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| **Which Materials for your aircraft?** |
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| Measuring the density of materials to choose which to use in an aircraft |
| **Subject(s):** Design and Technology, Maths, Science**Approx time:** 40-60 minutes |  | **Key words / Topics:** * density
* weight
* mass
* volume
* aircraft
* future of flight
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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 that if two things are the same size, the one that is denser is heavier.
* To be able to compare materials based on their density.
* To be able to measure the volume of water and the weight of an object.
* To be able to calculate density.
* To be able to communicate measurements using appropriate SI units.
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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 Design & Technology, Mathematics and Science. This resource focuses on understanding density and, through practical measurement, working out which materials are low and high density.Comparing two aircraft of the same design, the heavier one will need more energy and fuel to fly. It will also fly slower than a lighter aircraft. Making an aircraft from suitable materials with a lower density means less weight – so less fuel is needed and it can fly faster. Can you select the best materials from which to make an aircraft? |
| **Purpose of this activity**In this activity learners will learn about the density of materials through testing. Learners will have an opportunity to weigh and work out the volume of an object. They will use this information and their number skills to calculate the density. They will then repeat this for other objects and discuss their results as a class.This activity could be used as a main lesson activity to teach learners how to collect data through measurement and to use number skills in a practical context. It could also be used as one of several activities within a wider scheme of learning focussing on the use of maths and science to understand the properties of materials. |
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| **Activity** |  | **Teacher notes** |
| **Introduction (10-15 minutes)**Teacher to explain that learners are going to investigate density. They will work with a variety of objects made from different materials and test them to work out how dense they are. Show teacher presentation explaining the key concepts of density, volume and weight/mass and their implications for aircraft design.**Performing the experiment (20-30 minutes)**Teacher to demonstrate the steps shown in the teacher presentation and listed below.* Step 1 – Learners to weigh each object and write down the weight in g on the worksheet.
* Step 2 – Learners to:
* Place a bowl on a tray.
* Fill the bowl to the brim with water.
* Put the object in the water.
* The tray will catch all the water that overflows.
* Step 3 – Learners to:
* Carefully take the bowl from the tray.
* Pour the water on the tray into a jug.
* Write down how much water has been collected in ml on the worksheet.
* Step 4 – Calculate the density and write it down on the worksheet in g/cm3.
* Step 5 Repeat the process for each object.

Learners to complete each step to conduct the activity for themselves. The teacher presentation could be left on the whiteboard as a supporting guide as they do this.**Discussing the results of the activity (10-15 minutes)**Teacher to discuss the results of the activity with learners. What were the densities of the different materials? Were any of the results surprising? What could this mean when selecting the materials to make an aircraft? What other things would need to be considered when selecting the materials? |  | This activity requires an area appropriate for working with water. Learners may also require aprons, towels etc.This activity could be done in pairs or small groups.Learners use bowls with trays underneath to catch the water to be measured. However, if appropriate containers with graduated scales are available, (such as beakers from science), they could just observe the increase in volume. Choose a range of objects that will fit in the bowls or beakers and are resistant to water damage. Items made from metals (such as steel or aluminium, which have different densities) are particularly suitable.When demonstrating how to fill the bowl and immerse objects, learners should be made aware that immersing fingers will lead to inaccurate results.Demonstrate how to calculate the density of the object using the presentation example. The calculation example also appears on the worksheet as a reminder. |

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| **Differentiation** |  |  |
| **Basic** |  | **Extension** |
| * Use objects with simple geometric profiles.
* Provide calculators for the calculations.
 |  | * Create a spreadsheet to automatically calculate the density from the test results.
* Predict what the density will be for other items, based on their materials and the previous results.
* Watch video: **TES** – Finding the density of an irregular object: <https://www.tes.com/teaching-resource/density-finding-density-of-irregular-object-using-eureka-can-gcse-physics-12226447>.
* Investigate which other properties would need to be considered when selecting the materials to make aircraft.
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| **Resources** |  | **Required files** icon-docicon-pdficon-ppt |
| * Range of different materials to test
* Bowls and trays
* Science beakers/Measuring jugs
* Weighing scales
* Water
 |  |  Presentation – which material for your aircraft?icon-doc Which material for your aircraft worksheet |
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| **Additional websites** |  |  |
| * **BBC Bitesize** **–** How to work out density**:** <https://www.bbc.co.uk/bitesize/topics/z4vg9j6/articles/z9bgpbk>
* **BBC Bitesize** **–** What is Volume: <https://www.bbc.co.uk/bitesize/topics/zjbg87h/articles/zcrxtyc>
* **TES** – Finding the density of an irregular object: <https://www.tes.com/teaching-resource/density-finding-density-of-irregular-object-using-eureka-can-gcse-physics-12226447>
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| **Related activities (to build a full lesson)** |  |  |
| **Starters** (Options) * Ask learners to state three things they already know about weight, mass and volume
* Watch the video: **BBC Bitesize** **–** How to work out density**:** <https://www.bbc.co.uk/bitesize/topics/z4vg9j6/articles/z9bgpbk>
 | **Plenary*** Discuss the outcome of the activity. What were the densities of the different materials? Were any of the results surprising? What could the results mean when selecting the materials to use when making an aircraft?
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| **The Engineering Context** film |
| * The future of flight is a great context to explore the opportunities that working in the aeronautical engineering and travel industry presents! For example, manufacturing and maintaining aircraft.
* Designers and engineers must have a good understanding of density when they design aircraft. They need to know the density of the materials to make sure the aircraft has enough power to fly!
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| **Curriculum links** |
| **England: National Curriculum**MathsKS2 – Measurements* estimate volume [for example, using 1 cm3 blocks to build cuboids (including cubes)] and capacity [for example, using water]

ScienceKS2 - Properties and changes of materials* compare and group together everyday materials on the basis of their properties.
 | **Northern Ireland Curriculum**KS2 – Mathematics and NumeracyMeasures* develop skills in estimation of length, weight, volume/capacity, time, area and temperature.
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| **Scotland: Curriculum for Excellence**Maths - Number, money and measureMeasurement* MNU 4-11a

Sciences - MaterialsProperties and uses of substances* SCN 3-15a
 | **Wales: National Curriculum** KS2 - Mathematics Programme of StudyUsing measuring skills - Length, weight/mass, capacity* make estimates of length, weight/mass and capacity based on knowledge of the size of real-life objects

KS2 – Science The Sustainable Earth* a comparison of the features and properties of some natural and made materials
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| **Assessment opportunities** |
| * Informal teacher assessment of practical measurement skills through observation of learners.
* Formal teacher assessment of activity results.
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