

Work done on the system for reversible isothermal process, $W = -P_{\text{ext}} (V_f - V_i)$

For reversible isothermal process, $W = - \int_{V_i}^{V_f} P dV$ where P is the pressure exerted by the gas.

Free expansion is the expansion in Vacuum, that is, $P_{\text{ext}} = 0$. Hence, $W = 0$

Calculation of Work done for n mol ideal gas under isothermal and reversible condition:

We know, $PV = nRT$

$P = nRT/V$. So, $W = - \int_{V_i}^{V_f} \frac{nRT}{V} dV = - nRT \ln (V_f/V_i)$

Some key points about Enthalpy:

Enthalpy, $H = U + PV$

As U, P, V all are state variables, H is also state variable

H depends on system size, i.e., extensive property

As absolute value of internal energy can't be calculated, similarly absolute value of H also can't be determined. We can calculate change in enthalpy, ΔH

For ideal gas, $\Delta H = \Delta U + P\Delta V = \Delta U + (n_f - n_i)RT = \Delta U + \Delta_g nRT$

Heat Capacity:

Heat capacity the amount of heat required to increase the temperature a unit mass of an object by 1°C. The suffix p and v in heat capacities denote the process occurs either at constant pressure or at constant volume.

Relationship between C_p and C_v for ideal gas:

For 1 mol of ideal gas,

$\Delta H = C_p \Delta T$ and $\Delta U = C_v \Delta T$

$\Delta H = \Delta U + \Delta(PV) = \Delta U + \Delta(RT) = \Delta U + R\Delta T$

Hence, $C_p - C_v = R$