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presents...

# VEHICLES

## CLASSROOM WORK SCHEME

| TOPICS: | PAGE: |
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# NATIONAL CURRICULUM IN WALES:

**Science – Keystage 2**

**How things work:**

Pupils should use and develop their skills, knowledge and understanding by investigating the science behind everyday items, *e.g. toys, musical instruments and electrical devices*, the way they are constructed and work.

Pupils should be given opportunities to study:

1.) Forces of different kinds, *e.g. gravity magnetic and friction, including air resistance*.

2.) The ways in which forces can affect movement and how forces can be compared.

**Science skills: Communication**

Pupils should be given opportunities to:

1.) Search for, access and select relevant scientific information, from a range of sources, including ICT.

2.) Communicate clearly by speech, writing, drawings, diagrams, charts, tables, bar charts, line graphs, videos, & ICT packages, using relevant scientific vocabulary.

3.) Use standard measures and S.I. units, *e.g. kg, s, N, m.*

**Enquiry:**

Pupils should be given opportunities to carry out different types of enquiry, *e.g. pattern-seeking, exploring, classifying and identifying, making things, fair testing*, using and applying models, by:

# NATIONAL CURRICULUM IN WALES:

**Enquiry – Planning:**

Pupils turn ideas suggested to them, and their own ideas, into a form that can be investigated. They outline the planned approach/method recognising, deciding upon and giving some justification for each of the following when appropriate:

1.) The choice of success criteria.

2.) Predictions using some previous knowledge and understanding where and how to find relevant information and ideas.

3.) When carrying out a fair test, the key variables that need to be controlled and how to change the independent variable whilst keeping other key variables the same.

4.) The observations or measurements that need to be made.

5.) The equipment and techniques required for the enquiry.

6.) Any hazards and risks to themselves and others.

**Enquiry – Developing:**

Pupils follow the planned approach/method, revise it where necessary, and where appropriate:

1.) Use apparatus and equipment correctly and safely.

2.) Make careful observations and accurate measurements, using digital and ICT equipment at times

3.) Check observations and measurements by repeating them in order to collect reliable data.

4.) Make comparisons and identify and describe trends or patterns in data and information.

5.) Use some prior knowledge to explain links between cause and effect when concluding.

| YEAR GROUP: | NATIONAL CURRICULUM IN ENGLAND – PUPILS SHOULD BE TAUGHT TO: |
|---|---|
| **Year 3:** Forces & Magnets: | Compare how things move on different surfaces. |
| | Notice that some forces need contact between two objects, but magnetic forces can act at a distance. |
| | Observe how magnets attract or repel each other and attract some materials and not others. |
| | Compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials. |
| **Years 3 & 4:** Science Skills: | Asking relevant questions and using different types of scientific enquiries to answer them. |
| | Setting up simple practical enquiries, comparative and fair tests. |
| | Making systematic and careful observations and, where appropriate, taking accurate measurements using standard units, using a range of equipment. |
| | Gathering, recording, classifying and presenting data in a variety of ways to help in answering questions. |
| | Recording findings using simple scientific language, drawings, labelled diagrams, keys, bar charts, and tables. |
| | Reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions. |
| | Using results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions. |
| | Identifying differences, similarities or changes related to simple scientific ideas and processes. |
| | Using straightforward scientific evidence to answer questions or to support their findings. |
| **Year 5:** Forces: | Explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object. |
| | Identify the effects of air resistance, water resistance and friction, that act between moving surfaces. |

# SECTION ONE:

## MOVING VEHICLES – FORCES AND ROCKETS

### Science Note

☆ Forces can make an object **speed up, slow down, change direction or change shape**. They can also make an object start to move or stop or continue to travel at a constant speed.

☆ We encounter forces in everyday life in the form of pushes and pulls.

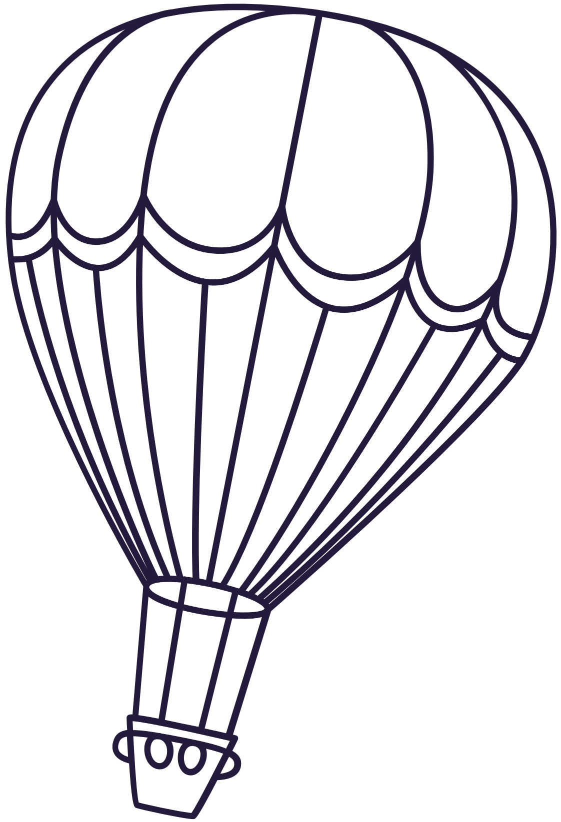
☆ Pulling forces, like the force of gravity, can make an object start to move and, if they keep pulling enough, the object will speed up. Starting to move and speeding up are both examples of **acceleration.**

☆ Pushing forces, like those created by a rocket thruster, can also make an object start to move and, if they keep pushing enough, the object will **speed up**.

☆ If the object is already moving in one direction, and it is pushed or pulled with a large enough force in the **opposite direction**, it will slow down (decelerate). For example, a rocket with thrusters pushing it **towards** the moon would have to reverse the direction of thrust in order to slow down. If they keep blasting in this opposite direction, the rocket will eventually slow to a stop and then begin to move (accelerate) away from the moon.

☆ If you apply a force (push or pull) to something squishy (like dough), **it will change shape.**

☆ A force can also work sideways in the form of a **twist.**



# SIR ISSAC NEWTON

Sir Issac Newton developed his ideas on forces into three main ideas. They can be summed up as:

## Newton's First Law:

A stationary object will remain still unless a force acts upon it. A moving object will continue moving unless a force acts upon it.

In daily life, we often see examples of a stationary object starting to move when pushed *e.g. the force of a kick on a football makes it move.*

The forces which slow you down are less obvious e.g. the force from the air pushing back against that moving football and the force of friction between the surface of the ground and the football.

## Newton's Second Law:

Newton's Second Law is all about calculating the size of the forces. (We won't need that.)

## Newton's Third Law:

For every action, there is an equal and opposite reaction. If we exert a force on an object, that object will exert the same sized force back on us.

The best way to picture this is to imagine sitting in a wheelie chair with your feet off the floor. In front of you, sits your partner, in another wheelie chair with their feet off the floor. You are facing each other and close enough to touch palms. If you push against your partner's hands (who is resisting you), who will move?

**The answer is… both of you.** You will move apart from each other. You exerted a force on your partner, so they moved backwards. But this made your partner exert an equal force in the opposite direction, so you move backwards too.

# LINKING THE SCIENCE TO THE STORY

Captain Houston and Lieutenant Schmidt make up the crew of a spacecraft. It is heading to the Planet Zorg on a mission. During the take-off, there is a malfunction and the craft heads off on the wrong way around the Earth at 'warp speed'. **This results in it going back in time.**

There are lots of questions to ask here to see what children know. It is important to find the science and the fiction in the story.

**Ask:**

☆ **Do you think time-travel exists?**

☆ **Which way is the wrong way around the Earth?**

A:

☆ **Can you time-travel by flying the wrong way around the Earth?**

☆ **Have you flown to Europe? America? They are different directions. Did anyone go back in time? Watch out for misunderstandings about time zones.**

A:

☆ **If you fly all the way around the world (towards the West), would you land before you took off?**

A:

**Establish that you can't time-travel this way but there is some real science in the story that we can study.** Rockets for example really do use lots of forces which we can investigate.

**Ask:**

☆ **Can you name a force?**

A: Suggest push if they need one to get started.

☆ **I can make the door close by pushing it. What else could I do with a push?**

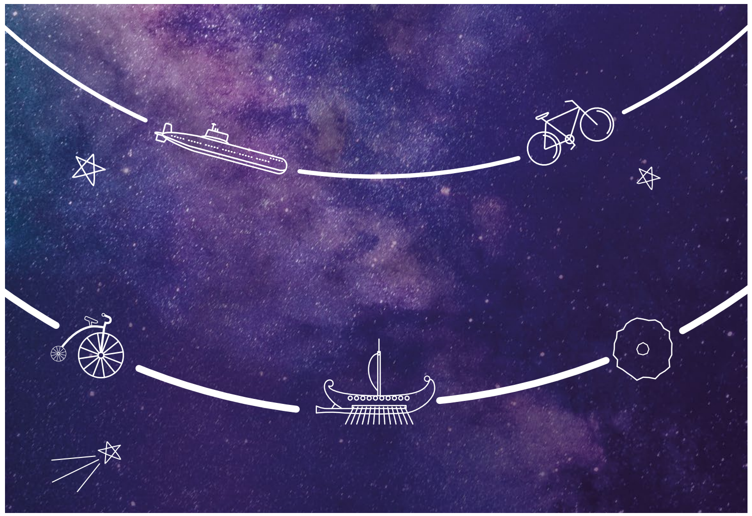
☆ **What could I do with a pull?**

☆ **What force would I need to launch a rocket?**

A: Push: a really big one.

☆ **What other forces would I need to drive the rocket?**

A: Press the start button = push force.



# ACTIVITIES TO TRY

**Play is really important in getting kids to engage with science concepts. They need to try a few things out and become curious- that's when they start asking interesting questions and caring about the answers.**

These activities build on one another, so I suggest teaching them in the order as listed below but you don't need to include every activity.

1.) **Play with toys which use forces – to find forces in use in a familiar context** (30 mins)
Choose some toys which use pushes (roll along toys, toy cars, pop-and-catch type toys, jumping poppers) and some which use pulls (pull back and go toys, pull along toys), some which use a twist (rubix cube) or a flick (paper lasers/sword flicker). Include things like rocket balloons and paper aeroplanes. Let the children play for ten minutes or so.

