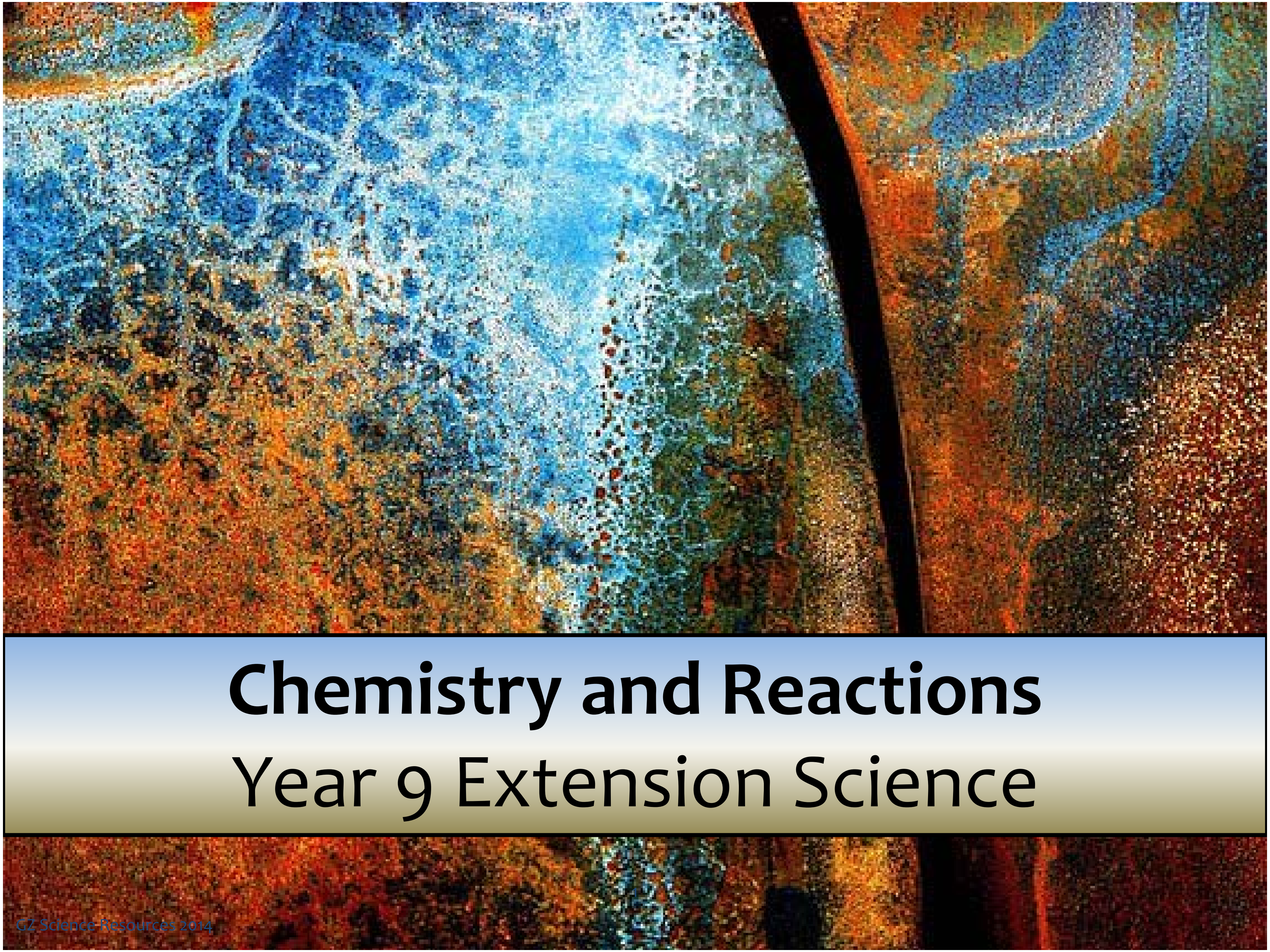


Chemistry and Reactions

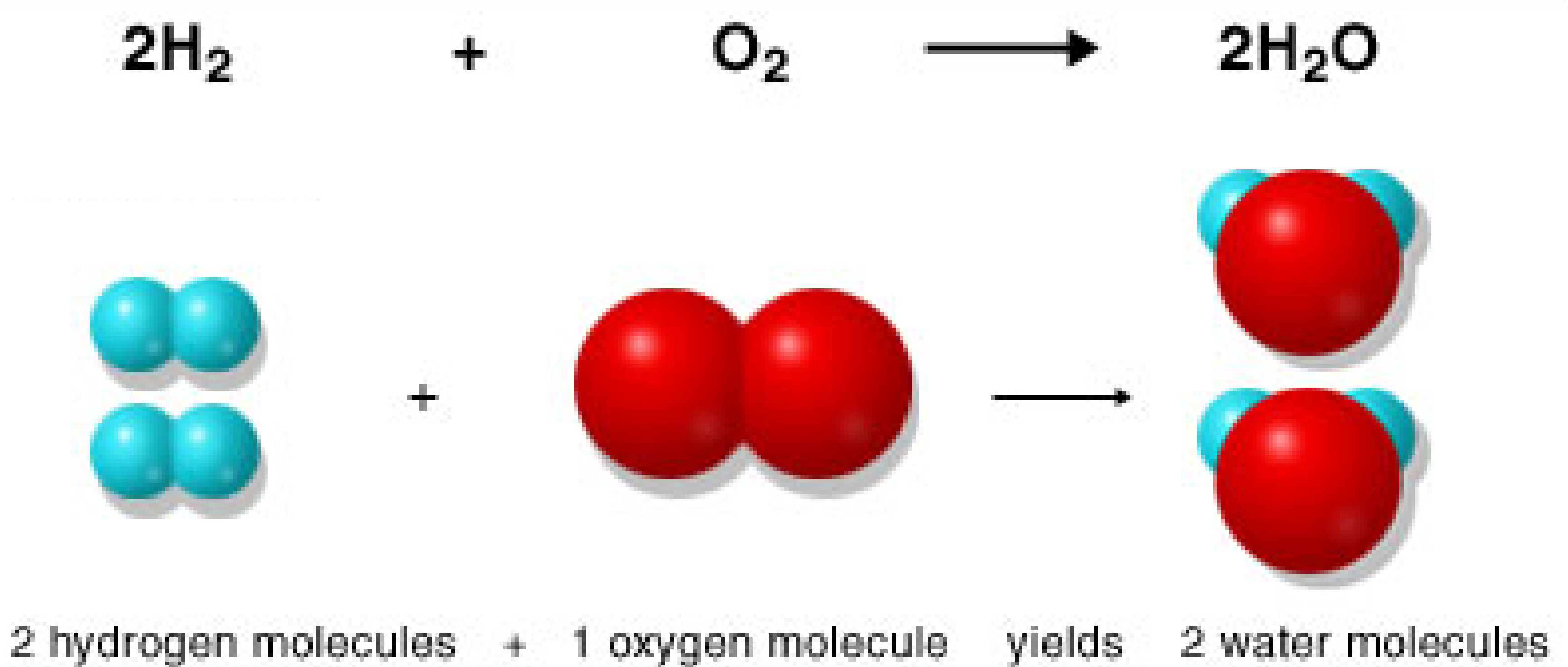
Year 9 Extension Science

1a

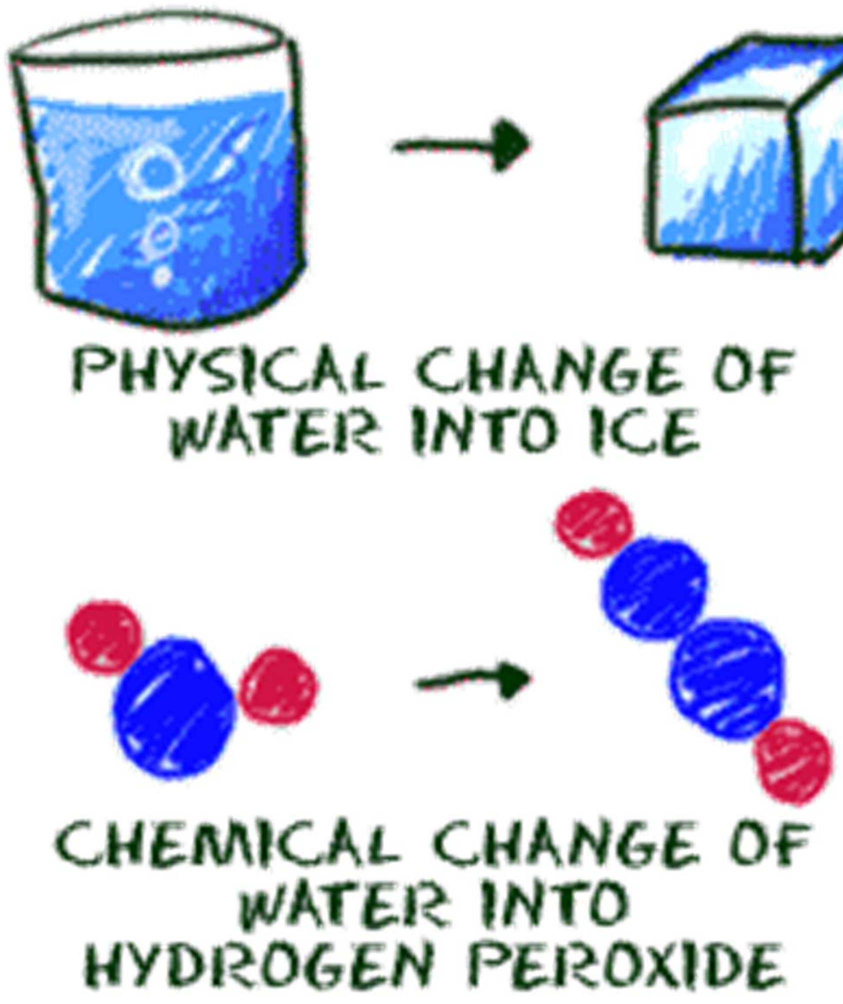
Reactants join together to form new products during chemical reactions

The atoms present in the **reactants** rearrange themselves in different combinations and form new bonds. The new combinations of atoms are called **products** and can either be single atoms or molecules.

Reactants Products



1a Recognising chemical and physical change



Physical changes are concerned with energy and states of matter. A physical change does not produce a new substance. Changes in state (melting, freezing, vaporization, condensation, sublimation) are physical changes. Examples of physical changes include bending a piece of wire, melting icebergs, and breaking a bottle

A **chemical change** makes a substance that wasn't there before. The starting and ending materials of a physical change are the same, even though they may look different.

