babcock™

STEM

SCIENCE | TECHNOLOGY | ENGINEERING | MATHS

Activity Catalogue

Key Stages 1-4

Contents

Introduction

Babcock encourage you to try our fun and challenging STEM activities in this catalogue. It aims to give you a better understanding on some real scenarios of how STEM based subjects relate to the work we do here at Babcock International.

We have activities which are suitable for each key stage to complete either at home or within the classroom. All activities are designed to provide further knowledge on how science, technology, engineering and maths is used in our everyday lives.

The world of STEM can be exciting and intriguing, at Babcock we take our duty very seriously on the promotion of STEM based subjects as they are vital to the world we live in today.

We welcome all feedback on the activities in this catalogue and would love for you to share your designs with us on: **Babcock.STEM.Events@babcockinternational.com**

For further information on our STEM opportunities, please visit our STEM website page on: **https://www.babcockinternational.com/who-we-are/babcock-and-stem/**

Our approach to STEM

We believe that encouraging an interest in STEM subjects should start early. The 5E model, developed by Plymouth City Council and adopted by Babcock (below) shows how we tailor our engagement to meet the needs of young people as they progress through the education system and towards employment.

Safety and practice of risk assessments

Safety note:

Please exercise appropriate and reasonable adult supervision for all activities in this book, based on the age and ability of each child.

Extreme care should be taken when using sharp objects such as scissors, electrical items and other materials listed in these activities.

Before undertaking any of the activities in this booklet, we encourage those participating to complete the below table to identify any potential hazards which could occur during the activity.

What is the hazard?	Using scissors or electric hairdryer	
What is the risk?	Possible injury if not used correctly	
What is the likelihood of this happening?	Low Medium High	
Who will this affect?	The person doing the activity or anyone around them	
What can be put in place to make this activity safer?	Use of safety scissors or help from an adult	

The human brain carries out hundreds of dynamic risk assessments every day without many of us realising, this could be anything from crossing the road to boiling a kettle. This activity will encourage individuals to think more about the potential safety hazards in their every day activities and any precautions which should be taken.

Structure challenge

1 HOUR

Materials

- Jelly beans/marshmallows or playdough
- Toothpicks
- Structure worksheet

Activity overview

Build a variety of 3D and complex structures.

Activity plan

- Use the worksheet to build simple 3D shapes with the toothpicks and jelly beans, marshmallows or playdough
- Complete the worksheet for each structure
- Experiment with various complex structures with different heights and shapes

Learning objectives

- Understand the difference between 2D and 3D shapes
- Understand the structure of different 3D shapes
- Understand the importance of stability within structures

Reflection questions

- What 2D shapes make up the 3D shape?
- How many faces, vertices and edges does the structure have?
- Which type of structure is more stable/stronger? What makes it stronger?

Challenge: Build a complex tower structure with as many 2D shapes within it as you can. Test the strength and stability of the structure by placing books on top.

Now try to build a stronger structure to hold more books, using the same number of toothpicks and jelly beans as before.

3D Structure	Number of...		
	Faces	Vertices	Edges
Cube Draw the 2D shapes used to make the structure:			
Cuboid Draw the 2D shapes used to make the structure:			
Triangle based pyramid Draw the 2D shapes used to make the structure:			

3D Structure	Number of...		
	Faces	Vertices	Edges
Square based pyramid Draw the 2D shapes used to make the structure:			
Triangular prism Draw the 2D shapes used to make the structure:			
Hexagonal prism Draw the 2D shapes used to make the structure:			

Build your own paper helicopter

1.5 HOURS

Materials

- Helicopter template (1 per group)
- Plain A4 paper (several sheets per group)
- Paperclips (5 per group)
- Scissors (1 pair per group) with adult supervision
- Ruler (1 per group)
- Pencils (1 per group)

Activity overview

The aim of the activity is for each group to build a paper helicopter and then vary the design to see how different factors affect its ability to fly.

Activity plan

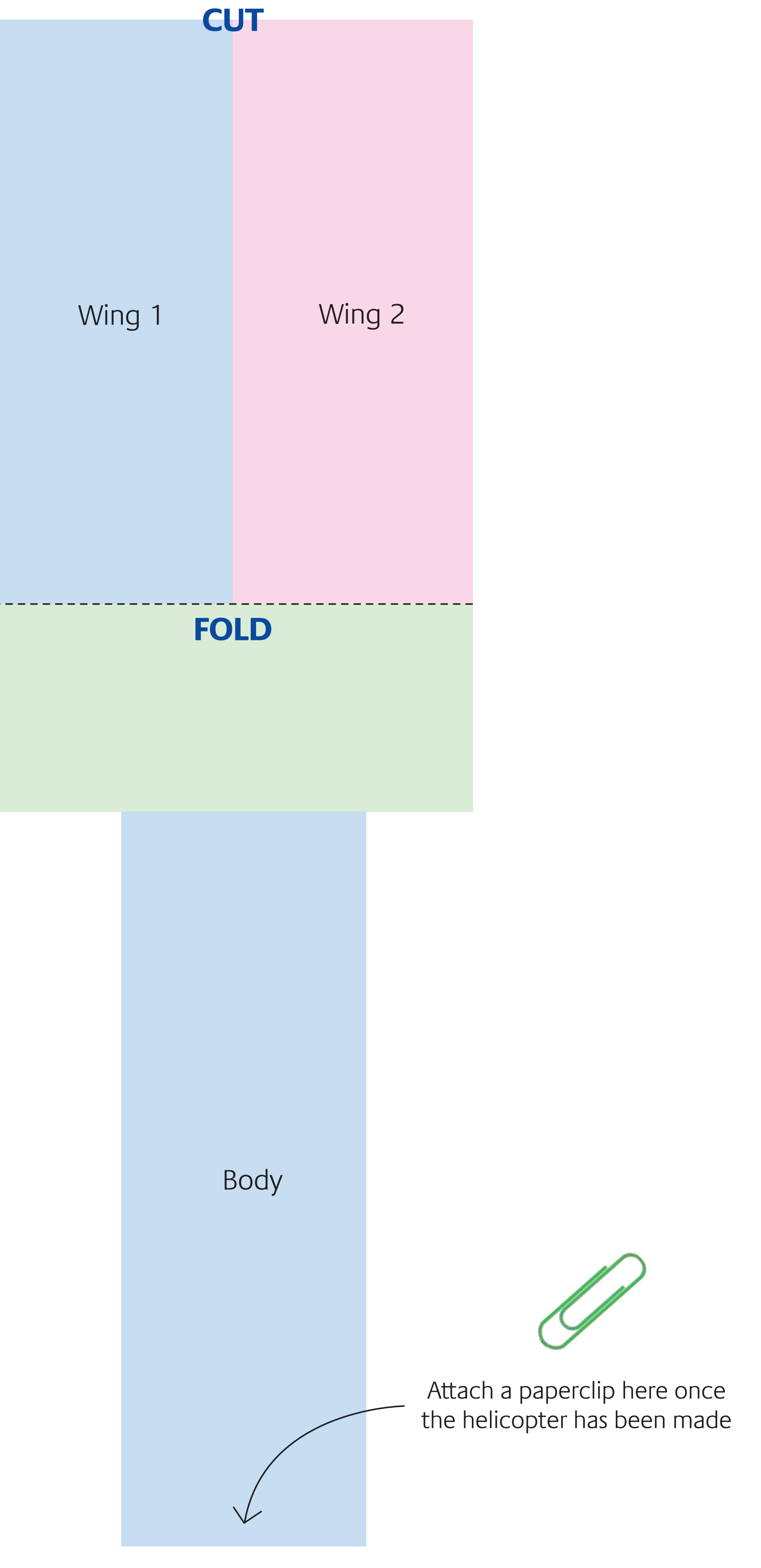
- In groups of three or four, the children will cut a sheet of A4 paper following the template provided and then fold this into a paper helicopter, before attaching a paperclip to give it some weight
- The group will then create different variations of the helicopter e.g. different width/length of wings/body, more/less paperclips, folding the corners of the wings etc
- If time allows the helicopters can also be decorated
- The different helicopters can then be compared by dropping them from a height onto a bullseye (simply holding above their head or even dropping from a window/balcony if such an area is available)
- The aim is for the helicopter to fall as slowly as possible down in a straight line
- The children will then choose their best helicopter and the different groups will compare their best attempts and a winner will be found

Learning objectives

- This activity allows the children to observe how different factors impact the final result, this principle can be applied to any experiment in STEM and demonstrates why choosing the optimum conditions for an experiment is vital
- Shows how helicopters use rotational forces to gain lift and slow the rate of the fall

Reflection questions

- Who had the best helicopter and why was it the best?
- Why is the way a helicopter flies different to an aeroplane?
- In future, how would you try to get the best results from an experiment?



Jumping fish

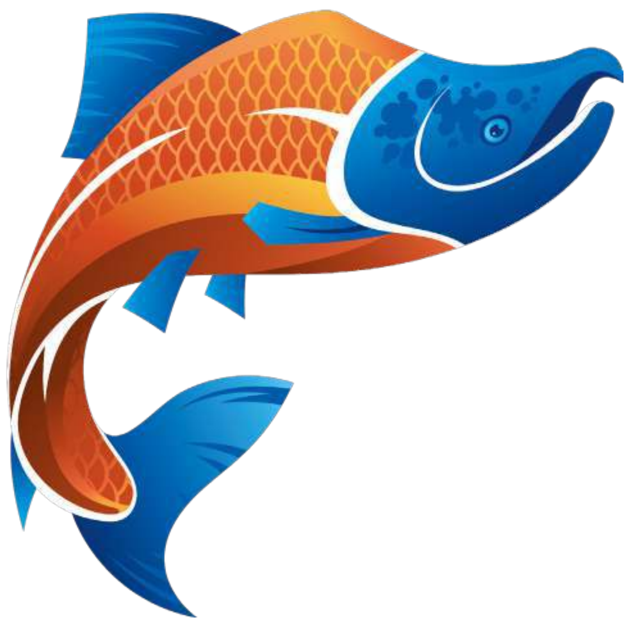
30-50 MINS

Using static electricity to make tissue paper fish 'jump' onto a balloon.

Key words/topics

- Balloon
- Charge
- Material properties
- Static electricity
- Tissue paper

Ever wondered why your hair sometimes sticks up and won't go down, or why you sometimes get a mild shock when you touch something? These are effects of the build-up of static electricity.



Purpose of this activity

In this activity you will investigate the effects of static electricity.
You will rub a balloon against your jumper and use the build-up of static charge to make tissue paper fish shapes 'jump' onto and stick to the balloon.

Introduction

We are going to investigate the effects of static electricity and use it to make paper fish 'jump' onto a balloon. You will need balloons, tissue paper and a safe pair of scissors.

Making tissue paper fish

Using safety scissors cut out fish shapes from tissue paper.

Try using different coloured tissue paper to make different coloured fish for more visual interest.

Blowing up the balloon

Blow up and tie your balloon – ask someone for help if you need it. The balloon should be blown up fully and tied so that no air can escape.

Making static electricity

Now rub the balloon against your jumper several times to 'charge' it with static electricity. If you are not wearing a jumper, then use your hair instead.

Making the fish 'jump'

Now hold the balloon just above your tissue paper fish shapes. The fish should 'jump' onto the balloon and stick to it.

Have fun watching the fish leap around and start to think about why the fish 'jump' onto and then stick to the balloon? How close does the balloon need to be for the fish to jump? What is causing this to happen?

The science

The balloon is charged with static electricity when it is rubbed against the jumper or hair. The tissue paper fish are attracted to this so 'jump' up towards the balloon and stick to it. When this static charge wears off, the fish will fall back off.

Radio communications with a tin can telephone system

1 HOUR

Materials

- 2 empty, clean cans
- String
- Printer
- Paper
- Two people

Activity overview

- Create your own method of communication
- Take it in turns to be a pilot and radio operator and test your communication skills

Activity plan

- Ask a responsible adult to punch a hole in the bottom of both cans
- Pass one piece of string through one can, then tie a knot in the end
- Pass the other end of the string through the second can and tie a knot in the end. (The string should be a reasonable length, e.g. at least two metres, otherwise the two people will so close that they will simply be hearing each other talk normally).
- One person needs to be the pilot and the other needs to be the radio operator
- Each person needs to hold a can, walk away from each other so that the string is taut
- The pilot should speak into the can whilst the radio operator holds it to their ear. Then try it the other way round
- Using the script below act out the different scenarios

Learning objectives

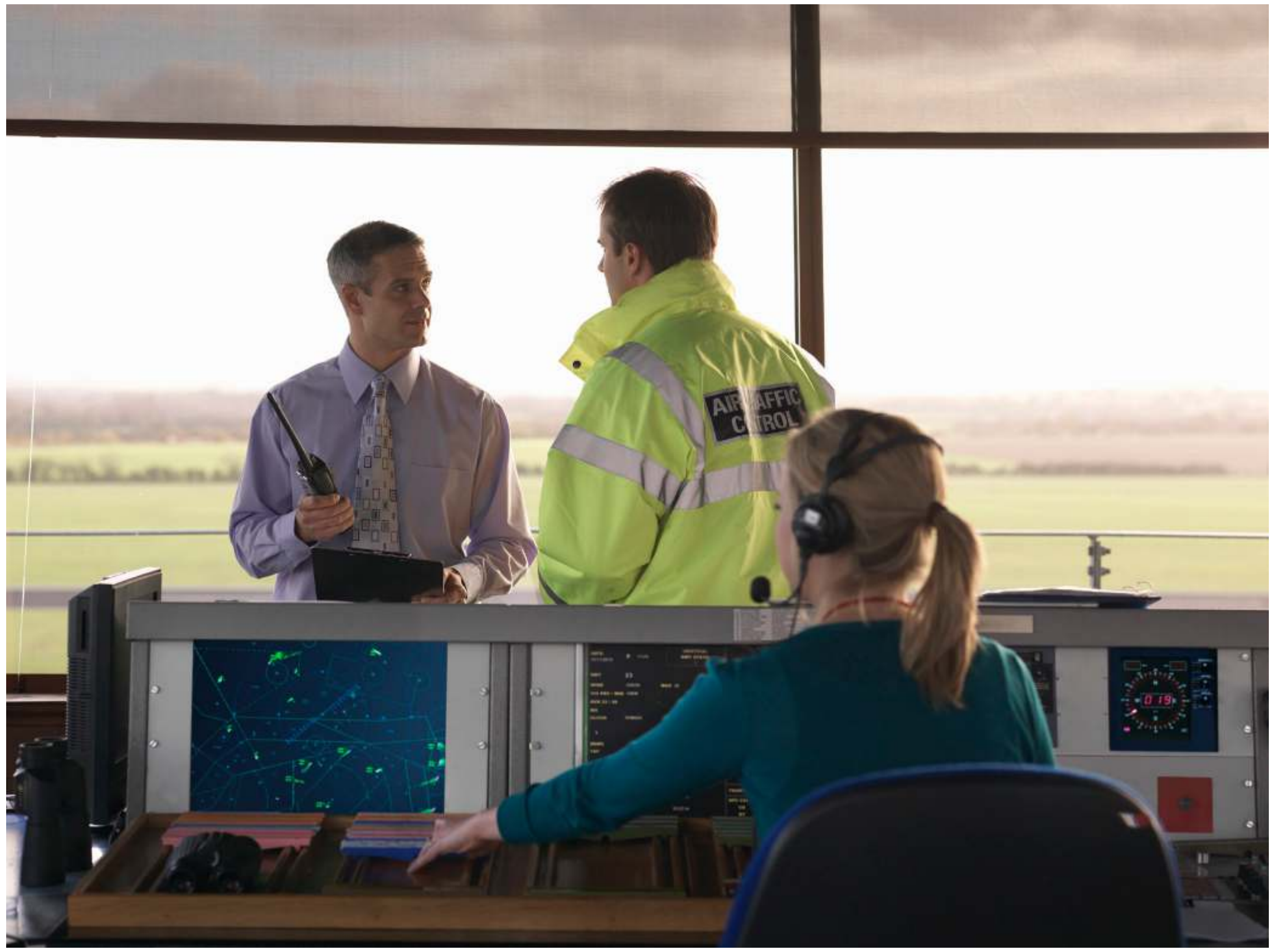
- Understand how to communicate clearly through an early method of communication
- Learn the basic radio conversation between a pilot and an air/ground radio

Reflection questions

- How easy was it to understand what each other said?
- How did you make it easier to hear each other?
- In a busy airfield environment with a lot of people flying, how do we know who is talking?

