

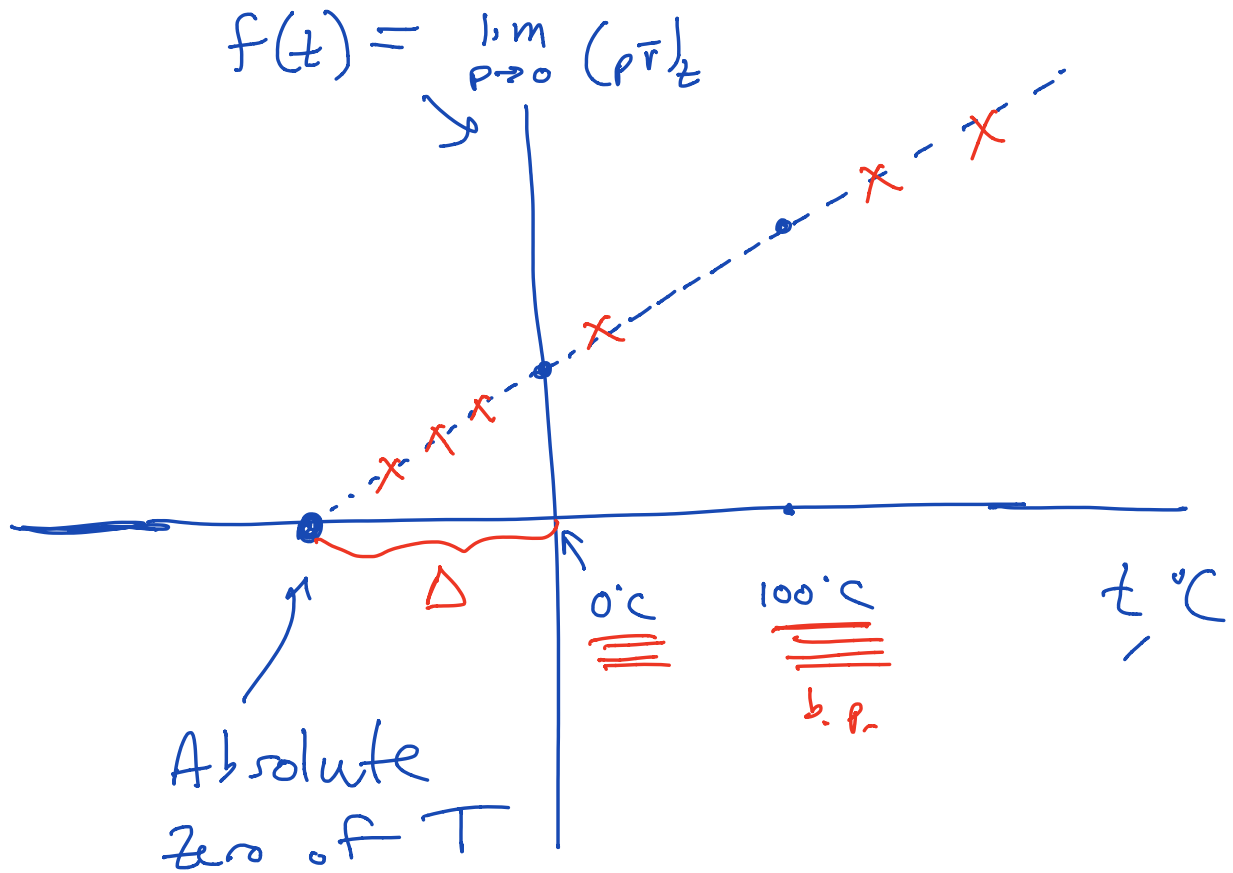
0th "law" \rightarrow operational defn
of T

{ fluid \rightarrow gas
property \rightarrow $\lim_{p \rightarrow 0} (p\bar{v})_t$ $\bar{v} = \frac{\text{volume}}{\text{\# moles}}$
reference pts
interpolation scheme

\hookrightarrow Temperature Scale

Absolute T scale

Thermodynamic T scale



$$f(t) = f(t=0^\circ\text{C}) + \left(\frac{f(t=100^\circ\text{C}) - f(t=0^\circ\text{C})}{100 - 0} \right) t$$

