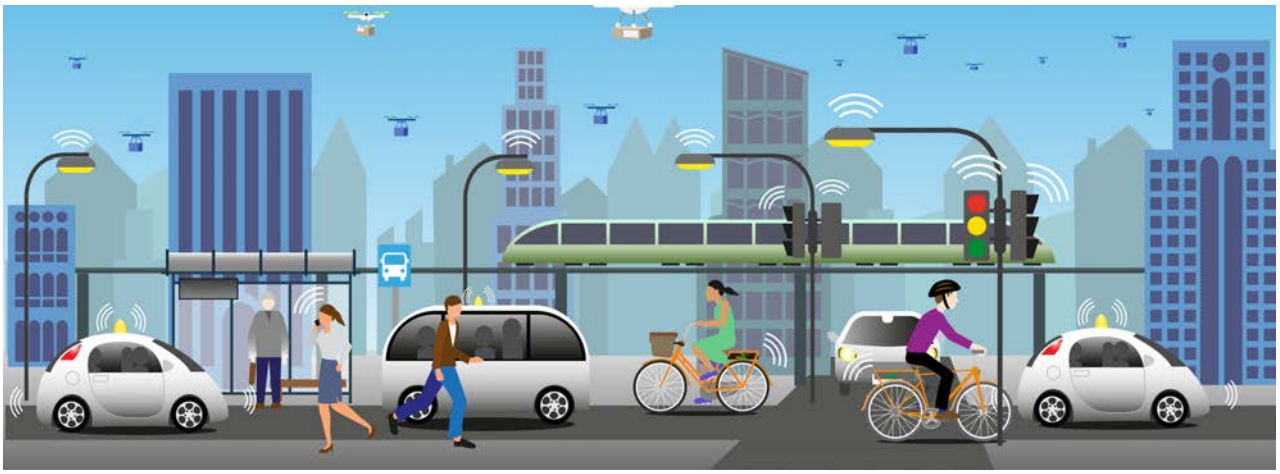
Scientastic
STEM Education

# Solar Kit:

# Sustainable Transport Electric Cars

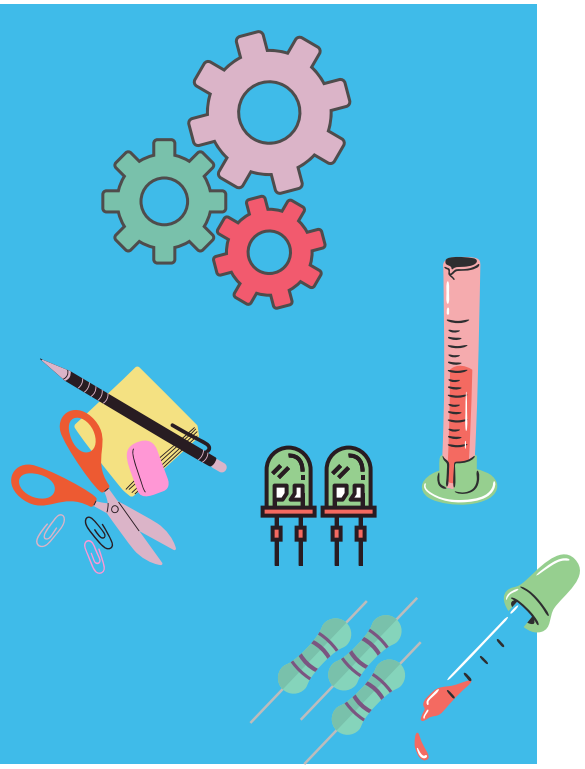
# Sustainable Transport

## Electric Vehicles



### Equipment Needed:

- card, recycled materials
- car template (optional)
- straw, axle,  and wheels
- wooden pulley
- plastic pulley
- Battery and battery box
- Motor
- Solar Panel
- Solar Motor
- tape/glue



# BACKGROUND INFORMATION

## What is an electric vehicle?

An electric vehicle is a vehicle that uses **electricity for power**. In fact it was one of the first kinds of transportation that did not use horse or human power.
Electric trains and cars were built in the **1830's**. In the early **1900's** there were more electric cars than gas powered cars. However cars powered by gasoline or diesel fuel become the most common kind of car for most of the last 100 years.

The first known electric carriage car was built in 1837 by Scotsman **Robert Davidson** and was powered by zinc-acid batteries. He later went on to develop an electric locomotive which was tested on the Edinburgh-Glasgow train line.

However, it was quickly established that such battery powered vehicles were not as economically viable as steam powered vehicles since the batteries were not rechargeable!!

