Measurements

1.1

Units of Measurement

Measurement

You make a measurement every time you

- measure your height.
- read your watch.
- take your temperature.
- weigh a cantaloupe.

Measurement in Chemistry

In chemistry we

- measure quantities.
- do experiments.
- calculate results.
- use numbers to report measurements.
- compare results to standards.

Measurement

In a measurement

- a measuring tool is used to compare some dimension of an object to a standard.
- of the thickness of the skin fold at the waist, calipers are used.

Stating a Measurement

In every measurement, a **number** is *followed* by a **unit**.

Observe the following examples of measurements:

Number	and Unit
35	m
0.25	L
225	lb
3.4	hr

The Metric System (SI)

The **metric system** or **SI (international system)** is

- a decimal system based on 10.
- used in most of the world.
- used everywhere by scientists.

Units in the Metric System

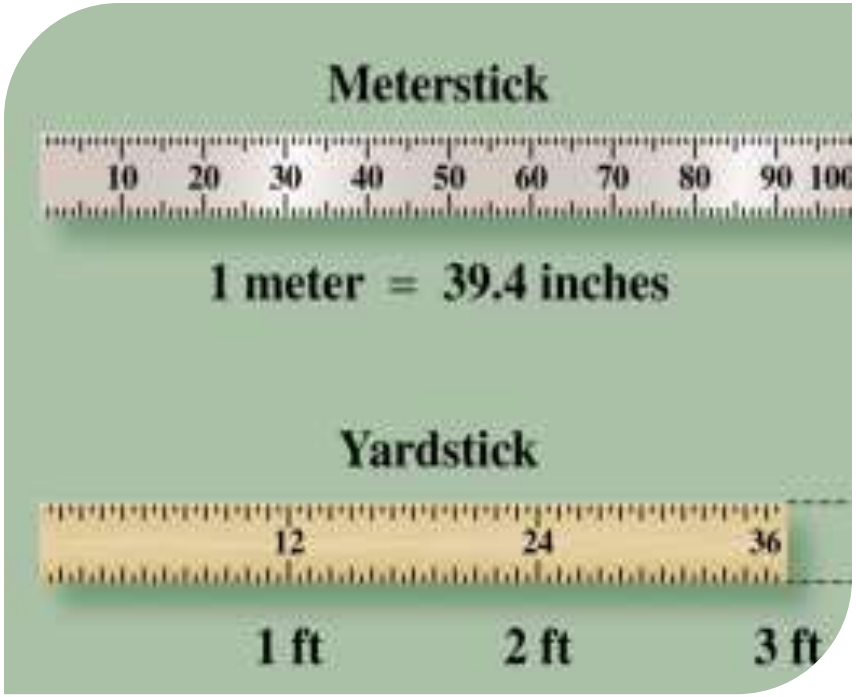
In the metric and SI systems, one unit is used for each type of measurement:

Measurement	Metric	SI
Length	meter (m)	meter (m)
Volume	liter (L)	cubic meter (m^3)
Mass	gram (g)	kilogram (kg)
Time	second (s)	second (s)
Temperature	Celsius (°C)	Kelvin (K)

Length Measurement

Length

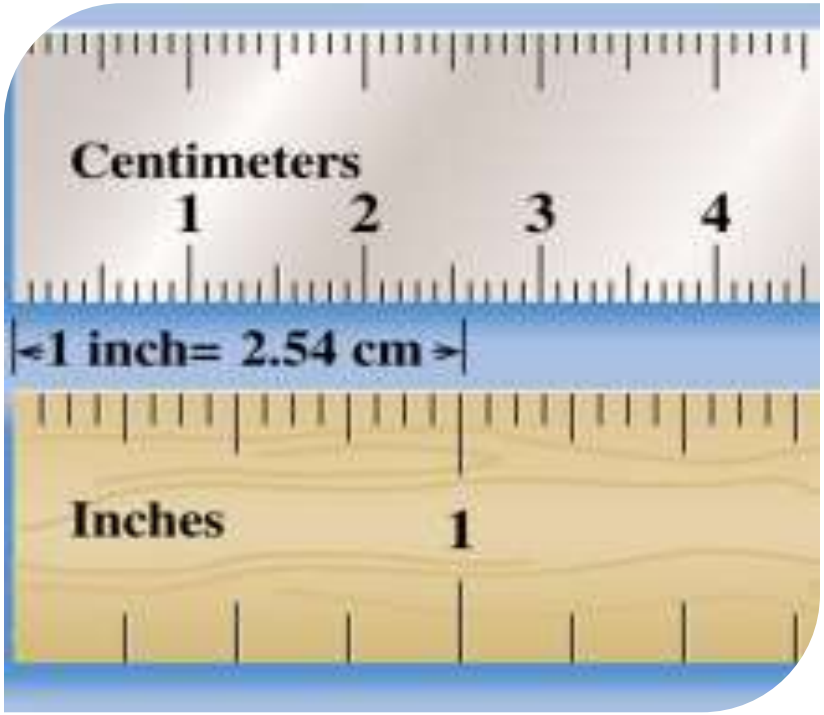
- is measured using a meter stick.
- uses the unit of **meter (m)** in both the metric and SI systems.



Inches and Centimeters

The unit of an inch is equal to exactly 2.54 centimeters in the metric (SI) system.

