1. According to Wikipedia at the top of Mt Everest (~5.5 miles above sea level) the pressure is .337 bar.

A. Convert this pressure to ATM

\[
0.337 \text{ bar} \times \frac{1 \times 10^5 \text{ Pa}}{\text{bar}} \times \frac{\text{kPa}}{1000 \text{ Pa}} \times \frac{\text{atm}}{101.325 \text{ kPa}} = 0.3326 \text{ atm}
\]

B. Convert this pressure to PSI

\[
0.3326 \text{ atm} \times \frac{14.7 \text{ psi}}{\text{atm}} = 4.89 \text{ psi}
\]

C. Convert this pressure mm Hg

\[
0.3326 \text{ atm} \times \frac{760 \text{ mm Hg}}{\text{atm}} = 253 \text{ mm Hg}
\]

2. I am going to fill a 1L balloon with air here in Spearfish where the pressure is 665 torr and the temperature is 10 °C, and then take it to the top of Harney Peak where the pressure is 581 mm Hg and the temperature is 0°C. What is the volume of the balloon now?

\[\frac{PV=nRT}{P_1V_1/T_1 = nR= P_2V_2/T_2}\]

Or you can solve for \(n\) under condition 1 and plug in for condition 2.

I'll go with the first equation so I don't have to convert \(P\) into atm

\[
\frac{665 \text{ torr} \times 1L}{(10 + 273)K} = \frac{581 \text{ torr} \times XL}{(0 + 273)K}
\]

\[
\frac{665 \text{ torr} \times 273K}{581 \text{ torr} \times 283K} \times 1L = 1.10L
\]
3. What is the density of argon gas when the pressure is 15 atm and the temperature is 200°C?

\[
\text{Density} = \frac{P}{RT} \times \text{Molar mass}
\]

\[
\text{Density} = \frac{15 \text{ atm}}{0.082061 \text{ L} \cdot \text{atm/mol} \cdot \text{K}} \times 39.95 \text{ g/mol} \times 473 \text{ K}
\]

\[
= 15.44 \text{ g/l}
\]

Density of gases is usually expressed in g/liter
Density of liquids and solids in g/mL

4. I have a 2L container of H\(_2\) gas at 2 Atm of pressure. I will connect this with a 4L container of O\(_2\) gas at 4 Atm of pressure. I will then open a valve between the two containers and let the gases mix.

A. What is the partial pressure of O\(_2\) in the final gas mixture?

Expand 4L of O\(_2\) @4 atm into a 6L total volume \((P_1V_1=P_2V_2)\) \(P_2 = P_1(V_1/V_2)\)

\[4 \text{ atm} \times (4\text{L}/6\text{L}) = 2.67 \text{ atm}\]

B. What is the total pressure of the gases in the final mixture?

Do the same for H\(_2\): \(2 \text{ atm} \times (2\text{L}/6\text{L}) = .67 \text{ atm}\)

Sum the two pressures \(P=2.67 + .67 = 3.34 \text{ atm}\)

C. What is the mole fraction of H\(_2\) in the final gas mixture?

\[X=P_1/P_{\text{tot}} = .67/3.37 = .20 \text{ (no units)}\]
5. Define (or give an equation for) the following terms:

An Extensive property
A property that depends on the amount of material in the system.

A State function
A function that depends only on the current state of a system, not the path taken to achieve that state.

\[ U \]
Total energy \( = q + w \)

\[ q_p \]
Heat obtained at a constant pressure, \( \Delta H \).

Specific Heat Capacity
The amount of heat required to raise the temperature of 1 mole of material by 1°C (or K).

\[ \Delta H_f^0 \]
The heat gained or lost when a compound in its standard state is formed from its elements in their standard states.

Adiabatic
No heat is exchanged between the system and its surroundings.

6. I am going to transfer 1.5 kJ of energy into a system. At the same time the system will expand from 1L to 15 L against a pressure of .25 atm. What is the \( \Delta E \) of the system.

\[ \Delta E = q + w; \quad 1.5 \text{kJ} = q; \quad w = -P \Delta V \]
\[ \Delta V = 15 - 1 = 14 \text{L} \]
\[-P \Delta V = -.25\times14 \text{L} = -3.5 \text{L-atm}\]
\[-3.5 \text{L-atm} \times (101.315 \text{J/L-atm}) = -355 \text{J}\]
\[ \Delta E = 1500 \text{J} - 355 \text{J} = 1145 \text{J} \]
7. Using these reactions:

\[
\begin{align*}
H_2(g) + \frac{1}{2}O_2(g) & \rightarrow H_2O(l) \quad \Delta H_1 = -285.8 \\
N_2O_4(g) + H_2O(l) & \rightarrow 2HNO_3(l) \quad \Delta H_2 = -76.6 \\
\frac{1}{2}N_2(g) + \frac{3}{2}O_2(g) + \frac{1}{2}H_2(g) & \rightarrow HNO_3(l) \quad \Delta H_3 = -174.1
\end{align*}
\]

Determine \( \Delta H_{rxn} \) for the reaction: \( 2N_2(g) + 5O_2(g) \rightarrow 2N_2O_5(g) \)

To get \( 2N_2O_5 \) as a product, reverse RXN 2 and multiply by 2

\[
4 \text{HNO}_3(l) \rightarrow 2\text{N}_2\text{O}_5(g) + 2\text{H}_2\text{O}(l) \quad -2\times -76.7 \quad +153.2
\]

To get rid of the \( 4\text{HNO}_3 \) reactants, multiply RXN 3 by 4

\[
2\text{N}_2(g) + 6\text{O}_2(g) + 2\text{H}_2(g) \rightarrow 4\text{HNO}_3(l) \quad 4\times -174.1 \quad -696.4
\]

To get rid of the \( 2\text{H}_2\text{O} \) product, reverse RXN 1 and multiply by 2

\[
2\text{H}_2\text{O}(l) \rightarrow 2\text{H}_2(g) + 1\text{O}_2(g) \quad -2\times -285.8 \quad +571.6
\]

Sum it all up

\[
4\text{HNO}_3(l) + 2\text{N}_2(g) + 6\text{O}_2(g) + 2\text{H}_2(g) + 2\text{H}_2\text{O}(l)
\]
\[
- 2\text{H}_2(g) + 1\text{O}_2(g) + 4\text{HNO}_3(l) + 2\text{N}_2\text{O}_5(g) + 2\text{H}_2\text{O}(l)
\]

\[
2\text{N}_2(g) + 5\text{O}_2(g) \rightarrow 2\text{N}_2\text{O}_5(g) \quad +153.2 - 696.4 + 571.6 = +28.4
\]

8. I have a 100g block of gold that is at 90°C, and I place it in contact with a 100g block of a second metal that is at 50°C in a well insulated container so the heat is exchanged between the two blocks under adiabatic conditions. If the final equilibrium temperature of the two blocks is 60°C, and the specific heat capacity of gold is \( 0.129 \text{J/g°C} \), what is the specific heat capacity of the second metal?

Adiabatic so heat lost by warm + heat gained by cold =0

Heat lost by warm = 100 g \( \times \) 0.129J/°C·g \( \times \) (60-90)
Heat gained by cold = 100g \( \times \) \( X \) J/°C·g \( \times \) (60-50)

\[
0 = [100 \text{g} \times 0.129 \text{J/°C·g} \times (60-90)] + [100\text{g} \times \text{X} \times (60-50)]
\]

\[
= -387 \text{J} + 1000 \text{X} \text{g·°C}
\]

\[
387 \text{J/1000 g·°C} = \text{X}
\]

\[
\text{X} = 0.387 \text{ J/g·°C}
\]