Have you been to a fairground?

Which rides did you go on?

Did you enjoy it?

Fairground Rides

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Can you name these rides?

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What makes them exciting?

Not knowing what happens next?

The illusion of danger?

A feeling like flying?

A sense of exhilaration?

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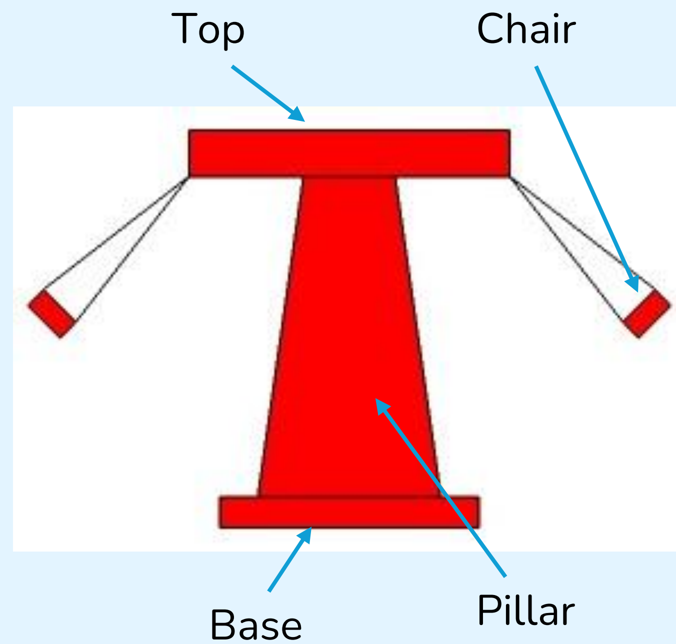
How does a chair-o-plane work?

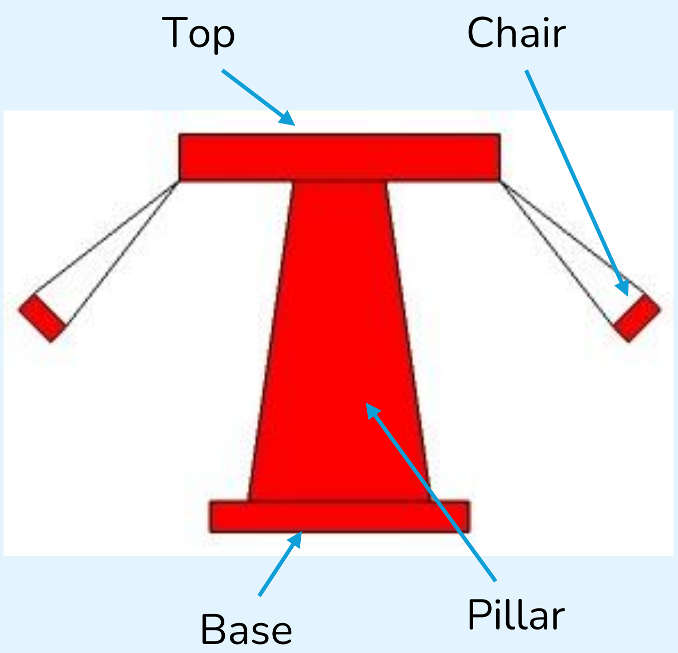


Which parts move?

Which parts stay still?

What do the parts do?

- The base provides a stable foundation for the ride.
- The pillar supports the rotating top high in the air.
- The riders sit in the chairs. These are fastened securely to the top with chains, allowing the chairs to swing out as the top rotates.



Context

Your local theme park wants to attract more visitors by including some rotating fairground rides. They have asked you to design and build some working examples to help select the new rides.

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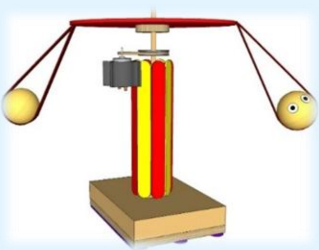
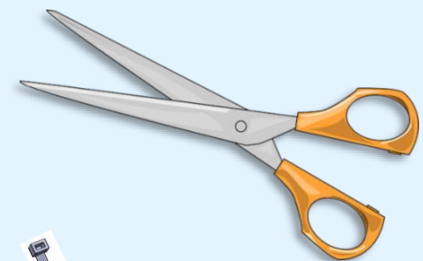
Learning Objectives

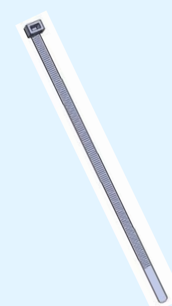
- Make and use simple series circuits.
- Understand and use mechanical systems, e.g. pulleys, shafts and bearings.
- Design and build purposeful, functional appealing products.
- Measure length and time, calculate distance travelled and speed.

Work Safely

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







Can you think of ways to reduce the risks?

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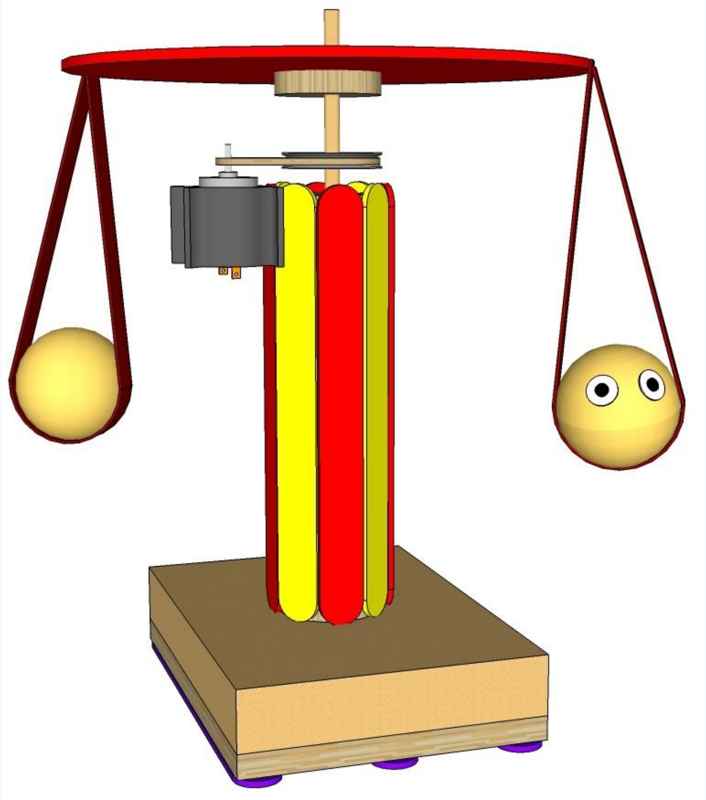
Identify the parts of a model chair-o-plane

