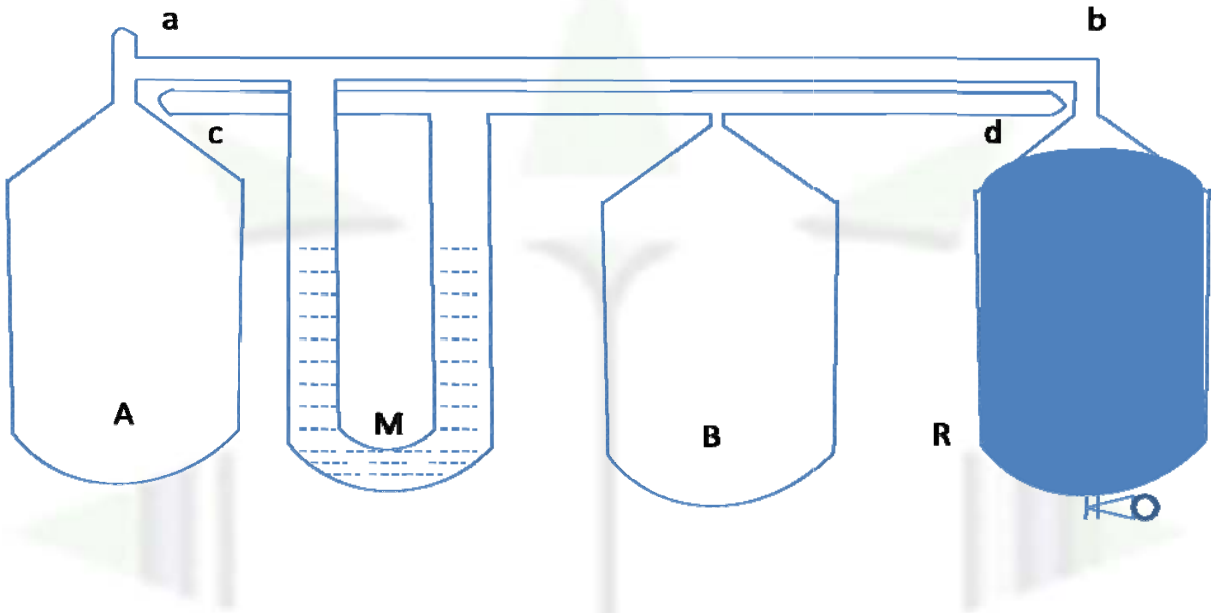
Constant Pressure (Compensated) Air Thermometer

Constant Pressure Air Thermometer: Compensated air thermometer

Description: The thermometer consists of two parts

(i) Thermometric part

(ii) Compensating part



The thermometric part consists of a bulb of silica A connected to an exactly similar bulb R through a capillary tube ab, bent twice at right angles. A is known as the bulb of the thermometer and R is filled with mercury by opening the outlet the mercury can be taken out from the bulb.

The compensating part consists of a bulb B exactly similar to A and is fitted with capillary tube CD of exactly same length and diameter as the capillary tube ab and are kept side by side so that the air contained in the capillary tube are at the same temperature. The thermometric and the compensating part are put into communication through a manometer M containing sulpheuric acid.

All the three bulbs A, B and R are immersed in melting ice the bulb R is filled with Hg. The ends of the capillary tubes are opened so that air at atmospheric pressure fills the bulb A , B and the capillary tubes. The ends of the capillary tubes are then sealed.

Since the volume pressure and temperature of air enclosed in the two parts of the apparatus are same hence according to the Avogadro's hypothesis the no of moles of air enclosed in the two parts of the apparatus are also same.

The bulb A is immersed in the unknown temperature bath while bulbs B and R are still immersed in melting ice. The pressure of air in bulb A increases as indicated by the difference in level in the manometer M. By opening the outlet Hg is taken out from the reservoir R, the volume of air in A will increases and pressure will decreases.

The Hg is continued to be taken out till the pressure of air in A restores to its original value as indicated by the equality in levels of liquid in the manometer. The volume of Hg taken out is measured.

Calculation :

Let V = The volume of bulb A or B

V' = The volume of air in each of the capillary tubes ab and cd

v = Volume of Hg taken out from the reservoir R i.e. the volume of air in the reservoir R

T = The temerature of the bath i.e. the temperature of air enclosed in the bulb A

T' = The temperature of air enclosed in the capillary tubes

T_0 = The temperature of air enclosed in the bulb B and the reservoir R

Let P = Pressure of air in both the parts of the apparatus

n = The no. of gram moles of air enclosed in both parts.

Applying gas equation to thermometric part

$$\frac{PV}{T}+\frac{PV'}{T'}+\frac{PV}{T_0}=nR \rightarrow (1)$$

Applying gas equation to the compensating part

$$\frac{PV}{T_0}+\frac{PV'}{T'}=nR \rightarrow (2)$$

From equation(1) and (2)

$$\frac{PV}{T}+\frac{PV'}{T'}+\frac{PV}{T_0}=\frac{PV}{T_0}+\frac{PV'}{T'}$$

$$T=\frac{VT_0}{(V-v)} \rightarrow (3)$$

Let θ be the temperature in ^{0}C then

$$T = 273+\theta = T_0+\theta$$

Putting in equation (3): $T_0+\theta=\frac{VT_0}{V-v}$

$$\theta=\frac{vT_0}{V-v} \rightarrow (4)$$

From equation (3) temperature in ^{0}K can be calculated.

Using equation (4) temperature of the bath in ^{0}C can be calculated.