The importance of clear communication when flying

There are two reasons why this is important. Firstly, a pilot needs to communicate with the radio operators to receive airfield information and for them to know what aircraft is coming in. Secondly, it is important for other pilots to know where all aircraft are in order to avoid collision; they could come from any direction!



Activity overview

With so much air above us, you would think that aircraft could fly wherever they wanted, but with hotspots around airfields and thousands of aircraft in the air at one time, it is vital to ensure that aircraft maintain a safe distance from each other. Radio operators are a vital part to making this work and they utilise not just what the pilot is telling them, but also radar and their eyes to maintain a full picture of what's happening in the skies.

If you want to see exactly what is flying right now, in real time, why not check out this website:

https://www.flightradar24.com/ Click on the aircraft to see their flight paths and you might be lucky enough to get a picture of the aircraft too!

One of our later activities is all about the phonetic alphabet.
Head to page 28 to get your radio talk nailed.

Finding a paper aeroplane's centre of gravity

1 HOUR

Materials

- A4 piece of paper
- Pen
- Paperclip

Activity overview

- Every object has a point through which the force of gravity acts, this is called the object's centre of gravity. It is important to know where the centre of gravity is on an aircraft as it affects how an aircraft flies
- Do the experiment below to find out where the centre of gravity is and what happens when you move it

Activity plan

- Make a paper aeroplane
- Balance the plane on one finger - or a ruler - the centre of gravity is the point where the plane balances without falling off
- Mark this point with a pen as you need it for the next part of this activity
- Throw your paper aeroplane and then draw the flight path - what does it look like?
- Add a paperclip to change the centre of gravity on your paper aeroplane - how does this affect the flight of your aircraft?
- Move the paperclip across your paper aeroplane and see how each placement affects the flight path - try this five times, and remember to draw the flight path each time!
- Discuss your findings

Learning objectives

- Understand what forces act on an aircraft and how they are generated
- Understand what the centre of gravity is and be able to find it on a paper airplane
- Be able to predict what will happen to the flight path when you change the centre of gravity

Reflection questions

- What effect does moving the centre of gravity have on the flight path? In real life adding people, fuel and cargo affects the centre of gravity so it's an important part of everyday flying operations
- Was there one position of the paper clip that made the paper plane fly better?
- Why is that one the best, did it fly the straightest or longest?

The importance of centre of gravity when loading an aircraft

Babcock has a fleet of over 530 aircraft and we operate many more. Our fleet includes a mixture of fixed wing (aeroplanes) and rotary wing (helicopters) aircraft many of which have had several modifications and re-fits to ensure they can carry out our specialist missions.

As part of our daily operations our technicians and engineers will load and unload multiple aircraft, as well as fueling, de-fueling and re-fueling them.

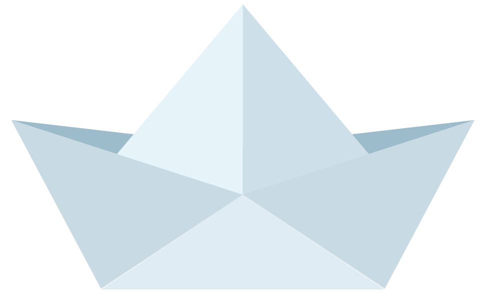
When fueling or loading an aircraft for flight it is important to understand what happens to the aircraft's aerodynamic properties when weight is added in different locations.

In our aerial firefighting operations, the centre of gravity of the Canadair waterbombers (pictured above) are constantly changing as they scoop up and release water over and over again. These aircraft can scoop up to 6,100 litres of water at a time so our pilots need to be highly aware of the change in centre of gravity so that they can keep the aircraft level and counteract the gravitational forces.

Complex calculations are used to work out where the centre of gravity is on an aircraft. Our engineers must be aware of what forces act on an aircraft, and how they change when fuel, people and cargo are added.

Paper boat challenge

1 HOUR



Materials

- A4 Paper
- Colouring pencils/pens
- Cling film/Tinfoil
- Sticky tape

Activity overview

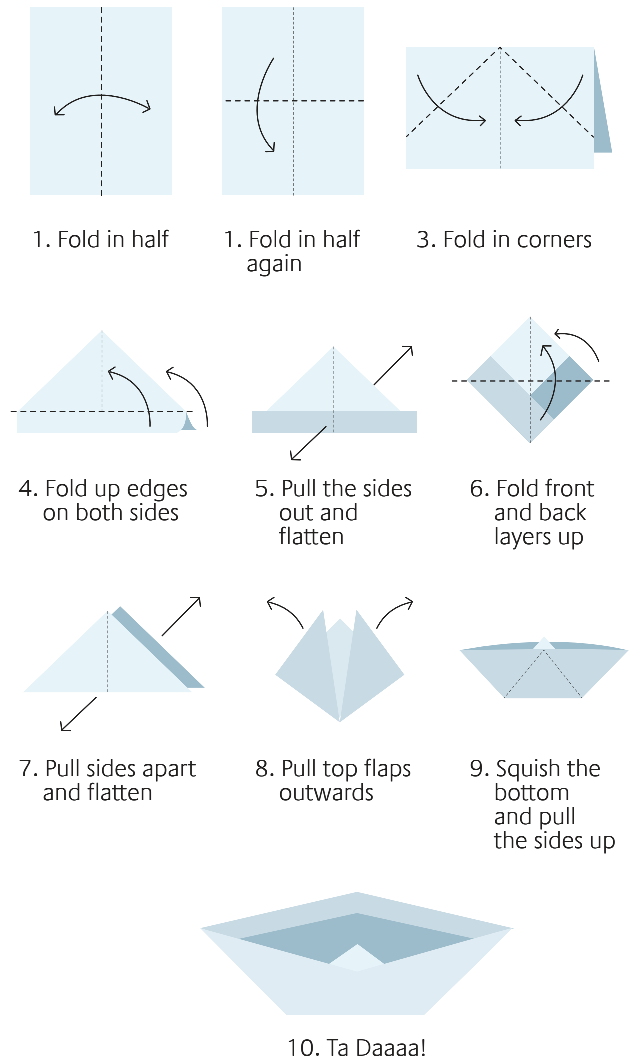
- This is a fun activity that focuses on the forces that act on a boat, and how boats are able to float when in water
- Do the activity below to help better understand these forces and put your artistic skills to the test!

Activity plan

- Make a paper boat using the instructions on the right
- Give your boat a name and a cool design
- Take a picture of your boat and share it with us using #BabcockSTEM
- Waterproof your boat using cling film, tinfoil and sticky tape
- Place your boat in water, checking to see that it floats. What forces act on the boat as you push it forward?
- Discuss why your boat floats on the water

Learning objectives

- Understand how buoyancy forces allow a boat to float on water
- Understand how density is important when designing a boat
- Observe the forces that act on a boat when it's in water



Reflection questions

- Why is the bottom of a boat narrow? Why does this help keep it afloat?
- What happens to your boat if you add more weight to it and why?
- What do Babcock engineers need to think about when designing boats? Think about weight, design, materials, and propulsion

The importance of buoyancy and density in ship design

Our engineers need to make sure that the ships we design and manufacture are fit for purpose. So why are buoyancy and density so important in ship design?

When an object is placed in water, it pushes water aside. This is known as displacement. The amount of water displaced is equal to how much of the object is in the water. Boats are shaped in a way that displaces as much water as possible, so that the water being pushed aside weighs more than the ship. This means the boat is buoyant because it is lighter than the water displaced around it, allowing the boat to float.

This is where density plays an important part. Density refers to the mass of an object has relative to its volume. A good example of the importance of density is comparing a bowling ball to a football. Although they often have the same volume (are the same size), the football is hollow and filled with air, meaning it has less mass (is lighter) than the bowling ball. When you place them both in water, their volumes displace the same amount of water. But because the football has less mass than the water displaced around it, it will float. The bowling ball is heavier than the displaced water, so it will sink.

As we mentioned, ships are designed to displace a huge amount of water. Although ships are very big, they are mainly hollow inside so their volume is much greater than their mass (similar to a football). This means a ship is a lot lighter than the water displaced around it, allowing the ship to easily float.

Apart from buoyancy, what other forces act on a boat as it moves forward? As buoyancy forces push the boat upwards, gravitational forces will pull the boat downwards. Propulsion forces from ship engines will push the boat forward which is known as thrust. This is met by wind resistance and water friction, also known as drag.

DIY Robot hand

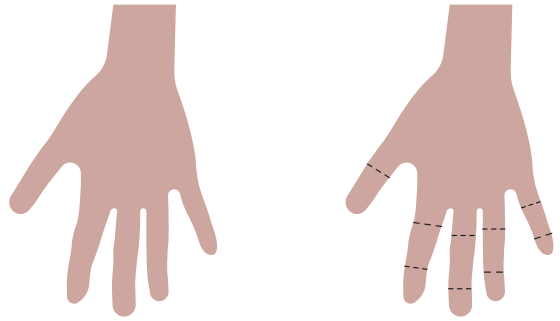
1 HOUR

Materials

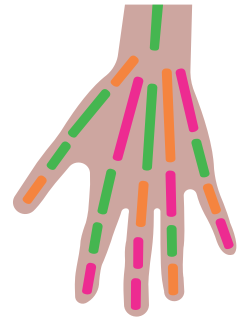
- Standard drinking straws (paper or plastic)
- Jumbo-size drinking straws (smoothie straws – paper or plastic)
- Card
- Scissors (with adult supervision)
- Pencils
- String (various colours if you can)
- Tape

Activity overview

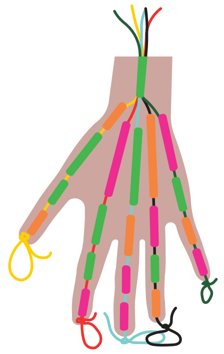
Combine your engineering and creative thinking skills to create a robot hand. This simple and inventive activity will show you how to create a moving, bendable hand.



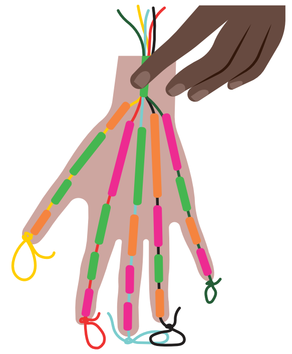
1. Trace an adult's hand onto the card, cut the outline with scissors and mark the joints of the finger. Where the joints have been marked, create folds so that your fingers 'bend'.



2. Cut the standard sized straws into ¼”, ½”, 1” and 2 ¼” sizes. Tape the standard straws onto the hand and tape the jumbo straw onto the wrist.



3. Using a different colour of string for each finger (if possible), cut five strands of string into two feet long pieces and put a knot in one end of each strand. Thread one strand of string through each finger – all the strands should meet at the wrist.



4. Pull on the strings individually and in combination to explore the wonder of robotic hands!

Learning objectives

- Understand the interconnectedness of arts and technology
- Think creatively about designing and building a robotic hand

Reflection questions

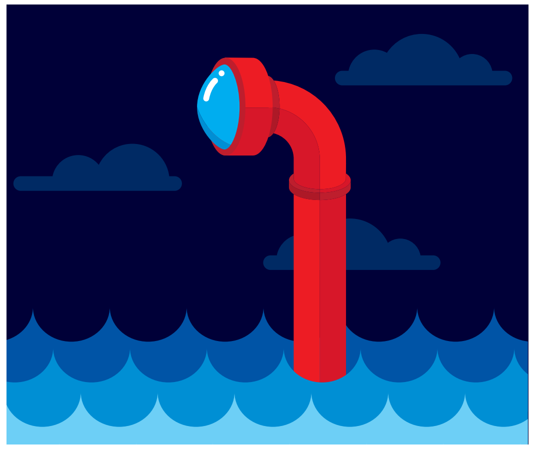
- Can you make other body parts, such as a foot?
- Can you improve your design by adding springs or bits of foam?

Periscope challenge

1 HOUR

Materials

- Cardboard box (An old cereal box would work well)
- Old mirrors or bought online/shop
- Cling film/tinfoil
- Sticky tape and glue



Activity overview

- This is a fun activity that focuses on using reflection of light to view images
- Do the activity below to help better understand how submarine periscopes operate

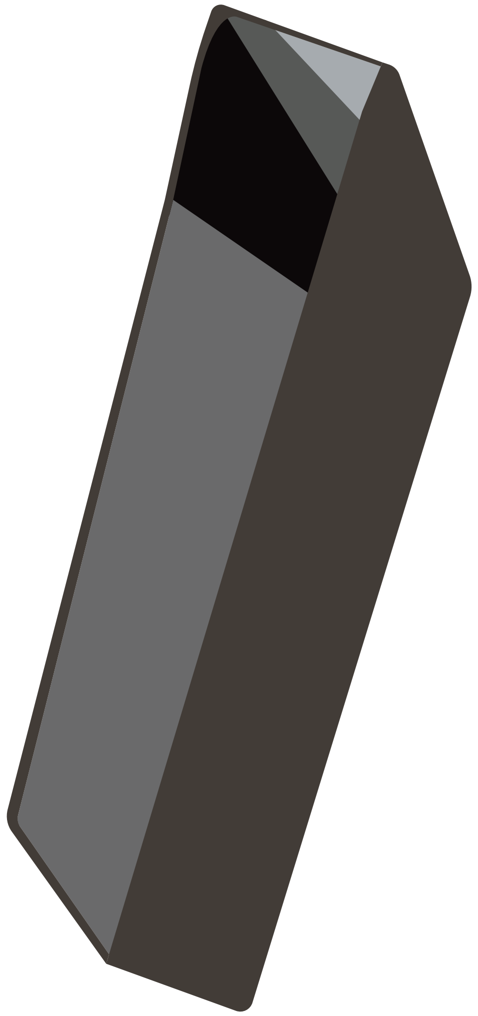
Activity plan

Using an old cardboard box follow the instructions below to create your periscope:

1. Make sure box is empty before using it
2. Print out or copy the template on the last page
3. Glue the template to the cardboard box and leave to dry
4. Cut around the template along the solid lines
5. Using a ruler to help, fold inwards along the dotted lines, using a ruler will allow the lines to stay straight
6. Glue or tape the flaps to create the shape of the periscope
7. Glue the mirrors into place on the sloped faces ensuring the mirrored face is visible!
8. Wrap the box in paper or colour/paint the box to a design of your choice

Take a picture of you using your periscope and share it with us using **#BabcockSTEM.**

Good luck on your mission!



Learning Objectives

- Understand how light reflects on a mirror and how this transfers to your eye
- Understand why it is important to be precise when manufacturing a product

Reflection questions

- What happens if the mirrors aren't positioned correctly? Can you see?
- What happens if the shape of your periscope isn't perfectly straight?
- What do Babcock engineers need to think about when fixing periscopes?

