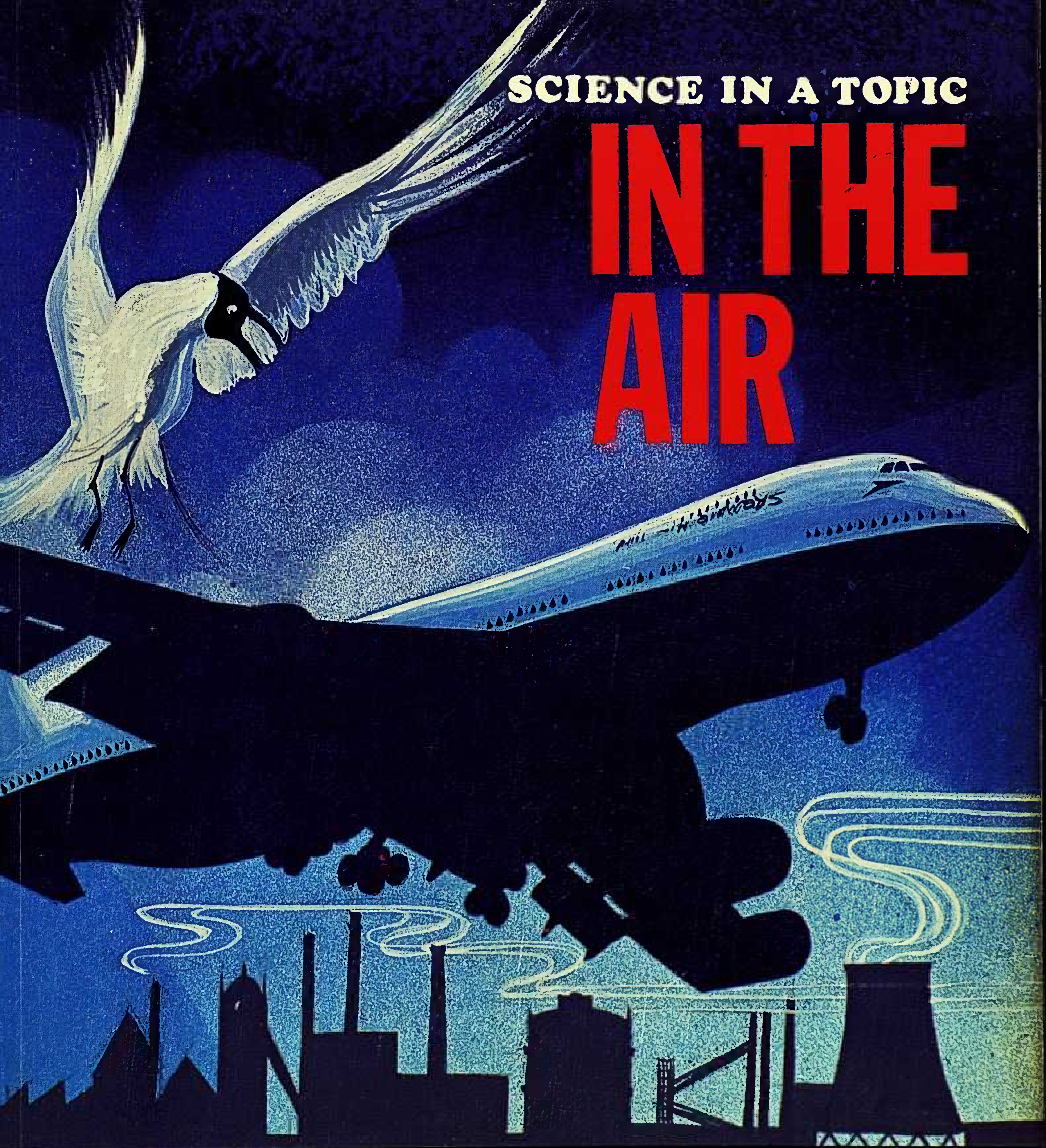
SCIENCE IN A TOPIC

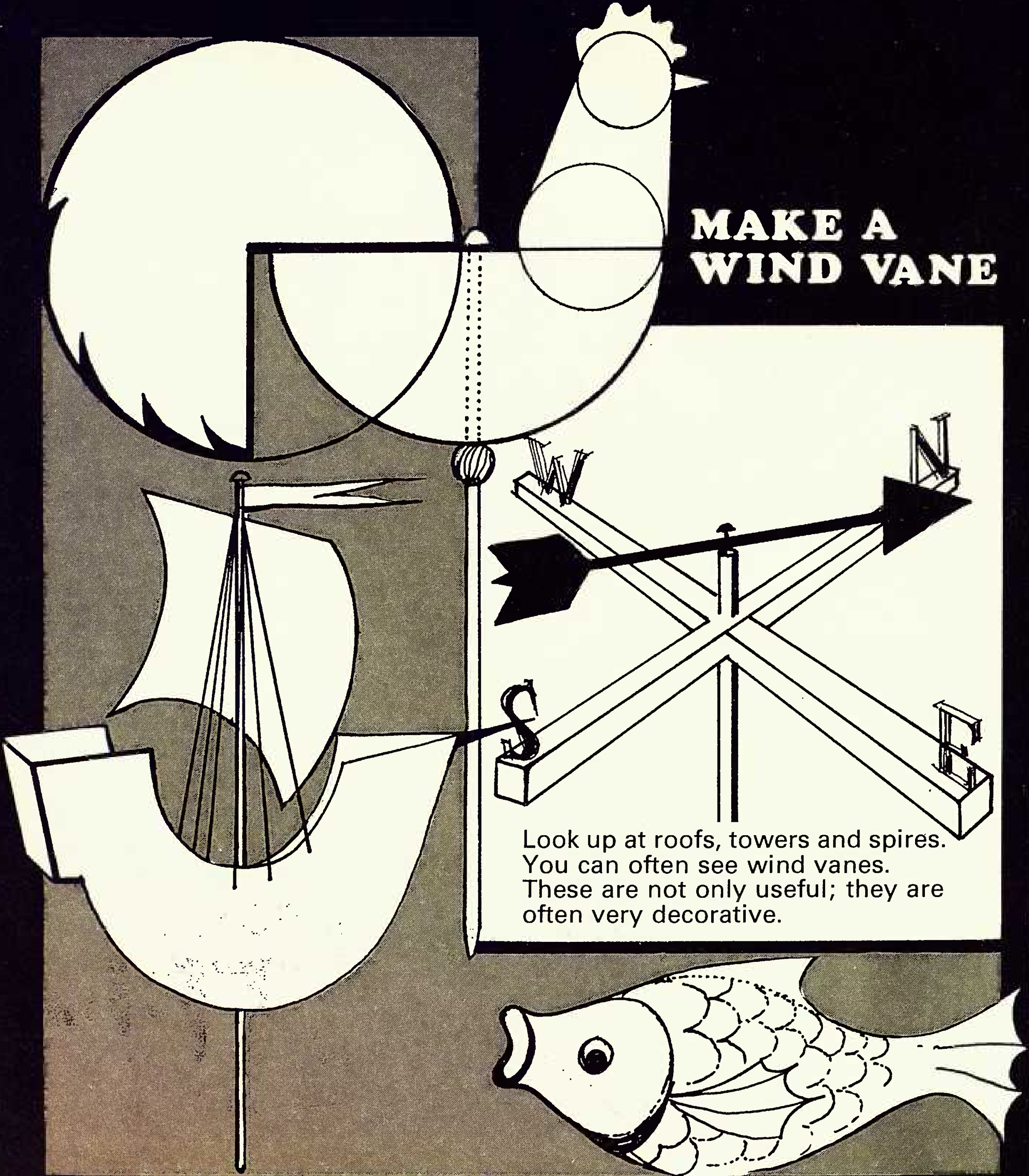
# IN THE AIR



Doug Kincaid
Peter S. Coles

HULTON

# MAKE A WIND VANE




Look up at roofs, towers and spires.
You can often see wind vanes.
These are not only useful; they are often very decorative.

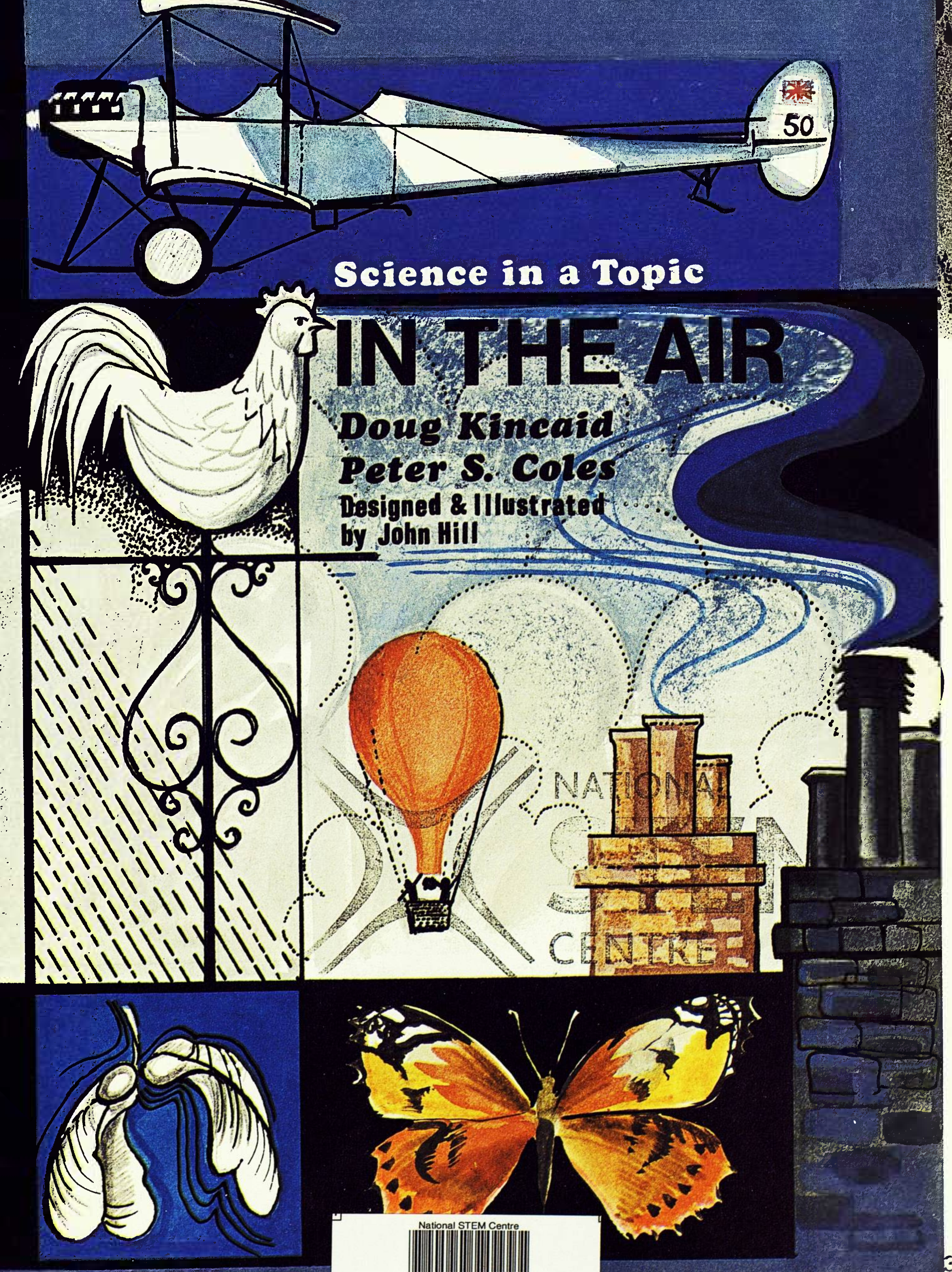
Make a wind vane yourself.
These drawings will help.
The vane must point into the wind.
It tells the direction the wind came from.
Page 14 shows you a simple wind vane. This will help you.

You must site your wind vane carefully.
Be sure it is not sheltered by walls or trees.
The wind can be deflected and your vane could give false readings.

Science in a Topic

# IN THE AIR

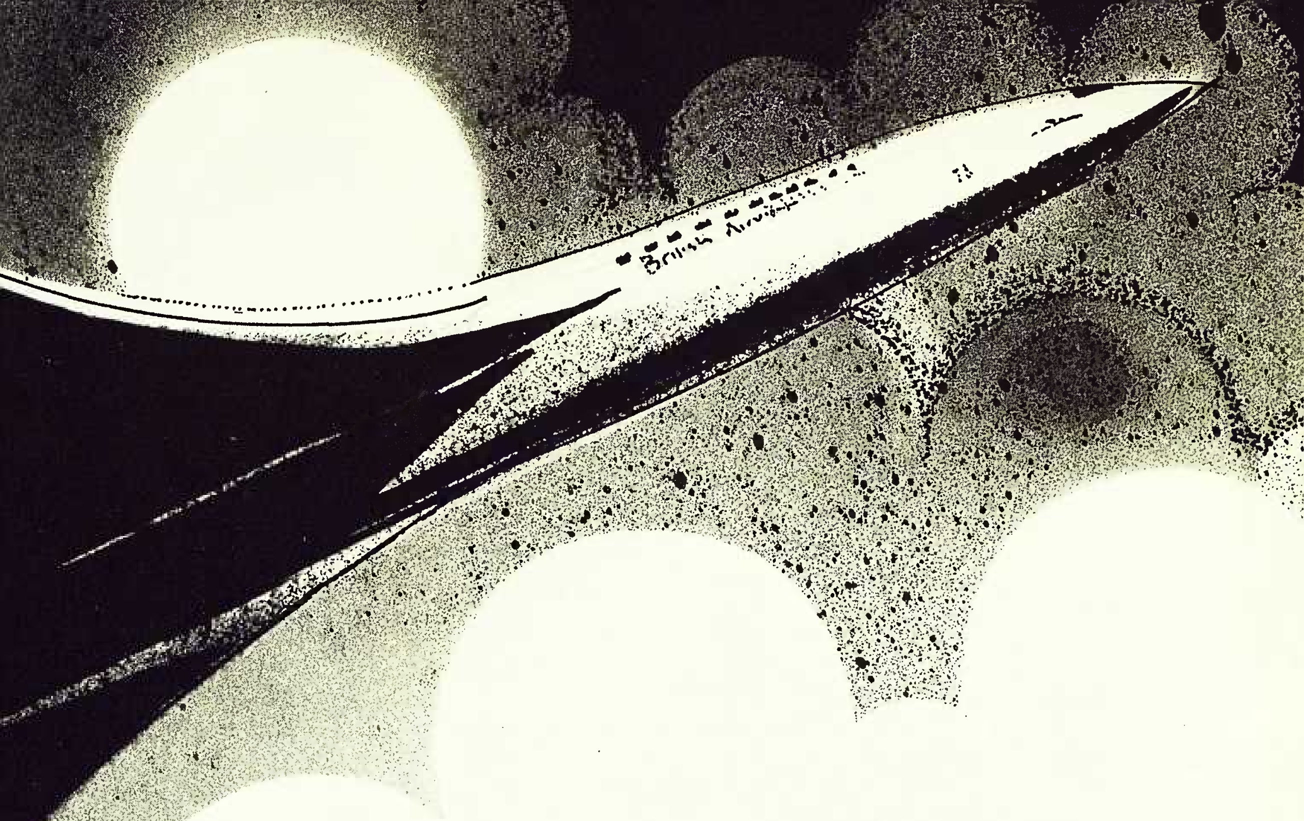
**Doug Kincaid**
**Peter S. Coles**
Designed & Illustrated
by John Hill






HULTON


ISBN 0 7175 0877 3
First published 1981
Hulton Educational Publications Ltd.



SCIENCE IN A TOPIC

# IN THE AIR

## About this book

This book is different from most others because:

1. It is not complete, but only part of a study – the science part. There will be a need to use many other books to find out about other aspects of the topic – history, geography...

2. It will not tell you information but will only ask you questions and suggest ways that you might find the answers for yourself. Many of the suggestions were some children's ways of trying to find an answer – you may have better ideas.

3. It is hoped that arising from these questions other questions will occur to you – do pursue these. (Your own questions and the ways you find to answer them are really the most important.)

4. You *do not need* to work through the book in the order set out; the sections of work can be done in the order that you wish.

5. There is no need to complete all of one section. If the work becomes harder as you progress through a section, see how far you can go.

# CONTENTS


1 THE AIR AROUND US 5
- The 'Empty' Bottle 6
- Feeling Air 7
- The Atmosphere 8
- Air Pressing 9
- The Barometer 10
- Compressed Air 11
- Air at Work 12

2 AIR AND WEATHER 13
- Windy Days 14
- Air – Wet and Dry 16
- Air and Clouds 18

3 BALLOONS AND AIRSHIPS 19
- Hot Air 20
- Making a Hot Air Balloon 22
- Lighter than Air 24

4 PARACHUTES, KITES AND GLIDERS 25
- Parachutes 26
- Kites 28
- Gliders 30
- Paper Gliders 32

5 AEROPLANES 33
- Icarus to Jumbos 34
- How Aeroplanes Fly 35
- Air Flow 36
- Testing Wings 38
- Lift and Balance 39
- Moving through Air 40
- Jets 42
- Jet Engines 43
- Twists and Turns 44

6 HELICOPTERS AND HOVERCRAFT 45
- Paper Helicopters 46
- Rotor Blades 47
- A Model Hovercraft 48

7 BIRDS 49
- Bird Studies 50
- Birds' Wings 52
- Feathers 53
- Migration 54

8 LIVING IN THE AIR 55
- Insects 56
- Plant Parachutes and Plumes 58
- Wings and Spinners 59
- Air and Life 60
- Oxygen 61
- Pollen and Pollution 62
- Air – the Future 63

FLOW CHART 64

BOOKS TO HELP YOU / SOME PLACES TO VISIT End papers



**SCIENCE IN A TOPIC SERIES**



by Doug Kincaid, County Staff Advisory Teacher, Science, Buckinghamshire, Team Member Schools Council 'Learning Through Science' Project.
Peter S. Coles, B.Sc., Chief Adviser, Berkshire.



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# THE AIR AROUND US

Our planet Earth is surrounded by a layer of air. We all live in this layer. We need air to live. Living things need air. Many things live and move in the air. Many non-living things are also found in the air. Some of them are made by man. Some are things we do not like or which may harm us. These also travel through the air.

Make an air exhibition. Include pictures of things that live and travel in the air.

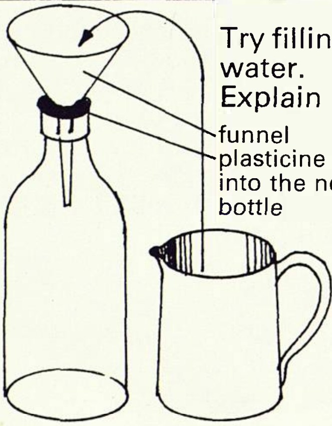
We cannot see air. We can feel it. We can see what it does. Air gets everywhere. There is some air in soil. There is some air in water. Most 'empty' things are full of air. What can you see happening that shows us that air is all around us?

***Section One***

# THE 'EMPTY' BOTTLE

How often do we talk about an 'empty' bottle?
Is it really *'empty'*?
Try these experiments with an 'empty' bottle.

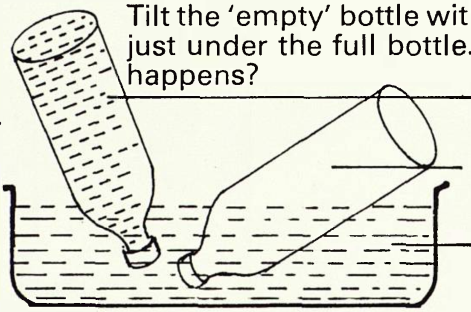
**1**



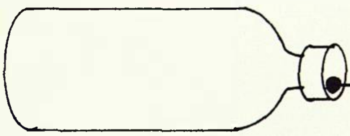

Try filling the bottle with water.
Explain what happens.

**2**

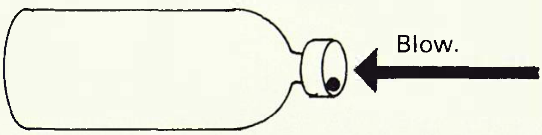
You need two bottles.
Fill one with water. Keep the other 'empty'.
Tilt the 'empty' bottle with its open top just under the full bottle. What happens?




**3**

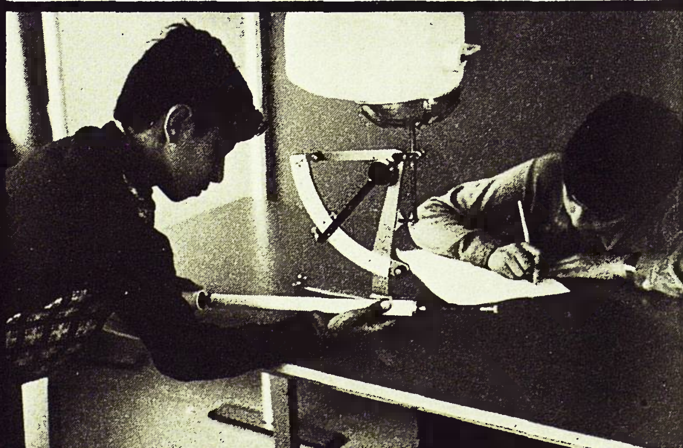



Can you blow the pea into the bottle?
Try.
Explain what happens.




These experiments show that the bottle was not empty.
It was full.
It was full of air.

Now use an 'empty' plastic container.
Try squeezing more air into the bottle.
Can you weigh the extra air in the bottle?

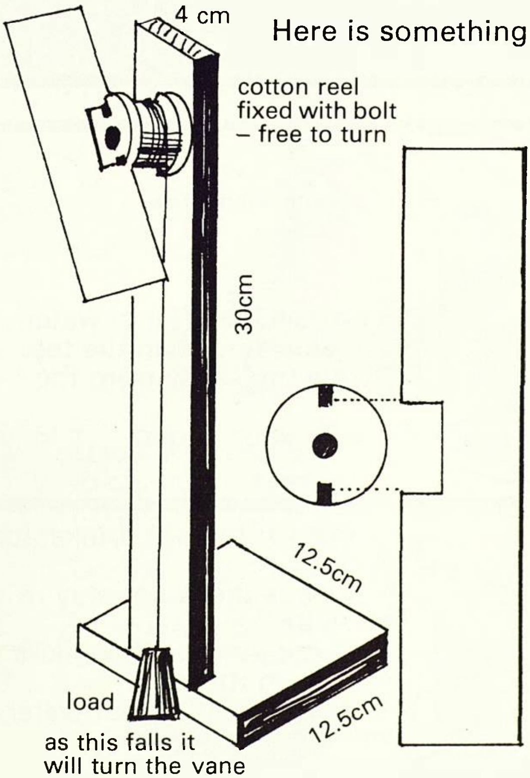


# FEELING AIR

On a windy day we can feel the air pushing.
Feel and measure the push of air.

Run 25m.
Time how long this takes.
Hold a large sheet of card in front of you.
Now run the 25m.
Time how long this takes.
Describe what you felt.
Try a smaller piece of card.
Try a larger piece.
Can you feel or measure any difference?
This group decided to plot a graph of their results.

