

The Force Of Gravity On The Average Person Is About 700 N At The Earth's Surface. Calculate The Gravity

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Understanding the force of gravity acting on objects and individuals is fundamental in physics. Specifically, knowing how gravity influences humans provides insights into daily life, engineering, space exploration, and scientific calculations. In this article, we delve into how to calculate the force of gravity on an average person, explore what this force represents, and examine the underlying physics principles.

What Is Gravity and How Does It Affect People?

Gravity is a fundamental force of nature that causes objects with mass to attract each other. On Earth, gravity gives weight to physical objects and causes them to fall toward the ground when unsupported. The force of gravity acting on a person is commonly referred to as their weight.

Key Concepts:

- Mass (m): The amount of matter in an object, measured in kilograms (kg).
- Gravitational Acceleration (g): The acceleration due to gravity near Earth's surface, approximately 9.81 meters per second squared (m/s²).
- Weight (W): The force exerted by gravity on an object, measured in newtons (N).

Relationship:

$$W = m \times g$$

This simple formula demonstrates that weight is directly proportional to mass and the acceleration due to gravity.

Calculating the Force of Gravity (Weight) on an Average Person

Given in the introductory sentence, the force of gravity on an average person is about 700 N at Earth's surface. To understand how this figure is derived, let's explore the calculation process.

Step 1: Determine the Average Mass of a Person

The average mass of an adult human varies globally, but for calculation purposes, a typical average

is around 70 kilograms (kg).

- Average Human Mass: approximately 70 kg

Step 2: Use the Standard Acceleration Due to Gravity

Near Earth's surface, gravity is approximately:

- g : 9.81 m/s^2

Step 3: Calculate the Weight

Applying the formula:

$$W = m \times g$$

$$W = 70 \text{ kg} \times 9.81 \text{ m/s}^2$$

$$W = 686.7 \text{ N}$$

Rounded to a whole number, this is approximately 687 N, which is close to 700 N as mentioned in the initial statement.

Note: The slight difference accounts for variations in actual human mass and local gravitational differences.

Understanding the Significance of the Force of Gravity

The force of gravity (weight) influences many aspects of human life and scientific measurement.

1. Why Do We Feel Our Weight?

Our bodies are in a constant state of free fall, but because the ground exerts an upward force (normal force), we feel "heavier." This normal force equals the gravitational force in magnitude when standing still.

2. Variations in Gravity

Gravity slightly varies across Earth's surface due to factors like:

- Latitude: Slightly weaker at the equator, stronger at the poles.

- Altitude: Decreases with elevation above sea level.
- Local density variations: Due to underground structures or mineral deposits.

Calculating Gravity in Different Contexts

While the standard calculation applies near Earth's surface, understanding gravity's influence in other contexts requires considering different parameters.

1. Gravity on Other Planets and Celestial Bodies

The same formula applies, but with different gravitational acceleration values.

Planet	Gravitational Acceleration (m/s ²)	Example Weight for 70 kg person
Moon	1.62	113.4 N
Mars	3.71	259.7 N
Jupiter	24.79	1735.3 N

2. Calculating Weight at Different Locations on Earth

If you want to estimate the weight of a person at a certain location:

$$W = m \times g_{\text{local}}$$

where g_{local} can be obtained from gravity maps or local measurements.

Implications of Gravity Calculations

Understanding how to calculate the force of gravity is essential in numerous fields:

- Engineering: Designing structures to withstand loads.
- Aerospace: Calculating launch forces and spacecraft trajectories.
- Medicine: Understanding how microgravity affects the human body.
- Education: Teaching fundamental physics principles.

Practical Applications of Gravity Calculations

Let's explore some real-world examples where gravity calculations are critical.

1. Designing Safety Equipment

Knowing the weight of individuals helps in designing safety gear such as harnesses, seatbelts, and crash barriers that can withstand the forces during accidents.

2. Space Missions

Calculations of gravity are vital for planning spacecraft trajectories, landings on other planets, and understanding how astronauts' weight changes in microgravity environments.

3. Sports Science and Biomechanics

Athletes' performance analysis often involves understanding forces acting on the body, including gravity's role during jumps, lifts, and accelerations.

