ENV-413: Thermodynamics of the Earth systems

Exercise session for Lecture 6

1. According to the second law of thermodynamics, the entropy of an irreversible process in an isolated system must always increase. On the other hand it is well known that the entropy of living systems remains small. (For example, the synthesis of highly complex protein molecules from individual amino acids is a process that leads to a decrease in entropy.) Is the second law invalid for living systems? Explain.

2. Show that $(\partial U/\partial S)_V = (\partial H/\partial S)_P$ and that $(\partial H/\partial P)_s = (\partial G/\partial P)_T$

3. One mole of ideal gas at 300 K is isothermally expanded from 5.0 L to 10.0 L. Compare the entropy changes for the system, surroundings and the universe if the process is carried out (a) reversibly and (b) irreversibly against a constant external pressure of 2.0 atm.

4) The heat capacity of chlorine gas is given by:

$Cp = (31 + 0.008T)$ J/K mol

Calculate the entropy change when 2 moles of gas are heated from 300 K to 425 K at constant pressure.

5) A quantity of 6.0 moles of a monoatomic ideal gas is reversibly heated at constant volume from 17 C to 35 C. Calculate the entropy change.

Would the value of ΔS be different if the heating were carried out irreversibly?