Pop Quiz 5, Chemistry 481, 11 Oct 2019. Name: ____________________

SHOW YOUR WORK

An ideal, monatomic gas ($C_v = \frac{3}{2}nR$) at temperature T_1 expands adiabatically from volume V_1 to volume V_2. The final temperature is T_2. Answer the following questions (give your answers in terms of R, n, T_1, and T_2). Note that these answers are very simple; if your answer involves complicated integration, or complicated exponenets, you are probably on the wrong path.

a What is q for the transformation? (3 pts) For an adiabatic transformation $\delta q = 0$. Thus $q = 0$

b What is w for the transformation? (7 pts) Since $q = 0$, by the first law $w = \Delta U$. For an ideal gas, the energy depends on only on the temperature, so $\Delta U = C_v \Delta T$. Thus, since here $C_v = (3/2)nR$, we have

$$w = \frac{3}{2}nR(T_2 - T_1) \tag{1}$$

Another, more involved, solution is

$$\delta w = -PdV = -nRT\frac{dV}{V} \tag{2}$$

For an adiabatic transformation of a monatomic ideal gas we know that

$$dU = C_v dT = (3/2)nRdT = \delta w = -PdV = -nRTdV/V$$

So $nRTdV/V = -(3/2)nRT \times dT/T = -(3/2)nRdT$. Inserting this Eq. (2) and then integrating give Eq. (1).