven basic units used in the International System of Units (SI).

The development of the Kelvin is only one of Thomson's great achievements. Born in Belfast in 1824 and raised for the most part in Glasgow, he was an avid **geologist** and **mariner** as well as a **scientist**. His list of achievements includes establishing the basic **laws of thermodynamics**, investigating the relationship between cable thickness and data flow (present day **bandwidth**), developing **submarine communication** systems, introducing accurate methods for **measuring electricity**, and inventing the **adjustable compass**. A great believer in the practical application of science, he was deeply involved in laying the **transatlantic telegraphic cables** for which he was knighted in 1866 and became known as **Lord Kelvin**. He died in 1907.