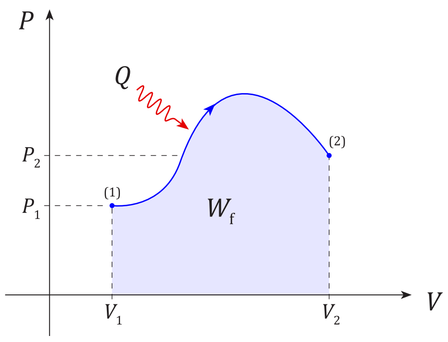
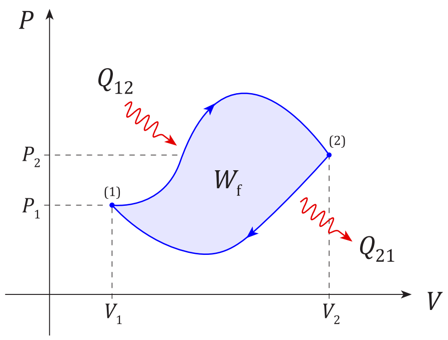
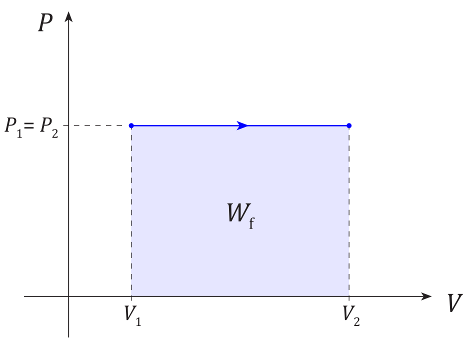
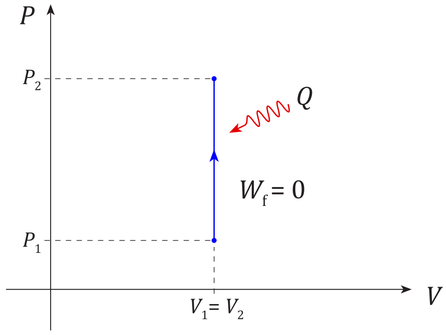
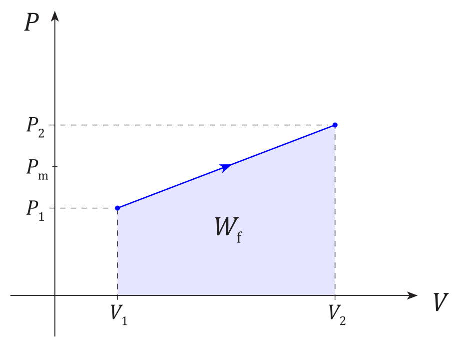
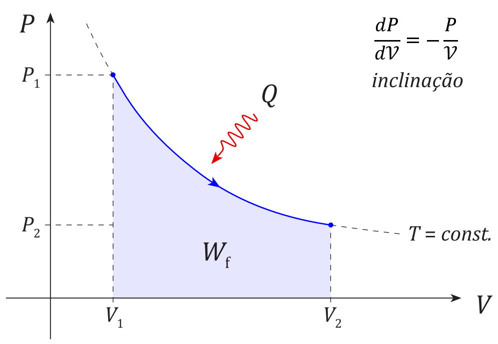
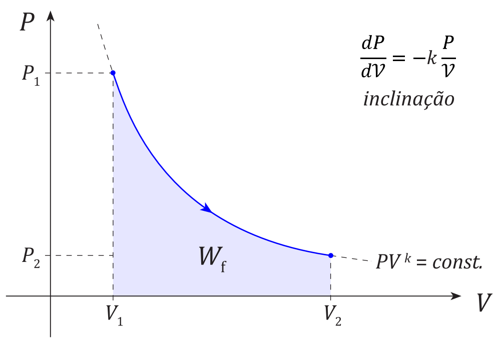
TERMODINÂMICA
Trabalho de Fronteira e Calor

SISTEMAS FECHADOS E ESTACIONÁRIOS (Sistemas de qualquer natureza e fase)

