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Photocopy Master Sheets

Years 9-10

Compounds & Reactions

Disk filename = "16.Reactions"

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Topics Available

Year 7-8 General Science

Disk Filename	Topic Name
01.Energy	Energy
02.Forces	Forces
03.Matter	Solids, Liquids & Gases
04.Mixtures	Separating Mixtures
05.Elements	Elements & Compounds
06.Cells	Living Cells
07.Life	Living Things
08.LifeSystems	Plant & Animal Systems
09.Astronomy	Astronomy
10.Earth	The Earth
11.Ecosystems	Ecosystems

Year 9-10 General Science

Disk Filename	Topic Name
12.Waves	Wave Energy (inc. Light)
13.Motion	Forces & Motion
14.Electricity	Electricity
15.Atoms	Atoms & Elements
16.Reactions	Compounds & Reactions
17.DNA	Cell Division & DNA
18.Evolution	Evolution of Life
19.Health	Health & Reproduction
20.Universe	The Universe
21.EarthScience	Earth Science
22.Resources	Resources & Technology

Year 11-12 Science Courses

Biology

Preliminary Core
Local Ecosystem
Patterns in Nature
Life on Earth
Evolution Aust. Biota
HSC Core
Maintain. a Balance
Blueprint of Life
Search for Better Health
Options
Communication
Genetics:Code Broken?

Chemistry

Preliminary Core
Chemical Earth
Metals
Water
Energy
HSC Core
Production of Materials
Acidic Environment
Chem.Monit.&Mngment
Options
Shipwrecks, Corrosion...
Industrial Chemistry

Earth & Envir. Science

Preliminary Core
Planet Earth...
Local Environment
Water Issues
Dynamic Earth
HSC Core
Tectonic Impacts
Environs thru Time
Caring for the Country
Option
Introduced Species

Physics

Preliminary Core
World Communicates
Electrical Energy...
Moving About
Cosmic Engine
HSC Core
Space
Motors & Generators
Ideas to Implementation
Options
Quanta to Quarks
Astrophysics

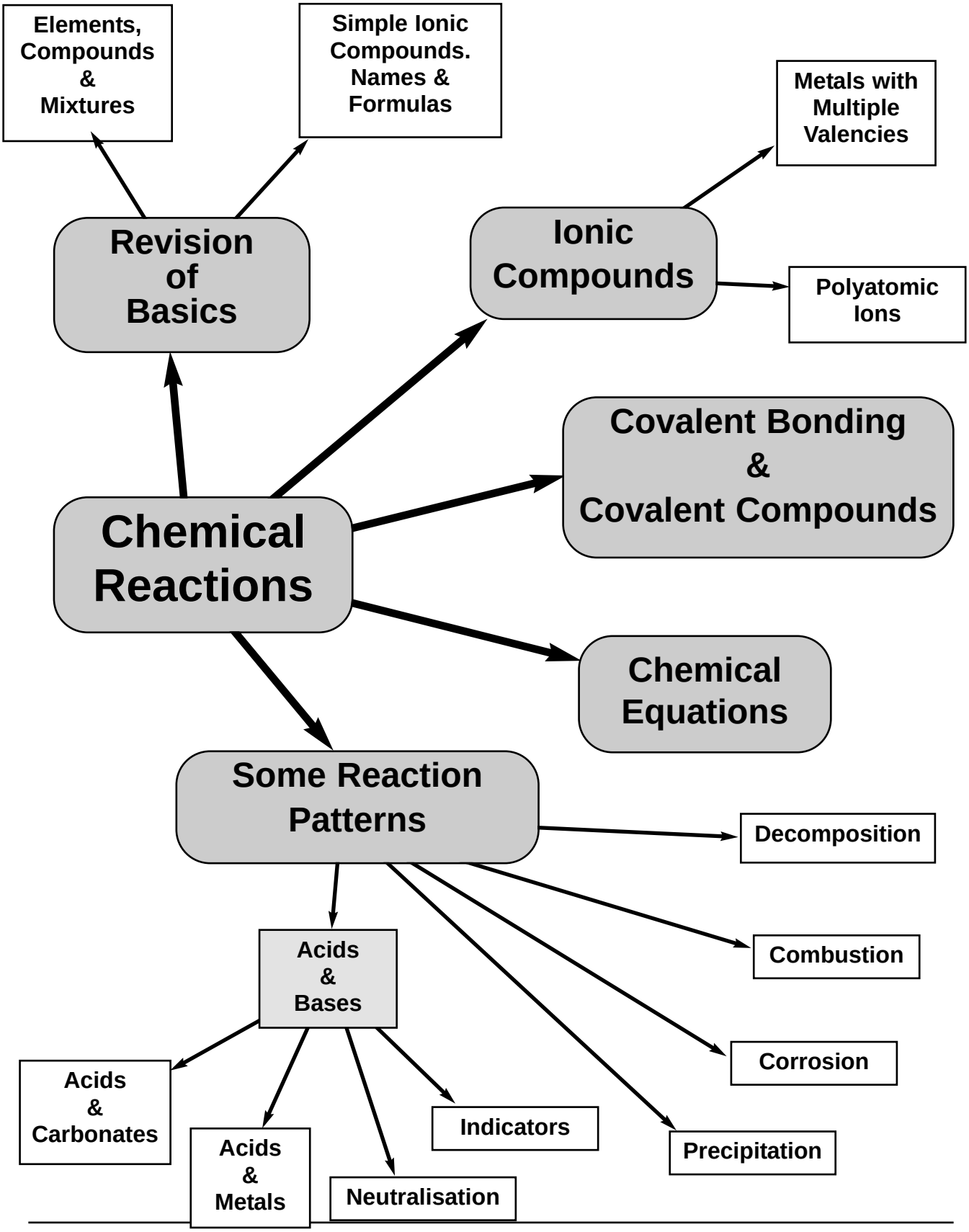
All Topics Available as PHOTOCOPY MASTERS and/or KCiC

Photocopy Masters (PDF files)
Black & White, A4 portrait-orientation for clear, economical photocopying.

KCiC = Key Concepts in Colour
Full colour, formatted for on-screen study and data projection. PDF + Powerpoint®
Powerpoint is a trademark of Microsoft Corp.

"Mind-Map" Outline of Topic

This topic belongs to the branch of Science called "Chemistry". Chemistry is the study of matter and materials. Chemistry looks at the properties of substances, and how substances can change into new forms.



Make your own "Mind-Map" TITLE PAGE.
Cut out the boxes. Sort them into an appropriate lay-out on a page of your workbook, then glue them down. Add connecting arrows and colour in.

Chemical Reactions

Revision of Basics

Ionic Compounds

Polyatomic Ions

Some Reaction Patterns

Chemical Equations

Simple Ionic Compounds. Names & Formulas

Covalent Bonding & Covalent Compounds

Elements, Compounds & Mixtures

Metals with Multiple Valencies

Precipitation

Corrosion

Acids & Bases

Acids & Carbonates

Acids & Metals

Neutralisation

Indicators

Combustion

Decomposition

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Acids & Bases

Acids & Carbonates

Acids & Metals

Neutralisation

Indicators

Combustion

Decomposition

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Why Study Chemistry?

Chemistry is the branch of Science most likely to confuse a student. There are many highly-intelligent, highly-educated adults who freely admit that Chemistry was the one thing they could not get their head around.

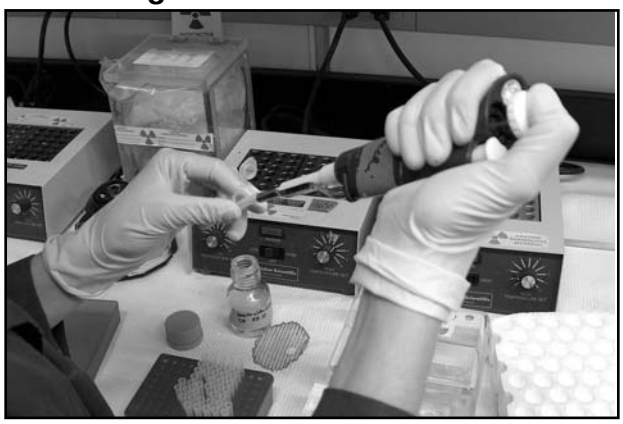
Chemistry is Vital to All Sciences

A Physicist doesn't need to know much Biology and if you become an expert in Plant Science you don't need to know about Astronomy.

Some branches of Science are quite independant of other branches, but Chemistry is important to all of them.

An understanding of atoms and chemical reactions is very helpful, even vital, in the study of Physics, Biology, Ecology, Astronomy, Medicine (and all the related "Health Sciences") Food Science, (even just being a good cook!) and Engineering.

Artists find benefits in knowing the chemistry of paints and materials and farmers do better if they understand fertilisers, pesticides & food chemistry.



How to Succeed at Chemistry

The key to understanding Chemistry is to nail down the basics.

Be sure you understand each simple fact before you move on. Master the basic skills by completing the worksheets and practice exercises. Learn it now and it will help you for life.

Careers in Science

The World Needs Scientists

The world needs scientists now and for the next 20-30 years as never before. We face enormous challenges to provide energy alternatives, while reversing the trend of global warming.

Chemical and biological scientists will be needed to help us switch to renewable resources to make fuels and plastics and much more.

Environmental scientists will be needed to study and report on the state of rivers and forests and the environmental impacts of major developments and building projects.

Even if you don't want to be a professional scientist as such, there are many popular, well-paid careers which are Science-based.

Health & Sports Sciences

Medicine, Physiotherapy, (and many other "therapy" occupations) Nursing and Sports Science all demand a good understanding of Science. Some tertiary institutions give enrolment preference to school-leavers who have studied Chemistry and/or Physics at HSC level.

***Engineering* is traditionally Physics-based, with some specialities needing Chemistry as well.**

Even in careers in the mass media, such as Journalism, there are opportunities for those with a scientific education. So many news stories, TV reports, etc, cover scientific issues that people with such knowledge are in demand.

