Teacher notes – KS2 Maths: How far can you glide? - Calculating Glide Ratio

This unit builds students' mathematical thinking and their ability to work scientifically. The class will make 3 designs of glider, measure how far they fly from a given height and calculate the glide ratio of each, followed by practice with a number of examples.

National curriculum areas addressed include:

- Multiplication, division, ratio, use of tables, measurement, averages and general mathematical and scientific vocabulary.

Introduction

Before starting the video, elicit experiences from the class. Has anyone been gliding? Seen a glider in the air? Are there any gliding sites local to the school? Does anyone know anything about gliding? The video starts by explaining the basics of gliding and explains what the students will be doing in the experiment. Pause the video for students to do the practical experiments; if it's not possible to let the students do the practical work, get them to write the results from the demo section of the video into a table as the basis for their calculations.

Student activity

Students select from a choice of 3 designs of paper glider – instructions overleaf – or can bring other models if available. The teacher should ensure that all designs are investigated across the group. Launching in a consistent manner from a known height – we use a 300mm block in the video but they should use whatever is convenient eg launch from a desktop. The first step is to make the gliders fly smoothly - they may need additional ballast on the nose in the form of paperclips to achieve this - and then to measure how far they go from a given height. This can incorporate calculation of averages, fractions, discussion of variability as appropriate. Calculation of the glide ratio is followed by a number of maths-based practice questions – others can be constructed as desired.

INFORMATION

GLIDE RATIO – WHY IT MATTERS
As you will see in the video, anything with wings will glide – but gliders are designed to be especially aerodynamic so that they can glide further between thermals and so go further and faster. This is also important for powered aircraft as it means they use less fuel to cover the same distance – costing less and with lower emissions. Aerodynamic development is often done on gliders as it's fairly easy to test new designs, for example the turned-up wing tips now common on airliners were first developed on gliders. Training gliders don't need a particularly good glide ratio as they won't be going far from their home site, but even so they typically have a glide ratio of 30:1 – and that's better than an Airbus or a 747 at around 17:1. The best gliders achieve around 60:1 and enable pilots to regularly make flights of 500km or more at speeds of up to 100mph. Read more about the world record flight of 3008km overleaf.

GO GLIDING: With around 80 sites from the Highlands of Scotland to the south west tip of England, wherever you live you'll never be far from a gliding club. You can find your closest gliding club and more about gliding on the BGA website www.gliding.co.uk

AWESOME FACT: after completing your training, you can fly a glider solo at age 14!

CAREERS INFORMATION: ***Aviation is not just about being a pilot!***
Students can learn more about the huge range of careers in aviation and aerospace at stem.caa.co.uk/careers-in-aviationand-aerospace

Post experiment activity

Fun fact: the world record distance for gliders is 3008km – to get an idea of this, if you started on the south coast of England, this would take you as far as Egypt – and all without an engine once the glider has launched!

In fact the flight was done in South America in the Andes. Wind blowing across mountains can provide areas of rising air known as 'wave lift' rather than having to take separate thermals. Wave lift happens when standing waves set up in the lee of mountain ridges, so in the Andes and other mountain areas, long flights can be planned to be mostly in lift. It's also possible to soar in the mountains using 'ridge lift' – rising air on the windward side of a mountain or hill where the wind is forced up over the rising ground. Most cross-country flying in the UK is done in thermal lift as described in the video.

As post-experiment activity, the class can research the Perlan Project https://perlanproject.org/ which is launching from South America aiming to take advantage of this wave lift to get a glider into the stratosphere. Questions for the class include: What's the highest the Perlan glider has flown? What's the furthest it's flown? What is its glide ratio?

There's more about Perlan in our KS2 Science unit 'Soaring into the Stratosphere' exploring air pressure - you will find this on the website.

Students can find out all about gliding at the British Gliding Association website www.gliding.co.uk and the Junior Gliding and Women Gliding communities at the links below. There's information about flying with and without an engine and all types of aviation at https://stem.caa.co.uk/ & www.airleague.co.uk – aviation is not just about being a pilot! The CAA STEM site is particularly good, showcasing the breadth of aviation and associated careers.

