

$$dG = VdP - SdT = 0$$

$dG \leq 0$ for a spontaneous process at constant T, P

$$PV = nRT \Rightarrow V = \frac{nRT}{P}$$

← volume is determined

$2NO_2 \rightleftharpoons N_2O_4$ to change volume, you can change # of mols. this is the inconsistency

Consider $H_2O(l) \rightleftharpoons H_2O(g)$

at $T = 373 K = 100^\circ C$ and $P = 1 atm$

This has $\Delta G = 0$ bc at equilibrium

$$\Delta G = \Delta H - T\Delta S$$

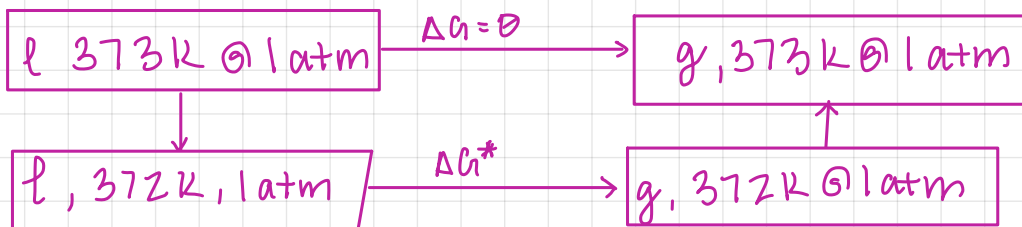
$$\text{but, } \Delta S = \frac{\Delta H}{T}$$

$$\Delta H = q \text{ at const } P$$

$P = 1 atm, T = 372 K = 99^\circ C \quad \Delta G > 0$

non-spontaneous direction

Spill water on desk, why does it eventually evaporate? bc pressure in room is less than equilibrium pressure of H_2O



* only $\Delta P = 0$

$$dG = -SdT \Rightarrow \Delta G = - \int_{T_i}^{T_f} SdT \approx -S(T_f - T_i)$$

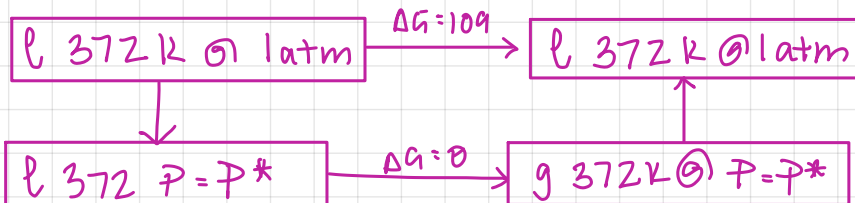
$$0 = -S^l(372K - 373K) + \Delta G^* - S^g(373 - 372) = S^l + \Delta G^* - S^g$$

$$\Rightarrow \Delta G^* = S^g - S^l > 0 = 109 J/mol$$

($\Delta G = 0$)

What is the pressure at which ΔG becomes spontaneous? lower than 1 atm

P^* to make $H_2O(l) \rightarrow H_2O(g)$ spontaneous @ 372 K



Vertical arrows: $dG = VdP \Rightarrow \Delta G = \int_{P_i}^{P_f} VdP$

$$l: \Delta G = V^l \int_{P_i}^{P_f} dP = V^l(P^* - 1)$$

$$\hookrightarrow 18.07 \text{ mL/mol} = 18.07 \text{ cm}^3/\text{mol}$$

$$g = \Delta G = \int_{P^*}^1 V dP = \int_{P^*}^1 \frac{nRT}{P} dP = nRT \ln\left(\frac{1}{P^*}\right)$$

$$109 \text{ J/mol} = 18.07 \text{ mL/mol} (P^* - 1) + 0 + nRT \ln\left(\frac{1}{P^*}\right)$$

$$.101 \text{ J} = 1 \text{ mL/atm}$$

$$\text{get } P^* = 0.965 \text{ atm}$$

* solve graphically for P^*

bc you have a log and linear term
taylor series

if you wanna try, use [wolframalpha.com](https://www.wolframalpha.com)