THE EARLY ATMOSPHERE

The Young Earth

Evolution of life on Earth has caused the Earth's atmosphere to change. When looking for clues into the composition of the Earth's early atmosphere, scientists study planets and moons (whose atmosphere has not changed for millions of years). In particular, scientists study volcanoes because they release lots of gases

Conflicting evidence

The atmospheres of Mars and Venus are mainly carbon dioxide. The atmosphere of Titan, one of Saturn's moons, is 98% nitrogen.

Space probes have shown that Titan has an icy interior rather than a rocky one (like Earth, Mars and Venus) which makes it more likely that the Earth's early atmosphere resembled that of Mars or Venus (i.e that it contained lots of carbon dioxide).

Oxygen

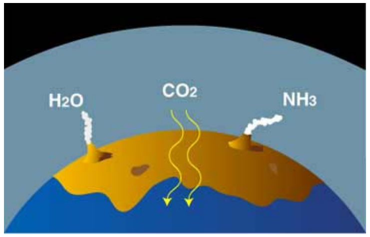
It's known what there was little or no oxygen in the Earth's early atmosphere

Evidence

The young Earth had lots of active volcanoes releasing ammonia (NH_3) and water. Volcanoes don't release oxygen. Iron compounds found in the Earth's oldest rocks could only form in the absence of oxygen.

The Earth's early atmosphere is generally considered to have lots of carbon dioxide and little oxygen.

It also contained water vapour and other gases (e.g methane and ammonia).



OXIDATION AND REDUCTION REACTIONS

Oxidation reactions: gain of oxygen

Reduction reactions: loss of oxygen

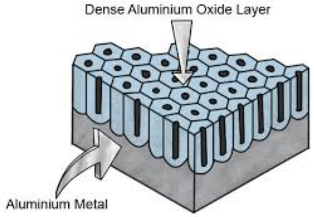
Corrosion of metals is oxidation

Corrosion happens when the surface of a metal changes by reaction with oxygen (sometimes with water)**.** e.g when iron corrodes it forms rust which is iron oxide.

Most metals corrode. The more reactive the metal, the more readily it becomes oxidised and the more rapidly it corrodes

Exception : aluminium!

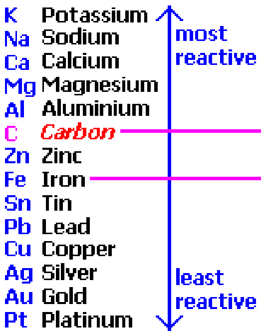
- Aluminium doesn't corrode as much as expected because upon reaction with oxygen it forms aluminium oxide, which acts as a protective layer and prevents any further corrosion.
- Less reactive metals are more resistant to oxidation and corrode less
- Very unreactive metals e.g. gold - don't corrode at all



Metal extraction is reduction

The majority of the compounds found in ores (from which metals are extracted) are metal oxides.

In order to obtain metals from their oxides, oxygen is removed and the process of extracting metals from their ores is a reduction reaction (the metal oxides lose their oxygen and are therefore 'reduced')



e.g. iron oxide + carbon → iron + carbon dioxide

In this example, the iron oxide is reduced to iron (it has lost its oxygen)

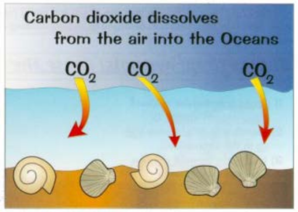
Questions on the Early Atmosphere

- Where do scientists look for clues about the Earth's early atmosphere?
- What fact has made scientists think that the Earth's early atmosphere was not the same as Titan's?
- How much oxygen was there in the Earth's early atmosphere?
- Where did the ammonia (NH_3)come from in the Earth's early atmosphere?

Questions on Oxidation and Reduction

- What type of reaction involves gaining oxygen?
- What type of reaction involves losing oxygen?
- Which of the above is the corrosion of metals?
- Why doesn't aluminium corrode?
- Is extracting metals from their ores a reduction or oxidation?

A CHANGING ATMOSPHERE



The Oceans

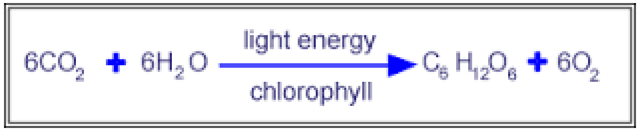
As the Earth became older, it cooled, and the water vapour in the atmosphere condensed into liquid water, forming the oceans.

1. Carbon dioxide dissolves in the oceans
2. Some marine organisms (e.g. coral) use carbon dioxide to make shells of calcium carbonate (over time these formed sedimentary rocks)

These mechanisms reduced the amount of carbon dioxide in the atmosphere.

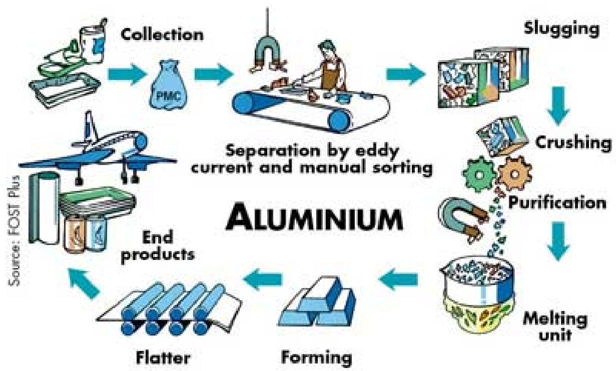
Photosynthesis

- Around 1 billion years ago some organisms developed the ability to photosynthesise which involves taking in carbon dioxide and releasing oxygen into the atmosphere.
- Over time, more and more photosynthesising organisms evolved (e.g. plants) which further reduced the levels of carbon dioxide in the atmosphere and increased levels of oxygen in the atmosphere.



RECYCLING METALS

Metals can be melted down and made into something new –recycling.



Advantages of recycling

Natural reserves of metal ores will last longer

For most metals, less energy (and therefore less expense) is needed to recycle them than to extract them from their ores.

Recycling reduces the need to mine ores (mining can damage the landscape and create dust and noise pollution in the same way as limestone quarrying.

It leads to less pollution as extracting some metals produces greenhouse gases.

e.g. sulphur dioxide is formed when lead is extracted from its ore, galena

Disadvantages of recycling

Costs and energy used in collecting, sorting and transporting metals to be recycled

For some metals, it is more expensive to recycle them than to extract them from their ores

How metals are recycled

Iron and steel are easily separated from other metals as they're magnetic. Others are separated by hand which is labour intensive.

PROPERTIES OF METALS

Shiny, conduct heat, conduct electricity, malleable (can be hammered into shape), ductile (can be stretched into wires.) Different metals, though, have slightly different properties and have different uses.

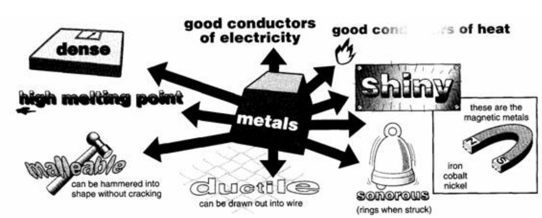
Aluminium: Has a low density and doesn't corrode as a protective layer of aluminium oxide forms quickly on its surface

It is used to make aeroplanes as it has such low density (the lighter the aircraft, the less fuel it needs to fly).

Copper: Good electrical conductor so copper is used to make electrical cables. It has low reactivity and doesn't react with water so is also used in water pipes.

Gold: Very unreactive, doesn't corrode, easily worked into shapes so can be used for jewellery. It's also a very good electrical conductor and tiny amounts are used inside most electronic devices, including mobile phones and computers.

Iron and steel: Iron is fairly cheap to extract from iron ore by heating with carbon, however, pure iron is too soft and it is often made into steel (a mixture of iron, carbon a nd other metals), which is stronger and harder.



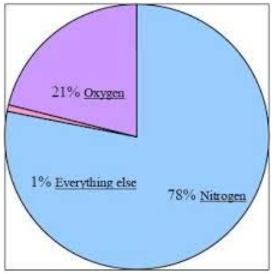
Questions on the Changing Atmosphere

- How did the oceans form?
- Name the gas that dissolved in the oceans.
- What did marine organisms do with this gas?
- Which process started happening about a billion years ago?
- What effect did this process have on the early atmosphere?
- Write down the symbol equation for photosynthesis.

Questions on Recycling Metals

- Define recycling.
- Name two advantages of recycling metals.
- Explain two disadvantages of recycling metals.
- How are metals separated during the recycling process?
- What do ductile and malleable mean?
- What property of aluminium makes it suitable for building aeroplanes?
- If gold is an excellent conductor why aren’t all wires made of gold?

THE ATMOSPHERE TODAY



The composition of the atmosphere

Nitrogen: 78%.

oxygen: 21%.

argon: 0.9%.

carbon dioxide: 0.04%

water vapour – variable from day to day so not included

There are also traces of other gases in the atmosphere e.g. nitrogen oxides, carbon monoxide, methane and sulphur dioxide. The amounts of these gases in the atmosphere can vary as they can be changed by natural causes or by human activities.

