Charle's law.

(1) French chemist, **Jacques Charles** first studied variation of volume with temperature, in 1787.

(2) It states that, "The volume of a given mass of a gas is directly proportional to the absolute temperature $(= {}^oC + 273)$ at constant pressure".

Thus, $V \propto T$ at constant pressure and mass

or $V = KT = K(t({}^oC) + 273.15)$, (where k is constant),

$$\frac{V}{T} = K$$

For two or more gases at constant pressure and mass

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} = \ldots\ldots K,$$

Charle's law can also be given as, $\left(\frac{dV}{dT}\right)_P = K$.

(3) If $t = 0^oC$, then $V = V_0$

Hence, $V_0 = K \times 273.15$

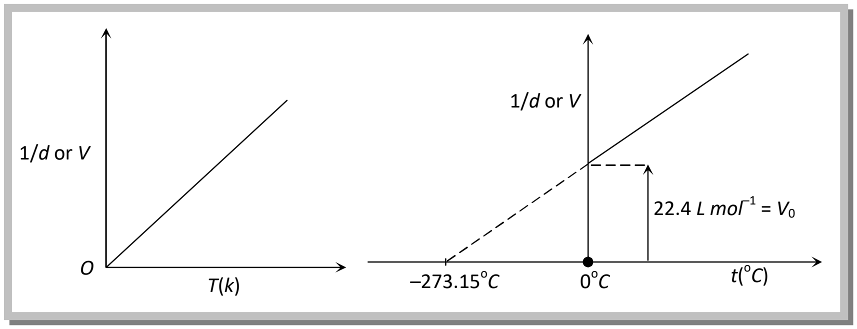
$$\therefore \quad K = \frac{V_0}{273.15}$$

$$V = \frac{V_0}{273.15}[t + 273.15] = V_0\left[1 + \frac{t}{273.15}\right] = V_0[1 + \alpha_v t]$$

Where α_v is the volume coefficient, $\boxed{\alpha_v = \frac{V - V_0}{tV_0} = \frac{1}{273.15} = 3.661 \times 10^{-3}\ {}^oC^{-1}}$

Thus, for every 1^o change in temperature, the volume of a gas changes by $\frac{1}{273.15}\left(\approx \frac{1}{273}\right)$ of the volume at 0^oC.

(4) **Graphical representation of Charle's law:** Graph between V and T at constant pressure is called isobar or isoplestics and is always a straight line. A plot of V versus $t({}^oC)$ at constant pressure is a straight line cutting the temperature axis at -273.15^oC. It is the lowest possible temperature.



(5) To lower the temperature of a substance, we reduce the thermal energy. Absolute zero (0K) is the temperature reached when all possible thermal energy has been removed from a substance. Obviously, a substance cannot be cooled any further after all thermal energy has been removed.

(6) At constant mass and pressure density of a gas is inversely proportional to it absolute temperature.

Thus, $\boxed{d \propto \frac{1}{T} \propto \frac{1}{V}}$ $\left[\because V = \frac{\text{mass}}{\text{d}}\right]$ or $\boxed{\frac{d_1}{d_2} = \frac{T_2}{T_1} = \frac{V_2}{V_1} = \ldots\ldots = K}$

(7) Use of hot air balloons in sports and meteorological observations is an application of Charle's law.