Shown below is a compilation of thermodynamic identities. In all cases, one proves them by starting on the left side of the equation and terminating when it equals the right hand side. The last three entries are for extra credit and are worth 12 points each. The extra credit is earned by demonstrating the proofs on the blackboard in the presence of a TA or GTE. Time allowed for all three is fifteen minutes, and this time limit is rigidly enforced. No paper or notes are allowed, and you will prove every result you use. Schedules for the proofs, to be performed during 6th and 7th week of term, will posted on the web under Latest News.

\[
\begin{align*}
\left( \frac{\partial T}{\partial P} \right)_H & = -\frac{1}{C_p} \left( \frac{\partial H}{\partial P} \right)_T; \quad \left( \frac{\partial (1/T)}{\partial P} \right)_H = \frac{1}{T^2C_p} \left( V - T \left( \frac{\partial V}{\partial T} \right)_P \right) \\
\frac{d}{dS} \left( \frac{E}{T} \right) & = \frac{E}{T^2}dT + \frac{P}{T}dV \\
\left( \frac{\partial S}{\partial V} \right)_T & = \left( \frac{\partial P}{\partial T} \right)_V; \quad \left( \frac{\partial S}{\partial T} \right)_V = \frac{C_v}{T} \\
\rho \left( \frac{\partial A}{\partial P} \right)_T & = \frac{\alpha_p TS}{\kappa_T C_v} - P \\
\frac{\partial U}{\partial P} & = V(\kappa_T P - \alpha_p T) \\
\frac{\partial H}{\partial T} & = C_p \left( 1 - \frac{\alpha_p \mu}{\kappa_T} \right) \\
C_p(\kappa_T - \kappa_S) & = TV \alpha_p^2 \\
\gamma & = \frac{C_p}{C_v} \\
C_p & = C_v + T \left( \frac{\partial V}{\partial T} \right)_P \left( \frac{\partial P}{\partial T} \right)_V \\
\left( \frac{\partial T}{\partial P} \right)_S & = TV \frac{\alpha_p}{C_p} \\
\frac{C_p}{C_v} & = \frac{\kappa_T}{\kappa_S} \\
\left( \frac{\partial A}{\partial T} \right)_S & = C_v \left( \frac{\partial \ln T}{\partial \ln P} \right)_V - S
\end{align*}
\]

\( \alpha_p \) is the coefficient of thermal expansion; \( \kappa_T, \kappa_S \) are the isothermal and adiabatic compressibility, respectively.