Natural causes

Volcanoes release carbon dioxide and sulphur dioxide

Lightning can produce nitrogen oxide

Human Activities

Deforestation: removal of trees so less photosynthesis and more carbon dioxide in the atmosphere.

Burning fossil fuels increases the amounts of carbon dioxide, carbon monoxide and sulphur dioxide in the atmosphere (harmful!)

Engines and furnaces release nitrogen oxides

Cattle and rice fields release large quantities of methane

Formation of nitrogen

Theory 1: volcanoes released nitrogen when the Earth was young (i.e. the early Earth's atmosphere already contained lots of nitrogen and resembled Titan's atmosphere. *As discussed previously, this theory is less likely*

Theory 2: nitrogen was added to the atmosphere gradually due to the reactions of nitrogen-containing compounds released from volcanoes

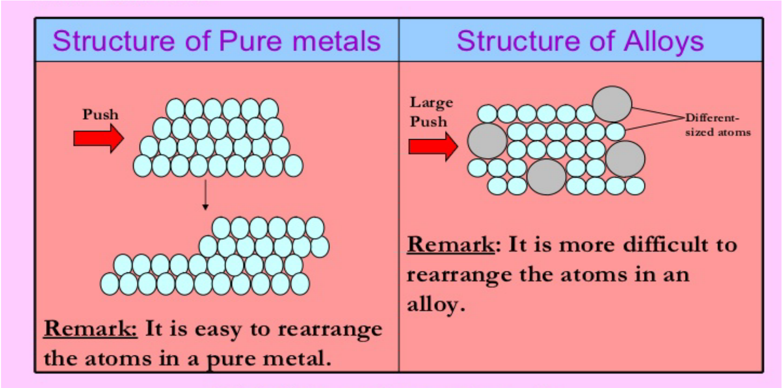
Metals and Alloys

Alloys

Many metals are mixed with small amounts of other metals to improve their properties for a particular use and such a mixture of metals is called an alloy.

Converting pure metals into alloys often increases their strength: In a pure metal structure all the atoms are the same size and are packed closely together in a regular arrangement. When a force is applied, the layers of atoms slide over each other, making the metal soft

In an alloy each metal in the mixture has different sized atoms and when force is applied, the atoms can't slide past each other as easily so the alloy is harder and stronger.



Examples of alloys:

- Iron: A big problem with iron is that it rusts however, iron can be made into the alloy stainless steel (mixture of iron and small amounts of chromium and nickel) which doesn't corrode
- Gold: Pure gold is too soft to be used in jewellery and other metals, e.g copper and silver, are added to make a harder and stronger alloy. The purity of gold is measured in carats, or as fineness:
  - Pure gold is 24-carat and has a fineness of 1000 parts per thousand
  - The lower the carat and fineness, the lower the purity of gold

Shape memory alloys:

Nitinol is an alloy of nickel and titanium and it is a smart material – i.e it has a property that changes with a change in conditions (usually temperature). Nitinol is a shape memory alloy which means if the shape of something made of nitinol is altered, it returns to its original shape when heated. Nitinol is used in the repair of a collapsed artery:

- Doctors slide a squashed nitinol tube into the damaged artery.As it warms up in the body, the nitinol returns to its original size and holds the artery open.
- Spectacles can be made from nitinol and if they get sat on they will reform there shape when heated.

Questions on Today's Atmosphere

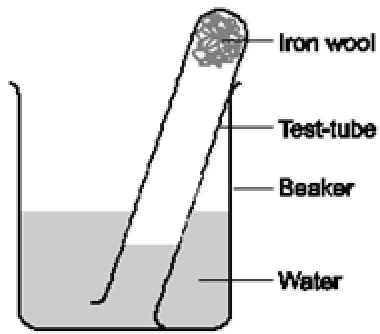
- Which gas is most abundant in today's atmosphere?
- The amount of which gases are affected by volcanic activity?
- Give two human activities which affect the amount of gases in the air.
- How did the amount of nitrogen in the air increase to the levels it is now?

Questions on Metals and Alloys

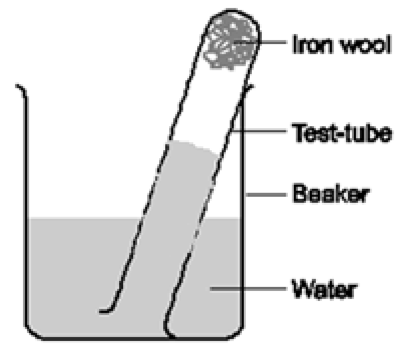
- Define an alloy.
- Why is an alloy stronger than a pure metal?
- What is the advantage of stainless steel over iron?
- What is a shape memory alloy?
- Name a Shape memory alloy and give an example of where it may be used.

Experiment to test % of oxygen in the air

BEFORE



AFTER



The air in the test tube at the start represents the total volume of air (mainly nitrogen (78%) and oxygen (21%)). After some time, the iron reacts with the oxygen in the test tube to form iron oxide.

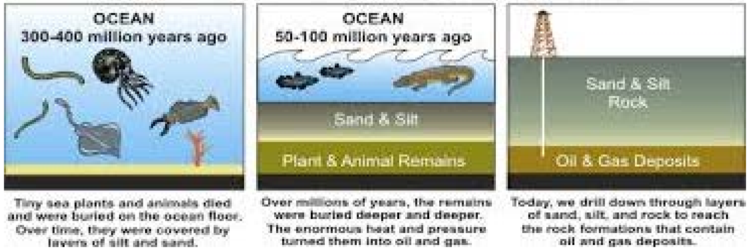
This means the oxygen in the test tube gets used up and the volume of air in the test tube decreases (only nitrogen left basically) hence the water will rise up the test tube to fill the space.

The difference between the initial volume of air in the test tube and the volume of air once the iron has fully reacted represents the volume of oxygen initially present

To calculate the percentage of oxygen in the air:

$$\%\text{ oxygen} = \frac{\text{start volume} - \text{end volume}}{\text{start volume}} \times 100$$

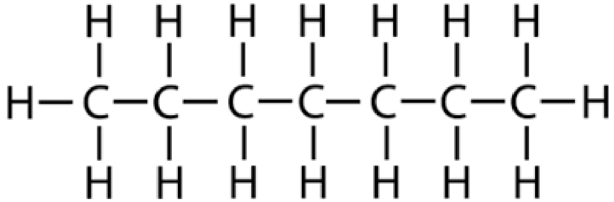
CRUDE OIL



Crude oil and natural gas are fossil fuels found in some sedimentary rocks deep underground

Formation of crude oil/natural gas

- When microscopic plants and animals in the sea die, their remains fall to the bottom of the sea
- Over millions of years, their remains are buried by sediments, stopping entry of oxygen and preventing their decay
- As more sediments build up on top of the remains, the heat and pressure increases and crude oil or natural gas are gradually formed



Composition of crude oil

A hydrocarbon is a compound that contains only carbon and hydrogen atoms.

Hydrocarbons with many carbon atoms are said to have ‘long’ carbon chains.

Hydrocarbons with few carbon atoms are said to have ‘short’ carbon chains.

Crude oil is a mixture of different hydrocarbon molecules (i.e some with long carbon chains and others with short carbon chains). Crude oil can also contain some impurities like sulphur.

Crude oil is a non-renewable resource:

The rate at which we are using crude oil is much greater than that at which it is being formed underground. At the present rate of consumption, the supply of crude oil is estimated to run out in the next 40 to 50 years

Currently most oil is obtained from drilling wells, but as demand for oil increases, surface mining of oil sands (which contain over half of the world’s remaining reserves of oil) will increase.

- But is it economic to mine these sands?
- Is it worth the damage to habitats?

Questions on Percentage of Oxygen in the Air

- Draw the apparatus needed for this experiment
- At the beginning how much oxygen is present in the test tube?
- What will happen to the water level as the oxygen reacts with the iron?
- Write down the equation you would use to calculate the percentage of oxygen in the air.

Questions on Crude Oil

- Describe how crude oil is formed.
- Which two elements are found in a hydrocarbon?
- Is crude oil renewable or non-renewable?
- Draw the hydrocarbon that has 7 carbons and 16 Hydrogen atoms.

ROCKS AND THEIR FORMATION

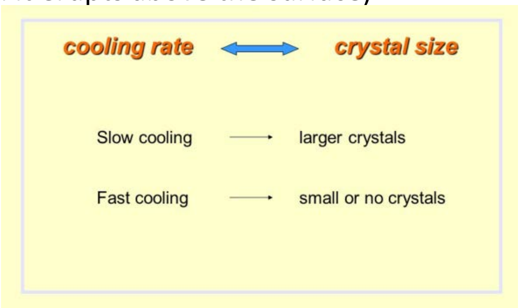
Igneous rocks e.g granite

Igneous rocks are formed by molten rock (called 'magma' underground and then called 'lava' when it erupts above the surface) cooling and then solidifying.

