# Physics I

Gravitation

Force between two bodies of mass m_1 and m_2: $F = G\dfrac{m_1 m_2}{r^2}$, where $G = 6.67\times10^{-11}\ \dfrac{Nm^2}{kg^2}$

Acceleration due to gravity on the surface of a planet: $g_{planet} = G\dfrac{m_{planet}}{r^2_{planet}}$

Gravitational potential energy $P.E. = mgh$ … close to the surface of the Earth

But $P.E. = -G\dfrac{Mm}{r}$ is more general, with the reference is at infinity.

Problem 1.- A mass of 4kg is placed at the origin and a mass of 9kg is placed at **L**=+15 meters as shown in the figure. At what point on the x-axis will a test mass of **m** kilograms experience zero net force?
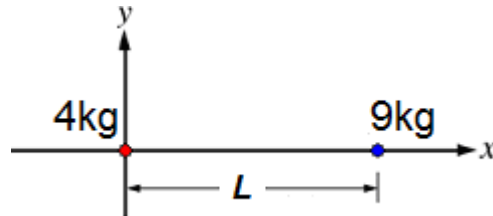
Problem 2.- Calculate the acceleration due to gravity on the surface of Ganymede (a satellite of Jupiter visible in binoculars), which has 0.0248 times the mass of the Earth and whose radius is 0.413 times the radius of the Earth.

Problem 2a.- Calculate the acceleration due to gravity on the surface of Ceres (g_ceres). Ceres is one of the largest known asteroids in the solar system. For your calculation assume the asteroid has the shape of a sphere with radius 460 km and mass 7.4×10^{21} kg.

Problem 2c.- Calculate the acceleration due to gravity on the surface of Mars, which has 0.11 times the mass of the Earth and whose radius is 0.53 times the radius of the Earth.

Problem 2d.- What is the acceleration due to gravity on the surface of Pluto given that its radius is 0.18 the radius of the Earth and its mass is 0.0021 the mass of the Earth.

Problem 3.- What would be the speed of an object that falls straight towards the Earth from a height of h=4×10^6 m when it reaches the surface of our planet?
[Ignore air resistance, assume initial velocity zero]
[Radius of the Earth R=6.38×10^6 m]

Problem 4.- Find the escape velocity from the surface of Mars whose mass is 0.64×10^{24} kg and a radius of 3.39×10^6 m.

Problem 4a.- Calculate the escape velocity from the surface of Pluto. For your calculation assume it has the shape of a sphere with radius 1,153 km and mass 1.305×10^{22} kg.

Problem 4b.- Calculate the escape velocity from the surface of Ceres. Ceres is one of the largest known asteroids in the solar system. For your calculation assume the asteroid has the shape of a sphere with radius 460 km and mass 7.4×10^{21} kg.

Problem 5.- Calculate the acceleration due to gravity on the surface of a small planet that has 0.125 times the mass and 0.5 times the radius of our planet.

Problem 5a.- Calculate the acceleration due to gravity on the surface of a giant planet that has 195 times the mass and 8 times the radius of our planet.

Problem 5b.- Find the escape velocity from the surface of the planet mentioned in the previous problem.

Problem 6.- Gravity is usually neglected in condensed matter and atomic physics because it is extremely weak compared to electromagnetic forces. To convince yourself that this is true: Calculate the gravitational attraction between an electron and an alpha particle (a helium nucleus) separated by 1 nm. (1 nm is 10^{-9} m)

Mass of the electron = 9.1×10^{-31} kg
Mass of the alpha particle = 6.7×10^{-27} kg

Problem 7.- Planet Y has twice the value of g as our planet (19.6 m/s^2) and it has 8 times the mass of Earth. What is the radius of planet Y?

Answer in terms of our planet's radius (R_E).

(A) $0.5R_E$ (B) R_E (C) $2R_E$ (D) $4R_E$ (E) $16R_E$

Problem 8.- Calculate the force due to gravity on a satellite of mass 84kg located 3 Earth radii away from the *surface* of the Earth.

Problem 9.- How far from the surface of the Earth would you have to go to have acceleration due to gravity of only 1/1000 of the value at the Earth surface?

Problem 10.- It is common to hear that people inside a space station, in orbit around the Earth, experiment "zero gravity". Is the gravity really zero inside the station?