Try out the sample chair-o-plane and discuss how it works.

Identify the following:

- Motor
- Drive belt (rubber band)
- Pulley
- Shaft (wooden rod)
- Rotating top



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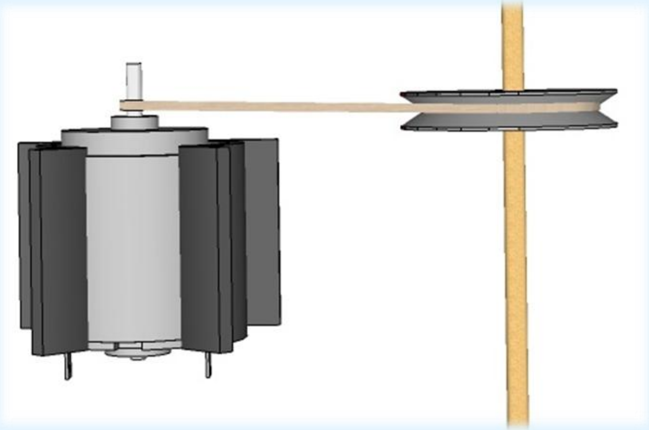
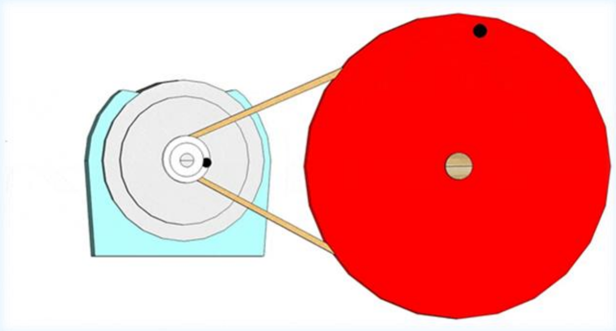
What does the pulley system do?

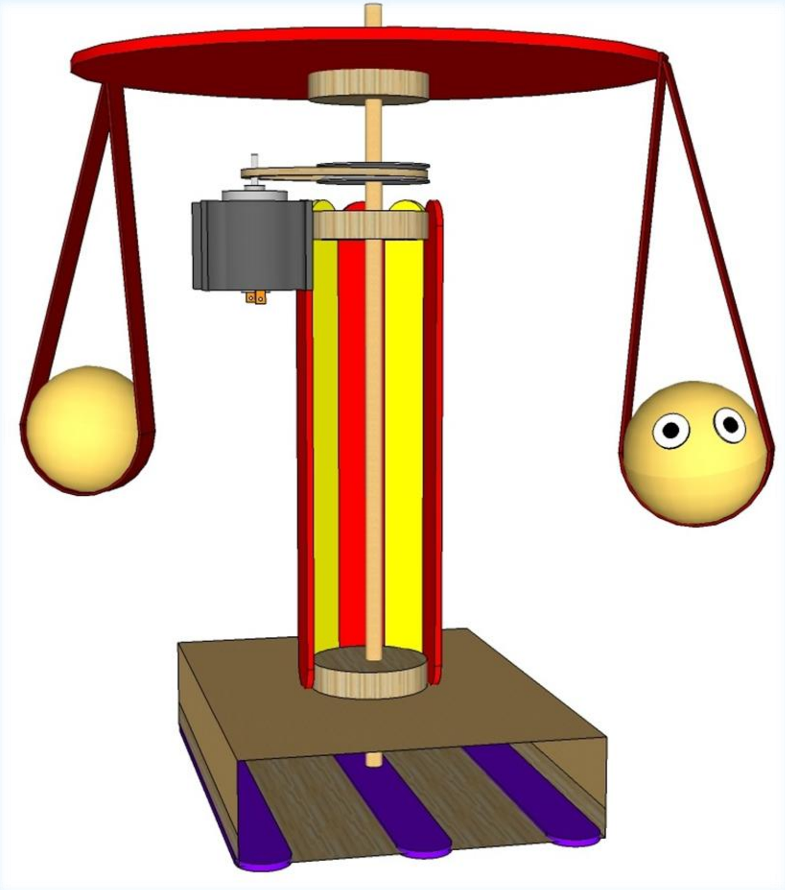
- The motor is not used to spin the chair-o-plane ride directly. This is because the motor shaft rotates too fast and does not produce enough ‘turning force’ (torque).
- Instead, a pulley system is used. The motor shaft drives a rubber band which is used as a drive belt.
- The drive belt turns a larger pulley which is mounted on a shaft connected to the rotating top.
- This system reduces the speed of rotation and increases the torque enough to turn the rotating top.





How is the shaft supported?