Igneous rocks are hard and are characterised by interlocking crystals

The size of the crystals depends on the rate at which the lava/magma cools:

- If magma/lava cools quickly rocks have small crystals
- If magma/lava cools slowly rocks have large crystals



Sedimentary Rocks e.g. chalk, limestone

Rocks are broken up by chemical reactions with water or air in a process called erosion.

Erosion happens as rocks are transported e.g along a river bed towards the sea.

Layers of these small pieces of rock ('sediment') build up on the sea bed and over a long time, these layers of sediment are compacted (squashed together), forming sedimentary rocks.

Sedimentary rocks:

Mostly form from pieces of other rocks. E.g chalk and limestone are made mostly from calcium carbonate

Can contain fossil remains of dead plants or animals, and/or imprints such as footmarks

Metamorphic Rocks e.g. marble

The action of heat and/or pressure can change rocks, causing new crystals to form and these changed rocks are called metamorphic rocks.

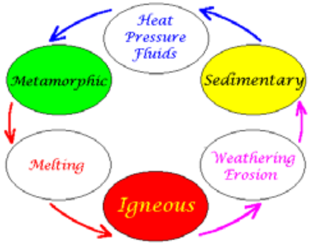
e.g the action of heat and pressure causes chalk or limestone to form marble; an example of a metamorphic rock

Properties of metamorphic versus sedimentary rocks:

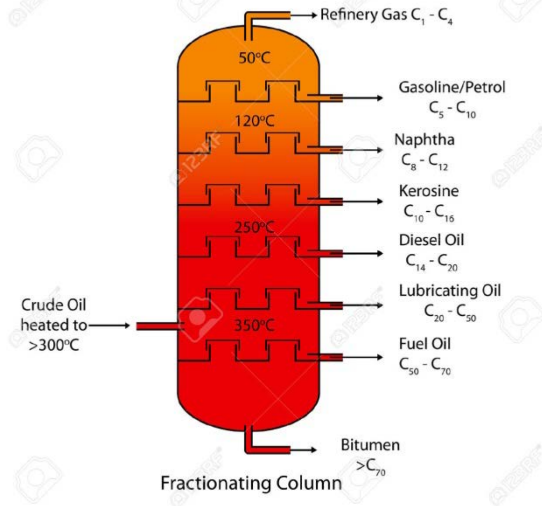
Marble: new crystals of calcium carbonate are formed that interlock tightly so marble is hard

Chalk and limestone: weakly joined grains with gaps between them so are crumbly

This explains why sedimentary rocks are more susceptible to erosion than igneous and metamorphic rocks



CRUDE OIL FRACTIONS



Fractional distillation

- The mixture of hydrocarbons in crude oil needs to be separated into simpler mixtures (called 'fractions') in a process called fractional distillation.
- The mixture of liquids is boiled in a fractional distillation tower and the vapour from it is condensed.
- The fractional distillation tower is hot at the bottom and cooler near the top.
- Different liquids condense at different temperatures so separates the mixture into smaller fractions of crude oil (bitumen, kerosene, petrol, diesel oil).
- Fractions with short carbon chains (e.g. gases):
  - Ignite (set alight) easily, have low boiling points and have low viscosity (they are runny) when in liquid form and condense at the top of the fractionating column
- Fractions with long carbon chains (up to 40 carbons e.g bitumen):

  Have much higher boiling points, are harder to ignite and have high viscosity (they are thick and sticky) when in liquid form and condense at the bottom of the fractionating column
- Order of fractions according to carbon chain length (from shortest to longest):

Fraction	Length of molecule	Ease of ignition	Boiling point	Viscosity
gases	short carbon chains (only a few carbon atoms)	easy	low (< 0°C)	runny
petrol	↓	↓	↓	↓
kerosene				
diesel oil				
fuel oil				
bitumen	long carbon chains (up to 40 Carbon atoms)	difficult	high (> 350°C)	thick and sticky

Questions on Rocks and Formation

- Name the three types of rock.
- Describe how igneous rocks form.
- What determines the size of the crystals in igneous rock?
- How do sedimentary rocks form and give an example of one?
- How does a sedimentary rock turn into a metamorphic rock?

Questions on Crude Oil Fractions

- What are fractions of crude oil?
- Is it hotter at the top or bottom of the fractionating column?
- Do shorter chains travel to the top of the column or the bottom?
- Describe the properties of shorter chain alkanes?
- Describe the properties of longer chain alkanes?

LIMESTONE AND ITS USES

Quarrying limestone

Limestone is removed from the ground at a quarry and explosions are used to break the limestone into pieces. These pieces are then cut into useful sizes and transported to customers.

Benefits of quarrying limestone

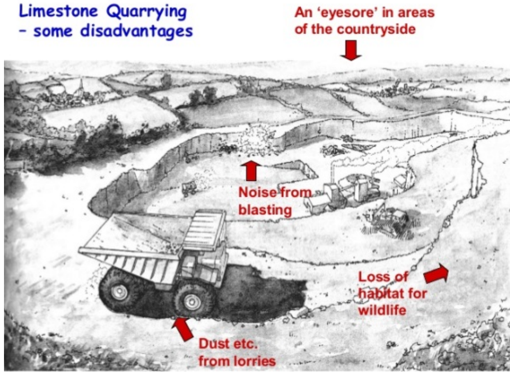
- It is used in the construction of buildings
- It can be crushed into smaller lumps to make a base for railway lines and roads
- It is a raw material for the manufacture of cement, concrete and glass
- It is valuable and is exported to other countries, helping the UK's economy
- Provides jobs to locals

Drawbacks of quarrying limestone

- Dusty and noisy so may affect the quality of life of the locals
- Destroys the original landscape and damages the tourist

industry (especially as the quarries are often in attractive places in the countryside

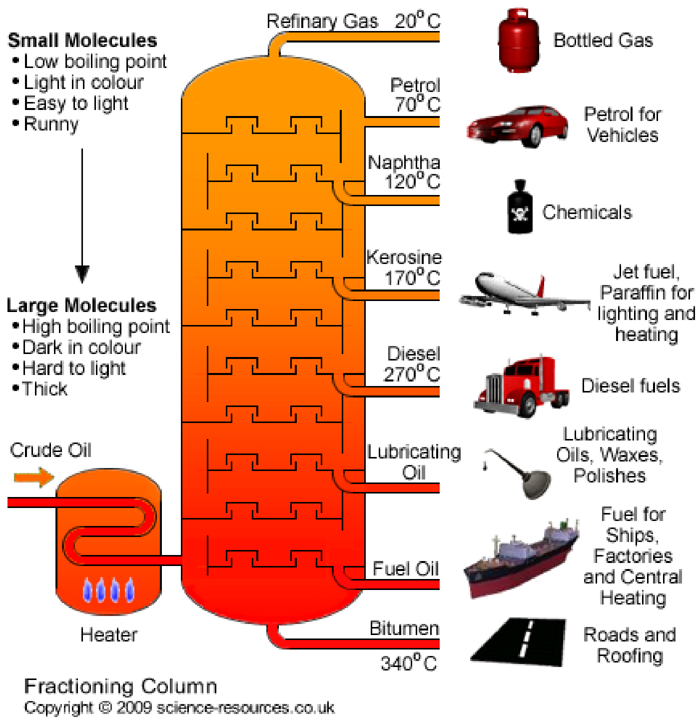
- Heavy lorries around the site cause extra traffic and pollution
- Destroys habitats of animals and birds.



Uses of Crude Oil Fractions

The different fractions of crude oil have different properties so have different uses.

- Gases (e.g methane): fuel for vehicles, bottled gas for camping stoves, heating and cooking in homes
- Petrol: fuel for cars
- Kerosene: fuel for aircraft
- Diesel oil: fuel for diesel engines (some cars, lorries, trains)
- Fuel oil: fuel for large ships and some power stations, fuel for heating.
- Bitumen: making roads, waterproofing flat roofs



Questions on Limestone

- How is limestone extracted from a quarry?
- Name three advantages of quarrying limestone.
- Why would local people complain about quarrying of limestone –give two reasons?
- If you wanted a job in the area around the quarry would your chances of employment be high or low? Discuss.

Questions on Uses of Crude Oil

Give a use of:

- Gases
- Petrol
- Kerosene
- Diesel Oil
- Fuel Oil
- Bitumen

CHEMICAL REACTIONS

Word equations

Word equations show what's happening in a chemical reaction:

e.g zinc carbonate → zinc oxide + carbon dioxide

Substances on the left of the arrow are called reactants (zinc carbonate in the above example) and substances on the right of the arrow are called products (zinc oxide and carbon dioxide in the above example).

Atoms and chemical reactions

Substances are made of atoms which are the smallest part of an element that can take part in a chemical reaction.

