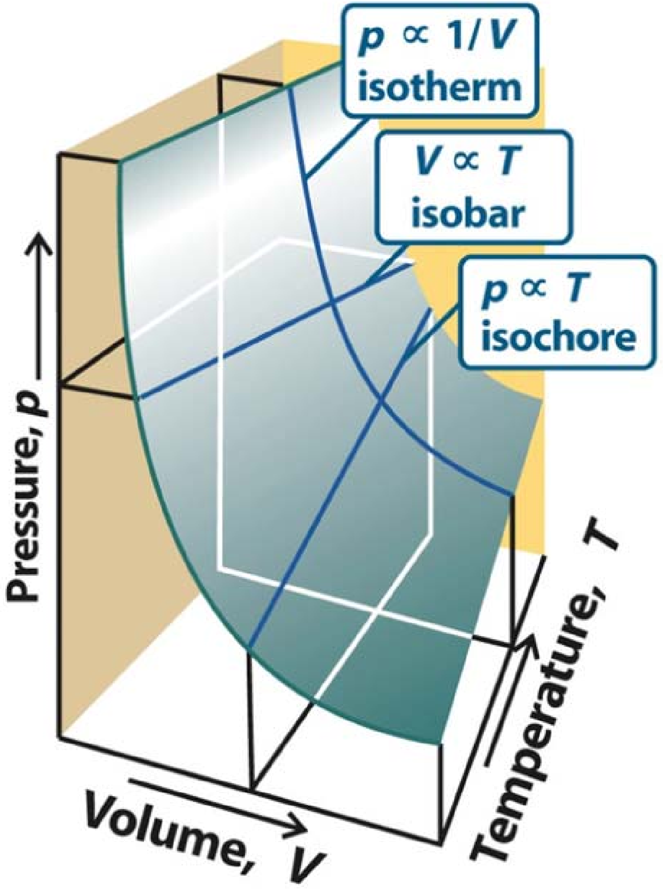

Figure 1-9
Atkins Physical Chemistry, Eighth Edition

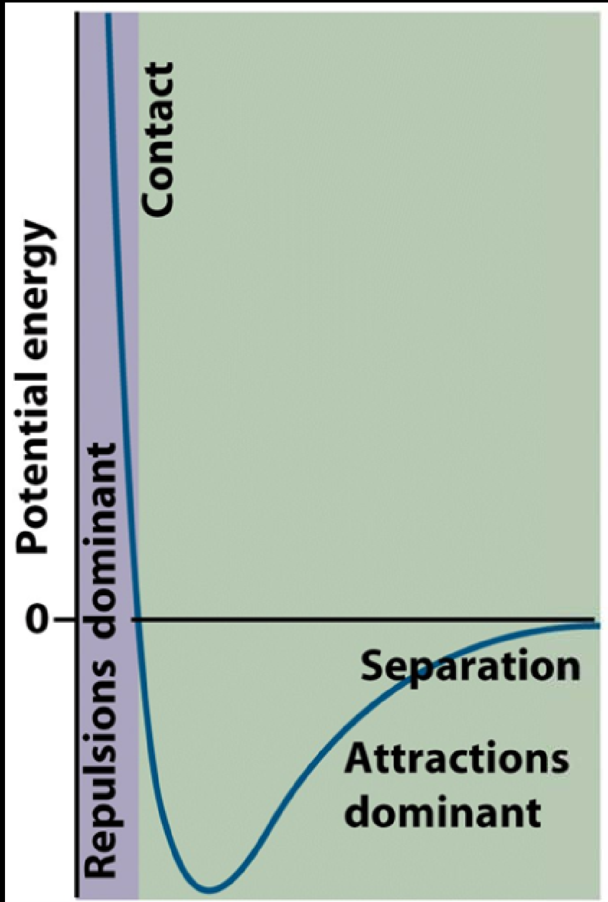

Figure 1-13
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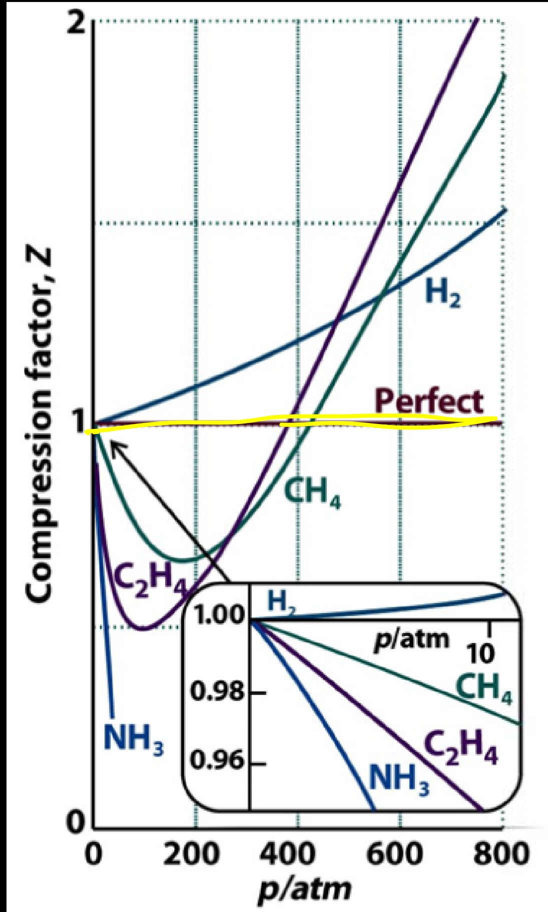


