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Specific heats of Gases

Q. A gas has two specific heats whereas a liquid has only one. Explain. Explain why the specific heat of a gas at constant pressure is greater than that at constant volume.

Ans:- Two specific heats of a gas: When a gas is heated, ordinarily there is an increase in volume as well as pressure in addition to the rise of temperature. For the sake of simplicity, either the volume or the pressure may be kept constant. Therefore a gas has two specific heats.

(i) Specific heat at constant volume, and (ii) Specific heat at constant pressure.

The specific heat of a gas at constant volume is the amount of heat required to raise the temp. of a unit mass of the gas through 1°C keeping the volume constant.

If dQ is the amount of heat required to raise the temp of a unit mass of the

gas through $dT°C$, keeping the volume constant, then

Specific heat at constant volume C_v,

$$= \left(\frac{dQ}{dT}\right)_V$$

The specific heat of a gas at constant pressure is the amount of heat required to raise the temperature of a unit mass of the gas through $1°C$, keeping the pressure constant.

If dQ is the amount of heat required to raise the temp. of a unit mass of the gas through $dT°C$ keeping the pressure constant, then

Specific heat at constant pressure C_p

$$= \left(\frac{dQ}{dT}\right)_P$$

The C.G.S unit of mass is a gm and of heat is a calorie. Therefore, C.G.S unit of specific heat is calories per gm per °C ($cal \cdot gm^{-1} C^{-1}$). The S.I unit of mass is a Kg and of heat (energy) is a Joule. Therefore the S.I unit of specific heat is Joules per Kg per degree Kelvin ($J\ Kg^{-1} K^{-1}$).

A liquid has only one specific heat: When a liquid is heated there is only an increase in volume, the change in pressure being almost zero and hence negligible. A liquid, therefore has only one specific heat.

Why C_p is $> C_v$: In the first case, the heat supplied is used to increase the speed and the kinetic energy of the molecules. This results in a rise of temp and an increase in the pressure of the gas. But as the volume is kept constant the gas does no external work.

In the second gas, since the pressure is kept constant, therefore, the volume increases. The heat supplied now does two things:

(i) it raises the temp of gas, and

(ii) it does work in expanding the gas against the external pressure.

The amount of heat required to raise the temp of the gas in this case is same as in first case when volume is kept constant but in addition heat energy has to be supplied to do external work. Hence the specific heat at constant volume, by an amount which is the equal to the work done in expanding gas against ext. pressure.