TRANSPORT

LINKS TO NATIONAL CURRICULUM

Science

- recognise that environments can change and that this can sometimes pose dangers to living things. (Year 4)
- identifying scientific evidence that has been used to support or refute ideas or arguments. (Years 5 & 6)
- talk about how scientific ideas have developed over time (Years 5 & 6)

History

- study an aspect or theme in British history that extends pupils' chronological knowledge beyond 1066 (Key Stage 2)

KEY AREAS COVERED

1) What were the earliest types of transport?
2) Why do some forms of transport cause pollution?
3) Which types of transport produce the highest carbon emissions?
4) How might transport change in the future?

Notes to Teachers

- These teaching notes run alongside a Powerpoint presentation and all slides are referred to in the notes. The information can be adapted to suit different ages of students by adding/deleting slides on the presentation and varying the level of detail used from the teacher notes.
- Activities given are suggestions only. The main purpose of these resources is to provide key information and visual aids for teachers to adapt to their needs.

KEY WORDS (in alphabetical order)

Air resistance - the force (friction) that air exerts against a moving object

Carbon dioxide: a gas that is formed by burning fuels, by the breakdown or burning of animal and plant matter, and by the act of breathing, and that is absorbed from the air by plants in photosynthesis.

Combustion - the scientific term for burning

Exhaust gases - any gas emitted as a result of the combustion of fuels

Emissions - production or discharge of anything, especially gas or radiation

Freight - cargo or goods transported by vehicles

Friction - the resistance an object encounters when moving over or through another

Fossil fuels - a fuel (such as coal, oil, or natural gas) formed in the earth from plant or animal remains from millions of years ago.

Infrastructure - the facilities which support modern human life such as water supply, sewage plants, housing, and roads

Internal combustion engine - an engine inside which fuel is burned

Minerals: valuable or useful chemical compounds that are formed naturally in the ground.

Modal Share - the percentage of travellers using a particular type of transportation or number of trips using that type of transport

Radiative forcing - the influence a climatic factor has on the amount of sunlight absorbed by the earth and the energy radiated back to space.

Transport - a method of carrying people or goods from one place to another

1. What were the earliest types of transport?

SUGGESTED STARTER ACTIVITY

Slide 3: What do we mean by transport?
Give children a set time to come up with as many different forms of transport, past and present as they can. Do they think to include travelling on foot? When might people use each type of transport? Would we take a plane to school? Why do the children think different forms of transport were invented?

[Map featured is the Cantino planisphere (1502) - the earliest surviving map to feature Portuguese geographic discoveries in the East and West, including the African Coast of the Atlantic and Indian Oceans]

TEACHING INPUT

Slide 4: Transport means to carry something from one place to another.

The earliest transport would have been people travelling on foot, carrying their belongings. Before roads, early humans would have had to travel over many different types of terrain, hunting for food. Foot protection helped people to cross ground that was covered with stones or roots and protected their feet from the cold. The earliest known pair of shoes, found in the Fort Rock Cave in the US state of Oregon, were made from bark and date from approximately 7000 or 8000 BC. People probably covered their feet even before that, but the materials have not survived.

This is a picture of the world's oldest leather shoe, which was found in Armenia and is believed to date to 3500 BC. It is made from a single piece of cowhide laced with a leather cord along seams at the front and back.

Slide 5: The very earliest paths would have been made by animals seeking food and later, by early humans following the animals to hunt them. Earth tracks were created by humans carrying goods from place to place. People often followed the same routes, so that, over time, flattened trails widened out into clear tracks. Some ancient trackways in the UK still exist. The Harrow way, or Harroway means the 'Old Way'. It ran from Seaton in Devon to Dover, Kent and probably dates back to Stone Age times.

Slide 6: As animals such as horses, oxen or donkeys were domesticated they would have helped to flatten and widen the tracks.

Animals were our first form of ridden transport and would have been used to carry goods and people from place to place. The travois, a frame used to drag loads, was probably the first type of vehicle to be developed. Later, sleds were built by people living in icy places.

Slide 7: At first, the wheels people invented were solid discs and would have been very heavy. They were then made lighter by using spokes. The very earliest wheeled vehicles may have been ox carts, used to move wood for building or produce from agriculture. People might have walked next to the carts, or they may have ridden at the front, with ropes to help steer the animals. Ox carts are still used in rural areas in many parts of the world.

