Y9 Cycle 3 Science

Scholar’s Guide

Oxford Spires Academy

Full Name: ____________________

Tutor Group : __________

Science Class : __________

Science Teacher(s): ____________________

Science Y9

Cycle 2

The Knowledge Organisers contain all the knowledge you need to learn.
Below is what you need to be able to do.

Lesson	**GCSE B7- Ecology**	**GCSE P5- Forces**
1-3	• Extract and interpret information from charts, graphs and tables relating to organisms within a community. • Explain how a change in an biotic and abiotic factor would affect a given community given appropriate data or context. • When provided with appropriate information: suggest the factors for which organisms are competing in a given habitat and suggest how organisms are adapted to the conditions in which they live.	• Describe the interaction between pairs of objects which produce a force on each object. The forces to be represented as vectors. • Calculate the resultant of two forces that act in a straight line. • Students should be able to apply Newton's Third Law to examples of equilibrium situations. • Students should be able to apply Newton's First Law to explain the motion of objects moving with a uniform velocity and objects where the speed and/or direction changes.
4-6	• Interpret graphs used to model predator-prey cycles. • **Required practical 7:** Use sampling techniques to investigate the effect of a factor on the distribution of this species.	• Students should be able to use vector diagrams to illustrate resolution of forces. • Substitute numerical values into algebraic equations using appropriate units for physical quantities.
7-9	• Explain the importance of the carbon and water cycles to living organisms. • Explain the role of microorganisms in cycling materials through an ecosystem.	• Interpret data from an investigation of the relationship between force and extension. • **Required practical activity 18**: investigate the relationship between force and extension for a spring.
10-12	• Students should be able to describe some of the biological consequences of global warming. • Students should be able to describe both positive and negative human interactions in an ecosystem and explain their impact on biodiversity.	• draw distance–time graphs from measurements and extract and interpret lines and slopes of distance–time graphs, translating information between graphical and numerical form. • Determine speed from a distance–time graph using the gradient of a graph.
13-15	• Evaluate the conflicting pressures on maintaining biodiversity given appropriate information.	• Estimate the speed, accelerations and forces involved in large accelerations for everyday road transport. • Evaluate the effect of various factors on thinking distance based on given data.

AQA Biology (Combined Science) Unit 7: Ecology Knowledge Organiser

Keywords

Biodiversity - the variety of living organisms.

Carrion - decaying flesh and tissue of dead animals.

Community - made up of the populations of different species living in a habitat.

Competition - the negative interaction between two or more organisms which require the same limited resource.

Consumers - feed on other organisms for their energy. Can be primary, secondary or tertiary.

Decomposers - organisms which feed on dead and decaying organisms. They break down the biomass and release nutrients into the soil.

Deforestation - the removal and destruction of trees in forest and woodland.

Ecosystem - the interaction between the living organisms and the different factors of the environment.

Global warming - the increase of the average global temperature.

Habitat - where a living organism lives.

Interdependence - the interaction between two or more organisms, where it is mutually beneficial.

Population - the number of individual organisms of a single species living in a habitat.

Predators - organisms which kill for food.

Prey - the animals which are eaten by the predators.

Producers - convert the sun's energy into useful compounds through photosynthesis. They are green plants or algae.

Scavengers - organisms which feed on dead animals (carrion).

Species - organisms of similar morphology which can interbreed to produce fertile offspring.

Abiotic and Biotic Factors

Abiotic factors are the non-living factors of an environment. E.g. moisture, light, temperature, CO_2, wind, O_2 or pH.

Biotic factors are the living factors of an environment. E.g. predators, competition, pathogens, availability of food.

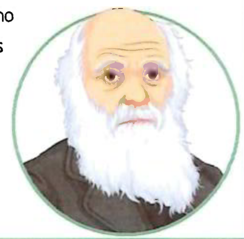
Adaptations

Adaptations are specific features of an organism which enable them to survive in the conditions of their habitat.