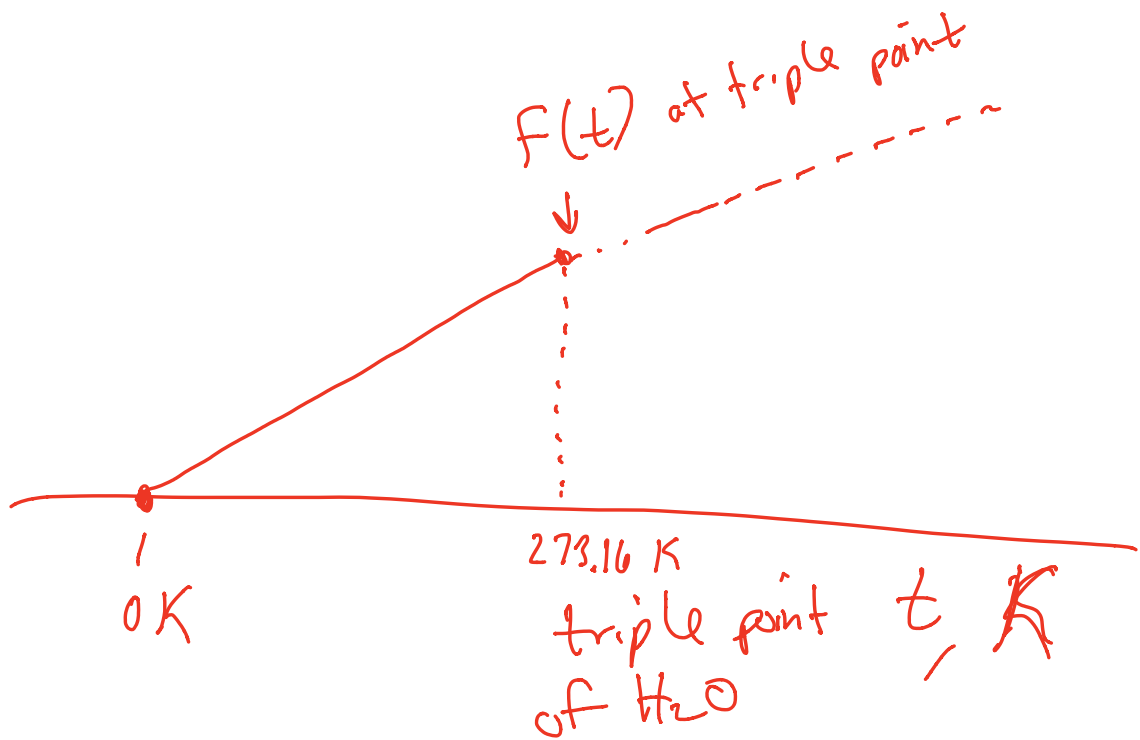
$$f(t=0^\circ\text{C}) = \lim_{p \rightarrow 0} (p\bar{v})_{t=0^\circ\text{C}}$$

$$\Delta = -273.15^\circ\text{C}$$

Absolute T scale : Kelvin

$$T(K) = T(^{\circ}C) + 273.15$$

lowest T possible is 0 K



$$\begin{aligned} \underline{\underline{f(t=273.16K)}} &\approx \lim_{p \rightarrow 0} (p\bar{v})_{tp} \\ &\approx \left(\frac{\lim_{p \rightarrow 0} (p\bar{v})_{tp}}{273.16K} \right) (273.16K) \\ &\quad \text{slope} \end{aligned}$$

Turns out that:

$$\left[\frac{\lim_{p \rightarrow 0} (p\bar{v})_{tp}}{273.16 \text{ K}} \right] = \frac{8.314 \text{ J/mole K}}{\text{Ideal Gas Constant}}$$

$$\lim_{p \rightarrow 0} (p\bar{v}) = RT$$

Ideal Gas Constant temperature in Kelvin

For All ^{real} Gases

$$\lim_{p \rightarrow 0} (p\bar{v}) = RT$$

holds

For Ideal Gas

$p\bar{V} = RT$ holds at

All pressures!!