**Ask:**

☆ **Which force did you use to make each toy work?**

☆ **Did some toys use more than one force?**

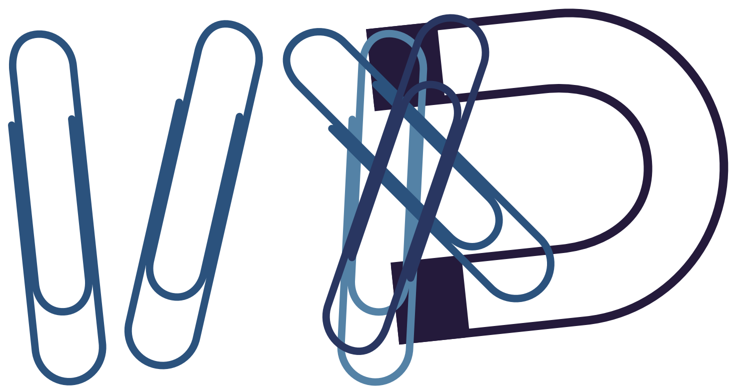
2.) **Play with magnets – to find that one force can be more powerful than another** (30 mins)
Put out a tray of different magnets. Let the children explore the equipment. Provide paperclips and other items that will be attracted to the magnets. Then, once they start showing you all the tricks they can do with the magnets, ask them to find out which is the strongest magnet. Celebrate all methods they suggest but look for the ones which are scientifically valid e.g. this one can pick up a paperclip through a bigger pile of paper/thicker book; or, this one can attract a paperclip which is further away.

**Ask:**

☆ **Which was the strongest magnet?**

☆ **How do you know?**

A: It moved the paperclip the furthest / carried the most paperclips / worked through the thickest book.



**Discuss that some magnets are stronger than others and can affect objects that are further away. Some forces are more powerful than others – the force of gravity is greater on the Earth than it is on the Moon.**

## Ask:

☆ **What happens if two people pull in the same direction?**
A: Force is combined.

☆ **What happened when Schmidt and Houston began to work together on the galley?**
A: Forces combined and they were able to slow the spaceship.

### 3.) Find the forces in the classroom – to identify different forces (20 mins)

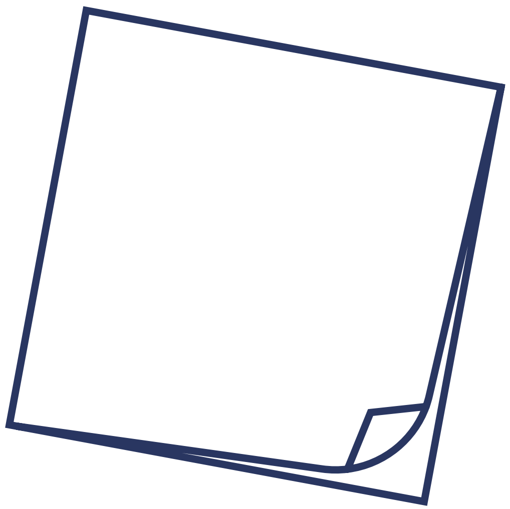
Use sticky notes marked with 'push', 'pull' or 'twist'. Look around the classroom for places you can stick the sticky notes.

Places to stick **'push'**: computer keys, iPad buttons, drawers, scissor handles, window openers and doors.

Places to stick **'pull'**: door handles, drawers, book covers, zips, pen lids and closed laptop lids.

Places to stick **'twist'**: handles, taps, bottle lids, volume knobs and glue stick bases.

Discuss how often we use forces in our everyday life.



**4.) Introduce the force of gravity by dropping objects - to observe that the force of gravity pulls us down towards the centre of the Earth** (15 mins)

Drop a ball in front of the children. Drop it by simply letting go.

**Ask:**

☆ **What is making the ball go down?**
A: Force of gravity.

☆ **Which direction does the ball fall?**
A: Straight down.

☆ **Where does the ball end up?**
A: Down then bounces up and down then ends up in the ground.

☆ **Why doesn't it stay down?**
A: Ball is bouncy.

☆ **What kind of ball might stay down?**
A: Ball of dough.

**4b.) Now take the same ball and roll it down a slope. Let it go in the same way as before** (15 mins)

**Ask:**

☆ **Why doesn't the ball go straight down like before?**
A: Force of gravity pulls it down but something is in the way, pushing it off course.

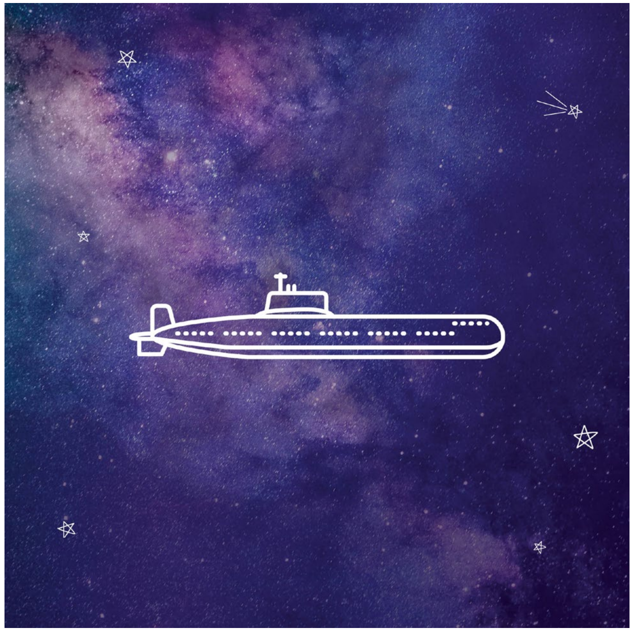
☆ **How could I get the ball to go up?**
A: Push / throw it upwards.

☆ **What would happen if I threw it upwards?**
A: It will come down in the end because the force of gravity is acting upon it.

☆ **What would happen if I was floating in space and I threw the ball above my head**
A: It would keep going up and not come back to me.

**4c.) Class discussion: Wrapping up these ideas** (15 mins)

Discuss with the class how you have to overcome the force of gravity in order to go up. Going uphill is harder work than going downhill. To make an enormous rocket go up against the force of gravity you need a very big upward push. In our 'Vehicles' story, this is provided by a rocket engine. Rocket fuel is burned to create exhaust gases. These come out of the end of the rocket and exert a push force backwards and the rocket moves forwards **(see Newton's third law)**.



**5.) Make a rocket: pushing up against gravity** (1 hour at least)
Make a set of rockets with your children. They could work in pairs or make one each.

There are three types described below – pick one suitable for the dexterity and maturity of your class. You may also want to consider the weather, as outdoor rockets don't launch in predictable ways on windy days! You can make all of these designs easily and cheaply in school.

**Be sure to set strict guidelines about keeping out of the way of flying rockets so no-one gets hurt!**

**5a.) Straw Rockets (indoor) – paper dart propelled by blowing down a straw**

***You will need:*** *scissors, paper, pencil, tape and sturdy drinking straws*

Roll a strip of paper around a cylindrical pencil. Tape it to make a tube. Slip it off the pencil and seal one end by folding it into a point. Add triangular paper fins as required. Slide the tube onto the drinking straw and blow to launch.

**5b.) Rocket Mice (indoor) – paper cone propelled by the air in a plastic milk bottle base**

***You will need:*** *clean plastic milk bottles, paper templates, scissors, and glue sticks*

This is a great activity which you can find online by searching for Rocket Mice on the London Science Museum's website. Download the template and cut out the paper shape to roll into a cone and glue in place. Add ears and tails or fins, as required, to make it into a mouse or a rocket.

Stand the cone on the neck of a clean and empty milk bottle. Clap your hands on either side of the bottle to create a jet of air to lift your rocket into the air.

https://learning-resources.sciencemuseum.org.uk/resources/rocket-mice/

**5c Plastic Bottle Rockets (outdoor) – plastic bottle propelled by carbon dioxide trapped inside**

You can find a video of the step by step instructions for this on the BBC Terrific Scientific DIY website.

***You will need:*** *a plastic bottle, paper straws, tape, paper, corks which fit in the necks of the bottles, kitchen towel, bicarbonate of soda and vinegar.*

Tape three straws to the side of the bottle so that they create a tripod around the neck of the bottle, and it will stand, neck downwards, on a flat surface.

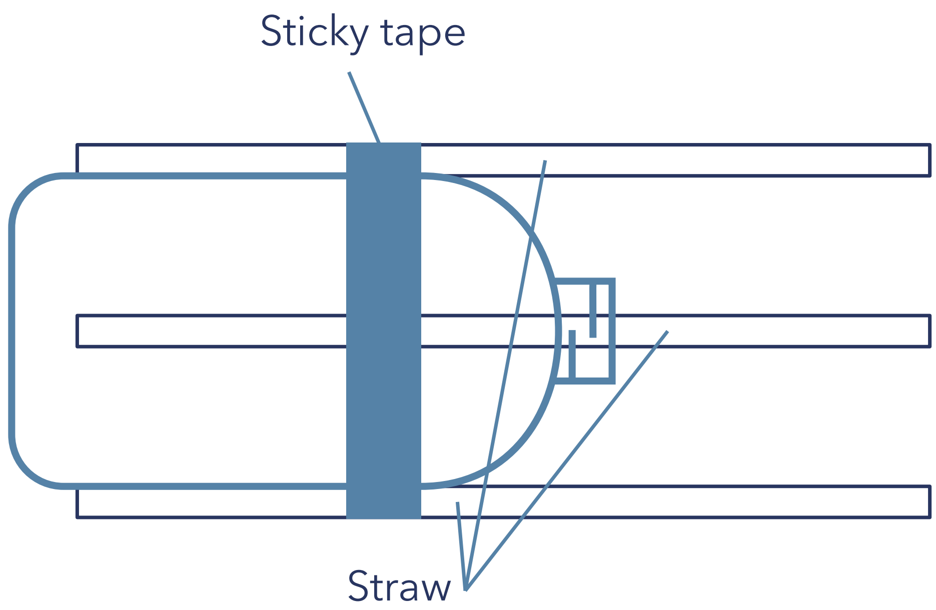
Mixing bicarbonate of soda and vinegar inside a corked bottle creates enough carbon dioxide gas to explode the cork out of the bottle and propel the bottle upwards. To do this in a controlled manner, teach the children how to roll up a teaspoon of bicarbonate of soda into a sheet of kitchen towel, creating a sausage shape, twisted at both ends, trapping the powder inside. Then. pour vinegar into the bottle until it is one third full.

When in position, outside, in a large space, with a flat surface and minimal wind, pop the kitchen towel containing the bicarbonate of soda into the bottle. Firmly push the cork into the neck, stand the bottle, neck downwards, on the straw legs and **stand well back**.

They can go off very quickly so make sure you know how to get the cork into the neck of the bottle quickly before you try launching the rocket.

https://www.bbc.co.uk/teach/terrific-scientific/KS2/zr63d6f

**Launch the rockets safely, several times and observe how far they go, how high they go and if there are any malfunctions!**



## Ask:

☆ **Which force makes them go?**
A: Push – blowing counts as pushing with your breath.

