SCIENCE AT WORK

Flight

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Contents

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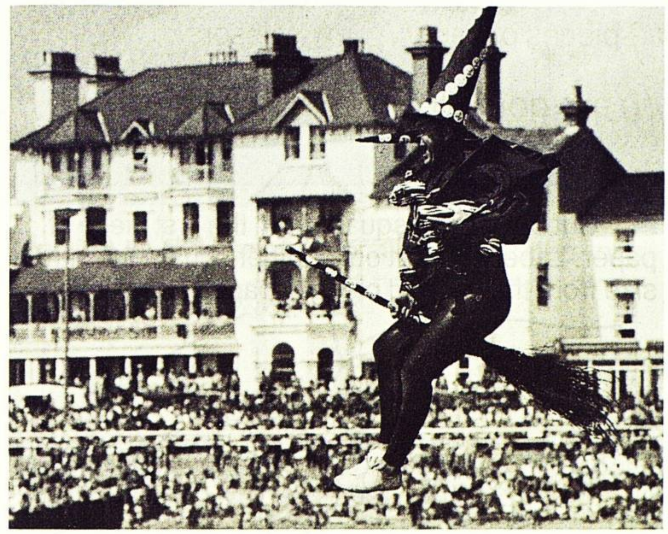
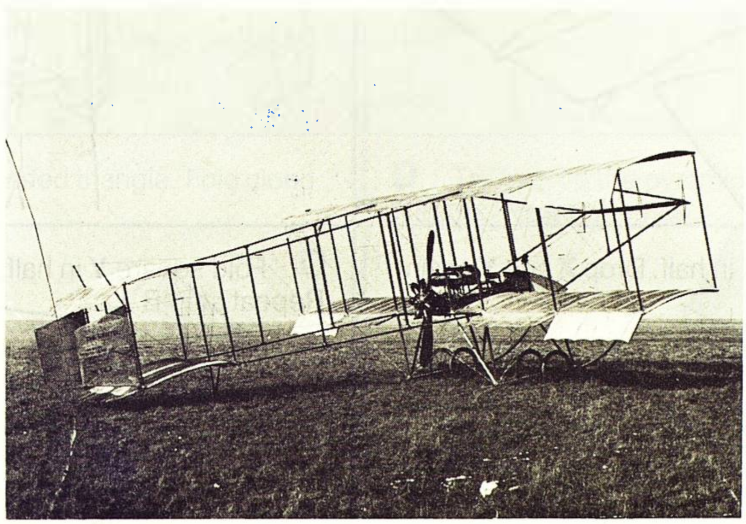
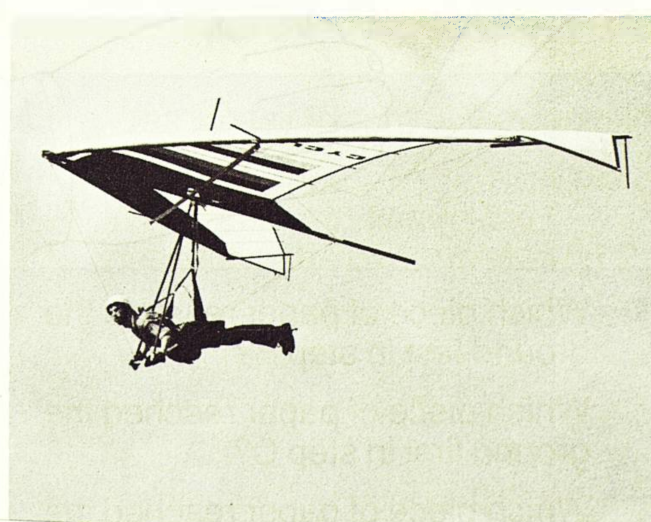
These photographs show some of the different ways of moving through air.







1 Falling through the air

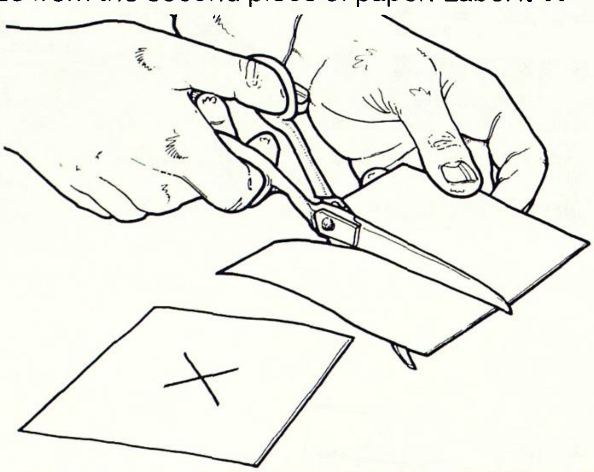
Falling sheets of paper

Apparatus

★ 2 pieces of paper ★ scissors

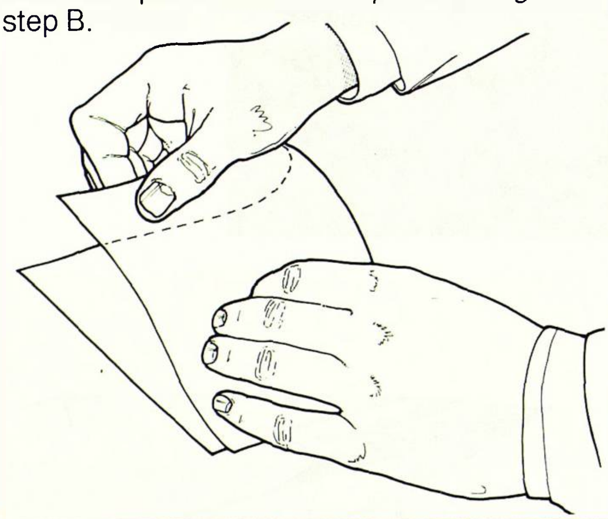
You are going to find out how the shape of a piece of paper affects how it falls.

A Cut out a large square from the first piece of paper. Label it **X.** Cut out another square the same size from the second piece of paper. Label it **Y.**

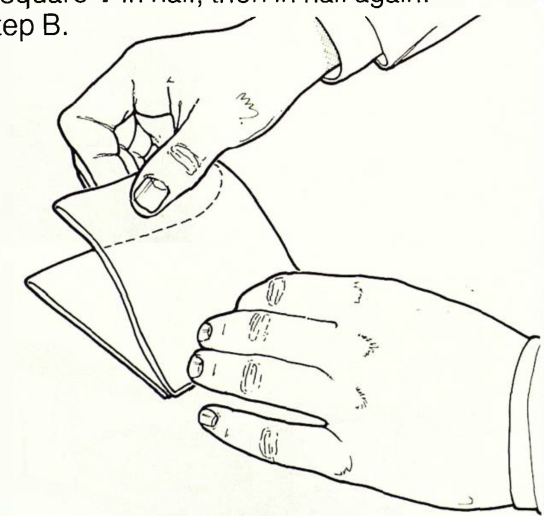


B Hold each square out flat. Drop them at the same time. Watch what happens.

C Now fold square **X** in half. Drop **X** and **Y** again as in step B.



D Fold square **Y** in half, then in half again. Repeat step B.



Q1 Which piece of paper reached the ground first in step B?

Q2 Which piece of paper reached the ground first in step C?

Q3 Which piece of paper reached the ground first in step D?

Q4 What can you say about the size of a piece of paper and the speed at which it falls?

Q5 Did the pieces of paper fall straight down, or did they sway from side to side?

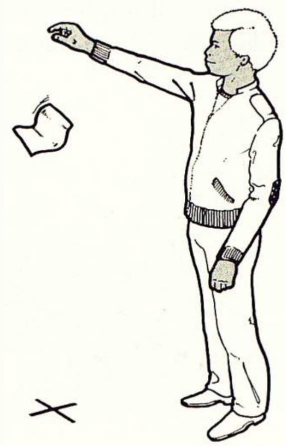
Directed descents

Apparatus

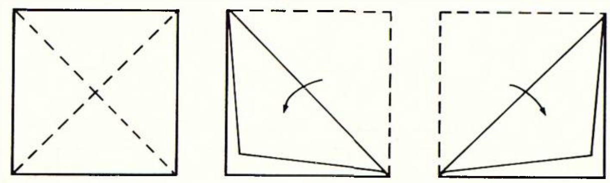
★ chalk ★ piece of A4 paper ★ scissors ★ glue

You are going to control the descent of a piece of paper by folding it.

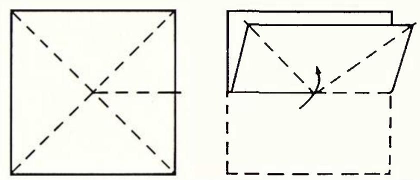
A Chalk a X on the floor. Cut out a large square from the piece of paper. Try to drop it onto the X. Repeat this a few times.



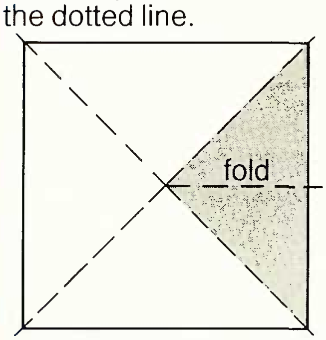
B Fold the piece of paper along the dotted lines.

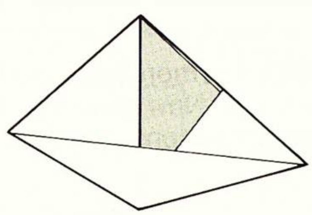


Open out the paper. Turn it over. Make a fold like this.



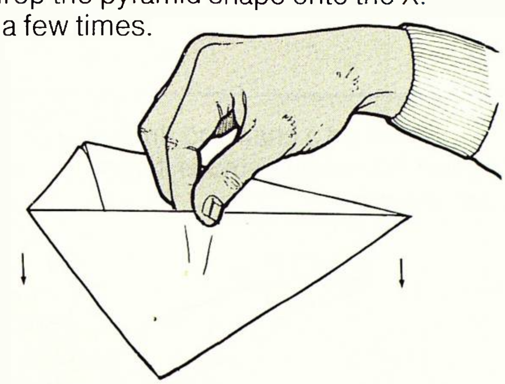
C Put glue on to the shaded triangle. Fold along the dotted line.



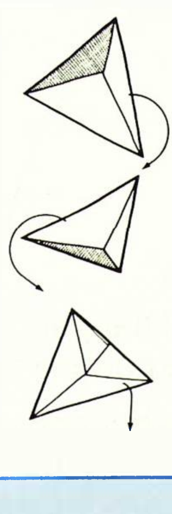


Your shape will look like this. Trim off the extra paper.

D Try to drop the pyramid shape onto the X. Repeat this a few times.



E Tilt the shape before you drop it. Watch what happens.



Q6 Was it easy to control the paper in step A?

Q7 Was it easier to control the descent of the paper in step D?

Q8 In step E, was the pyramid shape self-righting?

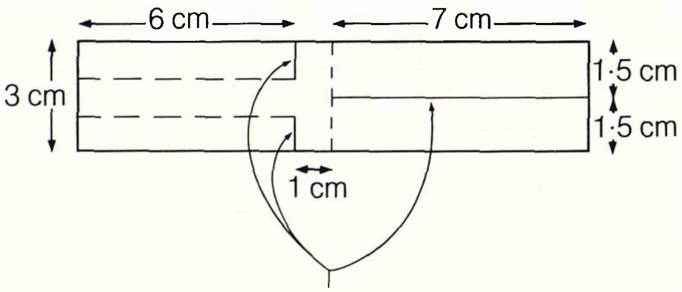
A directed descent with a paper helicopter

Apparatus

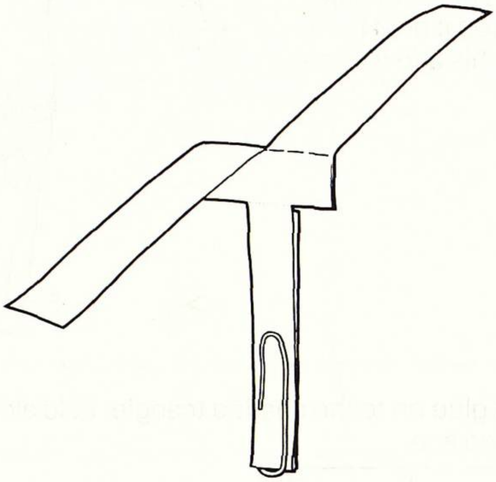
★ piece of A4 paper ★ ruler ★ scissors ★ paperclips

You are going to try and make another model which will make a controlled descent.

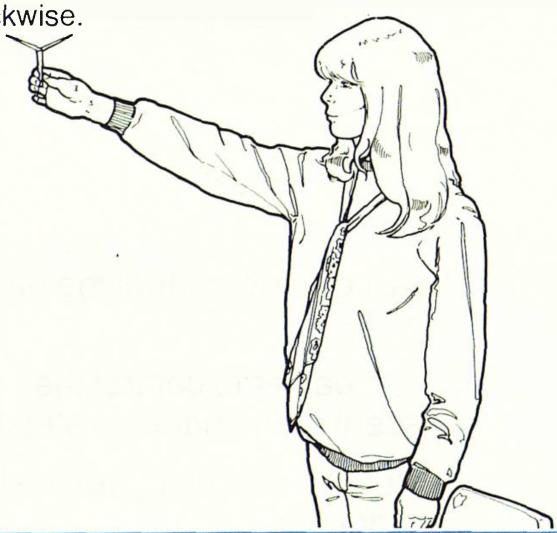
A Draw this shape. Cut it out where marked. The dotted lines are fold lines.



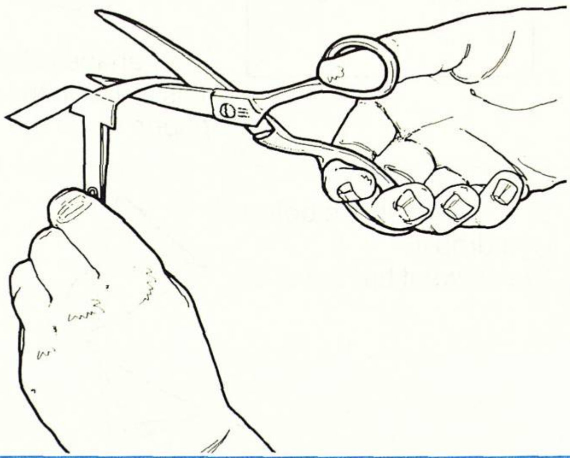
B Fold along the dotted lines to make the helicopter. Put a paperclip on the bottom.



C Stand on a chair and drop the helicopter. Adjust the wings to make it spin clockwise, then anticlockwise.



D Add more paperclips to the helicopter and drop it again. Now gradually shorten the wings. Watch what happens when you drop it this time.



Q9 How did you make the helicopter spin:
a clockwise?
b anticlockwise?

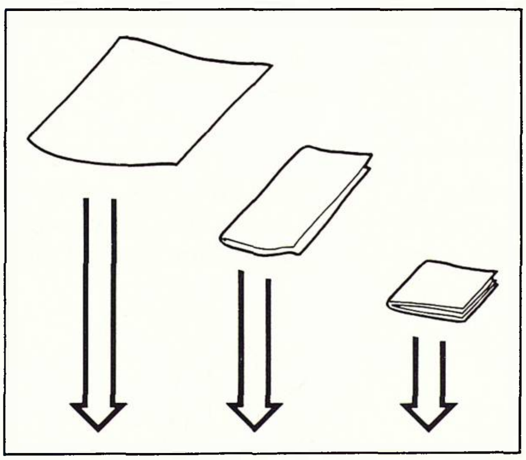
Q10 What happened when you added more paperclips?

Q11 What happened when you shortened the wings?

Information: Air resistance

As an object falls it pushes air out of the way. In return the air pushes on the object. This push is called **air resistance.**

The faster an object falls, the greater the air resistance.
A sky diver can fall at up to 190 km/h (120 mph); air resistance prevents him from falling faster.



Each piece of paper weighs the same. The smallest in area will fall fastest. It can move more easily through the air and has the least air resistance.

A flat object flutters from side to side as it falls. A curved shape is more **stable.**

Q12 What is air resistance?

Q13 How can you make an object fall more quickly?

Q14 Why do the free falling parachutists extend their arms and legs?

2 Parachutes

The rate of fall of a parachute

Apparatus

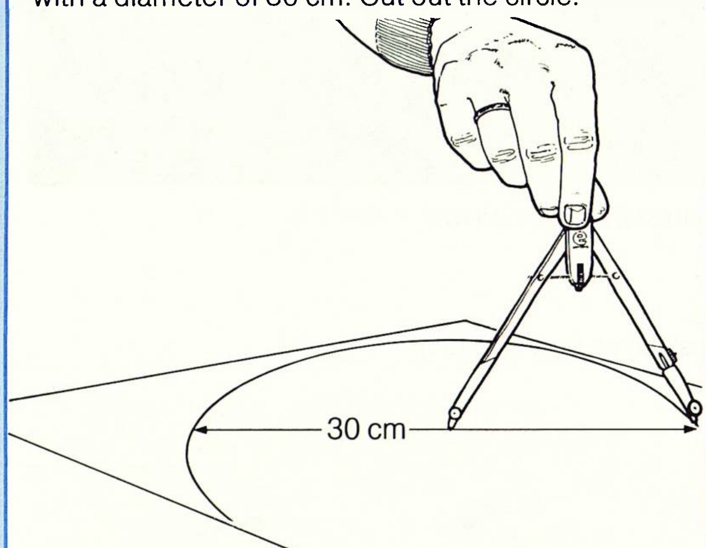
★ scissors ★ pair of compasses ★ piece of card 30 cm × 30 cm ★ sheet of polythene
★ masking tape ★ cotton thread ★ paperclips ★ stop clock ★ ruler

You are going to find out how the rate of fall of a parachute can be changed.

Q1 Copy this table.

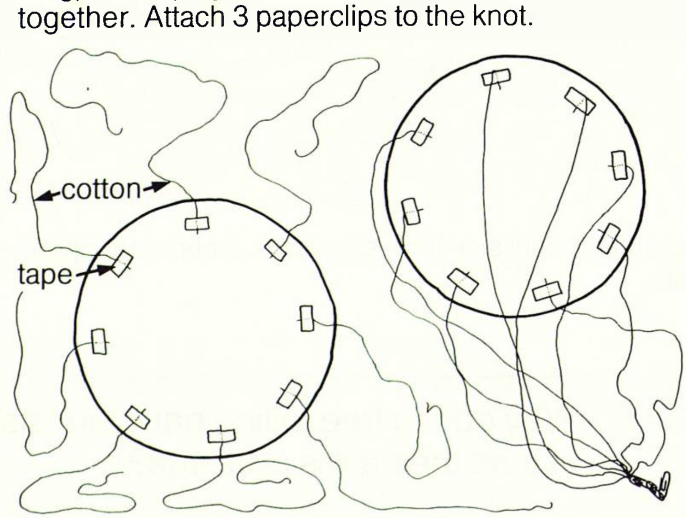
Number of paperclips	Diameter of polythene	With or without hole in polythene	Time taken to reach floor (s)

A Use the compasses to draw a circle on the card with a diameter of 30 cm. Cut out the circle.

