FLOAT YOUR BOAT

STEM ACTIVITY BOOK

Raytheon UK | ROYAL NAVY & ROYAL MARINES CHARITY

Introduction

Raytheon UK and the Royal Navy and Royal Marines Charity have partnered up to put together a range of fun and engaging Science, Technology, Engineering and Maths (STEM) activities that are perfect for keeping young people busy during the summer holidays.

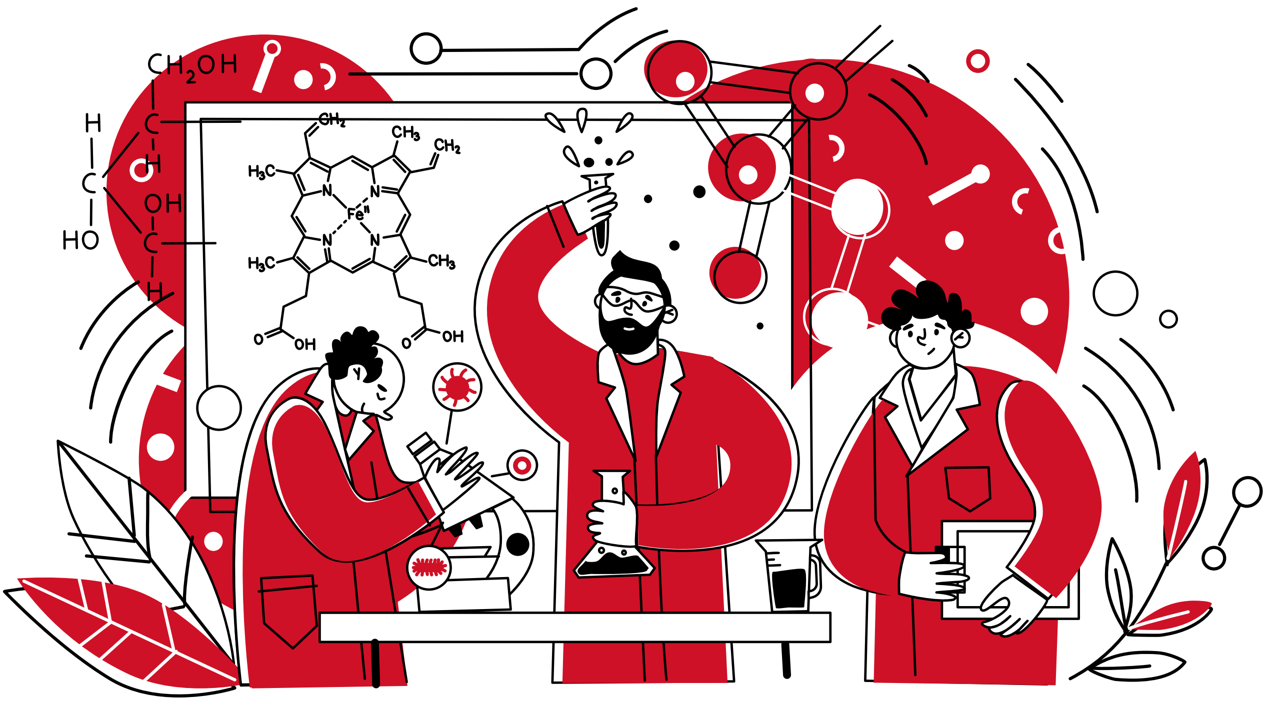
But we didn't want to let the fun stop there! That's why Raytheon UK's STEM Ambassadors have created an activity booklet of these activities to keep young students thinking about science, technology, maths and engineering before they go back to school.

Our booklet is comprised of activities to help young people learn about how STEM is used in the Royal Navy, and in designing and building ships. As well these activities, we have also included a section to educate children about the history of British Maritime and how ships have played an important role in the UK through history.

We're also excited to give students the chance to take part in a challenge that will require them to put their STEM skills to the test by designing and building their own ship. The winner will receive a special goody bag from the Royal Navy and Royal Marines Charity and Raytheon UK, so don't forget to send your pictures in to the RNRMC!

It's vital that we continue to encourage young students to become curious about STEM subjects so we can inspire the next generation of mathematicians, scientists and engineers. Raytheon UK's recent collaboration with the Science Museum and our flagship STEM event , the Quadcopter Challenge, are just a couple of ways that Raytheon UK have helped to inspire students outside of the classroom.

We hope that this booklet provides hours of fun and valuable learning during the summer period and beyond.



Introduction to Maritime & The Royal Navy

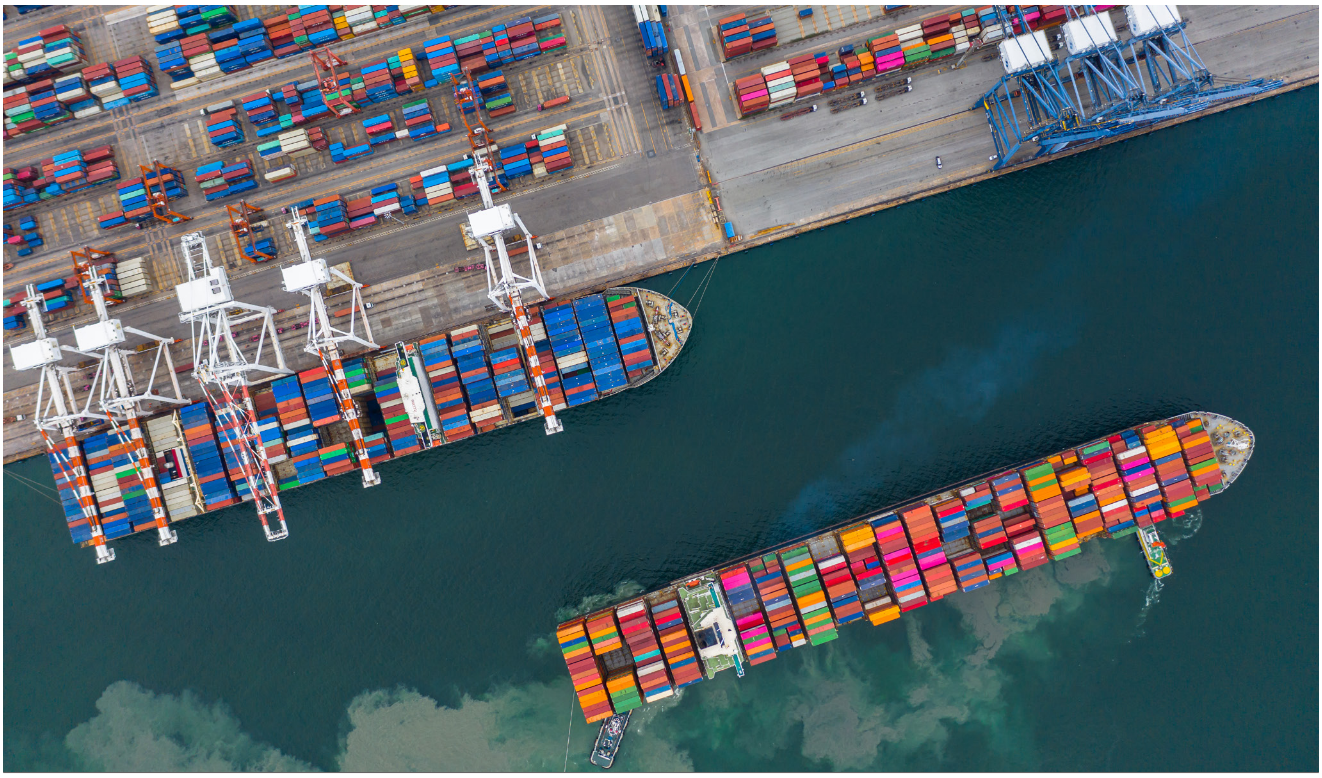
Why boats & ships have been important to the UK throughout history.