Here is something to make.




This can be used to measure how much the air slows down the turning vane.

Time how long the load takes to reach the ground.

Try different sized vanes.

Your results may depend on how you use the timer.
Scientists often repeat measurements several times.
Find out if this idea helps here.

Make various sized vanes of balsa wood, or card.
e.g.

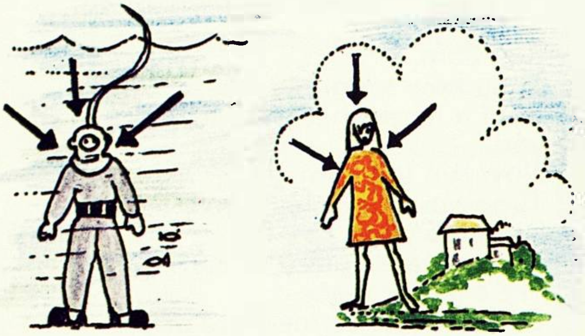
| | |
|---|---|
| Vane 1 | 2.5 × 17.5cm |
| Vane 2 | 5.0 × 17.5cm |
| Vane 3 | 7.5 × 17.5cm |
| Vane 4 | 10.0 × 17.5cm |
| Vane 5 | 15.0 × 17.5cm |

| Vane SIZE 1 | | | Vane SIZE 2 | | | Vane SIZE 3 | | | Vane SIZE 4 | | | Vane SIZE 5 | | | Vane SIZE 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/ | 2/ | 3/ | 1/ | 2/ | 3/ | 1/ | 2/ | 3/ | 1/ | 2/ | 3/ | 1/ | 2/ | 3/ | 1/ | 2/ | 3/ |
| | | | | | | | | | | | | | | | | | |

# THE ATMOSPHERE

We live at the bottom of a 'sea' of air.

A diver on the sea bed has water pressing all around him.

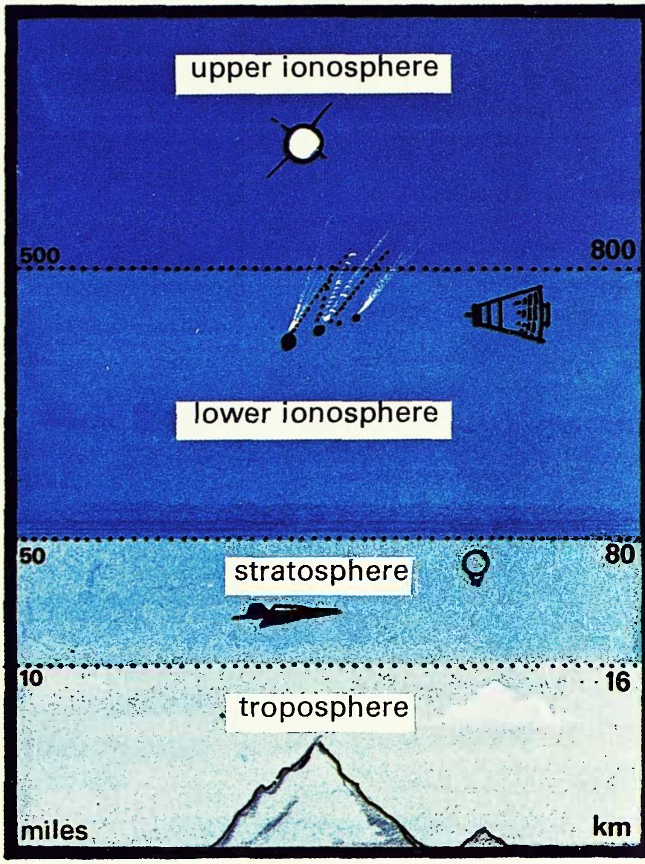


We on the Earth have air pressing all around us.

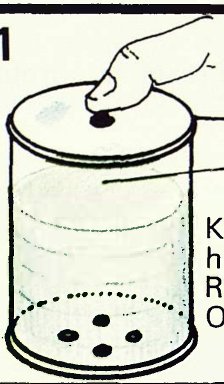
This layer of air that surrounds our earth is called the atmosphere.

This 'sea' of air pushes and presses in all directions.

Here are some experiments to show how the air's forces push.

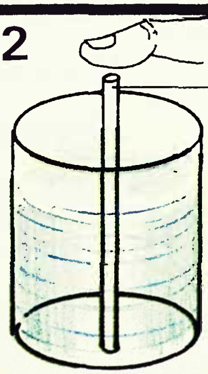



**1**



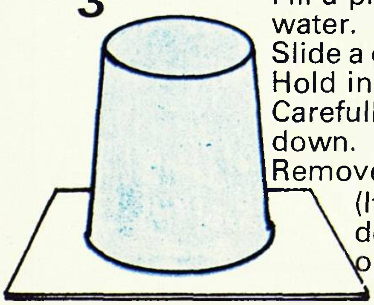

Keep finger on the top hole.
Remove and replace.
Observe what happens.

**2**




Put a straw into a jar of water.
Place your finger on the top.
Remove the straw from the jar.
Remove your finger.

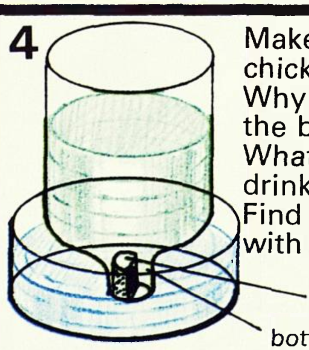
**3**



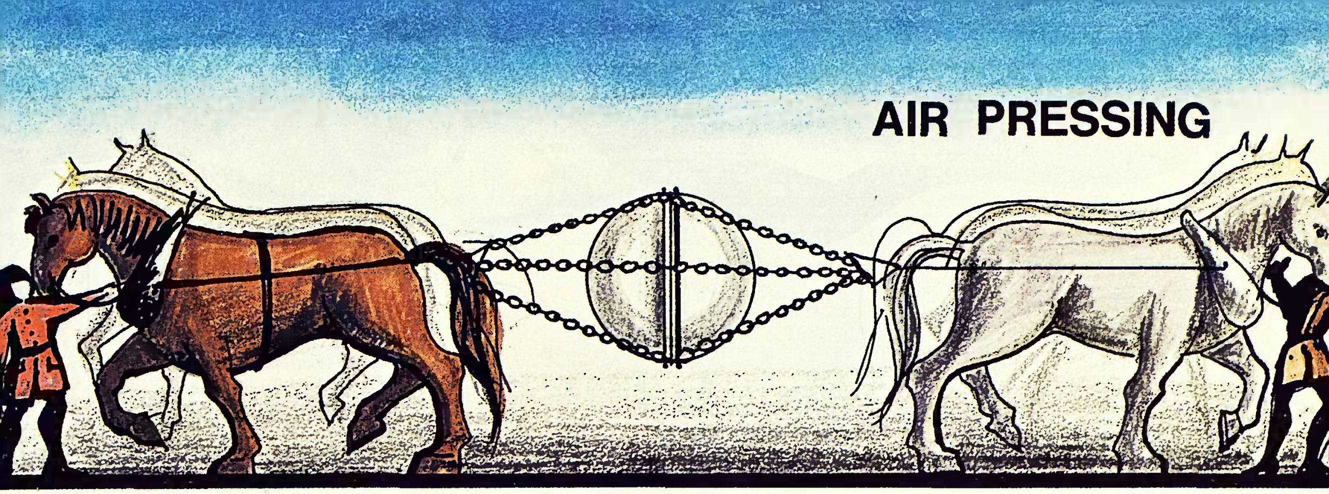
Fill a plastic beaker with water.
Slide a card over the top.
Hold in position.
Carefully turn upside down.
Remove your hand.
(It is a good idea to do this over a bowl or sink!)

**4**

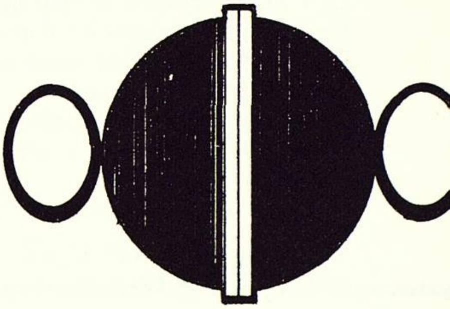
Make an automatic drinker for chicks.
Why does the water stay in the bottle?
What happens as the chicks drink from the dish?
Find out by taking out water with a straw.



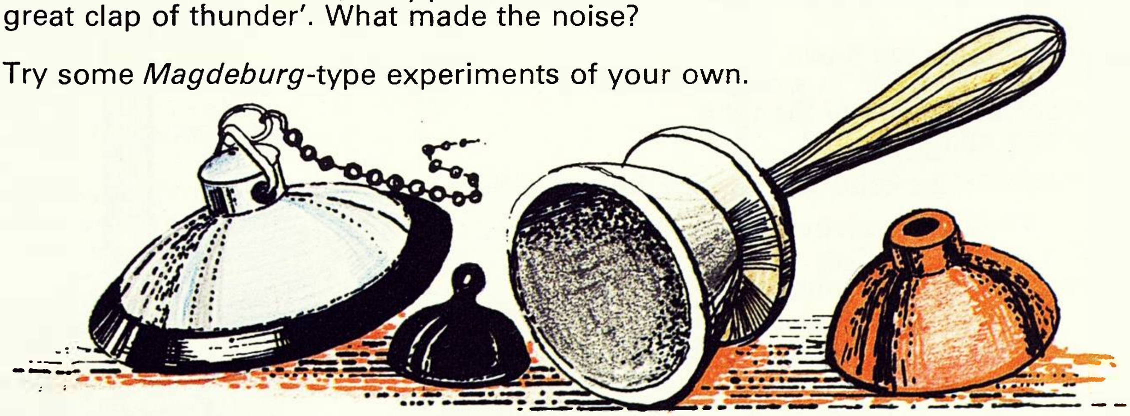
# AIR PRESSING



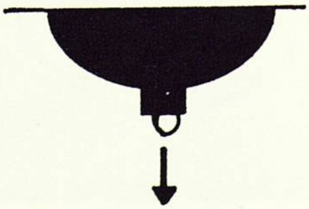
Just over three hundred years ago Otto von Guericke did one of the most famous of all scientific experiments. This took place in Magdeburg in Prussia in 1651.
He wanted to show how great the force of air pressing could be.
He used two hollow metal half-ball shapes. There was a leather washer between them. The air in the metal ball was pulled out with a pump.
Now the only thing holding the two halves together was the air pushing from outside.
Then they tried to pull the two halves apart.
It took two teams of eight horses before they parted.
Otto von Guericke wrote, 'they parted with a noise like a great clap of thunder'. What made the noise?

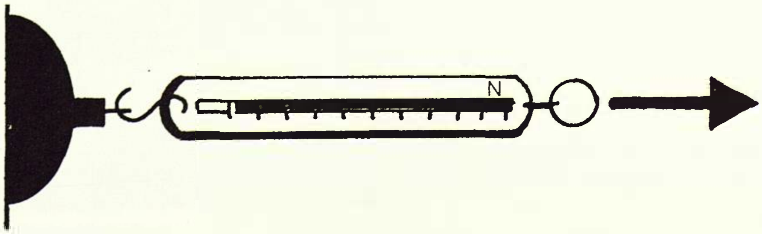


Try some *Magdeburg*-type experiments of your own.

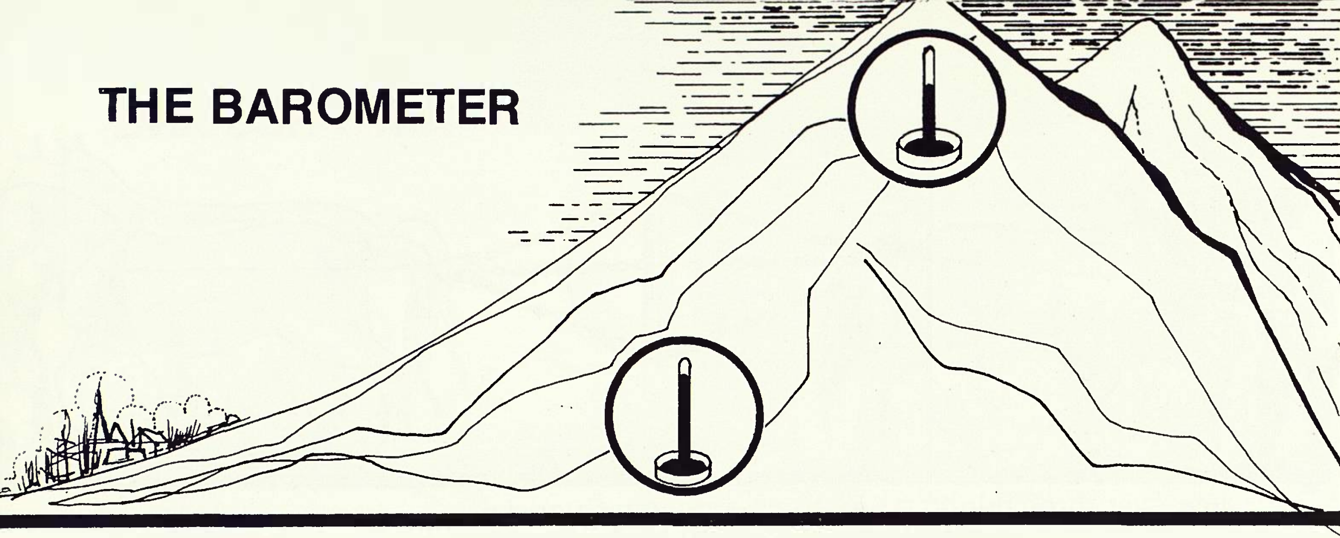


Use some suckers.
Press them together.
Press them on different surfaces.
(Try a plastic table top, glass, wood, floors, metal, bricks ...)
Do they 'stick' upwards and sideways as well as downwards?
Wet the sucker. Does it 'stick' better?
How well does it 'stick'?
Measure the forces needed to pull the suckers away.



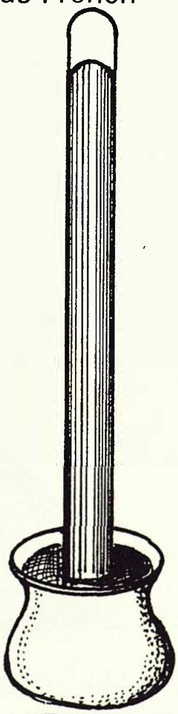


# THE BAROMETER



Our atmosphere is the layer of air around our planet.
Scientists wondered if there was less air higher up in the layer.
This idea was first tested by Blaise Pascal in 1648. He was a famous French scientist and thinker.
He measured the push of air at the bottom of a mountain.
He got someone to climb the mountain and measure the push at the top.
The mountain-top reading was less.

To measure these pushes he used an invention by an Italian scientist named Torricelli.

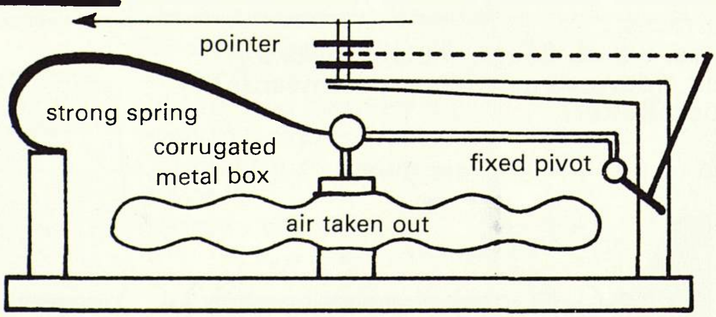


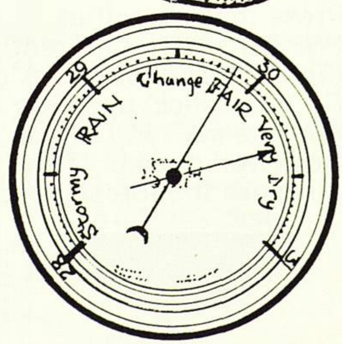
Torricelli had filled a glass tube with a heavy liquid called mercury.
He turned it upside down.
He put the open end in a dish of mercury.
It did not all run out of the tube.
What was holding it up?

The height in the tube changed slightly on different days.

Torricelli had made an instrument that measured the pressure of the air.
We call such an instrument a *barometer.*

Do not repeat Torricelli's experiment.
Do not use mercury.
It is very poisonous.
Even mercury vapour can be extremely dangerous.




dial

Here is a diagram of a modern barometer.
This measures the pressure of the air on a special 'box'.

# COMPRESSED AIR

On page 6 you tried squashing air into a plastic bottle.
When air, or any gas, is squashed into a smaller space, we say it is 'compressed'.
Sometimes a very strong container has to be made.

When you pump up a bicycle tyre, air is being compressed.

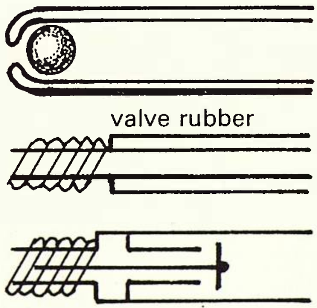
Compressed air keeps the car tyres hard.

Find out how a pump works.


Use a cycle pump.
Put your thumb over the end.
Push the handle.
Feel the air being squashed.

Take the pump apart.

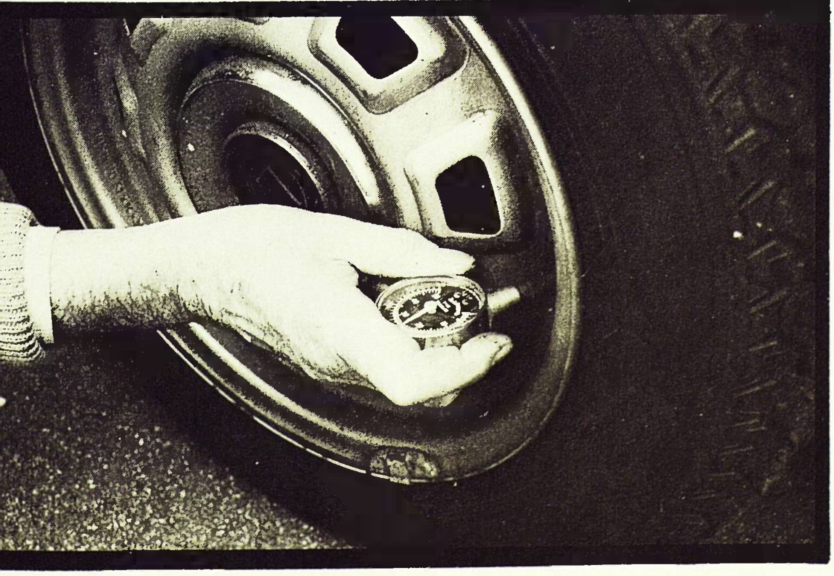
See what happens if you reverse the washer.
Use your thumb over the end again.
Use this 'new' pump on the plastic bottle (page 6).




An air valve lets air go one way and stops it coming back again.
When we pump up a tyre the air must go in but not come out.

A valve is used.

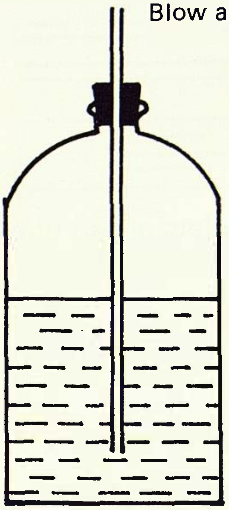
Find out how valves work.



It is important to know how much air has been pumped into tyres.
The *pressure* is measured to be sure it is right.

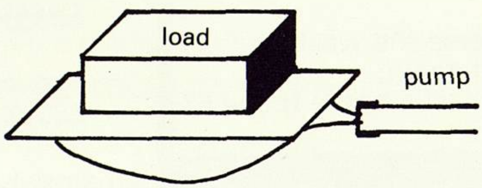
# AIR AT WORK

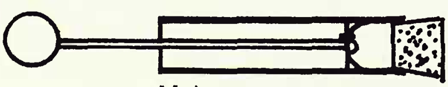
Air on the move will do **work**.
Wind can move ships.
It can blow down trees.
It can make great waves.
In a game of blow football air moves the ball.
A pop-gun uses air to shoot the cork.
We can squash lots of air into a small space with a pump.
This air can then be made to do **work**.
This road-mender is using **compressed air** to work his drill.
Try some 'compressed air' experiments for yourself.




a bottle fountain

Lift a load with air.

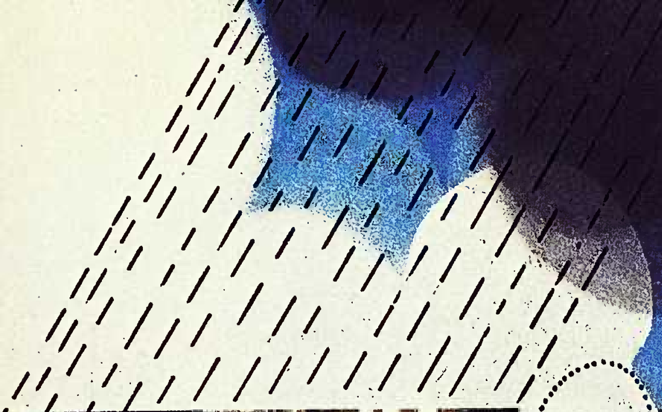


Make a pop-gun.

When a tyre is punctured the air inside rushes out.
When air is squashed up it is at **high pressure**.
When air is not squashed up it is at a **low pressure**.
When the tyre punctured, air moved.
It moved from high pressure to low pressure.

When air moves it will do **work**.
It can push, turn and lift.
It can push on the brakes of buses and lorries.
It can turn vanes and sails.
It can lift heavy loads.



# AIR AND WEATHER

What makes our weather?

Air on the move makes it windy.

Water in the air makes rain and snow.

Warm air and cold air make high pressure and low pressure weather patterns.

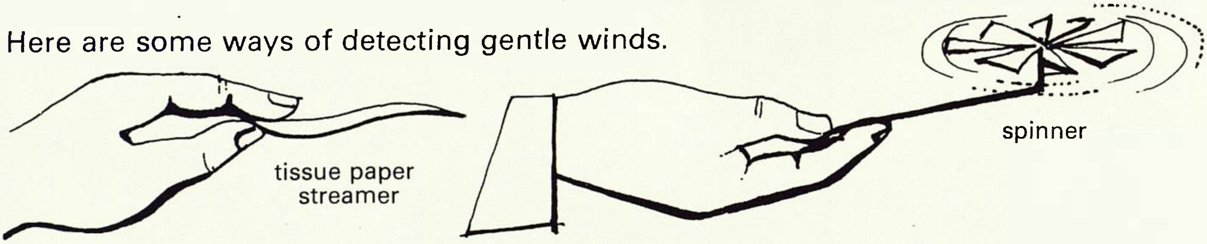

The weather can be very important to us in the plans we make.
- Will it be fine for Sports Day?
- Will the fine weather last until our trip next week?
- When will it be warm enough to go swimming?

