Specific Heat of Gases.

In case of gases, heat energy supplied to a gas is spent not only in raising the temperature of the gas but also in expansion of gas against atmospheric pressure.

Hence specific heat of a gas, which is the amount of heat energy required to raise the temperature of one gram of gas through a unit degree shall not have a single or unique value.

(i) If the gas is compressed suddenly and no heat is supplied from outside i.e. $\Delta Q = 0$, but the temperature of the gas raises on the account of compression.

$\therefore \quad C = \dfrac{\Delta Q}{m(\Delta T)} = 0$ i.e. C = 0

(ii) If the gas is heated and allowed to expand at such a rate that rise in temperature due to heat supplied is exactly equal to fall in temperature due to expansion of the gas. i.e. $\Delta T = 0$

$\therefore \quad C = \dfrac{\Delta Q}{m(\Delta T)} = \dfrac{\Delta Q}{0} = \infty$ i.e. $C = \infty$

(iii) If rate of expansion of the gas were slow, the fall in temperature of the gas due to expansion would be smaller than the rise in temperature of the gas due to heat supplied. Therefore, there will be some net rise in temperature of the gas i.e. ΔT will be positive.

$\therefore \quad C = \dfrac{\Delta Q}{m(\Delta T)} =$ Positive i.e. C = positive

(iv) If the gas were to expand very fast, fall of temperature of gas due to expansion would be greater than rise in temperature due to heat supplied. Therefore, there will be some net fall in temperature of the gas i.e. ΔT will be negative.

$C = \dfrac{\Delta Q}{m(-\Delta T)} =$ Negative i.e. C = negative

Hence the specific heat of gas can have any positive value ranging from zero to infinity. Further it can even be negative. The exact value depends upon the mode of heating the gas. Out of many values of specific heat of a gas, two are of special significance.

(1) Specific heat of a gas at constant volume (cv) : The specific heat of a gas at constant volume is defined as the quantity of heat required to raise the temperature of unit mass of gas through 1 K when its volume is kept constant, i.e., $c_v = \dfrac{(\Delta Q)_v}{m\Delta T}$

If instead of unit mass, 1 mole of gas is considered, the specific heat is called molar specific heat at constant volume and is represented by capital Cv.

$$C_v = Mc_v = \frac{M(\Delta Q)_v}{m\Delta T} = \frac{1}{\mu}\frac{(\Delta Q)_v}{\Delta T} \qquad \left[\text{As } \mu = \frac{m}{M}\right]$$

(2) Specific heat of a gas at constant pressure (cp) : The specific heat of a gas at constant pressure is defined as the quantity of heat required to raise the temperature of unit mass of gas through 1 K when its pressure is kept constant, i.e., $c_P = \frac{(\Delta Q)_p}{m\Delta T}$

If instead of unit mass, 1 mole of gas is considered, the specific heat is called molar specific heat at constant pressure and is represented by Cp.

$$C_p = MC_p = \frac{M(\Delta Q)_p}{m\Delta T} = \frac{1}{\mu}\frac{(\Delta Q)_p}{\Delta T} \qquad \left[\text{As } \mu = \frac{m}{M}\right]$$