# Chemistry 230 -- Quiz 4

September 26, 2001 — Tellinghuisen

**Pledge and signature:**

**Note:** If you want your paper returned folded (*i.e.*, score concealed), please print your name on the back.

1. (11) The molar heat capacity of many gases can be taken to be a linear function of $T$ over not-too-large ranges of $T$: $C_{P,\mathrm{m}} = a + b\,T$. $n$ mol of $N_2(g)$ is initially at 300K and 1.00 atm and may be treated as a perfect gas.

   (a) Obtain expressions for $q$, $w$, $\Delta U$, and $\Delta H$ for reversible heating of the gas to 400 K at constant $P$.

   (b) How do your results change if the heating is carried out at constant $V$.

2. (8) (a) Consider $CF_4(g)$. Give the total degrees of freedom and the numbers of translational, rotational, and vibratational degrees of freedom.

   (b) If only translation and rotation contribute to the heat capacity of $CF_4(g)$, estimate $C_{V,\mathrm{m}}$ and $C_{P,\mathrm{m}}$(units $R$), and $\gamma$ for it.

   (c) How much does vibration contribute to the heat capacity $C_{V,\mathrm{m}}$ for $CF_4(g)$: (i) in the low-$T$ limit? (ii) in the high-$T$ limit?

   (d) Consider $CF_4(g)$ and $CBr_4(g)$ at 300K. Which should have the larger heat capacity.

3. (7) 1.00 mol of a gas which obeys the equation $PV = nRT$ and has heat capacity $C_{P,\mathrm{m}} = a + b\,T$ (independent of $P$), is taken from the initial state ($P$, $V$) = (10.00 atm, 3.00 L) to the final state (3.00 atm, 10.00 L). Calculate as many of the following as possible, and for others, indicate why they cannot be determined: $\Delta P$, $\Delta V$, $\Delta T$, $\Delta U$, $\Delta H$, $q$, $w$.