GENERAL CHEMISTRY

Principles and Modern Applications

TENTH EDITION

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Matter: Its Properties and Measurement

1

Chemistry: Science that deals with the composition and properties of Matter

What is Matter?

Matter: Occupies space, has mass and inertia

Composition: Parts or components
ex. H_2O, 11.19% H and 88.81% O

Properties: Distinguishing features
physical and chemical properties

physical property: does not involve a change in composition
chemical property: involves conversion into a new kind of matter, with different composition

Classification of Matter

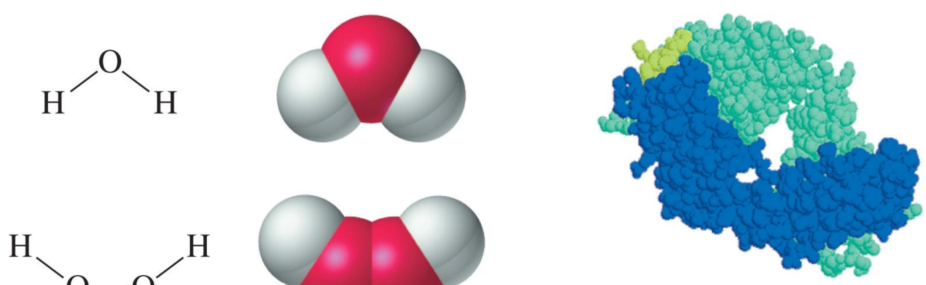
Matter is made of **atoms**.

Elements (periodic table). 112 elements known

About 90 of them available from natural sources

Compounds are comprised of two or more elements.

Molecules are the smallest units of compounds.



Gamma globulin

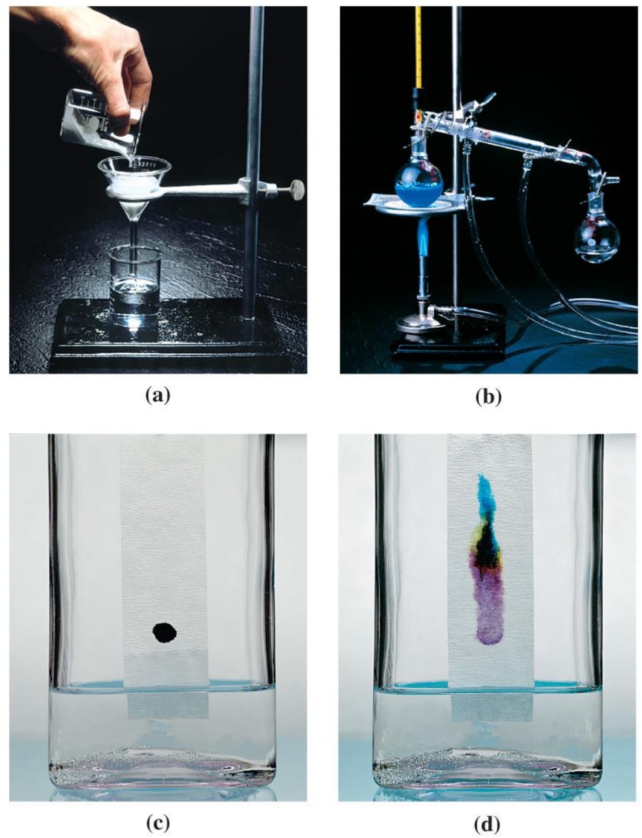
Single compound or element: pure ñsubstanceò

Several compounds or elements: mixture (can be separated by physical process)