For thousands of years, we have built boats and ships to travel and explore places far beyond the British seas. Sea travel, or 'maritime' travel, enabled famous British explorers like Captain James Cook to reach countries like Australia and New Zealand.

Without maritime our world would be very different. The food on our table would be very different if it weren't for explorers as potatoes, peppers, and bananas all come from afar. Fashion today would also look very different. The colour purple originated in Lebanon; a small trip across the Mediterranean Sea, would not have been possible without the mighty ships.

But even today, a lot of the goods we use every day, from our phones to our cars, are brought to the UK by ship.

But boats and ships have not always been as grand as they are today. Maritime travel can be traced back to the Neolithic Stone Age, almost 8,000 years ago! The first boat was believed to be a hollowed-out tree trunk, which functions in the same way as the modern canoe.



Then came the invention of oars and sails, which powered faster sea travel enabling international trade of food and materials and better defences of our country's borders. By the 17th century, ships had transformed from their once simple designs into engineering masterpieces.

It was in the 17th century that the Royal Navy was formed after the restoration of the monarchy under Charles II in 1660. In 1661 Sir William Penn and Samuel Pepys established the Naval Discipline Act which included the articles of war and founded the Royal Navy by statue. It was then in 1664 the Royal Marines were set up.

It was not until 1853 when continuous service in the navy was introduced under which seamen could make service in the navy a career and earn a pension at the end of it.

At the turn of the twentieth century the submarine was developed, and by World War I 74 had been built. In 1906, the first all big-gun battleship HMS Dreadnought was built, becoming the most powerful ship in the world at the time and making all other ships obsolete. In 1912, the Royal Naval Air Service was formed, and in 1918, HMS Argus was the first ship built to enable aircraft to take off and land with an unobstructed deck over the whole length of the ship. In 1923, HMS Hermes was the first purpose built aircraft carrier and the Fleet Air Arm came into existence a year later. The latter part of the century has seen the development of nuclear submarines and missiles.

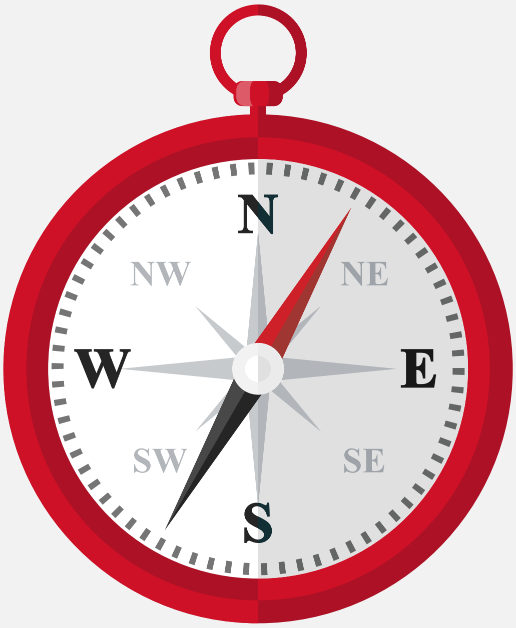
Today the Royal Navy is the third strongest maritime time force in the world after the USA and Russia.

So as you can see, Maritime has always had a special place in the heart of Britons. The British Isles are surrounded by water, so national prosperity and security depend on a mechanism to travel to other lands. The British Royal Navy uses maritime to defend our freedoms, privileges, and cultures from external threats; acting as a guardian and a diplomat, a humanitarian force for good, and a peacekeeper on the global stage. They hold the key to our nation's continued success and safety. Without ground-breaking developments of maritime travel in history, this would not be possible.

We hope that this booklet provides hours of fun and valuable learning during the summer period and beyond.

Learn about: How magnetism works in compasses

Make your own Compass



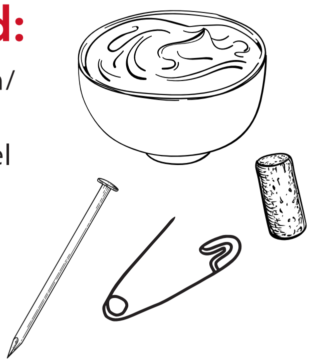
The magnetic compass is an ancient navigational tool used to indicate north, south, east and west. It's composed of a magnetised needle that aligns itself with the earth's magnetic field to point north.

In the Navy they use different navigational tools and systems to precisely track a ship's position and course across the ocean.

If you find yourself lost without a compass, you can easily make your own using a piece of magnetised metal and a bowl of water.

You will need:

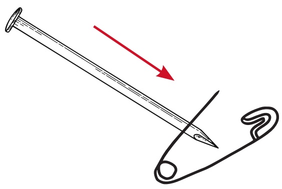
- A hairpin/Safety pin/ Needle
- Fridge Magnet/Steel or Iron nail
- Bowl of water
- Coin-sized cross section of cork



Making the compass

1. **Magnetising your compass:** You will need to magnetise your "compass needle". You will need to rub your metal item against your fridge magnet. Stroke the item in the same direction, rather than back and forth, using steady, even strokes. After 30-40 strokes, the item will be magnetised.

a. *If your magnetiser is a piece of steel or iron, tap the item to magnetise it. Stick the item into a piece of wood and wrap the top of the item 50 times.*



2. **Building your compass:** If you're using a sharp item you can insert this horizontally into the edge of the coin-sized piece of cork, so that it pierces through the cork and comes out the other side. Otherwise if your item cannot be inserted into the cork, balance this on top of the cork.

https://www.wikihow.com/Make-a-Compass

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Learn about: How magnetism works in compasses

Make your own Compass

a. *If you don't have any cork, you can use any item that floats instead, for example try a leaf.*

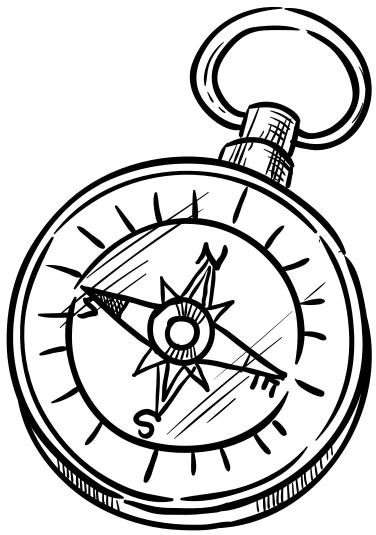
3. **Floating your compass:** Now you need to float the compass. Fill a bowl or jar with a few inches of water and place the compass on the water. The magnetised item will align itself with the earth's magnetic field to point north to south.

4. **Reading the compass:** Assess whether the item is magnetised. The compass should slowly spin either clockwise or counter clockwise to point from north to south. If it doesn't move, rub or tap the metal item again to magnetise it.

