Assignment-03

Course Name: Physics

Course code: Phy-201

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<u>Question:</u> Prove that pv^{γ} = constant?

<u>Ans:</u>

We know from the 1st law of Thermodynamics

$$dQ = du + dw$$

~~for at~~ an adiabatic process, we can say $dQ = 0$

So, $du + dw = 0 = du + pdv$ ---- (1)

we know $du = nC_v dT$ --- (2)

For an ideal gas $pv = nRT$

$$\Rightarrow T = \frac{pv}{nR}$$

$$\Rightarrow dT = \frac{pdv + vdp}{nR}$$

Putting (in) (2) we get,

$$du = \frac{c_v}{R}(pdv + vdp)$$

Putting this value of du in (1) we get

$$\frac{dp}{p} = -\frac{dv}{v}\,\frac{C_v + R}{C_v}$$

$$\Rightarrow \frac{dp}{p} = -\frac{dv}{v}\cdot\gamma \quad \left[\text{as } \gamma = \frac{C_p}{C_v} = \frac{C_v + R}{C_v}\right]$$

$$\Rightarrow \int\frac{dp}{p} = -\gamma\int\frac{dv}{v}$$

$$\Rightarrow \ln p = -\gamma \ln v + c$$

$$\Rightarrow \ln p + \gamma \ln v = K$$

$$\Rightarrow \ln p + \ln v^{\gamma} = K$$

$$\Rightarrow \ln (pv^{\gamma}) = K$$

$$\therefore\ pv^{\gamma} = \text{constant}$$

(proved)

Question: prove that $Tv^{\gamma-1}$ = constant.

Ans. we know

for an ideal gas, $pv = RT$

$\therefore p = \frac{RT}{V}$

Again; we know, pv^{γ} = constant

putting the value of p in the above equation we get.

$$\frac{RT}{V} \times V^{\gamma} = \text{constant}$$

or $RTV^{\gamma-1}$ = constant

or $T \cdot V^{\gamma-1}$ = constant [$\because$ R = constant]

(Proved)

Question Prove that $Tp^{\frac{1-\gamma}{\gamma}}$ = constant?

Ans. we know

$$P_1 V_1 = RT_1 \text{ and } P_2 V_2 = RT_2$$

From, above equation, we get.

$$V_1/V_2 = P_2 T_1 / P_1 T_2$$

Putting this value in equation.

$$\frac{T_2}{T_1} = \left(\frac{P_2 T_1}{P_1 T_2}\right)^{\gamma-1}$$

After solving this we get,

$$\frac{T_2}{T_1} = \left(\frac{P_1}{P_2}\right)^{(1-\gamma)}$$

talking γ root on both side.

$$Tp^{\frac{1-\gamma}{\gamma}} \text{ constant}$$

(proved)