But the weather can have even more important effects.
For example:
- A drought means that crops are lost.
- Rain, rain, rain can mean floods, damage and danger.
- Strong winds, gales and storms can even mean loss of life,
- Snow and ice can cut off towns and villages.

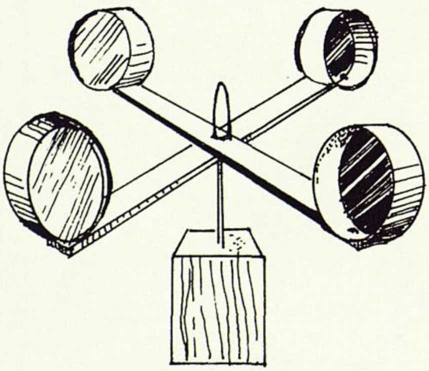
# WINDY DAYS —— STRENGTH & DIRECTION —

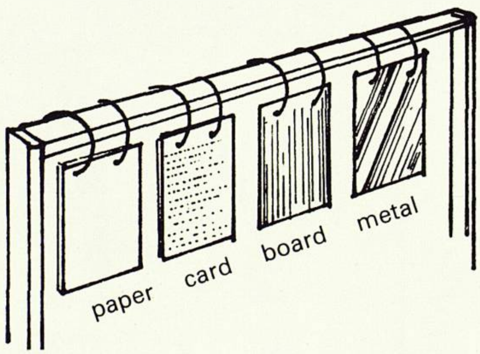
Where can you find winds?
Can you find winds and draughts around school?
How strong are they?
In what direction are they moving?

Here are some ways of detecting gentle winds.

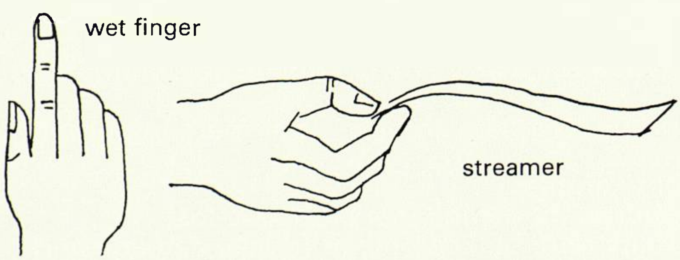


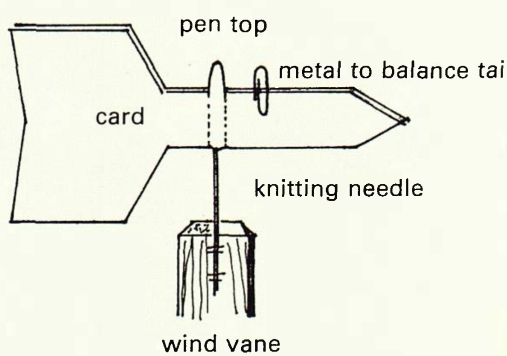

Here are some ways of measuring stronger winds.






Here are some ways to find wind direction.

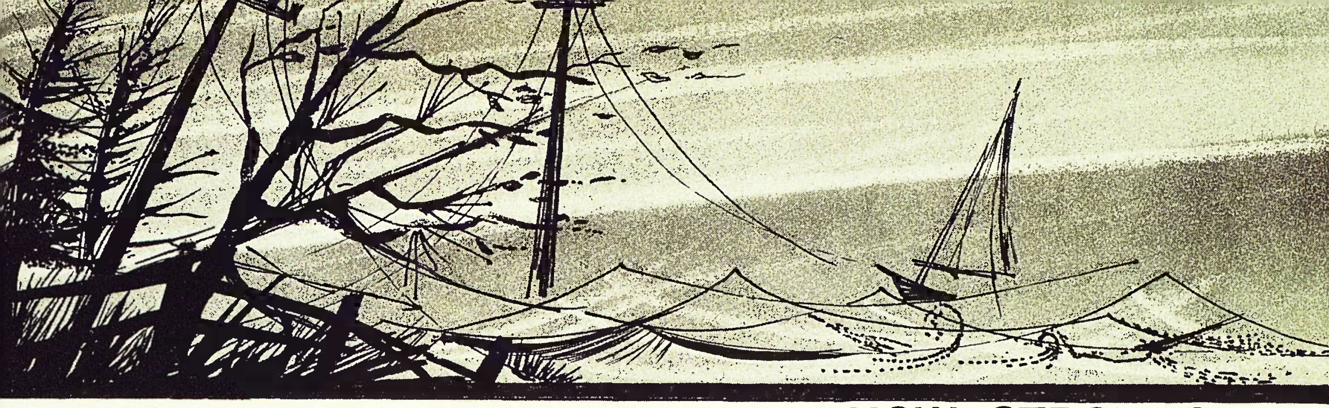



Clouds moving will tell you about higher winds.

Try some wind measurements in different places:
- out in the middle of a field
- around corners of the school
- between buildings.

Draw some plans and plot wind speeds and directions for different days.



## HOW STRONG?

Air on the move can be a gentle and pleasant breeze.
It can also be a fierce and frightening gale.

Look for signs of air moving on different days.
What happens when there is a gentle breeze?
What happens when there is a strong wind or gale?

Look at trees and bushes.

- Do leaves rustle?
- Do twigs and small branches move?
- Do small trees sway?
- Do large branches move?
- Do whole trees move?

Other signs of wind force are:

- dust and litter being blown about
- flags – limp, fluttering or flapping

These signs are found in a chart of the scales of wind strength.
It is named after Admiral Sir Francis Beaufort of the Royal Navy.
See how your observations fit with the Beaufort Scale.
The forces are numbered 1 to 12.
Find what names are given to each wind force.

| Beaufort Number | Wind name | Wind speed km.p.h. | m.p.h. | Observations |
|---|---|---|---|---|
| 0 | ? | 0-1 | 0-1 | vertical smoke |
| 1 | | 1-5 | 1-3 | drifting smoke |
| 2 | | 6-11 | 4-7 | slight leaf movement |
| 3 | | 12-19 | 8-12 | leaf movement and flags flap |
| 4 | | 20-29 | 13-18 | dust and litter movement, branches move |
| 5 | | 30-39 | 19-24 | gentle swaying of small trees |
| 6 | | 40-50 | 25-31 | large branches sway |
| 7 | | 51-61 | 32-38 | trees swaying, walking against wind hard |
| 8 | | 62-74 | 39-46 | twigs break, very hard to walk against wind |
| 9 | | 75-87 | 47-54 | slates blown off, large branches blown down |
| 10 | | 88-101 | 55-63 | trees uprooted, buildings damaged |
| 11 | | 102-120 | 64-75 | widespread damage |
| 12 | | over 120 | over 75 | disaster |

Measure the wind speeds (page 14). Link these with your observations.

# AIR - WET AND DRY

There is always some water in the air.
If the water is in tiny drops it makes clouds, mist or rain.

Often the water is more spread out through the air.
It cannot be seen. It is then called water vapour.

Some days there is very little.
It is then a hot dry day.

Some days the air holds a lot of water.
The day is then 'muggy' and humid.

Water vapour gets into the air in many ways.
The sun **evaporates** water from seas, lakes, rivers, ponds, puddles and damp earth.

Experiment to find how fast water evaporates.
One way is to measure puddles.
See how fast they shrink in size.
Measure puddles in different places.
Measure a puddle in the shade.
Measure a puddle in the full sun.
(You may need to make your own puddle if it is a sunny day.)
Note the temperatures.

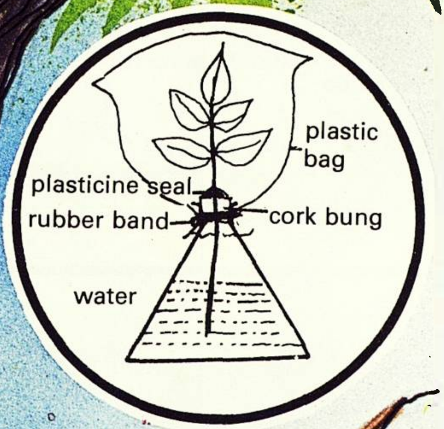
This group used a wet cloth.
They measured the drying time in different places.

Make your test fair.
Thoroughly wet the cloth.
Shake off drops and press between newspaper.
This will make sure each cloth is equally wet.

Plants give out water vapour.
Their roots take water in.
The leaves pass water out.

Work out how much water a tree gives out in a day:

- Take a spray of leaves.
- Set up like this (weigh the bag first).
- Leave it outside during the day.
- Carefully weigh the bag again to find the mass of water.

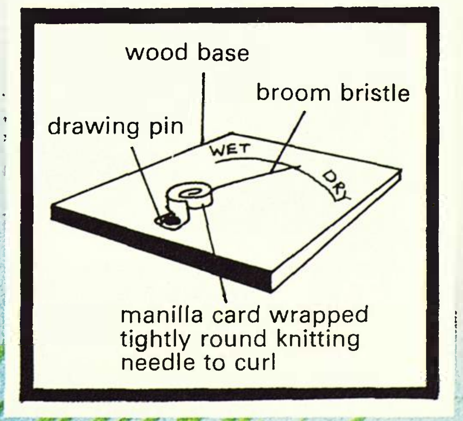



You will now need to estimate how many sprays like yours there are on a branch. Then, how many branches on the tree.

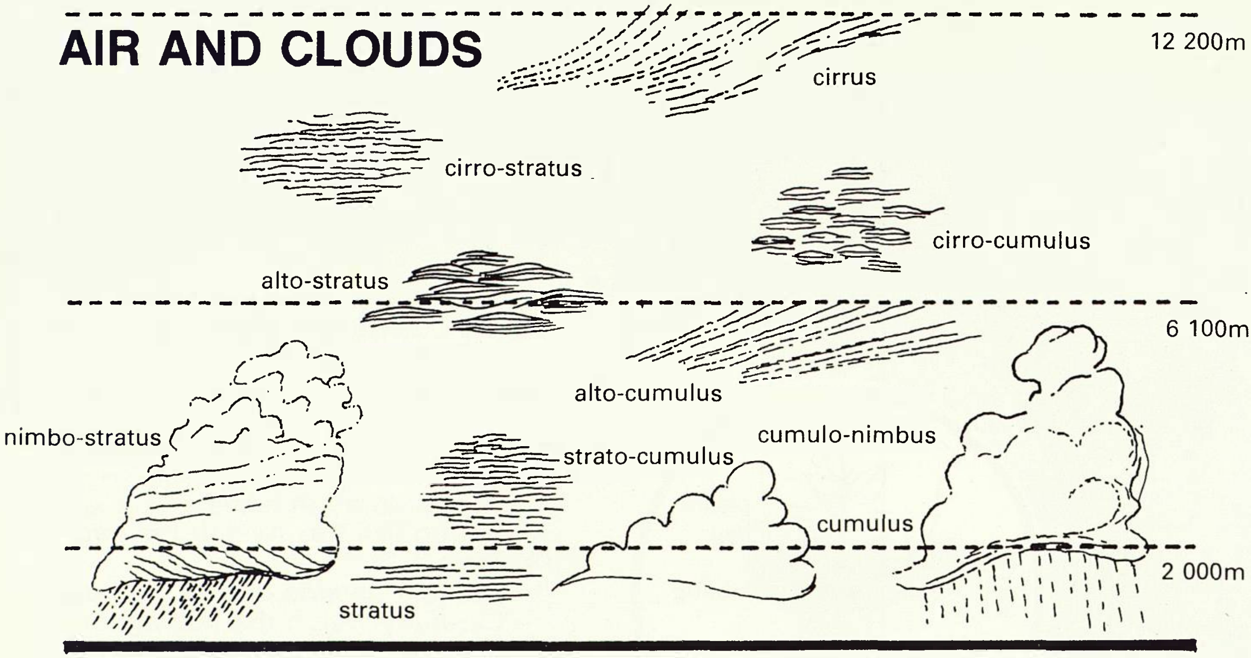
You will not get an exact answer.

Scientists often use such estimates. They give a good idea of what is happening.

Here is another way in which you could detect the water vapour in the air.
Try measuring the wetness on different kinds of day.



# AIR AND CLOUDS

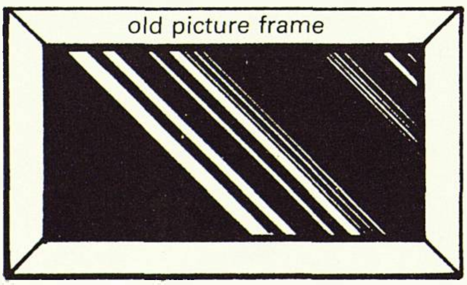


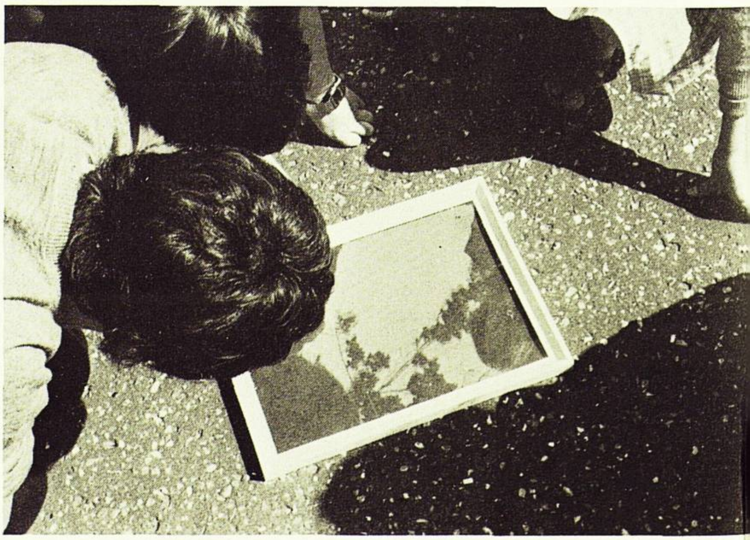

The higher up, the colder it becomes.
As warm, wet air rises it becomes colder.
The invisible water vapour **condenses**, and tiny drops of water form.
A cloud appears.
(You can see this on a cold winter's day. Your warm breath will make a 'cloud' in the cold air.)

Watch clouds.

- Are some clouds higher than others?
- What kinds of cloud are seen on rainy days?
- What kinds on fine days?
- In what direction are they moving?
- Is it the same direction as the wind you can feel?

Study the cloud types in the diagram above.
Match and name those you see.

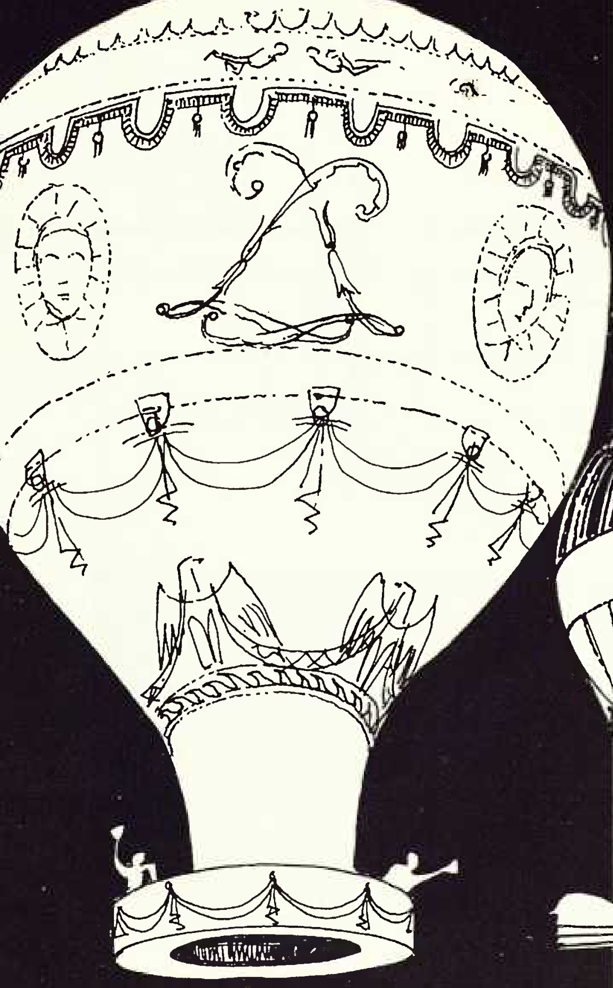


A good way to watch clouds is to make a cloud reflector.
Here is one which a keen weather study group made.

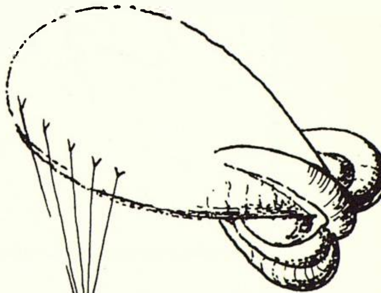
# BALLOONS AND AIRSHIPS

On 15 October 1783 two Frenchmen made the first aerial journey. This was in the Montgolfier brothers' hot air balloon. It was made of linen and paper. The air was heated by a straw bonfire. Earlier, on 19 September, three other 'passengers' had been airborne. 'Who' were they?

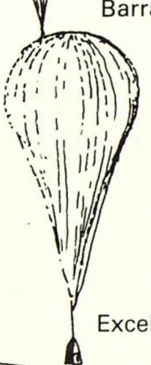


Montgolfier balloon 1783

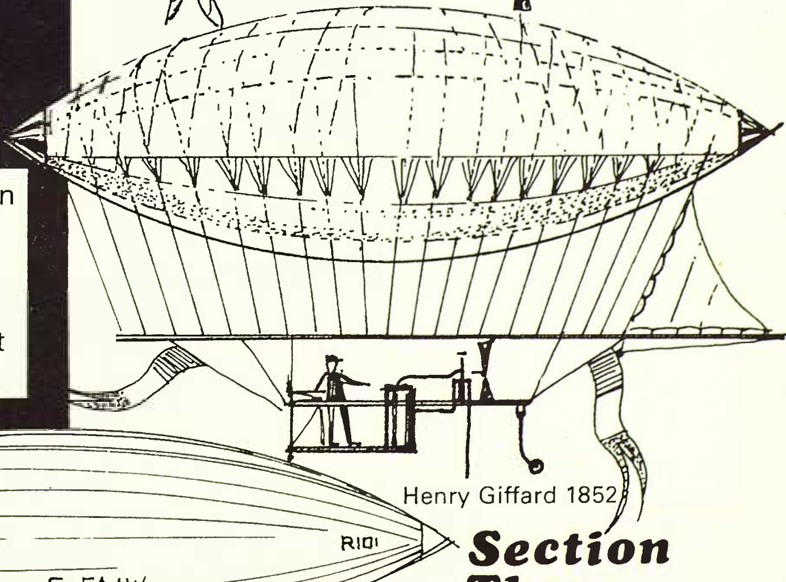
Blanchard and Jeffries 1785



Barrage balloon 1940

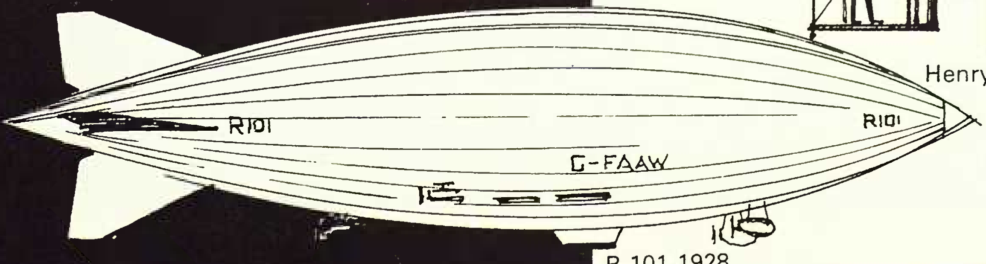


Excelsior II 1960



Henry Giffard 1852

Since that first flight there have been many other kinds of balloon. Some of the more important ones are shown here. Why are they so important and in what way do they differ? Find out what you can about these balloonists.

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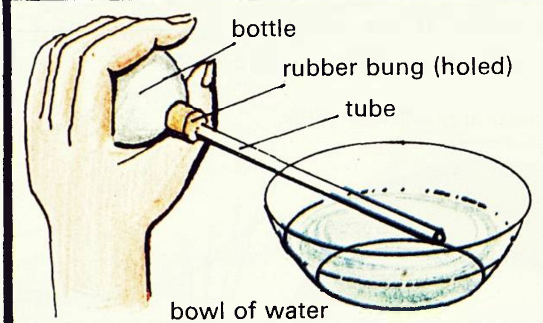
## *Section Three*

# HOT AIR

Why did the Montgolfier brothers' hot air balloon rise?

Here are some experiments.

They should help you to understand why.




**1** Warm the air in the bottle with your hands.

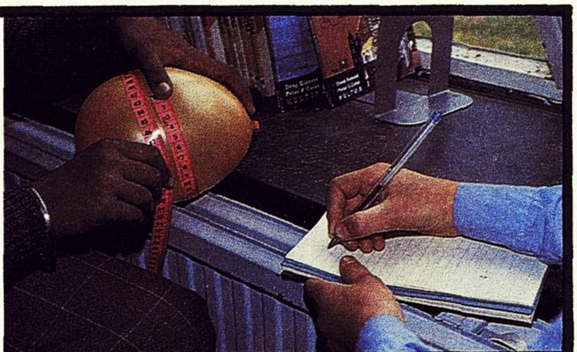
Notice what happens.

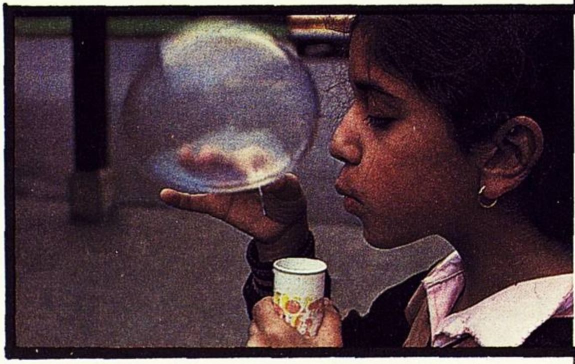
Take the warmth of your hands away.

Wait a little while.

What happens?

**2** Blow up a balloon.
(Not too full)
Measure it.
Put it on a radiator, or heat it with a hair dryer.
Measure again.
Put it in a refrigerator.
Measure once again.

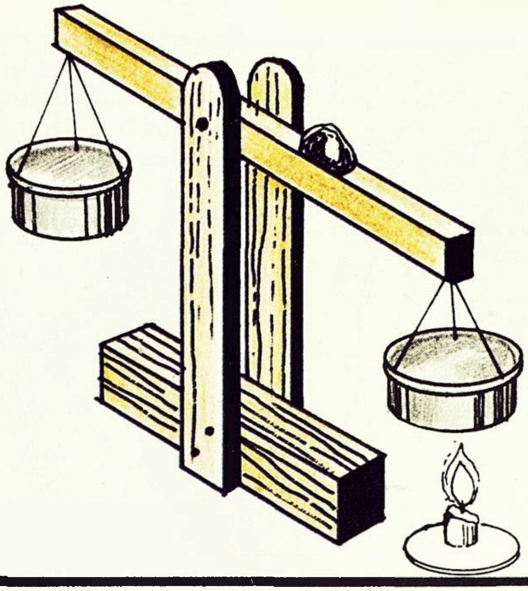




**3** Blow some soap bubbles.
Watch them carefully.
Do they rise, before they fall or burst?
Why?
(Clue: Where has the air in them come from?)