5. **Figure out which way is north:** Since the magnetised needle points from north to south, you can't use it to figure out where east and west are located until you know which way is north.

a. *Most phones have a compass app built in so you can use this application to check whether your compass is correct by lining up your digital compass to your home-made compass.*

b. *You can also use the sun's position in the sky to help you as the sun rises in the east and goes down in the west. So if the sun is going down on your left, north is ahead of you and south is behind you. If it's coming up on your left, north is behind you and south is ahead of you.*



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Learn about: Spelling

Naval Wordsearch

F	T	N	A	N	E	T	U	E	I	L	K	I	E	W	G	X	C	E	D	L	S	M
L	S	N	D	Y	U	B	E	M	I	T	I	R	A	M	I	K	I	D	K	J	H	E
E	S	O	I	R	O	L	I	A	S	V	F	B	G	C	C	F	L	M	N	P	F	R
E	Z	E	X	X	P	F	J	Y	W	X	N	S	H	I	P	S	C	T	I	Q	G	O
T	E	H	S	X	B	J	Q	S	T	E	M	M	X	V	W	W	Z	L	A	Y	O	D
V	F	T	K	M	H	S	U	B	M	A	R	I	N	E	C	P	R	A	T	L	P	O
K	M	Y	C	W	R	D	E	T	O	X	K	D	D	C	V	X	R	R	P	W	R	M
H	W	A	A	A	D	J	S	Z	G	D	O	U	T	O	D	C	C	I	A	T	F	M
Y	D	R	R	O	Y	A	L	M	A	R	I	N	E	W	I	G	H	M	C	T	N	O
X	M	C	R	K	D	O	N	M	R	Q	M	A	R	I	N	E	R	D	T	C	M	C
S	A	D	A	I	R	C	R	A	F	T	C	A	R	R	I	E	R	A	N	T	D	F
Y	T	M	B	V	F	P	O	J	Y	J	V	W	R	O	Y	A	L	N	A	V	Y	B
P	H	K	B	E	A	S	I	M	H	W	Z	H	D	B	T	X	T	Z	L	G	W	O
N	S	X	H	O	X	G	Y	F	M	U	B	Z	H	S	L	J	C	U	H	T	S	A
N	W	U	F	T	A	R	B	F	S	T	E	C	H	N	O	L	O	G	Y	T	U	T
R	I	S	X	W	S	E	N	G	I	N	E	E	R	I	N	G	T	A	N	T	L	W

Find the following words in the puzzle.
Words are hidden ← → ↑ ↓ and ↘

ADMIRAL	AIRCRAFTCARRIER	BARRACKS	BOAT
CAPTAIN	COMMODORE	ENGINEERING	FLEET
LIEUTENANT	MARINER	MARITIME	MATHS
RAYTHEON	ROYALMARINE	ROYALNAVY	SAILOR
SHIP	STEM	SUBMARINE	TECHNOLOGY

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Meet our STEM Ambassador

Kevin

1. How do STEM subjects fit into your role at work?

Science, Technology, Engineering and Maths... I am involved at all levels of the Design and Manufacture of Electronic Equipment, dealing with components some no larger that 0.25mm x 0.25mm x 0.125mm to machines that weigh several tonnes.

We work in an environment where these parts may reach high temperatures of 260°C and low temperatures of -40°C...

Every day we think in terms of how much, how quickly, how safely, how best, how to improve. We use all the tools we can get our hands on from screwdrivers and spanners to software and simulation.

We make and model, create and transform...using S.T.E.M at every turn, on every decision, on every fact and sometimes on every assumption.

We, try and prove and establish processes and procedures, and combine all our knowledge to build one thing of beauty, then ten things of beauty, then maybe even hundreds or even thousand of things and this enables us to make each one as identical to the last as is feasible. Now that's Engineering...

2. Have you found STEM working in unexpected places?

STEM is in everything we make and has been used to make everything that you use and see in your day to day life, from a Pencil to the International Space station, to the ships and planes of the Royal Navy!

3. What advice would you give to someone who wanted to study STEM subjects or follow a STEM career path?

Find out what you love and enjoy doing and then turn that thinking on its head. Where in the world would I use those skills in a work place environment?

For me it was Engineering and believe me when I say everything is Engineered, OK maybe not a tree or a bumble bee... but everything in our 'made' world has been through the head of a designer and the hands of an Engineer. Imagine doing things you like and getting paid for it.

4. Who is your STEM inspiration or role model, and why?

Growing up, I was influenced primarily by my family. My great-granddad, grandad, dad and my brother have all been boat builders! So, from a young age, I have always been around engineering and boats. I guess it was no surprise when I joined the Royal Navy as an Engineering Officer Cadet. This was the best move I could have made, and I owe everything I am today to those years in the Navy, not only did it teach me about engineering but also how to deal with tough situations – it was an invaluable experience!

Introduction to Maths

Maths is essential in everyday life and is used in everything we do. It is the building block for everything we use in our daily lives, including our mobile phones, houses, money, engineering, and even sports.

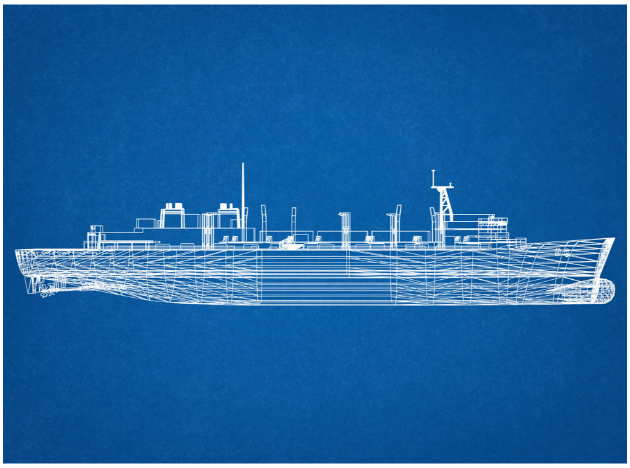
In the Navy, engineers, sailors, and mariners use maths in their everyday jobs to help them design new ships, plot their course across the sea, and understand the forces that are at work when a submarine goes under water.

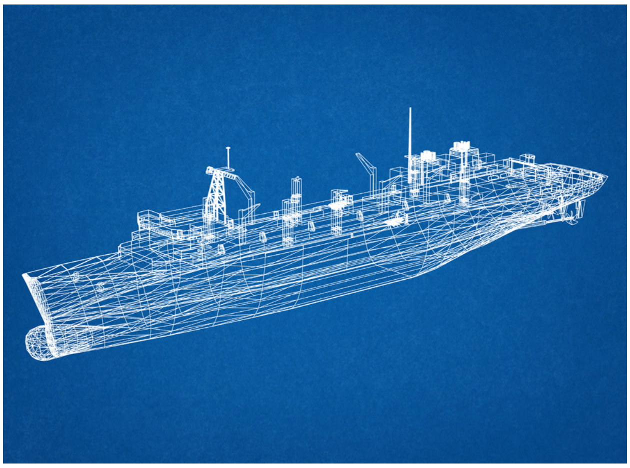
Our activities are focused on helping you understand how boats and ships are built. We will use maths to help you solve mathematical calculations and problems that an engineer would have to consider when they design a ship.

Each section contains a variety of challenges and questions for you to think about and solve.

Remember that maths is a logical subject. Being able to think logically is an important skill you can develop by completing puzzles regularly.

If a problem seems too hard, break it down into lots of smaller problems and solve those instead. Soon you would have solved the big problem!





Learn about: how to calculate composite surface areas

Surface Area of a Boat

It is important to know how much surface area is available on a boat or ship so that we know how many passengers or how much cargo it can hold.

We can simplify the shape of a boat to make finding the surface area easier.

