Q1

(1)

Radioactive decay follows the first-order differential equation:

$$\frac{dN}{dt} = -\frac{1}{\tau}N$$

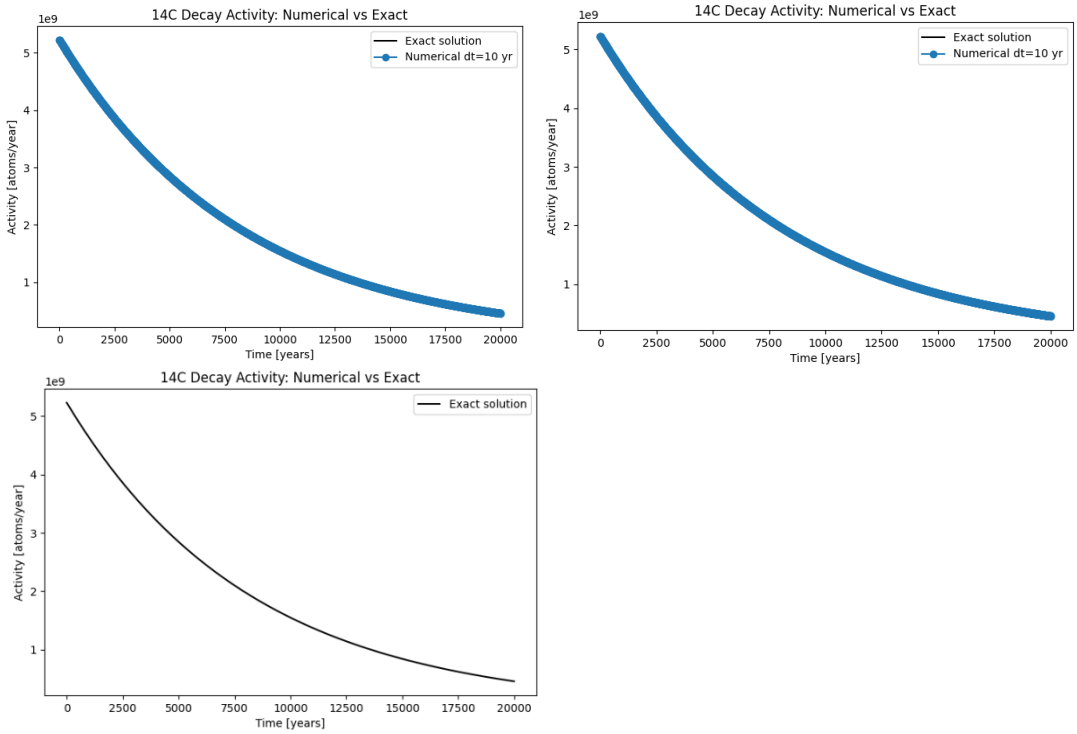
$$\Longrightarrow N(t) = N_0^{-t/\tau}$$

Plug in: $N(T_{1/2}) = \frac{N_0}{2}$

$$\frac{N_0}{2} = N_0 e^{-\frac{T_{1/2}}{\tau}}$$

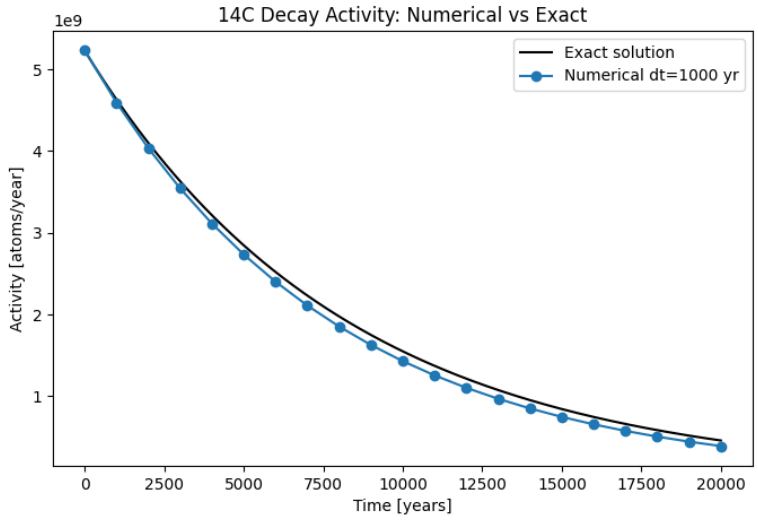
$$\Longrightarrow \tau = \frac{T_{1/2}}{ln2}$$

(2)



The numerical data with time-step widths of 10 and 100 years are match with the exact solution.