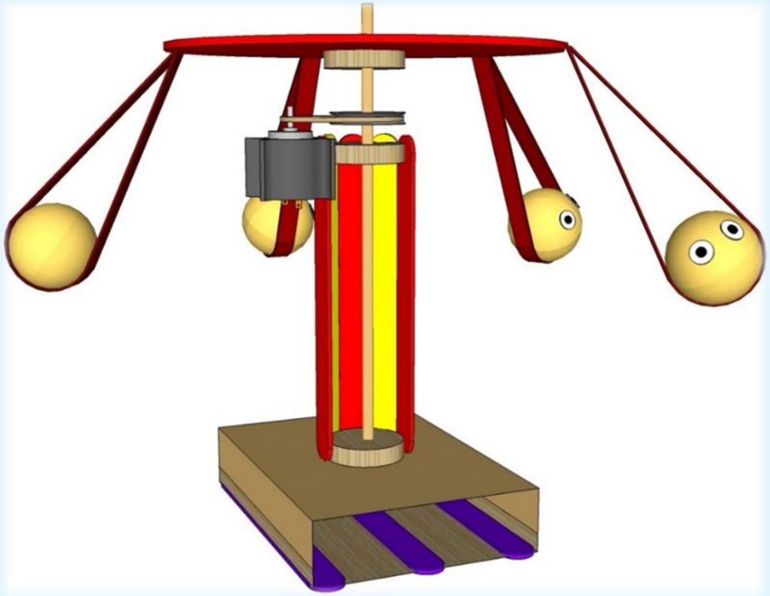
- The shaft is supported by two bearings in the central pillar.
- These bearings each have a hole in the centre which is slightly larger than the diameter of the shaft.
- The two bearings retain the shaft in position, while allowing it to rotate easily.
- At the bottom, the shaft rests on a jumbo lolly stick.



Forces acting on the chair-o-plane

The motor produces a rotational force (torque) which is used to spin the ride via the pulley system.

Friction forces act to slow the ride down. These include:



- Air resistance, as the chairs and their passengers whizz though the air.
- Friction acting between the rotating and stationary parts, for example between the shaft and the bearings.

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What a hammer thrower does

Have you seen a hammer thrower competing, for example in the Olympics? They have to throw a heavy metal ball attached to a wire and handle as far as possible.

In order to do this, they spin rapidly round in a circle to build up as much speed as possible, pulling the hammer inwards to keep it travelling in a circle.

Then they let go of the hammer, which flies off in a straight line, before coming to rest on the ground up to eighty metres away!

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Forces acting on the chair-o-plane passengers - 1

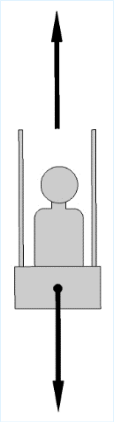
Gravity acts to pull the passengers and chairs downwards.

This is opposed by the tension in the chains which stops the chairs from falling down.

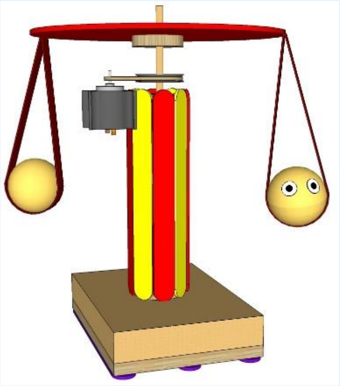
As the ride speeds up, centripetal force acts to pull the chairs round in a circle.

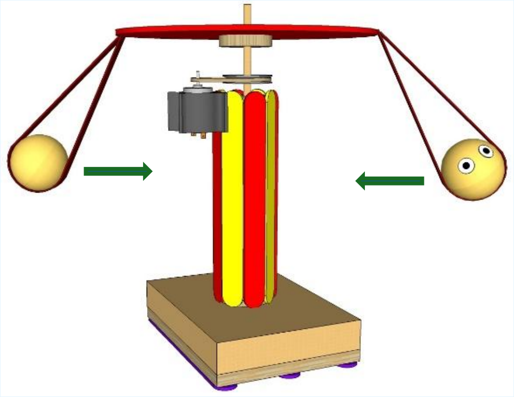
If the chairs were not pulled round in a circle, they would continue in a straight line in the same way as the hammer does, when released by the hammer thrower.

Tension



Gravity





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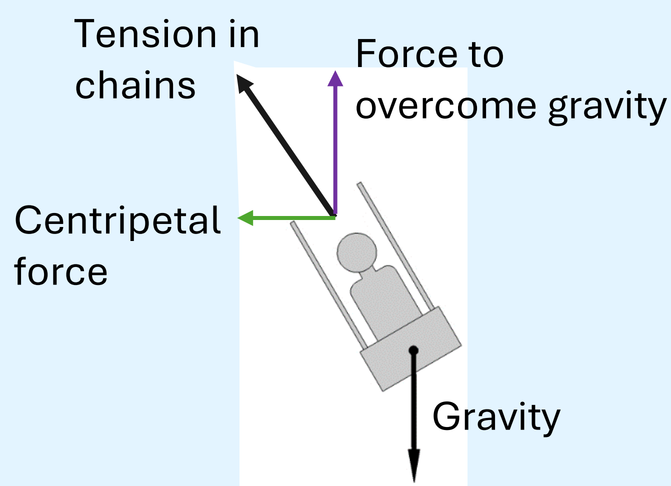
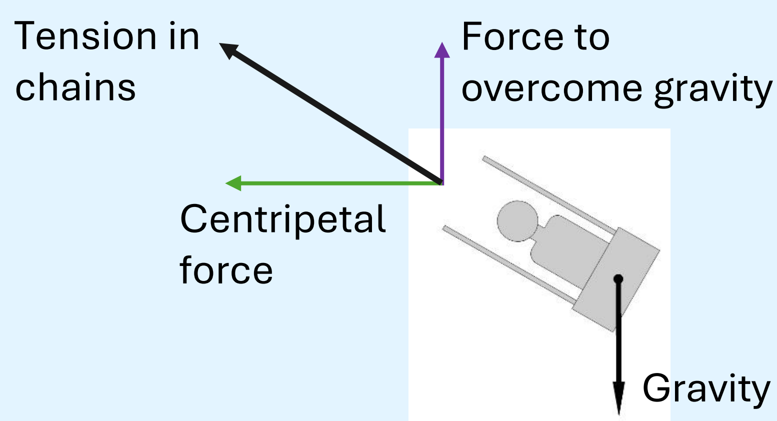
Forces acting on the chair-o-plane passengers - 2

When the ride spins, the chairs swing outwards.