Slide 8: Wheeled vehicles designed to be pulled by animals, were probably developed in the Ancient Near East, (roughly the place that we now call the Middle East) in the 4th or 5th millennium BC and spread to Europe and India in the 4th millennium BC and China in about 1200 BC.

According to Greek mythology, the chariot was invented by Erichthonius of Athens to conceal his feet, which were those of a dragon!

Two wheeled chariots, pulled by horses and carrying one or two passengers, were speedy. They were used for bringing new warriors into battle quickly when others became tired and for delivering messages. They were also used as fast-moving mobile platforms in battle.

Slide 9: Later inventions made carriages lighter to pull, so that they could travel more quickly. Suspension made them more comfortable to ride in (although they would still have been very bumpy compared with modern vehicles!) Horse-drawn carriages were used as private vehicles, taxis and even like 'buses' for lots of people in big cities. This form of transport was the quickest way of moving larger numbers of people over land from ancient times right up until the late 1800s.

Slide 10: Bicycles had also been invented by the 1800s although their designs were very different from the bikes we see today! This model is called a 'Penny Farthing,' named after the penny and the farthing coins which differed in size in a similar way to the wheels on the bicycle.

Slide 11: People have also travelled across water since prehistoric times. The earliest journeys across water must have been made even before Homo

Sapiens appeared on Earth and our ancestors have left evidence of such travel dating back hundreds of thousands of years.

Rock carvings dating back over 12000 years have been found in Azerbaijan and show a reed boat with people paddling it along.
The oldest boat discovered is called the Pesse canoe and was hollowed out of a tree trunk sometime between 8200 BC and 7600 BC. The boat was found in the Netherlands and can be seen there in a museum. Older boats have not been preserved.

Slide 12: The use of sails allowed boats to be propelled through the water using the power of the wind. Around 3000 BC, the use of metal tools allowed trees to be cut into planks, which transformed boat building. Early records of a ship with sails, like this one, appear on Egyptian vases from about 3500 BC. An even earlier painted disc showing a sailing ship was found in Kuwait and dated back to 5000 BC!

Slide 13: By 1000 BC, Austronesians in Island Southeast Asia were already using sailing boats to trade with China, South Asia, and the Middle East. There is evidence that magnetic compasses were used for navigation in China in 1088. The Arab Empire developed sophisticated ships and navigation tools which were later copied by European explorers in their own travels. By the 15th century, huge tall ships were also in use in Europe and people set out from there to discover parts of the world previously unknown to them.

Slide 14: The first 'heavier than air' craft that were designed to be lifted on the air were kites. The oldest picture of a kite is from a cave painting on Muna island in Indonesia and dates back to around 9000 BC. Kites have been flown in China since around the 5th Century BC.

People were fascinated with the science of flight. Tito Livio Burattini was an inventor who built a 'flying dragon' with four wings in 1647. In 1648, it was claimed that the invention was able to carry a cat, though wasn't able to lift Burattini himself.

Slide 15: Hot air balloons were developed from sky lanterns and use heat from a flame (usually from burning propane gas for modern balloons) to fill a large bag. The French brothers Joseph-Michel and Jacques-Étienne Montgolfier developed a hot air balloon and demonstrated it publicly on September 19, 1783, making an unmanned flight lasting 10 minutes. Balloons were used for observations during war time. The first untethered flight which carried people was in 1783, using another balloon designed by

the Mongolfier brothers.

People went on to develop steerable balloons called airships, but these often caught fire and exploded because they were filled with the flammable gas, hydrogen, which is lighter than air.

Slide 16: By studying the ways that birds wings worked, humans continued to learn about ideas such as 'uplift'. People tried to design machines that could carry humans in the air. Many died or were seriously injured as they jumped from towers with home-made wings strapped to their arms.

The picture on the left shows Jean Marie Le Bris trying out his flying machine "Albatros II" in 1868. By having his machine pulled by a horse on a beach, he was able to glide for a while at a height higher than his starting point.

On the right is an early glider made by the Wright Brothers, whose scientific experiments with gliders helped them to develop some of the earliest planes that could be controlled once they were in the air.

Slide 17: Until this time, vehicles were powered by humans, animals or by the wind. Hot air balloons started to use heat to lift into the air, but no one had worked out any other way to power their vehicles from inside. An invention was about to change the way that transport worked forever. What do modern day vehicles have to power them?