**4** Use paper tissue streamers or metal foil spinners to find hot air. Hold them over radiators.
What do they do?

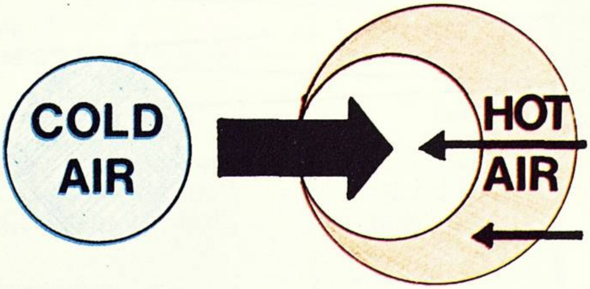
**NOT NEAR FLAMES**



**5** Use a metre stick to make a balance. Hang a tin upside down on each end. Make it balance with a piece of plasticine.

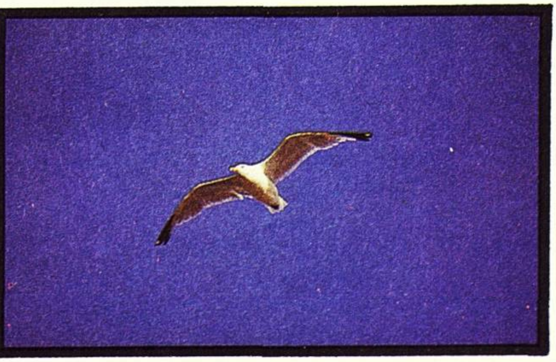
Place a candle under one tin. Observe, record what happens.

**6** Take the temperature near the floor and near the ceiling.

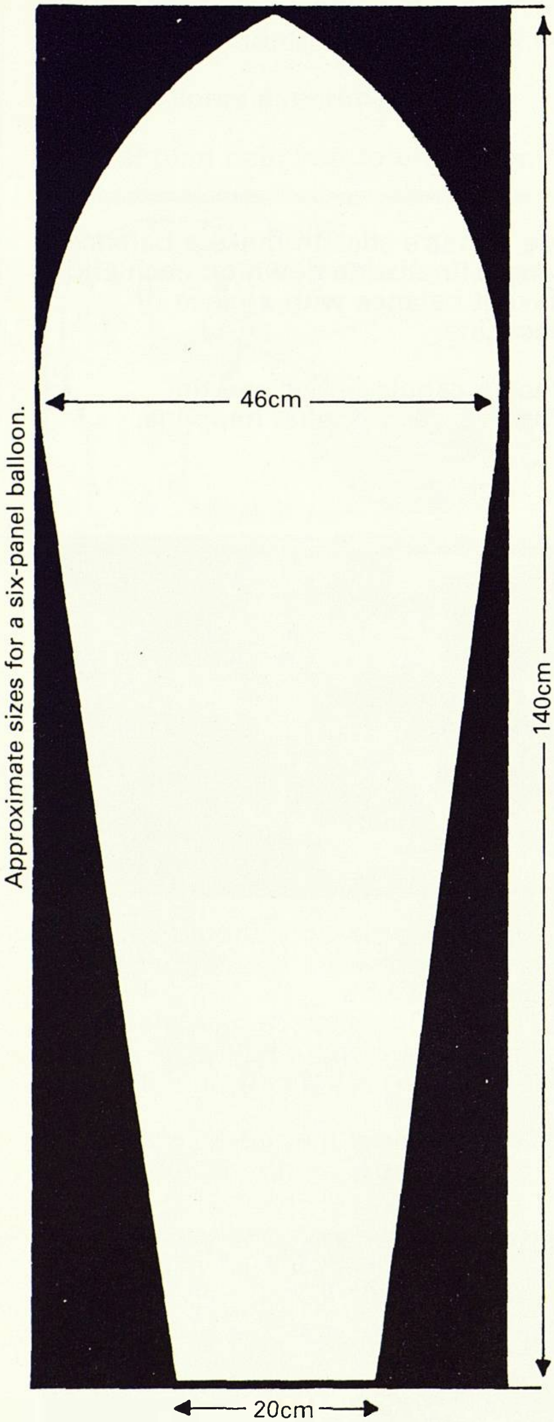



These experiments should show you that air will take up more space when it is hot.
The air in this space has been thinned out; there is less air.
It has been **expanded** to fill this space.
This hot air is therefore lighter.
It 'floats' up. The hot air rises.

Look for other signs of hot air going up.

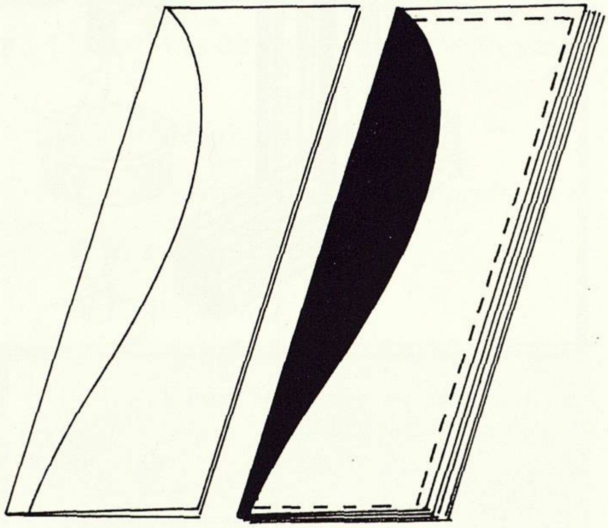


# MAKING A HOT AIR BALLOON

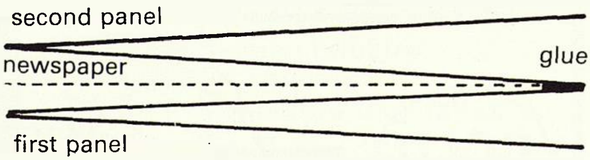



Template for one panel

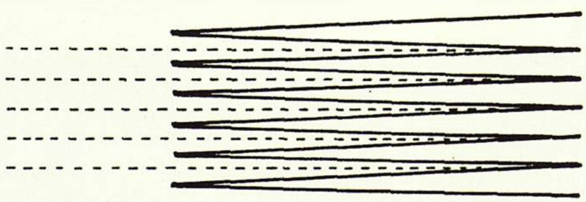
**1** Fold six pieces of tissue paper. Mark half the **template** shape on the folded edge. These can be stapled together along the three open edges and cut together, or cut separately.



**2** Place one of the folded panels on a piece of newspaper. Put a **thin** line of P.V.A. glue about 1cm in from the open edge. Do not use too much glue.

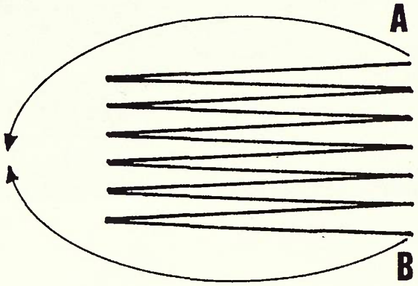



**3** Place a second folded section on top of this, so that they are glued together like this.

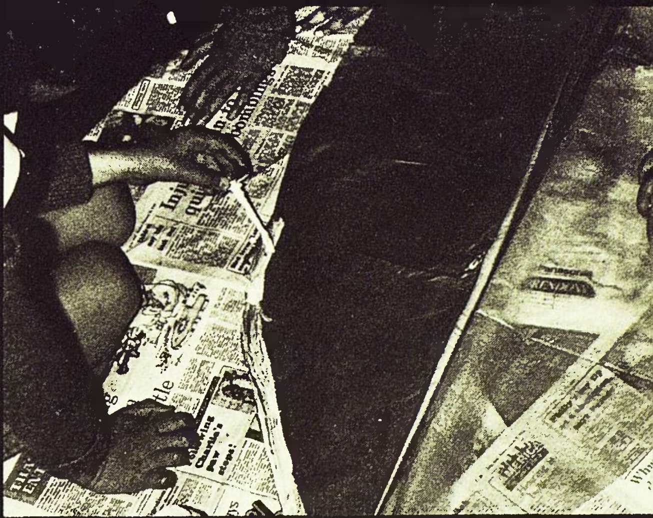


**4** Repeat until all six panels are joined together. It is a good idea to put newspaper between, to guard against sections sticking together.

5 Glue ‘A’ to B to complete the balloon.
Leave to dry.

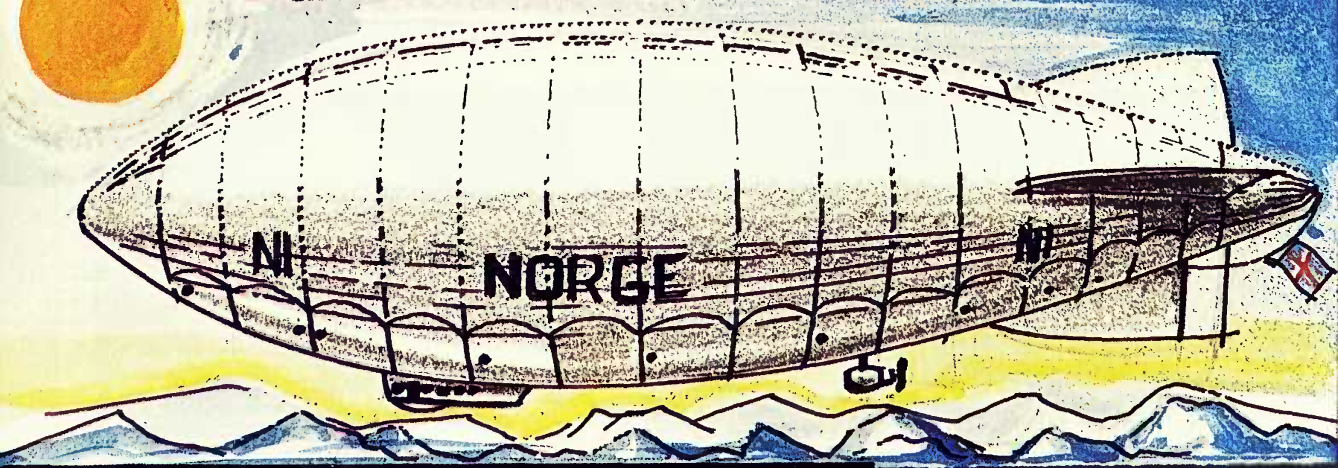



6 When the glue has dried blow up the balloon with a hair dryer. Allow the balloon to dry thoroughly before flying it.



7 Launch the balloon out of doors on a calm day. (Use a hair dryer.)
Hold the balloon over the hot air. Keep hold until the air inside is really hot.

# LIGHTER THAN AIR




There were no aeroplane journeys before 1903. There had, however, been many journeys in the air. Men used balloons and airships.

Balloons are just carried by winds.
Airships are driven by propellers. They are usually cigar-shaped. This shape helps them move more easily through the air.

There were many exciting and daring voyages in these earlier years.

The first flight over the North Pole was made in 1926 by the airship *Norge*. Read about Amundsen's great voyage. Find out too about the *Italia's* voyage which ended in disaster two years later.

In 1932 Professor Piccard made his record ascent to 1 6700m.
He was the first man to take a balloon into the stratosphere.
His record height has now been beaten. Find out who now holds the record.

In August 1978 the world was once again excited by a balloon flight. *Double Eagle II* had crossed the Atlantic. This was the longest balloon flight ever. Find how far it travelled and how long the journey took.

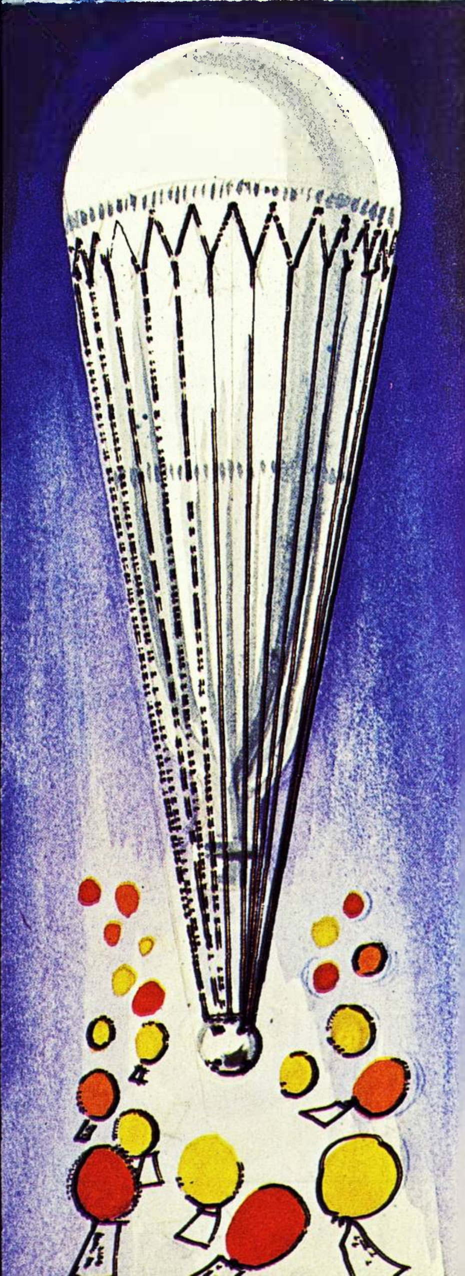
Balloonists need to control the flight. How do they make their balloon go up or come down?

Sometimes at fêtes and fairs there are balloon races. Gas-filled balloons are sent off. They carry a label with a name and address. The one that is sent back from farthest away wins a prize.

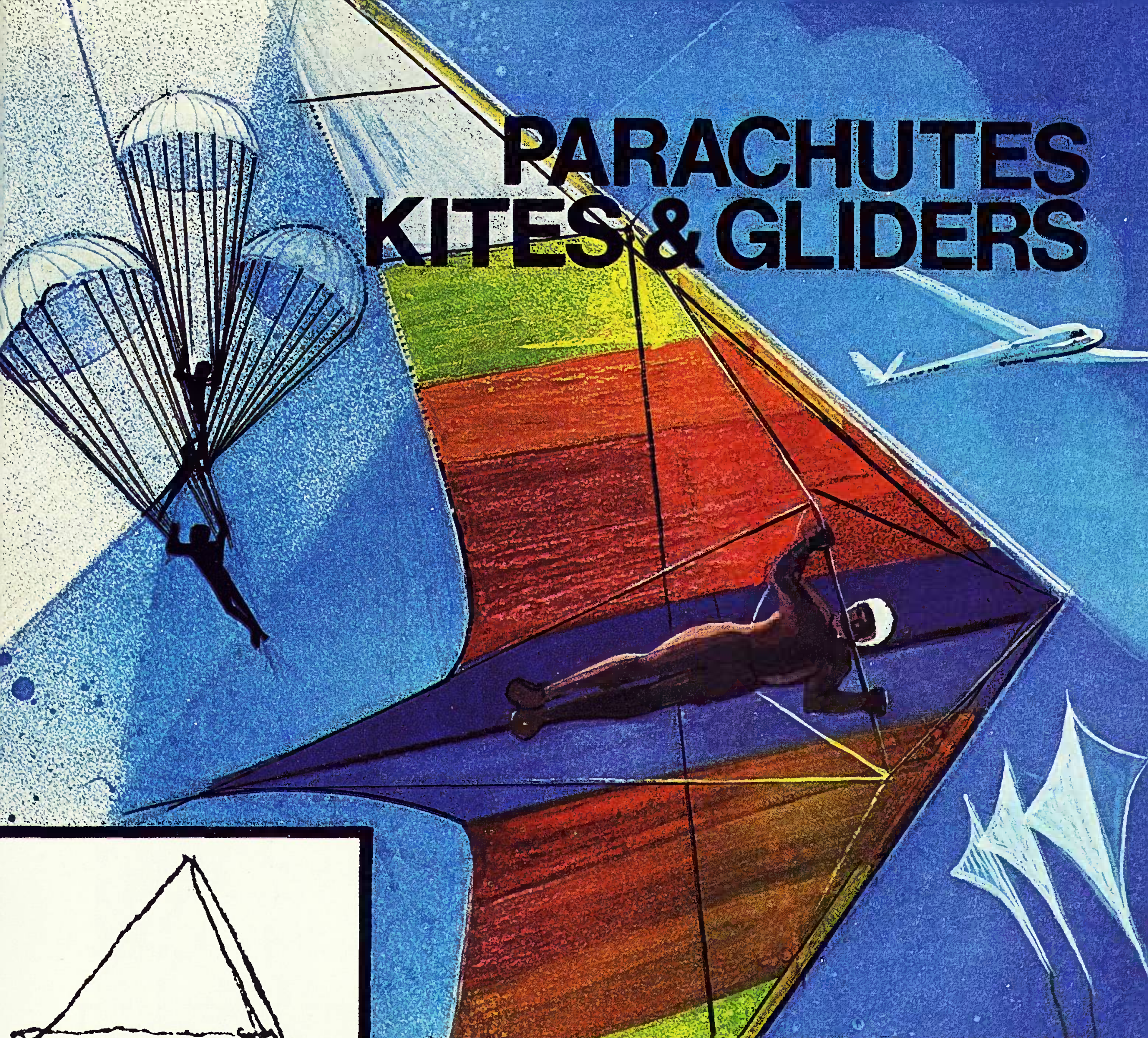
Your class could try this.
Your teacher may be able to get some balloons filled with hydrogen gas from a secondary school, or when there is a fête.

**WORK OUTSIDE. HYDROGEN IS FLAMMABLE.**

Before the race try some other experiments. Find out what load your gas-filled balloon will lift.
Why do the balloons come down?
Save one, watch it and then try to work out why.



# PARACHUTES KITES & GLIDERS

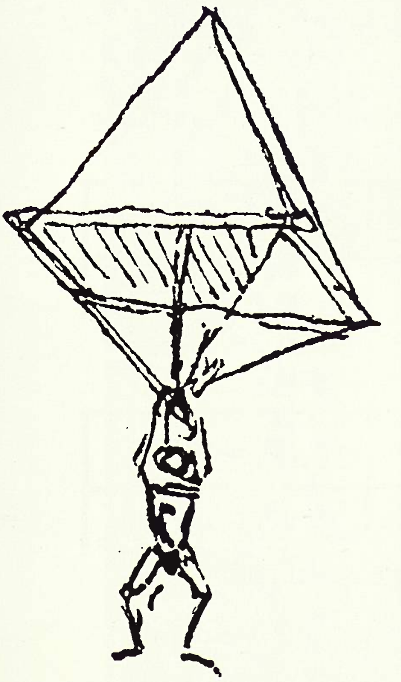


Men have always looked up into the sky and longed to fly.
Long before the first balloon or aeroplane carried man upwards, kites, gliders and parachutes had been used.

Kites were invented by the Chinese thousands of years before the birth of Christ.

What is believed to be a model glider has been found in an Egyptian tomb. This was carved in the third or fourth century B.C.

In this section you will be able to find how these ideas have developed and have been used.
You can also make some parachutes, gliders and kites and test them.



This parachute was designed by the great Leonardo da Vinci in 1485.

**Section Four**

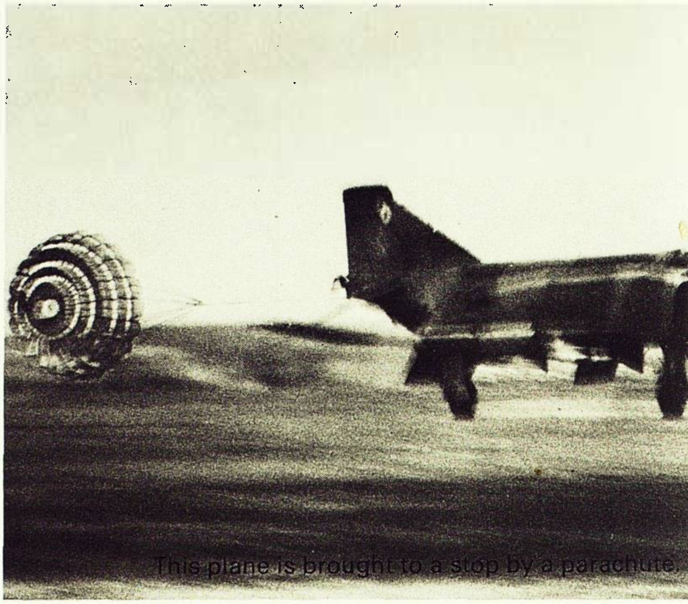
# PARACHUTES

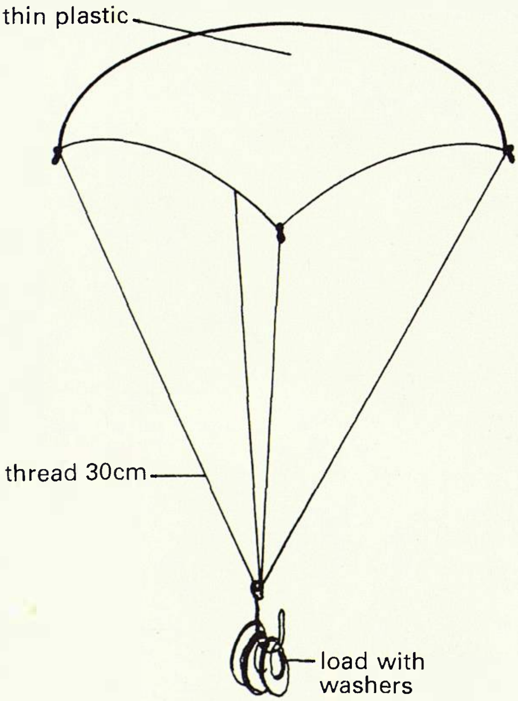
The parachute is very important in the story of flight.
It has saved life. Pilots have been able to jump to safety.

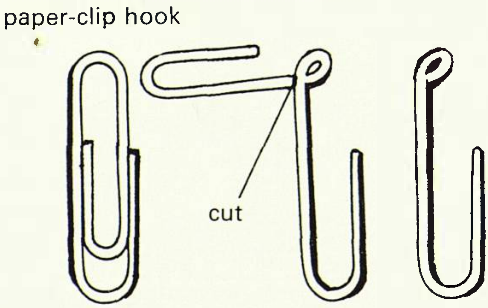
Parachutes have often been the only way to get food, medicine and other supplies to disaster areas.

Parachuting has become an exciting sport.

In Section Five you can learn about moving through air and streamlining. Streamlining can help speed up movement.
Parachutes can use the air to slow down movement.


This plane is brought to a stop by a parachute.




Make some parachutes and test them.

Very thin plastic is a good material to use.

Find out if size makes a difference to dropping time.

Try 20cm, 30cm, 40cm - - - - squares.

Make your tests fair.
Think about the dropping height and how you drop them.

| Parachute size | Dropping time |
|---|---|
| | |

Find out if the load on the parachute changes the dropping time.

| Parachute load | Dropping time |
|---|---|
| | |

Test other parachute materials.

Try cotton, nylon, paper, tissue paper....

If comparing materials, think about the fairness of your test. Think about the size, the load, the dropping height.