The tension in the chains provides both the force to overcome gravity, and the centripetal force to keep the chairs moving round in a circle.



As the ride speeds up, more centripetal force is needed to keep the chairs travelling in a circle, while the gravity force stays the same. The chairs swing outwards further, making the ride even more exciting!



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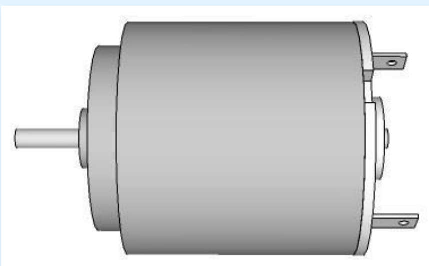
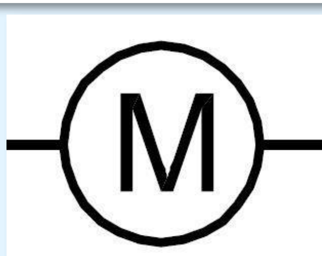
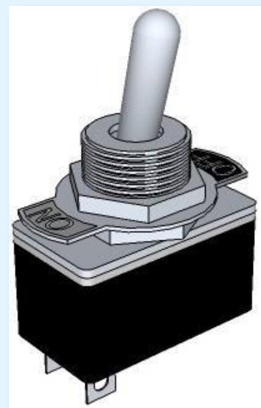
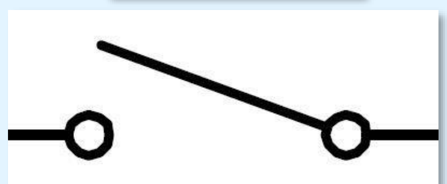
Identify the electrical parts

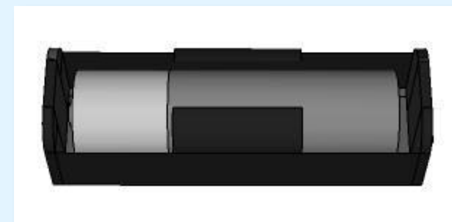
Name these electrical components:

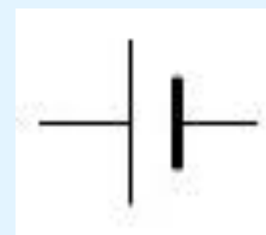


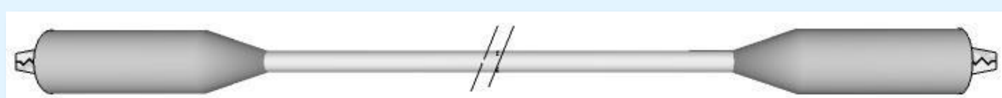












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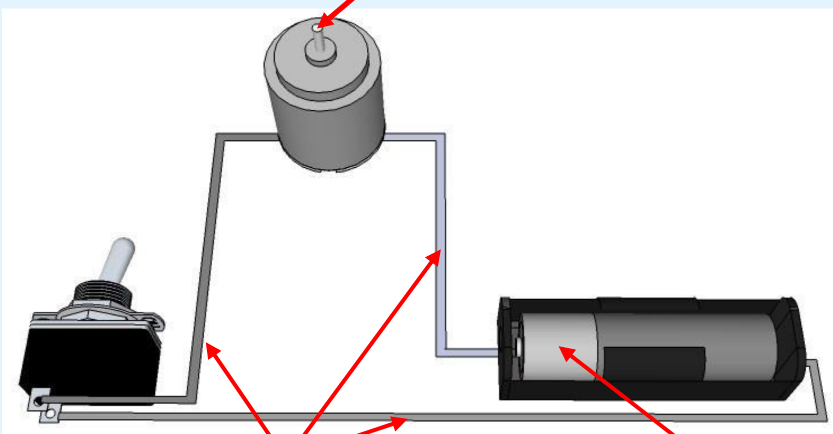
How the electric circuit works

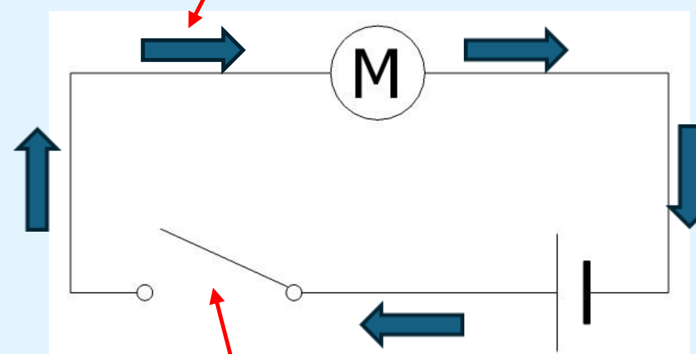
When the motor is powered, the motor shaft rotates.



Crocodile leads are used to connect the different electrical components together.

The battery ‘pushes’ electricity around the circuit.

Electricity flowing round the circuit.