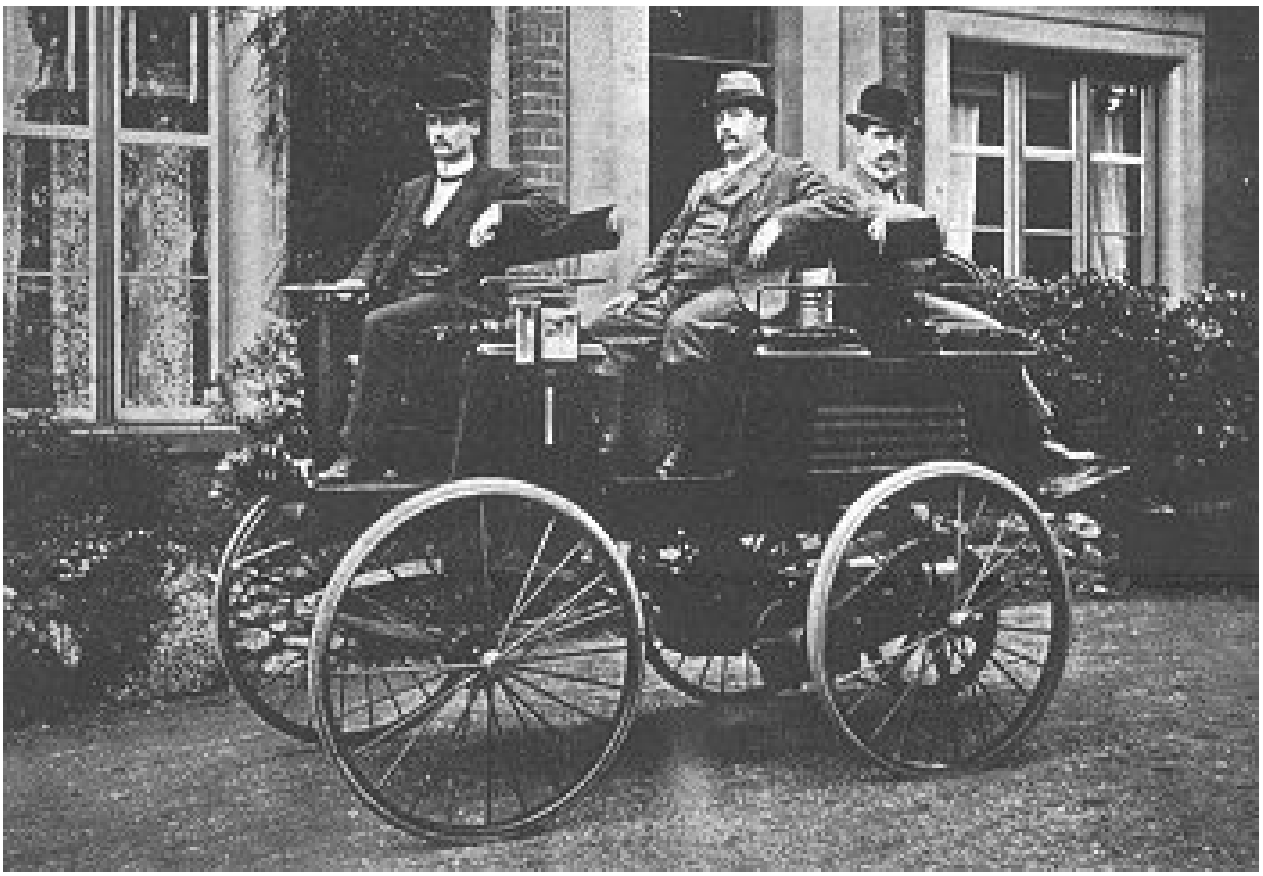


**Figure1: The first recorded Electric Locomotive**

Electric vehicles (EVs) are an important part of meeting global goals on climate change. They feature prominently in reducing the limit of global warming to well-below 2oC or 1.5oC. This would be in line with the Paris Agreement's targets.

The transport sector accounts for approximately a quarter of global greenhouse gas (GHG) emissions and is one of the major sectors where emissions are still rising.

EV's can power the future of transport:

- reduce the emissions that contribute to climate change and smog,
- improving public health and air quality and
- reducing ecological damage.

However, while no greenhouse gas emissions directly come from EVs, they run on electricity that is still, in large part, still produced from fossil fuels in many parts of the world. Energy is also used to manufacture the vehicle – and, in particular, the battery.

**The key to EV or future transport:**

**the energy that is used to power an EV should originate from a renewable source such as solar or wind.**

# STEM LAB:

## Engineer an Electric Vehicle

The electric car designed in this activity uses a pulley to transfer the mechanical energy from the motor to the wheels. The car activity introduces students to simple machines including pulley, wheel and axle and also compound machines. This activity allows students to develop their ideas about forces and motion, and simple machines. It is presumed that students have studied electric circuits prior to this activity - although not essential.

Design Criteria

- The vehicle must be powered by electrical energy - battery, solar, or a capacitor charged from a renewable energy source
- Vehicles can be constructed from Car Template and/or recycled sustainable materials. The box the STEM Kit arrived in can be used to make car protypes

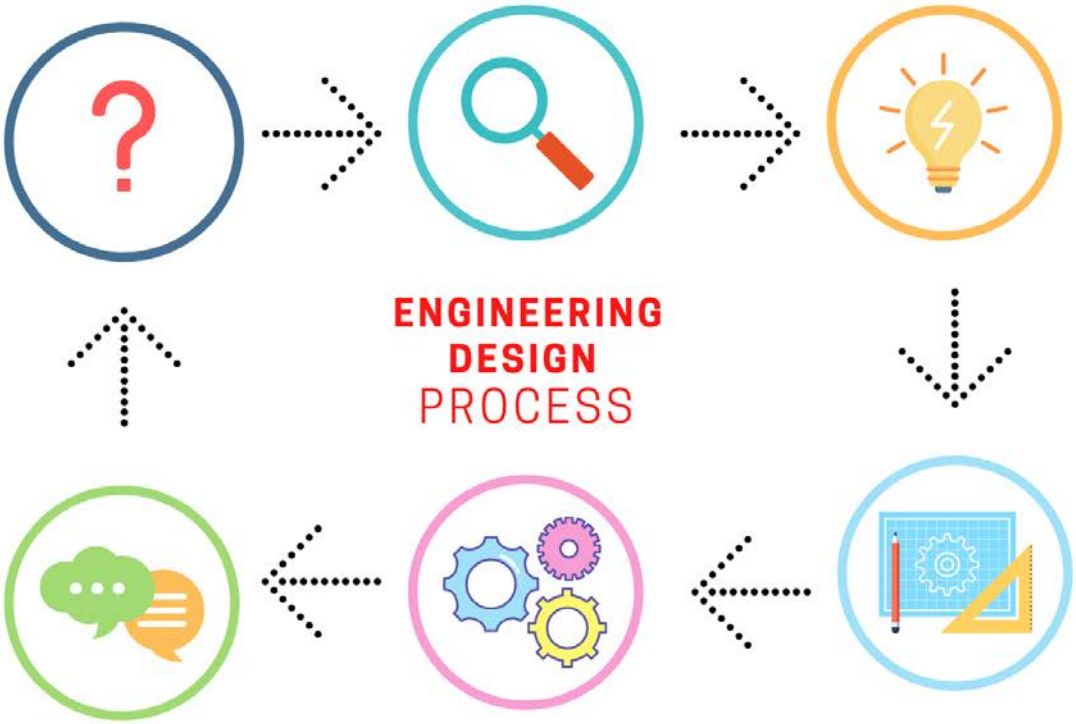
## Introduction Questions:

- Build a prototype as an example or
- Brainstorm ideas, what mechanism will drive the car forward?
- Battery-powered cars were among the first electrified vehicles - why did that change
- Why is the electrification of transport so important?

