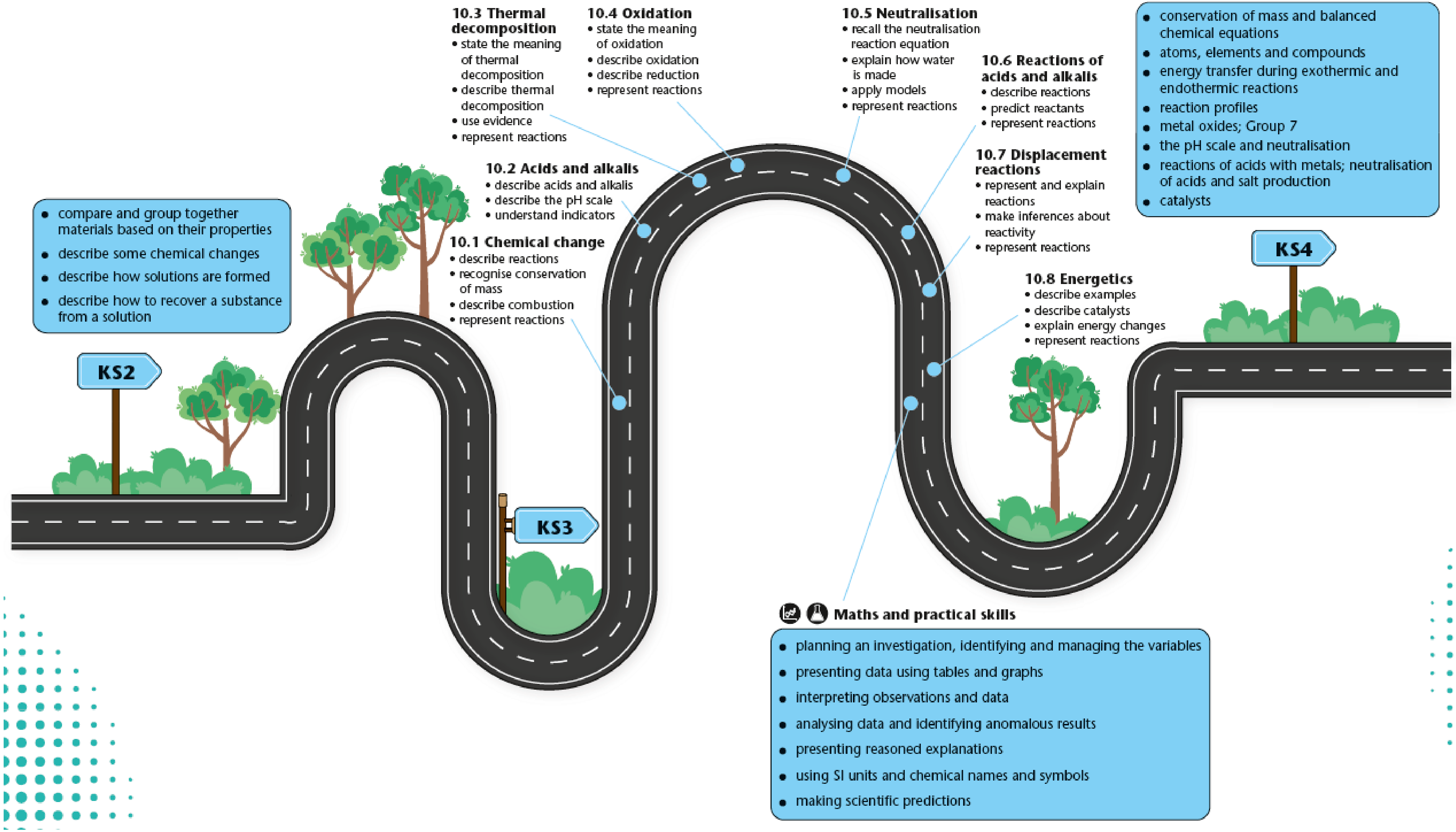
Chemical reactions

Road map

Where are you in your learning journey and where are you aiming to be?



Chemical reactions

Knowledge organiser

A **chemical reaction** is a change in which new substances are made. During a chemical reaction you may see:

- bubbles of gas
- a change in temperature
- a colour change
- a change in mass.

In any chemical reaction, the total mass of the reactants is the same as the total mass of the products. This is called the law of conservation of mass. Sometimes it may appear that the mass has changed. When this happens, there is normally a gas, either as a reactant or as a product, which accounts for the 'missing' mass.

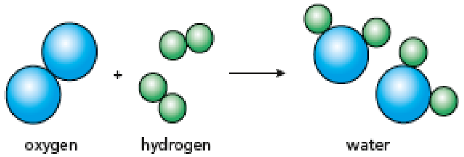
Burning is an example of a chemical reaction. The scientific name for burning is **combustion**. During combustion, a **fuel** reacts with oxygen to make carbon dioxide and water. The reaction releases useful energy. We can summarise combustion using an equation:

fuel + oxygen → carbon dioxide + water

If there is not enough oxygen available to react with all of the fuel, **incomplete combustion** takes place. The reaction has different products.

fuel + oxygen → carbon monoxide + carbon + water

During a chemical reaction, atoms rearrange and join together in a different way. New **products** are formed from the **reactants**. For example, hydrogen and oxygen react together to form water. Hydrogen and oxygen are the reactants and water is the product. One molecule of oxygen reacts with two molecules of hydrogen to form two molecules of water.



Notice that there are the same numbers of oxygen and hydrogen atoms at the start of the reaction as there are at the end of the reaction. They have been rearranged to form a new substance, water.

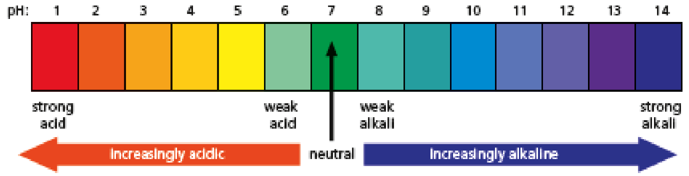
Some of the substances we use at home or in the laboratory are **acids**. Vinegar and lemon juice contain acids. Acids are substances with a **pH** less than 7. Concentrated acids are **corrosive**; dilute acids may be **irritants**. All acids contain the element hydrogen.