1a

Recognising chemical and physical change

Examples of Chemical Changes

burning wood
dissolving salt in water
mixing acid and base
digesting food

Examples of Physical Changes

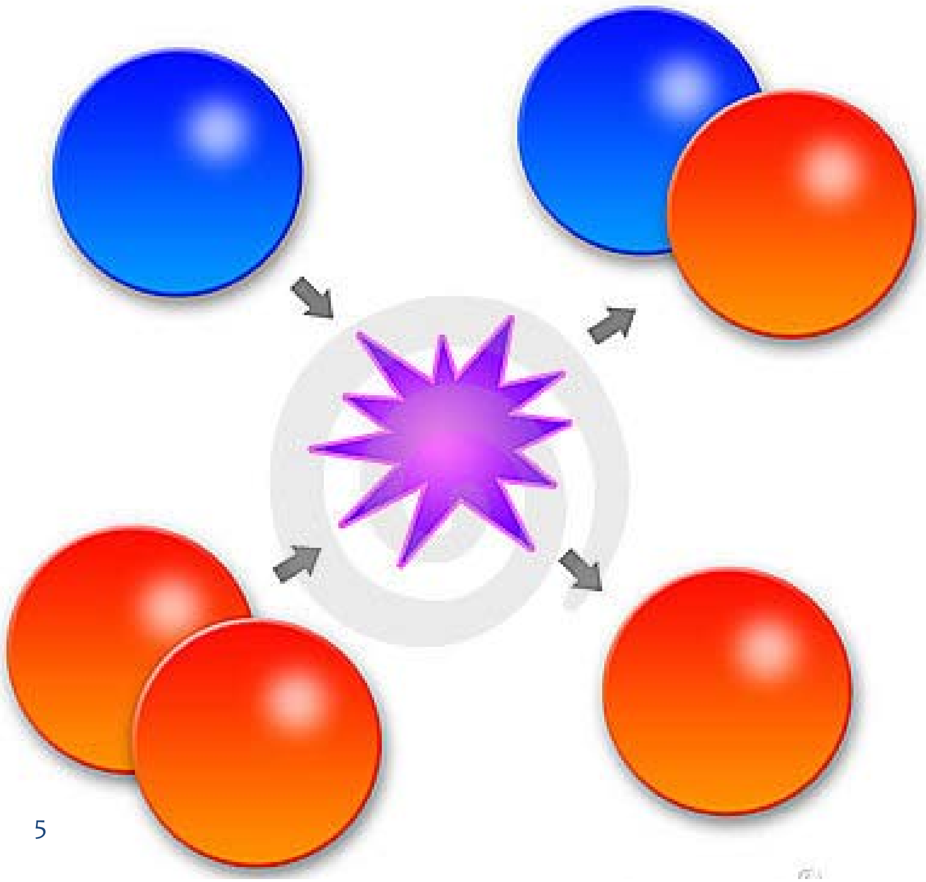
crumpling a sheet of paper
melting an ice cube
casting silver in a mould
breaking a bottle

Chemical reactions - naming reactants & products - and recognising chemical change

1b

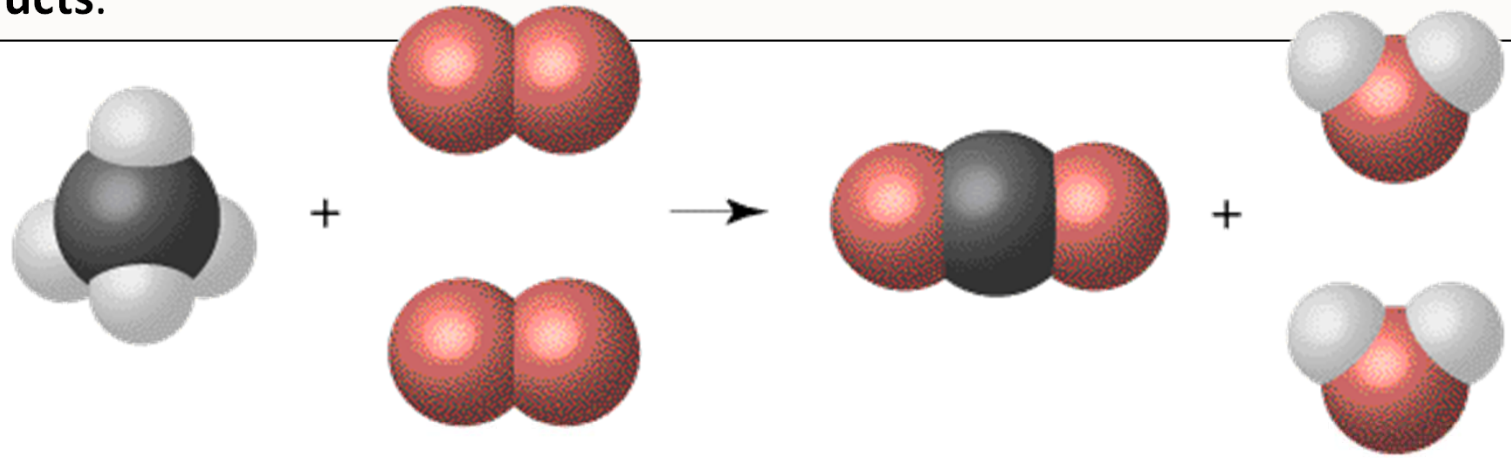
A **chemical reaction** is a process that produces a chemical change to one or more substances.
A chemical reaction will produce a **new substance.** Other observations may include a temperature change, a colour change or production of gas.
Chemicals that are used in a chemical reaction are known as **reactants**. Those that are formed are known as **products**.

Reactants → Products



1b Chemical equations

Compounds and elements can react together to form new substances in a **chemical reaction**. We use a **chemical equation** to show the substances we start with called **reactants**, and the substances that are formed called **products**.

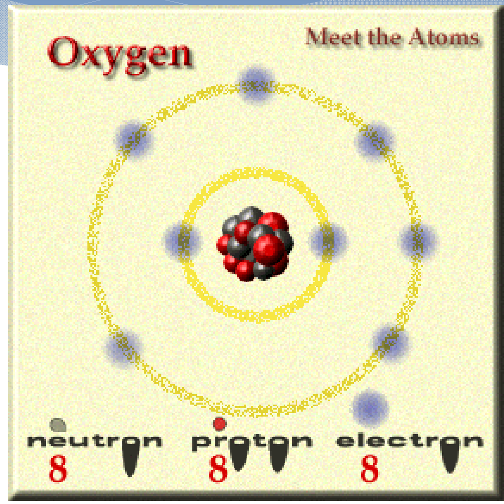


One methane molecule	+	Two oxygen molecules	→	One carbon dioxide molecule	+	Two water molecules
CH_4	+	$2O_2$	→	CO_2	+	$2H_2O$
(1 C, 4 H)		(4 O)		(1 C, 2 O)		(2 O, 4 H)

2a Making Oxygen gas

<u>What to do</u>

1. Put a small amount of Potassium Permanganate (condys crystals) into a boiling tube.
2. Put a bung with a delivery tube over the boiling tube and put the delivery tube into an upside down test tube to collect any gas.
3. Heat the tube gently with a Bunsen burner.
4. Remove delivery tube and place thumb over test tube.
5. Remove thumb quickly and place a glowing splint into the t-t.
6. If the splint re-ignites then it is likely the gas produced was oxygen.
7. Draw a labeled diagram of the equipment set up.



Oxygen in the air combines with iron to form rust.

2b Making Hydrogen gas

<u>What to do</u>

1. Put a small piece of zinc into a boiling tube with a small amount of dilute sulfuric acid.
2. Quickly put a bung with a delivery tube over the boiling tube.
3. Collect the gas from the delivery tube into an upside down test-tube.
4. Place thumb over top of the test tube
5. Hold a lit match at the mouth of the test tube and remove thumb quickly
6. If the gas makes a loud 'pop' then it is likely that the gas produced is hydrogen.
7. Draw a labeled diagram of the equipment set up.

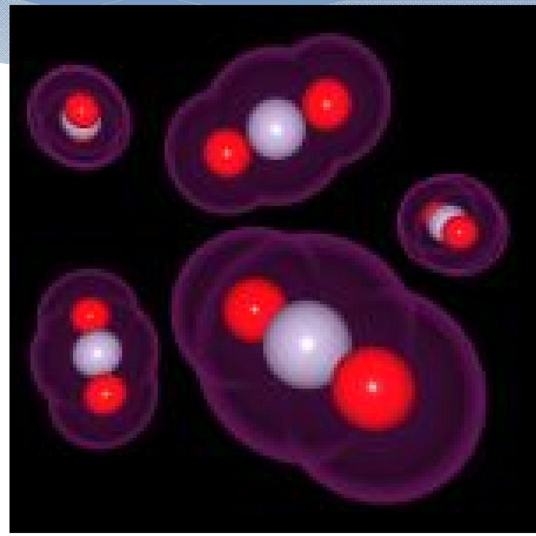
Hydrogen in Jupiter's Atmosphere

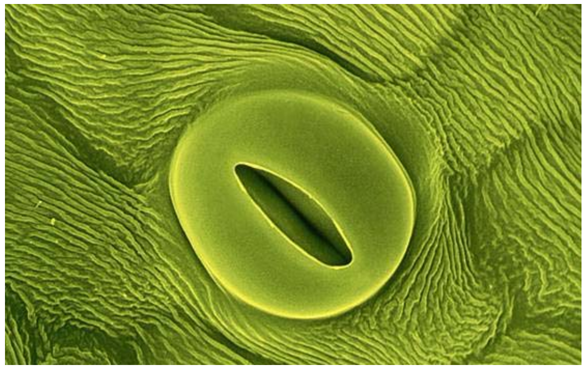
Rocket fueled by liquid hydrogen

2c Making Carbon Dioxide gas

<u>What to do</u>

1. Put a small amount of Sodium Bicarbonate (baking soda) into a boiling tube.
2. Put a bung with a delivery tube over the boiling tube.
3. Place the delivery tube into a test-tube filled with clear limewater
4. Heat the tube gently with a Bunsen burner
5. Observe the gas bubbling into the limewater.
6. If the limewater turns cloudy then it is likely that the gas produced is carbon dioxide.
7. Draw a labeled diagram of the equipment set up.



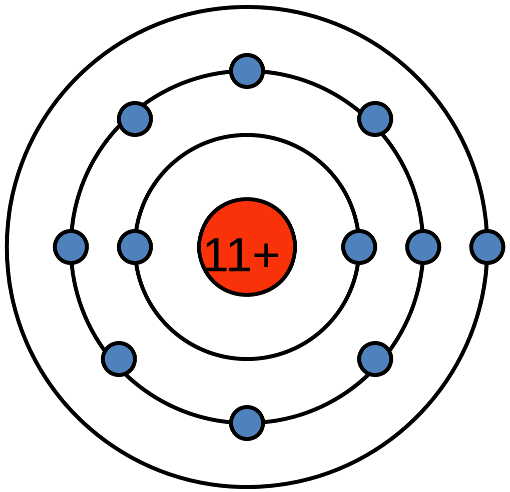


Plant stomata which allows CO_2 gas into the leaf

3a Ions are formed by gain or loss of electrons.

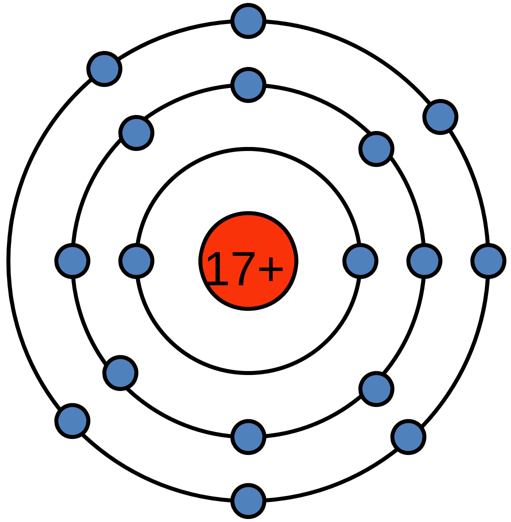
Ions are atoms or groups of atoms with electrical charge.
Elements are most stable when the outer shell (valence shell) is full.
Elements can lose or gain electrons when they react with other chemicals to form ions.

