PHYS 743, Homework 3, Fall 2017
Due Monday, October 16, 5 pm MST

1. Use the result of problem 2 (Homework 2):

   (a) To obtain the equation of state \( p = p(V, T) \) for an ideal gas of \( N \) monoatomic molecules using the procedure outlined in slides 2, 3 of Lecture 7 (Eqs. (2), (3) and below)

   (b) To calculate energy \( E \) and entropy \( S \) as functions of volume and temperature \( V, T \)

   (c) calculate thermodynamic potentials \( W, F \) and \( \Phi \) as functions of their natural variables

2. For an ideal classical gas of \( N \) monoatomic molecules derive

   (a) The relation between \( T \) and \( V \) at the adiabatic expansion/compression.

   (b) repeat 2a to find relation between \( p \) and \( V \) at the adiabatic expansion/compression.

   (c) Use Mathematica to plot \( p(V) \) (\( p-V \) diagrams) for adiabatic and isothermal processes on the same graph

   (d) repeat 2c to plot \( T(V) \) (\( T-V \) diagrams)

3. Use Maxwell relations to prove important thermodynamic formula:

\[
\left( \frac{\partial E}{\partial V} \right)_T + p(V, T) = T \left( \frac{\partial p}{\partial T} \right)_V ,
\]

which allows to calculate \( \left( \frac{\partial E}{\partial V} \right)_T \) from the equation of state.