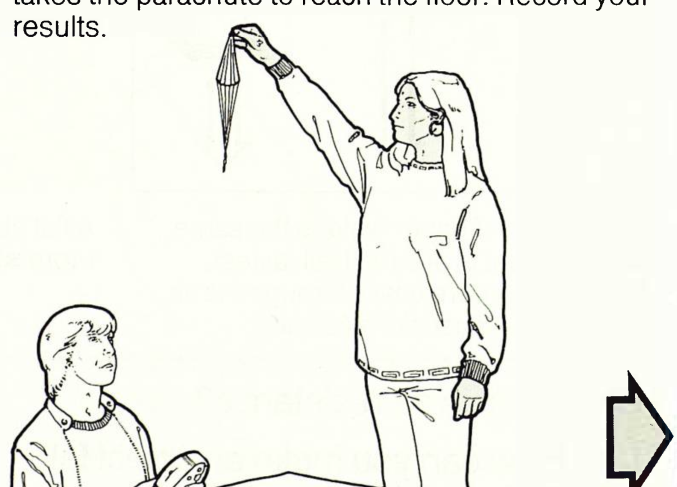


B Use the card to cut round a circle of polythene.

C Tape 8 pieces of cotton (each about 35 cm long) to the polythene as shown. Tie the ends together. Attach 3 paperclips to the knot.



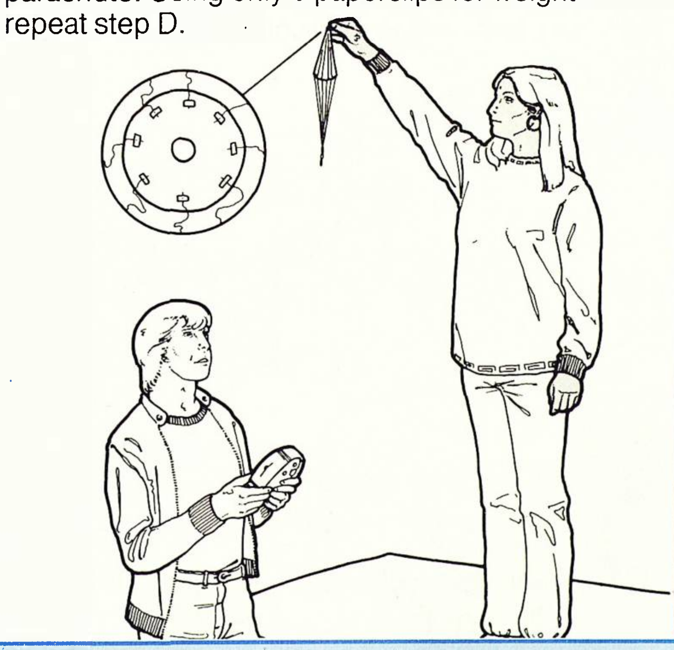
D Work with a partner. Stand on a table. Hold the parachute out as high as you can. Time how long it takes the parachute to reach the floor. Record your results.



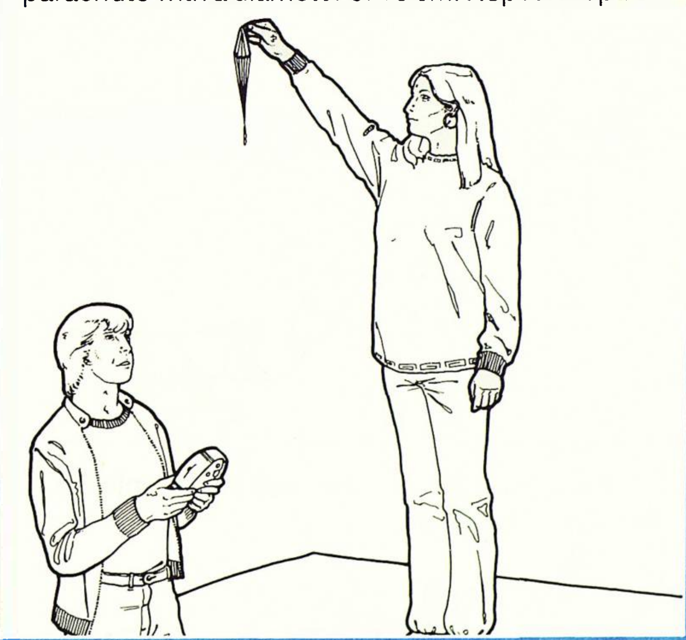
E Clip on 3 more paperclips. Repeat step D.

F Clip on another 3 paperclips. Repeat step D.

G Cut a hole (diameter 2 cm) in the top of the parachute. Using only 3 paperclips for weight repeat step D.



H Repeat steps A, B and C to make a parachute with a diameter of 15 cm. Repeat step D.



Q2 Which parachute fell most slowly?

Q3 Does a large parachute fall more slowly than a small one?

Q4 Does more weight make a parachute fall faster?

Q5 Did the parachutes in steps E, F and G fall straight down?

Q6 What was the effect of cutting a hole in the parachute in step G?

Parachutes in nature

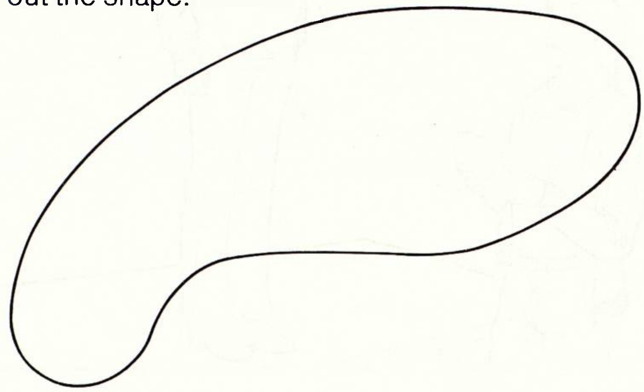
Apparatus

★ plasticine ★ piece of A4 paper ★ scissors ★ stop clock ★ sycamore seed

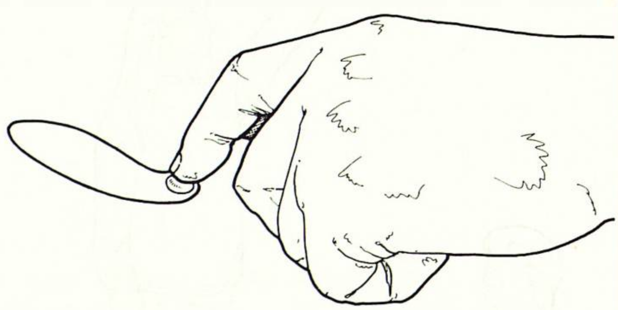
You are going to make a model seed and find out how fast it falls.

A Make a small plasticine ball (about the size of a pea). Drop it. Watch how it falls.

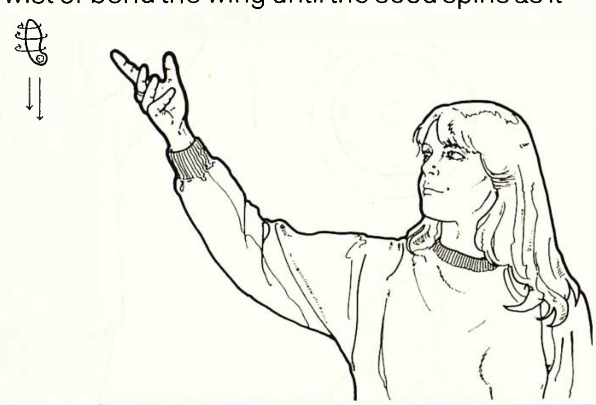
B Trace this shape onto the piece of paper. Cut out the shape.



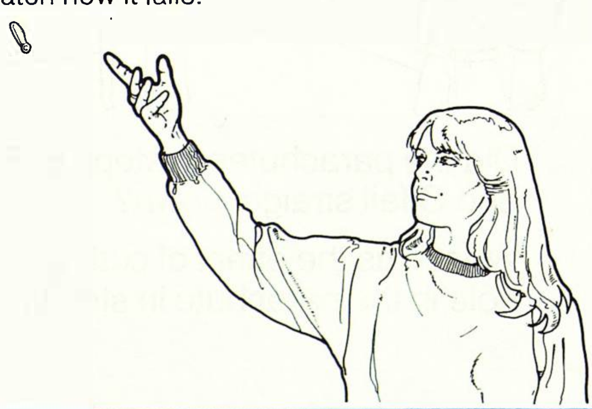
C Press the ball of plasticine onto the paper as shown.



D Throw the model seed into the air. Watch how it falls. Twist or bend the wing until the seed spins as it falls.



E If you have a sycamore seed throw it into the air. Watch how it falls.



Q7 Did your model fall like the sycamore seed?

Q8 Which fell faster, the plasticine ball or the model seed?

Q9 Did the wing make the plasticine ball fall more slowly?

Q10 What is the advantage of seeds falling slowly from trees?

Information: Parachutes and seeds

A parachute slows the descent of a body through the air to about 6 m per second (20 feet per second). Landing with a parachute feels like jumping off a wall about 180 cm high (6 feet high).

A parachute can be steered by pulling down on its **suspension lines** (ropes). This spills air from the opposite sides. By pulling down the suspension line to the right, the parachutist moves to the right. It also increases his rate of descent. This steering is very useful if there is a strong wind.

Parachutists landing on a marked target area.

Nature uses the **drag** of the air in the dispersal of seeds from some plants. The seeds from this dandelion are like parachutes. They are propelled forwards by the wind as they fall slowly. The seeds can be carried some distance from the parent plant.

The sycamore seed is slowed down by spinning through the air. Once again the purpose is to give the wind time to blow the seed away from the parent tree. The seed will grow better away from the shade of its parent tree.

3 Flight

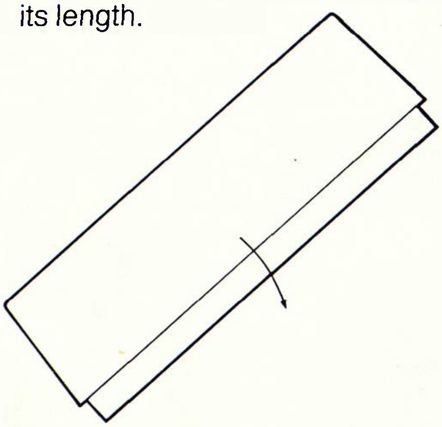
Making a paper glider

Apparatus

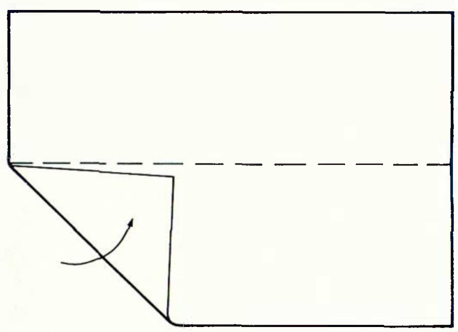
★ piece of A4 paper ★ sticky tape

You are going to make a paper glider.

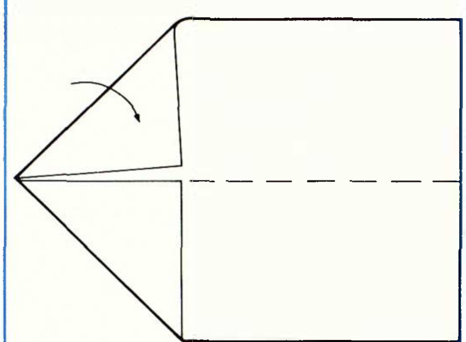
A Fold the paper in half along its length.



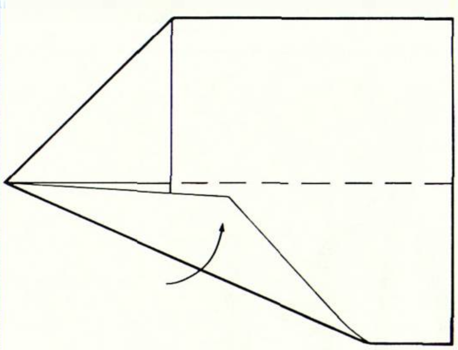
B Open out the paper. Fold over the left corner to the middle as shown.



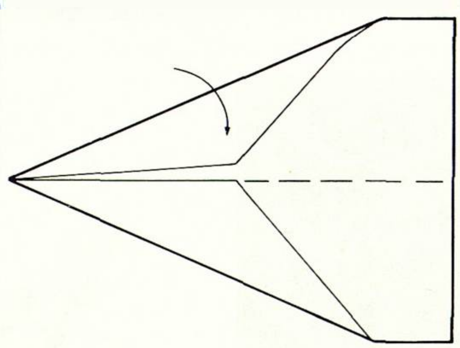
C Fold over the right corner to the middle as shown.



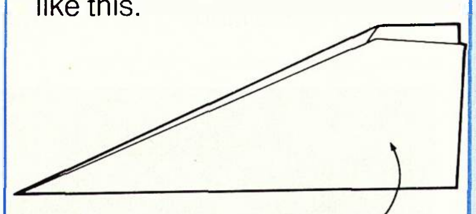
D Fold the left side again so that it meets the centre fold.



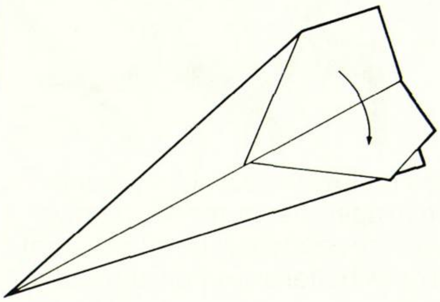
E Repeat step D for the right side.



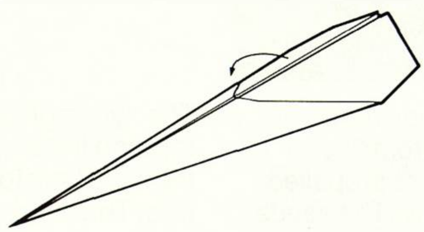
F Fold up the model and lay the paper flat. It should look like this.



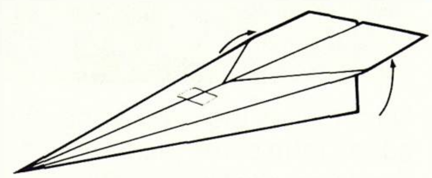
G Fold the left flap to make a wing. The model should look like this.



H Fold out the right flap to make a matching wing. The model should look like this.



I Fold up the wings slightly and hold them in place with some tape.



Gliding, stalling and diving

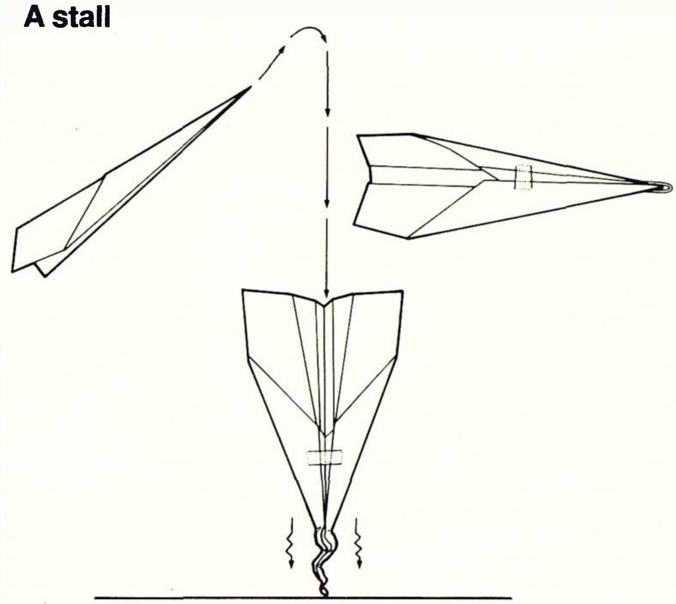
Apparatus

★ paper glider from page 10 ★ paperclips ★ scissors

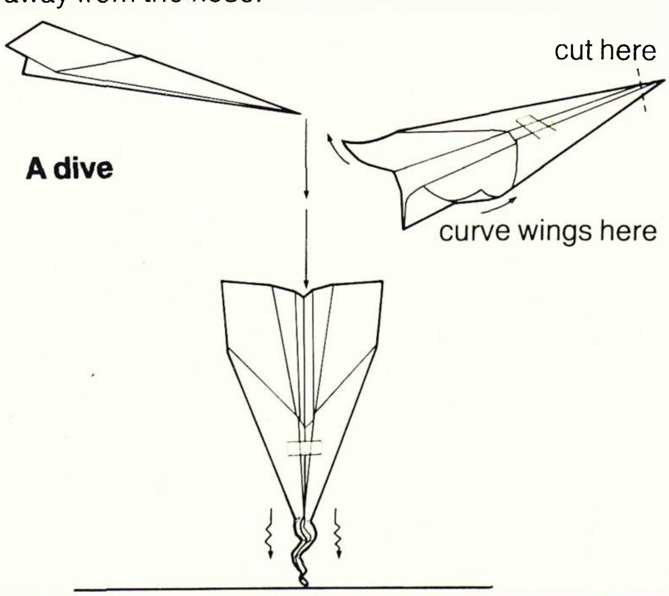
A Hold the glider above your head. Point it slightly downwards and gently push it forward. Watch how it flies.

B If your glider **stalls,** add paperclips to the nose until it **glides.**

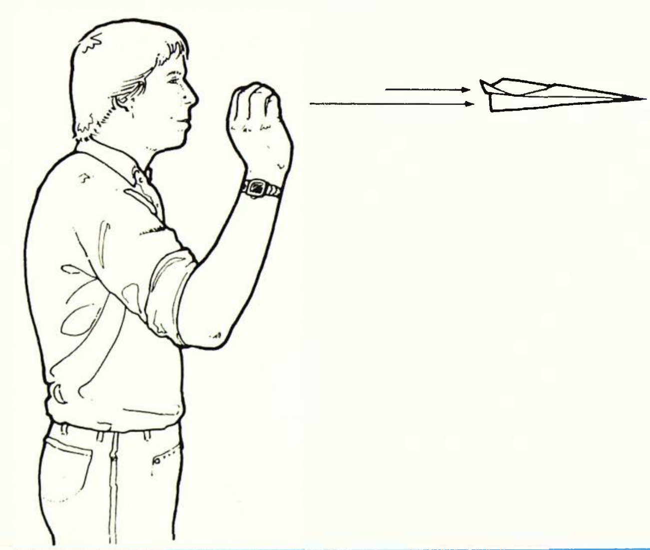
A stall



C If your glider **dives,** bend up the back of the wings in a slight curve. If it still dives, cut the paper away from the nose.



D If you still cannot get the glider to fly go back to steps G and H on page 10. Make bigger wings by folding over more of the flaps. Repeat steps A, B and C on this page.



Q1 What is a stall?

Q2 How can a stall be cured?

Q3 What is a dive?

Q4 How can a dive be cured?

