# Aviation development teacher notes

Key Stage 2

Science:

- Investigative skills
- Forces and movement

Key Stage 2

Design and Technology:

- Developing ideas
- Evaluating processes and products

## Overview of the activities

There are five activities described here. The activities can be used in sequence or individually.

1. Flying machines development presentation
2. Investigating the lifting properties of helium balloons
3. Investigating flight with paper aeroplanes
4. Jet propulsion using balloon-power
5. Investigating parachutes

NOTE: a suitable risk assessment must be performed before carrying out any practical activity.

## Science background notes for teachers

Early flight used 'lighter than air' balloons. Strictly speaking, it is the density of the gas inside the balloon that matters. Less dense than air and the gas will generate uplift. This can be thought of as similar to objects floating in water. Materials less dense than water will float. Those that are more dense will sink.

Hot air balloons fly (or 'float') because the air inside the balloon is heated by the burner and is less dense than the colder air outside. An airship contains helium gas which is less dense than air and so it rises. Early airships contained hydrogen gas but this is too flammable and no longer used.

When considering balloons, also think about the material the balloon is made of and any structures it carries. This will add weight and so inhibit the balloon from rising. The volume of the balloon needs to be sufficient to generate enough lift to overcome the total weight of the balloon.

Powered or heavier than air flight uses wings that are able to 'push' against the air and generate an upward force (lift). To do this, they must be moving and so aeroplanes have propellers or jet engines to generate the movement. Propellers have angled blades which cut through the air, pushing the air backwards which in turn pushes the aeroplane forwards. Jet engines burn fuel in a combustion chamber. This produces expanding gases which are forced out of the back of the engine. This pushes the aeroplane forward.

A helicopter's rotor blades are effectively moving wings.

Rockets generate upward force from the rocket motor at the base.

Kites and hang gliders effectively 'catch' the force of the wind. In themselves, their 'wings' do not generate lift. They allow the kite or hang glider to ride the air currents and wind that is present.

Gliders need to be towed to altitude to enable them to catch the wind currents and generate lift. Once high enough, their forward motion can be used to generate lift and a skilled pilot can use air currents to fly for great distances. Some birds are able to soar on the wind currents in this way after they have flapped their wings to reach a suitable altitude. For example, a buzzard whilst it is surveying the ground below for food.

## Activity 1 : Flying Machines presentation.

The presentation briefly charts the development of flying machines. It can be used as a short introduction.

### Preparation

- Download the PowerPoint presentation, Flying Machines. Use with an interactive whiteboard.

### Activity Notes

Wan Hu's rocket chair is possibly the earliest attempt at powered flight. Contemporary reports suggest that this exploded, leaving no sign of Wan Hu or his chair. Perhaps he was the first man in orbit!

The Montgolfier brothers used hot air balloons. Modern ones are still seen today. Balloons will float where they are taken by the wind. Large airships, such as the Hindenburg, have engines and propellers to drive them in the desired direction but they are still greatly influenced by the wind direction and speed. Airships are slow. The Hindenburg tragically burst into flames when landing in the USA following a transatlantic flight. It was filled with the highly flammable gas, hydrogen. Modern airships are filled with non-flammable, Helium gas.

Powered flight was first made by the Wright brothers in 1903. Early planes had two (biplane) and sometimes three rows of wings to generate the necessary lift. They were driven by piston engines and propellers. The jet engine was invented by Sir Frank Whittle and first flew from RAF Cranwell, Lincolnshire, UK in 1941. Jet engines are reliable, efficient and now power aircraft of all types.

### Extension

A follow up activity could be for the children to research and produce a timeline of the development of flying machines.

## Activity 2: Helium balloon lift off

In this activity, children investigate the amount of lift that is generated by one or more helium balloon.

### Preparation and Materials

- Helium-filled balloons that float (typically available from card or gift shops). Tie three long cotton threads to each balloon – long enough so that balloons can be retrieved if they float to the ceiling. One per group of children.
  Use fine cotton thread so that the weight of the threads can be ignored.
- Small, lightweight plastic or paper disposable cups.
- Sticky tape and dispenser.
- Sand and plastic spoons (only a small amount will be needed per group).
  Can use any materials that can be added to the plastic cup in small amounts, e.g. sugar or salt if more readily available.
- Digital scales to weigh the sand and cup (electronic kitchen scales weighing in 0.1g intervals would be ideal).
- Activity sheet (attached following the activity notes below).

### Activity Notes

Have the children work in small groups. Each group has one helium balloon, cup and sticky tape.

Children first hold the helium balloon to experience the pull of the balloon's lift.

Children attach the paper cup and add sand so that the balloon just floats level. The combined weight of the sand and the cup equals the amount of lift produced by the balloon. Too little sand and the balloon will rise as the upwards lift is greater than the downward weight. Too much sand and the balloon will sink as the weight exceeds the lift.

### Extension

Have children draw a diagram and indicate the forces acting on the balloon: lift upwards and weight downwards.

