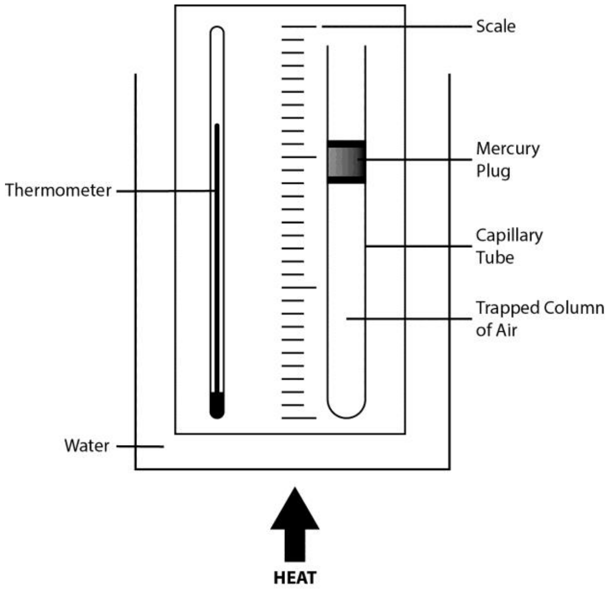
N5

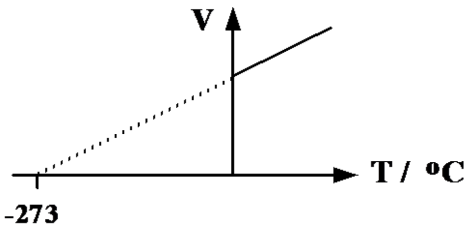
Relationship between Volume and Temperature of a Gas

Consider an experiment to determine the relationship between volume and temperature of a fixed mass of gas at a constant pressure.

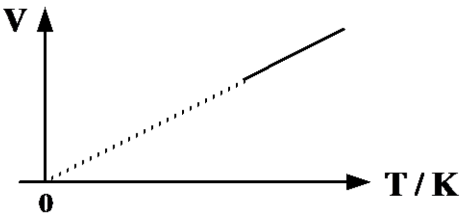


- As the water is heated, the volume of the gas is measured
- It is found that as the temperature increases, the volume increases

If a graph is drawn of volume against temperature, in degrees celsius, for a fixed mass of gas at a constant pressure, the graph is a straight line which does not pass through the origin. When the graph is extended until the volume reaches zero, again it crosses the temperature axis at -273 °C.   This is true for all gases



If the graph of volume against temperature is drawn using the kelvin temperature scale, the graph now goes through the origin:



Charles' law states that for a fixed mass of gas at a constant pressure, the volume of a gas is directly proportional to its temperature measured in kelvin (K):

$V \alpha T$ $\qquad$ $\frac{V}{T} = \text{constant}$ $\qquad$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Example

400 cm^3 of air is at a temperature of 20 °C. At what temperature will the volume be 500 cm^3 if the air pressure does not change?

$V_1 = 400\ cm^3$

$T_1 = 20\ °C = 293\ K$

$V_2 = 500\ cm^3$

$T_2 = ?$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{400}{293} = \frac{500}{T_2}$$

$\underline{T_2 = 366\ K = 93\ °C}$

Note: convert back to the temperature scale used in the question