

Name: _____
140 points
Dr. Jay H. Baltisberger

Test 2
Chemistry 261
March 31, 1999

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

- 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
- 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 $S_{sys} = -5.00 \text{ J/K}$?
A) 6.59 L B) 34.1 L C) 8.22 L D) 27.3 L E) none of these
- When 25.0 g of CH_3OH ($\rho = 0.791 \text{ g/cm}^3$) is pressurized from 100.0 kPa to 100.0 MPa, what is the net 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:

- 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.
- A gas obeying $p(V_m - b) = RT$ 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:

- 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.
- 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.
- Using Maxwell relations and the various differential equations we have used in class, express $(dS/dp)_V$ in terms of C_V , α , β , and T .
- Using $\mu_J = (dT/dV)_U$, prove that $\mu_J C_V = p - T/\beta$.