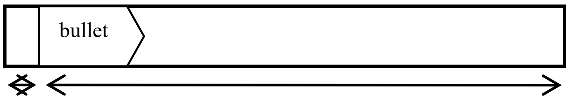
Don't forget you have other key problem types to study including but not limited to: conduction, radiation, specific heat, latent heat, Boltzmann distribution, and whatever else I'm forgetting right now!

******1a) A tire has a gauge pressure of 40 PSI (assume 1 atm = 15 PSI) at 20°C. The tire heats up to 45°C. The volume of the tire is approximately constant. In order to keep the tire at a gauge pressure of 40 PSI, you let some of the air out. What fraction of the air needs to let out of the tire?



A bullet in a gun is pushed out by expanding gas. As the gas expands the bullet moves along the barrel. The changing pressure is approximately given by the equation $P = aV - bV^3$. At the instant the gas first explodes in the tube the gas is trapped in the leftmost portion of the barrel with volume V_i. As the bullet is just leaving the barrel the gas fills the entire length of the barrel V_f. The bullet has mass m and starts from rest.

*2a) Assuming pressure is in Pa and volume in m^3, determine the units of the variable b.

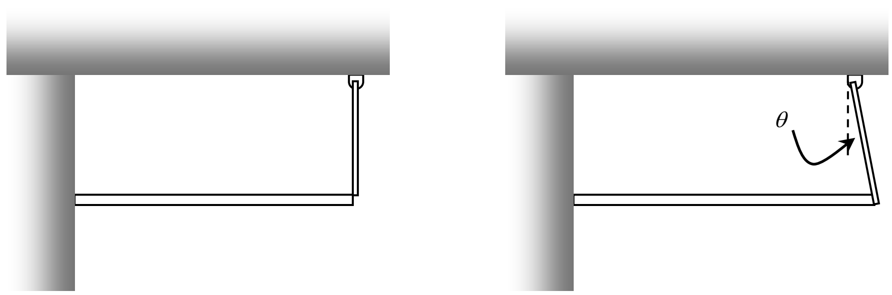
***3b) Determine an algebraic expression for the magnitude of work done by the expanding gas on the bullet (in terms of a, b, V_i and V_f).

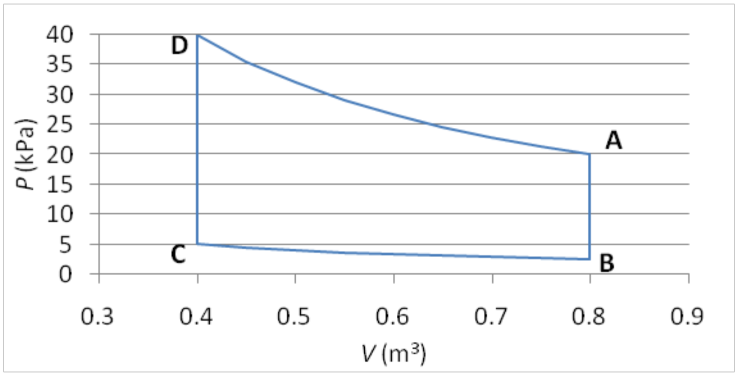
*2c) Explain if the work done on the bullet should be positive or negative.

***2d) Regarding the expanding gas/bullet problem. Sketch a PV diagram for the process described in the bullet and expanding gas problem. You may assume that V_i=0.10 m^3, V_f=0.61 m^3, a=2×10^6, and b=5×10^6 for this part.

**2e) Write an expression which could be used to determine the length L of the barrel for which there is no net force on the bullet in the x-direction (in terms of a, b, P_{atm}, and the radius of the barrel r). Assume the drag force is negligible (which is not a realistic assumption for a rapidly moving bullet but it makes the problem doable and is an interesting start to approaching this type of problem).

****3) A stiff rubber rod extends horizontally from a wall for 3.00 m. When both rods are at a temperature of -50°C, the end of the rod just barely touches a hanging brass rod of length 1.00 m (see above left side picture). The temperature increases to 30°C. As a result the brass rod hangs at a very slight angle from the vertical (exaggerated picture shown on the right). The coefficient of linear expansion for brass is 20x10^{-6} °C^{-1} and the coefficient of linear expansion for rubber is 80x10^{-6} °C^{-1}. Determine the angle from the vertical at which the rod hangs at the higher temperature. Specify if your answer is in degrees or radians.





******4a) A PV diagram is shown for a Stirling engine. The engine uses a diatomic gas between 100K and 1000K. Assume the cycle runs CW. Complete the chart. **Notice that the units of the pressure are given in kPa and the chart below uses kJ!** You shouldn't need the number of moles or the temperature at each point to do this calculation. If a process is not one of the major four types, list OTHER for the process type.

Process	**Process Type**	***Work done on gas* (kJ)**	***Q added to gas* (kJ)**	**ΔE *of gas* (kJ)**
A to B				
B to C				
C to D				
D to A				
For entire cycle				

*4b) Also calculate the efficiency of the cycle.

efficiency	

*4c) Suppose you want the engine to produce 20.0 Watts of power. How much energy per second must be absorbed by the engine?

how much erg per sec?	

***4d): First show that the efficiency of the Stirling engine is given by $\eta = \frac{(T_H - T_C)\ln\frac{V_A}{V_D}}{\frac{f}{2}(T_H - T_C) + T_H \ln\frac{V_A}{V_D}}$. Here use the fact that $T_H = T_{Hot} = T_A = T_D$ and $T_C = T_{Cold} = T_B = T_C$. Also use the fact that $V_A = V_B$ and $V_C = V_D$.