'Corrosive' hazard sign

'Harmful' hazard sign, which is used for substances that are not corrosive but are irritants.

Some other substances are **alkalis**. Soap and detergents contain alkalis. Alkalis are substances with a pH greater than 7. Like acids, concentrated alkalis can be corrosive and dilute alkalis may be irritants. All alkalis contain hydroxide particles (**chemical formula** OH).

An **indicator** is a substance that is a different colour in an acid and in an alkali. One example of an indicator is litmus. Litmus solution turns *red in acid* and *blue in alkali*. If a solution is neither an acid nor an alkali, we say it is **neutral.**



Universal indicator turns a range of different colours. The colour depends on whether the substance is an acid or an alkali *and* on how strong or weak it is. Each colour is given a **pH number**. The pH scale is a measure of the acidity or alkalinity of a substance.

Hydrochloric acid is an example of a strong acid, with a pH of 1. Vinegar is an example of a weak acid, with a pH of 3.

Oxidation reactions involve oxygen being added to another substance. This reaction forms compounds called oxides. During the combustion of a metal, oxygen is added to the metal:

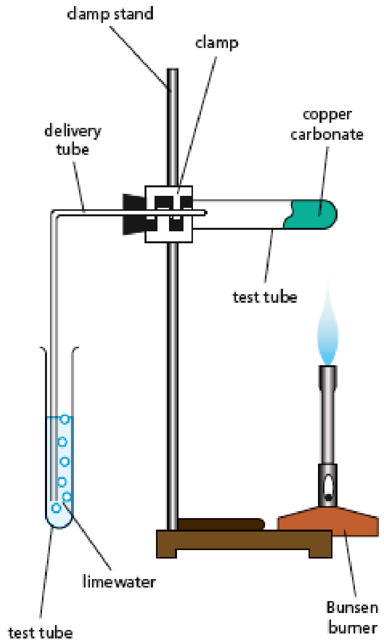
metal + oxygen → metal oxide

The mass of the metal oxide is greater than the mass of the metal because oxygen has been added.

When oxygen is removed from a metal oxide, the reaction is called **reduction**. This is the opposite of oxidation. Carbon can be used to remove oxygen from iron oxide.

Thermal decomposition reactions happen when some substances are heated and break down into simpler products. No new substances are added. When carbonates decompose, they produce a metal oxide and carbon dioxide:

metal carbonate → metal oxide + carbon dioxide



Key vocabulary	
acid	a substance that will neutralise a base; has a pH lower than 7
alkali	a base that is soluble in water; has a pH above 7
chemical formula	chemical symbols and numbers that show how many atoms of which elements are contained in a molecule of an element or compound
chemical reaction	a process in which one or more substances are changed into others, by the rearrangement of their atoms
combustion	the reaction of a fuel with oxygen that transfers thermal energy to the surroundings
conserved	when the quantity of something does not change after a process takes place
corrosive	can destroy skin and attack metal if spilled
fuel	any material that can be burned to release energy
incomplete combustion	when there is not enough oxygen available to react with all of a fuel during combustion
indicator	chemical that is a different colour in an alkali and an acid; used to identify whether an unknown solution is acidic or alkaline
irritant	a substance that causes the skin to become red, blistered and itchy
neutral	has a pH of 7
oxidation	a reaction in which a substance combines with oxygen
pH	a number from 1 to 14 on the pH scale of acidity and alkalinity
product	(of a chemical reaction) a substance made in a chemical reaction
reactant	a starting substance in a chemical reaction
reduction	a reaction in which oxygen is removed from a compound
thermal decomposition	a chemical change caused by heating, when one substance is changed into at least two new substances
universal indicator	an indicator that turns a range of different colours; each colour indicates a different pH value

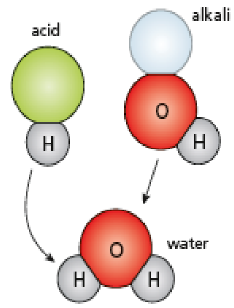
Chemical reactions

Knowledge organiser

A neutral substance has pH 7. It is made when an acid and alkali exactly neutralise one another. This is called **neutralisation**. Neutralisation is a chemical reaction; new products are formed.

acid + alkali → salt + water

Water is a product of the neutralisation reaction between acids and alkalis. The hydrogen from the acid combines with the hydroxide from the alkali to form water.



Acids react with bases to produce a **salt** and water. This is similar to the reaction you saw above between an acid and an alkali.

acid + base → salt + water

Salts are also formed in other reactions that involve acids. Acids react with metals to form a salt and hydrogen gas.

acid + metal → salt + hydrogen

Acids react with metal carbonates to form a salt, water and carbon dioxide.

acid + metal carbonate → salt + water + carbon dioxide

The reactivity series of metals places metals in order of their reactivity. It also includes two non-metals: hydrogen and carbon.

Most reactive

- K potassium
- Na sodium
- Ca calcium
- Mg magnesium
- Al aluminium
- C carbon
- Zn zinc
- Fe iron
- Sn tin
- Pb lead
- H hydrogen
- Cu copper
- Ag silver
- Au gold
- Pt platinum

Least reactive

In a **displacement reaction** a more **reactive** substance displaces (pushes out) a less reactive substance from a compound. An example is when iron is added to a copper sulfate solution. Iron is more reactive than copper. A chemical change occurs – iron displaces the copper to make iron sulfate:

iron + copper sulfate → iron sulfate + copper

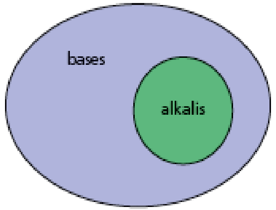
Acids contain hydrogen. When reactive metals react with acids, a displacement reaction occurs and hydrogen is displaced from the acid. If a metal is above hydrogen in the reactivity series, it will react to displace hydrogen. For example:

zinc + hydrochloric acid → zinc chloride + hydrogen

Non-metals also undergo displacement reactions. Chlorine and iodine are non-metals. Chlorine is more reactive than iodine. When chlorine gas is passed through sodium iodide solution, the chlorine displaces the iodine:

chlorine + sodium iodide → sodium chloride + iodine

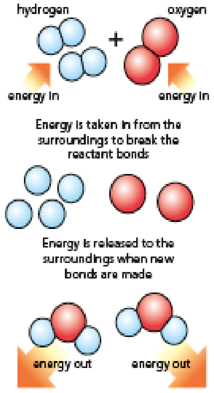
A **base** is any substance that neutralises an acid to produce a salt and water. An alkali is a soluble base – one that dissolves in water. Therefore, all alkalis are bases, but not all bases are alkalis. Metal oxides, metal hydroxides and metal carbonates are all examples of bases.



