Molecules and compounds

☞ **1** Use the words in the word bank to complete the following passage.

All matter is made up of a_____. Atoms are rarely found on their own. They are often found joined together, forming m_____.

In molecules, the atoms that are chemically joined together may all be the same or they may be d_____. We can have molecules of an e_____ – for example, hydrogen (H_2) or oxygen (O_2) – or we can have molecules of a c_____. Compounds are substances that are made up of t_____ or more elements chemically joined together. For example, w_____ (H_2O) and ammonia (NH_3) are both compounds. The s_____ H_2O and NH_3 are the formulas for water and ammonia. A chemical formula tells us which t_____ of atoms are present and how m_____ atoms of each type there are per molecule.

Word bank
symbols
atoms
different
molecules
two
water
type
element
many
compound

2 Classify each of the following as either a molecule of an element or a molecule of a compound.

P_4 _____ I_2 _____

HCl _____ CO _____

CH_4 _____ S_8 _____

3 Complete the following information. The first one has been done for you.

Substance	Formula	Each molecule contains
water	H_2O	2 atoms of hydrogen, 1 atom of oxygen
magnesium oxide	MgO	
salt (sodium chloride)	NaCl	
carbon dioxide	CO_2	
sugar	$C_{12}H_{22}O_{11}$	
oxygen gas	O_2	
ammonia gas	NH_3	

Naming compounds (1)

Most chemical **formulas** for **compounds** have numbers in them, as well as the symbols for different elements. These numbers tell us how many atoms of each element there are in one molecule of the compound.

Rule 1

When two elements are present:

- the metal is named first
- the elements will combine to made a compound ending in 'ide'
- if both are non-metals and one of them is hydrogen, hydrogen is written first.

For example:

KBr	potassium brom**ide**
MgO	magnesium ox**ide**
NaCl	sodium chlor**ide**
CaS	calcium sulf**ide**

Rule 2

When two or more elements combine with oxygen:

- the metal is named first
- the compound often ends with part of the name of the second element, combined with 'ate'.

For example:

Na_2CO_3	sodium carbon**ate**
$ZnSO_4$	zinc sulf**ate**
$NaNO_3$	sodium nitr**ate**
$MgSO_4$	magnesium sulf**ate**

Rule 3

When there are only two elements and both are non-metals:

- if hydrogen is present, it is written first
- prefixes are joined to the name of the second element to show how many atoms of it there are. The prefixes are:
  - di – 2 • tri – 3 • tetra – 4 • penta – 5.

  Mono means 1. The '1' is commonly left out, because scientists assume that no prefix means that there is only one of that atom.)

  For example:

CO_2	carbon **di**oxide	CO	carbon **mon**oxide
SO_3	sulfur **tri**oxide	HBr	hydrogen bromide

Naming compounds (2)

Use the information on the Resource sheet 'Naming compounds (1)' to answer the following questions.

☞ **1** Fill in the missing words in the sentences below.

a When two e_____ combine, the name usually ends in 'i_____'.

b When two elements combine, the m_____ is written first.

c When two or more elements combine with o_____, the name of the compound usually ends in 'a_____'.

d If two elements are present and both are n_____-metals, we use a p_____ on the second element.

e 'Mono' means o_____.

2 Name the compound that magnesium will make with each of the following elements:

a chlorine _____ **c** fluorine _____

b oxygen _____

3 Complete the table below.

Rule number	Chemical formula	Name of compound
Rule 1	NaBr	
	KI	
	Na_2O	
Rule 2	Na_2CO_3	
	H_2SO_4	
	$CuSO_4$	
Rule 3	SO_2	
	CO	
	NO_3	

Radicals

Many chemical **compounds** contain a chemical **radical**. A chemical radical is a group of atoms that tend to stay together when the compound reacts with another compound. The names of many chemical compounds include the name of the radical they contain.

☞ **1** Complete the table below. The first one has been done for you.

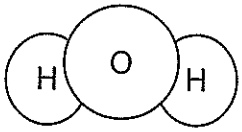
Name of common radical	Formula of radical	Contains
carbonate	CO_3	1 atom of carbon, 3 atoms of oxygen
hydrogen carbonate	HCO_3	
hydrogen sulfate	HSO_4	
hydroxide	OH	
nitrate	NO_3	
sulfite	SO_3	
sulfate	SO_4	
ammonium	NH_4	
phosphate	PO_4	