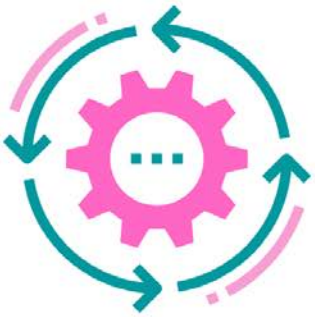
## Practical Lab:

Use the Engineering Design Process to design and build an electric car. A detailed version is attached as a lab book for you to fill in. We have also included a step-by-step picture guide. This is to help with building prototypes but you can design your unique version. Check out the Recycled Racers

Picture guide: battery-powered car. For solar-powered follow the same instruction but use solar panels and solar motors.



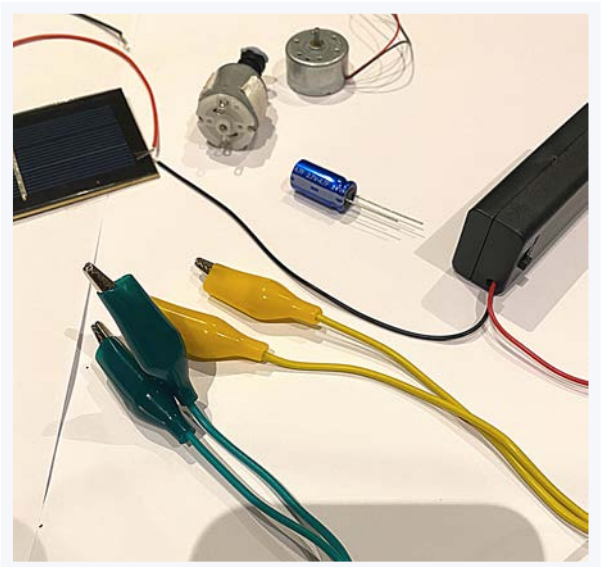
**ENGINEERING DESIGN** PROCESS



**ITERATE**

EVALUATE
*IMPROVE*
*REDESIGN*

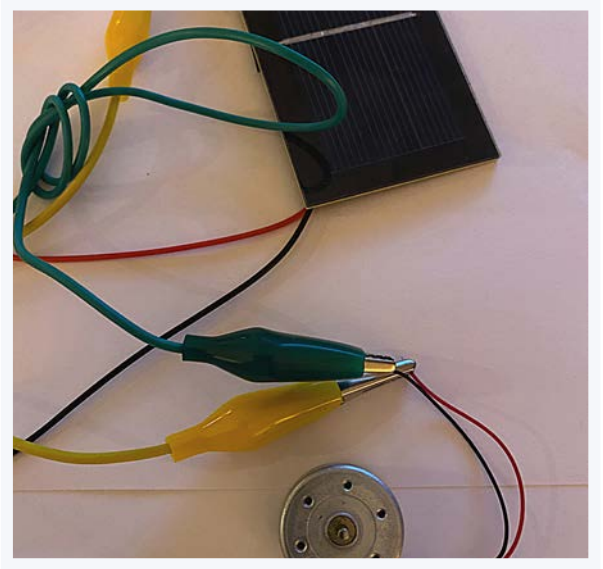
# Step by StepElectric Circuit: solar, battery or capacitor



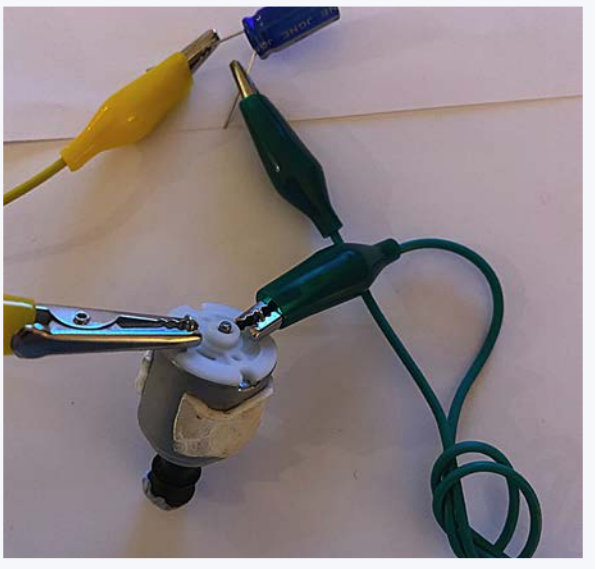
1. You will need:
Energy source: solar, battery or capacitor. Crocodile leads, Motor

(if crocodile leads are very long you can loop them over a tie in a knot to shorten)

2. Clip the crocodile leads onto the metal of the motor. Complete the circuit by attaching to the battery.

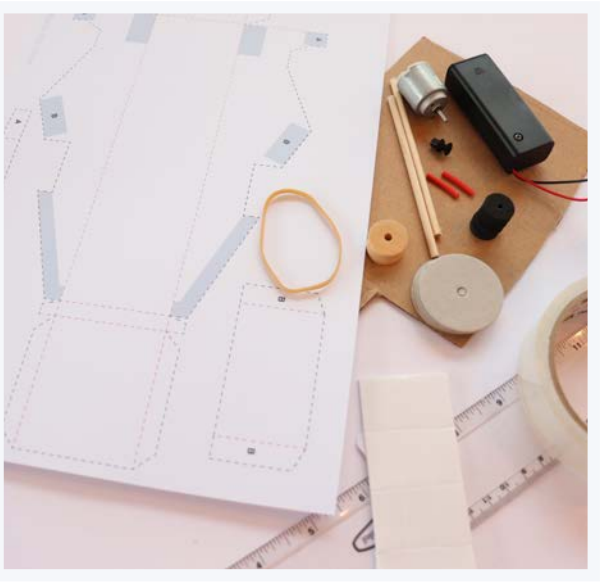


3. Solar Panel: Attach croc leads to the solar panel then complete the circuit by attaching to the solar motor. (Cover the panel with a sheet of paper if you don't want it to generate electricity when not in use)