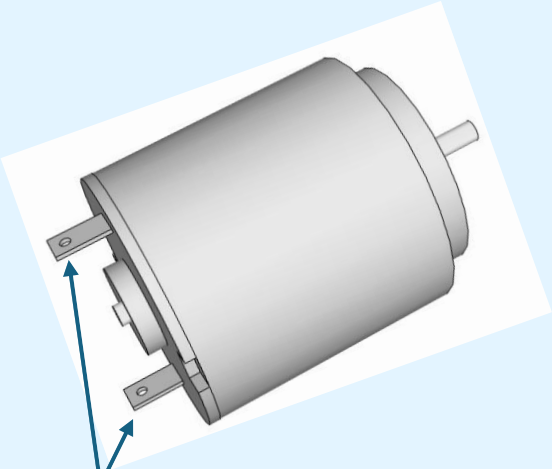


The switch is used to control the flow of electricity. When it is on, the electricity can flow. When it is off, there is a gap in the circuit and the electricity cannot flow round.

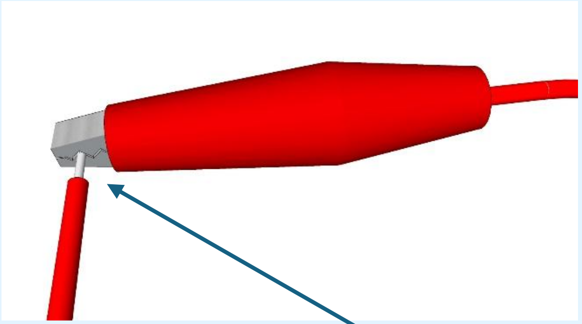
Connecting the crocodile clips

Where to connect the crocodile clips:

Connect to these two contacts on the switch.



Connect to these two contacts on the motor.

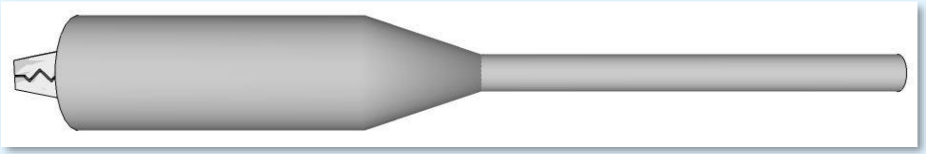


Connect to the metal ends of the wires from the battery box (not onto the plastic insulation).

Avoid short circuits

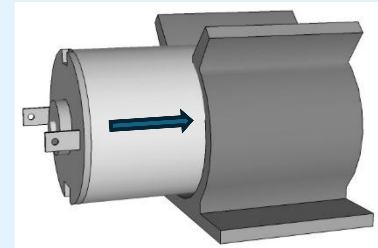
If batteries are 'short-circuited' they can get hot. So:

- Do not use alkaline or rechargeable batteries.
- Do not connect the bare ends of the wires from the battery directly together; they must be connected across the motor.
- Make sure the plastic sleeves cover the crocodile clips as shown here, to help prevent short-circuits if the clips touch.

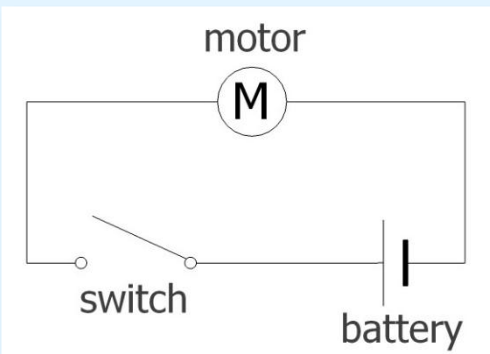


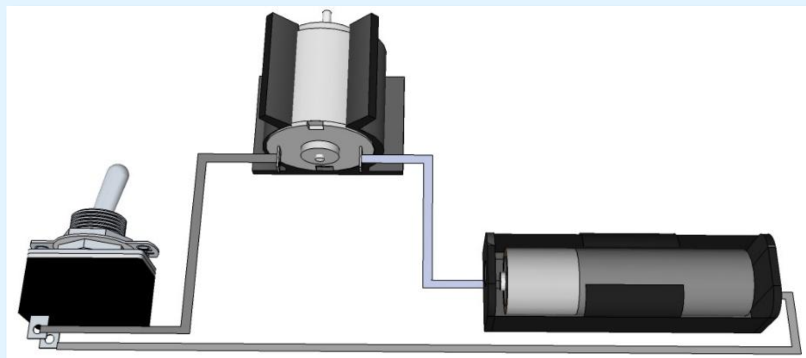
Make your circuit

- Fit the cell into the battery holder (the right way round).
- Push the motor into the motor mount (from the end, not from above).



- Lay out your components in a triangle, connect up the following circuit and check that it works.





- Remember that the crocodile leads must be clipped onto bare metal, not onto plastic insulation!

