

Newton's Law of Universal Gravitation

Every _____ in the universe exerts a _____ on every other particle

$$F_G = \frac{GmM}{r^2}$$

where:

$$G = 6.673 \times 10^{-11} \frac{Nm^2}{kg^2}$$

m and M = _____ of the objects

r = _____ between the _____ of the objects

What is the gravitational attraction between a 75-kg boy (165 lbs) and the 50-kg girl (110 lbs) seated 1 m away in the next desk?

Finding Acceleration Due to Gravity

Since weight is the _____ of _____

$$W = mg = \frac{GmM}{r^2}$$

$$g = \frac{GM}{r^2}$$

Find the acceleration due to gravity at the altitude of the ISS, 417.5 km above the earth.

Practice Work

1. How are weight and mass related? How are they different?
2. If the distance between two objects triples, what happens to the magnitude of the gravitation force between them?
3. When calculating the acceleration due to gravity, which mass do you use?

4. A bowling ball (mass = 7.2 kg, radius = 0.11 m) and a billiard ball (mass = 0.38 kg, radius = 0.028 m) may each be treated as uniform spheres. What is the magnitude of the maximum gravitational force that each can exert on the other? (Cutnell 4.18) **$9.6 \times 10^{-9} \text{ N}$**
5. On earth, two parts of a space probe weight 11000 N and 3400 N. These parts are separated by a center-to-center distance of 12 m and may be treated as uniform spherical objects. Find the magnitude of the gravitational force that each part exerts on the other out in space, far from any other objects. (Cutnell 4.19) **$1.8 \times 10^{-7} \text{ N}$**
6. What is the gravitational force between the earth, $m = 5.98 \times 10^{24} \text{ kg}$, and the sun, $m = 1.99 \times 10^{30} \text{ kg}$, if they are separated by $1.48 \times 10^8 \text{ km}$? (RW) **$3.62 \times 10^{22} \text{ N}$**
7. If Venus orbits the sun at $1.08 \times 10^8 \text{ km}$ and experiences a gravitational force of $5.54 \times 10^{22} \text{ N}$, what is its mass? (RW) **$4.87 \times 10^{24} \text{ kg}$**
8. What is the acceleration due to gravity on the surface of the Moon? (OpenStax 6.35a) **1.62 m/s^2**
9. What is the acceleration due to gravity on the surface of Mars? The mass of Mars is $6.418 \times 10^{23} \text{ kg}$ and its radius is $3.38 \times 10^6 \text{ m}$. (OpenStax 6.35b) **3.75 m/s^2**
10. (a) Calculate the acceleration due to gravity on the surface of the Sun. (b) By what factor would your weight increase if you could stand on the Sun? (Never mind that you cannot.) (OpenStax 6.36) **274 m/s^2 , 28 times**
11. What is the acceleration due to gravity as an altitude of $2.0 \times 10^6 \text{ m}$ above the earth's surface? (RW) **5.68 m/s^2**