Predict and test the lift produced by 2,3 or more balloons.

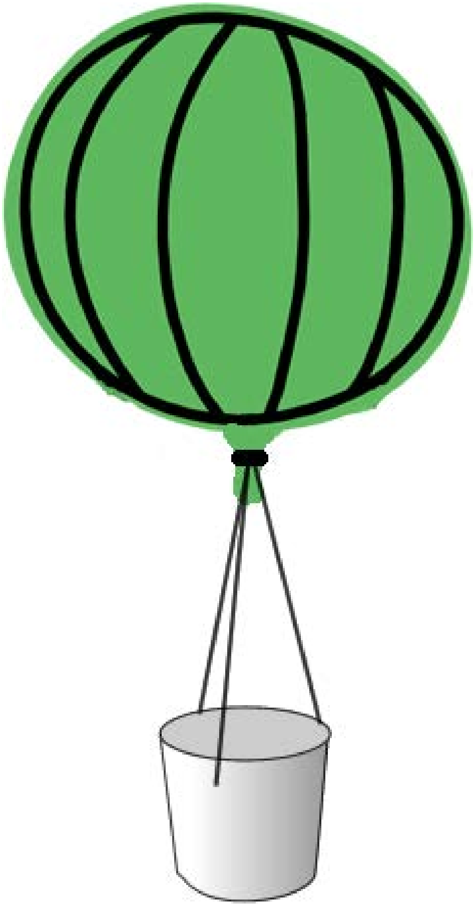
Have children work out how many balloons would be needed to lift them (needs scales to measure their weight).

# How much can a helium balloon lift?

You are going to see how much a helium-filled balloon can lift.

1. Hold onto the strings.
   Feel the balloon pulling up.
2. Get a small cup.
3. Use sticky tape to attach the strings from your balloon to the cup.
   You need to be able to put sand inside the cup.
4. Check to see that it still floats upwards.
5. Use a spoon to put a small amount of sand inside the cup.
   Check to see if the balloon still floats.
6. Put just enough sand into the cup so that the balloon just floats level.
7. Use the scales to find the weight of the cup and sand.

   This is the amount that the balloon can lift.



Predict how much two, three or even four balloons tied together could lift.

Try an investigation to test if your predictions are right.

How many balloons would it take to lift you?

# Activity 3: Investigating flight with paper aeroplanes

Children make paper aeroplanes to investigate flight.

## Preparation and Materials

- Download video instructions for making a simple paper aeroplane
- Sample paper aeroplane instructions sheet (attached below)
- Paper (can use different types of paper if a range of materials are to be tested)
- Paperclips to allow children to attach to their aeroplane to alter its balance
- Video camera to record the tests (optional)
- Complete a suitable risk assessment

## Activity Notes

Children need a large space to be able to test their design without aeroplanes hitting each other or the children. The school hall is ideal as it is not influenced by external winds. Designate a 'launch area' and a 'flight zone' into which the children throw their aeroplanes.

This activity can be set up in a range of ways. Working in groups of two or three will allow discussion and development of ideas.

Competition to get children to make a paper aeroplane with a particular property. For example:

- fly as far as possible in a straight line
- stays in the air the longest
- fly accurately to a target
- fly as level as possible
- fly in a circle back to the launch point
- fly as high as possible

As an investigation, children plan and test factors such as:

- launch speed and distance travelled
- how the use of different materials influences performance
- wing area and speed or distance of flight
- folding flaps into the wing, or using paper clips to adjust the balance of the aeroplane

