

Chapter 2

Measurements In Chemistry

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Chapter 2-1

Measurements are not exact

→
*Measurements can never
be exact; there is always
some uncertainty.*



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Chapter 2-2

Metric System



**Metric system units
are becoming
increasingly evident
on highway signs.**

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Chapter 2-3

Metric Prefixes

	Prefix*	Symbol	Mathematical Meaning*
Multiples	giga-	G	1,000,000,000 (10^9 , billion)
	mega-	M	1,000,000 (10^6 , million)
	kilo-	k	1000 (10^3 , thousand)
Fractional parts	deci-	d	0.1 (10^{-1} , one-tenth)
	centi-	c	0.01 (10^{-2} , one-hundredth)
	milli-	m	0.001 (10^{-3} , one-thousandth)
	micro-	μ (Greek mu)	0.000001 (10^{-6} , one-millionth)
	nano-	n	0.00000001 (10^{-9} , one-billionth)
	pico-	p	0.000000000001 (10^{-12} , one-trillionth)

*Other prefixes also are available but are less commonly used.
*The power-of-10 notation for denoting numbers is considered in Section 2.6.

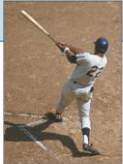


← Table 2.1

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Chapter 2-4

Metric System Base Units

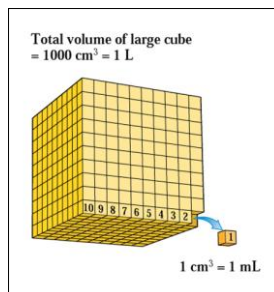
→ Fig. 2.2
Comparisons of the base metric system units of length, mass, and volume with common objects.

(a) Length	(b) Mass	(c) Volume
A meter is slightly larger than a yard. 1 meter = 1.09 yards. A baseball bat is about 1 meter long.	A gram is a small unit compared to a pound. 1 gram = 1/454 pound. Two pennies, five paper-clips, and a marble have masses of about 5, 2, and 5 grams, respectively.	A liter is slightly larger than a quart. 1 liter = 1.06 quarts. Most beverages are now sold by the liter rather than by the quart.
		
E.R. Deggringer		

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Volume Units (cm^3 , L and mL)



← Fig. 2.3
A cube 10 cm on a side is equal to 1 L; a cube 1 cm on a side is equal to 1 mL.

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Solution Concentration Units

The use of the concentration unit milligrams per deciliter is common in clinical laboratory reports dealing with the composition of human body fluids.

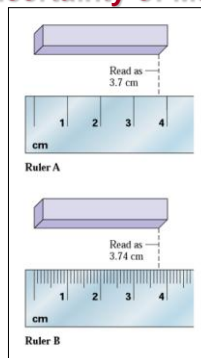
Healthy: LM	371203	371203	371303
M	27	Your Doctor Anywhere, U.S.A.	05169
000-00-000			032136
Test Name	Result	Units	Normal Reference Range
CHEM-SCREEN PROFILE			
CALCIUM	9.70	mg/dL	9.00-10.40
PHOSPHATE (as PHOSPHORUS)	3.00	mg/dL	2.20-4.30
BUN	16.00	mg/dL	9.00-21.0
CREATININE	1.80	mg/dL	0.60-1.30
BUN/CREATININE RATIO	12.21		12-20
URIC ACID	7.50	mg/dL	3.60-8.30
GLUCOSE	114.00	mg/dL	65.0-130
TOTAL PROTEIN	7.90	g/dL	6.50-8.00
ALBUMIN	3.10	g/dL	3.50-4.50
GLOBULIN	2.40	g/dL	2.10-3.50
ALBU/GLO RATIO	1.82		1.20-2.20
TOTAL BILIRUBIN	0.15	mg/dL	0.20-1.20
DIRECT BILIRUBIN	0.08	mg/dL	0.04-0.20
CHOLESTEROL	203.00	mg/dL	140-220
CHOLESTEROL PERCENTILE	50	PERCENTILE	1-74
HDL CHOLESTEROL	71	mg/dL	
LDL CHOLESTEROL	101.2	mg/dL	
TRIGLYCERIDES	148.00	mg/dL	50.0-200

(B) THE RESULT OBTAINED FOR THE CHOLESTEROL/HDL CHOLESTEROL RATIO FOR THIS PATIENT'S SAMPLE IS ASSOCIATED WITH THE LOWEST CORONARY HEART DISEASE (CHD) RISK.

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Chapter 2-7

Uncertainty of Measurements

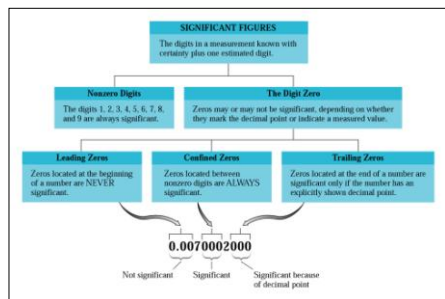


The scale on a measuring device determines the magnitude of the uncertainty for the recorded measurement.

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Chapter 2-8

Significant Figures in Measurements



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Chapter 2-9

Rounding off from Calculator Answer

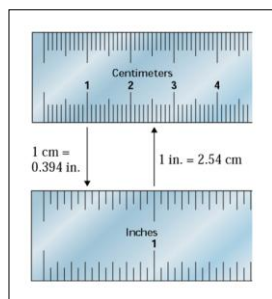
The digital readout on an electronic calculator usually shows more digits than are needed.