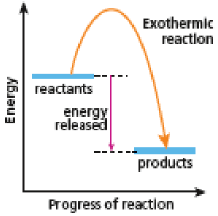
The name of a salt has two parts. The first part comes from the reactant that is not the acid; it is often a metal. For example, the alkali sodium hydroxide forms salts that start with 'sodium'. The end part of the name comes from the acid. For example, a salt formed from sulfuric acid and sodium hydroxide is called 'sodium sulfate'.

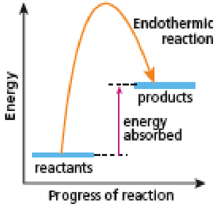
Acid used in reaction	Forms salts that end in…
hydrochloric acid	chloride
sulfuric acid	sulfate
nitric acid	nitrate

In a chemical reaction, existing **chemical bonds** are broken and new ones are made. Energy is needed to break chemical bonds; energy is released when new chemical bonds are made. The balance between these two processes explains why some reactions are endothermic and others are exothermic. If more energy is needed for **bond breaking** than is released in **bond making**, the reaction is endothermic. If less energy is needed for bond-breaking than is released in bond-making, the reaction is exothermic.



In some reactions, like combustion, there is an **energy transfer** to the surroundings – these are known as **exothermic reactions**, which cause the temperature of the surroundings to increase. Other reactions, like thermal decomposition, take energy from their surroundings – these are known as **endothermic reactions**, which cause the temperature of the surroundings to decrease. An energy profile diagram shows the energy changes taking place during exothermic and endothermic reactions.





A **catalyst** is a substance that is added to a chemical reaction to make the reaction faster. Catalysts are not changed by the reaction – they alter the **rate of reaction**. Most catalysts provide an alternative 'pathway' for the reaction that lowers the amount of energy needed for the reaction to proceed.