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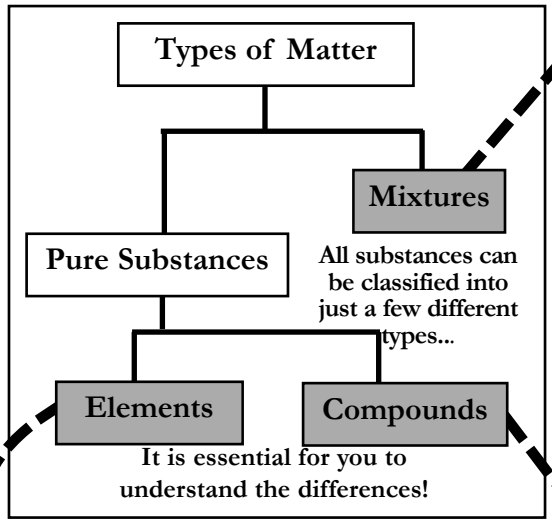
Elements, Compounds & Mixtures

The information on this page is absolutely vital to your understanding of this topic. Make sure you understand everything here before proceeding!

Every substance is either an element, a compound, or a mixture.



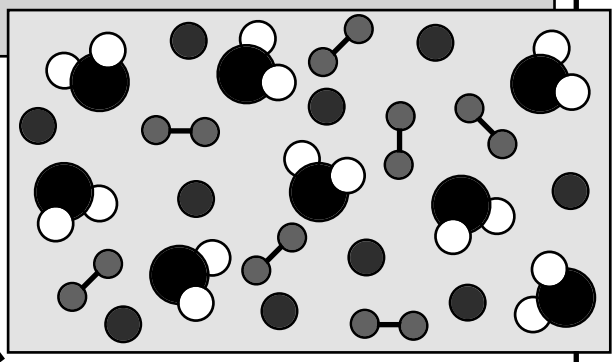
Mixtures

Not pure.
(Different particles within.)

Variable composition and properties.

Can be separated into parts by physical processes.
(filtering, distilling, etc)

May contain elements and/or compounds within the mix.



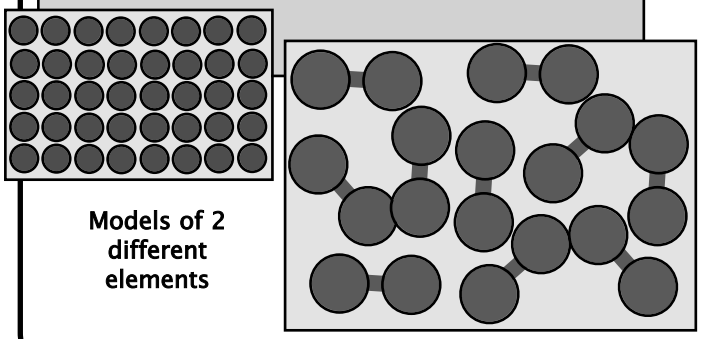
Elements

Pure Substance.
Only one type of atom present.

Each has a unique set of properties.

Listed on the Periodic Table, with its own symbol and Atomic Number.

Cannot be separated into parts by any physical or chemical process.



Models of 2 different elements

Compounds

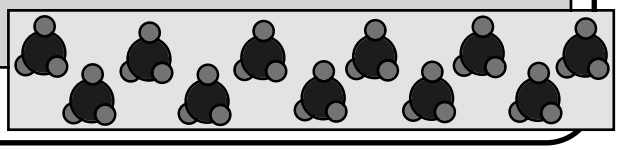
Pure Substance.
Only one type of particle present.

Each has a unique set of properties.

Contains 2 or more elements, chemically bonded together in a fixed ratio.

Cannot be separated into parts by any physical process.

Can be separated into its elements by chemical decomposition.



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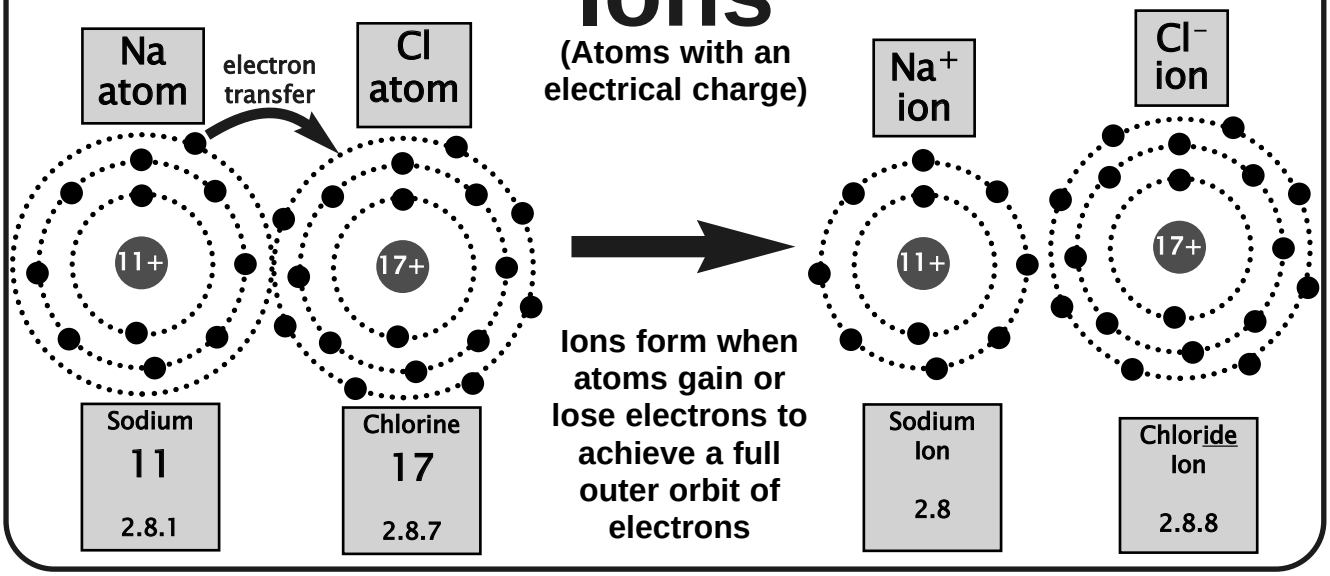
Chemical Bonding Creates Compounds

There are only about 100 chemical elements. Of these, more than half are very rare. Millions of chemical substances are made from just 30-40 elements combining together to form compounds... new substances, with unique properties.

You are reminded of some facts covered in a previous topic...

Ions

(Atoms with an electrical charge)



Ionic Compounds

When atoms become ions they stick together and form a new substance. This is a chemical compound, with different properties to the original elements. Ionic compounds form crystals, made of billions of ions stuck together.

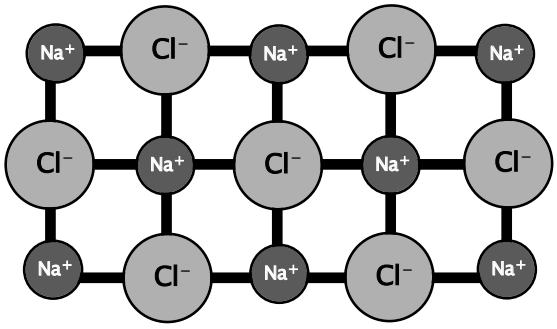
The diagram represents part of a crystal of salt. Salt is the ionic compound sodium chloride, NaCl.

In a real crystal there would be billions of ions in a 3-dimensional "lattice".

The "sticks" joining the ions represent the "ionic chemical bonds" holding the ions together. In reality, the bond is the force of electrical attraction due to their opposite charges.

The formula "NaCl" indicates that the ions stick together in a ratio of 1:1 (in equal numbers).

Other ions may join in a different ratio.



The compound is totally different to the elements it is made from.

Sodium: shiny, silver, soft metal. Good conductor. Reacts violently with water.

Chlorine: yellow-green gas. Poisonous. Non-conductor.

Salt: White crystals. Dissolves in water. Good on chips!

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Some More Things Covered Previously...

Naming Simple Ionic Compounds

When atoms gain or lose electrons to form ions, they then get stuck together by their electrical attraction to form a "crystal lattice" of ions.
This forms a new "compound", totally different to the original elements.

What is the name of each compound?

Names of Metal Ions

Metal atoms lose 1 or more electrons to form an ion. The name of the ion is the same as the atom.

e.g. Sodium atom → Sodium ion

Names of Non-Metal Ions

Non-Metals gain electrons to form ions. Their name always changes to end in -IDE.

e.g. Chlorine atom → Chloride ion

Names of Compounds

Simply put the two ion names together, with the metal always first.

Examples:

Compound of sodium + chlorine = "sodium chloride"
Compound of barium + oxygen = "barium oxide"
Compound of sulfur + aluminium = "aluminium sulfide"

Formulas for Simple Ionic Compounds

A chemical formula uses the symbols of the elements to describe a compound.
The symbols identify which elements are involved,
and shows the ratio in which the ions combine.

Steps to Write a Formula

1. Write down the symbols of the elements involved, with the metal always first.

2. For each element, consider its valency, or the charge on its ion. Work out the simplest ratio which gives equal amounts of (+ve) and (-ve) charge.

3. Write suffix numbers after each symbol to show this ratio.

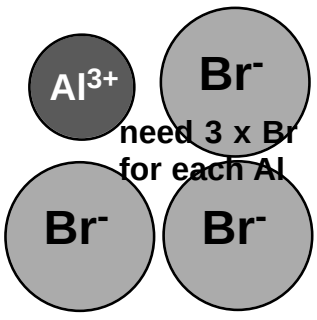
Number one (1) is not written. (It is assumed from the symbol.)

Examples

Compound of:

aluminium & bromine

Al Br

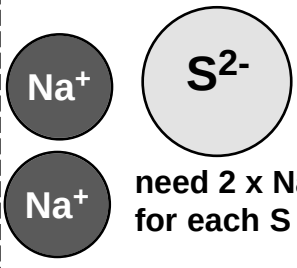


need 3 x Br for each Al

$AlBr_3$
aluminium bromide

sulfur & sodium

Na S



need 2 x Na for each S

Na_2S
sodium sulfide

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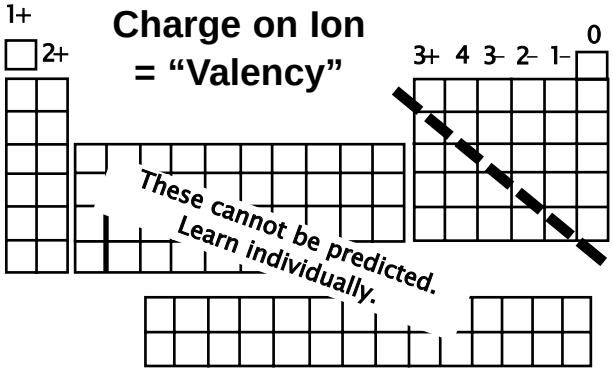
More on Valency

In a previous topic you were introduced to the idea of "valency". Valency is the "combining ratio" of an element which determines the ratio with which it will combine with others.