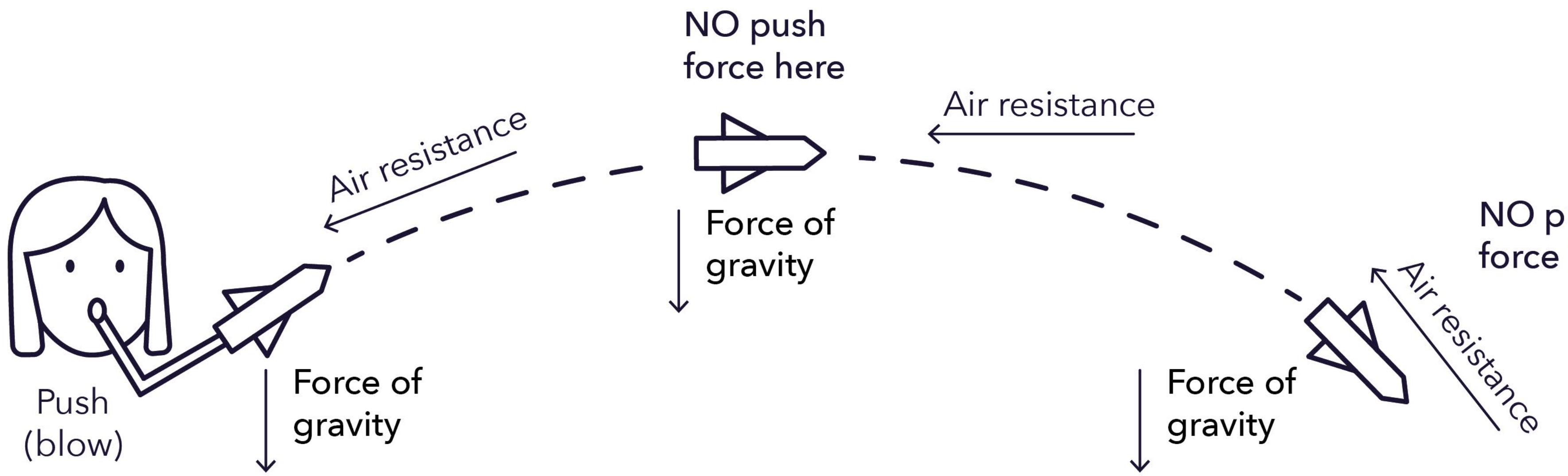
☆ **What affects the distance it travelled?**
A: Amount of push, whether it got stuck (friction might act against the push force if the rocket is stuck on its launcher), angle of launch, weight of rocket, streamlining of rocket, positioning of fins, amount of bicarbonate of soda or vinegar, seal of the cork etc.

☆ **How could you improve your rocket so that it goes further?**
A: Streamlining, more push, straw rockets need to be launched at about 45 degrees to go furthest, better seal on bottle rocket etc.

☆ **Which one goes furthest?**
A: Probably the one with the most push or most streamlined shape so it cuts through the air well.

1.) Draw diagrams together of the forces at play. Notice that whilst a push force will get the rocket moving, other forces will slow it down. When the rocket is moving, there is no longer any force pushing forwards but it is bumping into air particles and these slow the rocket down (more on this in session).

2). When the rocket is off the ground, gravity is acting on it. It will slow the upward movement of the rocket until it is no longer going up and then accelerate it towards the ground.



# MAKING STEM INTO STEAM

**English & Drama:**

1.) Pretend to be a rocket scientist and present your own TV programme or vlog on how to make a functional rocket and which forces you need to consider when building and launching the rocket.

2.) Create an advert for your rocket.

3.) Write an instruction booklet for Schmidt and Houston on rocket building and launching.

4.) Imagine Schmidt and Houston are travelling in your rocket. Tell the story of how they manage to create a big enough force to lift them off the Earth and into space.

5.) Write your own play script of Houston and Schmidt's next adventure. Where are they headed? What goes wrong with their rocket? Where do they end up? Who do they meet? What do they learn? How do they get home again?

**Art & Design:**

1.) Draw an exploded diagram to show how to construct your model with step by step instructions.

2.) Design a logo for your rocket which shows the forces involved launching it.

**Music:**

Using the tune from the song '*There's a hole in my bucket, dear Liza*', create a new song called '*There's a hole in my rocket, dear Houston dear Houston*'.

It might start:

*There's a hole in my rocket, dear Houston dear Houston,*
*There's a hole in my rocket, dear Houston dear Houston, a hole.*
*Then fix it Lieutenant, Lieutenant, Lieutenant,*
*Then fix it Lieutenant, Lieutenant, Lieutenant, fix it.*
*The cork it is leaking, is leaking is leaking*
*The cork it is leaking, the gas all leaked out.*
*Make the cork seal tighter, seal tighter seal tighter,*
*Make the cork seal tighter, and trap it inside.*
*There's not enough vinegar, 'nough vinegar, 'nough vinegar,*
*There's not enough vinegar, 'nough vinegar to make enough gas.*
*Well add some more vinegar, more vinegar, more vinegar,*
*Well add some more vinegar, more vinegar, more vinegar, and make some more gas.*

# MAKING STEM INTO STEAM

**Music**:

Compose a sequence of sounds and melodies which show the stages of the story:

1.) Lift off
2.) Something goes wrong
3.) Time goes backwards
4.) The car race
5.) The submarine
6.) The lorry
7.) The bicycle
8.) The balloon
9.) The boat
10.) The caveman and the wheel
11.) Leonardo the inventor
12.) Taking off and going back to the future

**Create a leitmotif for each character:**
In a musical story such as this opera, each character may have its own leitmotif. This is a short melody, like a jingle that is played whenever that character is on stage. You could compose a short melody to fit these characters:

1.) Captain Houston
2.) Lieutenant Schmidt
3.) The tortoise
4.) The hare
5.) Laurie – the lorry driver
6.) James Sadler – the balloonist
7.) The caveman
8.) Leonardo da Vinci – the inventor
9.) An alien from Planet Zorg

# SECTION TWO:

## SLOWING DOWN (RACE CARS AND HELICOPTERS)

### Science Notes:

**Friction:** When any surface moves over another surface, friction is produced.

Imagine a child running into the school hall, with a shiny, clean floor and skidding across the hall. A child in socks would skid much further than a child in grippy trainers. The grip that the trainers are providing is called friction. Some materials grip one another a lot: there is a lot of friction between rubber and tarmac. Some materials slide over each other well: there is not much friction between socks and a shiny floor, or an ice skate on ice.

Friction acts to slow a moving object down or prevent a stationary object from beginning to move. Friction helps us in everyday life by slowing the wheels when we apply the brakes on a bike or by stopping our shoes from slipping so we can walk safely.

Different materials provide different amounts of friction. Formula One engineers are constantly trying to develop tyres that have a lot of friction, so the tyres don't slip in the rain. They are often made from 'sticky' rubber to increase the friction but that rubber wears out very quickly, so they often need to change their tyres to keep the friction at a maximum.

**Air resistance:** When any object moves through air, it will encounter air resistance.

Air resistance is the force which slows you down because you are bumping into air molecules in your path. When you walk though water, you can feel the water getting in your way and slowing you down. This is water resistance. The air in your path does the same thing but we don't notice it (unless we are trying to run very fast carrying an open, large umbrella).

When an object moves, it bumps into the air molecules in its path and pushes them out of the way. The faster the object moves, the more air molecules it will bump into so the greater the air resistance.

The shape of the object will also affect the amount of air resistance. A bullet shape will bump into less air than a cube shape because the bullet shape can cut a path between the air molecules whilst a cube shape will have a large surface area at the front and bump into lots of air molecules. When an object is shaped to cut through the air and reduce air resistance, we say that it is streamlined. Racing cars are streamlined. They encounter less air resistance than lorries, for example, and can therefore reach higher speeds even if they both have the same amount of forward push.

Falling objects also encounter air resistance. A flat piece of paper will encounter more air resistance (and fall more slowly) than the same sheet of paper scrunched into a ball. The ball shape has a smaller surface area so it is easier for the air to flow around it rather than bumping into it (as it does on the flat sheet).

In space, there is no air so there is no air resistance. Once an object is moving in space, it will keep moving until it hits something (see Newton's first law). So, once Houston and Schmidt finally leave Earth's atmosphere and reach space, where there is no air, they can stop firing their engines and the rocket will keep moving at the same speed until they bump into something.

Similarly, if you watch the films from the first moon landings you can see that a feather and a hammer (very different shapes and weights) fall at the same rate, in the absence of air. The mass does not affect the speed at which it falls. On Earth, the feather would fall more slowly as it would encounter more air resistance but when there is no air, both hammer and feather fall at the same rate.

## Mass or weight?

In primary schools, we tend to talk about weight in maths lessons when we really mean mass.

**Mass** is measured in **grams** (and kilograms) and is a **measure of the amount of 'stuff'** in an object.

**Weight** is measured in **Newtons** and is a **measure of how much an object is pulled down** by the force of gravity. The weight of an object is dependent on the mass of an object and the force of gravity acting on it.

So, a 100g mass would have the same mass on the Moon (because it is the same amount of 'stuff' but a very different weight from its weight on Earth (because the Moon has a much weaker force of gravity than the Earth).

# FAMOUS SCIENTISTS IN THIS FIELD

**1.) Sir Isaac Newton – We met him in Section 1.**

**2.) Galileo Galilei** (1564 –1642)

When you drop different objects from a great height, sometimes they fall at different rates. Aristotle believed that heavier things would fall faster. It does appear that way sometimes. Imagine dropping a hammer and feather. The hammer falls faster. Children also see falling objects and can come to the conclusion that heavier things fall faster. It seems to make sense. But it is a misconception.

Galileo challenged this way of thinking with a simple test. Stories say that he dropped two balls of very different mass from the top of the Leaning Tower of Pisa. He dropped them at the same time, and they landed at the same time. The heavier ball was no faster than the lighter one.

(However, this is only true over a specific distance. Although, their initial rate of descent will be the same the same. One will stop speeding up quicker than the other.)

Galileo concluded that it is the shape that makes the most difference to the speed at which something falls. Objects which are wider and flatter encounter more air resistance than streamlined shapes. It is this increased air resistance that slows the descent of a falling object. Just think of a parachutist wearing her parachute in a pack on her back. The parachutist jumps out of the plane and begins to fall. She falls faster and faster for a while and then reaches a speed where she can't get any faster. When she opens the parachute, she slows down. She travels more slowly because the parachute has massively increased the air resistance.

**3.) Mark Chapman – Engineering director on the Bloodhound team** (present day)

In November 2019, a group of engineers, intent on breaking the land-speed record with a racing car, hit a top speed of 628mph in a test in very flat part of the desert in South Africa. They are currently using a jet engine. When they add a rocket motor too, they hope to smash the current record of 763mph (set by Andy Green, the driver of Bloodhound, in an earlier attempt, in a car called Thrust SSC).

