

Chemistry 431  
Problem Set 3  
Fall 2023

1. One mole of an ideal monatomic gas at 25.°C and 20. bar pressure is expanded adiabatically against a constant external pressure of 1.0 bar until equilibrium is reached. Calculate  $q$ ,  $w$ ,  $\Delta U$  and  $\Delta H$  for the process.
2. Three moles of an ideal monatomic gas at an initial pressure of 10.0 bar and an initial temperature of 100.°C are expanded adiabatically against a constant external pressure of 2.0 bar until equilibrium is reached. Calculate the final temperature of the gas.
3. Calculate  $q$ ,  $w$ ,  $\Delta U$  and  $\Delta H$  for the adiabatic reversible compression of 3.0 moles of an ideal diatomic gas from 5.0 liters at 35.°C to 1.0 liter.
4. A cylinder fitted with a frictionless piston contains 2.00 moles of an ideal monatomic gas at an initial pressure of 5.00 bar and an initial temperature of 298 K. The gas is first expanded adiabatically against a constant external pressure of 1.00 bar until equilibrium is reached, followed by an adiabatic, reversible compression until the final gas pressure equals the initial gas pressure of 5.00 bar. Calculate  $q$ ,  $w$ ,  $\Delta U$  and  $\Delta H$  for the overall, two-step process.
5. One mole of an ideal monatomic gas at 1.0 bar pressure and a temperature of 25.°C is taken through the following series of steps:
  - (a) A heating at constant volume to 100.°C;
  - (b) An adiabatic compression against a constant external pressure of 25. bar until the volume is halved;
  - (c) A cooling at constant pressure until the final temperature is 35.°C.

Calculate  $q$ ,  $w$ ,  $\Delta U$  and  $\Delta H$  for the overall process “a” + “b” + “c.” [Hint: Think about state functions before solving this problem. Do not “brute force” the solution.]

6. 2.00 moles of an ideal diatomic gas at a temperature of 298.K and a pressure of 5.00 bar are expanded adiabatically against a constant external pressure of 2.00 bar until equilibrium is reached. The gas is then compressed adiabatically and reversibly until the change in the enthalpy  $\Delta H$  for the two step process (first expansion, then compression) is 0. Calculate the final volume after the completion of the two-step process.

7. Two containers are joined together as in the Joule experiment. One contains 1.0 moles of He at  $75.^{\circ}\text{C}$ , and the other contains 2.0 moles of  $\text{N}_2$  at  $25.^{\circ}\text{C}$ . The gases are allowed to diffuse into each other adiabatically. Assuming the gases to be ideal, what is the final temperature of the system?