Valency of Simple Ions

You saw previously that, for many of the elements of the Periodic Table, the valency is the same as the charge on the ion.



You can easily predict the valency of many elements from their position in the table.

You will recall that it arises from atoms losing or gaining electrons to achieve full outer orbits

Now it is time to learn more...

Transition Metal Valencies

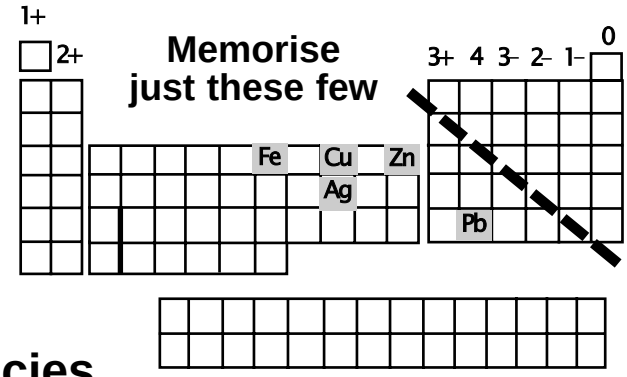
The "Transition Metals" are the large "block" of elements in the middle of the Periodic table. Their valencies cannot easily be predicted, and so the few important (and commonly encountered) elements must be memorised.

Zinc (Zn)

Loses 2 electrons, so ion charge = 2+.

Silver (Ag)

Loses 1 electron, so ion charge = 1+.



Some have Multiple Valencies

Here's where it gets a bit messy!

Atoms of <u>copper</u> (Cu) can "shuffle" electrons from one orbit to another. The result is that sometimes a copper atom loses 1 electron to form Cu^{+}. At other times the atom loses 2 electrons and forms Cu^{2+} ions.

Iron and lead atoms can do something similar:

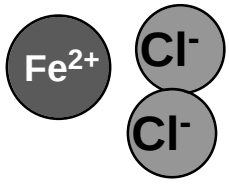
<u>Element</u>	<u>Ions Possible</u>
Copper	Cu^{+} and Cu^{2+}
Iron	Fe^{2+} and Fe^{3+}
Lead	Pb^{2+} and Pb^{4+}

More Than One Compound

This means that (for example) iron can combine with chlorine in 2 different ways:

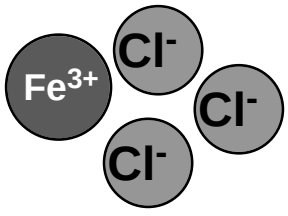
<u>Two Different Iron Chlorides</u>

If iron ions are Fe^{+2}



$FeCl_2$
iron (II) chloride

If iron ions are Fe^{+3}



$FeCl_3$
iron (III) chloride

These are different compounds, with different formulas and must be given different names.

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Worksheet 1
Simple Ionic Compounds (Revision)

Student Name.....

1. Write the <u>name and formula</u> for a compound made up of:

a) potassium and iodine.

....

b) barium and fluorine.

....

c) magnesium and sulfur

....

d) chlorine and aluminium

....

e) oxygen and silver

....

2. A student attempted to write some chemical formulas. He got the symbols correct, but everything else is wrong. Write the correct formula & name.

a) aluminium oxygenide, AlO_2

....

b) sulfurium calcide, Ca_2S_1

....

c) bromium hydrogide, H_1Br_1

....

d) zinc sulfurious, Zn_2S_2

....

e) sodoxide, ONa

....

Use This Table for Worksheets 1 & 2

Ions & Valencies of Some Common Laboratory Elements

METALS (lose electrons)				NON-METALS (gain electrons)			
Element	Symbol	Electrons in outer orb.	Valency (ion charge)	Element	Symbol	Electrons in outer orb.	Valency (ion charge)
Hydrogen	H	1	1+	Fluorine	F	7	1-
Sodium	Na	1	1+	Chlorine	Cl	7	1-
Potassium	K	1	1+	Bromine	Br	7	1-
● Silver	Ag	1	1+	Iodine	I	7	1-
Magnesium	Mg	2	2+	Oxygen	O	6	2-
Calcium	Ca	2	2+	Sulfur	S	6	2-
Barium	Ba	2	2+	Nitrogen	N	5	3-
● Zinc	Zn	2	2+	Phosphorus	P	5	3-
Aluminium	Al	3	3+	Carbon	C	4	4-
Multiple Valency Metals							
● Copper	Cu	1 or 2	1+ or 2+				
● Iron	Fe	2 or 3	2+ or 3+				
● Lead	Pb	2 or 4	2+ or 4+				

● **Memorise these. All others can be deduced from the Periodic Table.**

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Worksheet 2

Tutorial Worksheet
Compounds of
Multiple-Valency Metals

Student Name.....

Formulas

Work out the formula exactly as usual.

Metal symbols first, non-metal second.

You must figure out the smallest ratio of ions which will give the same amount of +ve and -ve electrical charge.

Names

As usual, name the metal first.

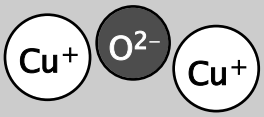
For metals with more than one possible valency, you must write the valency number (but not the charge sign) in Roman numerals, in brackets after the metal's name.

These Roman numerals are shown in the name only, never in the formula.

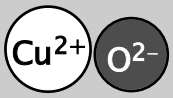
Examples

Copper ions can be Cu^{+} or Cu^{2+}.

Combined with oxygen, there are 2 possible compounds:



Cu_2O
copper (I) oxide



CuO
copper (II) oxide

To speak these names, say: "copper-one-oxide" "copper-two-oxide"

Fill in the blank spaces in this table.

Note: Symbols for ions MUST include a charge. Formula for a compound MUST NOT.

Ions present		Compound Formula	Compound Name
positive	negative		
Cu^{2+}	Br^{-}	a)	b)
c)	d)	CuBr	e)
f)	g)	h)	iron (III) fluoride
Fe^{2+}	F^{-}	i)	j)
k)	l)	PbS	m)
n)	o)	PbS_2	p)

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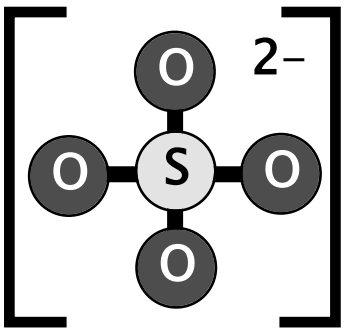
Polyatomic Ions (poly = many)

Here's another complication involving ionic compounds. There are a number of ions that are made up of 2 or more atoms bonded together in a group. Somewhere in this group of atoms are one (or more) extra electrons, so the entire group is charged electrically.

Example: Sulfate ion, SO_4^{2-}

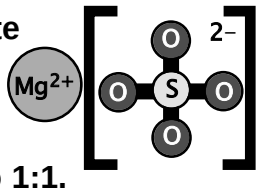


A sulfur atom is bonded to 4 oxygen atoms, with 2 extra electrons between them.

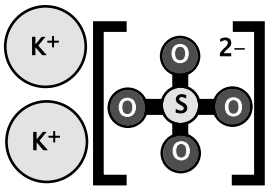
This group of atoms acts just like a simple ion with the same charge. It will form ionic compounds by combining with positive metal ions.

e.g. magnesium sulfate, $MgSO_4$

Solid magnesium sulfate crystals contain billions of Mg^{2+} ions and SO_4^{2-} ions. They combine in a ratio 1:1.



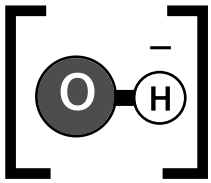
Potassium sulfate has formula K_2SO_4 because 2 potassium ions are needed for each sulfate ion.



Other Polyatomic Ions

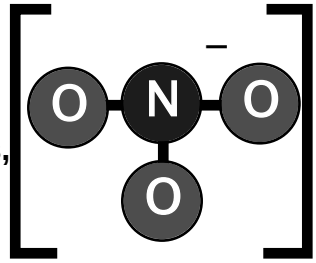
Hydroxide ion, OH^-

1 oxygen atom and 1 hydrogen atom, with 1 extra electron.



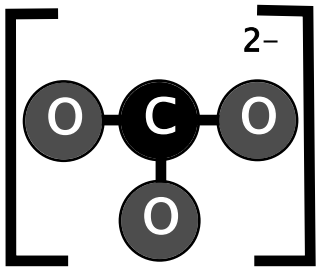
Nitrate ion, NO_3^-

1 nitrogen atom and 3 oxygen atoms, with 1 extra electron.



Carbonate ion, CO_3^{2-}

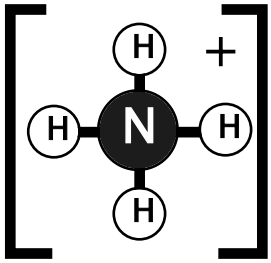
1 carbon atom and 3 oxygen atoms, with 2 extra electrons.



Ammonium ion, NH_4^+

1 nitrogen atom and 4 hydrogens, with 1 <u>less</u> electron.

<u>Note</u>: Ammonium is positively charged and acts like a metal ion.



Polyatomic ions are NOT compounds by themselves. They can form a compound by bonding with another ion of opposite charge, but cannot exist by themselves.

Naming Compounds

Naming a compound containing a poly-atomic ion is simple; just name the ions in order... (+ve) ion first.

$CaCO_3$ = calcium carbonate
KOH = potassium hydroxide
NH_4Cl = ammonium chloride

Chemical Formulas

Formulas are worked out (as usual) by arranging to have equal amounts of (+ve) and (-ve) charge. If more than 1 polyatomic ion is needed, the <u>group must be bracketed</u>.

e.g. $Mg(OH)_2$, $Cu(NO_3)_2$

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Worksheet 3

Tutorial Worksheet
Compounds of Polyatomic Ions

Use the Table of Data Next Page

Student Name.....

Names Dead easy!

As usual, metal (or +ve ion name) first.

Names of polyatomic ions do not change.

If multiple-valency metals are involved, the rules for their names still apply.

example: the compound of Fe^{3+} ion and the hydroxide ion (OH^-) is

iron (III) hydroxide, $Fe(OH)_3$

Formulas

As usual, you must figure out the smallest ratio of ions which will give the same amount of +ve and -ve electrical charge.

Treat the polyatomic ion exactly as if it was a simple ion.

