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| **Discover mass, volume and density** | | | |
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| Hands-on weighing activity with water | | | |
| **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: ⚠ | | | |
| **Subject(s): Maths and Science**  **Approx time:** 40 - 60 minutes |  | | **Key words / Topics:**   * James Webb Space Telescope * Density * Weight * Mass * Volume |
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| **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 set of resources developed with the theme of the James Webb Space Telescope (JWST) to support the teaching of the primary national curriculum. They are designed to support the delivery of key topics within maths and science. This resource focuses on understanding density and, through a series of practical tests, working out which materials are low and high density.  The James Webb Space Telescope (JWST) will be the largest, most powerful telescope ever launched into space. It follows in the footsteps of the Hubble Space Telescope as the next great space science observatory, designed to answer outstanding questions about the Universe and to make breakthrough discoveries in all fields of astronomy.  The JWST will reveal the hidden Universe to our eyes: stars shrouded in clouds of dust, molecules in the atmospheres of other worlds, and light from the first stars and galaxies. With its suite of state-of-the-art instruments, it will push the frontiers of our knowledge of the Solar System, of how stars and planets form, and of galaxy formation and evolution, in new ways.  The telescope will launch on an Ariane 5 rocket from Europe’s Spaceport in French Guiana. From there it embarks on a month-long journey to its destination orbit around the second Lagrange point (L2), about one and a half million kilometres from Earth. In the first month after launch, Webb will unfold its sunshield, which is the size of a tennis court, and then deploy its 6.5-metre primary mirror that can detect the faint light of distant stars and galaxies with a sensitivity a hundred times greater than that of Hubble.  The JWST is the size of a tennis court. The heavier the telescope is, the harder it will be to launch it into space. We need to understand about density so we can choose lightweight materials to make it – so it will be easier to send into space. | | | |
| **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.  Teacher to hand out equipment and worksheet needed for the task to learners.  **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 grams (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 millilitres (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 use on the JWST? |  | | 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.  Ensure plastic sheets are used to cover tables as this may be a messy activity.  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. |
| **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> |
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| **Resources** |  | | **Required files** icon-docicon-pdficon-ppt |
| * Range of objects to test * Bowls and trays * Science beakers/Measuring jugs * Weighing scales * Water |  | | Discover mass, volume and density presentation  icon-doc Discover mass, volume and density worksheet |
| **Additional websites** |  | |  |
| * **BBC Bitesize** **–** How to work out density**:** <https://www.bbc.co.uk/bitesize/articles/zk3t2v4> * **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 * What video: **BBC Bitesize** **–** How to work out density**:** <https://www.bbc.co.uk/bitesize/articles/zk3t2v4> * **NASA on the** [James Webb Space Telescope](https://www.youtube.com/watch?v=6VqG3Jazrfs) * **Intro facts (3 minutes)** [to inspire the next generation](https://www.youtube.com/watch?v=D8TRoLImYUY) | | **Extension** (Options)   * 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>   **Plenary**   * Discuss the outcome of the activity. What were the densities of the different materials? Were any of the results surprising? | |
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| **The Engineering Context** film |
| Space Engineers must have a good understanding of density when they load cargo onto a spacecraft. They need to know the density of the materials they are loading to make sure the rockets have enough power to allow the spacecraft to lift off. |

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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**  Maths - Number, money and measure  Measurement   * MNU 4-11a   Sciences - Materials  Properties and uses of substances   * SCN 3-15a | **Wales: National Curriculum**  KS2 - Mathematics Programme of Study  Using 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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