3.1	***3.2***	***3.3***	***3.4***	***3.5***	***3.6***	***3.7***	***Total***
2	1	4	1	6	6	24	44

Dimerization Thermodynamics (CODS-CT Team Round Pt. 2 #1)
NO_2 causes the brown color of smog. At 300 K, the following reaction can occur with equilibrium constant $K_p = 0.10$:

$$N_2O_{4\,(g)} \rightleftharpoons 2\ NO_{2\,(g)}$$

3.1 Draw the Lewis Structures of NO_2 and N_2O_4

3.2 Smog is browner on hot days than on cold days. Is the formation of N_2O_4 from NO_2 exothermic or endothermic?

3.3 What are the Constant Pressure($C_{p,m}$) and Constant Volume ($C_{v,m}$) Molar Heat Capacities of NO_2 and N_2O_4 respectively according to the equipartition theorem?

The values of $S_m°$(300 K) for NO_2 and N_2O_4 are 240.1J/(mol K), 304.3 J/(mol K) at 300 K.

3.4 What is the change in entropy for the dimerization of NO_2 at 300 K?

3.5 What is the change in entropy for the dimerization of NO_2 at constant pressure at 400 K?
Hint: Recall that dS=dq/T for some infinitesimal heat transfer at temperature T. You may need to use the heat capacities from ***3.3***

0.1 mol of N_2O_4 (g) is added to a container and allowed to equilibrate at 300 K at which point it has volume $V_i = 1$ L. The sample of gas is allowed to expand reversibly and isothermally(the temperature is always 300 K) to a final volume of $V_f = 5$ L. (You may assume that the expansion is carried out such that the sample is always at equilibrium)

3.6 Ignoring the formation of NO_2, how much work is done by the gas reversibly expanding from 1 L to 5 L?
Hint:
The work done by a single gas expanding in a piston is dW = -PdV for an infinitesimal increase in volume. At each point in this reversible expansion, P= nRT/V, so dW = -nRT/V dV. From here the amount of work done can be computed via integration.

3.7 How much work is actually done by the gas in Joules, taking into account formation of NO_2?
Hint:
You will need to modify the approach from ***3.6*** to solve this problem and potentially make some approximations.