Cation Sodium (Na)



Sodium now becomes the sodium ion Na^+

Anion Chlorine (Cl)

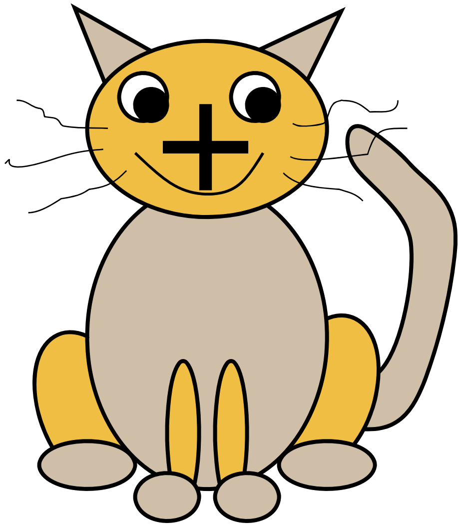


Chlorine now becomes the chlorine ion Cl^-

3a Ions are formed by gain or loss of electrons.

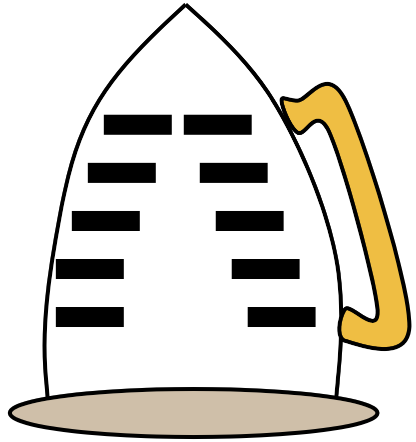
Atoms that lose electrons form positively charged ions, or cations.
Atoms that gain electrons form negatively charged ions, or anions.

Cation (Cat)



Metals lose electrons to form Cations. They have 1-3 electrons in their outside shell

Anion (an Iron)



Non-Metals gain electrons to form Anions. They have 7-8 electrons in their outside shell.

3b

Ion Chart - Cations.

1+	2+	3+
sodium Na^{+}	magnesium Mg^{2+}	aluminium Al^{3+}
potassium K^{+}	iron (II) Fe^{2+} ferrous	iron (III) Fe^{3+} ferric
silver Ag^{+}	copper (II) Cu^{2+} cupric	Chromium Cr^{3+}
ammonium NH_4^{+}	zinc Zn^{2+}	
Hydrogen H^{+}	barium Ba^{2+}	
Lithium Li^{+}	lead Pb^{2+}	
	tin Sn^{2+}	

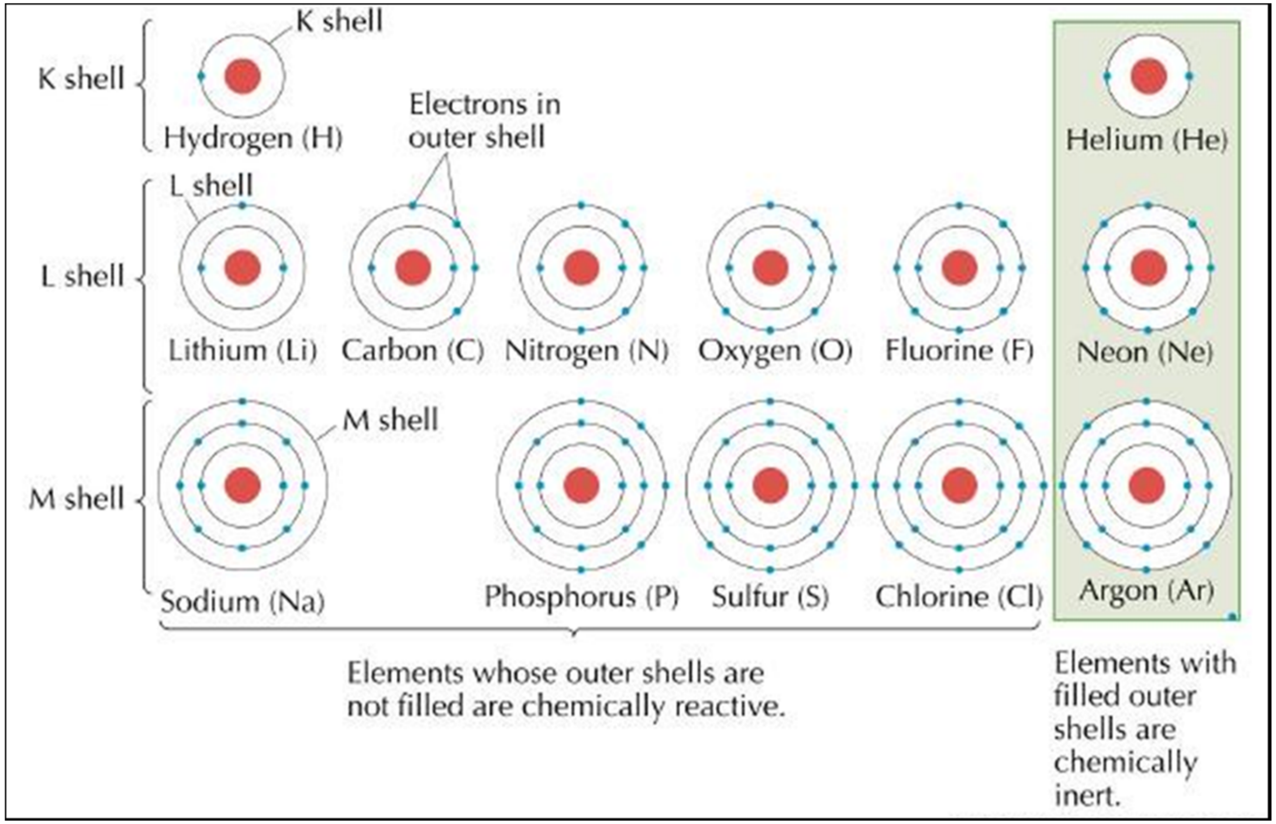
3b

Ion chart - anions

1-		2-	
chloride	Cl^-	carbonate	CO_3^{2-}
iodide	I^-	oxide	O^{2-}
hydroxide	OH^-	sulfide	S^{2-}
hydrogen carbonate	HCO_3^-	sulfate	SO_4^{2-}
fluoride	F^-	sulfite	SO_3^{2-}
bromide	Br^-		
nitrate	NO_3^-		
		3-	
		phosphate	PO_4^{-3}

3c

There is a relationship between the group number and the number of outer electrons.



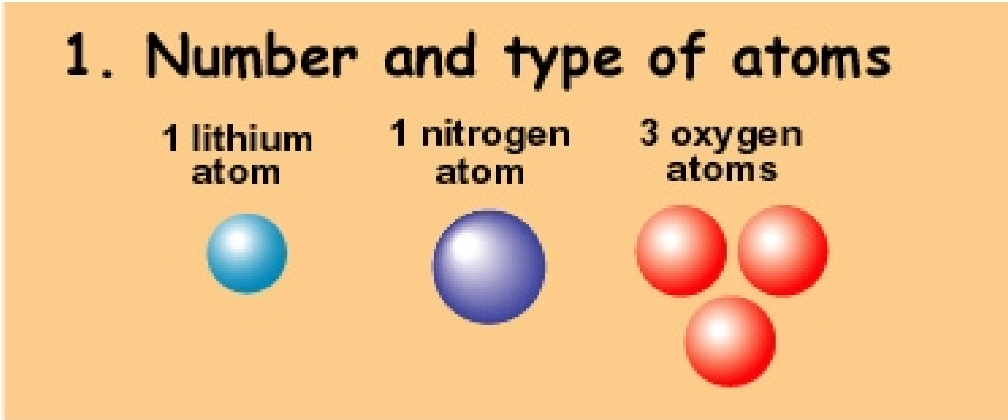
The elements in a group have the same number of electrons in their outer shell. Every element in the first column (group one) has one electron in its outer shell. Every element on the second column (group two) has two electrons in the outer shell.

As you keep counting the columns, you'll know how many electrons are in the outer shell.

extension

4a Elements are pure substances that combine to make mixtures & compounds

A formula tells you the type of atoms that are in a compound and the number of each atom.



A number in front of the compound tells you how many molecules there are. **A number after** an atom tells you how many atoms of that type are in the molecule. **A number after brackets** tells you how many times to multiply every atom inside the brackets.

4a Cross and Drop method for balancing ionic compounds

1. Write down the ions (with charges) that react to form the compound. Cation comes before Anion.

Al^{3+} O^{2-}

Al_2O_3

2. Cross and drop the charge numbers.
3. Place brackets around a compound ion.

4. If the numbers are both the same remove.

5. If any of the numbers are a 1 they are removed

6. Remove any brackets if not followed by a number

H^{+} SO_4^{-2}

$H_2(SO_4)_1 \longrightarrow H_2SO_4$

5a

Acids– their characteristics

Acids are a family of substances which all show **acidic characteristics** or properties. These properties relate to how the acids react with other chemicals.

They have a **sour taste** and react with metals. Acids can be found in nature and called **organic acids** or manufactured in the laboratory and called **mineral acids**.

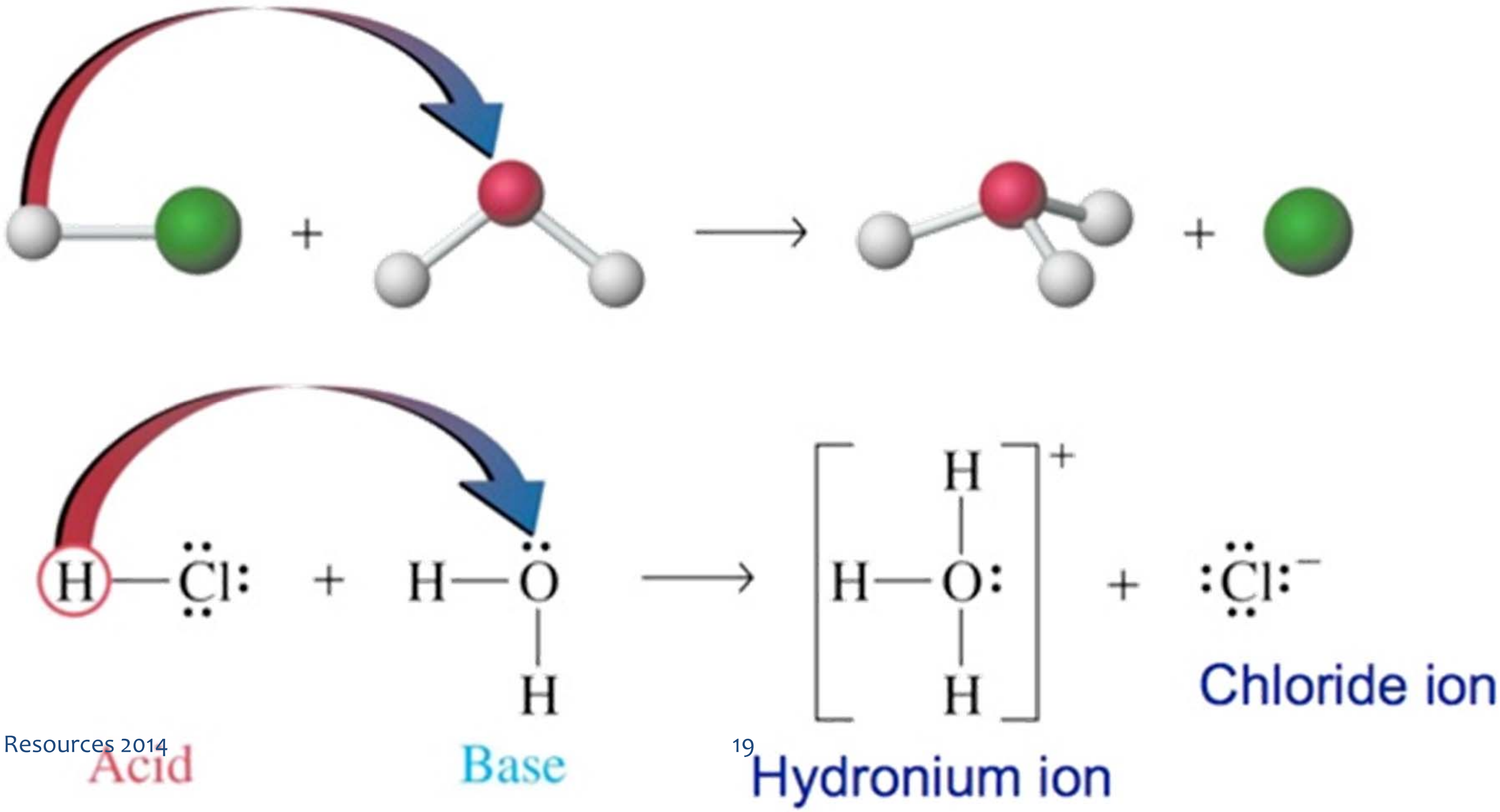
5a Bases – their characteristics

Bases are a family of Chemicals that can remove acid particles (H^+) from a solution. They have opposite properties from acids.