Processo (quase-estático)	**Trabalho de Fronteira** (W_f)	**Calor** (pela 1ª Lei da Termodinâmica)	**Diagrama** *P-V*
QUALQUER	$W_f = \int_{\mathcal{V}_1}^{\mathcal{V}_2} P d\mathcal{V}$ $\delta W_f = P d\mathcal{V}$ $w_f = \int_{v_1}^{v_2} P dv$ $\delta w_f = P dv$	$Q = \Delta U + W$ $\delta Q = dU + \delta W$ $q = \Delta u + w$ $\delta q = du + \delta w$ $W = W_f + W_{\text{outros}}$ $W_{\text{outros}} = W_{\text{eixo}} + W_{\text{ele}} + \cdots$	
CÍCLICO ($\Delta U = 0$)	$W_f = \oint P d\mathcal{V}$	$\Delta U_{\text{ciclo}} = 0 \Longrightarrow Q = W$ se $W_{\text{outros}} = 0$ então $Q = W_f$	
ISOBÁRICO ($P = \text{const.}$) ($dP = 0$)	$W_f = P\Delta\mathcal{V}$	$Q = \Delta H + W_{\text{outros}}$ $q = \Delta h + w_{\text{outros}}$ se $W_{\text{outros}} = 0$ então $Q_P = \Delta H$ $q_P = \Delta h$	
ISOCÓRICO ($\mathcal{V} = \text{const.}$) ($d\mathcal{V} = 0$)	$W_f = 0$	$Q = \Delta U + W_{\text{outros}}$ $q = \Delta u + w_{\text{outros}}$ se $W_{\text{outros}} = 0$ então $Q_V = \Delta U$ $q_V = \Delta u$	

“LINEAR” $\left(\frac{\Delta P}{\Delta \mathcal{V}} = \text{const.}\right)$	$W_f = \frac{P_1 + P_2}{2}\Delta \mathcal{V}$ $= P_m \Delta \mathcal{V}$	$Q = \Delta U + W_f + W_{\text{outros}}$	

SISTEMAS FECHADOS E ESTACIONÁRIOS (Gases ideais ou perfeitos, $U = f(T)$)

Processo (quase-estático)	**Trabalho de Fronteira** (W_f)	**Calor** (pela 1ª Lei da Termodinâmica)	**Diagrama** *P-V*
ISOTÉRMICO $(T = \text{const.})$ $(dT = 0)$ $(P\mathcal{V} = \text{const.})$	$W_f = mRT \ln \frac{\mathcal{V}_2}{\mathcal{V}_1}$ $P_1\mathcal{V}_1 = P_2\mathcal{V}_2 = mRT$ $\frac{\mathcal{V}_2}{\mathcal{V}_1} = \frac{P_1}{P_2}$	$\Delta U = 0 \Longrightarrow$ $Q = W$ se $W_{\text{outros}} = 0$ então $Q = W_f$	
ADIABÁTICO $(Q = 0)$ $(P\mathcal{V}^k = \text{const.})$	$W_f = \frac{P_2\mathcal{V}_2 - P_1\mathcal{V}_1}{1-k}$ $W_f = \frac{mR(T_2 - T_1)}{1-k}$ $W_f = -\Delta U$ $k = \frac{c_P}{c_V} > 1$	$Q = 0$	
POLITRÓPICO $(P\mathcal{V}^n = \text{const.})$ $n = 0 \Longrightarrow$ isobárico $n = 1 \Longrightarrow$ isotérmico $n = k \Longrightarrow$ adiabático $n = \infty \Longrightarrow$ isocórico	$(\boldsymbol{n \neq 1})$ $W_f = \frac{P_2\mathcal{V}_2 - P_1\mathcal{V}_1}{1-n}$ $W_f = \frac{mR(T_2 - T_1)}{1-n}$ $(\boldsymbol{n = 1})$ $W_f = mRT \ln \frac{\mathcal{V}_2}{\mathcal{V}_1}$	$Q = \Delta U + W$