Physics C2801 | Professor Christ
due 11/11/2021

Assignment #8

Reading:

Nov 9	Kleppner and Kolenkow 14
Nov 11	Kleppner and Kolenkow 13

Problems:

57. Kleppner and Kolenkow 6.16

58. Kleppner and Kolenkow 12.7

59. Kleppner and Kolenkow 12.10

60. Kleppner and Kolenkow 12.13

61. Kleppner and Kolenkow 12.14

62. Kleppner and Kolenkow 12.15

63. Kleppner and Kolenkow 12.19

64. Using Python study the motion of the earth (mass $6 \cdot 10^{24}$ kg) around the sun (mass $1.99 \cdot 10^{30}$ kg) for the case that the Earth's velocity is 1/2 of its usual velocity to make the orbit less circular. Use $G = 6.67 \cdot 10^{-11}$ for Newtons' gravitational constant. Write your own Python code or start with the sample code given on the course website: PythonPage labeled "`PlanetaryMotion.ipynb`". Treat the Sun as fixed at the origin and start the Earth at the initial position $(x, y) = (1.48 \cdot 10^{11}\text{m}, 0)$ and with the initial velocity $(v_x, v_y) = (0, 1.5 \cdot 10^4\text{m/sec})$ (1/2 of the Earth's actual velocity). You need only include the two plots requested in parts (a) and (d) and your result for (b) with your solutions.

    (a) Using a leap-frog integrator (as in the Python example "`Leapfrog.ipynb`" on the web) and a time step of 1000 seconds, plot the resulting Earth orbit for one year.

    (b) Add to your code to determine the smallest distance between the Earth and the Sun for this more eccentric orbit.

    (c) Enhance your Python program to calculate the kinetic and gravitational potential energy of the Earth at each time step.

    (d) Make a plot of the kinetic, potential and total energy as a function of time. Show that energy is (approximately) conserved.

    (e) What is the size of energy non-conservation (in Joules) if a time step of $\Delta t = 1000$ sec. is used?