Vocabulary Focus: Recognize SI units and their importance for measurement
Reading Focus: understanding atoms, elements and compounds formulae
Writing Focus: Varying The Sentence Beginning

Studying Mathematical Terms, Units, Symbols

The International System of Units (abbreviated SI) is the metric system used in science, industry, and medicine. Every field of science involves taking measurements, understanding them, and communicating them to others. In other words, we all have to speak the same basic language.
The SI system, also called the metric system, is used around the world.
There are seven basic units in the SI system: the meter (m), the kilogram (kg), the second (s), the kelvin (K), the ampere (A), the mole (mol), and the candela (cd).

Unit name	Unit symbol	Quantity name	Quantity symbol	Dimension symbol
meter	m	length	l, x, r	L
kilogram	kg	mass	m	M
second	s	time	t	T
ampere	A	electric current	I	I
kelvin	K	thermodynamic temperature	T	Θ
candela	cd	luminous intensity	I_v	J
mole	mol	amount of substance	n	N

Metric units use a prefix, used for conversion from or to an SI unit. Below is a chart illustrating how prefixes are labeled in metric measurements.

SYMBOL	PREFIX	MULTIPLICATION FACTOR
T	Tera	10^{12}
G	Giga	10^{9}
M	Mega	10^{6}
k	Kilo	10^{3}
h	Hecto	10^{2}
da	Deka	10^{1}
d	Deci	10^{-1}
c	Centi	10^{-2}
m	Milli	10^{-3}
μ	Micro	10^{-6}
n	Nano	10^{-9}
p	Pico	10^{-12}

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Calculations

9 + 2	= nine plus two equals / is equal to
20 – 7	= twenty minus seven equals / is equal to
4 x 36	= four multiplied by thirty-six/four times thirty-six equals / is equal to
10: 5	= ten divided by five equals / is equal to
$\log_a x$	= Log base a of x equals / is equal to

Powers and roots

x^2	x squared
x^3	x cubed
x^4	x to the fourth (power)/ x to the four/ x to the power (of) four/ x raised to the fourth power
x^{-5}	x to the power (of) minus five / x to the minus five / x to the minus fifth (power)
x^y	x to the y
$\sqrt{x}$	the square root of x
$\sqrt[3]{x}$	the cube root of x
$\sqrt[n]{x}$	the nth root of x

Numbers

100	a / one hundred
101	a hundred and one
4,938	four thousand nine hundred and thirty-eight
5,405	five thousand four hundred and five

Ordinals

1st	the first
2nd	the second
3rd	the third
24th	the twenty-fourth

Decimals

0.25	zero point two five	(*After the point, say numbers separately*)
$\frac{1}{2}$	a / one half	
$\frac{5}{2}$	five halves	
$\frac{1}{3}$	a / one third	
$\frac{2}{3}$	two thirds	
$\frac{1}{4}$	a / one quarter	
$\frac{1}{5}$	a / one fifth	
$\frac{3}{7}$	three sevenths	
$\frac{27}{200}$	twenty-seven over two hundred	(*Complex fractions are usually said with over.*)
$\frac{a}{b}$	a over b	

Percentages
27 % twenty-seven per cent

Temperature
95° C ninety-five degrees Celsius/Centigrade
13° F thirteen degrees Fahrenheit

Units
mol mole
mol/dm3
a mole per cubic decimetre / AmE decimeter
ml millilitre / AmE milliliter

Symbols

( )	round brackets
[ ]	square brackets
{}	curly brackets
(A+B)	open brackets, A plus B, close brackets / A+B in brackets
A < B	A is less than B
A > B	A is greater than B
A ≠ B	A is not equal to B
A ≈ B	A is approximately equal to B
→	give(s), lead(s) to, yield(s)
↔	forms and is formed from
x_2	subscript
x^2	superscript
p1V1 = p2V2	small p subscript one capital V subscript one equals small p subscript two capital V subscript two