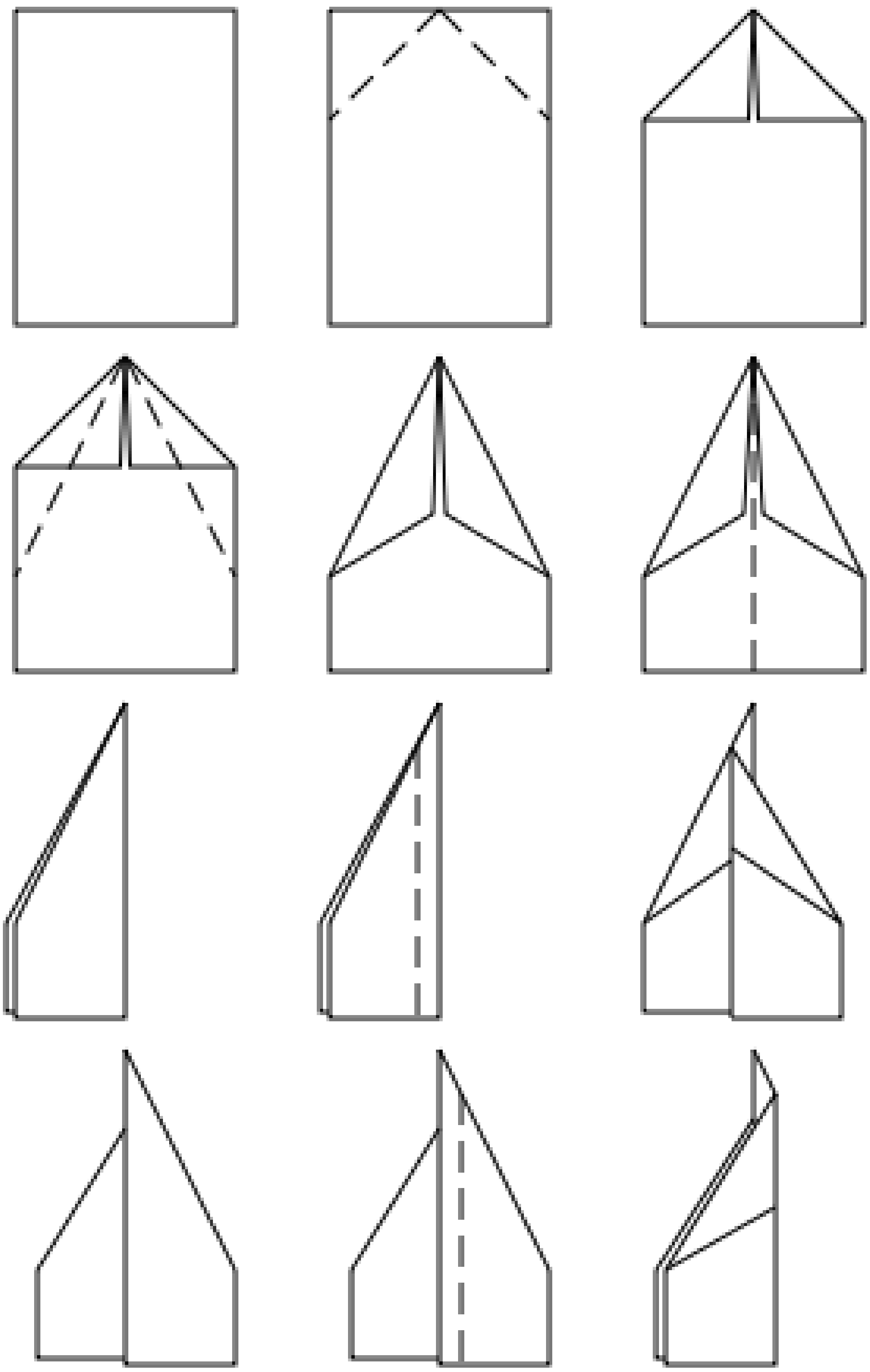
Use this as an opportunity to discuss the possible variable that could be tested and to design a set of controlled and reliable tests.

<u>Extension</u>

Use video or digital cameras to record how the designs developed and the various tests that the children performed. Children can add commentary or make a presentation to show their design and test process.

**Paper Aeroplane**

Make the folds shown by the dotted lines.
Go from left to right.



Source: Wikipedia

## Activity 4: Jet propulsion using balloon-power

Children make a simple balloon-powered jet.

As air forces out of the back of the balloon, this generates a forward thrust that pushes the balloon forward. This principle is the same as a jet engine, which burns fuel to produce gases which forces out of the back of the jet engine.

Good balloon-jets will travel over 10m and so the school hall makes an ideal place to test them.

### Preparation and Materials

Each group will need:

- Balloon-jet activity sheet (follows these activity notes)
- balloon
- sticky tape
- drinking straw
- scissors
- string (parcel string works well and can be seen easily when stretched out)
- Complete a suitable risk assessment

### Activity Notes

Children set up and fly their balloon-jets along guide strings as shown in the activity sheet.

Use normal parcel string as this is easy to see when stretched out across the classroom or hall. It is useful to specify a 'test area' within the classroom or hall.

Run a competition to see which group can make the fastest balloon-jet.

Discuss the forces acting on the balloon-jet. Forward 'push' from the air escaping from the balloon, air resistance as the jet flies forward and friction between the drinking straw and the string.

### Extension

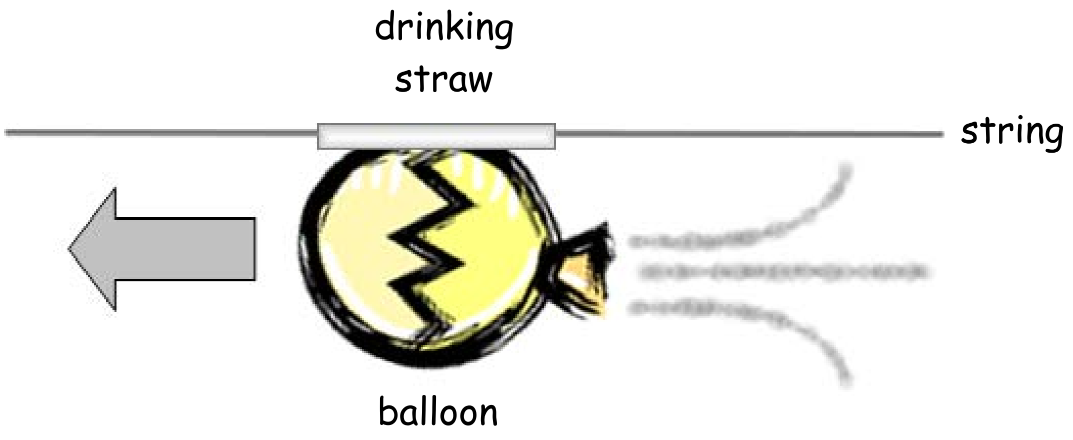
Have children draw a diagram and indicate the forces acting on the jet-balloon: guide string holding balloon up, weight pulling down, thrust pushing balloon forward, drag from air resistance, friction from resistance of straw on string.

