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# Eco-car 1 for AutoSTEM

## Pedagogical guidelines and construction instructions

This guide has 2 parts:

1. How the Eco-car 1 can be used to introduce a number of STEM concepts
2. How to construct the Eco-car 1 (your children can make the Eco-car 1).

### How the Eco-car can be used to learn STEM areas

The construction and use of the Eco-car 1 allows the teaching of a number of STEM concepts within the construction and assembly process.

#### Introducing STEM concepts

The Eco-car 1, allows teachers to speak about aspects of mathematics and physics.

- Mathematics
  - Counting: five wooden sticks, one straw (will be divided into three parts), four bottle tops, two skewers
  - Measuring length: Sticks, straws and skewers have to be cut into pieces of given length (3cm, 4cm, 10 cm etc.). Older children will use a ruler, younger children can use fingerbreadth and span. Direct comparison to make a hole in the bottle top that is 'just' big enough for the wooden skewer to pass through and still be tight.
  - Designing (shapes): The car's chassis has the shape of an equilateral pentagon with adjacent right angles. If the rear part is a square, the front part will be an equilateral triangle, which has angles of  $60^\circ$ . It has mirror symmetry.
  - Locating: use spatial concepts like rear, front, under, top, bottom, centre (find the centre of a circle), around, rotation (the motion of the axles and the wheels), translation (the forward motion of the car)
- Physics
  - Energy: different types of energy:
    - work (The child does work by applying a force to the rubber band.)
    - elastic energy: potential energy due to the deformation of the rubber band



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- rotational kinetic energy (the rotation of the wheels)
- translational kinetic energy (the forward motion of the car)
- thermal energy (heat)
- Force: The child uses force to deform the rubber band.
- Rolling friction: the force resisting the motion when the wheels roll on a surface
- Conservation of energy: Energy can be converted but not destroyed. The child's work is converted into elastic energy (of the rubber band), elastic energy into rotational energy (of the axles and wheels), rotational energy into translational energy (of the car), translational energy into thermal energy (the wheels and the ground become slightly warmer through friction)
- Centre of mass: In order to find the centre of a wheel, the children can balance the bottle top on the tip of a skewer.

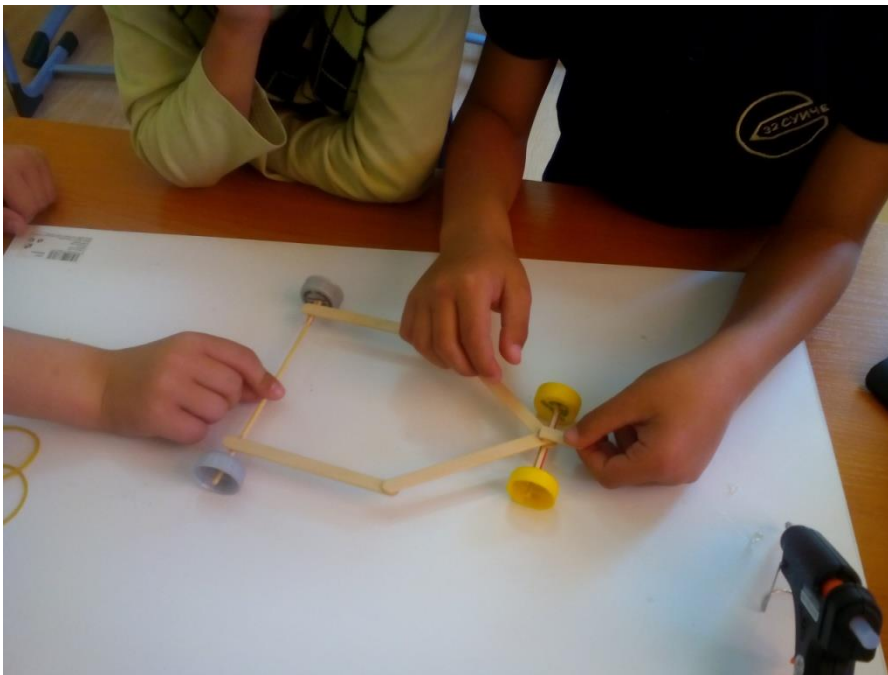


Figure 1. Children making the Eco-car 1



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## How to construct the Eco-car 1

