Answer the following multiple choice questions for 10 points each. 
Must show complete work for full credit to be given:

1. For an ideal gas at 22 atm and 5˚C undergoing a Joule-Thompson expansion to 1 atm and a final temperature of –5˚C, calculate $\mu = (dT/dp)_H$.

   A) 4.40 atm/K   B) 0.077 atm/K   C) 2.20 atm/K   D) 0.476 K/atm   E) 13.0 K/atm

2. An ideal gas is compressed isothermally and reversibly from 15.0 L, 250.0 K and 1.00 atm. What final volume gives a net $\Delta S_{sys} = –5.00$ J/K

   A) 6.59 L   B) 34.1 L   C) 8.22 L   D) 27.3 L   E) none of these

3. When 25.0 g of CH$_3$OH ($\rho = 0.791$ g/cm$^3$) is pressurized from 100.0 kPa to 100.0 MPa, what is the net $\Delta G$ for the process?

   A) 3160 J   B) –3160 J   C) 1980 J   D) –1980 J   E) none of these

Choose one of the following two exercises for 20 points:

4. A primitive Carnot steam engine (100.0˚C inlet temperature) operates with an exhaust temperature of 60.0˚C, what is the maximum efficiency of this engine? Compare this with the efficiency of a modern steam engine where the pressurized boiler heats the steam to 300.0˚C at the inlet and it exits with a 80.0˚C exhaust.

5. A gas obeying $p (V_m – b) = R T$ is subject to a Joule-Thompson expansion. What will the temperature do: increase, decrease or stay the same? Note that $b > 0$ and you need to use $\mu = (dT/dp)_H$ and $(dH/dp)_T = T (dV/dT)_p – V$.

Choose two of the following four problems for 45 points each:

6. Decide whether $dq = (R T / p) dp – R dT$ is exact. Determine if, after multiplying both sides by $1/T$ the resulting $dq / T = (R / p) dp – (R / T) dT$ is exact. Comment on the result.

7. For a Carnot cycle, draw a graph of the process on a S (entropy) versus T (temperature) diagram. Show that the area enclosed by the curve is equal to the work done by the cycle.

8. Using Maxwell relations and the various differential equations we have used in class, express $(dS/dp)_V$ in terms of $C_V$, $\alpha$, $\kappa_T$, and T.

9. Using $\mu_j = (dT/dV)_T$, prove that $\mu_j C_V = p - \alpha T / \kappa_T$. 