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physics

"Concept of Heat"

Heat is defined as energy in transit. It is only used when there is transfer of energy between two or more systems.

Consider two systems A & B in thermal contact with one another and surrounded by adiabatic walls.

For system A:—

$$Q = U_2 - U_1 + W \quad \text{—— (i)}$$

where Q = energy transferred,
U_1 = the internal energy
U_2 = final internal energy
W = workdone.

Similarly for system B

$$Q' = U_2' - U_1' + W' \quad \text{—— (ii)}$$

$$\Rightarrow Q + Q' = [(U_2 + U_2') - (U_1 + U_1')] + (W + W') \quad \text{—— (iii)}$$

The total change in the internal energy of the composite system $= (U_2 + U_2') - (U_1 + U_1')$

The work done by the composite system $= W + W'$

It means that the heat transferred by the composite system $= Q + Q'$. But the composite system is surrounded by adiabatic walls and the net heat transferred is zero.

$\therefore Q + Q' = 0$

or $Q = -Q'$ ——————— (iv)

Thus, for two systems A & B in inter contact with each other, and the composit system surrounded by adiabatic walls an (as the neat heat transfered is zero.) the heat gained by one system is equal to the heat lost by the other system.

* Heat capacity $= \frac{Q}{\Delta T}$

Different materials have different cap to absorb heat to produce a given chang of tempature in a given mass. If material of mass m absorbs heat Q so that its temperature rises through ΔT then heat capacity $= \frac{Q}{\Delta T}$

Specific Heat(c):- Heat capacity per un mass is known as specific heat is denoted by c

$\therefore$ specific heat $= \frac{\text{Heat Capacity}}{\text{mass}} = \frac{C}{m}$

note:- 1. A liquid has only one specific heat.

2. But gases posses two sp. heat

(i) Sp. heat at constant volume

(ii) sp. heat at constant pressure

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

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

sp. heat of water $= 4.18 \times 10^3$ Joule/Kg °C

$$C_P > C_V$$

Difference betn Two sp. heats.

$$dQ_V = C_V dT \quad \text{——— (i)}$$

$$dQ_P = C_P dT \quad \text{——— (ii)}$$

workdone $= dW = PAdx = Pdv$

$$dQ_V = dU_V + dW_V$$

As volume remains Constant

$$dW_V = PdV = 0$$

$$dQ_V = dU_V \quad \text{——— (iii)}$$

fig ①

$$dU_V = C_V\,dT \quad \text{—(iv)}$$

$$dW_p = p\,dV_p$$

$$dQ_p = dU_p + p\,dV_p \quad \text{—(v)}$$

$$C_p\,dT = dU_p + p\,dV_p \quad \text{—(vi)}$$

$$dU_p = dU_V.$$

$$C_p\,dT = C_V\,dT + p\,dV_p \quad \text{—(vii)}$$

or, $(C_p - C_V)\,dT = p\,dV_p$

∵ for idealgas $PV = RT$

$$p\,dV_p = R\,dT$$

$$(C_p - C_V)\,dT = R\,dT \quad \text{—(viii)}$$

∴ $C_p - C_V = R$ — in $J\,mol^{-1}K^{-1}$

$c_p - c_v = r$ — in $ergs\,gm^{-1}K^{-1}$

$c_p - c_v = \dfrac{r}{J}$ — in calories

This formula is known as Mayer's relations

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