Remember!

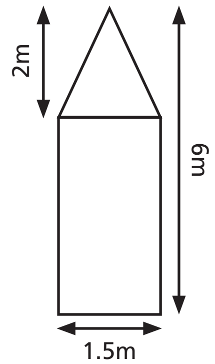
Area of rectangle = length x width

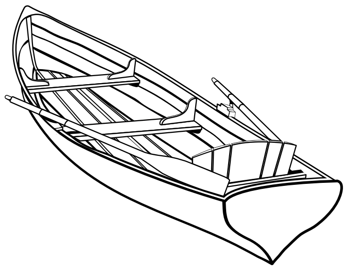
Area of triangle = half x base x height

Surface Area Question 1:

This rowing boat has a **width of 1.5m** and an **overall length of 6m**.
The bow section is 2m long.

Calculate the surface area of this boat.

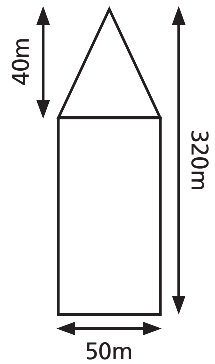


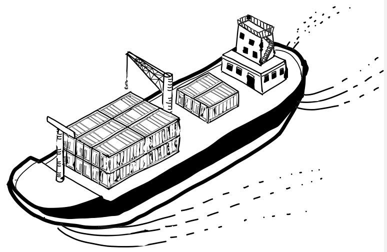


Surface Area Question 2:

This cargo boat has a **width of 50m** and an **overall length of 320m**.
The bow section is 40m long.

Calculate the surface area of this boat.





To find the surface area of the boat, you will first need to find the area of the rectangular part, then the area of the triangular part, and finally add the two together. Remember, as you are calculating the area, your units will be m^2.

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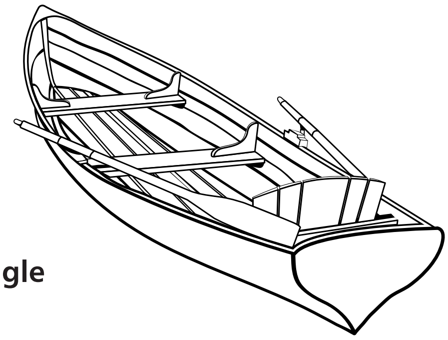
Surface Area Solutions

Surface Area Question 1: Rowing Boat

Area of rectangle = length x width
Area of rectangle = (6m-2m)x 1.5m
Area of rectangle = 4m x 1.5m
Area of rectangle = $6m^2$

Area of triangle = 1⁄2 x length x width
Area of triangle = 1⁄2 x 2m x 1.5m
Area of triangle = $1.5m^2$

Total surface area = area of rectangle+area of triangle
Total surface area of rowing boat = $6m^2$+$1.5m^2$
Total surface area of rowing boat = $7.5m^2$

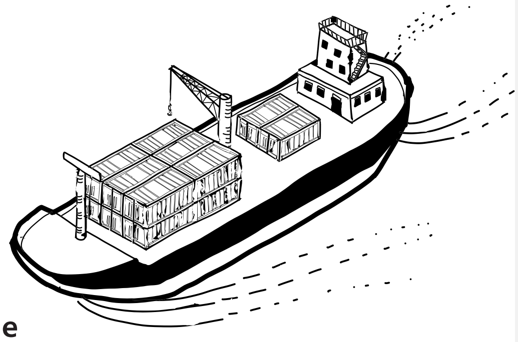


Surface Area Question 2: Cargo Boat

Area of rectangle = length x width
Area of rectangle = (320m-40m) x 50m
Area of rectangle = 280m x 50m
Area of rectangle = $14,000m^2$

Area of triangle = 1⁄2 x length x width
Area of triangle = 1⁄2 x 40m x 50m
Area of triangle = $1,000m^2$

Total surface area = area of rectangle+area of triangle
Total surface area of cargo boat = $14,000m^2$+$1,000m^2$
Total surface area of cargo boat =$15,000m^2$



Surface Area Conclusions

Surface area can be approximated by simplifying the complex shape into simple shapes, such as rectangles and triangles. This is how you can break down complicated problems into simple steps.

Engineers need to calculate how much surface area is available on boats so that they know how much space there is for passengers and cargo.

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Learn about: how distance and weight affect balance on a seesaw

Weight Distribution

When loading a boat, it is crucial to distribute the weight evenly across the boat. If the boat is weighted too heavily at one side, it will capsize and sink. When designing the boat, engineers calculate how best to distribute the weight to ensure the boat will not tip over if too many people are on it.

Weight Challenge 1:

Can you balance ten 2p pieces on the ruler?

You should be able to do this easily with five 2p pieces on each side.

Can you find a way to balance the ruler with more 2p pieces on one side than the other?

(Hint: the closer to the eraser a 2p is, the less it will tilt the ruler)

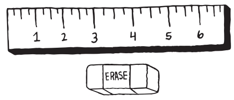
Remove all the 2p pieces from the ruler.

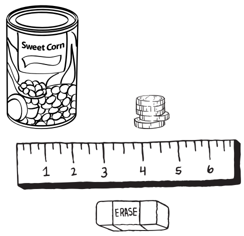
Balance the ruler on the eraser, with a weight (such as a potato, or a tin of beans) on top of both the ruler and eraser.

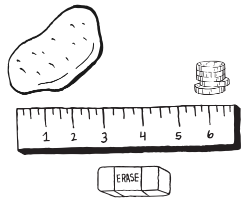
Can you balance the 2p coins more easily now?

Place all 2p pieces on the same side of a seesaw in the park. Does it move at all?

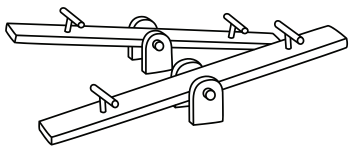
Why is this?







Weight Challenge 2:



Sit on a seesaw, with a family member or friend of a similar size on the opposite side. You should balance with each other.

Now you and the other person should sit on the same side of the seesaw. Your weight will tilt the seesaw as it has become unbalanced.

Warning:* *Remember to follow social distancing guidelines at all times.

Weight Distribution Conclusions

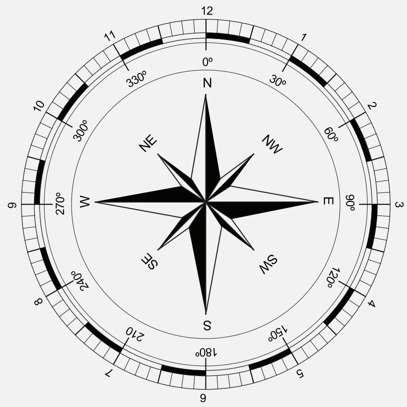
If the weight is distributed evenly on both sides of the seesaw or ruler it will not tilt – this means that the seesaw or ruler is balanced.

The heavier the seesaw or ruler is, the less likely it is to be moved by weights on either end (like the 2p coins on the seesaw.)

When loading a ship, the cargo will be distributed evenly around the ship to help it balance, this will help ensure that when people move around the ship it will not tilt to one side but remain balanced.

Learn about: How bearings are used to calculate position and direction

Navigation



Ships navigate from one port to another using bearings.

A bearing is the angle between North and the direction an object is travelling in.

