Homework 3

1. A sample consisting of 65.0 g of xenon is confined in a container at 2.00 atm and 298 K and then allowed to expand adiabatically (a) reversibly to 1.00 atm, (b) against a constant pressure of 1.00 atm. Calculate the final temperature and the expansion work at each case. Use the fact that xenon is a monoatomic gas.

2. Calculate the final pressure of a sample of carbon dioxide that expands reversibly and adiabatically from 57.4 kPa and 1.0 L to a final volume of 2.0 L. Take $\gamma = 1.4$.. (b) Calculate the final pressure of a sample of water vapor of mass 1.4 g that expands reversibly and adiabatically from an initial temperature of 300 K and volume 1.0 L to a final volume of 3.0 L. Take $\gamma = 1.3$.

3. A sample of 4.0 mol O_2 is originally confined in 20 L at 270 K and then undergoes adiabatic expansion against a constant pressure of 600 Torr until the volume has increased by a factor of 3.0. Calculate q, w, ΔT, ΔU, and ΔH. (The final pressure of the gas is not necessarily 600 Torr).

4. A primitive air-conditioning unit for use in places where electrical power is unavailable can be made by hanging up strips of linen soaked in water: the evaporation of water cools the air. Calculate the heat required to evaporate 1.00 kg of water at (a) 25ºC, (b) 100ºC. (Use data in Table 2C.1)

5. A sample of 1.00 mol perfect gas molecules with $C_{p,\mathrm{m}} = (7/2)R$ initially at 1 atm pressure is put through the following cycle: (a) constant-volume heating to twice its initial temperature, (b) reversible, adiabatic expansion back to its initial temperature, (c) reversible isothermal compression back to 1.00 atm. Calculate q, w, ΔU, and ΔH for each step and overall.

6. Estimate the standard internal energy of formation of liquid methyl acetate (methyl ethanoate, CH_3COOCH_3) at 298 K from its standard enthalpy of formation, which is -442 kJ mol^{-1}.

7. The standard enthalpy of combustion of naphthalene is -5157 kJ mol^{-1}. Calculate its standard enthalpy of formation. (Use data in Tables 2C.4 and 2C.5 in the Resource Section)

8. When 120 mg of naphthalene, $C_{10}H_8(s)$ was burned in a bomb calorimeter, the temperature rose by 3.05 K. Calculate the heat capacity of the calorimeter. By how much will the temperature rise when 10 mg of phenol, $C_6H_5OH(s)$, is burned in the calorimeter under the same conditions? (Ex. 2C.5(a)).

9. Calculate the standard enthalpies of formation of N_2O_5 from the following data:

$2\,NO(g) + O_2(g) \rightarrow 2NO_2(g)$	$\Delta_r H^{\circ} = -114.1$ kJ mol^{-1}
$4\,NO_2(g) + O_2(g) \rightarrow 2N_2O_5(g)$	$\Delta_r H^{\circ} = -110.2$ kJ mol^{-1}
$N_2(g) + O_2(g) \rightarrow 2NO(g)$	$\Delta_r H^{\circ} = +180.5$ kJ mol^{-1}

10. Heat capacity data can be used to estimate the reaction enthalpy at one temperature from its value at another. Use the information in Table 2C.5 in the Data Section to predict the reaction enthalpy of $2\,NO_2(g) \rightarrow N_2O_4(g)$ at 100ºC from its value at 25ºC.