Homework 3

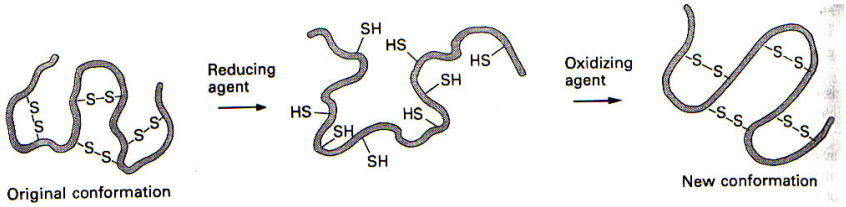
Distributed: Wednesday, January 31, 2001 **Due: Wednesday, February 7, 2001**

This homework assumes you have already done the suggested textbook problems (see http://ir.chem.cmu.edu/chem106/).

Please show your work.

Average Bond Enthalpies (kJ/mol)

S – S	429
S – H	339
O – H	463
O =O	498



1) During a permenent, strands of hair are reduced using ammonium thioglycolate to break the disulfide bonds. The unraveled hair is wound on rollers for shape, and then oxidized by potassium bromate to form new disulfide bonds.

a) (2pts) Using the bond enthalpies quoted above, calculate ΔH for the following process, in which a disulfide bond reacts with two free hydrogen atoms to form two S-H bonds:

--S—S-- + H + H → --S—H + H—S--

b) (2pts) Suppose the hydrogen atoms are produced from water according to the following process

$H_2O \rightarrow 2\ H + \frac{1}{2}\ O_2$

Using the bond enthalpies quoted above, calculate ΔH for the following process:

--S—S-- + H_2O → --S—H + H—S-- + $\frac{1}{2}\ O_2$

2) (3 points) One possible source of acid rain is the reaction between nitrogen dioxide, a pollutant from automobile exhausts, and water:

$$3\ NO_{2(g)} + H_2O \rightarrow 2\ HNO_{3(g)} + NO_{(g)}$$

Using Appendix D in the textbook, determine whether this is thermodynamically feasible, i.e. spontaneous, under standard conditions (T=298.15K, P=1atm): (ΔH_f^o for $HNO_{3(g)}$ = -135.06 kJ/mol, S^o for $HNO_{3(g)}$ = 266.38 J/mol K)

3) (3 points) Without doing any calculations, predict the signs (+, -, or near 0) of ΔH and ΔS for the following processes, all occurring at constant T and P. You must explain your predictions

(a) $2\ NO_{2(g)} \rightarrow N_2O_{4\ (g)}$

(b) A 10-g block of gold is melted in a jeweler's crucible

(c) $CH_{4(g)} + 2\ O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)}$ [Hint: CH_4 is methane, which is natural gas.]