2 Circle the correct formula for each of the following compounds. Use the table in question 1 to help you.

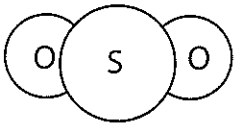
a	magnesium carbonate	$MgCO_2$	MgCO	$MgCO_3$
b	zinc sulfate	$ZnSO_3$	$ZnSO_4$	$ZcSO_4$
c	ammonium chloride	NH_4Cl	NH_3Cl	NH_4CL
d	potassium nitrate	KNO_2	KNO_3	PNO_3
e	sodium hydrogen carbonate	$SHCO_3$	$NaHCO_2$	$NaHCO_3$
f	sodium hydroxide	SOH	NaOH	NaHO

Naming molecules

Molecules of a compound or element can be represented in diagrams. Below are two common molecules.



water



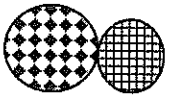
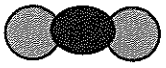
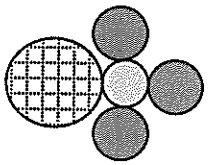
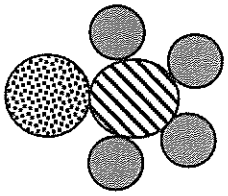
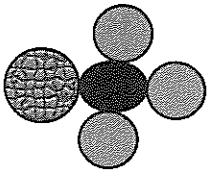
sulfur dioxide

☞ **1** Match the names and formula to the correct diagrams using the key below.

Key

carbon nitrogen magnesium oxygen

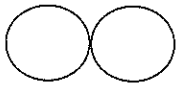
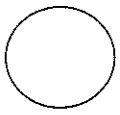
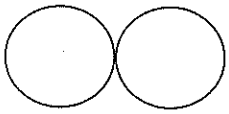
zinc sodium sulfur chlorine potassium

Name	Formula	Molecular diagram
sodium nitrate	$ZnCO_3$	
magnesium sulphate	KCl	
potassium chloride	$NaNO_3$	
nitrogen dioxide	$MgSO_4$	
zinc carbonate	NO_2	

Joining elements (1)

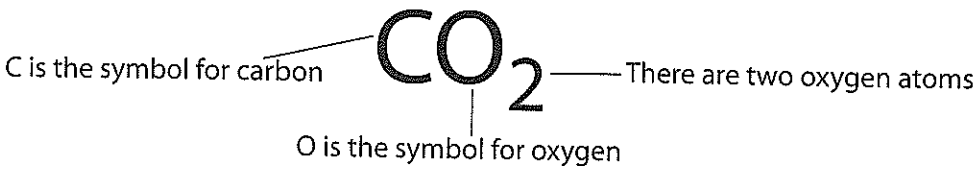
In some **elements**, such as oxygen, the atoms pair up. A particle that is made up of more than one atom is called a **molecule**. We can show this using the chemical symbols for the atoms involved. For example, oxygen molecules can be represented as O_2. The number in the **formula** shows how many atoms of the type there are in the molecule.

We can represent molecules by drawing coloured circles to show the atoms. When we draw a molecule we draw the atoms of that type touching, to show that they are chemically joined together.

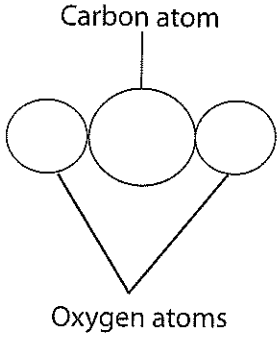
Element	Formula for molecule	Picture of molecule
oxygen – a non-metal gas 	O_2	 oxygen gas
nitrogen – a non-metal gas 	N_2	 nitrogen gas

When two or more atoms from different elements join together, they form a **compound**. The formula for a compound shows the types of elements that are in the compound and the ratio (how many atoms of each element there are).

Carbon dioxide is a compound made up of carbon and oxygen. It has the formula:



This formula tells us that a molecule of carbon dioxide is always made up of one carbon atom and two oxygen atoms. We don't need to add a one after carbon. A chemical formula only includes a number after an element symbol if there is more than one atom of that element.



Joining elements (2)

Read the Resource sheet 'Joining elements (1)', then answer the following questions.

☞ **1** Use the words in the word bank to complete the table.

Word	Description
atom	Tiny p _____ that cannot be b _____ down into s _____ substances
element	Made up of only o _____ type of a _____
compound	Made up of t _____ or more e _____ joined together
molecule	Two or more a _____ joined together. If the atoms are the s _____ it is a m _____ of an element. If the atoms are d _____, it is a molecule of a c _____.

