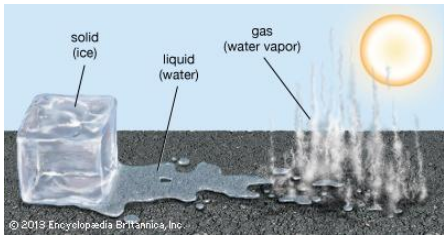
The law of conservation of mass is a fundamental principle of physics. According to this law, matter can be neither created nor destroyed. In other words, the mass of an object or collection of objects never changes, no matter how the parts are rearranged. In an ordinary chemical reaction, the sum of the masses of the reactants (the substances undergoing the change) equals the sum of the masses of the products (the substances resulting from the reaction). For example, the mass of wood and oxygen that disappears in combustion is equal to the mass of water vapor, carbon dioxide, smoke, and ash that appears following the reaction.

CONSERVATION OF MASS IN CHEMICAL AND PHYSICAL SYSTEMS

Mass is conserved in chemical reactions because the same atoms are present in the reactants as in the products, although they are combined in different ways. For example, calcium (Ca) can react with oxygen (O_2) to form the compound calcium oxide (CaO):

$$2\ Ca + O_2 \rightarrow 2\ CaO$$

Notice that the reactants consist of 2 atoms of calcium and 1 molecule of oxygen, which contains 2 atoms of oxygen. The product is 2 molecules of calcium oxide, each consisting of 1 calcium atom and 1 oxygen atom. The number and types of atoms before the reaction—2 calcium atoms and 2 oxygen atoms—is equal to the number and types of atoms in the product—2 calcium atoms and 2 oxygen atoms. The atoms are arranged differently in the product compared to the reactants, but the same amount and type of mass is present before and after the reaction.



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Mass also in conserved when matter undergoes physical changes, such as changes of state. For example, water is made up of hydrogen and oxygen atoms, with a chemical formula of H_2O. Water can exist in three states—solid (ice), liquid, and gas (water vapor, or steam). The mass of a sample of water will remain the same regardless of a change of state. If 1 gram of ice cubes is melted, it will produce 1 gram of liquid water and, as the temperature increases, 1 gram of water vapor:

$1g\ H_2O_{ice} = 1g\ H_2O_{water} = 1g\ H_2O_{steam}$

Furthermore, the number of hydrogen and oxygen atoms in the ice would equal the number of hydrogen and oxygen atoms in the liquid water and the water vapor.