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| **What is aerodynamics?** |
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| Making and testing an aerofoil |
| **Subjects:** Engineering**Approx. time:** 50 - 60 minutes |  | **Key words / Topics*** aerodynamics
* aerofoil
* aircraft
* camber
* drag
* flight
* lift
* thrust
* wing
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| **Suggested Learning Outcomes**  |  |  |
| * To understand the terms lift, drag and thrust.
* To understand how an aerofoil works.
* To be able to make and test a simple aerofoil design.
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| **Introduction** |  |  |
| This is one of a set of resources produced in conjunction with the engineering company Arconic. The resources are designed to support teaching of key engineering concepts at both key stage 3 and key stage 4, including the new GCSE in Engineering. This resource focusses on understanding aerodynamics and making a simple aerofoil.Understanding aerodynamics is key to understanding flight. Aerofoils are designed to allow aircraft to fly. The design of these is crucial to minimise drag and increase lift. |
| **Purpose of this activity**In this activity, learners will make and test a simple design for an aerofoil. They will learn about the terms lift, drag and thrust and how these apply to aircraft. It will build knowledge of aerodynamics theory and how this can be applied.This could be used as a one-off main lesson activity, as an introductory lesson to a wider unit of work focussing on aerodynamics or as part of a scheme on aircraft design using all of the resources developed in association with Arconic. It could also be used to support the existing IET Faraday resources ‘Speedy boats’ and ‘Wind tunnel testing’. |
| **Activity**  |  | **Teacher notes** |
| **1. Introduction to the importance of understanding aerodynamics (5 mins)**Teacher to introduce the term aerodynamics and discuss its meaning and importance. Explain how understanding aerodynamics allows people to understand how aircraft fly. **2. Lift, drag and thrust (5 mins)**Explain the meaning of lift, drag and thrust. Show and explain how an aerofoil works using these key terms and the diagram on the teacher PowerPoint.**3. Making and testing an aerofoil (20 mins)**Explain that learners will be making their own simple aerofoil and testing how it works. Learners then make and test their aerofoil using the instructions provided on the handout and teacher PowerPoint.* Fold your piece of paper in half.
* Create an upwards camber by moving the top end of the paper back slightly from the bottom end.
* Stick the top end down with tape.
* Put your aerofoil on your desk and apply moving air to the front of it, level with the edge of the table. What happens?

**4. Making alternative aerofoil designs (20 – 30 mins)**Learners should attempt to make different shapes of aerofoil and test how the change in shape affects how it works. For example:* An aerofoil with a flat bottom and a small upwards camber.
* An aerofoil with a flat bottom and a larger upwards camber.
* An aerofoil with a square front.

All observations from testing should be recorded on paper or in exercise books. Discuss the results of testing with the class – how did each aerofoil work? |  | This activity can be completed as individuals or in small groups. **Making and testing the aerofoil**A small piece of paper (A5) would be suitable to make the aerofoil. Air could be applied by blowing or using an electric fan on a low setting. The aerofoil could also be attached to the desk with a piece of string during the testing to prevent it from moving backwards and so that flight can be more easily observed. This could be fed through the space inside the aerofoil, and taped to the desktop at both ends, allowing some slack so that it can raise/fly. Alternatively, a wood dowel could be inserted loosely through a hole made in the top and bottom of the aerofoil. **Different aerofoil shapes**Aerofoils with a smaller upwards bow and a flat bottom are designed to reduce drag and increase speed, for example fighter jets and race planes.Aerofoils with a larger upwards bow and a flat bottom are designed to produce higher lift but slower speeds, for example transport aircraft.A square shaped front would not be a good design for an aerofoil as it the air would not flow aerodynamically around the shape.The teacher may also wish to discuss angle of attack and how this affects flight. |
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| **Differentiation** |  |  |
| **Basic** |  | **Extension** |
| Learners could be provided with pre-manufactured aerofoil shapes. |  | Use CAD software to design an aerofoil for a commercial jet airliner. What characteristics would the aerofoil need to include? What materials and processes would be needed to manufacture it? |
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| **Resources** |  | **Required files** icon-docicon-pdficon-ppt |
| * Projector/Whiteboard
* Small pieces of paper or thin card
* Tape, e.g. masking tape.
* String
 |  | icon-ppt Understanding aerodynamics Teacher Presentationicon-pdf Understanding aerodynamics Learner Handout |
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| **Additional websites** |  |  |
| The following websites can be used for additional background information or to aid with the activity: * **NASA – Beginner’s guide to aerodynamics:** Resources for teaching and studying the theory of aerodynamics. <https://www.grc.nasa.gov/www/k-12/airplane/bga.html>
* **YouTube - Creating an aerofoil in Solidworks:** - How to use CAD software to create an aerofoil design. <https://www.youtube.com/watch?v=KyiqxdDlxQA>
* **IET Faraday resource – Speedy boats:** Teaching resources for testing the speed of boat designs. https://faraday-secondary.theiet.org/resource-pages/speedy-boats/
* **IET Faraday resource – Wind tunnel testing:** Teaching resources for using a wind tunnel to test aerodynamic characteristics of objects. https://faraday-secondary.theiet.org/resource-pages/wind-tunnel-testing/
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| **Related activities (to build a full lesson)** |  |  |
| **Starters*** Identify and describe examples everyday applications of aerodynamics.

**Main*** ACTIVITY: Understanding aerodynamics
* ACTIVITY: Speedy boats
* ACTIVITY: Wind tunnel testing
 | **Plenary*** Discuss the differences in aerofoil design and how these affect how an aircraft flies.
* Reflection on Objectives and PLT skills used
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| **The Engineering Context** film |
| Aerodynamics is required learning as part of the GCSE Engineering 9-1 course. The knowledge gained can also be used when designing products that have an aerodynamics element to them, such as racing vehicles or different types of aircraft. |

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| **Curriculum links**  |
| **England: National Curriculum**Design & Technology * KS3 1a, 1e, 3d
 | **Northern Ireland: Curriculum**Technology & Design* KS3 Knowledge, understanding and skills: Communication – use of free-hand sketching and formal drawing techniques and ICT tools (including 3D modelling).
* Objective 2: Explore technical inventions and designs that have met a social need cost-effectively.
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| **Scotland: Curriculum for Excellence**Technologies* TCH 3-05a, TCH 4-12a
 | **Wales: National Curriculum**Design and Technology* KS3 Range: Designing: 6, 7
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| **GCSE Engineering**AQA Engineering* 3.4.3
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| **Assessment opportunities** |
| Regular questioning throughout the activity, formal teacher assessment of completed work, including results of testing. |
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| **Personal, learning & thinking skills (PLTS)** |
| * Independent enquirer
* Creative thinker
* Self-manager
* Effective participator
* Team worker
* Reflective learner
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