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Chapter 2-10

Unit Conversions



It is experimentally determined that 1 inch equals 2.54 cm, or 1 cm equals 0.394 inch

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Chapter 2-11

Unit Conversion Factors

	Metric to English	English to Metric
Length		
1.00 inch = 2.54 centimeters	1.00 in.	2.54 cm
	2.54 cm	1.00 in.
1.00 meter = 39.4 inches	39.4 in.	1.00 m
	1.00 m	39.4 in.
1.00 kilometer = 0.621 mile	0.621 mi	1.00 km
	1.00 km	0.621 mi
Mass		
1.00 pound = 454 grams	1.00 lb	454 g
	454 g	1.00 lb
1.00 kilogram = 2.20 pounds	2.20 lb	1.00 kg
	1.00 kg	2.20 lb
1.00 ounce = 28.3 grams	1.00 oz	28.3 g
	28.3 g	1.00 oz
Volume		
1.00 quart = 0.946 liter	1.00 qt	0.946 L
	0.946 L	1.00 qt
1.00 liter = 0.265 gallon	0.265 gal	1.00 L
	1.00 L	0.265 gal
1.00 milliliter = 0.034 fluid ounce	0.034 fl oz	1.00 mL
	1.00 mL	0.034 fl oz

← Table 2.2

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Chapter 2-12

Common Conversion Factors

Characteristics of Conversion Factors <ul style="list-style-type: none"> • Ratios that specify how units are related to each other • Derived from equations that relate units <ul style="list-style-type: none"> 1 minute = 60 seconds • Come in pairs, one member of the pair being the reciprocal of the other <ul style="list-style-type: none"> 1 min = 60 sec 60 sec = 1 min • Conversion factors originate from two types of relationships: <ul style="list-style-type: none"> (1) defined relationships (2) measured relationships 	Conversion Factors from DEFINED Relationships <ul style="list-style-type: none"> • All English-to-English and metric-to-metric conversion factors • Such conversion factors have an unlimited number of significant figures <ul style="list-style-type: none"> 12 inches = 1 foot (exactly) 4 quarts = 1 gallon (exactly) 1 kilogram = 10³ grams (exactly) • Metric-to-metric conversion factors are derived using the meaning of the metric system prefixes. 	Prefixes That INCREASE Base Unit Size <ul style="list-style-type: none"> kilo- 10³ mega- 10⁶ giga- 10⁹
	Conversion Factors from MEASURED Relationships <ul style="list-style-type: none"> • All English-to-metric and metric-to-English conversion factors • Such conversion factors have a specific number of significant figures, depending on the precision of the defining relationship <ul style="list-style-type: none"> 1.00 lb = 454 g (three sig figs) 1.000 lb = 453.6 g (four sig figs) 1.0000 lb = 453.59 g (five sig figs) 	Prefixes That DECREASE Base Unit Size <ul style="list-style-type: none"> deci- 10⁻¹ centi- 10⁻² milli- 10⁻³ micro- 10⁻⁶ nano- 10⁻⁹

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Chapter 2-13

Densities and Masses

Both of these items have a mass of 23 grams, but they have very different volumes; therefore, their densities are different as well.



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Chapter 2-14

Properties of Gases, Liquids and Solids

→ Table 2.3

Solids (25°C)			
gold	19.3 g/cm ³	table salt	2.16 g/cm ³
lead	11.3 g/cm ³	bone	1.7–2.0 g/cm ³
copper	8.93 g/cm ³	table sugar	1.59 g/cm ³
aluminum	2.70 g/cm ³	wood (pine)	0.30–0.50 g/cm ³
Liquids (25°C)			
mercury	13.55 g/mL	water	0.997 g/mL
milk	1.028–1.035 g/mL	olive oil	0.92 g/mL
blood plasma	1.027 g/mL	ethyl alcohol	0.79 g/mL
urine	1.003–1.030 g/mL	gasoline	0.56 g/mL
Gases (25°C and 1 atmosphere pressure)			
chlorine	3.17 g/L	nitrogen	1.25 g/L
carbon dioxide	1.96 g/L	methane	0.66 g/L
oxygen	1.42 g/L	hydrogen	0.08 g/L
air (dry)	1.29 g/L		

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Why the Coin floats on Mercury?



← Fig. 2.9

The penny is less dense than the mercury it floats on.

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Chapter 2-16

Measurements of Body Density



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Chapter 2-17

Specific Heat of Substances

→ Table 2.4

Substance	Specific Heat (cal/ g · °C) ^a
water, liquid	1.00
ethyl alcohol	0.58
olive oil	0.47
wood	0.42
aluminum	0.21
glass	0.12
silver	0.057
gold	0.031

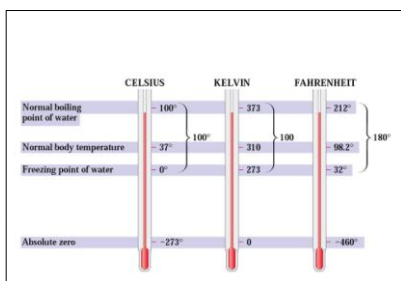
^aThe unit notation cal/g · °C means calories per gram per degree Celsius.

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Temperature Scales

• Fig 2.10
The relationships among the Celsius, Kelvin, and Fahrenheit temperature scales are determined by the degree sizes and the reference point values.



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Chapter 2-19