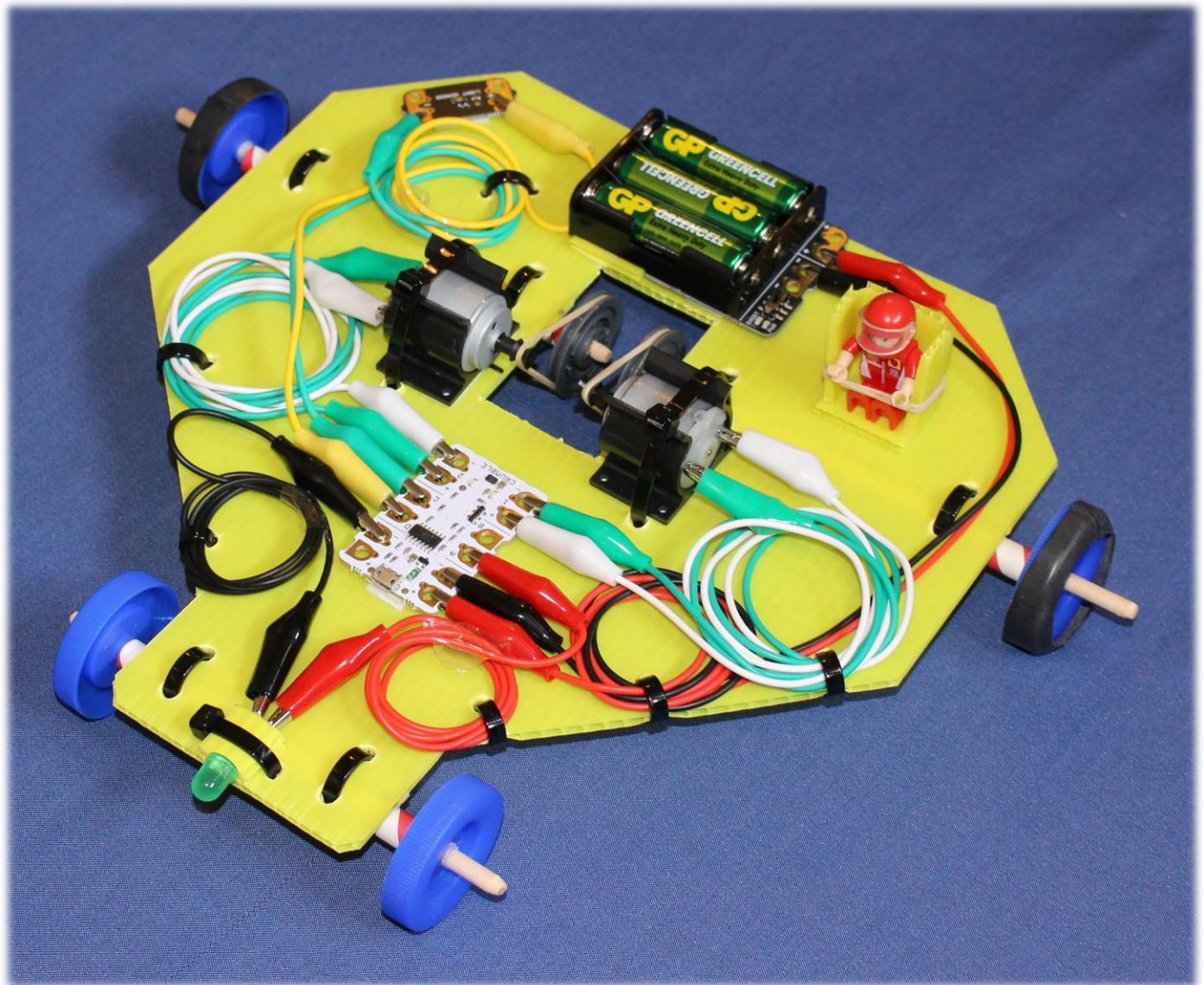


Instructions 2 – Crumble Vehicle Extension Activities



Crumble Vehicle Project

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Follow this step-by-step guide to extension activities for your Crumble robotic vehicle.