Let's practice

Write the following expressions

25,326 = _____
58th = _____
1.012 15,123,014 = _____
7^6 = _____
100°C = _____
11.019 = _____
5 H_2O 3 H_2SO_3 = _____
8% = _____
2 $KClO_3$ → 2 KCl + 3 O_2 = _____
14^{-2} = _____
9 mol/dm3 = _____
5 Cu $(NO_3)_2$ = _____
$\sqrt[4]{16}$ = _____
$\frac{6}{7}$ = _____

$\frac{3}{4}$ = _____

$\frac{6}{2}$ = _____

$\frac{45}{173}$ = _____

Reading Comprehension

Atoms, elements and compounds

Chemists use symbols and formulae to represent elements and compounds. Word equations and balanced chemical equations represent the changes that happen in chemical reactions.

Chemical symbols

All substances are made from tiny particles called atoms. An atom is the smallest part of an element that can exist.

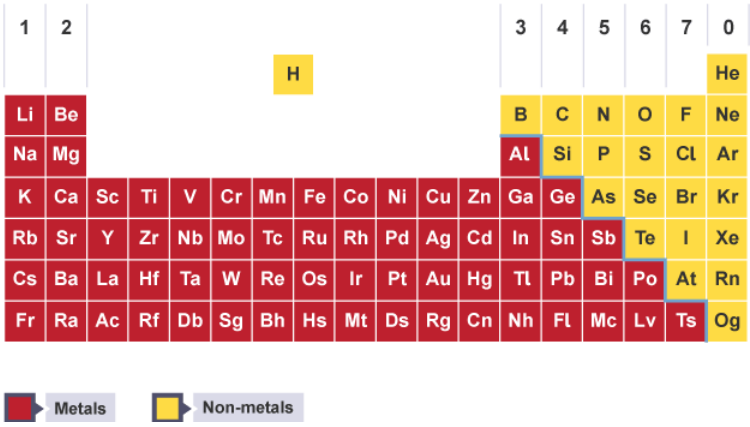
Atoms of each element are represented by their own chemical symbol. A chemical symbol:

- consists of one or two letters
- always starts with a capital letter, with any other letter in lower case

For example the symbol O represents an atom of oxygen, and Na represents an atom of sodium. You must write the chemical symbol of sodium as Na, not as NA, na or nA.

There are over 100 different elements. The names and symbols of the elements are shown in the periodic table. Elements are arranged into groups with similar properties. Groups are numbered from 1 to 7, then 0.

In the periodic table, metals are on the left of the stepped line, and non-metals are on the right.



Each box in the periodic table shows the chemical symbol for an element

Chemical formulae of elements

A chemical formula is used to represent an element or compound in balanced chemical equations. The formula for most elements is just its chemical symbol. For example:

- helium, He
- lithium, Li
- beryllium, Be
- boron, B
- carbon, C
- neon, Ne
- sodium, Na
- magnesium, Mg

It's important to use the names and chemical symbols for the first 20 elements in the periodic table, as well as the elements in groups 1 and 7.

Some non-metal elements exist as molecules that are made up of two atoms joined together. The formulae of these elements are the element's symbol followed by a subscripted '2'. For example:

- iodine, I_2
- bromine, Br_2
- chlorine, Cl_2
- fluorine, F_2
- oxygen, O_2
- nitrogen, N_2
- hydrogen, H_2

A mnemonic can be used to remember these elements: ***I Bring Clay For Our New House.***

It's important to remember which elements exist as molecules, and which do not. Take care to use the correct form in chemical equations involving these elements.

Chemical formulae of compounds

A compound is a substance that contains two or more elements that are chemically combined. The elements in a compound are present in fixed proportions. For example, carbon dioxide always has 12 g of carbon for every 32 g of oxygen.

A chemical formula can be used to represent a compound. The formula shows:

- the symbols for each element in the compound
- the number of atoms of each element in a unit of the compound

For example, magnesium oxide is made up of two elements, magnesium and oxygen. Its formula is MgO. This shows that it has one atom of magnesium for every one atom of oxygen.

