How are Mass and Volume Related?

How can you measure the density of a substance? You could determine a substance’s density if you knew how much of the substance occupies a certain space. To find out how much of a substance occupies a space, you can first of all measure the mass of the substance. Mass is the amount of matter in a substance. Volume is a measurement of the amount of space occupied by the substance. The volume of a regular shaped solid (such as a prism or a cylinder) can be measured directly using a ruler. The volume of an irregularly shaped object, such as an apple, can be found indirectly, by using an overflow can, and determining the volume of the displaced water.

 

As you know, the volume of a liquid can be measured using a measuring cup or graduated cylinder. The volume of a gas can be determined by measuring the volume of the container that holds it. The greatest amount of fluid that a container can hold is called its capacity. Capacity is usually measured in litres or millilitres.

Keep in mind that mass and weight are not the same. Weight is the force of gravity exerted on an object. As you may recall from earlier studies, a force is a push or pull, anything that causes a change in the motion of an object. Gravity is the natural force that causes an object to move toward the centre of the Earth. All forces, including weight, are measured in newtons (N). The pull of gravity everywhere on Earth is essentially the same. On Earth, gravity pulls on an object with a downward force of 9.8 N for every kilogram of its mass. Thus, a bag of sugar with a mass of 2.26 kg weighs 22.1 N on Earth.

The density of a substance can be determined by calculating its mass-to-volume ratio. You can do this by dividing the object’s mass by its volume. Therefore, the formula for density is:

**Density (*D*) = Mass (*m*)**

 **Volume (*v*)**

For example, the density of an object having a mass of 10 g and a volume of 2 cmᵌ is 5g/cmᵌ. The density of solids is usually given in g/cmᵌ (grams per centimetre cubed). The density of liquids and gases is often given in g/L (grams per litre) or g/ ml (grams per millilitre). Using pure water as an example, you could express its density as either 1 g/cmᵌ OR 1 g/ml (1 cmᵌ = 1 ml)

As long as the pressure and temperature stay the same, the mass-to-volume ratio, or density, of any pure substance is a constant, which means it does not change. According to particle theory, the size of the particles of a substance does not change when the mass of volume of the substance changes. A certain number of particles of a particular size will always occupy a certain space. As the number of particles increases from substance to substance, the space required for those particles must also increase. Therefore, density is a property of matter that is unique to a specific pure substance.