Summary and Key Takeaways

- The force of gravity acting on an average person weighing about 70 kg is approximately 700 N at Earth's surface.
- The calculation uses the fundamental physics formula $(W = m \times g)$.
- Variations in gravity across Earth's surface and on other celestial bodies can be computed similarly by substituting the appropriate gravitational acceleration.
- Understanding gravity's influence is crucial across multiple scientific and engineering disciplines.

Conclusion

Calculating the force of gravity on a person provides a tangible link between abstract physics concepts and everyday experiences. Recognizing that an average human's weight is about 700 N due to gravity helps us appreciate the fundamental forces shaping our environment and informs practical applications in technology, health, and exploration. Whether standing on Earth or venturing into space, understanding gravity remains central to comprehending our universe.

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Frequently Asked Questions

How is the force of gravity on an average person calculated?

It is calculated using the formula $F = m g$, where F is the gravitational force, m is the person's mass, and g is the acceleration due to gravity ($\sim 9.8 \text{ m/s}^2$).

What is the approximate mass of an average person if the gravitational force is 700 N?

Using $F = m g$, $m = F / g = 700 \text{ N} / 9.8 \text{ m/s}^2 \approx 71.43 \text{ kg}$.

Why does the force of gravity vary slightly depending on location on Earth?

Because Earth's density and shape cause small variations in gravitational acceleration, making gravity slightly higher at the poles and lower at the equator.

How does the Earth's mass influence the gravitational force experienced by a person?

The Earth's mass creates a gravitational pull that determines the force experienced by objects and people on its surface, calculated via Newton's law of universal gravitation.

What units are used to measure the gravitational force on a person?

The gravitational force is measured in newtons (N), which quantify the force exerted by gravity on the person.

If a person's weight increases to 800 N at Earth's surface, what would be their approximate mass?

Mass = $800 \text{ N} / 9.8 \text{ m/s}^2 \approx 81.63 \text{ kg}$.

What assumptions are made when calculating gravitational force on a person at Earth's surface?

Assumptions include that gravity is uniform at the surface, the person's mass remains constant, and the acceleration due to gravity is approximately 9.8 m/s^2 .

Additional Resources

The force of gravity on the average person is about 700 N at the Earth's surface. Calculate the gravity.

Introduction: Understanding Gravity and Its Significance

Gravity is an omnipresent force that governs the motion of planets, stars, and even everyday objects. Its influence extends from shaping the cosmos to determining the weight of a single individual standing on Earth's surface. For the average person, the force of gravity, commonly known as weight, is approximately 700 Newtons (N). This seemingly simple figure opens the door to a deeper exploration of the fundamental principles of physics, particularly Newtonian mechanics, and how they relate to our daily lives.

In this article, we will analyze what this force entails, how it is calculated, and what it reveals about Earth's gravitational pull. We will also delve into the physics concepts underlying gravity, the factors influencing weight, and practical applications of these principles. By understanding the science behind this force, readers can appreciate the intricate balance of forces that keep us grounded and how variations in these forces can impact everything from space travel to engineering.

1. The Concept of Weight and Force of Gravity

1.1 What Is Weight?

Weight is the force exerted on an object due to gravity. It is a vector quantity, meaning it has both magnitude and direction—specifically, directed toward the center of the Earth. The weight of an object depends on two primary factors:

- Its mass (how much matter it contains)
- The acceleration due to gravity at the location

Mathematically, the weight (W) is expressed as:

$$W = m \times g$$

where

- (m) is the mass of the object (in kilograms)
- (g) is the acceleration due to gravity (in meters per second squared, m/s^2)

1.2 Why Is the Force of Gravity Important?

Gravity influences nearly every aspect of physical existence: from the way objects fall, to the orbits of celestial bodies, to the structural integrity of buildings and bridges. For individuals, understanding their weight and the forces acting upon them is essential in fields as diverse as

biomechanics, aerospace engineering, and medicine.

2. Earth's Gravity: The Fundamental Constant

2.1 The Acceleration Due to Gravity on Earth

The acceleration due to gravity on Earth's surface, denoted as (g) , is approximately 9.81 m/s^2 . This value is not uniform across the globe; it varies slightly due to factors such as:

- Earth's rotation
- Variations in Earth's density and composition
- Altitude above sea level
- Local geological formations

However, for most practical purposes, 9.81 m/s^2 is used as a standard value.

2.2 How Does Gravity Vary With Location?

While the average (g) is 9.81 m/s^2 , it can range from about 9.78 m/s^2 at the equator (due to Earth's rotation causing a slight centrifugal effect) to approximately 9.83 m/s^2 at the poles. These variations are subtle but can be measured with precise instruments and are significant in geophysics and navigation.