- As **North** is the start point, it is given the bearing 000°. Bearings are numbered clockwise until 359° when they arrive back at North and become 000° again.
- **East** is a quarter of the way around the compass, so is given the bearing 090°, which is a quarter of 360° and is perpendicular to North.
- **South** is halfway around the compass, so is given the bearing 180°, which is half of 360°.
- **West** is three-quarters of the way around the compass, so is given the bearing 280°, which is three-quarters of 360°.

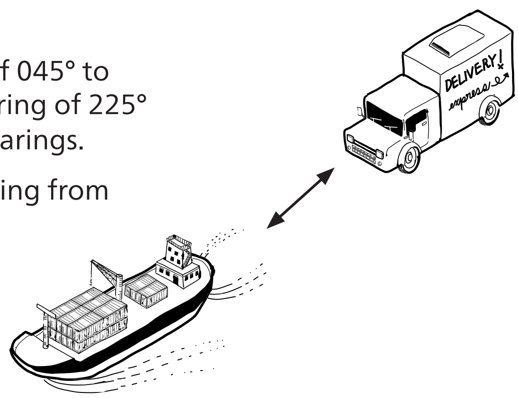
Use the compass to find the bearings in this questions.

Look at this boat. It needs to travel on a bearing of 090° to get to the lorry. The lorry needs to travel on a bearing of 280° to get to the boat. Use the compass to find the bearings.

Navigation Question 1: If you subtract one bearing from the other, what number do you get? Why?

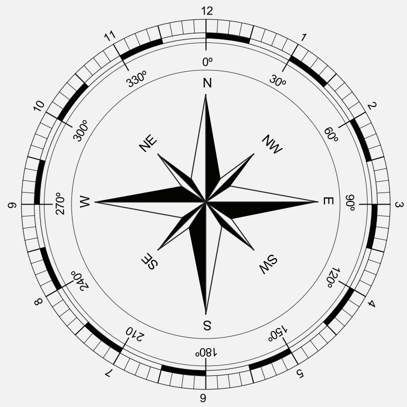
Look at this boat. It needs to travel on a bearing of 045° to get to the lorry. The lorry needs to travel on a bearing of 225° to get to the boat. Use the compass to find the bearings.

Navigation Question 2: If you subtract one bearing from the other, what number do you get? Why?



Learn about: How bearings are used to calculate position and direction

Solutions to Bearings Questions



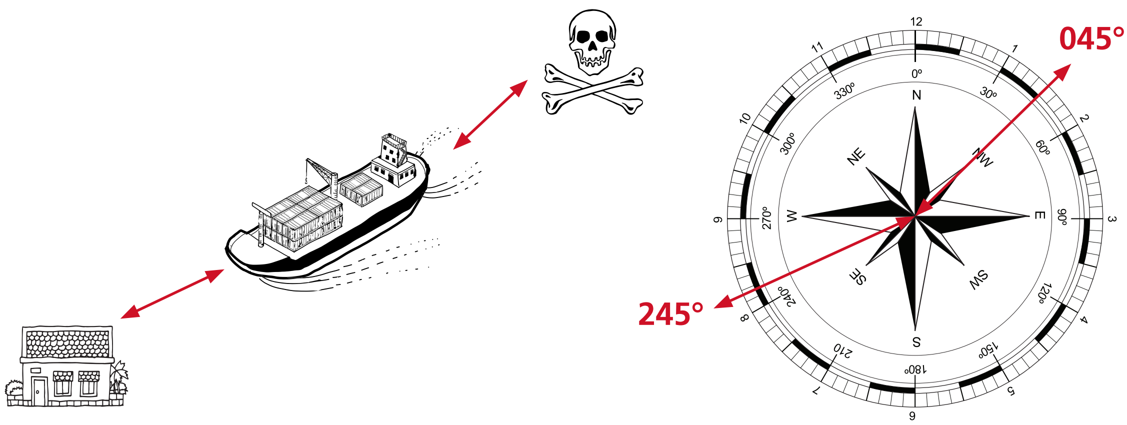
You will always get 180°, because these objects are in line with each other, and a straight line has 180°.

Remember!

You must always use three digits when giving a bearing. This is in case a digit is dropped by accident. It makes sure the person receiving the message knows they have all of the information before proceeding and making a terrible mistake!

Look at the example below:

This ship receives instructions to travel on a bearing of 45°. This is only two digits. The captain of the ship doesn't realise there was a bad communication link, and the leading "2" has been lost; the instruction should read "travel on a bearing of 245°"! The captain hasn't done a check to make sure all three digits are present and so heads off in the wrong direction.



Navigation Conclusions

Ships use bearings to navigate the waters.

When there is a straight line between two objects, there will be 180° between them.

Bearings consist of three digits.

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Meet our STEM Ambassador

Stephanie

1. How do STEM subjects fit into your role at work?

My job as a test engineer is to find the things that are broken, fix them and make sure they don't break again. I utilise maths to help me analyse data and technology to develop new processes that help to fix any issues we face. We need to make sure we stay ahead of the competitor with the most up-to-date technology that's available. We create, design, and engineer new solutions to problems to make sure we avoid them in future.

2. Have you found STEM working in unexpected places?

Many people find maths boring, but I find it fascinating. Once you learn how numbers fit and work together, you'll find that maths shows up in everything. Maths is money, time, logic, planning, probability; maths isn't just numbers. Being good at maths gives you a massive advantage in life. Learn how to plan your time and manage your money.

3. What advice would you give to someone who wanted to study STEM subjects or follow a STEM career path?

Do what you enjoy. If you enjoy the work that you do, you will never have to work a day in your life.

4. Who is your STEM inspiration or role model, and why?

Matt Parker, the Numberphile. He has an excellent YouTube channel and writes hilarious books. He teaches maths in a funny way and makes it exciting and memorable. He often tours the country doing roadshows, so it's worthwhile watching out for him in your nearest city.

Introduction to Engineering

Materials used in boat construction

Boats can be made of a vast range of materials. The Vikings used the most common material available to them that would float: wood! Therefore, they made boats from local timber. On the other hand, modern boats or ships are made from multiple materials that suit the purpose of the vessel. Examples of modern materials are given below.

A boat, like a racing speed boat, needs to be constructed of materials that are light, but also strong and flexible. This type of vessel will usually use plastic or carbon composite materials for the structure, which are specially designed to meet these needs when travelling through the water at high speeds. Although these are excellent materials for this type of boat, they can be expensive and hard to maintain.

Bigger boats and vessels, such as large military aircraft carrier vessels or cruise liners, travel at much slower speeds compared to a speed boat. These boats need to be strong but not flexible. Therefore, they are typically made of metal or heavier materials as they are durable and cheap to maintain.

Wood is still used in making boats, but this has mostly been phased out. It is a difficult material to work with and does not offer the same durability or performance as the materials above. Wooden boats are mainly small personal ones that do not require much maintenance or travel shorter distances at a slower pace.

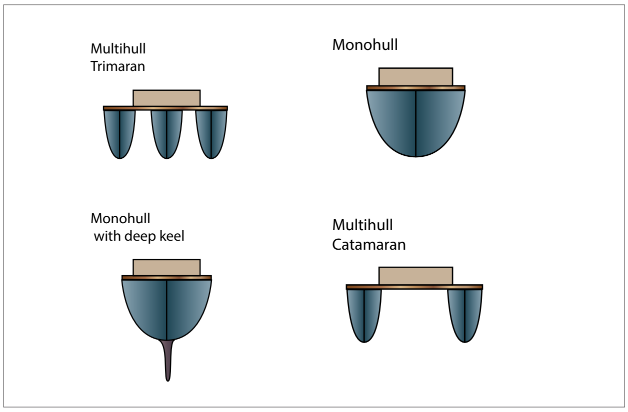
The shape of a boat

The most common shapes of boats are shown below. The hull (the bottom of the ship) is

typically V- or U-shaped. However, the depth and width of the hull varies across ships and depends on how fast or slow it needs to travel. The deeper a ship's hull goes into the water, the more stable it will be as it displaces more water, but this makes it harder to steer.

