Consider a closed system undergoing a process over time.

\[ \delta Q - \delta W = \delta W = \delta W \]

**Conservation of Energy**

\[ \frac{d}{dt}(E)_{sys} = \dot{Q} + \dot{W} + \dot{E}_o - \dot{E}_o \]

\[ d = \quad \text{(no KE or PE)} \]

\[ d = \quad \text{(1)} \]

**Accounting of Entropy**

\[ \frac{d}{dt}(S)_{sys} = \sum \frac{\dot{Q}}{T_0} + \dot{E}_o - \dot{E}_o + \dot{S}_{cen} \]

\[ dS = \quad \text{= } \quad \text{=} \]

**Substituting into (1)**

**Solve for \( Tda \)**

**The 1st \( Tda \) Relation**

From def'n of \( h \)

\[ h = u + pu \quad \therefore \quad dh = \]

Solving for \( du \)

\[ du = \]
SUB INTO 1ST TdQ RELATION

\[ TdQ = \]  
\[ TdQ = \]  

SECOND TdQ RELATION

TRUE! BUT THESE EQN'S ARE GOOD FOR ANY SUBSTANCE AND ANY PROCESS!

NOW FOR AN IDEAL GAS

\[ dQ = \frac{dH}{T} - \frac{U}{T} \, dP \]

\[ \Delta Q = \]  

\[ \Delta Q_2 - \Delta Q_1 = \]

IF YOU USE 1ST T-dQ RELATION

\[ \Delta Q_2 - \Delta Q_1 = \int_{T_1}^{T_2} C_v \, \frac{dT}{T} + R \ln \left( \frac{U_2}{U_1} \right) \]

*GET IT? TEDIOUS? HA!
Ideally gases are ideal. What if they aren't?

Introducing...

The compressibility factor

\[ Z = \] for an ideal gas

Data for non-ideal behavior well-correlated on

Generalized compressibility chart

\[ P_R = \frac{P}{P_T} \]

\[ T_R = \frac{T}{T_T} \]

"Reduced" P * T

More to come...