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| **How high will it go?** |
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| Finding the height achieved by a flying object using trigonometry |
| **Subject(s):** Mathematics, Design & Technology**Approx time:** 80 - 125 minutes |  | **Key words / Topics:** * clinometer
* angle
* trigonometry
* tangent / tan
* height
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| **Stay safe** Whether you are a scientist researching a new medicine or an engineer solving climate change, safety always comes first. An adult must always be around and supervising when doing this activity. You are responsible for:• ensuring that any equipment used for this activity is in good working condition• behaving sensibly and following any safety instructions so as not to hurt or injure yourself or others Please note that in the absence of any negligence or other breach of duty by us, this activity is carried out at your own risk. It is important to take extra care at the stages marked with this symbol: ⚠ |
| **Suggested Learning Outcomes**  |  |  |
| * To understand how to use tangents to calculate the dimensions of a triangle
* To be able to measure the height of a balloon, released into the air, using trigonometry
* To make a clinometer to measure an angle
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| **Introduction** |  |  |
| This is one of a series of resources designed to allow learners to use the theme of the future of flight to develop their knowledge and skills in in Design & Technology, Engineering and Mathematics. This resource focuses on making a clinometer and using trigonometry to work out the height of a released balloon. |
| **Purpose of this activity**In this activity learners will work out the height of a released balloon using a clinometer and trigonometry.This activity could be used as a main lesson activity to teach learners about the practical application of trigonometry. It could also be used as part of an introduction to the use of trigonometry within engineering. |
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| **Activity** |  | **Teacher notes** |
| **Introduction (5-10 minutes)**Teacher to explain that learners are going to make a clinometer and measure, using trigonometry, how high a balloon travels when released at head height.**Use of trigonometry (10 – 15 minutes)**Using the presentation, teacher to explain how trigonometry can be used to work out the height of something using the tangent. **(continued on next page)****Demonstration (10-15 minutes)**Teacher to present the following steps to produce a clinometer, as shown on the presentation:* Print out the handout onto thin card
* Carefully cut out the templates of the protractor and the slider
* Punch two holes, using a sharp pencil and an eraser below, at the points indicated on the templates ⚠
* Attach the protractor and slider using a brass split pin paper fastener to make the clinometer.

**Making the clinometer (20-30 minutes)**Learners to make their own clinometer using the available equipment. **Measuring the balloon height (30-45 minutes)** Learners to work together in pairs, separated by a set distance measured using a tape measure (e.g. 5 m). One learner inflates and holds the balloon at head height. The second learner holds the clinometer level with the balloon. When the balloon is released and flies upwards, the second learner tracks it with the clinometer until it reaches its peak, noting the angle achieved. Learners repeat this several times and record the angle for the best height attained on the activity sheetLearners then use the angle recorded to calculate the heights achieved.**Plenary (5-10 minutes)**Learners to discuss their results and what balloon heights were achieved.  |  | The introduction or revision of trigonometry could be delivered as a class teaching activity. The practical activity should be carried out in pairs or small groups.**Steps to make the clinometer**Either print off the handout onto thin card or print onto paper then glue onto card. The holes could be punched with sharp pencils and erasers or a single hole-puncher.**Making the clinometer** Sticky tack or foam sheets could be used as backing as an alternative to an eraser. Learners should not try to push through the hole whilst holding the card in their hand!**Measuring the balloon height**The activity may be carried out either in the school hall or outdoors, if there is minimal wind interference. Learners will need to react quickly to track the maximum height that the balloon reaches. |
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| **Differentiation** |  |  |
| **Basic** |  | **Extension** |
| * Use the examples shown in the presentation to help understanding of the trigonometry
* Provide a kit of materials pre-cut to the sizes shown on the teacher presentation, that learners can then assemble using the examples shown.
 |  | * Learners could change the distance of the gap between them to see how this affects the calculations
* Learners could try different balloon shapes to see if they fly higher.
* Learners could measure the height of large objects, such as the height of the school.
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| **Resources** |  | **Required files** icon-docicon-pdficon-ppt |
| * Thin card
* Balloons
* Balloon pump, if required
* Brass split pin paper fasteners
* Scissors
* Sharp pencils and erasers
* Calculators
* Tape measure
 |  | icon-ppt Presentation How high will it go? How high will it go handout How high will it go activity sheet |
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| **Additional websites** |
| * **YouTube –** What is trigonometry? https://www.youtube.com/watch?v=T9lt6MZKLck
* **BBC Teach**: Maths KS3 Trigonometry: https://www.bbc.co.uk/teach/class-clips-video/maths-ks3-gcse-trigonometry/zhgtscw
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| **Related activities (to build a full lesson)** |  |  |
| **Starters** (Options) * Show the **BBC Teach**: Maths KS3 Trigonometry video to revise trigonometry.
 | **Plenary*** Learners to discuss their results and what balloon heights were achieved.
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| **The Engineering Context** film |
| Topographic engineers that survey the landscape to make maps use trigonometry to calculate the heights of hills and mountainous terrain. |

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| **Curriculum links** |
| **England: National Curriculum**Maths* KS3 – Geometry and measures

 use Pythagoras’ Theorem and trigonometric ratios in similar triangles to solve problems involving right-angled triangles  | **Northern Ireland Curriculum**Mathematics and numeracyDeveloping pupils’ Knowledge, Understanding and Skills* Knowledge and understanding of Shape, Space and Measures
* The application of mathematical skills to real life and
* work situations
 |
| **Scotland: Curriculum** **Shape, position and movement*** MTH: 4-16a
 | **Wales: National Curriculum** * KS4 Using measuring skills

use trigonometry and Pythagoras’ theorem to calculate the length of a side in a right angled triangle  |
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| **Assessment opportunities** |
| * Informal teacher assessment of practical measurement skills through observation of learners.
* Formal teacher assessment of the results produced using trigonometry.
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