A ship with a narrow V-shaped hull will displace less water and so can travel faster. However, it is not as stable because it's centre of gravity is higher than larger ships which tend to be weighed down by heavier engines. The overall design of the vessel needs to be a compromise between stability and manoeuvrability - that is why there are so many different types!

To allow the boat to move through the water, the front of the ship needs to displace the water that it is travelling through. To be more efficient and to allow more water to move, the front of the ship is shaped like a knife or a sharp point as this enables the ship to "slice" through the water.



Source: https://en.m.wikipedia.org/wiki/File:Monohull.svg

Learn about: How to use a material's properties for a flotation device

Boat Design Challenge

The Problem: The Mississippi Cookie Company transports their cookies from their factory in Minneapolis, MN to their distribution center in New Orleans, LA. Since the route is over 1,400 miles on the Mississippi River, it is important to ship as many cookies as possible each trip. Their largest barge was damaged in a recent storm, and they need to replace it with another water-craft that will support the weight of thousands of boxes of cookies.

The Challenge: A representative from the Mississippi Cookie Company has contacted you to design a model of a boat that will support enough weight to transport their cookies from Minneapolis to New Orleans.

The Materials: You must construct your model boat using the following materials: Popsicle sticks, aluminium foil and Elmer's School Glue. You may also use any of the following optional materials: plastic straws, corks, paper. Remember that a big part of this challenge is to create a model that will support weight and be economical to build. Decide which materials you want to use wisely! The optional materials are expensive!

The Cost: Your boat must be cost efficient to build. You have a budget of **£1000** to build your boat. Using the cost of materials below, calculate the cost.

- Lumber (popsicle sticks) = £50 each
- Sheet Metal (aluminium foil) = £25/sheet
- Welding materials (glue) = £50 bottle
- Reinforcements (plastic straws) = £25 each
- Buoys (corks) = £50 each
- Cable/rope (masking tape) = £10/inch

Brainstorm, Design and Build!

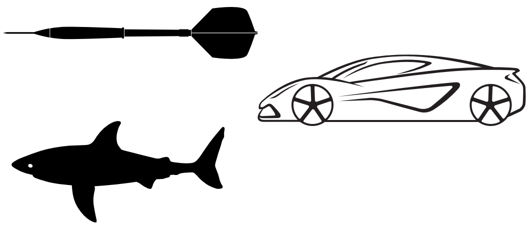
What design do you think would be the best for this challenge? Sketch your boat design and brainstorm some ways that you think might make it strong enough to support the most weight and be the most economical to build. Build your model and test it to see if you will get the job!

https://www.educationworld.com/sites/default/files/build-a-boat.pdf

Learn about: hydrodynamics in boat bow design

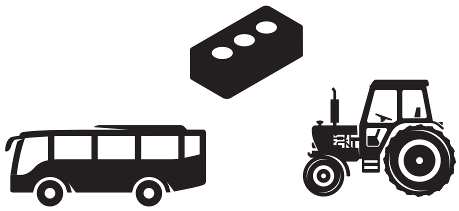
Angles on a Boat

Angles Question 1: Think of things that travel quickly. A dart. A supercar. A shark. What do you notice is common to the front of all of these things?



THEY ALL HAVE POINTED FRONTS

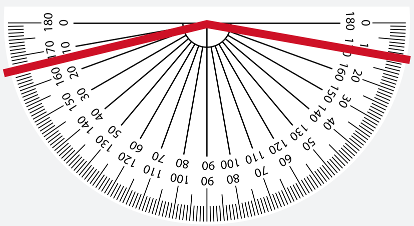
Angles Question 2: Think of things that travel slowly. A bus. A brick. What do you notice is common to the front of all of these things?

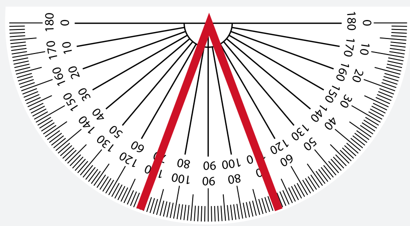


THEY ALL HAVE FLAT FRONTS

When an object travels, it is met with air or water resistance, which slows down the object. The sharper the front, the lower the resistance. This means that objects with a sharp front, experience less air resistance, and so are able to travel fast. Objects that travel quickly through water can be described as hydrodynamic and objects that travel quickly through air can be described as aerodynamic.

Imagine the front of a boat, also known as the **bow**. It is crucial to design the front of the ship to be hydrodynamic, so that it travels through the water quickly. This means the angle of the bow needs to be sharp.





This image above shows a wide angle for the front of a boat is **not** hydrodynamic. This means it will encounter a lot of resistance and so travel slowly, but it will allow more space for cargo and/or passengers.

This image above shows a sharp angle for the front of a boat that is hydrodynamic. This means it will encounter less resistance and so can travel faster, but it will struggle to carry lots of cargo and/or passengers.

Aerodynamic: having a shape which reduces the drag from air moving past

Hydrodynamic: having a shape which reduces the drag from water or other liquids moving past

Learn about: How to practice fine motor skills

Origami Boat

You will need:

- 1 Rectangular sheet of paper

What to do:

1. Start with your rectangular paper. Lay it down vertically and fold it from left to right so the corners meet up. Unfold the paper, rotate it 90 degrees and fold it in half again.

2. Flip the paper so that the fold opens toward you. Then, fold down the top corners towards the middle of the paper while leaving 1-2 in (2.5-5 cm) of space at the bottom.

3. Grab the flap at the bottom of the paper and fold it up against the bottom of the 2 folded triangles. Turn the paper over and do the same thing to the flap on that side. This will make a paper hat.
    - On 1 side of the paper, grab the corners of the rectangle that are sticking out over the triangle. Wrap these parts of the paper around the edges of the triangle and crease them so that they stay wrapped around the edge of the triangle. Repeat on the other side.

4. Pick up the triangle, rotate it 45 degrees, then use your fingers to open up the bottom of the triangle. Pull the paper apart gently until it pops into a square shape. Make sure the bottom corners of the triangle fold over each other and become the bottom corner of a diamond.

5. Arrange your paper so that the bottom points of the diamond can fold upward. Fold up 1 corner, aligning it with the top corner. Then, flip the paper over and do the same thing to the other side.

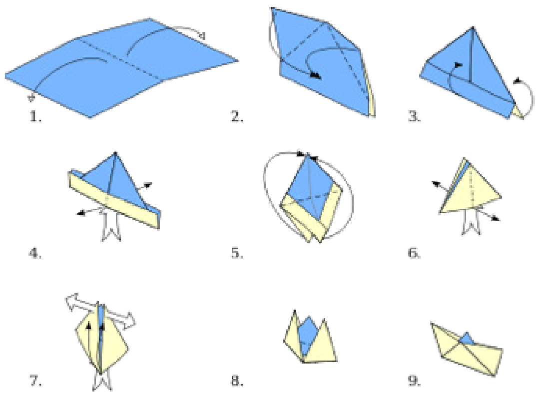
6. Just like last time, pick up the triangle, rotate it 45 degrees, then open up the bottom of your new triangle with your fingers. Crease the paper along its edges so that it stays in the square shape.