Word bank
atoms
broken
compound
two
particle
simpler
different
same
one
elements
atom
molecule

2 Decide whether each of the following statements is true or false.

a An element is made up of only one type of atom. _____

b A compound can be made of atoms that are the same or different. _____

c A molecule is always made up of two or more different types of atoms. _____

d We use a formula to show the type of elements and the number of atoms of each element in a molecule. _____

e Nitrogen dioxide has the formula NO_2. This tells us that there are two elements present, nitrogen and oxygen, and that one molecule contains one nitrogen atom and two oxygen atoms. _____

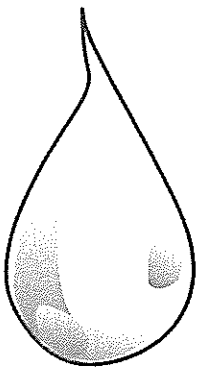
3 Circle the element symbols and underline the formulas of compounds in the box below.

SO_2	Cu	Zn	NaCl	Cl	H_2O	K

Common compounds

Millions of different substances exist on earth. These substances are all made up of just 100 or so elements, which join up in different ways to make different **compounds**.

☞ **1** Water is one of the most common compounds on earth. Number the following sentences about water in an order that makes sense, then rewrite the paragraph in your workbook.



_____ This means that each molecule of water has two atoms of hydrogen combined with one atom of oxygen.

_____ Approximately 70% of an adult's body is made up of water.

_____ Water is one of the most common compounds on earth.

_____ Water is a common compound made up of the elements hydrogen and oxygen.

_____ It is essential for all life on earth.

_____ Scientists write the formula H_2O to represent the water molecule.

2 Draw lines to join up the sentence parts about table salt.

The scientific name for table salt	a compound.
Sodium chloride is	to flavour food.
A molecule of sodium chloride is made up	is sodium chloride.
The formula for table salt is	sodium, which is a metal, and chlorine, which is a non-metal.
Table salt contains two elements:	of one atom of sodium and one atom of chlorine.
Salt is used	NaCl.

3 Draw a diagram of a molecule of water and a molecule of table salt (sodium chloride).

Drawing and making molecules

Molecules are particles that are made up of more than one atom. In a molecule of an **element**, the atoms are the same. In a molecule of a **compound**, the atoms are different.

☞ **1** Using a molecular kit and the periodic table, build the common molecules listed in the table below, then complete the table. When drawing the molecules, use the same colour as the atoms in the molecular kit.

Molecule name	Formula	Molecule diagram	Element or compound
oxygen	O_2		Element
carbon dioxide	CO_2		
ozone	O_3		
water	H_2O		
table salt	NaCl		

2 Next to each molecular compound, write down the name and number of each type of atom that is joined to make the molecule. The first one has been done for you.

a water (H_2O) 2 hydrogen atoms and 1 oxygen atom

b sulfur dioxide (SO_2) _____

c carbon monoxide (CO) _____

d hydrochloric acid (HCl) _____

e table salt (NaCl) _____

Writing chemical formulas

Writing chemical formulas can be tricky, but it is a lot easier if you remember a few rules.

☞ **1** Fill in the missing vowels (a, e, i, o, u) to complete the rules for writing formulas.

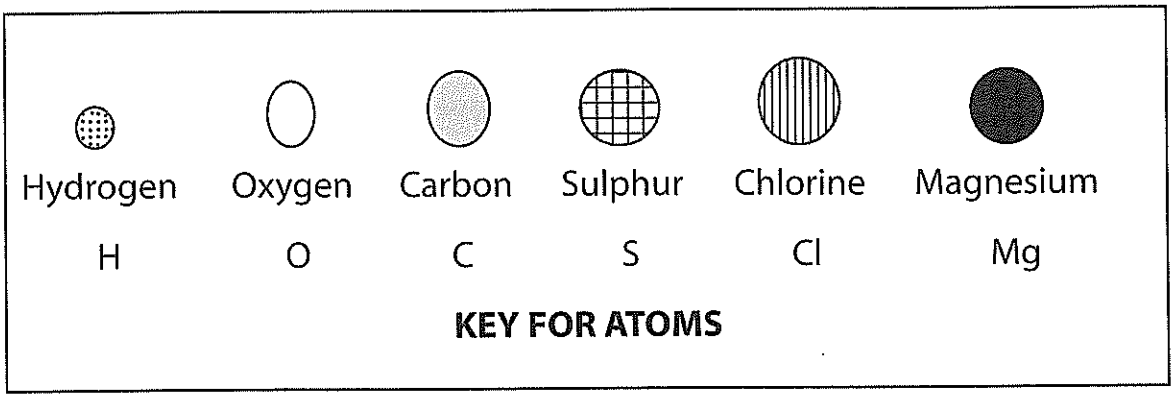
Rule 1: When an el __ m __ nt symbol has one l __ tt __ r, use a c __ p __ tal letter.