3. Calculating the Force of Gravity on an Average Person

3.1 Establishing the Average Person's Mass

To compute the force of gravity (weight), we need an estimated mass for an average adult. Based on global health data and demographic studies, an average adult's mass is approximately:

- 70 kilograms (kg)

This figure is a reasonable approximation for the purposes of this calculation, acknowledging that individual weights vary.

3.2 Applying the Formula

Using the formula:

$$W = m \times g$$

with

- $(m = 70 \text{ kg})$
- $(g = 9.81 \text{ m/s}^2)$

we get:

$$W = 70 \, \text{kg} \times 9.81 \, \text{m/s}^2 = 686.7 \, \text{N}$$

Rounding this value, the force of gravity (or weight) is approximately 687 N.

3.3 The Reported 700 N Value

The figure often cited as about 700 N for the force of gravity on an average person is a rounded estimate, accounting for slight variations in individual mass and local gravity. Factors such as a person weighing more or less than 70 kg, or being at a different altitude, will slightly alter the exact figure.

4. Factors Influencing the Force of Gravity on a Person

4.1 Variations in Body Mass

- Lighter individuals (e.g., 50 kg) will experience a weight of approximately $(50 \times 9.81 = 490.5 \, \text{N})$.
- Heavier individuals (e.g., 90 kg) will experience about $(90 \times 9.81 = 882.9 \, \text{N})$.

Thus, the force of gravity directly correlates with body mass.

4.2 Elevation Above Sea Level

As altitude increases, the distance from Earth's center grows slightly, causing a marginal decrease in gravity. For example:

- At about 10,000 meters (roughly the cruising altitude of commercial jets), gravity reduces by roughly 0.3%, making the force slightly less than on the surface.

4.3 Earth's Shape and Density Variations

Earth is not a perfect sphere; it is an oblate spheroid with a slightly larger radius at the equator than at the poles. This shape causes subtle differences in gravity:

- Slightly weaker at the equator
- Slightly stronger at the poles

Furthermore, local geological features can cause minor fluctuations in gravity, which are measured in geophysical surveys.

5. Practical Applications and Implications

5.1 Engineering and Structural Design

Engineers must consider the forces of gravity when designing structures. For example:

- Buildings must withstand the downward force exerted by their mass plus the weight of occupants.
- Aerospace engineers account for gravity to determine thrust requirements for rockets.

5.2 Space Travel and Microgravity

Understanding Earth's gravity is crucial for space missions. When astronauts are in orbit, they experience a condition called microgravity, where the apparent weight is nearly zero due to free-fall conditions. This has profound effects on the human body, including muscle atrophy and bone density loss.

5.3 Medical and Biomechanical Studies

Accurate knowledge of weight and gravitational forces assists in:

- Designing prosthetics
- Developing exercise regimens for weight management
- Understanding the biomechanics of movement

6. Broader Context: The Universal Law of Gravitation

6.1 Newton's Law of Universal Gravitation

Isaac Newton formulated the law stating that every mass attracts every other mass with a force proportional to the product of their masses and inversely proportional to the square of the distance between their centers:

$$F = G \frac{m_1 m_2}{r^2}$$

where

- F is the gravitational force
- G is the gravitational constant ($6.674 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$)
- m_1 and m_2 are the masses involved
- r is the distance between centers

6.2 Connecting the Law to Weight Calculation

On Earth, this law simplifies to the weight formula because one mass is the Earth's mass (M_E) and the other is the person's mass (m), with r being Earth's radius (R_E):

$$W = m \times g = G \frac{M_E}{R_E^2} \times m$$

Using Earth's known values, this formulation yields the standard gravity of approximately 9.81 m/s^2 .

7. Conclusion: The Significance of the 700 N Force

The approximate 700 N force exerted by gravity on an average person encapsulates fundamental physical principles. It illustrates how mass and the universal gravitational constant combine to produce a force that influences every aspect of our existence—from simple daily activities to complex scientific endeavors.

Understanding this force not only provides insight into basic physics but also equips us with the knowledge to innovate in engineering, medicine, and space exploration. As our exploration of the universe advances, the importance of grasping gravitational forces remains central, reminding us that even a seemingly simple number like 700 N carries profound scientific significance.

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