SUGGESTED ACTIVITIES

Transport sorting

Give out pictures of different types of transport, or ask children to make their own. Ask them to work in pairs or small groups to sort the different types of transport into sets. What types of groupings do they choose? Discuss ideas, reasons and any misconceptions.

Travel survey

How many different types of transport have children in the class ever used? Carry out a survey across the school and make charts and graphs of the results. What is the most unusual type of transport anyone has ever used?

Paper aeroplane gliding experiment.

Use the creation of paper planes not only to explore ideas of uplift, but as a chance to plan and carry out fair tests. In finding out which plane can glide for the furthest distance, pupils can explore the idea of variables and can decide which to change and which to keep the same on their plane design. They may vary the size of the paper that they use, the type of paper or the weight of the nose, via the addition of paper clips. Use the planning sheet (below) to record plans for the test.

My paper plane experiment plan

I decided to test:

_____

_____

_____

What variables could I change?

The variable I decided to change was:

The variables I will keep the same are:

My prediction is that:

My plane design:

2. Why do some forms of transport cause pollution?

SUGGESTED STARTER ACTIVITY

Slide 18: Explore what the children understand by the terms 'pollution' and 'emissions'. Can they explain why vehicles can be bad for the environment?
Explore the ways that vehicles are powered in modern times. Where does the energy come from to power them, in simple terms? Can the children understand the idea of fuel being put into an engine to power the vehicle?

TEACHING INPUT

Slide 19: Fossil fuels are the remains of plants and animals that have been buried deep in the ground for hundreds of millions of years. Over that time, pressure and heat have turned them into coal, oil and gas. The energy stored inside them can be released when they are burned, but this releases gases into the atmosphere. When powered engines were invented, they needed fuel to make them work.

Slide 20: Combustion is the scientific name for burning. In a combustion reaction, a substance reacts with oxygen from the air. Combustion reactions happen at high temperatures, and transfer energy to the surroundings as light and heat. The energy that the reaction produces can be used to heat water, cook food, generate electricity or even power vehicles. Combustion produces new compounds (a substance formed

when two or more chemical elements are chemically bonded together) called oxides.

Slide 21: When fossil fuels are burned, an oxide called carbon dioxide (CO2) is released into the atmosphere as a waste product. CO2 is a 'greenhouse gas', acting as an invisible blanket, trapping heat from the sun and warming the Earth in a process known as the greenhouse effect . The more fossil fuels that are burned, the more the amount of CO2 in the atmosphere increases and the thicker the blanket becomes, trapping more heat. This is causing global warming and speeding up climate change.

A more detailed explanation of the greenhouse effect can be found on YPTE's video which can be downloaded using this link: **http://ypte.org.uk/videos/the-greenhouse-effect**

Slide 22: During the Industrial Revolution of the 1800s, the invention of the steam engine changed the way that transport worked. Steam engines used coal to heat water and produce steam, which at high pressure was used to power paddles and later propellers. These steamships didn't need the wind to be blowing in a certain direction, in fact, they didn't need the wind to be blowing at all. This meant that new trade routes could be opened up and people were able to trade goods around the world more easily than ever before in human history. However, the gases produced by the burning coal caused illness and the engines often exploded under the pressure of the steam. Many people died in steamboat disasters.

Slide 23: The first steam train was developed over 200 years ago and changed the way that goods and people were transported. There had been train tracks before that time, but the carts were pulled by animals which got tired and needed to be rested regularly. Steam trains also used coal fires to heat water. The steam produced drove pistons to move the train. In 1825, the first public passenger and freight railway in the world, the Stockton and Darlington Railway, opened.

Not only could materials to build factories and machines be moved around the country more quickly, but so could newspapers and post, leading to the first high speed mass communication. People could now travel greater distances in faster times. Transport would never be the same!

Slide 24: Although engineers did experiment with steam powered cars, the invention that was more successful was the internal combustion

engine. In 1885, the Benz Patent Motorwagen was designed and built by Karl Benz in Germany. It was the first vehicle designed for large scale production that featured a combustion engine. These engines ran on a liquid petroleum called ligroin.

The first long journey ever made in a motor car was by Bertha Benz, Karl's wife, who drove it on a round trip of 121 miles in August 1888.