(3)



$$N_{exact} = N_0 \cdot 2^{-2} = \frac{N_0}{4} = 1.075 \times 10^{13}$$

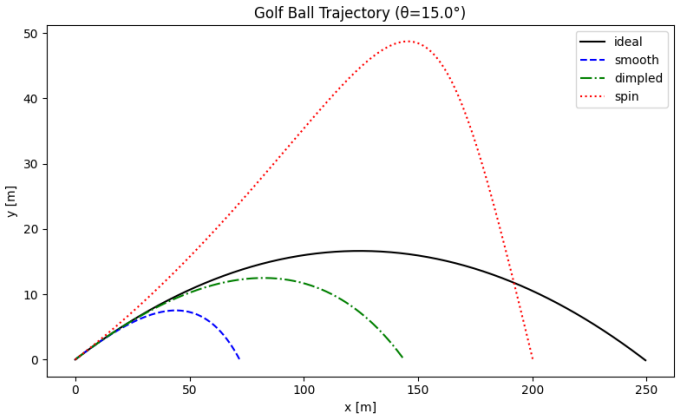
Numerical N_{num} at 2 half-lives:

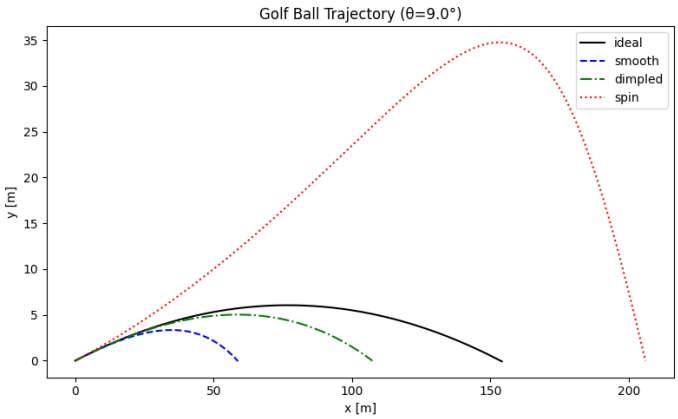
$$N_{num} = 9.827 \times 10^{12}$$

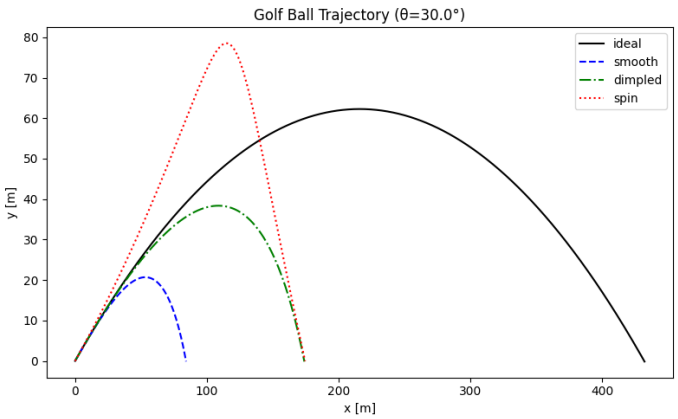
$$error = \frac{|N_{num} - N_{exact}|}{N_{exact}} \times 100\% \approx 8.59\%$$

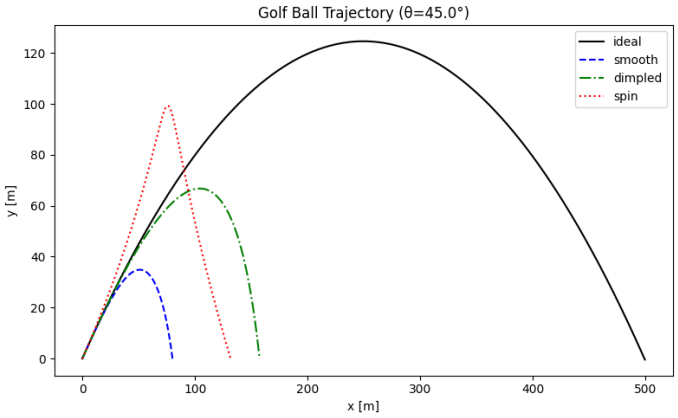
The numerical solution with time-step widths of 1000 years has some errors but they are still acceptable.

Q2


Golf Ball Trajectory (θ=15.0°)
ideal
smooth
dimpled
spin
y [m]
x [m]
0
10
20
30
40
50
0
50
100
150
200
250


Golf Ball Trajectory (θ=9.0°)
ideal
smooth
dimpled
spin
y [m]
x [m]
0
5
10
15
20
25
30
35
0
50
100
150
200


Golf Ball Trajectory (θ=30.0°)
ideal
smooth
dimpled
spin
y [m]
x [m]
0
10
20
30
40
50
60
70
80
0
100
200
300
400


Golf Ball Trajectory (θ=45.0°)
ideal
smooth
dimpled
spin
y [m]
x [m]
0
20
40
60
80
100
120
0
100
200
300
400
500