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| **Wind tunnel calculations** |
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| Using a wind tunnel to test aerodynamic characteristics of objects  |
| **Subject(s):** Science, Design & Technology**Approx time:** 30 mins  |  | **Key words / Topics:** * aerodynamics
* forces
* streamline
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| **Suggested Learning Outcomes** |  |  |
| * Draw the pathways that air travels over basic objects
* Explain why a wind tunnel is used
* Explain the link between the test results from a wind tunnel and air resistance
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| **Introduction** |  |  |
| Students will start to explore the requirements of aerodynamic design through testing simple shapes in a wind tunnel. The activity focuses on students acquiring an understanding of aerodynamics through testing, experimenting and developing.This activity involves teaching a similar set of key principles from both a science and engineering/design and technology viewpoint. The learning can be reinforced through both subjects, developing the strong links between them. |
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| **Activity** |  | **Teacher notes** |
| NOTE: You will need to have constructed a wind tunnel with test bed – see resources below for further instructions.The following link will help students understand what a wind tunnel is and why industry uses them: http://www.youtube.com/watch?v=TtLh2P56LvYicon-doc Use the **Wind Tunnel Testing (Worksheet)** Ask the students to predict what will happen when different shapes are put in the test bed e.g. will there be a lot of resistance or little resistance? Put the suggested shapes on the test bed, one at a time. The students need to complete the worksheet as each of the different shapes are tested (make sure you use the same shape but place it with a different face aimed at the wind, in order to illustrate that this is an important factor to consider). |  | This is where your students will start to gain a real understanding of aerodynamics. When air flows without interruption, it generally flows in a straight line. However, once you put an object in its path the air will take the shortest possible path around the object. The shapes of the object will affect the flow of air in different ways; this simple test should clearly illustrate this phenomenon. |
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| **Differentiation** |  |  |
| **Basic** |  | **Extension** |
| icon-doc Use the **Wind tunnel calculations basic (Worksheet)** Students to draw what they see in the wind tunnel and relate this to what it means in terms of air resistance or speed possible. |  | icon-doc Use the **Wind tunnel calculations extension (Worksheet)** film Watch the **Skeleton Bob: How it Works?** Film. CFD (computational fluid dynamics) is a technique now being used in ‘high end’ engineering. Ask the students to identify the advantages of CFD, based on the information on the website and in the clip. Discuss the advantages and disadvantages of this new technology in relation to traditional wind tunnel testing. Can the students identify products that could/would be tested using CFD? |
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| **Resources** |  | **Required files** icon-docicon-pdficon-ppt |
| * Wind Tunnel
* Shapes for testing (Prism, cylinder, pyramid, cuboid and any other shapes/objects available)

Note: Please do not be put off if you have never made a resource as complex as this - here are some suggestions on how it could be achieved:* ‘A’ Level students build a wind tunnel with little support from you by using the resources below (i.e. self- directed)
* Either the science or the design and technology technician makes the tunnel (or both)
* You ask your local specialist science or technology college to support you
* You could buy one! (see link below)
* You could set the making of the wind tunnel up as an after school club or challenge for the G and T students in your school
* Use your local university for support
* GCSE or KS3 students build the simple version (see relevant links in the table below)

Obviously, once you have made a tunnel it will be available for both the science and design and technology departments for years to come. |  | icon-doc Wind Tunnel Testing Basic (Worksheet) icon-doc Wind Tunnel Testing Extension (Worksheet)  |
| **Additional websites** |  |  |
| * Simple wind tunnel for young children to make KS3 student: <http://www.brighthubeducation.com/middle-school-science-lessons/2660-how-to-make-a-wind-tunnel>
* A detailed article written by a science teacher in the States - A Wind Tunnel in Your Classroom: The Design and Implementation of a Portable Wind Tunnel for Use in the Science Classroom. **Aimed at Teachers or A’ Level students:** <http://arxiv.org/pdf/physics/0208039>
* Site looking at building a complex wind tunnel – all details are given for construction and testing. **Aimed at teachers only:** <http://www.techdirections.com/BuildAWindTunnel.pdf>
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| **Related activities (to build a full lesson)** |  |  |
| **Starters** (Options)* FILM: Skeleton Bob
* ACTIVITY: Aerodynamic forces
* ACTIVITY: Aerodynamic design
* ACTIVITY:Aerodynamics Timeline
* ACTIVITY: Streamlined shapes

**Main** (Options)* ACTIVITY: What Makes a Fast Boat?
* ACTIVITY: CAD engineer
* ACTIVITY: Speedy Boats
* ACTIVITY: Presenting Speedy Boats results
* ACTIVITY: Energy transfer
* ACTIVITY: Renewable energy debate
 | **Extension** (Options)* ACTIVITY: **Wind Tunnel Testing**

**Plenary*** GAME: Science Friction
* Opportunities within activity for presentations, peer/self assessment
* Reflection on Objectives and PLTS skills used
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| **The Engineering Context** film |
| * **The story** Skeleton Bob
* **How it works?** The Concept
* **Who makes it work?**  Kristan Bromley
* **Who makes it work?**  Richard Bromley
* **Who makes it work?**  Dan Fleetcroft
* **Who makes it work?**  Shelley Rudman
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| **Curriculum links and PLTS** |
| **England**Science * KS3 2a, 2b, 2e, 27d
 | **Northern Ireland**Technology & Design* Design – identifying problems; investigating, generating, developing, modelling and evaluating design proposals; giving consideration to form, function and safety

Learning Outcomes* research and manage information effectively to investigate design issues, using Mathematics and ICT where appropriate;
* show deeper understanding by thinking critically and flexibly, solving problems and making informed decisions, using Mathematics and ICT where appropriate
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| **Scotland**Technologies* TCH 3-01a, TCH 3-13a
 | **Wales**Design & Technology * 4.2, 4.5
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| **GCSE Engineering**AQA Engineering* 3.4.3
 | **GCSE Science**AQA Combined Science Trilogy* 6.5.1.2

AQA Combined Science: Synergy* 4.6.1.1

Edexcel Combined Science* Physics: 9.1

Eduqas Combined Science* 2.3: 3a

OCR Gateway Science: Combined Science A* P2.2a

OCR 21st Century Science: Combined Science B* P4.1: 2
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| **GCSE Physics**AQA Physics* 4.5.1.1

Edexcel Physics* 9.1

Eduqas Physics* 3a

OCR Gateway Science: Physics A* P2.2a

OCR 21st Century Science: Physics B* P4.1: 2
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| **Personal, learning & thinking skills (PLTS)** |
| **>** Reflective Learner |