Slide 25: Modern internal combustion engines look very different from the early model. For a very comprehensive explanation of how the combustion engine works, see **https://www.youtube.com/watch?v=vIJ50aUiBgM**

Slide 26: Unlike steamboats and trains which had large coal fires on board, the combustion that happens in an internal combustion engine happens in very small chambers inside the engine itself. Mixed with air, it is ignited by a spark. The exhaust gases that are produced (including carbon dioxide, carbon monoxide and sulphur dioxide) come out of the exhaust pipe and enter the atmosphere.

Slide 27: In Britain alone, there were 32 million cars, 4.1 million Light Goods Vehicles, 0.5 million Heavy Goods Vehicles, 1.3 million motorcycles, 0.15 million buses & coaches, and 0.77 million other vehicles licensed at the end of September 2019. The UK government has pledged to reduce carbon emissions from road transport, aiming for nearly all cars on the road by 2050 to be zero-emission. This would mean ending sales of non zero-emission cars by 2035. At the end of 2018, only around 0.2 million of the 39 million cars on the road met these targets.

Slide 28: All vehicles which use any kind of fossil fuel will create emissions, but they don't all create the same amounts. Although diesel trains do exist, their engines are different from those of cars. The diesel engine powers a shaft which drives a generator to make electricity. This electricity then powers traction motors at the train's wheels. Many modern trains now run on electricity which is delivered directly to the wheels through an electrified line on the tracks.

Slide 29: Engines on some of the world's biggest ships can be as tall as a four-storey house, and as wide as three London buses. That means a lot of fuel is required, which in turn creates a large amount of CO2. Added to this problem, many ships still burn what is called 'bunker fuel'. This is made

from the leftovers at the end of the oil refining process and is particularly heavy and toxic, containing more sulphur than other fuels.

Slide 30: The aviation industry is responsible for around 2% of all human-caused CO2 emissions globally and this amount is expected to keep rising as numbers of flights increase, even when the maximum use of lower carbon fuel is factored in.

Other emissions from planes, such as nitrogen oxides and even water vapour can affect **radiative forcing,** by altering the balance of heat energy in the atmosphere.

When aeroplanes emit water vapour under certain conditions, it can increase the number of cirrus clouds and this, too, can increase warming of the planet.

Slide 31: Which forms of transport do you think have the highest emissions? Ask pupils to discuss their ideas and give reasons for their choices.

SUGGESTED ACTIVITIES

Timeline of transport

Children work individually or in groups to draw and research a particular type of transport. Make a class timeline and add the types of transport to the line, showing when they were in use.

Research an inventor

Children could choose an inventor from the early or modern days of the transport industry and explore the ways that their inventions have impacted on the world as we know it today.

3. Which types of transport produce the highest carbon emissions?

SUGGESTED STARTER ACTIVITY

Slide 32: Using the transport cards provided (below) ask children to arrange the types of vehicles in order of the carbon they think each emits. Record the results then see whether the children's predictions match those in the lesson.

Teaching note:

The following slides use the calculations made for the European Environment Agency report (EEA) using a 2013 database. The figures are estimates and are currently being updated in light of new fuel types, more efficient engines and other relevant information. Calculations are very difficult to judge accurately as there are so many factors that must be taken into consideration.

To calculate the figures below, the EEA first considered each vehicle's fuel consumption per km. This number was then multiplied by a specific emission factor (which depends on the fuel used).

The emissions of the manufacturing process are estimated as well as those for scrapping the vehicle at the end of its life. Afterwards, the results were divided by the number of passengers and the number of kilometers travelled to give a number measured in *grams (g) of Carbon Dioxide (CO2) per passenger per kilometer travelled (km).*

CO2 Emissions from passenger transport (2013):

- 14 g of CO2 / passenger/km for the train
- 42 g CO2 / passenger/km for a small car
- 55 g of CO2 / passenger/km for an average car
- 68 g CO2 /passenger/km for a bus
- 72 g CO2 /passenger/km for a two-wheel motor
- 285 g CO2 /passenger/km for a plane

TEACHING INPUT

Slide 33: All vehicles create emissions via their production. Factories use electricity, which is often produced by burning fossil fuels. The mining and creation of their materials (such as metals) creates more.

