Thermal Physics Homework #1

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1) Thermal Equalibrium
- 2 objects in physical contact after a long time.
- When the flow of heat $Q = 0$.
- Ex: Your hand touching a cold door knob (after a while).

Mechanical Equalibrium
- When the net force becomes zero.
- A compressed volume of gas expands until its (Ex) pressure matches outside its container.

Diffusive Equalibrium
- A state where particles in a volume have no preferential direction / flow within.
- Ex: Mixing Salt and Water until it is clear.

2) Relaxation Time
- The time it takes for a state to reach equalibrium.

Mechanical Equalibrium usually uses ensemble properties, so the mechanics are more classical than statistical.

Thermal Equalibrium can be sped up by decreasing the difference in temperature between the objects.

3) Ideal gas can represent air at STP pretty well since none of the paramcters are extreme. They deviate after paramcters are shifted around.

4) $A = 132\ ft^2$

$h = 10ft$

$\rho = 0.0763\ lb/ft^3$

$m = 28.96\ g/mol$

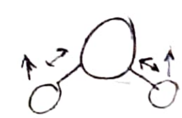
$N = V\rho \cdot \frac{454g}{1lb} \cdot m^{-1}$

$= (1320\ ft^3)\left(\frac{454g}{1lb}\right)(0.0763\ lb/ft^3)\left(\frac{1mol}{28.96g}\right)$

$= 1578.9\ mol \sim \boxed{9.51 \cdot 10^{26}\ \text{Air molecules}}$

5)

	x(1) ↕	x(2)	x(1)	Total
Monatomic Gases :	3	0×1	0	3
Diatomic Gases (↓T) :	3	0×2	2	5
Diatomic Gases (↑T) :	3	1×2	2	7
Cubic Solids (↑T) :	3	3×1	0	6
Water Vapor (↑T) :	3	3×2	3	12



6) $\Delta U = Q + W$

Fast Bubble :	Adiabatic	$Q=0$	$\Delta U = W$
Slow Bubble :	Isothermal	$\Delta U = 0$	$Q = -W$

Fast : $dU = \frac{f}{2} N k_b dT = -PdV = dW \Rightarrow V_i T_i^{f/2} = V_f T^{f/2}$

(Ideal gas law substitution) $\Rightarrow V^{\gamma} P = c,\ \gamma = 1 + 2/f$ $\quad V_0^{\gamma} P_0 = V_f^{\gamma} P_f \Rightarrow V_f = V_0 \sqrt[\gamma]{P_0/P_f}$

Slow : $P_0 V_0 = P_f V_f \Rightarrow V_f = V_0\left(\frac{P_0}{P_f}\right)$, and since $P_0 > P_f$ and $\gamma > 1$, then

(Ideal gas when $\Delta T = 0$)

$\boxed{V_{slow} > V_{fast}}$