Stabilising

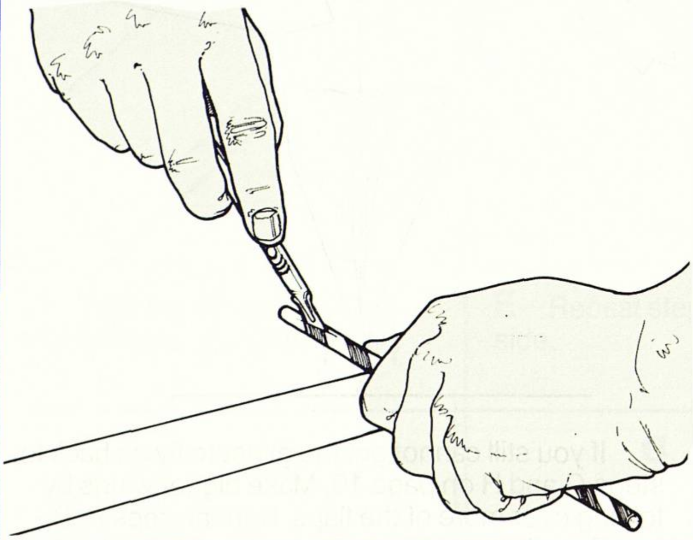
Apparatus

★ straws ★ piece of stiff paper ★ scalpel ★ ruler ★ scissors

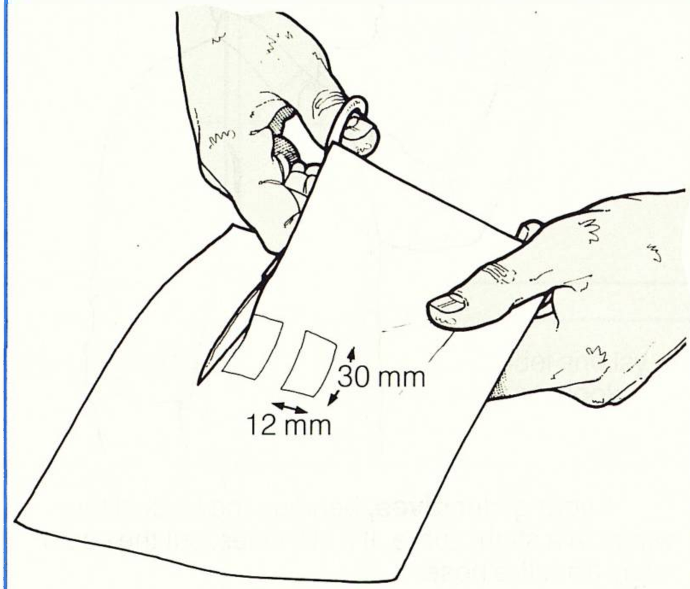
You are going to find out if fins help an object to keep on course.

Take great care when using a scalpel.

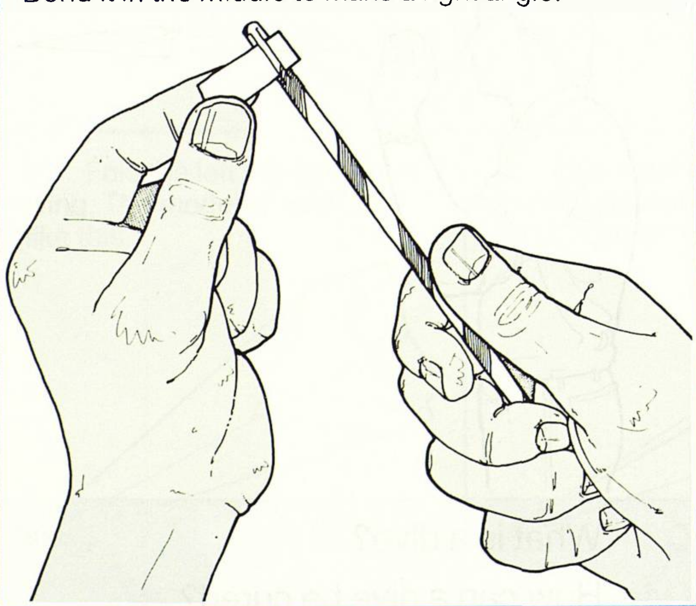
A Using a scalpel carefully cut 2 pairs of slots at one end of the straw and opposite each other. Each slot should be 15 mm long and 1 cm from the end of the straw.



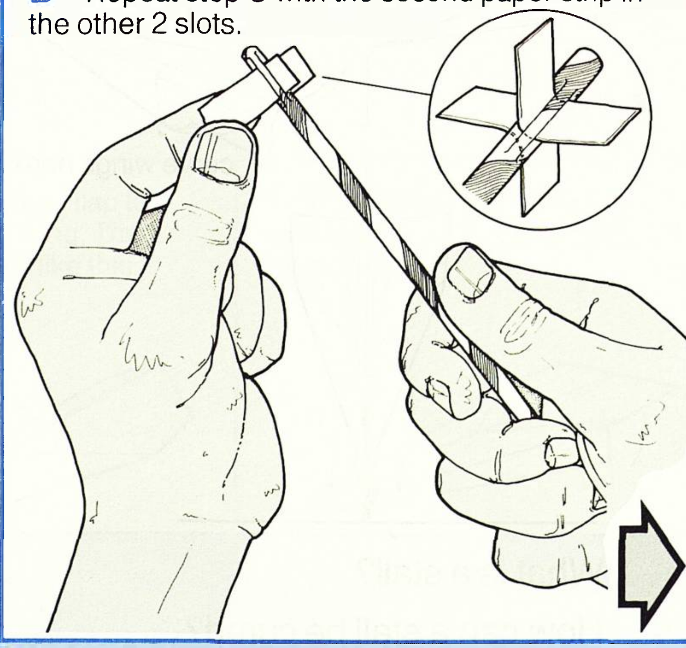
B Cut out 2 strips of stiff paper. Each strip must be 30 mm long and 12 mm wide.



C Push one strip through 2 neighbouring slots. Bend it in the middle to make a right angle.



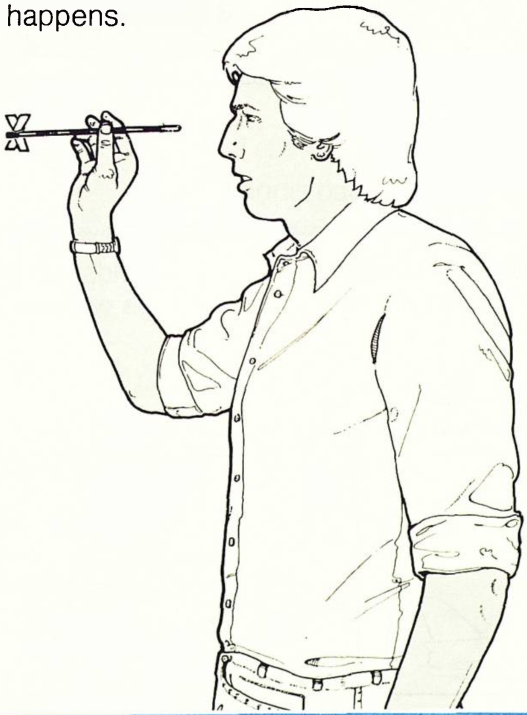
D Repeat step C with the second paper strip in the other 2 slots.



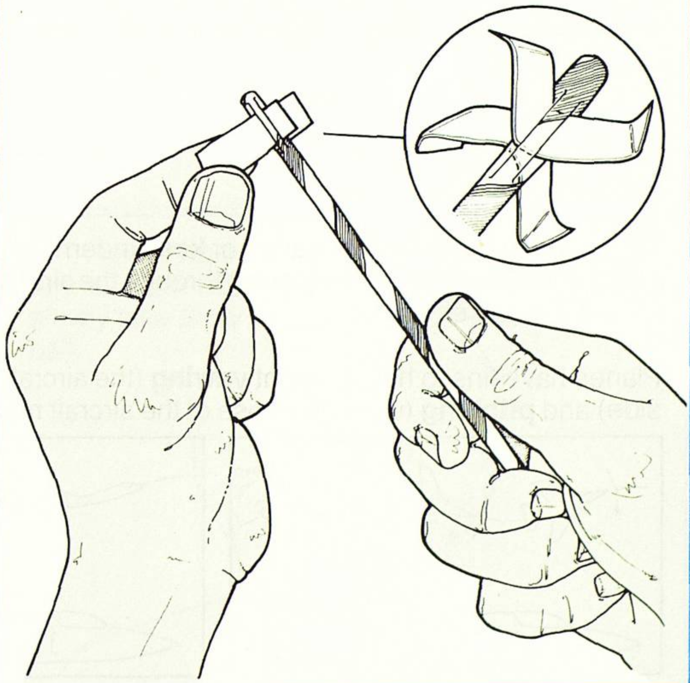
E Throw a straw end-on. Then throw your dart end-on.

F Throw a straw sideways-on. Then throw your dart sideways-on.

G Throw your dart with the fins at the front. Watch what happens.



H Twist the fins to make your dart spin as it flies.



Q5 Did the fins make your dart fly straight?

Q6 Should the fins be at the back or front of an object?

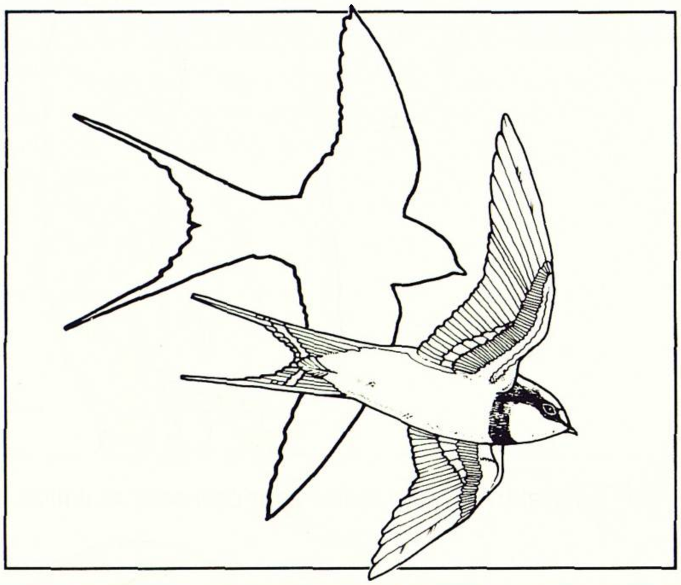
Q7 What happens if the fins are at the front?

Q8 How did you make your dart spin?

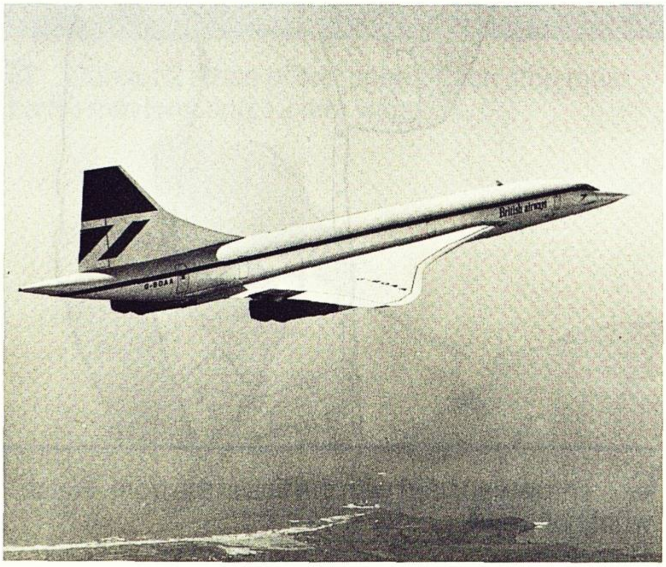
Information: Streamlining

Anything which has to move through the air at speed needs a smooth, pointed shape.
This is called a **streamlined** shape. It helps cut down air resistance or drag.

The swallow has a top speed of about 150 km/h (94 mph). Note its streamlined shape.



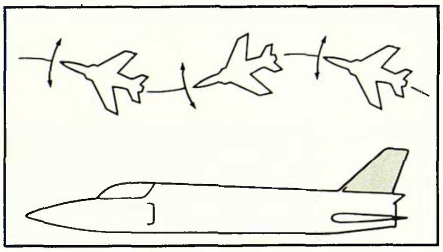
Concorde has a top speed of about 2179 km/h, over twice the speed of sound. Its shape is specially designed to reduce air resistance. The nose droops down for take-off and landing to help the pilot see ahead. In flight the nose is raised for maximum streamlining.



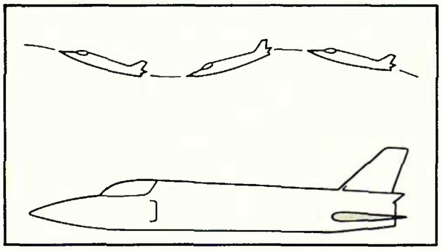
Information: Yawing, pitching and rolling

Your paper glider has a central fin, or **keel** underneath. This helps to **stabilise** it (make it fly straight) when moving through the air. The fins on the straw dart have the same effect.

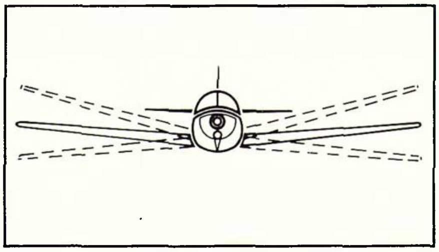
Planes have fins to help prevent **yawing** (the aircraft moving from side to side) and **pitching** (when the nose of the aircraft moves up or down).



This fin helps prevent yawing.



The tailplane helps prevent pitching.



Having the wings bent upwards helps prevent **rolling.**

Q9 What is streamlining?

Q10 What is yawing?

Q11 What is pitching?

Q12 What is rolling?

4 Forces for flight

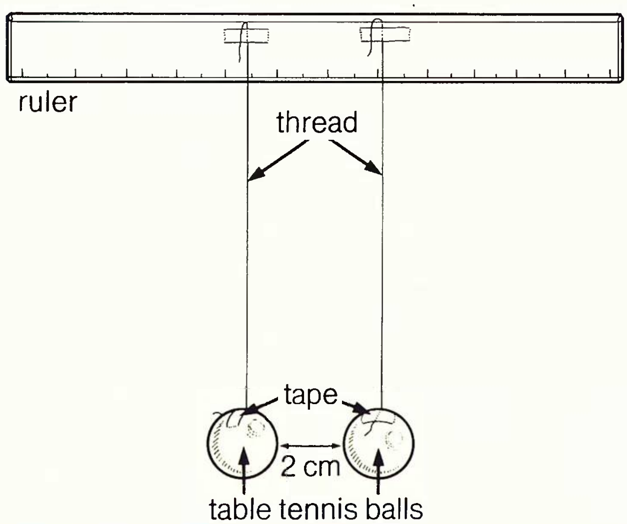
Air flowing over a curved surface

Apparatus

★ ruler ★ cotton thread ★ sticky tape ★ 3 table tennis balls ★ egg cup
★ funnel ★ 2 pieces of A4 paper ★ clampstand ★ model wing ★ air blower
★ straws ★ string

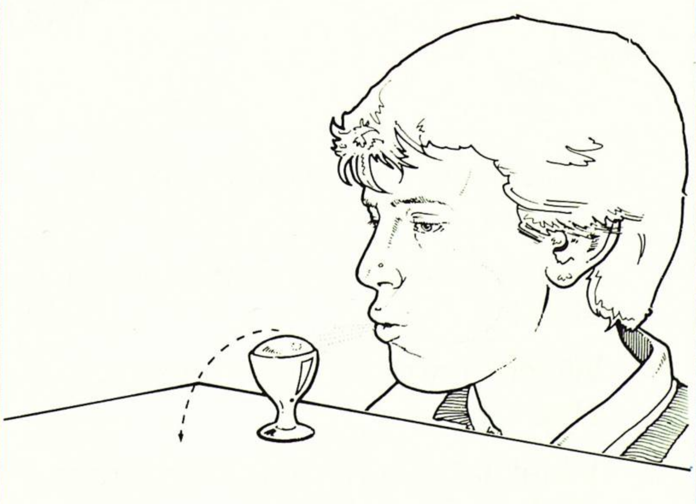
You are going to find out what happens when you blow air over a curved surface.

A Set up this apparatus. The balls should be 2 cm apart.



B Blow between the 2 balls. Watch how the balls move.

C Put a table tennis ball in an egg cup. Blow over the top of the egg cup. Watch what happens.



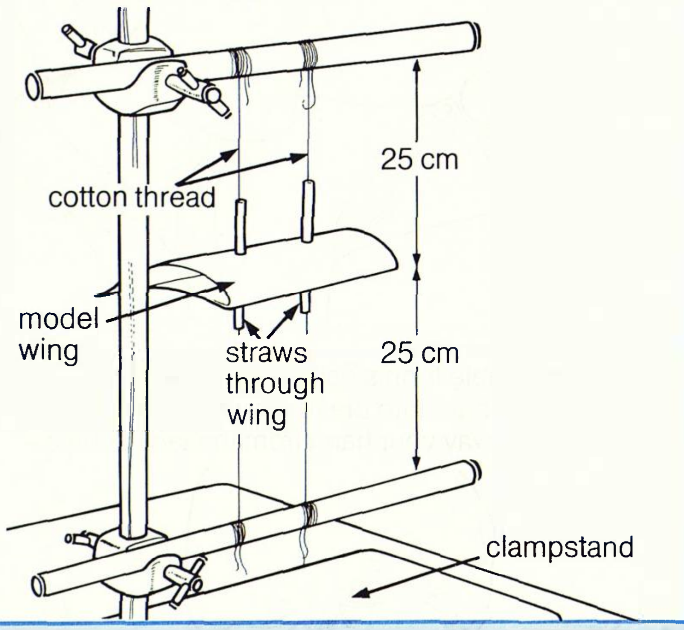
D Hold a table tennis ball in an upside-down funnel. Blow hard into the funnel. At the same time slowly take away your hand from the table tennis ball.

Forces for flight

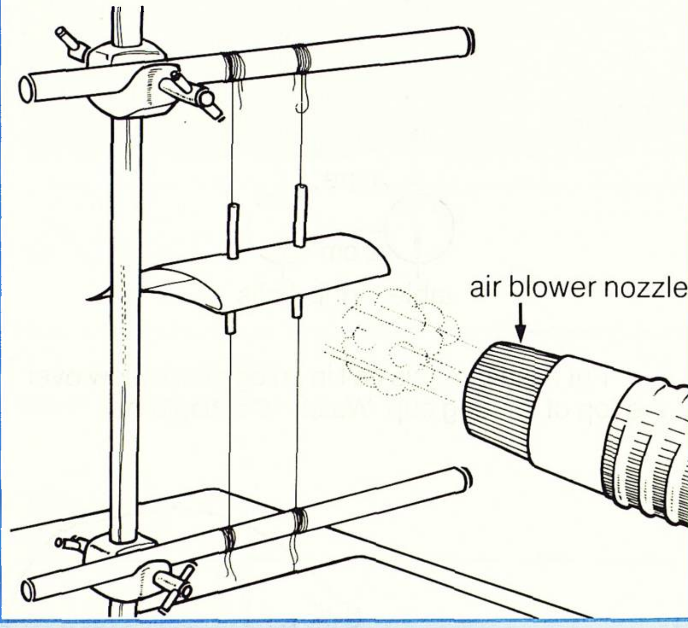
E Support a piece of paper on 2 piles of books as shown. Blow under the paper. Watch what happens.

