

CH353 – Physical Chemistry I
Spring 2012, Unique 52135

Homework, Weeks 1 – 2

1. What pressure is exerted by 250 g of CO₂ gas at 25°C in a container 1.5 dm³ in volume if it behaves as a perfect gas? What pressure would it exert if it behaves as a van der Waals gas? Comment on any differences.
2. Calculate the work (in Joules) done for each of the following examples:
 - a) McQuarrie and Simon textbook (1.8 kg) is carried up three flights of stairs with a horizontal displacement of 10 m.
 - b) An ideal gas expands isothermally from 1.0 L to 1.9 L at 25°C against a constant external pressure of 1.0 atm.
 - c) HCl gas, behaving as a van der Waals gas, is compressed isothermally and reversibly from 1.9 L to 1.0 L at 25°C at an initial pressure of 14.0 atm. (For HCl_(g), $a = 5.536 \text{ atm L}^2 \text{ mol}^{-2}$ and $b = 3.049 \times 10^{-2} \text{ L mol}^{-1}$.)
3. In a van der Waals gas, there is a temperature at which the attractive and repulsive intermolecular forces balance each other, and the behavior of the gas approaches that of an ideal gas. Find an expression for this temperature, in terms of a , b , and any other variables you need.
4. A gas at room temperature is sealed in a container with strong rigid walls. It is then heated vigorously.
 - a) Determine whether ΔU , q , and w of the system are positive, negative, or zero during the heating.
 - b) The container is then cooled to its original temperature. Determine whether ΔU , q , and w of the system are positive, negative, or zero during the cooling.
 - c) If the heating is step 1 and the cooling is step 2, determine the signs of $(\Delta U_1 + \Delta U_2)$, $(q_1 + q_2)$, and $(w_1 + w_2)$.
5. A chemical reaction takes place in a container with a cross-sectional area of 1 m². As a result of this reaction, a piston is pushed out 500 cm against an external pressure of 1.0 atm. Calculate the work done by the system.
6. Use the van der Waals equation to plot the compressibility factor against pressure for methane gas at 180 K and 250 K. Comment on any differences.