GENERAL CHEMISTRY
CH 103

Section
00:00 - 00:00 S. T. Th

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Room

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1. INTRODUCTION: MATTER & MEASUREMENTS

1.4 Units of Measurements

1.5 Uncertainty in Measurements

1.6 Dimensional Analysis

Units of Measurements

Measurement =	**number**	**+ unit**
	1.5	**meter**
	0.85	**kilogram**

International System of Units (SI)

Based on the metric system (powers of 10)

Seven base units + derived units

SI Base Units

Base Quantity	Name of Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Temperature	kelvin	K
Amount of substance	mole	mol
Time	second	s
Electrical current	ampere	A
Luminescence intensity	candella	cd

Prefixes Used with SI Units

Prefix	Symbol	Factor	Example
giga-	G	10^9	1 gigabyte (Gb) = 1x10^9 bytes
mega-	M	10^6	1 megameter (Mm) = 1x10^6 m
kilo-	k	10^3	1 kilogram (kg) = 1000 g
deci-	d	10^{-1}	1 decimeter (dm) = 1 x 10^{-1} m
centi-	c	10^{-2}	1 centimeter (cm) = 1 x 10^{-2} m
milli-	m	10^{-3}	1 millimeter (mm) = 1 x 10^{-3} m
micro-	μ	10^{-6}	1 micrometer (μm) = 1 x 10^{-6}m
nano-	n	10^{-9}	1 nanometer (nm) = 1 x 10^{-9} m
pico-	p	10^{-12}	1 picometer (pm) = 1x10^{-12} m

Derived Units

Volume:

V = length x width x height

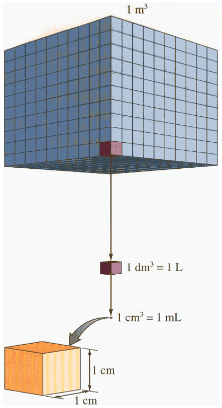
m x m x m = m^3 Cubic meter

In lab we use L:

1 m^3 = 1000 L

1 dm^3 = 1 L = 1000 mL

1 mL = 1 cm^3 = 1 cc



1 m^3

1 dm^3 = 1 L

1 cm^3 = 1 mL

Derived Units

Density:

$$d = \frac{\text{mass}}{\text{volume}} = \frac{\text{kg}}{\text{m}^3}$$

$$\underset{\text{solids}}{\frac{1\ \text{g}}{\text{cm}^3}} = \underset{\text{liquids}}{\frac{1\ \text{g}}{\text{mL}}} = \frac{1\ \text{kg}}{\text{dm}^3} = \frac{1000\ \text{kg}}{\text{m}^3}$$

for gases: $\frac{\text{g}}{\text{L}}$

Temperature Scales

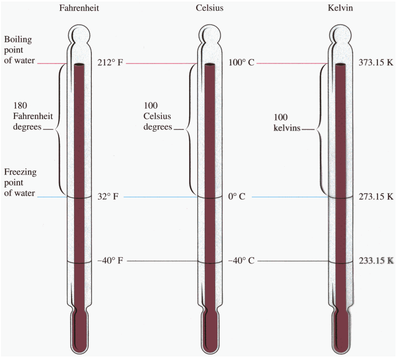
Three scales in use:

Kelvin (K)

Celsius (°C)

Fahrenheit (°F)

Fahrenheit Celsius Kelvin



$$\Rightarrow \frac{100}{180} = \frac{5}{9}$$

$$\frac{9}{5} = \frac{180}{100} \Leftarrow$$

Conversion Between Scales

°F → °C $\quad$ $$°C = (°F - 32°F) \times \frac{5°C}{9°F}$$

°C → °F $\quad$ $$°F = \frac{9°F}{5°C} \times °C + 32°F$$

°C → K $\quad$ $$K = °C + 273$$

Uncertainty in Measurements

Numbers in scientific work are:

Exact numbers

There values are known exactly

1 dozen = 12, 1 kg = 1000 g, 3 students

Inexact numbers

There values have some *uncertainty*

UNCERTAINTY **ALWAYS EXIST IN MEASURED QUANTITIES**

Precision and Accuracy

Precision:

How close a set of measurements are to each other

Mass of 5 g object:

student A:	5, 7, 3
student B:	5, 7, 6

Student B is more precise

Precision and Accuracy

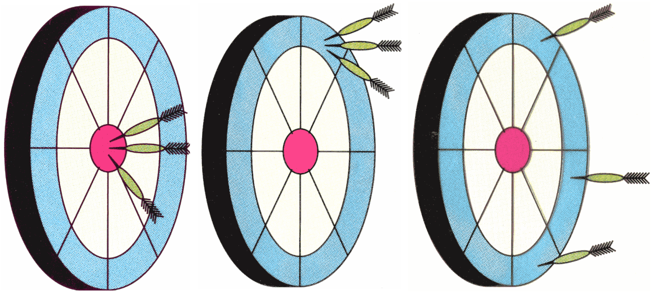
Accuracy:

How close a measurement is to the “true” value

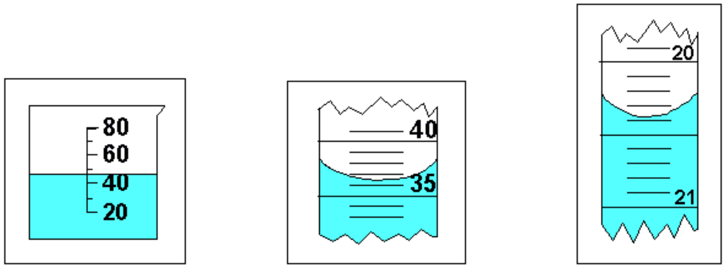
Mass of 5 g object:

average of student A:	5
average of student B:	6

Student A is more accurate



Accuracy:	accurate	not accurate	not accurate
Precision:	precise	precise	not precise



47 mL	36.5 mL	20.37 mL
± 1 mL	± 0.1 mL	± 0.01 mL
2 sf	3 sf	4 sf

Significant Figures

Number of certain digits plus the first uncertain digit

Indicates the margin of error (uncertainty) in a measured or calculated quantity

Uncertainty = ±1 in the last digit unless otherwise indicated

Counting Significant Figures

All digits are SIGNIFICANT except:

Zeros at the beginning of a number.

ALWAYS NOT SIGNIFICANT

00250105 0.00250105

Zeros at the end of a number without a decimal place. MAY OR MAY NOT?

1200 10000

Counting Significant Figures

May or May Not

1200	2 – 4 sf
1.2×10^3	2 sf
1.20×10^3	3 sf
1.200×10^3	4 sf
1200 ± 1	4 sf
1200 ± 10	3 sf

Counting Significant Figures

Exact numbers

Contain $\underline{\text{infinite}}$ number of significant figures

Counting Objects:

15 students

6 APPLES

Conversion Factors:

1 dozen = 12 objects

1 inch = 2.54 cm exactly

Examples

How many significant figures in each of the following?

1.0070 m	5 sig figs
100890 L	5 sig figs
3.29×10^3 s	3 sig figs
0.0054 cm	2 sig figs
3200000	2 sig figs
3 oranges	infinite

Rounding Off Numbers

If the digit to be removed is:

> 5 round up

$2.345\underline{7}$ to 4 sig figs 2.346

If the digit to be removed is:

< 5 round down

$2.3\underline{4}57$ to 2 sig figs 2.3

Rounding Off Numbers

If the digit to be removed = 5

Nonzero digits after: round up

$2.3\underline{5}401$ to 2 sig figs 2.4

$2.3\underline{5}00102$ to 2 sig figs 2.4

Rounding Off Numbers

If the digit to be removed = 5
Zero digits after

round up if preceding digit is odd

2.350 to 2 sig figs 2.4

round down if preceding digit is even

2.450 to 2 sig figs 2.4

Significant Figures in Calculations

Addition and subtraction(+/-)

Follow the fewest number of decimal places

6.8 + 11.934 = 18.734

= 18.7 3 sig figs

Examples

Calculation	Calculator	Answer
3.24 m + 7.0	10.24 m	10.2 m
100.0 g - 23.73 g	76.27 g	76.3 g
0.02 cm + 2.371 cm	2.391 cm	2.39 cm
2.030 mL - 1.870 mL	0.16 mL	0.160 mL

