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.

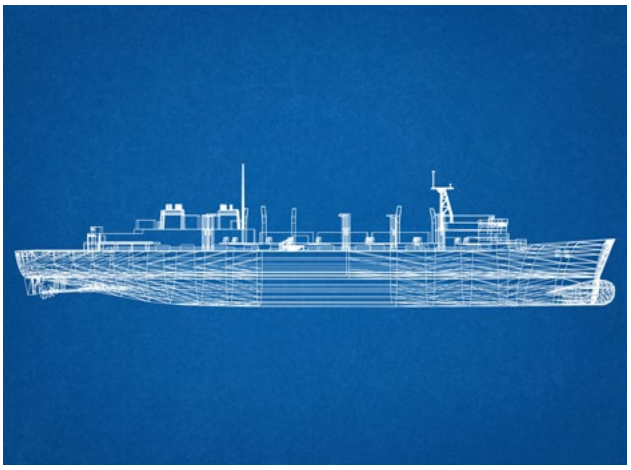
In the Navy, engineers, sailors, and mariners use maths in their everyday jobs to help them design new ships, plot their course across the sea, and understand the forces that are at work when a submarine goes under water.

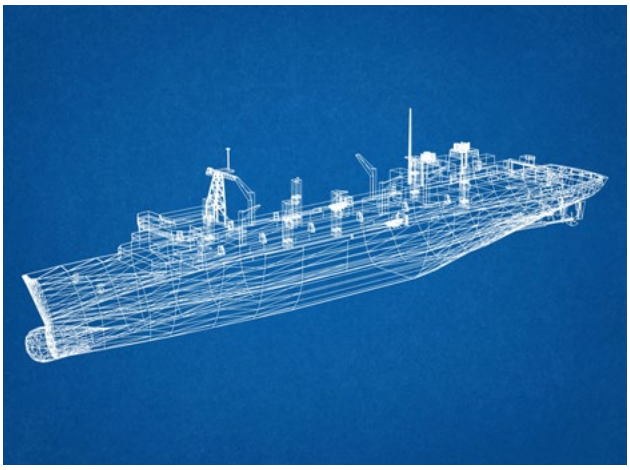
Our activities are focused on helping you understand how boats and ships are built. We will use maths to help you solve mathematical calculations and problems that an engineer would have to consider when they design a ship.

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

One reason it is important to know how much surface area is available on a boat or ship is 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!

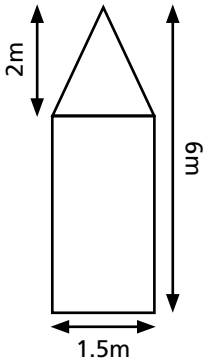
Area of rectangle = length x width

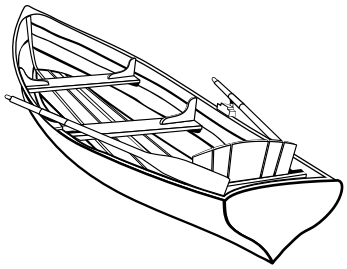
Area of triangle = half x base x height

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.

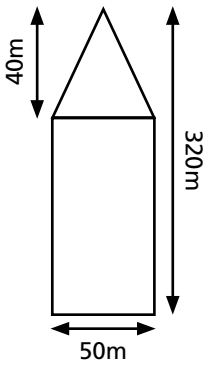


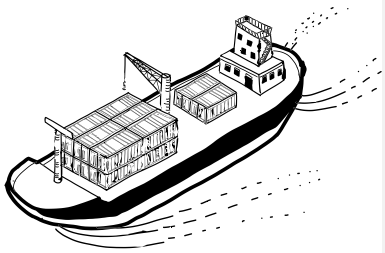


Surface Area Question 2:

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.

Raytheon UK | ROYAL NAVY & ROYAL MARINES CHARITY

Learn about: How to calculate composite surface areas

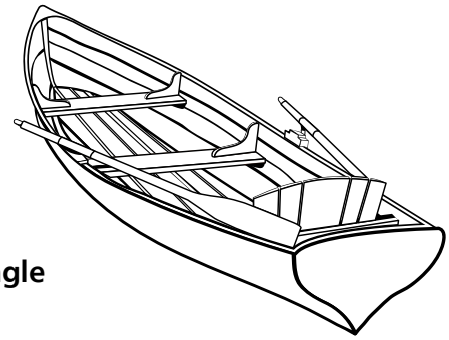
Surface Area Solutions

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 = $7.5m^2$

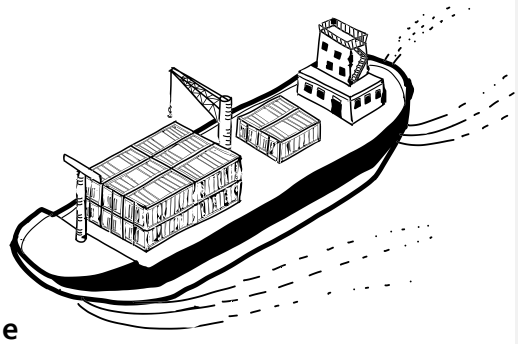


Surface Area Question 2: Cargo Boat

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.

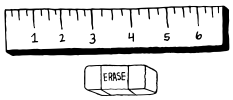
Raytheon UK | ROYAL NAVY & ROYAL MARINES CHARITY

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.

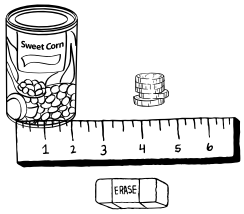
Weight Challenge 1:



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?