F Hold a piece of paper as shown. Blow over the paper.

G Set up this apparatus.



H Blow air at the model wing with the air blower.



Q1 Which way did the balls move in step B?

Q2 Which way did the ball move in step C?

Q3 **a** Could you blow the ball out of the funnel in step D?
b Which way did the blowing make the ball move?

Q4 Which way did the paper move in step E?

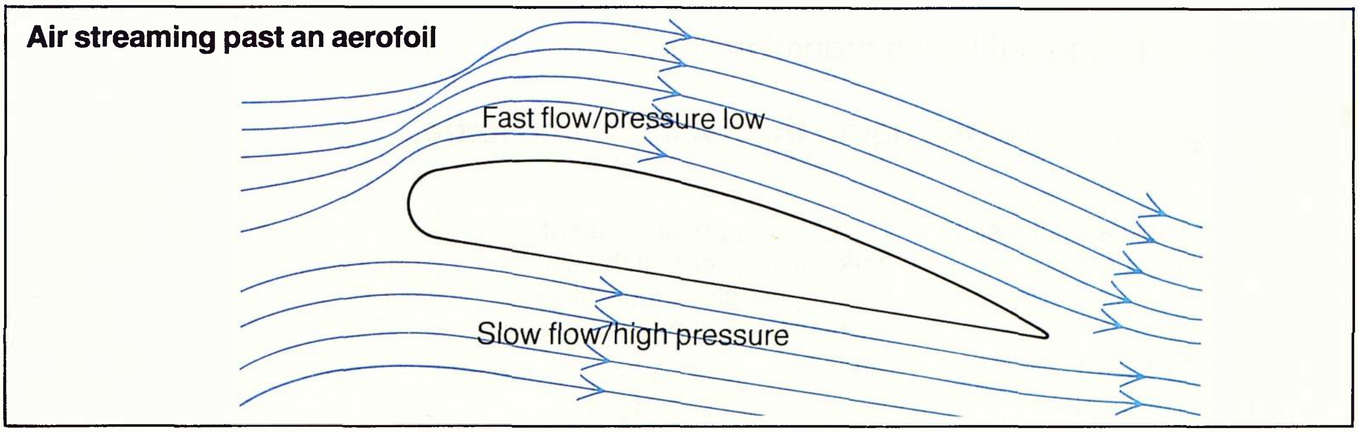
Q5 Which way did the paper move in step F?

Q6 Which way did the wing move in step H?

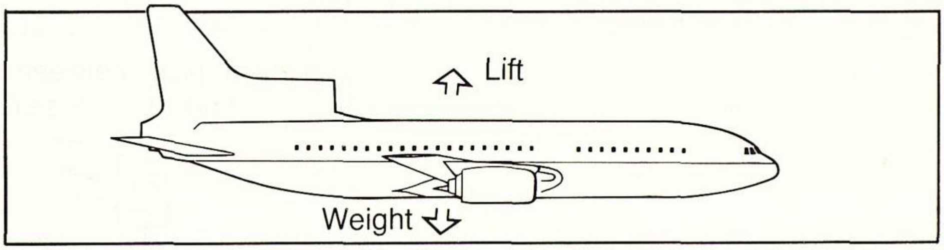
Q7 What happens as you blow harder in steps E and F?

Information: Lift

The shape of an aeroplane's wing is called an **aerofoil.** Usually the top is curved, the bottom is flat. The diagram below shows a wing from one end and the way the air flows over it.

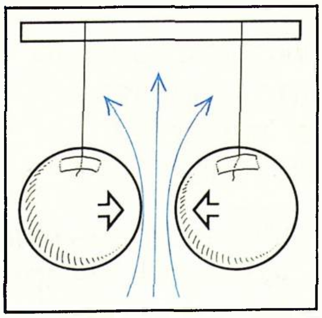


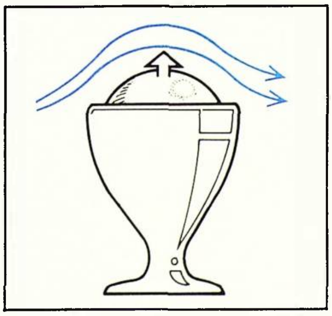
As the aeroplane flies, air rushes over the wings. The air travelling over the top has to travel further and therefore faster than the air passing along the bottom. This gives **low air pressure** on the top of the wing. The wing is pushed upwards and the aeroplane is lifted off the ground. When this **lift** balances the **weight** of the plane, the plane will fly at a steady height.

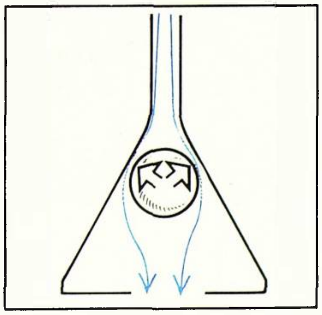


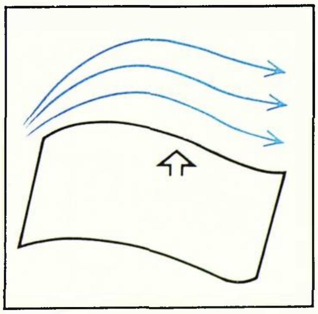
The wing is angled slightly upwards at the front edge to give more lift. This angle is called the **angle of attack.**

A fast flow of air over a curved surface causes low pressure.
FAST FLOW – PRESSURE LOW
This explains what happened in the experiments on pages 15 and 16.


Step B


Step C


Step D


Step F

Q8 What is lift?

Q9 What happens if the lift on a wing is greater than the weight of a plane?

Thrust

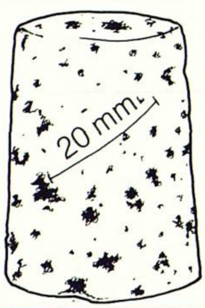
Apparatus

★ hacksaw ★ cork ★ piece of stiff card ★ piece of dowelling (15 cm long)
★ sharp knife ★ glue ★ tracing paper ★ ruler

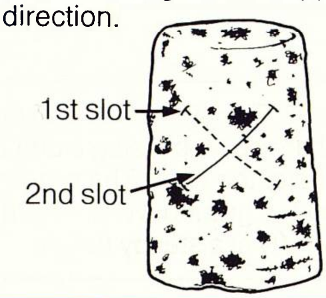
You are going to find out how a propeller works.

Take great care when using the hacksaw and knife.

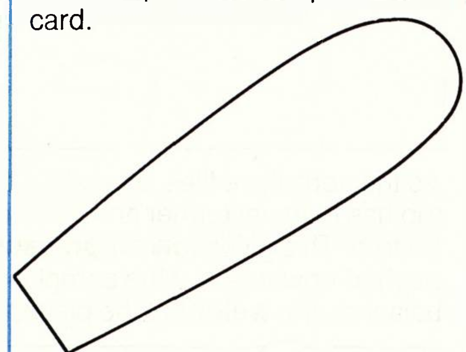
A With the hacksaw cut a slot (20 mm long) in a cork.



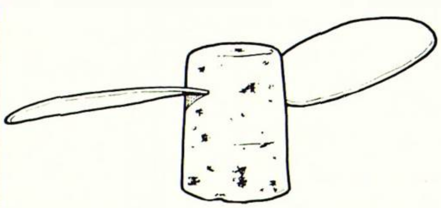
B On the opposite side of the cork cut another slot the same length. This slot should slope at the same angle in the opposite direction.



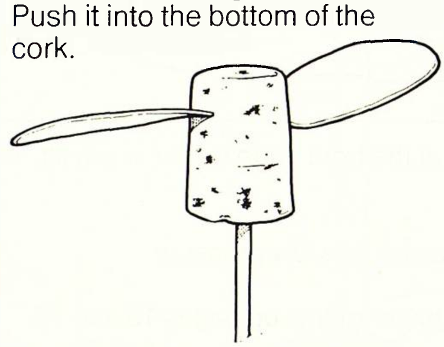
C Trace round this shape. Cut out 2 shapes from the piece of card.



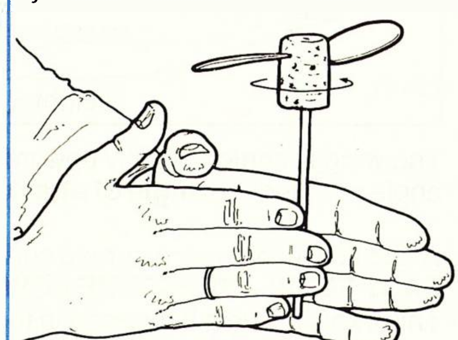
D Glue the shapes into the slots.



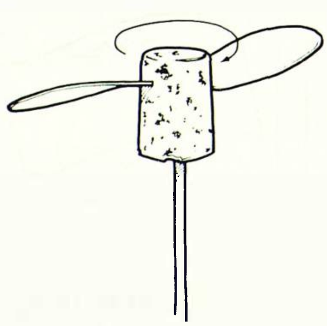
E Sharpen one end of the piece of dowelling with a knife. Push it into the bottom of the cork.



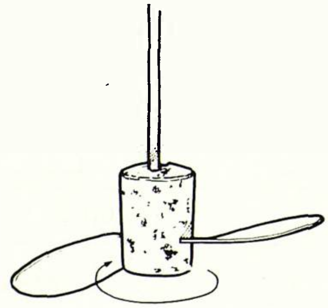
F Spin the propeller between your hands as shown. Release it.



G Now spin the propeller the other way and then release it.



H Turn the propeller upside-down. Spin it as in step G.



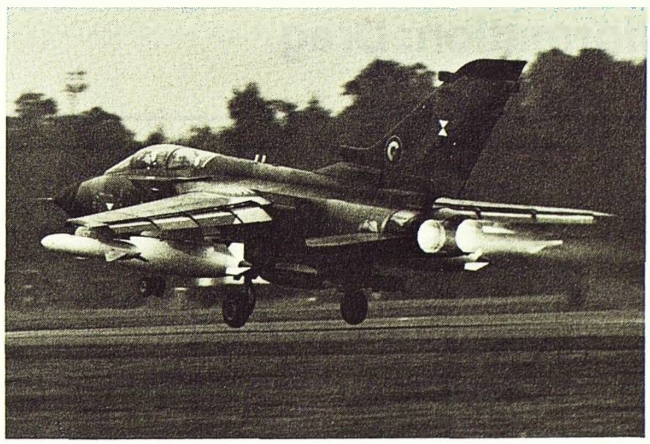
Q10 What happens to the propeller:
a in step F?
b in step G?

Q11 What happens when the propeller is spun upside-down in step H?

Information: Thrust

A plane needs to continue moving through the air for its wings to develop lift. The push that keeps the plane moving forward is called **thrust.** In some aircraft thrust is provided by a propeller (or **airscrew**). A propeller bores its way into the air in much the same way as a screw bores into wood. As the propeller **rotates**, the blades push the air back. The air then pushes the propeller (and the plane) forward. The faster the propeller spins, the greater the thrust.

The **rotors** of a helicopter work in a similar way to the propeller, except that they lie flat and rotate on the top of the helicopter. The **pitch** (angle of the blades) can be altered. This helps the pilot control the movement of the helicopter.



Jet aircraft have no propellers. They produce thrust by blasting hot gases out of the back of the plane. This pushes the plane forward.

Q12 What is thrust?

Q13 How does a jet plane fly?

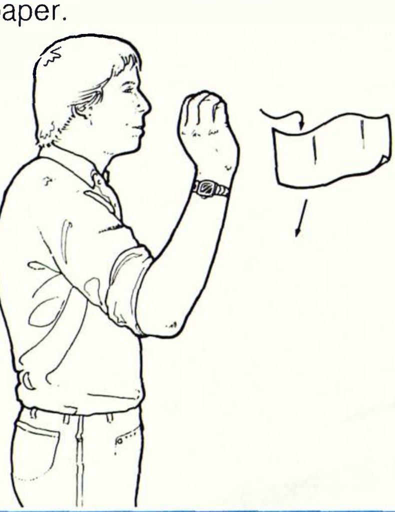
Drag

Apparatus

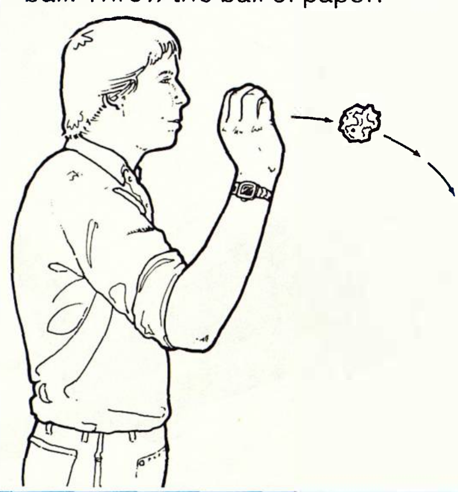
★ 2 pieces of A4 paper

You are going to find out how to alter the **drag** on a piece of paper.

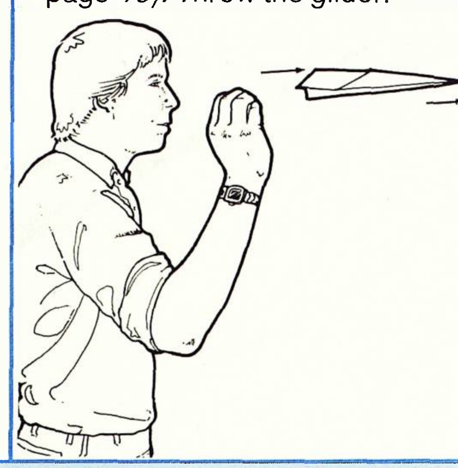
A Try to throw a flat piece of paper.



B Crumple the paper into a ball. Throw the ball of paper.



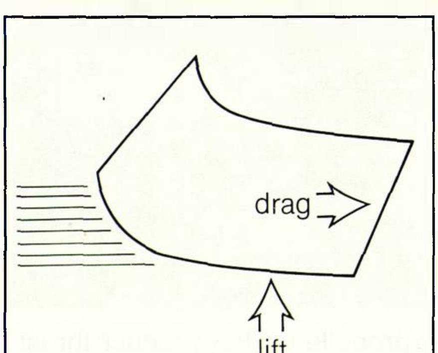
C Make the second piece of paper into a paper glider (see page 10). Throw the glider.



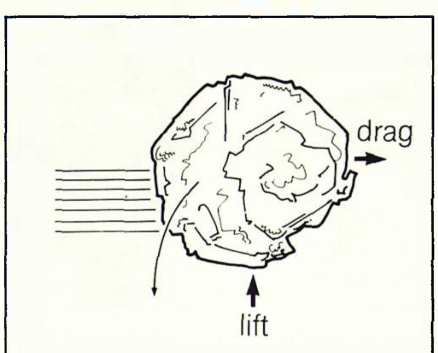
Q14 **a** Was it easier to throw the paper in step A or step B?
b Why do you think it was easier?

Q15 What was the difference between the way the ball of paper and the paper glider moved through the air?

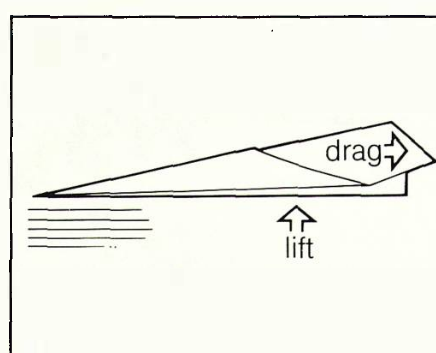
Information: Drag



The drag on this piece of paper is so large that it is difficult to make it move through the air. Air trapped under the paper gives it an upwards push.

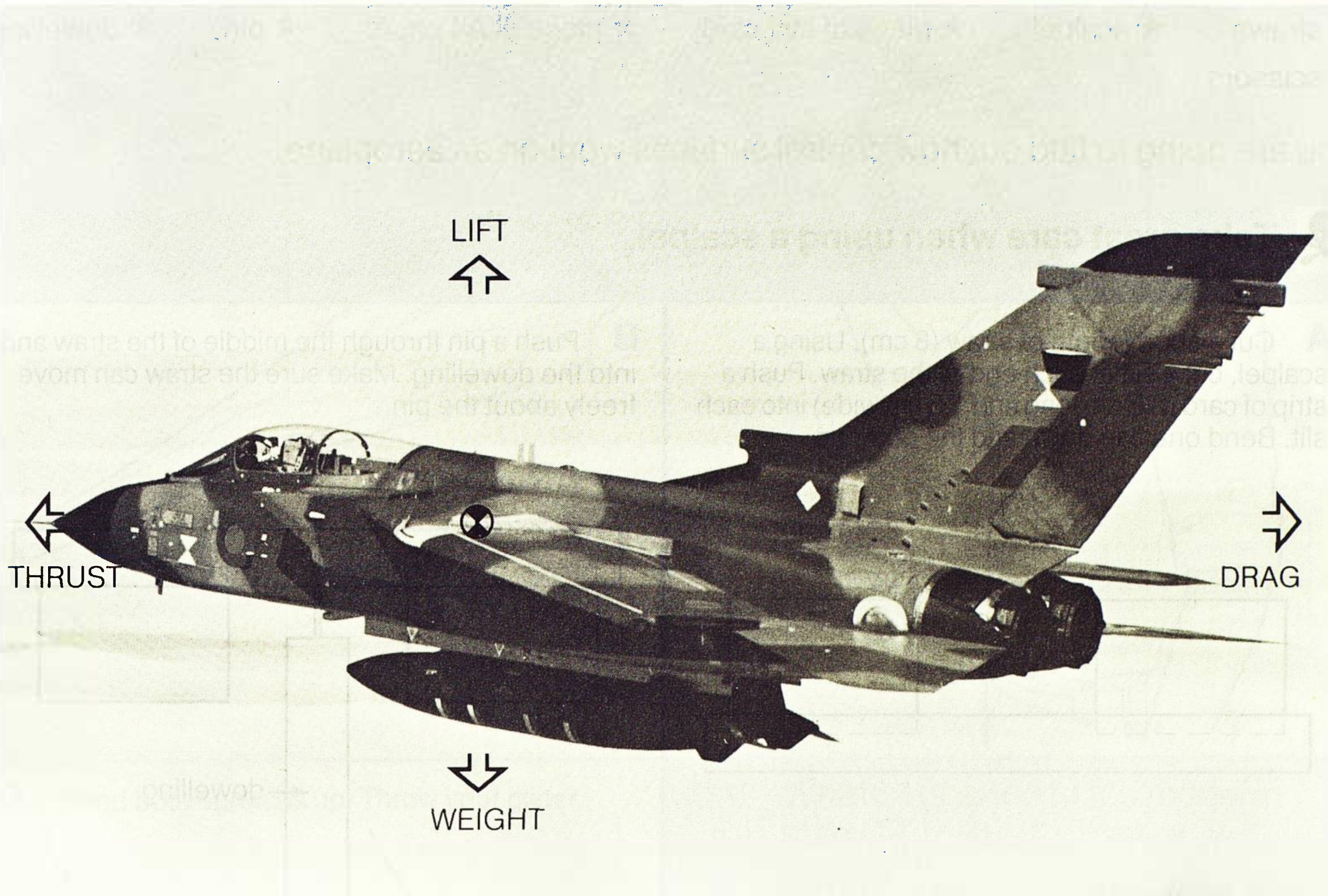


The drag is much reduced on the paper ball. The upwards push from the air ("lift") is also much reduced.