Slides 34- 35: It's easy to think that riding a bicycle produces no carbon emissions at all as they have no fuel tank and no exhaust pipe! However, they do still create emissions when they are made. The production of a bicycle accounts for around 5g of CO2 per kilometer travelled. Next we need to take into account their fuel - the food that the person cycling eats! The CO2 emissions from the average European diet would account for about another 16g of CO2 per kilometer. As meat production has higher carbon emissions than most vegetable production, vegetarian cyclists create less CO2 than other cyclists!

Slides 36 - 37: It can be very tricky to calculate emissions from cars as there are so many different engines. Cars emit different amounts of carbon based on the speeds they are driving and the type of fuel they run on. Furthermore, these calculations are based on the cars having four people travelling in them, which is often not the case. If a small car has only the driver travelling, then the carbon emitted rises to 168g per kilometre. An average sized car with only the driver travelling could be emitting closer to 220g a kilometre, which is close to the EEA calculations for a plane. Reducing the short journeys that we make by car when we could walk, would have a huge impact on the environment.

Slides 38 - 39: Once again, the emissions from a bus are calculated based on an average number of passengers, in this case, around 13 at a time. If lots of people took the bus, the amount of carbon per passenger would reduce. As buses can carry more people in a smaller space than it would take to drive them all by car, they can also help to reduce the number of people on the road causing traffic jams. This also helps reduce the emissions being released into the air as all the vehicles sit still on the road, stuck in the traffic.

Slides 40 - 41: The calculations for CO2 emissions from trains was calculated based on 156 passengers all travelling at once. Trains can be much more environmentally friendly ways to travel over longer distances than planes or cars. A good example of this is the difference in CO2 emissions produced when travelling from London to Paris by plane versus travelling on the Eurostar train. A return trip produces 244 kg per person on the plane and only 22kg per person on the Eurostar - around 90% less!

Slides 42 - 43: Although improvements to jet fuel have started to reduce the CO2 emissions of planes, they are still high. Worldwide, flights produced 915 million tonnes of CO2 in 2019. The calculation here, of 285g of CO2 per passenger, per kilometer, was based on fuels used in 2013 and is assuming 88 passengers on a plane. Again, this is a very rough estimate as there are many types of planes. As we have seen, there are also other emissions from planes that may cause even more harm than CO2.

Slide 44 - 45: While cruise ships weren't included in the EEA calculations as they are the responsibility of the International Maritime Organisation, using the same calculation as for other vehicles suggests that luxury liners produce around 400g of CO2 per passenger, per kilometer. According to an independent environmental research organisation, international shipping (Including cruise and freight shipping) produced 812 million tonnes of carbon dioxide in 2015. This is more carbon than the whole of Germany produced in the same year. In fact if shipping were a country, it would be the 6th most polluting country in the whole world.

Huge cruise ships also use large amounts of electricity on board during their voyages and produce huge amounts of waste. On a typical one-week long voyage a cruise ship also generates more than 50 tonnes of rubbish, a million tonnes of grey (waste) water, 210,000 gallons of sewage and 35,000 gallons of oil-contaminated water. Some of this is pumped directly into the ocean.

Ships also produce large quantities of other dangerous gases. In 2017, the 47 cruise ships owned by one luxury cruise company emitted more sulphur oxide than every single car in Europe (260 million vehicles) did in the same year.

Slide 46: Look back at pupils' predictions about the vehicles with the highest carbon emissions. Were they accurate? Were the children surprised by any of the figures? Can the children think of any ways that carbon emissions could be cut?

