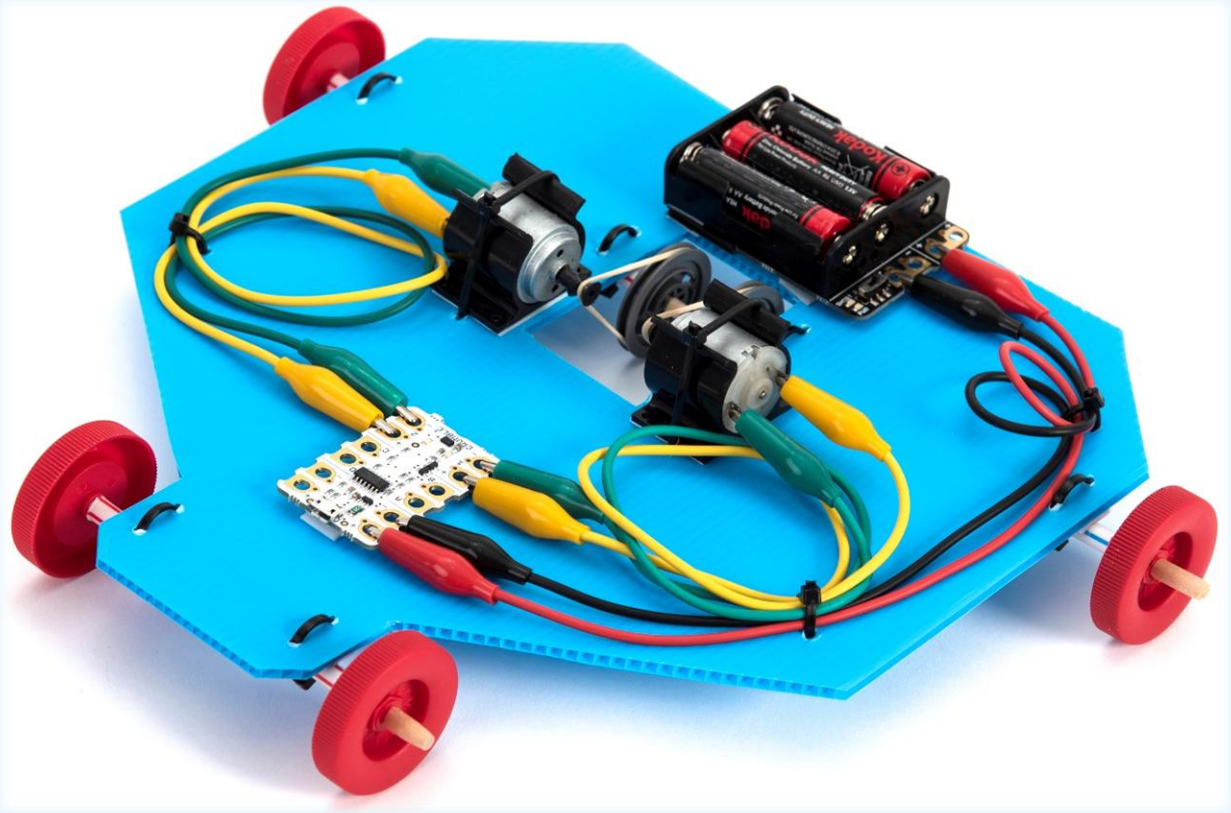
Crumble Robotic Vehicle



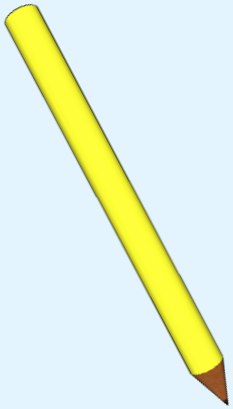
Create your vehicle

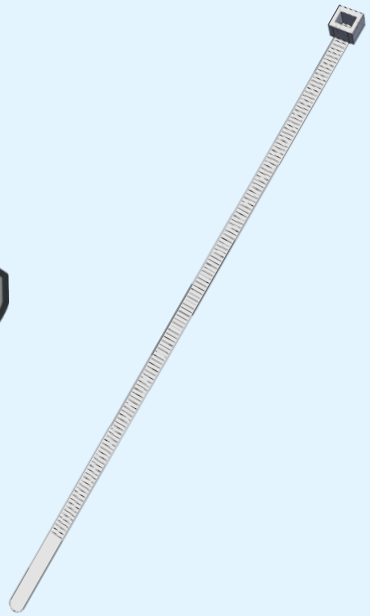
Learning Objectives

- Computing – design, write and debug programs.
- Electricity - recognise electrical components and their symbols.
- Forces – recognise that some mechanisms such as pulleys allow a smaller force to have a greater effect.
- D&T – understand and use mechanical, electrical and control systems in products.

Work Safely

Look at the tools and equipment. Can you spot any potential hazards?

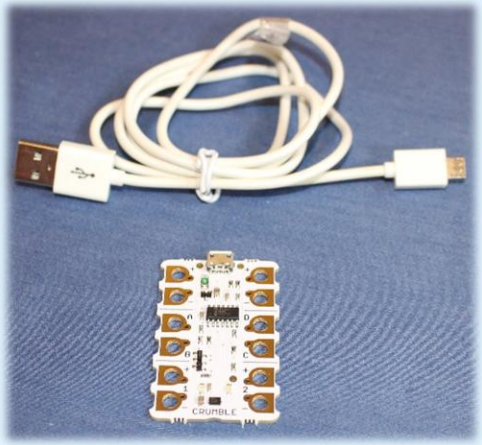


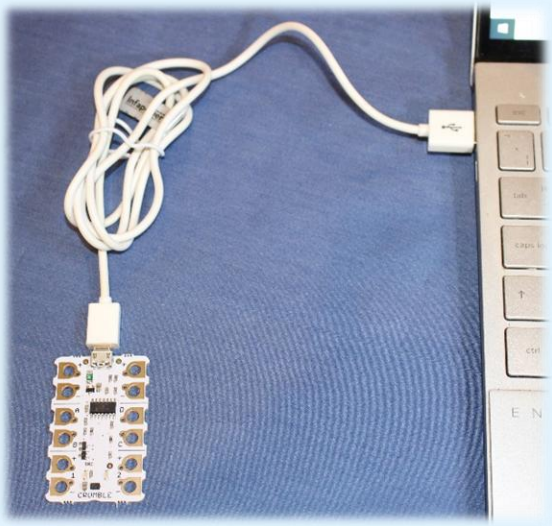


Can you think of ways to reduce the risks?

Connect up the Crumble controller

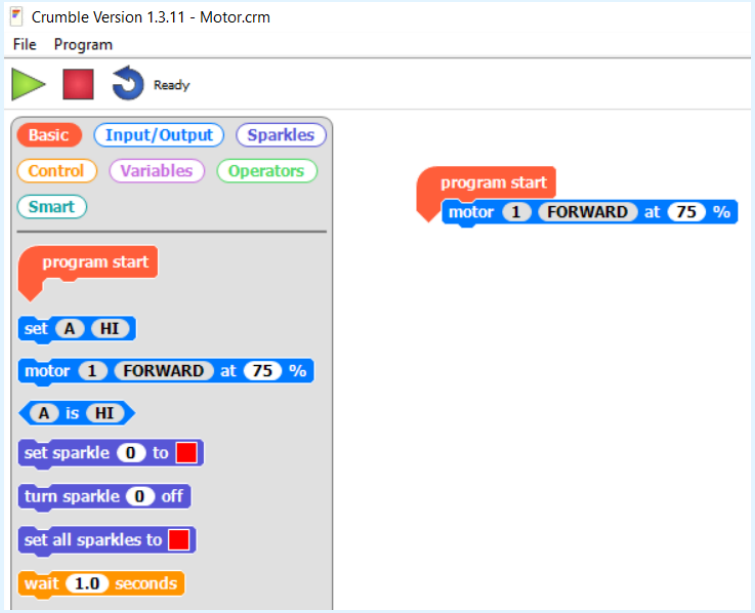
- Collect a micro-USB lead and a Crumble controller.
- Plug one end of the micro-USB lead into the Crumble.
- Place the Crumble on a spare piece of paper.
- Plug the other end of the micro-USB lead into a USB port on your computer.