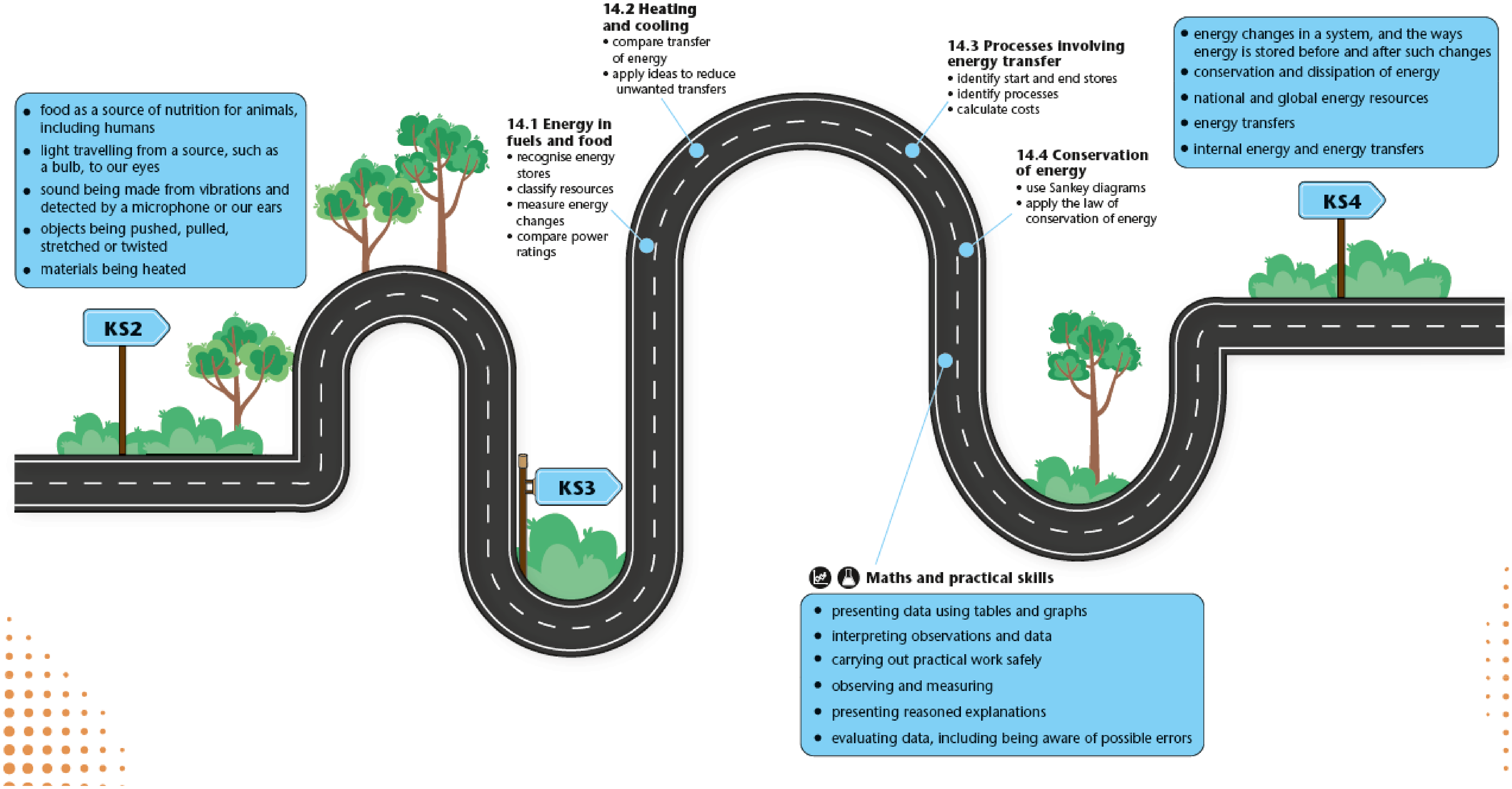
Key vocabulary

base	a substance that will neutralise an acid
bond breaking	when a chemical bond is broken by overcoming the force of attraction between particles; energy is transferred in from the surroundings
bond making	when a chemical bond is made by the force of attraction between particles; energy is transferred out to the surroundings
catalyst	substance that speeds up a chemical reaction
chemical bond	the force of attraction between two atoms
displacement reaction	a chemical reaction in which one substance takes the place of another in a compound
endothermic reaction	a chemical reaction in which energy is taken in, causing a cooling of the surroundings
energy transfer	the passing on of energy from one energy store to another energy store
exothermic reaction	a chemical reaction in which energy is given out, causing a warming of the surroundings
neutralisation	to make a substance neutral (pH 7) by adding an acid or a base
rate	the number of times something happens in a unit of time, such as a second
rate of reaction	a measure of the speed of a reaction; for example, the number of molecules of product produced over a set time
reactive	inclined to react in a chemical reaction; some substances are more reactive than others
salt	a substance formed when an acid reacts with a base, a metal or a metal carbonate

Energy

Road map

Where are you in your learning journey and where are you aiming to be?



Energy

Knowledge organiser

Stored **energy** is called **potential energy**. Energy can be stored in several different ways:

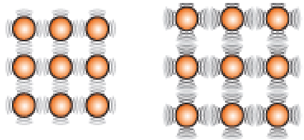
- **chemical potential energy** (for example, in **fuels** and food)
- **elastic potential energy** (for example, in a stretched or compressed spring)
- **gravitational potential energy** (for example, an apple on a tree)
- **kinetic energy** (for example, a moving car)
- **thermal energy** (for example, a hot cup of tea) – it is responsible for the temperature of an object.

Energy transfer is the passing on of energy from one store to another. Energy can be transferred between stores in various ways including heating, doing mechanical work, by an electrical current or by waves.

We measure energy in **joules (J)** or **kilojoules (kJ)**.

Power is the rate at which energy is transferred. It is measured in **watts (W)** and **kilowatts (kW)**.

Different **foods** contain different amounts of energy per gram.



Thermal (heat) energy is transferred through a material by **conduction**. The vibrating particles within the material transfer energy by colliding with their neighbours. A material that conducts heat is called a **thermal conductor**, a material that does not is called a **thermal insulator**.

Electricity can be generated using **renewable energy** sources, such as the wind, or **non-renewable energy** sources, such as gas.

Gas and electricity companies calculate the cost of home energy use using the unit **kilowatt-hours (kW h)**.

The cost of using an electrical appliance can be calculated using the equation:

cost = power (kW) × time (hours) × price (per kW h)

Key vocabulary

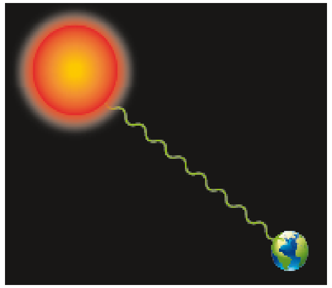
conduction	the transfer of energy by passing on energy to nearby particles
energy	the potential to do work or produce heat
energy transfer	the passing on of energy from one energy store to another
food	a substance that provides living things with nutrients and energy
fuel	a material that is burned to release its stored energy
joule (J), kilojoule (kJ)	unit of energy; 1000 J = 1 kJ
kilowatt-hour (kW h)	the energy transferred in 1 h by an electrical appliance with a power rating of 1 kW
non-renewable energy	energy from a source, such as a fossil fuel, that will run out because it cannot be replaced quickly enough
power	amount of energy that something transfers each second; measured in watts (W)
radiation	energy given out in the form of a wave; it can pass through a vacuum
renewable energy	energy from a source that will not run out, such as the sun or wind
temperature	the measure of how hot or cold an object is; unit is degrees Celsius (°C)
thermal conductor	a material that allows energy to pass through it quickly by the process of thermal conduction
thermal insulator	a material that does not allow energy to pass through it quickly by the process of thermal conduction
watt (W), kilowatt (kW)	unit of power; 1000 W = 1 kW; 1 W is equal to a joule per second (1 J/s)

When energy is transferred, not all of the energy is useful for the intended purpose. We say that any energy transferred to a store where we cannot use it is **wasted energy**. This can happen, for example, when friction heats up two surfaces that rub together, or when a hot object heats up the air around it.

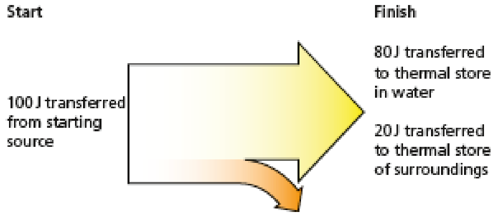
When energy is being transferred, we can keep track of the increase or decrease in the amounts of energy in each store by drawing an **energy transfer diagram**.

Whenever energy is transferred no energy is ever 'lost' or 'used up'. The quantity of energy stored before the change is the same as the quantity stored after the change. This is called the **law of conservation of energy**.

Thermal (heat) energy can be transferred from a hotter object to a cooler one by thermal **radiation**. The energy is transferred as a wave, and does not require the presence of particles to travel through.



The energy supplied to and the energy outputs from a system can be represented on a **Sankey diagram**. This shows which of the outputs are useful. The width of each arrow represents how much energy is transferred, so the diagram also shows the proportion of the input energy that is useful and that the total amount of energy is conserved.



