PHY566 Homework #2

Due Date: Feb. 4th, 5:00pm via Sakai

Carbon Dating

The Carbon isotope ${}^{14}_{6}C$ is widely used for dating of ancient artifacts containing biological material. It undergoes β^- decay with a half-life time of $T_{1/2} = 5700$ years. Suppose an ancient artifact originally contained 10^{-12} kg of ${}^{14}_{6}C$ (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) Derive analytically the relation between half-life time, $T_{1/2}$ and decay constant τ as defined in class. [1 point]

b) write a computer code to numerically calculate the activity of the sample, defined as $R(t) = -dN/dt$, over a duration of 20,000 years. Use numerical time-step widths of 10 and 100 years. Plot the results in appropriate units together with the exact (analytical) solution in the same graph. [6 points]

c) Increase the time-step width to 1,000 years and replot. Is the accuracy of the numerical solution still acceptable? (e.g. what is the percentage deviation from the exact result after 2 half-lifes?) Is the deviation from the exact result as large as you would expect from the neglected 2nd order term? [3 points]

Your homework submission should consist of:

- a document, created in LaTeX, outlining the problem, detailing your solution and discussing your results - the document should include the requested figures. The document should be in pdf format and you should use colors and different marker symbols to enhance the readability of your figures.
- the Python code that you used to solve the problem and generate the figures

All files should be named in the following way:
[PHY566_your name_homework#2_filedescriptor]