Chapter 2 - Homework

2.1 Calculate the constant pressure molar heat capacity of $Cl_2(g)$, assuming that (a) the molecules are rigid, and (b) the molecules can vibrate.

2.2 Calculate the constant pressure molar heat capacity of $C_6H_6(g)$, assuming that (a) the molecules are rigid, and (b) the molecules can vibrate.

2.3 Calculate the constant pressure molar heat capacity of $CO_2(g)$, assuming that (a) the molecules are rigid, and (b) the molecules can vibrate.

2.4 A sample of 1 mole of Ar is expanded isothermally at 0 ^oC from 22.4 L to 44.8 L. Calculate q, w, ΔU and ΔH for the expansion occurring:
(a) Reversibly
(b) at constant external pressure equal to the final pressure of the gas.
(c) freely (against zero pressure)

2.5 A sample consisting of 1 mole of a perfect gas atoms, for which $C_{V,m}$ = (3/2)R, initially at p_1 = 1 atm and T_1 = 300 K is heated reversibly to 400 K at constant volume.
Calculate the final pressure, ΔU, q and w for this process.

2.6 A sample of 1 mole of H2(g) is condensed reversibly and isothermally to liquid water at 100 ^oC**.** The standard enthalpy of vaporization of water at 100 ^oC is 40.6 kJ/mol.
Calculate w, q, ΔU and ΔH for this process.

2.7 A 15. g strip of magnesium (M=24.3) is place in a beaker of dilute HCl(aq). Calculate the work involved in this reaction. The atmospheric pressure is 1.0 atm and the temperature is 23 ^oC.

2.8 Solid tungsten will react with gaseous carbon monoxide to form solid tungsten hexacarbonyl according to the equation: $W(s) + 6\ CO(g) \rightarrow W(CO)_6(s)$. What is the work involved when two moles of W(s) reacts with CO(g) to form two moles of $W(CO)_6(s)$ at 150 ^oC and 1 bar pressure?

2.9 The constant pressure molar heat capacity of a perfect gas is given by:
$C_{p,m} = a + bT$, a = 20.17 J/mol•K , b = 0.37 J/mol•K^1
Calculate q, w, ΔU and ΔH when the temperature of 1. mole of the gas is raised from 25 ^oC to 200 ^oC
(a) at constant pressure
(b) at constant volume

2.10 A sample of carbon dioxide, $CO_2(g)$ (M=44) of mass 2.45 g at 27. ^oC is allowed to expand reversibly and adiabatically from 500 mL to 3.0 L.
The constant pressure molar heat capacity of CO_2 is 37.11 J/mol•K.
What is the work involved in this expansion?

2.11 When 3. mol of O_2 is heated at a constant pressure of 3.25 atm, its temperature increases from 260 K to 285 K. Given that the constant pressure molar heat capacity of O_2 is 29.4 J/mol•K, calculate q, ΔU and ΔH for this process.

2.12 A sample consisting of 1.0 mol of a perfect gas with C_V = 20.8 J/mol•K is initially at 3.25 atm and 310 K. It undergoes a reversible adiabatic expansion to a final pressure of 2.50 atm. Calculate the final volume and temperature and the work involved in this process.

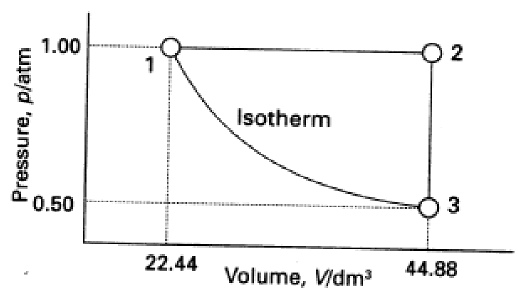
2.13 A certain liquid has an enthalpy of vaporization, $\Delta_{vap}H^o$ = 26.0 kJ/mol. Calculate q, w, ΔH and ΔU when 0.50 mol is vaporized at 250 K and 750 torr.

2.14 The standard enthalpies of formation of ethylbenzene ($C_6H_5C_2H_5(l) = C_8H_{10}$), $CO_2(g)$, and $H_2O(l)$ are -12.5 kJ/mol, -393.5 kJ/mol and -285.8 kJ/mol, respectively. Calculate the standard enthalpy of combustion of ethylbenzene (at 25 ^oC).

2.15 For a van der Waals gas, the internal pressure is: $\pi_T = \left(\frac{\partial U}{\partial V}\right)_T = \frac{n^2 a}{V^2}$.

For $N_2(g)$, a = 1.35 L^2atm/mol^2 and b = 0.039 L/mol. Calculate ΔU, q and w for the expansion of 2. moles of N_2g) from 1.0 L to 24.8 L.

2.16 A sample consisting of 1. mol of perfect gas atoms (for which $C_{V,m}$ = (3/2)R) is taken through the cycle in the figure shown below.
(a) Determine the temperature at the points 1, 2 and 3.
(b) Calculate q, w, ΔU and ΔH for each step, and for the overall cycle.



2.17 A sample consisteing of 1. mol of a perfect gas (for which $C_{p,m}$ = (7/2)R) is initially at T_1 = 298 K and p_1 = 1. atm. The gas is put through the following cycle: (a) constant volume heating to twice its initial pressure, (b) reversible adiabatic expansion back to its initial temperature, (c) reversible isothermal compression back to p = 1. atm. Calculate q, w, ΔU and ΔH for each step, and for the overall cycle.