

12.7: The Thermodynamic Functions for an Ideal Gas

In this section I tabulate the changes in the thermodynamic functions for an ideal gas taken from one state to another.

One mole of an ideal gas going isothermally and reversibly from P_1V_1T to P_2V_2T or adiabatically and reversibly from $P_1V_1T_1$ to $P_2V_2T_2$.

	Isothermal	Adiabatic
Work done by gas	$RT \ln(V_2/V_1)^*$	$\frac{P_1V_1 - P_2V_2}{\gamma - 1} = \frac{R(T_1 - T_2)}{\gamma - 1} = C_V (T_1 - T_2)$
$U_2 - U_1$	0	$-\frac{P_1V_1 - P_2V_2}{\gamma - 1} = -\frac{R(T_1 - T_2)}{\gamma - 1} = -C_V (T_1 - T_2)$
Heat absorbed by gas	$RT \ln(V_2/V_1)$	0
$S_2 - S_1$	$R \ln(V_2/V_1)$	0
$H_2 - H_1$	0	$-\frac{P_1V_1 - P_2V_2}{1 - 1/\gamma} = -\frac{R(T_1 - T_2)}{1 - 1/\gamma} = -C_P (T_1 - T_2)$
$A_2 - A_1$	$-RT \ln(V_2/V_1)$	$-\frac{R(T_1 - T_2)}{\gamma - 1} - T_2S_2 + T_1S_1$
$G_2 - G_1$	$-RT \ln(V_2/V_1)$	$-\frac{R(T_1 - T_2)}{1 - 1/\gamma} - T_2S_2 + T_1S_1$

*Note that for isothermal processes on an ideal gas, we can write $(V_2/V_1) = (P_1/P_2)$.

A difficulty will be noted in the entries for the increase in the Helmholtz and Gibbs functions for an adiabatic process, in that, in order to calculate ΔA or ΔG , it is apparently necessary to know S_1 and S_2 , and not merely their difference. For the time being this is a difficulty to note on one's shirt-cuff, and perhaps return to it later.

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