Bases have a slippery feel to them and common house hold bases include floor clearers and antacid tables to fix indigestion. Bases that dissolve into water are called an alkali.

5b Acids– their characteristics

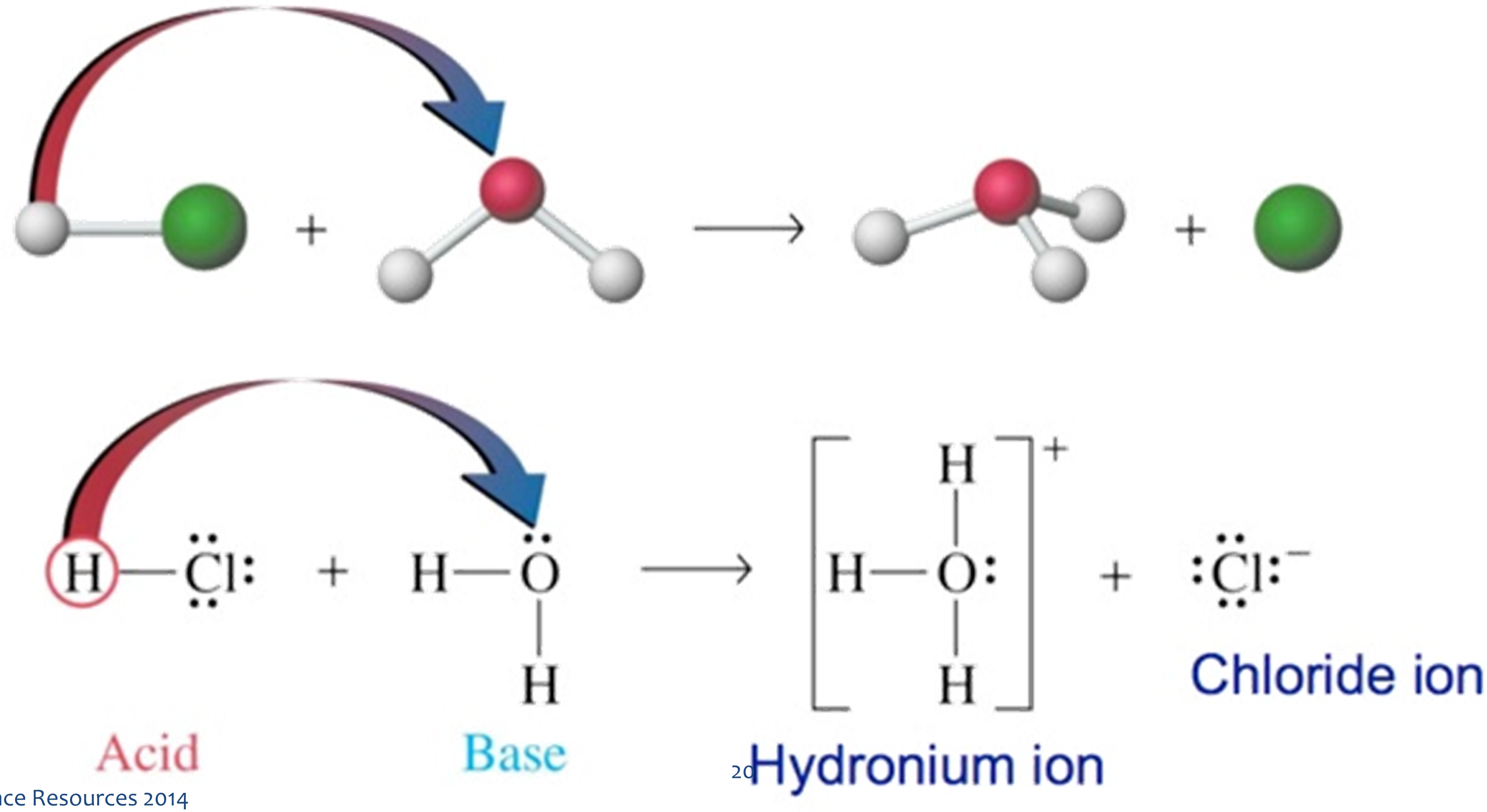
An **Acid** donates its **Hydrogen ion** (H+) , which is really just a proton - the electron remains behind.



5b

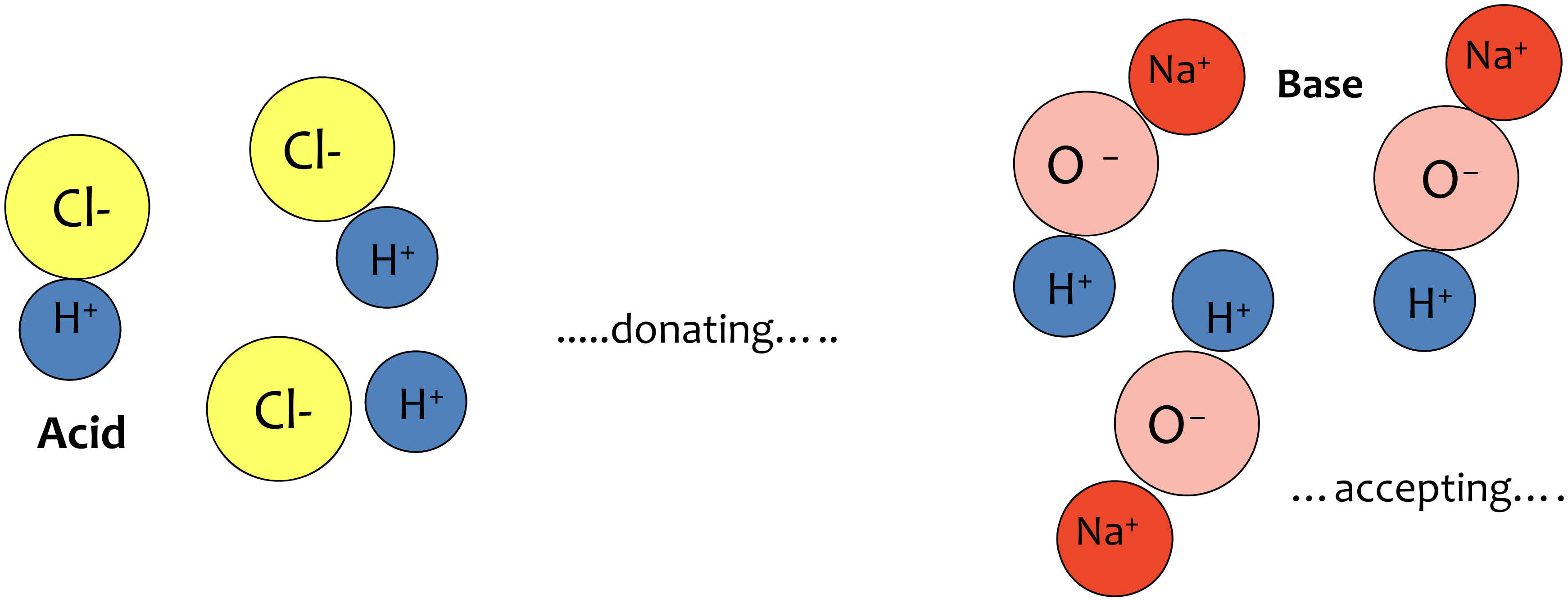
Bases – their characteristics

A **Base** accepts a **Hydrogen ion** that have been donated from an Acid. Some substances such as water can act as both an Acid or a base depending on what other substance the water is with.



5b The Brønsted–Lowry theory

An **acid** is a molecule or ion that is able to lose, or "donate," a hydrogen ion (proton, H+), and a **base** is a species with the ability to gain, or "accept," a hydrogen ion (proton).



5c Common acids - names and formula

Name	Chemical formula
Hydrochloric Acid	HCl
Sulfuric Acid	H_2SO_4
Nitric Acid	HNO_3
Acetic Acid	CH_3COOH

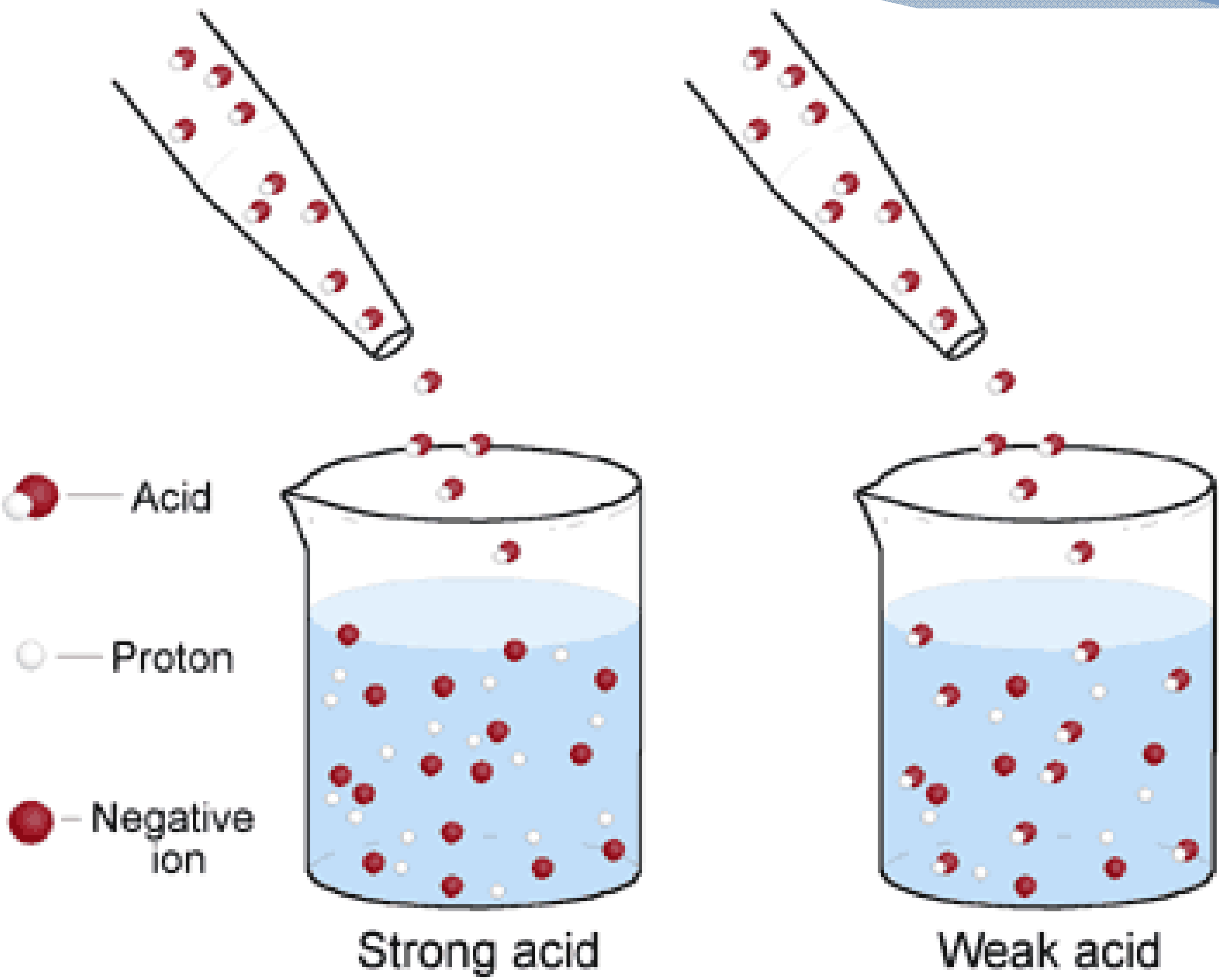
React with most metals to form hydrogen gas
Taste sour (like lemons)
Frequently feel "sticky"
Usually gases or liquids