Rule 2: When an element symb __ l is made up of tw __ letters, use a capital l __ tter and a l__ wer case letter.

Rule 3: When there is m __ r __ than one at__ m of an element, you must show this by writing a sm __ ll number after the __ lem __ nt symb__l.

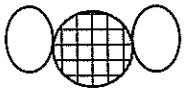
Rule 4: The m__ tal is usually written f __ rst.

Rule 5: Some compound names give you cl __ __ s about the __rd__r of the __l __ment symb __ ls.

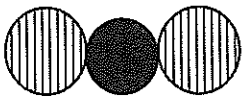


2 Use the key above to write the formulas for the molecules below.

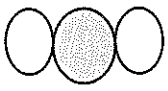
water _____



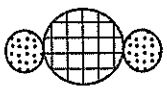
sulfur dioxide _____



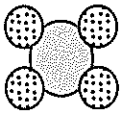
magnesium chloride _____



carbon dioxide _____



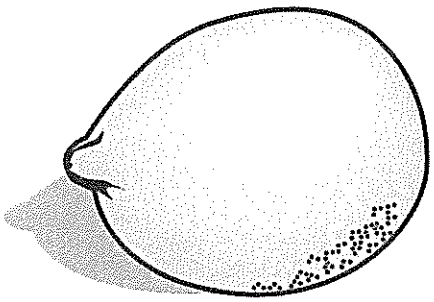
hydrogen sulfide _____



methane _____

What are acids and bases?

Acids and **bases** are two important groups of chemicals that have many different uses in everyday life.



☞ **1** Use the notes below to write a paragraph about **acids** in your workbook.

- very common substances used in everyday life
- contain the element hydrogen
- strong acids are dangerous because they are corrosive
- many foods are acidic, such as citrus fruits and vinegar
- a sour taste
- attack other substances
- common acids include citric acid, found in fruit, and acetic acid, which is vinegar
- common laboratory acids include hydrochloric, sulfuric and nitric acid

2 Fill in the missing vowels (a, e, i, o, u) to complete the passage below about bases.

Bases are the chem __ c __ l opposite of ac __ ds. They have a b __ tter t __ ste and feel slippery or soapy to t __ __ ch. They are often used around the h __ me as cleaning agents. Like acids, some b __ ses are very c __ rr __ sive and therefore can be very d __ ng __ ro __ s to taste and touch. We say that those bases are c __ ust __ c. Strong bases, such as s __ dium hydr __ x __ de and p __ tassi __ m hydroxide are found in __ ven and dra __ n cleaners. Other bases are used in s __ __ ps, shampoos and d __ shwashing liq __ ids. Bases that d __ ssolv __ in w __ t __ r are called alkal __ s.

3 Read the following list of substances. Underline the bases in red pen. Circle the acids in green.

- lemon juice
- sodium hydroxide
- vinegar
- drain cleaner
- nitric acid
- dishwashing liquid
- potassium hydroxide
- cola
- oven cleaner
- lemonade

Indicators

Work safely

Acids and **bases** are often colourless solutions, so it can be hard to tell them apart. To find out if a substance is an acid or a base we use **indicators**, which change colour when mixed with an acid or a base. **Litmus** is an indicator that is made from plants.

Experiment: What colour does litmus paper turn in acids and bases?

Aim: To find out the effect of acids and bases on litmus paper.

Equipment

- red and blue litmus paper
- 3 test tubes
- safety glasses
- labelled dropper bottles of acidic, basic and neutral substances
- test-tube rack

☞ **1** Use the words in the word bank to complete the method.

Method

a Put on safety glasses (and other protective clothing as advised by your teacher).

b Cut three 2-centimetre pieces each of red __ __ __ __ __ __ paper and __ __ __ __ litmus paper.

c Label each test __ __ __ __ using a marker pen. Write 'acid' on one, '__ __ __ __' on another and '__ __ __ __ __ __ __' on the last one.

d Pour in 2 centimetres of each __ __ __ __ __ __ __ __ __ into the correct __ __ __ __ tube.

e Place a piece of __ __ __ litmus paper in each test tube.

f Record any __ __ __ __ __ __ change in the table below.

g Pour substances down the sink with running __ __ __ __ __.

h Repeat the experiment, this time testing with blue litmus paper.

Word bank
neutral
substance
litmus
red
blue
water
tube
colour
test
base

2 Complete the experiment and record your results in the table below.

Type of substance	Effect on red litmus paper	Effect on blue litmus paper
acid		
base		
neutral		