A compound consists of the atoms of two or more different elements chemically joined together and the chemical formula of a compound shows the symbols of the elements it contains and the ratios in which their atoms are present.

e.g. with calcium carbonate

- Its chemical formula is $CaCO_3$
- It's a compound
- It contains 3 elements: calcium, carbon and oxygen
- It contains 1 calcium atom, 1 carbon atom and 3 oxygen atoms

Balancing equations

This involves first writing the word equation into chemical form. To balance the equation there must be the same numbers of atoms of each element on both sides of the arrow.

Word equation:	sodium oxide + water → sodium hydroxide
Chemical equation:	$Na_2O_{(s)} + H_2O_{(l)} \rightarrow NaOH_{(aq)}$
Balanced chemical equation:	$Na_2O_{(s)} + H_2O_{(l)} \rightarrow 2NaOH_{(aq)}$

- Note that state symbols are added to each substance:

  s – solid/ g – gas/ l – pure liquid (e.g water)/ aq – aqueous solution…formed when substances dissolve in water (e.g sodium hydroxide)

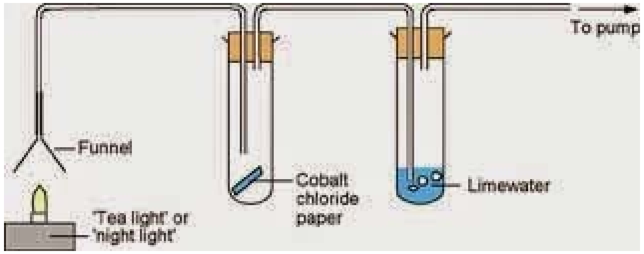
Complete and Incomplete Combustion

When hydrocarbon fuels burn they react with oxygen and release heat and light energy. This is an oxidation reaction called combustion. When enough oxygen is present, all the hydrocarbon is used up and the only products are carbon dioxide and water. This is known as 'complete combustion'

e.g combustion of methane (the main gas in natural gas):

Methane + oxygen → carbon dioxide + water

Balanced equation: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$



Detecting products of a complete combustion reaction:

Anhydrous copper sulphate turns blue when it comes into contact with water and Limewater turns cloudy when carbon dioxide is bubbled through it. So when hydrocarbons are burnt fully in air (i.e when complete combustion occurs), anhydrous copper sulphate turns blue and limewater turns cloudy

INCOMPLETE COMBUSTION

Sometimes a burning fuel may not have enough oxygen. In this case, 'incomplete combustion' occurs which means there isn't enough oxygen for all the carbon atoms to form carbon dioxide (as each carbon must combine with 2 oxygen atoms) and some of the carbon may form carbon monoxide (CO – 1 carbon combines with 1 oxygen atom) and/or solid particles of carbon (C – no oxygen combined with carbon atom).

2 possible reactions occur when hydrocarbon fuels burn without enough oxygen.

e.g with methane:

Methane + oxygen →carbon monoxide + water — less oxygen

Methane + oxygen →carbon + water — very little oxygen

Bunsen burners and combustion

When the air hole of a Bunsen burner is open, complete combustion occurs and the flame is blue so is often called a 'clean' flame.

When the air hole of a Bunsen burner is closed there isn't enough oxygen so incomplete combustion occurs and flame is yellow. The yellow colour is caused by the hot carbon particles (soot) glowing.

Carbon monoxide problems

Carbon monoxide is an odourless, colourless toxic gas andiIt reduces the amount of oxygen that can be transported around the body in the blood.

Faulty gas boilers (in which oxygen flow is restricted) and fires produce carbon monoxide and this can lead to death by carbon monoxide poisoning so it is essential that all fuel-burning appliances must be serviced regularly and homes should be fitted with carbon monoxide detectors.

Soot (carbon) problems

- Soot produced in appliances such as boilers can clog up pipes carrying waste gases away
- Soot is also produced by vehicles. Breathing in sooty air can lead to lung disease
- Soot also leaves black marks on buildings/walls

Questions on Chemical Reactions

- Name all four state symbols.
- What is the difference between an element and a compound?
- How many atoms are in the following compounds:
- Li_2CO_3
- $NaOH$
- H_2O
- $C_6H_{12}O_6$

Questions on Complete and Incomplete Combustion

- When a hydrocarbon combusts completely what are the two products formed?
- Which tests will prove that the above prodcuts have been formed?
- During incomplete combustion which gas is less abundant than during complete combustion?
- What are the products of incomplete combustion when there is a little less oxygen and when there is a lot less oxygen?
- Which of the products is dangerous?
- How does a Bunsen burner demonstrate incomplete and complete combustion and how are the flame colours linked to the type of combustion?

Conservation of Mass

Atoms/matter/mass are **NOT** made or destroyed in a chemical reaction. They are only **<u>rearranged</u>** to form new products.

total mass before = total mass after a reaction

This rearrangement of atoms means products and reactants have different physical and chemical properties

Precipitation reactions

- This is when two soluble (shown by $_{(aq)}$ state symbol) substances react together to form an insoluble (shown by$_{(s)}$ state symbol) product, called the precipitate.

e.g.

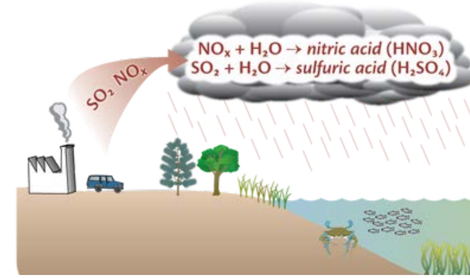
Silver nitrate + potassium bromide → potassium nitrate + silver bromide

$AgNO_{3\,(aq)}$ + $KBr_{(aq)}$ → $KNO_{3\,(aq)}$ + $AgBr_{(s)}$

AgBr is the solid precipitate formed in this example

Remember that even though a solid is formed, the total mass before and after the reaction is still the same!

ACID RAIN



Discovering the problem

In the 1970s, the numbers of fish caught in lakes and rivers in southern Norway started to decrease and Scientists noticed that these lakes and rivers were much more acidic than those in other parts of the country that still had healthy fish.

Looking at weather patterns, scientists concluded that pollution from factories and power stations in Europe was being carried in the atmosphere, making the rainfall (more) acidic and this acid rain was killing the fish.

Causes of acid rain

Acid rain is rain that is more acidic than usual (has a pH of less than 5.2)

Hydrocarbon fuels contain sulphur impurities so when fuels are burnt, the sulphur reacts with the oxygen from the air to form sulphur dioxide gas. Sulphur dioxide dissolves in rainwater and lowers its pH, forming acid rain. Nitrogen oxides from cars are also released into the air.

Effects of acid rain

Makes rivers, lakes and soils acidic and harms organisms that live there.

- Damages trees
- Speeds up the weathering of buildings/statues made of limestone or marble and the corrosion of metal

Solutions to problem of acid rain:

- Reducing amount of sulphur in petrol, diesel and fuel oil
- Removing acidic gases from power station emissions (by neutralising them with a basic (alkaline) compound such as calcium carbonate)

Questions on Conservation of Mass

- State the Law of Conservation of Mass.
- How would you identify a precipitation reaction?
- $AgNO_{3\ (aq)}$ + $KBr_{\ (aq)}$ → $KNO_{3\ (aq)}$ + $AgBr_{\ (s)}$

  58g + 45g → 63g + X

- Using the Law of conservation of mass what is the mass of AgBr in the equation above?

Questions on Acid Rain

- What did Norwegian Scientists notice about the lakes in Norway?
- How did they explain what they had observed?
- How does acid rain form?
- State two effects of acid rain.
- Give details of two methods that are being used to solve the problem of acid rain.

REACTIONS OF CALCIUM COMPOUNDS

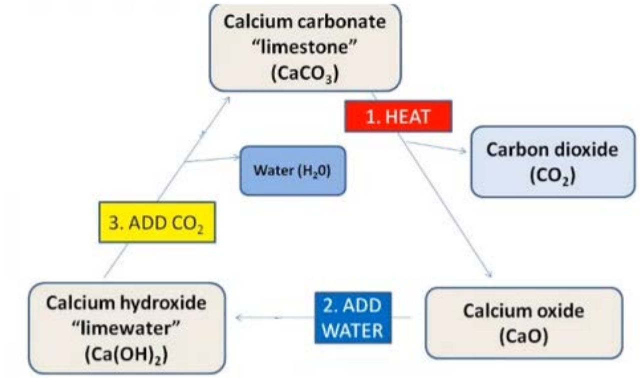
Step 1 - Thermal decomposition of calcium carbonate ($CaCO_3$)
When heated strongly, calcium carbonate breaks down to form calcium oxide and carbon dioxide. This type of reaction (i.e breakdown using heat) is called thermal decomposition

Word equation: calcium carbonate → calcium oxide + carbon dioxide

Chemical equation $CaCO_3 \rightarrow CaO + CO_2$

Note: zinc carbonate and copper carbonate thermally decompose much more easily than calcium carbonate

Step 2 - Calcium oxide + water
Word equation: Calcium oxide + water → calcium hydroxide
Chemical equation: $CaO_{(s)} + H_2O_{(l)} \rightarrow Ca(OH)_{2\,(s)}$

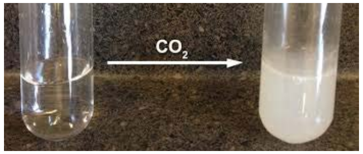


In this reaction calcium oxide dissolves in water to form calcium hydroxide – a crumbly, white solid.

