1 Problems

. In chapter 20.

$$4, 6, 7, 20, 63, 69, 77, 71\text{part a} \tag{1}$$

1. **Adiabatic Expansion**

   (a) Starting from $dW = pdV$ show that the work done during an adiabatic expansion is

   $$W = \frac{1}{\gamma - 1}\left[P_1V_1 - P_2V_2\right] \tag{2}$$

   where γ is the adiabatic index

   (b) For an ideal gas expansion explain why $dU = nC_v dT$. Use this to show that

   $$\Delta U = nC_v(T_f - T_i) \tag{3}$$

   (c) Show that for an adiabatic expansion $\Delta U = -W$. Show that the expressions given in Eq. 2 and Eq. 3 are consistent with this

2. **Internal Combustion Engines:** Briefly explain how an internal combustion engine works. Draw a PV cycle. Indicate the different piston strokes work in conjuction with this cycle. Whats the role of the crankshaft and the camshaft? Extra Credit: What are the design constraints of the compression stroke? What are the design constraints of the ignition stroke?

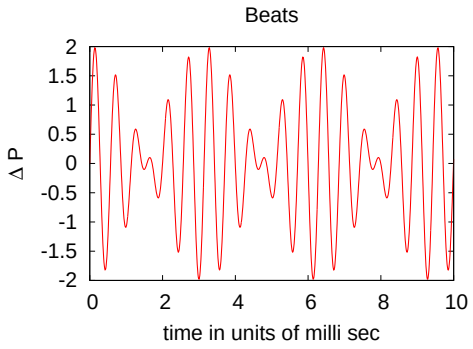
3. **Sound 1** At a lound "concert" the band plays close to the threshold of pain. The sound level is $100dB$ one meter away from a loundspeaker which broadcasts in all directions.

   (a) Determine determine the sound level 1 km away.

   (b) Is this soft/loud/inaudible?

   (c) What is the pressure deviation from equilibrium relative to atmospheric pressure ($1\,\text{atm} \approx 1bar = 10^5 N/m^2$ remember!) one meter from the loadspeaker

4. **Sound 2** The following picture shows the Pressure measured while beating two frequencies f_1 and f_2.



   (a) Estimate from the figure these two frequencies. You may find it convenient to work the next problem first.

   (b) Show that the sum of two sin waves $\sin(2\pi f_1 t)$ and $\sin(2\pi f_2 t)$ can be written as a product of sin and cos waves.