If more than one polyatomic ion is needed in the formula, its symbols must be bracketed.

e.g. $Mg(NO_3)_2$ NOT $MgNO_3{}_2$

This could be mis-understood to mean 32 atoms of oxygen, when what is meant is that there are TWO nitrate (NO_3^-) ions.

Fill in the blank spaces in this table.

Note: Symbols for ions MUST include a charge. Formula for a compound MUST NOT.

Ions present		Compound Formula	Compound Name
positive	negative		
Ca^{2+}	NO_3^-	a)	b)
c)	d)	AgOH	e)
f)	g)	h)	iron (II) sulfate
Ba^{2+}	CO_3^{2-}	i)	j)
k)	l)	$Al(NO_3)_3$	m)
NH_4^+	Cl^-	n)	o)
p)	q)	r)	ammonium sulfate

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Use this Table for Worksheets 3 & 4

Data for Common Laboratory Ions

METALS (lose electrons)				NON-METALS (gain electrons)			
Element	**Symbol**	**Electrons in outer orb.**	**Valency (ion charge)**	**Element**	**Symbol**	**Electrons in outer orb.**	**Valency (ion charge)**
Simple Ions				**Simple Ions**			
Hydrogen	H	1	1+	Fluorine	F	7	1-
Sodium	Na	1	1+	Chlorine	Cl	7	1-
Potassium	K	1	1+	Bromine	Br	7	1-
● Silver	Ag	1	1+	Iodine	I	7	1-
Magnesium	Mg	2	2+	Oxygen	O	6	2-
Calcium	Ca	2	2+	Sulfur	S	6	2-
Barium	Ba	2	2+	Nitrogen	N	5	3-
● Zinc	Zn	2	2+	Phosphorus	P	5	3-
Aluminium	Al	3	3+	Carbon	C	4	4-
Multiple Valency Metals				**Polyatomic Ions**			
● Copper	Cu	1 or 2	1+ or 2+	Hydroxide	OH		1- ●
● Iron	Fe	2 or 3	2+ or 3+	Nitrate	NO_3		1- ●
● Lead	Pb	2 or 4	2+ or 4+	Sulfate	SO_4		2- ●
				Carbonate	CO_3		2- ●
Polyatomic Ion							
● Ammonium	NH_4		1+				

● **Memorise these. All others can be deduced from the Periodic Table.**

Worksheet 4
Ionic Allsorts

Student Name.....

Compound Name	Ions Involved +ve	Ions Involved -ve	Formula
zinc hydroxide	a)	b)	c)
d)	K^+	CO_3^{2-}	e)
f)	g)	h)	Ag_2O
ammonium nitrate	i)	j)	k)
l)	m)	n)	$FeSO_4$
o)	Fe^{2+}	S^{2-}	p)

Compound Name	Ions Involved +ve	Ions Involved -ve	Formula
aluminium nitrate	q)	r)	s)
aluminium sulfide	t)	u)	v)
w)	x)	y)	$Al_2(SO_4)_3$
lead (IV) iodide	Pb^{4+}	z)	aa)
ab)	ac)	ad)	$CuCO_3$
hydrogen sulfate	ae)	af)	ag)

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Covalent Chemical Bonding

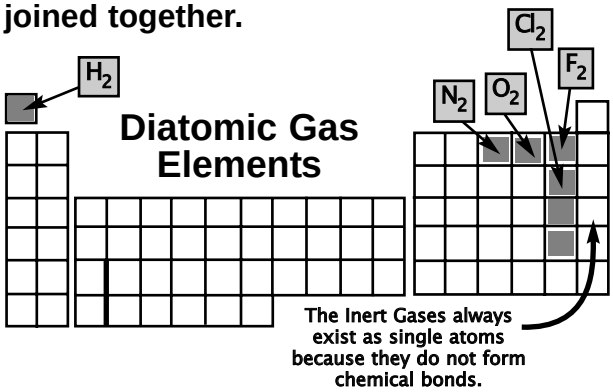
Forming ions is not the only way atoms can achieve a full outer orbit.
Ionic bonding is not the only way that chemical compounds can form.

Some atoms achieve full outer orbits by <u>sharing electrons</u> with each other.

Diatomic Molecules

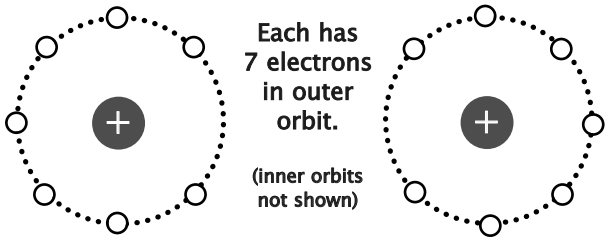
(di = 2. "diatomic" = 2 atoms)

Many of the elements which are gases at room temperature are not made up of single atoms, but of <u>pairs</u> of atoms joined together.

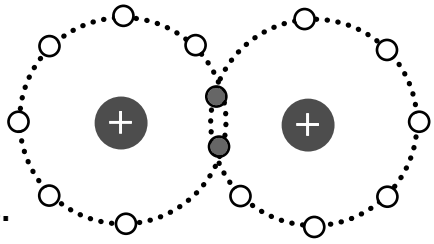


How does this happen?

Imagine 2 chlorine atoms:



If they get very close together, they can <u>share</u> a pair of electrons.



Each atom now has a full orbit of 8 electrons, and achieves the most stable quantum energy state possible.

These atoms are now <u>bonded</u> together to form a <u>molecule</u> of chlorine gas, Cl_2.

Similarly, H_2, N_2, O_2, F_2 (as well as Br_2 & I_2) form diatomic molecules by sharing electrons in a "<u>covalent bond</u>".

Covalent Compounds

Many atoms can bond together to form "molecules" by sharing a pair of electrons.

Mostly it is the non-metal elements (which all need to gain electrons) which form these covalent, sharing bonds.

(Metal atoms need to lose electrons, so they form ions and go in for ionic bonding.)

Non-metals can gain electrons by either:

- **forming -ve ions & ionic bonds,**

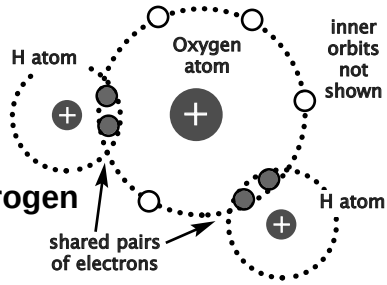
or

- **sharing electrons covalently.**

Water

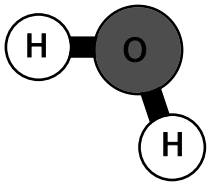
Our most familiar compound is covalent.

One oxygen atom shares a pair of electrons with each of 2 hydrogen atoms.



Each atom achieves a full outer orbit by sharing electrons.

Water is made up of <u>molecules</u> of H_2O.



There are no ions involved. The atoms are "bonded" together by the sharing of pairs of electrons.

More important covalent compounds next page...

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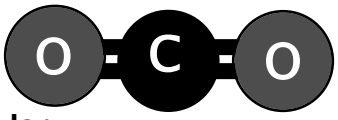
Some Important Covalent Compounds

The names and formulas of some covalent compounds are not easy to predict. However, there are only a few covalent compounds that you really need to know about. For these few you should simply memorise them.

Carbon Dioxide, CO_2

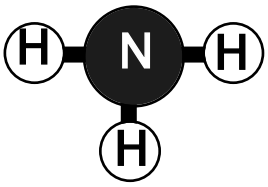


CO_2 is a gas which we breathe out. It is produced by cellular respiration in all living things.

Plants need CO_2 for photosynthesis.

CO_2 is produced by the burning of carbon-based fuels like coal and petrol. The increasing levels of CO_2 in the atmosphere are believed to be causing climate changes due to the "Greenhouse Effect".

Ammonia, NH_3



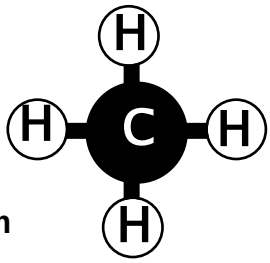
Ammonia is a poisonous gas with a strong smell.

It is very important for making fertilisers, fabrics, explosives, paints and dyes and many other useful materials. Millions of tonnes of NH_3 are manufactured each year.

Do not confuse these chemicals:

Ammonia	Ammonium ion
NH_3	NH_4^+
covalent compound	polyatomic ion

Methane, CH_4

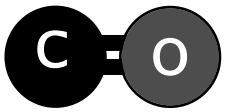


Methane is the simplest member of a huge "family" of compounds made from carbon and hydrogen.

Methane is an inflammable gas and is the main chemical in "natural gas" which is used as a fuel.

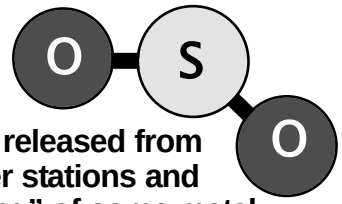
It is also produced naturally by many living things and, like CO_2, is a "greenhouse gas".

Carbon Monoxide, CO



A colourless, odourless poisonous gas. It is produced when carbon-based fuels do not burn properly. Large amounts are released in vehicle exhausts.

Sulfur Dioxide, SO_2



Another poisonous gas, SO_2 can be a terrible pollutant if released from coal-burning power stations and during the "smelting" of some metal ores. It caused serious environmental damage years ago, but those industries have been forced to "clean-up their act".

Chemical Reactions v. Physical Changes

Now that you know about chemical bonding and chemical compounds, you can better understand chemical reactions.
Firstly, you are reminded of the differences between chemical & physical change.

Chemical Reactions

Result in <u>new substances</u> being formed.

Atoms are re-arranged and bonded together in new combinations.

Physical Changes

<u>No new substances</u> are formed. Substances may change state. (e.g.solid to liquid) Mixtures may be separated, (e.g. filtered) but the same chemical substances are still there.

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Chemical Reactions and Equations

In a chemical reaction the atoms, ions and molecules are re-arranged.
Existing chemical bonds may be broken, and new bonds are formed.

The exact same atoms are still present,
(and still exactly the same number of atoms and same mass)
but they are re-arranged into new combinations, so new substances are formed.

Example: Oxygen and Hydrogen React to Form Water

If elements oxygen gas and hydrogen gas are mixed together and a spark or flame provided to start the reaction, they react (violently) to form the compound water.