- Heat is given off
- Fizzing
- Steam is produced

When more water is added, calcium hydroxide dissolves to form a colourless calcium hydroxide solution called limewater.
Note: $Ca(OH)_2$ means that each unit of calcium hydroxide contains 2 hydroxide units. One unit of calcium hydroxide contains 1 calcium atom, 2 oxygen atoms and 2 hydrogen atoms.

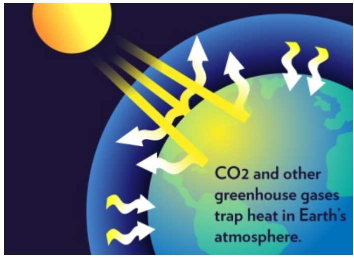
Step 3 - Calcium hydroxide solution (limewater) + carbon dioxide
When carbon dioxide is bubbled through limewater (originally a colourless solution), the limewater turns cloudy. This happens because carbon dioxide and limewater (calcium hydroxide solution) react to form a solid precipitate called calcium carbonate.



Word equation: calcium hydroxide + carbon dioxide → calcium carbonate + water
Chemical equation: $Ca(OH)_{2\,(aq)} + CO_{2\,(g)} \rightarrow CaCO_{3\,(s)} + H_2O_{(l)}$

This is the test for carbon dioxide gas – it will turn limewater cloudy because calcium carbonate solid forms!

CLIMATE CHANGE



Some gases in the atmosphere, such as carbon dioxide, methane and water vapour, trap heat energy and help keep the Earth warm and this is known as the ***greenhouse effect*** and these global warming gases are referred to as ‘greenhouse gases’.

Over the last 200 years there has been a dramatic increase in the levels of these greenhouse gases in the atmosphere, particularly CO_2 which has led to the global warming effect. Global warming effect is an increase in temperature and is likely to change weather patterns, causing climate change (also, the rising sea levels caused by melting ice caps mean flooding is an ever increasing danger to low-lying places).

The concentration of gases in the atmosphere (and the Earth’s temperature) can change due to natural processes however, most scientists believe that the large increases in the levels of greenhouse gases in the atmosphere are due to human activities. The dramatic increase in CO_2 concentration in the atmosphere is thought to be due to more burning of fossil fuels and the increase in methane levels is thought to be due to increased large-scale farming.

Reducing the amount of carbon dioxide

One way of reducing the amount of carbon dioxide being added to the atmosphere is by limiting the use of fossil fuels. Chemists are currently investigating two further methods to actively reduce the level of carbon dioxide in the atmosphere.

1. Adding iron compounds to oceans – known as iron seeding -Iron is an essential nutrient for plants and is often in short supply so by adding iron encourages plants to grow. Plants use carbon dioxide for photosynthesis and when they die, the plants sink to the ocean floor and the carbonate in their shells is buried so carbon is removed from the atmosphere for a long time.
2. Converting carbon dioxide into hydrocarbons. The idea is to capture carbon dioxide from fossil-fuelled power stations and reacting it to make hydrocarbon compounds such as propane and butane.

Questions on Calcium Carbonate

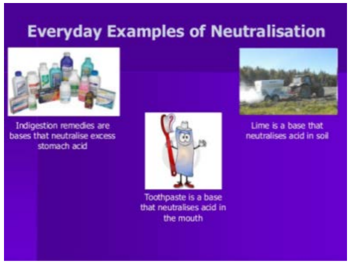
- What happens to calcium carbonate when you heat it?
- Finish this equation to show what happens when you heat calcium carbonate.

  $CaCO_3 \rightarrow$
- Describe three things you would observe if you added water to Calcium Oxide.
- If you add CO_2 to limewater what is the product that forms that turns limewater milky?

Questions on Climate Change

- Name three greenhouse gases.
- How do these gases lead to global warming?
- Which of these gases has increased the most over the last 200 years? How has this happened?
- How does global warming affect cold, icy habitats?
- Give two ways of reducing the amount of carbon dioxide in the air.

Uses of Calcium Compounds



Calcium compounds can be used by farmers to neutralise acidic soil

Acids can be neutralised by alkalis in a neutralisation reaction:

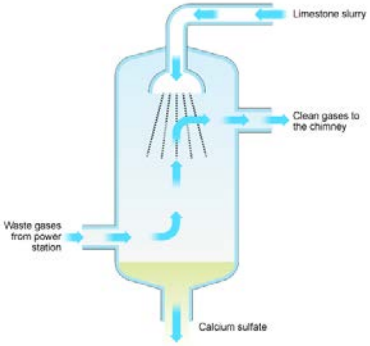
Acid + alkali → salt + water

Some crops don't grow well if the soil is too acidic so to reduce acidity of the soil, farmers can spray alkalis such as calcium carbonate, calcium oxide or calcium oxide over their fields.

Calcium carbonate can be used to remove harmful emissions from coal-fired power stations

Many power stations use coal, which contains sulphur impurities and when the coal burns, the sulphur reacts with oxygen to form sulphur dioxide. Nitrogen oxides are also formed. These non-metal oxides are acidic.

Both sulphur dioxide and nitrogen oxides are harmful gases that produce acid rain if they escape into the atmosphere. To stop this, calcium carbonate is sprayed through the acidic gases (i.e. sulphur dioxide and nitrogen oxides), neutralising them and in this way, limestone (calcium carbonate) reduces harmful emissions and helps to reduce acid rain.



CHOOSING FUELS

What makes a good fuel?

1. Low toxicity : It doesn't produce harmful gases: Most fuels cause pollution because when they burn completely they release CO_2 into the atmosphere (or carbon monoxide and soot if not enough oxygen is present and incomplete combustion occurs). Crude oil contains sulphur impurities so when it burns, sulphur dioxide gas is also formed which can lead to acid rain.

2. Usability: It burns easily (i.e is flammable):Fuels that are very easy to light can also be dangerous if they're not stored and transported carefully

3. Energy: A small amount of it produces a lot of heat energy.

e.g. burning hydrogen produces most energy hence it's used as fuel for rockets

4. Storage: It's easy to store and transport. Coal and other solid fuels are easy to store and transport by lorry or train. Gas fuels such as methane and hydrogen must be stored at high pressure to reduce the size of the tanks needed to store them.

TEACUP

stands for

Toxicity, Energy, Availablilty, Cost, Usability, Pollution Storage

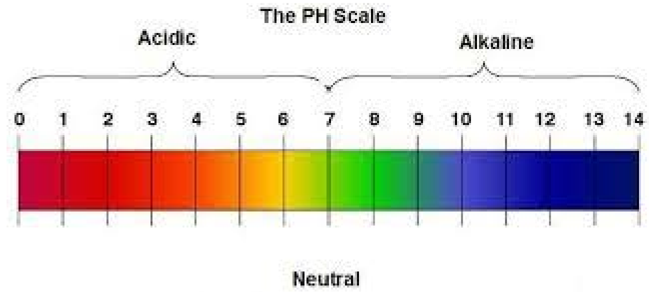
Questions on Uses of Calcium Compounds

- To which type of soil would farmers need to add calcium compounds?
- What is the general equation for the reaction between an acid and an alkali?
- Are non-metal oxides acidic or alkaline?
- Which two acidic gases are produced in power stations?
- What can be done to neutralise these gases?

Questions on Choosing Fuels

- What does TEACUPS stand for?
- Which gases produced when a fuel burns are toxic?
- Why are fuels combusted?
- What does usability mean?
- What are the issues involved with storing hydrogen gas as a fuel?

pH SCALE



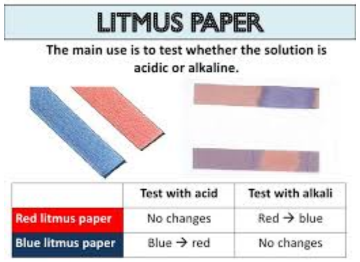
- Acids and alkalis can be described using the pH scale
  - Scale runs from pH1 (strong acid) to pH14 (strong alkali)
  - A neutral liquid has a pH of 7 (e.g. water)
  - pH5 - weak acid and pH9 - weak alkali

Note - difference between a base and an alkali

– *Some bases are soluble and when dissolved in water, bases are called alkalis*

- Universal indicator can be used to find out if a liquid is an acid or an alkali by dipping it into the liquid and observing its colour:
  - Yellow/orange/red – acid
  - green – neutral
  - blue/purple – alkali
  - The closer to red the stronger the acid (i.e red – strong acid, yellow – weak acid)
  - The closer to purple the stronger the alkali (i.e purple – strong alkali, blue – weak alkali)

- Litmus paper (must be damp to work) is also an indicator
  – Blue litmus paper turns red under acidic conditions (no change under alkaline or neutral conditions)
  – Red litmus paper turns blue under alkaline conditions (no change under acidic or neutral conditions)



BIOFUELS

Biofuels are obtained from living organisms or from organisms that have recently died e.g wood, crops. They're possible alternatives to fossil fuels.