Adaptations can be structural, behavioural or functional:

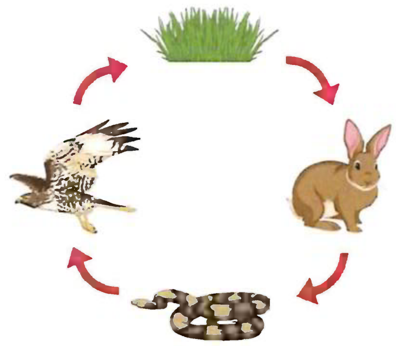
- **Structural adaptations** are features of the organism's body e.g. colour for camouflage.
- **Behavioural adaptations** are how the organism behaves e.g. migration to a warmer climate during colder seasons.
- **Functional adaptations** are the ways the physiological processes work in the organism e.g. lower metabolism during hibernation to preserve energy.

A plant or animal will not physically change to adapt to its environment in its lifetime. Instead, there is natural variation within the species and only organisms whose features are more advantageous in the environment survive. The survivors then go on to reproduce and pass on their features to some of their offspring. The offspring who inherit these advantageous features are better equipped to survive. Charles Darwin described this process as 'survival of the fittest'.



Food Chains

The source of all energy in a food chain is the sun's radiation. It is made useful by plants and algae which produce organic compounds through photosynthesis.

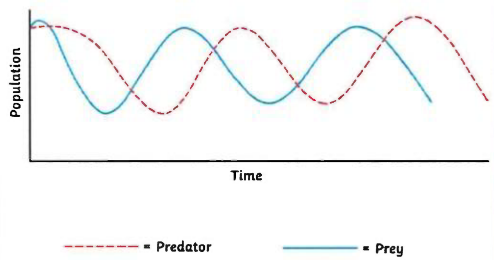


The living organisms use the energy to produce biomass and grow.

When a living organism is consumed, some of the biomass and energy is transferred. Some of the energy is lost.

Remember: the arrow in a food chain indicates the direction of the flow of energy.

Populations of predators and prey increase and decrease in cycles. The size of the predator population depends on the size of the prey population and vice versa. Overall, there is a stable community.



Competition

Species will compete with one another and also within their own species to survive and to reproduce.

Mutualism occurs when both species benefit from a relationship.

Parasitism occurs when a parasite only benefits from living on the host.

Animals compete for resources such as food, water and space/shelter. They may also compete within their own species for mates.

Plants compete for resources including light, water, space and minerals. All these resources are needed for photosynthesis so the plant can make its own food. Plants do not need to compete for food.

Deforestation and Land Use

Humans use land for buildings, quarrying, mining, agriculture and landfill. As the human population increases and we take more land, there is less space for other organisms to live.

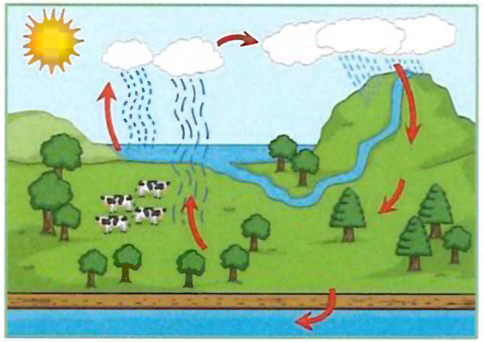
Deforestation (to use wood as a fuel/material or to clear space for other uses) destroys habitats where other organisms live.

Peat bogs are produced when decomposition occurs over a very long time. Peat stores a lot of carbon and can be extracted for use by gardeners or as an energy source. Burning peat releases a lot of carbon dioxide into the atmosphere which contributes to the greenhouse effect.

Trees absorb carbon dioxide for photosynthesis, so as they are cut down and removed, less carbon dioxide is taken from the atmosphere. Furthermore, when the trees are burned, they release carbon dioxide back into the atmosphere. The excess carbon dioxide can lead to global warming and the changes to the ecosystem cause reduced biodiversity.

AQA Biology (Combined Science) Unit 7: Ecology Knowledge Organiser

Water Cycle



Convection is the movement caused within a fluid as the hotter, less dense material rises and colder, denser material sinks under the influence of gravity. This results in the transfer of heat.