Separation of Mixtures ï Physical Processes

Filtration

Distillation

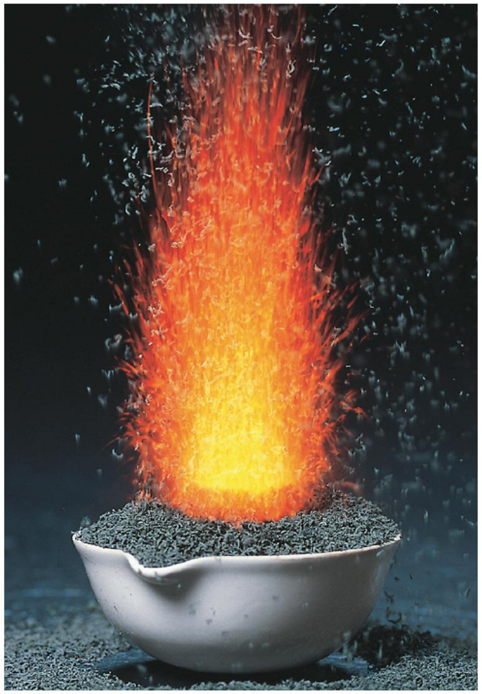


Chromatography

▲ FIGURE 1-5

Separating Mixtures: a physical process

Chemical processes



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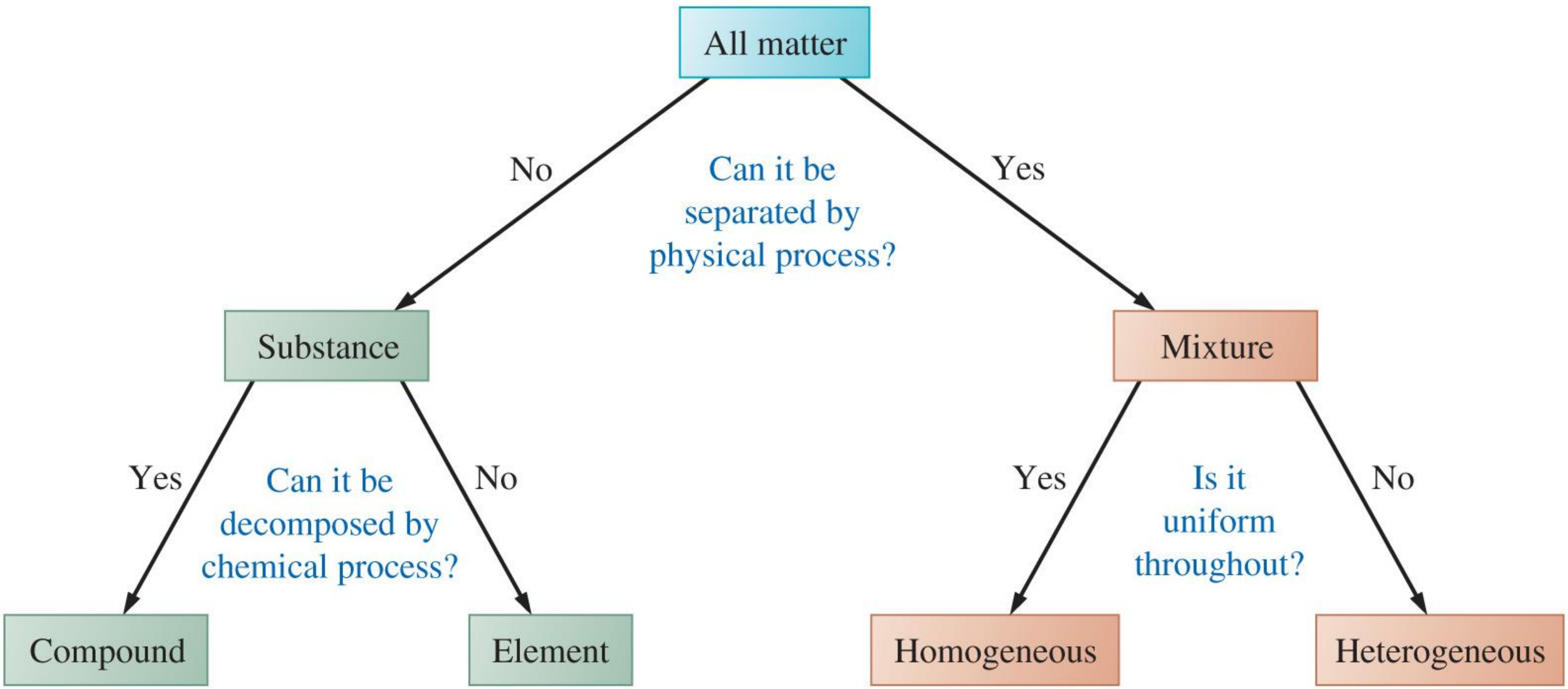
Ammonium dichromate **decomposes** into chromium(III) oxide, nitrogen and water when heated