What conditions
must hold?

low Pressure

High T

Low Density

$p = 1 \text{ atm}$ close to ideal
conditions

for simple gases; N_2 , O_2 ,
 He , etc.

$$pV = nRT ; p\bar{V} = RT$$

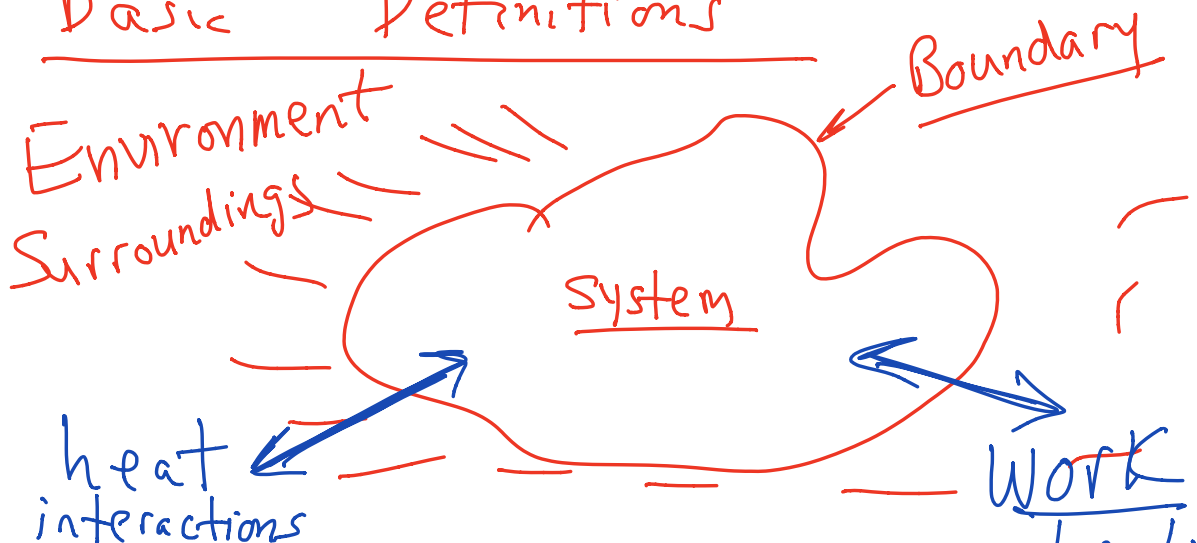
$$p, V, T, n$$

Equations of State!

$$p(n, V, T) = \frac{nRT}{V}$$

I. C. E. O. S. is just
one of many

Basic Definitions



Boundary : Rigid ; Flexible Interacting

Adiabatic Boundary
(prevents heat interactions)
Insulation

Types of Systems :

Open System : exchanges material
and energy with
surroundings

Closed System : exchanges only
energy w/ environment

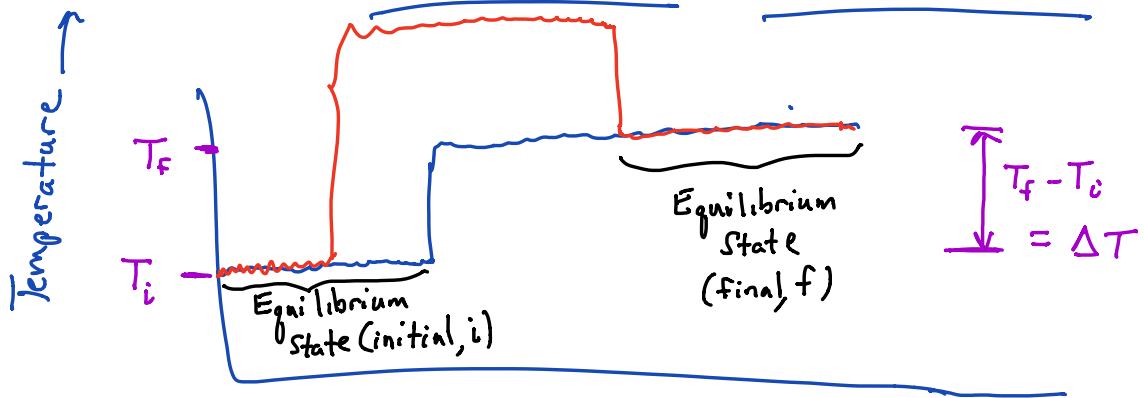
Isolated System : no exchange with
surroundings

Systems at Equilibrium

Macroscopic properties

V, T, P, n

→ constant over time



ΔT independent of path !!!!!!
State Variables time →

∴ T is state variable & state function

Another way to say T is a state function (variable):
 $T_f - T_i = \Delta T = \int_{\text{initial}}^{\text{final}} dT$ ← important concept