Children develop the design of their balloon-jet. Factors for the children to vary could include:

- different types of balloon
- how much the balloon is inflated

- effects of fins or a nose cone added to the jet
- length of drinking straw
- different types of string

# Balloon-jet




Use some sticky tape to attach a drinking straw to your balloon.
Thread the string through the straw.
See how your jet-powered balloon flies along the string.

How can you make your balloon go faster or further?

What could you change?

What could you add to your balloon-jet?

# Activity 5: Investigating Parachutes

This activity will require children to test their parachutes by dropping them from a height. Suitable risk assessment and precautions should be taken to ensure this activity is done safely.

Children make and test a range of parachute designs. Flexible plastic from a carrier bag or tissue paper are suitable materials to make the parachute. Sample templates are provided. These can be photocopied onto card and increased in size to test different sizes of canopies. However, children should be encouraged to develop their own designs.

Making the parachutes can be quite tricky and time-consuming. It is suggested that this activity be used with children who are able to cut and stick with reasonable accuracy and speed.

## Preparation and Materials

- Parachute jump video from YouTube (RAF Falcons parachute display team – interview with team leader and footage of jump) http://www.youtube.com/user/RAFFalcons#p/a/u/0/_XDAq7guJ0s
- Parachute presentation
- Parachute template worksheet copied onto normal copier paper or transferred to lighter tissue paper (attached following these activity notes)
- Sheets of flexible plastic or tissue paper
- Sticky tape
- Light string
- Scissors
- Plasticine
- Suitable risk assessment

## Activity Notes

Show the video to illustrate how a parachute works. The extra air resistance slows down the descent of the jumper. Discuss when and where parachutes are used (for sport, military aircraft but not on passenger aircraft). What would happen if everyone on a passenger airliner was given a parachute?

Parachute presentation shows the early design concept by Leonardo da Vinci and development of functioning parachutes. Modern day parafoils act like wings and are highly manoeuvrable, as shown by the Falcons display team video clip.

Parachutes can be made using a variety of designs and materials.

Children make a parachute and test it using a small plasticine ball or lightweight model person. Discuss why new parachute designs would first be tested using a model rather than a real person.

If plasticine is used, it will deform on impact with the ground. Children could use this as a measure of the effectiveness of the parachute when investigating different parachute designs.

When investigating the parachute design, children should think about how to make the tests reliable and accurate, as well as how the design of the parachute may be changed. This could include:

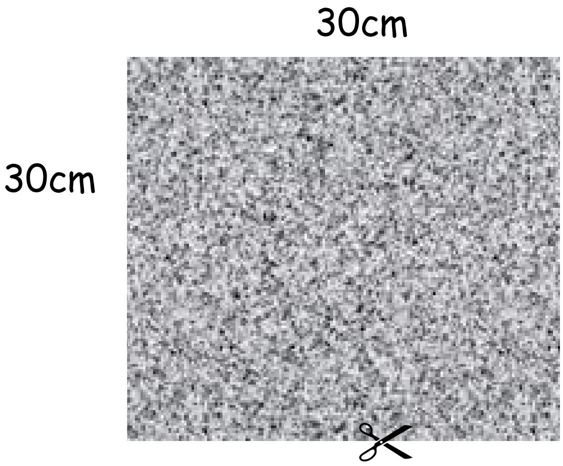
- height from which the parachute is dropped
- how can they measure the effectiveness of the parachute (time to fall, speed of fall, deformation of the plasticine)
- what weights can the parachutes be used with
- how the area of the parachute influences its rate of fall
- influence of the shape of the parachute
- number string threads used (attachment points) and stability of the parachute

Extension

Children can video their tests to allow more detailed examination of how their parachutes perform.

Children can investigate the use of multiple parachutes that could be used with heavier objects. For example when dropping equipment from aeroplanes.