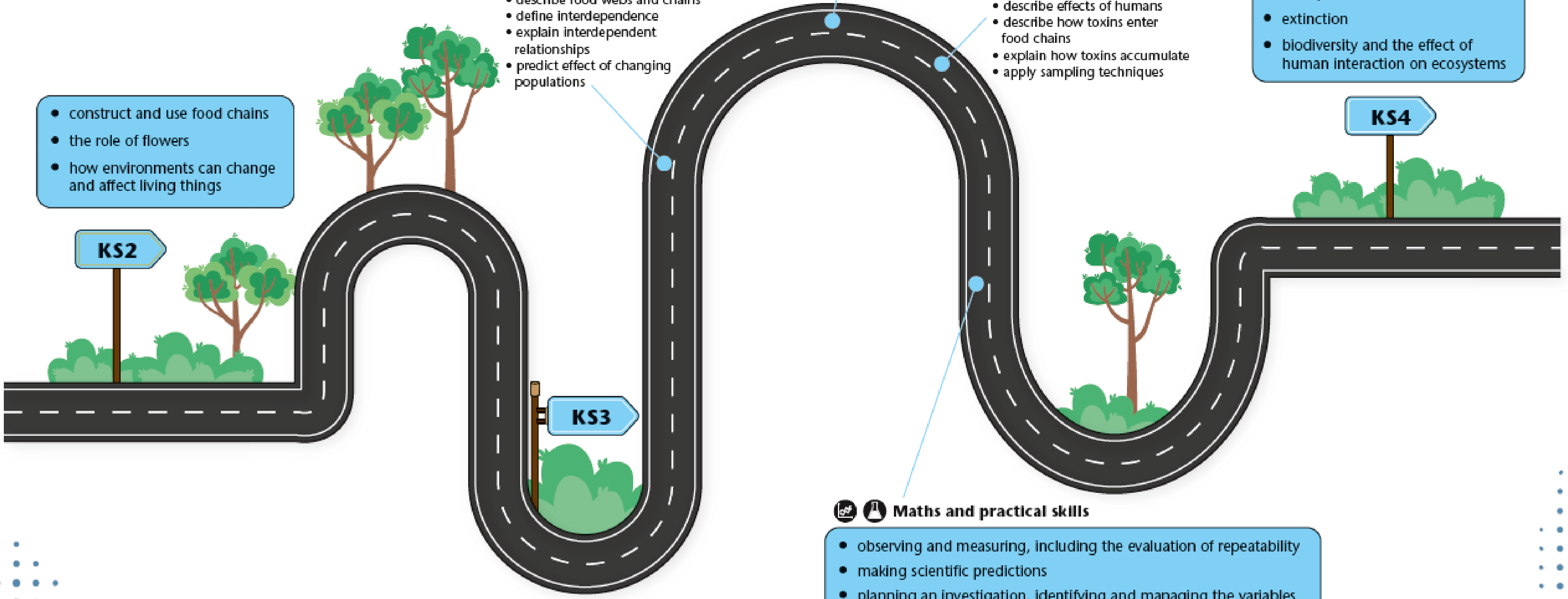
Key vocabulary

chemical potential energy	the energy store that is emptied during chemical reactions
elastic potential energy	the energy store of an elastic object when it is stretched or compressed
energy transfer diagram	a diagram with arrows showing how energy is transferred between energy stores
gravitational potential energy	the energy store of an object because of its height above the ground
kinetic energy	the energy stored in a moving object
law of conservation of energy	energy cannot be created or destroyed, only stored or transferred; this means that the total energy is the same before and after a change
Sankey diagram	an energy transfer diagram that shows what proportion of the input energy is transferred as useful or as wasted output
thermal energy	the energy store filled when an object is warmed up

Interdependence

Road map

Where are you in your learning journey and where are you aiming to be?



- construct and use food chains
- the role of flowers
- how environments can change and affect living things

5.1 Food webs and interdependence
- describe food webs and chains
- define interdependence
- explain interdependent relationships
- predict effect of changing populations

5.2 The importance of insects
- explain importance of insects
- describe food security
- discuss food security risks

5.3 Impact of organisms on their environment
- describe effects of humans
- describe how toxins enter food chains
- explain how toxins accumulate
- apply sampling techniques

- adaptations, interdependence and competition
- organisation of an ecosystem
- trophic levels in an ecosystem
- food production
- extinction
- biodiversity and the effect of human interaction on ecosystems

Maths and practical skills
- observing and measuring, including the evaluation of repeatability
- making scientific predictions
- planning an investigation, identifying and managing the variables
- suggesting improvements to practical work
- using sampling techniques
- analysing data and identifying anomalous results
- presenting reasoned explanations

Interdependence

Knowledge organiser

The biological material that makes up the organisms in a **population** is known as **biomass**. This biomass contains chemical energy.

Some of the biomass is transferred between populations when organisms are eaten. Energy is then released. We say energy flows from one organism to another when it is eaten.

The amount of energy available at each step decreases as organisms use energy to move and grow.

An **ecosystem** is made up of the **community** of organisms and the physical environment. The organisms interact with each other and the physical environment.

The feeding relationships within a community of organisms can be modelled using **food chains**. Food chains show how biomass (and energy) transfers or flows from one organism to another and between populations.

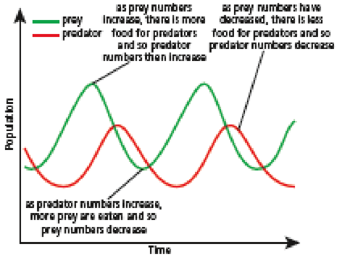
A simple food chain – the arrows show the transfer of biomass

Each population of organisms in a food web can affect the others. For example, in the food web on the right:

- a decrease in the amount of grass seed means less food for the mice, and so their numbers may decrease
- fewer mice means less food for the owls
- the owls may then eat more shrews, and the number of shrews may decrease
- the number of worms may then increase, as fewer are eaten by shrews.

Each organism can also be affected by the physical **environment**.

Predator–prey relationships can be shown on a graph.



Predators must be adapted to catch enough food to survive. Prey must be adapted to escape predators to ensure survival.

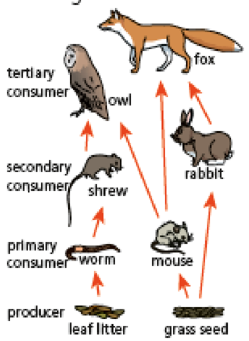
A change in the prey population size affects the predator population size. This then affects the prey population size, and so on.

All food chains start with **producers** and include one or more **consumer**.

- Producers make their own food and are the source of biomass for food chains. They are green plants, so they make their food by photosynthesis using light energy.
- **Primary consumers** eat producers.
- **Secondary consumers** eat primary consumers.
- **Tertiary consumers** eat secondary consumers.

The levels in a food chain or web are called **trophic levels**. They show the position of an organism in the chain.

Food chains connect to form **food webs**. In the food web, we can see more relationships than the food chain. For example, the fox feeds on mice as well as rabbits, and mice also feed on the grass.