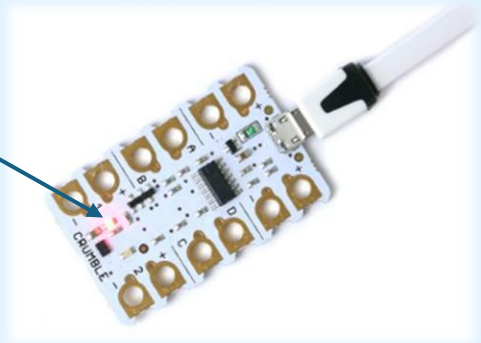




Run a simple program

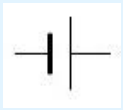
- In the Crumble software, drag the command ‘motor 1 forward at 75%’ from the left-hand column and attach it to the ‘program start’ icon on the right.
- Click on the green arrow (top left of the screen) to start the program.
- Check that ‘motor 1 LED’ on the Crumble controller lights up.
- Click on the red square (top left) to stop the program.

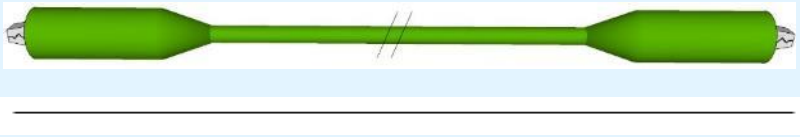


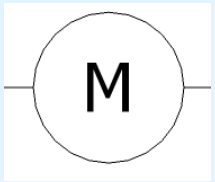


Identify these electrical parts

Name these electrical components and their symbols:



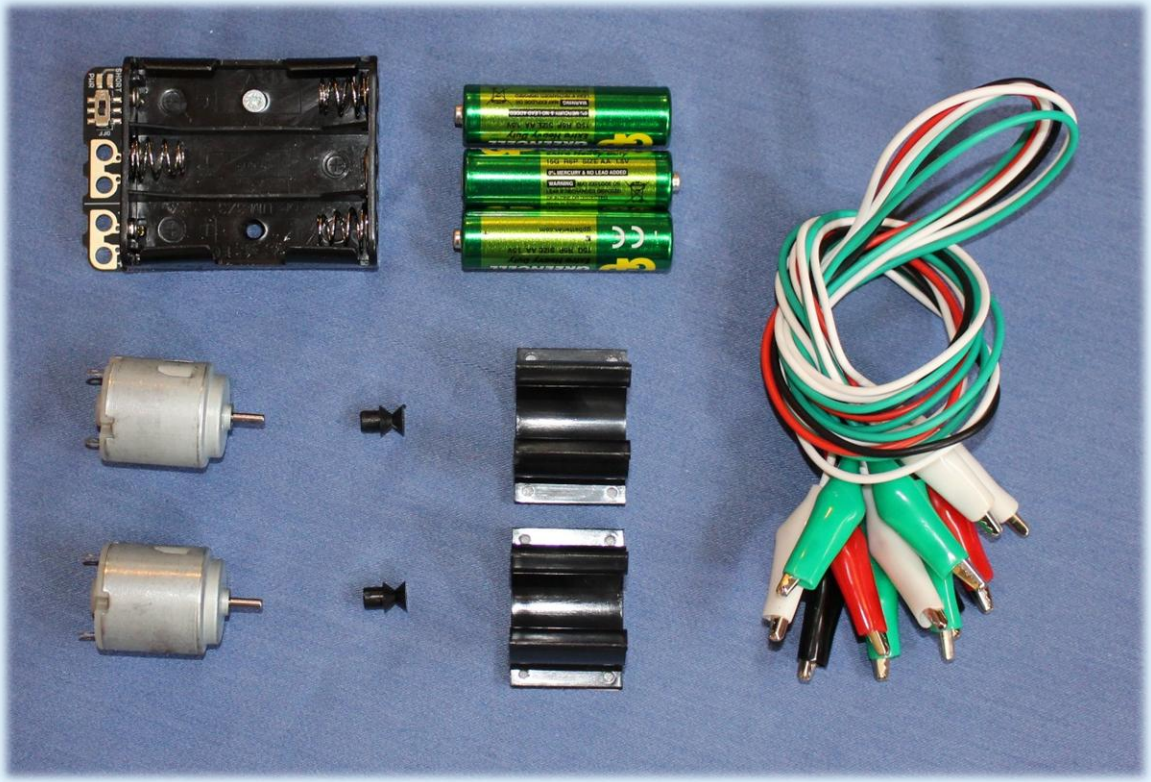




Now complete the first two rows of your worksheet.

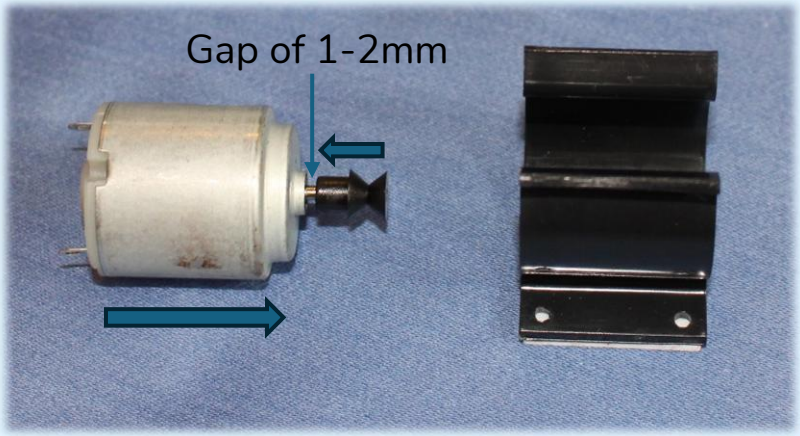
Collect these parts

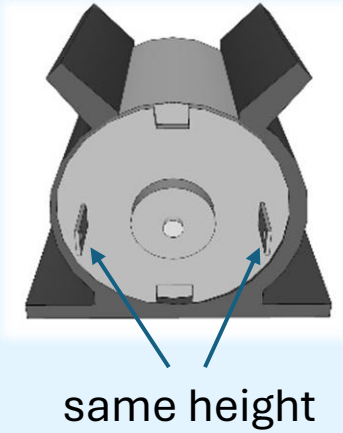
- Battery box
- 3 cells
- 2 motors
- 2 motor pulleys
- 2 motor mounts
- 6 crocodile leads



Mount the motor pulleys and motors

- Push the motor pulleys onto the motor shafts as shown by the short arrow.
- Slide the motors into the motor mounts. Push the motors in from the end, as shown by the long arrow. (If you push them in from above you can snap the motor mount.)
- Turn the motors in the mounts so that the contacts are at the same height.





Understand your battery box

Look at your battery box and identify:

- Where to connect the positive crocodile lead.
- Where to connect the negative crocodile lead.
- The on/off switch.
- The ‘power on’ LED.
- The ‘short circuit’ LED.
- Which way round the cells will go.

