CHEM352: Physical Chemistry I
Homework Set I - due 14^{th} of Sept, 5.00 pm

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Lecture: Tue, 2.10-3.25 pm & Fri 2.10-3.25 pm, **C111**
Office hours: Wed, 4-6 pm, **Library - Science Center, 7^{th} floor**

Problem 1 CH1/5pts

Obtain expressions for ideal gas for following relations:

$$\kappa_T = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T \tag{1a}$$

$$\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P \tag{1b}$$

$$\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P \tag{1c}$$

$$\mu_{JT} = \left(\frac{\partial T}{\partial P}\right)_H = -\frac{1}{C_P}\left[\left(\frac{\partial U}{\partial V}\right)_T\left(\frac{\partial V}{\partial P}\right)_T + \left(\frac{\partial PV}{\partial P}\right)_T\right] \tag{1d}$$

$$\left(\frac{\partial H}{\partial P}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V\left(\frac{\partial V}{\partial P}\right)_T + V \tag{1e}$$

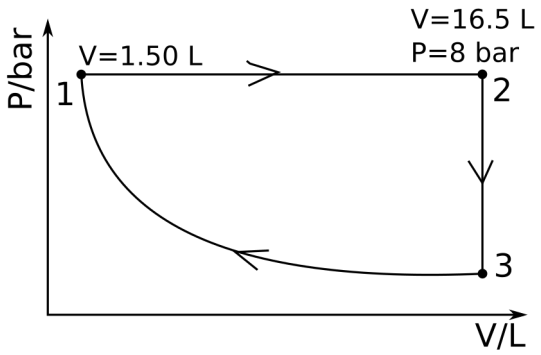
Problem 2 (2.37 and 2.38) CH2/5pts

Calculate ΔH and ΔU, q and w for:

1. the transormation of 2.50 mol of an ideal gas from 19.0°C to 550.0°C and constant pressure of 19.5 atm, if $C_{P,m} = 20.9 + 0.042$ [T/K] in units of J· K^{-1} · mol $^{-1}$.
2. the transormation of 1.75 mol of an ideal gas from 21.2°C to 380°C and constant volume of 3.00 L, if $C_{V,m} = 20.8$ J· K^{-1} · mol $^{-1}$.

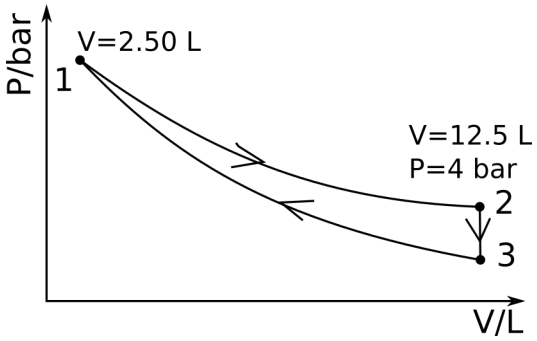
Problem 3 CH2/5pts

A system containing 3.00 mol of an ideal gas for which $C_{V,m} = 20.8$ [J · mol $^{-1}$ K $^{-1}$] is taken through the cycle in the diagram following isobaric, isochoric and isothermic transitions respectively. Calculate q, w, ΔU and ΔH for each segment and the cycle, assuming that the heat capacity is independent of temperature.



Problem 4 CH2/5pts

A system containing 4.50 mol of a *monoatomic* ideal gas for which $C_{V,m} = 31.2$ [J · mol $^{-1}$ K $^{-1}$] is taken through the cycle in the diagram following isothermal, isochoric and adiabatic transitions respectively. Calculate q, w, ΔU and ΔH for each segment and the cycle, assuming that the heat capacity is independent of temperature.



Problem 5 CH1/5pts

The a and b constants for Van der Waals equation of state for enthane are equal $a = 5.5818$ [$dm^6 \cdot bar \cdot mol^{-2}$] and $b = 0.0065144$ [$dm^3 \cdot mol^{-1}$]. Calculate the molar volume of the gas at 300K and 200 atm and compare it to the molar volume of ideal gas and experimental value of 0.071 L/mol^{-1}. (1): Pay attention to units; (2): VdW equation is a cubic equation for volume with one real and two complex roots. Use iterative Newton-Raphson method to find the real root: $x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$. Make an educated guess for x_0.