Periscopes old and new

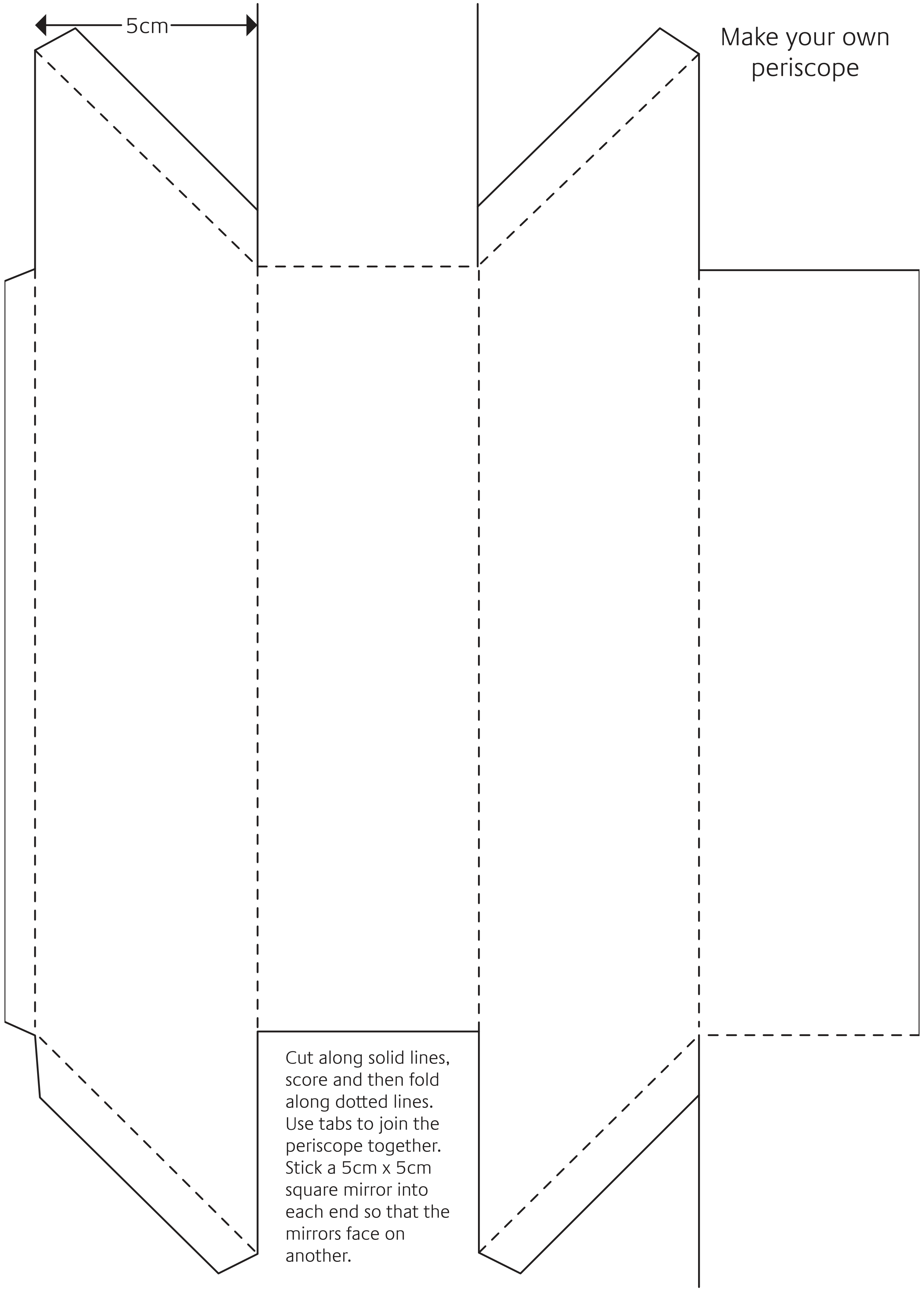
The first naval periscope was invented in 1845 and consisted of a vertical tube containing two mirrors set at 45 degrees. These were used within submarines to see above the waterline when the submarine was fully submerged.

Older style submarines use a traditional periscope similar to the one we have built using mirrors and pipes. Newer ones are a lot more advanced.

But how does the periscope work?

Light reflects away from a mirror at the same angle that it hits the mirror. In your periscope, light hits the top mirror at a 45 degree angle and reflects away at the same angle, which bounces it down to the bottom mirror.
The reflected light hits the second mirror at a 45 degree angle and reflects away at the same angle, into your eye.

See page 20 for a template to make your own periscope.



Design your own airfield

2 HOURS

Materials

- Paper
- Pens and pencils

Activity overview

Read the description of a typical airfield and then create your own

Activity plan

Using the description, draw an airfield which contains all of the elements described:

- Runway (at least 2!)
- Windsock
- Control tower
- Hangars
- Maintenance hangar
- Fuel bowsers
- Fire truck station
- Café
- Briefing rooms
- Car park
- Guard room

Learning objectives

- Understand how an airfield is laid out
- Realise what the important parts of an airfield are and why

Reflection questions

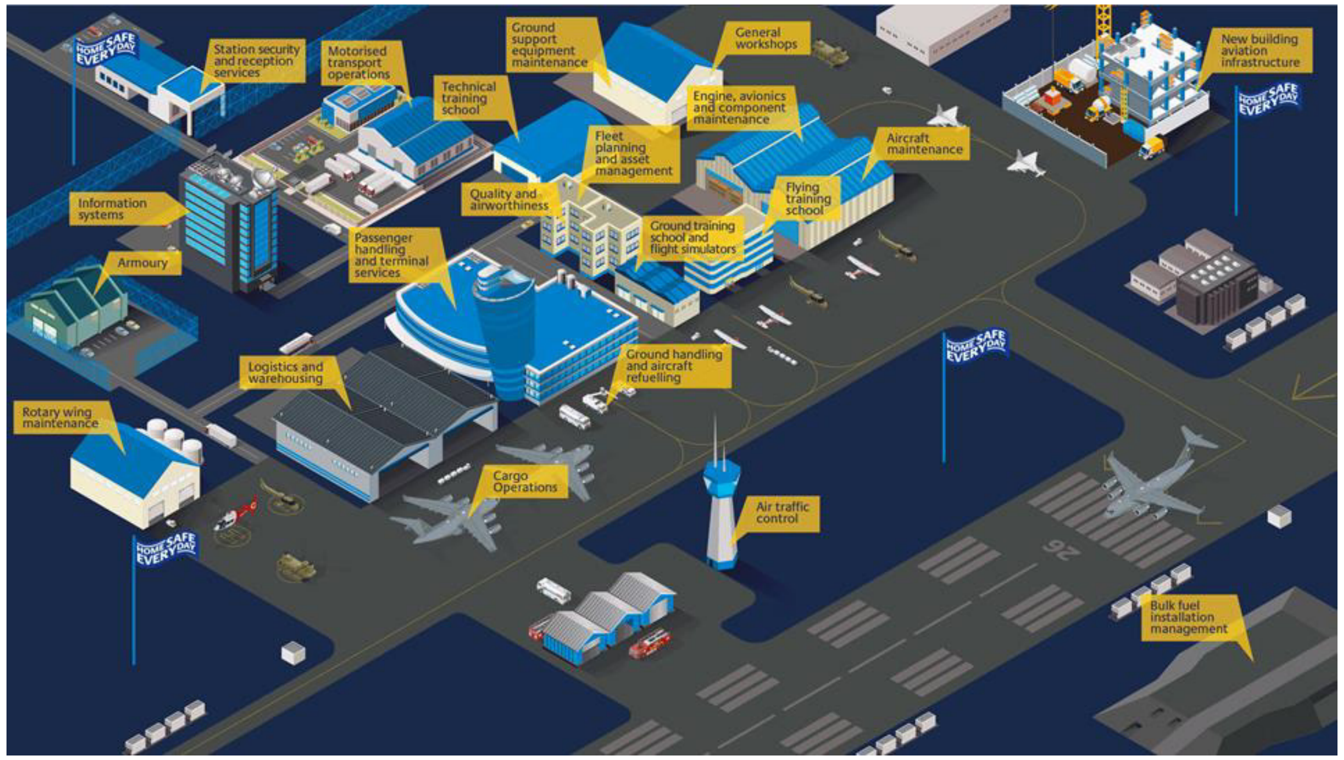
- Where is the best place to put a control tower?
- Can you follow a pilot all the way through their flying? First, they would arrive at the guardroom and check-in. Then they would have to park their car. Next would be planning their flight in the briefing room. Then they would need to go and check their aircraft over in the hangar. Once that is done they can get in their aircraft and talk to the radio operators to find out the airfield information. They will then taxi out to the runway and take-off. When they have finished their flying, they will come back and land on the runway. Then they will taxi to the fuel bowsers to top up, then back to the hangar and put the aircraft to bed. Head back to the briefing rooms for a debrief and then pop to the café for a cup of tea and some cake (flying is tiring work!). Back to the car, go and checkout at the guard room and then head home.

Babcock and air station support

Babcock Aviation operates at around 300 sites across the world, with varying levels of air station support. One of our contracts with the MoD is called HADES and this involves supporting military airfields across the UK and providing services such as security, refueling, storing and maintaining weapons, maintaining ground support equipment, providing and maintaining motorised transport and welcoming visiting pilots. All of these support functions have a direct impact on allowing the military to continue flying and protecting our nation.

A lot of the airfields that we operate have even more facilities than the ones we've discussed in this activity, every single one vital to completing the missions required. The ones you have placed on your airfield are the crucial elements for every airfield but some sites will have flying schools, armories or medical equipment stores.

Each airfield is specifically built for the purpose of the site, whether it is military flying training, air ambulance or firefighting and Babcock adapts to each situation to provide the right service for our customers.



Heavy aircraft take longer to gain the speed they need to take-off. This means they need a longer runway. Heavy aircraft also need a much harder surface to take-off from, whereas a light aircraft can take off on grass (as long as it's not too wet and muddy!)

Airfield Brief

Every airfield has at least one runway, but normally has two at right angles to each other so that the aircraft can always take off into the wind. You may know that a runway is allocated a number; this is based on the direction of the runway. A compass is used to work out the direction of the runway and the first two numbers are then used to mark the runway. When a pilot is coming in to land, they are told which runway to land on e.g. '26'. Then when they fly over the airfield, they will see the numbers painted and will aim to touchdown on those numbers.

At each end of the runway is a windsock, this tells the pilot which direction the wind is blowing and how strongly it is blowing just above ground level. A pilot about to take-off or land will need to know this information to ensure a successful take-off and landing.

Every aircraft is communicated with by radio operators who can inform them of the airfield conditions and guide them to/from the airfield. It is important that the radio operators have good sight of the runway and any aircraft that are flying in or out. It also needs to be high enough to see over any buildings. This building is called the 'Control Tower'.

Every airfield needs hangars to store the aircraft in; this protects them from the weather and keeps them in good condition. It is best if the hangar doors open on to a taxiway, which leads from the hangar to the runway so that the aircraft have a solid surface to move along.

Where there are aircraft there is a need for maintenance so a maintenance hangar is very important. All aircraft must be fit to fly and if there is a problem then it needs to be fixed quickly to get it back in the air as soon as possible.

All aircraft need fuel to run so it is important to have fuel bowsers. Depending on the airfield, it will either need to be in a position where aircraft can taxi to it or there will be trucks that take the fuel from the bowser to the aircraft.

In case of an emergency, every airfield has a fire truck and staff trained to act in an emergency. The fire truck should be stored in its own building to protect it from the elements. The fire truck station should be one of the closest buildings to the runway so that if something does happen, they can respond as quickly as possible.

To encourage pilots to fly to an airfield it's important to have a café for food and drinks. A full pilot is a happy pilot! It is also good to have some briefing rooms where pilots can plan their flights and instructors can do any ground schooling with students.

Pilots will drive a long way to go to a good airfield and there will probably be some keen aircraft photographers visiting so it is a good idea to have a car park for everyone.

Aircraft are expensive and it's important to protect them as much as possible, so some airfields will have a guard room at the entrance, to keep an eye on who comes in and goes out.

Create your own windsock

1 HOUR

Materials

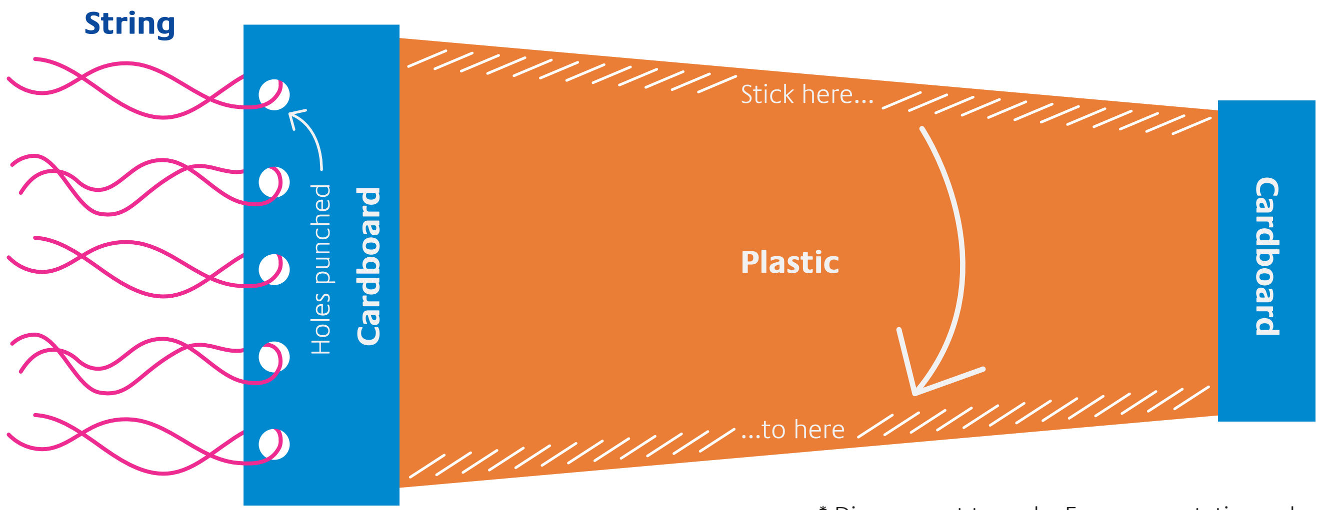
- Hair dryer or fan
- Plastic bag
- String
- Card
- Scissors (with adult supervision)
- Hole punch
- Pen with clip
- Sellotape

Activity overview

Create a windsock, then using a fan or hair dryer, test how your windsock works.

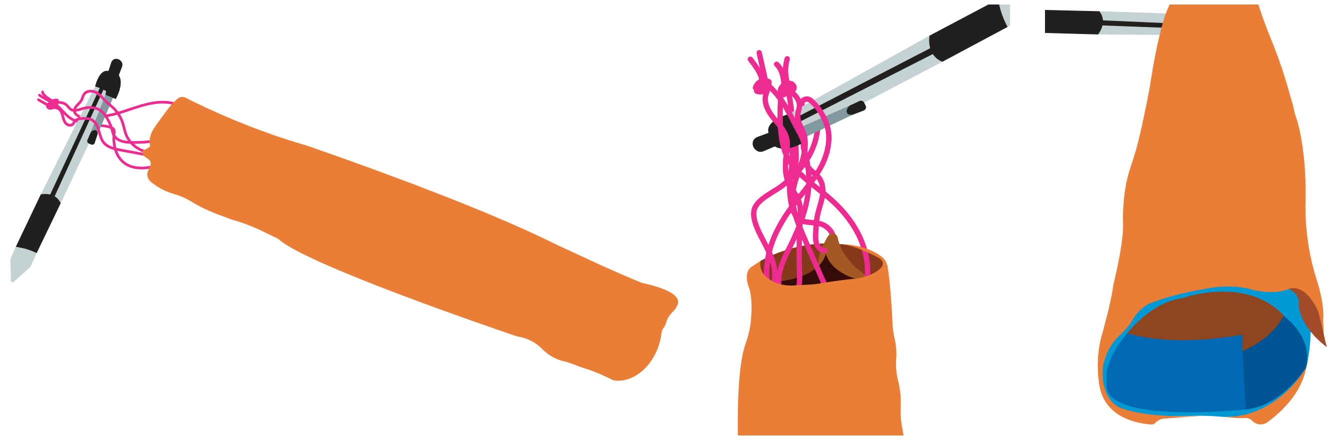
Activity plan

- Cut a plastic bag into a 20cm x 15cm x 20cm x 10cm quadrilateral
- Cut one 15cm x 2cm and one 10cm x 2cm rectangles of cardboard
- Punch 4 holes along one of the rectangles of cardboard
- Place one piece of cardboard at each end of your plastic rectangle, ensuring that the holes stick above the edge of the plastic. Secure them together using sticky tape
- Now role up the plastic and card, sticking the long sides together to create a long tube
- Cut 4 lengths of string, each 10cm
- Put each piece of string through one of the holes in the cardboard, tying the ends together to create a loop



* Diagram not to scale. For representation only.