$p = \text{pressure, } v = \text{volume}$

also state functions / variables

So, for a change in a system that involves initial pressure, P_i , and final pressure, P_f ,

$$P_f - P_i = \Delta P = \int_{\text{initial}}^{\text{final}} dP$$

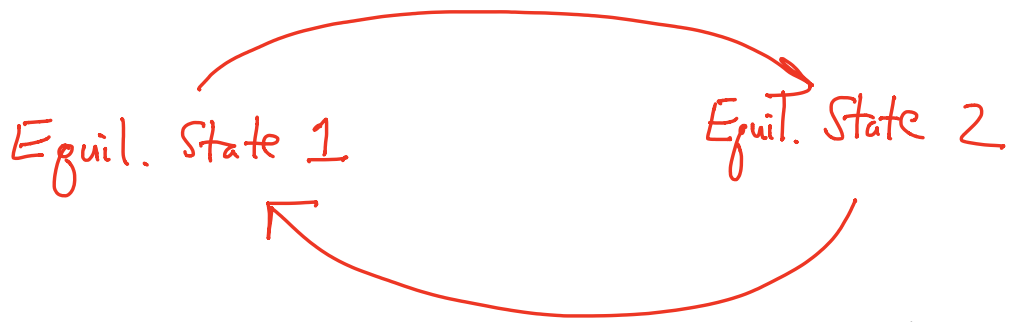
So for a change in a system that involves initial volume, V_i , and final volume, V_f ,

$$V_f - V_i = \Delta V = ?$$

↖ use integral notation here as in previous 2 cases

Think about this:

Consider a cycle (or cyclic process) where we start from initial equilibrium state (1), go to an intermediate equilibrium state (2), and then return to our initial equilibrium state (1)



(looks kind of like a "cycle" )

If we tracked Temperature, T , through this process, we could write:

$$\int_1^2 dT + \int_2^1 dT = ?$$

↑ what numerical value is this?

The combination of integrals can be written more succinctly as:

$$\int_1^2 dT + \int_2^1 dT = \oint dT$$

denotes an integral over a cycle (or cyclic process)

If T is a state function,
what numerical value is :

$$\oint dT = ?$$

If P is a state function,
what numerical value is :

$$\oint dP = ?$$

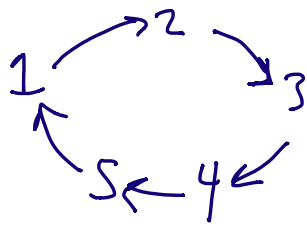
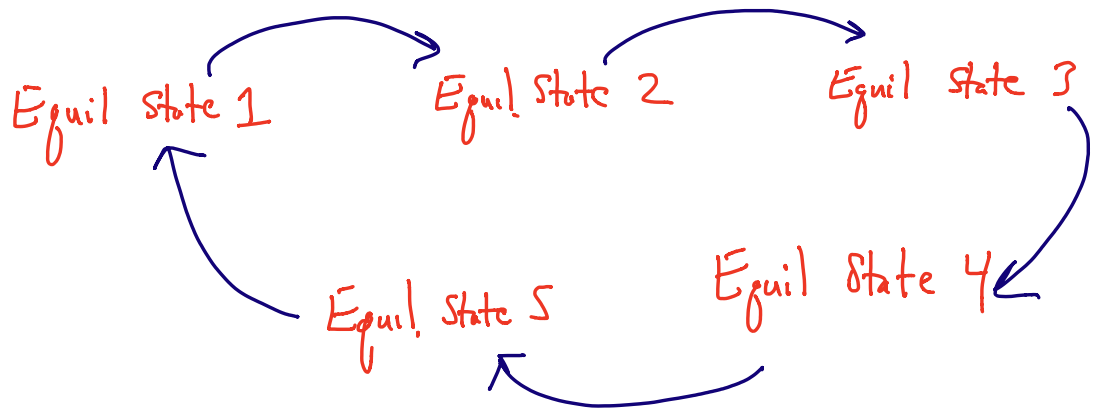
If V - - - - - ;

$$\oint dV = ?$$

Because state variables are independent of path, they hold a special place in our discussions of thermodynamics

They will become our good friends.

Finally, we can think about cycles such as:



What is
$$\oint dT = \int_1^2 dT + \int_2^3 dT + \int_3^4 dT + \int_4^5 dT + \int_5^1 dT$$

if T is a state function.

If you follow so far, you're on your way to being master of state functions!