Weather balloons

Weather balloons are used to gather temperature and pressure data at various altitudes in the atmosphere. The balloon rises because the density of the helium inside the balloon is less than the density of the surrounding air outside the balloon. As the balloon rises, the surrounding air becomes less dense, and thus the balloon's ascent slows until it reaches a point of equilibrium. During the day, sunlight warms the helium trapped inside the balloon, which causes the helium to expand and become less dense. Thus, the balloon will rise higher. During the night, however, the helium in the balloon cools and becomes denser, thus, the balloon will descend to a lower altitude. The next day, the sun heats the helium again and the balloon rises. Over time, this process generates a set of altitude measurements that can be approximated with a polynomial equation. Assume that the following polynomial represents the altitude or height in metres during the first 48 hours following the launch of a weather balloon:

$$alt(t) = -0.12t^4 + 12t^3 - 380t^2 + 4100t + 220$$

where the units of *t* are hours. The corresponding polynomial model for the velocity in **meters per hour** of the weather balloon is

$$v(t) = -0.48t^3 + 36t^2 - 760t + 4100$$

Question 1

Write a program that will print a table of the altitude and the velocity for this weather balloon using units of meters (for altitude) and **meters per second** (for velocity). Let the user enter the start time and the ending time, where all the time values must be less than 48 hours. The program will then prints the altitude and velocity for every hour. You can use the plots below to cross check your outputs. But you are not expected to produce them O.



Question 2

Improve the program written in Question 1 to include the following validations.

- 1. Ensure that the end time is always greater than the start time. If it is not, the program will keep asking the user to re-enter the start time and the end time.
- 2. Check that the user inputs for times stay within the proper bounds, i.e. from 0 to 48 hours. Otherwise, user will be asked to re-enter the information. You may also want to print message to remind users about this.

Question 3

Improve the program further to enable it to print peak altitude and peak velocity and their corresponding times.

Question 4

Modify your program so that now the altitude and velocity values generated are stored in altitude array and velocity array respectively.

Question 5

Modify the program so that the user is also allowed to enter the interval (in minutes) between lines of the table, i.e. it will be no longer displayed every hour by default. For example, the following is a sample output weather balloon information every 15 minutes over a 2 hour period, starting 4 hours after the balloon was launched.

C:\Windows\system32\cmd.exe	
Enter start time: 4 Enter end time: 6 Enter interval (in minutea): 15	
4.00 hrs Altitude: 11277.2 4.25 hrs Altitude: 11663.2 4.50 hrs Altitude: 12019.2 4.75 hrs Altitude: 12346.2 5.00 hrs Altitude: 12645.0 5.25 hrs Altitude: 12916.5 5.50 hrs Altitude: 13161.6 5.75 hrs Altitude: 13381.3 Press any key to continue .	28 m Velocity: 0.45 m/s 29 m Velocity: 0.41 m/s 29 m Velocity: 0.38 m/s 22 m Velocity: 0.35 m/s 00 m Velocity: 0.32 m/s 52 m Velocity: 0.29 m/s 69 m Velocity: 0.26 m/s 39 m Velocity: 0.23 m/s

Question 6

Modularise your program by including at least the following two functions.

- 1. Function Altitude that takes time, t, as input and produce corresponding altitude value as output.
- 2. Function Velocity that takes time, t, as input and produce corresponding velocity value as output.

Question 7

Modify the program so that it stores the time, altitude and velocity information generated in a data file named myballoon.txt