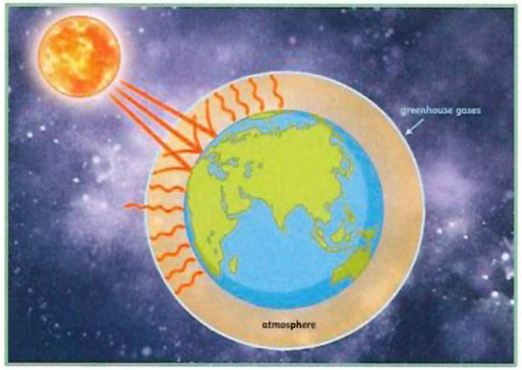
Evaporation occurs when heat energy from the surroundings (or a heat source) is transferred to water particles as kinetic energy. The particles begin to move more rapidly and can turn from a liquid into a gas.

Condensation occurs when moving particles transfer kinetic energy to the surroundings. The particles begin to move even more slowly and can turn from a gas into a liquid.

Precipitation occurs when rain, snow, sleet, or hail falls to (or **condenses** on) the ground.

Transpiration is the process by which water is carried through plants from roots to the stomata on the underside of leaves and it evaporates into the surroundings.

Global Warming



The **greenhouse effect** is the natural process where some of the Sun's radiation is trapped within the insulating layer of the atmosphere. This maintains a temperature suitable to support life on Earth.

Most of the radiation from the Sun is absorbed by the Earth when it reaches the surface. The rest of the infrared radiation is reflected from the surface and absorbed by the greenhouse gases and clouds in the atmosphere. This is then re-emitted in all directions.

However, due to many contributing factors, the global temperature is gradually increasing. Several gases, called greenhouse gases, trap the heat around the Earth; the most concerning is carbon dioxide. Human activities contribute to the excess amount of carbon dioxide in the atmosphere and so are a cause of global warming.

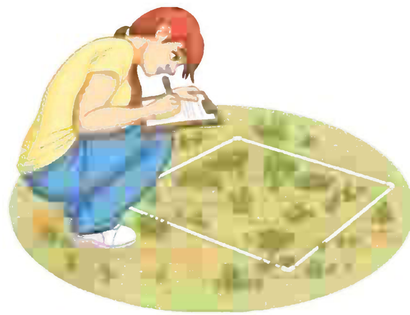
Global warming leads to the melting of ice caps, rising sea levels, flooding, changes to climate, changes in migration patterns, changes in species distribution and reduction in biodiversity.

RPI: Field Techniques Quadrats and Transects

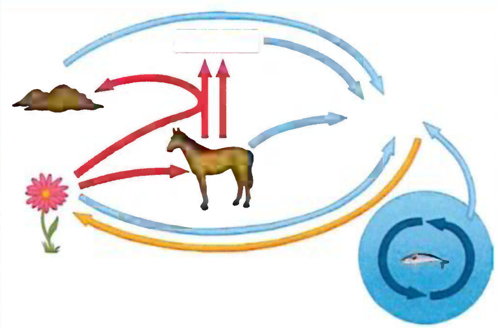
The distribution of an organism is affected by the environment and abiotic factors.
Quadrats can be used to measure the frequency of an organism in a given area e.g. the school field. You could count the individual organisms or estimate the percentage cover. You must collect data from at least two areas to make a comparison. Quadrats should always be placed randomly.

Transects are used to measure the change of distribution across an area e.g. from the edge of a river and moving further from the water's edge. You could either count the number of organisms touching the transect at regular intervals or use a quadrat placed at regular intervals along the transect.

$$\text{mean} = \frac{\text{total number of organisms}}{\text{number of quadrats}}$$



Carbon Cycle

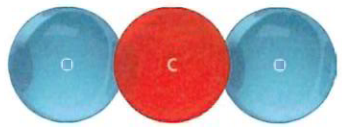


The main focus on the carbon cycle is its transfer to and from the atmosphere. When carbon is in the atmosphere, it combines with oxygen to form carbon dioxide, a greenhouse gas.

Carbon is transferred from the atmosphere when plants absorb carbon dioxide for photosynthesis and when the gas is dissolved into oceans.

Carbon is transferred to the atmosphere through respiration by animals, plants and bacteria and by combustion of fossil fuels (coal, oil and natural gas).

Dead animals and plants are decomposed and their matter is broken down by microbes and fungi. These organisms are collectively called decomposers. When the organisms are broken down, the microbes and fungi release carbon dioxide into the atmosphere through respiration.