Early parachutes wobbled as they came down. Can you think why?

This was cured by having a hole in the top.

Try making a hole in your parachute.

Experiment with this idea.

What difference does the size of the hole make?

Can it be too big, or too small?

What is the best size for a parachute hole?

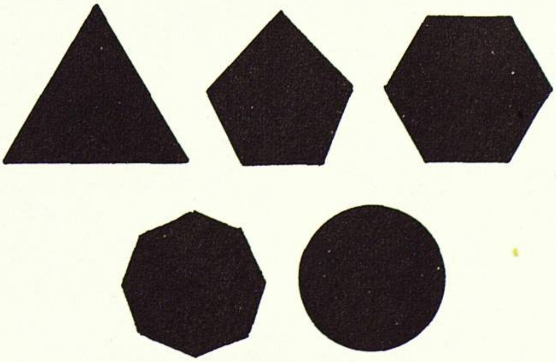
What happens if the hole is not in the middle?

You are trying to find out about the difference the holes can make. What must you make sure about in connection with the size, the material, the load, the dropping height?

Your parachutes have all been square-shaped. Is a square the best shape?

Try 3-sided, 5-sided 6-sided and 8-sided shapes. Try a circle.

To make these tests fair the area of each should be the same. For those of you who are on keen on mathematics this would be quite a challenge.



Changing the string length is something else you could try and test.

# KITES

Kites are usually thought of as toys.
They have been used for more serious things:
– Kites have been used to signal.
– They have been used for fishing.
– They have been used to discover secrets of the atmosphere.

In 1757 Benjamin Franklin used a kite in an experiment to investigate lightning.
A year later Professor Richman was killed when repeating the experiment in St. Petersburgh.

It is fun to make and fly kites.
Kites teach us a lot about flight and flying.
Kite flight is similar to aircraft flight.
The same forces are at work.

These forces are:

1 LIFT

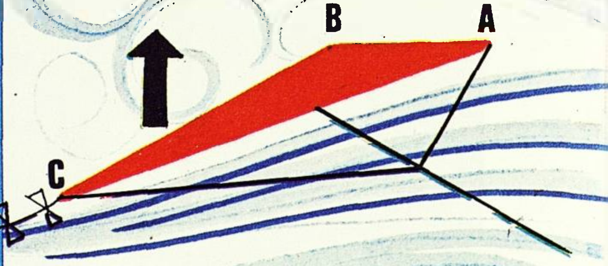
2 GRAVITY

3 DRAG

You can feel these forces as you hold the kite's flying line.
Your pull on the string balances them.
The kite moves when the forces change.

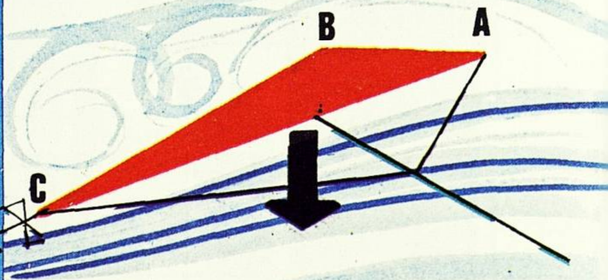
**1 LIFT**

The air flows faster over A B C than A C.
The kite is lifted upwards.
(see pages 35, 36)




**2 GRAVITY**

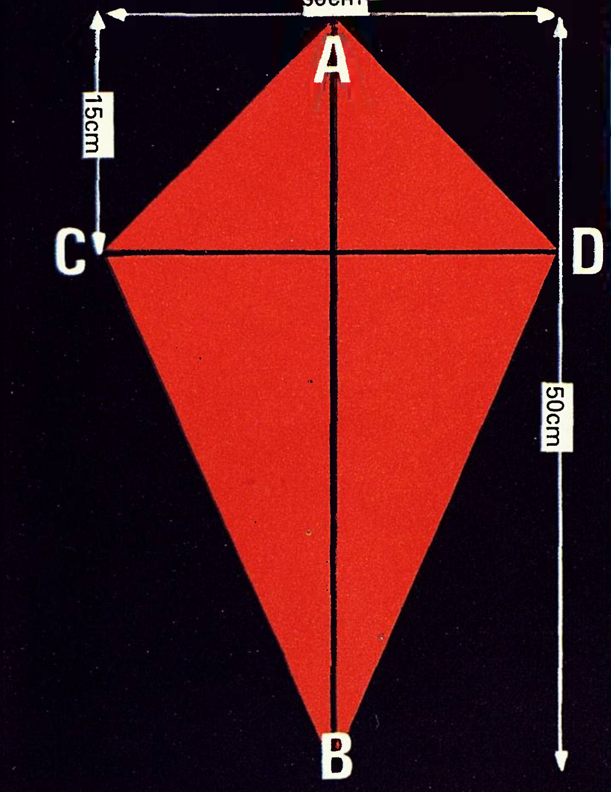
The kite is heavier than air.
It is pulled towards Earth.

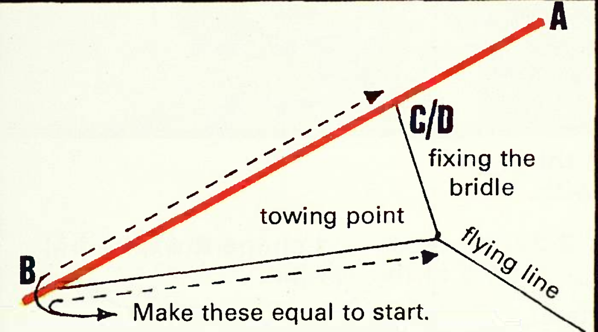



**3 DRAG**

The air swirls past and so pushes the kite.


**BE CAREFUL WHERE YOU FLY A KITE. NEVER NEAR ELECTRIC WIRES.**



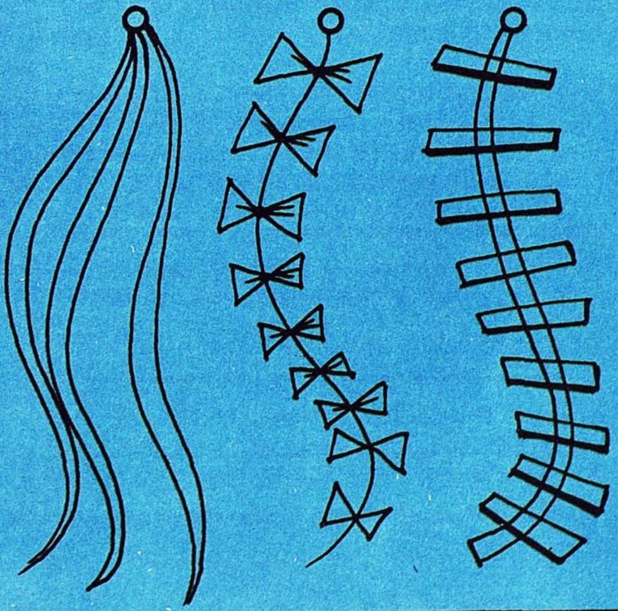

Fix the flying line to the bridle.
This bridle makes a lot of difference to how the kite flies.
It may not even fly at all if the towing point is set wrongly.
Test to find the best point to tie.

Here is a design for a simple kite.

There are hundreds of other kite designs you can try.

Make a frame of thin split bamboo cane
Use thread to tie the joints, then glue.
Cover with strong paper or thin plastic.

To fly successfully the kite must be kept headed into the wind.
One way to do this is to give a kite a tail.
Experiment with the tail.
Find how important a kite tail is.
Fly the kite with no tail.
Make tails of different lengths and try them.
Make different kinds of tail and try these.



The stunter kite is exciting to fly.

See if you can work out how it twists and turns.

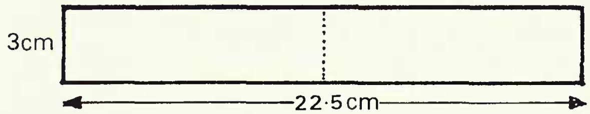
# GLIDERS

Sir George Cayley is known as the 'Father of Flying'. This is because he was the first man to understand **heavier-than-air flight**. He studied the shapes of wings. He began to understand how wings could lift.
The first person ever to be carried aloft in a heavier-than-air craft was a ten-year-old boy. He flew in a glider built by Sir George Cayley in 1849.
These experiments with gliders led to the aeroplanes we know today.
Gliders are still used today, but mainly for sport.
The glider has no engine.
It does not use any fuel.
It can fly for a long time and travel quite long distances.

Find out more about gliders and gliding:
- Where is gliding done?
- How are these sailplanes launched into the air?
- How do they stay up?

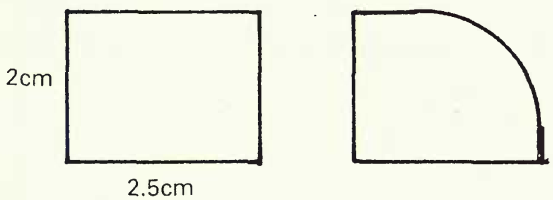
Make a model glider from balsa wood 1.5mm thick.
You can then use your model to experiment with.

**1** Cut the wing and score the middle.

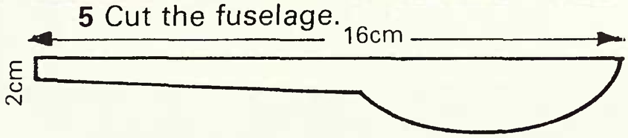



**2** Score, crack and shape the dihedral (angle of the wings).

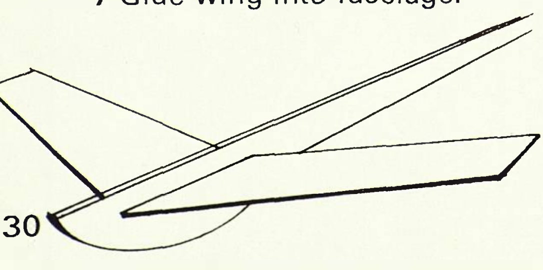

**4** Cut and shape the fin.



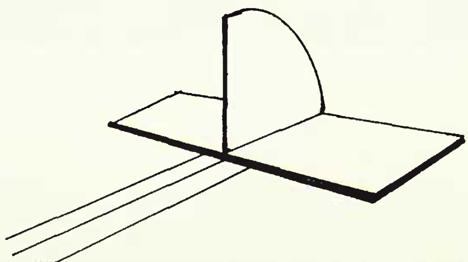

**5** Cut the fuselage.

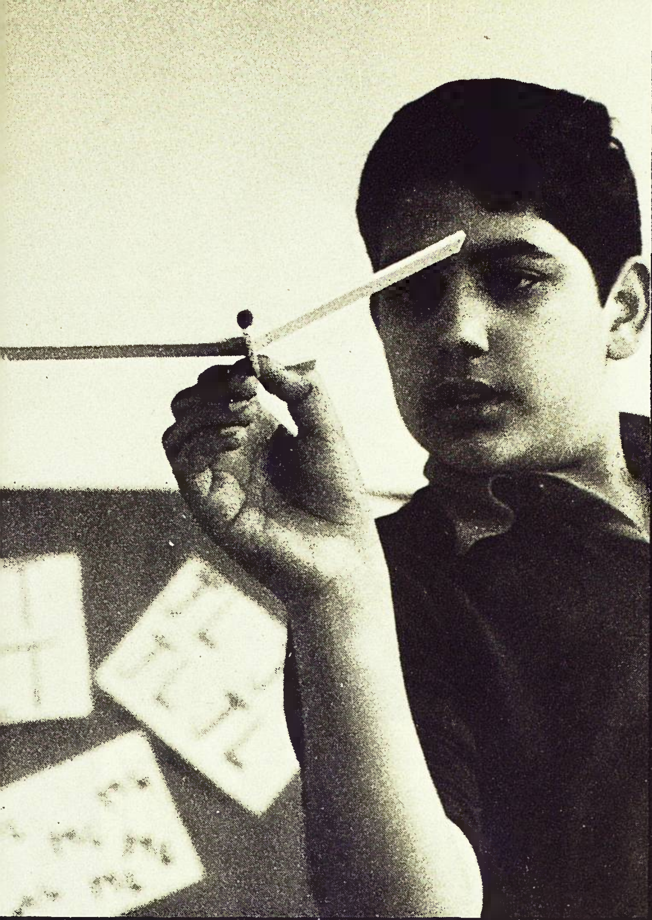



**7** Glue wing into fuselage.

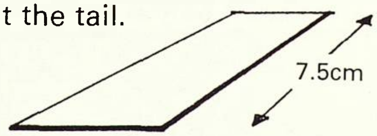


**8** Glue fin to tail – tail to fuselage.

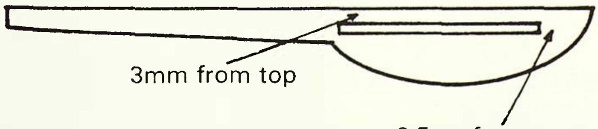




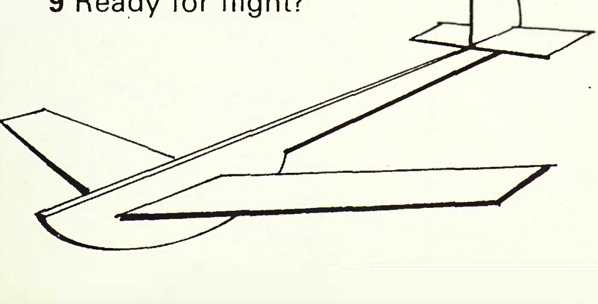
**3** Cut the tail.



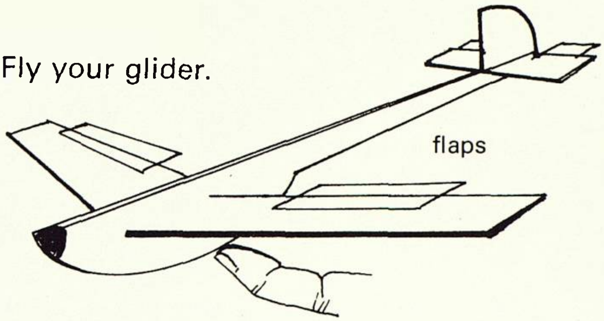

**6** Cut slot for wing (using wing to mark).




**9** Ready for flight?



Fly your glider.




Add a 'nose load'.
It needs to balance about here.
Use your finger as the *pivot.* (You can learn more about balancing in *Science in a Topic: Ships*, pages 34-37.)

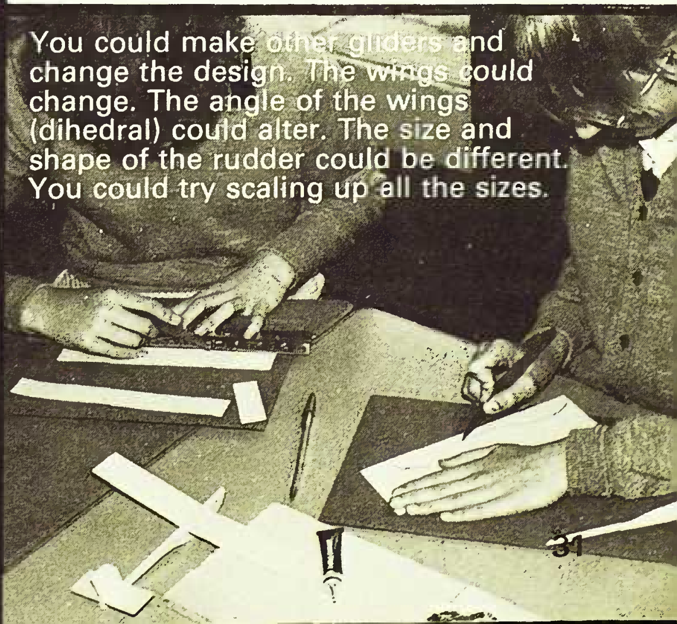
Make test flights.
Experiment in the school hall in still air.
Experiment by changing the nose load.
Find the load that gives the longest flight.

Experiment with the height from which you launch the model.

Now try outside. Launch *into* the wind. Then launch *with* the wind.

*Can the flight be controlled?*
Make your glider turn left, turn right, fly straight, loop the loop.

Try adding controls.
Try gluing thin card flaps and bending.
Try bending up, bending down and one up *and one down.*

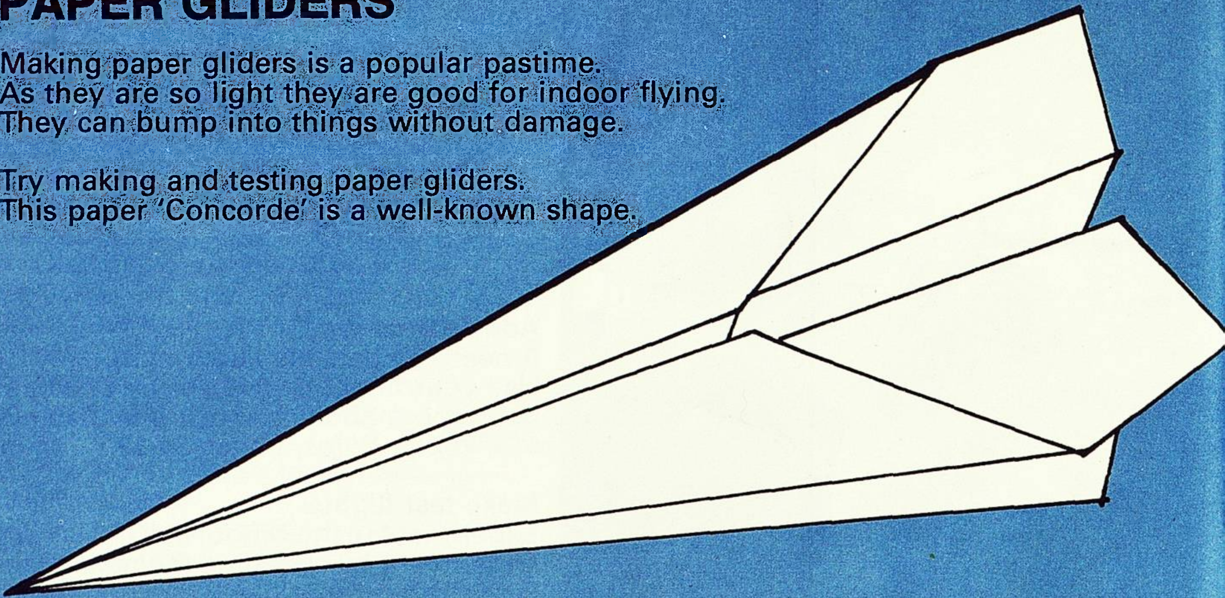


You could make other gliders and change the design. The wings could change. The angle of the wings (dihedral) could alter. The size and shape of the rudder could be different. You could try scaling up all the sizes.

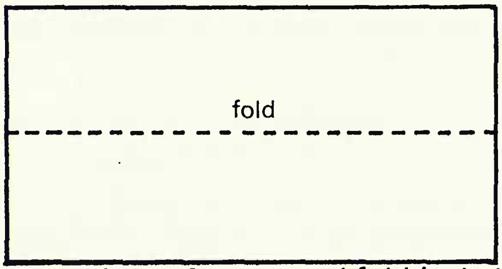
# PAPER GLIDERS

Making paper gliders is a popular pastime.
As they are so light they are good for indoor flying.
They can bump into things without damage.

Try making and testing paper gliders.
This paper 'Concorde' is a well-known shape.

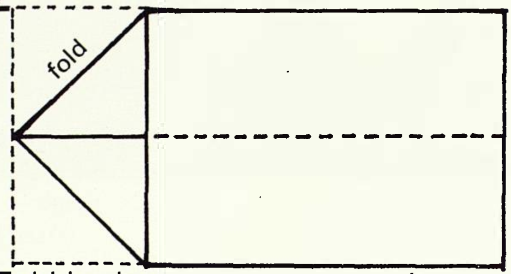


1



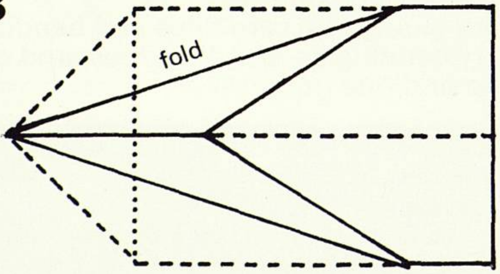

Take a piece of paper and fold in half.

2



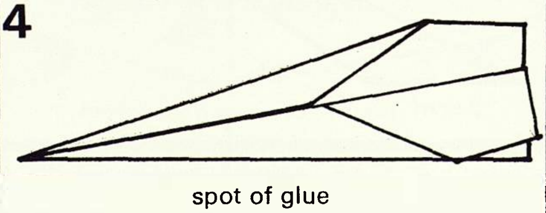

Fold back corners on one end.

3



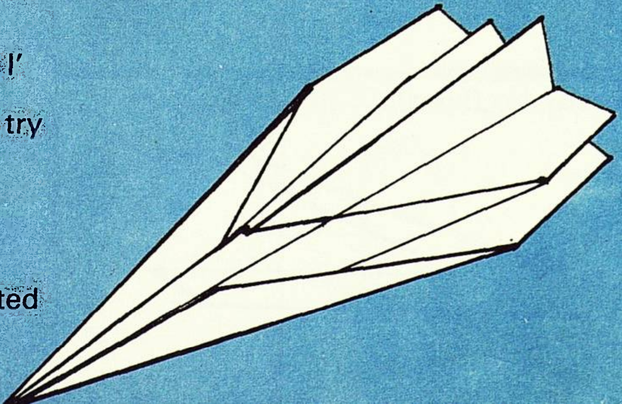

Fold edges of point to centre.

4




Refold in half and turn down edges to form the wings.

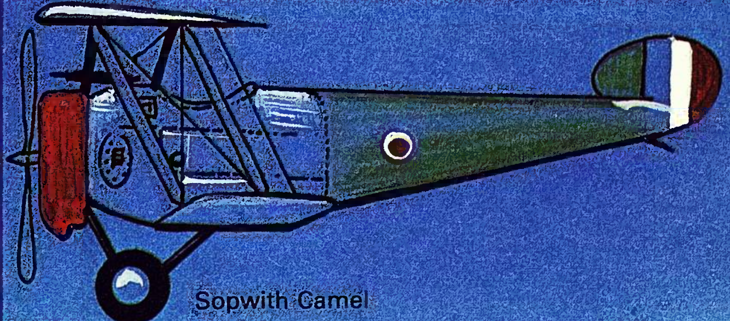
Try adding an extra wing like this.
Make test flights and compare 'Mark I' and 'Mark II'.
Add loads to your paper aircraft and try further test flights.