7. Pull out the triangles on the side of the square. Start at the top of the diamond, and gently pull the two sides apart so that the seam running down the middle of the diamond blooms.

8. Crease the bottom of the folded out sides to make the boat a bit stronger.

9. You have created an origami boat!

Float your boat. Fill a small tub with water and place the boat on the water. If it starts to droop a little, keep making small adjustments to keep the sides up and prevent the boat from sinking. You can reinforce the corners with clear tape and tape around the bottom to keep your boat dry.



Source: https://zh.m.wikipedia.org/wiki/File:Origami_boat.svg

https://www.wikihow.com/Make-a-Paper-Boat

Meet our STEM Ambassador

Laura

1. **How do STEM subjects fit into your role at work?**
   Being an engineer is one of the core careers for STEM. It's super valuable as engineers build societies! Engineers have built everything around you in one way or another, and without them, society would not be what it is now. As an engineer, all the STEM subjects help me to do my job. We use our knowledge of science, engineering, and mathematics to create new technologies every day.

2. **Have you found STEM working in unexpected places?**
   What part of society you contribute to determines how much you exercise these skills? If you're working in Finance, you use mathematics and technology to create all sorts of ways to do your job better. You wouldn't think technology is a big part of Finance, but it is. Using excel, databases or other tools allow Finance workers to do their jobs easier. Another example is journalists. You wouldn't think journalists use much STEM subjects, but they do. Imagine the technology tools they would need to create their stories. Video and audio editing, computer applications, website design, the list goes on.

3. **What advice would you give to someone who wanted to study STEM subjects or follow a STEM career path?**
   My path to engineering was not quite a straight road, but I got there in the end. I took all my GCSE's, which included Maths, Science, English, and Information Technology. I went on to do A-levels in Physics, Maths and Computer Science. From there I did a Bachelor of Engineering at Surrey University in Electronic Engineering and Space Systems. Then I did a Master of Science in Astronautics and Space System Engineering. If you want to be an engineer, you can start as an engineering apprentice and learn and get paid at the same time. The main things to start with is Maths and Science at school. From there, you can do anything as an engineer.

4. **Who is your STEM inspiration or role model, and why?**
   From a young age, I don't think I had a STEM inspiration or role model. I didn't have STEM clubs or anything like that, so I had to find out my own path and what I was passionate about. This is why I am so glad students have industry and organisations promoting STEM so they can learn about what opportunities are out there. Although later in life I found the inspirational stories of astronauts and scientists a true inspiration.

Learn about: how to write a science experiment

Float your Boat

You are going to make three boats out of different materials and test to see which ones float, then try to explain why!

Preparation:

Gather boat-making materials e.g.

- Sponges
- Styrofoam (Large Pieces or Cups, Bowls, Or Small Plates)
- Wood Scraps
- Cardboard Scraps or Small Boxes and Lids
- Egg Cartons
- Paper Tubes and Straws
- Foil Wrap
- Plastic Containers
- Variety of Paper
- Child Safety Scissors
- Glue and Tape
- Water Table or Large Basin
- Coins/Counters

Prediction:

Out of all the materials you've collected, which do you think will make the best boat?

I think ______________________

will float best because ______________

____

____

Materials:

Which materials did you use?

____

____

____

____

____

____

____

____

Method:

Which materials did you use?

1. We collected all the materials we needed to make a boat.
2. We picked one material and turned it into a boat.
3. We placed the boat on the water.
4. We added coins in the boat until it sunk.
5. We then repeated steps 2-4 for each material.

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Learn about: how to write a science experiment

Float your Boat

Results:

Fill in the table

Material	Did it float?	How many counters did it hold?

Analysis:

What did the results show? Why?

Conclusion:

What happened in your experiment? What could you do differently next time?

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Learn about: how surface area affects hydrodynamics

Splash Challenge

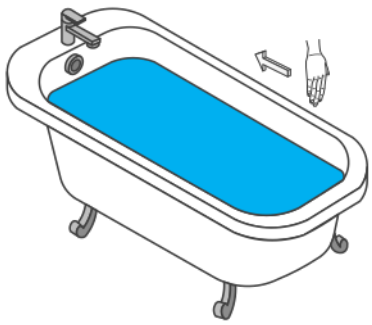
You will need:

- 1x bath or bucket
- 1x human hand
- 1x adult to supervise (and to splash)

What to do:

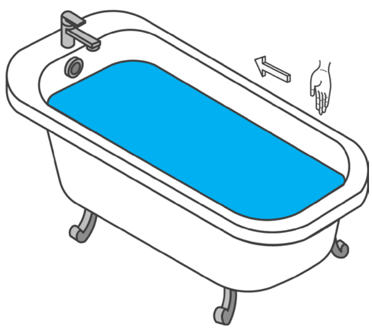
1. Place your open and flat hand in the water with the palm facing the opposite end. Stand the adult at the opposite end of the bath.
2. As fast as you can, keeping your hand open, palm towards the other end and fingers together, move your hand to the other end of the bath (towards the adult). Make sure your hand stays in the water when moving from one end to the other.
3. Allow the Adult to dry off if they have been splashed.
4. Place your hand in the water with your first finger facing the opposite end. Stand the now dry adult at the opposite end of the bath.
5. As fast as you can, keeping your hand open, the first finger towards the other end and fingers together, move your hand to the other end of the bath (towards the adult). Make sure your hand stays in the water when moving from one end to the other.
6. Allow the Adult to dry off if they have been splashed.

End A



End B

End A



End B

Learn about: how surface area affects hydrodynamics

Splash Challenge
Conclusion

When you carried out steps 1 to 3, you were creating a wide surface area that displaced more water, which would have caused a bigger splash, meaning it was not hydrodynamic. There was a large splash because there was a large amount of water being displaced by your hand, and most of it couldn't move away fast enough. In this case, more energy was needed to move through the water as there was a larger surface area, which meant more water had to be displaced.

When you carried out steps 4 to 6, you were creating a narrow surface area that displaced less water, which would have caused a small splash, meaning it was hydrodynamic. There was a small splash because there was a small amount of water being displaced by your hand, and most of it could move away fast enough. In this case, less energy was needed to move through the water as there was a small surface area, which meant less water had to be displaced.

Using this principle, boats have a thin front (like a knife-edge) to reduce surface area, which means there is less water to displace and less water resistance. This lessens the splash at the front of the ship, which makes them more hydrodynamic. Overall, this means that a sharp front bow means boats can travel at faster speeds through the water.

Introduction to Technology

Types of boats and ways they can be designed

The way that boats have been powered has considerably changed over the past 100 years. Where traditionally they were powered by people, using oars, or by the wind, using sails. Until recently, they were powered by steam engines, until they developed electric and diesel engines. Using a powered boat has meant that people can travel longer distances, more efficiently, using fewer people. This has been advantageous to the Navy as it has meant that ships could travel further at a quicker speed, without being forced to follow the wind.

Engine Types

Now let's look at the three types of engines you'll find on powered boats: outboard, inboard and stern drive engines.

What is an Outboard Engine?

Outboard engines are mounted outside of the boat's hull, which is why they're called "outboards". They are used to both power and steer the boat (by moving the entire engine). On smaller boats, this is often done using a hand tiller, while on larger boats a steering wheel is used.