Making the paper into the shape of a glider cuts down the drag, but keeps some lift. This is the best shape to make paper fly.

Information: Lift, thrust and drag



The Tornado is an advanced combat aircraft powered by 2 new technology, reheated fan engines.

Q16 What causes:
a lift?
b thrust?
c drag?

Q17 When thrust and drag are equal, what can you say about the plane's speed?

Q18 If the plane's weight is greater than the lift, what happens?

Q19 If the pilot increases the thrust (turns the propeller faster), the plane will climb. Why is this?

Q20 How does the lift compare with the weight of the plane at take-off?

5 Control in the air

Control surfaces

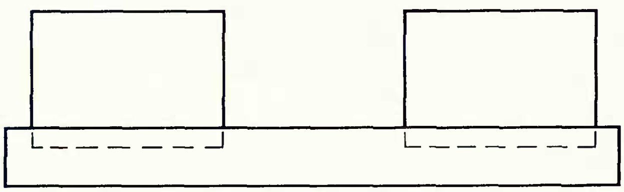
Apparatus

★ straws ★ scalpel ★ piece of stiff card ★ piece of A4 paper ★ pin ★ dowelling
★ scissors

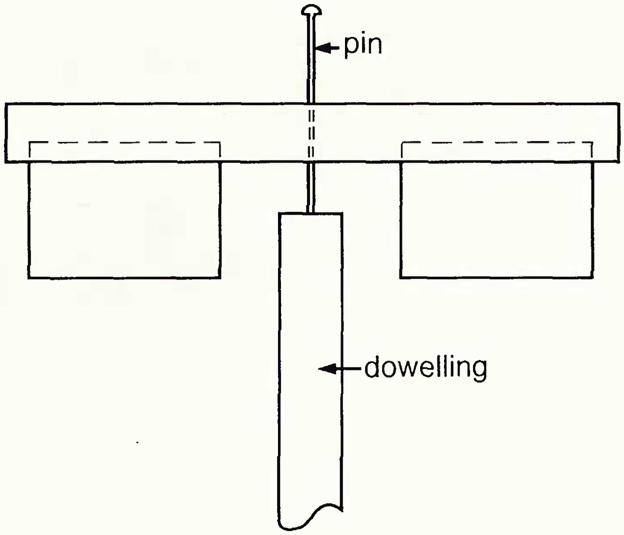
You are going to find out how control surfaces work on an aeroplane.

Take great care when using a scalpel.

A Cut a short length of straw (8 cm). Using a scalpel, cut a slit at each end of the straw. Push a strip of card (2·5 cm long and 1·5 cm wide) into each slit. Bend one flap down and the other up.

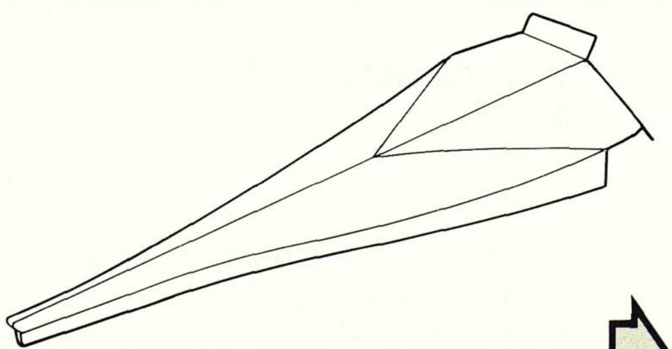


B Push a pin through the middle of the straw and into the dowelling. Make sure the straw can move freely about the pin.

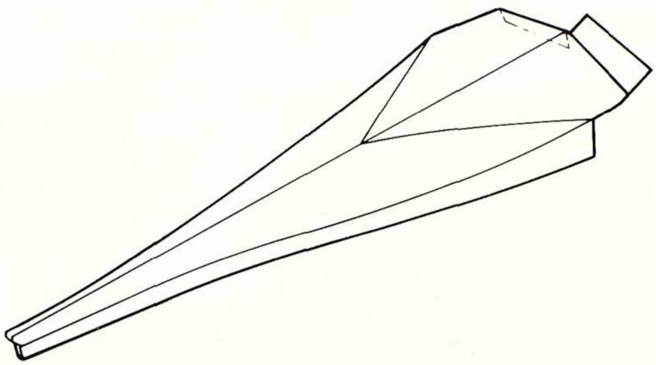


C Blow gently at the model.

D Make a paper glider (see page 10). This time, make sure the wings are bent slightly down. Cut **control surfaces** in each wing as shown. Bend one surface up and the other down. Throw your glider.

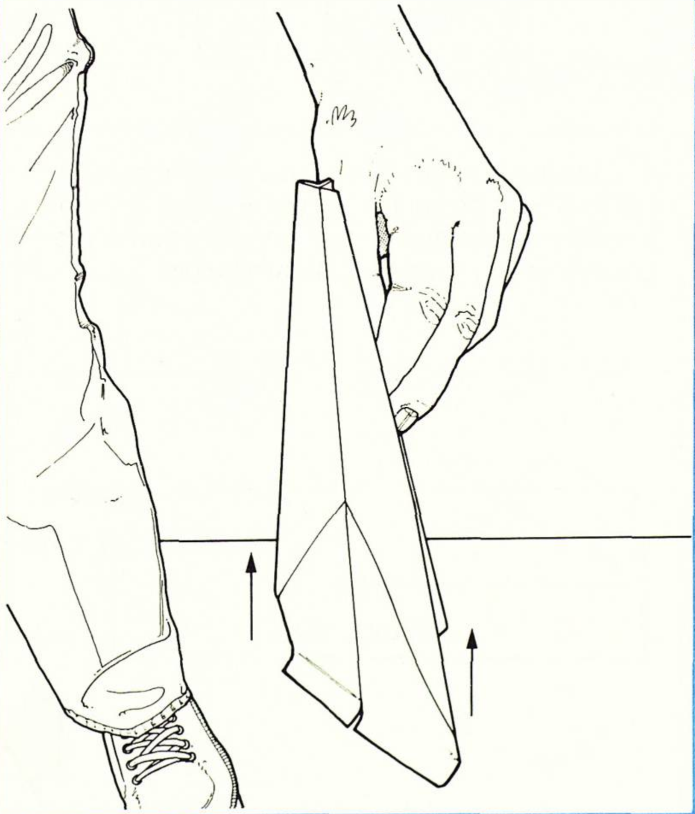


E Bend the control surfaces the other way. Throw your glider.



F Now bend both surfaces down. Throw your glider.

G Bend both surfaces up. Throw your glider.



Q1 What happened to the model in step C?

Q2 What happened to the glider in:
a step D?
b step E?
c step F?
d step G?

Q3 Which way does the air push the control surfaces in step F?

Q4 What does this make the tail of the glider do?

Q5 Explain what the control surfaces do in step G.

A balsa wood glider

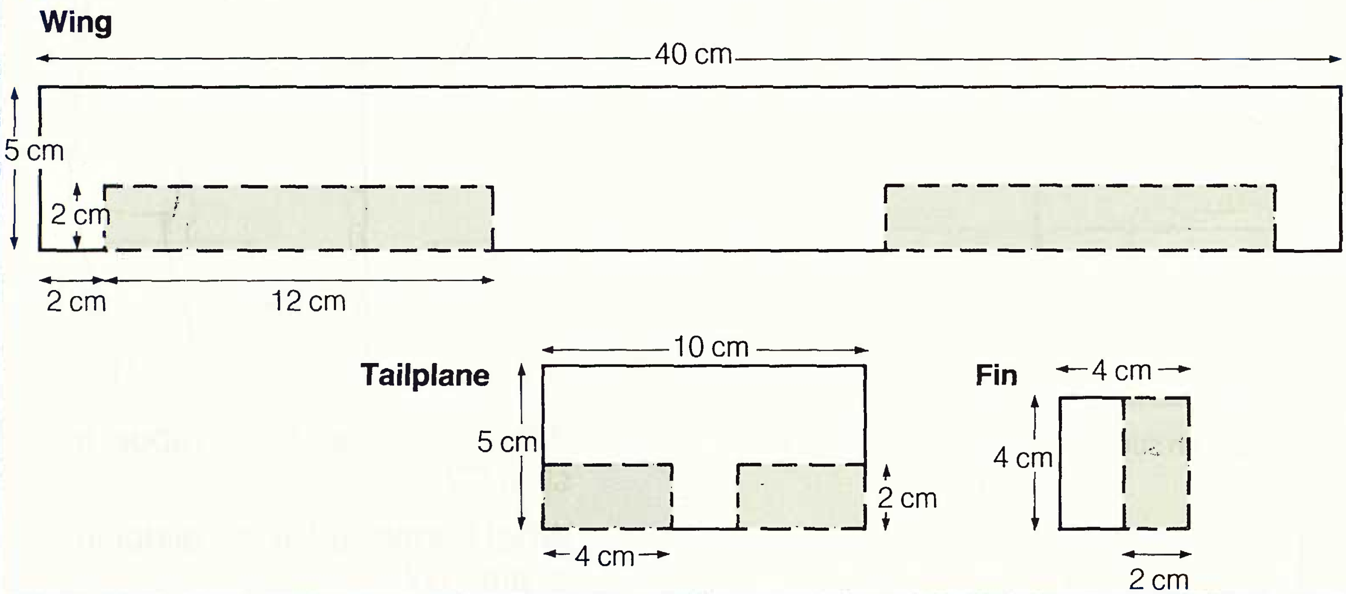
Apparatus

★ sheet of balsa wood 60 cm × 5 cm × 1·5 mm ★ balsa cement ★ ruler ★ plasticine
★ balsa rod 40 cm × 1 cm × 5 mm ★ masking tape ★ pins ★ sharp knife

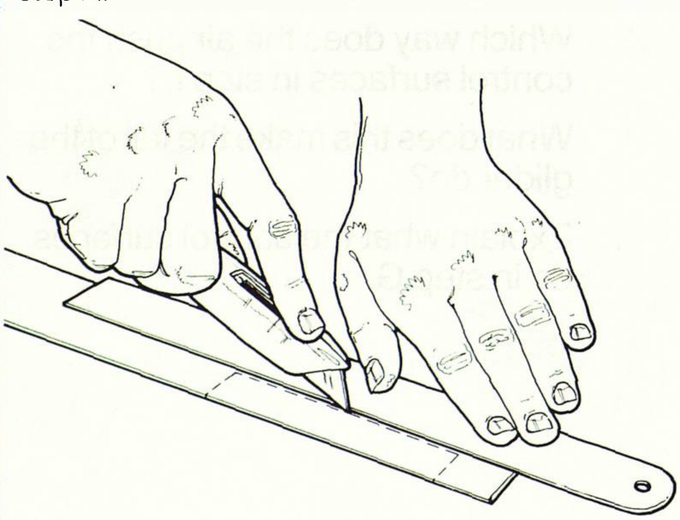
You are going to make a balsa wood glider.

Take great care when using a sharp knife.

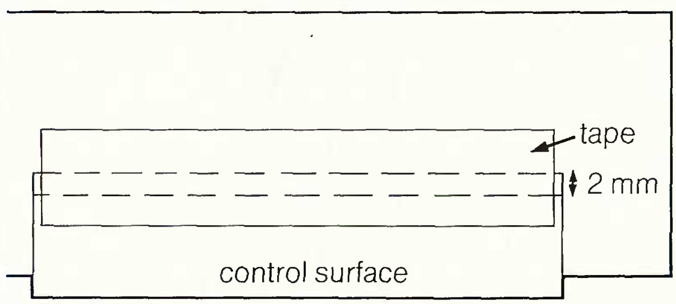
A Cut out the wing, tailplane and fin from the balsa sheet.



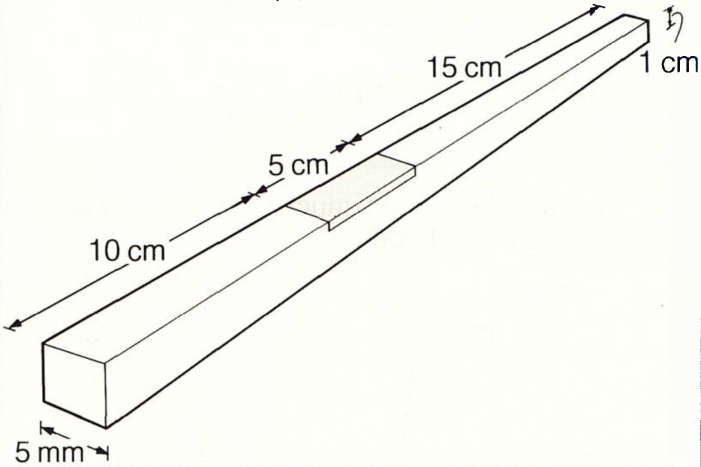
B Using a sharp knife and a ruler cut out the control surfaces as shown by the shaded areas in step A.



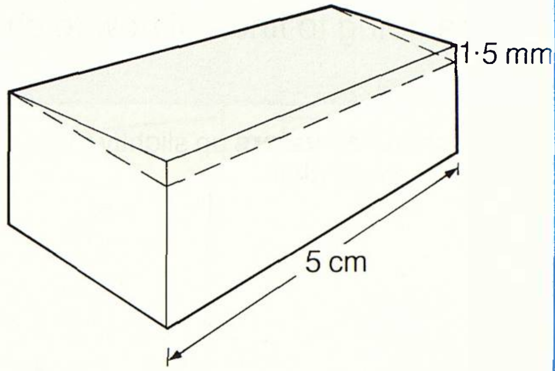
C Fix the control surfaces back in place with a piece of tape on each side. Leave a gap of 2 mm between the control surfaces and the part of the glider they are fixed to as shown below.



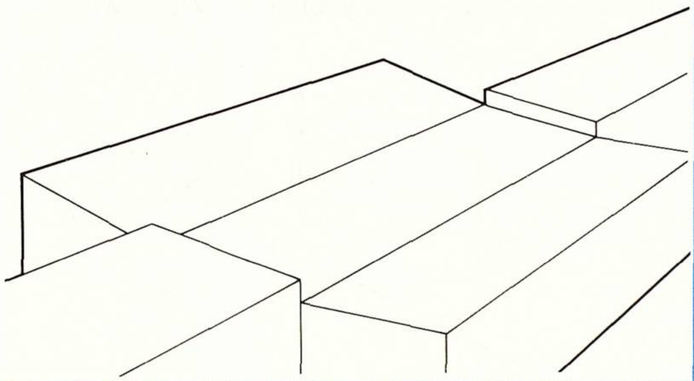
D Using the balsa rod prepare the body of the glider as shown. Cut out the shaded area. (Make the cut 1·5 mm deep.)



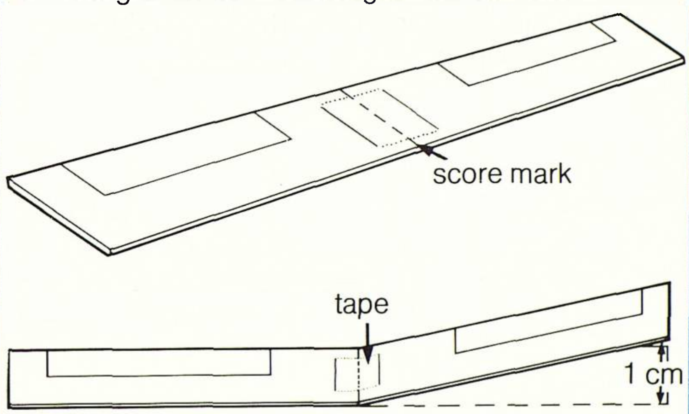
E Cut 2 pieces of balsa rod 5 cm long. Using a ruler draw a line 1·5 mm from one edge of each piece. Using a sharp knife cut out the shaded area as shown.



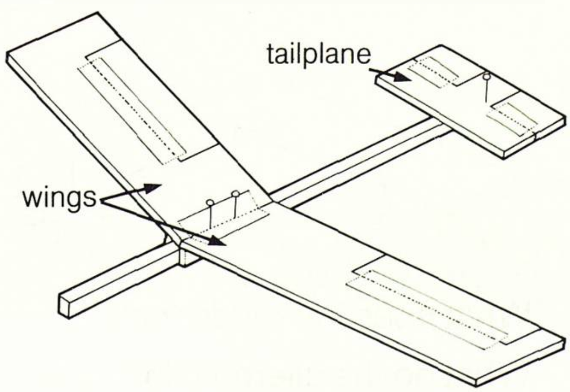
F Using the balsa cement fix the 2 pieces of balsa rod to the body of the glider as shown. The 2 pieces should fit into the area cut out in step D. Leave the cement to harden.



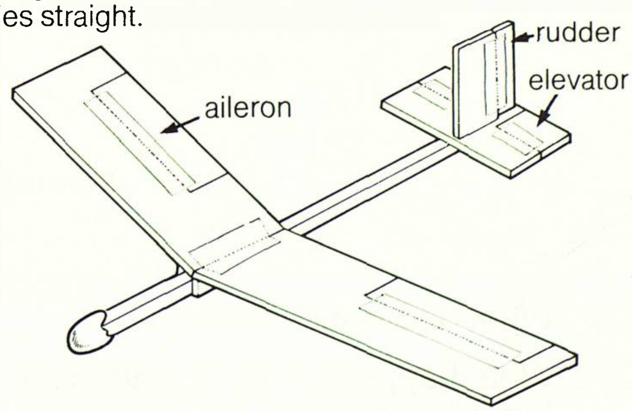
G Score lightly across the middle of the wing. Put a piece of tape over the score mark. Turn the wing over and carefully bend each end up. The ends of the wing should be 1 cm higher than the middle.



H Using the balsa cement glue the wings and tailplane into place on the body of the glider. Hold the wings in place with pins until the cement hardens.



I Glue the fin into place on the tailplane. Leave the cement to harden. Make sure all the control surfaces on the wings, tailplane and fin are level. Weight the nose of the glider with plasticine until it flies straight.