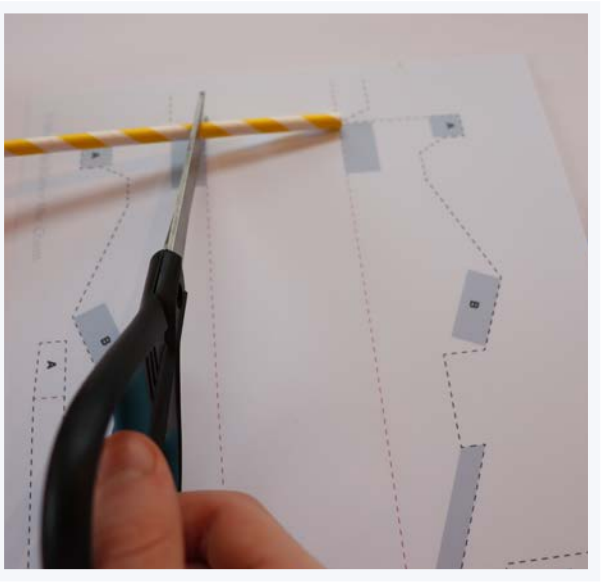


4. Capacitor:
Charge capacitor using a solar panel. Connect crocodile leads to the motor then complete the loop by attaching to the capacitor.

# Step by Step Guide: Car Base Design



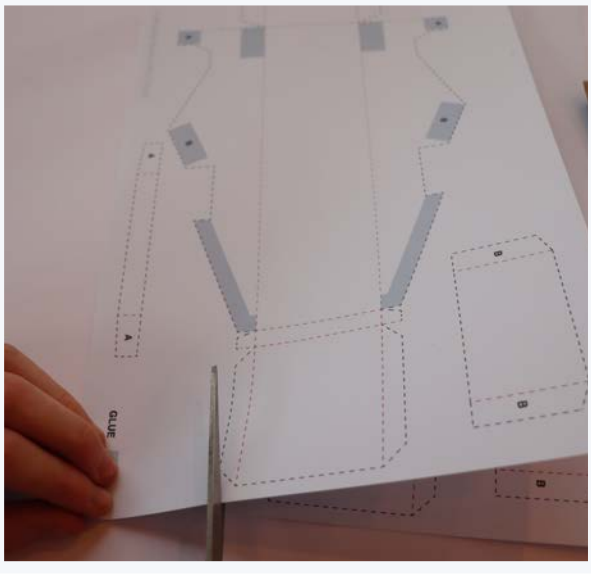
5. .You will need:
Recycled material (cardboard), car template (optional) wheels, axle, straw, tape, sticky fixer or pritt stick, colours, scissors and ruler!



6. You absolutely do not have to use the car template but you do need to decide the width of your car base!! Remember don't make the car wider than axles or the wheels won't fit!!

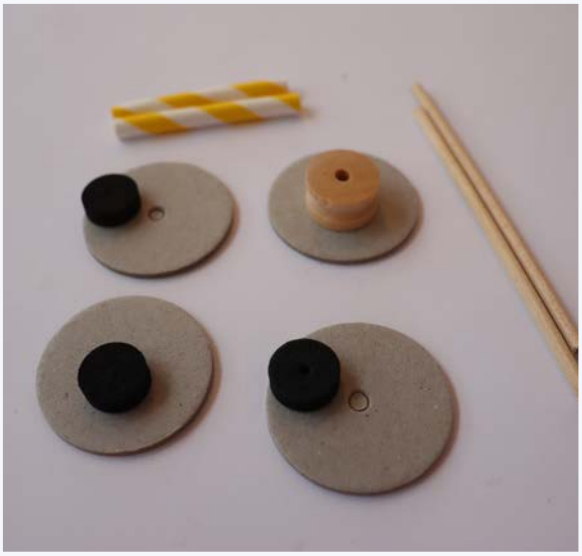
Cut two axle supports (to the width of the base of the car.

7. Cut a piece of recycled card ( cereal box, shoe box etc) to the size of the base. We measured the base at approx. 5cm x 18cm!