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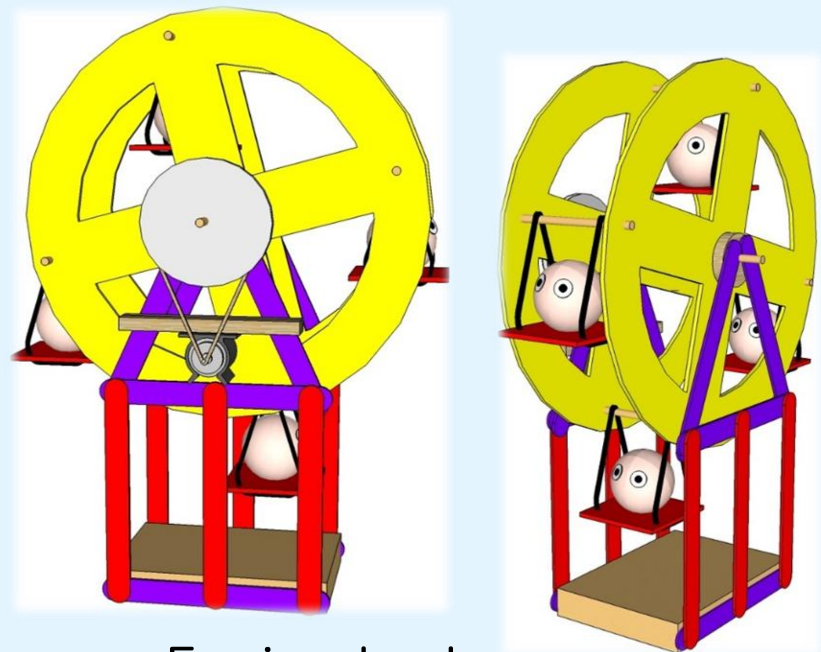
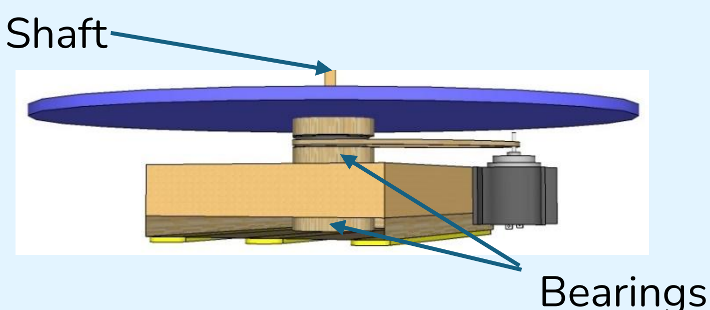
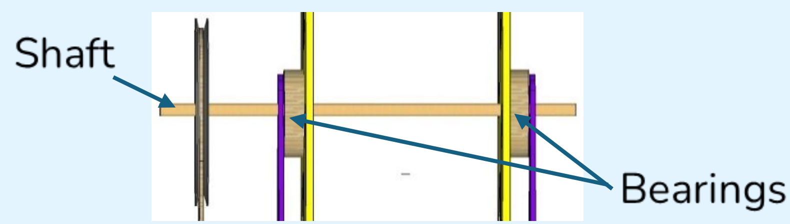
Some other examples of rotating fairground rides

Merry-go-round



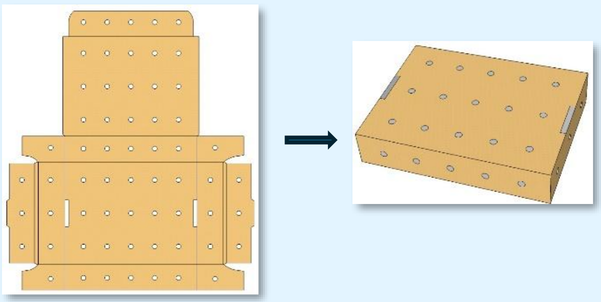
Ferris wheel





Materials available to make your fairground ride

Apart from the electric circuit, you have the following materials to make your fairground ride:



Cardboard task box

Various sizes of rubber band

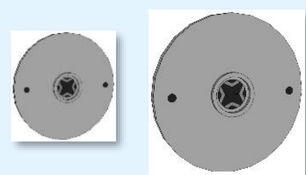
Corrugated plastic sheet

Square section wood

Wooden wheels with 6mm hole

Cotton reels

Motor pulley



Various sizes of pulley

Wooden wheels with 5mm hole

Wooden dowel

Jumbo lolly sticks

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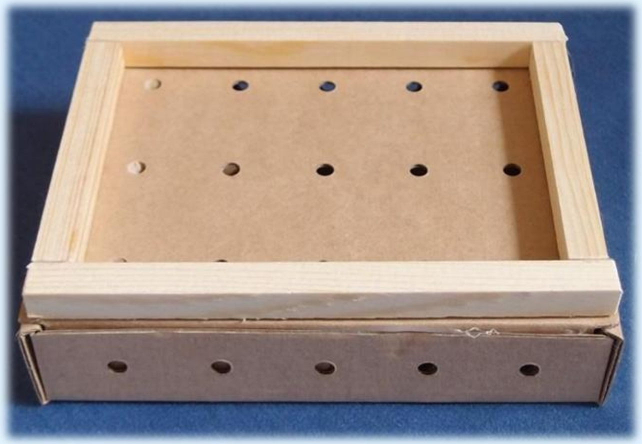
Plan your fairground ride

- This presentation gives step-by-step instructions on making a chair-o-plane.
- Instruction sheets are also available for the merry-go-round and Ferris wheel, which are slightly harder.
- If you prefer, you can design your own rotating fairground ride.

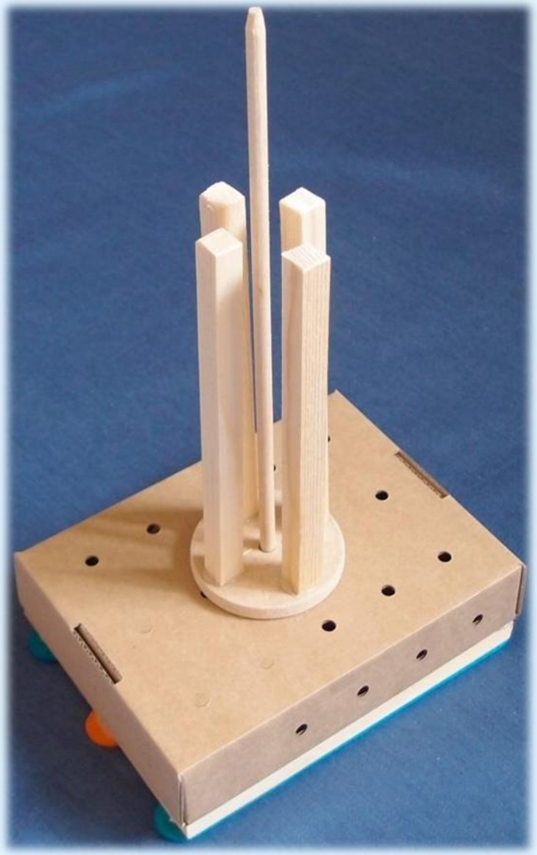
Make the chair-o-plane base

- Fold up the cardboard task box and glue the final seam.
- Cut two 14cm lengths of square section wood and two 8.5cm lengths.
- Make a frame and glue it to the base as shown.
- Glue 3 giant lolly sticks to the frame, one each side and one in the middle.