Technology for Fun

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Identify the Crumble terminals

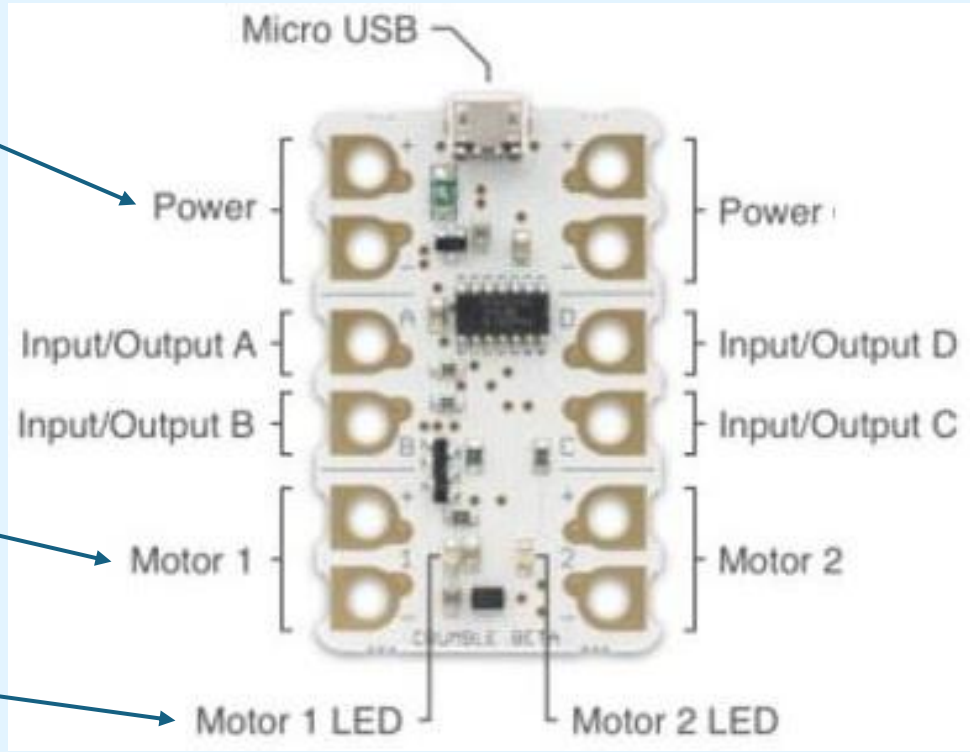
Connect to the computer

Connect either power terminal to the battery

Connect to low power inputs/outputs

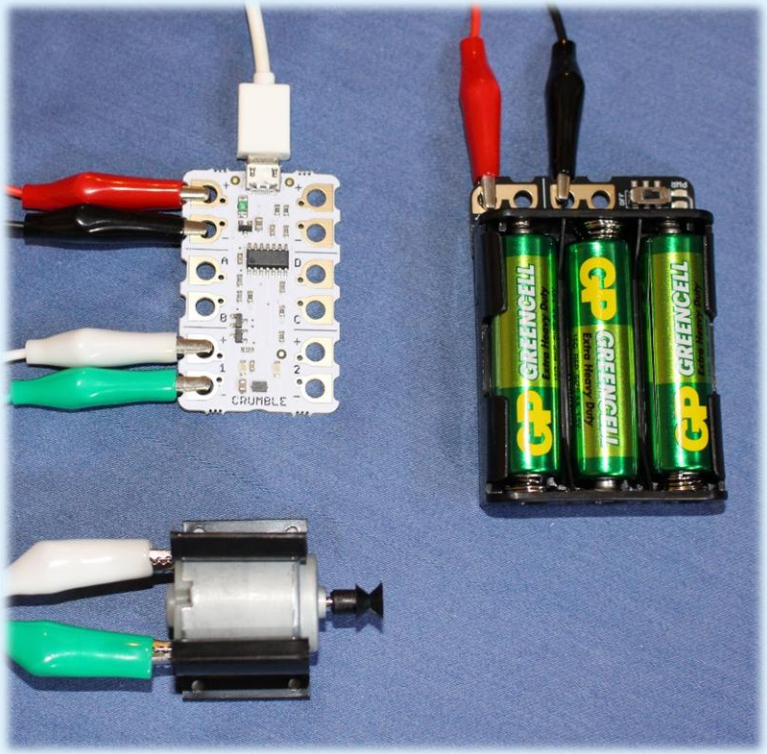
Connect motor output to the motor

Lights up when motor output is on.



Connect up the Crumble circuit

- Connect the battery box to one of the ‘Power’ terminals.
- Connect a motor to the ‘Motor 1’ terminals.
- Ask an adult to check your connections are correct.
- Fit the three cells into the battery box. The flat end of each cell should push up against the spring.



Technology for Fun

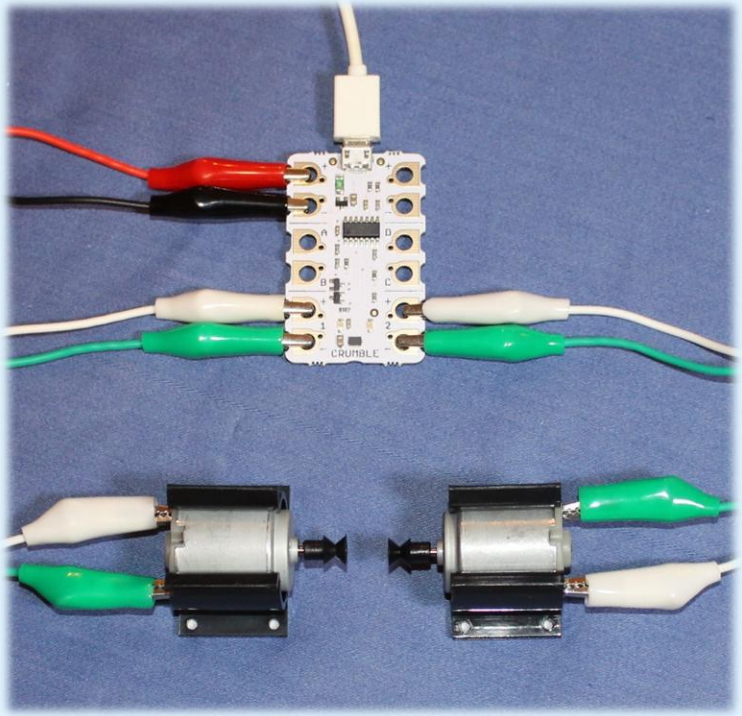
Try running the motor

- Switch on the battery box.
- Run this program and check the motor shaft rotates.
- Stop the program.
- Click on ‘forward’ to change it to ‘reverse’. Does this turn the motor the other way?
- Click on ‘75%’ and try different numbers. Can you tell the difference in motor speed?

Run Stop

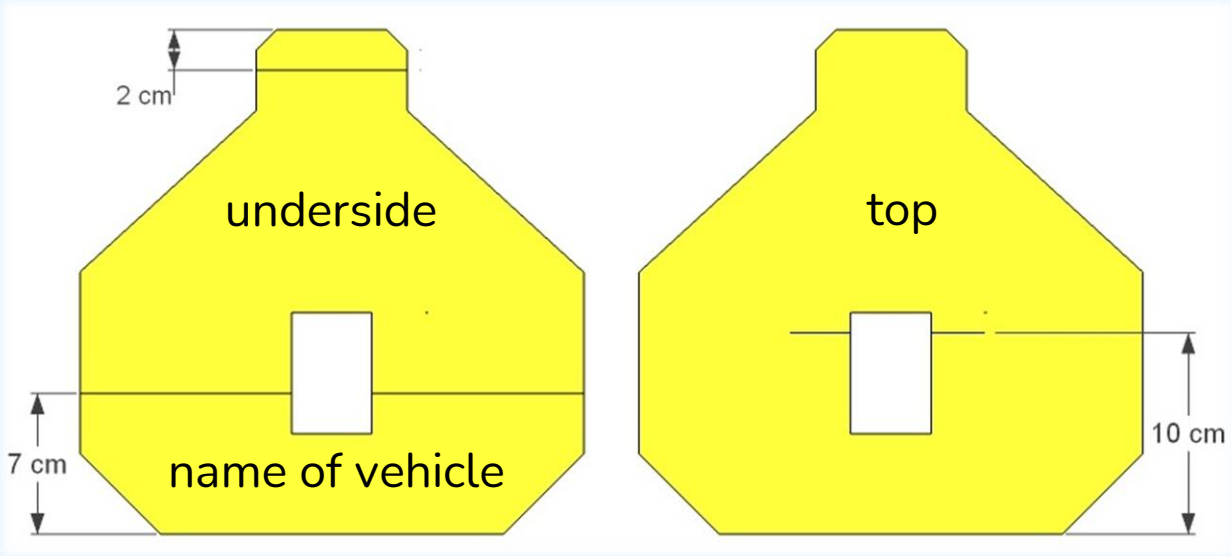
Run both motors

- On your worksheet, complete the wiring diagram to show the second motor connected to the ‘Motor 2’ terminals.
- Connect up the second motor.
- Your worksheet shows a flowchart to run both motors at 50% power for 5 seconds and then stop.
- Construct and run a program to do this and check the motors behave as you expect.
- Unclip the crocodile leads.