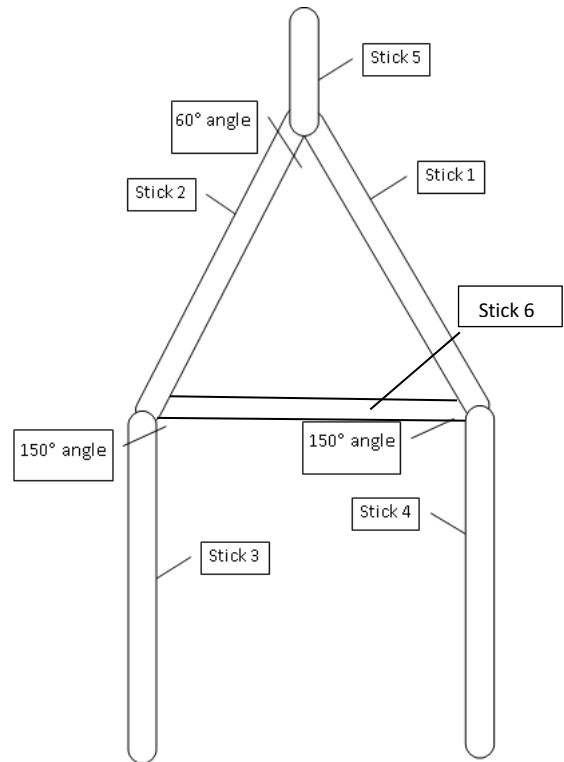
### Parts and tools required

- 5x Wooden sticks used for lollipops
- 1x Paper/plastic drinking straws
- 4x Plastic bottle tops (each set of 2 must be the same size) for wheels
- 2x Wooden kitchen skewers
- Hot melt Glue gun
- Long Rubber bands
- (Optional) Strong tape (electric insulating tape)
- Ruler

### Method

It is best to watch the video XXXXX before starting the construction:

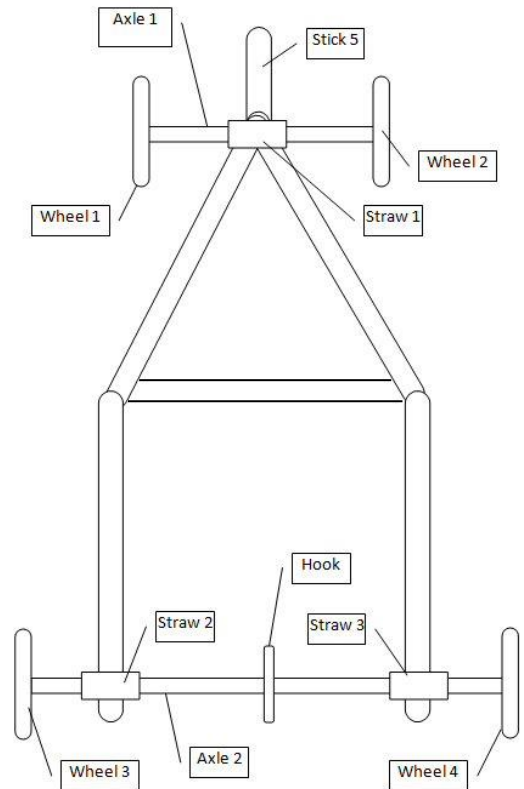
1. Stick the end of a lollipop stick (Stick 1) to a second one (Stick 2) to find the correct angle for the 2 lollipop sticks measure the length of one stick. Place the 2 lollipop sticks together at one end, when the distance is the same as the length you will have made the correct angle. OR you can measure an angle of  $60^\circ$  between the 2 lollipop sticks. Then stick them together with a glue gun.
2. Stick a third lollipop stick (Stick 3) to the end of stick 1, and Stick 4 to the end of Stick 2 so that Stick 3 and 4 are parallel and the whole shape has a mirror symmetry. The angle between Stick 2 and 3 and the angle between Stick 1 and 4 are both  $150^\circ$ .
3. Cut Stick 5 from a complete Lollipop stick. Stick 5 should be at least 4 cm long. Then stick Stick 5 above the join of Stick 1 and 2 pointing upwards, with at least 3 cm pointing out from the join.
4. Cut from your straws:
  - a. 2 x 3cm pieces (Straw 2 and 3)
  - b. 1 x 4cm piece (Straw 1)