5c Common bases - names and formula

Name	Chemical formula
Sodium Hydroxide	$NaOH$
Calcium Hydroxide	$Ca(OH)_2$
Ammonia	NH_3
Potassium hydroxide	KOH

Feel "slippery". (because your skin dissolves a little when you touch them.)
Taste bitter (like baking soda)
React with oils and greases (used as cleaners)
Frequently solids

5d Understand the difference between strong and weak acids and bases



You can define acids and bases as being "strong" or "weak". **Strong acids** are compounds that completely break up in water. All of the H+ ions (protons) break away from the original acid molecule in water. A **weak acid** only loses some of it's H+ ions (protons) in water.

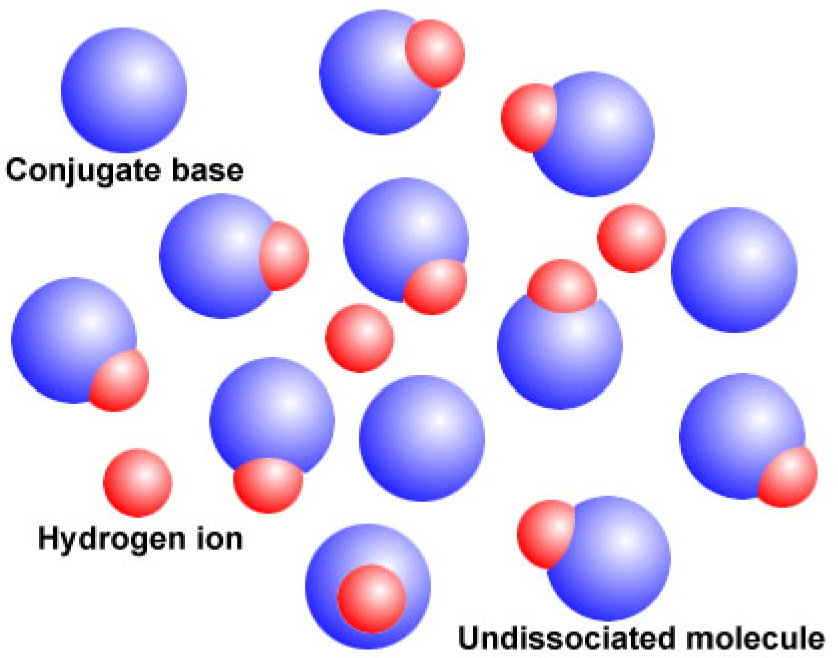
For strong bases, all of the OH- ions break away from the molecule in water.

5d Understand the difference between strong and weak acids and bases

Strong Acids	Weak Acids	Neutral solution	Weak Bases	Strong Bases
Readily donate all their protons when dissolved	donate only a small proportion of protons		Accept only a small proportion of protons	Readily accept protons
Concentration of H+ ions is **greater** than that of OH- ions		Concentration of H+ ions is the **same** as that of OH- ions		Concentration of H+ ions is **less** than that of OH- ions

Increasing acidity ⟷ **Increasing alkalinity**

5d Understand the difference between strong and weak acids and bases



Weak acids dissociate only slightly in aqueous solution. The majority of molecules remain undissociated.

When a base accepts a proton, it becomes an acid because it now has a proton that it can donate. And when an acid donates a proton it becomes a base, because it now has room to accept a proton.

These are what we call **conjugate pairs** of acids and bases.

When an acid gives up its proton, what remains is called the **conjugate base** of that acid. When a base accepts a proton, the resulting chemical is called the conjugate acid of that original base.

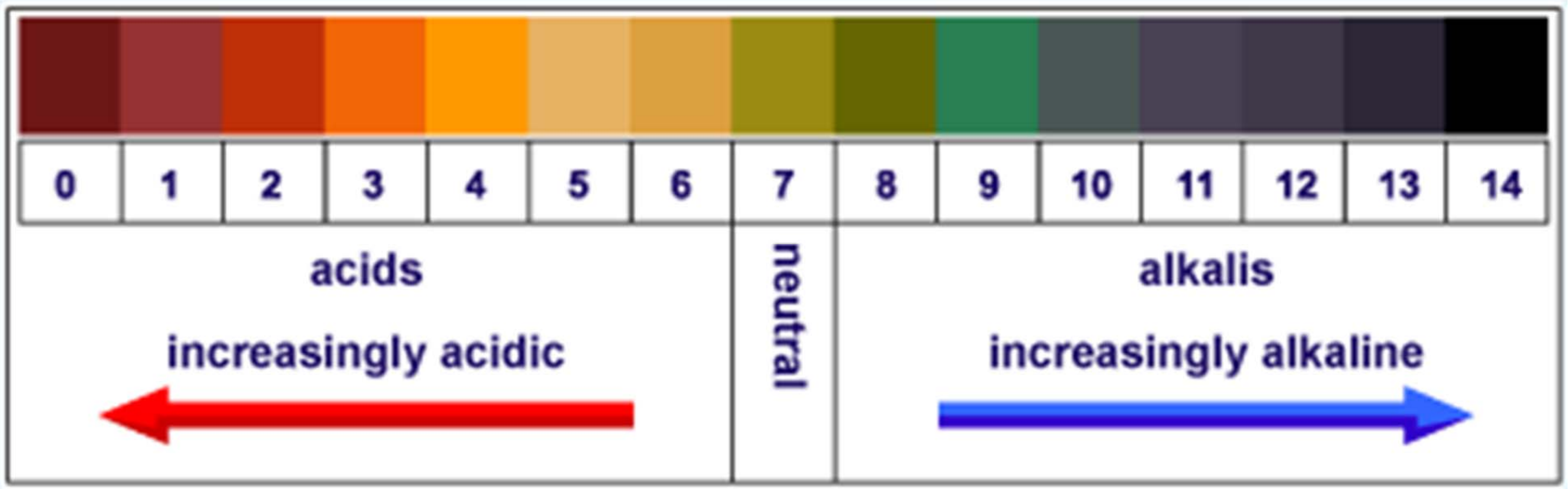
Describe solutions as acidic, alkaline or neutral in terms of the pH scale.

6a

Acids have a pH less than 7

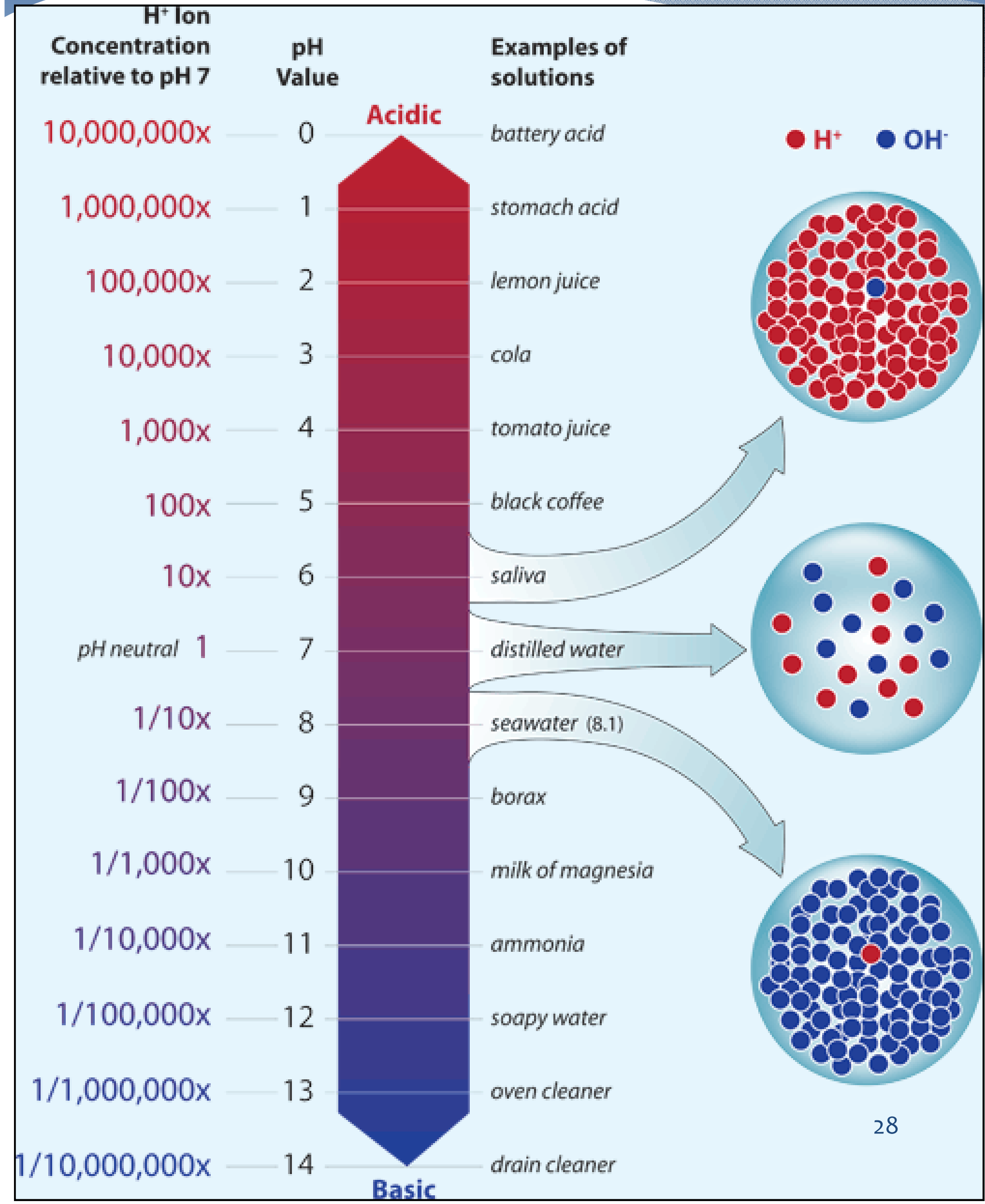
Neutral substances have a ph of 7

Alkalis have pH values greater than 7



The pH scale is **logarithmic** and as a result, each whole pH value below 7 is ten times more acidic than the next higher value. For example, pH 4 is ten times more acidic than pH 5 and 100 times more acidic than pH 6.