These engineers have been working hard to reduce air resistance by refining the shape of the vehicle, and at the same time, increasing air resistance to slow the car down, using parachutes.

They have also had to maximise the friction of the tyres to grip the road.

This process is often called tinkering: first, they make the design they have thought of and test it. If it doesn't work perfectly, then they try changing one element to see if they can improve the performance of the design. Then they test it again.

Tinkering is a great skill for children to learn as it gives them the perseverance to keep trying at something that isn't instantly working perfectly. It also encourages them to observe carefully and analyse why it isn't working well and figure out what could be changed.

**The BBC have made some super clips available online from their BBC Two show 'Bloodhound Adventure', for teachers to use in class.**

# FAMOUS SCIENTISTS IN THIS FIELD

**4.) John Boyd Dunlop** (1840-1921)

John Dunlop was a vet. One day he noticed that his son was not comfortable on his new bicycle – all bicycles then had solid rubber tyres and didn't cushion the ride over cobbles and uneven roads.

John Dunlop had sheets of rubber covering his veterinary table and he used one of these to make a new kind of tyre for his son's bicycle. He neatly cut and stitched the rubber sheet into tubes exactly the right size to fit around the bicycle wheel and then he sealed the stitching with liquid rubber. Then, he pumped air into the tube and he had made a pneumatic tyre! Another inventor, Robert William Thomson was working on a similar idea so it wasn't long before the pneumatic tyre was put to good use on motor cars.

**5.) Leonardo da Vinci – The inventor** (1452 –1519)

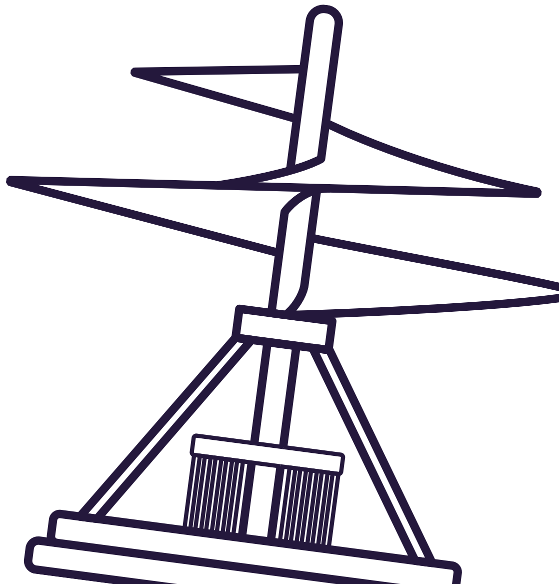
Leonardo trained as a painter but his notebooks show that he was also a talented inventor and spent a lot of time studying anatomy.

In the time when Leonardo lived, there was no man-powered flight but he would often observe how nature solved the problem of getting off the ground (or landing safely) and use what he observed to dream up new flying machines.

It seems that Leonardo knew about an invention called an Archimedes Screw. This is a simple machine which uses a screw, turning inside a tube, to lift water from a lower level to a higher one. He may also have seen seeds with wings which turn as they fall. Maybe these inspired him to design a helicopter that used a screw design to spin itself upwards into the air. Sadly, the design would never have worked but the idea of applying something you have observed to solve a problem in a different area is what engineers do all the time. If you want a modern example, look up the 'kingfisher bullet train' in Japan, which copies the shape of a kingfisher's head to minimise the air resistance on the front of this high-speed train.

Leonardo also invented a hang-glider and a parachute, both of which would have worked. His drawings show he was inspired by nature when drawing his designs - his glider was based on the design of a bird wing.

Of course, Leonardo could have been inspired by a spacecraft falling out of the sky like the one in the story!



# LINKING THE SCIENCE TO THE STORY

Schmidt and Houston manage to slow the space craft down by working together. Eventually they are slow enough to 'drop out of warp speed' and can turn the ship around. The spaceship moves unpredictably and flies too close to the Earth. They are pulled towards Earth by the force of gravity. They fall into the garden of Leonardo da Vinci, in the 15th Century.

Leonardo, who is fascinated by the idea of creating a flying craft, observes the spaceship falling towards the ground. He is excited to see such a machine and puts his mind to fixing the spaceship. Leonardo, then, invents a way to repair the ship, using pieces of other vehicles.

## Ask:

- ☆ **In the story, Schmidt and Houston have to pull together to get the space craft to slow down. Can you think of any other examples where two people (or animals) work together to combine their force?**

  A: Tug of war teams, rowers, tandem bicycle, dogs pulling a sledge, horses pulling a cart, the characters in 'The Giant Turnip'.

- ☆ **Can you think of any examples where two people (or animals) work in different directions?**

  A: Guy ropes on opposite ends of a tent, opposing teams on tug of war, dog pulling on a chew toy, people using a two-man saw.

- ☆ **The space craft can speed and slow down. How do you speed up and slow down the vehicles you use?**

  A: Pedal vs brakes, engine vs brakes, pushing with feet vs dragging feet.

- ☆ **How do you think brakes work?**

  A: Rubbing, pressing, they may even say friction.

Tell the children you are going to investigate forces that work against each other.

# ACTIVITIES TO TRY

These activities build on one another, so it is recommended to teach them in the order as listed below but you don't need to include every activity.

**1.) Dropping paper shapes – to see how the shape affects the way it falls** (20 mins)

Start by holding two flat, unfolded sheets of A4 paper out at arm's length, with the flat side facing the floor. Ask the children, which one will hit the floor first. Keep taking guesses and comments without letting on who is right or wrong. Then, without warning, scrunch up one piece of paper and drop them both from the same height at the same time.

They'll all shout, **"CHEAT!"**

## Ask:

☆ **How did I cheat? I dropped both sheets at the same time!**

A: One is smaller – they may even say the scrunched one got heavier but do point out that the mass hasn't changed just because the shape changed.

☆ **What made the difference?**

A: The shape.

☆ **What is happening with the flat sheet paper? Does it float straight down?**

A: You may want to watch again – it floats sideways and zigzags to the floor – air is trapped under it and then, as the paper tips, the air escapes.

☆ **What would happen if I dropped the paper sideways, with the thin edge to the floor and the flat side to the wall?**

A: Try it and note it does fall faster until it turns and starts to fall flat side to the floor.

☆ **If I had 3 identical sheets of paper and dropped them at the same time, how could I get them to hit the ground at three different times?**

A: 3 different shapes with very different surface areas.

# ACTIVITIES TO TRY

**1a.) Follow up task** (20 mins)

What made a difference to the speed at which your shapes fell? (flat shapes that have a large surface area will bump into more air molecules on the way down so they will encounter more air resistance and fall more slowly)

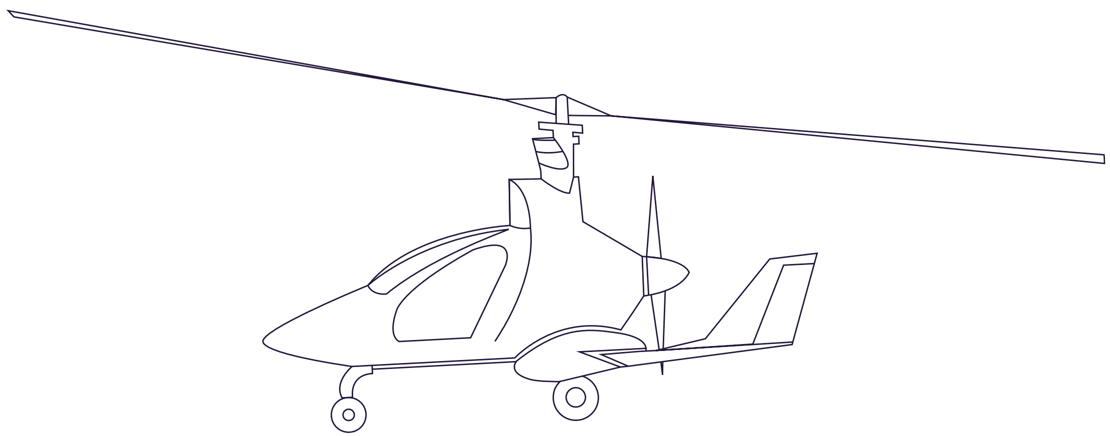
**Ask:**

☆ **What made a difference to the speed at which your shapes fell?**

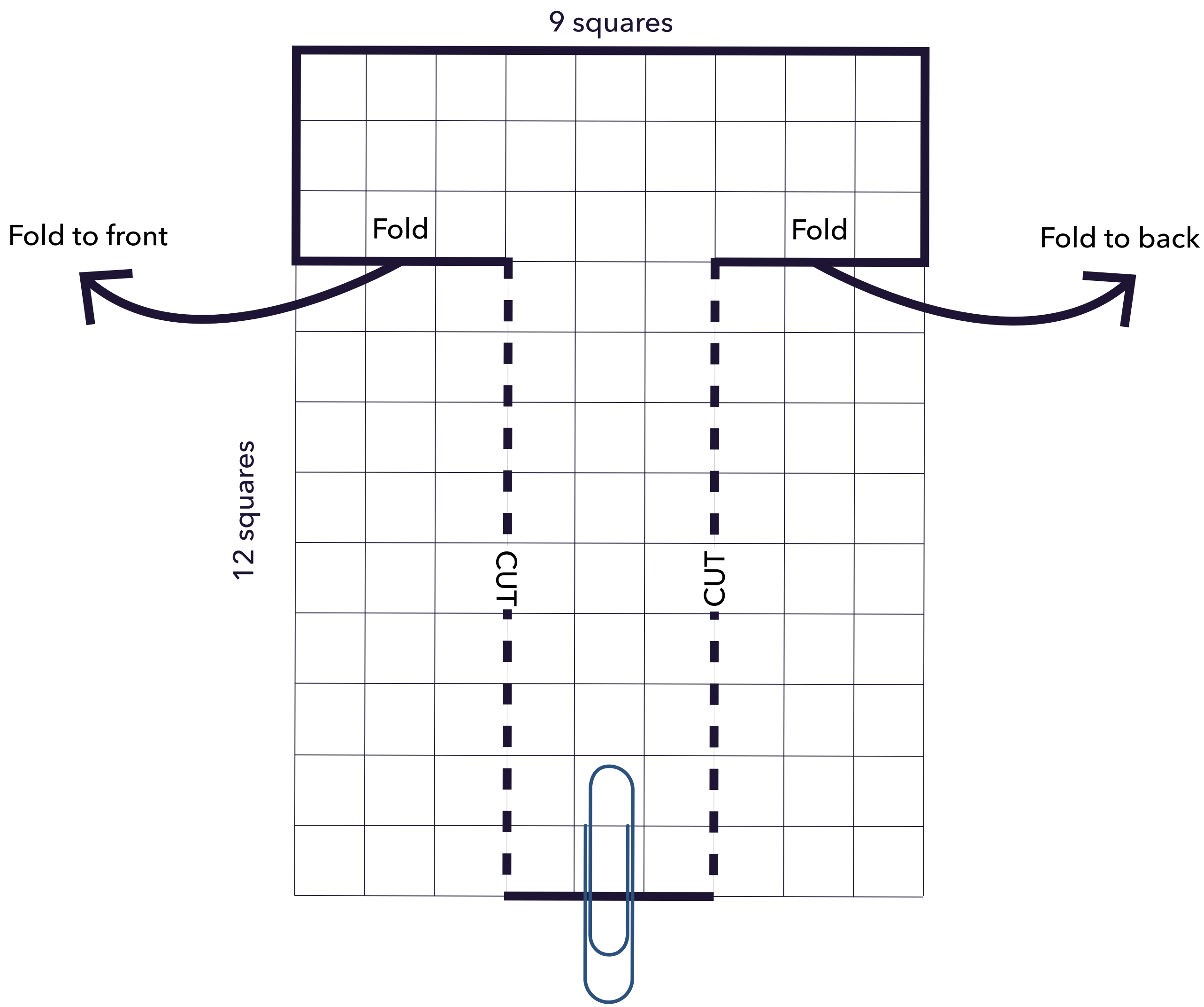
A: Flat shapes that have a large surface area will bump into more air molecules on the way down so they will encounter more air resistance and fall more slowly.

