Answer on Question#38712, Molecular Physics | Thermodynamics

Can the specific heat at constant volume be greater than the specific heat at constant pressure? Justify by

applying the first law of thermodynamics.

Answer

No. The specific heat at constant pressure is always greater than specific heat at constant volume.

c_p - specific heat at constant pressure, c_v - specific heat at constant volume.

When a body is heated at constant volume, no external work is done and so the heat supplied is consumed only in increasing the internal energy. We write the first law in terms of internal energy

$$\delta q = du = c_v \cdot dT,$$

where u - internal energy.

But if the body is heated at constant pressure, the body expands against the external pressure so does some external work. In this case the supplied heat is used up in increasing the internal energy and in doing some external work. Since the internal energy is depends only on temperature, for the same rise of temperature the internal energy will increase by the same amount whether the pressure or volume remains constant. But since external work is additionally done for constant pressure than at constant volume to produce the same rise in temperature. We write the first law in terms of internal energy

$$\delta q = c_p \cdot dT = du + dW = c_v \cdot dT + dW,$$

where W - external work. $dW > 0 \rightarrow c_p \cdot dT > c_v \cdot dT \rightarrow c_p > c_v.$

Above is the reason for c_p is always greater than c_v.