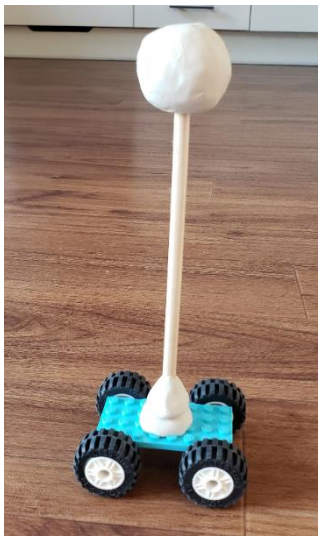
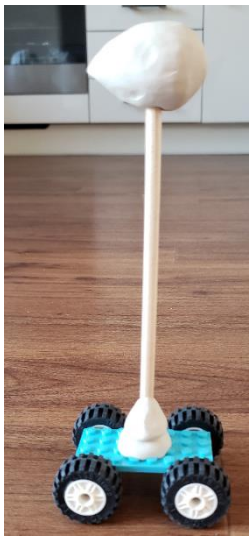
It's a Drag!

This is a simple experiment that you can try at home to understand what the drag of a 3D object is. For this experiment you need:

- A simple cart made with Lego (4 wheels and a small platform will do)
- Plasticine
- A round stick (an ice lolly stick, a chopstick, …)
- A hairdryer

Put a bit of the plasticine on the platform of the cart and insert one end of the stick into it. The other end of the stick is where we are going to place the objects we want to measure the drag of. Let's try first with a sphere: shape the plasticine into a ball and insert it on the free end of the stick (without deforming it too much!). Switch on the hairdryer and point towards the sphere on top of the stick – see how far the cart goes and measure that distance on the floor.





Next, modify the back half of the sphere to make it into a cone shape. Do not change the front half and do not add/remove plasticine as we want to 1) have the same frontal area facing the hairdryer and 2) maintain the same weight. Switch on the hairdryer again and see how far the cart travels this time.

Can you explain why the distance is different?

Answers and follow-on experiments

You can compare the drag of these objects by measuring the distance travelled by the cart on each of the cases.

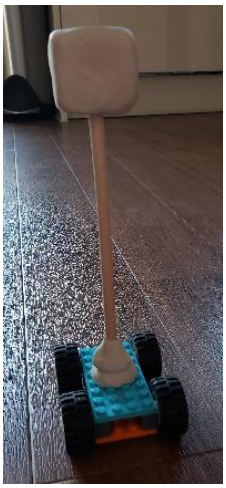
In fluid dynamics, drag is a force that opposes the motion of an object through the air. The cone-shape object is what we call a streamlined object and it deflects

the air gradually over its surface reducing the resistance to the flowing air. When the air is forced to turn more sharply, like in the case of the sphere, the air cannot follow the shape of the object and the resistance of the body to the flowing air increases. See the '**Flow Visualization'** activity to understand what happens to the flow when it is subject to certain sudden geometrical changes.

For our experiment the larger the resistance (drag) of the object to the flowing air, the further the cart can travel.

An object shaped like an aeroplane would present low resistance to the air going around it as it is designed to minimise drag. In our experiment, an object shaped like an airplane would move only a short distance along the floor as it does not oppose the motion of the air through it as much as the other objects.

Follow-on experiments:



- Repeat the same experiments for different object sizes and shapes, and see how far the cart travels down the track each time.
- Some hairdryers allow you to change the air speed – if you can do that, check what happens when you change the air speed in the cases above. Does the air resistance depends on the air speed?
- One way to recover part of the energy that is wasted when the cart travels would be to install an extension spring between a fixed point at the start and the cart. This spring creates a resistance to the cart's pulling force and stores the energy, which can be used to bring the cart back when the hairdryer is switched off. Use a spring, or a rubber band, and attach one end to a fix point at the start and the other end to the cart and check whether you can bring the cart back!

Note for experimentalists!

- *Do each test a few times and average your data.*
- *The distance covered by our cart also depends on the friction between the cart wheels and the floor, and this friction depends on the weight of the object. To make sure we are comparing only the effect of drag, try to keep the weight of the test object constant.*
- *Point the hairdryer to the centre of the object. Do not direct the air directly to the wheels of the cart as you would be observing a different mechanism.*