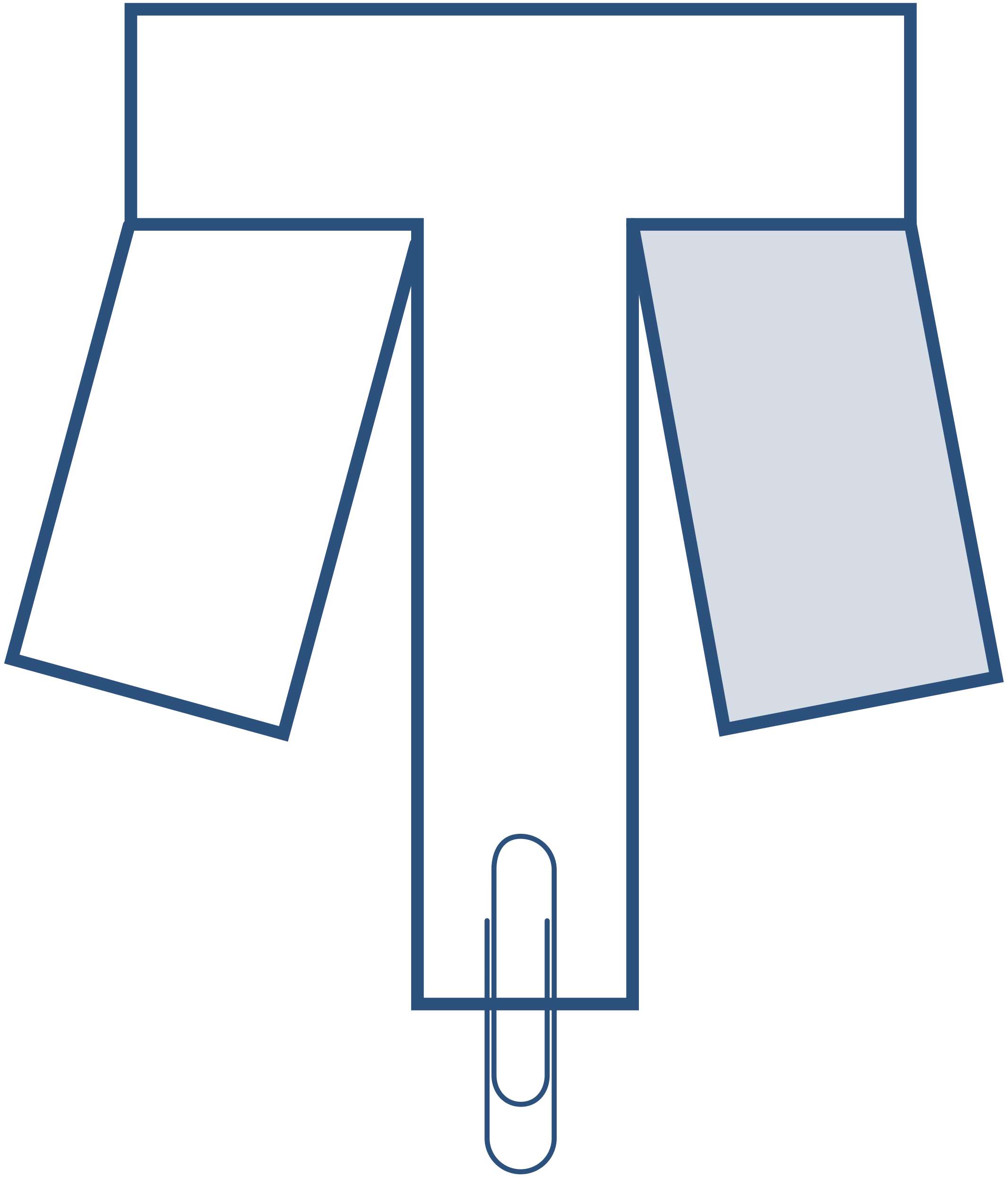
**2.) Make paper Gyrocopter – to investigate air resistance** (90 mins)

There are lots of different designs of gyrocopter you could make and they all have different names. If you search online for paper helicopter or paper gyrocopter, or paper whirlybird you should find a good design. This is my favourite:



**2.) Make paper Gyrocopter** (90 mins) – CONTINUED
Provide a simple template – I use squared paper and mark a rectangle 12cm by 9cm. Then I make two cuts as shown. Fold the wings into place - one in each direction and your gyrocopter is formed. Give the children a few minutes to play with their gyrocopter. It will spin as it falls, much like a sycamore seed.





## Ask:

☆ **Can you make it spin the other way?**

A: Fold each wing in the opposite direction.

☆ **Why does it fall slowly?**

A: The wings are 'catching the air'.

☆ **What could we change?**

A: The area of the wings, the size of the gyrocopter, the material it is made from, wings with holes cut into them, the position of the paperclip – AVOID ADDING MORE PAPERCLIPS as the gyrocopter will fall faster for complex reasons and children will think it means that heavier things fall faster – which they don't (see Galileo above).

☆ **Can you test which ones are slower to fall and which are faster?**

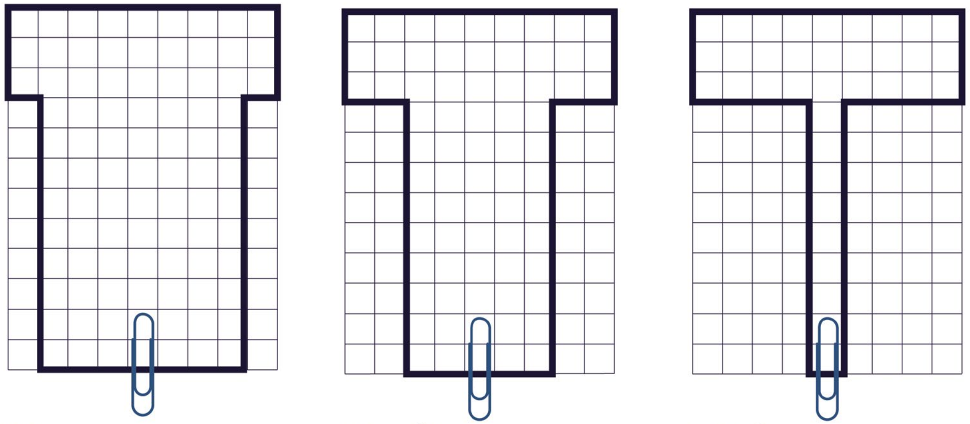
A: Time different gyrocopters as they fall or race two to see which wins.

☆ **What should we keep the same to make our test fair?**

A: Height of drop, size of paperclip etc.

**2.) Make paper Gyrocopter** (90 mins) – CONTINUED

**Fair Testing**: If you want to do a fair test, alter the area of the wing and you should find a pattern – the larger the area of the wing, the more air resistance, and the more slowly the gyrocopter will fall. However, once the gyrocopter gets to 30cm in length, normal A4 paper tends to be too floppy to hold the wings out at a 90-degree angle, so they flop, and the gyrocopter falls without spinning so the results no longer show the same pattern at this point.



**Narrow wings** **Medium wings** **Wide wings**

Try using paper of the same type to make three different gyrocopters: one with wings 3cm wide, one with wings 2 cm wide and one with wings 1 cm wide. Then time them falling from a set height. Plot a line graph of the results (area of wing x time to fall) and see if you get a pattern. You may even be able to use the line graph to predict how long a gyrocopter with 4cm wide wings will take to fall.

**Comparative Testing**: If you want to do a comparative test, try changing the materials (A4 paper, newspaper, sugar paper, card, tissue) but not the size or shape of the gyrocopters. Time how long they take to fall from a set height and make the results into a bar chart. If you use very floppy paper, the wings won't hold the 90 degree angle and they fall without spinning.

# ACTIVITIES TO TRY

**3.) Make elastic band racers – to investigate grip (friction on the wheels)** (90 mins)

There are lots of designs for elastic band racing cars on the internet. You can even get a class kit of 10 set of the items you need. (see Curiosity box pack: https://stemday.co.uk/shop/zoomy-racer/ ). They all work on much the same principle: an elastic band, fixed to the inner front wall of the car, is wound around the rear axle by turning the wheels 'backwards'. When you let go of the wheels, the elastic band turns the rear axle and the car goes forward. One of the most important things to learn in this practical session is how to tinker with the design to improve the performance of the car. It won't always run fast or straight so the children will have to watch it move and try to work out what to change to make it run straighter and faster.

***You will need:*** *axles and wheels which fit together (2 axles and 4 wheels per car), a box to make the chassis and strong elastic bands which can be looped together to make one long band (or long elastic bands)*

Make elastic band racers with your class. Start with a basic design and test them.

Drawing to come

**Ask:**

☆ **Did you get your car to go a long way? How? What problems did you solve to get it to go further?**

A: Reducing friction on the axle by making sure it is straight and not rubbing against the holes too much, or winding the band tighter.

☆ **Can you explain what forces are involved here?**

A: Elastic band pulls and turns the wheel, friction slows it down.

☆ **How could we improve the performance of your car?**

A: straighten wheels, wind elastic band centrally, change the surface it is running on.

