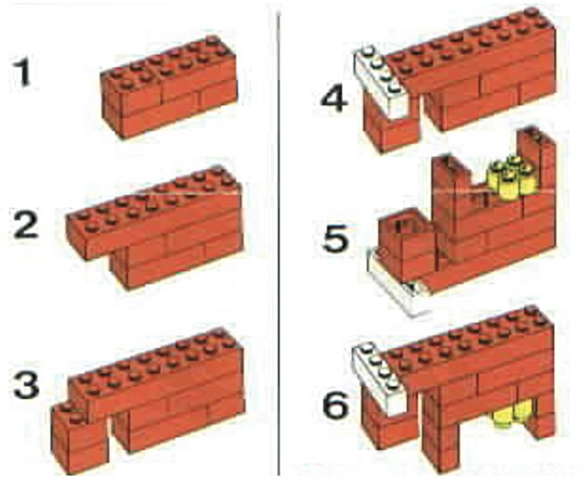
Reflect

If you want to determine the amount of matter in an object, you can calculate its **mass**.

To measure mass, we can use a balance scale or a digital scale.

Look at the plastic pieces on the right that make a toy cow when fully assembled. Imagine you wanted to know the mass of the cow. You could measure the mass of each part and total the sums. You could also take the whole cow in step 6 and measure its mass. Would the two measurements be the same?



mass – the amount of matter contained in an object.

No matter how many parts of an object are put together, the **mass** of a whole object is always the same as the sum of the mass of its parts. When an object is broken into parts, the parts have the same total mass as the original object. When you add the mass of each part of an object, that total will be the same as the mass of the whole object. Scientists have a special term for this concept; it is called the **law of conservation of mass**.

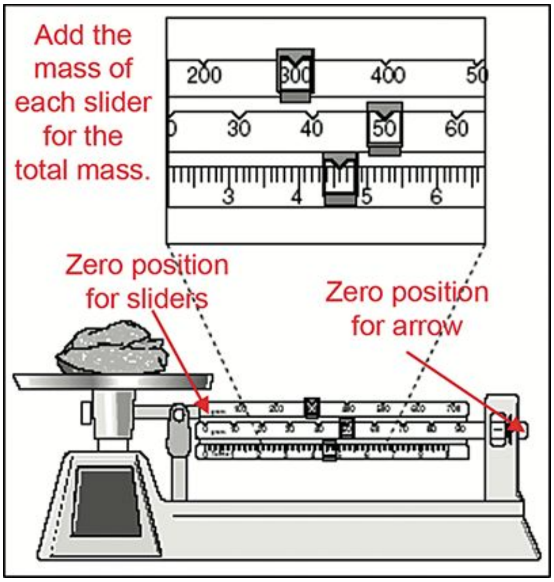
For example, say we take an apple, measure its total mass with a balance scale, and determine that its mass is 157 grams. And let's say that we cut it up into four pieces and then measure the mass of each piece individually. This is what we measured:

- Piece 1 = 35 g
- Piece 2 = 40 g
- Piece 3 = 42 g
- Piece 4 = 40 g

law of conservation of mass – the mass of a whole object is always the same as the sum of the masses of its parts

Then, we can add up each piece of the apple (35 g + 40 g + 42 g + 40 g = 157 g). Did you notice the total mass of the apple equalled the sum of its individual pieces? The total mass of the apple did not change, even though it was cut up into pieces, which proves the law of conservation of mass.

How to Find the Mass of an Object
You can measure mass using a triple-beam balance, named after the three arms that hold different-sized metal mass sliders: a small mass slider (single grams), a medium mass slider (tens of grams), and a large mass slider (hundreds of grams).



First, set your balance scale arrow to zero and all sliders to their left (zero) position. Next, place your object on the pan. This causes the arrow to move upward. Now, move each slider to the right, beginning with the largest slider, until the arrow is back on the zero position. Add the number of grams on each of the three arms. Notice that the arm with the single gram slider has marks for tenths of a gram. The rock in this picture has a mass of 300 + 50 + 4.6 grams, or 354.6 grams.

The mass of the rock is 354.6 grams.

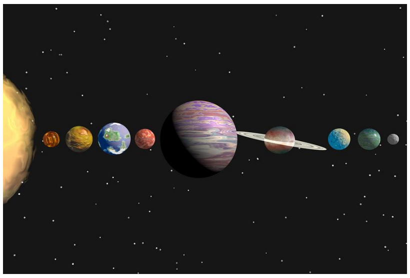
What Do You Think?

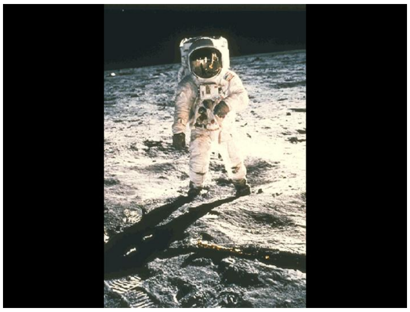
What is the mass relationship between the parts of an object and the whole object?
No matter how many parts of an object are put together, the **mass** of a whole object is always the same as the sum of the mass of its parts. When an object is broken into parts, the parts have the same total mass as the original object. When you add the mass of each part of an object, that total will be the same as the mass of the whole object.

