Chapter J - Problems

Blinn College - Physics 2425 - Terry Honan

Problem J.1

A 200 kg mass sits at $x = 0$ and a 500 kg mass sits at $x = 0.4$ m.
(a) What is the net gravitational force on a 50 kg mass at the midpoint of the two, $x = 0.2$ m.
(b) Where on the x axis would the net force on a third mass be zero.

Problem J.2

Consider a 80 000 kg uniform solid sphere with a 1.2 m. What is the gravitational field a distance of r from the center for the values:
(a) $r = 0$, (b) $r = 0.6$ m, (c) $r = 1.2$ m, (d) $r = 2.4$ m

Problem J.3

Four equal spherical masses m are put at the corners of a square is sides of length a. What is the total potential energy of the configuration?

Problem J.4

Planet X has 20 times the mass of the earth and 3 times the Earth's radius. It orbits star Y, which has 8 times the mass of the sun. The orbital radius of X is 5 AU, where 1 AU is the radius of the Earth's orbit about the sun.
(a) If an alien from planet X weighs 500 Zorgs on X then what is his Earth weight in Zorgs. (Zorgs are the alien unit of force and weight.)
(b) What is the orbital period of X about Y in years?

Problem J.5

The escape speed from the surface of a spherical planet is 2000 m/s. If a rocket is shot off this planet at a speed of 2500 m/s then what is its speed when a long distance from the planet?

Problem J.6

Two stars of equal mass M orbit about their common center of mass in a binary star system. Each star moves in a circular orbit of radius R so the distance between them is 2 R.
(a) Derive an expression for the speed v as a function of R and M.
(b) Eliminate R from the derived result by writing R in terms of the period T and speed, to obtain an expression relating v, T and M. Solve for the mass.
(c) Two stars in such a binary system are observed to orbit each other once every 18.3 days. Suppose also that Doppler shift data gives the speed of the masses to be 1.5×10^5 m/s. What is the (equal) mass M of the stars? (Note: Binary star systems

are important tools for finding masses of stars in astronomy.)

Problem J.7

A satellite of mass m initially on the surface of a spherical planet of mass M and radius R. How much energy is needed to launch it into a circular orbit a height h above the planet.

Problem J.8

(a) Consider any object orbitting the sun. Show that if the semimajor axis a is measured in AU, where 1 AU is the Earth-sun distance, and if the period T is measured in years then

$$T^2 = a^3 \quad (T \text{ in years and } a \text{ in AU})$$

(b) Halley's comet is observed to have a period of 75.6 yr. Its distance of closest approach is 0.57 AU. What is its largest distance from the sun in its orbit?

Problem J.9

Suppose a spherical planet has no atmosphere or one of negligeable thickness.

(a) Show that the escape speed is $\sqrt{2}$ larger than the speed of an orbit just above the surface.
(b) A satellite orbits with a period T just above the surface. What is the average density of the planet? Density is the mass per volume.