Here are some more examples of compounds and their formulae. The subscript number in a formula shows if there is more than one atom of an element.

Name of compound	Formula
Sodium chloride	NaCl
Potassium bromide	KBr
Magnesium iodide	MgI_2
Carbon dioxide	CO_2
Carbon monoxide	CO
Sulfur trioxide	SO_3
Water	H_2O
Ammonia	NH_3
Methane	CH_4

Many compounds exist naturally. They can also be formed from their elements in chemical reactions. In a chemical reaction, one or more new substances are formed. Most chemical reactions involve energy changes.

It is not easy to split up a compound into its elements - the only way to do this is in chemical reactions.

In compounds made up of nonmetal elements only, the second word of the compound's name starts with mon, di, or tri, eg carbon dioxide. This shows the number of atoms of this element for every one atom of the first element in the name. So for carbon dioxide there are two oxygen atoms for every carbon atom.

Chemical formulae of ions

An ion is a charged particle formed when an atom, or a group of atoms, loses or gains electrons. The number and sign of its electrical charges are shown in superscript text.
Names and formulae of some common ions:

Name of ion	Formula of ion	Electrical charge(s)
Sodium	Na^{+}	One positive
Magnesium	Mg^{2+}	Two positive
Chloride	Cl^{-}	One negative
Oxide	O^{2-}	Two negative

Simple formulae

The formula of an ionic compound can be predicted using the formulae of its ions. The numbers of ions in a formula must give an equal number of positive and negative charges.

Name of compound	Formula	Electrical charges
Sodium chloride	$NaCl$	One positive, one negative
Sodium oxide	Na_2O	Two positive, two negative
Magnesium oxide	MgO	Two positive, two negative
Magnesium chloride	$MgCl_2$	Two positive, two negative

Word equations

A word equation represents a chemical reaction using the names of the substances involved. Word equations do not show any chemical symbols or formulae.

Reactants and products

Reactants are substances that react together in a chemical reaction. In a chemical reaction, the atoms or ions in reactants separate from one another. They join back together in a different way to form products.
Word equations always take this form: reactants → products
A + sign separates two or more reactants, or two or more products.

Example word equations

Potassium hydroxide reacts with sulfuric acid. Potassium sulfate and water are formed in the reaction. This means that:

- the reactants are potassium hydroxide and sulfuric acid
- the products are potassium sulfate and water
- the word equation is: potassium hydroxide + sulfuric acid → potassium sulfate + water

Chemical equations contain an arrow and not an equals sign. The arrow means 'reacts to make'.

There can be different numbers of reactants and products. For example:

- sodium + chlorine → sodium chloride
- calcium carbonate → calcium oxide + carbon dioxide

Balanced chemical equations

A balanced chemical equation represents a chemical reaction using the formulae of the reactants and products. It shows the **number** of units of each substance involved.

State symbols

Balanced chemical equations sometimes include state symbols in brackets after each formula. They show the physical state of that substance.

State symbol	Meaning
(s)	Solid
(l)	Liquid
(g)	Gas
(aq)	Aqueous solution

An aqueous solution forms when a substance dissolves in water.

State symbols are useful because they show what a substance is like. For example:

- $H_2O(l)$ is liquid water but $H_2O(g)$ is steam and $H_2O(s)$ is ice
- $HCl(g)$ is hydrogen chloride gas but $HCl(aq)$ is hydrochloric acid

Balancing an equation

The law of conservation of mass states that no atoms are lost or made during a chemical reaction, so the total mass of the products is equal to the total mass of the reactants.
This means that chemical reactions can be represented by symbol equations. A balanced symbol equation has the same number of atoms of each element on both sides of the arrow.

To balance an equation, add numbers to the left of one or more formulae. Here is one way to work out how to do this for the reaction between nitrogen and hydrogen.