Figure 1-14
Atkins Physical Chemistry, Eighth Edition

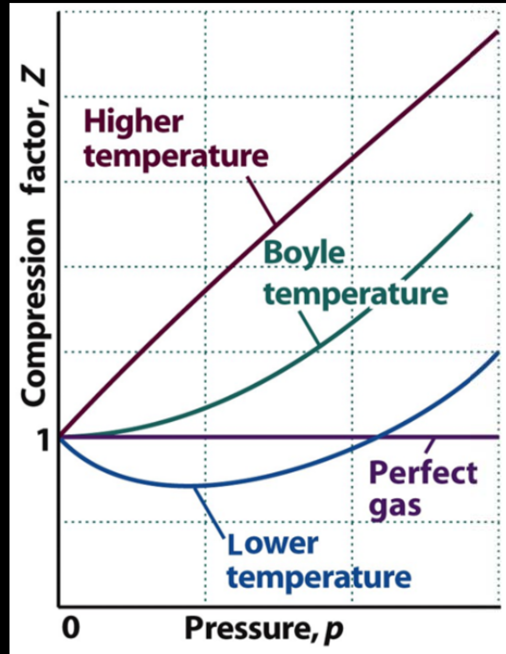


Figure 1-16
Atkins Physical Chemistry, Eighth Edition

$$\frac{PV_m}{RT} = Z$$

Virial Eqn.