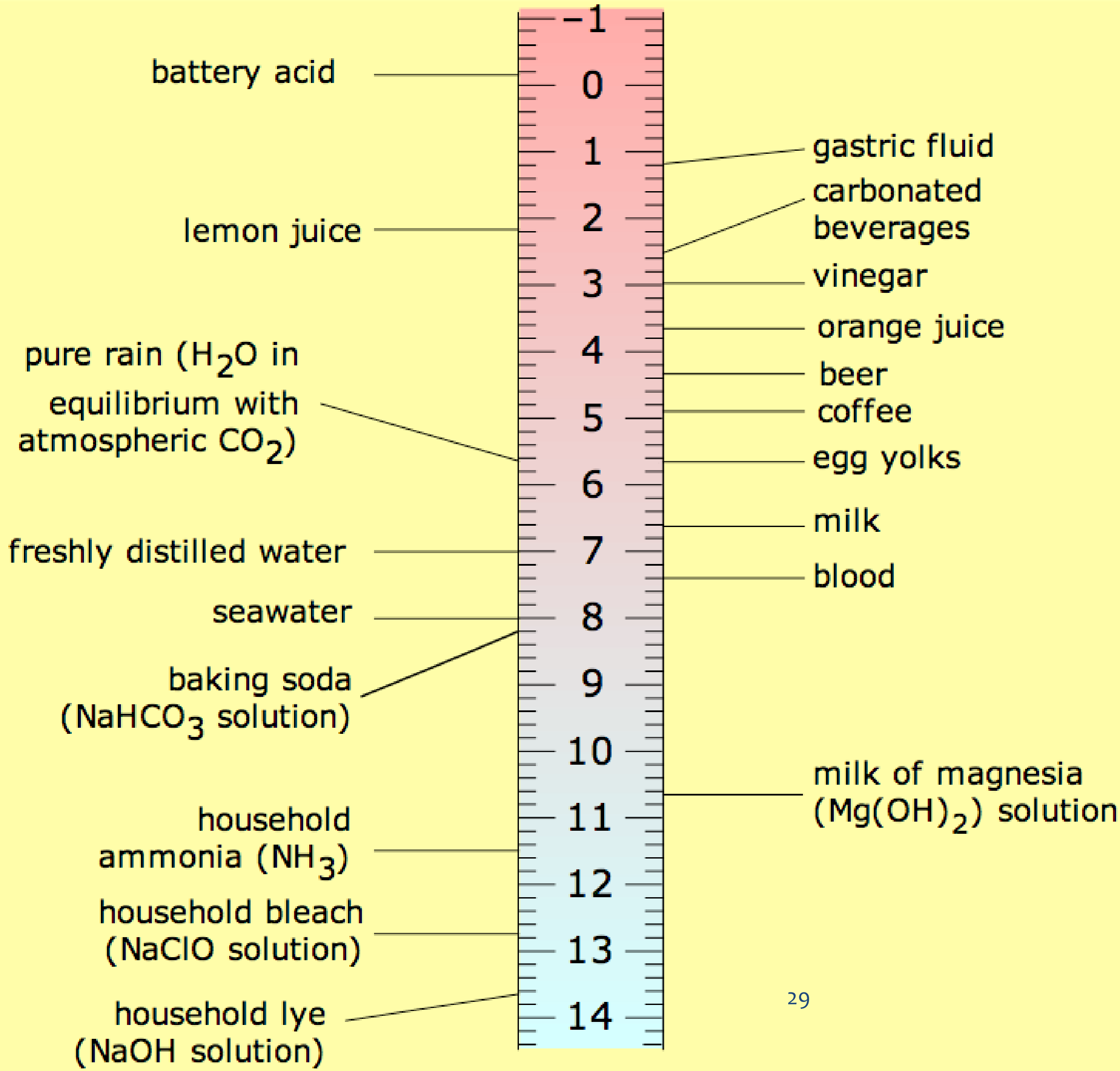
6a The pH scale measures level of acidity and alkalinity



The **pH scale** measures how acidic or alkaline a substance is. Substances with a pH of 7 are **neutral**, substances with a pH greater than 7 are **alkaline** (or 'basic') and substances with a pH lower than 7 are **acidic**. Alkalis are 'bases' that are soluble in water. (All alkalis are bases but not all bases are alkalis.)

The pH of a substance is determined by the concentration of hydrogen ions. The higher the concentration of hydrogen ions the lower the pH.

Describe solutions as acidic, alkaline or neutral in terms of the pH scale.



Pure water is **neutral**. But when chemicals are mixed with water, the mixture can become either acidic or basic. Examples of acidic substances are vinegar and lemon juice. Lye, milk of magnesia, and ammonia are examples of basic substances

Indicators are used to determine whether substances are acid, base or neutral.

6b

Indicators can be used to determine the pH of a solution by the colour change.

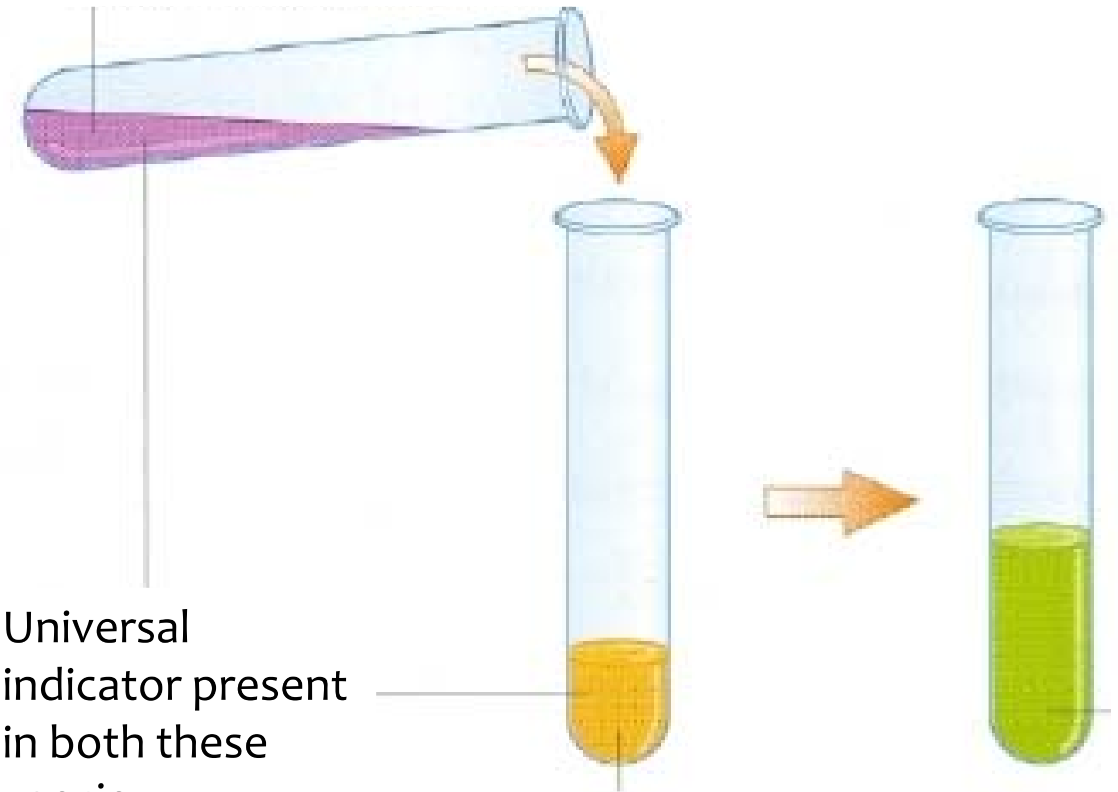
An indicator is a large organic molecule that works somewhat like a " color dye". They respond to a change in the hydrogen ion concentration. Most of the indicators are themselves weak acids.

The most common indicator is found on **litmus paper**. It is red below pH 4.5 and blue above pH 8.2

Universal Indicator, which is a solution of a mixture of indicators is able to provide a full range of colours for the pH scale.

6c

During neutralisation reactions hydrogen ions combine with hydroxide ions to form water molecules.



Neutralisation is a reaction where an acid reacts with an alkali to form a neutral solution of a salt and water.

Acid + Alkali → Salt + Water

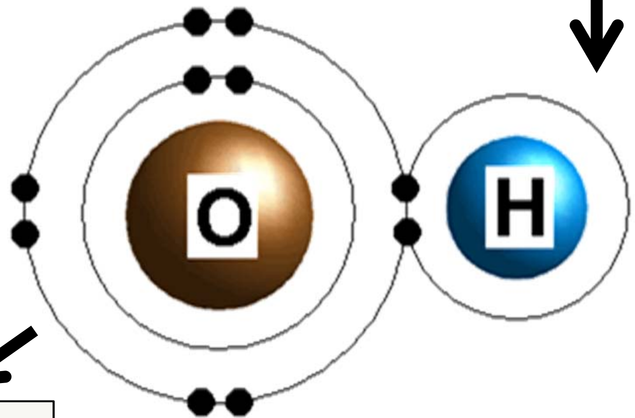
6c

During neutralisation reactions hydrogen ions combine with hydroxide ions to form water molecules.

From an acid

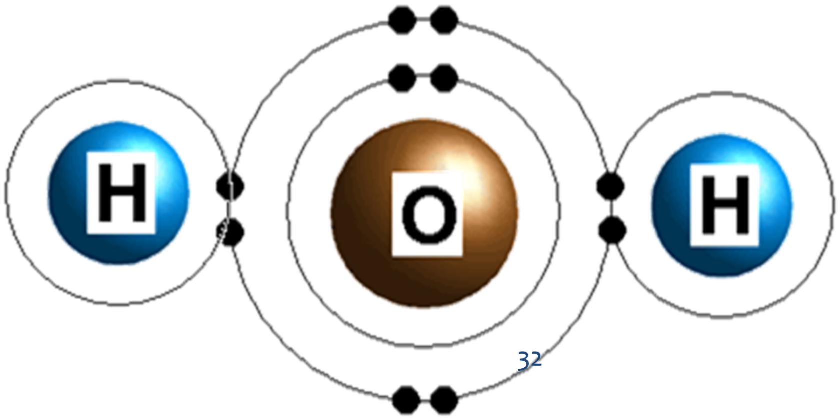
Hydrogen ion
1 proton
0 electrons
= +1 charge