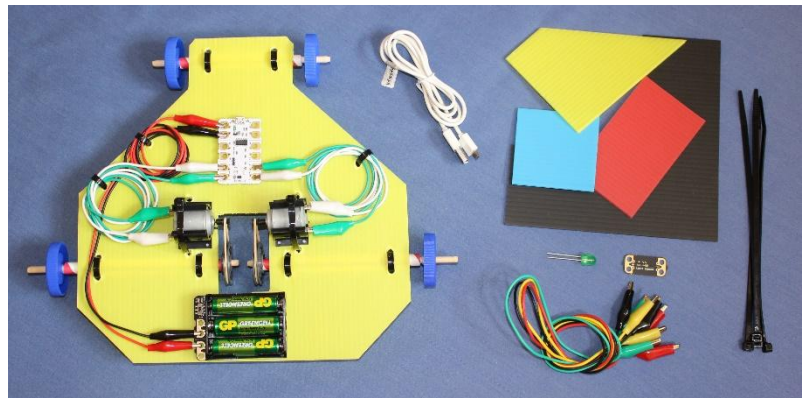
Associated resources:

- Crumble Robotic Vehicle Lesson Plan
- Instructions 1 – Make a Crumble Robotic Vehicle
- Presentation 1 – Create your Crumble Robotic Vehicle
- Worksheet 1 – Crumble Robotic Vehicle
- Presentation 2 – Crumble Vehicle Extension Activities
- Worksheet 2 – Crumble Vehicle Extension Activities

You will need:

Parts from class kit:

- Crumble robotic vehicle
- Micro-USB lead
- Corrugated plastic sheet (you can use offcuts from making vehicle bases)
- 1 LED (light emitting diode)
- 1 Crumble light sensor
- 4 crocodile leads
- 4 cable ties



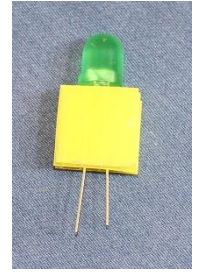
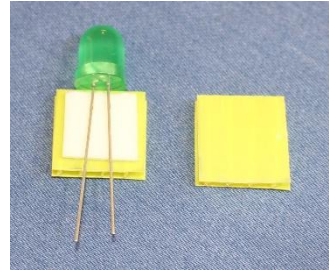
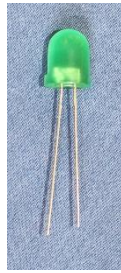
Other parts, tools and consumables

- 1 computer with internet connection
- Blu Tack
- Ruler
- Felt tip pen
- Scissors
- Sharp pencil
- Double sided foam sticky tape, 12mm wide x 1mm thick, heavy duty
- Masking tape
- Old mountain bike inner tube, long balloon or small round balloon
- Wooden ramp or length of plywood and protractor
- Measuring tape
- Low melt glue gun
- Stopwatch
- Lightweight passenger e.g. plastic mini-figure (optional)
- Decorations e.g. self-adhesive gems (optional)

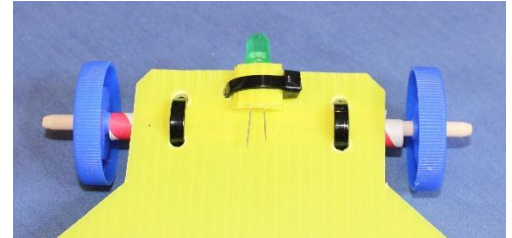


Activity 1 – Fit an LED headlight

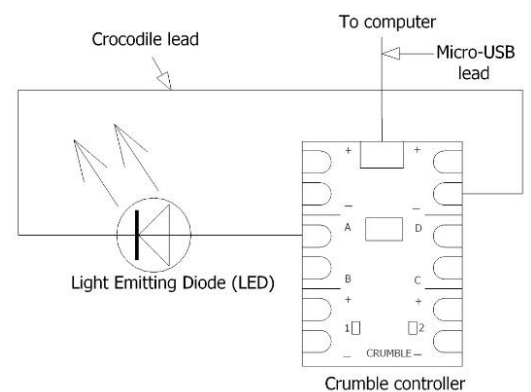
- Carefully separate the LED legs a little so you can clip onto them more easily. Cut two 1.5cm squares of corrugated plastic. Use double-sided foam tape to sandwich them either side of the LED legs.