Word Equation: Oxygen + Hydrogen ⟶ Water

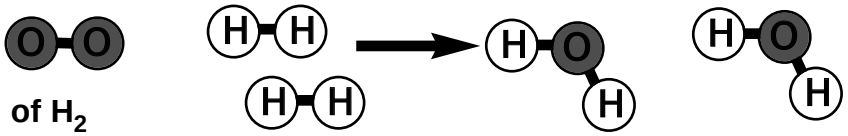
Symbol Equation: $O_2 + H_2 \longrightarrow H_2O$

(Remember that oxygen & hydrogen are diatomic molecules... O_2 and H_2)

This symbol equation is NOT fully correct, because it does not show the same number of atoms before and after the reaction.
To be fully correct, a symbol equation must be "balanced".

Balanced Equation: $O_2 + 2\,H_2 \longrightarrow 2\,H_2O$

The models explain:



1 molecule of O_2 reacted with 2 molecules of H_2 to form 2 molecules of H_2O.

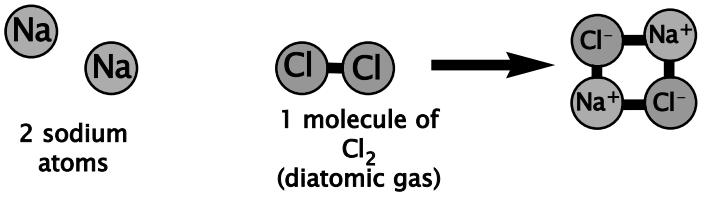
There are exactly the same number of each atom before and after the reaction.
(In a real reaction there would be billions of each, but the ratio is the same.)

Another Example: Sodium and Chlorine React to Form Salt

Word equation: Sodium + Chlorine ⟶ Sodium Chloride (salt)

Symbol Equation: $Na + Cl_2 \longrightarrow NaCl$ (not balanced)

Balanced Equation: $2\,Na + Cl_2 \longrightarrow 2NaCl$



2 sodium atoms

1 molecule of Cl_2 (diatomic gas)

Ions in a crystal lattice

(billions of them in a real reaction)

The chemicals you start with are called "Reactants" ⟶ **The chemicals you end up with are called "Products"**

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Worksheet 5
Balancing Equations

Student Name.....

Balance each of the following chemical equations.
Remember you must NOT change any formulas.
Balance an equation by writing numbers in front of a formula ONLY.

1. ..... Ba + O_2 → ..... BaO

2. ..... FeO + C → ..... Fe + CO_2

3. ..... Al + ... Cl_2 → ..... $AlCl_3$

4. ..... H_2 + N_2 → ..... NH_3

5. ..... H_2O_2 → ..... H_2O + O_2

6. ..... Al + ... O_2 → ..... Al_2O_3

7. ..... HNO_3 + Mg → H_2 + $Mg(NO_3)_2$

no more help!

8. Na_2CO_3 + $CaCl_2$ → $CaCO_3$ + NaCl

9. $FeCl_2$ + Na_2S → FeS + NaCl

10. H_2O + Na → H_2 + NaOH

11. $Ba(OH)_2$ + H_2SO_4 → H_2O + $BaSO_4$

12. $(NH_4)_2CO_3$ → NH_3 + CO_2 + H_2O

13. P_4 + O_2 → P_2O_5

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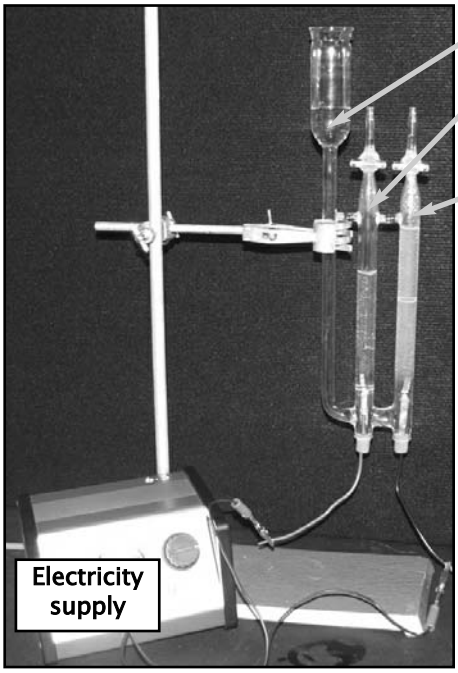
There are many types of chemical reactions.
The rest of this topic looks at some important types, one-by-one.

Decomposition Reactions

Decomposition means to break down into simpler parts.

Decomposition of a Compound into its Elements

You may see this reaction demonstrated:



Word Equation

Water ⟶ Hydrogen + Oxygen

Balanced Symbol Equation

$$2H_2O \longrightarrow 2H_2 + O_2$$

This process was very important in the history of modern Chemistry. Many of the chemical elements were first discovered when various substances were decomposed by heat or electricity.

Most of our important metals are mined as chemical compounds (in a metal "ore") which must be decomposed to collect the pure metal.

Decomposition of Carbonates

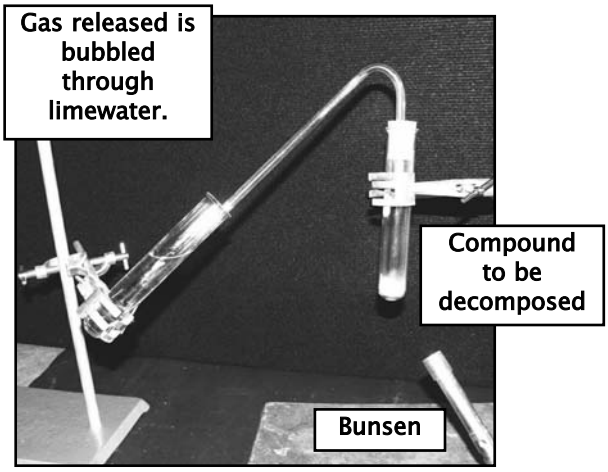
"Carbonates" are ionic compounds containing the carbonate ion, CO_3^{-2} combined with a metal ion.

When heated, carbonate compounds decompose into simpler chemicals:

example:

calcium carbonate ⟶ calcium oxide + carbon dioxide

$$CaCO_3 \longrightarrow CaO + CO_2$$



Identifying Common Gases

As you investigate chemical reactions you may learn tests to identify some common gases.

Carbon dioxide, CO_2 reacts with "limewater" and makes it go "milky".

Hydrogen, H_2 makes a "pop" noise if it is ignited.

Oxygen, O_2 can cause a smouldering splinter of wood to burst into flame.

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Worksheet 6
Decomposition
Word Equations

Student Name.....

1. If you pass electricity into molten salt (sodium chloride) it decomposes into its elements. Write a word equation for this.

2. Write a word equation for the decomposition of magnesium sulfide.

3. If silver iodide is exposed to light, it decomposes. Write a word equation.

4. The element fluorine was first discovered by the decomposition of calcium fluoride. Write a word equation.

5. Write a word equation for the decomposition of magnesium carbonate into magnesium oxide and carbon dioxide.

6. Copper (II) carbonate decomposes in a similar way. Write the word equation.

7. What about potassium carbonate?

8. Silver nitrate decomposes when heated to form silver, oxygen gas and a brown gas called nitrogen dioxide. Write a word equation for this change

Worksheet 7
Decomposition
Word & Symbol Equations

Student Name.....

Write a symbol equation for each reaction in Worksheet 6, then balance.

1. **(remember, the element chlorine is Cl_2)**

2. **(Note: the element sulfur forms covalent molecules of 8 atoms in a ring: S_8)**

3. **(iodine is I_2)**

4. **(fluorine is F_2)**

5.

6.

7.

8. **(Nitrogen dioxide = NO_2. Don't forget oxygen is O_2. This is a tough one!)**

Combustion Reactions

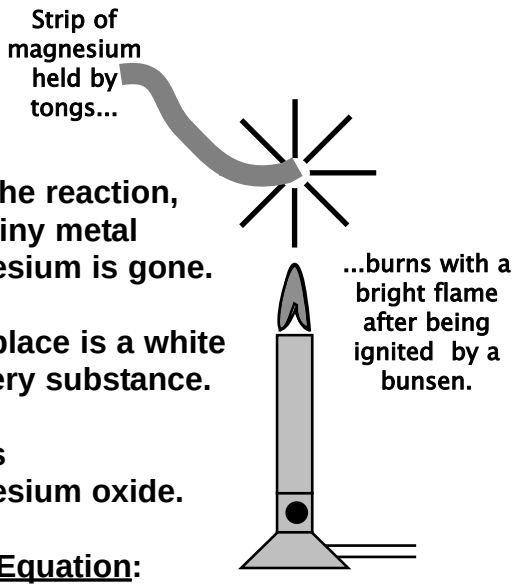
"Combustion" simply means burning.

Combustion reactions always involve a "fuel" chemical which combines with oxygen (O_2) to form oxide compounds.

Generally, the reaction releases a lot of heat energy.
Flames are regions of gas which are so hot that they glow.

Combustion of an Element

You may have seen the burning of magnesium, an active metal.



After the reaction, the shiny metal magnesium is gone.

In its place is a white powdery substance.

This is magnesium oxide.

Word Equation:

magnesium + oxygen → magnesium oxide

(Oxygen comes from the air)

Balanced Symbol Equation:

$$2Mg + O_2 \rightarrow 2MgO$$

If the element sulfur is burned:

sulfur + oxygen → sulfur dioxide

$$S + O_2 \rightarrow SO_2$$

Basically any element can undergo combustion in air and form the oxide compound of that element.
(Inert gases do not react of course.)

Combustion of Carbon-Based Fuels

All of our important fuels such as coal, petrol or natural gas, are mixed compounds of carbon combined with hydrogen.

For example, the gas which burns in a bunsen is often propane, C_3H_8.

When it burns, the fuel compound decomposes into its elements and each combines with oxygen to form the oxide compound of that element.

Oxide of carbon = carbon dioxide, CO_2.
Oxide of hydrogen = water, H_2O.

propane + oxygen → carbon dioxide + water

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

(Check carefully to see how this was balanced)
(Because of the heat, the water forms as vapour.)

The burning of wood, coal, petrol, diesel, natural gas, LPG, etc all produce carbon dioxide and water as the main products.

Incomplete Combustion

If there is not enough oxygen available, combustion may produce carbon monoxide (CO) as well as CO_2. Sometimes "soot" is produced. Soot is solid particles of carbon which have not been able to find any oxygen to combine with.

This is what happens if you completely close the air hole on a bunsen. You will see smoke (soot). The yellow flame is cooler and shows poor burning of fuel.