SUGGESTED ACTIVITIES

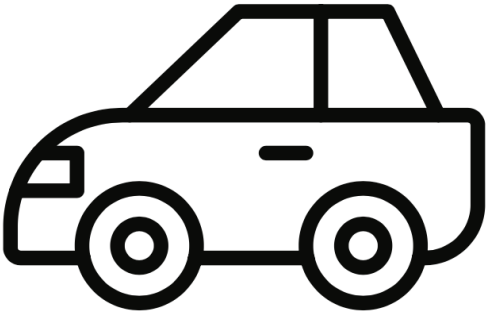
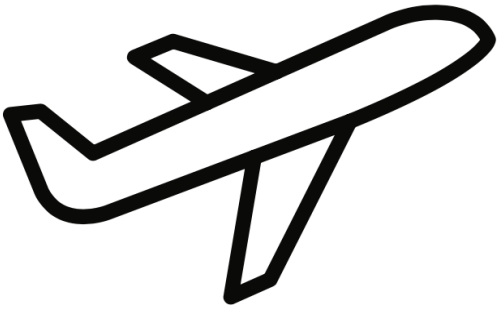
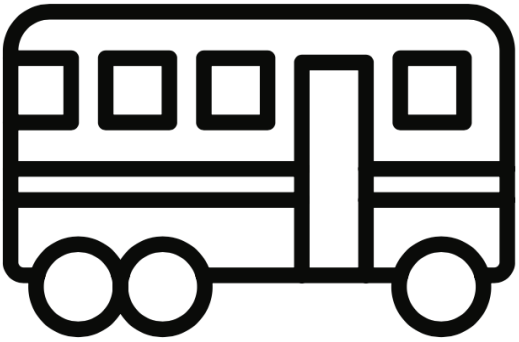
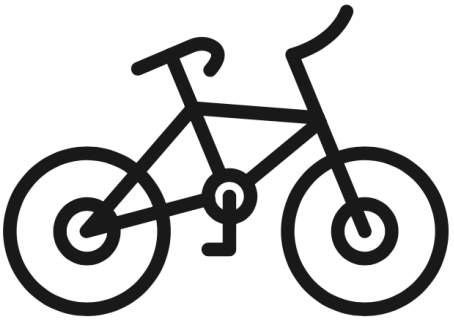
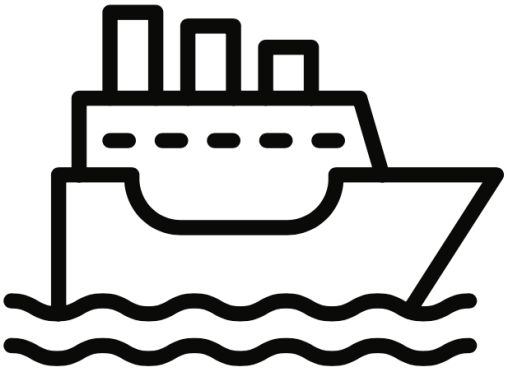
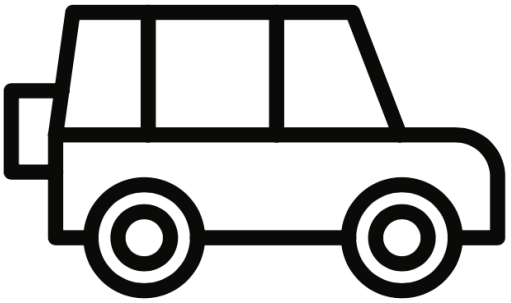
Class carbon count

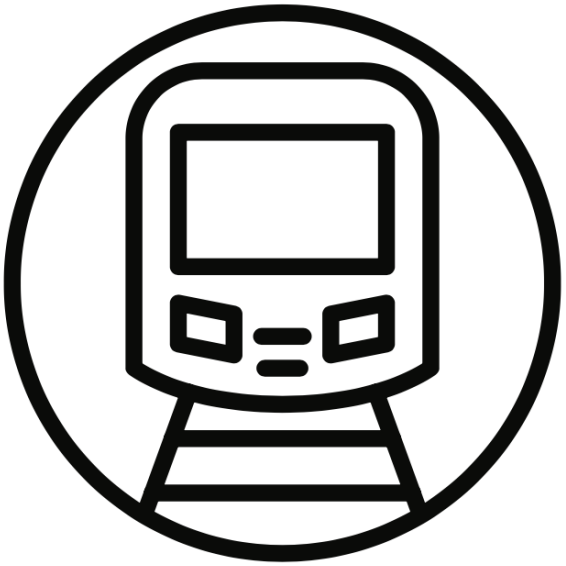
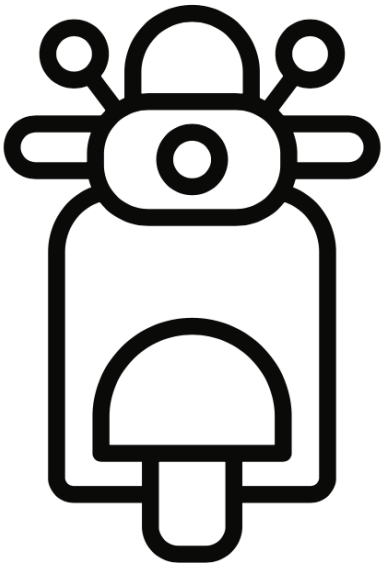
Using the figures suggested by the EEA as a guide, calculate an estimate of the class's carbon footprint based on their transport use over a set period. Who travels to school by car and is the car full? Who cycles? If you include a holiday period, you may also be able to consider flights and train rides that have been made. Conducted annually in the same time period, the count could become a useful school database for future work.