- Foam tape the LED sandwich to the front of the vehicle with the long leg on the left as shown. Make a hole either side and hold in place with a cable tie.

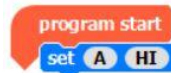


- Wire the LED up as shown on this wiring diagram. Use one crocodile lead to connect the long leg of the LED to output A on the Crumble. Use a second crocodile lead to connect the short leg to the negative (-) terminal. You may need to move the Crumble further back on your vehicle to give you space to plug the micro-USB lead into the front of the Crumble.

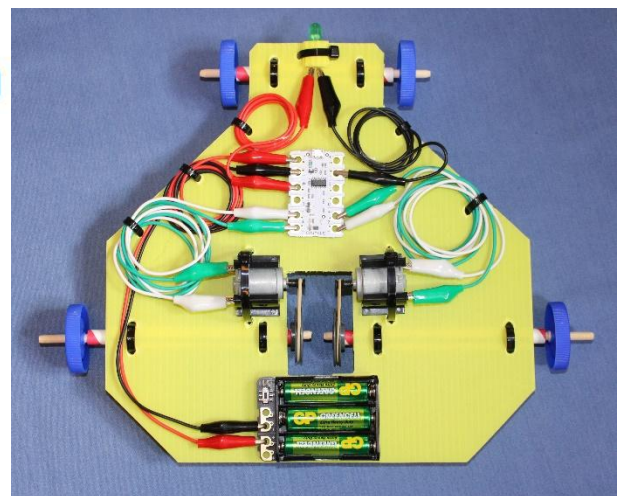
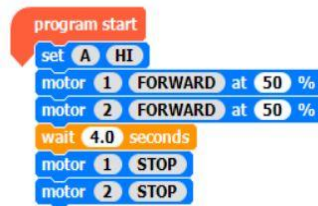


- Connect the Crumble to the computer and program the LED to light up – an example is shown here.

If it doesn't light up you may have connected the LED back to front – you can try swapping over the crocodile clips.

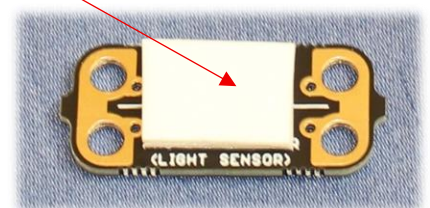
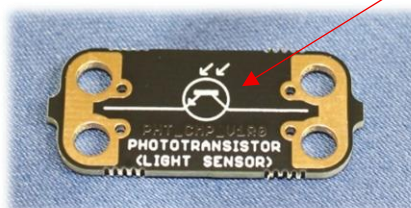
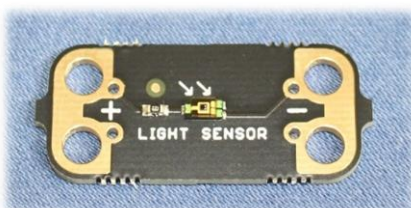


- Write a program to run the Crumble vehicle with the headlight on – an example is shown here. Run the motors at 50% power or less or they may draw too much current for the Crumble. Remember to download the program using the green arrow, unplug the micro-USB lead and switch on the battery box to run the vehicle.

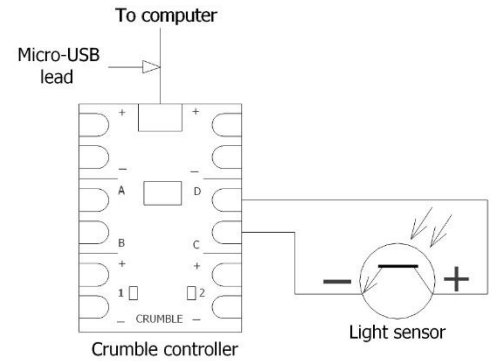
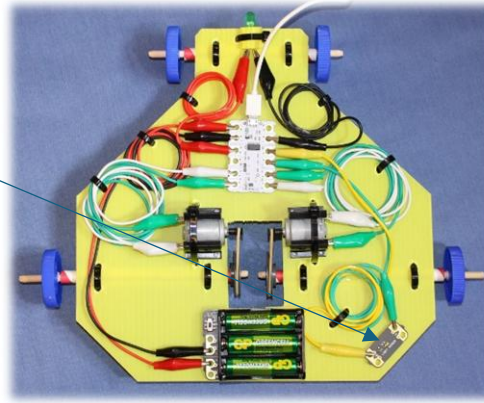


Activity 2 – Make the headlight come on in the dark

- Stick a double layer of double-sided foam sticky tape in the middle of the underside of the light sensor.



