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| **Investigate why boats float** | | | |
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| Using Archimedes’ principle to investigate why boats float | | | |
| **Subject(s):** Design & Technology, Mathematics, Science  **Approx time:** 40-70 minutes |  | | **Key words / Topics:**   * Archimedes’ principle * buoyancy * density * displacement * floating and sinking * mass * volume * weight |
| **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 Archimedes’ principle works * To understand that if two things are the same size, the one that is denser is heavier * To understand how boats use the Archimedes principle to stay afloat | | | |
| **Introduction** |  | |  |
| This is one of a series of resources produced in association with Fairfield Control Systems that are designed to allow learners to use the theme of waterways 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, and which will therefore float or sink. | | | |
| **Purpose of this activity**  In this activity learners will learn what is meant by density. Learners will perform an experiment to see whether modelling clay moulded into different shapes either sinks or floats. They will discuss why this happens and how the principle demonstrated allows boats to stay afloat.  This could be used as a one-off main lesson activity to build knowledge and understanding of Archimedes’ principle. It could also be used as part of a wider scheme of learning focussing on basic scientific principles and/or and the importance of the waterways in the United Kingdom. | | | |
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| **Activity** |  | | **Teacher notes** |
| **Introduction (10-15 minutes)**  Teacher to explain that learners are going to investigate why boats float. Explain that they will work modelling clay into different shapes and investigate whether each shape sinks or floats.  Teacher to show presentation slides 3-5 explaining the key concepts of density, volume and mass, and their link to Archimedes. Teacher could link this into the Falkirk Wheel shown on slide 6.  Learners to collect the equipment and resources needed for the experiment.  **Performing the activity (20-30 minutes)**  Teacher to demonstrate the steps shown in the teacher presentation and listed below.   * Step 1 - Fill the jug with 600 ml of water. Roll a 50 g piece of modelling clay into a ball. Place the ball into the jug. What happens to the ball? (The ball should sink as it is denser than the water). * Step 2 - The level of the water will now have raised to about 650 ml. Write down the displacement of the water. Discuss why the ball has sunk. * Step 3 - Mould the modelling clay ball into a small boat shape. Place the boat into the jug. The displacement is the same as the weight has not changed. The density is less so the boat floats.   **Plenary (10-15 minutes)**  Teacher to discuss the results of the activity with learners. How much water was displaced for the different shapes? Were any of the results surprising? Why did the different shapes float or sink?  Teacher to explain why boats float using the information on slide 10 of the presentation. |  | | This activity could be done in pairs or small groups.  This activity requires an area appropriate for working with water. Learners may also require aprons, towels etc.  Learners could weigh the modelling clay by themselves, or this could be done in advance by the teacher/technician.  Learners should use appropriate containers with graduated scales (such as beakers from science).  When demonstrating how to fill the water container and immerse objects, learners should be made aware that immersing fingers will lead to inaccurate results.  **Results of the experiment**  In step 2 the ball should sink as it is denser than the water.  In step 3 the shape now has round sides of solid material and air in the middle. Its overall average density is less, so it will float. The displacement is the same as the weight has not changed. This is Archimedes’ principle in action. |
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| **Differentiation** |  | |  |
| **Basic** |  | | **Extension** |
| * Provide a mould to make the boat shape from the modelling clay. * Pre- measure the mass of modelling clay used. |  | | * Try adding small items into the modelling clay boat. How much weight it can carry before it sinks? * Calculate the density of the ball and the boat shape made from modelling clay. |
| **Resources** |  | | **Required files** icon-docicon-pdficon-ppt |
| * Bowls and trays * Science beakers/Measuring jugs * Weighing scales * Water * Modelling clay |  | | Presentation – Investigate why boats float |
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| **Additional websites** |  | |  |
| * **BBC Bitesize** **–** What is Volume:<https://www.bbc.co.uk/bitesize/topics/zjbg87h/articles/zcrxtyc> * **YouTube:** Falkirk Wheel: <https://www.youtube.com/watch?v=_tBH9SE-Kw8> * **YouTube:** Buoyancy: What makes Something Float or Sink: <https://www.youtube.com/watch?v=nMlXU97E-uQ> * **Fairfield Control systems website:** [https://www.fairfields.co.uk/](https://emea01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.fairfields.co.uk%2F&data=05%7C01%7C%7C4dc3028e5da442738d9f08dad86492aa%7C84df9e7fe9f640afb435aaaaaaaaaaaa%7C1%7C0%7C638060223713198401%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=HArsg5SYyeH3563Zd3%2ByRwiYrh8tbOAi2tWit%2BsWM5w%3D&reserved=0) , <https://www.fairfields.co.uk/fcs/sectors/waterways/> | | | |
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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 **YouTube:** Falkirk Wheel: <https://www.youtube.com/watch?v=_tBH9SE-Kw8> | | **Plenary**   * Discuss the results of the activity with learners. How much water was displaced for different shapes of modelling clay? Did the materials float or sink? Were any of the results surprising? | |
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| **The Engineering Context** | | | | |
| * The waterways (including their protection, maintenance and control) is an excellent context to explore opportunities that working in the engineering industry presents. For example, constructing locks, building narrowboats or making and maintaining boat lifts. * Engineers often make models of working systems to test how they function. For example, a crane designer will make models of different crane designs to see which structures can provide the best support and which designs can lift the heaviest object. | | | | |

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| **Curriculum links** | |
| **England: National Curriculum**  Maths  KS2 – Measurements   * estimate volume [for example, using 1 cm3 blocks to build cuboids (including cubes)] and capacity [for example, using water]   Science  KS2 - Properties and changes of materials   * compare and group together everyday materials on the basis of their properties. | **Northern Ireland Curriculum**  KS2 – Mathematics and Numeracy  Measures   * develop skills in estimation of length, weight, volume/capacity, time, area and temperature. |
| **Scotland: Curriculum for Excellence**  Sciences   * SCN-208b * By investigating floating and   sinking of objects in water, I can apply my understanding of buoyancy to solve a practical challenge. | **Wales: Curriculum for Wales**  **Primary – Science and Technology**   * Forces and energy provide a foundation for understanding our universe * Design thinking and engineering offer technical and creative ways to meet society’s needs and wants. |

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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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