▲ FIGURE 1-6

A chemical change: decomposition of ammonium dichromate

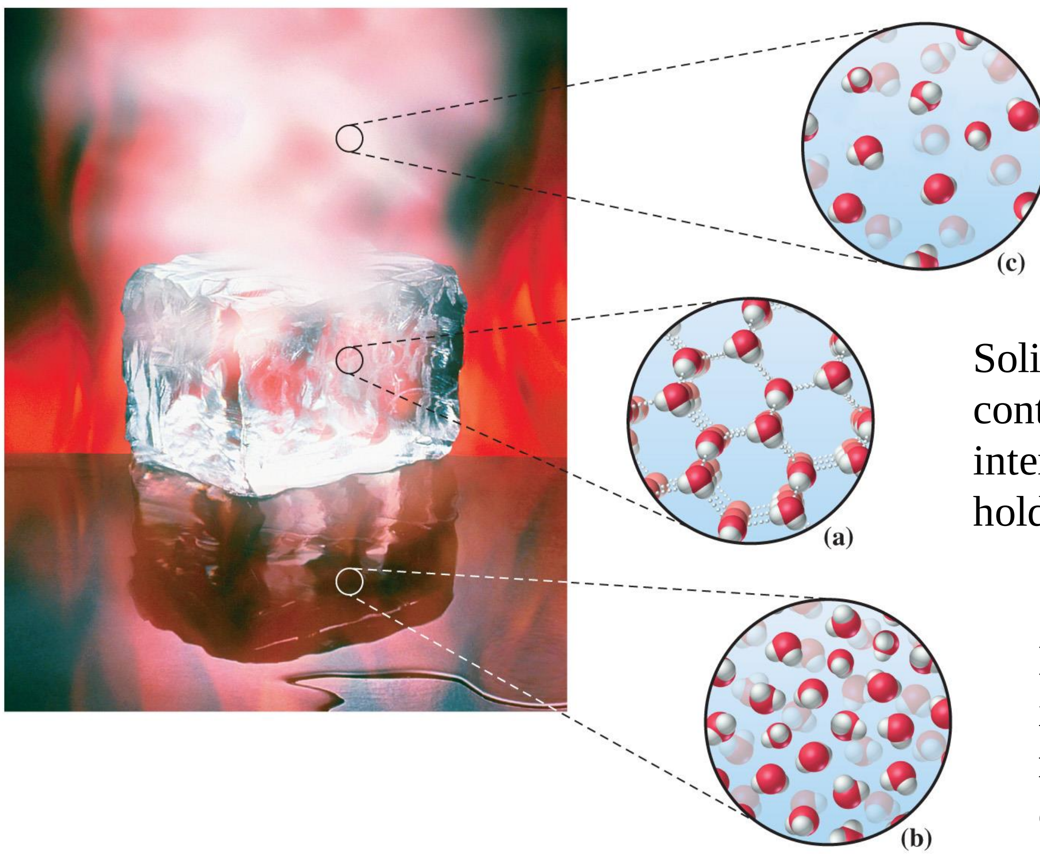
A classification scheme for matter



Uniform in composition and properties throughout

Composition and properties vary from one part to another

Sates of Matter: solid, liquid, gas



Gas: molecules are separated by large distances expanding to a the volume of their container

Solid: molecules are in close contact, with strong interactions between them holding them rigid

Liquid: molecules are in intermediate contact, not rigidly associated with each other; will assume the shape of its container

Examples:

Physical or chemical properties?

1. Iron nail is attracted to a magnet
2. Bronze statue develops a ñgreenò coating over time

Substances or mixtures?

1. Clean fresh air
2. Ice
3. Seawater
4. Bronze

Examples

How would you separate the following mixtures into their components?