- Attach the light sensor to the vehicle. Make sure it is somewhere accessible where you can clip the crocodile leads on.



- Connect up the light sensor as shown on the wiring diagram. Connect the positive terminal on the light sensor to terminal D on the Crumble, and the negative terminal to terminal C. Coil the wires up neatly and cable-tie them to the base.

- Program the LED to come on in the dark – an example is shown here. This sets the output voltage to terminal D high and then monitors the voltage coming back from the light sensor at terminal C. When light falls on the light sensor, the voltage at C will be high, similar to terminal D. When it is dark the voltage at D will be low and the LED should light up.

```

program start
do forever
  set D HI
  let u = analogue C
  if u < 70 then
    set A HI
  else
    set A LO
  end if
end if
loop
  
```

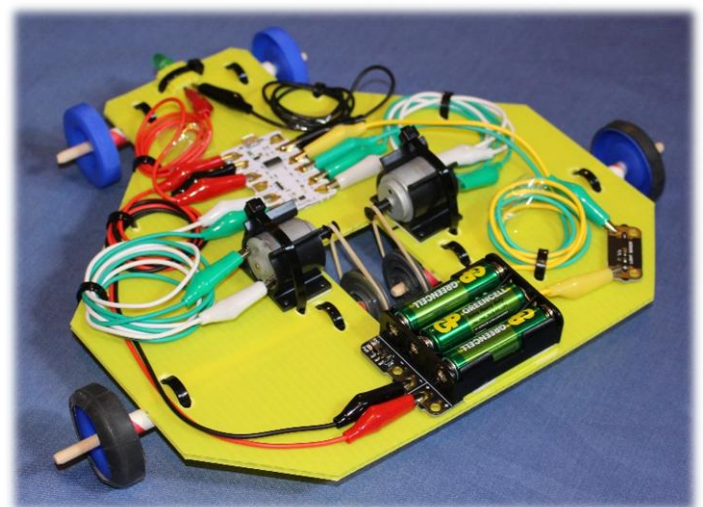
```

program start
  set D HI
  wait 1.0 seconds
  let u = analogue C
  if u < 70 then
    set A HI
  else
    set A LO
  end if
  motor 1 FORWARD at 50 %
  motor 2 FORWARD at 50 %
  wait 3.0 seconds
  motor 1 STOP
  motor 2 STOP
  wait 2.0 seconds
  motor 1 FORWARD at 50 %
  motor 2 REVERSE at 50 %
  wait 2.0 seconds
  motor 1 STOP
  motor 2 STOP
  set A LO
  
```

- Cover the light sensor with your hand and run the program to check the LED lights up. You can adjust the value of 70 up or down (e.g. between 10 and 100) so that the light comes on at different levels of darkness.
- Incorporate the automatic headlight into your Crumble vehicle program by including your code just after 'program start' – an example is shown here. Remember to download the program to the Crumble using the green arrow, unplug the micro-USB lead, then switch on the battery box to start the program. In order to get the LED to come on, cover the light sensor with your hand when switching on.

