HomeworkA-PythonMath

June 1, 2022

Due Thursday, June 9th at 5:00pm

Please read the instructions *carefully* and complete all the requested steps. You can complete this assignment either using JupyterHub on `Scorpius` or using Anaconda installed on your own computer. If you want help installing Python on your own computer, please see the "Install scientific Python on your own computer" document in the Modules section of `Canvas`. Come to office hours for help!

For this and all future assignments, you should complete your assignment in a jupyter notebook (but will turn in an html version of your notebook for easier grading). Once you've created your notebook, change the name (up at the top) to "`homeworkA_{identikey}`", replacing "`{identikey}`" with your identikey (get rid of the squiggly brackets).

While we will later teach you how to use more modules and packages to simplify your coding, **please do not use any modules or packages not yet introduced in class.**

1 Newton's Law of Gravitation

The (classical, non-relativistic) magnitude of the force of gravity between two bodies is given by

$$F = G\frac{m_1 m_2}{r^2}$$

where $G = 6.67 \times 10^{-11}$ m^3 kg^{-1} s^{-2} is Newton's gravitational constant, m_1 and m_2 are the masses of the bodies (kg), and r is their separation (m).

In your jupyter notebook, write Python code that performs the following tasks:

1. Calculate and print the gravitational force, in Newtons, for an astronomer with a mass of 65 kg standing at the surface of the Earth. You may look up numbers for the mass and radius of the Earth. You should define and use Python variables in this calculation. For questions 1-4, don't worry about significant figures (as antithetical as it might be to your scientist training!)
2. Repeat your calculation of the gravitational force for a 65 kg astronomer standing on the surface of the Moon, the Sun (ignoring the obvious challenge with standing "on" the Sun), and the exoplanet Kepler-51b, which has a mass that is 2.1 times that of the Earth and a radius that is 7.1 times that of the Earth. You can likely copy and paste some code from the previous question. *Only* modify (or create new) variables for numbers that have changed (i.e. you can likely reuse some of your variables from Q1). Be sure to print your answer for all three cases.

3. A black hole is an object with such strong gravity that even light cannot escape from it. To make the Sun into a black hole, you would have squish its entire mass down into a radius of only 3 km (known as the event horizon). Please calculate and print the (classical) gravitational force for a 65 kg astronomer "standing" at the event horizon of a solar mass black hole. (Be careful with your units!) *Again, you should not need to redefine all your variables.*

4. Calculate (and print) the ratio of the force of gravity standing on the event horizon ($F_{g,BH}$) to the force of gravity standing on Earth ($F_{g,Earth}$). Additionally, calculate (and print) the base-10 logarithm of this ratio, i.e., $\log_{10}(F_{g,BH}/F_{g,Earth})$. This gives you the order-of-magnitude comparison of the two forces.

5. Many of the numbers you printed in the previous sections probably had *way* too many significant figures in them. Write Python code that prints out a formatted version of your force calculation from Q1 rounded down to fewer significant figures. If you have already been using formatting commands the whole way through, simply repeat one here.

2 Turn in your Assignment

Your final version of your assignment should run from top to bottom without errors. (You should comment out or delete code blocks that didn't work.) To create a clean version, rerun your notebook using "Kernel|Restart & Run All." Be sure to save this final version (with output). To submit, click "File|Download As >|HTML (html)" inside jupyter notebook to convert your notebook into an HTML web page file. It should have a name like `homework#_{identikey}.html` (where # is the appropriate letter for this week's homework). You can open this file in a browser to see what it looks like! Please upload this HTML file as your homework submission on `Canvas`.