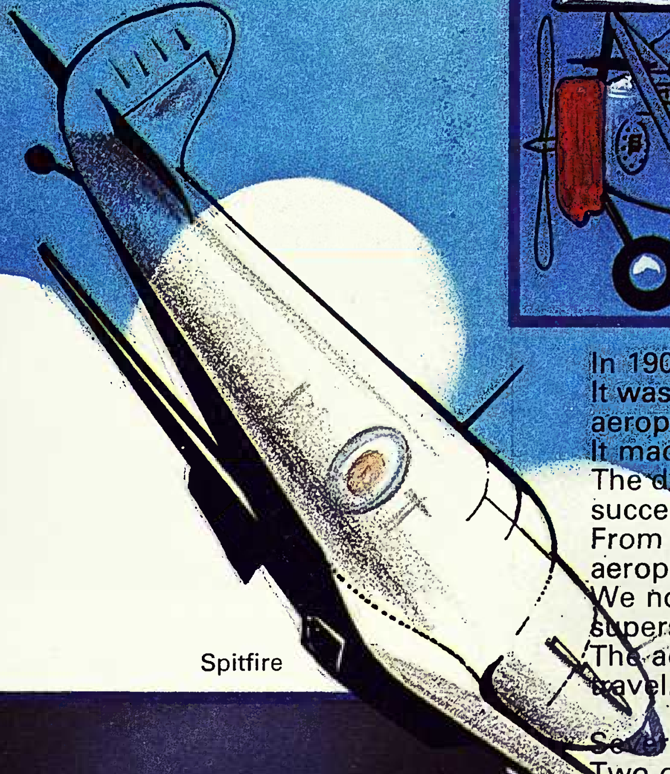
There are many designs for paper gliders.
Make and test other models.
Some books that will help you are listed on the inside back cover.

Wright Brothers 1903

# AEROPLANES



Sopwith Camel

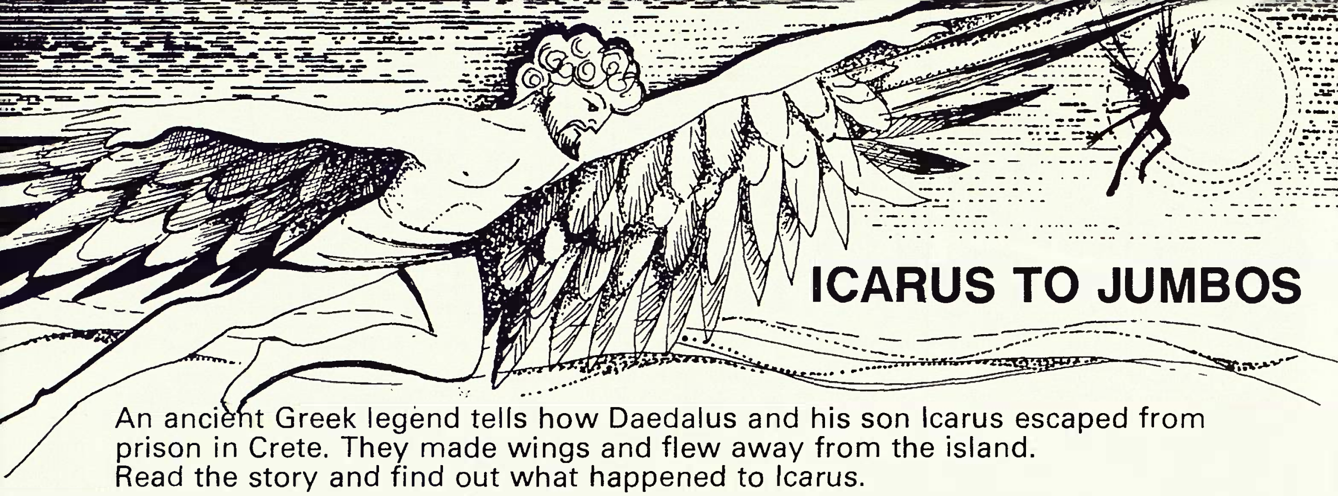


Spitfire

In 1903 the first aeroplane flew.
It was the *Flyer,* which was the first powered aeroplane to carry a man.
It made a flight of 36.5m.
The designers Wilbur and Orville Wright had succeeded after four years of experiments.
From that beginning, in one lifetime the aeroplane has developed.
We now have Concorde, Jumbo Jets and supersonic flight.
The aeroplane is now a common way of travel.

Several famous air shows are held regularly.
Two of the best-known are those at Farnborough and Paris.
You could start to arrange for your own air show.
It could include other fliers, not just aeroplanes.
Start collecting pictures and making models.
As you use this book make careful records and charts to display in your air show.

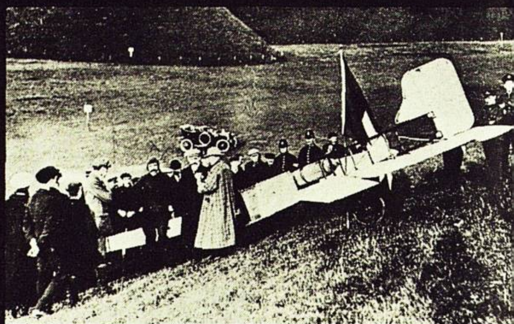
Jump Jet



# ICARUS TO JUMBOS

An ancient Greek legend tells how Daedalus and his son Icarus escaped from prison in Crete. They made wings and flew away from the island. Read the story and find out what happened to Icarus.

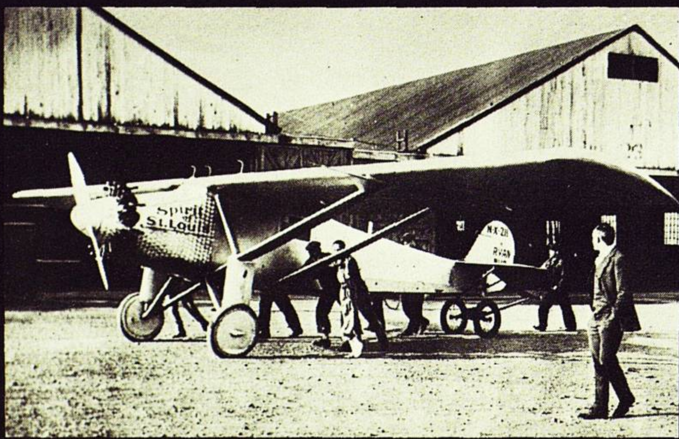
The first attempts at flying tried to copy the wings of birds. Find out about Otto Lilienthal and Percy Pitcher.



Then the Wright brothers made their historic flight.
When and where did this take place?

Louis Blériot made a historic flight in 1909.
Where did his flight start and end?

During the First World War (1914-1918) there was rapid progress in aircraft design.
Find out about the Sopwith Camel and the Fokker D V11.



A great challenge to early fliers was to cross the Atlantic Ocean.

Find out when and in what kind of aeroplane Alcock and Brown made this crossing.

Who flew the *Spirit of St. Louis* across the Atlantic?

In the 1920s and 1930s longer flights were made over the oceans. Seaplanes and flying boats were built.
The Second World War (1939-45) again brought rapid changes in design.
Look for pictures of the famous fighter and bomber planes.
The Gloster Meteor was the first jet plane.
What was the name of the first jet in passenger service?

Collect photographs of today's planes for your air show.


# HOW AEROPLANES FLY

An aeroplane flies because air moves over its wings.

These great forces on the wings can lift the heavy aircraft up.

Try some tests for yourself to find out about **air** and **lift**.

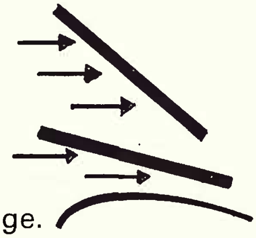
Use a piece of stiff card.

Hold it like this.

Run with it.

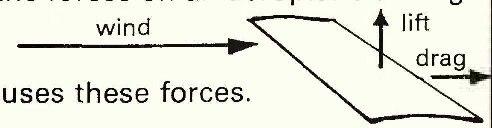
Try changing the angle.

Try curving the front edge.



Run with it again.

You should be able to feel two forces at work. These are the forces on an aeroplane's wing.




Air flow causes these forces.

As you change the angle you should feel these change.

Experiment with a wing shape.

Use stiff paper. 40cm × 5cm

Make this shape. Hold it like this.

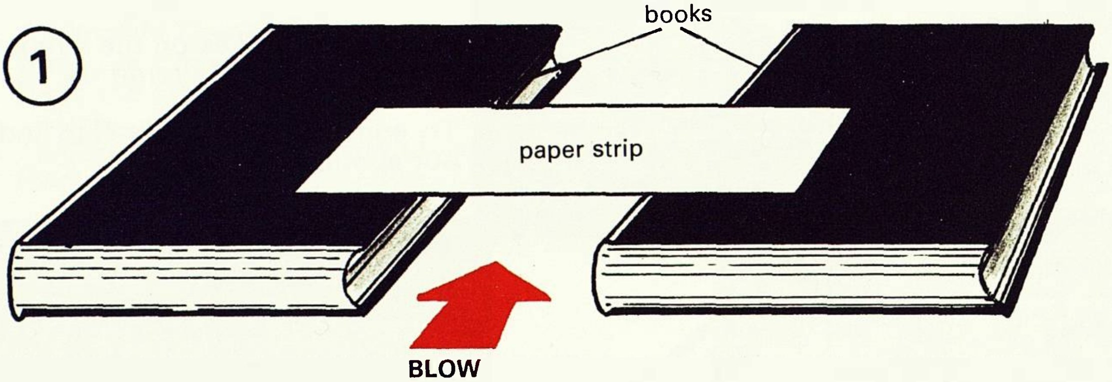

The wing shape makes air flow faster over it than under it. Fast-moving air has a lower pressure than slow-moving air. Faster air is 'stretched out and thinner'. The wing is pushed up, the aeroplane flies.

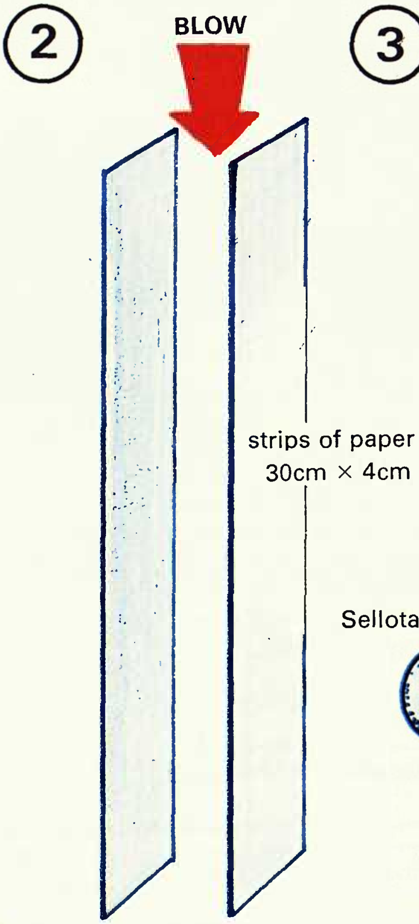
fast-moving air has a lower pressure

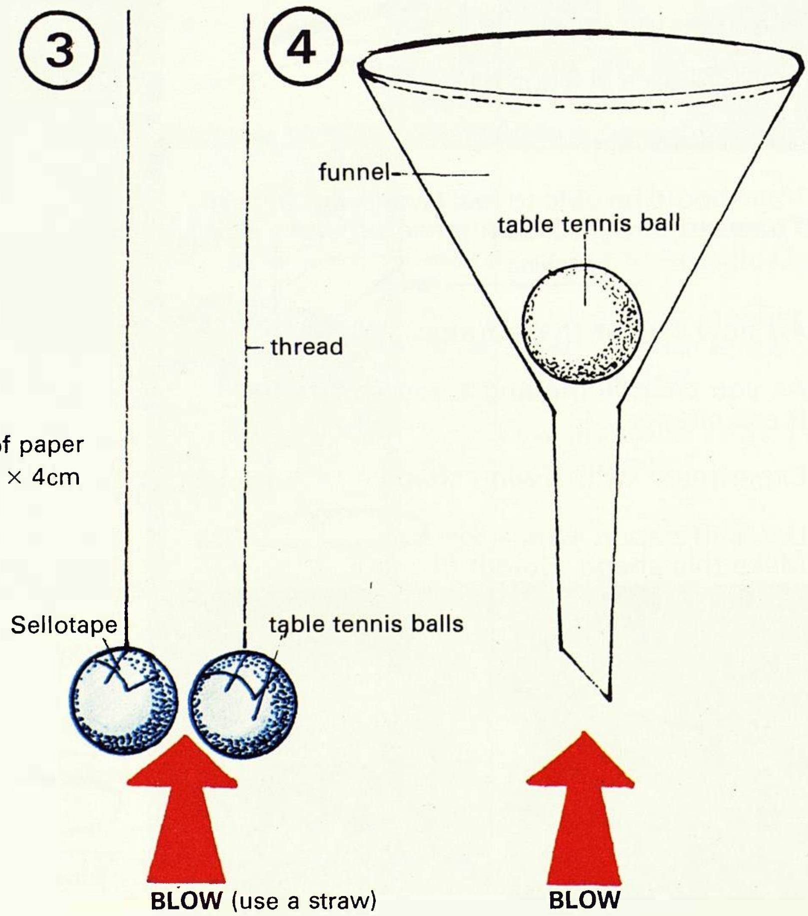
slow-moving air has a higher pressure

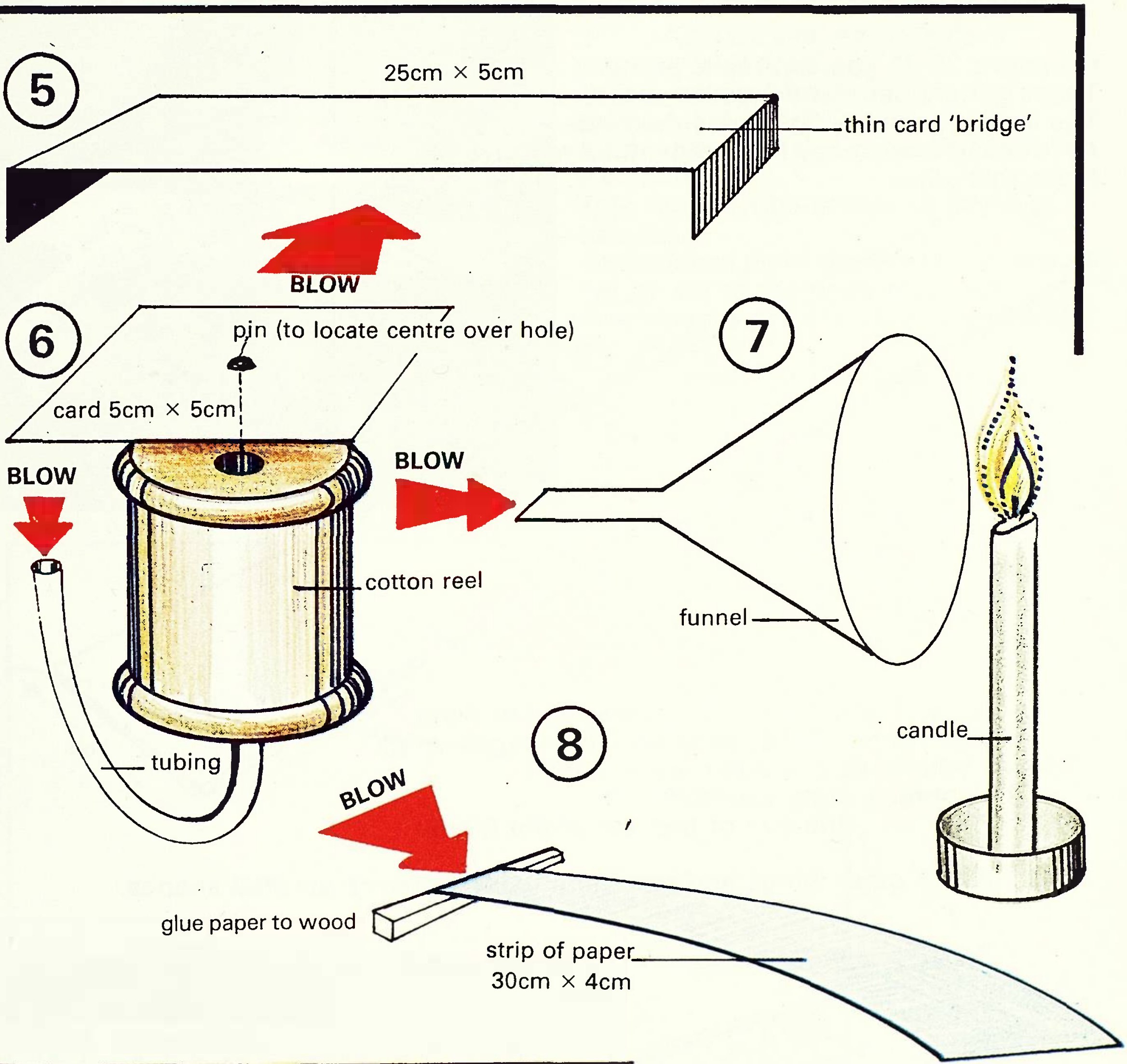
# AIR FLOW

Air can lift Jumbo Jets carrying five hundred passengers.
These experiments will help your understanding.
Try each of them.
**First predict what you think will happen.**
Try the experiment.
Observe carefully and record what happened.






Make a drawing of what you did.

Mark on it where you think there was **high pressure** (**H.P.**)

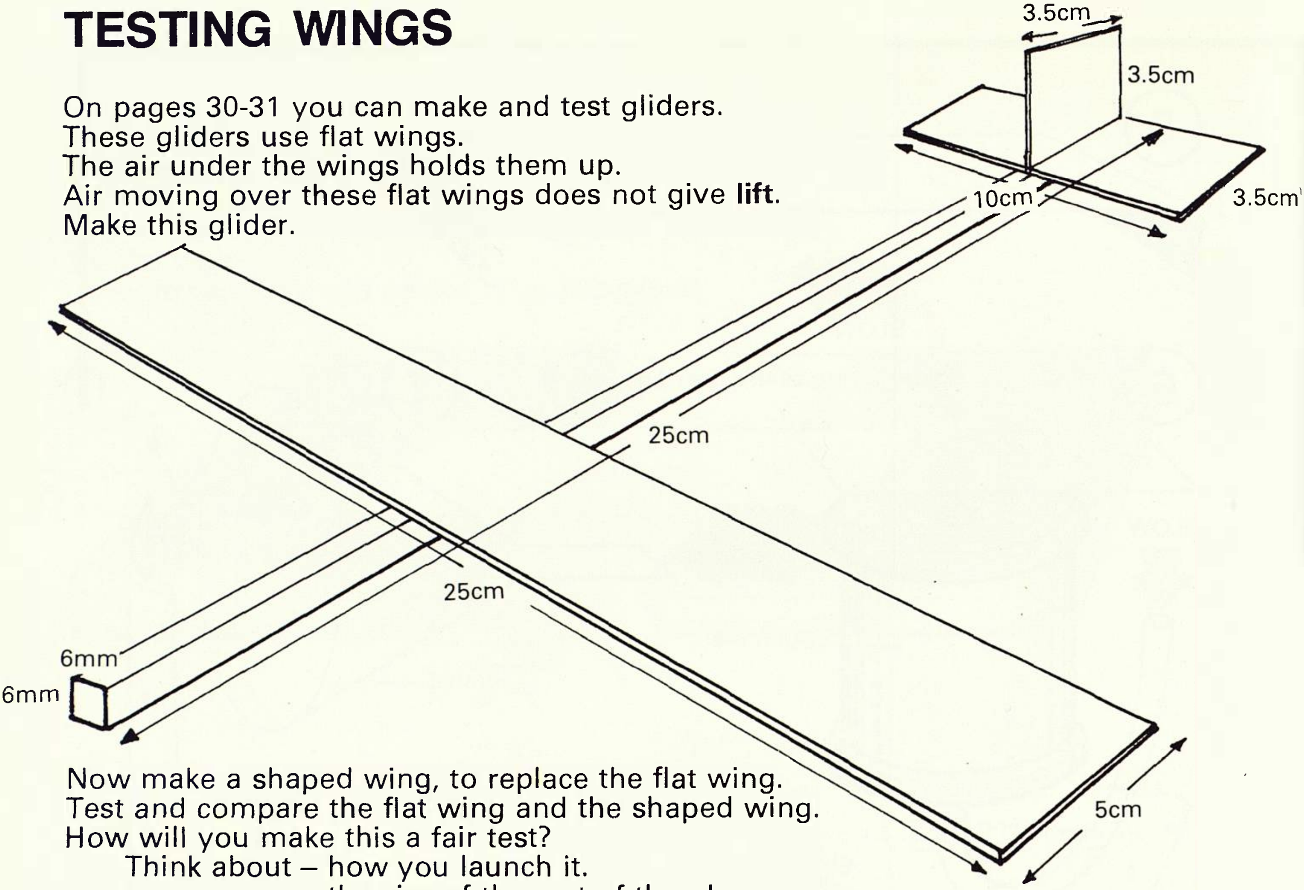
Mark on it where you think there was **low pressure** (**L.P.**)

Think which way the thing moved.

Remember the push is from **high** to **low**.

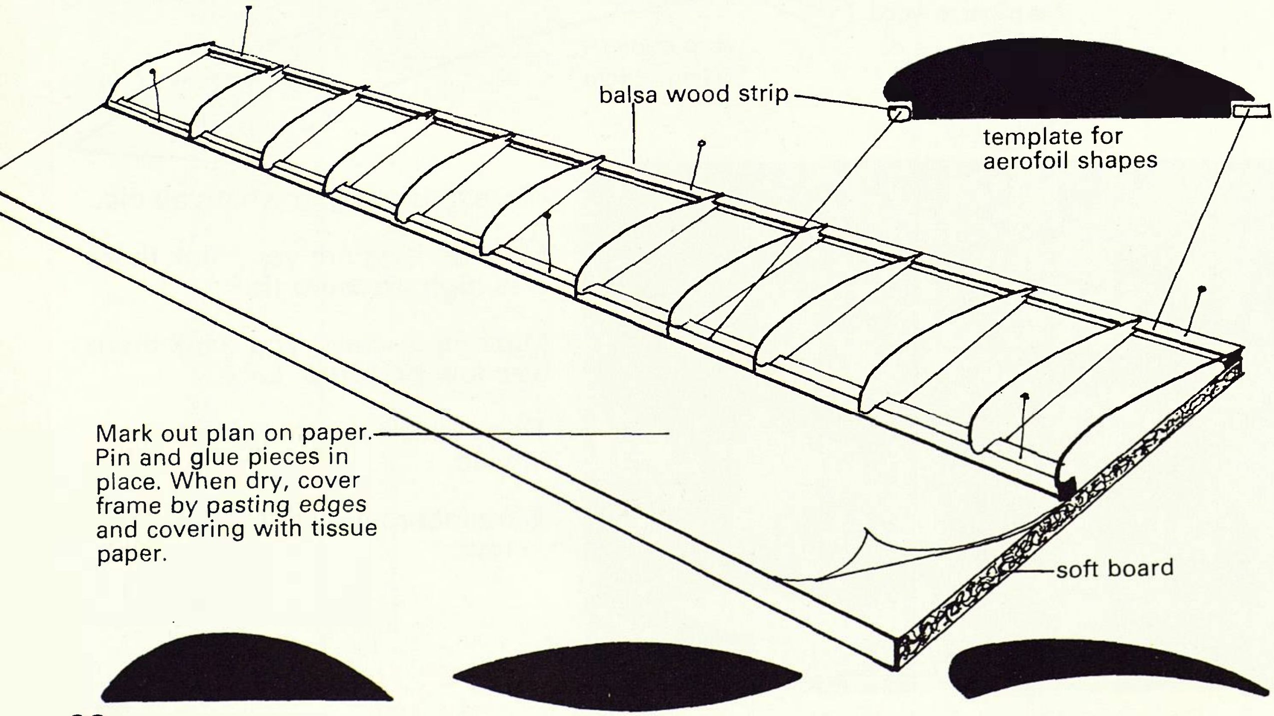
# TESTING WINGS

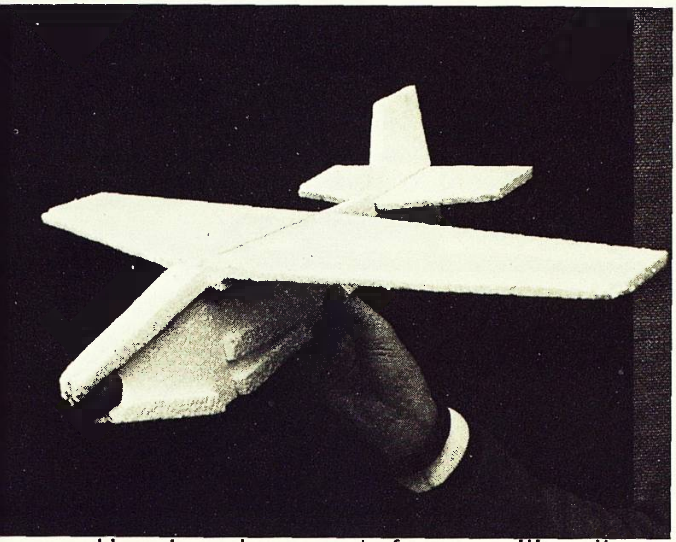
On pages 30-31 you can make and test gliders.
These gliders use flat wings.
The air under the wings holds them up.
Air moving over these flat wings does not give **lift**.
Make this glider.