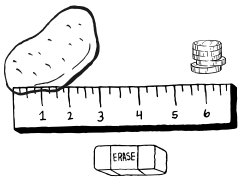


(Hint: the closer to the eraser a 2p is, the less it will tilt the ruler)

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.

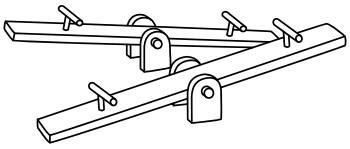
Can you balance the 2p coins more easily now?



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 and take care when moving on and off the seesaw.*

Weight Distribution Conclusions

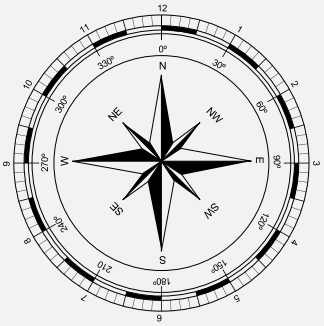
If the weight is distributed evenly on both sides of the seesaw or ruler, it will not tilt – this means that the seesaw or ruler is balanced.

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 in a number of ways, one of which is pilotage which uses bearings.

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

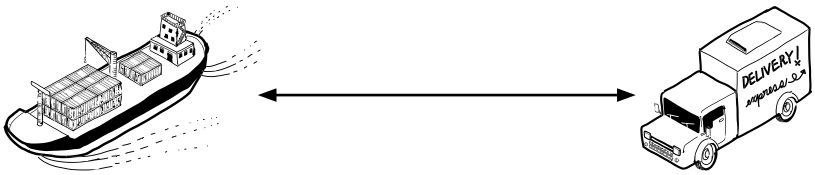
- As **North** is the start point, it is given the bearing 000°. Bearings are numbered clockwise until 359° when they arrive back at North and become 000° again.
- **East** is a quarter of the way around the compass, so is given the bearing 090°, which is a quarter of 360° and is perpendicular to North.
- **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 270^0, which is three-quarters of 360^0.

Other methods of navigation include: Dead Reckoning, which is navigation by determining position from point of departure, Electronic Navigation, using satellites or other systems, and Celestial Navigation, which uses the sun, moon plants and stars to fix your position.

Use the compass to find the bearings in this questions.

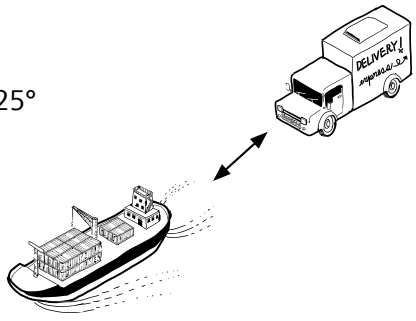
Look at this boat. It needs to travel on a bearing of 090° to get to the lorry. The lorry needs to travel on a bearing of 270° to get to the boat. Use the compass to find the bearings.

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



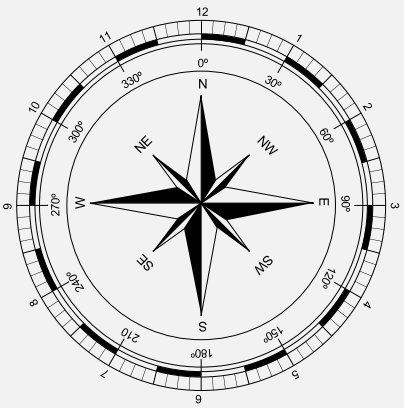
Look at this boat. It needs to travel on a bearing of 045° to get to the lorry. The lorry needs to travel on a bearing of 225° to get to the boat. Use the compass to find the bearings.

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



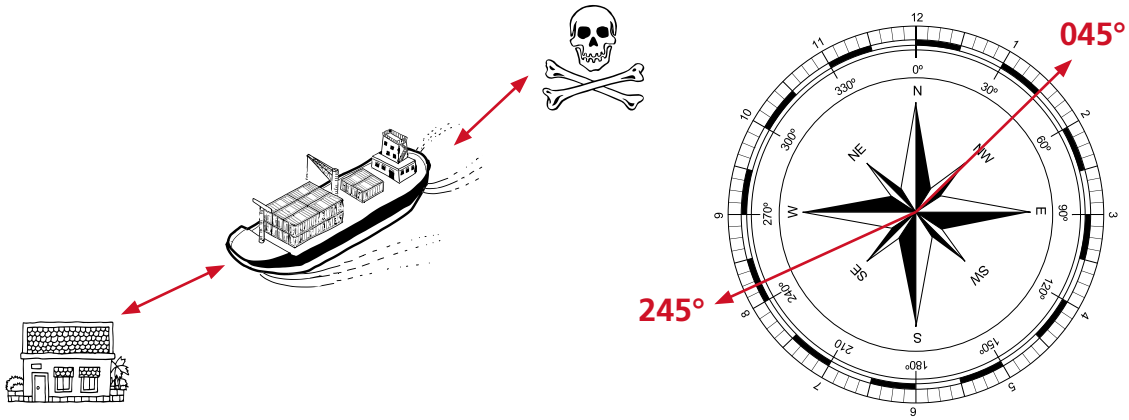
You will always get 180°, because these objects are in line with each other, and a straight line has 180°.

Remember!

You must always use three digits when giving a bearing, i.e. 180° would be spoken as: One Eight Zero, or 090° would be spoken as: Zero Nine Zero. This makes sure it is clear to the person receiving the message before acting on it so they do not make 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.

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.

Raytheon UK | ROYAL NAVY & ROYAL MARINES CHARITY