We hope you found this useful and a fun way to encourage young people into the world of STEM and aviation. Girls in particular are under-represented in these areas and we are working to change this. Inspire them with videos of our STEM role models along with other exciting gliding-based STEM resources covering various elements of the National Curriculum on gogliding.uk and at www.gliding.co.uk/STEM. You can contact the Go Gliding team at gogliding@gliding.co.uk.

Student notes are shown overleaf.

Student Worksheet: How far can you glide? - Calculating Glide Ratio

Do you know about gliding?

Do you know what a glider can do? It's an awesome way to fly, and glider pilots fly hundreds of kilometres at speeds of over 100kph, just using renewable energy from the sun and the wind. To get into the air, they have to be launched using a winch, a bungee or be towed by a light aircraft. Once in the air, they have to find rising air, generally in the form of 'thermals' – a bubble of rising air in which the pilot circles to climb. Between climbs the glider descends, some gliders descend more steeply than others, and the measure of how far a glider goes horizontally compared to the height lost is known as the gliders' GLIDE RATIO. A glider with a better glide ratio will go further for the same height loss, and this better performance means you don't have to climb as far to fly a distance across country. As the glider is usually climbing by circling in a thermal and effectively staying in one place as it does it, this means you can go further and faster.

Your challenge*: *Build a glider, fly it and calculate its Glide Ratio

**Templates for the 'standard' designs of glider are attached. These match the designs shown in the photographs.*

What you need:

- A4 paper to make the glider plus paperclips to ballast the nose of the glider to make it fly properly
- An elastic band to launch with so you get a consistent launch as in the video
- Measuring tape

The Experiment:

- First watch the video to learn a bit about gliding and the experiment you are going to do.
- Make your glider according to one of the designs at the back of the worksheet. Make sure that between the class, all the designs get made so you can see which performs the best. If you have a foam glider or one you've made previously, why not bring that along and test it. Once you have made the glider, give it a name! This is called its 'call sign', as it is how we identify the gliders when we are talking to each other or air traffic control on the radio.
- Launch your glider and find out whether it flies in a controlled manner. If it does not fly smoothly try putting paper clips on the nose to ballast it until it flies smoothly without pitching up and stalling.
- Once your glider is flying properly, launch it from a known height and see how far it flies - measure horizontally from where you launched it to the point that it touches the ground.
- Calculate the glide ratio which is: $\dfrac{\text{Horizontal distance flown in metres}}{\text{Launch height in metres}}$
- Launch it two or three times and write your results into a table.
- Calculate the average glide ratio that your glider achieved.

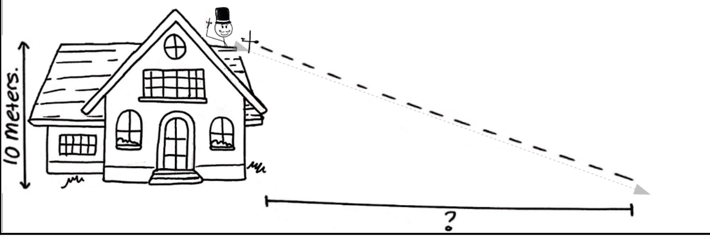
Launch	Launch height (m)	Flight distance (m)	Glide Ratio ??:1
1			
2			
3			

Now you are ready for the Challenge Questions!

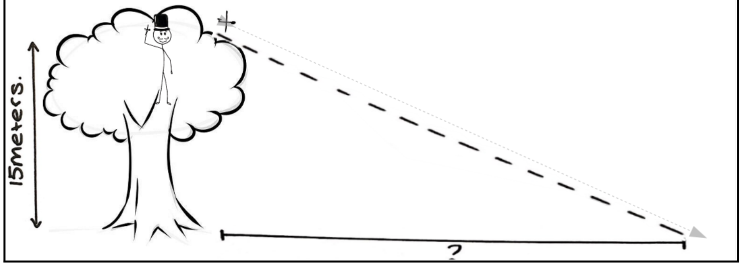
...Turn the page...

