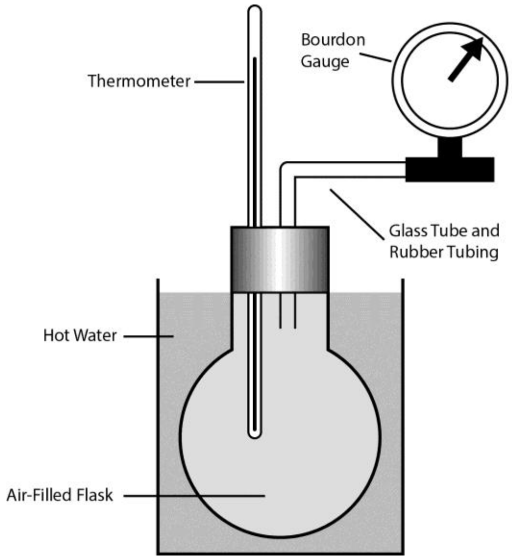
N5

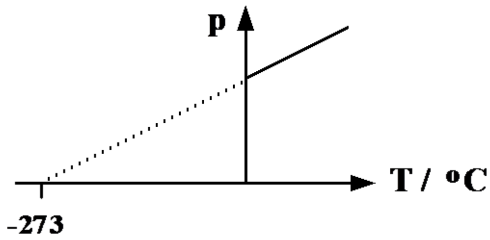
Relationship between Pressure and Temperature of a Gas

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



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

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



Kelvin Temperature Scale

N5

The temperature -273°C is called **absolute zero** and is the zero on the Kelvin temperature scale. At a temperature of absolute zero, 0 K, all particle motion stops and this is therefore the lowest possible temperature.

One division on the kelvin temperature scale is the same size as one division on the celsius temperature scale, i.e. temperature **differences** are the same in kelvin as in degrees Celsius e.g. a temperature increase of 10°C is the same as a temperature increase of 10 K.

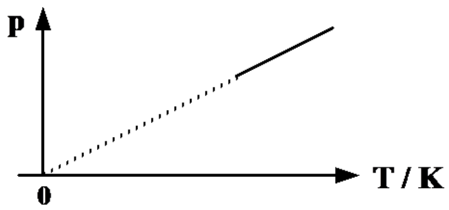
Note: the unit of the kelvin scale is the kelvin, K, **not** degrees kelvin, °K!

Converting temperatures between °C and K

Converting °C to K add 273

Converting K to °C subtract 273

If the graph of pressure against temperature is drawn using the kelvin temperature scale, zero on the graph is the zero on the kelvin temperature scale and the graph now goes through the origin:



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

$p \propto T$

$\frac{p}{T} = \text{constant}$

$\frac{p_1}{T_1} = \frac{p_2}{T_2}$

Example

Hydrogen in a sealed container at 27 °C has a pressure of 1.8×10^5 Pa. If it is heated to a temperature of 77 °C, what will be its new pressure?

$p_1 = 1.8 \times 10^5$ Pa

$T_1 = 27$ °C = 300 K

$p_2 = ?$

$T_2 = 77$ °C = 350 K

$\mathbf{p_1 / T_1 = p_2 / T_2}$

$1.8 \times 10^5 / 300 = p_2 / 350$

$\underline{\mathbf{p_2 = 2.1 \times 10^5\ Pa}}$