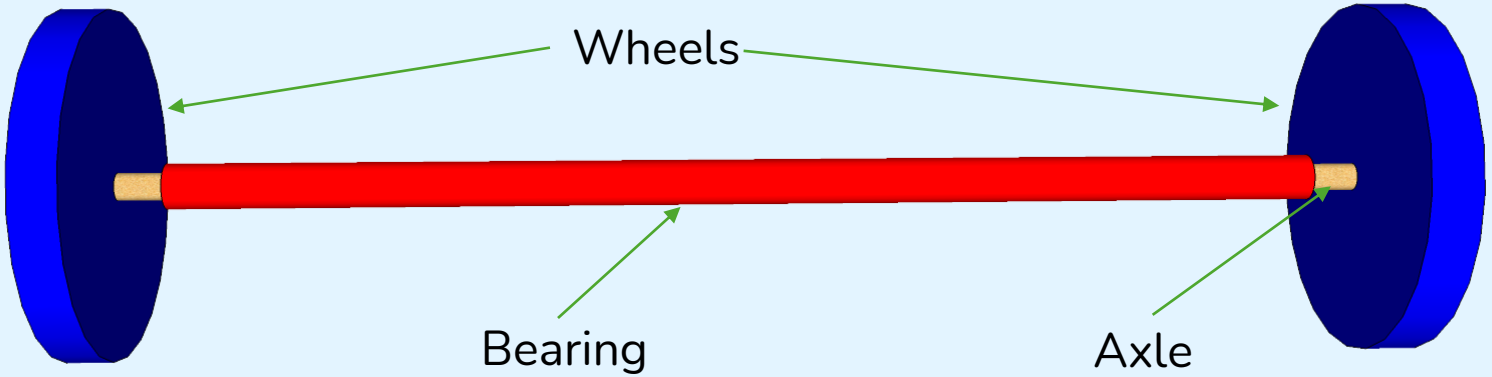
Prepare the base

- Select your vehicle base and neatly cut out the outline. Save the offcuts for use later.
- Mark lines on the underside and top as shown. This is to help you position your components correctly.



- Think up a name for your vehicle and write it on the underside.

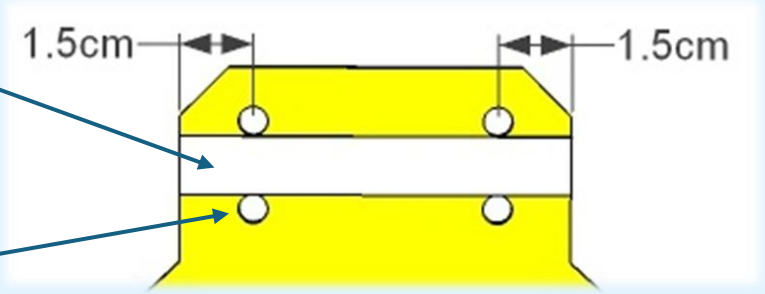
Why we use wheels, axles and bearings

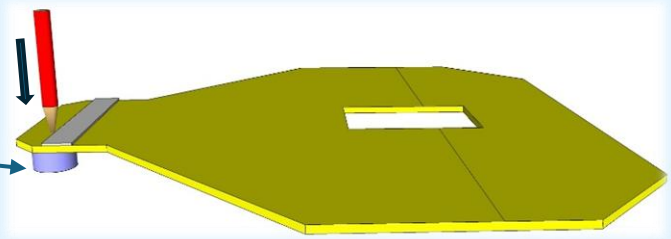


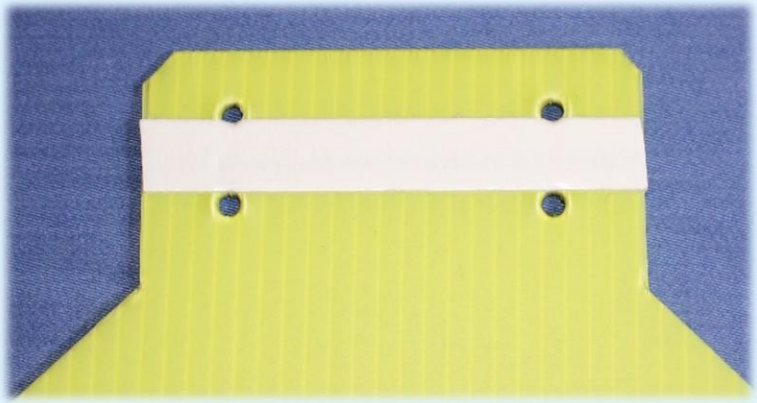
- The wheels support the vehicle, allowing it to move by rolling smoothly over the ground.
- The axles connect the wheels together.
- The bearings support the axles while allowing them to rotate easily.
- Why, instead of pushing the wheels hard up against the bearing, should you leave a small gap?

Prepare to fit the front bearing

- Stick foam tape centrally along the line at the front of the base.
- Pierce four holes in the base either side of the foam tape, roughly 1.5 cm in from the edge.
- Support the base on a lump of Blu Tack as shown, so you don't bend the base or pierce your fingers with the sharp pencil.
- Enlarge each hole from top and bottom until a cable tie fits through.







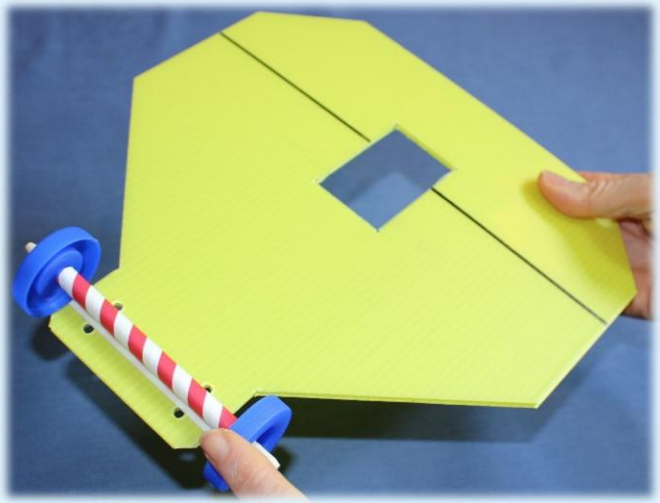
Technology for Fun

Fit the front bearing

- Measure, mark and cleanly cut a 9.5 cm length of straw.
- The cut end will become flattened – round it out again with the pencil.
- Peel the protective film off the foam tape.
- Stick the piece of straw to the foam tape, as shown. This is the front bearing.

Fit the front axle

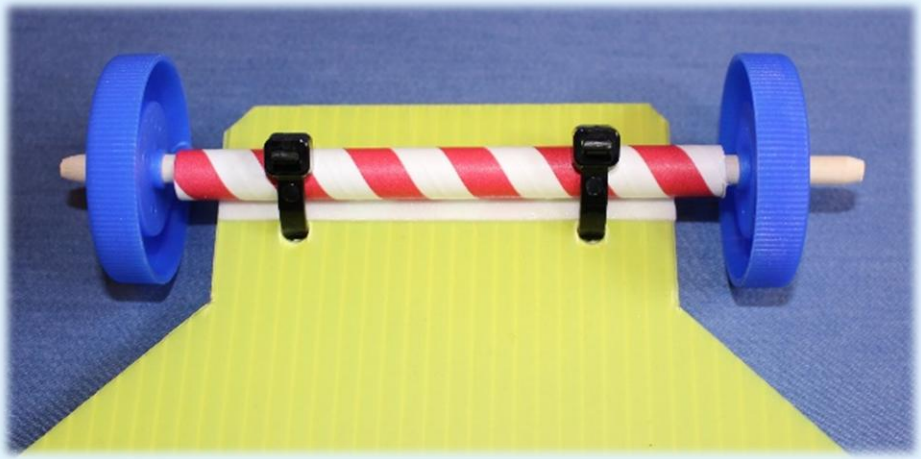
- Take a 14 cm rod, slightly sharpen both ends and push on the wheels.
- Remove one wheel and push the rod through the straw.
- Refit the second wheel with a gap of about 2 mm between the wheel and straw end. If the wheels are loose on the rod, glue them on.
- Hold the base and spin the wheel with your finger to check the axle (rod) rotates easily in the bearing.