What is an Inboard Engine?

Inboard engines are located inside the boat's hull. Inboard engines are automotive engines that have been modified for boats. These engines power a drive shaft connected to a propeller. Unlike an outboard, an inboard only powers the boat. To steer an inboard, you use a rudder that is located behind the propeller and turned by a steering wheel.

What is a Stern Drive Engine?

A stern drive engine is sometimes called an "inboard-outboard" because it has similarities with both other types of engine. Similar to inboards, they use an automotive engine mounted on the inside of the hull. Similar to outboards, a steering wheel turns the drive unit to steer the boat.

Image source: https://www.boaterexam.com/boating-resources/boat-engine-types-sizes.aspx

Learn about: How forces affect buoyancy

Buoyancy Explained

When something is in the water, two forces are acting on it.

- The Weight of the object upon the water
- The force of the water pushing up against the object Upthrust

So, if the weight of the object is equal to or less than the Upthrust it floats. This is called Buoyant.

If the weight is greater than the Upthrust, it sinks.

You will need:

- Large bowl for water
- Lollypop stick / Plastic Spoon
- Pebble / Coin

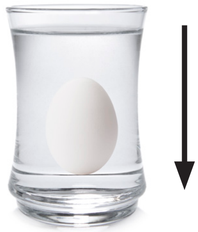
What to do:

1. Fill the bowl with water
2. Drop the lollypop stick or plastic spoon into the bowl. Did it float or sink?
3. Now drop the pebble or coin into the water

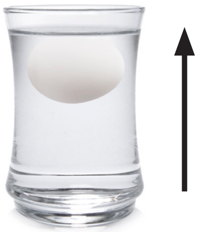
Did it float or sink?

Conclusion: The Lollypop stick or plastic spoon floated because the weight of them was less or equal to the Upthrust of the water.

The pebble or coin was heavier than the Upthrust of water.



The item has sunk because it is heavier than the upthurst of water



The item floats because the weight of it is less or equal to the upthrust of water

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Learn about: How propulsion causes objects to move

Propulsion or Thrust

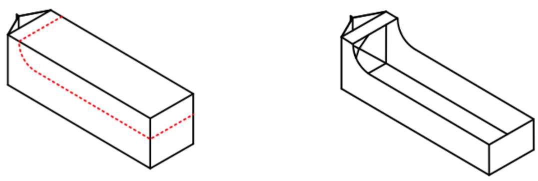
We are going to look at propulsion or thrust with a small Balloon Boat experiment.

You will need:

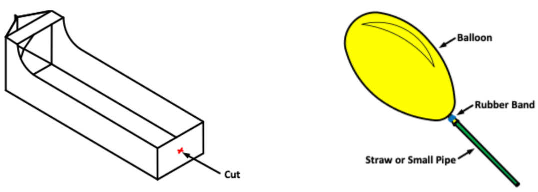
- Scissors
- Milk or Juice Carton (Cardboard or Plastic)
- Rubber Band
- Balloon
- Small pipe or Drinking straw
- Bathtub / Bucket of water

What to do:

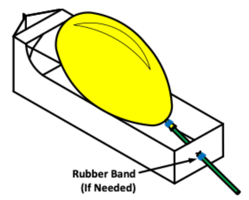
Cut the Carton to make a Boat. Carefully cut a Milk or Juice Carton as shown using scissors:



Fit the Straw in the balloon using a rubber band. Carefully insert the Straw into the opening of the balloon, and use a rubber band to hold it in place. Make sure it's tight enough to hold the straw but not too tight that the straw is pinched and air cannot go through it. You can test it by trying to inflate the balloon a small amount through the straw.

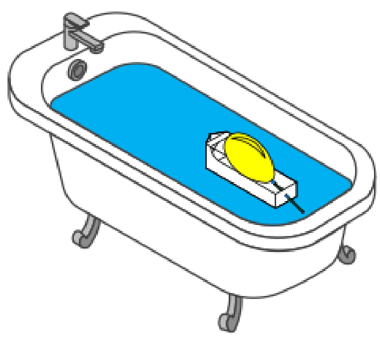


Push the straw through the slit in the Boat. Carefully push the straw through the slit in the end of the carton. Make sure it's secure, if it's loose, use a rubber band on the outside of the carton to hold the straw in place.



Blow the balloon up. Hold the balloon firmly by the tail and tube. Blow into the balloon through the tube, then quickly cover the opening of the tube with your finger. Keep holding the tail end of the balloon.

Set the boat into a body of water point and let go. You can use anything, from a sink to a bathtub to a swimming pool. Keep your finger over the tube, point the boat in the direction you want to go (the straw should point in the opposite direction) and let go!

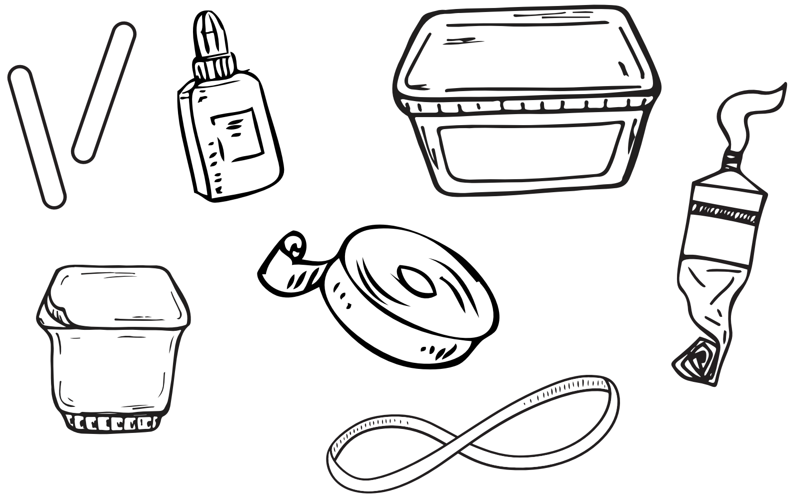


Learn about: How propulsion causes objects to move

Make a
Self-Propelling Ship

You will need:

- Margarine tube
- Yoghurt pot
- 2 craft sticks
- Super glue or glue gun
- Duct tape
- Acrylic paint
- Elastic band
- Another piece of plastic



What to do:

1. Get a parent to superglue two lollipop sticks to each side of the margarine tub, leave it to stick overnight (you can also tape it with duct tape to make sure it sticks). Also, do the same of the yoghurt pot lid and stick it to the lid.
2. (Optional) Paint and design your boat!
3. Cut the additional piece of plastic into the shape below – cut two slits until halfway down the plastic – to make a paddle. It must be able to fit between the lollipop sticks.
4. Feed the elastic band around the lollipop sticks and twice through the plastic paddle.
5. Wind up the paddle clockwise and let it go!

Source: https://www.redtedart.com/margarine-tub-tug-boat-craft/

Learn about: Spelling

Wordsearch Solution

What was your score?

/20

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Photo/ Image consent form

FOR ALL AGES

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Since 2007, the Royal Navy and Royal Marines Charity, in partnership with Greenwich Hospital, has distributed thousands in grants to over 30 front line charities. This money is used directly to support sailors and marines, both serving and veteran, full-time and reservist, as well as their families. This funding, through the work of front-line charities has helped care for older age veterans, improve the relationships within naval families, assisted those in times of need, helped sailors and marines transitioning into civilian life, as well as improving morale of those serving and deployed.

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