$$Z(T) = 1 + B'(T)\,p + C'(T)\,p^2 + \cdots$$

$$= 1 + \frac{B(T)}{V_m} + \frac{C(T)}{V_m^2} + \cdots$$

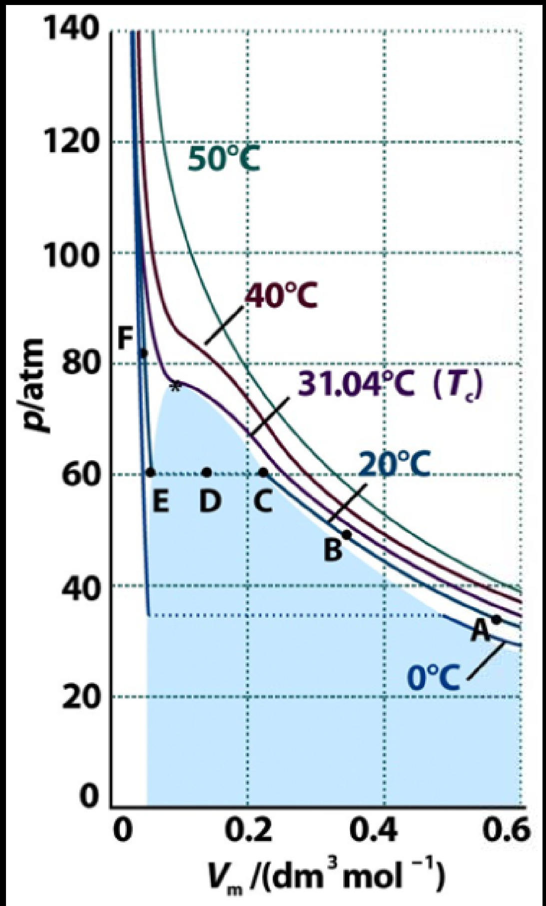


Figure 1-15
Atkins Physical Chemistry, Eighth Edition

$$\frac{dZ}{dp} = B' + 2C'p + \cdots$$

$p \to 0$ $\quad dZ/dp = B'$

$B'(T) \longrightarrow 0$ as p is small

$T_B \to$ Boyle's Temp.

$$P_{id} V_{id} = nRT$$

$$V = V_{id} + nb$$

$$p = P_{id} - \frac{an^2}{V^2}$$

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

Van der Waals equation

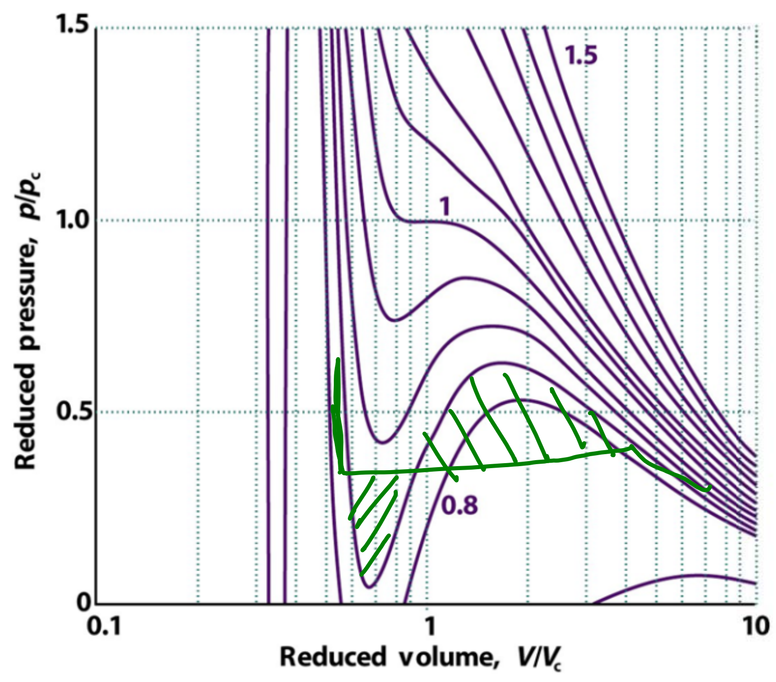
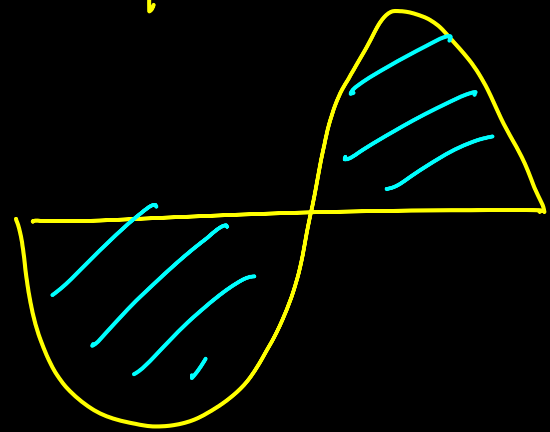