1. Ground glass and sucrose
2. Pure water from seawater
3. Oil and water
4. Iron from iron oxide

1-4 The Measurement of Matter

TABLE 1.1 SI Base Quantities

Physical Quantity	Unit	Symbol
Length	meter[a]	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Amount of substance[b]	mole	mol
Electric current[c]	ampere	A
Luminous intensity[d]	candela	cd

All other physical quantities have units that are derived from these seven base quantities (example: volume)

Slide 10

PD4 This table needs to be replaced with table in the new colour scheme.
Philip Dutton, 3/3/2010

decimal system

TABLE 1.2 SI Prefixes

Multiple	Prefix
10^{18}	exa (E)
10^{15}	peta (P)
10^{12}	tera (T)
10^{9}	giga (G)
10^{6}	mega (M)
10^{3}	kilo (k)
10^{2}	hecto (h)
10^{1}	deka (da)
10^{-1}	deci (d)
10^{-2}	centi (c)
10^{-3}	milli (m)
10^{-6}	micro (μ)[a]
10^{-9}	nano (n)
10^{-12}	pico (p)
10^{-15}	femto (f)
10^{-18}	atto (a)
10^{-21}	zepto (z)
10^{-24}	yocto (y)

[a]The Greek letter μ (pronounced "mew").

PD5 This table needs to be replaced with the one in the new colour scheme
Philip Dutton, 3/3/2010

Mass

Mass is the **quantity** of matter in an object.

