

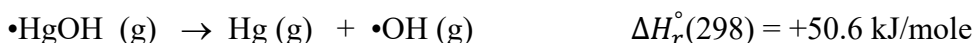
To get full credit: Show your work and EXPLAIN answers not based on calculation.

Exercises 2.6, 2.8, 2.16, 2.24, 2.25, and 2.29 from the 9th Edition of Atkins and de Paula.

Exercise A. Exercises 2.18 and 2.22 from the 9th Edition of Atkins and de Paula. For this question, pay attention to sig figs!

Problem 1. The most accurate compilation of thermochemical data is at <https://atct.anl.gov/>. Use data from version 1.122 of this database, plus the data below, to determine $\Delta H_f^\circ(298\text{ K})$ for HOHgONO. All data is for the gas phase. For this question, pay attention to sig figs!

For Hg (g) $\Delta H_f^\circ(298) = 61.38\text{ kJ/mole}$



Exercise B. Consider O₂ with C_{V,m} of 21.0 J/mole K (assumed independent of temperature).

i) What is the value of C_{P,m}?

ii) 5.00 moles of O₂ is heated from 280 K to 320 K at constant volume. What is ΔH ?

iii) 5.00 moles of O₂ is cooled from 320 K to 280 K at constant pressure. Find the value for ΔH without doing any calculation

iv) Using the data from Problem 1, and without doing any calculation, determine $\Delta H_r^\circ(298)$ for: $\text{Hg (g)} + \bullet\text{OH (g)} \rightarrow \bullet\text{HgOH (g)}$

Exercise C. Compute $\Delta H_r^\circ(250\text{ K})$ for: $\text{C (g)} + \text{CO}_2\text{ (g)} \rightarrow 2\text{ CO (g)}$

Problem 2 Use the data in Table 2.8 in the **back** of the textbook as needed to compute $\Delta H_r^\circ(500\text{ K})$ for: $\text{C}_2\text{H}_2\text{ (g)} + \text{CH}_4\text{ (g)} \rightarrow \text{C}_3\text{H}_6\text{ (propene, g)}$
(assume C_{P,m} independent of temperature, which is not a good assumption here).

Problem 3. Consider 1.00 mole of an ideal gas initially at 298 K, V₁ = 0.0250 m³. It expands isothermally to V₂ = 0.0500 m³ L against an opposing pressure defined by:

$$P_{\text{opp}} = 0.900\text{ bar} - 0.5P_{\text{gas}}.$$

Problem 3.A Use calculus to compute the work.

Problem 3.B Draw a P-V plot and highlight the area corresponding to the work.

Problem 4. 1.00 moles of an ideal gas with $C_{v,m} = 3R/2$. It starts at $T_1 = 1150$ K, $P_1 = 5.00$ bar, V_1 and undergoes the following steps:

- Adiabatic reversible compression to $P_2 = 10.0$ bar, T_2 , V_2
- Expansion at constant pressure until $V_3 = 10V_1$
- Compression by constant $P_{\text{opp}} = P_4$ until $T_4 = 1250$ K.

Compute ΔU for the overall process.

NOTE: This looks tedious, but with a little thought, you can calculate the answer quickly.

Exercise D. Exercise 2.32-2.33 and from the 9th Edition of Atkins and de Paula.

Exercise E. Consider $\left(\frac{\partial U}{\partial V}\right)_T$. How do the assumptions behind the ideal gas law lead to the conclusion that this partial derivative is zero for an ideal gas?

Problem 5. Consider 1.00 moles of gas compressed isothermally and reversibly from 25 L and 20.0 degrees Celsius to 0.250 L (just as in Exercise A and Problem 1 of Homework #3).

For a gas with $\left(\frac{\partial U}{\partial V}\right)_T = \frac{-cn}{V}$, what is ΔU if $c = 300$ J/mole?

Problem 6. We define ΔH_f° of the elements to be zero when they are in their most stable state (gas/liquid/solid) at standard state (1 bar partial pressure of gas or external pressure of liquid/solid). Imagine a different definition, where ΔH_f° for H atom is defined to be zero. Under this definition, compute ΔH_f° for H_2 gas.