Control in the air

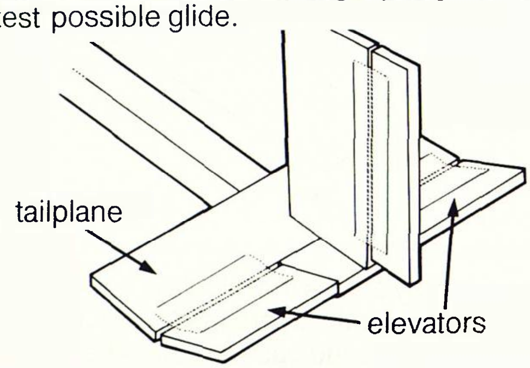
Flying a balsa glider

Apparatus

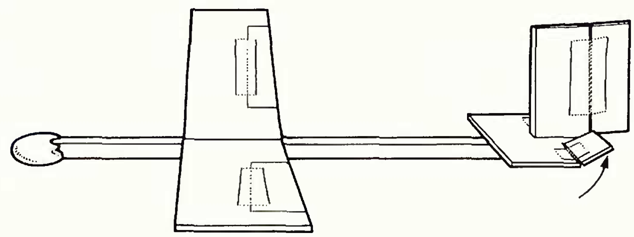
★ balsa glider made on pages 24 and 25.

You are going to find out how to change the flight path of your glider.

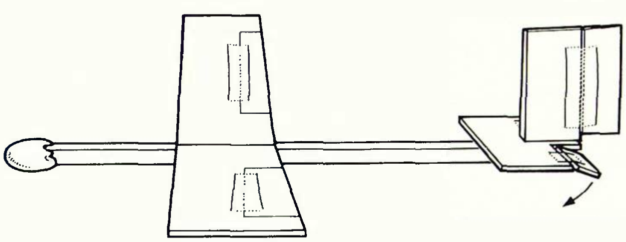
A Turn the **elevators** up slightly to give the flattest possible glide.



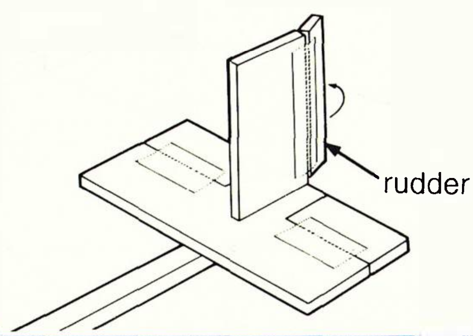
B Turn the elevators up much further. Throw your glider. Watch what happens.



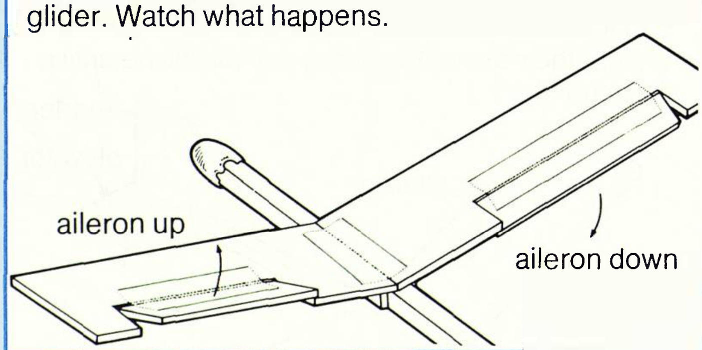
C Turn the elevators down. Throw your glider. Watch what happens.



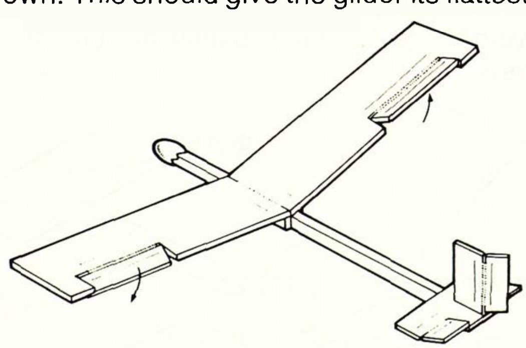
D Turn the **rudder** but keep all the other control surfaces straight. Throw your glider. Watch what happens.



E Turn one **aileron** up and the other down. Keep all the other control surfaces straight. Throw your glider. Watch what happens.



F Throw your glider with the control surfaces set as shown. This should give the glider its flattest turn.



Q6 What do the elevators do?

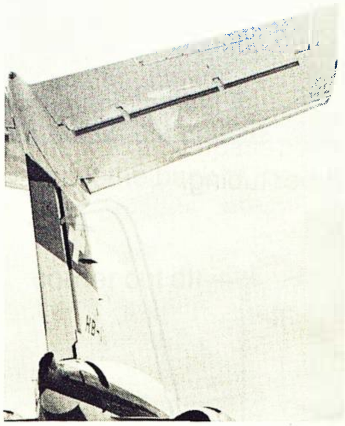
Q7 What happens if the elevators are turned up too far?

Q8 What does the rudder do?

Q9 What do the ailerons do?

Information: Controls

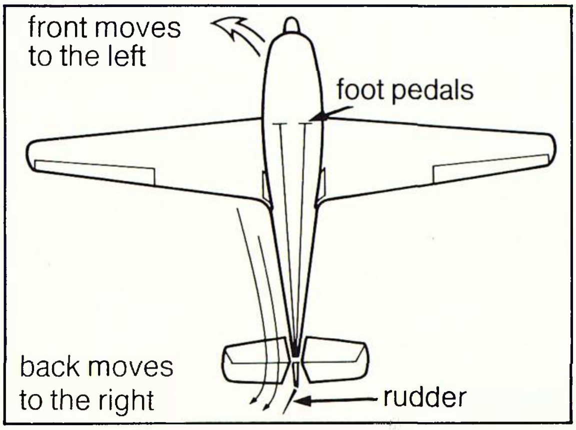
A pilot controls an aeroplane using **foot pedals, a control column** and **engine throttles.**



Foot pedals

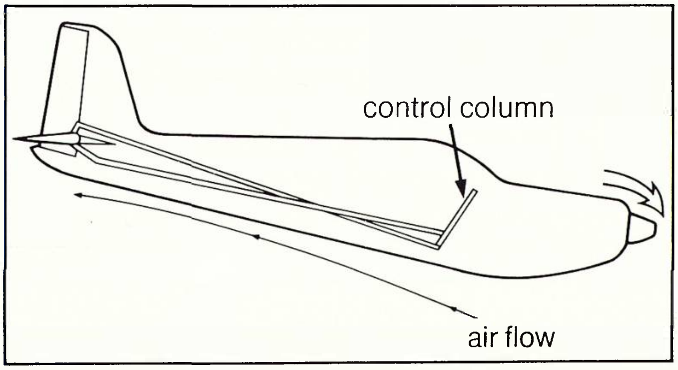
The foot pedals control the rudder, a control surface on the tailplane. If the rudder is turned to the left, the air flow pushes the tail of the plane to the right and the front of the plane turns left.

Plane seen from above

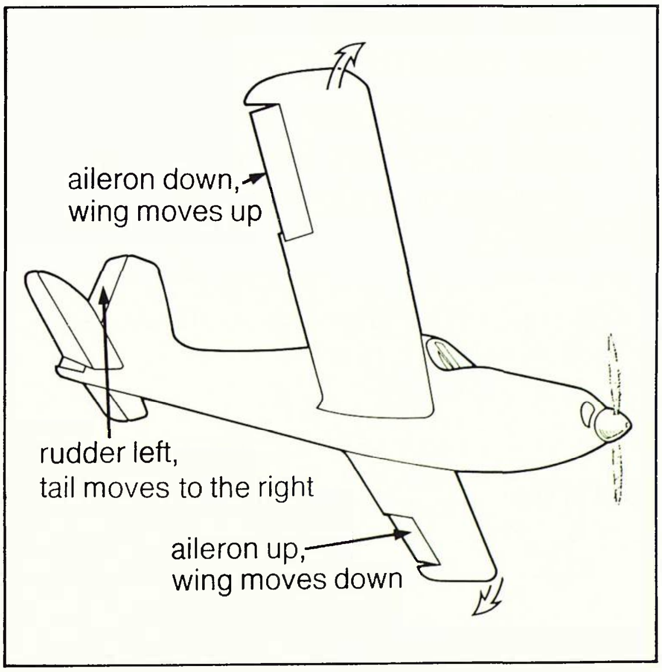


Control column

When the control column is pulled forwards or backwards it operates the elevators (control surfaces on the tailplane). When the control column is moved to the right or left it operates the ailerons (control surfaces on the wings).



The control column is forward so the elevators are down. The air flow pushes the tail up and the plane dives.



The control column is pushed to the left and the ailerons move as shown. The plane **banks** (tilts) left. This stops the plane skidding sideways. In practice the pilot uses ailerons and rudder to get the best turn, and the engine throttles to control thrust.

Q10 How does the pilot make the plane move to the right?

Q11 How does the pilot stop the plane skidding sideways?

6 Space flight

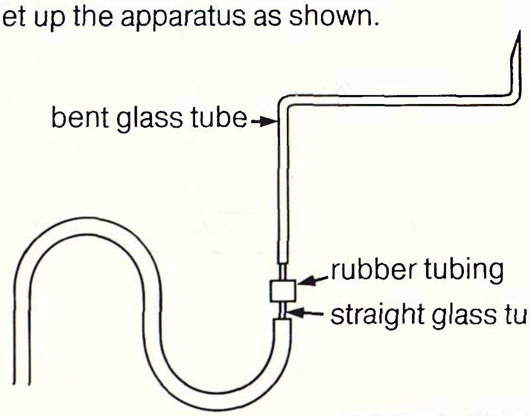
Pushing in pairs (1)

Apparatus

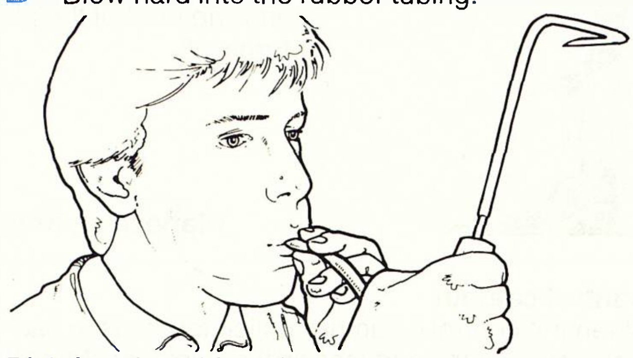
★ rubber tubing ★ straight glass tube ★ bent glass tube ★ straw ★ bulldog clip
★ string ★ "sausage" shaped balloon ★ sticky tape

You are going to find out how rockets work.

A Set up the apparatus as shown.



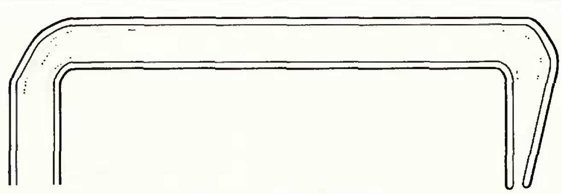
B Blow hard into the rubber tubing.



Disinfect the tubing after use.

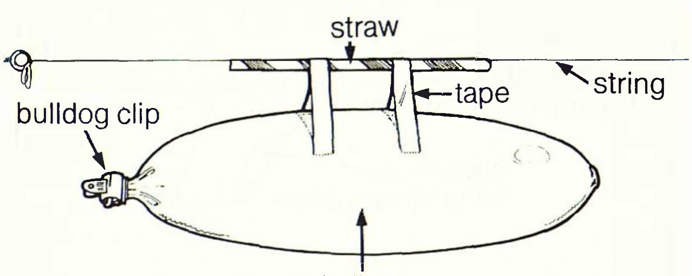
Q1 What happened to the bent glass tube when you blew in air?

Q2 Copy this drawing. Add arrows to show which way the air goes and which way the bent glass tube moves.

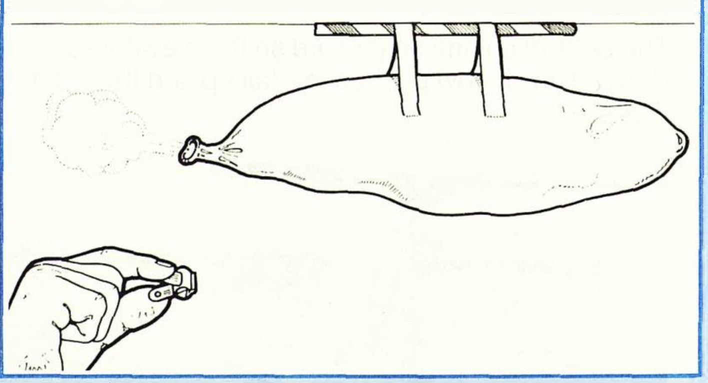


Bent glass tube seen from above.

C Set up the apparatus as shown. Tie each end of the string to opposite walls.

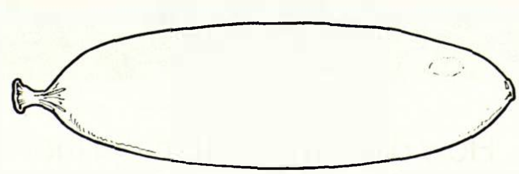


D Remove the bulldog clip.



Q3 What happened when you removed the bulldog clip?

Q4 Copy this drawing. Add arrows to show which way the air goes and which way the balloon moves.

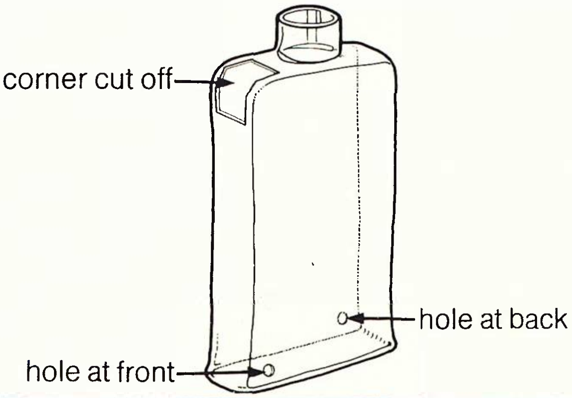


Pushing in pairs (2)

Apparatus

- ★ flat plastic bottle
- ★ scissors
- ★ pair of compasses
- ★ thread
- ★ paperclip
- ★ 500 cc beaker

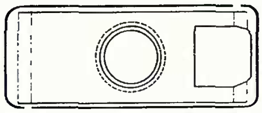
A Ask your teacher for the plastic bottle. Make 2 holes with a compass point, one at the front and the other at the back of the bottle.



B Using the thread and a paperclip hang the bottle over the sink. Fill the bottle with water.

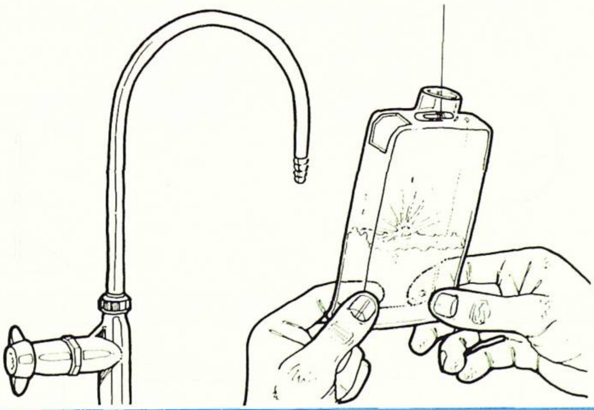
Q5 What happened when the bottle was filled with water?

Q6 Copy this drawing. Add arrows to show which way the water goes and which way the bottle spins.

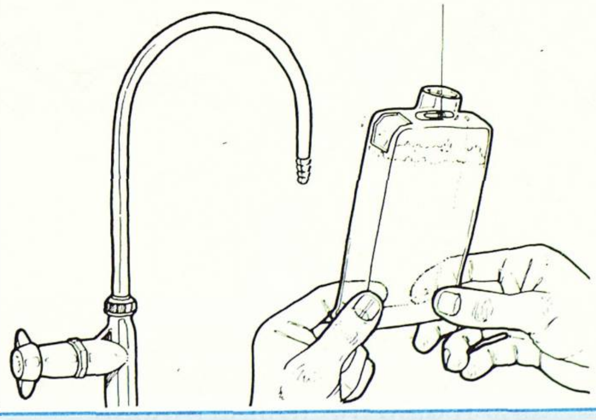


Bottle seen from above

C Put your fingers over the holes and half fill the bottle with water. Take your fingers away and count the number of turns the bottle makes.



D Repeat step C, but fill the bottle up to the top.



Q7 What happened to the number of turns as more water (fuel) was put into the bottle?

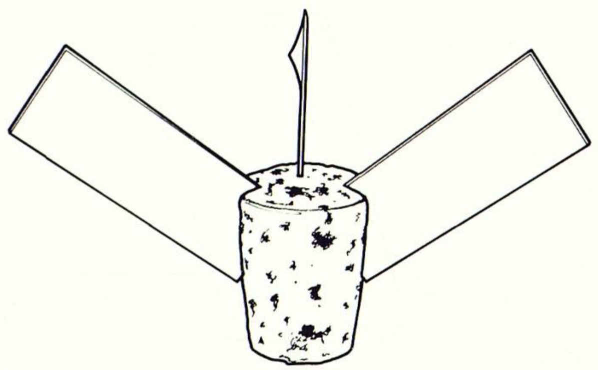
Pushing in pairs (3)

Apparatus

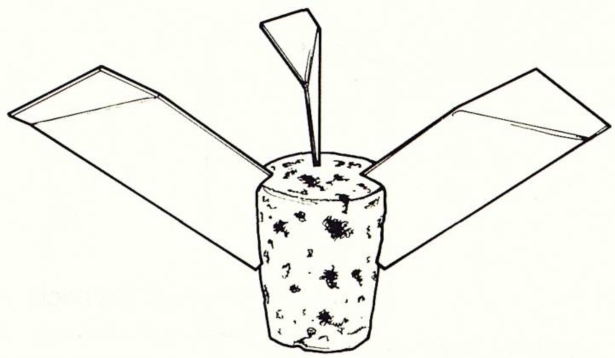
★ cork ★ scalpel ★ 3 strips of card 8 cm × 3 cm ★ glue ★ CO_2 rocket trolley

Take great care when using a scalpel.

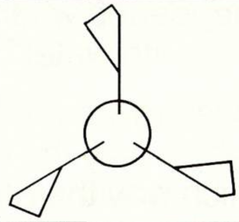
A Make 3 slits (3 cm long) in the cork, equal distances apart. Glue a strip of card into each slit.



B Twist each strip of card anticlockwise. Drop your "shuttlecock".

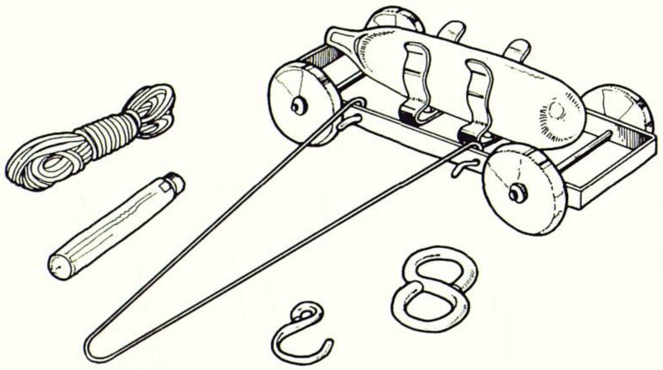


Q8 Copy this drawing. Add arrows to show which way the air is pushed and which way the shuttlecock spins.