Make the chair-o-plane column - 1

- Cut 25cm of wooden rod and sharpen both ends slightly.
- Turn the base over. Slide the rod down through the two central holes so that it rests on the lolly stick.
- Use the rod as a guide to glue on a wheel with a 6mm hole.
- Cut four 14cm lengths of square wood. Make sure the ends are square and glue them onto the wheel.



Make the chair-o-plane column - 2

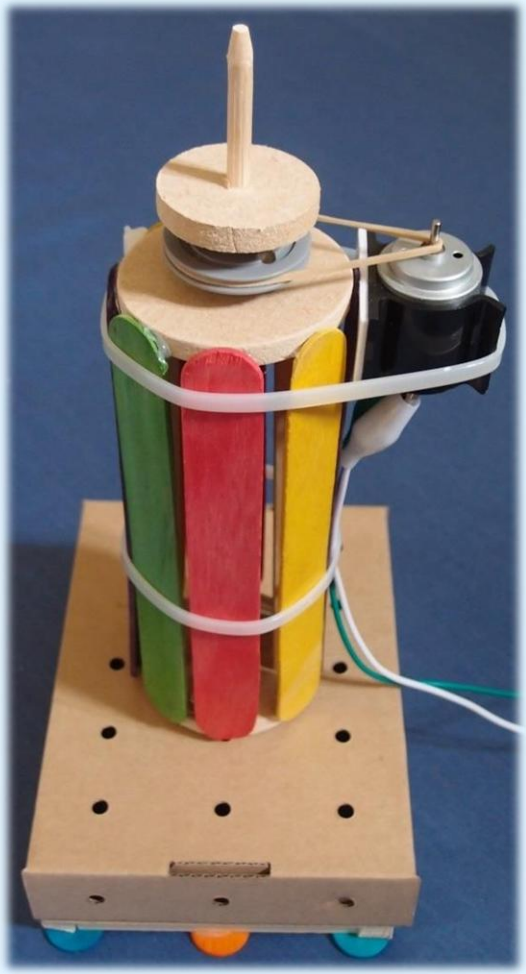
- Glue the second wheel with the 6mm hole onto the top of the square wood, again using the rod as a guide.
- Don't get glue on the rod or in the hole.
- Remove the rod so that you don't get glue on it.
- Glue the ends of the eight remaining giant lolly sticks onto the two wheels as shown.

Prepare the shaft

- Mark the rod 5cm from the end.
- Push on the pulley so that it covers the mark. If it is very tight, you could clamp the rod in a vice so that the mark is just showing then push the pulley on.
- Push the 35mm diameter wheel onto the short end of the rod until it is about 1cm from the pulley.
- Sharpen the rod end furthest from the wheel to a conical shape (not spikey) to reduce friction.

Fit the motor

- Clip the motor into the motor mount.
- Stick it to the top of a lolly stick.
- Attach firmly with a cable tie.
- Cable tie the crocodile leads to the column.
- Slide the rod down the column.
- Stretch the rubber band over the pulley and motor shaft.
- Turn on and check the rod rotates.



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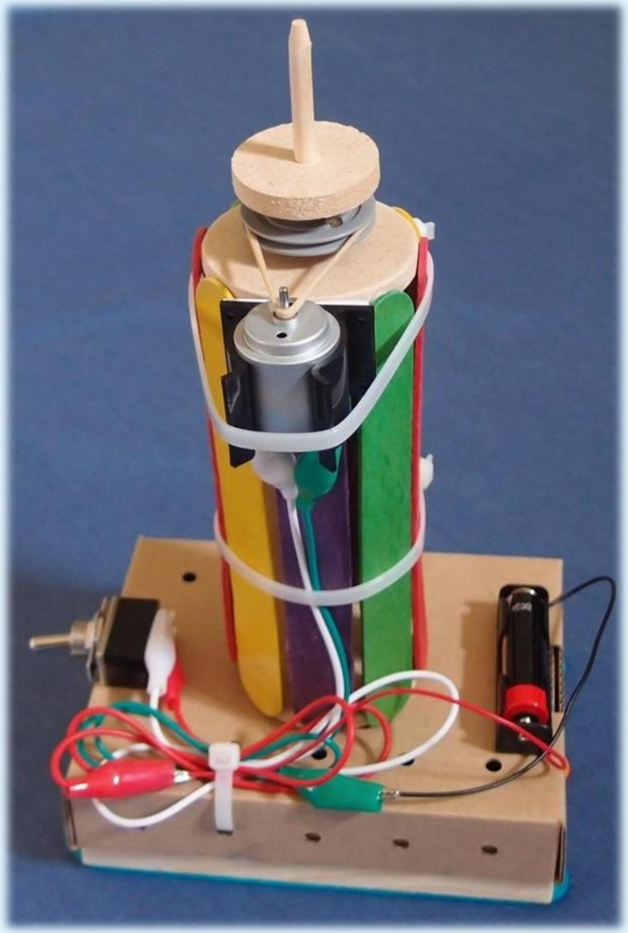
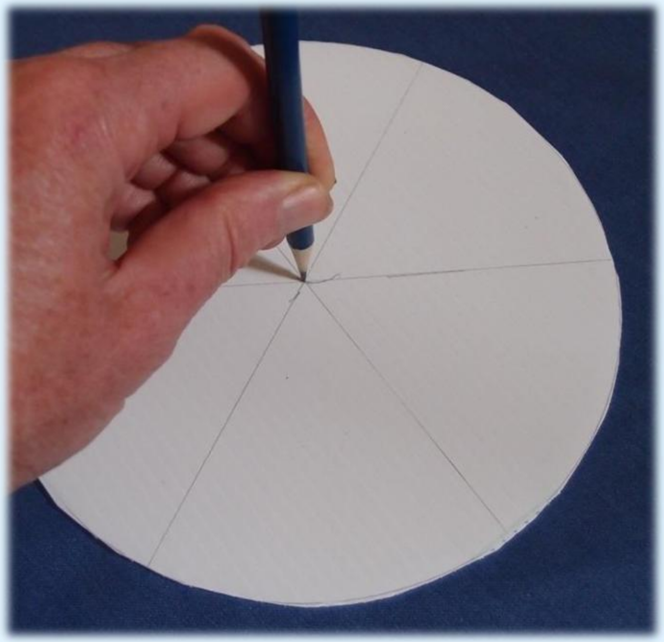
Attach the electrical parts

