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| **Session 2**  | **Measuring general properties of matter to determine density** |

## Assessed criteria

**Criterion C: Processing and evaluating**

**Criterion E: AIE**

**Objectives**

To learn more about density, an intensive characteristic of matter.

**Background**

Everything we see is made of matter. Mass and volume are two extensive properties of matter that are needed to determine the density of a body. Density on the other hand is an intensive property of matter.

We can then use the formula shown below to calculate the density:

**Density = mass / volume**

Why do objects that are the same size sometimes have different weights? The answer is to do with their **density**. An objects density is determined by comparing its mass to its volume.

If you compare a rock and a cork that are the same size (they have equal volume), which is heavier? The rock is heavier because it has more mass. The rock is denser than the cork then, because it has more mass in the same volume – this is due to the atomic structure of the elements, molecules and compounds that make it up.

But, how can we measure the volume of an object?

 The amount of space an object takes up is called its volume. The volume of regular shaped solid objects can be easily calculated using mathematics. However, how can we measure the volume of an object with an irregular shape? Well, this problem was solved many years ago by a man named Archimedes who lived in Greece.



**Eureka!**

This exclamation was most famously said by the ancient Greek scholar Archimedes; he shouted "Eureka!" when he stepped into a bath and noticed that the water level rose — he suddenly understood that the volume of water displaced must be equal to the volume of the part of his body he had submerged.

This meant that the volume of irregular objects could be measured with precision, a previously very difficult problem. Apparently, he wanted to tell everybody his realisation so much, that he leapt out of his bathtub and ran through the streets of Syracuse naked!

Here is a diagram to demonstrate this principle.

1. In measuring cylinder (a) the initial volume of a liquid is measured.
2. The object to be investigated is then placed in the measuring cylinder and the water level rises due to the object taking up space (volume) inside the cylinder.
3. The final volume is measured as shown in (b) and the volume of the object can then be calculated using the following equation:

$$Final volume of liquid-Initial volume of liquid = Volume of the solid$$

**Materials**

* 3 cubes of known material (side of cubes 1 cm)
* 2 irregular objects
* 2 regular objects small enough to fit in the measuring cylinder
* Measuring cylinder
* Electronic scale
* Weighing boat

**Procedure – Work in pairs** (Complete the table as you go)

1. Record in a table the mass of all the solids with the help of an electronic scale (remember to use the tare button before putting your solid in the weighing boat).
2. Use a measuring cylinder to determine the volume of the different objects. Make sure to record the initial and final volumes for each object.
3. Calculate the difference between the initial and the final volume to determine the volume of each object.
4. Calculate the densities of the all objects. Make sure to include your calculations.
5. Present the processed data in a proper table.
6. Plot a graph of the densities of the different objects, ordering them from least to most dense.

**Results**

Fill in the data as you carry out the experiment.

Table 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| --- | --- | --- | --- | --- |
| **Object** | **Mass (units)** | **Initial Volume (units)** | **Final Volume (units)** | **Volume of object (units)** |
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**Calculations:**

You must show a sample calculation for the final volume on one of your objects. But all of the calculations for density.

Don’t forget the units!

**Results**

Include a table with the processed data.

Include the graph

**Conclusions and Evaluation**

**Questions**

1. Look on the Internet or any other source the density of the known materials (the cubes) and compare the measured densities of the cubes to their actual density. Are your results accurate?