

Mass and Weight

What is mass?

Mass is a measurement of how much matter is in an object. Mass is a combination of the total number of [atoms](#), the density of the atoms, and the type of atoms in an object.

How to Measure Mass

Mass is usually measured in kilograms which is abbreviated as kg.

In physics there are different ways of determining the quantity of mass. Two of the most commonly used are inertial mass and gravitational mass.

- Inertial mass - Inertial mass is determined by how much the object resists acceleration. For example, if you push two objects under the same conditions with the same amount of force, the object with the lower mass will accelerate faster.
- Gravitational mass - Gravitational mass is a measurement of how much gravity an object exerts on other objects. It can also be the measurement of how much gravity an object experiences from another object.

When scientists want to express mass in terms of atoms and molecules they use the atomic mass unit which is abbreviated "u". One atomic mass unit is equal to 1/12 of the mass of carbon-12.

What is the difference between mass and weight?

Weight is different from mass. Weight is the measure of the force of gravity on an object. The mass of an object will never change, but the weight of an item can change based on its location. For example, you may weigh 100 pounds on Earth, but in outer space you would be weightless. However, you will always have the same mass on Earth as you have in outer space.

Measuring Weight

In the United States we usually measure weight in pounds, but in physics when we are describing weight as a force, it is generally measured in Newtons which is abbreviated as "N".

Converting Mass to Weight

Since gravity is fairly consistent on Earth, weight will be consistent as well. This allows us to use a formula to convert weight into mass or mass into weight. The formula is:

$$\begin{aligned}\text{force} &= \text{mass} * \text{acceleration} \\ &\text{or} \\ f &= ma\end{aligned}$$

In this equation force is equal to the weight. The acceleration is the acceleration caused by

gravity "g" which is 9.8 m/s^2 .

Now we can substitute weight for mass and 9.8 m/s^2 for acceleration to get the formula:

$$\begin{aligned}\text{weight} &= \text{mass} * g \\ \text{weight} &= \text{mass} * 9.8 \text{ m/s}^2\end{aligned}$$

Example:

What is the weight of a 50 kg mass object?

$$\begin{aligned}\text{weight} &= 50 \text{ kg} * 9.8 \text{ m/s}^2 \\ \text{weight} &= 490 \text{ N}\end{aligned}$$

Is mass the same as size?

No, mass is different than size or volume. This is because the type of atoms or molecules as well as their density helps to determine the mass. For example, a balloon filled with helium will have much less mass than a similar sized item made of solid gold.

The Law of Conservation of Mass

The *law of conservation of mass* states that the mass of a closed system must remain constant over time. This means that although changes are being made to the objects in a system, the overall mass of the system must remain the same.

Interesting Facts about Mass and Weight

- The word "mass" comes from the Greek word "maza" meaning "lump of dough."
- Scientists estimate that the total mass of the universe is between 10^{52} kg and 10^{53} kg.
- 1000kg is equal to a metric tonne.
- [Greek philosopher Plato](#) said that weight was the natural tendency of objects to seek their kin.
- The gravity of Earth can vary as much as 0.5% depending on where you are on Earth.
- If you weigh 100 pounds on Earth you would weigh 37.7 pounds on Mars and 236.4 pounds on Jupiter.