- Loop each piece of string through the clip on your pen
- Hold the bottom of your pen so that your windsock is hanging from the top of the pen. Now point a hair dryer or fan at your windsock
- Try changing the direction of the air. If you can, change the strength. What happens?



Learning objectives

- Understand how a windsock operates
- Discover why a windsock is an important bit of kit at every airfield

Reflection questions

- When you move the direction that the air is coming from, what happens to the windsock?
- If you can change the strength of the air flow, can you see a difference in the angle of the windsock?

The use of windsocks when flying

Every single one of our 1,300 pilots relies on a windsock for every one of our 90,000 missions. This really simple bit of kit can be seen at the end of every runway, at every helipad and even on the side of the road. A pilot will check the exact weather before they get into their aircraft, but this can change quickly and can be quite different when you get to the end of the runway, ready to take off, so a windsock can really help to tell exactly what the wind is doing in that moment.

A windsock tells us two things. Firstly, it tells us which direction the wind is blowing. Using a compass, we can identify which direction the windsock is blowing. If it is pointing to the east, it means that we have a westerly wind, because the wind is coming from the west to the east.

Secondly, the angle of the windsock tells us how fast the wind is moving. You can buy different sized windsocks that will measure different speeds but if we have a 30 knots windsock then you would know that if the windsock is at a 90° angle to the pole, then the wind is blowing at 30 knots. If it is 45° from the pole, then the wind strength is 15 knots.

Windsocks are usually made of bright orange fabric so that they are clearly seen. Some windsocks will also have white stripes.

Safely supporting an egg's descent from height

1-2 HOURS

Materials

- Paper
- An Egg
- Tape
- A first floor window or balcony (and a safe space below them)

Activity overview

- Since the beginning of time, humanity has tried to combat the effect of gravity through flight and other methods. One method that has been used and perfected over the years is the use of a parachute to generate air resistance on a huge scale and slow the speed towards the earth's surface due to gravity
- Complete the experiment below to see if you can create a suitable solution to prevent an egg from breaking when it is dropped from height

Activity plan

- Create a method to transport and protect the egg so that it doesn't break when it's dropped from a height of 5 meters or more. Think about how you package the egg up, if a parachute would help, and what other methods might stop the egg from cracking
- Now test it out. Drop the contraption from your window or balcony (ensuring it will not hit anyone below!) and then check to see if the egg survived without cracking
- Did your contraption work? Why not have another go and see if you can do any better

Learning objectives

Understand what parachutes do and how they slow down the effects of gravity. Create the best one for your egg!

Reflection questions

- Is there anything you could have done better to achieve a smoother landing?
- Is there anything you think could be improved on your parachute to ensure the egg is comfortable and does not break?

Why parachutes are so important

Babcock maintains military parachutes at various sites across the UK. Some aircraft have parachutes built into the ejection seats, such as the Hawk T2, whilst in others, such as the Grob 120, the students and instructors must wear a parachute. In cases of emergency, these vital pieces of kit allow pilots to vacate an aircraft and land safely on the ground.

Just like everything else relating to the aircraft, these require maintaining to ensure that in the event of an ejection, the pilot and instructor are not harmed or injured. It is part of our job to service and maintain these lifesaving bits of kit for the military and we take this job very seriously.

Did you know that a pilot is only allowed to eject from an aircraft a certain amount of times before they are not allowed to fly again? Every time you eject, the pressure created reduces your height!

Using the phonetic alphabet for aircraft identification

1 HOUR

Materials

- Pen
- Paper

Activity overview

- Learn the phonetic alphabet
- Understand how an aircraft registration is spoken

Activity plan

- Spend at least 20 minutes looking at the phonetic alphabet on the below page and do your best to remember it
- Hide the phonetic alphabet
- Write down the aircraft registrations in phonetic as you would say it on the radio

Learning objectives

- Remember the phonetic alphabet
- Understand how pilots and radio operators communicate clearly

Further activity

- Can you spell your name using the phonetic alphabet?
- When you're in the car, try saying the car registrations using the phonetic alphabet as they drive past. If you're on the radio you would also separate the numbers, so FG21 would be said 'Foxtrot, Golf, Two, One'

Using the phonetic alphabet to keep in touch

To communicate clearly over the radio, pilots and radio operators use something called the phonetic alphabet. This is used across the world so that everyone can communicate with each other. Every aircraft has a unique registration, like a car, which is painted on the side of the aircraft and is used when talking to the radio operators on the ground, so that they know who to talk to. A registration looks like G-BPCK and is said 'Golf, Bravo, Papa, Charlie, Kilo'.

Radios aren't always reliable and the signal may not be strong enough to hear clearly. Using the phonetic alphabet and saying the numbers separately means that a message can be received, even when the radio signal is poor.

Babcock train over 20,000 student pilots a year and all of them must know the phonetic alphabet in order to communicate via radio.

Did you know that the first letter of an aircraft registration shows what country it is from? If it starts with G then it is from the UK. F is for France, N is for USA.

Remember the phonetic alphabet below

Alpha
Bravo
Charlie
Delta
Echo
Foxtrot
Golf
Hotel
India
Juliet
Kilo
Lima
Mike
November
Oscar
Papa
Quebec
Romeo
Sierra
Tango
Uniform
Victor
Whiskey
Xray
Yankee
Zulu

Write the phonetic version of these aircraft registrations

C-GMFX	Charlie	-	Golf	Mike	Foxtrot	Xray
D-HAFG		-				
G-CLKO		-				
E-CHOQ		-				
F-GPCR		-				
G-WROL		-				
I-ZANL		-				
F-HBKZ		-				
G-BYUJ		-				
I-DPCS		-				
G-TVAL		-				
C-GJFO		-				
D-HAVY		-				
E-CFVO		-				
C-GMFZ		-				
E-CJAK		-				
F-HLNO		-				
G-BZRS		-				
E-CKUQ		-				
I-EITH		-				
F-HZAP		-				

Environmental sustainability

1 HOUR

Activity overview

Environmental sustainability: It is vital that we look after our planet – earth. We've only got one!

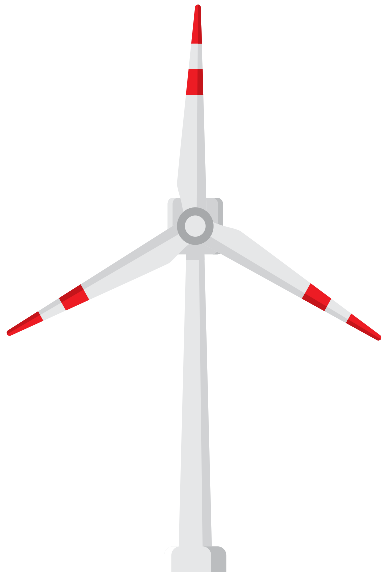
It is important to only use what we need and ensure we get the most out of everything that we use.

Only use what you need

You wouldn't sharpen a new pencil every time you wanted to write something, as that would be a waste.

Make the most out of everything we use

- You wouldn't eat your soup with a tiny teaspoon, as you would be taking lots of mouthfuls to finish the soup. Using a big spoon is more efficient
- It is important to make sure that we are efficient to help protect the environment



Challenge 1

Stacey has left the lights and TV on all night and forgot to close the fridge door. The windows were open all night and the heating was on. In the morning, the food was rotten and she had to throw it all out and go back to the shops to get more.

What could she have done better?

1. What are the wastes?
2. What could she have done differently?

Challenge 2

Stacey wants to spread the word about climate change and the environment.

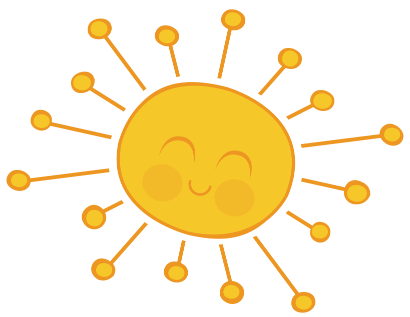
Can you help her by designing a poster?

1. Design a poster of a healthy environment

OR

2. Design a poster showing the dangers of climate change

Please send any posters to: marine.rosyth.stem@babcockinternational.com



Learning objective

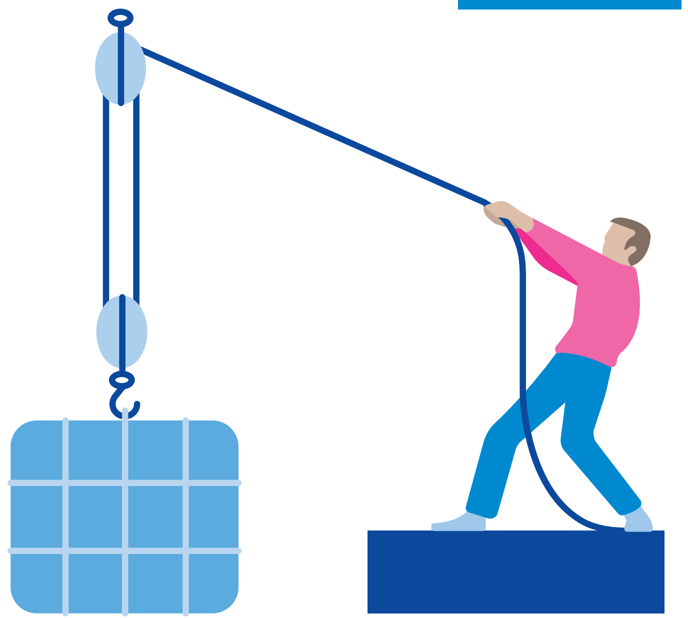
- Understand how sustainability is linked to the environment
- Learn how we can make changes to be environmental

Build a pulley system

1 HOUR

Materials

- 2x Small Cardboard Boxes
- 2x Pencils
- Sewing Spool
- String
- Paperclip

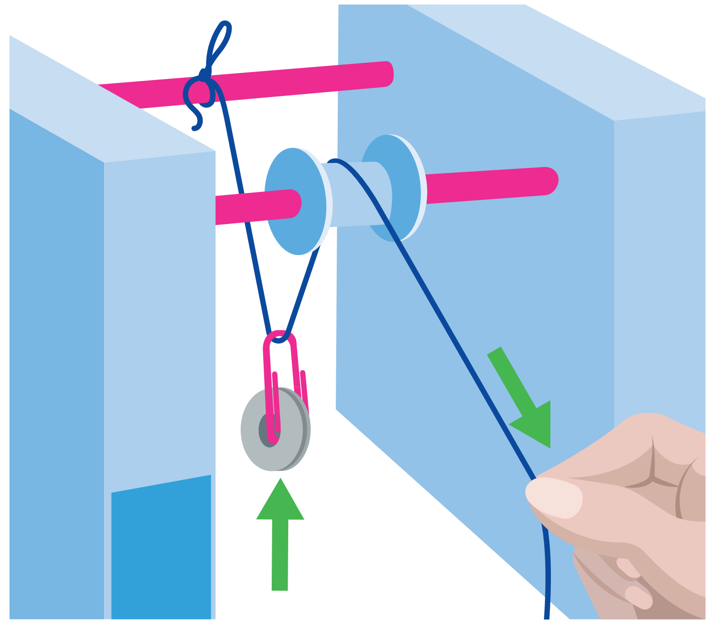


Activity overview

- In this activity we will learn what a pulley is and how they use mechanical advantage to lift heavy objects
- Use the Activity Plan below to build your own compound pulley system

Activity plan

- Use two boxes of the same size, such as cereal boxes, and place them on a flat surface
- Slide the sewing spool onto the middle of one of your pencils. If you don't have a sewing spool, try wrapping Blu Tack around the pencil as an alternative
- Make two pairs of holes approx. 5-6 cm apart for the pencils to go into
- Tie one end of the string to the middle of the other pencil
- Slide the paperclip onto the string so it's between the two pencils
- Attach a load to the paperclip and test out your pulley system!

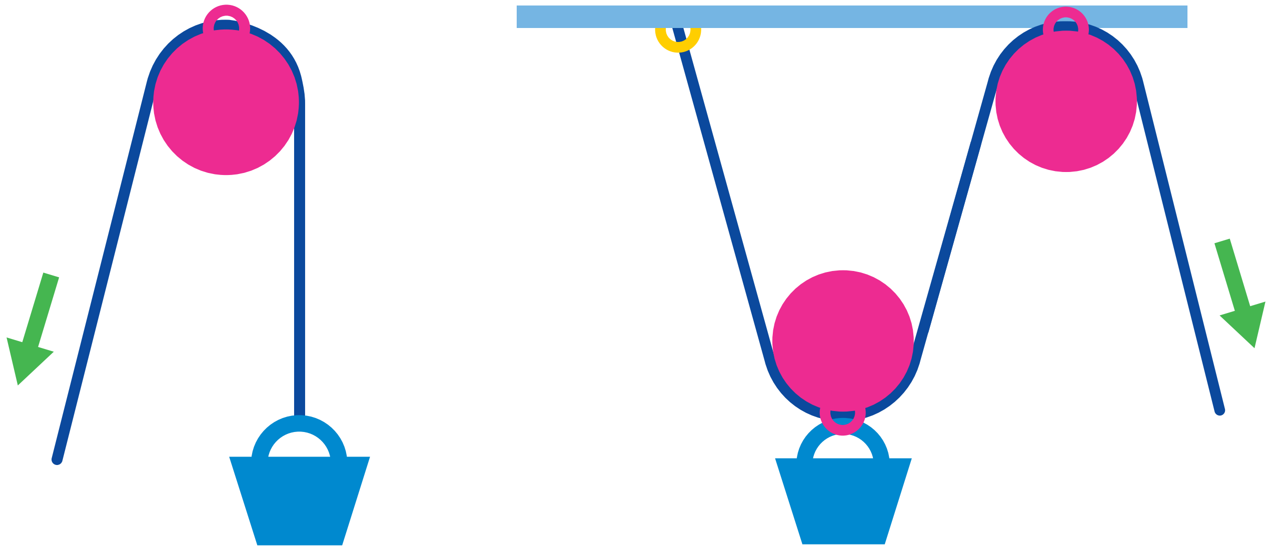


Reflection questions

- How could your pulley be designed differently to further reduce the weight of the object?
- Why would Babcock need to use pulleys?

What is a pulley system?