Step	Result
Check to see if there are an equal number of atoms of each element on both sides. There aren't.	$N_2 + H_2 \rightarrow NH_3$
There are two nitrogen atoms on the left but only one on the right, so put a big 2 on the left of the NH_3.	$N_2 + H_2 \rightarrow 2NH_3$
Check again. There are two hydrogen atoms on the left but (2 × 3) = 6 on the right, so put a big 3 in front of the H_2.	$N_2 + 3H_2 \rightarrow 2NH_3$
Check again to see if there are equal numbers of each element on both sides. There are.	(Two nitrogen atoms and six hydrogen atoms)
Add the state symbols if asked to do so.	$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

Balanced chemical equations only show formulae, not names. A balancing number, written in normal script, multiplies all the atoms in the substance next to it.

Quiz: tick the right answer

1. What is the chemical symbol for the element mercury?
   a) Hg
   b) HG
   c) hg

2. What is the name of the compound with the formula MgBr2?
   a) Magnesium bromide
   b) Magnesium dibromide
   c) Magnesium bromine

3. How many different types of atom are in one molecule of a substance that has the formula N2O4?
   a) 6
   b) 4
   c) 2

4. What is the best definition of a compound?
   a) A substance made up of two or more elements that are chemically combined
   b) A substance made up of two or more elements that are chemically combined in fixed proportions
   c) A substance made up of two elements that are chemically combined in fixed proportions

5. What is the formula of a substance made up of Al3+ ions and O2- ions?
   a) Al2O3
   b) Al3O2
   c) AlO3

6. What are the reactants in this word equation? sodium hydroxide + hydrochloric acid → sodium chloride + water
   a) Sodium hydroxide and sodium chloride
   b) Sodium hydroxide and hydrochloric acid
   c) Sodium chloride and water

7. Which numbers correctly fill the gaps to balance this equation? _Na + Cl2 → _NaCl
   a) 2, 4
   b) 4, 2
   c) 2, 2

8. Which numbers correctly fill the gaps to balance this equation? C_3H_8 + __O_2 → __CO_2 + __H_2O

a) 3, 3, 2
b) 10, 3, 8
c) 5, 3, 4

Writing:

Varying Sentence Beginning

Starting every sentence with a noun, pronoun or noun phrase can make your writing extremely repetitive and boring. In order to make your writing more complex and fluent, you should learn to vary the structure and beginnings of your sentences.

➢ Start with a PREPOSITIONAL PHRASE:	***With** a smile*, *Ken ran the race knowing he would win.*
➢ Start with a PARTICIPLE (-ing /-ed) PHRASE:	***Knowing** he would win, Ken ran the race with a smile.*
➢ Start with a DEPENDENT CLAUSE:	***Because he knew he would win**, Ken ran the race with a smile.*
➢ Start with an ADJECTIVE / ADVERB:	***Happily**, Ken ran the race knowing that he would win.*
➢ Start with an INFINITIVE:	***To win**, Ken ran the race smiling, sure of his success.*

LET'S PRACTICE

Revise the following sentences by varying their beginnings.

■ Use the notes in parentheses to determine whether the sentence should start with: adjective/ adverb, infinitive, participle phrase, dependent clause or a prepositional phrase.

1. The public was highly entertained by silent films in the early days of moviemaking. (Prepositional phrase)

➢ _____

2. The stars of these first films had to be very expressive in their use of gestures because there was no dialogue. (Dependent clause)

➢ _____

3. Moviemakers congregated in Hollywood, California, and developed a film community. (participle phrase)

➢ _____

4. Someone usually played a piano in the theater to accompany the action in the film. (infinitive)

➢ _____

5. Humans bonded with wolves originally. (Adverb)

- _____

Rewrite the following sentence, using different sentence openings.

Jacqueline called Marilyn to ask her if she wanted to meet at the library to study for an upcoming biology exam.

- _____
- _____
- _____
- _____
- _____

Rewrite the following paragraph, combining sentences and using a variety of sentence structures.

My cousin enjoys her job. She is a counselor at a summer camp. She teaches crafts during the day. She sleeps in a cabin with ten-year-olds. She says that some of them are homesick at first. They usually get over it after a couple of days.

_____
_____
_____
_____
_____
_____
_____