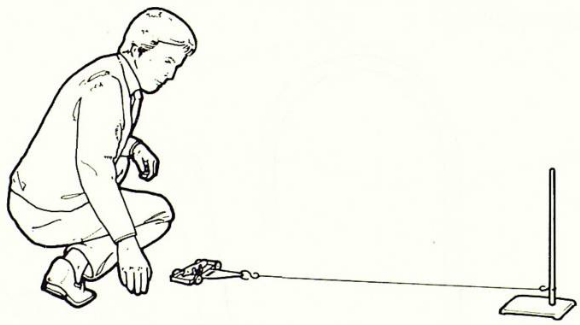


Shuttlecock seen from above

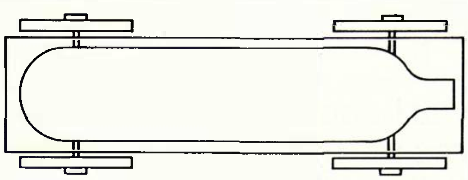
C Your teacher will set up a CO_2 rocket trolley.



D Watch carefully what happens as your teacher releases the gas.



Q9 Copy this drawing. Add arrows to show which way the gas goes and which way the trolley moves.



Pushing in pairs (4)

Apparatus

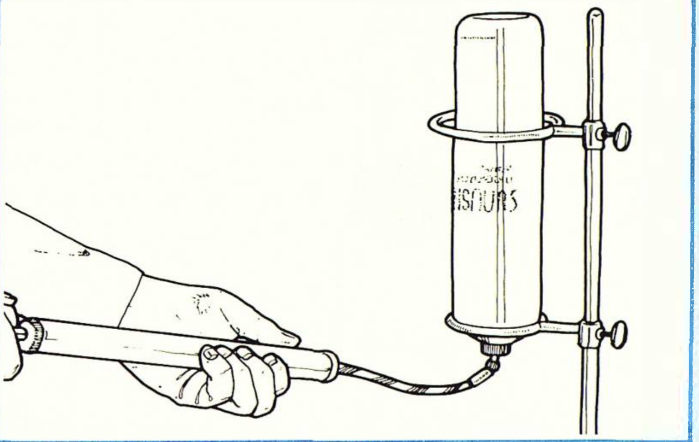
★ clampstand ★ empty washing-up liquid bottle ★ bicycle pump ★ 2 funnel holders
★ plastic cap fitted with bicycle tyre valve ★ beaker

You are going to make a water rocket and launch it.

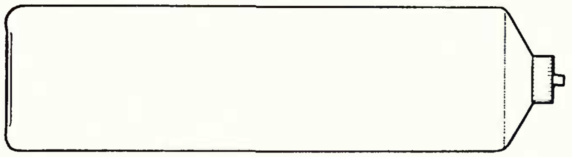
Keep your head out of the way of the rocket in step B.

A Quarter fill the washing-up liquid bottle with water. Fit the plastic cap with the valve onto the bottle. Set up the apparatus as shown.

B Pump air into the rocket until it "lifts off".



Q10 Copy this drawing. Add arrows to show which way the water goes and which way the rocket moves.



Information: Rockets

There is no air in space, so propeller-driven aircraft cannot be used. Rockets carry their own fuel, which blasts out of the back of the spacecraft. The fuel is pushed out in one direction and the rocket is forced forward in the opposite direction.

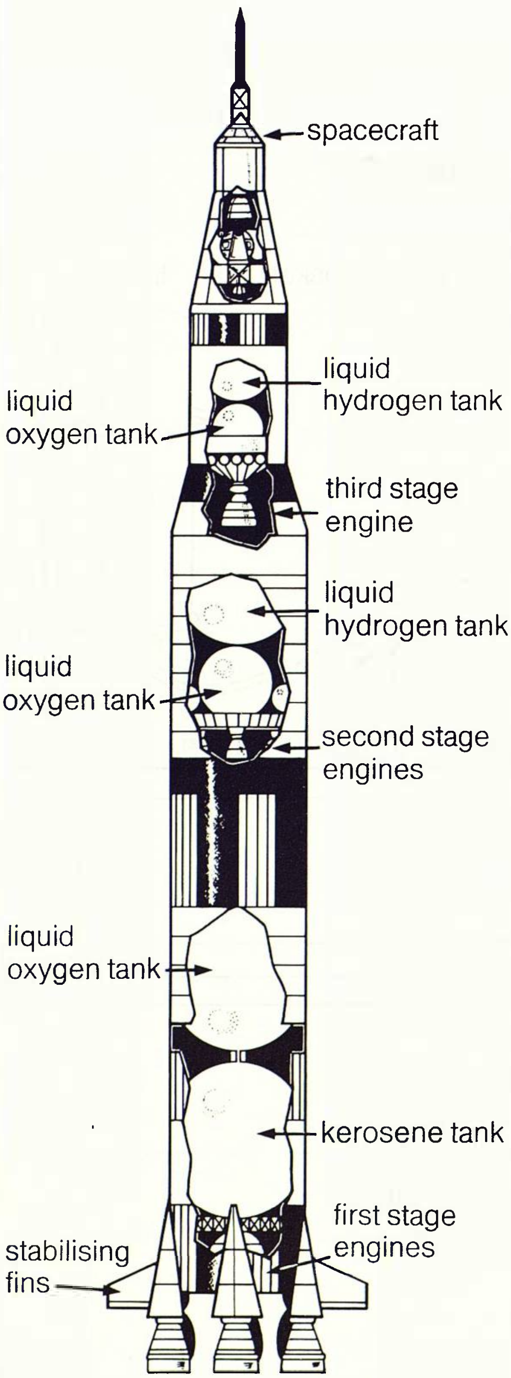
Rockets launched from earth need to be streamlined so that they can push through the earth's atmosphere more easily. In space, objects like **lunar modules** and **satellites** do not need to be streamlined because there is no air to push through.

Q11 Why do rockets need to be streamlined?

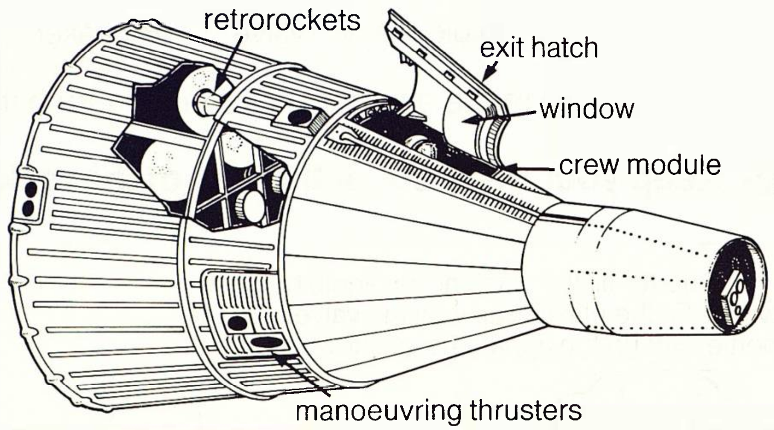
Q12 What kind of spacecraft does not need to be streamlined?

Information: Rockets

Moon rocket



Gemini spacecraft



This rocket has 3 stages. Each fires in turn. When the fuel in a stage is used up the stage falls away and the next stage fires.

The rocket carries **oxygen** inside it in liquid form. The other fuels used are **kerosene** and **hydrogen.** These burn with oxygen, and the hot gases blasting out of the back of the rocket force the rocket upwards.

A multistage rocket like this is needed to lift a spacecraft into **orbit.**

Spacecraft like the Gemini have **thrusters** (small rockets) so that the spacecraft can be **manoeuvred** (turned) in the **vacuum** of space.

Q13 Why is more fuel carried in the first stage than in the third stage of a rocket?

Q14 What is the purpose of the stabilising fins?

Teachers' Guide to Flight

SCIENCE AT WORK

Introduction

The units

Science at Work is a series of 18 science units for 14-16 year old, less able pupils. Each unit consists of a pupils' book and a teachers' guide. Each provides a complete half-term's course of study. The units are self-contained, and can be taken in any order.

The pupils' books

The pupils' books provide information, practical investigations and questions. Pupils are thus able to work from the books at their own pace; generally, the work becomes more difficult towards the end of each book and the weakest pupils are not expected to finish every unit. The material has been checked by a language specialist, who has ensured that the reading level is as low as possible.

INVESTIGATIONS

Each investigation begins with a list of the apparatus required. The purpose is then stated, and instructions for the investigation given (in words and pictures). Finally, the pupils are asked questions which help them record their results and draw conclusions. (Throughout the books a pupil is expected to make a written response each time a 'Q' appears.)

INFORMATION

Appropriate information from the real world follows most investigations, in most cases from the world of work. Questions are also asked about these information sections.

The teachers' guides

Each unit has a teachers' guide. This contains record sheets and information for the teacher.

RECORD SHEETS

Record sheets in the form of masters are provided in each guide. These sheets will save pupils copying tables, and will help them write answers to questions as complete sentences. One record sheet is provided for each chapter of the pupils' book. Teachers may decide to give record sheets only to those pupils who have difficulty with writing; alternatively, they may be given to all pupils.

OTHER RESOURCES FOR THE TEACHER

Each teachers' guide contains:
course and unit objectives
hints on introducing and teaching the unit
an apparatus list (for technicians)
safety procedures
new scientific words (which pupils may have difficulty reading)
answers to questions in the pupils' book
a resource list.
Specimen questions for a post-unit test are also included.

Examining the course

Science at Work is derived from a successful and well-proven modular scheme developed by teachers in Manchester LEA. Most of the pupils following the course in Manchester gain a CSE Mode III certificate in science. Model CSE papers for most of the regional examination boards are available on request from Addison-Wesley.

Aims of the course

1. To provide a flexible science course based on non-sequential study units. Though developed predominantly for less able pupils, the course can cater for pupils capable of CSE grade 1 by the addition of suitable extension work.
2. To develop pupils' thinking in scientific methodology and the approach to problem solving.
3. To give knowledge and understanding of science relevant to pupils' interests, environment, and future work and leisure needs.
4. To develop pupils' interest in science and enjoyment of science.
5. To provide a wide range of practical experiences and develop practical skills.
6. To develop the ability to work both independently and as a member of a team.

General objectives of the course

1. To develop the ability to carry out experimental procedures and written work according to instructions.
2. To develop manipulative skill in handling equipment and an awareness of safe practice.
3. To develop powers of accurate observation.
4. To develop the ability to check statements and assertions against tests of observation and experiment.
5. To develop skill in handling the interpretation of data.
6. To develop the ability to look for and make generalisations (this objective is likely to be achieved by only the ablest pupils).
7. To be able to understand and recall the factual content of the material.
8. To develop communication skills – verbal, written, and mathematical.
9. To develop the ability to apply knowledge gained.
10. To encourage pride in neatly and accurately produced work.
11. To develop awareness of the responsible use of science and technology.

Objectives of the Flight unit

When they have completed the unit the pupils will have an increased awareness of the applications of the principles of science to the phenomenon of flight. They will have developed manual skills through using tools and glue to make models. They will also find out:

how to use the drag of the air to make controlled descents with paper models
how to fold paper to make streamlined shapes
how to make paper fly through the air
how nature uses the drag of the air in seed dispersal
that the forces involved in flight are lift, weight, thrust and drag
how to trim a paper model to prevent it stalling and diving
how to control the flight of paper planes and straw darts using control surfaces and fins
that a fast flow of air produces low pressure
how fast flow/pressure low is used by aircraft to produce lift
how a real and a model aircraft can be made to roll, pitch and yaw
that forces occur in pairs
that rockets work on the principle of forces occurring in pairs
how movement is possible in space

Teaching the Flight unit

Introducing the unit

The unit may be introduced in several ways:

1. A visit to an airport or a museum of flight.
2. A discussion of questions like: How heavy is a jumbo jet? How can it be supported and controlled in the air?
3. A discussion of the photographs on page 1 of the pupils' book on the different ways that man can move through the air.
4. A short talk on the history of powered flight – Orville and Wilbur Wright, Blériot etc.

Teaching the unit

The pupils' book contains 6 chapters. Most chapters have practical and information sections. There are sequential questions within each chapter: these indicate when a student has to write in a notebook. For slow readers and writers, there are record sheets to each chapter. The record sheets are copyright free and are contained within this teachers' guide (pages 8–15).

Samples of the type of questions that may be used for assessment when pupils have completed the unit are on page 16.

In the pages which follow, each chapter is discussed with reference to: apparatus per working group; new scientific words; safety and teaching hints; answers to practical questions (where necessary); resources.

Detailed teaching notes

1 FALLING THROUGH THE AIR

FALLING SHEETS OF PAPER
(pupils' book page 2)

Apparatus: scissors; 2 pieces of A4 paper

This first experiment introduces the idea of how the amount of drag depends on the surface area of the object. The argument that the paper is made heavier by folding could be discussed.
In step B both pieces of paper should take the same time to fall. Make sure they are dropped from the same height. The experiment should be repeated a number of times.

Q1 Both together.
Q2 Paper labelled X.
Q3 Paper labelled Y.
Q4 The smaller the surface area of the paper, the faster it falls.
Q5 Swayed from side to side.

DIRECTED DESCENTS
(pupils' book page 3)

Apparatus: chalk; scissors; piece of A4 paper; glue

The drag of the air is used to make a stable descent. If the model gets tilted during its descent it presents a bigger surface area to the air. There is now more drag on this surface, and the model is pushed back to its stable position.
Q6 No. Q7 Yes. Q8 Yes.

A DIRECTED DESCENT WITH A PAPER HELICOPTER
(pupils' book page 4)

Apparatus: piece of A4 paper; ruler; scissors; paperclips
New Words: air resistance, stable

The measurements for the helicopter are not critical, although pupils should be encouraged to follow the instructions. If the flaps are made too long there will be too much drag and the helicopter will not spin.

Q9 a) and b) By folding the flaps over in the opposite direction.
Q10 Falls faster.
Q11 Falls faster.

2 PARACHUTES

THE RATE OF FALL OF A PARACHUTE
(pupils' book pages 6 and 7)

Apparatus: piece of card 30 cm x 30 cm; sheet of polythene; masking tape; cotton thread; paperclips; scissors; pair of compasses; stop clock; ruler

Try to keep the thread untangled. Cutting a hole in the polythene increases the stability of the descent.

Q2 Parachute in step D.
Q3 Yes. Q4 Yes.
Q5 Parachutes E and F move from side to side. Parachute G falls straight down.
Q6 It makes the parachute more stable.

PARACHUTES IN NATURE
(Pupils' book page 8)

Apparatus: plasticine; piece of A4 paper; scissors; sycamore seed; stop clock
New Words: suspension lines, drag

Trace round the shape given in the pupils' book for the best results. You may need to vary the amount of plasticine before the model will spin downwards like a sycamore. If possible get a real sycamore seed for comparison. A small paperclip can be used instead of plasticine.

Q7 Yes.
Q8 Plasticine ball.
Q9 Yes.
Q10 They are given time to be blown away from the parent tree and therefore a better chance of survival.

3 FLIGHT

MAKING A PAPER GLIDER
(pupils' book pages 10 and 11)

Apparatus: piece of A4 paper; sticky tape; paperclips; scissors
New Words: stalls, glides, dives

Pupils will probably need some help with this, so it is a good idea to practise the design yourself beforehand. Folding up the wings slightly in step I inhibits the model gilder rolling. A gentle launch, rather than a forceful throw which produces too much drag, gives the best glide.

Q1 This is where the glider is tail heavy. The nose of the glider comes up, more drag is produced and forward speed is reduced.
Q2 Weighting the nose with a paperclip.
Q3 This is where the nose is too heavy and the tail comes up. This causes drag, the glider loses forward speed and falls.
Q4 Bending up the back edge of the wings very slightly.

STABILISING
(pupils' book pages 12 and 13)

Apparatus. straws; pieces of stiff paper; scalpel; ruler
New Words: streamlined, keel, yawing, pitching, rolling

SAFETY: For some pupils you may find it advisable to provide straws with 15 mm slots already prepared. Two straws are needed; one is used as a control. The paper should be fairly stiff. Aim the straw at a target drawn on the chalkboard. The flights on the straw keep it on course. The other straw will roll, pitch and yaw.

Q5 Yes. Q6 At the back.
Q7 Turns round so that fins are at the back (because of the air resistance on the fins).
Q8 Twisted the fins.

4 FORCES FOR FLIGHT

AIR FLOWING OVER A CURVED SURFACE
(pupils' book pages 15 and 16)

Apparatus: ruler; cotton thread; sticky tape; 3 table tennis balls; egg cup; funnel; 2 pieces of A4 paper; clampstand; air blower; straws; string; model wing

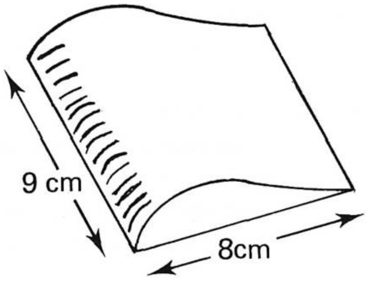
All the following experiments illustrate the principle of where there is a fast flow of air the pressure is low.

In steps A and B the table tennis balls are suspended 2 cm apart. Blowing between them makes them move together.

In step C make sure the table tennis ball fits right inside the egg cup. Pupils should blow *over*, not *into* the egg cup. The ball jumps out of the cup since there is low pressure above the ball and higher pressure inside the egg cup.

In step D the fast flow of air between the ball and the funnel produces a low pressure region. The atmospheric pressure then holds the ball in position. Pupils must blow hard.

The model wing is made from stiff paper.



New Words: aerofoil, lift, angle of attack, fast flow – pressure low

In step E the air under the paper bridge is fast flowing and produces low pressure. Atmospheric pressure pushes down on the paper and the bridge collapses.
In step F the paper has a similar shape to a section of an aircraft's wing. Blowing over the top of the paper gives a fast flow of air and a low pressure above the wing. Higher pressure below the paper causes the paper to be pushed up. It experiences lift.
In steps G and H the model wing section should be constructed as shown. Use a blower to direct air at the wing, not on the underside of the wing. The wing section will rise.

Q1 Towards each other.
Q2 Upwards.
Q3 a) No. b) Vibrates in the funnel.
Q4 Down. Q5 Up. Q6 Up.
Q7 In step E the paper bridge is pushed down very quickly.
In step F the piece of paper is rapidly lifted.

THRUST
(pupils' book pages 18 and 19)

Apparatus: hacksaw; cork; piece of stiff card; dowelling 15 cm long (or lollipop stick); knife; glue, tracing paper; ruler
New Words: thrust, airscrew, rotates, rotors, pitch

SAFETY: You may wish to prepare the corks in advance.
In steps F and H the propeller is pushing the air downwards, so the propeller rises. In step G the propeller is pushing the air upwards, so the propeller is pushed downwards.
Acceleration or thrust forwards takes place when the force of the propeller or jet engine is greater than the drag of the air.

