The number of independent, intensive properties needed to fix the state of a substance is equal to the number of quasistatic work modes plus one.

* State: condition of a system described by the value of its properties

circular definition: see definition, circular
definition, circular:  see circular definition

- A **SIMPLE SUBSTANCE** has only **1** WORK MODE
- A **COMPRESSIBLE SUBSTANCE** has only **1** WORK MODE, AND ITS $P dV$ = _COMP. EN._ WORK.

THE STATE POSTULATE FOR A SIMPLE COMPRESSIBLE SYSTEM SAYS THAT YOU NEED... $1 + 1 = 2$

2. PROPERTIES (TO FIX THE STATE)

EXAMPLES

$U = U(V, T)$

$D = D( )$

$h = h(p, T)$

$p = p(V, T)$

WHY IS THIS ONE SO IMPORTANT?

EASY TO MEASURE.
\[ u = u(v, T) \]

\[ du = \left( \frac{\partial u}{\partial v} \right)_T dv + \left( \frac{\partial u}{\partial T} \right)_v dT \]

**Joule's Experiment:**

\[ \frac{dE}{dt} = Q + W + I \]

1. Rigid, Insulated
2. \( T_2 = T_1 \)
3. "Air = Ideal Gas"

**From Cons. of Energy**

\[ U_2 = U_1 \quad \Rightarrow \quad U = U(T) \quad \forall \quad u = \frac{U}{m} = f(T) \]

\[ du = \left( \frac{\partial u}{\partial v} \right)_T dv + \left( \frac{\partial u}{\partial T} \right)_v dT \]

\[ du = C_v dT \]

\[ U_2 - U_1 = \int_{T_1}^{T_2} C_v dT \]

\[ U_2 - U_1 = U_2(T_2) - U_1(T_1) \]

*NEVER MIX YOUR IDEAL GAS TABLES!*
\[ dh = \left( \frac{\partial h}{\partial p} \right)_T \, dp + \left( \frac{\partial h}{\partial T} \right)_p \, dT \]

\[ h = h(p, T) \]

Recall the definition of \( h \): \( h = U + pV = U(T) + RT \)

And so for an ideal gas: \( h = f(T, u) \)!!

\[ dh = \left( \frac{\partial h}{\partial p} \right)_T \, dp + c_p \, dT \]

\[ \text{for ideal gas} \]

\[ dh = c_p \, dT \]

\[ h_2 - h_1 = \int_{T_1}^{T_2} c_p \, dT \] \( \text{same stuff w/} \)

\[ h_2 - h_1 = h(T_2) - h(T_1) \]

\[ \text{iff } c_v = \text{const and } c_p = \text{const} \]

\[ U_2 - U_1 = c_v(T_2 - T_1) \]

\[ h_2 - h_1 = c_p(T_2 - T_1) \]

*Can you show that \( R = c_p - c_v \)?