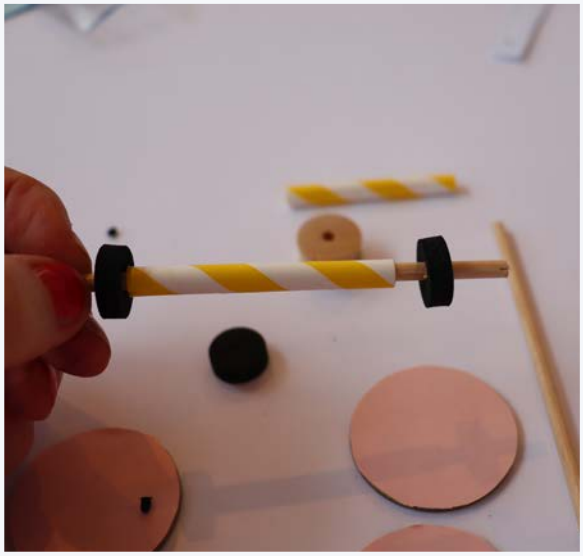



8.
Cut out the car template, if you are using it!!

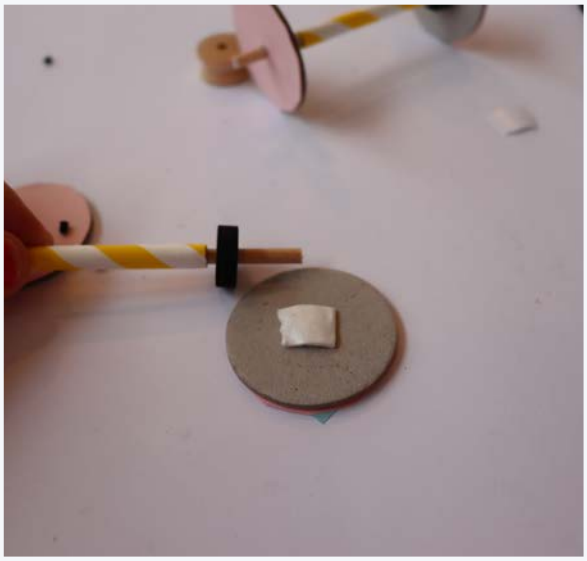
# Step by Step: Wheel and Axle



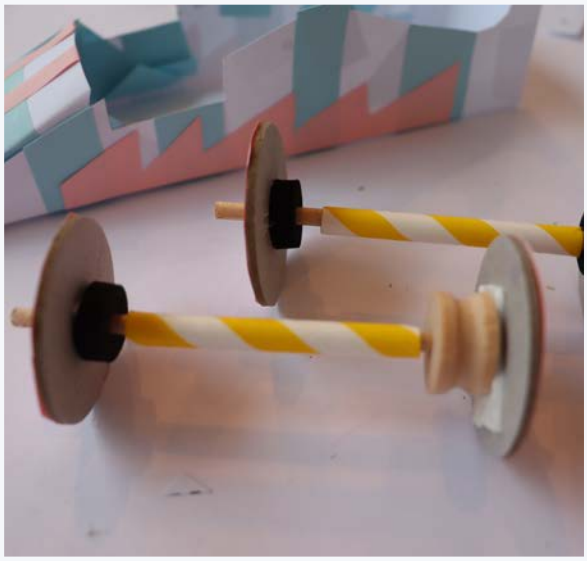
9. You will need:
Four wheels, axle support (cut to size of base of the car), axle, washers **(NOT ESSENTIAL)** x 3, wooden pulley , sticky fixer and/or Pritt Stick



10. Pop the axle into axle support (straw) and add a washer to either end.

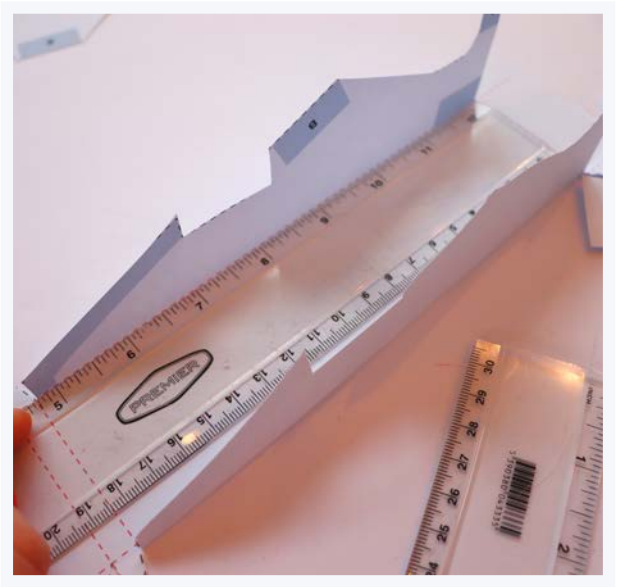


11. Attach a wheel to each washer. To keep the wheel securely in place add some pritt stick or a little sticky fixer.



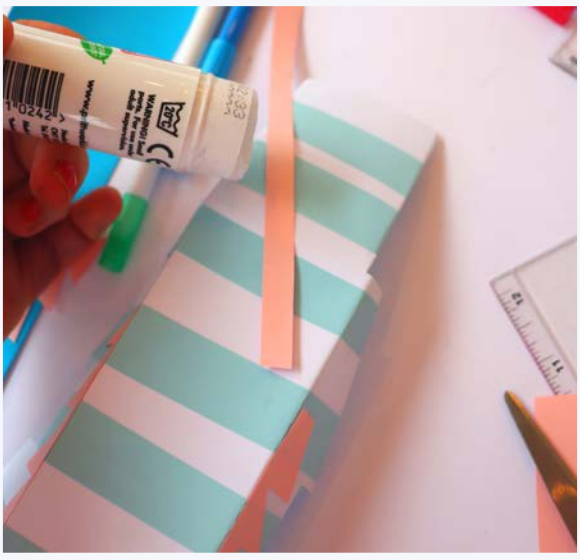
12. One of the wheels will have a wooden pulley attached instead of a washer. Ensure all four wheels can spin freely

# Step by Step: Car template assembly




13. Use a ruler to help fold the template along the red dashed lines. The ruler helps with the folds and creases.

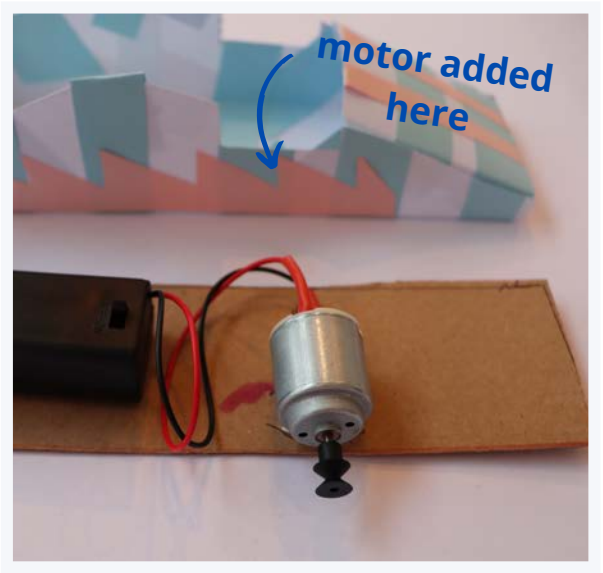
14. Flip the car base over and start decorating. You can use markers, stickers, pencil, crayons - or just leave it white!



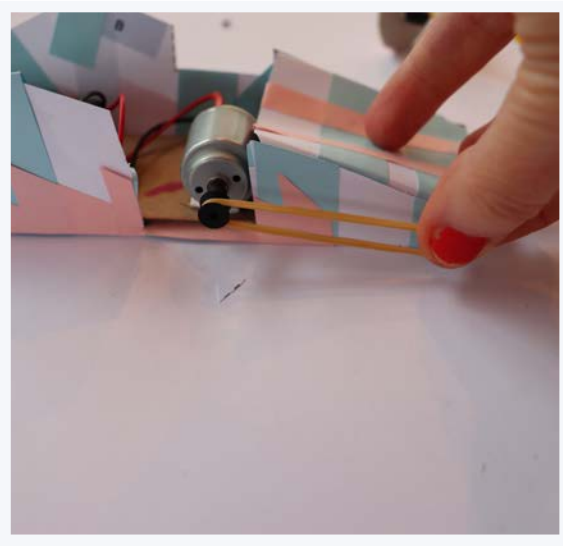
15. We used scrap pieces of paper and collaged them onto the car.