Challenge Questions

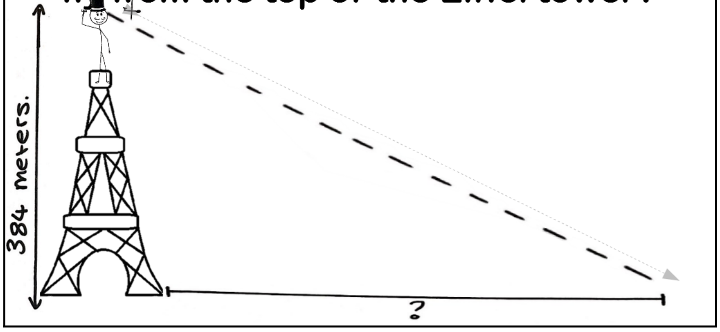
Question 1: how far will your glider fly from 10m high?



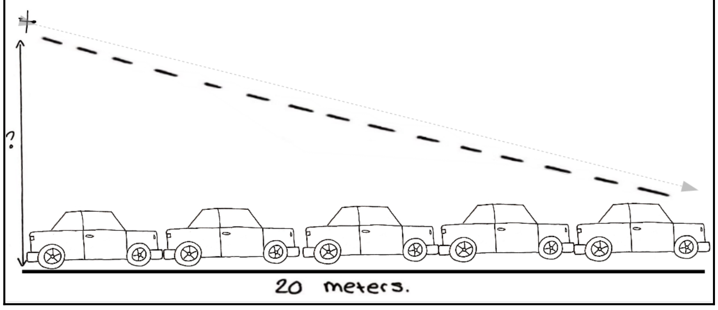
Question 2: how far can your glider fly from the height of a tree?



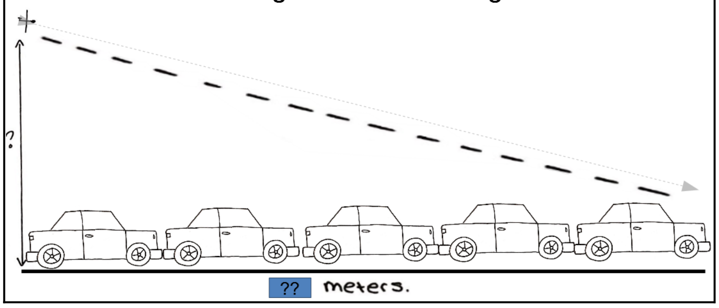
Question 3: how far will your glider fly from the top of the Eiffel tower?



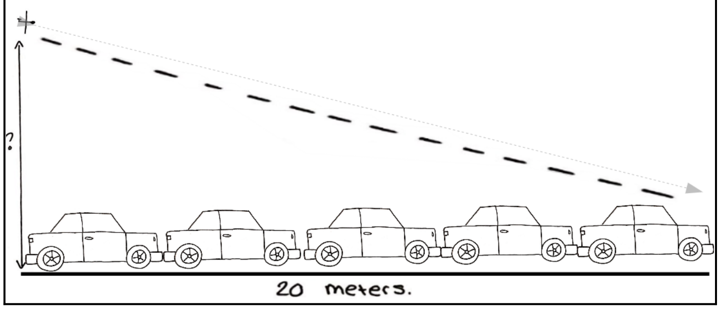
Question 4: how high does your glider need to start to fly the length of 5 cars?



Question 5: What's the *minimum* height it needs to fly over 5 cars if you have more cars to choose from – 3 are 4m long and 3 are 3.5m long?



Question 6: What height would a Nimbus 4 with a glide ratio of 60:1 need to fly over 5 cars 4m long?



We hope you had fun learning about gliding and calculating your glider's glide ratio!

You can find lots of information on flying with and without an engine at **gliding.co.uk, womengliding.co.uk and airleague.co.uk**. And remember that **Aviation is not just about being a pilot! -** there's information about the huge range of careers in aviation and aerospace at **stem.caa.co.uk/careers-in-aviation-and-aerospace** as well as on the Air League site.

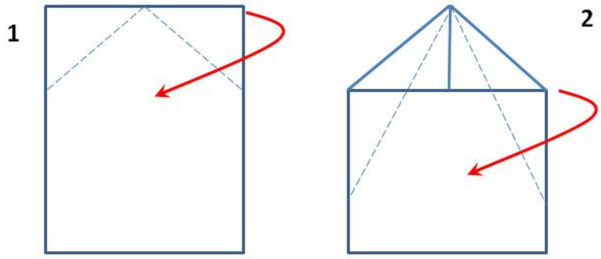
Now you've found out a bit about gliding, why not pop along, see it happening and maybe have a go!
Find your nearest Gliding Club at gliding.co.uk/club-finder/

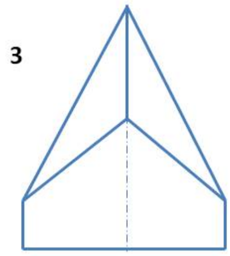
We really hope to see you on an airfield soon!