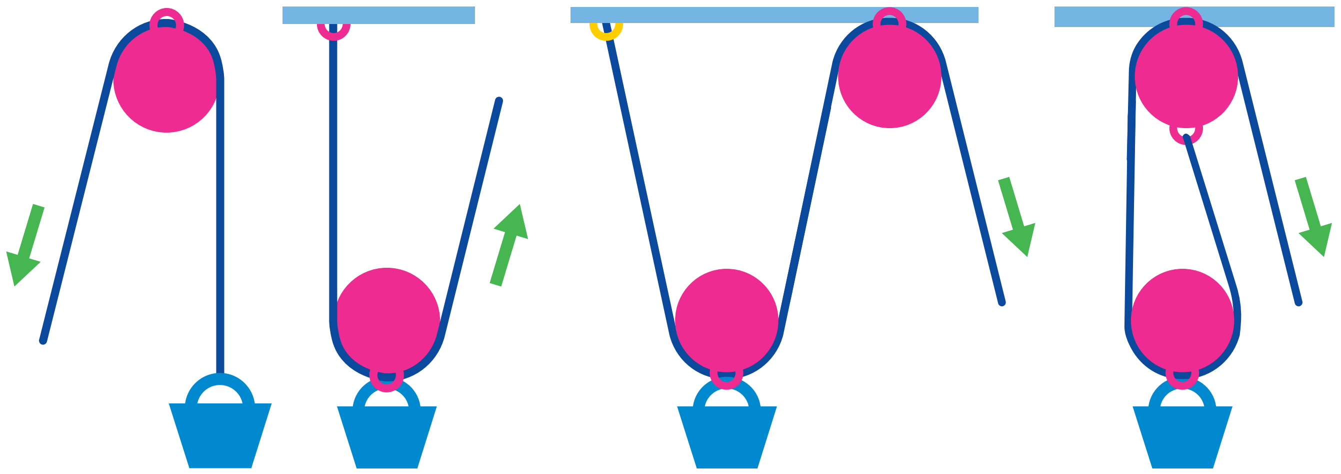
Sometimes lifting heavy objects can be difficult when only using human force. This can be helped by using a 'simple machine' known as a pulley. A pulley system is a collection of one or more wheels which are used with a rope or chain to make it easier to lift things. A basic pulley consists of a wheel on a fixed axle, with a groove along the wheel's edge to guide a rope or chain. The amount of force required to lift the object is equal to the load. For example, if our load weighs 100kg then we will have to apply 100N (Newtons) of force to lift the load.



The amount of effort that is required to lift the object can be greatly reduced by adding two or more wheels together. As more pulleys are added, you increase your mechanical advantage. This means it becomes increasingly easier to lift the same load. The only difference is that you need a longer piece of rope/chain to lift the same load.

Mechanical advantage is the measurement of how much force is required when using a pulley system. The bigger the mechanical advantage, the less force is required, but the greater the distance you have to use that force. So for a two wheeled compound pulley, you only have to apply 50N of effort to lift a 100kg load. The fixed axle is helping to lift the load by giving us the other 50N of effort required. An example can be seen in the two-wheeled pulley system above. If you look at the wheel connected to the load, one side is being lifted by the person/machine using force (green arrow), and the other side is being lifted by the yellow hook.

Types of pulley



From left to right:

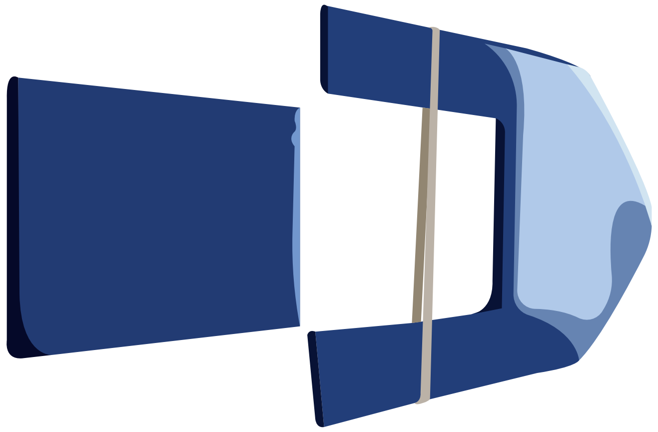
- Fixed pulley
- Moveable pulley
- Compound pulley
- Block and tackle

Propulsion power!

1 HOUR

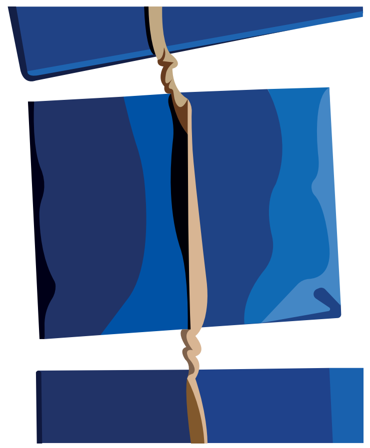
Materials

- Cardboard
- Rubber band
- Sticky/duct tape



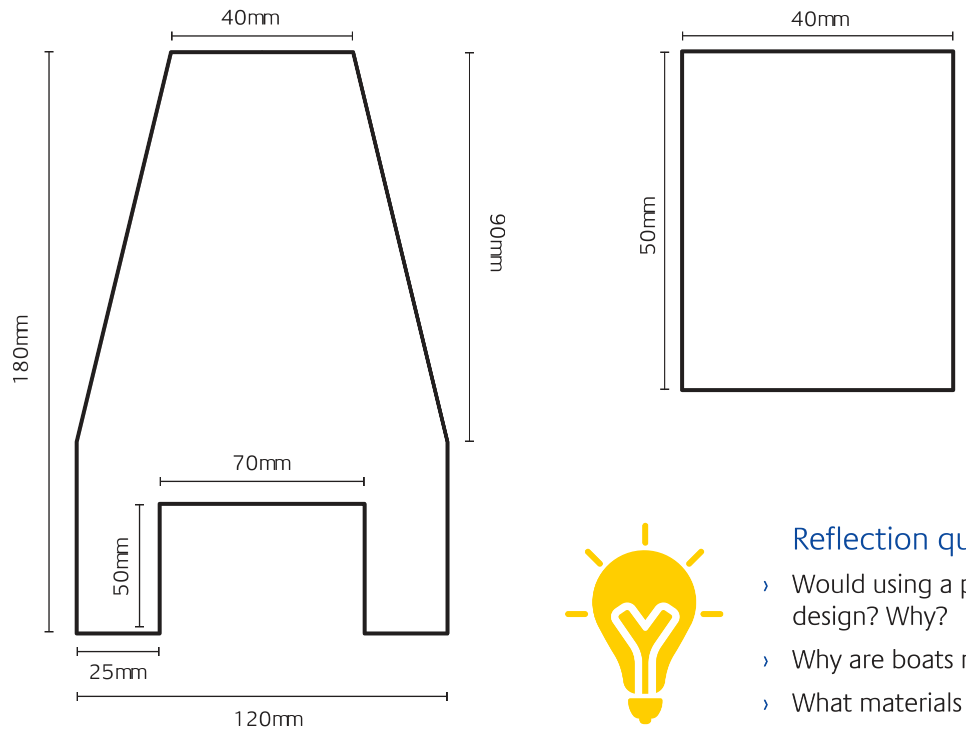
Activity overview

- This is a fun activity that uses a propeller to move your boat through water
- Create this experiment and see how fast your boat will go!



Activity plan

- Create the shape of your boat and propeller with some cardboard using the templates below
- Wrap your boat and propeller with duct tape or sticky tape to keep them waterproof
- Attach the rubber band to your boat, and place the propeller in the middle
- Wind the propeller until the rubber band is tightly wrapped (see the example)
- Place the boat in water whilst keeping a hold of the propeller
- Release the propeller and watch your boat accelerate forward!
- Take a picture of your boat and share it with us using #BabcockSTEM
- **EXTRA:** See if you can create a similar boat using a plastic bottle



Reflection questions

- Would using a plastic bottle improve your boat's design? Why?
- Why are boats narrow at the front?
- What materials are used to make ships and why?

Babcock Marine Crossword

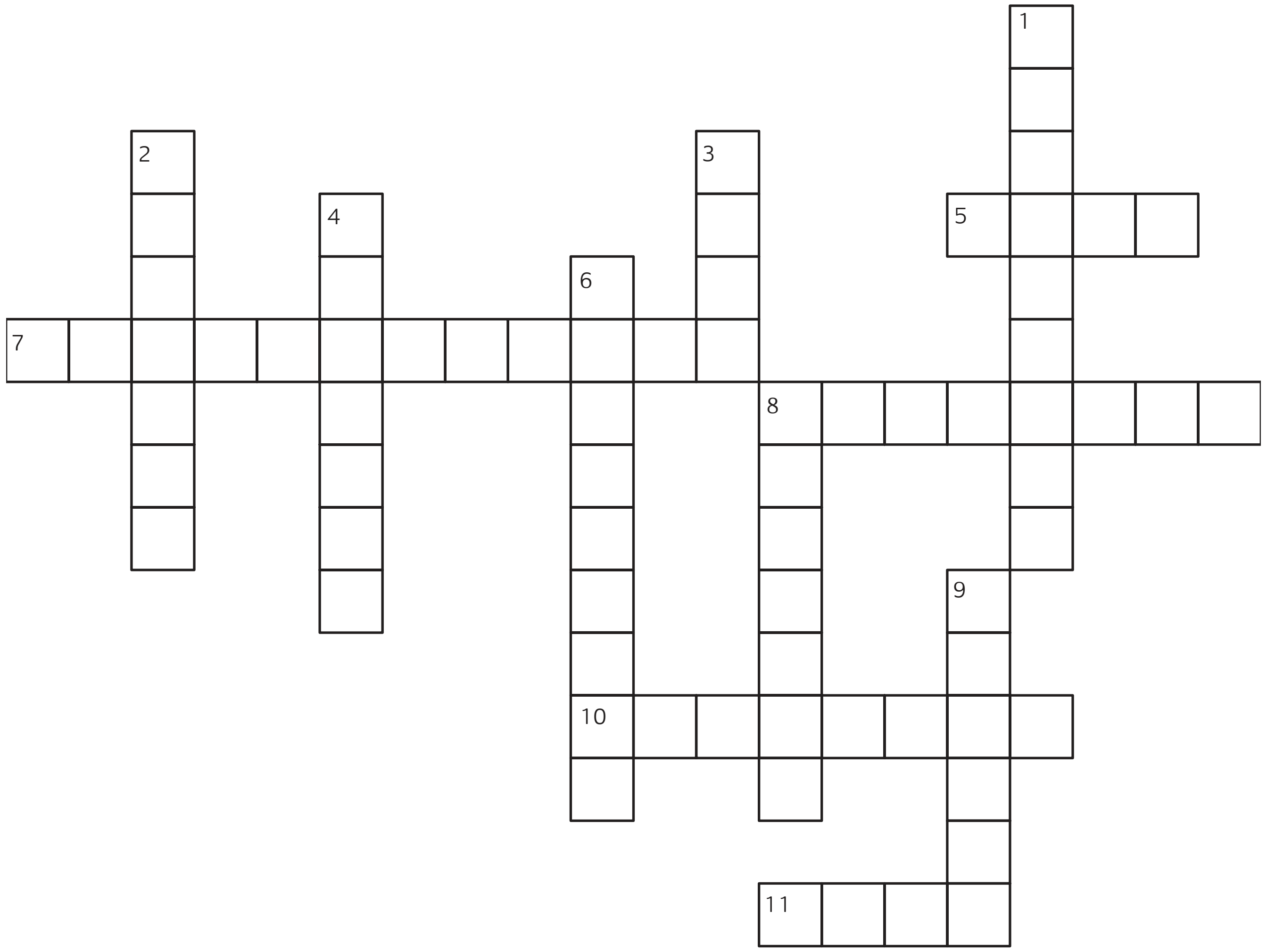
Use the previous boat, submarine and periscope activities to complete the crossword below. You might want to use the internet for extra help!

Across

5. Wind resistance or water friction
7. The object pushes water aside
8. Upward force on a boat in water
10. This increases as you go deeper in water
11. Unit of measurement for speed at sea

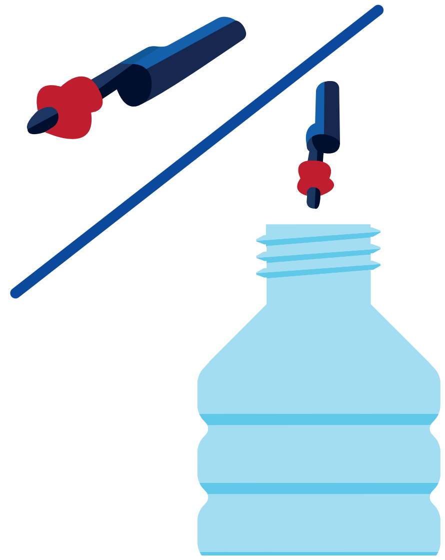
Down

1. Nautical term for the right side of a ship
2. Mass of an object relative to its volume
3. Nautical term for the left side of a ship
4. Force that pulls the boat downwards
6. Used to see out of a submarine
8. Tank that fills with water in a submarine
9. Force that pushes a boat forward



How submarines work – Cartesian diver

1 HOUR



Materials

- Empty bottle
- Pen lid
- Blue Tack (or Playdough)

Activity overview

- This is a fun activity that uses the Cartesian Diver science experiment to demonstrate the principle of buoyancy
- Create this experiment to help understand how submarines dive and resurface

Activity plan

- Fill an empty bottle with water
- Find a pen lid and place some blue tack at the end to give it more weight. This will represent a submarine!
- Drop the pen lid into the bottle. The pen lid should float upright at the top of the water
- If it doesn't stay upright, try adding more blue tack (you might want to practice in a glass of water first)
- Once your pen lid is upright, squeeze the bottle gently and watch the pen lid sink to the bottom. Release the bottle and watch the pen lid rise to the top
- Discuss why the pen lid does this

Learning objectives

- Understand how buoyancy forces allow a submarine to dive and resurface
- Understand how density is important when designing a submarine
- Observe the forces that act on a submarine when it's in water

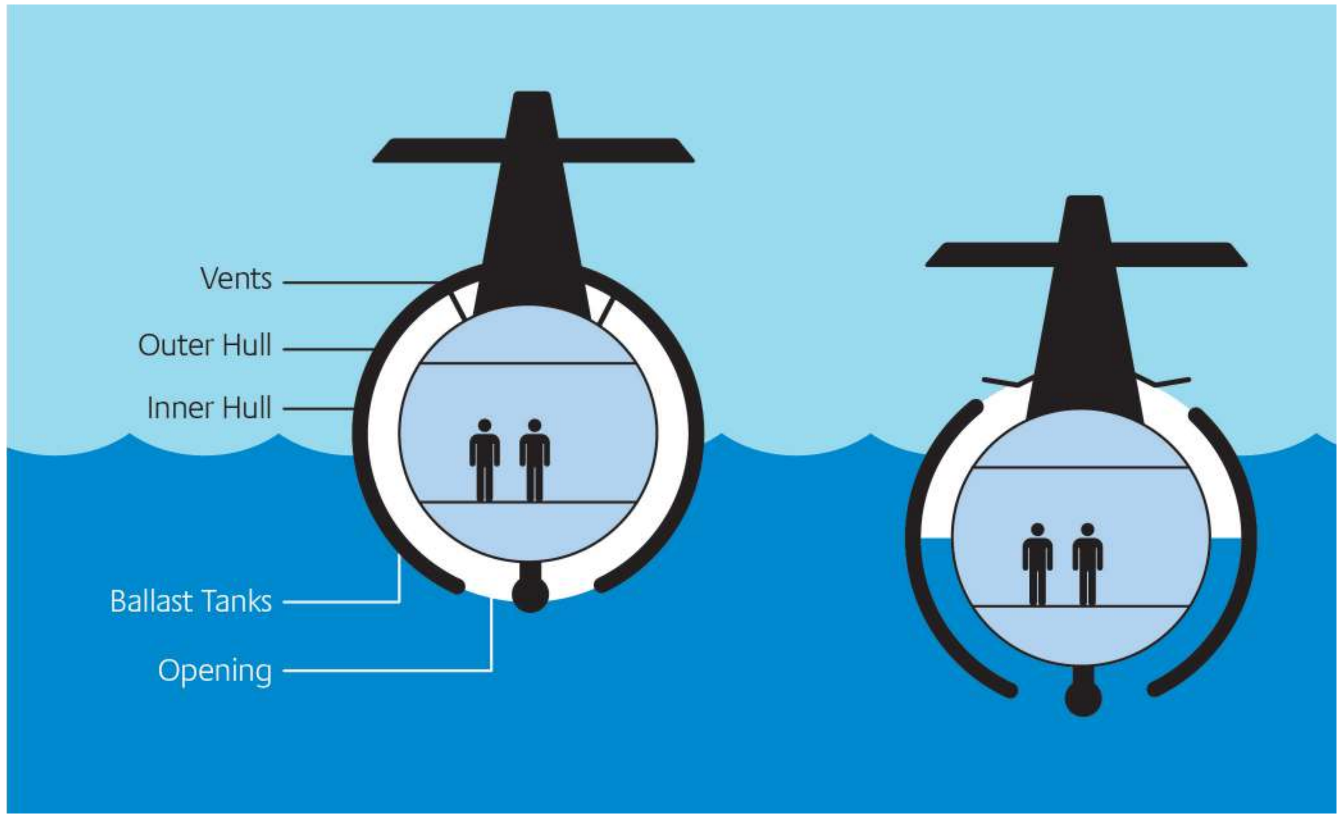
Reflection questions

- Why does squeezing the bottle make the pen lid sink?
- What happens to your submarine if you add more weight to it and why?
- What do Babcock engineers need to think about when designing submarines? Think about weight, design and materials.

