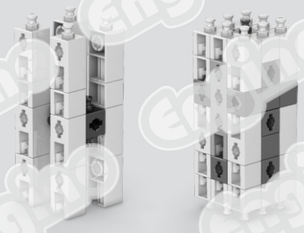
Learning about: **Aeronautics**

Density of a volume

Birds have many physical features, besides wings, that work together to enable them to fly. A basic requirement to achieve flying is a structure which combines strength with light weight. Bird bones are a great example, as they are actually hollow with air sacs inside. This reduces the force of weight! Follow the experiment to discover how this can be applied to aircrafts!



Engino® Bone models

Discover:
- How to calculate the volume of an object?
- Why flying machines need to be designed with low density materials.
- How to wrap a cuboid in paper.

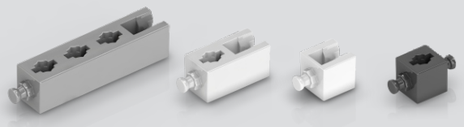
Level Of Difficulty ★★☆☆☆

Materials Needed:
- Engino® (STEM24) How aircrafts work?
- A4 paper, Measuring tape
- Scissors, Adhesive tape.

Procedure:

1. Find the instructions **online** and build the two bone models (bone 1 and bone 2).

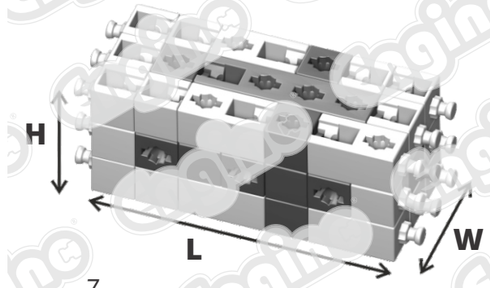
2. The two bones have the **same dimensions**, even though they are built by different parts. Choose any of the two shapes and measure its 3 dimensions, that is **length, width and height**. Instead of using a ruler, you can measure the size of the shape using the **Engino units** as shown in the image below. Write your findings in **exercise 1** and then do **exercise 2**.



4 units **2 units** **1 unit** **1 unit**

3. Let's wrap the bones with a paper using the **design presented** in **exercise 3**. Ask an adult to cut the paper with the scissors along the **dotted lines**. **Bent** the paper along the **continuous lines** and wrap inside the bone model. Strap the edges of the paper using an adhesive tape and write on the outer side of the paper which bone is placed inside.

Exercise 1. Measure the bone's length, width and height. Write them on the space below.



Length = *7* **units**

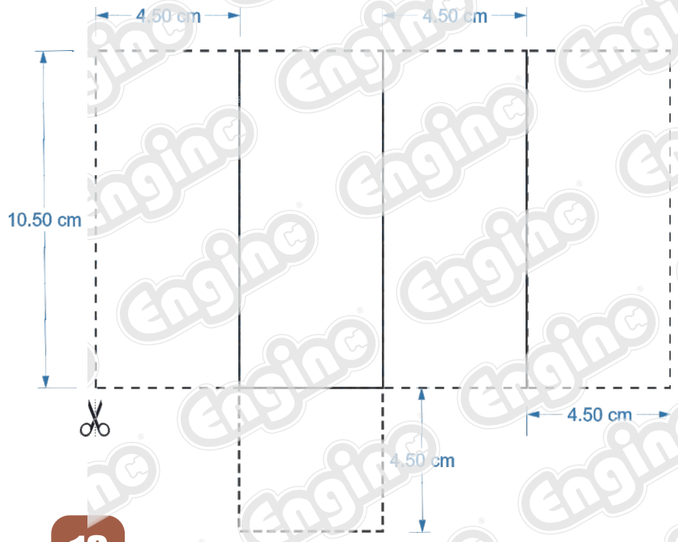
Width = *3* **units**

Height = *3* **units**

Exercise 2. Can you calculate its volume? To do so all you have to do is to multiply its three dimensions.

Volume = L x W x H = *63* **cubic units**

Exercise 3. Draw the following design on an A4 paper. Remember to do this twice since you will wrap both bone models.



Procedure (continue):

4. Now both models should be wrapped in a paper. Grab one model on each hand and try to feel their weight difference. Is this noticeable? Do **exercise 4**.

5. Let's calculate for each model the ratio of its **mass** to its **volume**. This ratio is the **density** of an object which describes the amount of matter that is included in a volume. Read **exercise 5** and do the calculations.

6. As you can see, the density of bone 1 is less compared to bone 2. This is because they have the same volume, but bone 1 is less massive. Think on how this can also affect the flight and do **exercise 6**.

Exercise 4. According to your estimation, what can you tell about the mass of the two bone models. Choose the appropriate statement:

- ☐ *Both models feel like having the same mass.*
- ☑ *Bone 2 seems to have more mass.*
- ☐ *Bone 1 seems to have more mass.*

Exercise 5. Use the formula below to calculate the density of the two bone models.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Bone 1: Density = *4 / 63*

Bone 2: Density = *9 / 63*

Exercise 6. How can this be related an aircarft's fuselage? Would you prefer to design an aircraft with high or with low density?

An aircraft can have a large fuselage in volume made with light materials. It is preferable to have a low density aircraft to save fuel and carry more.

Ever wondered?

Planets orbit the Sun due to the gravitational force. In fact, the Sun pulls the planets inwards and this causes their orbital motion. Gravitational force is also the reason that the Moon stays in orbit around the Earth, and the reason why objects fall down to Earth.

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