AQA Biology (Combined Science) Unit 7: Ecology Knowledge Organiser

Biodiversity and Waste Management

Biodiversity is the variety of living organisms on the earth or in an ecosystem. It is important in helping to maintain stable ecosystems. Organisms are often interdependent, relying on others as food sources, or to create suitable environmental conditions to survive. Human survival is also dependent on this biodiversity.

The global human population has exceeded 7 billion.
Human population has increased due to modern medicine and farming methods, reducing famine and death from disease.
This means a greater demand for food, resources and water.
It also means more waste and emissions are created.

Sewage, toxic chemicals, household waste and gas emissions pollute the water, land and air, killing plants and animals and reducing biodiversity.

Maintaining Ecosystems and Biodiversity

There are many ways that biodiversity and ecosystems are maintained:

- Breeding programmes can help to protect endangered species from extinction.
- Conservation programmes can help to protect and preserve specialised ecosystems and habitats such as peat bogs and coral reefs.
- Reintroduction of hedgerows and field margins on agricultural land can help improve biodiversity by breaking up the monoculture crops.
- Sustainable forestry programmes help to manage the woodlands and reduce the deforestation to a sustainable rate.
- Societies actively encourage recycling and reusing of products and packaging to reduce the household waste going to landfill sites.

Unfortunately these programmes can be difficult to manage. They are often expensive and are difficult to regulate. People who are employed in certain areas, e.g. tree felling, cannot always transfer their skills to an environmentally friendly role and so become unemployed. It is difficult to maintain biodiversity whilst preventing crops being overrun with pests and weeds, which would affect food security for the human population.

AQA Combined Science: **Physics Topic 5 Forces**

Scalar and Vector Quantities

A **scalar** quantity has **magnitude** only. Examples include temperature or mass.

A **vector** quantity has both **magnitude** and **direction**. Examples include velocity.

Speed is the scalar(e.g. 5m/s), velocity is a vector (5m/s East)

A vector quantity can be shown using an **arrow**. The size of the arrow is relative to the magnitude of the quantity and the direction shows the associated direction.

Contact and Non-Contact Forces

Forces either **push** or **pull** on an object. This is as a result of its interaction with another object.

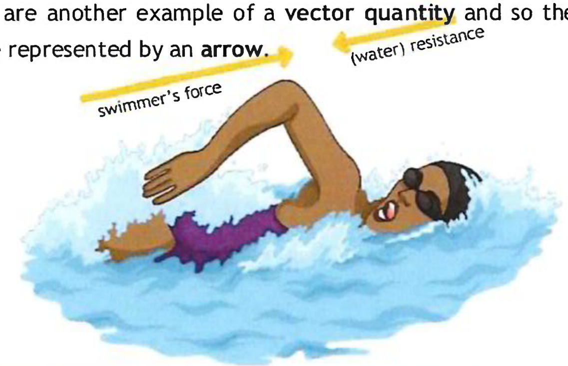
Forces are categorised into two groups:

Contact forces - the objects are touching e.g. friction, air resistance, tension and contact force.

Non-contact forces - the objects are not touching e.g. gravitational, electrostatic and magnetic forces.

Forces are calculated by the equation: **force (N) = mass (kg) × acceleration (m/ s^2)**

Forces are another example of a **vector quantity** and so they can also be represented by an **arrow**.



Gravity

Gravity is the natural phenomenon by which any object with mass or energy is drawn together.

- The **mass** of an object is a scalar measure of how much matter the object is made up of. Mass is measured in **kilograms (kg)**.
- The **weight** of an object is a vector measure of how gravity is acting on the mass. Weight is measured in **newtons (N)**.

weight (N) = mass (kg) × gravitational field strength (N/kg)

(The gravitational field strength will be given for any calculations. On earth, it is approximately 9.8N/kg).

An object's **centre of mass** is the point at which the weight of the object is considered to be acting. It does not necessarily occur at the centre of the object.

The **mass** of an object and its **weight** are **directly proportional.** As the mass is increased, so is the weight. Weight is measured using a **spring-balance** (or **newton metre**) and is measured in **newtons** (N).

Resultant Forces

A **resultant force** is a single force which replaces several other forces. It has the same effect acting on the object as the combination of the other forces it has replaced.

The forces acting on this object are represented in a **free body** diagram.
The arrows are relative to the magnitude and direction of the force.