16. Use tape or pritt stick to assemble the car. The base is now complete.

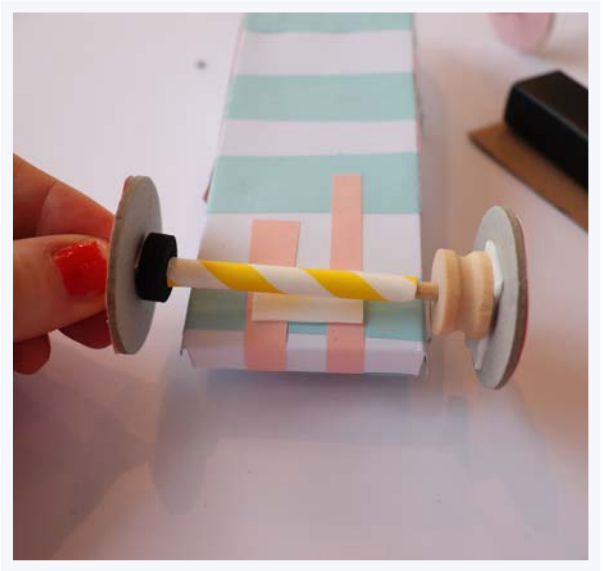
# Step by Step: add a circuit to car assembly



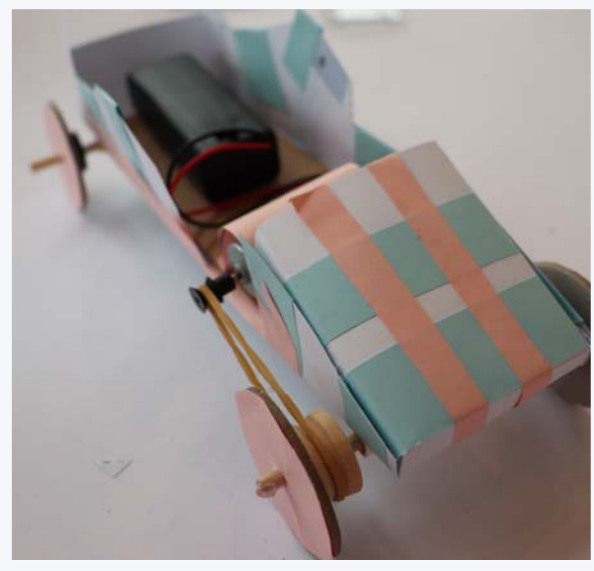

17. We like to add the circuit to a piece of recycled card - in this way if we need to fix anything it is easy to remove it. Stick the motor to the card (about 6cm back from the top)



18. Cut a little bit from the door of the car and pop circuit inside. The pulley will sit neatly on the outside. Add an elastic band. This is a good spot for the wheels to be attached.