Examples of biofuels:

Ethanol: It's made by processing wheat, sugar cane or sugar beet and can be mixed with petrol for use as fuel in car engines. Using ethanol helps reduce demand for petrol and conserves crude oil supplies.

Biodiesel: made from vegetable oils by chemical reactions.

Advantages of Biofuels

1. Biofuels are renewable (i.e stores can be quickly replaced). Crude oil (petrol, kerosene, diesel oil)/natural gas (methane) stores instead can't be replaced so are non-renewable.

2. Biofuels are less polluting: The carbon dioxide released when biofuel plants are burned gets re-absorbed by (biofuel) plants for photosynthesis so overall, biofuels don't add carbon dioxide to the atmosphere and are said to be 'carbon neutral'.

(Note: energy is needed to make fertiliser for the crops, to harvest them, to process them and to transport the biofuel to where it's needed. So if you take into account the manufacturing and distributing processes then biofuels are not carbon neutral).Burning of fossil fuels instead releases sulfur dioxide (causes acid rain) and carbon dioxide (contributes to global warming) into the atmosphere

Disadvantages of Biofuels

1. Lots of land is required in order to grow the crops so less farmland for growing food. Clearing of forests (deforestation) to make space in which to plant biofuel crops.

2. There are fewer gas stations where you can fill up on biofuels

3. Lower fuel efficiency (so you have to fill up more often).

Questions on pH Scale

- If the pH of a substance =6, what two words would you use to describe it?
- If the pH of a substance = 14, what two words would you use to describe it?
- Water has a pH of 7 which means it is neutral. What colour would it turn Universal Indicator?
- How is an alkali related to a base?
- What do you have to do to litmus paper for it to work?
- What colour would blue litmus turn in acidic conditions?

Questions on Biofuels

- What is a biofuel?
- Name two biofuels.
- Explain how each of the above is made.
- Give two advantages of biofuels.
- Give three disadvantages of using biofuels.
- Do you think fields should be used for growing crops for food or for fuel?

INDIGESTION

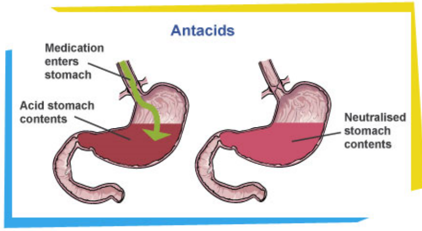
Indigestion remedies/neutralisation reactions

The stomach produces hydrochloric acid (HCl) which kills bacteria that may be in the food and it provides acidic conditions for digestive enzymes to work best.

Sometimes the stomach can produce too much acid which leads to acid indigestion.

Medicines called antacids (which contain bases/alkalis) can neutralise the excess stomach acid and are used in treating indigestion.

- When an acid reacts with an alkali it is called a neutralisation reaction.
- Antacids can either be metal oxides, metal hydroxides or metal carbonates e.g. calcium oxide, calcium hydroxide or calcium carbonate.



USING HYDROGEN AS A FUEL

Advantages of hydrogen versus petrol

1. Hydrogen fuel is renewable, petrol is non-renewable

2. Hydrogen is less polluting: Hydrogen burns (reacts with oxygen) in a fuel cell to release energy. Water is the only waste product so hydrogen is known as a 'clean' fuel. Burning petrol instead releases sulfur dioxide (causes acid rain) and carbon dioxide (contributes to global warming) into the atmosphere.

Equation: $2H_2 + O_2 \rightarrow 2H_2O$

Disadvantages of hydrogen vs petrol

Before cars with fuel cells can become widely used, hydrogen has to be more easily and economically available.

1. Using hydrogen fuel is more expensive because electricity is required to produce it (because hydrogen is obtained by electrolysing water) and there is a lower fuel efficiency (so you have to fill up more often)

2. Hydrogen fuel is less safe as Hydrogen is flammable so care must be taken when transporting it. Hydrogen is a gas, petrol is a liquid so hydrogen gas leaks are more likely

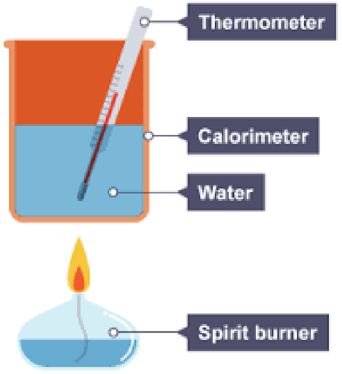
3. Hydrogen is more difficult to store as Hydrogen must be stored at high pressure to reduce the size of the tanks needed to store them.

4. There are fewer gas stations where you can fill up on hydrogen fuel.

INVESTIGATING FUELS

Note: the amount of energy released when a fuel burns can be determined experimentally using a calorimeter.

- Observe the temperature rise when the same volume of water is heated by different fuels
- The greater the temperature rise, the more energy released by the fuel



Questions on Indigestion

- Name the acid the stomach produces.
- State two reasons why the stomach produces this acid.
- What causes indigestion?
- Would an antacid be acidic or akaline?
- Name three metal compounds that can be used as an antacid.

Questions on Using Hydrogen as a Fuel

- Is hydrogen renewable or non-renewable? Explain why?
- Hydrogen is known as a clean fuel. Why? Write down the equation that supports this.
- Give three disadvantages that Hydrogen has compared with petrol.
- Describe a simple experiment that you could conduct in the lab to see which fuel gave out the most energy.

3 General Equations for Neutralisation Reactions

Acid + Metal oxide (base) → salt + water
Acid +Metal hydroxide (alkali) → salt + water
Acid +Metal carbonate → salt + water + carbon dioxide

The salt formed depends on the acid. In the case of indigestion remedies the acid being neutralised is HCl (as it is the one present in the stomach) so chloride salts are produced.

e.g. if indigestion tablet contains calcium carbonate

Hydrochloric acid + calcium carbonate → calcium chloride + water + carbon dioxide

$$2HCl_{(aq)} + CaCO_{3\,(s)} \rightarrow CaCl_{2\,(aq)} + H_2O_{(l)} + CO_{2\,(g)}$$

Sulphuric acid and nitric acid can also be neutralised.

If sulfuric acid is neutralised → sulphate salts are produced:
e.g. Sulfuric acid + copper oxide → copper sulfate + water

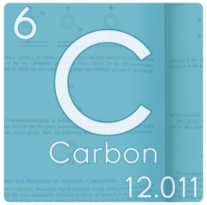
$$H_2SO_{4\,(aq)} + CuO_{(s)} \rightarrow CuSO_{4\,(aq)} + H_2O_{(l)}$$

If nitric acid is neutralised → nitrate salts are produced:
e.g. Nitric acid + sodium hydroxide → sodium nitrate + water

$$HNO_{3\,(aq)} + NaOH_{(s)} \rightarrow NaNO_{3\,(aq)} + H_2O_{(l)}$$

Problem	Neutraliser	Effect
Decaying Teeth	Toothpaste	Acid + Alkali = Neutral
Indigestion	Milk of Magnesia	Acid + Alkali = Neutral
Wasp Sting	Vinegar	Alkali + Acid = Neutral
Bee Sting	Baking Soda	Acid + Alkali = Neutral
Soil Decay	Adding Lime	Acid + Alkali = Neutral

ALKANES



Carbon is in group 4 of the periodic table which means it has four electrons in the outer shell so needs four more to gain a full shell. This means each carbon forms four bonds with other atoms (either 4 single bonds, or 2 single bonds and a double bond).

Hydrogen is in group 1 so forms just one bond with other atoms.

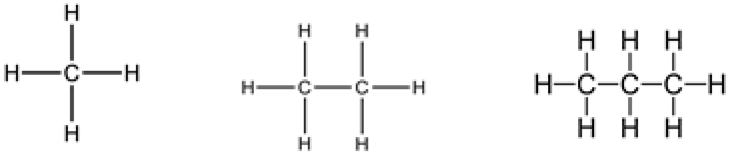
Alkanes

In an alkane molecule, each carbon is bonded to four other atoms with single bonds (see diagrams below).

Hydrocarbons with single carbon-carbon (C-C) bonds are referred to as ‘saturated’.