The car is being pushed to the left by a force of 30N. It is also being pushed to the right by a force of 50N.

The resultant force is 50N - 30N = 20N

The 20N resultant force is pushing to the right, **so the car will move right.**

When a resultant force is not zero, an object will **change speed (accelerate or decelerate)** or **change direction (or both)**.

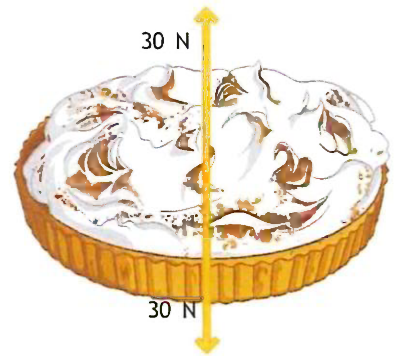
When an object is stationary, there are still forces acting upon it.

In this case, **the resultant force is 30N - 30N = 0N.**

The forces are in **equilibrium** and are **balanced.**

When forces are balanced, an object will either **remain stationary** or if it is moving, it will continue to move at a **constant speed.**

When resultant forces act along the same line, you calculate the resultant force as shown below.



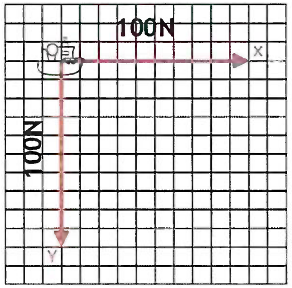
AQA GCSE Physics (Separate Science) Unit 5: Forces

Resultant Forces

A **vector diagram** can be used to determine the resultant of two forces that are not acting in a straight line.

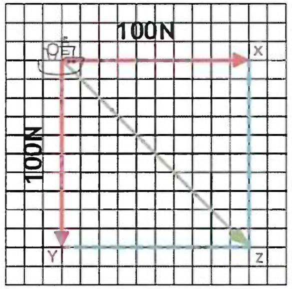
Worked example 1:

A boat is being pulled toward the harbour by two winch motors. Each motor is pulling with a force of 100N and they are working at right angles to each other. These forces are represented by lines OX and OY.



Construction lines can be added to the diagram to form rectangle OXZY. The line OZ is the diagonal of this rectangle.

OZ is the resultant force. It is the hypotenuse of the right-angle triangles OYZ and OXZ.



We can use the Pythagoras' theorem to calculate its length.

$$a^2 + b^2 = c^2$$

$100^2 + 100^2 = OZ^2$

$100^2 + 100^2 = 20\,000$

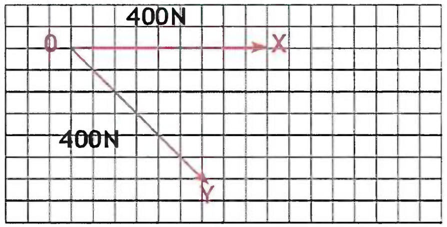
$\sqrt{20\,000} = 141.42$

The resultant force is 141.42N.

Alternatively, you can measure line OX and work out how many newtons are represented by each cm. Then measure the length of OZ and use your scale to calculate how many newtons the length represents.

Worked example 2:

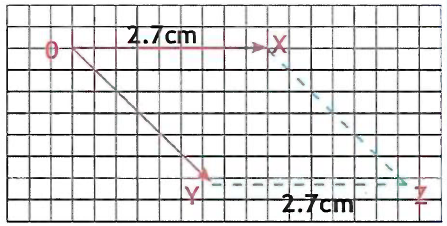
A horse drawn carriage is pulled by two horses with a force of 400N each. The horses are pulling in different directions and are not acting at an angle of 90°. OX and OY represent the force from each horse respectively, they represent the same magnitude of force so they will be the same length.



To calculate the resultant force in this situation we must use a **parallelogram of forces.**

First, measure the length of OX. In this example it is 2.7cm.

Draw a line 2.7cm long from Y, parallel to OX. Connect the end of this line to X to form a parallelogram.



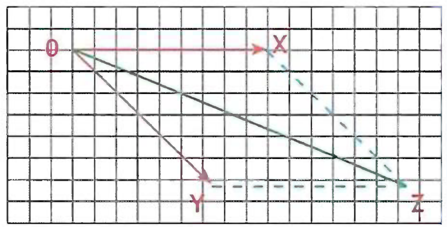
The line OZ is the diagonal of this parallelogram. OZ is the resultant force.