# Parachute Peril



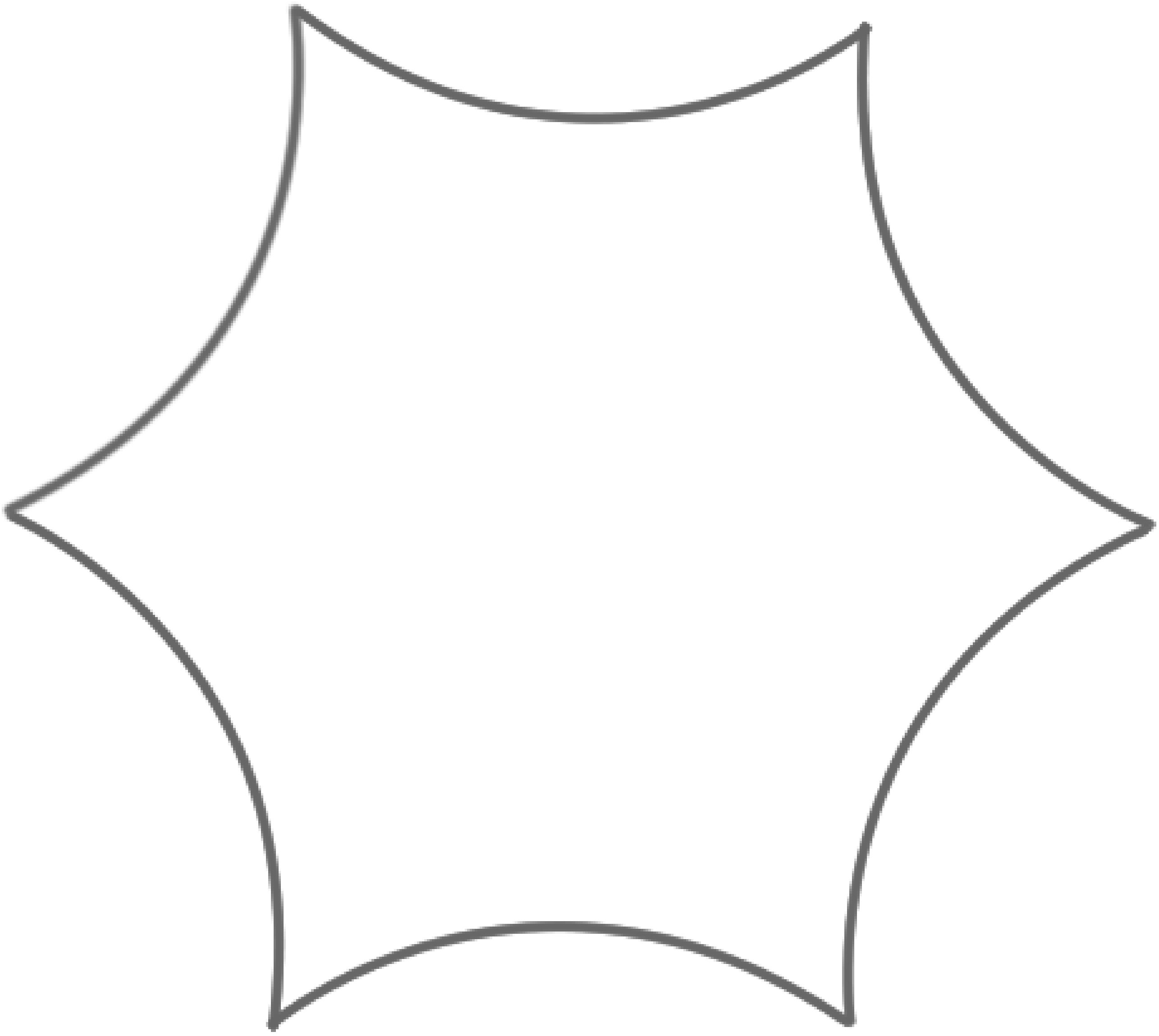

1. Get a sheet of thin plastic or tissue paper.
2. Lay it out in front of you.
3. Carefully cut out a square that is 30cm by 30cm in size.
4. Cut 4 pieces of string 30cm long.
5. Use sticky tape.
   Stick one end of each piece of string to each corner of your square.
6. Gather the other ends of the strings together. Tie them into a knot.
7. Use sticky tape to attach your model person or plasticine ball to the end of the strings.