Now make a shaped wing, to replace the flat wing.
Test and compare the flat wing and the shaped wing.
How will you make this a fair test?
Think about – how you launch it.
– the size of the rest of the plane.

You could try other wings and test them using different aerofoil shapes.

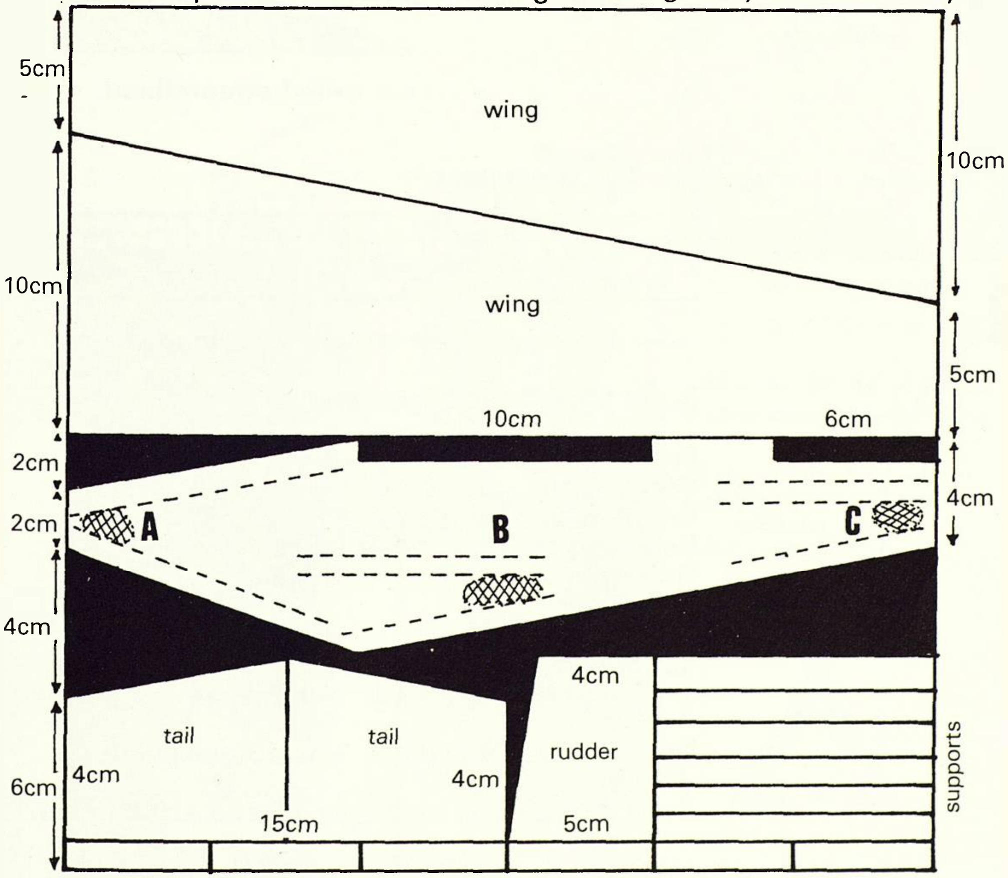




Here is a plane made from a ceiling tile.

# LIFT AND BALANCE

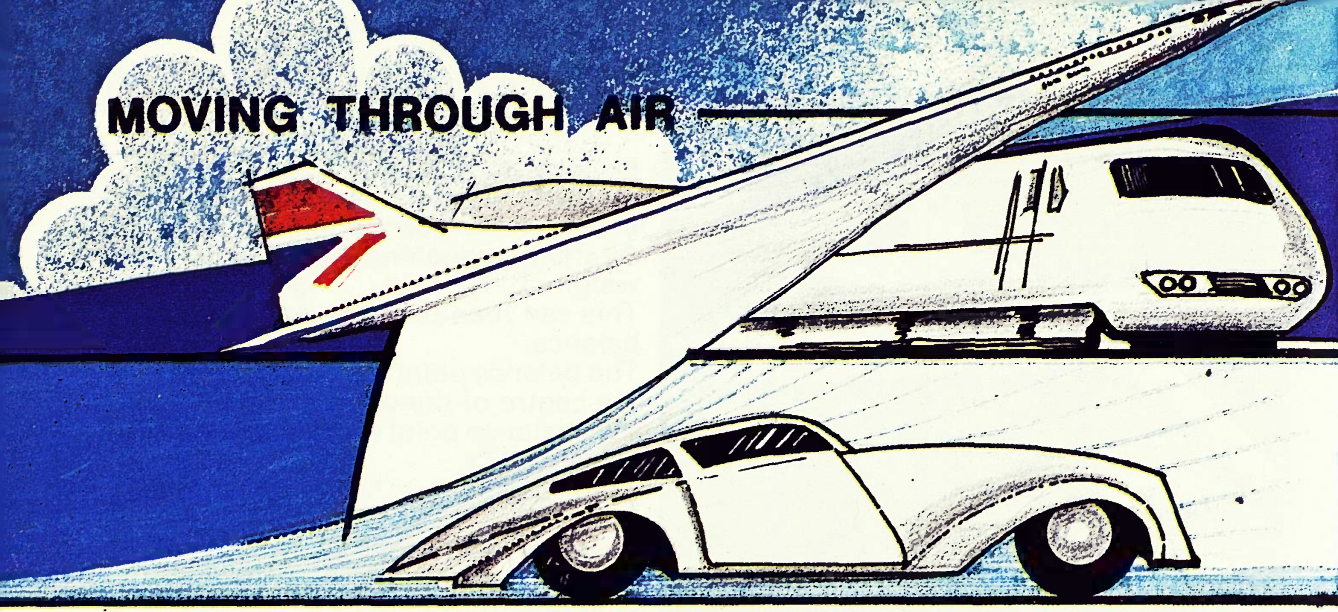
It is important that an aircraft is properly balanced.
Before take-off passengers are given their seat numbers.
All the luggage and cargo is carefully weighed.
This can then be loaded to *trim* the balance.
The balance point for most aircraft is at the centre of the wing and body.
This balance point is called the CENTRE OF GRAVITY.
(See *Science in a Topic: Ships*, page 35.)
Try making a model to test with different loads.
Find how these alter the centre of gravity and how they alter the flight.




You can add plasticine loads to these places **ABC**.
Record the position and mass of the loads.
Also try adding more load to the centre of gravity.

| Load at A | Load at B | Load at C | Flight details |
|---|---|---|---|
| | | | |

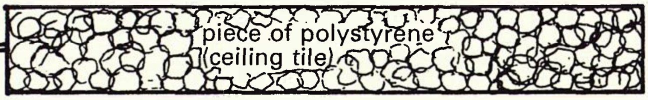
# MOVING THROUGH AIR

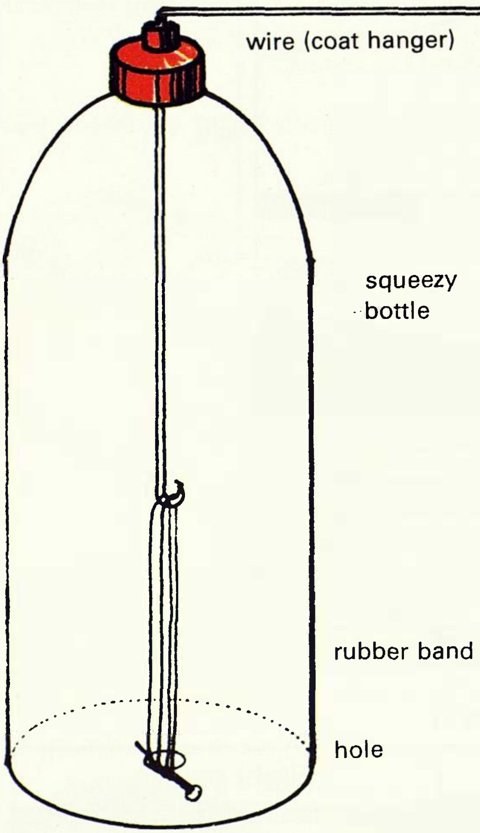


When planes move quickly through air, their shape is very important.
Some move more easily through the air than others.
The push of the air against them is less.

These shapes that offer much less **resistance** to the air are called **streamlined**.

Collect and draw pictures of fast-moving things.
How does their streamlined shape help fast movement?




Here is a way to test streamlined shapes.

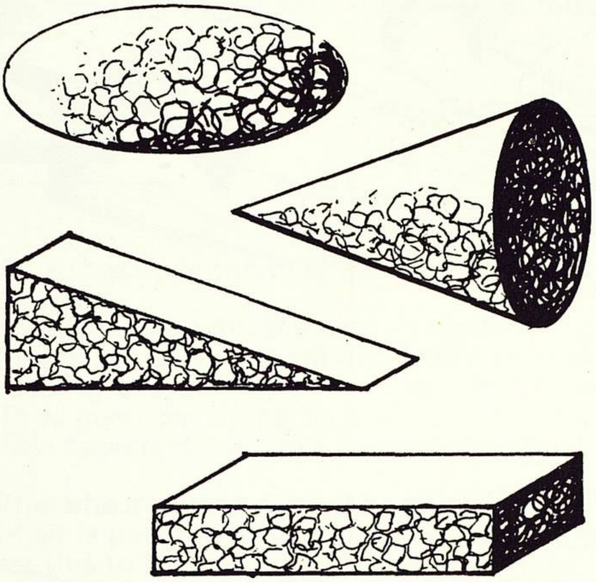
Make this elastic band **rotor**.

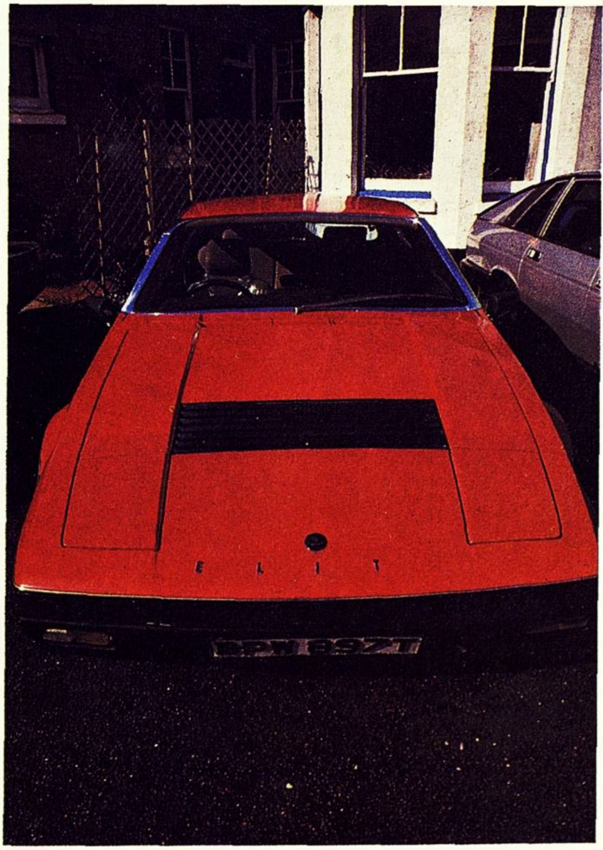
Fix shapes to the wire arm.
Wind up the rotor arm.
Count as you wind.
Release and time until it stops.
How will each test be made fair?

Try fixing the shapes in different positions:
flat on, edge on, sloping.
Try using different sizes and shapes.

Does the way the shape is fixed make a difference?
Does the position on the arm make a difference?

Experiment with solid shapes.
Use a polystyrene ball.
Make and test some of these shapes.





These could be made of balsa wood.

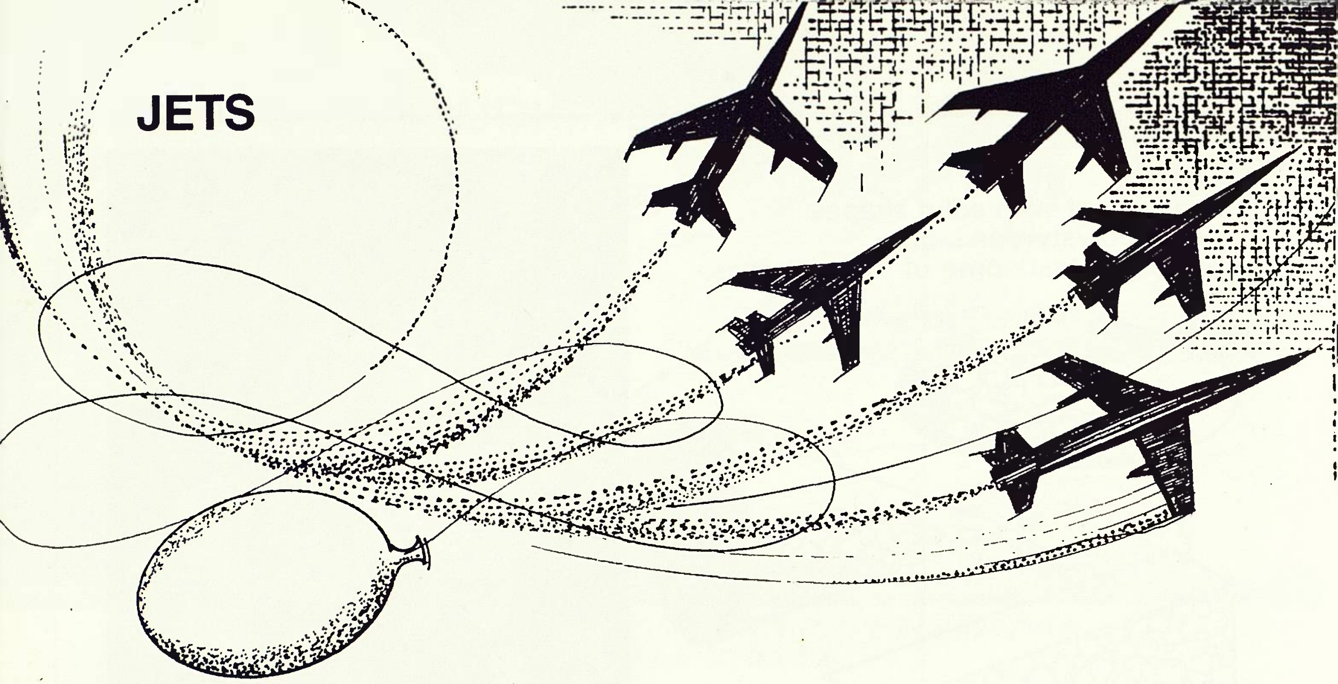
They could be cut from thick expanded polystyrene.

They could be cut and built from polystyrene ceiling tiles.

**CAUTION**

Use a sharp knife to cut polystyrene and do not rub or sand. The tiny pieces can be dangerous to breathe in.
If you use a hot wire cutter, it must be done near an open window or outside.

# JETS



You have probably already 'experimented' with a jet.

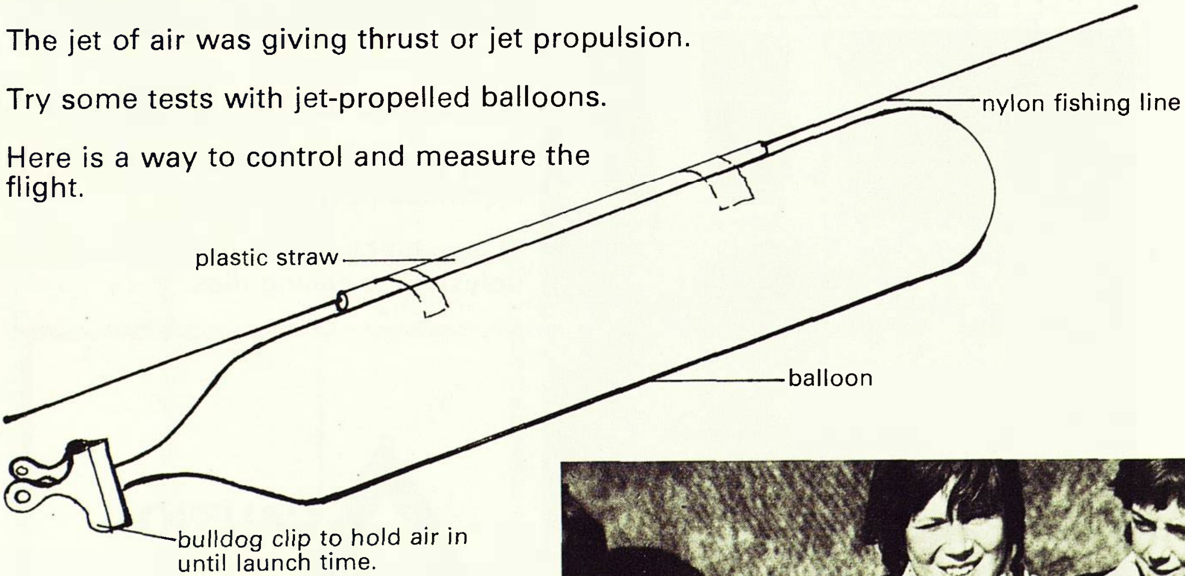
Have you blown up a balloon and then let it go?

The balloon was driven by the jet of air. The air jet rushed from the balloon and pushed it forward.

The jet of air was giving thrust or jet propulsion.

Try some tests with jet-propelled balloons.

Here is a way to control and measure the flight.




How far can you get the balloon to travel?

Try the thread, slack and tight.

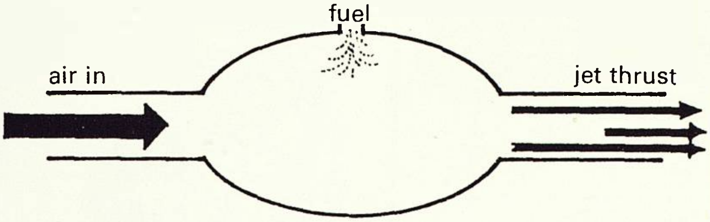
Try different balloons.

Try changing the size of the jet hole. (Plug with a small cork – holed.)

# JET ENGINES

It is quite common to hear the scream and roar of jet engines today. The jet engine is, however, a fairly recent invention. The first jet aeroplanes flew in 1941.

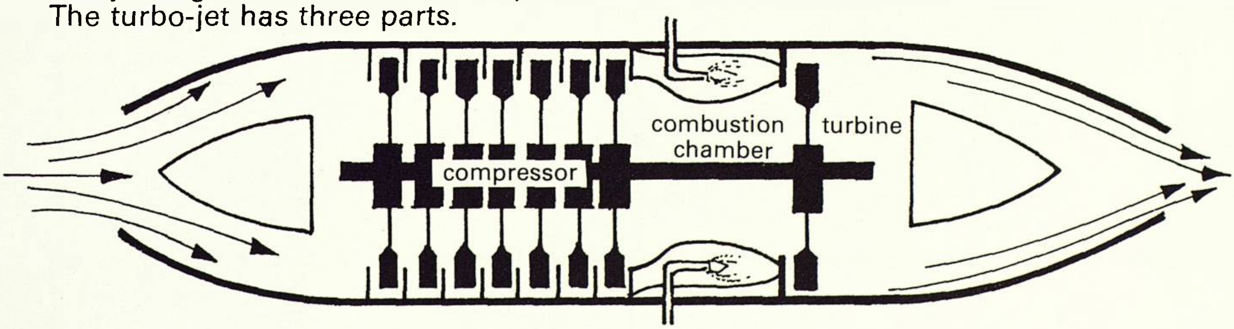
The first jet engines were simple open tubes.




Air is forced in the tube as the aircraft goes forward.
Fuel is mixed with the air and **ignited**.
The gases burn and expand. More air is still rushing into the front.
They push out of the back as a flaming jet.
This speeds the aircraft forward.

There is one great disadvantage with this engine. It cannot work until a great rush of air is pushing in. It needs to be travelling at about two hundred miles an hour for this to happen.
It can only be used if the aircraft has already reached this speed.
This engine is called a ram jet.

The jet engine that is most widely used now is called a **turbo-jet**.
The turbo-jet has three parts.