The length of OX is 2.7cm and the force is 400N.

We can work out how many newtons are represented by each cm by doing the calculation:

400 ÷ 2.7 = 148.15

1cm = 148.15N



Measure OZ. In this example it is 5cm. 5 × 148.15 = 740.74

The resultant force is 740.74N.

Newton's Laws of Motion

<u>Newton's first law</u>

If the resultant force acting on an object is zero...

- **a stationary object will remain stationary.**
- **a moving object will continue at a steady speed and in the same direction.**

Inertia - the tendency of an object to continue in a state of rest or uniform motion (same speed and direction).

<u>Newton's second law</u>

The acceleration of an object is proportional to the resultant force acting on it and inversely proportional to the mass of the object

force (N) = mass (kg) × acceleration (m/s²)

Inertial mass - how difficult it is to change an objects velocity. It is defined as the ratio of force over acceleration.

<u>Newton's third law</u>

When two objects interact, the forces acting on one another are always equal and opposite.

For example, when a book is laid on the table the table pushes up on the book. The book pushes down on the table. These two forces are equal and opposite.

Required Practical Investigation Activity 6: Investigate the Relationship Between Force and Extension for a Spring

$F = k \times e$

force applied (N) = spring constant (N/m) × extension (m)

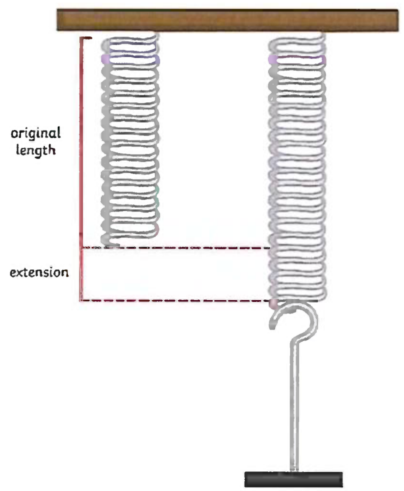
You should be familiar with the equation above and the required practical shown to the right.

The spring constant is a value which describes the elasticity of a material. It is specific to each material. You can carry out a practical investigation and use your results to find the spring constant of a material.

1. Set up the equipment as shown.
2. Measure the original length of the elastic object, e.g. a spring, and record this.
3. Attach a mass hanger (remember the hanger itself has a weight). Record the new length of the spring.
4. Continue to add masses to the hanger in regular intervals and record the length each time.

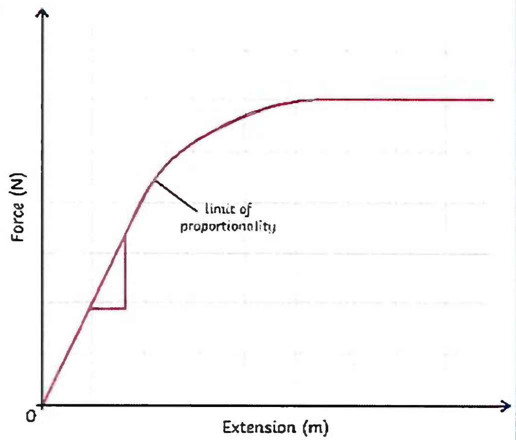
Once you have your results, you can find the extension for each mass using this formula: **spring length - original length**

The data collected is continuous so you would plot a **line graph** using the x-axis for extension (m) and the y-axis for force (N). As a result of Hooke's Law, you should have a **linear graph**. The **gradient of the graph is equal to the spring constant**. You can calculate it by rearranging the formula above or by calculating the gradient from your graph.