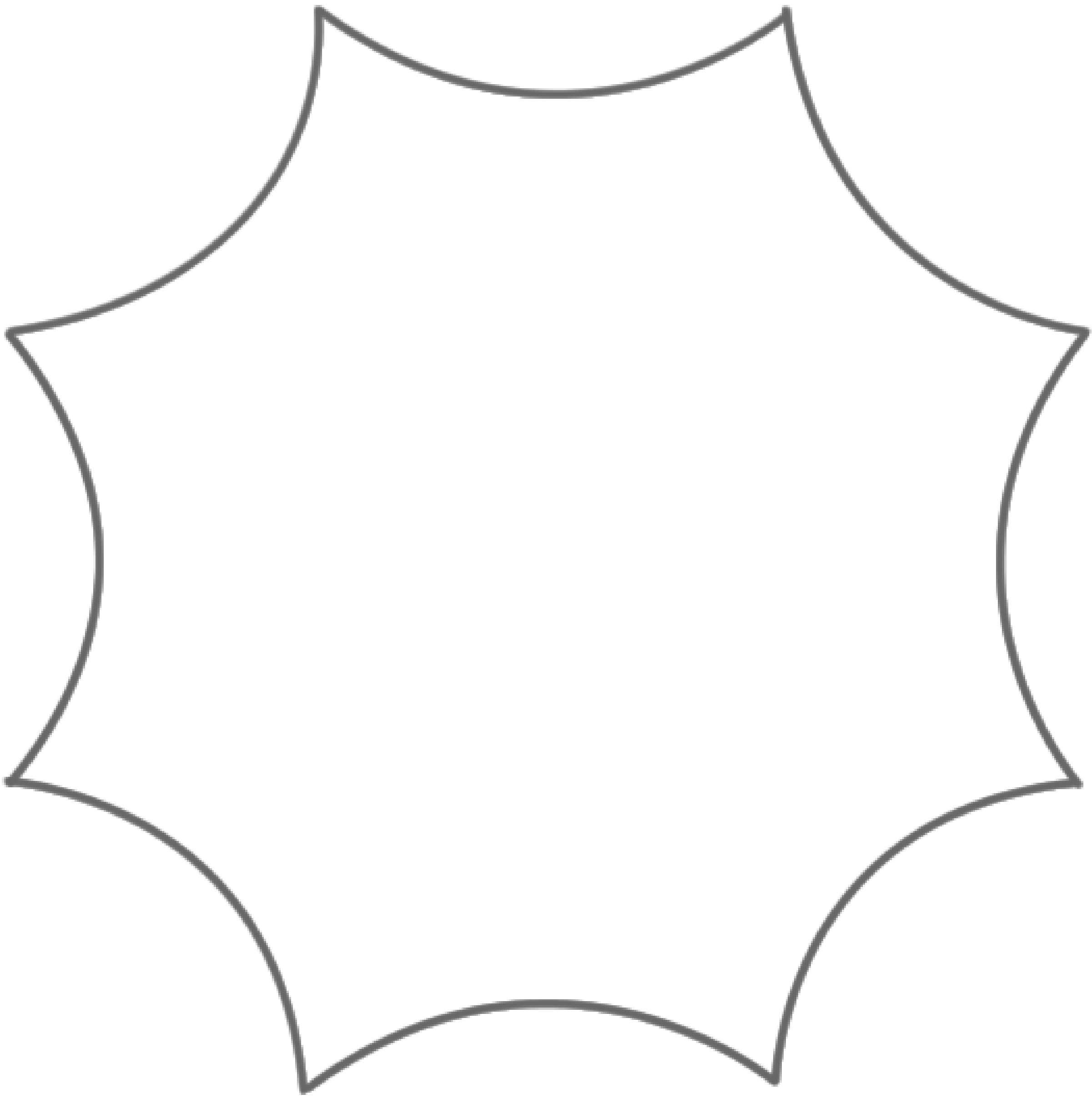
Test how well your parachute works.

Try making some other designs.

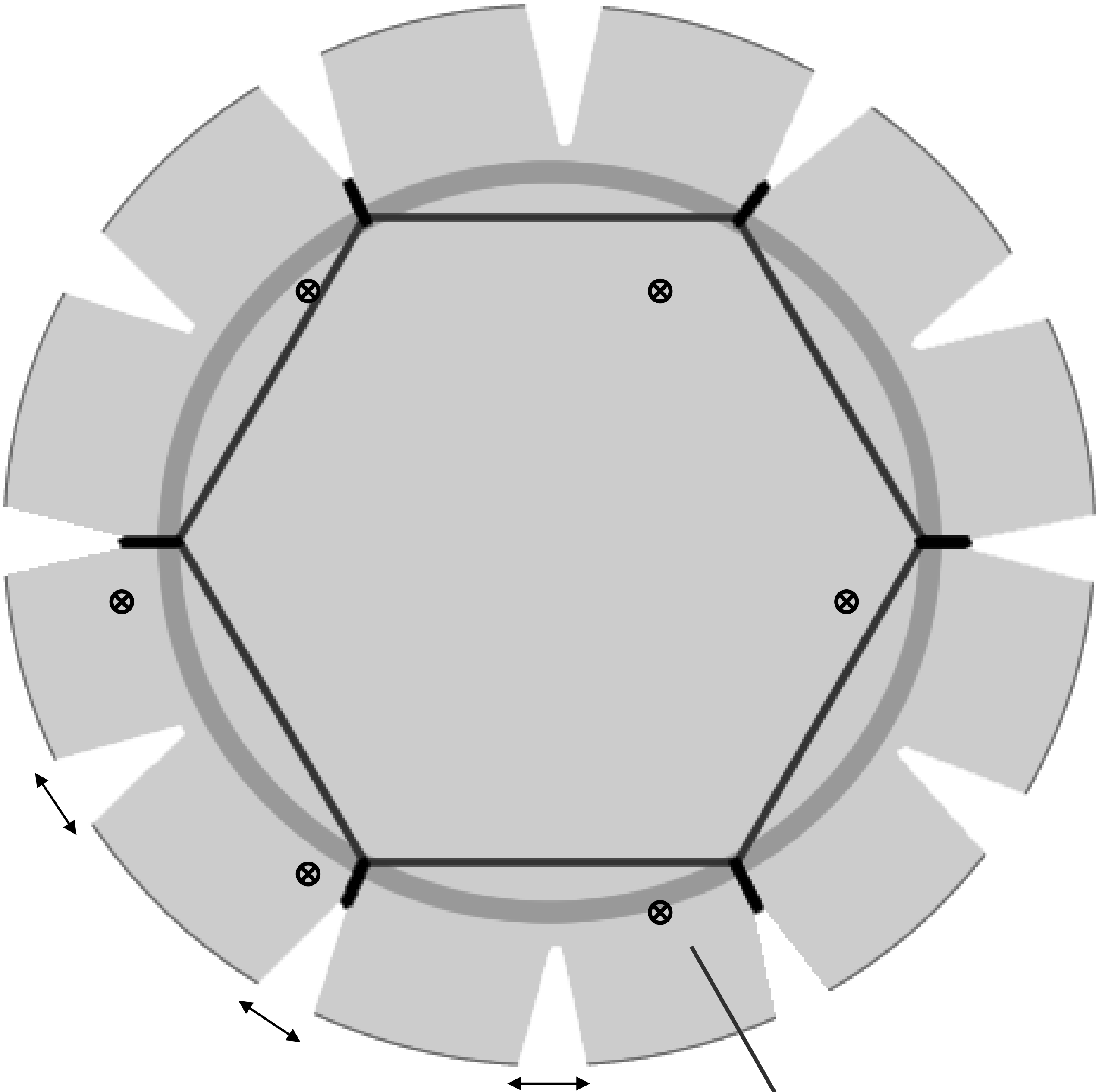
Can you make a better parachute?

