

ME.  
Session 1

15) The molar specific heat at const volume of an ideal gas is equal to 2.5 times the universal gas constant ( $8.314 \text{ J/mol}\cdot\text{K}$ ) when the temp  $\uparrow$  by  $100 \text{ K}$ ; the change in molar specific enthalpy is  $\text{--- J/mol}$ ;

$$\begin{aligned} h_2 - h_1 &= C_p (T_2 - T_1) \\ &= (C_p) (100) \\ &= (R + C_v) (100) \quad C_p - C_v = R \\ &= (R + 2.5R) (100) \quad C_p = (R + C_v) \\ &= 3.5R \times 100 \\ &= 350R \\ &= 350 \times 8.314 = \underline{\underline{2909.9 \text{ J/mol}}} \end{aligned}$$

one kg of an ideal gas ( $R = 400 \text{ J/kg}\cdot\text{K}$ ): specific heat at const volume  $C_v = 1000 \text{ J/kg}\cdot\text{K}$ . at 1 bar,  $300 \text{ K}$  is contained in a sealed rigid cylinder. During an adiabatic process  $100 \text{ kJ}$  of work is done on the system by a stirrer. The  $\uparrow$  in entropy of the system is  $\text{--- J/K}$ ;

solution

$$m = 1 \text{ kg}$$

$$R = 400 \text{ J/kg}\cdot\text{K};$$

$$C_v = 1000 \text{ J/kg}\cdot\text{K};$$

$$T_1 = 300 \text{ K}$$

$$W = 100 \text{ kJ}$$

$$dq = du + dw$$

$$dq = 0 \text{ (adiabatic)}$$

$$dw = m C_v dT \text{ (const volume)}$$

$$dT = \frac{100 \times 10^3}{10^3}$$

$$= 100 \text{ K}$$

$$T_2 = T_1 + 100 = \underline{\underline{400 \text{ K}}}$$

$$\Delta S = mC_v \ln \left[ \frac{T_2}{T_1} \right] + R \ln \left[ \frac{V_2}{V_1} \right]$$

$$V_2 = V_1 \text{ (rigid cylinder)}$$

$$\Delta S = 1 \text{ kg} \times 1000 \times \ln \left[ \frac{400}{300} \right]$$

$$= \underline{\underline{287.68 \text{ J/K}}}$$

## Session 2

(25) A mass  $m$  of a perfect gas at pressure  $P_1$  and volume  $V_1$  undergoes an isothermal process. Final pressure is  $P_2$ , final volume is  $V_2$ . The work done on the system is considered ~~as~~ positive.

WD in the process;

(a)  $P_1 V_1 \ln \frac{V_2}{V_1}$

(b)  $-P_1 V_1 \ln \left[ \frac{P_1}{P_2} \right]$

(c)  $RT \ln \left( \frac{V_2}{V_1} \right)$

(d)  $-mRT \ln \left[ \frac{P_2}{P_1} \right]$ .

### Solution

isothermal process;

$$PV = mRT \quad (T = \text{constant}) \text{ i.e. } PV = \text{constant};$$

$$PV = C;$$

$$\begin{aligned} \text{workdone} &= \int P dV = \int \frac{C}{V} dV \\ &= C [\ln V],^2 \end{aligned}$$

$$= \left[ P_1 V_1 \ln \frac{V_2}{V_1} \right]$$

but this is the expression when

note:

we consider WD ~~on~~ the

but it is given WD on the system is +ve;  
hence take -ve sign

$$W = - P_1 V_1 \ln \left[ \frac{V_2}{V_1} \right]$$

$$= - P_1 V_1 \ln \left[ \frac{P_1}{P_2} \right] \quad \checkmark$$

∴ [option B is correct]

(38) one kg of an ideal gas ( $R = 287 \text{ J/kg K}$ ) undergoes an irreversible process from state 1 (1 bar, 300K) to state 2 (2 bar, 300K). The change in specific entropy ( $s_2 - s_1$ ) of the gas in ( $\text{J/kg K}$ ) in the process is;

1                      2  
1 bar, 300K        2 bar, 300K;

$$s_2 - s_1 = m \left[ c_p \ln \left[ \frac{T_2}{T_1} \right] + R \ln \left( \frac{P_1}{P_2} \right) \right]$$

$$= m \left[ 0 + 287 \ln \left( \frac{1}{2} \right) \right]$$

$$(s_2 - s_1) = -287 \ln 2 = \underline{\underline{-198.93}}$$

note: don't forget to keep the -ve sign;