UCF Physics PHZ 3150: Introduction to Numerical Computing
Fall 2021 Homework 8
Due October 21 2021

Problem 1 (**5 points**). Make a new folder named `hw8_<yourname>` under you `handin` folder. As always, your log is part of your homework. After each problem number, give your answer and the names of any files you are handing in for each problem. If you made a HW8 entry in your log in a prior session and want to change it, just copy it to the current (last) session, and edit there. We will grade the last entry only. All text related to one assignment should be in one entry, with the problems done in order.

Problem 2 (**10 points**). Remember that an ellipse is defined as the points in space where: $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$. Make an array `x` and an array `y` that go from -100 to +100 with a step of 0.1. Make a function `ellipse(x,y,a,b)` that when called will plot an ellipse. Call the function for a = 12, b = 2 and a = 4, b =20.

Problem 3 (**25 points**). Create a function `order_array(input_array)` that takes as input an array of numbers and orders them from smaller to larger (don't use any predefined function -numpy or otherwise- though!). Write an appropriate and informative docstring. Make a `hw8_support_funct.py` and save the function there.

Import the function in the main homework folder and call it for the array: `np.array([4,5,2,10,42,22,8,12])`. Now use the appropriate numpy function to test your results. Does your function work?

Problem 4. (**20 points**) In the early 17th century Kepler used observations of the motions of planets in our Solar System to derive his now famous laws of planetary motion. According to these laws, all planets in our Solar system move around in elliptical orbits with the Sun in one focus (1st law), their speed varies along the orbit with the further they are from the Sun the slower they move (2nd law) and their orbits are such that the square of their period is proportional to the cube of their (average) distance to the Sun (3rd law). Here you will test the validity of the 3rd law to planets of our Solar system and extrapolate it to constrain the orbital distance of three exoplanets from their parent stars.

In the `hw8_support_funct.py` make a function called `kepler_3rd(period)` that gets as input the orbital period of a planet in years and returns the orbital distance of a planet to the Sun. This function should use the simple approximation for the 3rd law: $P^2 \propto \alpha^3$, since it will focus on planets of our Solar system. From Kepler's 3rd law P^2/α^3=

constant, so you can deduce that ${P_1}^2/\mathrm{P}_2^2 = {\alpha_1}^3/a_2^3$. Use this equation in your function. Write an appropriate docstring.

Use the (P,α) properties of our Earth as the reference point (P1,α1). Remember that the period of our Earth is 1 year or 365.25 days and a_orb = 1 AU (1 Astronomical Unit ~ 150,000,000km or 92,967,000 miles).
Import the function in your main homework .py and calculate the distances of the other planets of our Solar system using the observed periods from the following table:

Planet	Period [days]
Mercury	87.96
Venus	224.7
Mars	686.97
Jupiter	4332.82
Saturn	10775.6
Uranus	30687.15
Neptune	60190.03

How do the values you get compare to the actual distances of the planets (0.4 AU ; 0.7 AU ; 1.524 AU ; 5.2 AU ; 9.6 AU ; 19.2 AU and 30.1AU) ? Make a plot that compares the real distances with the ones you retrieve from Kepler's law. Make sure you specify manually different symbols and colors for the two sets (predicted and real distances).

Bonus 2 points: Use the names of the planets as tick labels on the x axis.

Problem 5 (**10 points**). Prepare and submit your homework. Write what you will do to make and submit the zip file into your log. Don't forget to also commit your finalized log and push it to GitHub. When satisfied, close the log, copy it to your homework directory, and run the commands to make and submit the zip file. Turn the file in on WebCourses.