

1) The factorial ($n!$) of a positive integer n is the product of all integers less than or equal to n . [1 mark]

1. Write a code, using for loops, that asks the user to enter a number n and then calculates $n!$
2. Change the code to ask for a number M and find the smallest number n whose factorial is greater than M .

2) Consider a ball starting from $y=0$ with an initial velocity upwards of 46 m/s [2 marks]

1. Calculate the maximum height of the ball
2. Use Euler's method to calculate the velocity and position of the ball as a function of time. Calculate the evolution over 10 seconds using time steps dt of 1s, 0.1s and 0.01s.
3. Make a figure with 2 subplots showing v vs t on the top plot and y vs t on the bottom plot, for each choice of time step.
4. Find the maximum height for each of the values of dt and compare to the exact answer.

3) Terminal Velocity [2 marks]

1. Use Euler's method to model a cat falling from the window of a 20 storey building. Don't worry, it will live because cats always land on their feet.
Assume that
 - The mass of the object (cat) is 4kg
 - The initial height of the cat is 50m
 - The force acting on the cat is given by $F(v) = -mg + kv^2$.
 - The value for $k = 0.07 \text{ kg/m}$.
 - $g = 9.81 \text{ m/s}^2$
 - The initial velocity is zero
2. Generate a figure with 2 subplots, the top one showing velocity vs time and the bottom showing position vs time.
3. Calculate the time at which the cat hits the ground and its velocity.
4. By looking at the graph, determine whether the cat has reached terminal velocity before it hits the ground.