The Measurement Process:

1. **Select an object and an attribute of the object to measure, such as its length, area, volume, weight, temperature,….**

2. **Select an appropriate unit to measure the attribute.**

3. **Determine the number of units needed to measure the attribute. (This may require a measurement device.)**

Non-standard Units:

For length, you could use a hand. For liquid volume, you could use some container. For cooking, you could use a pinch or dash.

Non-standard units are not necessarily convenient or consistent.

Standard Units:

The English System:

Length:

Unit	Abbreviation	Relation to a foot
Inch	**in.**	$\frac{1}{12}\ ft$
Foot	**ft**	$1\,ft$
Yard	**yd**	$3\,ft$
Mile	**mi**	$5{,}280\,ft$

Conversions:

1) Convert 48 inches into feet.

$$48in \cdot \left(\frac{1\,ft}{12in}\right) = 4\ ft$$

2) Convert 66 inches into feet.

$$66in \cdot \left(\frac{1\,ft}{12in}\right) = 5\tfrac{1}{2}\ ft$$

3) Convert 2 miles into yards.

$$2mi \cdot \left(\frac{5{,}280\,ft}{1mi}\right) \cdot \left(\frac{1yd}{3\,ft}\right) = 3520\,yds$$

4) Convert 11,440 yards into miles.

$$11{,}440\,yd \cdot \left(\frac{3\,ft}{1yd}\right) \cdot \left(\frac{1mi}{5{,}280\,ft}\right) = 6.5mi$$

Area:

Unit	Relation to a square foot
Square inch	$\frac{1}{144}\ ft^2$
Square foot	$1\ ft^2$
Square yard	$9\ ft^2$

Conversions:

1) Convert 48 square inches into square feet. $48in^2 \cdot \left(\frac{1\,ft^2}{144in^2}\right) = \frac{1}{3}\ ft^2$

2) Convert 6 square feet into square inches. $6\ ft^2 \cdot \left(\frac{144in^2}{1\,ft^2}\right) = 864in^2$

3) Convert 48.6 square feet into square yards. $48.6\ ft^2 \cdot \left(\frac{1yd^2}{9\,ft^2}\right) = 5.4yd^2$

4) Convert 3 square yards into square inches.

$$3yd^2 \cdot \left(\frac{9\,ft^2}{1yd^2}\right) \cdot \left(\frac{144in^2}{1\,ft^2}\right) = 3888in^2$$

Volume:

Unit	Relation to a cubic foot
Cubic inch	$\frac{1}{1728}\ ft^3$
Cubic foot	$1\ ft^3$
Cubic yard	$27\ ft^3$

Conversions:

1) Convert 4,320 cubic inches into cubic feet. $4{,}320in^3 \cdot \left(\frac{1\,ft^3}{1{,}728in^3}\right) = 2.5\,ft^3$

2) Convert 3.5 cubic feet into cubic inches. $3.5\,ft^3 \cdot \left(\frac{1{,}728in^3}{1\,ft^3}\right) = 6048in^3$

3) Convert 197.1 cubic feet into cubic yards. $197.1\,ft^3 \cdot \left(\frac{1yd^3}{27\,ft^3}\right) = 7.3yd^3$

4) Convert 3 cubic yards into cubic inches. $3yd^3 \cdot \left(\frac{27\,ft^3}{1yd^3}\right) \cdot \left(\frac{1{,}728in^3}{1\,ft^3}\right) = 139968in^3$

Weight:

Unit	Relation to a pound
Ounce	$\frac{1}{16} lb$
Pound	$1 lb$
Ton	$2{,}000 lbs$

Conversions:

1) Convert 176 ounces into pounds. $176 ounces \cdot \left(\frac{1 lb}{16 ounces} \right) = 11 lbs$

2) Convert 4.5 pounds into ounces. $4.5 lb \cdot \left(\frac{16 ounces}{1 lb} \right) = 72 ounces$

3) Convert 3 tons into ounces. $3 tons \cdot \left(\frac{2{,}000 lbs}{1 ton} \right) \cdot \left(\frac{16 ounces}{1 lb} \right) = 96000 ounces$

4) Convert 30,000 ounces into tons.

$$30000 ounces \cdot \left(\frac{1 lb}{16 ounces} \right) \cdot \left(\frac{1 ton}{2000 lbs} \right) = .9375 tons$$

Temperature:

Fahrenheit scale with water freezing at $32°F$ **and boiling at** $212°F$ **--- a range of** $180°F$**.**

The Metric System:

The metric system is an example of an ideal system of units.