Carbon data display

Use the carbon emissions data provided to produce charts and graphs for a class display showing which types of transport are the biggest polluters.

Transport cards

 small car	 aeroplane
 bus	 bicycle
 cruise ship	 average sized car

 train	 motor bike

4. How might transport change in the future?

Slide 47: If we are to avoid global warming leading to a climate disaster, we will have to reconsider many aspects of the transport that we use nowadays. Scientists and engineers are working hard to come up with all kinds of inventions to help improve the situation.

Maybe we will need to think of alternative sources of power!

Provide 'tinker trays' or 'tinker tables' for children to explore some scientific materials to help them understand some of the concepts covered in the next lesson. Provide materials to set up simple battery powered circuits and a selection of magnets, supporting children to explore the way that poles attract and repel.

TEACHING INPUT

Slide 48: The electric car might seem like a modern invention, but the first electric vehicle that drove reliably on the streets was this one designed by Gustave Trouve in 1881! In 1884, a British Inventor, Thomas Parker (who also electrified the London Underground) built the first production electric car. In 1897 a fleet of electric taxis was in use in London. Electric cars were far more expensive than those with combustion engines, however and the infrastructure was not available so that lots of people could use them. When plentiful sources of crude oil were discovered to make petrols, most people lost interest in them.

As people became concerned with the fact that oil reserves would one day run out, interest in electric vehicles grew again. The EV1 (Electric vehicle 1) by General Motors was the first mass produced modern electric car.

Slide 49: Elon Musk's Tesla Motors is now known for producing electric vehicles such as the 2008 Roadster (which is also the car that was sent into space in February 2018). Many people believe they are the future of road transport. The UK government has even pledged to ban sales of all new petrol and diesel cars from 2035 in favour of zero emission cars such as electric ones.

Slide 50: Even if it is possible to create enough electric cars to meet demand by 2035, there are concerns as to whether it will be possible to provide all the necessary charging points across the UK by that time. Added to that is the fact that the electricity used to charge the cars is only as 'green' as the method used to generate it. At the moment, almost half of the UK's electricity is still generated by fossil fuels. (This is great progress however as 2019 was the first year where more than half of the UK's electricity came from renewable sources).

Slide 51: As demand for electric cars grows, one major problem is getting hold of enough of the **minerals** used to produce their batteries. Global production of electric vehicles is expected to top four million cars in 2020, rising to 12 million in 2025. In Europe alone, 540,000 electric cars will be sold this year, an increase from 319,000 last year. This will see the demand for lithium increase more than three times by 2025 and the increase in cobalt, another precious mineral used for batteries, increase by 60%.

Although it's hard to predict exactly how much lithium we have left, in 2015, it was estimated that the planet had enough lithium reserves to maintain global production for 365 years. However, with the new demand for electric cars driven by government plans to ban sales of other types of vehicle, that 365 year supply would be used up within 18 years of the whole world shifting to electric cars (based on 80 million car sales per year).

Cobalt has the additional problem of coming predominantly from the Democratic Republic of Congo, a country where child labour is rife and demand for valuable minerals is driving violent conflict. Further to that, there is likely to be insufficient capacity to mine the amount of cobalt that these batteries will require. Jaguar Landrover had to pause production of its electric I-Pace in February 2020 as their battery supplier was simply not able to manufacture enough batteries for them to use in the cars. Other alternatives may well be needed.

Slide 52: In 2013 the Hyundai Tucson FCEV was the first commercially mass-produced hydrogen fuel cell vehicle in the world. London is exploring the use of hydrogen fuel cell powered buses, and is planning to have several on the road in 2020.
Hydrogen fuel cells react hydrogen with oxygen and use the resulting energy to create electricity to power the car. This reaction only produces water as a byproduct. Unfortunately, though it is possible to make

hydrogen from renewable sources, at present most of it is made from methane, another greenhouse gas. It's currently hard to predict whether future developments in technology will enable hydrogen cells to be used in ways that have a positive impact on the environment.