How submarines dive and resurface

As we know, an object will float depending on its density (how heavy it is for its size) and if it is buoyant. This is explained further in our Paper Boat Challenge. Unlike a boat, a submarine needs to become denser in order to sink. But how does this happen?

This is achieved with ballast tanks. Ballast tanks are empty sections of the submarine, designed to be filled with water. When a submarine needs to dive the ballast tanks are filled with water, making the submarine heavier. When it needs to resurface, air is blown into the ballast tanks which pushes the water back out. This allows the submarine to become more buoyant. An example of this is placing an empty bottle in water which will float. The more water that is added to the bottle, the more it sinks.



Cartesian diver explained

How does using the ballast tanks cause sinking and rising? The Cartesian Diver experiment demonstrates this. When dropped in the water, the pen lid contains enough air inside to float. Squeezing the bottle allows the pen lid to sink, and releasing your hand from the bottle allows the pen lid to rise. But why is this?

When the pen lid is dropped into the water, the air inside allows it to be buoyant. When the bottle is squeezed, water goes into the pen lid and compresses the air inside. As the volume of the pen lid doesn't change, the pen lid therefore becomes denser. The density of the pen lid is now greater than the density of the water, resulting in the pen lid sinking.

An object in water experiences a downward force of gravity, as well as an upwards buoyant force. Pressure of the water increases with depth, causing the upward buoyant force to be greater than the downward force on the object. The buoyant force is equal to the weight of the fluid displaced by the object. Sinking of an object will occur when the object density is greater than the density of the water.

How to stop sailboats capsizing

1 HOUR

Materials

- Sponge cloth
- Toothpick
- Cork
- 4x Wall pins / Small nails
- Tin foil

Activity overview

- This activity involves building a sailboat
- Create this experiment and see how your sailboat remains upright

Activity plan

- Poke a toothpick in the centre of the cork so it sticks upright. This will be your boat's mast
- Cut a square of your dry waterproof material (sponge cloth) approximately 6 centimeters square. Poke the toothpick through opposite ends to create your sail
- You've made a sail boat! Place it in water and blow on it from behind. What happens? Chances are it tipped over! We will need to add something to fix this
- Carefully start adding the nails/pins to the bottom of the cork in a straight line then place your sailboat back in the water. Does your boat move in a straight line?
- Your sailboat needs a keel! Connect your nails/pins together with a square piece of tin foil. Tightly wrap the tin foil around the nails/pins to make a fin shape
- Place your boat back in the water and blow on it from behind. Does the keel help it move in a straight line?
- Try experimenting with a bigger sail, and altering your keel to compensate for this

Reflection questions

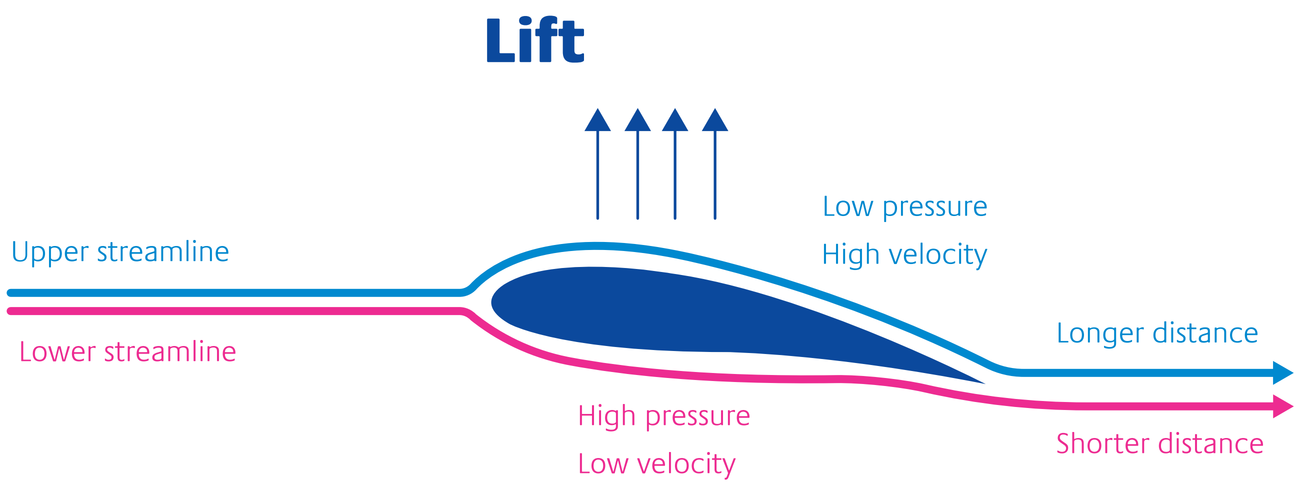
- Why would adding the keel stop the sailboat from capsizing?
- Is the direction of the wind important?
- Can sailboats move faster than the wind?
- What is a rudder used for on a sailboat, and where is it located?

How do sailboats move forward?

Sailboats are able to move by travelling in the same direction as the wind. However, they often need to move forward regardless of wind direction. So how do they achieve this?

Sails work in the same way as plane wings, shown in the diagram below. Due to its shape, the air travelling over the wing moves faster than the air travelling under the wing. This results in the air pressure above the wing being lower. The higher air pressure below then pushes the wing upwards, allowing the plane to fly. This is known as 'lift'. This can be seen by holding a piece of paper at one end and allowing the other end of the paper to fold down naturally. Blowing over the top of the paper will lift the lower hanging end.

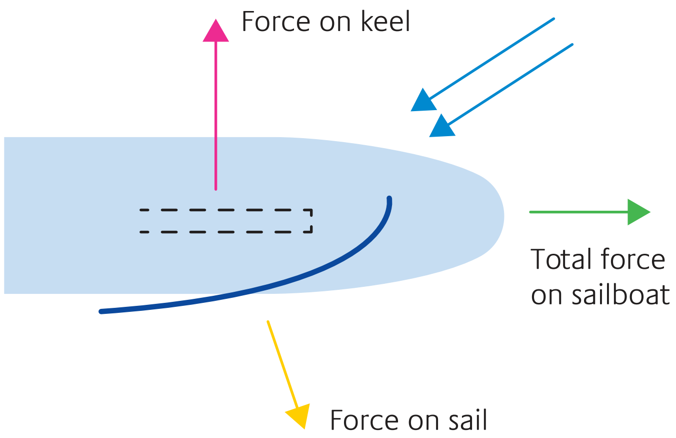
Now imagine a sail is a plane wing on its side, where lift is a sideways force instead of an upwards force. But because the wind typically hits the sail from an angle, this means the lift is both in a sideways and forward direction. So there needs to be a solution to stop the boat drifting sideways and to only move forward.

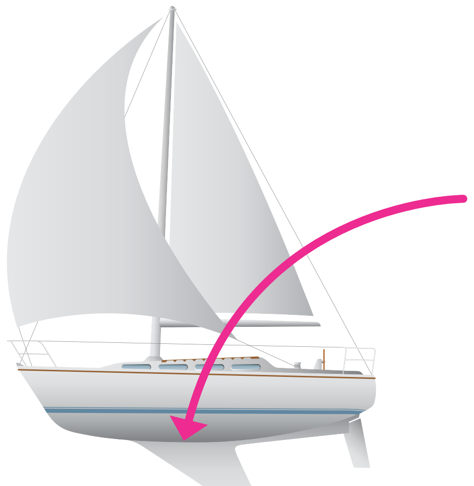


Why do sailboats need a keel?

The keel has two main functions: to keep the boat from being blown sideways in the wind and to keep the boat upright. The keel is fixed to the bottom centre of the sailboat, providing the sideways resistance needed to counter the force on the sails.

So how does the keel help the sailboat go straight forward? The keel also acts as a wing and develops its own lift underwater in the opposite direction of the sail's lift. Both keel and sail create a combination of forces in the forward and sideways directions. Their sideways forces are in opposite directions so they cancel each other out, leaving only the forward forces.





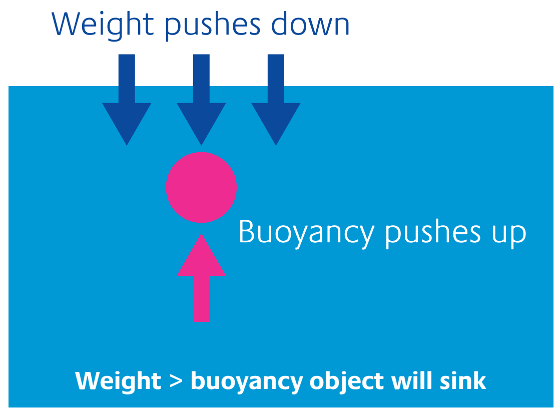
Keels carry ballast (gives the boat stability) by being made from a heavy material. The keel's broad, flat surface helps create sideways force by displacing water in the opposite direction that the boat is leaning. Although the keel is much smaller than the sails, the density of the water allow its force to be strong enough to stop the sailboat capsizing.

Buoyant boats

1 HOUR

Materials

- Modelling clay, one-half stick (50-60 grams) per person
- One piece of Lego
- One coin
- One small stone
- One piece of paper
- 1-2 sponges and/or dish rags for wiping up drips and spills
- Several paper towels
- One box to contain water
- One water bottle



Activity overview

- This task is focused on buoyancy and material science. The principles of floatation are used heavily by Babcock when designing and building boats and submarines. We are involved in the design and manufacture of some of the largest submarines in the world so need a very clear understanding of buoyancy and how it is affected by the materials we use when building the submarines. The students will experiment with different types of materials to discover which float and which sink. Upon learning the basic principles of buoyancy, students will design boats out of plasticine and see which can hold the most weight. It is important to study the effects of displacement during this process
- Try the steps below to find out how displacement works and test the knowledge gained using the final task

Activity plan (see diagram for help)

- Using the box filled with water test the buoyancy of the Lego, coin, and stone. Guess if the item will float or sink before testing it
- Using the Lego brick test different orientations, try the studs facing down, try them facing up, try the brick pushed underwater first, and finally try the brick on its side
- Test an empty water bottle and show that pushing down on the bottle to displace more water makes the bottle push upwards harder due to more water being displaced
- Test a ball of plasticine without any modifications to show that it does in fact sink
- The student will now design a boat on paper first and attempt to build it using the plasticine. It will be tested using the Lego, coin, and stone or other weights and the design can be updated if at any point the boat sinks. The student should use all the knowledge they have gained from the previous activities to make the best boat they can

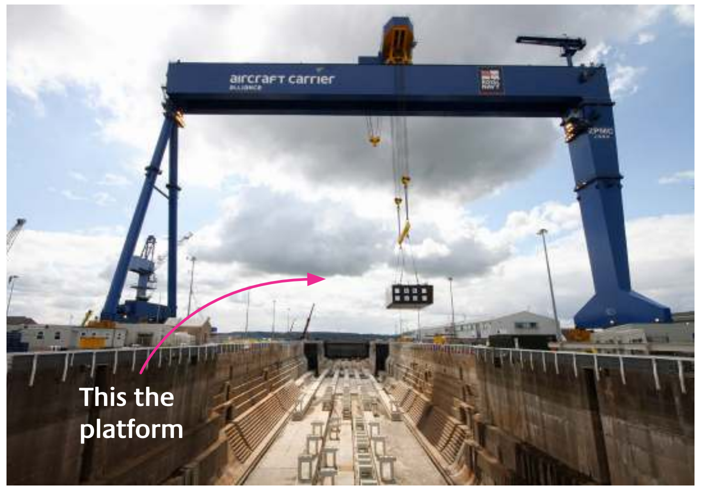
Learning objective

- Ability to design a boat that floats and outline why using the principle of buoyancy
- Ability to explain why a specific design of boat is better than another
- Ability to describe the best material properties for building a boat and why

Building the Goliath Crane

1 HOUR

This top beam is what you will be building



Materials

For the crane:

- Spaghetti / straws / cardboard / paper
- Elastic bands / 10cm of sellotape / string / Blu Tack
- Two bags of sugar / flour and some spare change

For the platform:

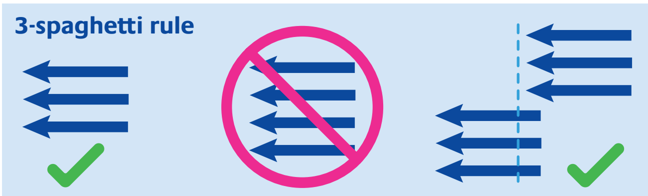
- Cardboard
- String

Activity overview

Design a new crane for Babcock! Your aim is to build the beam across the top of the crane, and carry as heavy a load as possible (the spare change) on a platform, before your beam cannot take any more weight.