An Ideal System of Units:

1. **The fundamental units can be accurately reproduced without reference to a prototype. (Portability)**

2. **There are simple ratios(conversion factors)among units of the same type.(Convertibility)**

3. **Different types of units are defined in terms of each other using simple relationships.(Interrelatedness)**

Length:

Unit	Abbreviation	Relation to a meter
millimeter	**mm**	$\frac{1}{1{,}000}m$ or $.001m$
centimeter	**cm**	$\frac{1}{100}m$ or $.01m$
decimeter	**dm**	$\frac{1}{10}m$ or $.1m$
meter	**m**	$1m$
dekameter	**dam**	$10m$
hectometer	**hm**	$100m$
kilometer	**km**	$1{,}000m$

Conversions:

1) Convert 480mm into meters.

$$480mm \cdot \left(\frac{1m}{1000mm} \right) = .48m$$

Decimal point 3 places to the left.

2) Convert 6.6cm into millimeters.

$$6.6cm \cdot \left(\frac{10mm}{1cm} \right) = 66mm$$

Decimal point 1 place to the right.

3) Convert 2km into dekameters.

$$2km \cdot \left(\frac{1000m}{1km}\right) \cdot \left(\frac{1dam}{10m}\right) = 200dam$$

Decimal point 2 places to the right.

4) Convert 423.56dm into kilometers.

$$423.56dm \cdot \left(\frac{1m}{10dm}\right) \cdot \left(\frac{1km}{1000m}\right) = .042356km$$

Decimal point 4 places to the left.

Area:

Unit	Abbreviation	Relation to a square meter
Square millimeter	mm^2	$\frac{1}{1{,}000{,}000}m^2$ or $.000001m^2$
Square centimeter	cm^2	$\frac{1}{10{,}000}m^2$ or $.0001m^2$
Square meter	m^2	$1m^2$
Square kilometer	km^2	$1{,}000{,}000\,m^2$

Conversions:

1) Convert 480,256 square milimeters into square meters.

$$480256mm^2 \cdot \left(\frac{1m^2}{1000000mm^2} \right) = .480256m^2$$

Decimal point 6 places to the left.

2) Convert 6.23754 square kilometers into square meters.

$$6.23754km^2 \cdot \left(\frac{1000000m^2}{1km^2} \right) = 6237540m^2$$

Decimal point 6 places to the right.

3) Convert 48.6 square meters into square centimeters.

$$48.6m^2 \cdot \left(\frac{10000cm^2}{1m^2} \right) = 486000cm^2$$

Decimal point 4 places to the right.

Volume:

Unit	Abbreviation	Relation to a liter
Milliliter(cubic centimeter)	$mL\left(cm^3\right)$	$\frac{1}{1{,}000}$ L or $.001L$
Liter(cubic decimeter)	$L\left(dm^3\right)$	$1L$
Kiloliter(cubic meter)	$kL\left(m^3\right)$	$1{,}000\,L$

Conversions:

1) Convert 42,280 liters into kiloliters.

$$42280L \cdot \left(\frac{1kL}{1000L}\right) = 42.28kL$$

Decimal point 3 places to the left.

2) Convert 6.23754 liters into milliliters.

$$6.23754L \cdot \left(\frac{1000mL}{1L}\right) = 6237.54mL$$

Decimal point 3 places to the right.

Mass:

Unit	Abbreviation	Relation to a gram
milligram	**mg**	$\frac{1}{1{,}000}g$ or $.001g$
gram	**g**	$1g$
kilogram	**kg**	$1{,}000\,g$

Conversions:

1) Convert 176 mg into grams.

$$6176mg \cdot \left(\frac{1g}{1000mg}\right) = 6.176g$$

Decimal point 3 places to the left.

2) Convert 176 mg into kilograms.

