Problem Set 4
(due: 5:00 pm on Wednesday, June 7, 2006)

Do the following problems from *Introduction to Cosmology*, Barbara Ryden, Addison-Wesley:

Chapter 11: Problems 11.1, 11.2, 11.3

Do the following problem:

In lecture, we assumed that inflation occurred during the GUT phase transition in the early universe ($\varepsilon_{GUT} \sim 10^{14}$ GeV). Some have speculated that instead of occurring during the GUT era, inflation may have occurred at the lower energy of 10^{12} eV that is associated with the symmetry breaking of the electro-weak force.

(a) In this scenario, calculate the age of the universe t_w, when the inflation begins. Assume the universe is radiation dominated before t_w.

Next assume that the inflation potential depth $V_o = \varepsilon^4/(\hbar^3 c^3)$, where ε is the energy at which the phase transition occurs. This leads to a de-Sitter universe $a \propto \exp(Ht)$.

(b) Calculate H in s^{-1} for this lower energy inflation.

(c) Show that the size of a causally connected region at the end of inflation is

$c e^N [2 t_w \exp(H t_w) + H^{-1}]$, where N is the number of e-foldings that take place during inflation.

(d) Calculate the size of this region in meters at the end of inflation if $N = 30$.