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Worksheet 8
Combustion
Word Equations

Student Name.....

Write a word equation for:

1. the combustion of carbon to form carbon dioxide.

2. the burning of calcium in air to form calcium oxide.

3. the burning of phosphorus to form phosphorus pentoxide (compound of phosphorus and oxygen).

4. combustion of methane to form carbon dioxide and water.

5. combustion of petrol. (The main compound in petrol is "octane" which is a compound of carbon and hydrogen.)

6. the incomplete burning of octane to form some CO_2, some carbon monoxide and water.

Worksheet 9
Combustion
Word & Symbol Equations

Student Name.....

Write symbol equations and balance.

1. The combustion of calcium in air to form calcium oxide. (remember oxygen = O_2)

2. The burning of carbon to make carbon dioxide.

3. The burning of methane (CH_4) to carbon dioxide and water.
(hint: balance oxygens last)

4. The burning of aluminium.

5. The combustion of ethanol, C_2H_6O (a petrol additive).
hint: balance oxygens last, and carefully.

6. The combustion of undecane ($C_{11}H_{24}$) a component of diesel fuel.

7. The incomplete combustion of acetylene (C_2H_2) to form water vapour and equal quantities of carbon dioxide and carbon monoxide.

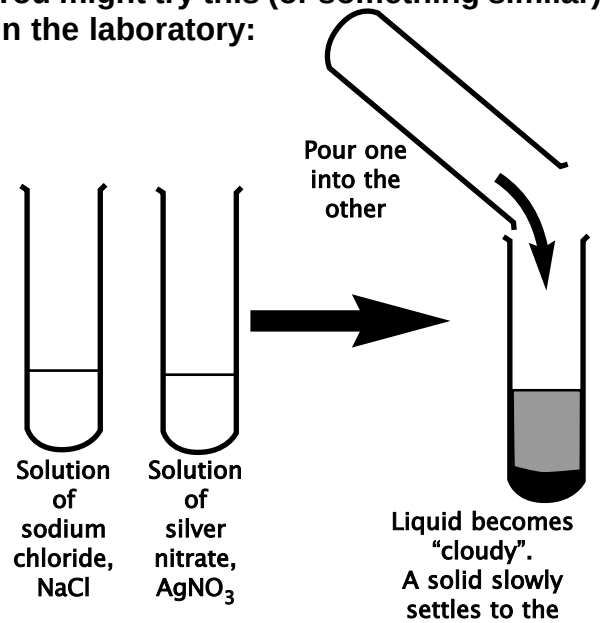
Precipitation Reactions

Many of the ionic compounds are soluble in water. They dissolve to form clear solutions... they may be coloured, but are "see-through".

If you mix together 2 different ionic solutions, often nothing happens... they just mix together. Sometimes, however, a reaction occurs...

An Insoluble Precipitate

You might try this (or something similar) in the laboratory:



Explanation

When added together, there were 4 types of ions mixed:

Na^+, Cl^-, Ag^+ and NO_3^-

However, the combination of Ag^+ and Cl^- ions is <u>not soluble</u> in water.

These ions instantly joined into a solid crystal lattice and tiny solid particles appeared, <u>suspended</u> in the water. This solid will slowly fall down ("precipitate") to the bottom. The other ions remain in solution as a new, dissolved compound.

Equations

sodium chloride + silver nitrate → silver nitrate + sodium chloride

$NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

precipitated

Predicting a Precipitate

How can you predict when a reaction will occur, or when nothing will happen?

Well, it's fun to find out by experiment!

However, if you methodically mix different solutions with each other and record exactly when reactions occur, certain patterns appear.

You will find that the following solutions will produce lots of results when mixed with solutions containing metal ions such as Cu^{2+}, Pb^{2+}, Ag^+, Fe^{3+}, Zn^{2+}.

Potassium hydroxide, KOH
Sodium carbonate, Na_2CO_3
Sodium sulfide, Na_2S

More Examples

sodium sulfide + copper(II) sulfate → copper(II) sulfide + sodium sulfate

$Na_2S + CuSO_4 \rightarrow CuS + Na_2SO_4$

(copper(II) sulfide is insoluble)

potassium hydroxide + silver nitrate → silver hydroxide + potassium nitrate

$KOH + AgNO_3 \rightarrow AgOH + KNO_3$

(silver hydroxide is insoluble)

sodium carbonate + lead(II) nitrate → lead(II) carbonate + sodium nitrate

$Na_2CO_3 + Pb(NO_3)_2 \rightarrow PbCO_3 + 2NaNO_3$

(lead(II) carbonate is insoluble)

Worksheet 10
Precipitation
Word Equations

Student Name.....

1. Solutions of potassium carbonate and zinc chloride were mixed. A precipitate of zinc carbonate formed because it is not soluble. Write a word equation for this.

2. When solutions of sodium iodide and lead (II) nitrate were mixed, a bright yellow precipitate of insoluble lead (II) iodide formed. Write a word equation for the reaction.

3. When a solution of iron (III) chloride was added to sodium hydroxide solution, a precipitate formed. What is the name of the most likely precipitate?
Answer with a word equation, showing which substance precipitated.

4. Barium sulfate is not soluble in water, but barium nitrate is soluble. What would happen if a barium nitrate solution was mixed with copper (II) sulfate solution? Answer by writing a word equation.

Worksheet 11
Precipitation
Word & Symbol Equations

Student Name.....
Write an equation in words, then in symbols and balance.

1. Solutions of sodium carbonate and lead (II) nitrate were mixed. A precipitate of lead carbonate formed because it is not soluble. Another compound remained in solution.

2. When solutions of potassium sulfate and barium hydroxide were mixed, a precipitate of insoluble barium sulfate formed.

3. Solid copper (II) sulfide formed when solutions of copper (II) sulfate and sodium sulfide were mixed.

4. When sodium hydroxide and silver nitrate solutions were mixed a solid precipitate formed. You should be able to guess what it was and write an equation.

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Corrosion

The most familiar example of corrosion is the rusting of iron or steel. More generally, corrosion means a chemical reaction to a metal which weakens it and eats it away.

Rusting

Iron and steel are used to make car bodies, bridges, ships, building frames, tools, etc. Unfortunately, these things can "rust" and eventually fall apart.

Rusting is like a slow combustion:

iron + oxygen ⟶ iron(III) oxide

$$Fe + O_2 \rightarrow Fe_2O_3 \text{ (unbalanced)}$$

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3 \text{ (rust)}$$

Corrosion of Other Metals

Corrosion of metal doesn't always involve oxygen. In some cases, other elements are involved.

For example, silver (e.g. jewellery) can "tarnish" and turn black by reacting with chemicals containing sulfur.

silver + sulfur ⟶ silver sulfide

$$2Ag + S \rightarrow Ag_2S \text{ (tarnish)}$$

Whether it reacts with oxygen, or something else, the point is that the metal is not the metal element any more. It reacts to form a compound which is ugly & weak. The metal loses its shininess and its strength... this is corrosion.

Acids & Bases

Acids are very important compounds in chemistry because they are involved in so many chemical reactions. "Bases" can be thought of as "opposites" of acids, because each can destroy the other chemically.

Acids

Acids are compounds which dissolve in water and releases hydrogen ions (H^+).

The most common laboratory acids are:

Hydrochloric acid = hydrogen chloride = HCl

Sulfuric acid = hydrogen sulfate = H_2SO_4

Nitric acid = hydrogen nitrate = HNO_3

Acids are corrosive, have a sour taste, and undergo many chemical reactions, as you will see.

Bases

There are many different "bases", but here we will concentrate on the strong bases called "alkalis".

An alkali is a compound which dissolves in water and releases hydroxide ions (OH^-).

The most common laboratory alkalis:

Sodium hydroxide = $NaOH$

Potassium hydroxide = KOH

Both acids and alkalis need to be handled with care. Laboratory solutions are diluted and relatively safe, but concentrated acids or alkalis can burn holes in skin, clothing or eyeballs... follow all safety instructions!

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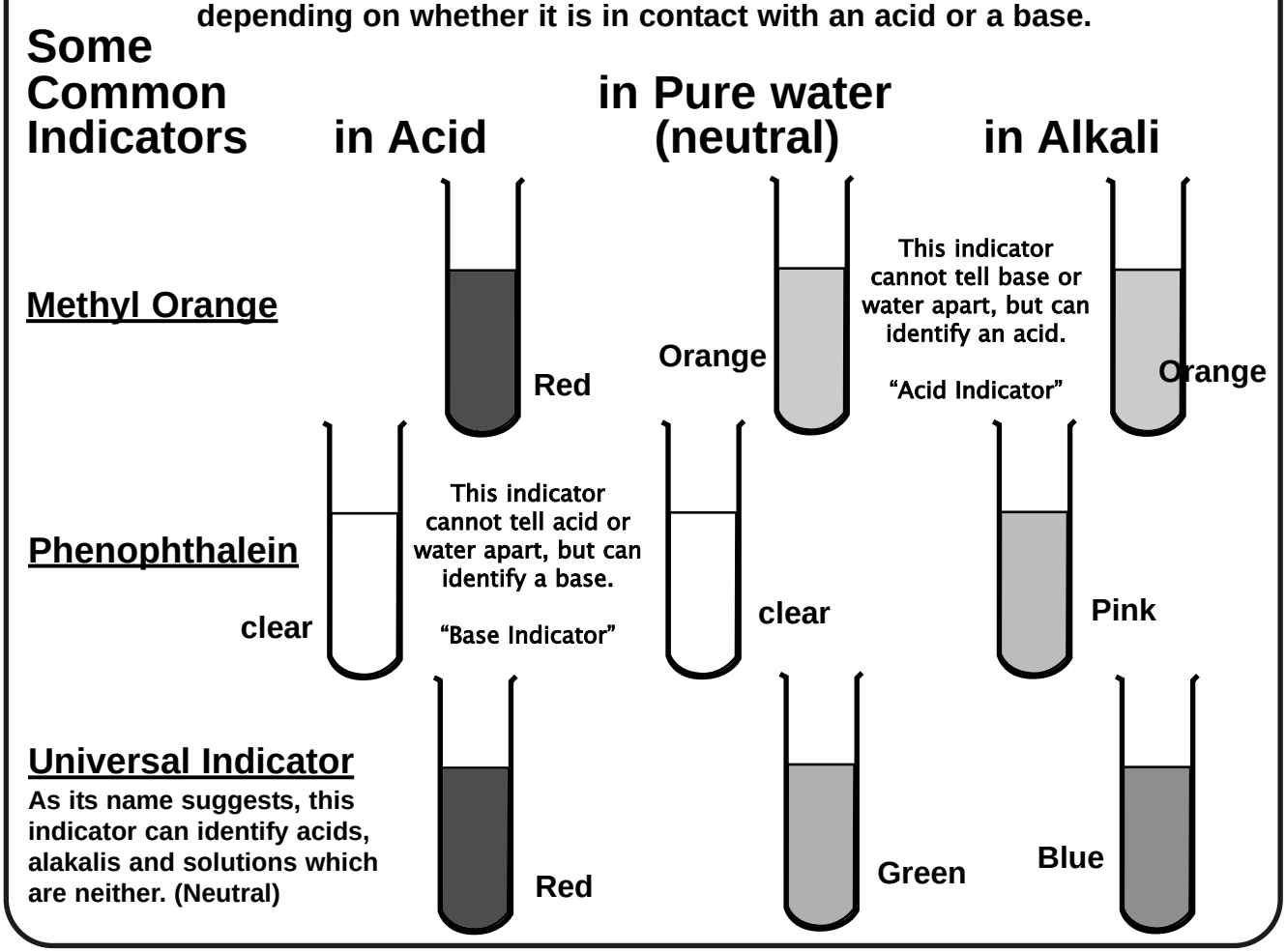
Acid-Base Indicators

Indicators are useful for identifying acids or bases.
An indicator chemical is coloured and it changes colour quite noticeably depending on whether it is in contact with an acid or a base.