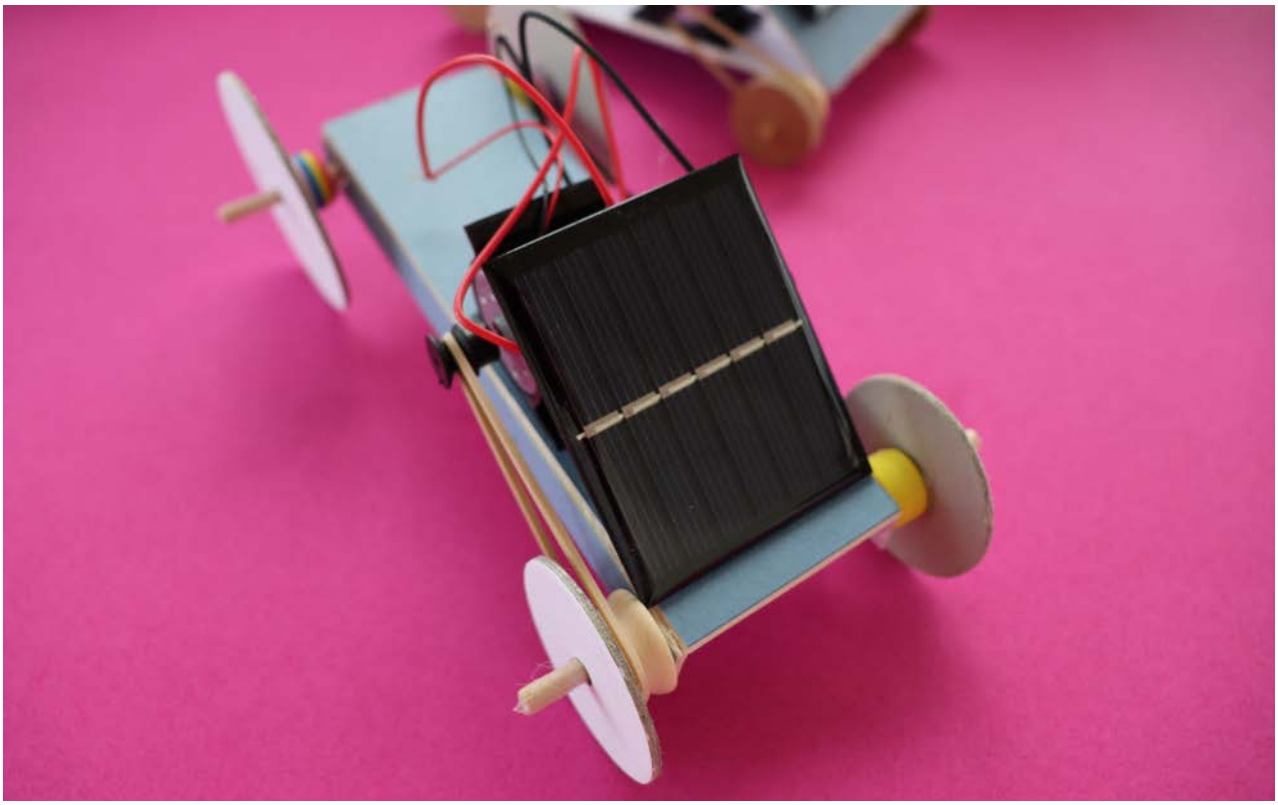


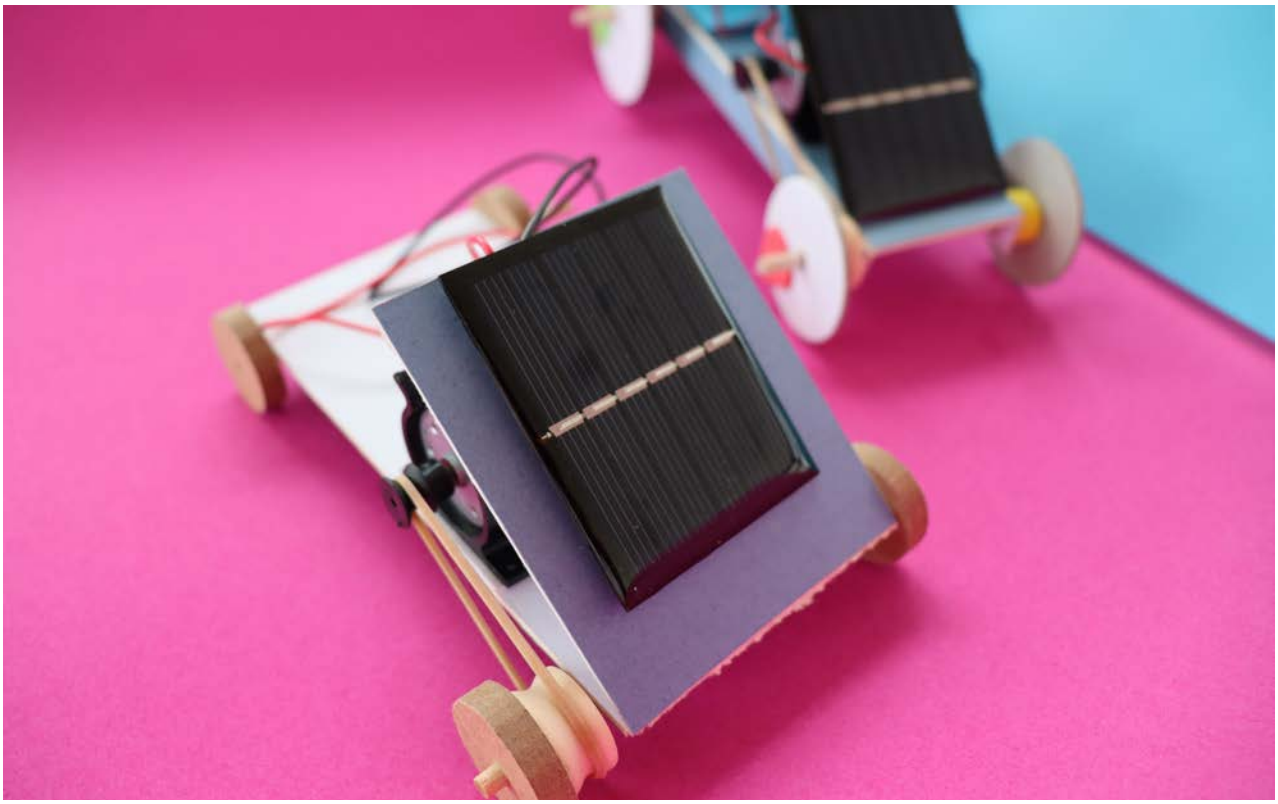
19 Attach wheel and axle with glue, sticky fixer or tape. Remember to add the wheel with pulley to the same side as the motor!!



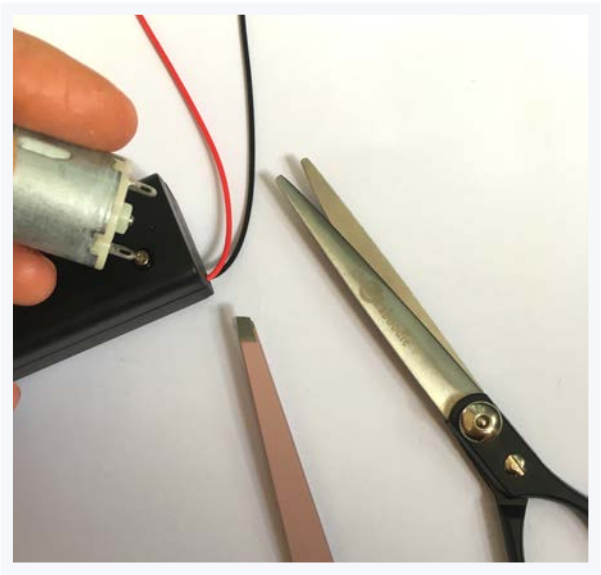
20 FINISHED!! Add elastic band and switch on!!

# Solar Car:





# Tip to remove screw from battery box:



The battery box may have a small screw. If you don't have a small screwdriver - a tweezers, nail file or scissors will work perfect....OR WE SOMETIMES JUST USE THE METAL ON THE MOTOR as a screwdriver TO UNDO THE SCREW!!

# Troubleshooting Guide:

Science and engineering can involve a lot of problem solving and trial and error. It is really ok if the car doesn't work perfect on the first go. The most important bit is trying to figure out why and fix it.

