CHEM352: Physical Chemistry I
Homework Set I - due 10^{th} of Sept, 5.00 pm

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Lecture: Tue, 2.10-3.25 pm & Fri 2.10-3.25 pm, **C111**

Problem 1 — CH1/5pts

Obtain expressions for ideal gas for following relations:

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

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

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

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

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

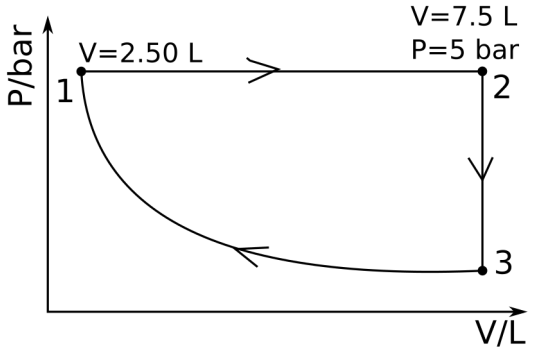
Problem 2 (2.37 and 2.38) — CH2/5pts

Calculate ΔH and ΔU, q and w for:

1. the transormation of 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 $^{-1}$].
2. 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 $C_{P,m} = 20.9 + 0.042 \cdot T \cdot K^{-1}$ in units of J· K^{-1} · mol $^{-1}$.

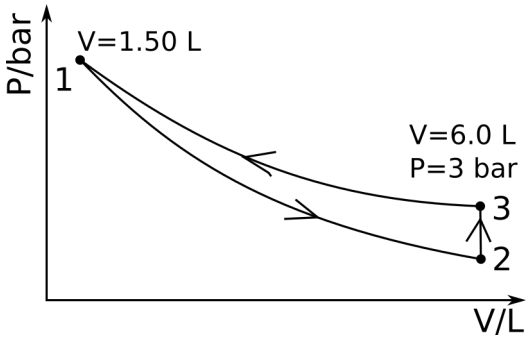
Problem 3 — CH2/5pts

A system containing 3.00 mol of an ideal gas for which $C_{V,m} = 20.8$ [J · mol $^{-1}$ K $^{-1}$] $\simeq \frac{5}{2}R$ 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 1.50 mol of a *monoatomic* ideal gas for which $C_{V,m} = 12.47$ [J · mol $^{-1}$ K $^{-1}$] $\simeq \frac{3}{2}R$ 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**

Starting from vdW equation of state, find:

1. An expression for the total differential dP in terms of dV and dT.
2. Determine whether dP is an exact differential.

Next derive thermal expansion β and isothermal compressibility κ coefficients for the vdW gas.