Neutralisation

Neutralisation is the reaction which occurs if an acid is mixed with a base. Each destroys the other so that (if you have just the right quantities) the products are neutral water and another dissolved ionic compound.

The key to understanding neutralisation

Every acid contains	Every alkali contains	These react to form

$$H^+ + OH^- \rightarrow H_2O$$

The hydrogen ions (in every acid) react with the hydroxide ions (in every alkali) to form water, which is neutral.

Example Reactions

Hydrochloric acid + potassium hydroxide → water + potassium chloride

$$HCl + KOH \rightarrow H_2O + KCl$$

Sulfuric acid + sodium hydroxide → water + sodium sulfate

$$H_2SO_4 + 2NaOH \rightarrow H_2O + Na_2SO_4$$

Water is always formed. The other product is called "a salt". Hydrochloric acid always produces "chloride salts", sulfuric always gives "sulfate salts" and nitric acid always makes "nitrate salts".

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Worksheet 12
Corrosion Reactions

Student Name.....

1. Write a word equation to describe:

a) the surface corrosion of aluminium. (When exposed to air, a layer of aluminium oxide forms.)

b) the corrosion of zinc to zinc oxide.

c) the tarnishing of copper to copper (I) sulfide in the presence of sulfur.

d) the corrosion of lead to lead (IV) oxide.

2. Write a symbol equation (and balance) for each reaction described in Q1 at left.

a)

b)

c) (use the symbol "S" for elemental sulfur)

d)

Worksheet 13
Neutralisation

Student Name.....

1. Write a word equation for the neutralisation reaction between:

a) hydrochloric acid and potassium hydroxide.

b) sulphuric acid and calcium hydroxide.

c) sulphuric acid and sodium hydroxide.

d) nitric acid and barium hydroxide.

e) hydrochloric acid and magnesium hydroxide.

2. Write a symbol equation (and balance) for each reaction described in Q1 at left.

a)

b)

c)

d)

e)

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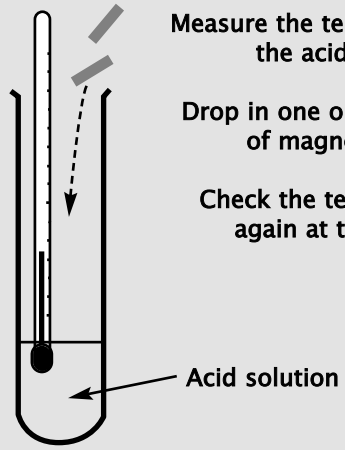
Acids React with Metals

Example:

Acid Reacts With Magnesium



Observed Changes
Temperature rises.
Bubbles form, because a gas is produced.
Magnesium is "eaten away" and disappears.

If the reaction at left was done with hydrochloric acid:

hydrochloric acid + magnesium → hydrogen + magnesium chloride

$$2HCl + Mg \rightarrow H_2 + MgCl_2$$

If nitric acid was reacted with zinc:

nitric acid + zinc → hydrogen + zinc nitrate

$$H_2SO_4 + Zn \rightarrow H_2 + ZnSO_4$$

In general terms:

Acid + Metal → Hydrogen + a "salt"

You will find that not all metals will react and some react faster than others.

Acids React with Carbonates

Carbonates are ionic compounds containing a metal ion and the carbonate group, CO_3^{-2} which is a polyatomic ion.

When acids react with carbonates they always produce CO_2 gas and water and a "salt" compound.

$$\text{acid} + \text{carbonate} \rightarrow CO_2 + H_2O + \text{a "salt"}$$

Exactly which "salt" forms depends on which acid and which carbonate is used.

Examples:

copper(II) carbonate + sulfuric acid → carbon dioxide + water + copper(II) sulfate

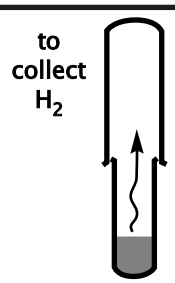
$$CuCO_3 + H_2SO_4 \rightarrow CO_2 + H_2O + CuSO_4$$

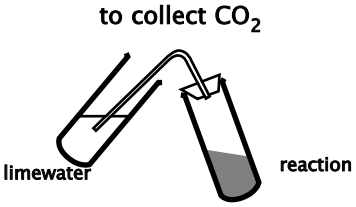
sodium carbonate + hydrochloric acid → carbon dioxide + water + sodium chloride

$$Na_2CO_3 + HCl \rightarrow CO_2 + H_2O + 2NaCl$$

Testing the Gases

Both these reaction types produce a gas. When you carry out these reactions in the laboratory, be sure to test the gas produced to confirm its identity. These diagrams suggest how this can be done.





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Worksheet 14
Acids & Metals

Student Name.....

1. Write a word equation for the reaction between:

a) sulfuric acid and zinc.

b) nitric acid and aluminium.

c) hydrochloric acid and iron.

d) nitric acid and lead.

2. Write a symbol equation (and balance) for each reaction described in Q1 at left.

a)

b)

c) **(assume Fe^{2+} ion forms)**

d) **(assume Pb^{2+} ion forms)**

Worksheet 15
Acids & Carbonates

Student Name.....

1. Write a word equation for the reaction between:

a) copper (II) carbonate and nitric acid.

b) potassium carbonate and sulfuric acid.

c) hydrochloric acid and calcium carbonate.

d) iron (III) carbonate and nitric acid.

e) sulfuric acid and magnesium carbonate.

2. Write a symbol equation (and balance) for each reaction described in Q1 at left.

a)

b)

c)

d)

e)

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Topic Test 1

Compounds & Reactions

Student Name..... Score = /30

Answer all questions in the spaces provided.

This test is designed to be completed without reference to the Periodic Table.

1. (5 marks)
Match each description to an item from the list. To answer, write the letter (A,B,C, etc) of the list item beside the description.

Description	matches with	List Item
a) Electrical charge on an ion which has lost electrons.		.....
b) An element which always forms diatomic molecules.		.....
c) The name of a common negative ion.		.....
d) When an acid and alkali react.		.....
e) Reaction which destroys metals.		.....

List Items Not all will be used. Some may be used more than once.

A. oxygen	D. corrosion
B. neutralisation	E. positive
C. combustion	F. chloride

2. (4 marks)
What is the difference between ionic chemical bonding and covalent chemical bonding?

3. (3 marks)
Name these compounds.

a) CO_2

b) NaCl

c) H_2SO_4

4. (14 marks)
Write an equation in words to describe:

a) the combustion of zinc in air.

b) the neutralisation of hydrochloric acid by potassium hydroxide.

c) the decomposition of copper carbonate to copper oxide and a certain gas.

d) the reaction of sulfuric acid on the metal calcium.

5. (4 marks)
a) The familiar substance "salt" is described as being an "ionic crystal lattice". What does this mean? Use a simple, labelled diagram to explain.

b) Another familiar substance, "water", is described as "covalent molecules". What does this mean? Use a simple, labelled diagram to explain.

Topic Test 2

Compounds & Reactions

Student Name..... Score = /27

Answer all questions in the spaces provided.

This test requires the use of the Chemical Data Table on p14.

1. (5 marks)
Name the following compounds.

a) $BaSO_4$ .....

b) CH_4 .....

c) $Fe(OH)_2$ .....

d) NH_4NO_3 .....

e) $Al_2(CO_3)_3$ .....

2. (5 marks)
Write the chemical formula for:

a) calcium nitrate .....

b) iron (III) bromide .....

c) copper (II) hydroxide .....

d) ammonium sulfate .....

e) ammonia .....

