

Name:

PHY401 (Fall 2005), 08/29/05

## Homework Assignment #1

(*Due Date:* Monday, September 05, 12:40 pm, in class)

### 1.1 *Cesium Isotope Decay* (10 pts.)

The  $^{137}_{55}\text{Cs}$  isotope  $\beta$ -decays with a half-life of  $T_{1/2} = 30 \text{ years}$  (recall that the “lifetime”  $\tau = 1/\Gamma$  as introduced in class is related to the half-life by  $\tau = T_{1/2}/\ln 2$ ; why?). The initial size of the sample consists of 2 kg of  $^{137}_{55}\text{Cs}$  (recall that 1 mol of a substance, which has a mass corresponding to the atomic mass-number in *grams*, contains  $N_A = 6.022 \cdot 10^{23}$  particles).

- (a) Write a FORTRAN code to numerically calculate the activity of the sample, defined as  $R_{Cs}(t) = -dN_{Cs}/dt$ , over the first 20 *years*. Use a time-step width of 0.5 *years*. Plot the result in appropriate units using GNUPLOT together with the exact (analytical) solution in the same graph. Attach both the plot and your fortran source code.
- (b) Increase the time-step width to 5 years and replot. Is the accuracy of the numerical solution still acceptable?