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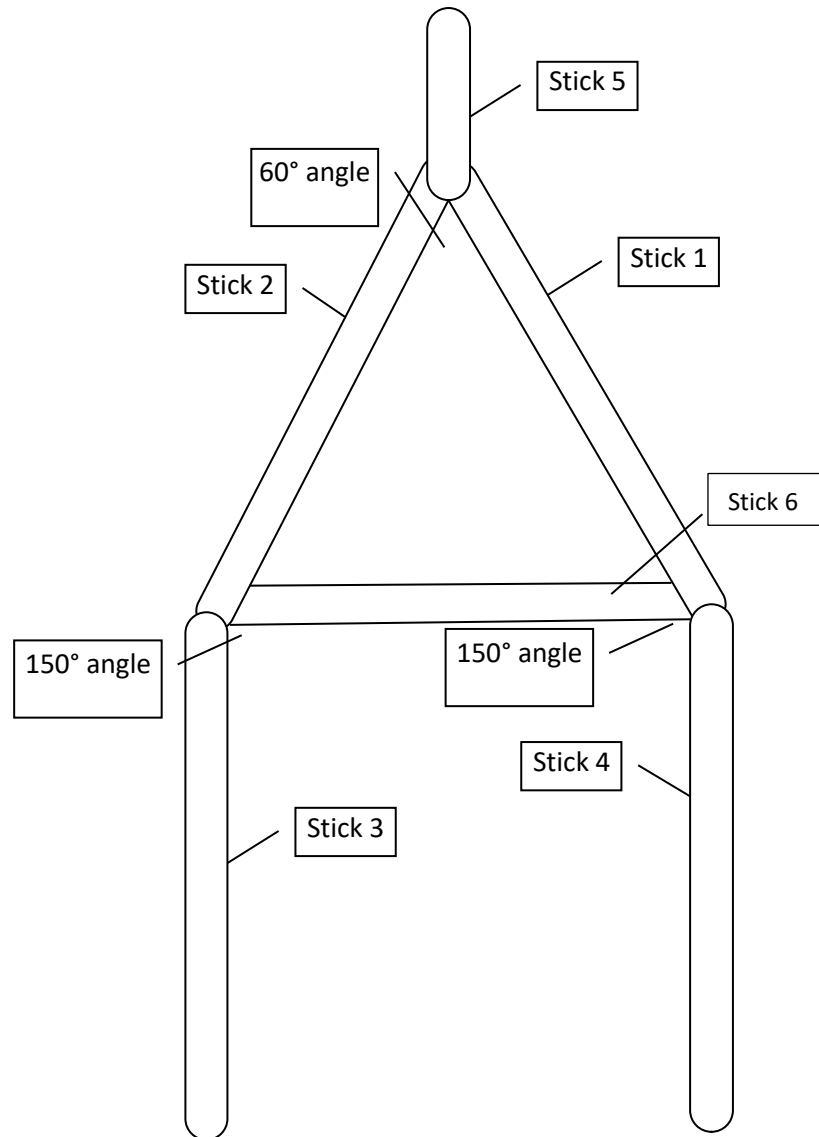
5. Stick Straw 2 to the bottom end of stick 3 and Straw 3 to the bottom end of stick 4. They should be stuck at right angles to the sticks.
6. Stick the Straw 1 underneath the join of stick 1 and 2,
7. Make holes in the centre of the 4 bottle top wheels. You might need to work out how to find the centre of each wheel. The holes must be 'just' big enough for the wooden skewers to pass through and still be tight.
8. Cut one wooden skewer so that it is 6 cm longer than the total distance between the ends of Stick 3 and 4 (Axle 2).
9. Cut a second wooden skewer to 10cm long. (Axle 1)
10. Cut a third piece 3cm long from one part of the left over wooden skewers (Hook).
11. Thread one wheel onto one end of Axle 1 and Axle 2.
12. Wait until the glue you have used to make your Eco car 1, is set, before going to the next step.
13. Thread Axle 1 through Straw 1 and fix Wheel 2 on to the end.
14. Thread Axle 2 through Straw 2 and 3 and fix wheel 4 on to the end.
15. Measure the length of Axle 2. Make a mark on Axle 2 that is  $\frac{1}{2}$  the distance. Stick the Hook to the halfway point with the glue gun. It should be stuck at the Hooks halfway point but it is not a critical point.
16. Wait for the glue to dry well before the final steps.
17. Take the elastic band and hook one end over the Hook, and the other end over Stick 5.
18. Turn Axle 2 and wind the elastic band around the axle and the hook. When it is tight, place on a smooth floor and let go. Weeeeeeeeeeee



If the Hook becomes detached then wind some strong tape around the join to make it stronger.



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