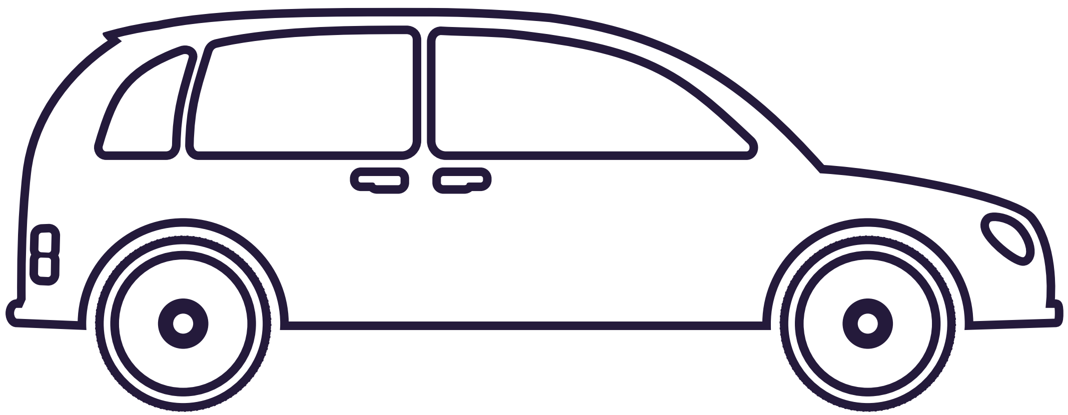
☆ **How could we improve the performance of your car?**

A: Straighten wheels, wind elastic band centrally, change the surface it is running on.

☆ **How could we change the car to improve the performance?**

A: Make it more streamlined or coat the wheels in something grippy.

Let the children work on their cars and then evaluate the performance of their design at the end. You could ask them to draw their ideal car and justify their design choices. This is often a good option for children who feel they know how they could get their model to work well but didn't have time to achieve it.



# MAKING STEM INTO STEAM

**English & Drama**

1.) Research modern inventions which have been inspired by nature e.g. the kingfisher bullet train, butterfly eggs which inspired the structure of buildings or shock absorbers inspired by woodpecker skulls. Present your own vlog or TV documentary explaining how nature can inspire scientists and engineers.

2.) Find out about Leonardo's many inventions. Role-play Leonardo showing Schmidt and Houston some of his inventions in his notebook. When Schmidt and Houston see something that has since been built, like the hang-glider, they can explain to Leonardo how these inventions will exist in the future and how they differ from Leonardo's designs. Is Leonardo pleased or annoyed that someone else has brought his idea to life?

3.) Play "Yes And". (This is a talking game to encourage children to be creative, fluent speakers and to build upon the ideas of others.) To play the game, a group of players takes turns to add to an idea. The idea begins with the words, "Let's design a spaceship". Players take turns to add an element to the spaceship. They cannot change or remove any ideas that have already been added. They can only say "Yes… and…" so the play might progress as follows:

*Let's design a spaceship…*
*Yes, and let's say there are fins on the spaceship…*
*Yes, and let's say the nose cone is really pointed to make it streamlined…*
*Yes, and let's say it is solar powered…*
*Yes, and let's say the solar panels are all over the ship…*
*Yes, and let's say it uses 3 parachutes to slow it down when it lands on Earth…*
*Yes, and let's say it has robot arms which come out of special hatches…*
*Yes, and let's say those robot arms have robot hands so it can fix the solar panels…*

Once you have designed a ship, try drawing it!

# MAKING STEM INTO STEAM

**English & Drama**

4.) What kind of vehicle would you like to drive/fly in the future? Where would your invention take you? Draw a labelled diagram of your invention. Write a set of instructions so that your design can be made by others.

5.) Write an advert for the vehicle you designed. Write it for an audience of tortoises and hares.

6.) Read the hare and the tortoise as referenced in the opera. Read other stories with the same message such as Awongalema. (You can find versions of this African folk-tale on the internet.) Write your own story about a slow car and a fast car and show how slow and steady wins the race.

7.) Write a story for younger children based on 'The Giant Turnip' where you show how pulling together can create a bigger force.

**Art & Design**

1.) Make observational drawings of winged animals, like those drawn by Leonardo da Vinci – what kind of flying machine would those observations inspire you to design? Draw your design and label it – you could even have a go at writing the labels in mirror writing like Leonardo. Explain how your invention works.

2.) Design a car that would win a 'slow race' by using friction and air resistance to slow it down. Draw your design.

**Music**

1.) Watch Commander Chris Hadfield singing David Bowie's 'Space Oddity', whilst on the International Space Station. Look carefully at the background of each shot.
**Can you see anything interesting? How does the song make you feel? Which song would you sing if you were in space?**

Try rewriting the song as if you are Schmidt and Houston.
It might go something like this:

*This is ground control to Hou – ou – ston*

*You've really gone off course*

*Since you left the handbrake on…*

2.) Listen to Flight of the Bumblebee by Rimsky-Korsakov, Ride of Valkyries by Wagner and Indiana Jones Theme by John Williams.

What kind of movement is the music trying to capture?

3.) Compose a jingle to go with the advert for your car.

# SECTION THREE:

## BALANCING ACT (HOT AIR BALLOONS AND BOATS)

### Science Notes:

**Balanced forces**
When something is not moving or changing speed, you might think that there are no forces acting upon it but in fact there are forces acting upon us all the time on Earth. However, they may be balanced and thereby cancel each other out, in effect. Let's put that into context:

1.) When you stand still, you are not falling and yet the force of gravity is still pulling you down towards the centre of the Earth. This is because the ground is pushing you back up and balancing out the downward force.

2.) When you float on the water in a swimming pool, the force of gravity is pulling you down but the force of upthrust from the water below you is pushing you up with equal force so you float.

3.) When a helium balloon is tied to a chair, the helium balloon is being pushed upwards by the upthrust of the air below it, but the force of gravity holding the heavy chair down is pulling on the string and balancing out the upward force so the balloon doesn't float away. Of course, as soon as the string comes loose, the downward force is removed, the forces are no longer balanced and the balloon will start to move upwards.

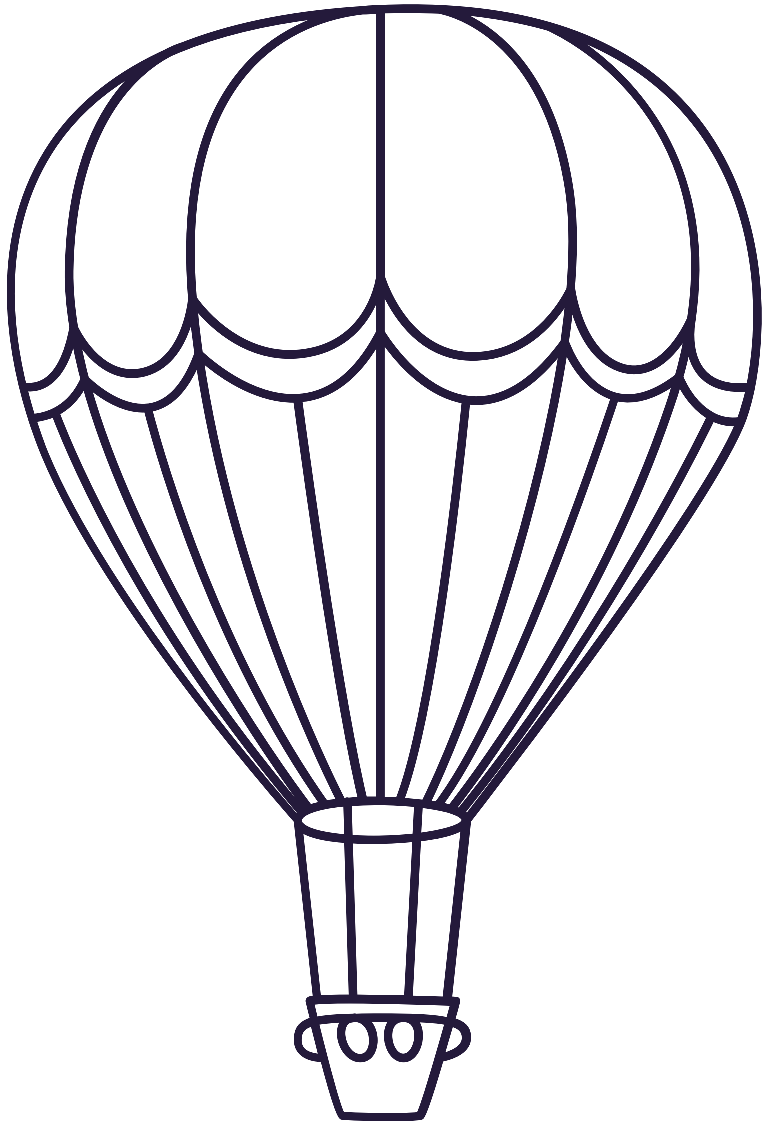
**Terminal Velocity**
A falling object will get faster and faster – it accelerates towards the ground. There comes a point where that object will no longer speed up - it is travelling at its terminal velocity. The reason it cannot go any faster is because the downward pull of the force of gravity is now balanced out by the upward push of air resistance. When it is falling more slowly, the air resistance is less as it is 'bumping into' less air molecules per second. When it goes a little faster, it will bump into more air molecules per second, so air resistance is increased. Eventually, at terminal velocity, the object is bumping into so many air molecules per second that it is slowed down in equal measure to the pull of gravity – the forces are balanced and the object continues to fall at a constant speed. It no longer accelerates. This is the terminal velocity.

**Upthrust**
When you try to push an inflated football under water, you can feel the force of upthrust pushing it back to the top again. In order for the ball to go underwater, it must push some water out of the way. This water is displaced. The weight of the displaced water (remember weight is a measure of force measured in Newtons) is equal to the upward force of upthrust on the object. The more water that is displaced, the greater the upthrust.

## Science Notes:

**Density**
Different materials have different densities. These different densities are partly due to each type of particle having a different mass but it is also due to how closely packed those particles are. If the particles are closely packed and have a large mass, the material will be dense and feel heavy. If it is more dense than water, it will sink. Consider a 1cm cube of lead (a dense metal) - it will sink in water and it is heavier than a 1 cm cube of many other metals, such as aluminium. Helium, however, is a particle with a low mass and the particles are very spread out. This gives it a lower density than water and also a lower density than air, so it floats in air.

When air is heated, as in a hot air balloon, the heat makes the air expand. The particles spread out so the air becomes less dense than the cold air outside the balloon so it floats on air and the upthrust of the cold air pushes the warm air in the balloon upwards.



# FAMOUS SCIENTISTS IN THIS FIELD

**Sir Issac Newton**
We met him in Session 1 (see his third law - page 6).

**Archimedes** (288BC – 212BC)
Archimedes is attributed with being the first person to work out that the buoyancy of a material is related to the amount of water it displaces (pushes out of the way). Some stories say he worked this out when he saw that the water level in his bath went up when he got in. And that he was so pleased with this brainwave that he leapt out of the bath shouting, **"Eureka!"**. He was also known for figuring out that you could work out if a golden crown was actually solid gold or a gold coloured substitute by dunking them both in water. The solid gold is very dense and will displace more water than a less dense fake.