3. (3 marks)
Balance the following equations

a) $Al + Br_2 \longrightarrow AlBr_3$

b) $Ca(OH)_2 + H_2SO_4 \longrightarrow H_2O + CaSO_4$

c) $FeCl_2 + K_2S \longrightarrow FeS + KCl$

4. (14 marks)
For each of the following reactions:
i) write a word equation (2 marks) **ii) write a symbol equation & balance it. (5 marks)**

a) Pentane (C_5H_{12}) burns in air to form carbon dioxide and water.

i)

ii)

b) Hydrochloric acid reacts with magnesium hydroxide.

i)

ii)

Answer Section

Worksheet 1

1.
a) potassium iodide, KI
b) barium fluoride, BaF_2
c) magnesium sulfide, MgS
d) aluminium chloride, $AlCl_3$
e) silver oxide, Ag_2O
2.
a) aluminium oxide, Al_2O_3
b) calcium sulfide, CaS
c) hydrogen bromide, HBr
d) zinc sulfide, ZnS
e) sodium oxide, Na_2O

Worksheet 2

a) $CuBr_2$ b) copper (II) bromide
c) Cu^+ d) Br^- e) copper (I) bromide
f) Fe^{3+} g) F^- h) FeF_3
i) FeF_2 j) iron (II) fluoride
k) Pb^{2+} l) S^{2-} m) lead (II) sulfide
n) Pb^{4+} o) S^{2-} p) lead (IV) sulfide

Worksheet 3

a) $Ca(NO_3)_2$ b) calcium nitrate
c) Ag^+ d) OH^- e) silver hydroxide
f) Fe^{2+} g) SO_4^{2-} h) $FeSO_4$
i) $BaCO_3$ j) barium carbonate
k) Al^{3+} l) NO_3^- m) aluminium nitrate
n) NH_4Cl o) ammonium chloride
p) NH_4^- q) SO_4^{2-} r) $(NH_4)_2SO_4$

Worksheet 4

a) Zn^{2+} b) OH^- c) $Zn(OH)_2$
d) potassium carbonate e) K_2CO_3
f) silver oxide g) Ag^+ h) O^{2-}
i) NH_4^+ j) NO_3^- k) NH_4NO_3
l) iron (II) sulfate m) Fe^{2+} n) SO_4^{2-}
o) iron (II) sulfide p) FeS
q) Al^{3+} r) NO_3^- s) $Al(NO_3)_3$
t) Al^{3+} u) S^{2-} v) Al_2S_3
w) aluminium sulfate x) Al^{3+} y) SO_4^{2-}
z) I^- aa) PbI_4
ab) copper (II) carbonate ac) Cu^{2+} ad) CO_3^{2-}
ae) H^+ af) SO_4^{2-} ag) H_2SO_4

Worksheet 5

1. $2Ba + O_2 \longrightarrow 2BaO$

2. $2FeO + C \longrightarrow 2Fe + CO_2$

3. $2Al + 3Cl_2 \longrightarrow 2AlCl_3$

4. $3H_2 + N_2 \longrightarrow 2NH_3$

5. $2H_2O_2 \longrightarrow 2H_2O + O_2$

6. $4Al + 3O_2 \longrightarrow 2Al_2O_3$

7. $2HNO_3 + Mg \longrightarrow H_2 + Mg(NO_3)_2$

8. $Na_2CO_3 + CaCl_2 \longrightarrow CaCO_3 + 2NaCl$

9. $FeCl_2 + Na_2S \longrightarrow FeS + 2NaCl$

10. $2H_2O + 2Na \longrightarrow H_2 + 2NaOH$

11. $Ba(OH)_2 + H_2SO_4 \longrightarrow 2H_2O + BaSO_4$

12. $(NH_4)_2CO_3 \longrightarrow 2NH_3 + CO_2 + H_2O$

13. $P_4 + 5O_2 \longrightarrow 2P_2O_5$

Worksheet 6

1. sodium chloride → sodium + chlorine
2. magnesium sulfide → magnesium + sulfur
3. silver iodide → silver + iodine
4. calcium fluoride → calcium + fluorine
5. magnesium carbonate → carbon dioxide + magnesium oxide
6. copper (II) carbonate → carbon dioxide + copper (II) oxide
7. barium carbonate → carbon dioxide + barium oxide
8. silver nitrate → silver + oxygen + nitrogen dioxide

Worksheet 7

1. $2NaCl \rightarrow 2Na + Cl_2$
2. $8MgS \rightarrow 8Mg + S_8$
3. $2AgI \rightarrow 2Ag + I_2$
4. $CaF_2 \rightarrow Ca + F_2$
5. $MgCO_3 \rightarrow CO_2 + MgO$
6. $CuCO_3 \rightarrow CO_2 + CuO$
7. $K_2CO_3 \rightarrow CO_2 + K_2O$
8. $2AgNO_3 \rightarrow 2Ag + O_2 + 2NO_2$

Worksheet 8

1. carbon + oxygen → carbon dioxide
2. calcium + oxygen → calcium oxide
3. phosphorus + oxygen → phosphorus pentoxide
4. methane + oxygen → carbon + water dioxide
5. octane + oxygen → carbon + water dioxide
6. octane + oxygen → carbon + carbon + water dioxide monoxide

Worksheet 9

1. $2Ca + O_2 \rightarrow 2CaO$
2. $C + O_2 \rightarrow CO_2$
3. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
4. $4Al + 3O_2 \rightarrow 2Al_2O_3$
5. $C_2H_6O + 3O_2 \rightarrow 2CO_2 + 3H_2O$
6. $C_{11}H_{24} + 17O_2 \rightarrow 11CO_2 + 12H_2O$
7. $C_2H_2 + 2O_2 \rightarrow CO_2 + CO + H_2O$

Worksheet 10

1. potassium carbonate + zinc chloride → zinc carbonate + potassium chloride
2. sodium iodide + lead (II) nitrate → lead (II) iodide + sodium nitrate
3. iron (III) chloride + sodium hydroxide → iron (III) hydroxide + sodium chloride
4. barium nitrate + copper (II) sulfate → barium sulfate + copper (II) nitrate

Worksheet 11

1. $Na_2CO_3 + Pb(NO_3)_2 \rightarrow PbCO_3 + 2NaNO_3$
2. $K_2SO_4 + Ba(OH)_2 \rightarrow BaSO_4 + 2KOH$
3. $CuSO_4 + Na_2S \rightarrow CuS + Na_2SO_4$
4. $NaOH + AgNO_3 \rightarrow AgOH + NaNO_3$

Worksheet 12

1.

a) aluminium + oxygen → aluminium oxide

b) zinc + oxygen → zinc oxide

c) copper + sulfur → copper (I) oxide

d) lead + oxygen → lead (IV) oxide

2.

a) $4Al + 3O_2 \rightarrow 2Al_2O_3$

b) $2Zn + O_2 \rightarrow 2ZnO$

c) $2Cu + S \rightarrow Cu_2S$
or $16Cu + S_8 \rightarrow 8Cu_2S$

d) $Pb + O_2 \rightarrow PbO2$

Worksheet 13

1. a)

hydrochloric acid + potassium hydroxide → water + potassium chloride

b) sulfuric acid + calcium hydroxide → water + calcium sulfate

c) sulfuric acid + sodium hydroxide → water + sodium sulfate

d) nitric acid + barium hydroxide → water + barium nitrate

e)

hydrochloric acid + magnesium hydroxide → water + magnesium chloride

Worksheet 13 (cont)

2.

a) $HCl + KOH \longrightarrow H_2O + KCl$

b) $H_2SO_4 + Ca(OH)_2 \longrightarrow 2H_2O + CaSO_4$

c) $H_2SO_4 + 2NaOH \longrightarrow 2H_2O + Na_2SO_4$

d) $2HNO_3 + Ba(OH)_2 \longrightarrow 2H_2O + Ba(NO_3)_2$

e) $2HCL + Mg(OH)_2 \longrightarrow 2H_2O + MgCl_2$

Worksheet 14

1.

a) sulfuric acid + zinc → hydrogen + zinc sulfate

b) nitric acid + aluminium → hydrogen + aluminium nitrate

c) hydrochloric acid + iron → hydrogen + iron chloride

d) nitric acid + lead → hydrogen + lead nitrate

2.

a) $H_2SO_4 + Zn \longrightarrow H_2 + ZnSO_4$

b) $6HNO_3 + 2Al \longrightarrow 3H_2 + 2Al(NO_3)_3$

c) $2HCl + Fe \longrightarrow H_2 + FeCl_2$

d) $2HNO_3 + Pb \longrightarrow H_2 + Pb(NO_3)_2$

Worksheet 15

1.

a) copper(II) carbonate + nitric acid → carbon dioxide + water + copper(II) nitrate

b) potassium carbonate + sulfuric acid → carbon dioxide + water + potassium sulfate

c) calcium carbonate + hydrochloric acid → carbon dioxide + water + calcium chloride

d) iron(III) carbonate + nitric acid → carbon dioxide + water + iron(III) nitrate

e) magnesium carbonate + sulfuric acid → carbon dioxide + water + magnesium sulfate

Worksheet 15 (cont)

2.

a) $CuCO_3 + 2HNO_3 \longrightarrow CO_2 + H_2O + Cu(NO_3)_2$

b) $K_2CO_3 + H_2SO_4 \longrightarrow CO_2 + H_2O + K_2SO_4$

c) $CaCO_3 + 2HCl \longrightarrow CO_2 + H_2O + CaCl_2$

d)

$Fe_2(CO_3)_3 + 6HNO_3 \longrightarrow 3CO_2 + 3H_2O + 2Fe(NO_3)_3$

e) $MgCO_3 + H_2SO_4 \longrightarrow CO_2 + H_2O + MgSO_4$

Topic Test 1

1. a) E b) A c) F d) B e) D

2. Ionic bonding is when atoms gain or lose electrons and become ions. Ions are bonded by electrical attraction.

Covalent bonding involves the sharing of electrons. The atoms have to stay together to share, so they are bonded.

3.

a) carbon dioxide
b) sodium chloride (salt)
c) hydrogen sulfate, or sulfuric acid

4.

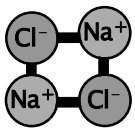
a) zinc + oxygen → zinc oxide

b) hydrochloric acid + potassium hydroxide → water + potassium chloride

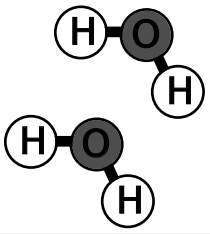
c) copper carbonate → carbon dioxide + copper oxide

d) sulfuric acid + calcium → hydrogen + calcium sulfate

5.a) A salt crystal is made of billions of +ve and -ve ions all attracted to each other in a 3-dimensional grid, or lattice.



b) Water is made up of separate molecules. Each one has 2 hydrogen atoms and 1 oxygen atom. They are bonded together by sharing pairs of electrons.



Topic Test 2

1.

a) barium sulfate
b) methane
c) iron (II) hydroxide
d) ammonium nitrate
e) aluminium carbonate

2.

a) $Ca(NO_3)_2$ **b)** $FeBr_3$

c) $Cu(OH)_2$ **d)** $(NH_4)_2SO_4$

e) NH_3

3.

a) $2Al + 3Br_2 \longrightarrow 2AlBr_3$

b) $Ca(OH)_2 + H_2SO_4 \longrightarrow 2H_2O + CaSO_4$

c) $FeCl_2 + K_2S \longrightarrow FeS + 2KCl$

4.

a) i) pentane + oxygen ⟶ carbon dioxide + water

ii) $C_5H_{12} + 8O_2 \longrightarrow 5CO_2 + 6H_2O$

b) i) hydrochloric acid + magnesium hydroxide ⟶ water + magnesium sulfate

ii) $2HCl + Mg(OH)_2 \longrightarrow 2H_2O + MgCl_2$

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