Gravitation practice problems (derivation based)

Question 1 (a) Define escape velocity. Derive expression for escape velocity of an object from the surface of planet.

(b) Does it depend on location from where it is projected?

Question 2 Derive an expression for the gravitational potential energy above the surface of the earth.

Question 3 If a person goes to a height equal to radius of earth from its surface, what would be his weight relative to that on the earth?

Question 4 Find the height from the surface of earth at which weight of the body of mass *m* reduced to 36% of its weight on the surface (R_e=6400 Km).

Question 5 Derive an expression to show that the value of acceleration due to gravity decreases with the depth.

Question 6 Two bodies of mass m_1 and m_2 are placed at a distance *r* apart. Show that the position, where the gravitational field due to them is zero, the potential is given by

$$V_{grav} = -\frac{G}{r}\left(m_1 + m_2 + 2\sqrt{m_1 m_2}\right)$$

Question 7 Two masses M_1 and M_2 are initially at rest at infinite distance apart. They approach each other due to gravitational interaction. Find their speed of approach at the instant, when they are distance *r* apart.

Question 8 Define orbital velocity and find the expression for orbital velocity of for a satellite orbiting at height *x* above the surface of the earth.

Question 9 Write a detailed note on geostationary satellites.

Question 10 Suppose that gravitational force varies inversely as the n^{th} power of distance. Then find the expression for the time period of a planet in a circular orbit of radius R.

Question 11 If T is the time period of the satellite revolving just above the surface of a planet, whose average density is ρ, show that ρT^2 is a universal constant.

Question 12 A particle is projected vertically upwards from the surface of earth (radius R) with a kinetic energy equal to half of the minimum value needed for it to escape. Find the height to which it rises above the surface of earth.