A simple food web

Different organisms in an ecosystem can affect each other in many ways.

Competition – organisms within an ecosystem compete for resources when they are in short supply. For example, plants may compete for water, animals may compete for food.

Predator–prey relationships – **predators** prey on other animals for food; **prey** are eaten by predators (for example, foxes prey on rabbits).

Symbiosis – a close, long-term relationship between different organisms. There are several types of symbiosis.

Insects are essential for the pollination of some plants, including some food crops (plants for food). For example, bees are extremely important to human food production, as they pollinate many types of fruit and vegetable crops.

Insect populations can be negatively affected by:

- increased predator populations
- disease
- adverse weather and changes in climate – this may mean that plants flower earlier, before insects are able to pollinate them, or for shorter periods
- pesticides
- a decrease in insect-pollinated plants, for example, when wild flowering plants are removed to grow crops.

Food security means that all people, at all times, have access to enough safe and nutritious food for an active and healthy life. Any factor that reduces insect populations is a risk to food security.

Monoculture is an intensive form of farming where single crops are grown over large areas. This reduces insect populations as there is not enough variety of food and there may not be enough nutrients for insect health.

A decrease in insect populations due to over use of **pesticides** (for example, a decrease in wild bees has led to farmers in China needing to hand pollinate fruit and vegetable crops as a way to increase food security)

Key vocabulary	
biomass	the mass of living organisms; contains chemical energy
commensalism	the type of symbiosis where one organism benefits but the other does not
community	populations of two or more different species occupying the same geographical area at the same time
competition	the struggle between organisms for resources or survival (for example, food)
consumer	an animal that eats other animals or plants
ecosystem	the living things and their non-living environment in a given area
environment	the surroundings, such as air, water, soil, climate and food sources, where an organism lives
food chain	part of a food web, starting with a producer and ending with a top predator
food security	when all people, at all times, have access to enough safe and nutritious food for an active and healthy life
food web	more than one food chain interconnected
monoculture	a single crop grown in a large space
mutualism	the type of symbiosis where both organisms benefit
parasitism	the type of symbiosis where one organism benefits and the other is harmed
pesticide	a chemical applied to crops to destroy pests
population	a group of the same type of organism living in the same area
predator	an animal that preys on other animals
prey	an animal that is hunted and killed by other animals (predators)
primary consumer	an organism that eats a producer
producer	the plant at the start of a food chain that makes its own food (typically a green plant)
secondary consumer	an organism that eats a primary consumer
symbiosis	a relationship between two different types of organism
tertiary consumer	an organism that eats a secondary consumer
trophic level	the position of an organism in a food chain
yield	the amount of useful product obtained

Interdependence

Knowledge organiser

All organism populations in an ecosystem can affect other organism populations, for example, through competition or predation. These associations between living things are called **biotic factors**.

Within an ecosystem, physical factors such as temperature, availability of water, nutrients and light, carbon dioxide concentration and pH of soil, also affect populations. These physical factors are called **abiotic factors**.

The role that an organism plays within a community, including all the biotic and abiotic factors, is its **niche**.

Humans are a major factor in causing changes to the environment. As medical treatment has improved, humans are living longer. As the human population increases, the impact on the environment increases:

- habitats are lost as more land is needed for farming and building
- pollution increases as we have more factories and vehicles and we generate more rubbish
- animals are hunted for food, sport, medicines, their fur and horns, etc.

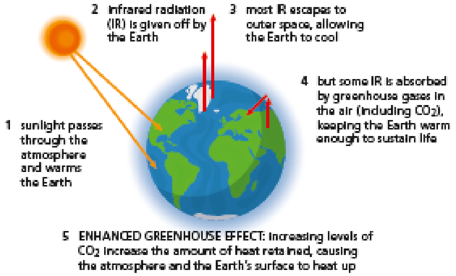
The impact of these actions is a decrease in the number and number of types of plants and animals. This reduces **biodiversity**.

Ecology is the study of the interactions between organisms and the environment. We study populations of plants and animals by **sampling**. Sampling is a scientific survey: the observations are used to make estimates about whole populations. Random sampling means we choose areas to sample at random rather than selecting them. This removes **bias**.

Quadrats are used to sample plants or slow-moving animals. A quadrat is a square frame (commonly 50 cm × 50 cm). The quadrat can be used to sample in different ways:

- to count the number of a single species, for example, the number of barnacles
- to count the number of different species; this is a measure of biodiversity
- to estimate the percentage of the quadrat filled by any one species, for example, grass.

Global warming has a large impact on the environment. It is caused by **greenhouse gases**, such as carbon dioxide and methane, trapping too much heat around the Earth.



Several human activities add to these greenhouse gases:

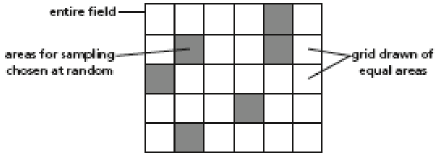
- burning fossil fuels (coal, oil, gas) – releases carbon dioxide
- deforestation – fewer trees to take in carbon dioxide
- landfill waste – waste decomposes releasing methane.

The effects of global warming are wide-ranging and can lead to loss of **habitats** for many organisms, including humans:

- increasing land and ocean temperatures
- **climate change** (for example, more frequent **droughts**, storms, heat waves)
- melting glaciers
- rising sea levels.

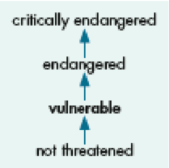
Here is an example of using a quadrat to estimate the population size of daisies in a field.

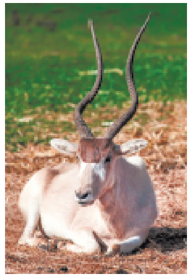
1. Place the quadrat randomly within the area being studied.
2. Count how many daisies are within the quadrat.
3. Repeat the procedure 10 times within the field. Choose samples randomly, for example, by drawing the entire area as a grid and then choosing coordinates at random, as shown below.



   Ensure all squares are of equal size.
4. Calculate the average number of daisies.
5. Multiply the result to estimate the population size for the entire area (for example, if the area sampled makes up 20% of the entire field, multiply the average number by 5).

