Temperature

- Temperature scale was originally defined by how much mercury expands between the freezing and boiling points of water, defined as $0°C$ an $100°C$.

$$T_c = C_1 \frac{\Delta V}{V_o} + C_2$$

- Inbetween $0°C$ and $100°C$ a thermometer based on mercury and one based on Alcohol gave slightly different answers.

- For low density gas, it was found that the ratio of pressures $P_{steam}/P_{freezing}$ at constant volume was the same independent of the gas type. It thus gave a universal (gas independent) scale

☆ $$T = T_{ref} \frac{P}{P_{ref}} \qquad (const \ volume)$$

So we need to pick a reference temperature measure gas pressure at very low density (so $P_{ref} \rightarrow 0$), then keeping the volume of gas fixed, measure the press. at some other point. This defines the temperature using ☆

Temperature define by the volume expansion of mercury

$$T_{\text{Celsius}} = C_1 \Delta V/V + C_2$$

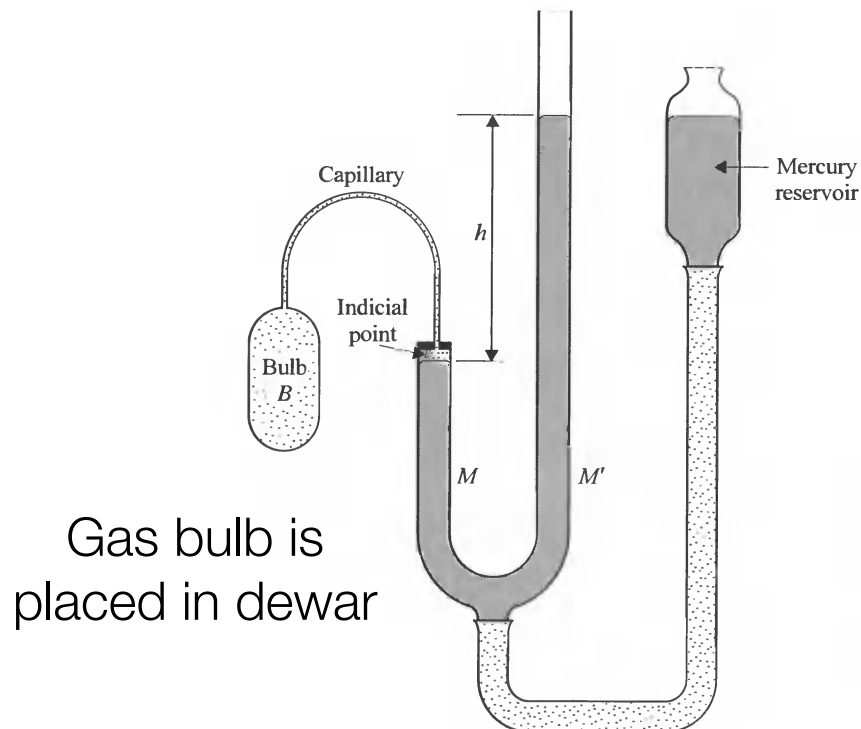The constants are chosen so that freezing is 0 and boiling is 100.

The constant volume ideal gas thermometer

Changes in pressure in the bulb (at constant volume) defines a temperature scale:

$$T \equiv T_{ref}\frac{P}{P_{ref}}$$

T_{ref} is a conventional
constant

Capillary

Mercury
reservoir

h

Indicial
point

Bulb
B

M   M'

Gas bulb is placed in dewar

Place the bulb in the sample. If the sample is hot, then the gas will try to expand. But we can then increase the height of the mercury column h, increasing the pressure on the gas, to keep the volume of the gas fixed (at the indicial point). The pressure of the gas can be measured from the height of the mercury column.

The measured pressure P relative to a reference point P_{ref} defines the temperature scale, which depends only very weakly on the type of gas.

- In practice the reference temperature was the temperature and pressure when water, ice, and water vapor are in equilibrium, the "triple point".

  T_{ref} was chosen to be 273.16 °K to have agreement the celsius scale

- Subsequent theory (which we will develop) confirmed the significance of the ideal gas scale

- All other thermometers are calibrated against the ideal gas one.

  For instance the resistance of platinum varies with temperature, and thus knowing the resistance determines the temperature.

Platinum Resistance Thermometer $4500
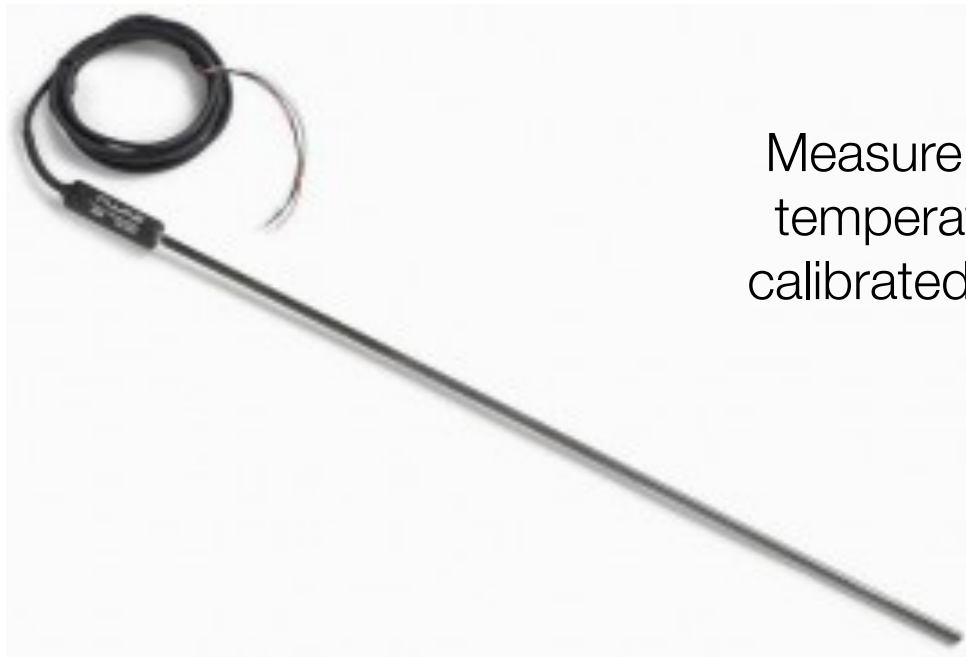
Measure the resistance as a function of temperature. This temperature scale is calibrated against some kind of ideal gas thermometer