Technology for Fun

Restrain the front bearing

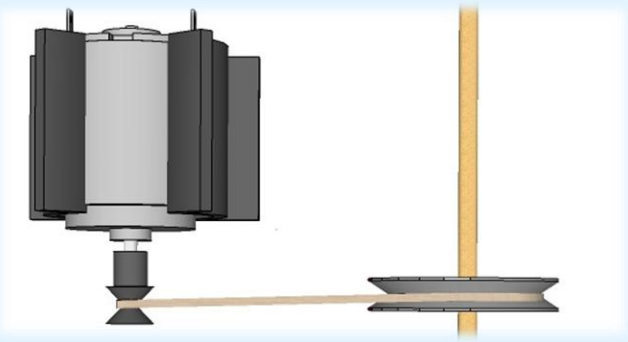
- Fit cable ties through the holes and fasten them around the bearing.
- Tighten them gently to stop the bearing moving, then cut the ends off.

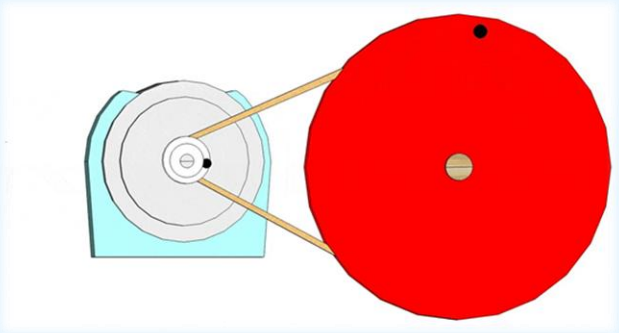


- Don’t pull the cable ties too tight (or you can crush the straw and stop the axle from rotating).
- Check the axle still rotates freely in the bearing.

Why we use a pulley system

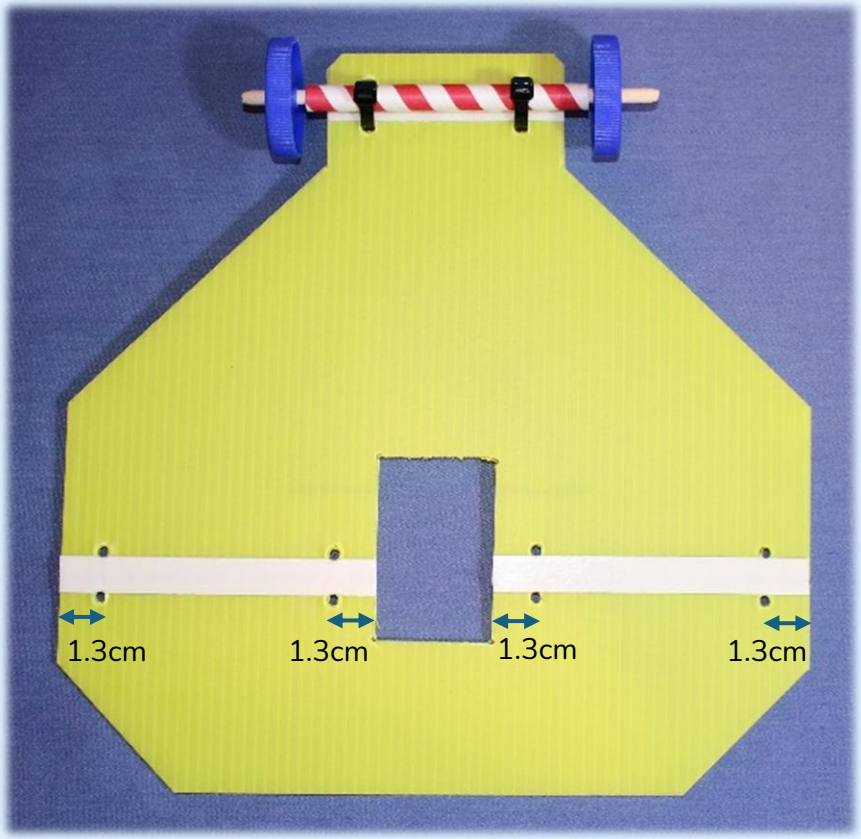
- The motors cannot drive the wheels directly to make the vehicle move, because the motor shaft rotates too fast and does not produce enough ‘turning force’ (torque).
- Instead, a pulley system is used. A motor pulley fitted to the motor shaft uses a rubber band to drive a larger pulley.
- The larger pulley is mounted on an axle connected to the wheels.
- This system reduces the speed of rotation and increases the torque sufficiently to drive the vehicle.





Prepare to fit the rear axles

- Stick two 10.5 cm long strips of double-sided foam tape centrally along the lines 7 cm from the rear of the underside of the base.
- Make holes roughly 1.3cm from the edge as shown on either side of the tape, supporting the base with Blu Tack.
- Enlarge the holes until a cable tie fits through.



Prepare the rear axles

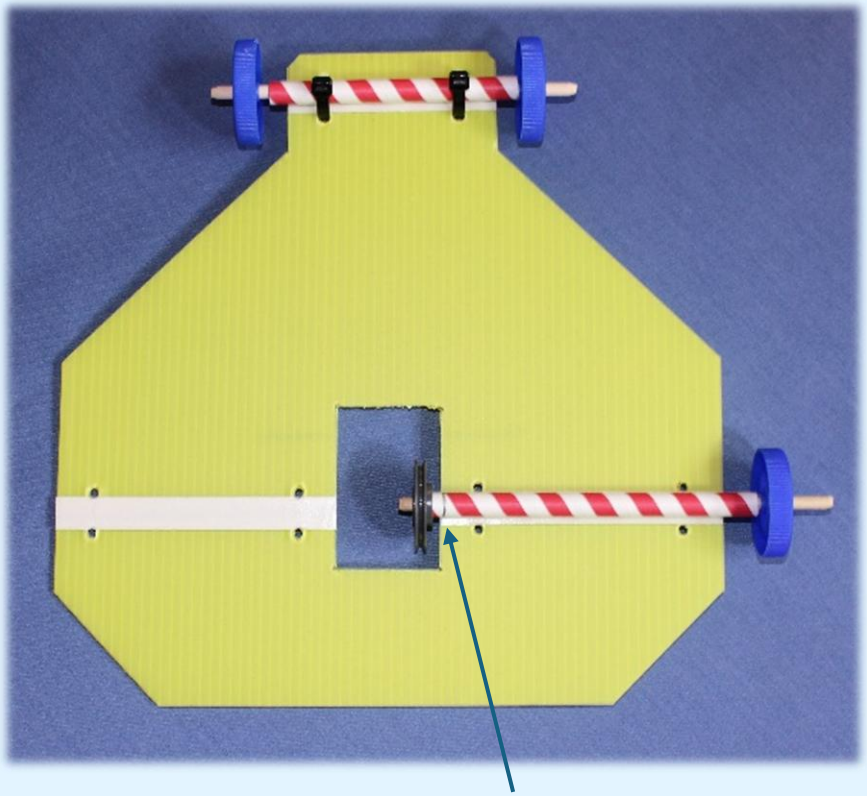
- Take two 16 cm long wooden rods and sharpen the ends very slightly.
- The length of the sharpened part must be less than 0.5 cm.
- Mark the rod 0.5 cm from one end.
- Push on a pulley until you can just see the mark. The pulley should fit tightly.

Assemble the rear axles

- Cut two 12 cm long pieces of straw.
- Round out the cut ends with a pencil.
- Mark 0.5 cm from one end of each straw.
- Push the straws onto the axles, marked end first.
- Attach a wheel firmly to each axle, leaving a gap of about 2 mm between wheel and the straw.