Critically **endangered** organisms are at risk of becoming **extinct**. A series of categories are used to describe how at risk a species is:





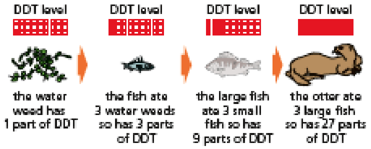
Some species are extinct in the wild and exist only in captivity.

This scimitar-horned oryx is an example.

Rainforests are an example of a habitat affected by human activity. Nearly half of all animal species live in rainforests. Loss of habitat is the biggest threat to rainforests and the organisms living there.

- Primary consumers eat plants containing toxins; secondary consumers eat the primary consumer; and so on up the food chain.
- Organisms at the lower end of a food chain may take up only small concentrations of toxin.
- If these organisms are then eaten by organisms in the next trophic level, the toxin gets passed on.
- Organisms generally get bigger along a food chain, and eat more than one of the organisms in the previous trophic level. This means that the toxin becomes more concentrated as it passes through the food chain. This is known as **bioaccumulation**.

DDT is a pesticide that was used in the 1960s. It entered rivers and contaminated plants. The plants then entered the food chain. Otters at the top of the food chain were killed due to bioaccumulation.



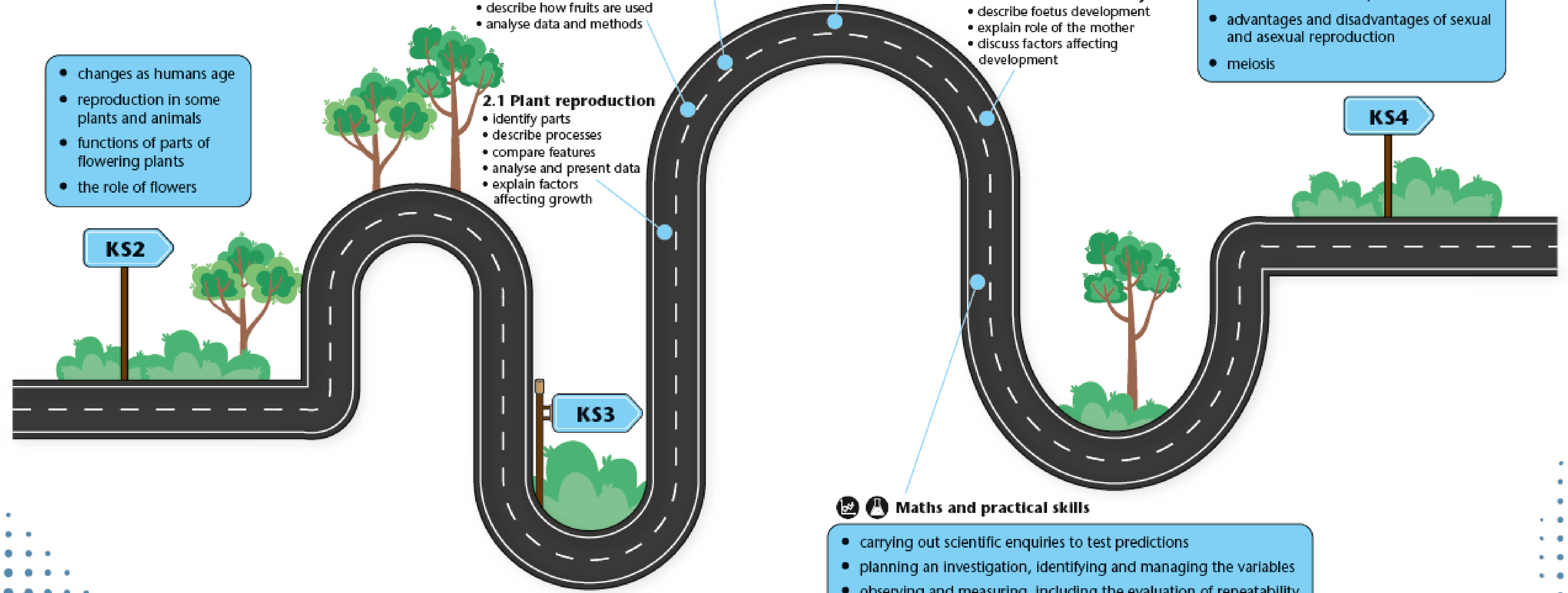
Key vocabulary

abiotic factors	physical factors within an environment
bias	a tendency to favour one thing or another, rather than being objective
bioaccumulation	the increase in the concentration of a chemical as it is passed from one organism to another along a food chain
biodiversity	the variety of different organisms within an ecosystem
biotic factor	a factor associated with the living things in an environment
captive breeding	the breeding of animals away from the wild, for example, in zoos or wildlife reserves, to conserve the species
climate change	the change in climate patterns, such as temperature and rainfall
conservation	the protection of the Earth's natural resources, including organisms and the physical environment
DDT	a pesticide used in the 1960s
drought	a prolonged period of abnormally low rainfall, leading to a shortage of water
ecology	the study of the interactions between organisms and the environment
endangered	when there are so few of a species left that it could become extinct
extinct	when a species dies out and no more individuals remain
fertiliser	a chemical put on the soil to increase its fertility and support crop growth
global warming	the gradual increase in the overall temperature of the Earth's atmosphere, caused by greenhouse gases such as carbon dioxide
greenhouse gas	gases such as carbon dioxide and methane that trap heat around the Earth
habitat	the natural home or environment of an organism
insecticide	a chemical applied to crops to kill insects that damage the crops
niche	the role of an organism within its ecosystem
quadrat	a square frame used in ecology to sample populations
rainforest	dense forest rich in biodiversity, typically found in tropical areas with consistently heavy rainfall
sampling	the study of part of a population to then infer a conclusion about a whole population
toxin	a substance that damages a living organism
vulnerable	when the number of a species drops but not so low that it is endangered

Plant Reproduction

Road map

Where are you in your learning journey and where are you aiming to be?