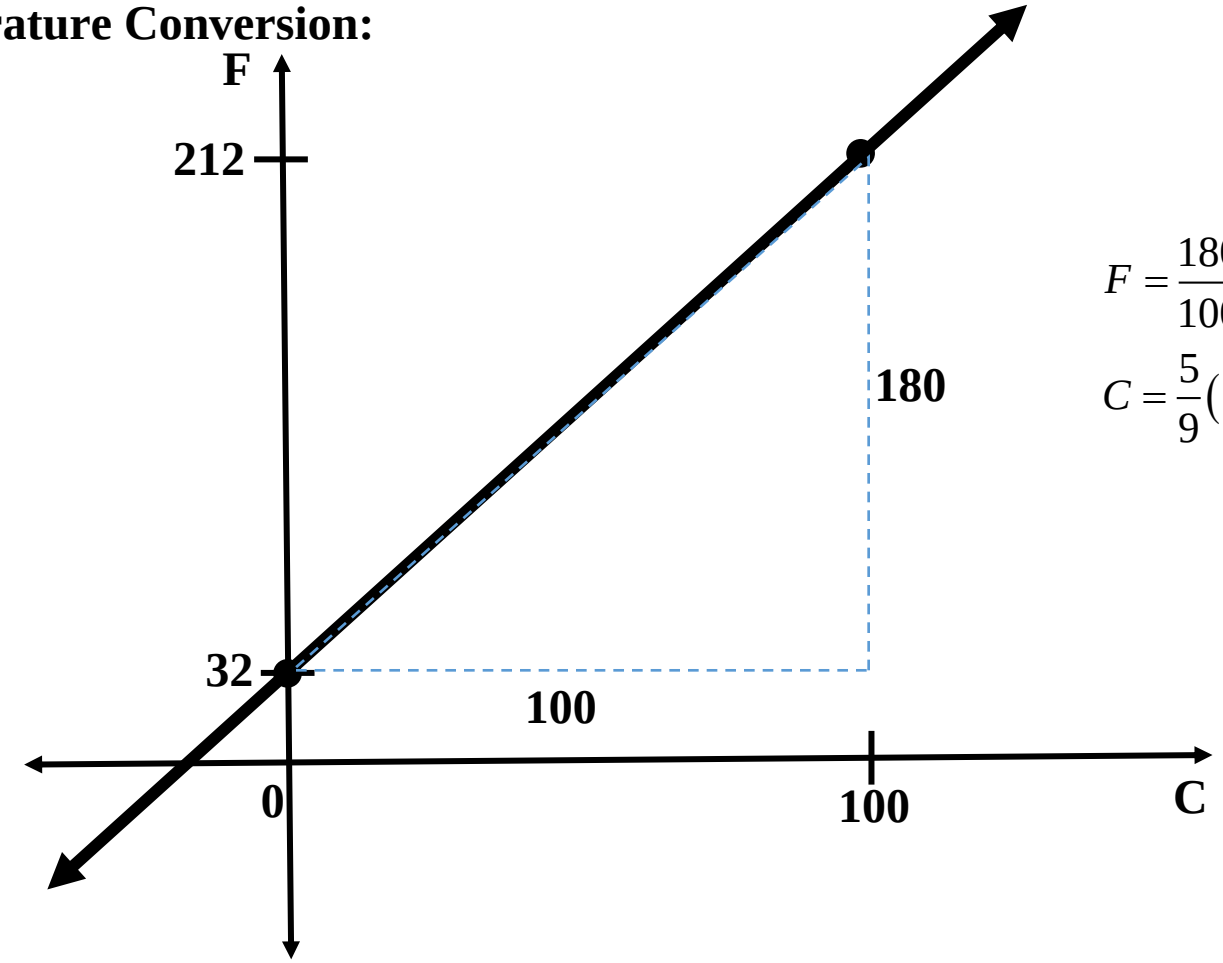
$$176mg \cdot \left(\frac{1g}{1000mg}\right) \cdot \left(\frac{1kg}{1000g}\right) = .000176kg$$

Decimal point 6 places to the left.

Temperature:

Celsius scale with water freezing at $0°C$ **and boiling at** $100°C$ **--- a range of** $100°C$**.**

Temperature Conversion:



$$F = \frac{180}{100}C + 32 = \frac{9}{5}C + 32$$

$$C = \frac{5}{9}(F - 32)$$

Convert $55°C$ into Fahrenheit.

$$F = \frac{9}{5}C + 32 \Rightarrow F = \frac{9}{5} \cdot 55 + 32 \Rightarrow F = 131$$

$$\boxed{131°F}$$

Convert $78°F$ into Celsius.

$$C = \frac{5}{9}(F - 32) \Rightarrow C = \frac{5}{9}(78 - 32) \Rightarrow C = 25\tfrac{5}{9}$$

$$\boxed{25\tfrac{5}{9}°C}$$

Rate Conversions:

Convert 55 miles per hour into feet per minute.

$$\frac{55 miles}{1 hour}\cdot\left(\frac{1 hour}{60\, minutes}\right)\cdot\left(\frac{5{,}280\, feet}{1 mile}\right)=4840\, ft/min$$

Convert 40 kilograms per meter into grams per centimeter.

$$\frac{40 kg}{1 m}\cdot\left(\frac{1{,}000 g}{1 kg}\right)\cdot\left(\frac{1 m}{100 cm}\right)=400 g/cm$$

Convert $72 lb/ft^3$ **into tons per cubic yard.**

$$\frac{72 lb}{1 ft^3}\cdot\left(\frac{1 ton}{2{,}000 lb}\right)\cdot\left(\frac{27\, ft^3}{1 yd^3}\right)=.972\, ton/yd^3$$