Alkanes are known as saturated hydrocarbons (‘saturated’ because they can’t form bonds with any more atoms). Alkanes follow the general formula:

$$C_nH_{2n+2}$$



Methane (CH_4) is the simplest alkane, with one carbon atom joined to four hydrogen atoms

Ethane (C_2H_6) has two carbon atoms

Propane (C_3H_8) has three carbon atoms.

Questions on Neutralisation reactions

- Finish the following general equations:
- Acid + Base →
- Acid + Metal →
- Acid + Metal carbonate →
- Name the salt formed in the following reactions:
- Hydrochloric acid + potassium oxide
- Nitric acid + Lithium hydroxide
- Sulphuric Acid + copper carbonate

Questions on Alkanes

- What group is carbon in? How many electrons does it have in its outer shell? How many bonds does it try to form?
- What is the general formula for an alkane? What would the formula of hexane be if it contains 6 carbon atoms?
- What does saturated mean?
- Draw the displayed formula for octane.

ELECTROLYSIS OF HYDROCHLORIC ACID - $HCl_{(aq)}$

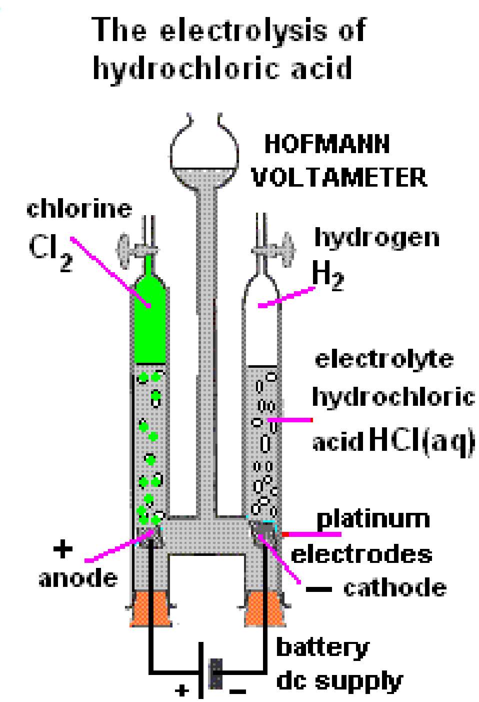
Electrolysis is a process in which electrical energy, from a d.c. (direct current) supply, decomposes compounds.

e.g. hydrochloric acid can be broken down into its component parts – hydrogen and chlorine – by electrolysis

Word equation: hydrochloric acid → hydrogen + chlorine

chemical equation: $2HCl \rightarrow H_2 + Cl_2$

- Compounds that can be decomposed by electrolysis are electrolytes.
- During electrolysis it's useful to be able to test the gases that could be given off.
- Test for hydrogen: squeaky pop sound.
- Test for Chlorine: turns damp litmus red then bleaches it.



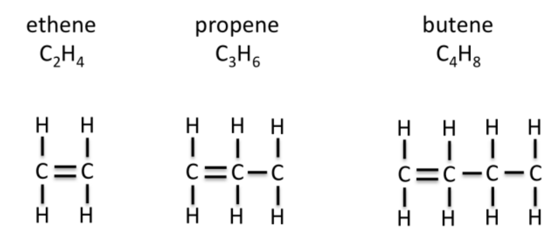
Alkenes

Hydrocarbon molecules that have a double bond (*just one!*) between two of the carbon atoms (C=C) are known as alkenes

The C=C double bond means that these carbon atoms are not bonded to the maximum number of other atoms (i.e they're bonded to 3 not 4 other atoms)

Alkenes are known as 'unsaturated' hydrocarbons and have the general formula:

$$\boxed{C_nH_{2n}}$$



Ethene (C_2H_4) is the simplest alkene. It has 2 carbon atoms

Propene (C_3H_6) has 3 carbon atoms.

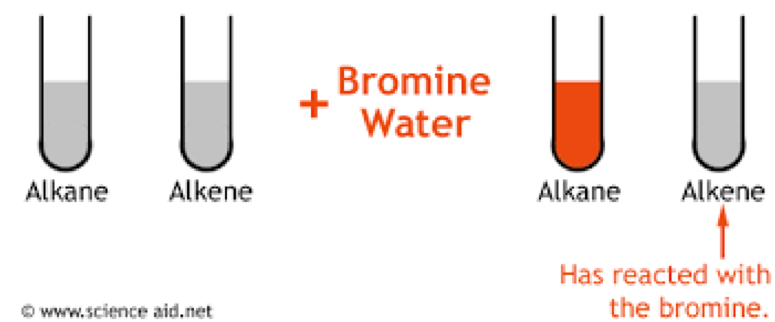
Bromine test to tell alkanes and alkenes apart:

The bromine test is used to find out if a compound has double bonds (i.e whether it is an alkane or an alkene). When bromine water (orange colour originally) is mixed with a saturated hydrocarbon (alkane)there is no colour change (i.e stays orange)

e.g. ethane + bromine water (orange)→orange-coloured liquid

When bromine water is mixed with an unsaturated hydrocarbon (alkene), it goes from orange to colourless

e.g. ethene + bromine water (orange)→colourless liquid



Questions on Electrolysis of HCl

- Define electrolysis
- What is an electrolyte?
- Name the two products formed during the electrolysis of HCl.
- How would you test for the two gases given off during this electrolysis?
- Write the word and symbol equation for this electrolysis reaction.

Questions on Alkenes

- What is the general formula for an alkene? What would the formula of pentene be if it contains 5 carbon atoms?
- Is pentene saturated or unsaturated? How do you know?
- Draw the displayed formula of octene.
- What observations would you make if you added orange Bromine water to octene and octane? Explain what is happening if you can.

ELECTROLYSIS OF SEA WATER NaCl (aq)

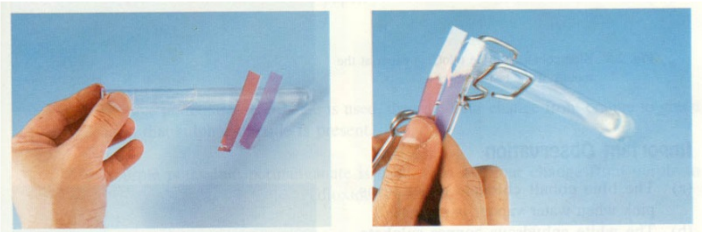
The most common dissolved substance in sea water is sodium chloride (common salt).

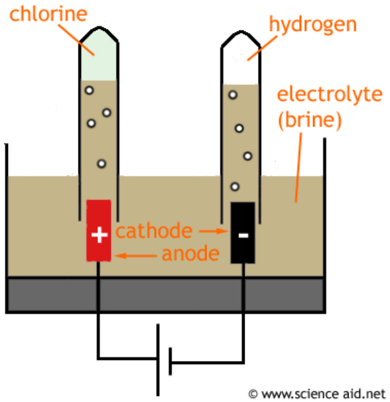
If a direct current is passed through sea water, chlorine gas is produced at one of the electrodes (hydrogen produced at the other.

Chemical test for chlorine:

Hold a piece of damp blue litmus paper in the mouth of the test tube

If the gas is chlorine the paper will first turn red and then turn white as it's bleached





Uses of chlorine

Chlorine is a yellow-green gas with a pungent smell

Uses of chlorine:

- Kills microorganisms so is used to treat water supply (e.g. used in swimming pools)
- In manufacturing bleach and other cleaning products
- In the manufacture of plastics such as PVC

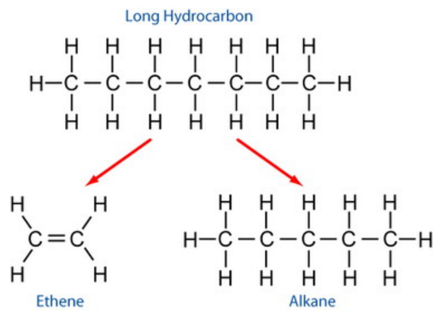
Chlorine has many uses mainly because of its high reactivity and ability to readily form compounds with other substances. However, chlorine gas is also toxic and if a gas leak occurred near a town, or a tanker transporting the gas had an accident, it could have devastating consequences

CRACKING

Longer hydrocarbons can be broken down by heat ('thermally decomposed') into more useful shorter hydrocarbons by a process called cracking. In most cases, a long chain alkane is thermally decomposed into a shorter chain alkane and an alkene.

$C_6H_{14} \rightarrow C_4H_{10} + C_2H_4$

Note: there are still the same numbers of carbon and hydrogen atoms before and after cracking



Shorter chain alkanes produced in cracking are used as fuels (e.g petrol). Most of the short chain alkenes produced in cracking are used for making plastics. Ethene is also used for ripening fruit

Why is cracking needed?

- When crude oil is separated by fractional distillation, some fractions are present in greater amounts than others (e.g more fuel oil is present than petrol or diesel).