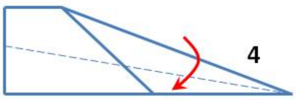
Gliding STEM Resources

3 GLIDER DESIGNS:

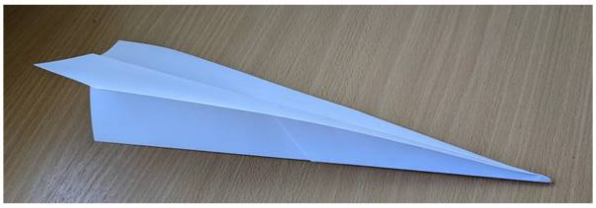
Glider Design 1



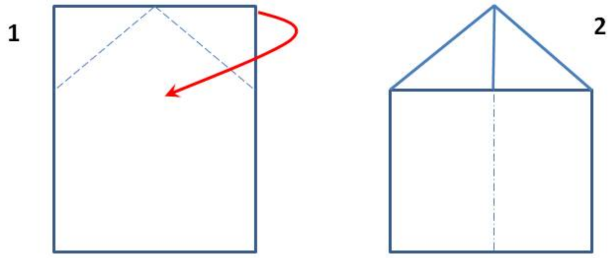


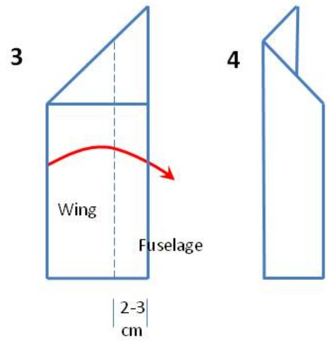


1) Fold corners to centreline
2) Fold again to centreline
3) It should look as left, now turn it over and fold along centreline
4) Fold top edge to bottom to complete your glider



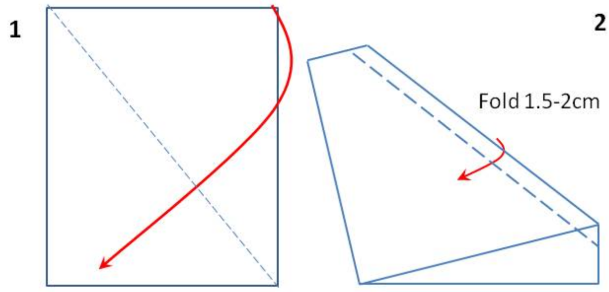
Glider Design 2

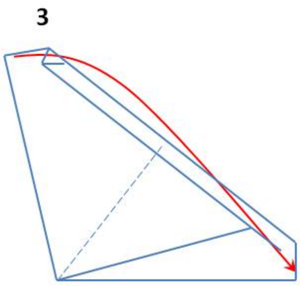




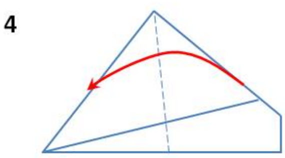
1) Fold corners to centreline
2) Turn it over and fold along centreline
3) Fold outside edges to leave a 2-3cm high 'fuselage'
4) Now open the wings back up symmetrically either side of the fuselage

Glider Design 3





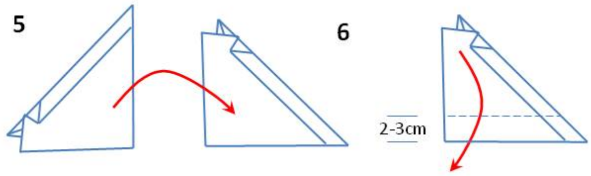
1) Fold corner to corner
2) Fold 1.5-2 cm along long edge
3) Fold top left corner to bottom right corner



4) Fold right to left, lining up the edges to the left – it should look like 5 overleaf!

...nearly there....

Glider Design 3



5) Turn it one quarter turn to the right so it looks like this
6) Fold each side down along the dotted line, then open back out to form the wings