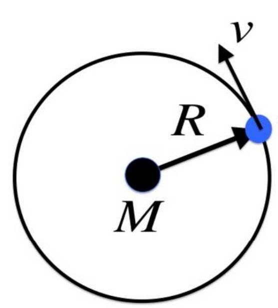
Physics 3344 Professor Olness
Homework 7 Due: October 11, 2018

1) Evaluate approximately the ratio of mass of the Sun to that of Earth, using only the lengths of the year and of the lunar month (27.3 days), and the mean radii of Earth's orbit (1.49 × 10^8 km) and of the Moon's orbit (3.8 × 10^5 km).

2) Consider elliptical orbits given by: $r(\theta) = \dfrac{a(1-e^2)}{1+e\cos[\theta]}$.

a) Find the min and max of r.
b) Make a polar plot for various choices of e, and comment.

. A small meteoroid of mass m is in the circular orbit of radius R around a very heavy stellar object of mass M. Let the Newton's gravitational constant be G.



(a) Find the speed v of the meteoroid, its angular momentum L, and its total mechanical energy E.

(b) Suppose the stellar object suddenly explodes in a spherical symmetric way without gaining any momentum, and loses part of its mass to a region far away from the system, and becomes a neutron star of mass $M_f < M$. Assume that the explosion happens very fast compared to the meteoroid motion, and the meteoroid motion is not disrupted during the process, and the meteoroid moves in the gravitational feld of the newly born neutron star. Find the minimum value of M_f that the meteoroid orbit is still bound to the neutron star.

(c) Supposing that $M_f = \frac{3}{4}M$, fnd the farthest distance from the neutron star R_m and the velocity at that point v_m.

4) Haley's Comet approaches the sun to within 0.570 A.U., and its orbital period is 75.6 years. (A.U. is the abbreviation for astronomical units, where 1 A.U. = $1.5*10^{11}$m is the mean Earth-Sun distance.) How far from the sun will Haley's comet travel before it starts its return journey?

5) a) Compute the escape velocity from the surface of the earth.
b) Imagine I could reduce the radius of the earth to R but keep the mass the same. For what value of R would the escape velocity be the speed of light.
c) Repeat b) but for the mass of the sun.

6) Start with a potential of the form

a) attractive: $V(r) = -k / r$.
b) repulsive: $V(r) = + (½) k r^2$.

a) Analytically compute the equation for the orbit, $dr/d\theta$.
(If you can not do the integral analytically, do not worry, but give it a try.)

b) Compute the turning points. Does this effective potential have a stable minimum? Are there both elliptical and hyperbolic orbits?

c) Plot the potential V(r), the centrifugal term, and the effective potential.

d) Using my Mathematica program for numerically computing the orbits of planets. choose some values, and plot the orbit for your particular potential. Try this for both E<0 and E>0. Comment as the accuracy of the program, and if the results are reasonable.