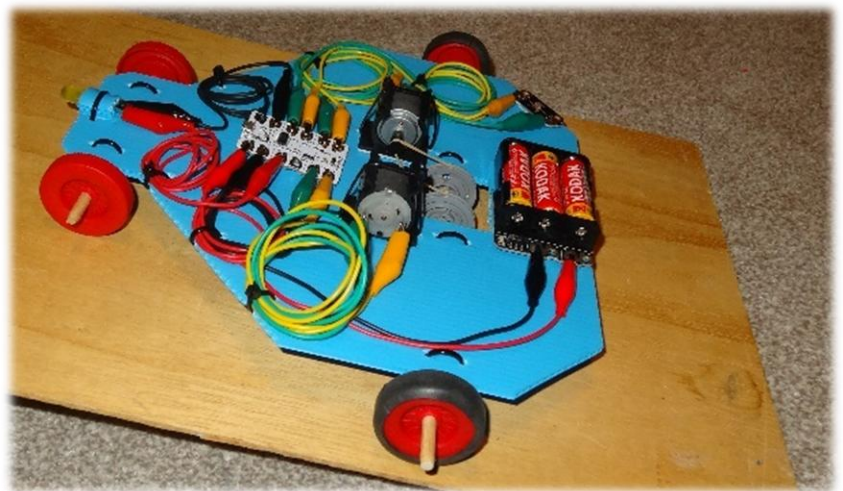
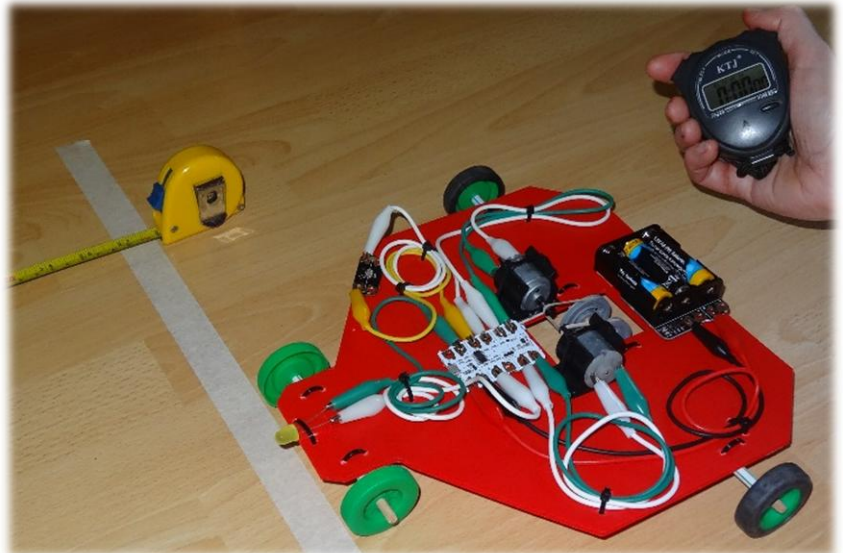
Activity 3 – Improve traction on the driving wheels

- The vehicle steers by driving the two rear wheels independently at different speeds and/or directions. The front wheels are not steerable, so they have to skid across the floor to allow the vehicle to turn.
- In order to keep plenty of traction on the rear (driving) wheels whilst allowing the front wheels to skid, you need to keep the centre of gravity just in front of the rear axles. You can do this adjusting the position of the crocodile leads backwards or forwards.
- In order to further improve traction, you can add 'tyres' to the driving wheels. Cut 1.5cm wide slices of bicycle inner tube or balloon and stretch them over the rear wheels.



Activity 4 – Find out more about how your vehicle moves

- Set up a start and finish line a fixed distance apart (e.g. 2m) on a smooth floor. Set your motors to 50%, time your vehicle over the distance and calculate the speed (e.g. 0.6m/s).
- You can try and obtain higher speeds, for example by starting the motors on 50% to give the Crumble time to boot up, then go up to 100%. Place the vehicle some distance before the start line to allow it to get up to speed, then time the travel between the start and finish lines.
- Try the vehicle on different surfaces such as a smooth floor, carpet and outside on the playground or the field. Find out whether this affects the speed and the vehicle's ability to turn. You may be able to get the vehicle to turn on a rougher surface by moving the centre of gravity nearer the rear axles.
- Try running the vehicle up the ramp. Adjust the ramp angle and record the maximum angle at which the buggy can travel up the ramp (roughly 10°).



Activity 5 – Carry a passenger

- If you have a lightweight plastic figure or small soft toy you can design a seat for it using offcuts of corrugated plastic. Make sure you fit a restraint to stop it falling out of its seat!
- You can also decorate the vehicle with gems or other lightweight decorations.

