Stuff for Thursday, May 17, 2012

- PS#14 due up front. PS#13 and 1094 sheet returned.
- Quiz tomorrow on T1, T2, *and* T3.

T1, T2 and T3 Stuff

- Specific heat c: $dU = mc\,dT$ or $c \equiv \frac{1}{m}\frac{dU}{dT}$
- Ideal gas law: $PV = Nk_B T$ with $k_B = 1.38 \times 10^{-23}$ J/K
- Temperature and energy:

$$K_{\rm avg} = \frac{1}{2}[mv^2]_{\rm avg} = \frac{3}{2}k_B T \quad \Longrightarrow \quad v_{\rm rms} \equiv \sqrt{[v^2]_{\rm avg}} = \sqrt{\frac{3k_B T}{m}}$$

- Thermal energy of a gas: $U = \frac{f}{2}Nk_B T$
  - Near room T, $f \approx 3$ (monatomic gas), $f \approx 5$ (diatomic gas), and $f > 6$ (polyatomic gas)
  - f is called the number of molecular “degrees of freedom”
- Gas processes ($PV = Nk_B T$ always): heat is energy flow because of ΔT
  - First Law: $\Delta U = Q + W$
  - Expansion or compression work: $dW = -P\,dV$
  - Adiabatic ($Q = 0$): $TV^{\gamma-1} = \text{const.}$ $\quad PV^{\gamma} = \text{const.}$ $\quad \gamma = 1 + 2/f$

T4, T5 and T6 Stuff

- *macrostate* specified by macroscopic variables
  - e.g., 3 out of P, V, N, T for ideal gas
- *microstate* specified by quantum state of *every* molecule
- *multiplicity* Ω is number of microstates with same macrostate
  - e.g., same U, N
- macropartition table given $\Omega(U, N)$ uses $U = U_A + U_B =$ constant; note that total multiplicity $\Omega_{AB} = \Omega_A \times \Omega_B$
- fundamental assumption: each accessible microstate is equally probable $\Longrightarrow$ relative probabilities of macropartitions equals ratio of (total) multiplicities
- Einstein solid with oscillator energy $\varepsilon = \hbar\omega$:
  - $\Omega(N, U) = \dfrac{(3N + U/\varepsilon - 1)!}{(3N - 1)!(U/\varepsilon)!}$ $\qquad U = \sum_i^{3N} n_i \varepsilon$ $\qquad U = 3Nk_B T$
- Entropy $S = k_b \ln \Omega$, so $\Omega = e^{S/k_b}$; for systems A and B, $S_{AB} = S_A + S_B$
  - $\partial S / \partial U = 1/T$ defines temperature (hold other variables fixed)