Fit one rear axle

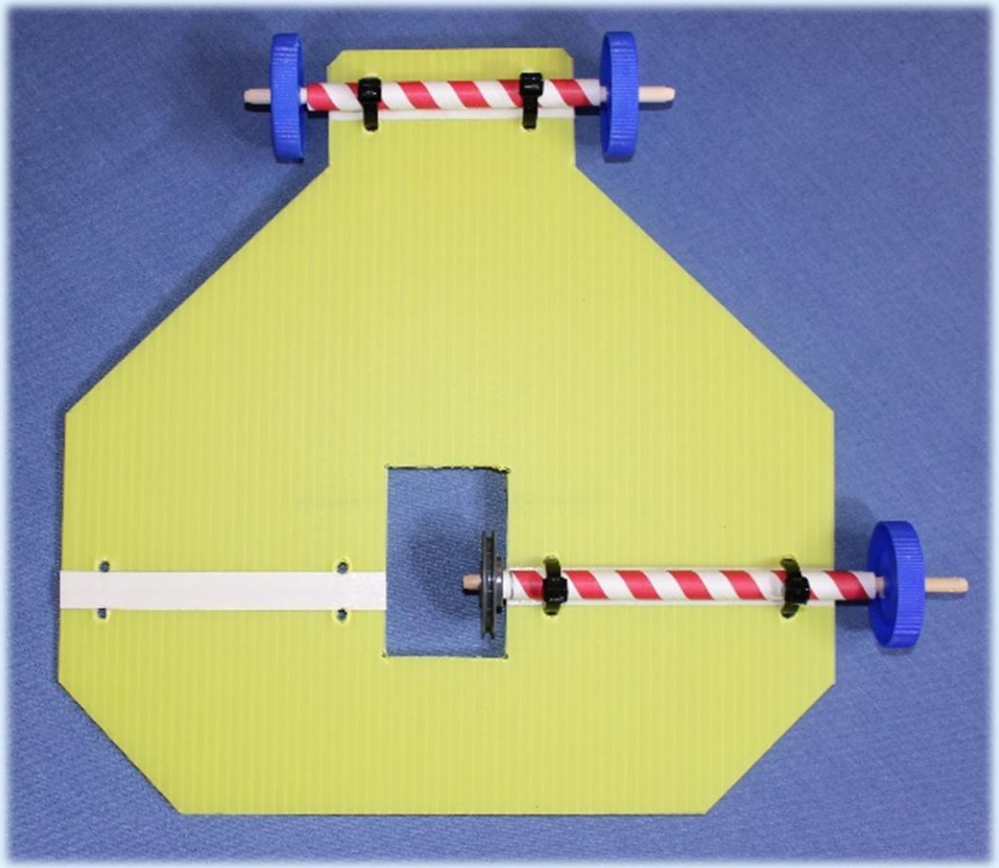
- Remove the protective film and stick the straw to the foam tape, with the mark on the straw in line with the edge of the slot.
- The pulley should be in the slot. The straw should overlap the slot by 0.5cm.
- Hold the base and spin the wheel to check the axle turns easily in the bearing.



Mark is in line with edge of slot

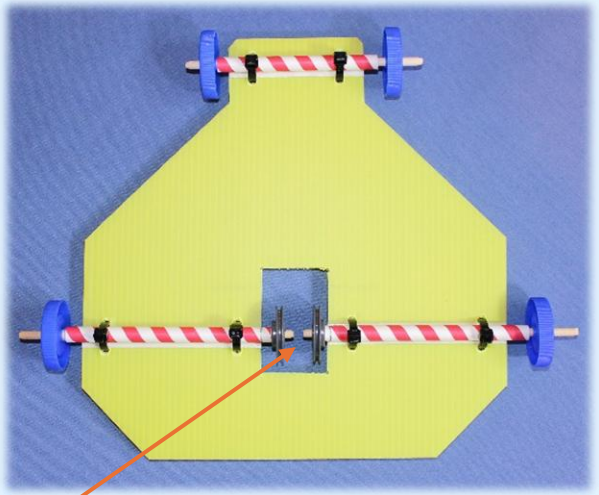
Restrain the rear bearing

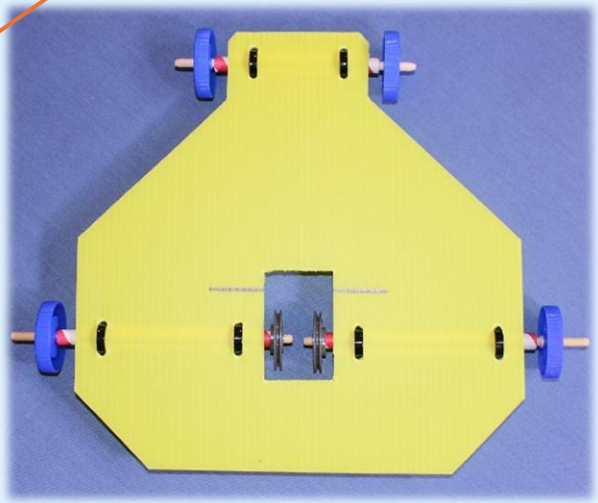
- Fit two cable ties as shown, but don't pull them too tight.
- Cut off the ends of the cable ties as short as possible.
- Hold the base and spin the wheel again to check the axle still rotates freely.



Fit and restrain the second rear axle

- Remove the protective film and fit the second rear axle. The straw should overlap the slot by 0.5 cm.
- Fit the cable ties and make sure the axle rotates freely. There should be a gap between the ends of the two rods.
- Turn the base over – you now have a rolling chassis.

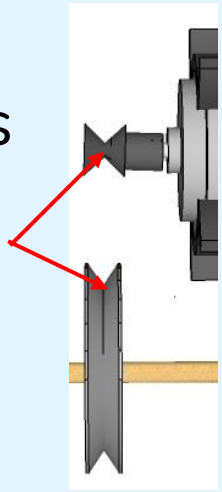




Position the motors on the base

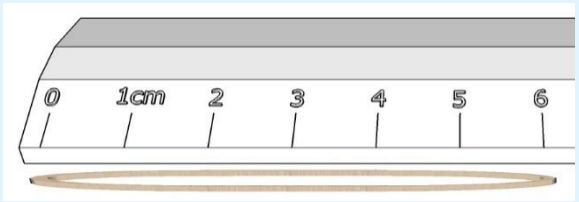
- Stick the motor mounts onto the base so the motor shafts line up with the lines marked 10cm from the rear.

- Ensure the vees of the two corresponding pulleys line up.

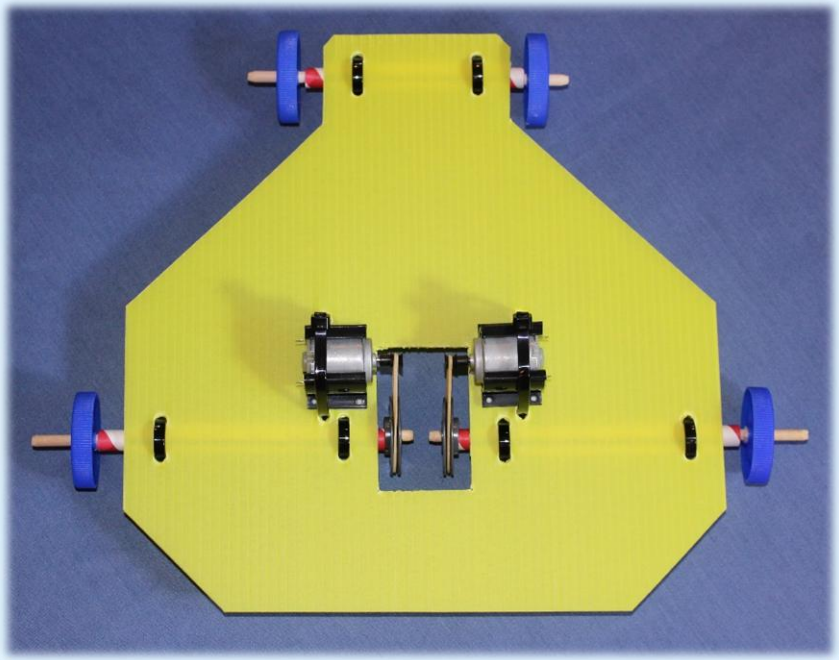


Attach the motors and drive belts

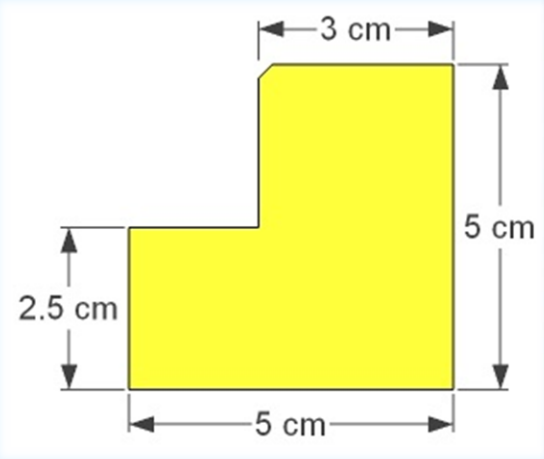
- Find two 6cm long rubber bands (drive belts).