Significant Figures in Calculations

Multiplication and division (×/÷)

Follow the fewest number of significant figures

6.38 x 2.0 = 12.76

= 13 2 sig figs

Examples

Calculation	Calculator	Answer
3.24 m x 7.0 m	22.68 m^2	23 m^2
0.02 cm x 2.371 cm	0.04742 cm^2	0.05 cm^2
710 m ÷ 3.0 s	236.666.. m/s	240 m/s
1818.2 lb x 3.23 ft	5872.786 lb.ft	5870 lb.ft

Mixed Operations

$(4.02 + 5.612)(15.2 - 15.15) = ??$

$(9.632)\ (0.05) = 0.4816$

$= 0.5 = 5 \times 10^{-1}$

$(67.12 + 71.59)(0.0056) \div (4.23 - 4.19) = ??$

$(138.71)\ (0.0056) \div (0.04) =$

$(138.71)\ (0.0056) \div (0.04) = 19.4194$

$= 20 = 2 \times 10^{1}$

Dimensional Analysis Factor-Label Method

Convert between different units using a conversion factor

$$\text{given quantity} \times \text{conversion factor} = \text{desired quantity}$$

$$\cancel{\text{given unit}} \times \frac{\text{desired unit}}{\cancel{\text{given unit}}} = \text{desired unit}$$

Dimensional Analysis Factor-Label Method

Some Conversion Factors:

1 in = 2.54 cm

$$\frac{1\ \text{in}}{2.54\ \text{cm}} \equiv \frac{2.54\ \text{cm}}{1\ \text{in}}$$

1 mm = 10^{-3} m

$$\frac{1\ \text{mm}}{10^{-3}\ \text{m}} \equiv \frac{10^{-3}\ \text{m}}{1\ \text{mm}} \equiv \frac{10^{3}\ \text{mm}}{1\ \text{m}} \equiv$$

Dimensional Analysis

How many mL are in 1.63 L?

$$\text{given} \times \frac{\text{desired}}{\text{given}} = \text{desired}$$

$$1.63\,\cancel{\text{L}} \times \frac{1000\ \text{mL}}{1\ \cancel{\text{L}}} = 1630\ \text{mL}$$

$$1.63\ \text{L} \times \frac{1\ \text{L}}{1000\ \text{mL}} = 0.00163\ \frac{\text{L}^2}{\text{mL}}$$

Dimensional Analysis

The density of gold is 19.3 g/cm^3.
Convert the density to lb/in^3.

1 lb = 453.6 g; 1 in = 2.54 cm exactly.

$$\frac{19.3\,\cancel{\text{g}}}{\cancel{\text{cm}^3}} \times \frac{1\ \text{lb}}{453.6\ \cancel{\text{g}}} \times \frac{(2.54\ \cancel{\text{cm}})^3}{(1\ \text{in})^3} = 0.697245\ \text{lb/in}^3$$

$$= 0.697\ \text{lb/in}^3$$

Convert density to kg/m^3 and lb/ft^3

Dimensional Analysis

The speed of sound in air is about 343 m/s. What is this speed in miles per hour?

1 mi = 1609 m; 1 h = 60 min; 1 min = 60 s

$$\frac{343\ \cancel{\text{m}}}{\cancel{\text{s}}} \times \frac{1\ \text{mi}}{1609\ \cancel{\text{m}}} \times \frac{60\ \cancel{\text{s}}}{1\ \cancel{\text{min}}} \times \frac{60\ \cancel{\text{min}}}{1\ \text{h}}$$

$$= 767.433\ \text{mi/h}$$

$$= 767\ \text{mi/h}$$

Dimensional Analysis

How many µm are there in 1.5 x 10^{-7} km?

$$1.5 \times 10^{-7}\ \cancel{\text{km}} \times \frac{10^3\ \cancel{\text{m}}}{1\ \cancel{\text{km}}} \times \frac{10^6\ \mu\text{m}}{1\ \cancel{\text{m}}}$$

$$\times \frac{1\ \mu\text{m}}{10^{-6}\ \text{m}}$$

$$= 1.5 \times 10^2\ \mu\text{m}$$