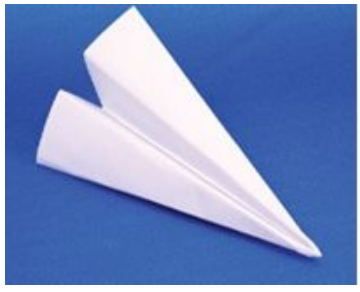
Physical and Chemical Properties

Reflect

How can you describe a piece of paper? You can talk about its color and size. What other **properties** of paper can you identity? Imagine that you took a full sheet of paper and folded it into a paper airplane. Would you still have paper? Yes. Being flexible or foldable is a property of paper. Will paper burn if it is near a flame? Yes. Being flammable is another property of paper. You could measure other properties of the paper, such as its mass, volume, and density. Properties help distinguish one substance from another.



properties – physical and chemical characteristics of matter used to describe or identify a substance

Not all properties can be seen when you first observe or measure a substance. Physical properties can be seen without chemically changing the matter, while chemical properties are observed during a chemical reaction:

- *Physical properties* are characteristics that can be observed or measured without changing the substance, such as state of matter (solid, liquid, gas), color, melting point, odor, density, and conductivity.
- *Chemical properties* are characteristics that can only be observed or measured when atoms of matter rearrange during a chemical change, such as flammability (burning); corrosion and rusting, or oxidation (reactivity with the oxygen in air); and reactivity with water (some metals explode in contact with water!).

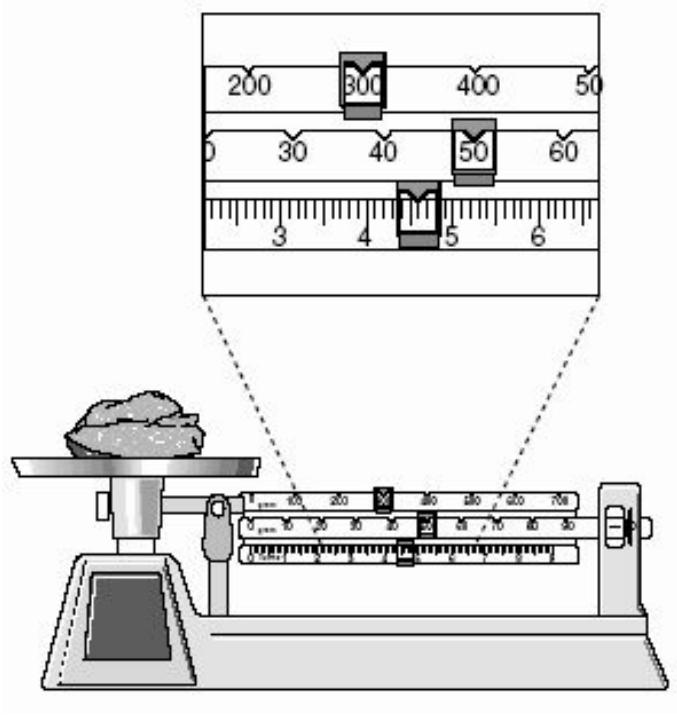
Look Out!

Some physical properties depend on the size of the substance. An *intensive property* is a bulk property and does *not* depend on the amount of matter. Intensive properties include shape, state of matter, color, temperature, density (sink or float, or g/cm^3), hardness (resistance to breaking), luster (shine), texture, malleability (ability to flatten), ductility (ability to be drawn into a wire), flexibility (ability to bend), attraction or repulsion to magnets, melting point, boiling point, odor, heat conductivity, electrical conductivity, solubility (ability to dissolve in water), and viscosity (resistance to flow). For example, when a diamond is cut, the pieces maintain their intrinsic property of hardness. A piece of paper remains white even when folded. Water will freeze at 0°C, regardless of the amount of water present. Intensive properties can be observed and measured to determine the identity of a substance.

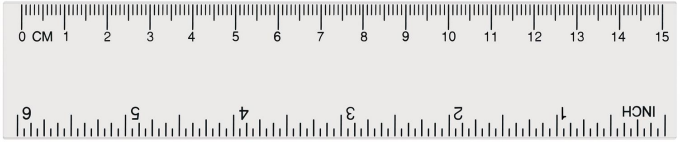
In contrast, an *extensive property* is proportional to the amount of material. Examples of extensive properties include mass, length, and volume. A ream of paper has more mass and volume than a sheet of paper. A foot-long hot dog has more length than a regular hot dog.

What Do You Think?

How can you measure physical properties accurately?
Use the proper equipment to measure extensive physical properties of mass, length, or volume.

