UNIVERSITY OF NAIROBI

DEPARTMENT OF PHYSICS

SPH 201: MECHANICS II

Problem Set 3: Gravitation

These Problems are Group based. Each individual to SUBMIT SOLUTIONS TO ANY TWO problems

Constants: $G = 6.7 \times 10^{-11}\ Nm^2Kg^{-2}$; $g = 10\ ms^{-2}$; Radius of Earth = 6,300Km; $M_e = 5.98 \times 10^{24}$ Kg;

1. A Geostationary communication satellite has the same period as the Earth such that relative to a point on the Earth below, the satellite is at rest. How high above the surface of the Earth is the orbit of such a satellite

2. The moon orbits the earth in an approximately circular path of radius 3.8×10^8 m. It takes about 27 days to complete one orbit. Determine the mass of the earth from these data?

3. By assuming the earth to be a uniform sphere
   (a) Calculate the period of rotation of a satellite which is describing an equatorial orbit at 1400 km above the surface, and its speed in orbit.
   (b) If the satellite is traveling in the same direction as the rotation of the earth, what is the interval between successive times at which it will appear vertically overhead to an observer at a fixed point on the Equator.

4. An object is projected vertically upward from the earth's surface with initial speed V_o. Neglecting air resistance, Determine
   (a) the speed at a distance H above the earth's surface and
   (b) the smallest velocity of projection needed in order that the object never return

5. An artificial satellite of 3500 kg made of aluminium is in circular orbit at a height of 100 km above the surface of the earth. Atmospheric friction removes energy from the satellite and causes it to spiral downwards so that it ultimately crashes into the ground.
   (a) Determine the initial orbital energy (gravitational plus kinetic) of the satellite
   (b) Determine the final energy when the satellite comes to rest on the ground and the amount of energy change
   (c) Suppose that all this energy is absorbed in the form of heat by the satellite, is it enough to melt or vaporize the satellite? [Melting point of aluminium = 660^{o}C, heat of fusion = 95.3 Kcal/Kg, heat of vaporization = 2520 Kcal/Kg.]

6. If the earth were suddenly stopped in its orbit, how long would it take for it to fall into the sun?