**The Montgolfier brothers**
**Joseph-Michel** (1740 -1810) **& Jaques-Etienne** (1745 – 1799)
The Montogolfier brothers were from a family of paper manufacturers and they developed the first globe-shaped, paper balloon and successfully proved that this kind of paper envelope could be used to hold a gas. They believed that they had invented a new gas inside the balloon and named it Montgolfier Gas but really they had just heated air. The brothers had observed that sparks in a fire were carried upwards by 'a force' and experimented with heating the air inside a paper bag. They showed that this paper bag would lift into the air and then developed different kinds of balloons which would work on the same principle. Their first manned, untethered flight took place on November 21st 1783, in France, with a science teacher and the Marquis d'Arlandes on board, and earned the brothers a place in aeronautical history.

**James Sadler** (1753 -1828)
James Sadler was the first English aeronaut. An Italian called Vincenzo Lunardi was the first to launch a balloon England but James was the first Englishman to fly. He lived in Oxford where he was a pastry chef in his family business, rather than an educated scholar at the University as you might expect. At that time, scientists believed that smoke could be used to fill a balloon but Sadler knew it had something to do with the heat of the fire. He developed a way to create an adjustable fire, fuelled by coal gas which could be operated in the basket below the balloon to make the balloon ascend (with extra heat) or descend. He set off on 4th October 1784 from Christ Church Meadows, Oxford and rose to a height of about 3,600ft and travelled about 6 miles.

# LINKING THE SCIENCE TO THE STORY

In our story, we meet James Sadler. He is launching his balloon for the first time, from Christ Church Meadows as Schmidt and Houston pass overhead in their spacecraft. He sees our characters and believes they are angels. James is the first Englishman to fly in a balloon so he has been warned he may hit the sky or bump into strange creatures as there was very little known about the sky, or the atmosphere, at this point in history. He certainly wouldn't know what a spacecraft was or that machines like this would be developed in the future.

**Ask:**

☆ **How did people travel on land in 1753?**

A: Horseback, horse and carriage, boats (note: the car wasn't invented until the 1880s).

☆ **Imagine yourself in that world of 1753. No-one has seen the world from the air. What do you think amazed James Sadler when he looked down on the Earth from above for the first time?**

A: Everything is small, the countryside looks very green, the sky doesn't have a roof, it's harder to breathe.

☆ **If you saw a spacecraft, what might you think it was?**

A: Angels, a beast, a god.

☆ **What did James have to do to go up?**

A: heat the air – hot air rises, throw out heavy items – ballast - sandbags.

☆ **If the balloon is travelling upwards, it will be bumping into air molecules in its path. This will cause some air resistance. In which direction will air resistance be acting on the balloon?**

A: It will push down – any object moving though air will encounter some air resistance in the opposite direction to travel.

☆ **If the balloon is travelling downwards, which way is air resistance acting now?**

A: Upwards.

**Ask:**

☆ **What did he have to do to get down again?**
A: Let the air cool, let out some air, turn off the fire.

☆ **What is the name of the force pulling him down?**
A: Force of gravity.

☆ **Does the force of gravity affect the balloon when it is accelerating upwards?**
A: Yes but the force pushing the balloon up is greater than the force of gravity at this point.

We have already investigated gravity and the forces at play on falling objects. Now we are going to investigate the force that makes the balloon go up.

# ACTIVITIES TO TRY

These activities build on one another, so I suggest teaching them in the order as listed below but you don't need to include every activity.

**1.) Burn Magic Wish Paper - to see the effect of heating air** (20 mins)
You can buy this paper on the internet. It is not cheap, but one packet lasts me for about 5 sessions. You can also use the paper wrapped around some Italian amaretti biscuits and some posh teabags that unfold to make a long tube but do try them out in advance as they don't all work as expected. The safest option is this magic wish paper. Follow the instructions and launch indoors, from a fire-proof surface (e.g. metal tray) into a space well away from the children. Don't open any windows as the paper may get blown over in a draught.

When you light the top of the tube of paper, the flame will burn down almost to the bottom before something amazing happens – the last of the ash, often still tube shaped, will fly up into the air and then float gently down. You may want to repeat this activity a few times so that the children get the chance to fully observe what happens.

Drawing to come

## Ask:

☆ **What did you see?**

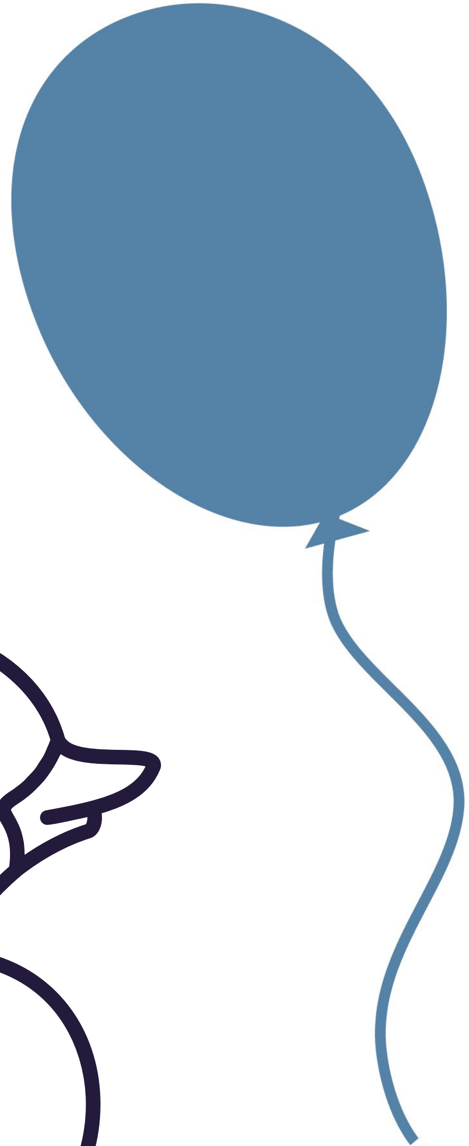
☆ **What made it go up?**

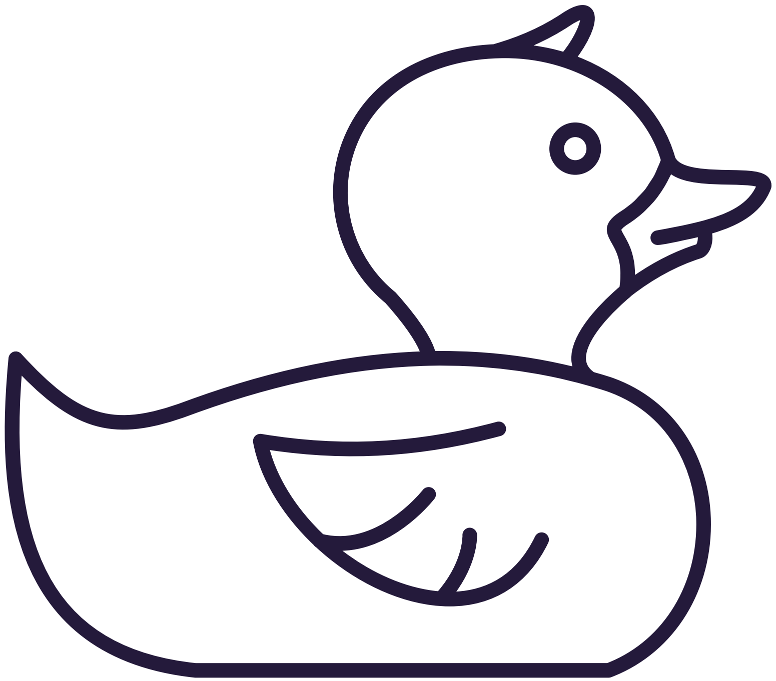
A: Accept all answers to begin with then being pointing them to the idea that the flame makes the air hot and hot air rises.

☆ **What made it come down again?**

A: The force of gravity, the air is cooler, the force of gravity is now greater than the upward force because the air has cooled.

You may want to use this activity to explain that hot air rises because the particles of air spread out when heated. When particles spread out, it affects the density of the material - hot air is less dense than the colder air around the balloon. A rubber duck, filled with air, is less dense than water so it floats on top. If you push it down into the water, it will rise up to the top when you let go. Helium gas in a balloon is less dense than the air around so it will rise up to float on top of the air. Hot air is less dense than cold air so a hot air balloon rises up to float on top of the air. The force which pushes the hot air upwards is called upthrust.

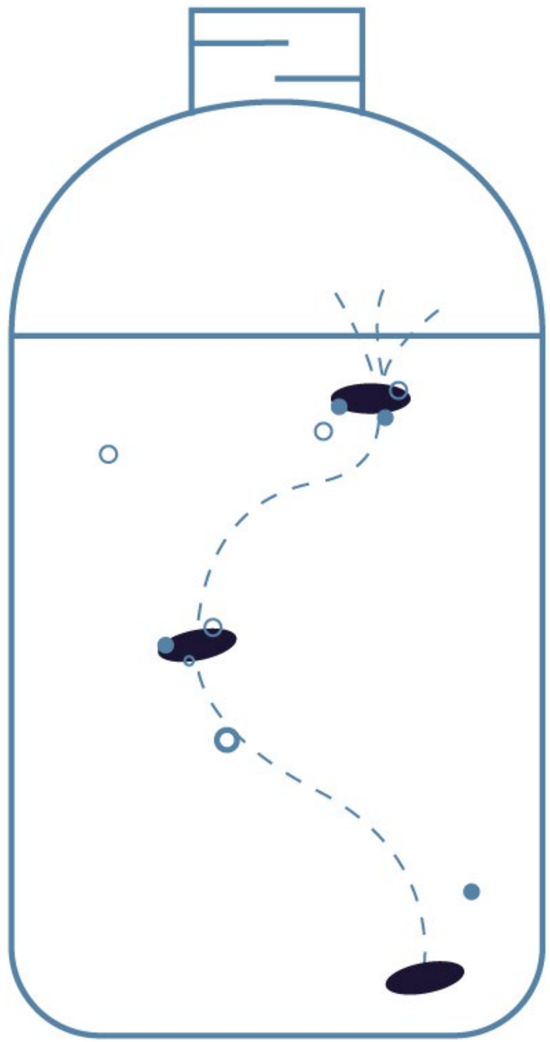




**2. Raisins in Lemonade** (20 mins)

Take the cap off a bottle of fizzy water or lemonade. Drop in a few raisins (check for allergies first) and watch the raisins rise with the bubbles of carbon dioxide and drop when the bubbles reach the surface and pop. You can do this with a small group and one bottle of lemonade or you can put a bottle on each table. It is important for the children to be able to see what is going on. Give the children time to observe. You could make one bottle less fizzy by letting the gas out before the lesson. This may then spark observations about how many raisins are carried up. If there is less fizz left (gas dissolved in the liquid) then there will be less bubbles and the raisins will float up less frequently. If you look closely, you can see that it often needs more than one bubble to lift a large raisin to the surface.

