Physics 595CL – Homework 2

1) When the internal energy, U, is given as a function of volume and temperature, i.e., $U = U(V,T)$, show that:

$$\delta Q = \left(\frac{\partial U}{\partial T}\right)_V dT + \left[\left(\frac{\partial U}{\partial V}\right)_T + P\right] dV$$

and

$$\left(\frac{\Delta Q}{\Delta T}\right)_V = \left(\frac{\partial U}{\partial T}\right)_V$$

as discussed in class in connection with the definition of heat capacity at constant volume.

2) Andrews 2.1. You need only find the total enthalpy of the atmosphere as a function of temperature, which you may assume to be constant. Approximate the density of sea water by the density of pure water and assume that the surface area of the oceans is 70.9% of the surface area of Earth, or 3.61×10^8 km². Use data from the appendix (pg 225-6) as needed.

3) Consider a parcel crossing isentropic surfaces. If radiative cooling is just enough to mantain the parcel on a fixed isobaric surface, what is the relative change of its temperature when the parcel's potential temperature has decreased by 90% of its original value.

4) During an evening, long wave radiative heat transfer with the surface causes a dry air parcel to descend so that its pressure increases from 900 hPa to 910 hPa, and its entropy decreases by 15 J kg⁻¹ K⁻¹. If its initial temperature is 280 K, determine the parcel's a) final temperature and b) final potential temperature.

5) Andrews 2.4

6) Andrews 2.9