1. Siberia: \[ T_f = \frac{9}{5} T_c + 32 = \frac{9}{5} (-71) + 32 = -96 \, {\text{°F}} \]
   \[ T_K = T_c + 273 = -71 + 273 = 202 \, {\text{K}} \]

   Death Valley: \[ T_c = \frac{5}{9} (T_f - 32) = \frac{5}{9} (134 - 32) = 57 \, {\text{°C}} \]
   \[ T_K = T_c + 273 = 57 + 273 = 330 \, {\text{K}} \]

2. There's no "right" answer here, but look for what happens as you cool the system (remove energy) or crystals form and merge. Sometimes they'll have "defects" of various types. Also try the "ball" examples to see how other forms of energy get converted to "thermal" energy.

3. The positive slope of the liquid-gas phase boundary implies that at lower pressure (higher altitude), water boils at a lower temperature.

   Therefore, at high altitude, noodles must cook at a lower temperature, and that takes longer.
4. (a) Molar mass = \( M = \frac{M_{\text{sample}}}{n} \)

\[ \Rightarrow n = \frac{M_{\text{sample}}}{M} = \frac{2.5 \text{ g}}{197 \text{ g/mol}} = 0.0127 \text{ mol} \]

(b) \( N = nN_A = (0.0127 \text{ mol}) \times (6.02 \times 10^{23} \text{ mol}^{-1}) = 7.6 \times 10^{22} \)

5. \( PV = Nk_B T \Rightarrow N = \frac{PV}{k_B T} = \frac{(10^{-3} \text{ m})(10^{5} \text{ N/m}^2)(1 \text{ m})^3 (1 \text{ m})^3}{(1.38 \times 10^{-23} \text{ J/K})(293 \text{ K})} \]

\[ = \frac{2.5}{1} \text{ } \]

6. My living room measures about 7 m by 4 m by 2.5 m.

So \( N = \frac{PV}{k_B T} = \frac{(10^{-3} \text{ m})(70 \text{ m}^3)}{(1.38 \times 10^{-23} \text{ J/K})(300 \text{ K})} = 1.7 \times 10^{27} \)

\[ \approx \frac{2 \times 10^{27}}{} \]

7. Both rooms have the same volume and, because of the open door, have the same pressure — otherwise air would immediately rush from one to the other. But the ideal gas law says

\( PV = Nk_B T \Rightarrow N = \frac{PV}{k_B T} \propto \frac{1}{T} \)

So the cooler room (B) has more molecules.
8. On the ground, \[ P_1V_1 = Nk_B T_1 \] \[ \Rightarrow \frac{P_1}{T_1} = \frac{V_1}{Nk_B} \]

Up high, \[ P_2V_2 = Nk_B T_2 \]

Solve for \( V_2 \):
\[ V_2 = V_1 \cdot \frac{P_1}{P_2} \cdot \frac{T_2}{T_1} \]
\[ = (2.2 \text{ m}^3) \left( \frac{760 \text{ torr}}{380 \text{ torr}} \right) \left( \frac{225 \text{ K}}{293 \text{ K}} \right) \]
\[ = 3.14 \text{ m}^3. \]

9. (a) The work done on the gas is:
\[ W = -P \cdot \Delta V = -(10^5 \text{ N/m}^2)(2.5 \text{ l} - 1.5 \text{ l}) \left( \frac{1 \text{ m}^3}{1000 \text{ l}} \right) \]
\[ = -100 \text{ N m} = -100 \text{ J.} \]

So the work done by the gas is +100 J.

(b) Again, \[ W = -P \cdot \Delta V \]
\[ = -(10^5 \text{ N/m}^2)(1.0 \text{ l} - 2.5 \text{ l}) \left( \frac{1 \text{ m}^3}{1000 \text{ l}} \right) \]
\[ = +150 \text{ J} = \text{ work done on the gas} \]
So the work done by the gas is +150 J.

(c) To maintain constant pressure you'd need to heat the gas or it expands, or cool it or it is compressed. You could do this with a flame and an ice bath...
10. \( P \) vs. \( V \)

(a) \( W_{\text{by system}} = \text{area} = (40 \text{ Pa})(4 \text{ m}^3 - 1 \text{ m}^3) = 120 \text{ J} \).

(b) Break the area into 2 pieces:

\[ \triangle = \frac{1}{2}(30 \text{ Pa})(3 \text{ m}^3) = 45 \text{ J} \]
\[ \square = (10 \text{ Pa})(3 \text{ m}^3) = 30 \text{ J} \]

\[ 75 \text{ J}, \text{ total} \]

(c) \( \text{area} = (10 \text{ Pa})(3 \text{ m}^3) = 30 \text{ J} \).

11. \( P \) vs. \( V \)

\[ W = -\text{(area)} \propto \frac{1}{2}(\text{base})(\text{height}) \]
\[ = \frac{1}{2}(V_f - V_i)(P_f) \quad \text{(neglecting } P_i) \]
\[ = \frac{1}{2}(1 \text{ atm} - .99 \text{ atm})(200 \text{ atm}) \]
\[ = \frac{1}{2} (.01 \text{ atm})(200 \text{ atm})(\frac{1 \text{ m}^3}{1000 \text{ L}})(\frac{1 \text{ atm}}{1 \text{ atm}}) \]
\[ = 100 \text{ J} \]

Given the enormous pressure required, 100 J of work doesn't seem like much...