From a base



Hydroxide:
9 protons
10 electrons
= -1 charge

Neutralisation



Water
10 protons
10 electrons
= 0 charge

6d Balanced equations for salt formation

Bases **neutralise** acids and a salt and water are formed

H^+ Acid + Base OH^- → Salt + H_2O

Example

$HCl + NaOH \rightarrow NaCl + H_2O$

Hydrochloric Acid + Sodium Hydroxide → Sodium Chloride + Water

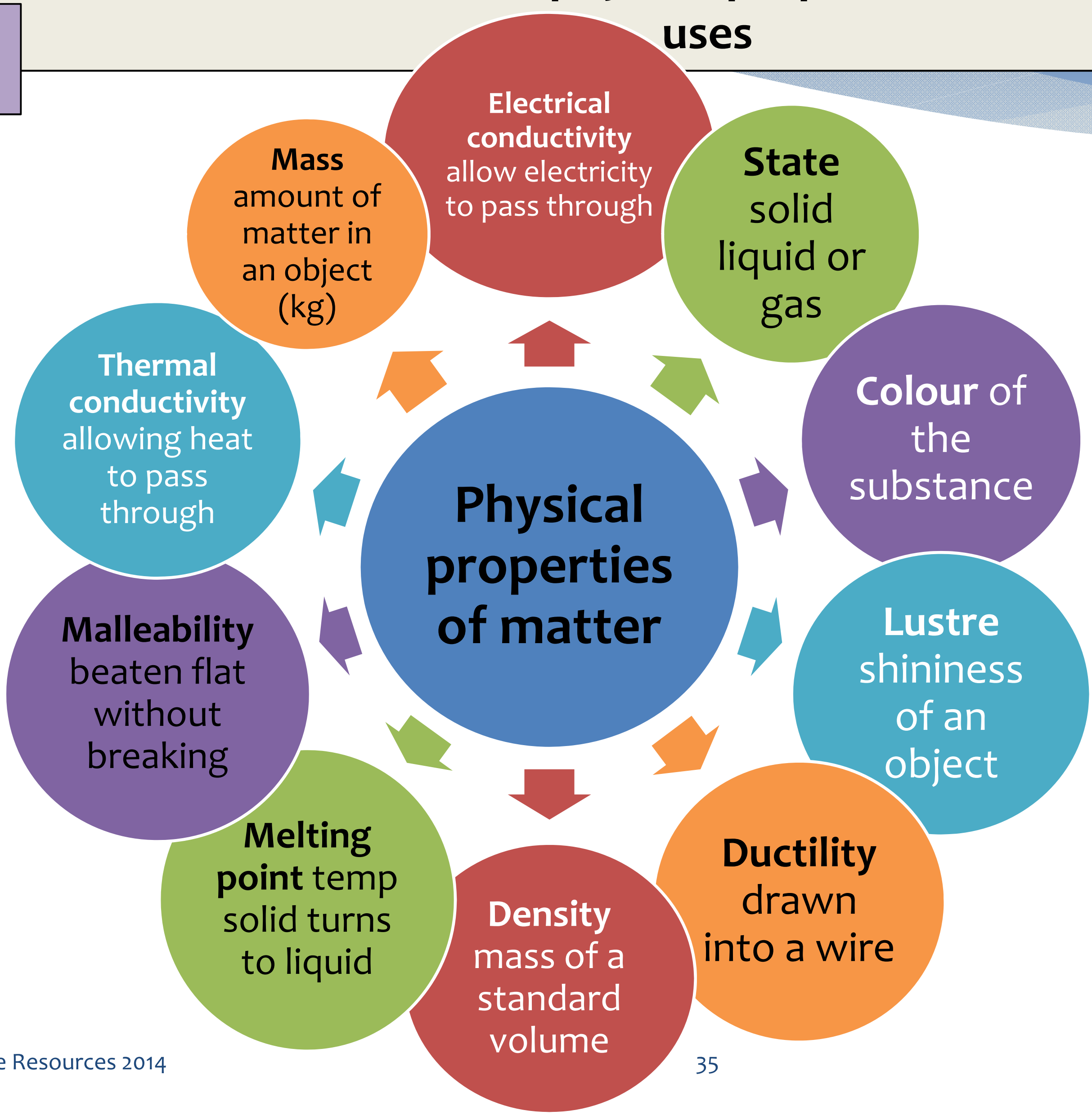
7a

Metals

Metals can be distinguished from non-metals by their physical properties; they are strong, dense, shiny solids that can be worked into different shapes. They are good conductors of heat and electricity.

There is a link between the physical properties of substances and their uses

7a



Substances can be distinguished by their different physical properties. Some groups of substances, such as metals, can show similar physical properties.

7a Metals and non-metals

Group	Physical properties	Chemical properties
Metals	>Lustre >good conductor >High density >High melting point >Malleable and Ductile	>Easily lose electrons >Corrode easily
Semi-Metals	>Solids >Can be shiny or dull >Ductile and malleable >Conduct heat and energy better than Non Metals but not as good as metals	
Non-Metals	>No lustre >Poor conductor >Brittle >Not ductile >Low density >Low melting point	>Tend to gain electrons

Some metals are more suitable for certain uses than others because of their physical properties

7b

We select appropriate metals which are the most useful for the task or technology they assist with because of their particular characteristics.

Metal	*Uses*	*Property involved*
copper	Pipes. Wires. cooking pots	Unreactive with air and water Excellent electrical conductor good thermal conductor
aluminium	Aircraft frames wires	Strong light and unreactive Good conductor and ductile
mercury	thermometers	Expands regularly with heat
lead	Roof flashing	Very malleable
zinc	galvanising	Forms a protective coat
tin	Tin coating	Unreactive with air and water
silver	jewellery	Malleable, ductile, unreactive
iron	Car bodies Structural steel	Forms strong alloys, malleable Forms strong alloys, flexible

7d Metal reactivity

Metals react with other chemicals with varying speed or not at all. Differences in reactivity are shown in the reactivity series of metals.

Reactivity series

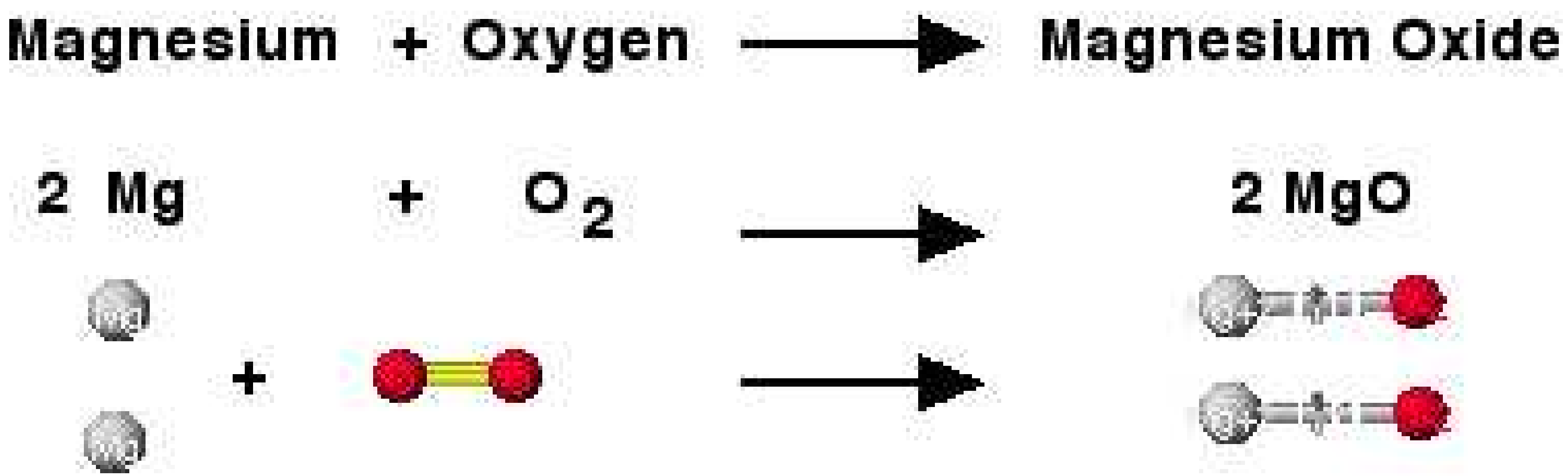
Unreactive very reactive

Metals will react faster if they are more reactive – more reactive metals give up their electrons more readily to react with other chemicals

Pt >Au>Ag>Cu>Pb>Sn>Fe>Zn>Al>Mg>Ca>Li>Na>K>Rb>Cs

8a Metals form oxides by reaction with oxygen

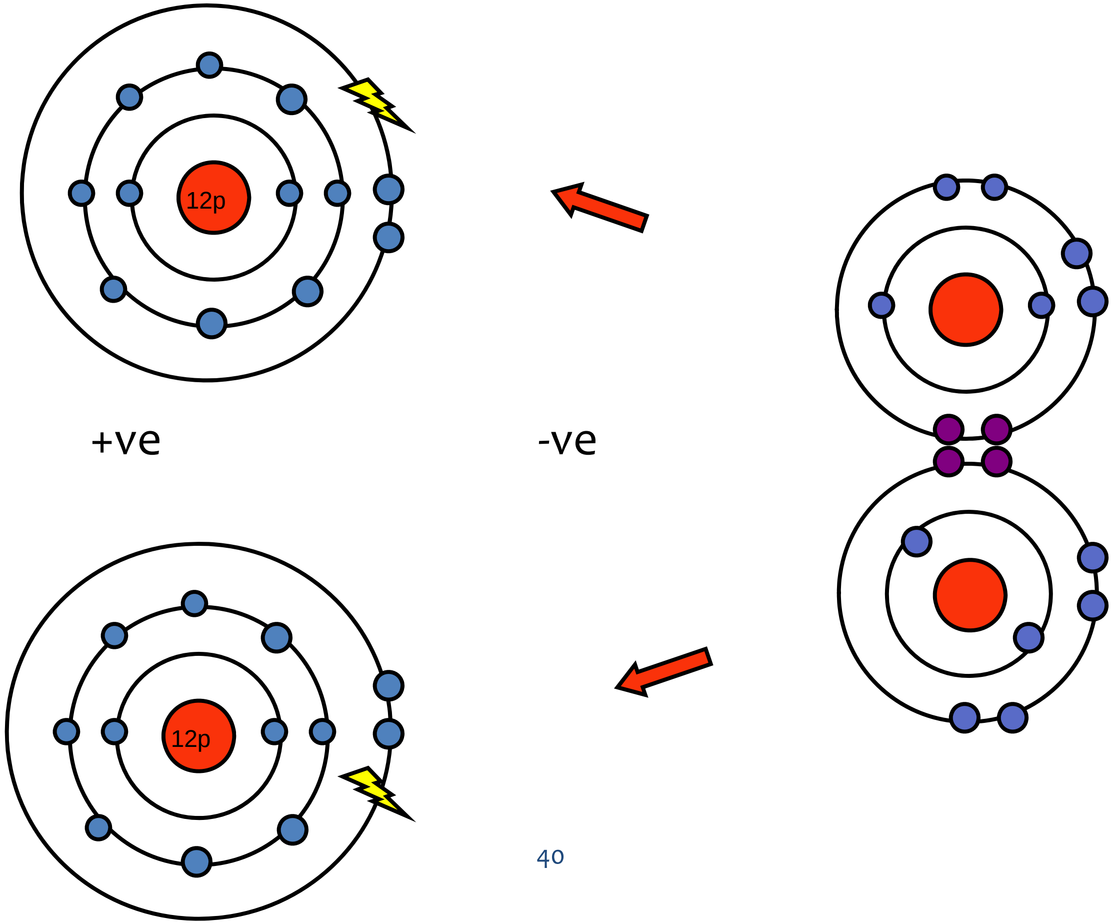
Metals react with oxygen in the air to produce **metal oxides**, like magnesium oxide.
Electrons are lost from the metal to form a cation (positive ion) and gained by the oxygen to form an anion – oxide (negative ion). The cation and anion then join together to form a **neutral** metal oxide.