The density of a raisin is greater than the density of water so it sinks. The density of a carbon dioxide bubble is less than that of water so it floats. When you combine enough bubbles and a raisin, the overall density of the raisin and the gas (in the bubbles) together is less than water so upthrust forces the raisin up. The bubbles pop and the raisin on its own will sink again.



**Ask:**

☆ **What did you see?**
A: Bubbles on the raisins, bubbles popping.

☆ **What is happening?**
A: Bubbles forming on the raisin and then they rise up, bubble pops and raisin falls.

☆ **How many bubbles did it need to go up?**
A: One large, two or three small perhaps – it depends on the raisin!

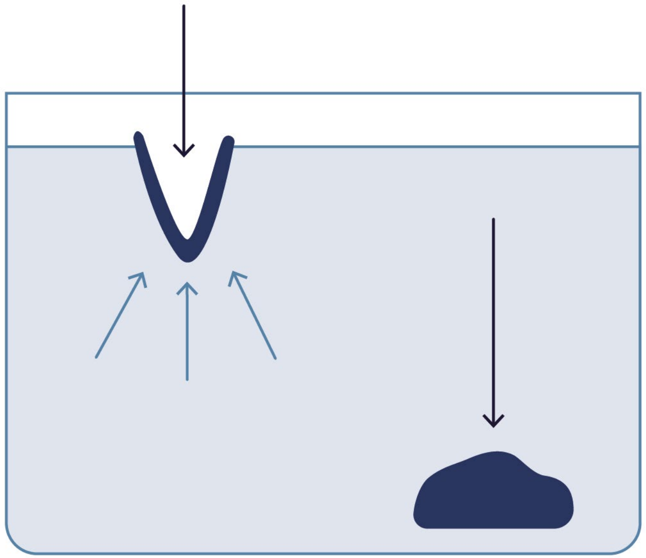
☆ **What does it remind you of?**
A: Arm bands in a swimming pool, pushing an inflatable underwater.

☆ **How might it remind you of a hot air balloon?**
A: The bubble carries the raisin up like the balloon carries the basket underneath up, if the balloon pops the basket would fall down.

You may want to explain at this point that the basket below the basket cannot float in the air. The basket is too dense. However, with enough air in the balloon that is hot and less dense then there will be enough upthrust to lift the balloon. The basket, the balloon and the hot air together are less dense than air.

You could discuss how many helium balloons it would take to lift a person, or a house, like the one in the film 'UP'. Each balloon can lift about 14 grams so it will be a very large number of balloons for a person, let alone a house.

**3.) Make Plasticine boats - to see the effect of upthrust in water** (40 mins)
A quick and easy demonstration of how upthrust is dependent on the overall density of an object is to make boats out of plasticine. Give each child a small ball of plasticine (about 25g) and roll it into a ball. Drop the ball in water and the Plasticine will sink. The density of plasticine is greater than the density of water. However, if you introduce some air into the shape by making a boat, the shape now includes the air inside the boat so the overall density of the boat shape is less than the ball of Plasticine alone. If you get the shape right, the Plasticine will float. The force of upthrust pushing upwards on the larger surface area of the boat is enough to keep the Plasticine on top of the water.



**Ask:**

☆ **Did anyone get the Plasticine to float?**

A: Most will.

☆ **What shape did you have to make the Plasticine to make it float on top of the water?**

A: Flat boat shapes.

☆ **What problems did you have?**

A: Water leaking into the boat and sinking it – when the water gets into the boat it has a greater density than the air it is replacing and when the overall density of Plasticine and water is greater than water, it sinks.

☆ **If we had a huge metal ship… and we squished into a block of metal like they do with cars at a scrap yard… would it still float?**

A: Possibly – if enough air remains trapped inside, probably not - if there is very little air inside.

☆ **What would happen if we did the same with a wooden boat?**

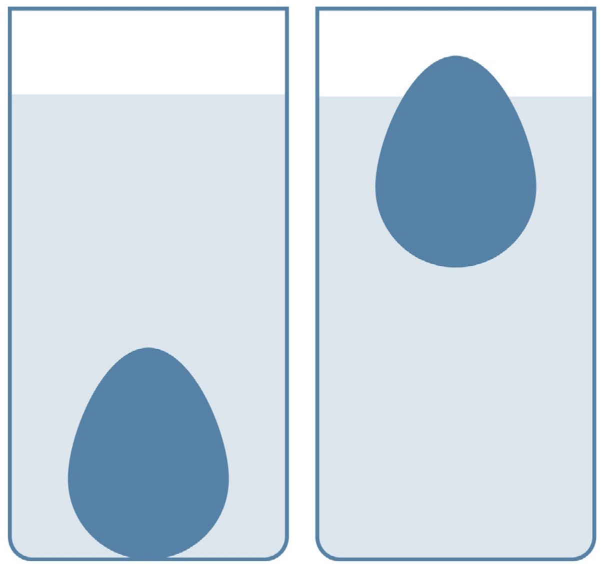
A: Pieces of wood might float but the main part would probably fill with water and the heavy metal parts on the boat likely cause it to sink.

**4. Do the 'Seagull's Egg' trick - to show that upthrust is greater in salt water**
(20 minutes not including preparation)

Preparation: Before the children arrive, prepare a clear tank of tap water and another clear tank of water with as much salt as you can dissolve in it. Add the salt gradually whilst stirring to ensure it all dissolves and no granules are left on the bottom to give the game away. Check an egg will float in it! Then, remove all eggs from the tanks and allow the children in.

Tell the children you are going to investigate whether or not eggs float. Ask for a volunteer to come to the front and stand next to the tank of tap water. Give them a fresh egg (check for allergies first). You stand next to the tank of saltwater and have another fresh egg in your hand – you may want to choose one that is different in colour to add to the 'magic'.

Ask the children whether eggs float. They may have seen boiled eggs sitting in the bottom of a pan of water. Then, as the child to put their egg into the tap water – carefully so it doesn't crack. It will sink to the bottom. Next, put your egg into the saltwater. Yours will float as the saltwater is more dense than the egg (whereas the tap water is less dense).



**Ask:**

☆ **What is happening?**
A: One egg is floating.

☆ **How strange. What might the reasons be?**
A: Different egg.

☆ **Why might some eggs need to float?**
A: Seabird / river bird – in case it falls into water.

☆ **Do chicken eggs need to float?**
A: No.

☆ **What other reasons?**
A: Egg is boiled / egg is off – crack the egg to prove it is fresh and replace with another if you like – they'll all float in salt-water.

☆ **What other reasons?**
A: Different water – save this until last – swap the eggs over – the egg in saltwater will float.

☆ **What could be different about the water?**
A: Water from a different source / saltwater / magic water

☆ **What happens when I push the egg to the bottom ?**
A: It rises up again – pushed up by upthrust - just like a balloon in air.

Spend time discussing how the upthrust of saltwater is greater because it is **more dense** than tap water. If you go to the Dead Sea, where it is really salty, it is really difficult to swim because you can't submerge yourself in the water properly. As it is very dense, there is lots of **upthrust** to push you up.

# MAKING STEM INTO STEAM

**English and Drama**

1.) Show a clip from 'The Aeronauts' film (Amazon Films, 2019) which is loosely based on real events. Watch the part where the balloon is launched. Ballast is released to reduce the overall density of the balloon and basket. The air is inside the balloon is heated to make it expand and become less dense. Role-play being at a balloon launch like this. You could even be James Sadler. You could have the characters in the balloon argue about how to get the balloon to rise or have a TV reporter interviewing the aeronauts to find out how the balloon works. Explain why the balloon will rise and what forces are involved.

2.) Write a newspaper report or TV script for the report on the balloon launch. Use your role-play as inspiration for the quotes and interviews.

3.) Pretend to be a magician with a magic egg. Perform the trick with great flourish to another class and then explain how the trick works.

4.) Learn other magic tricks which use forces e.g. pulling out a slippery tablecloth from under a tea set (which requires heavy objects to stay still whilst you pull out the cloth, with little friction, from underneath) or the tin which rolls uphill (due to a weight hidden inside). Perform the tricks and explain the forces.

**Art & Design**

1.) Imagine you are an aeronaut like James Sadler. You want to create a spectacle with your first balloon launch. All projects like this need rich funders to help pay for the equipment. Who would you want to impress with your balloon? How would you decorate it to encourage people to give you money towards to your project? Design your own balloon with this in mind. (You can use the rich and famous of today if you don't know who would have been famous in James Sadler's time.

**Music**

1.) Listen to 'Those Magnificent Men in Their Flying Machines'. It has a fairground feel, just like the launch of the balloon in 'The Aeronauts' film. When flying machines were first invented, people came from miles around to see the show. The scientists had to sell tickets as a way of funding their ventures. Can you update the song to perform at a launch of your own balloon design? Can you add in some technical language to help others understand the forces involved? E.g.

*Those magnificent people in flying machines,*
*They go up with the hot air*
*And down with the cold*
*They amaze every audience*
*And steal every scene*
*They go up with the hot air*
*And down with the cold*

2.) Watch a clip from 'The Aeronauts' which shows how quiet it is as you leave the Earth behind. Compose a piece of music which reflects how quiet it becomes as you leave the noise of the Earth behind.

# USEFUL RESOURCES

## Print:

**Science Fiction, Science Fact (ages 8-12)** Jules Pottle (Routledge, 2018)

**'Standing on the Shoulders of Giants'** Sinclair, Strachen and Trew PSTT, 2019
(Chapters on John McAdam and John Dunlop)

## Online:

**Time Zones:**
BBC Bitesize KS3 Time Zones: https://www.bbc.co.uk/bitesize/topics/zvsfr82/articles/zjk46v4

**Bloodhound Resources:**
BBC Two Bloodhound Adventure: https://www.bbc.co.uk/programmes/b01cwzzk/clips

**BBC Terrific Scientific Forces Investigation:**
Lots of ideas in the additional resources section: https://www.bbc.co.uk/teach/terrific-scientific/KS2/z6c86v4

**Vehicles Video**
The history of vehicles: https://www.youtube.com/watch?v=FaLCQo8NJFA

**Clips from 'The Aeronauts' film (Amazon Films, 2019)**

**Rocket Mice:**
Resources by the Science Museum in London: https://learning-resources.sciencemuseum.org.uk/resources/rocket-mice/

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