- Make holes either side of the motor mounts, supporting the base on Blu Tack, and fit cable ties.
- Pull the cable ties tight and snip off the ends.
- Fit the drive belts and check that the vees of the pulleys still line up.



Prepare the battery box



Use an offcut of corrugated plastic to make this shape.

Stick tape to the bottom of the battery box as shown.

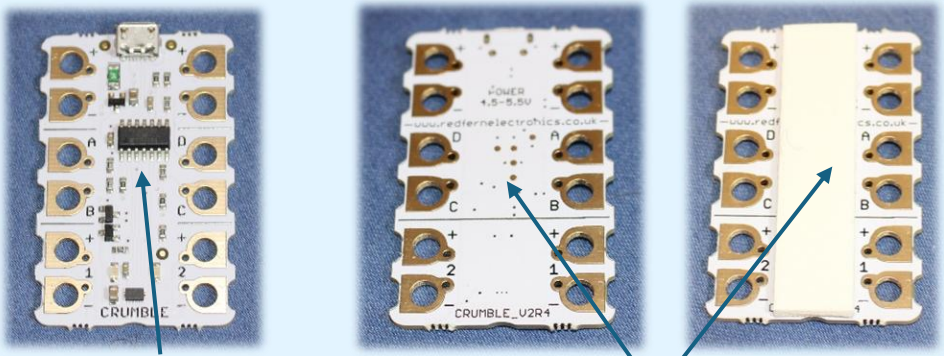
Peel off the protective film and stick the plastic shape to the battery box.

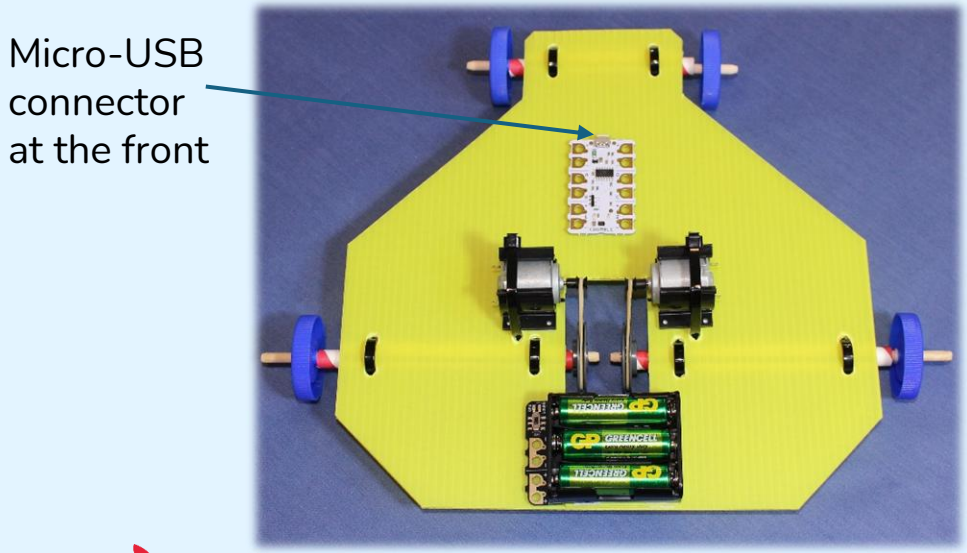
Attach foam tape to the bottom of the battery box/plastic shape.

Technology for Fun

Attach the battery box and Crumble

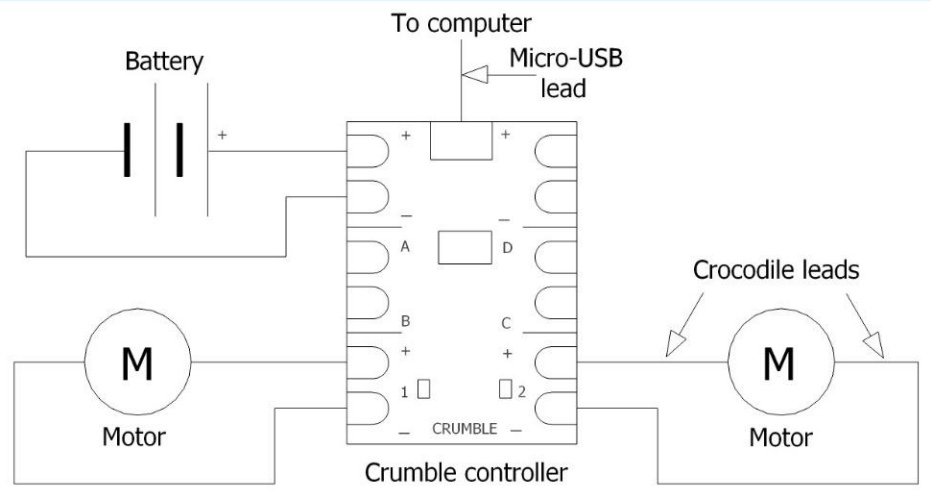
- Stick a double thickness of foam tape along the middle of the Crumble on the side without the components.
- Peel off the protective film and attach the battery box and Crumble to the base as shown. The micro-USB connector should face the front of the vehicle.