Figure 1-18
Atkins Physical Chemistry, Eighth Edition

Maxwell's construction

Equal areas



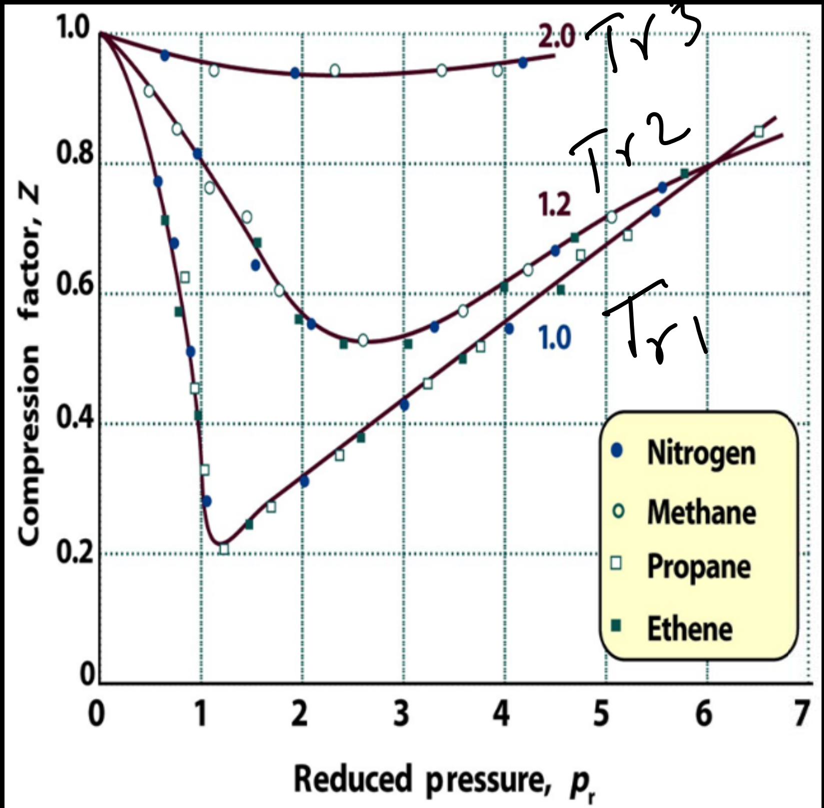


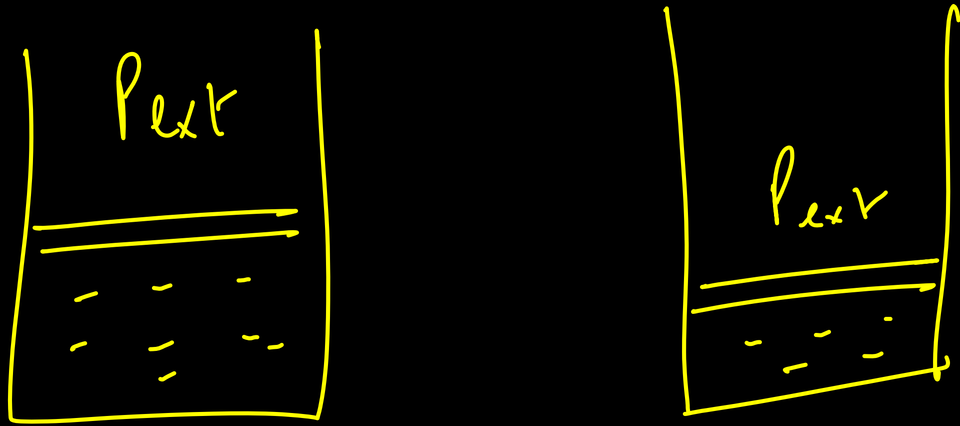
Figure 1-19
Atkins Physical Chemistry, Eighth Edition