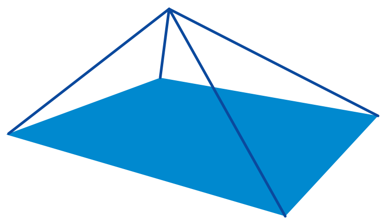
Activity plan

- Collect all the ingredients above, or as many as you can find. The bags of flour or sugar, spare change (you will get back), and then as many of the other materials as you can
- Place the two bags of sugar 30cm apart from each other on a flat surface – these will make your supports, which you will place your beam on top of. Remember your beam needs to be longer than 30cm to balance across the top, as you are not allowed to attach it or tie it to the sugar bags
- To build the beam, first draw a design of what you want your beam to look like. Think of the different ways to attach the materials together, in order to find the strongest method. Don't forget that you can't overlap more than three spaghetti in a row (see the diagram to the right)

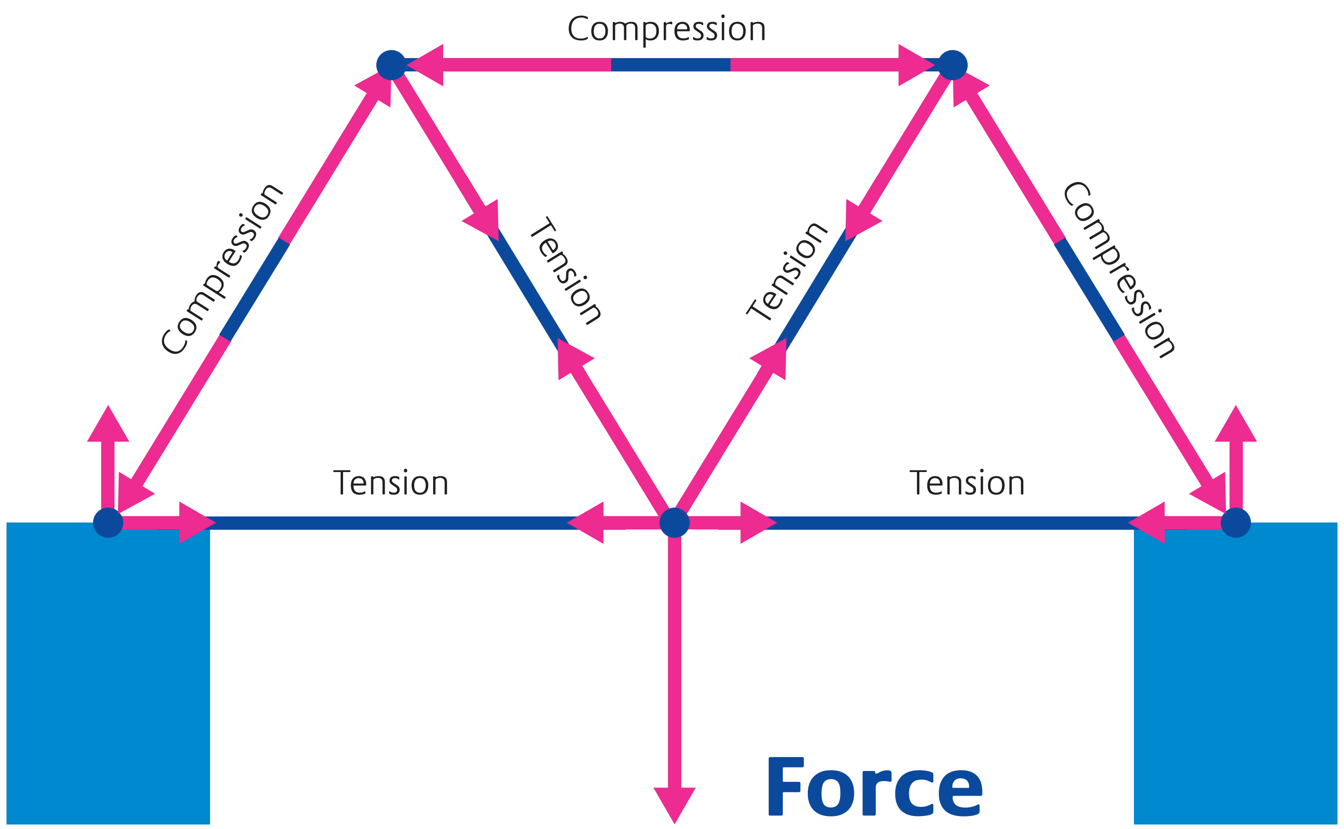


- Using the materials that you have available, and the design you have drawn, look to build the top beam out of spaghetti, straws, cardboard, elastic bands, sellotape, string and Blu Tack. Remember – you don't need to use all the materials; try to pick the strongest. Think about the forces acting on the crane
- Once you have finished building the crane, it's time to test it. However, first, we need to build the platform to hang from our beam
- For this, get an old cereal box or piece of cardboard and cut out two 10x10cm squares. Put a hole in each corner of two squares, wide enough to fit string through. If you have a hole puncher, use this
- Cut two pieces of string 15cm long. Put the two pieces of card that you have cut back-to-back, and thread one piece of string down through the bottom left hole, along the back of the card, then up through the top left. Do the same with the right, and tie all four pieces of string at the centre. Tie or attach this onto your beam. You are now ready to start testing it! Keep adding weight, making a note of how many you manage to place on before the beam can't take any more weight. Try to beat this score next time

Finished platform



Back view



Learning objective

The Goliath Crane manages three important forces: compression, tension and weight.

If you push or pull too hard on your crane, it could result in the crane buckling. You want the performance of your beam to be strong and stable, minimising bending. Think about how you would achieve this.

Reflection questions

- How many coins did the crane manage to hold?
- Looking back, did you use the right materials and what would you have changed?
- How would you rate your design now, and would you have tried something different?
- Did you think of the force pulling down on the crane?

Rubber band powered submarine

1 HOUR

Materials

- 2x plastic bottle
- 1x rubber band
- Lollipop stick
- Scissors (with adult supervision)
- String or a paper clip
- Tub of water

Activity overview

The challenge of this activity is to build a functioning submarine powered by a rubber band that can cross a tub of water in the fastest way possible.

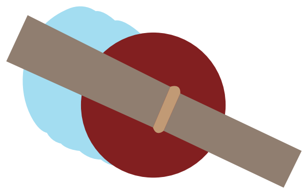
The key elements are:

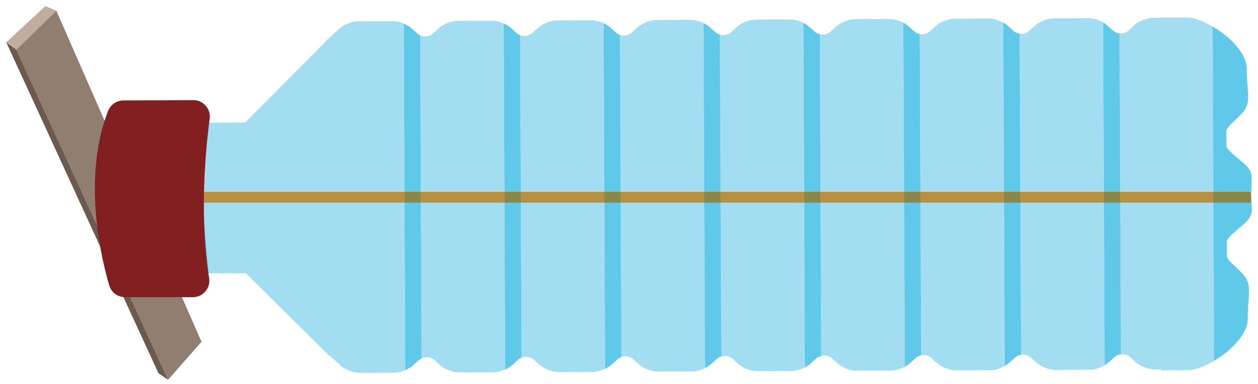
- The submarine must be self-starting from a standing start and only the rubber band is allowed to provide drive (no external forces allowed)
- The submarine must be made from completely recycled materials, where possible
- The submarine must be as watertight as possible; small leaks may be difficult to avoid

Activity plan

Build phase - body

- Start by cutting a small hole in the centre of the cap. Cut a similar hole in the centre of the bottom of one of the bottles (just wide enough to fit the rubber band through)
- Tie a length of string, which is approximately the same length as the bottle, around the rubber band and feed the band through the bottom of the bottle whilst keeping a hold of the string (an unfolded paperclip could also work)
- Remove the cap from the bottle before feeding the rubber band through the lid of the bottle. Secure on the top of the lid using a lollipop
- Screw the lid back on
- Now pull the string back out the bottom of the bottle until the elastic band is stretched across the length of the bottle
- Tie a secure knot in the string and cut off any excess string. You should have something like this:
- The sub can be tested in this condition or you can build a propeller using the second bottle





Build phase - propeller:

- Using the second bottle, carefully cut the bottle about ¼ of its length down from the lid
- Keep the section with the lid and recycle the rest of the bottle
- Similar to before, cut a small hole in the lid big enough to fit the rubber band through
- Cut a series of lines along the length of the bottom of this section, at even distances (about 4 or 5 should do)
- Peel back these sections while slightly twisting them in one direction to create your propeller
- Take hold of the rubber band on the body of the sub and remove the lollipop stick before feeding the rubber band through the lid of the propeller (upside down to the lid of the body), and secure on the other side using more string
- Screw on the rest of the propeller to the lid
- The build phase is now complete

Testing phase

- To charge the propeller of the submarine, simply hold the body and twist the propeller to create tension in the rubber band
- Keep twisting until you feel like there is enough resistance coming from the band (careful not to twist too much, as you may snap the rubber band)
- When ready, place the submarine in one side of your tub of water and release. Remember - the propellers on submarines are at the back!
    - How quickly/slowly did your sub manage to cross the surface of the water?
    - What happens when we charge the propeller more or less?
    - Can your sub go in a straight line when it is moving fast?

- Now fill your sub up with some water and retest
    - What happens to its performance?
    - Does it look more or less stable than when it was on the surface?

Remember: Your submarine may leak more water into the body, so test this part quickly

- Now completely fill your sub up with water and retest
    - What happens this time?
    - Is there too much water in the body for the sub to function properly?

Learning objective

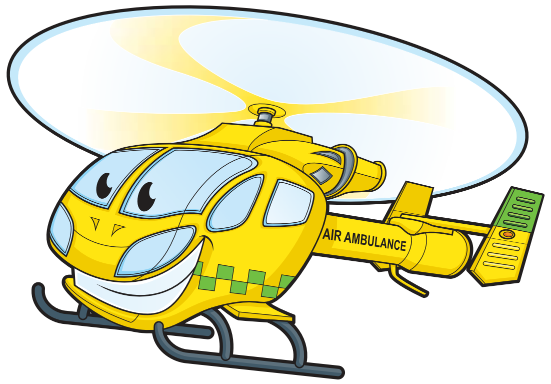
- Gain a basic understanding on how propellers can be used to generate thrust
- Gain a basic understanding of buoyancy forces

Reflection questions

- What forces act on the submarine when it is travelling through the water?
- Why does the submarine sink when we fill it with too much water?
- How could we better balance the submarine, so it can go in straight lines more effectively?
- How could we make the submarine more/less buoyant?

Flight Plan: Plotting a course using compass directions

1-2 HOURS



Materials

- Pencil and rubber
- Ruler
- Printer
- Scissors (with adult supervision)
- A4 Paper

Activity overview

- A compass utilizes the Earth's magnetic field to help people navigate, especially our pilots!
- Using the map provided, draw out the flight plan, following the directions, to help the Air Ambulance get the patients to hospital

Activity plan

- Read the information on magnetic fields, how they work and how it helps us navigate
- Print out the compass, helicopter and two maps
- Cut out the compass and helicopter
- Set the compass on BASE and ensure it is aligned to north from the map
- Using the table on the first map, mark the next point on the map. Using your compass and a ruler, work out the direction and distance of travel
- Continue this until you have returned to base. Fly your helicopter along the route like a true pilot would after mapping their path
- On the second map, you are given the direction and distance of travel, use this to determine the reference and to identify the sites you visit along the way

Learning objective

- Understand what the Earth's magnetic field looks like
- Understand what happens to a magnetic object when placed in a magnetic field
- Be able to use compass directions to plot a flight path

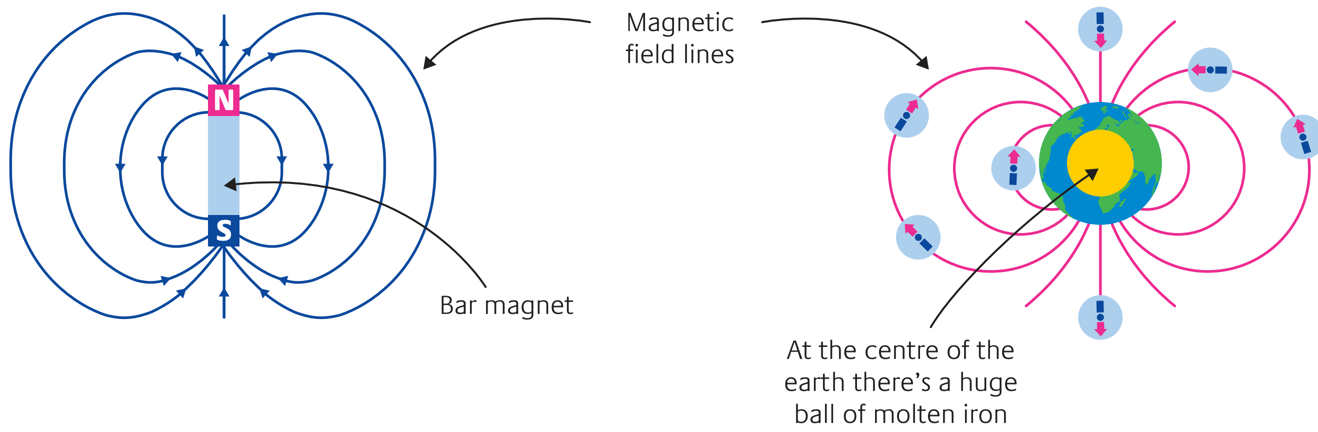
Reflection questions

- What was the total distance travelled on each trip?
- How does a compass work so that you know which direction to head?
- Can you use a compass to map a route around your house?

Is it a bird, is it a plane? Navigating via the Earth's magnetic field

Many animals migrate seasonally to take advantage of more plentiful resources – these being mainly food and better places to lay nests. Different animals have developed clever ways to help them navigate, such as using the stars, memorizing landmarks and even using their sense of smell! However, some birds, particularly the European Robin, are thought to have a very mysterious method, which involves sensing the Earth's magnetic field…but how does it all work?

Just like a magnet, the Earth has its own magnetic field which is generated by its huge molten iron core. A magnetic field is invisible to the human eye, but we can represent them as lines coming out of the North Pole and entering the South Pole as below:

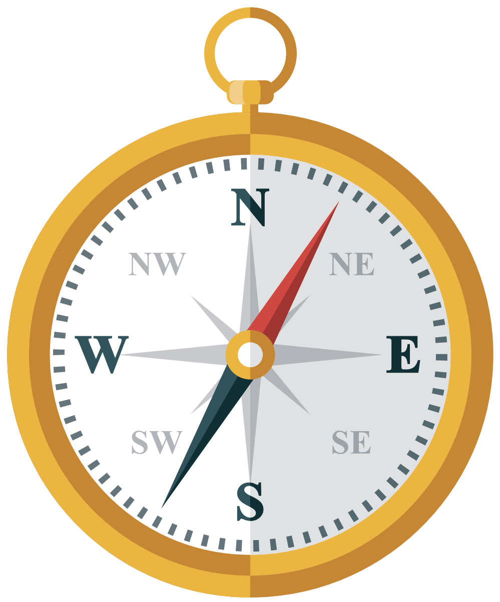


When a magnetic material (such as iron, cobalt or nickel) is placed in a magnetic field, it will feel a force and consequently align with the magnetic field lines.

People have developed a tool called a compass, which takes advantage of the Earth's magnetic field to help us navigate, especially our pilots!

A compass consists of:

- A tiny magnetic needle, which is free to move in the magnetic field
- A dial to show which direction the needle points



Just like the iron filings, the needle feels a force and aligns with the field – By watching where the red tip points, we can figure out which direction is north, east, south or west!

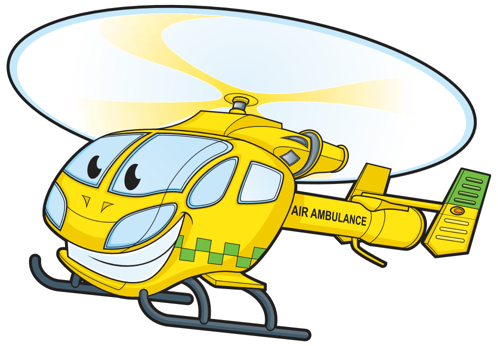
All of our aircraft are fitted with a compass to help our pilots find their way. Whether that's putting out fires over Italy, training fighter pilots in France or saving people with the Air Ambulance in the UK, it all relies on compass navigation!

Cockpits in modern aircraft (like the one above) have very sophisticated navigation equipment, which relies not only on the Earth's magnetic field, but also electronic onboard computers that bounce signals off satellites in space! The computers perform calculations very fast, which relay the aircrafts position to the pilots. This is similar to how our mobile phones can track our location.