Mass is a physical property.
Physical properties are characteristics of objects that are present even if the object changes physically, such as with folding or cutting. A piece of paper still has the same density, color, texture, etc., even when you fold or cut it. Other physical properties, such as weight and density, however, depend on the amount of matter in the object.

Be careful that you do not mix up the terms mass and **weight**, as they are completely different. **Weight** is a measure of the pull of gravity on an object, whereas mass is how much matter is contained in an object.

Look Out!





Mass never changes.
We measure mass in grams (g) and kilograms (kg). Weight depends on the pull of gravity. Weight can change, unlike mass. We measure weight in ounces (oz) and pounds (lbs). For example, the gravity of Jupiter is 234% of Earth's gravity. So, if you weighed 80 lbs on Earth, you would weigh 187.2 lbs on Jupiter (80 x 2.34 = 187.2 lbs). Now, that is not saying that your body is going to balloon to that weight; your mass stays the same. What you are made of stays the same; the only thing that would change is your weight, because it is a measure of the pull of gravity on your body. In this case, the larger the planet, the more gravity that it has; or, the greater the mass, the greater the gravity.

When Neil Armstrong became the first person to walk on the Moon on July 20,1969, his body weighed less on the Moon compared to his weight on Earth. Why? The pull of gravity is less on the Moon than it is on Earth. However, Armstrong's mass stayed the same on both Earth and the Moon.

Scientists in the Spotlight
Antoine Lavoisier, known as the "father of modern chemistry," discovered the law of conservation of mass around 1785. This law is one of the most important laws of modern chemistry or physics. Lavoisier stated that the law means that atoms of an object cannot be created or destroyed. Yet that can be moved around and changed into different particles. Basically, he stated that nothing is lost, nothing is created, and everything is transformed.

Try Now

On a hot summer day, you and your friend decide to make lemonade. Here is what you use: 1 cup sugar, 5 cups water, and 8 lemons. You measured the mass of the lemons, which was 496 grams (g). The water minus the container was 225 g per cup, for a total of 1,125 g. If the total mass for the mixture was 1,821 g, what would be the the mass of the cup of sugar? *Hint: Use the law of conservation of mass.*

Law of Conservation of Mass

Imagine a ball of modeling clay. The physical properties of the clay could be the color, texture, state of matter, volume, mass, or weight.

1. Hold the ball and estimate the clay's mass in grams. Record this estimate.

Estimate of the mass of the clay ball = ___________________________ grams (g)

2. Find the mass of the ball of clay, using grams on a balance scale, and record the clay's mass. Then, compare it to your original estimate from above.

Estimate of the Mass of the Clay Ball in Grams (g)	**Actual Mass of the Clay Ball in Grams (g)**	**Difference Between Estimate and Actual Amount**

My estimate was ____ compared to the actual mass of the clay ball.

3. Split the clay ball into four smaller balls, and list the properties of the smaller balls. Are the properties of the clay the same, except for the size and mass of each ball?

4. Find the mass of each ball of clay and record its mass in grams (g).

Ball of Clay	Actual Mass in Grams (g)
1	
2	
3	
4	

5. Collect all the clay and mold it back into a large ball. Guess the mass of the large ball of clay. Record your estimate in the chart below.

6. Find the mass of the large ball of clay and compare the mass to your estimate and to the mass of the original ball of clay. (The reformed ball of clay will probably have a little less than the original ball because some of the clay may have remained on your hands or desktop.)

Estimate of the Mass of the Clay Ball in Grams (g)	Actual Mass of the Clay Ball in Grams (g)	Difference Between Estimate and Actual Amount

Why does the reformed ball have a little less mass? If all the pieces of stray clay were gathered up and added back to the clay ball, would the total mass of its parts be the same as the original whole ball of clay?

Connecting With Your Child

Fun with Pencil Pieces and Parts

To help your child further understand the law of conservation of mass, which states that the mass of an object equals the sum of the mass of each of its parts, give your child a handful of new, unsharpened, wooden pencils. Follow these steps:

- You will need a pencil sharpener that can collect the pencil shavings, a sensitive scale that can measure small weights (like the ones used to measure small portions of food), and paper and a pen or pencil to record the data.
- Have your child measure the total mass of all the pencils and record that information.
- Next, have your child sharpen all the pencils.
- Collect all the pencils and the shavings from the sharpener. Together, find and record the mass of the shavings and the mass of the pencils.
- Next, have your child use the pencils to complete homework assignments (or complete a writing assignment), then have him or her record the pencils' mass again.
- What parts of the pencils could not be collected? (the graphite used for writing and the erasers used for removing graphite)
- Challenge your child to write an equation to calculate the mass of the graphite and erasers used.

S + UP + GE = Total Mass

Shavings (bag holding shavings) + **U**sed **P**encils + **G**raphite and **E**rasers used up = Total Mass of pencils

- Have your child fill in the values and find the mass of the missing (used) graphite and erasers.

Here are some questions to discuss with your child:

1. Explain how this activity proved the law of conservation of mass.
2. How is the law of conservation of mass important in our everyday lives?