Other shapes that could be tried as Parachute templates





Round saucer



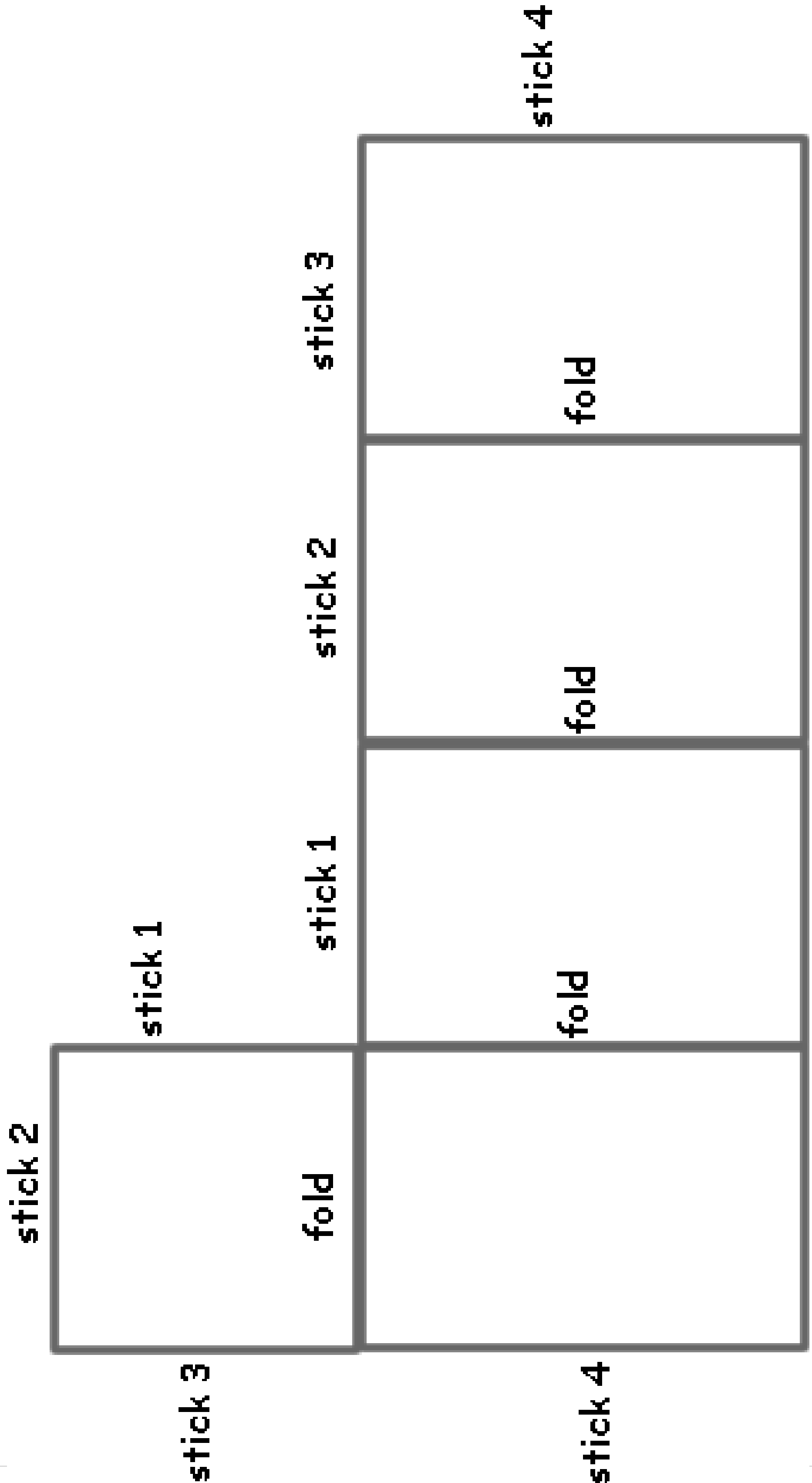
Use sticky tape to join the edges together.