$$P_r = \frac{P}{P_c}, \quad V_r = \frac{V}{V_c}$$

$$T_r = \frac{T}{T_c}$$

Principle of corresponding states

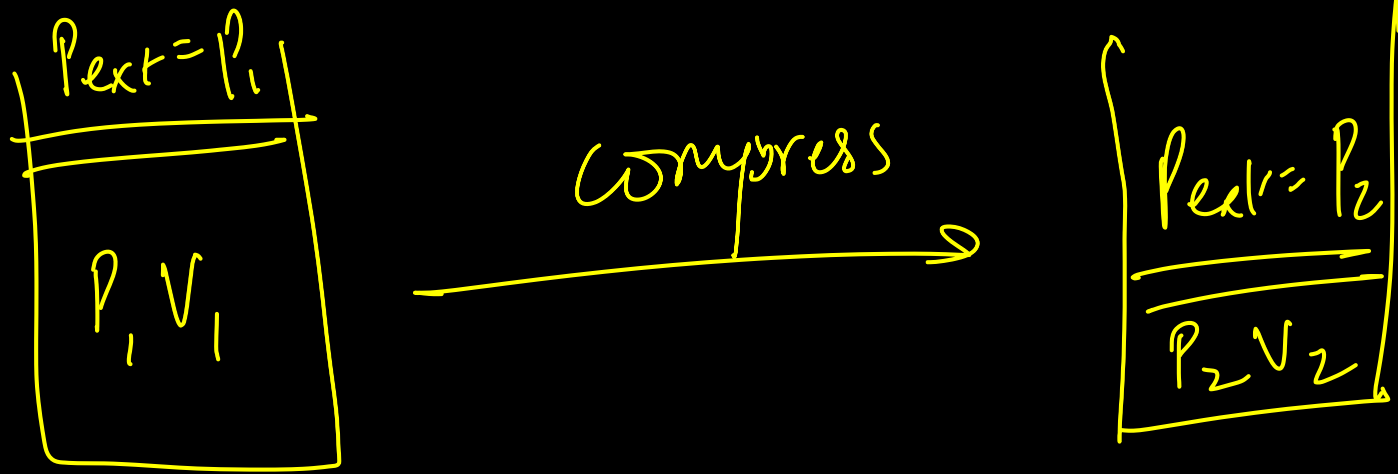
$$P_r = \frac{8T_r}{3V_r - 1} - \frac{3}{V_r^2}$$

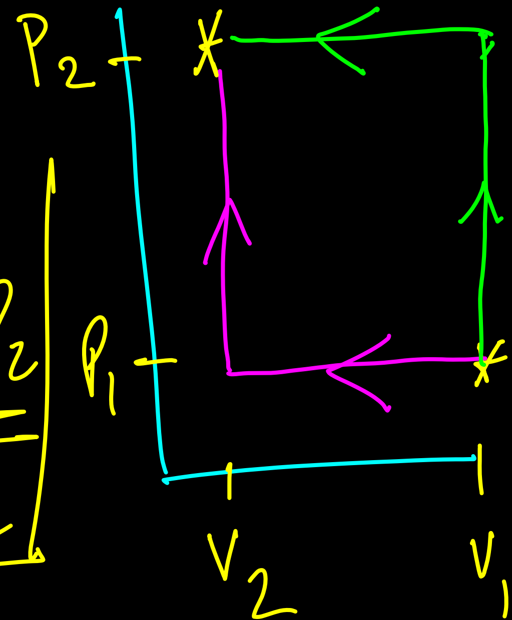


Energy into sys
+ve

Energy out of sys
−ve

$$dw = -P_{ext}\, dV$$





$$w = -\int_{V_1}^{V_2} P_1\, dV - \int_{V_2}^{V_2} P\, dV^{\to 0} = -P_1 (V_2 - V_1)$$

$$w = -\int_{V_1}^{V_1} P\, dV^{\,0} - \int_{V_1}^{V_2} P_2\, dV = -P_2 (V_2 - V_1)$$

'U'