extension

8a Metals form oxides by reaction with oxygen

2Mg	+	O_2	→	2MgO
Magnesium	+	Oxygen	→	Magnesium Oxide



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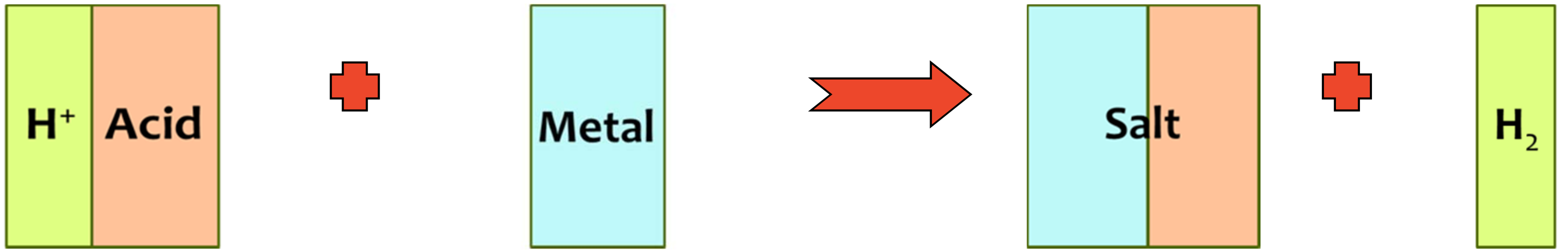
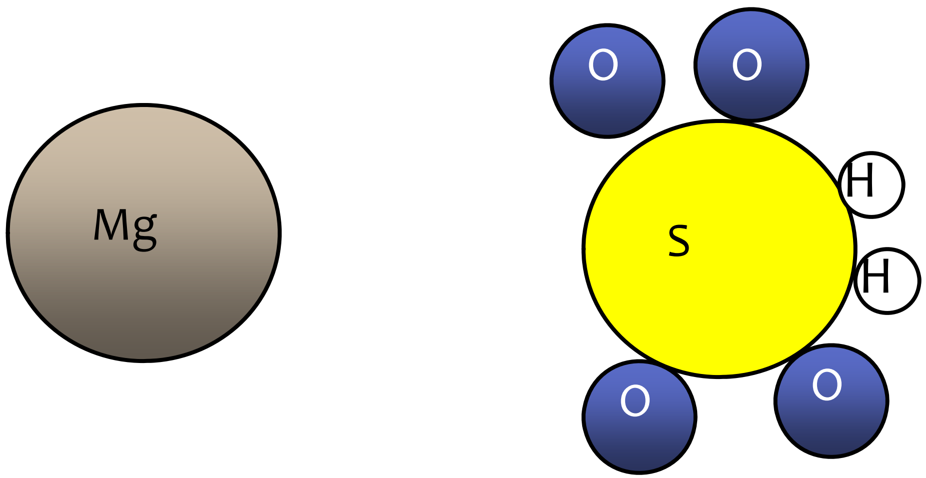
8b Metals form salts and hydrogen gas when reacting with acid

Acids react with metals to give a salt and hydrogen. Most metals will react with acid – especially if the acid is heated and concentrated

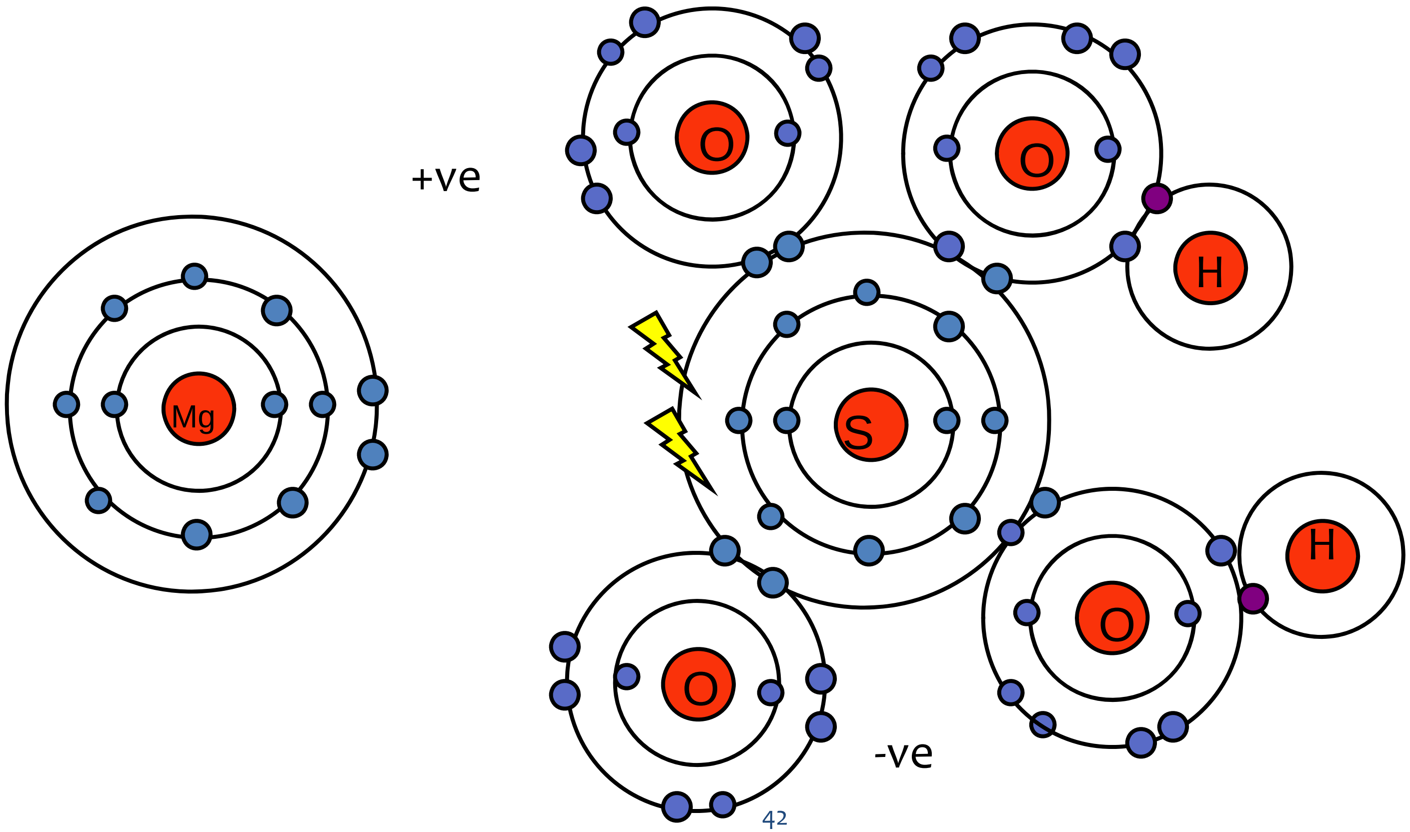




extension

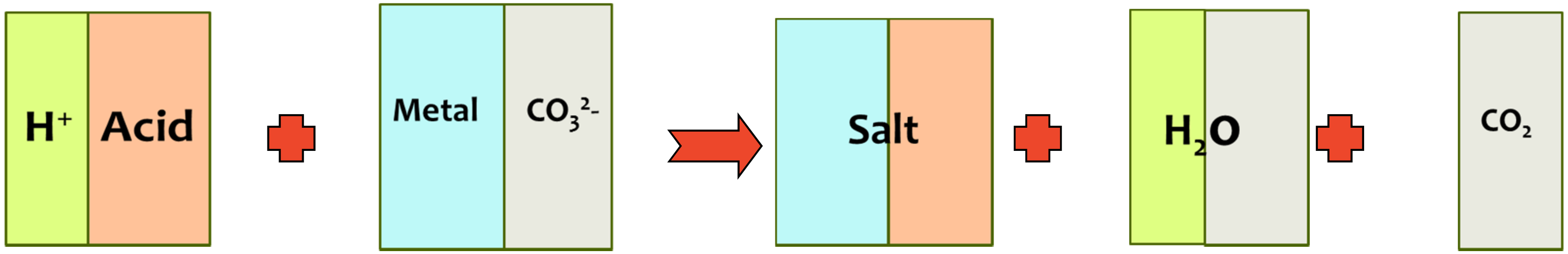
8b Metals form salts and hydrogen gas when reacting with acid

Mg	+	H_2SO_4	→	$MgSO_4$	+	H_2
Magnesium	+	Sulfuric Acid	→	Magnesium sulfate	+	hydrogen gas



8c Metal carbonates form salts , water and carbon dioxide gas when reacting with acid

Acids react with Carbonates to give a salt and water and carbon dioxide.



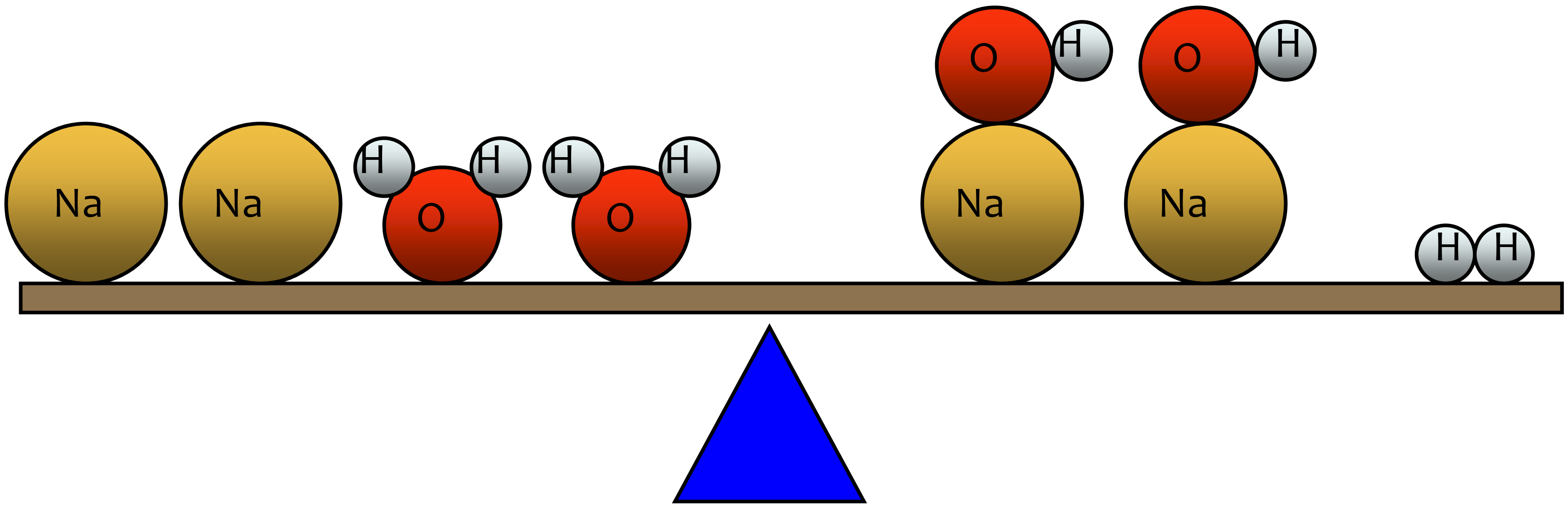
H2SO4	+	$CaCO_3$	→	$CaSO_4$	+	H_2O	+	CO_2
sulfuric Acid		calcium carbonate		calcium sulfate		water		carbon dioxide

We can test to see if carbon dioxide has formed by bubbling the gas into another test tube filled with lime water. The lime water will turn cloudy if the gas is carbon dioxide.

8d Balancing Chemical equations

Balanced equations must have the same number of atoms on each side of the equation i.e. reactants and products.

$$2Na + 2H_2O = 2NaOH + H_2$$



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