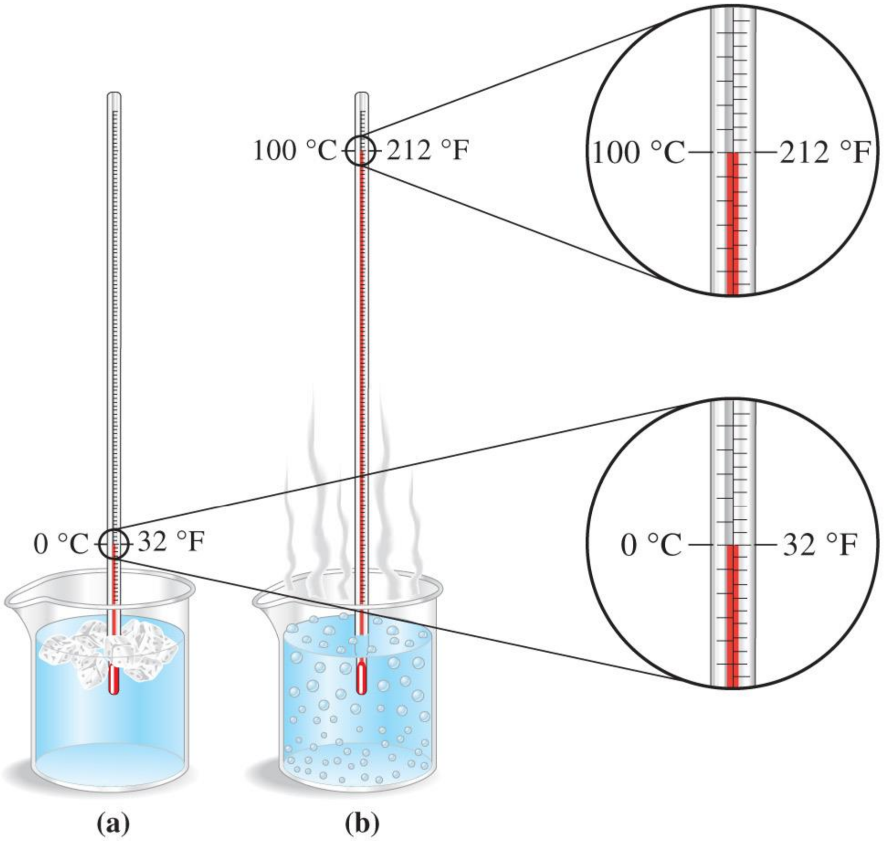
SI Unit: Kilogram

Weight is the force of gravity on an object

$W \alpha m$ $\qquad$ $W = g \times m$

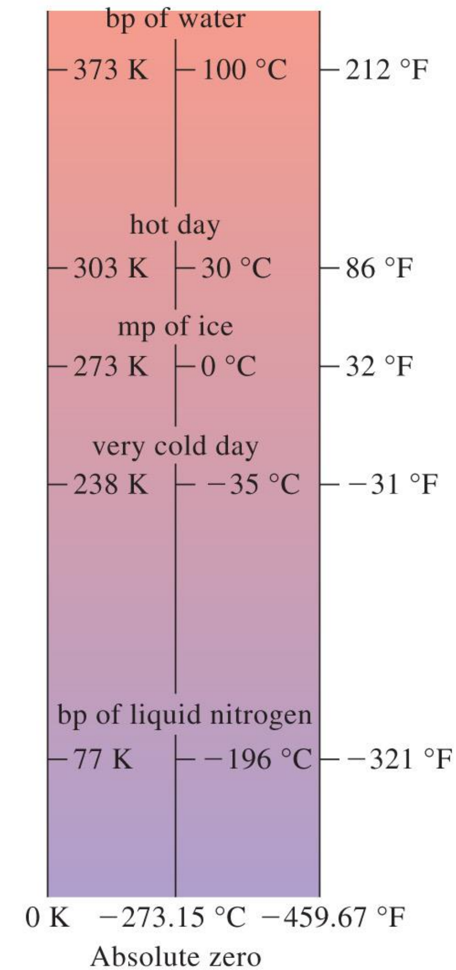
Temperature:

