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Conservation Law of Mass

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"Mass" is a basic property of a physical body which describes the amount of matter in it. In contrast to "weight" that is the force of gravitational attraction between an object and earth or some other astronomical body mass is not depending in the location of the body in space. We feel our weight while standing on the floor due to reaction of the floor on the bottom of our legs as dictated by Newton's third law, action = reaction, where the action is our weight. While mass cannot change under ordinary circumstances, weight changes dependent where the object is.

In the classic mechanics of Newton (1643-1727) mass is defined as a measure to the persistence of a body, or as the degree of opposition of the body to a change in his motion (change in speed or direction). In other words, as a body mass is higher, his resistance to change in his motion is higher and the force needed for the change is higher. At about 1687 Newton provided also a working definitions for mass according to $m = \rho V$, where the weight of the body on the surface of earth is simply the force acting between the body and the entire earth. However, the Austrian philosopher and physicist Ernst Mach (1838-1916) and other scientists preferred to define mass from Newton's second law $m = F/a$ where force is either attraction or push while its source may be gravitation, electricity, magnetism, or the effort of muscles. Nowadays, it is accepted that mass is the amount of substance in a body, and more strictly the measure of its inertia, which is a property of the body that causes it to resist changes in the state of motion. An important fact about mass is as follows. About two hundred years scientists believed that Newton's approach was eternal, which assumed that mass was independent of its motion. And then came Einstein, and at the beginning of the twenty century presented his special relativity theory which led to the conclusion among others that the mass of a body increases with its speed according to $m = m_o [1 - (v/c)^2]^{0.5}$ where mo is the mass of the body at rest, m is its mass when it is moving with a speed v relative to an observer where c is the speed of light. The concept of mass is described by two artworks that try to demonstrate two "extremes" of it. Mass approaching zero is demonstrated by the artwork of the surrealist Giacometti (1901-1966) (Figure 1), and in comparison, mass approaching infinity is demonstrated by the sculpture of the Colombian Botero (1932) located in one of the streets of New York (Figure 2).

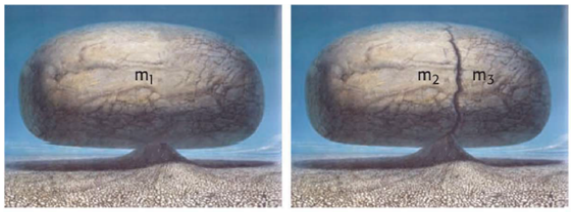
$m \rightarrow 0$

Figure 1: Mass approaching zero.

The law of conservation of mass is usually attributed to Antoine Laurent Lavoisier (1743-1794), a French chemist, who established the law in 1789. He was one of the few chemists of his time to fully

$m \rightarrow \infty$

Figure 2: Mass approaching infinity.



$m_1 = m_2 + m_3$

mass conservation law

in any change of state the total mass is conserved

Figure 3: Total mass is conserved.

$m_1 + m_2$

Figure 4: Total mass is equal.

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Figure 5: Total mass is equal to the combination of the halves.

appreciate the importance that the weight of the products of a chemical reaction must equal the weight of the reactants, which is identical with the following statements of the law, namely, "in any change of state, the total mass is conserved" or "mass is neither created nor destroyed in any chemical reaction." It is interesting to mention that although the paternity of the law of the conservation of mass is generally attributed to Lavoisier, it was known well long before him. It goes back to the ancients Greeks. Anaxagoras expressed it this way in 450 B.C.E.: "Nothing is born or perishes, but already existing things combine, then separate anew."

The law of mass conservation is demonstrated by two artworks based on the version that "in any change of state, the total mass is conserved". In the first artwork the total mass of the complete rock is equal to its two halves (Figure 3). The second artwork is that of Fernando Botero's (1932, Colombian) original painting "A Man and Woman"(1989) on the L.H.S (Figure 4). On the right hand side the two halves of the images are combined in two ways where their total mass is equal to the combination of the halves (Figure 5).