Q10 a) It rises. b) It descends.
Q11 It rises.

DRAG
(pupils' book page 20)

Apparatus: 2 pieces of A4 paper
New Words: drag, lift, weight, streamlined

In step A the piece of paper will not fly. The drag of the air greatly resists the forward motion.
In step B the crumpled ball moves forward through the air but falls quickly because of the reduced drag.
The best shape for flight is one that will fall slowly, but travel forwards through the air. This is a streamlined shape.

Q14 a) Step B. b) Less drag (air resistance).
Q15 The glider moves forward and falls slowly.
The paper ball moves forward too but falls quickly.

Answers to questions in pupils' book, page 21

Q16 a) Air flowing over an aerofoil shape (wing) causes lift.
b) Thrust is the push that keeps a plane moving. It is provided by either a propeller or a jet.
c) Drag is caused by the plane's shape as it moves through the air.
Q17 The plane moves at a constant speed.
Q18 The plane loses height.
Q19 The increased speed of the plane causes more air to flow over the wings, resulting in greater lift.
Q20 Lift is greater than the weight of the plane.

5 CONTROL IN THE AIR

CONTROL SURFACES
(pupils' book pages 22 and 23)

Apparatus: straws; scalpel; piece of A4 paper; piece of stiff card; pin; scissors; dowelling

SAFETY: You may wish to prepare the slits in the straws in advance.
The air flow gives a downwards push on the left hand strip of card and an upwards push on the right hand card. This causes anticlockwise rotation.
The glider is the same one as before, but the wings should be bent downwards slightly to facilitate rolling. To make the glider loop the loop launch it vertically as shown in step G.

Q1 Rotates.
Q2 a) Anticlockwise roll. b) Clockwise roll.
c) Dive. d) Loop the loop.
Q3 Upwards.
Q4 Pushes the tail up.
Q5 The air pushes on the control surfaces, causing the tail to be pulled down.

A BALSA WOOD GLIDER
(pupils' book pages 24, 25 and 26)

Apparatus: balsa wood sheet 60 cm x 5 cm x 1.5 mm; balsa cement; ruler; balsa rod 40 cm x 1 cm x 5 mm; masking tape; pins; sharp knife; plasticine
New Words: elevators, ailerons, rudder, engine throttles, banks, control column

Follow the instructions and dimensions for the glider closely. It may be a good idea to make a model yourself beforehand, as pupils could find this difficult to make and may need help. It is only necessary to bend the control surfaces slightly to get the best flight from the glider, since we do not want to create a lot of drag.

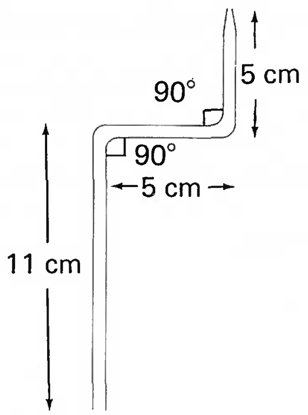
Q6 Makes the plane climb or dive.
Q7 The plane stalls.
Q8 Turns the plane to the left or right.
Q9 Makes the plane bank or tilt.

6 SPACE FLIGHT

PUSHING IN PAIRS (1)
(pupils' book page 28)

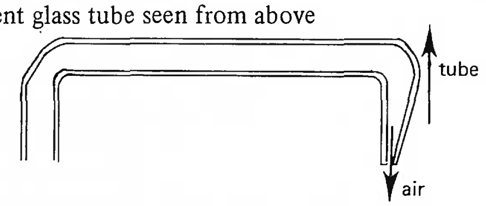
Apparatus: rubber tubing; straight glass tube; bent glass tube; straw; bulldog clip; string; 'sausage' shaped balloon; sticky tape

The bent glass tube in step A should have a bore of about 5 mm. It should be bent into this shape.



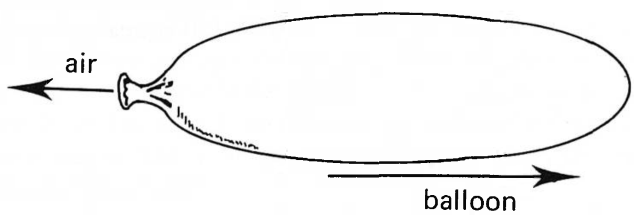
In step B blowing hard into the rubber tubing will make the bent glass tube rotate. Air is pushed out from the jet and this in turn pushes back on the glass tube.

Q1 It rotates.
Q2 Bent glass tube seen from above



In step D the balloon is pushed forward by air released from inside the balloon being ejected backwards.
A 'sausage' balloon is the best shape for this experiment.

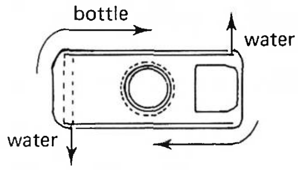
Q3 The balloon moves along the string.
Q4



PUSHING IN PAIRS (2)
(pupils' book page 29)

Apparatus: thread; paperclip; large beaker; plastic bottle (rectangular shape); scissors; pair of compasses

SAFETY: You should prepare the hole in the top of the bottle beforehand. The pupils can use the pair of compasses to make holes in the bottle. The holes should be level.
The bottle should spin as water comes out of both holes. (A garden sprinkler works on the same principle.)
The water pressure provides the forces causing rotation.
Q5 It spins.
Q6 Bottle seen from above

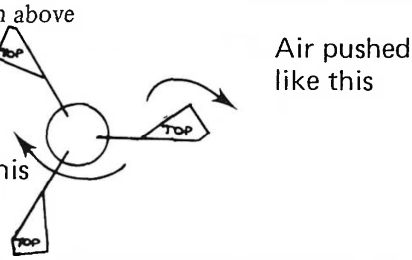


Q7 Increases the number of turns.
Turns faster.

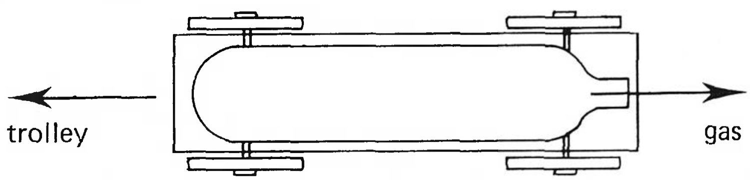
PUSHING IN PAIRS (3)
(pupils' book page 30)

Apparatus: cork; scalpel; 3 strips thick paper 8 cm x 3 cm; glue; CO_2 rocket trolley; CO_2 sparklet

You may wish to prepare the corks in advance. Twisting each strip of paper causes rotation of the 'shuttlecock'. If the slant of the paper strips is reduced the shuttlecock will fall and rotate more slowly. Less air is being pushed to the side and the greater surface area presented means the upward drag is increased.
Q8 Shuttlecock seen from above



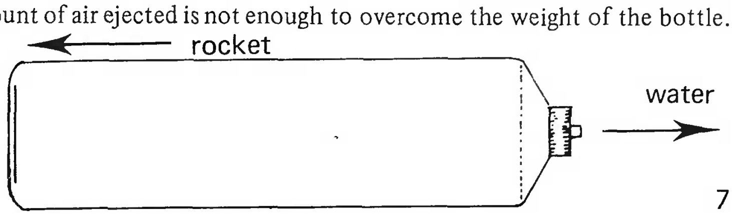
The CO_2 trolley and sparklet are available from Philip Harris Limited, Lyme Lane, Shenstone, Staffs. and Griffin & George Limited, 285 Ealing Road, Alperton.
The trolley should be tethered to a central pivot (clampstand with a heavy weight will suffice). When the gas is released it will travel very rapidly in a circle.
Q9 Trolley seen from above



PUSHING IN PAIRS (4)
(pupils' book page 31)

Apparatus: clampstand; plastic bottle (washing up liquid type); bicycle pump and valve; 2 funnel holders; beaker
New Words: lunar module, satellites, orbit, thrusters, manoeuvred, vacuum

SAFETY: Make sure pupils keep their heads out of the way!
You should glue the bicycle valve into the bottle cap beforehand. Pump air into the bottle until lift off occurs.
Rockets eject enormous masses of fuel to provide the necessary thrust. The water rocket will not work using air only, because the thrust produced by the small amount of air ejected is not enough to overcome the weight of the bottle.
Q10



1 Falling through the air

FALLING SHEETS OF PAPER (page 2)

Q1 In step B . . . .

Q2 In step C paper *X/Y* reached the ground first.

Q3 In step D paper *X/Y* reached the ground first.

Q4 The paper falls faster if it has a *greater/smaller* surface area.

Q5 The pieces of paper . . . .

DIRECTED DESCENTS (page 3)

Q6 It *was/was not* easy to control the descent of the paper in step A.

Q7 It *was/was not* easy to control the descent of the paper in step D.

Q8 The pyramid shape in step E *was/was not* self-righting.

A DIRECTED DESCENT WITH A PAPER HELICOPTER (page 4)

Q9 a) I made the helicopter spin clockwise by . . . .

. . . .

b) I made the helicopter spin anticlockwise by . . . .

. . . .

Q10 When more paper clips were added the helicopter . . . .

Q11 When the wings were shortened the helicopter . . . .

INFORMATION: AIR RESISTANCE (page 5)

Q12 Air resistance is . . . .

Q13 An object will fall more quickly if . . . .

Q14 The free falling parachutists extend their arms and legs to . . . .

. . . .

RECORD SHEET

2 Parachutes

THE RATE OF FALL OF A PARACHUTE (pages 6 and 7)

Q1

Number of paperclips	Diameter of polythene	With or without hole in top of polythene	Time taken to reach floor (s)
3			
6			
9			
3			
3			

Q2 The parachute that fell most slowly was . . . .

Q3 A large parachute *does/does not* fall more slowly than a small one.

Q4 More weight *does/does not* make a parachute fall faster.

Q5 The parachute in step E . . . .

The parachute in step F . . . .

The parachute in step G . . . .

Q6 When a hole was cut in the parachute in step G it . . . .

. . . .

PARACHUTES IN NATURE (page 8)

Q7 The model seed *did/did not* fall like a sycamore seed.

Q8 The . . . . fell faster than the . . . .

Q9 The wing *did/did not* make the plasticine ball fall more slowly.

Q10 The advantage of seeds falling slowly from trees is . . . .

. . . .

RECORD SHEET

3 Flight

GLIDING, STALLING AND DIVING (page 11)

Q1 A stall is . . . .

Q2 A stall can be cured by . . . .

Q3 A dive is . . . .

Q4 A dive can be cured by . . . .

STABILISING (pages 12 and 13)

Q5 The fins *did/did not* make the dart fly straight.

Q6 The fins should be at the . . . . of an object.

Q7 When the fins are at the front of the dart it . . . .

. . . .

Q8 I made the dart spin by . . . .

INFORMATION:STREAMLINING, YAWING, PITCHING AND ROLLING (page 14)

Q9 Streamlining is . . . .

Q10 Yawing is . . . .

Q11 Pitching is . . . .

Q12 Rolling is . . . .

4 Forces for flight

AIR FLOWING OVER A CURVED SURFACE (pages 15 and 16)

Q1 The balls moved . . . .

Q2 In step C the ball moved . . . .

Q3 a) I *could/could not* blow the ball out of the funnel.

b) Blowing made the ball . . . .

Q4 In step E the paper moved . . . .

Q5 In step F the paper moved . . . .

Q6 In step H the wing moved . . . .

Q7 As you blow harder in step E the paper . . . .

As you blow harder in step F the paper . . . .

INFORMATION: LIFT (page 17)

Q8 Lift is . . . .

Q9 If the lift on a wing is greater than the weight of the plane, the plane will . . . .

. . . .

THRUST (page 19)

Q10 a) In step F the propeller . . . .

b) In step G the propeller . . . .

Q11 When the propeller is spun upside down it . . . .

INFORMATION: THRUST (page 19)

Q12 Thrust is . . . .

Q13 A jet plane flies by . . . .

4 FORCES FOR FLIGHT (Continued)

DRAG (page 20)

Q14 a) It was easier to throw the paper in . . . .

b) It was easier because . . . .

Q15 The difference between the way the ball of paper and the paper glider moved through the air was . . . .

. . . .

INFORMATION: LIFT, THRUST, DRAG (page 21)

Q16 a) Lift is caused by . . . .

b) Thrust is caused by . . . .

c) Drag is caused by . . . .

Q17 The speed of the plane is *increasing/decreasing/constant.*

Q18 If the weight is greater than the lift the plane will . . . .

Q19 The plane will climb because . . . .

Q20 At take-off the lift of the plane is . . . . the weight of the plane.

5 Control surfaces

CONTROL IN THE AIR (pages 22 and 23)

Q1 In step C the model ....

Q2 a) In step D the glider ....

b) In step E the glider ....

c) In step F the glider ....

d) In step G the glider ....

Q3 In step F the air pushed the control surfaces *downwards/upwards*.

Q4 This makes the tail of the glider move *downwards/upwards*.

Q5 In step G the control surfaces ....

FLYING A BALSA GLIDER (page 26)

Q6 The elevators ....

Q7 If the elevators are turned up too far the glider will ....

Q8 The rudder ....

Q9 The ailerons ....

INFORMATION: CONTROLS (page 27)

Q10 The pilot makes the plane move to the right by ....

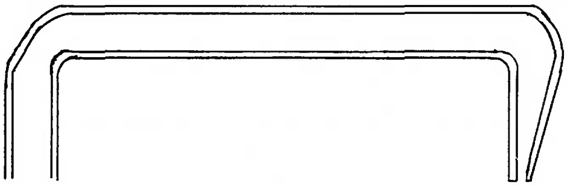
Q11 The pilot stops the plane skidding sideways by ....

6 Space flight

PUSHING IN PAIRS (1) (page 28)

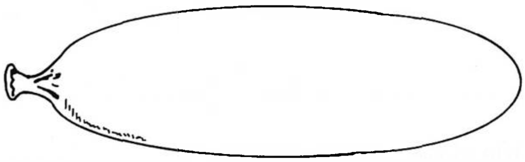
Q1 When air was blown in to the rubber tubing, the bent glass tube ....

Q2



Q3 When the bulldog clip was removed the balloon ....

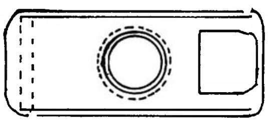
Q4



PUSHING IN PAIRS (2) (page 29)

Q5 When the bottle was filled with water it ....

Q6



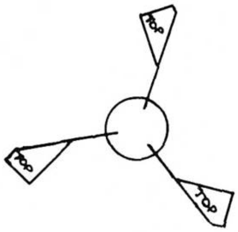
Q7 As more water was added to the bottle the number of turns *increased/decreased*.

RECORD SHEET

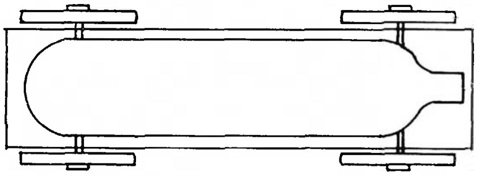
6 SPACE FLIGHT (Continued)

PUSHING IN PAIRS (3) (page 30)

Q8

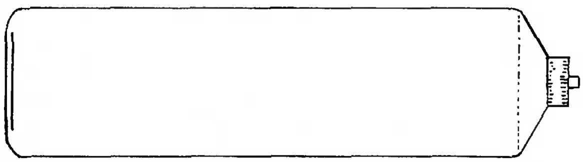


Q9



PUSHING IN PAIRS (4) (page 31)

Q10



INFORMATION: ROCKETS (pages 31 and 32)

Q11 Rockets need to be streamlined because . . . .

Q12 . . . . and . . . . do not need to be streamlined

because . . . .

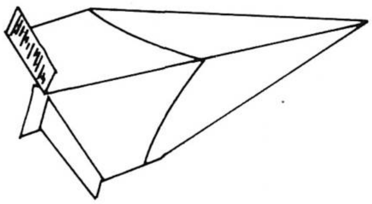
Q13 More fuel is carried in the first stage than the third stage because . . . .

. . . .

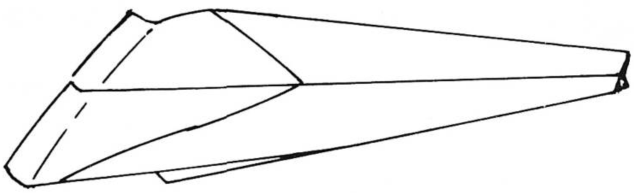
Q14 The stabilising fins are used to . . . .

Specimen post-unit questions

1 Look at the control surfaces on this glider. Which way will the glider move when it is thrown? Draw an arrow to show the direction.

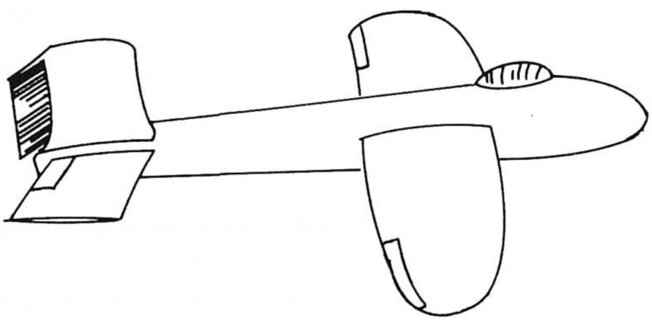


2 Draw an arrow to show which way this glider will move.



3 Make a sketch to show how you would set the control surfaces on your paper glider to make it dive.

4 Which way will this plane move?



5 A propeller gives a plane forwards push.
This push is called: Tick (√) your answer.
a) drag b) lift
c) thrust d) weight

6 Complete this paragraph:
A plane can make three kinds of movements in the air. It can r_ _ _, p_ _ _ _ and _ _ _. A pilot can control the movements of his aircraft by pulling on the control column. The control column operates moveable c_ _ _ _ _ _ _ _ _ _ _ _ _ _ _. On the wings these are called _ _ _ _ _ _ _ _ _. On the tailplane they are called _ _ _ _ _ _ _ _ _ _ and on the tail fin the control surface is called the _ _ _ _ _ _ _. The rudder controls _______ movements. The ______ control rolling movements. The elevators control ______ movements.

7 When air flows over a wing the wing is pushed upwards. This upwards push is called: Tick (√) your answer.
a) thrust b) drag
c) lift d) yaw

8 Explain how it is possible for rockets to manoeuvre in space.

9 In hang gliding if the lift on the hang glider is greater than your weight, then the hang glider will: Tick (√) your answer.
a) descend b) ascend
c) stall d) bank

10 Skydivers can leave the aircraft at different times and yet meet up as they fall through the air. Explain how they could do this.

Reference books

R.S. Barnaby, *How to Make and Fly Paper Aircraft*, Piccolo Books
Newing & Bowood, *Air, Wind and Flight*, Ladybird Books
S. Simon, *Paper Aeroplane Book*, Puffin Books
Know How Book of Flying Models, Usborne Publishers
R. Turnill, *The Observer's Spaceflight Directory*, Frederick Warne, 1978
Teaching Primary Science Aerial Models, Macdonald Educational Ltd, 1978

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