- The shorter fractions in crude oil (petrol, diesel) are in greater demand than the longer fractions (fuel oil, bitumen). To make supply meet demand, oil companies use cracking to break down longer molecules into more useful shorter molecules

Questions on Electrolysis of Sea Water

- What is the most abundant substance found in sea water?
- Name the two products formed during this electrolysis.
- How would you test for the gases produced?
- Give two uses for chlorine gas.
- What risks are associated with chlorine gas?

Questions on Cracking

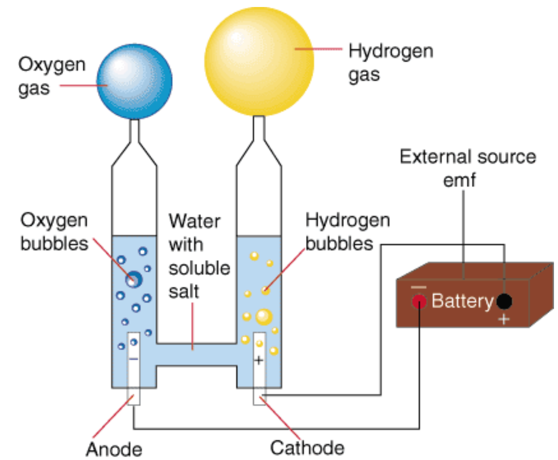
- What happens during cracking?
- Why is this also known as a thermal decomposition?
- If $C_{12}H_{26}$ is cracked give 6 possible products that might form.
- What are the alkenes that are made used for?
- How is cracking related to supply and demand?

ELECTROLYSIS OF WATER – $H_2O(l)$

Electrolysis of water results in hydrogen and oxygen gas being given off at the electrodes.

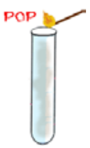
Word equation: water → hydrogen + oxygen

Chemical equation: $2H_2O \rightarrow 2H_2 + O_2$

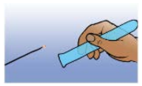


- Chemical test for hydrogen:

  Hold a lighted splint in the mouth of the test tube and if the test tube contains some hydrogen it will explode with a squeaky 'pop'



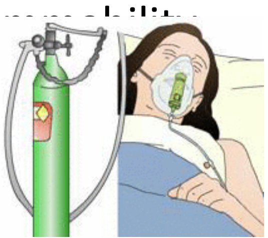
- Chemical test for oxygen:



  - Light a splint and then blow the flame out so that the end of the splint is just glowing
  - Put the glowing splint in the mouth of the test tube
  - If the gas is oxygen, the glowing splint will relight bursting into flame again

Uses of hydrogen and oxygen:

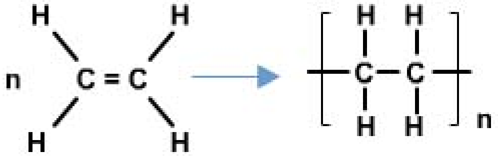
- Hydrogen is used as a rocket fuel as it is highly flammable
- Hydrogen is also the lightest gas, but due to its high fla hydrogen is rarely used to fill airships
- Oxygen is given as supplemental air in hospitals



POLYMERISATION

Polymers are substances made up of thousands of simple repeating units. Monomers are substances whose molecules react together to form polymers. This process is called polymerisation.

e.g. poly(ethene) (a polymer) is made from lots of ethene monomers. The number of ethene molecules that join together to make one molecule of poly(ethene) is very large (thousands/millions). n is used to indicate a large number (i.e ‘n’ lots of ethene molecules join to form a polymer made up of ‘n’ number of ethene repeating units). *Note polymers lose the C=C double bond*



Some polymers are natural e.g cellulose (found in plant cell walls) and other polymers are manufactured e.g plastics.

Properties and uses of (manufactured) polymers

Poly(ethene) : made from ethene monomers.

- Properties: Flexible, cheap, good insulator
- Uses: carrier bags, plastic bottles, insulation for electrical wires, cling film

- Poly(propene) – made from propene monomers:
    - Properties: flexible, shatterproof, strong, long lasting, high softening point
    - Uses: plastic bags, buckets, ropes, washing up bowls, carpets

- Poly(chloroethene) – PVC made from chloroethene monomers:
    - Properties: tough, cheap, long-lasting, good insulator
    - Uses: window frames, gutters, pipes, insulation for electrical wires
- Poly(tetrafluoroethene) – PTFE or Teflon……made from tetrafluoroethene monomers:
    - Properties: tough, slippery, resistant to corrosion, good insulator
    - Uses: non-stick coatings for saucepans.

Questions on Electrolysis of Water

- What are the two gaseous products formed when water is electrolysed?
- Write down the equation for the electrolysis of water.
- Describe how you would test the two gases produced.
- Give one use for each of the gases produced.

Questions on Polymerisation

- Define polymerisation.
- What do mono, poly and mer mean?
- What is polyethene made from?
- What does the ‘n’ indicate in a polymerisation equation?
- Why is the polymer still called polyethene if it no longer has a double bond?
- Give an example of a naturally occurring polymer.
- Give a use of polyethene, polypropene, pvc and PTFE and explainethe properties of each polymer that make it suitable for each use.

ORES

Some Metals are found as pure elements

e.g gold and platinum – are found naturally in the Earth's crust as elements. They are found as uncombined elements because they are ***very unreactive*** and don't form compounds. A physical method can be used to collect them such as sieving or panning.

Most Metals are found as compounds

However, most metals are reactive and readily form compounds (the more reactive a metal is, the more easily it reacts with other substances to form compounds). The compounds formed are mainly metal oxides which are found in rocks called ores in the Earth's crust as metal ***ores.***

To obtain these metals they must be extracted from ores in the Earth's crust

Examples

- Haematite (iron ore) contains enough iron oxide for it to be profitable to extract iron from it
- Similarly, aluminium is extracted from bauxite (aluminium ore) and copper from malachite (copper ore)

Extracting metals from ores

Some metals can be extracted by heating their compounds with carbon:

e.g iron: iron oxide + carbon → iron + carbon dioxide

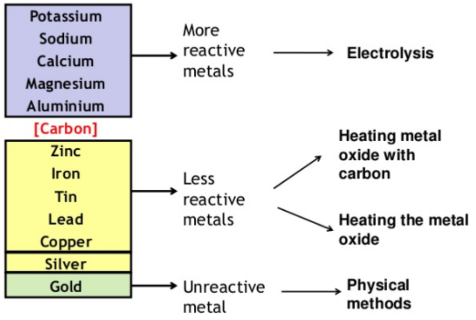
Chemical equation: $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$

Other metals are extracted from their compounds by electrolysis of a molten compound:

e.g aluminium: aluminium oxide → aluminium + oxygen

Chemical equation: $2Al_2O_3 \rightarrow 4Al + 3O_2$

Summary



The method used to extract a metal depends on its reactivity. The less reactive metals are extracted using carbon (e.g iron, zinc, lead, copper). More reactive metals are more difficult to extract because they form stronger, more stable compounds. The more reactive metals need to be extracted by electrolysis (e.g sodium, calcium, magnesium, aluminium) – a more powerful method. Metals with very low reactivity (e.g. gold) are found as elements and don't need to be extracted.

Extraction using electrolysis is more expensive than with carbon due to the cost of electricity and the more reactive the metal, the harder and more expensive it is to extract from its ore

PROBLEMS WITH POLYMERS

Materials such as wood and paper are biodegradable which means they will naturally breakdown or rot because microbes can feed on them. Most manufactured polymers have many uses because they are not biodegradable so last for a long time. When thrown away in landfill sites, these polymers stay there for a long time. When burned ('incinerated'), they release energy that can be used to generate electricity, however most also produce toxic products

Overcoming problems associated with disposal of polymers

1. Developing biodegradable polymers
    - Biodegradable polymers would rot after only a few years if they ended up in a landfill site however, this is still quite a long time and best option is to reduce the amount of plastic sent to landfill sites in the first place.

2. Reusing and recycling materials
    - One way to reduce the amount of plastic sent to landfill sites is by reusing materials e.g reusing plastic bags rather than throwing them away after just a single use
    - If an item can't be reused anymore then the material it is made from can be recycled (i.e. processed and used to make new objects). Paper, glass and metal waste is already recycled in the UK. Polymers are more difficult to recycle because the waste needs to be sorted into different types of polymer before each type can be made into new objects.

Questions on Ores

- Why are gold and platinum found as pure elements?
- What is an ore? Name an ore of iron and copper.
- Why can you extract zinc using carbon but to extract aluminium from its ore you have to use electrolysis?
- Write the word equation for the extraction of iron from iron oxide using carbon. Can you write the symbol equation?
- Why would scientists prefer not to use electrolysis?

Questions on Problems with Polymers

- Define biodegradable.
- Manufactured polymers are not biodegradable. Give two problems associated with trying to dispose of these polymers.
- Describe two ways that we can overcome the problems caused by disposing of polymers.
- Why is recycling polymers more time consuming than recycling paper, glass and metal?