$đw$, $đq$ inexact

$(đw + đq)$ exact dU Energy

internal energy

$dU_{sys} = đw + đq$, $dU_{surr} = -(đw + đq)$

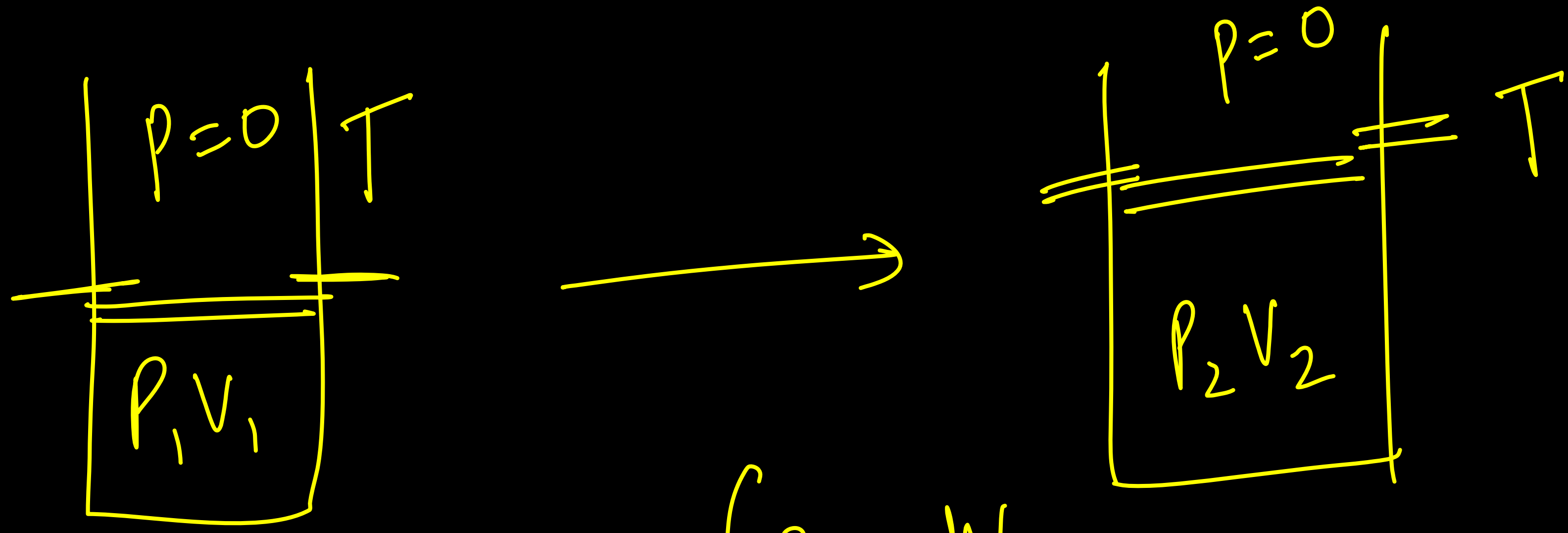
$$dU_{sys} + dU_{surr} = 0$$ = Energy Conservation

