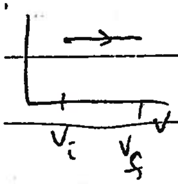
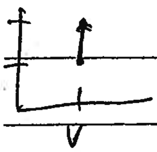
$pV = Nk_BT$

4 – Summary of Processes for ideal gas, quasistatic when reversible

$U = \frac{f}{2}Nk_BT = \frac{f}{2}pV$

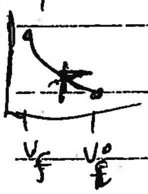
	W_{on} / W_{by}	ΔU	$Q = \Delta U - W_{on}$
isobaric	$+p(V_f - V_i)$	$\frac{f}{2}p(V_f - V_i)$ $\frac{f}{2}Nk_B(T_f - T_i)$	$\left(\frac{f+2}{2}\right)p(V_f - V_i)$ $C_p(T_f - T_i)$
isochoric	0	$\frac{f}{2}(p_f - p_i)V$ $\frac{f}{2}Nk_B(T_f - T_i)$	$\frac{f}{2}(p_f - p_i)V$ $C_V(T_f - T_i)$ $= \frac{f}{2}Nk_B(T_f - T_i)$
isothermal	$+Nk_BT\ln(V_f/V_i)$	0	$-Nk_BT\ln V_f/V_i$





isothermal: $T = \text{const} = U$

$W_{on} = -\int_{V_i}^{V_f} p\,dV$ (1.30), $p = \frac{Nk_BT}{V}$



isentropic adiabat

$Q = 0$

$pV^\gamma = \text{const}$

$TV^{(\gamma-1)} = TV^{2/f} = \text{const}$

$\gamma = \frac{f+2}{f}$

$= 5/3$ monatomic

$= 7/5$ diatomic

$W_{by} = -\frac{\text{const}}{\gamma - 1}\left(V_f^{-(\gamma-1)} - V_i^{-(\gamma-1)}\right)$

$\frac{\text{const}}{V^\gamma} = p$

$= -\frac{(p_fV_f - p_iV_i)}{\gamma - 1}$

$W_{on} = -\int_{V_i}^{V_f} p\,dV$

$\propto -\int V^{-\gamma}\,dV = \frac{V^{-(\gamma-1)}}{\gamma - 1}$

$\Delta U = -W_{on} = \Delta W_{by}$

$\Delta U = \frac{f}{2}Nk_B(T_f - T_i)$

$\propto Nk_B\left(V_f^{-2/f} - V_i^{-2/f}\right)$

$= \frac{f}{2}(p_fV_f - p_iV_i)$

$= \frac{1}{\gamma - 1}(p_fV_f - p_iV_i)$

$\gamma = 1 + \frac{2}{f} \Rightarrow \gamma - 1 = \frac{2}{f}$

Q: 0

$\text{const} = p_0V_0^\gamma = Nk_BT_0V_0^{(\gamma-1)} = p_0\left(\frac{Nk_BT_0}{p_0}\right)^\gamma = p_0^{-(\gamma-1)}(Nk_BT_0)^\gamma$

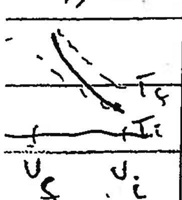


Fig 1.12