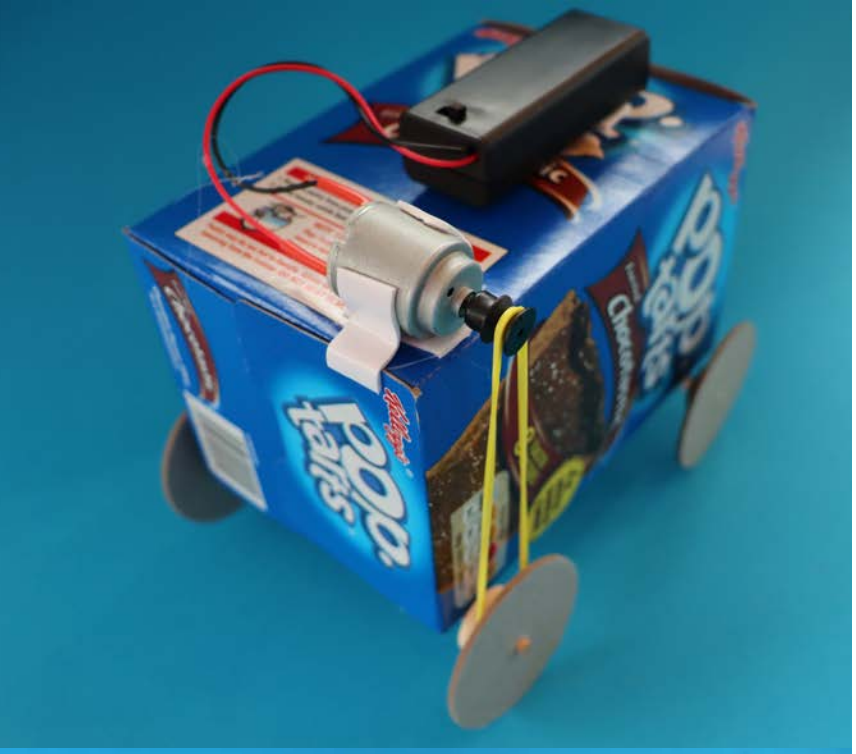
The wheels need to be able to freely rotate around the paper axle. Ensure that they are not too tight and pushed against the side of the car or cardboard. If the car doesn't function as a moving car with a push do not add the circuit until you have solved this.

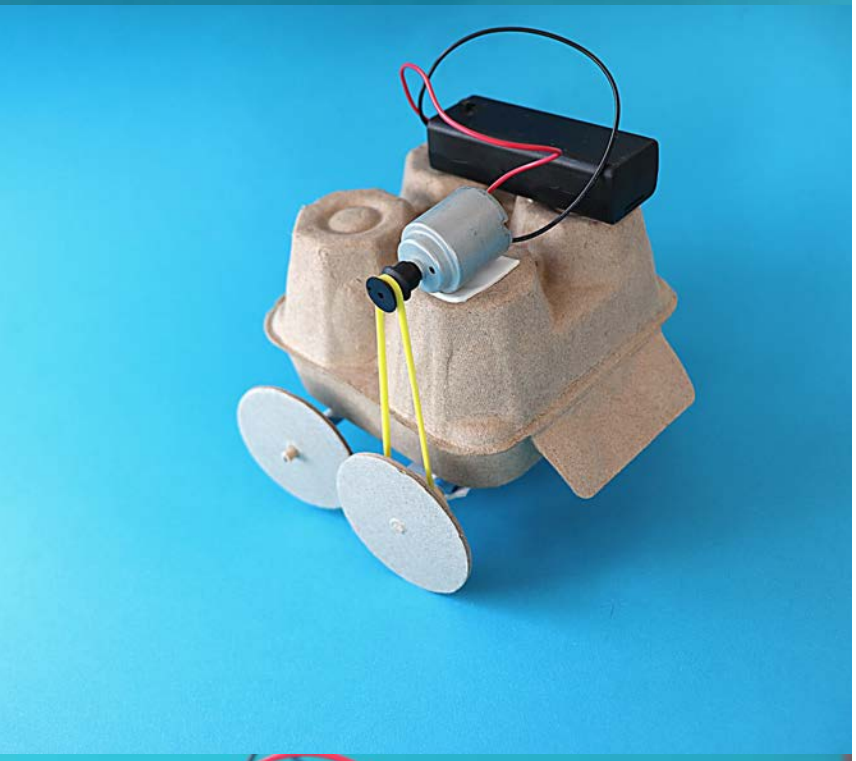
The car wont travel in a straight line or move at all if the wheels are wobbly. If this happens secure with a little tape or glue.

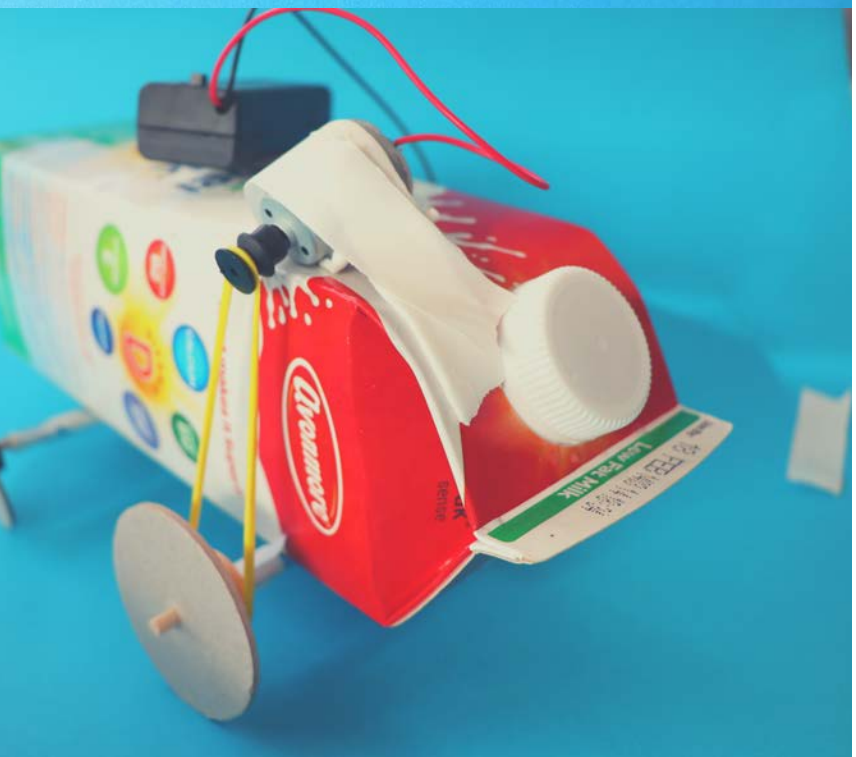
If your car does move think how would you improve the design or what would you change to get it to travel further.

If the motor is not turning check that the wires are still attached

If the motor is turning backwards flip the wires!!






# Engineer a Recycled Racer

Unleash your creativity, imagination and innovation skills!

Design and build amazing zooming racers from recycled materials.

Now that you know the basic engineering to build an electric car - why not transform some recycled materials into speedy racers.

Whats needed:

- electric circuit
- IMAGINATION!
- CREATIVITITY!
- PROBLEM SOLVING!
- FUN!

Why not put design skills to the test and set up a recycled race event!!

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