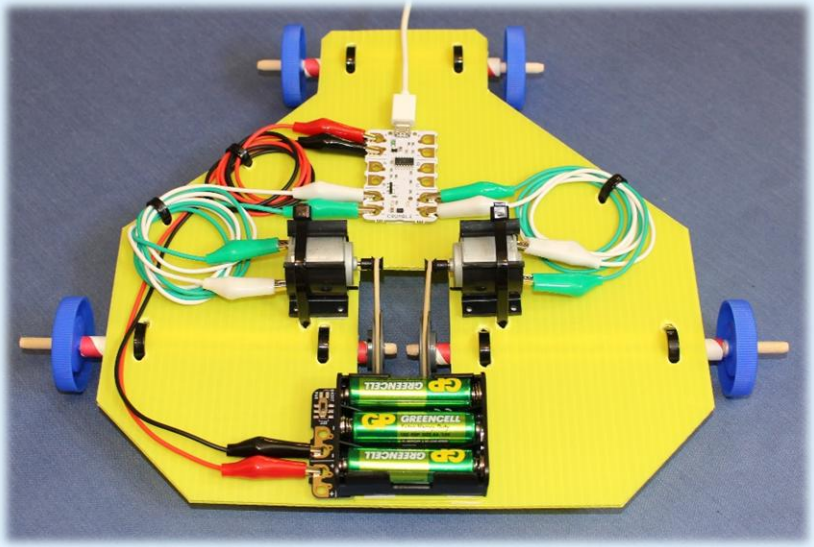




Re-connect the circuit

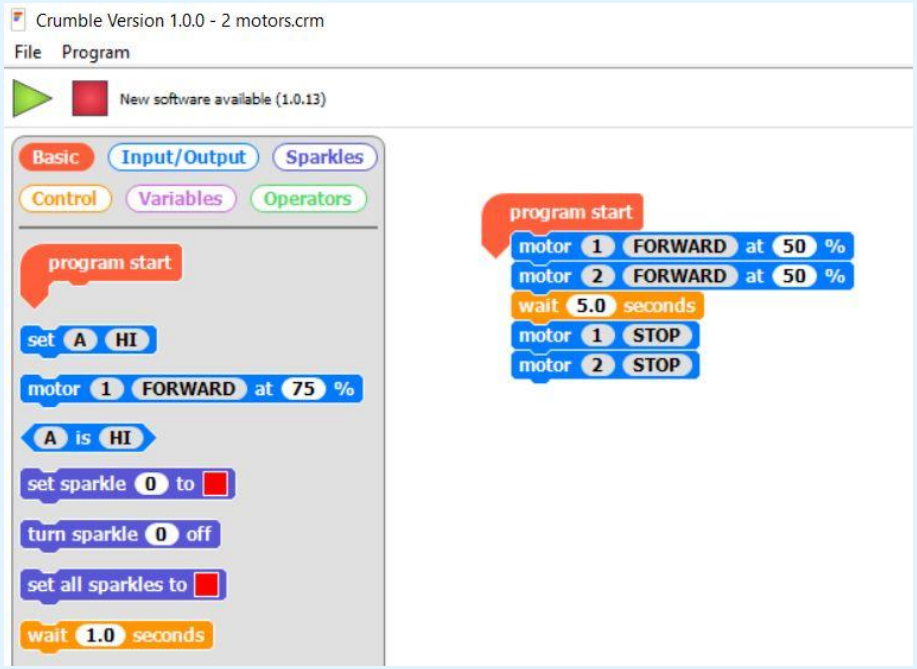
- Re-connect the circuit.
- Coil the wires up neatly and cable-tie them to the base.





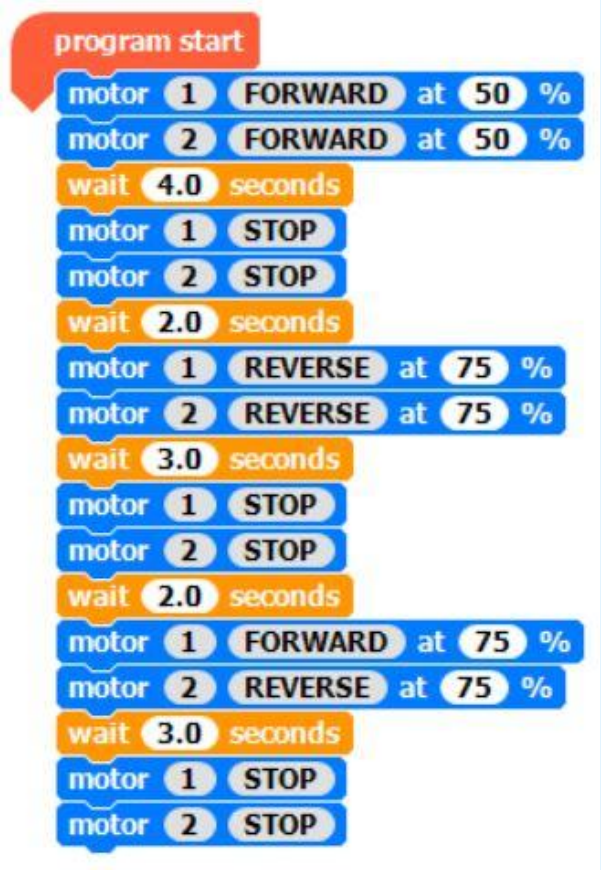
Construct a program

- Construct this program; drag commands from the left and drop them on the right. Click on values to change them.
- Hold the vehicle off the table. Switch on the battery box and click on the green arrow to start.
- Check both drive wheels turn forwards.
- If either turns backwards swap over the crocodile clips on the motor terminals.



Try out the vehicle

- Disconnect the micro-USB lead.
- Place the vehicle on a smooth floor.
- Switch the battery off, then on again.
- The vehicle should go forwards for 5 seconds, then stop.
- Program the vehicle to go backwards, forwards and spin on its axis – here is an example.
- Always start the motors on 50% power or less.
- Try programming the vehicle to follow the course laid out.
- Always switch off the battery when not in use.

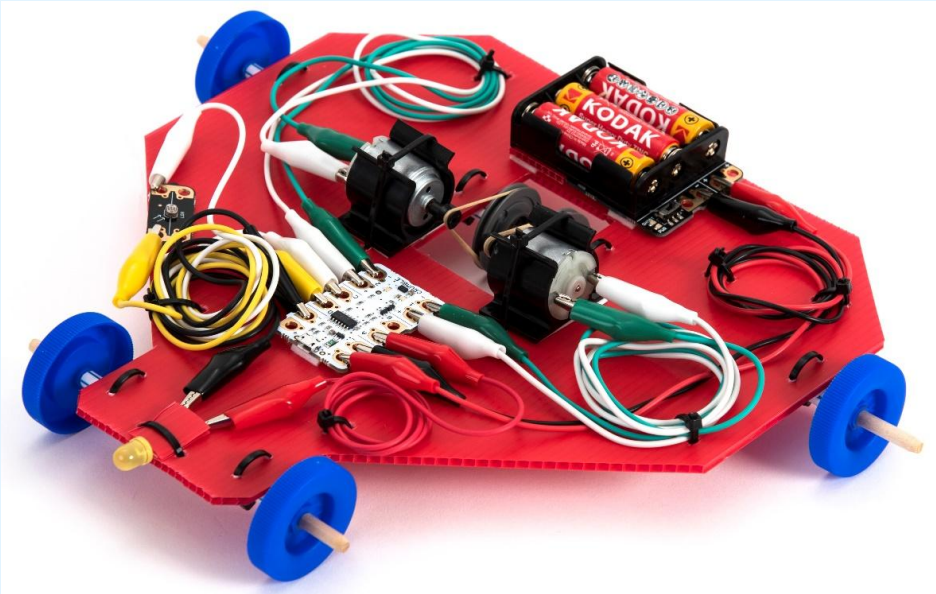


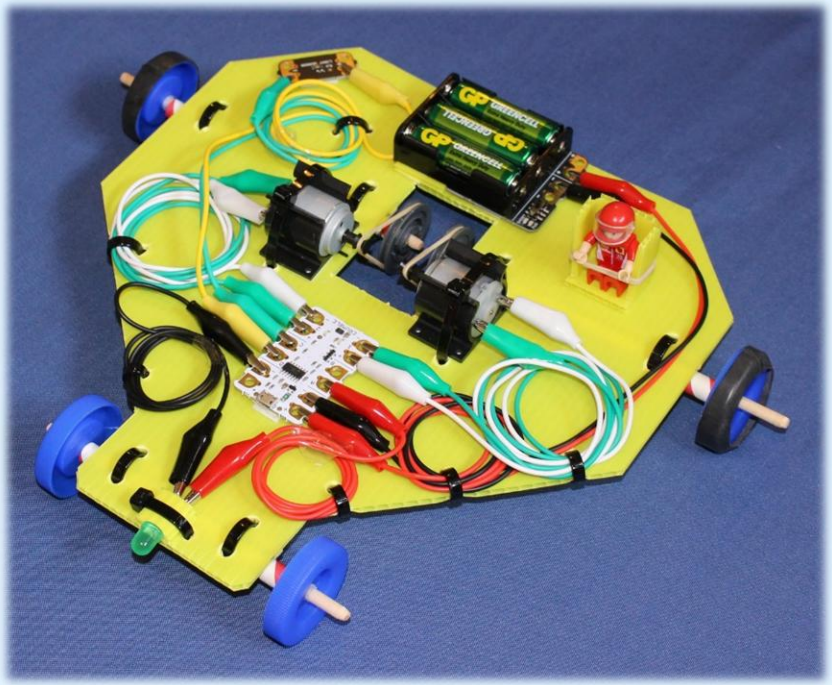
Technology for Fun

Plenary

- Discuss what you have learnt and complete your worksheet.
- How did you get the motors to go faster and slower?
- Suggest two ways to reverse the direction of the motors.
- Why do you need low friction between the axles and the bearings?
- What precautions did you take to ensure this, and how did you check?
- Why do you need high friction between the rubber band drive belts and the pulleys?
- Why do the wheels and pulleys need to be a tight fit on the axles?
- What problems did you encounter and how did you overcome them?
- What was the most interesting thing you learnt?

Move on to the Extension Activities





Technology for Fun