KS2

- changes as humans age
- reproduction in some plants and animals
- functions of parts of flowering plants
- the role of flowers

2.1 Plant reproduction
- identify parts
- describe processes
- compare features
- analyse and present data
- explain factors affecting growth

2.2 Seed dispersal
- describe methods
- explain importance and adaptations
- describe how fruits are used
- analyse data and methods

2.3 Reproduction in humans
- identify organs
- describe fertilisation
- explain roles of organs
- compare plants and humans

2.4 Puberty and the menstrual cycle
- describe and explain changes
- describe the menstrual cycle
- apply the menstrual cycle to infertility

2.5 Development of a foetus and the effect of lifestyle
- describe foetus development
- explain role of the mother
- discuss factors affecting development

KS4

- hormones in human reproduction
- contraception
- use of hormones to treat infertility
- sexual and asexual reproduction
- advantages and disadvantages of sexual and asexual reproduction
- meiosis

Maths and practical skills

- carrying out scientific enquiries to test predictions
- planning an investigation, identifying and managing the variables
- observing and measuring, including the evaluation of repeatability
- interpreting observations and data
- suggesting improvements to practical work
- calculating results and converting between different units
- presenting reasoned explanations
- writing scientific questions

Plant Reproduction

Knowledge organiser

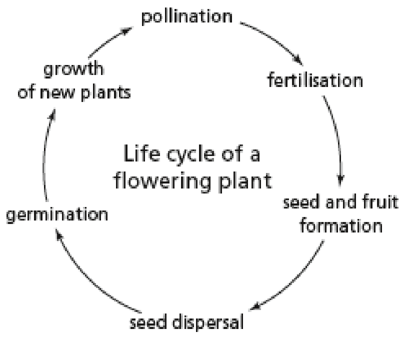
Reproduction is the production of offspring.

In sexual reproduction, the male sex cells fertilise the female sex cells. Sex cells are also called **gametes**.

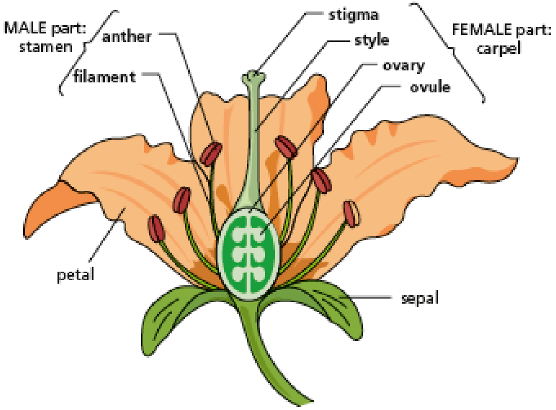
In flowering plants, the male gamete is a pollen cell and the female gamete is an ovule.

In humans, the male sex cell is a sperm and the female gamete is an ovum.

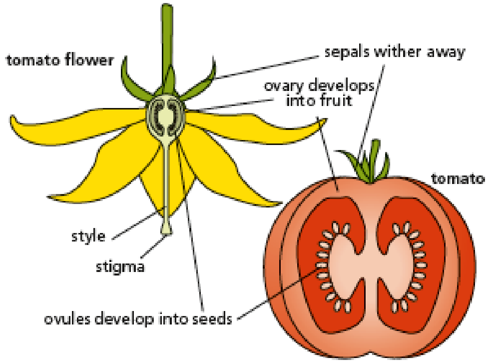
Fertilisation is the joining of the nucleus of a male gamete and the nucleus of a female gamete.



Most flowers have male and female parts.



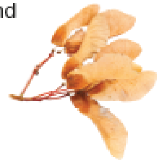
Following fertilisation, each fertilised ovule becomes a **seed**, and the ovary develops into a **fruit**. The fruit protects the seeds until they are ripe and ready to form a new plant.



Methods of seed dispersal can be investigated and compared. For example, the distance travelled by seeds dispersed by different methods can be measured. Here, the independent variable is the method of dispersal; the dependent variable is the distance travelled.

Seed dispersal can happen by:

- wind



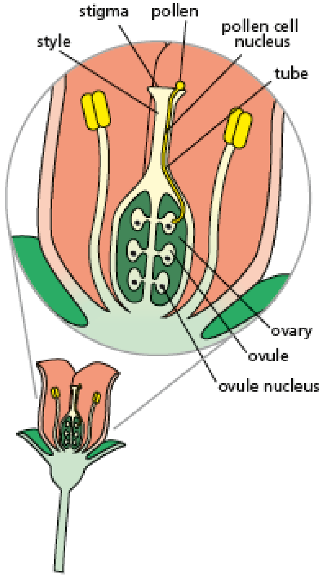
- explosion – pods explode on touch
- water

- animals – they eat the fruit and carry the seeds inside them.

Pollination is when pollen produced in the anther is transferred to the stigma of a different plant of the same type. Pollen can be transferred by wind or insects.

Insect-pollinated plants	**Wind-pollinated plants**
have brightly coloured flowers to attract insects	have long anthers that hang outside the flowers, so pollen is caught on the wind
have sweet smells to attract insects	produce huge amounts of pollen to increase chances of pollination
produce nectar inside the flower to attract insects inside or near the pollen	have long, feathery stigmas that hang outside flowers so pollen can stick to them
produce sticky or spiky pollen to stick to insects	often have no scent or bright colours as don't need to attract insects

Following pollination, the nucleus of the male pollen cell moves to the ovary, where it joins with the nucleus of the ovule. This is called fertilisation.



Key vocabulary	
anther	the pollen-producing part of the stamen of a flower
carpel	the female part of a flower
fertilisation	the joining of the nucleus of a male sex cell with the nucleus of a female sex cell
filament	the 'stalk' of the stamen that supports the anther
fruit	the ovary of a plant after fertilisation; the fruit contains the seeds
gametes	sex cells
germination	the stage when a seed begins to grow into a plant
insect pollination	pollination caused by insects carrying and transferring the pollen
ovary	the organ in female plants that contains ovules, and in animals that makes egg cells
ovule	the female sex cell (egg) of a plant
pollination	the process of transferring pollen from the anther of a flower to the stigma of a flower on another plant of the same type
reproduction	the production of offspring
seed	the ovule of a plant after fertilisation
seed dispersal	the spreading of seeds from a plant to a new area
stamen	the male part of a flower
stigma	the pollen-receiving part of a flower
style	the female part of a flower through which pollen travels to fertilise an ovule
wind pollination	pollination caused by wind carrying and transferring the pollen