- Glue the switch and battery holder to the base.
- Tidy up the crocodile leads and cable tie them to the base.



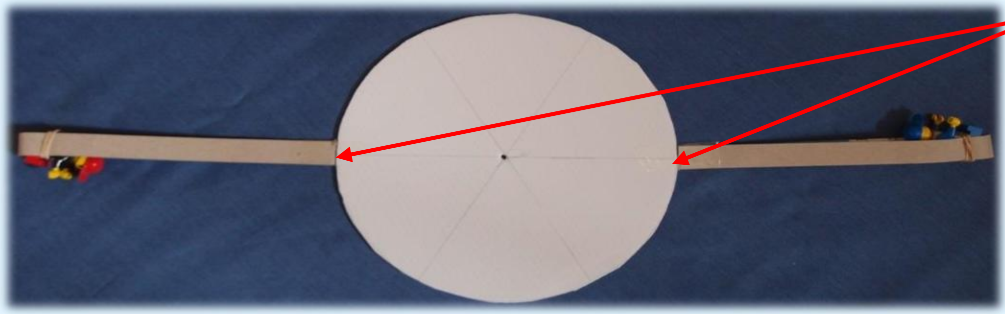
Make the rotating disc

- Mark out a circle on the corrugated plastic sheet about 17cm diameter.
- Cut it out with large scissors.
- Draw a line though the centre.
- Mark out lines at 60° to this.
- Use a sharp pencil to make a hole in the centre, just big enough to fit onto the shaft.
- Glue the disc onto the top of the 35mm wheel.



Make the chairs

- Design chairs for your passengers.
- Sellotape them firmly to the disc at the positions marked. The Sellotape should act as a hinge so that the chairs can fly out as the disc rotates.
- Passengers with equal weight and chairs of equal length should be opposite one another so that the forces balance.



Leave a small gap between the chair and disc to act as a hinge

Complete the chair-o-plane

- Try out your chair-o-plane to make sure it works.
- Decorate it and make any adjustments.
- Tidy up and fill in your worksheet.

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Extension Activity

Find out how fast the passengers are travelling:
Stick a piece of tape onto the disc near the centre, time 10 revolutions (revs) and estimate the diameter of the circle travelled by the passengers.

Here is a worked example:
10 revs in 8 seconds; revs per minute = 8 x 60/10 = 48 rpm
Diameter of circle = 0.38 m; circumference = π x 0.38 = 1.2 m
Distance travelled in one minute = 48 x 1.2 = 58 m
Distance travelled in one hour = 60 x 58 m = 3500 m = 3.5 km
Distance travelled in one hour (miles) = 3.5 x 5/8 = 2.2 miles

So, speed = 3.5 kilometres per hour, or 2.2 miles per hour

Plenary

Discuss how the activity went and what you have learnt.

- What difficulties did you encounter and how did you overcome them?
- What would you do differently if you were starting again?
- Which rides would you choose for the theme park and why?

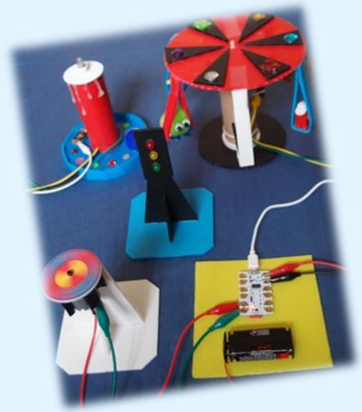
- What have you learnt about:
  - Electric circuits?
  - Pulleys?
  - Shafts and bearings?
  - Calculating speed?

- What did you enjoy most about the activity?

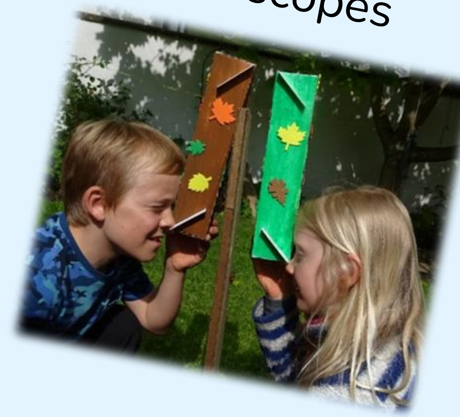
More fun design & make project kits from TTS

Balloon Buggies

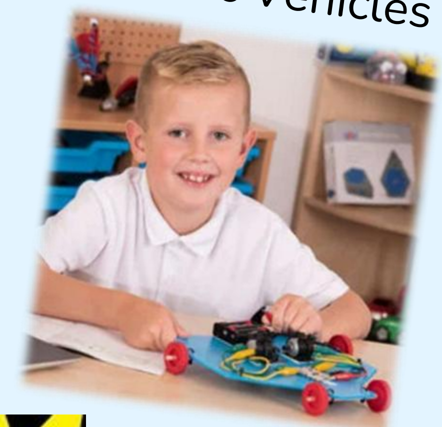
Crumble Kit



Periscopes



Robotic Vehicles



Make your own light

Motorised vehicles

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