Slide 53: When passenger steam trains were invented, people were concerned that travelling so 'quickly' could be very dangerous. Some believed that travelling at 50mph would make humans melt!
The maglev train can travel at 268 miles per hour (431 kilometres per hour) but this is nothing compared to the new versions of the train which are being tested. Some of those have been able to travel at 374 mph in tests and much faster speeds are possible.

Maglev trains (short for magnetic levitation) use two sets of magnets, one set to repel and push the train up off the track, and another set to move the elevated train forwards. Because the train isn't touching the ground, the lack of **friction** allows for higher speed and the train only has to contend with **air resistance**.

Slide 54: While the Maglev exists already, the Hyperloop is just an idea at the moment. Another of Elon Musk's ideas, the Hyperloop concept is being worked on by various different groups as they try to make it a reality. The idea is that a pod, carrying passengers or goods, travels like a maglev through an airless network of sealed tubes to do away with air resistance altogether. In theory, these pods could travel at thousands of miles per hour.

Slide 55: The future of transport may not be about creating new types of vehicle, but encouraging people to use the low emission vehicles that we already have - bicycles. In the Netherlands people use their bicycles for a far higher percentage of journeys than people do in the UK. The **modal share** of cycling in the Netherlands is 27% (in some cities, such as Zwolle, it's much higher at 46%) compared with only 2% in the UK.
In order to encourage people to cycle more, especially in city centres, where concerns about air quality are greater, there have been lots of adaptations to cycling **infrastructure**.

Slide 56: There are special bicycle only roads that join up some cities so that people can travel more safely. In many Dutch towns and cities, cycle only paths run through the middle of town and all motor vehicles have to take a longer route round a ring road on the outskirts of the town.

Slide 57: In order to help avoid collisions with traffic, this roundabout, called the Hovenring between Eindhoven, Veldhoven and Meerhoven in The Netherlands is only for bicycles. Opened in June 2012, It is the first suspended bicycle roundabout in the world.

Slide 58: As well as changing roads and building cycle paths, other ways to encourage more people to use bikes can be as simple as offering them for hire in city centres and providing plenty of safe places to lock them up.

Slide 59: However, when it comes to travelling quickly to places far across the globe, there may not be many options except taking a plane. With no real solutions to the problems of emissions from planes (or from cruise liners), is it time for people to stop taking so many trips abroad for their work or holidays? With transport producing 14% of global emissions and rising with more and more people travelling further and more often than ever, a change in people's lifestyle choices might be vital if we are to avoid further climate disaster.

Slide 60: Do you think people would be willing to change the way they travel to help the environment? What sorts of changes do you think would be easy to make and which ones would be more difficult? How about the way that our food and the goods in our shops are transported? Do you think people would be willing to go without some of these things?

SUGGESTED ACTIVITIES

Design a vehicle of the future

In ancient times, people would have been mystified by the idea of a vehicle powered by an engine. Even 200 years ago, today's vehicles would have seemed magical. Imagine explaining to the inventor of the hot air balloon that one day humans would use rockets to travel into space!

Maybe the vehicles that we will use in the future are ones we can't yet imagine. Draw designs for a futuristic vehicle explaining how it is able to work in ways which do not harm the environment.

Town planning

How would your local town or local area need to change in order to encourage more people to use their cars less often? Pupils could carry out

surveys of car users and could make maps and plans of current cycle paths and pedestrianised areas. Where might new cycle tracks be planned?

Transport of goods

Using the labelling on food packaging, or by looking at the country of manufacture on clothes labels or the box of a new product, investigate how far items that the children own have travelled to reach them. What types of vehicles do you think were used to carry the items? Would people manage if they could no longer have these things? What might they eat or use instead?

Make a maglev train

Explore the properties of magnets in context by building a simple example of a maglev train. Make a track from a length of balsa wood or cardboard, with walls to keep the 'train' steady. Glue a series of small magnets down the centre of the track, making sure that the poles are all facing the same way. Attach two further magnets to a block of balsa wood cut to fit between the walls of the track, ensuring that the magnets will repel those on the track. If the magnets on the track have north facing upwards, then those on the 'train' must have north facing downwards. Once the glue has dried overnight, the train should hover over the track, between the walls. A gentle push should send it moving along.

We value your feedback!

Let us know what you thought of this lesson plan by completing this Google Form https://forms.gle/cGAwi9AWXfSZgrYa9. **Thank you!**