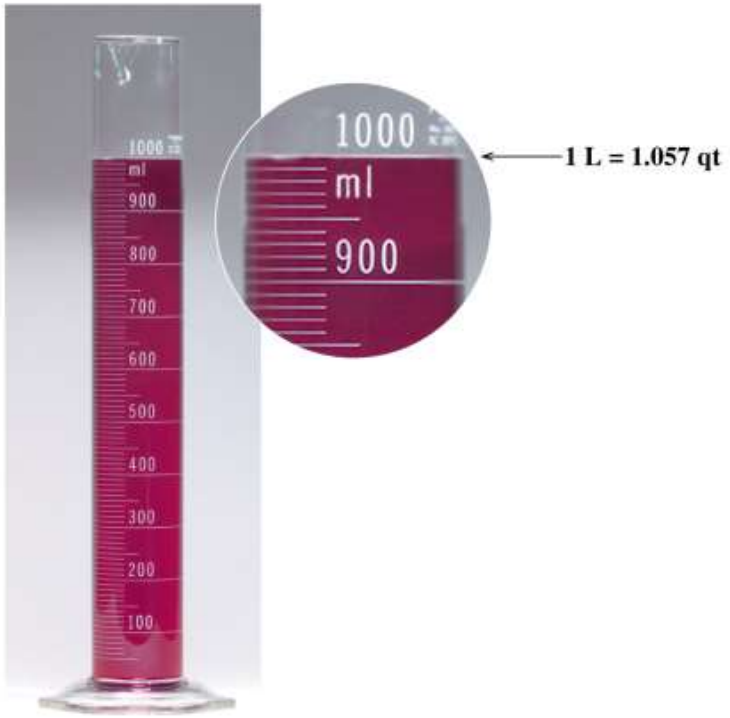
1 in. = 2.54 cm



Volume Measurement

Volume

- is the space occupied by a substance.
- uses the unit **liter (L)** in metric system.
- uses the unit **m^3(cubic meter)** in the SI system.
- is measured using a graduated cylinder.



Mass Measurement

The **mass** of an object

- is the quantity of material it contains.
- is measured on a balance.
- uses the unit **gram (g)** in the metric system.
- uses the unit **kilogram (kg)** in the SI system.

Temperature Measurement

The **temperature** of a substance

- indicates how hot or cold it is.
- is measured on the **Celsius (°C)** scale in the metric system.
- on this thermometer is 18ºC or 64ºF.
- in the SI system uses the **Kelvin (K)** scale.

Time Measurement

Time measurement

- uses the unit **second(s)** in both the metric and SI systems.
- is based on an atomic clock that uses a frequency emitted by cesium atoms.

Learning Check

For each of the following, indicate whether the unit describes 1) length 2) mass or 3) volume.

____ A. A bag of tomatoes is 4.6 kg.

____ B. A person is 2.0 m tall.

____ C. A medication contains 0.50 g aspirin.

____ D. A bottle contains 1.5 L of water.

Solution

For each of the following, indicate whether the unit describes 1) length 2) mass or 3) volume.

__2__ A. A bag of tomatoes is 4.6 kg.

__1__ B. A person is 2.0 m tall.

__2__ C. A medication contains 0.50 g aspirin.

__3__ D. A bottle contains 1.5 L of water.

Learning Check

Identify the measurement that has an SI unit.

A. John's height is

1) 1.5 yd. 2) 6 ft. 3) 2.1 m.

B. The race was won in

1) 19.6 s. 2) 14.2 min. 3) 3.5 hr.

C. The mass of a lemon is

1) 12 oz. 2) 0.145 kg. 3) 0.6 lb.

D. The temperature is

1) 85°C. 2) 255 K. 3) 45°F.

Solution

A. John's height is

3) 2.1 m.

B. The race was won in

1) 19.6 s.

C. The mass of a lemon is

2) 0.145 kg.

D. The temperature is

2) 255 K.

Scientific Notation

Scientific notation

- is used to write very large or very small numbers.
- for the width of a human hair of 0.000 008 m is written 8 x 10^{-6} m.
- of a large number such as 4 500 000 s is written 4.5 x 10^{6} s.

Some Powers of Ten

Standard Number	Multiples of Ten		Scientific Notation
10 000	$10 \times 10 \times 10 \times 10$		1×10^{4}
1 000	$10 \times 10 \times 10$		1×10^{3}
100	10×10		1×10^{2}
10	10		1×10^{1}
1	0		1×10^{0}
0.1	$\frac{1}{10}$		1×10^{-1}
0.01	$\frac{1}{10} \times \frac{1}{10}$	$= \frac{1}{100}$	1×10^{-2}
0.001	$\frac{1}{10} \times \frac{1}{10} \times \frac{1}{10}$	$= \frac{1}{1\,000}$	1×10^{-3}
0.000 1	$\frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10}$	$= \frac{1}{10\,000}$	1×10^{-4}

Comparing Numbers in Standard and Scientific Notation

Here are some numbers written in standard format and in scientific notation.

Number in Standard Format	Number in Scientific Notation
Diameter of the Earth	
12 800 000 m	1.28×10^{7} m
Mass of a human	
68 kg	6.8×10^{1} kg
Length of a pox virus	
0.000 03 cm	3×10^{-5} cm

Learning Check

Select the correct scientific notation for each.

A. 0.000 008

1) 8×10^{6} 2) 8×10^{-6} 3) 0.8×10^{-5}

B. 72 000

1) 7.2×10^{4} 2) 72×10^{3} 3) 7.2×10^{-4}

Solution

Select the correct scientific notation for each.

A. 0.000 008

2) 8×10^{-6}

B. 72 000

1) 7.2×10^{4}

Learning Check

Write each as a standard number.

A. 2.0×10^{-2}

1) 200 2) 0.0020 3) 0.020

B. 1.8×10^{5}

1) 180 000 2) 0.000 018 3) 18 000

Solution

Write each as a standard number.

A. 2.0×10^{-2}

3) 0.020

B. 1.8×10^{5}

1) 180 000

The End

Thanks