SI Unit: Kelvin



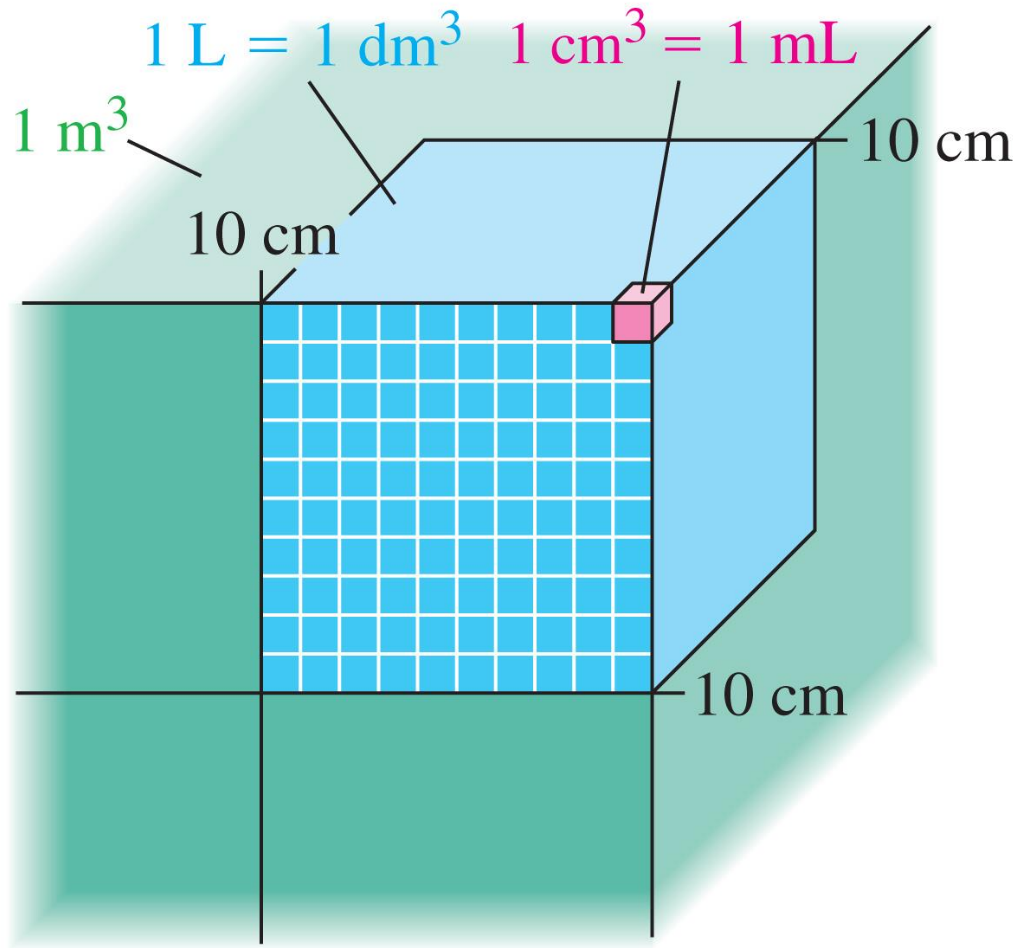
Freezing pt. of water = 0ºC

Boiling pt. of water = 100ºC



Kelvin scale: assigns 0K to the lowest possible temperature (= –273.15ºC)
interval size (degree) is the same as the Celsius scale

Volume (derived unit)



SI Units

Length	meter, m
Mass	Kilogram, kg
Time	second, s
Temperature	Kelvin, K
Quantity	Mole, 6.022×10^{23} mol^{-1}

Non-SI Units

Length	Angstrom, Å, 10^{-8} cm
Volume	Liter, L, 10^{-3} m^3
Energy	Calorie, cal, 4.184 J
Pressure	

$1 \text{ Atm} = 1.064 \times 10^2$ kPa

$1 \text{ Atm} = 760$ mm Hg

Derived Units

Force	Newton, kg m s^{-2}
Pressure	Pascal, kg m^{-1} s^{-2}
Energy	Joule, kg m^2 s^{-2}

(SI: Systeme Internationale dôUnites)

Density = mass/volume

$$d = m/V$$

$$m = Vd \qquad V = m/d$$

Units: g/mL

Mass and volume are **extensive** properties

(depend on the quantity)

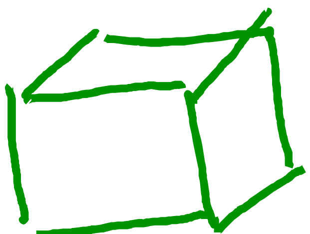
Density is an **intensive** property

Can use the **density (**d) to obtain mass if the volume is known, or the volume is the mass is known

Example

What is the mass of a cube of osmium that is 1.25 inches on each side?

Have volume, need density = 22.59g/cm^3



1.25 in

$(1.25)^3 \, in^3$

$2.54 \, cm = 1 \, in$

$$V = \left(1.25 \, \cancel{in} \times \frac{2.54 \, cm}{1 \, \cancel{in}}\right)^3 = \left[(1.25)(2.54)\right]^3 cm3$$

$32.007 \, cm^3$

Slide 17

PD1 Replace figure, density value is wrong
Philip Dutton, 3/3/2010

$$d = \frac{m}{V}$$

$$32.007\ cm^3 = V$$

$$d = 22.59\ gr/cm^3$$

$$m = dV = 32.007\ \cancel{cm^3} \times 22.59\ g/\cancel{cm^3}$$

$$= \underline{723.}\ g$$

Percent Composition (example)

Seawater is 3.5% sodium chloride (salt) by mass

ñthere are 3.5g of sodium chloride per 100g of seawaterò

3.5g(NaCl)/100g(seawater)

Using percent composition (conversion factor):

Can obtain the mass of sodium chloride in a sample of seawater of a given mass

Or, the mass of seawater that contains a given amount of sodium chloride

Example

Seawater is 3.5% sodium chloride (salt) by mass

ñthere are 3.5g of sodium chloride per 100g of seawaterò

3.5g(NaCl)/100g(seawater)

Using percent composition (conversion factor):

How much NaCl is there in 670g of seawater? 3.5% by mass

$$\frac{3.5\text{ g NaCl}}{100\text{ g seawater}}$$

$$670\text{ g }\cancel{\text{seawater}} \times \frac{3.5\text{ g NaCl}}{100\text{ g }\cancel{\text{seawater}}} = 23.45\text{ g NaCl}$$

Uncertainties in Scientific Measurements

- Systematic errors.
  - Thermometer constantly 2° C too low.
- Random errors
  - Limitation in reading a scale.
- Precision
  - Reproducibility of a measurement.
- Accuracy
  - How close to the real value.