

[Prev](#)

1

2

3

4

[Next](#)

# Measuring

*In science, data can be collected by making **measurements**.*

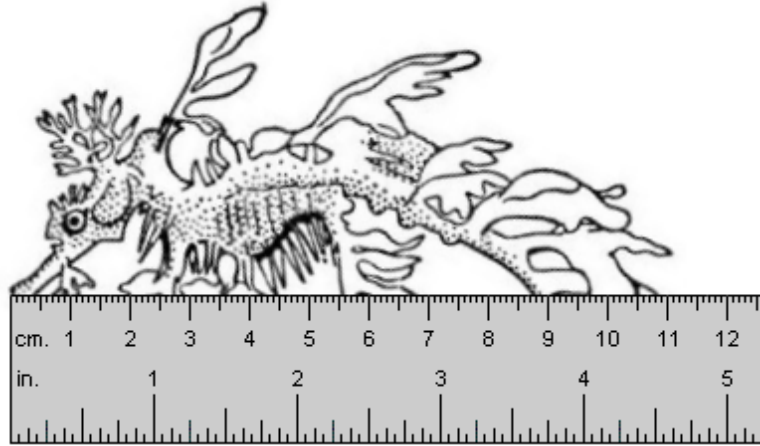
One way to make observations is to make measurements using laboratory tools. Properties that can be observed through measurement include length, mass, width, height, volume, and temperature.

Different tools measure properties with different levels of precision. Digital scales, clocks, and other tools automatically show the right number of decimal places. Analog tools—ones that aren't digital—will have a particular smallest unit that is marked on them. When using analog tools, measurements should not be rounded to the smallest unit. Instead, measure how many complete smallest units there are, then estimate the fraction of the last smallest unit. This will be demonstrated in the examples below.

## Measuring Length, Width, or Height

Rulers, meter sticks, and tape measures can all be used to measure length, width, and height.

Sometimes lab tools that measure length can measure in both metric and standard units. For example, the ruler shown below has marks that measure centimeters along the top and marks that measure inches along the bottom.



How long is the leafy sea dragon? Its nose is lined up with the end of the ruler, and its longest "leaf" is a bit past 11 cm. Since the ruler's smallest unit is tenths of centimeters, we need to measure the sea dragon to hundredths of centimeters. You can hold a piece of paper or other straight-edged object up to the screen to help line up the measurement. It looks like it may go just a bit past 11.1 cm.

So, the length of the sea dragon could be about **11.13 centimeters**.

Tape measures are flexible and can be used to measure curved objects and circumferences. Meter sticks are straight and are good for measuring distances from one thing to another.

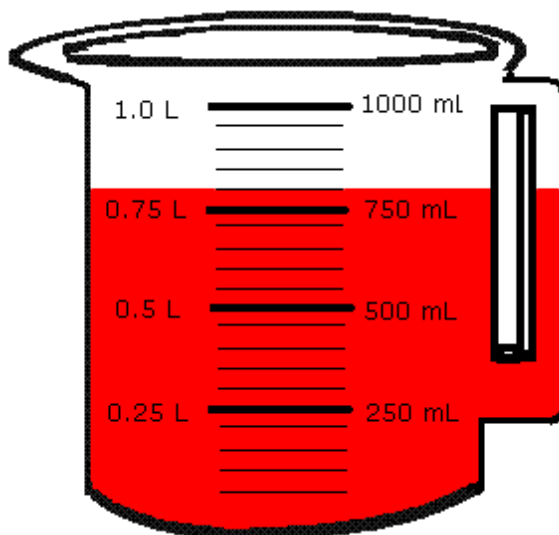
## Measuring Mass

Mass is often measured using a scale or balance.

To measure the mass of an object on a scale, place the object on the scale. Then read the number off of the dial or display. Be sure that you know which units the scale is using to measure the mass.

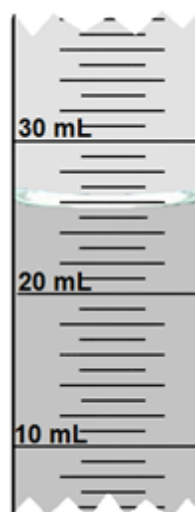
A triple-beam balance has three movable weights. When they are properly positioned, the tray with the object on it will balance, lining up with the indicator arrow. Then the values that each weight points to should all be added up to find the total mass.





Can you determine the volume, or amount, of juice in the pitcher above? The unit that this pitcher uses to measure volume is liters. The small marks on the pitcher are 0.05 L, or 50 mL. You should estimate the volume to the nearest 10 mL, or 0.01 L. Therefore, the volume of the juice is **0.80 liter**.

Graduated cylinders can measure volumes of liquids very precisely. The volume should always be read from the bottom of the meniscus. In the image below, the meniscus is the thick white line.



This graduated cylinder measures to the nearest milliliter, so we need to estimate the volume to the nearest tenth of a milliliter, or one decimal place. This cylinder is holding about **25.7 mL** of liquid.

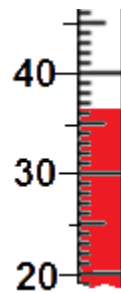
## Measuring Temperature

Temperature is how hot or cold something is. It is measured in degrees Fahrenheit ( $^{\circ}\text{F}$ ) or degrees Celsius ( $^{\circ}\text{C}$ ).

Thermometers are used to measure temperature. Thermometers are usually glass tubes with markings on them. Liquid in the tube changes volume depending on the temperature.

You read a thermometer the same way you read the volume of a liquid. The mark that lines up with the surface of the liquid is the temperature.

If the thermometer below measures in  $^{\circ}\text{C}$ , what is the temperature?



The smallest unit this thermometer measures is  $1^{\circ}\text{C}$ , so we should measure to  $0.1^{\circ}\text{C}$ . Therefore, the temperature reading from the thermometer in the picture is about  **$36.3^{\circ}\text{C}$** .

## Measuring Time

A stopwatch is used to measure time. Some stopwatches have two dials: one can measure minutes, the other seconds. The watch shown below measures minutes in the small dial and seconds in the large dial. Since the smallest unit marked on the watch is five seconds, we need to measure to the nearest second.



This stopwatch reads **47 minutes and 18 seconds**.

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