Principles of Physics: Problem Set #12

(The Last One!)

Ideal Gas Processes and Entropy

$$PV = nRT \quad ; \quad \Delta U = \frac{f}{2} nR\Delta T \quad ; \quad f = \begin{cases} 3 & \text{monatomic} \\ 5 & \text{diatomic} \end{cases} \quad ; \quad \Delta U = Q + W \quad ; \quad W = -P\Delta V$$

$$\Delta S_{\text{isolated}} \geq 0 \quad ; \quad \Delta S = \frac{Q}{T}$$

Due: Friday Nov. 16 in class

Notes: 1) This Monday Prof. Dava Newman from MIT (and formerly NASA) will visit our class.
2) The final exam for this course is Tuesday, Nov. 20 8-10 AM in Colton 2.
3) Please fill out the on-line course evaluation (via Student Portal) for this class.

Reading assignment:

for Mon,	Ch 14 (pp 328-331)	[Entropy and the 2nd Law of Thermodynamics]
for Wed,	Ch 14 (pp 328-331)	[Heat engines and perpetual motion machines]
for Fri,	Ch 5 (pp 90-102)	[Laws and their limits ... models of reality]

Problem assignment:

(WARNING - The problem naming/numbering scheme in the text is confusing, so ALWAYS double check whether a problem is guided review (**GR**), skill building (**SB**), **Synthesis**, etc.)

CHAPTER 7

MC-6 (pg 156 ... ideal gas cycle)
MC-7 (pg 157 ... phase changes for a material)
MC-8 (pg 157 ... ideal gas process: constant-pressure volume change)

A1. Consider one mole of a monatomic ideal gas. Determine the heat Q needed to increase the temperature of the gas by 20°C ...
a) if the gas volume is fixed; b) if the gas pressure is fixed.
c) Sketch both of these processes on a PV diagram.

A2. Consider one mole of a diatomic ideal gas that starts at T_A=400 K and goes through the following cyclic process: i) cool at fixed pressure to T_B=200 K; ii) heat at fixed volume to T_C=400 K; iii) heat at fixed pressure to T_D=800 K; iv) cool at fixed volume back to T_A=400 K. Sketch this cycle on a PV diagram and compute ΔU, Q, and W for each step (show these results in a table).

A3. When an object of mass *m* and specific heat *c* undergoes a temperature change the thermal energy change is $\Delta U = mc(T_f - T_i)$ and the entropy change is $\Delta S = mc \ln(T_f/T_i)$. Suppose a 1.0 kg block of aluminum (*c* = 900 J/kgK) at initial temperature is 80°C is dropped into the ocean at temperature 5°C and allowed to come into thermal equilibrium.
a) What is the entropy change of the block?
b) What is the entropy change of the ocean (the ocean's temperature will not really change).
c) Does the total entropy change satisfy the second law of thermodynamics?