Spring Constant and Hooke's Law

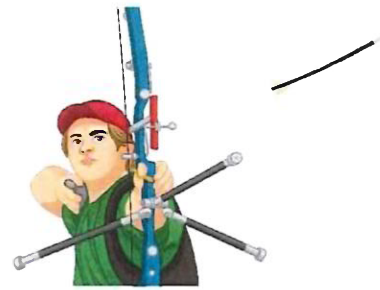
Hooke's Law describes that the extension of an elastic object is **proportional** to the force applied to the object. However, there is a maximum applied force for which the extension will still increase proportionally. If the **limit of proportionality** is exceeded, then the object becomes **permanently deformed** and can no longer return to its original shape. This can be identified on a graph of extension against force when the gradient stops being linear (a straight line) and begins to **plateau**. The limit is shown on the graph above and this is the specific object's **elastic limit.**



Forces and Elasticity

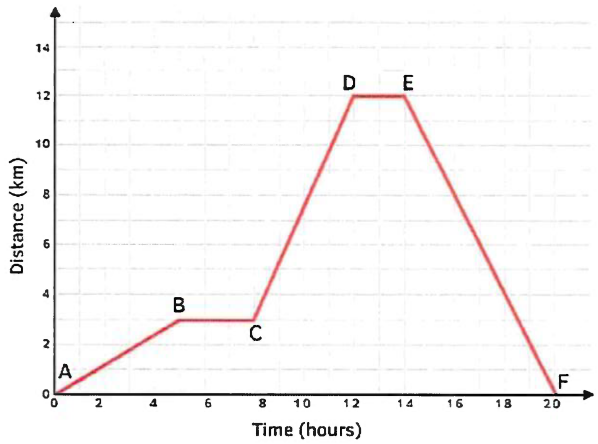
When work is done on an elastic object, such as a spring, the energy is stored as elastic potential energy.

When the force is applied, the object changes shape and stretches. The energy is stored as elastic potential and when the force is no longer applied, the object returns to its original shape. The stored elastic potential energy is transferred as kinetic energy and the object recoils and goes back to its original shape.



Distance-Time and Velocity-Time Graphs

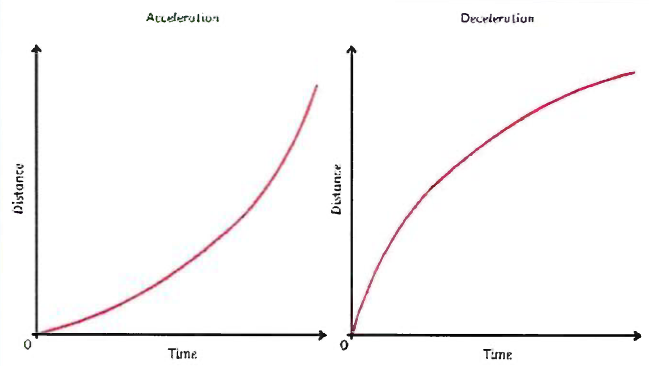
When an object travels in a **straight line**, we can show the distance which has been covered in a **distance-time graph**.



You should be able to understand what the features of the two types of graph can tell you about the motion of an object.

Graph Feature	Distance-Time Graph	Velocity-Time Graph
x-axis	time	time
y-axis	distance	velocity
gradient	speed	acceleration (or deceleration)
plateau	stationary (stopped)	constant speed
uphill straight line	steady speed moving away from start point	acceleration
downhill straight line	steady speed returning to the start point	deceleration
uphill curve	acceleration	increasing acceleration
downhill curve	deceleration	increasing deceleration
area below graph		distance travelled

Changing Speed on a D-T graph



When the graph is a **straight line**, it is representing a **constant speed.** A **curve** represents a changing speed, either **acceleration** or **deceleration**. The speed at any given point can be calculated by drawing a **tangent** from the curve and finding the **gradient** of the tangent.

Distance vs Displacement

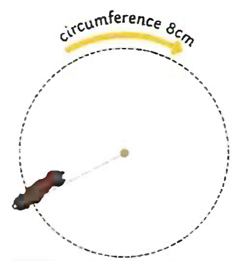
Distance is a scalar quantity. It measures how far something has moved and does not have any associated direction.

Displacement is a vector quantity. It measures how far something has moved and is measured in relation to the direction of a straight line between the starting and end points.

E.g. A dog is tethered to a post.
It runs around the post three times. Each lap is 8m

Distance = 8 × 3 = 24m

Displacement = 0m (The dog is in the same position as when it started.)