Just like our aircraft, scientists believe that some birds, such as the European Robin also have a compass of their own. Unlike the compasses that people have built, which are mechanical and made of metal, the Robin's compass is biological and relies on some very spooky science called quantum physics. Similar to onboard computers, extremely fast quantum calculations take place, which allow the Robin to 'sense' the Earth's magnetic field and fly in the right direction during their migratory flights.

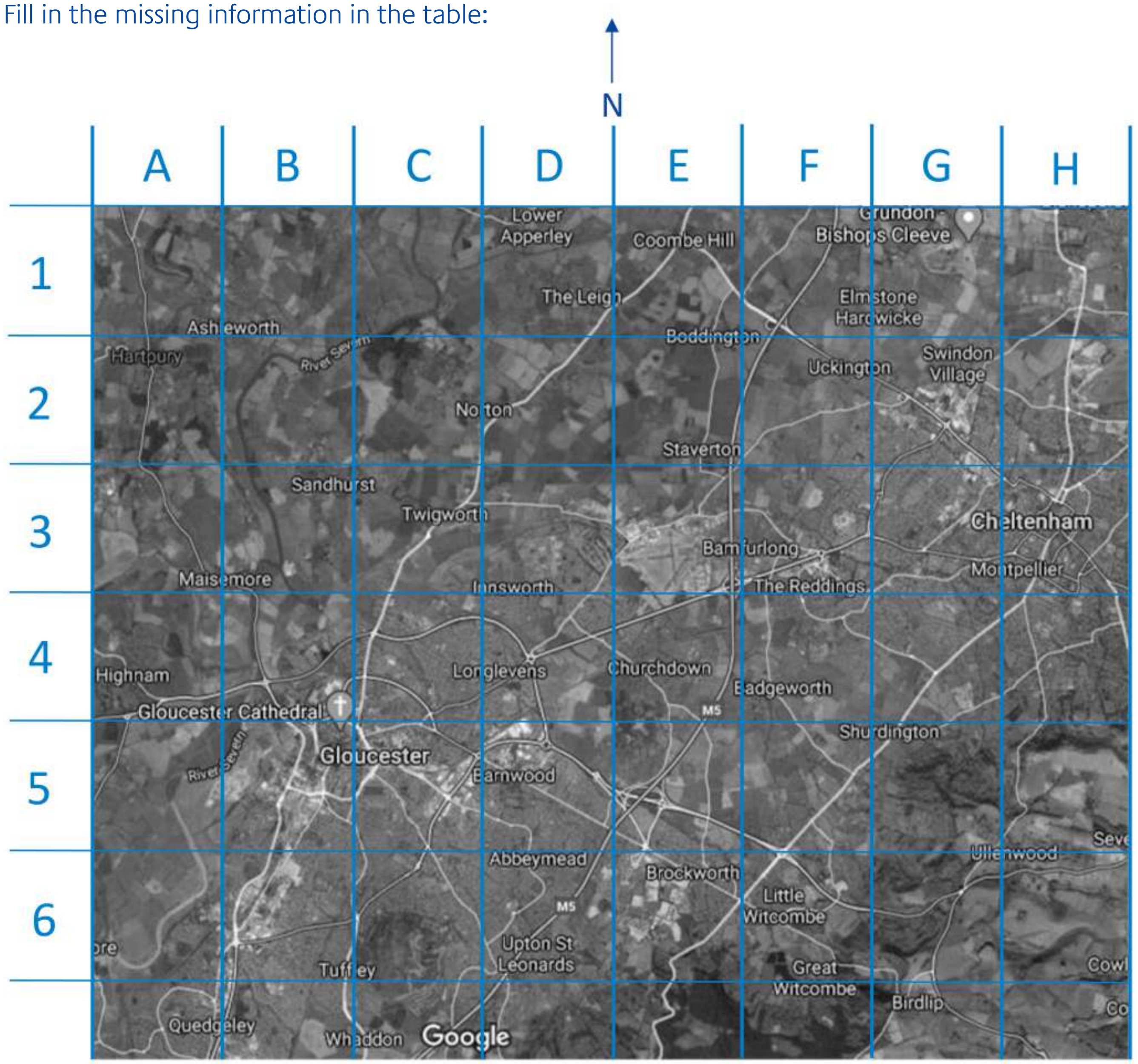
Perhaps one day we will discover the secret behind the Robin's mysterious compass and harness it to help our pilots save lives and protect the communities of the future…

Print and cut out the compass and helicopter below:



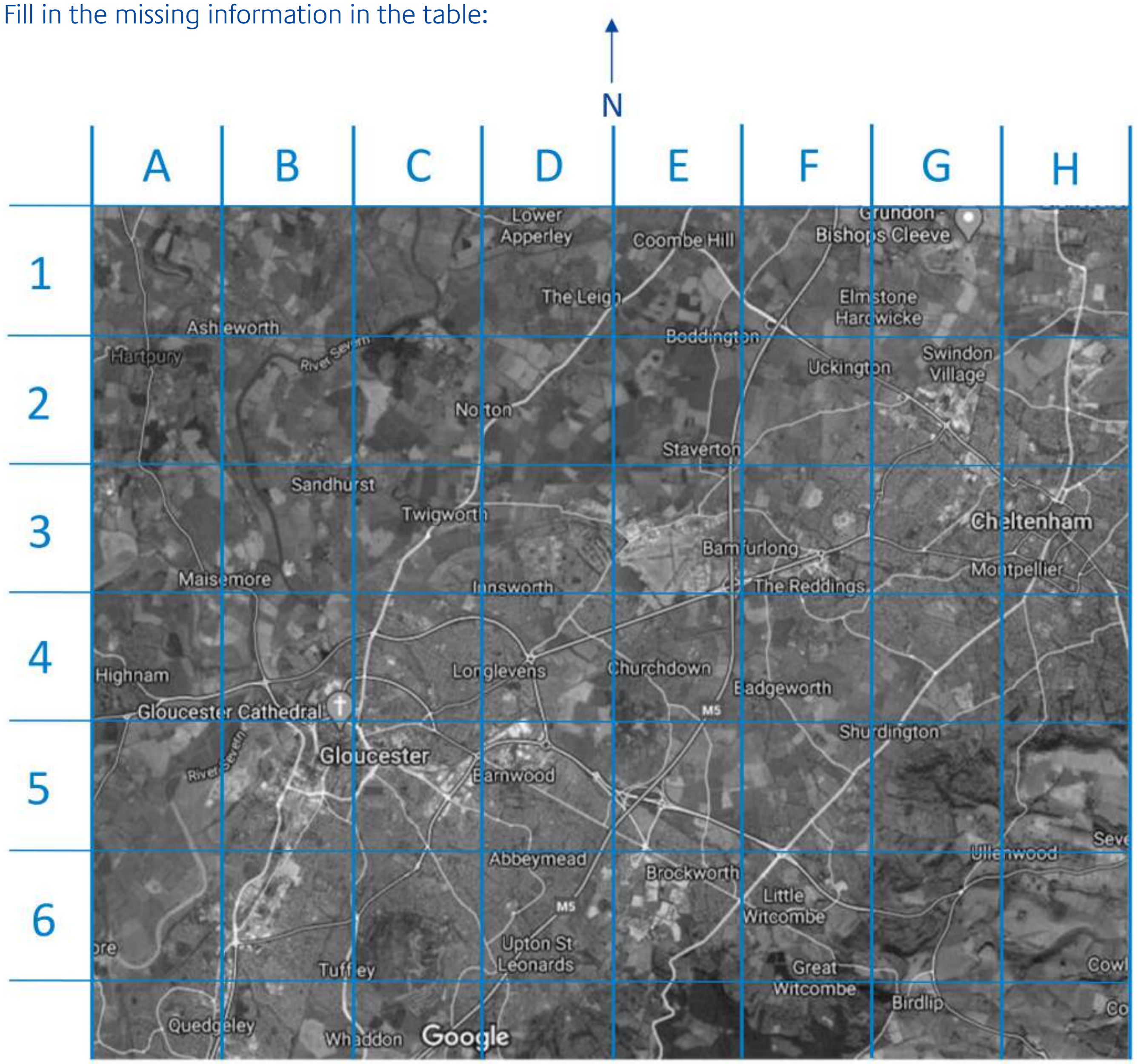
Print out the maps on pages 51 and 52.

Fill in the missing information in the table:



Location	Direction	Distance	Co-ordinate
Base	0	0	E3
Patient 1			B2
Hospital			E5
Patient 2			G6
Hospital			E5
Base			E3

Fill in the missing information in the table:



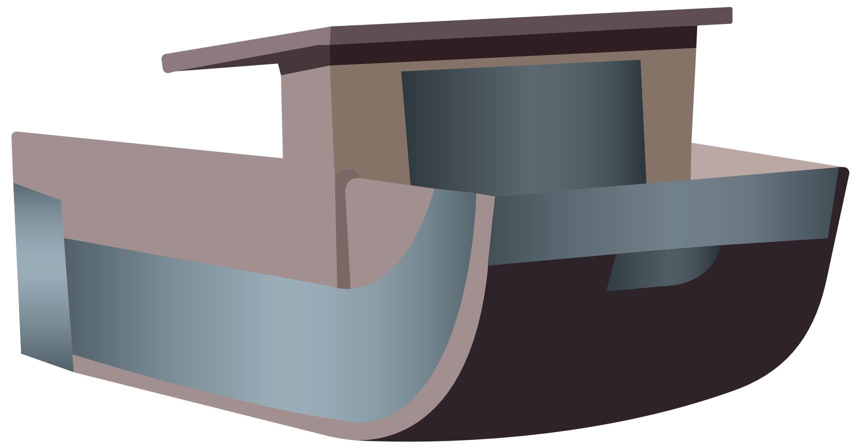
Location	Direction	Distance	Co-ordinate
Base	0	0	E3
Patient 1	SE	5cm	
Hospital	WNW	7cm	
Patient 2	SW	4cm	
	NE	4cm	
	ENE	3cm	
Patient 3	NW	4cm	
	S	4cm	
	ENE	3cm	

Build a cardboard boat

1 HOUR

Materials

- Cardboard
- Tape or glue
- Rubber bands
- Foil
- Scissors (with adult supervision)
- A weight of approx. 200 grams



Activity overview

This task is all about buoyancy, by creating and learning from different designs, you will be able to see which designs can carry the most weight and are more buoyant.

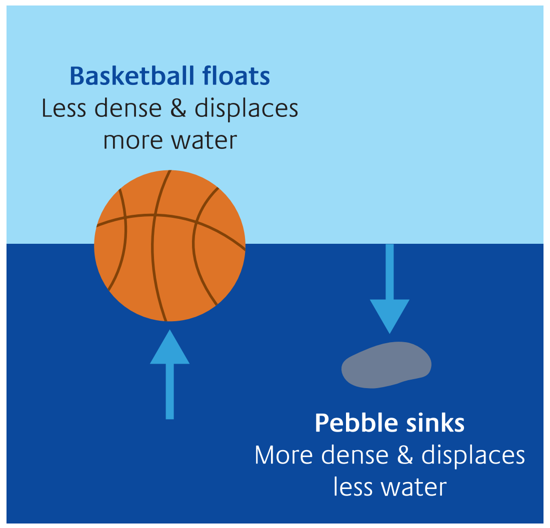
Activity plan

- Sketch out several boat designs, it can be as basic or as complicated as you like, as long as you think you can make it out of cardboard
- Next draw out the basic shape of your boat on the cardboard, and cut it out
- Create walls for your boat from cardboard
- Stick the bottom of the boat and the walls together with tape or glue
- Back everything with foil – be careful not to leave any gaps where the water can get in
- Set your boat afloat in the sink or a bath
- Slowly add the weights into the boat

Learning objective

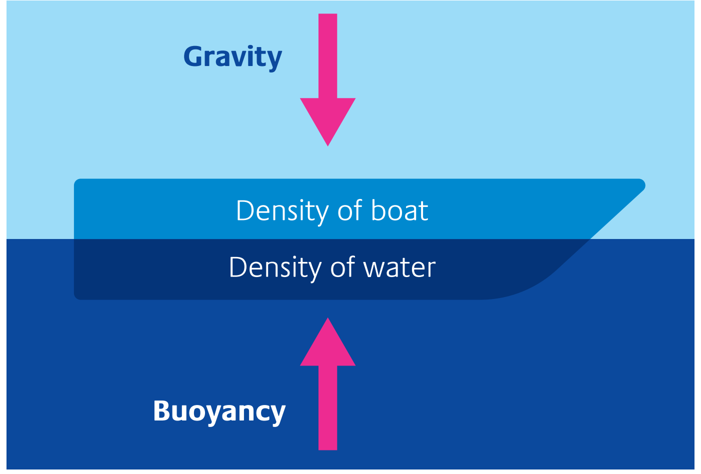
Sinking and floating

- Have you ever tossed a small pebble into a lake or river? What happens? It sinks, right? Have you ever wondered why that little pebble sinks to the bottom, but a huge boat made of metal floats on top of the water? Let us investigate and find out! Go around your house and grab a few different objects, it could be anything from fruit to coins, to a can of diet coke, and fill your sink with water. Time to test these by placing the objects into the water! Were any of the results surprising, and did you notice anything about the objects that floated?
- Every object that you put into water will either float or sink. It does not have anything to do with how big the object is. For example, you could put a metal spoon in water and it will sink, but a piece of paper as big as your house might float. Therefore, size does not have anything to do with sinking and floating. What does?



Density and Water

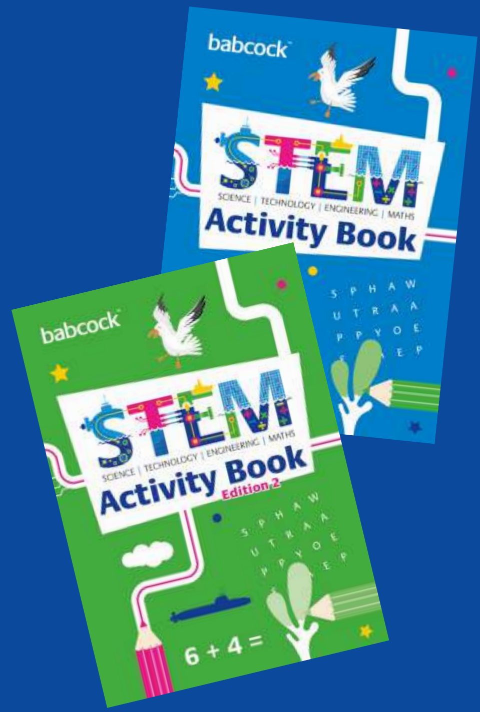
- Density is what decides whether an object sinks or floats. Density is affected by how much an object weighs in a specified area. Therefore, if you filled a shoebox with feathers and weighed it, and then filled the same size shoebox with pebbles and weighed it, they would not have the same weight. The pebbles would weigh more. This means that the shoebox with pebbles is denser than the shoebox with feathers
- When a boat is placed in water, it displaces an amount of water equal to the boat's weight – as long as the object is less dense than the water, it will float



Reflection questions

- How can you change your design so that it can hold more weight?
- Using the principles that you have learnt about density and weight, how do you think submarines are able to rise to the surface, but also able to dive to the bottom of the sea?

We have more fun activities in our STEM Activity Books. You can find these on our STEM website through the following links.



Activity Booklet Edition One:

https://www.babcockinternational.com/wp-content/uploads/2020/08/STEM-at-home-Activity-Booklet.pdf

Activity Booklet Edition Two:

https://www.babcockinternational.com/wp-content/uploads/2020/10/STEM-Activity-Book-Edition-2.pdf

Get in touch with us using the email address below if you'd like more details about how to work directly with us to deliver activities like the ones included within this booklet.

For further information, please contact our STEM team via: Babcock.STEM.Events@babcockinternational.com

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