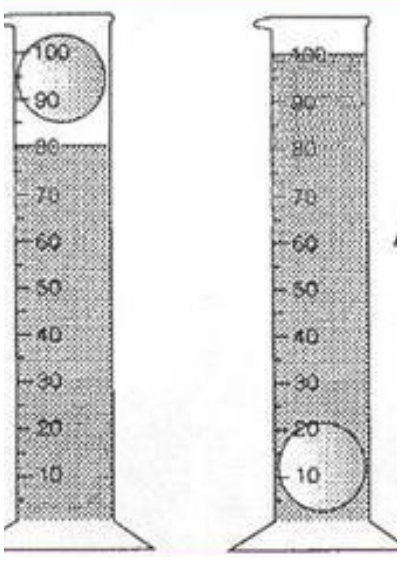


Finding mass: Use a balance scale to measure the amount of matter in an object in grams. Be sure to set the mass sliders to zero, if using a triple arm balance. Look at the scale numbers at eye level. Move the 100 g slider to the right until the balance arrow is centered. Then move the 10 g slider to the right until the arrow is centered. Lastly, use the 1 g slider until the balance arrow centers. Only the 1 g slider can be placed between two numbers. Add the three measurements for the total mass in grams (300 g + 50 g + 4.6 g = 354.6 g). *Note: When finding the mass of a liquid, there is one extra step. You must mass the empty container and subtract it to get the mass of the liquid alone.*



Finding length: Use a metric ruler or meterstick to accurately measure the length of the object. Remember, a meterstick is usually 100 cm long. Each centimeter is divided into 10 mm. *Note: Do not confuse the inch side with the centimeter side of the ruler.*

Finding volume (V): For solids with flat sides, use a metric ruler to measure the length, width, and height in cm. Then use the same formula you would in math class. To find the volume of a rectangular prism, for example, use V = l x w x h. Your answer will be in cm^3 or mL. Conveniently, 1 cm^3 has the exact same volume as 1 mL, so these units are interchangeable.



To find the volume of an irregular solid, place enough water to submerge the object in a graduated cylinder. Write down the volume of the water. Carefully lower the object into the water. Record the volume of the water and object. Then simply subtract to find the volume of the object in mL or cm^3. This is called the water displacement method for finding volume (100 mL – 80 mL = 20 mL).

Try Now

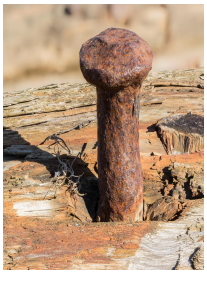
Physical Properties

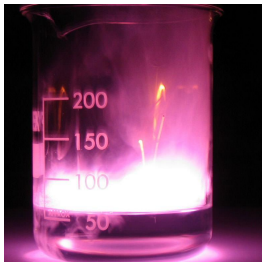
Consider the following physical properties and fill in the missing information.

Property	Tool	Unit
Mass		
Length		
Volume of a regular solid		
Volume of a liquid or an irregular solid		
Melting and boiling points		

Chemical Properties

Consider the following objects and describe some of their chemical properties after observing a chemical reaction.



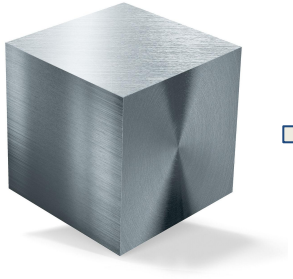


Substance	Chemical Property	Description
Wood		Wood catches on fire, displaying the production of light and heat.
Iron nail		Brittle orange rust, a new substance, forms on the surface of the object.
Potassium		When placed in water, potassium explodes rapidly, giving off heat and light.
Fruit		Organic tissues break down and begin to give off a foul odor when left in the heat over time.

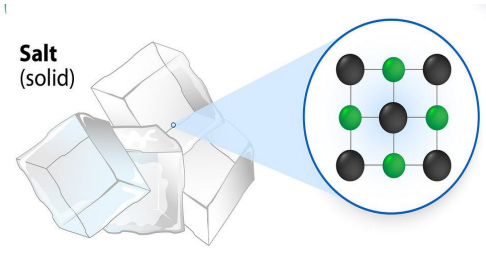
Reflect

Properties and Reactions

The production of a new substance is the only undeniable evidence that a chemical reaction has occurred. By examining the physical properties of the substances before and after the suspected chemical change, we can determine if a new substance was produced.



For example, sodium is a shiny silver solid, and chlorine is a toxic green gas. When sodium and chlorine react, they form sodium chloride (table salt). Sodium chloride is a white, granular solid. We know a chemical reaction has occurred because the properties of salt are so different from the properties of sodium and chlorine that it is easy to observe that a new substance was formed.



Look Out!

It is not always easy to determine if a new substance was formed. Sometimes the products of a chemical reaction can share some properties in common with the reactants that formed them. In these cases, very careful observation and measurement of many different properties should be made to determine if a new substance has formed. For example, when hydrogen peroxide (H_2O_2) is left out in an open dish, it will go through a decomposition reaction, breaking down into water (H_2O) and oxygen gas. This reaction of peroxide in the dilute solutions we can buy at the pharmacy will be very slow and impossible to observe by simply watching the liquid. However, if the properties of the clear liquids are carefully observed before and after the reaction, it is possible to prove a chemical change occurred. The table below shows two physical properties and one chemical property that could be used to prove a new substance was produced.

Substance	Odor	pH	Reactivity of Small Sample with Yeast
Hydrogen peroxide H_2O_2	Displeasing odor	Acidic	Fast reaction producing foamy bubbles and heat
Water H_2O	No odor	Neutral	Unreactive