Acceleration

Acceleration can be calculated using the equation:

acceleration (m/s²) = change in velocity (m/s) / time taken (s)

A dog is sitting, waiting for a stick to be thrown. After the stick is thrown, the dog is running at a speed of 4m/s. It has taken the dog 16s to reach this velocity. Calculate the acceleration of the dog.

a = Δv ÷ t

a = (4-0) ÷ 16

A = 0.25m/s²

Speed

speed = distance ÷ time

You should be able to use this equation and rearrange it to find the distance or time.

Example: John runs 5km. It takes him 25 minutes. Find his average speed in metres per second.

1) Convert units. 5km x 1000= 5000m, 25mins x 60= 1500s

2) Speed = 5000m ÷ 1500s
Speed = 3.33m/s

Speed continued

You should be able to recall the typical speed of different transportation methods.

These values are average only. The speed of a moving object is rarely constant and always fluctuating.

Activity	Typical Value
walking	1.5m/s
running	3m/s
cycling	6m/s

Stopping and Braking Distance

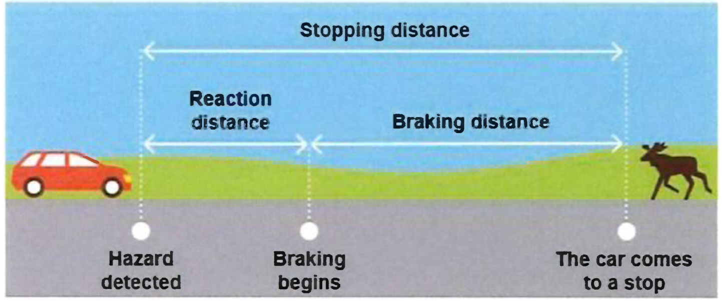
The **stopping distance** of a vehicle is calculated by: **stopping distance = thinking distance + braking distance**

Reaction time is the time taken for the driver to respond to a hazard. It varies from 0.2s to 0.9s between most people.

Reaction time is affected by:

- **tiredness**
- **drugs**
- **alcohol**
- **distractions**

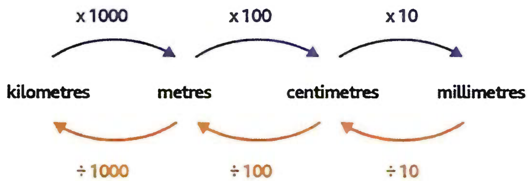
You can measure human reaction time in the lab using simple equipment: a metre ruler and stopwatch can be used to see how quickly a person reacts and catches the metre ruler.



Maths Skills

Converting Units

Scientists are fussy and we have to use the specific units in calculations. This means we have to convert units



Doing Physics equations

1) Convert the units
2) Find the correct equation on the equation sheet
3) Put the numbers into the equation
4) Rearrange the equation.

Example: Calculate the acceleration of a toy car with a mass of 500g and a force of 1N

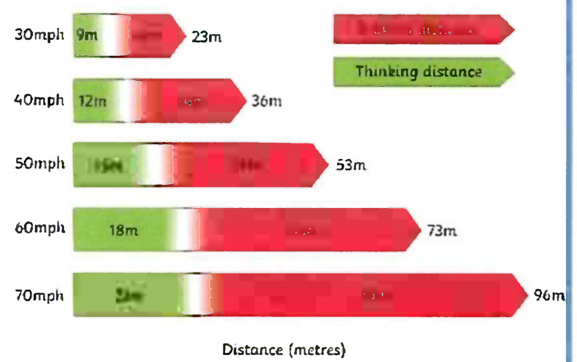
1) 500g ÷ 1000 = 0.5Kg

2) force (N) = mass (kg) × acceleration (m/s²)

3) 1N = 0.5Kg x ?

4) 1N ÷ 0.5 = 2 m/s²

The **braking distance** is the distance travelled by a vehicle once the **brakes are applied** and until it reaches a full stop.



Braking distance is affected by:

- **adverse weather conditions** (wet or icy)
- **poor vehicle condition** (brakes or tyres)

When **force** is applied to the brakes, **work is done** by the **friction** between the car wheels and the brakes.

The work done reduces the **kinetic energy** and it is transferred as **heat** energy, increasing the **temperature** of the brakes.

increased speed = increased force required to stop the vehicle

increased braking force = increased deceleration

Large decelerations can cause a huge increase in **temperature** and may lead to the **brakes overheating** and the driver **losing control** over the vehicle