$$\Delta U_{sys} + \Delta U_{surr} = 0$$

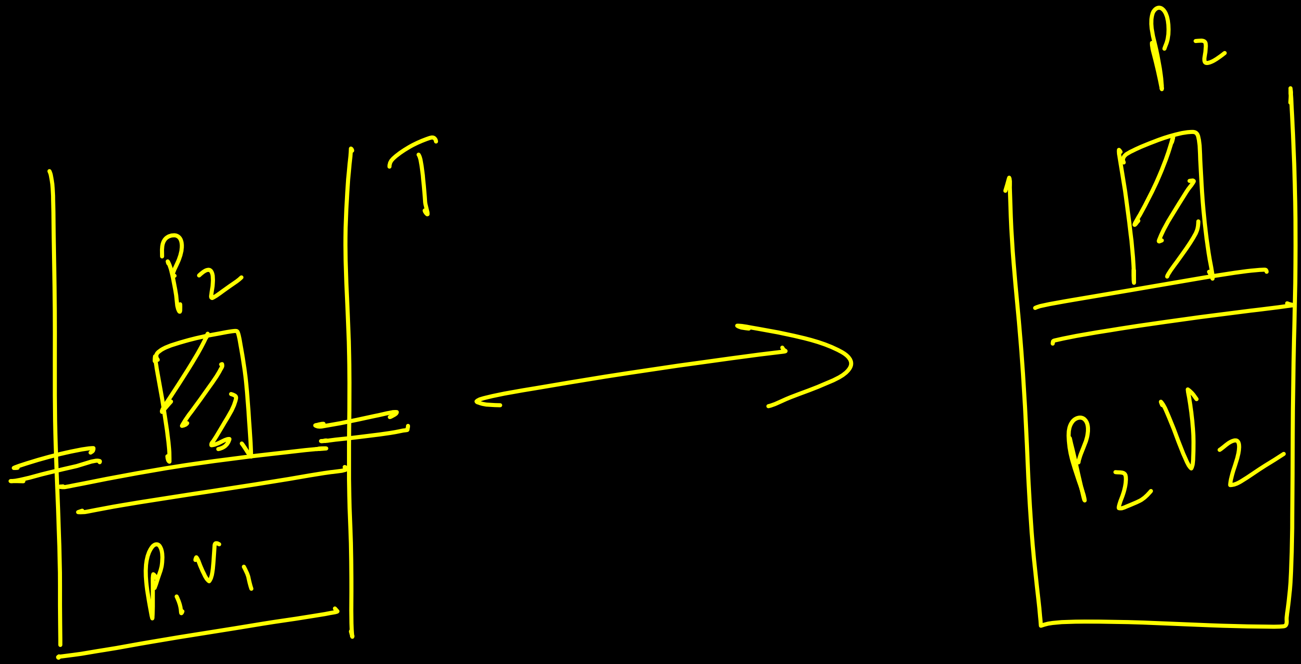
FIRST LAW

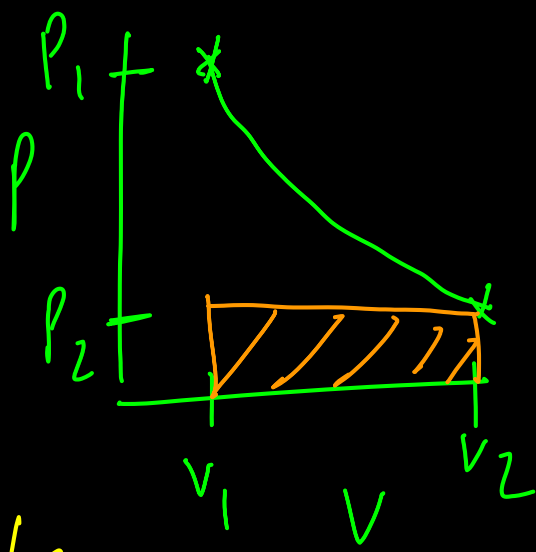
Isothermal Gas Expansion $\Delta T = 0$

gas $A(P_1, V_1, T) \longrightarrow A(P_2, V_2, T)$



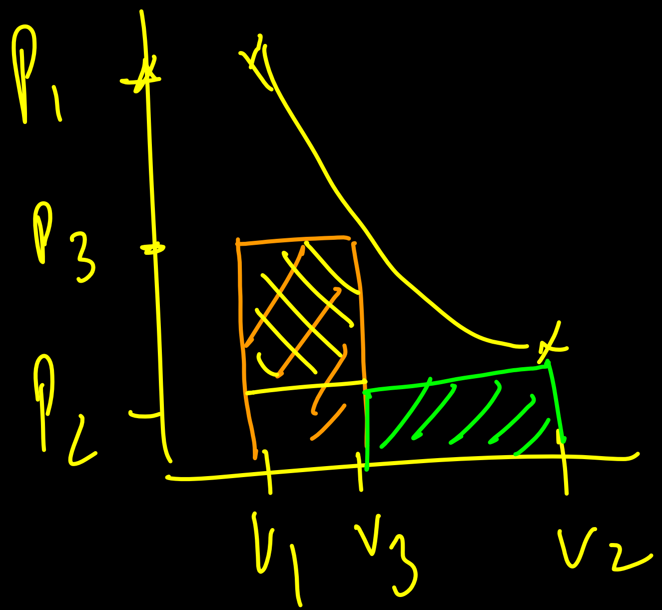
$$W = -\int P_{ext}\, dV = 0$$



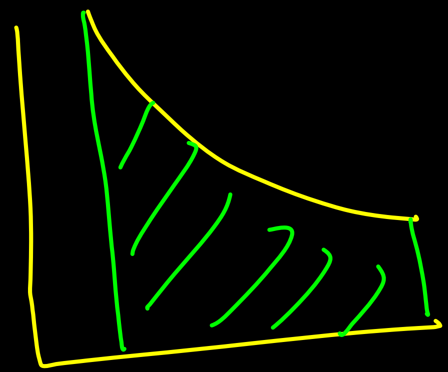


$$w = -\int P_{ext}\, dV = -P_2 \int_{V_1}^{V_2} dV$$

$$= -P_2 (V_2 - V_1)$$



$$W = -P_3(V_3 - V_1) - P_2(V_2 - V_3)$$



Max work obtained under reversible conditions.

$$W = -\int P\,dV = -\int \frac{RT}{V}\,dV = RT \ln \frac{V_1}{V_2}$$