Gravitational Force

Isaac_Toms Brainy's

February 2022

This was written by Isaac_Toms Brainy's Writing Team headed by Ayodeji Adesegun.

> "I was the first camera team to visit the moons of Jupiter."
>
> *Galileo*

1 Questions

1. Suppose the gravitational force between two massive spheres is $100N$. If the distance between the spheres is doubled, what is the force between the masses?
2. A mass of $5kg$ is held at a position $2m$ away from a mass of $10kg$. What is the gravitational attraction between the two masses?
3. Suppose the gravitational force between two spheres is $30N$. If the magnitude of each mass doubles, what is the force between the masses?
4. Two small objects of mass $90kg$ and $100kg$ respectively are separated by a distance of $12m$. Determine the force of attraction between the two objects. [Take $G = 6.67 \times 10^{?11} Nm^2kg^{-2}$]
5. Calculate the force of gravity between Earth (mass = $6.0 \times 1024kg$) and the moon (mass = $7.4 \times 1022kg$). The average distance between the earth and the moon is $3.8 \times 108m$.
6. A dying star is gravitationally accelerated at $0.063ms^{-2}$ toward an object that is $8.7 \times 1010m$ away. For this to occur, how much mass must the object possess?
7. A woman whose mass is 70 kg on Earth's surface is in a spacecraft at a height of twice Earth's radius above Earth's surface. What is her mass (not weight) there? [Take Earth's radius =$6370km$]
8. A uniform spherical planet has radius R and the acceleration due to gravity at its surface is g. What is the escape velocity of a particle from the planet's surface?
9. The radius of the earth is $6370km$ and the acceleration due to gravity is $9.81ms^{-2}$. Find the escape velocity of a rocket launched from the earth's surface.
10. Write Newton's law of universal gravitation.
11. An object takes $2.40s$ to fall $5.00m$ on a certain planet. Find the planet's mass if its radius is $5250km$.

12. One of the Echo satellites consisted of an inflated aluminum balloon $30m$ in diameter and of mass $20kg$. A meteor having a mass of $8.0kg$ passes within $6.0m$ of the surface of the satellite. If the effect of all bodies other than the meteor and satellite are ignored, what gravitational force does the meteor experience at closest approach to the satellite?

13. Neutron stars, such as the one at the center of the Crab Nebula, have about the same mass as our sun but have a much smaller diameter. If you weigh $675N$ on the earth, what would you weigh at the surface of a neutron star that has the same mass as our sun and a diameter of $20km$?

14. The mass of Venus is 81.5% that of the earth, and its radius is 94.9% that of the earth. If a rock weighs $75.0N$ on earth, what would it weigh at the surface of Venus?

15. Titania, the largest moon of the planet Uranus, has $\frac{1}{8}$ the radius of the earth and $\frac{1}{1700}$ the mass of the earth. Find the average density of Titania.

16. Rhea, one of Saturn's moons, has a radius of $765km$ and an acceleration due to gravity of $0.278\ ms^{-2}$ at its surface. Calculate its mass and average density.

17. At what distance above the surface of the earth is the acceleration due to the earth's gravity $0.980ms^{-2}$ if the acceleration due to gravity at the surface has magnitude $9.80ms^{-2}$?

18. The mass of a certain planet Ayod is one-hundredth that of the earth while its radius is one-quarter of the earth's radius. If the acceleration due to gravity on the earth is $10ms^{-2}$. Then, find its value on Ayod. [Take Earth's radius =$6370km$, Earth's mass=$5.97 \times 10^{24}kg$]

19. An unmanned lander is sent to the surface of the planet Mars, which has radius $R_M = 3.40 \times 10^6 m$ and mass $m_M = 6.42 \times 10^{23} kg$. The earth weight of the Mars lander is 3920 N. Calculate its weight F_g and the acceleration g_M due to the gravity of Mars $6.0 \times 10^6 m$ above the surface of Mars (the distance at which the moon Phobos orbits Mars)

20. Given a system of reference objects, we can define a gravitational field that describes the motion of a test mass under the influence of gravity. The gravitational field strength g is the force experienced per unit mass due to this gravitational field.

    By Newton's second law, the field strength is also the acceleration due to gravity. Verify that the gravitational field strength is $g = \frac{-GM}{r^2}$