More Gravitation

1. What happens to your weight if you travel to a planet with the same radius as Earth but half the mass? Explain briefly.

2. What is the gravitational field strength on the Moon?

3. How much would you weigh on the Moon?

4. Compare the gravitational field strength on the surface of the following planets:
   a) Planet A vs Planet B (Planet A has 3× the mass, radius is the same
   b) Planet X vs Planet Y (same mass, but Y has 4× the radius

5. An 80 kg person is on a planet the same size as Earth. If his weight on the surface is 650 N, determine the mass of the planet.

6. Two objects of equal mass are separated by 5.0 m. The gravitational force between them is 1.0×10^{-9}N. Determine the mass of each object.

7. How high above the surface of Earth would a 68 kg person experience a gravitational force of 250 N?

8. How far above Earth's surface do you need to travel in order to be half your weight on Earth?

9. A rock is dropped from a height of 6.0 m on a newly discovered planet. The rock reaches the ground in 0.88 seconds. If the planet has a mass of 7.77×10^{24}kg, determine the radius of the planet.

10. A satellite orbits a distant planet at a height of 1.8×10^{6}m above its surface. It travels at an orbital speed of 4200 m/s. The planet has a radius of 3.2×10^{6}m. Determine the mass of the planet.

11. A 950 kg spacecraft is placed halfway between Earth and the Moon. The distance between Earth and the Moon is 3.84×10^{8} m.
    a) Calculate the gravitational force from Earth on the spacecraft.
    b) Calculate the gravitational force from the Moon on the spacecraft.
    c) Determine the direction of the net force.

Determining the Mass of the Earth Using Free-Fall Measurements

Purpose

To calculate the mass of Earth by:

1. Measuring the distance an object falls and the time of the fall.
2. Calculating the acceleration due to gravity g.
3. Using Newton's Law of Universal Gravitation to compute the mass of Earth.

Materials

- Stopwatch (or slow-motion video timer)
- Meter stick or measuring tape
- Small dense object (ball bearing, metal nut, etc.)
- Safe vertical drop zone (1–3 m)

Procedure

1. Measure a vertical drop height d(minimum 2.0 m).

2. Hold the object stationary at this height. Initial velocity is 0 m/s.

3. Drop the object and measure the fall time t.
    - Repeat at least **5 trials** to reduce reaction-time error.

4. Record all values.

5. Compute the average time t_{avg}.

6. Calculate a using kinematics. This is gravitational acceleration.

7. Use Newton's Law of Gravitation to calculate Earth's mass:

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

8. Compare your calculated mass with the accepted value:

$$\%\ Error = \frac{M_{\text{experimental}} - M_{\text{accepted}}}{M_{\text{accepted}}}$$