Do this all the way round, so that the parachute forms a saucer shape.

String,

Use sticky tape to attach one piece of string to each of the six places shown with a

Cube


stick 4
stick 3
fold
stick 2
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stick 1
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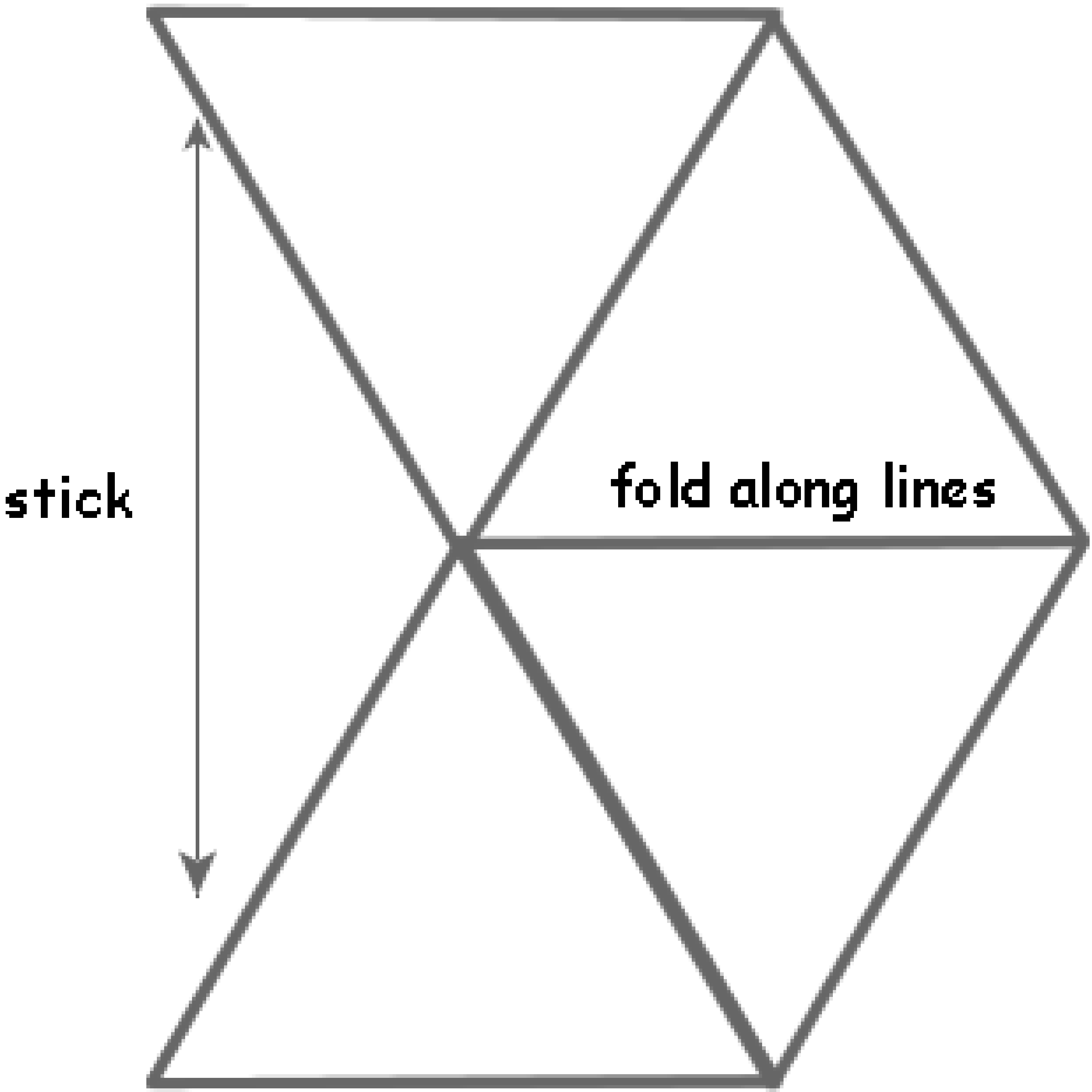
stick 4

Pyramid



Tube