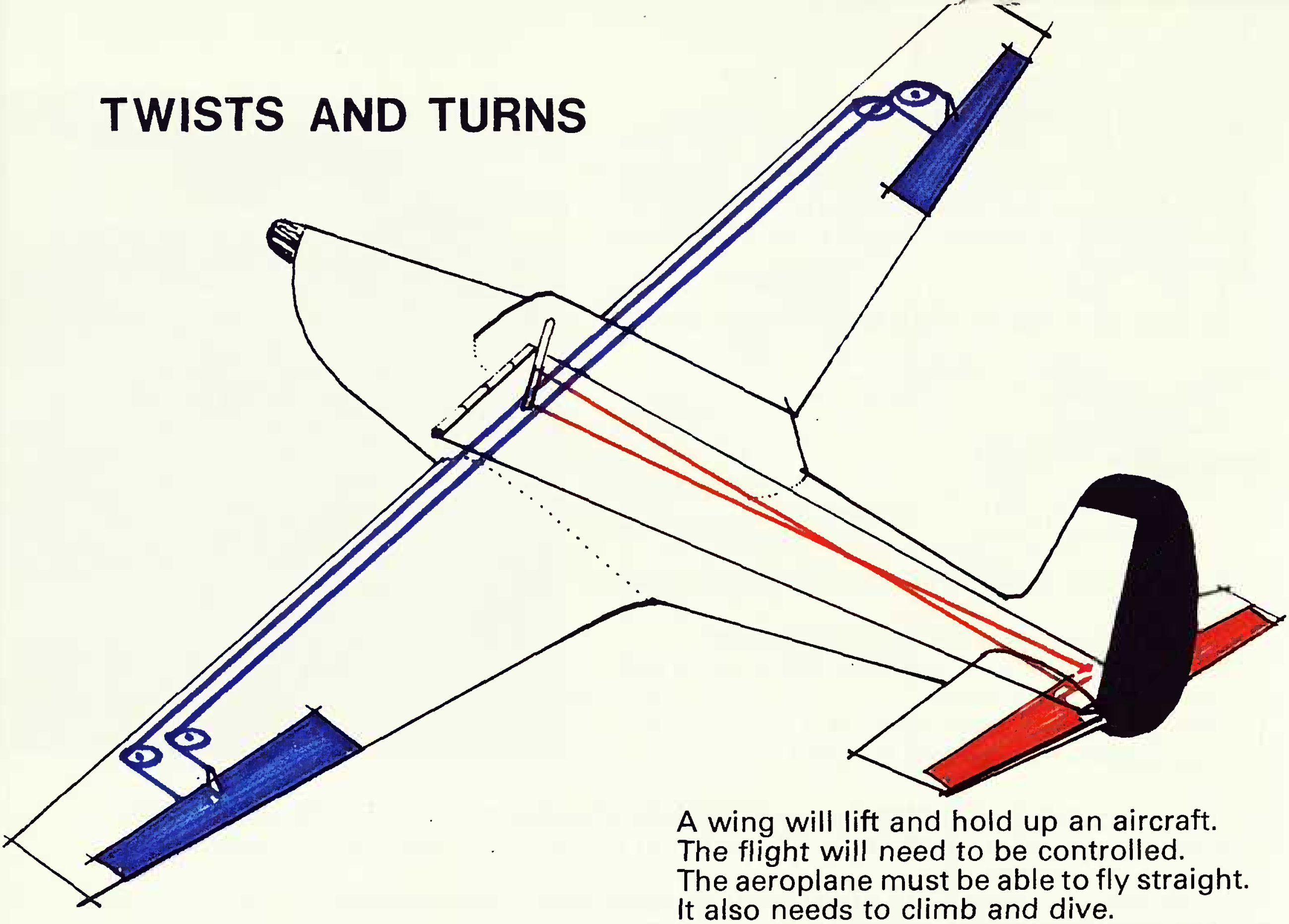



1 COMPRESSOR
This is like a powerful fan that forces air into the engine.

2 COMBUSTION CHAMBER
Here the fuel (kerosene) is squirted in.
This mixes with the stream of air.
It is then **ignited**.

3 THE TURBINE
The hot gases rush out through the fan-like blades of the turbine.
This makes the turbine spin at high speed.
The aircraft is thrust forward at great speeds.
The turbine also drives the **compressor**.

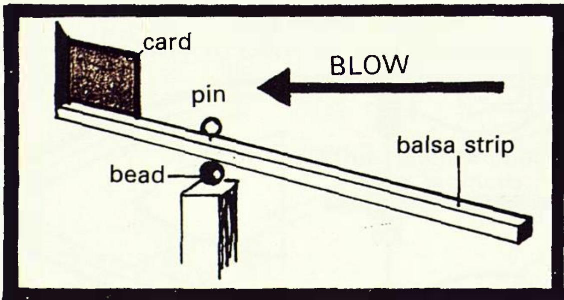
# TWISTS AND TURNS



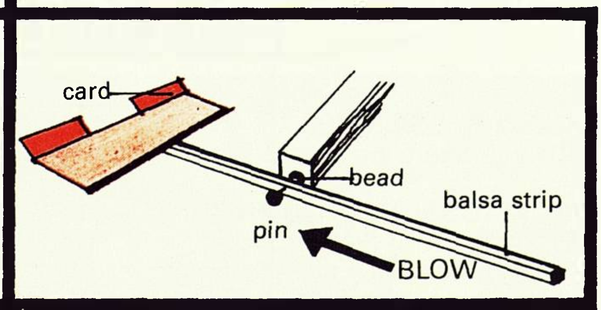
A wing will lift and hold up an aircraft.
The flight will need to be controlled.
The aeroplane must be able to fly straight.
It also needs to climb and dive.
It will need to turn.
To do this the pilot moves these controls.

Find out for yourself about how these work.

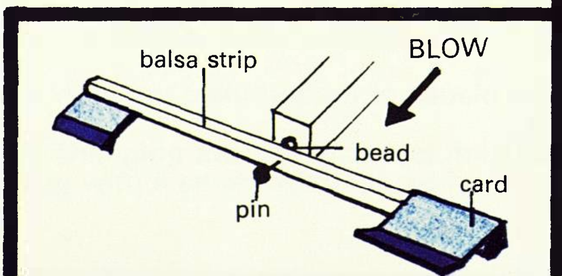
**The rudder**




**The elevator**




**The ailerons**




Which control turns?
Which control climbs and dives?


# HELICOPTERS & HOVERCRAFT

## THE HELICOPTER

This aircraft has only been in use since 1943. Ideas and experiments had been tried since the early 1900s.

Helicopters have proved to be very useful:

- They can climb.
- They can hover steadily in mid-air.
- They can land in a small space.
- They can go almost anywhere.

They can reach mountains, seas, flooded areas, earthquake areas, disasters, lighthouses and snow-bound villages.

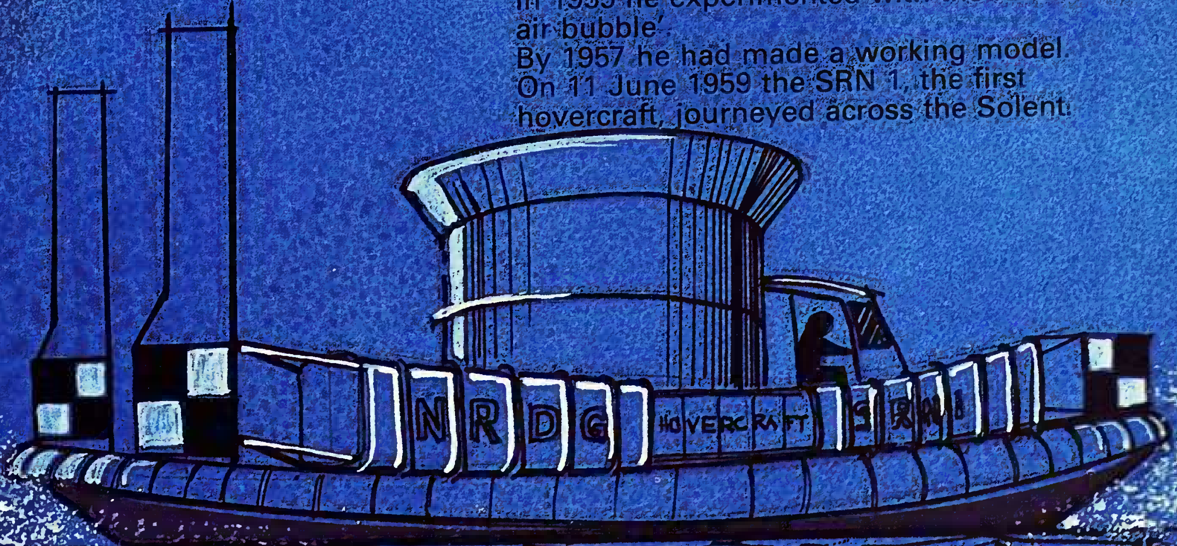
## THE HOVERCRAFT

In 1953 Christopher Cockerell, a boatbuilder, tried ways to make his boats go faster.

In 1955 he experimented with the idea of 'an air bubble'.

By 1957 he had made a working model.

On 11 June 1959 the SRN 1, the first hovercraft, journeyed across the Solent.

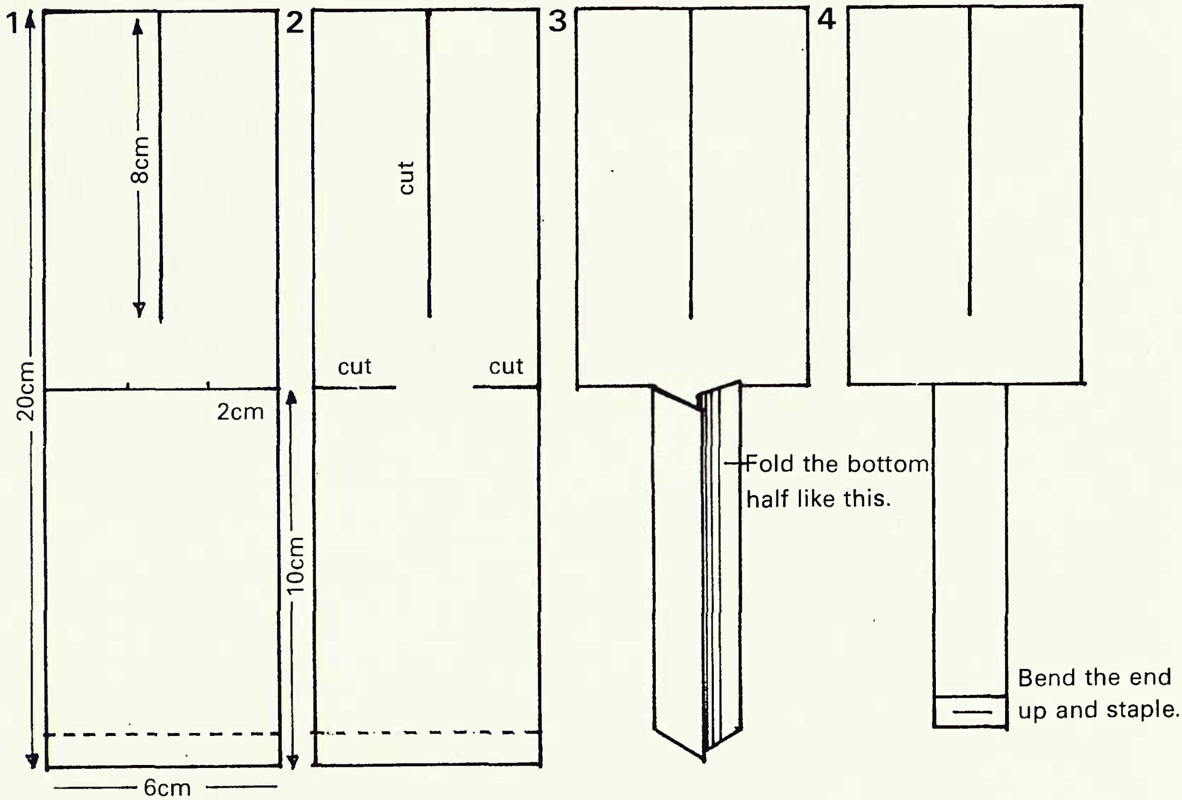


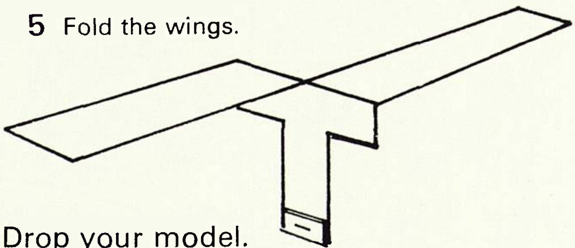



Section Six

# PAPER HELICOPTERS

Here is how to make a paper 'helicopter'.
You need a piece of paper 20cm × 6cm.
Measure and mark the paper.




Drop your model.
Time how long it takes to spin to the floor.
What might change this?
Try adding loads (paper clips).
What difference will wing size make?
Instead of an 8cm cut try – 4cm – 6cm.
Try different ways of dropping the model.
Let it go upside down.
Hold the wings together and let go.
What happens if the 'helicopter' is damaged?
  Cut off half a wing.
  *Punch holes in the wings.*
Try making a different sized helicopter – larger – smaller.

# ROTOR BLADES

How do rotor blades and propellers work?

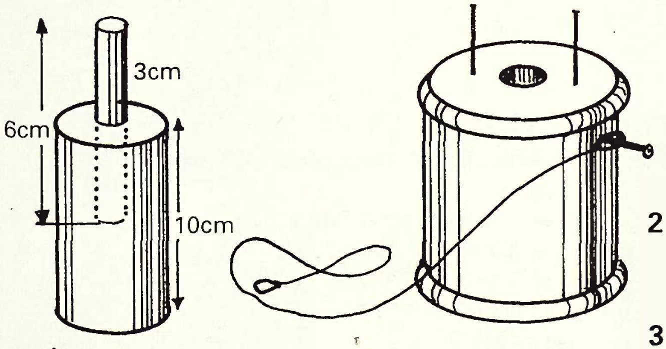
The name **helicopter** comes from two Greek words
- **helix**, which means a screw.
- **pteron**, a word meaning wing.

So it means a wing that screws its path through the air.

Make a model air-screw to experiment with.
You will need:
a piece of broom-handle 10cm long
a cotton reel (not all plastic reels are suitable)
a piece of 6mm dowel rod 6cm long
(the cotton reel must fit over this easily)
a piece of string about 1m long with a small loop tied at one end
3 small nails
material for the propeller – thin aluminium is best – tin, card, plastic.

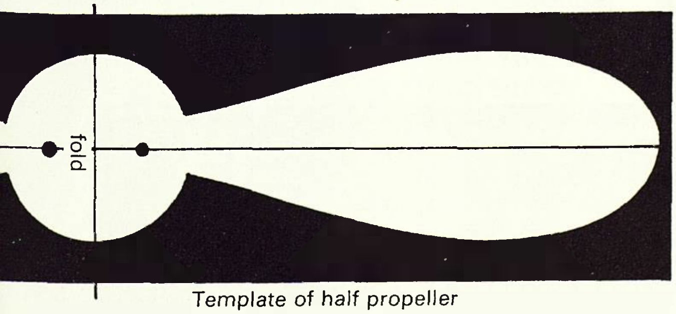
How to make it:

**1** Drill a hole about 3cm deep in the broom-handle to take the dowel rod (a tight fit).




**2** Cut the heads from the nails. Knock into the cotton reel 1cm from edge.

**3** Mark and cut out the propeller. Use this **template**. Use paper marked from this, cut out and then place on the aluminium. Draw round and then cut out. Using the cotton reel nails, mark their position on the propeller. Drill holes slightly larger than the nails. Give the blades of the propeller a twist.




*Template of half propeller*

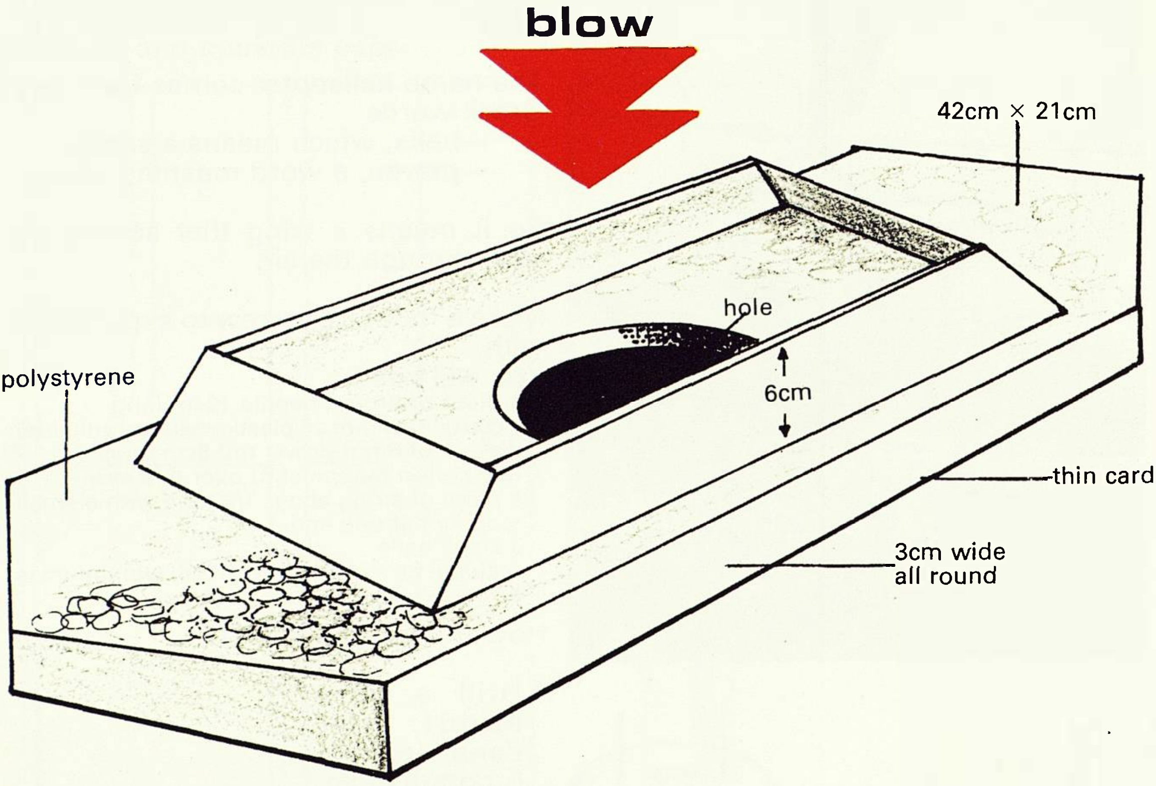
**Does it matter which way the blades are twisted?**

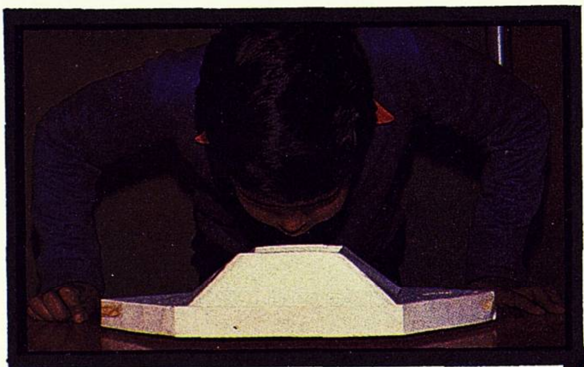
Fly your propeller.
How high does it fly?
How far does it fly?

What things make a difference to the flight?
– size of propeller blades?
– length? – width? – shape?
– the twist given to the blades?
– how much twist?

# A MODEL HOVERCRAFT

Here is a model to make. It will give you some idea of how a hovercraft works.



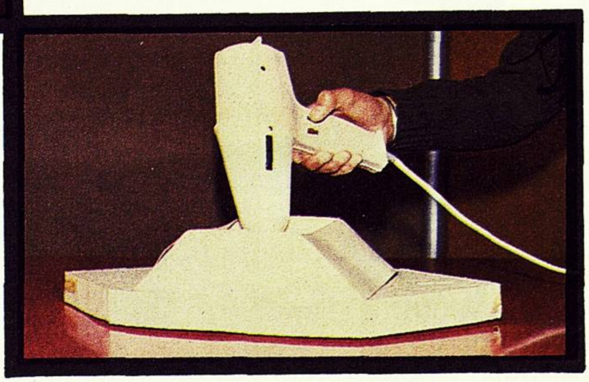



Try blowing.
How does it move over different surfaces?

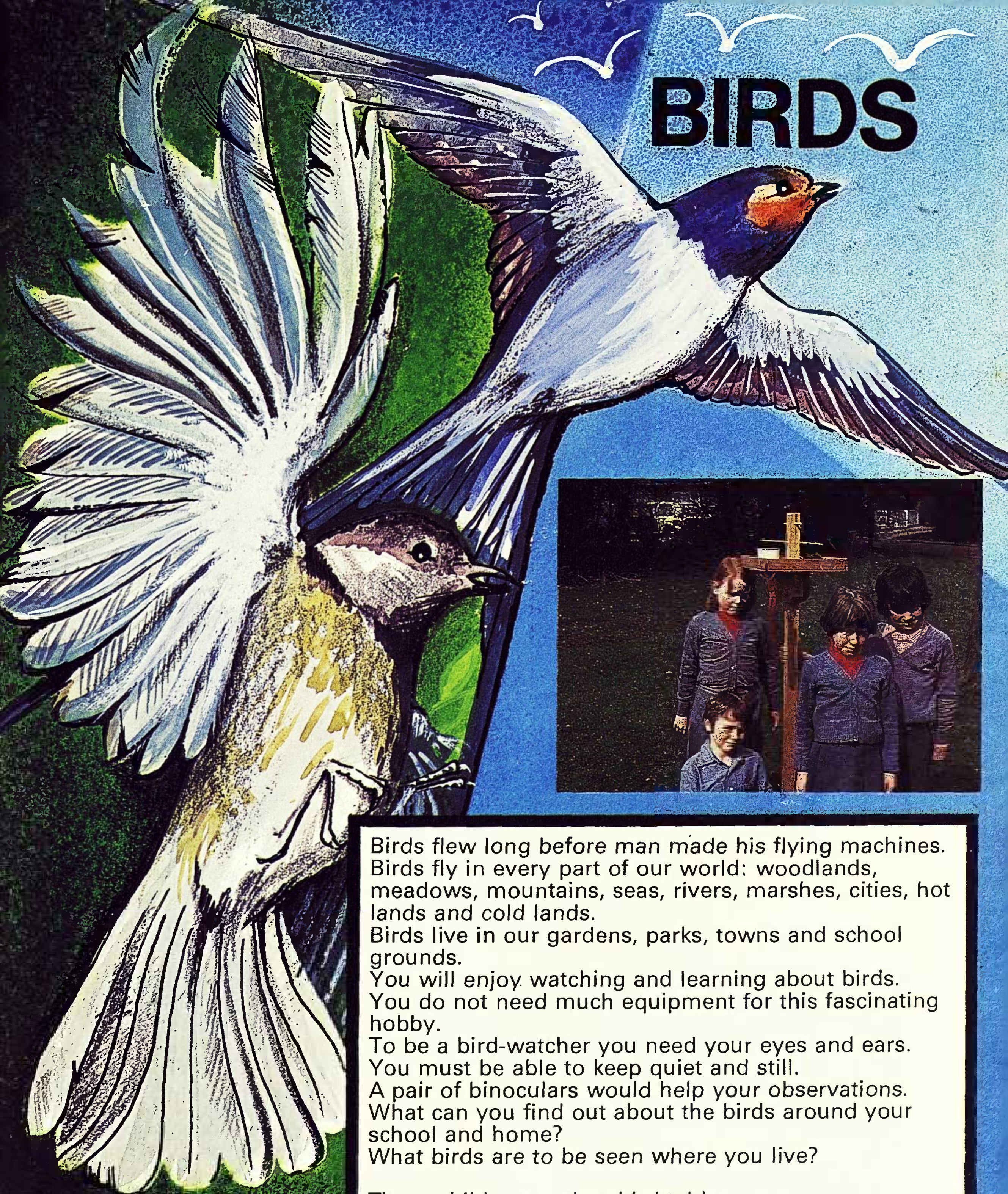
- smooth lino tiles
- grass
- a wood floor
- concrete
- carpet

Try using a fan or hair dryer.

You will find more ambitious models to make, using electric motors, in some of the books listed on page 65.



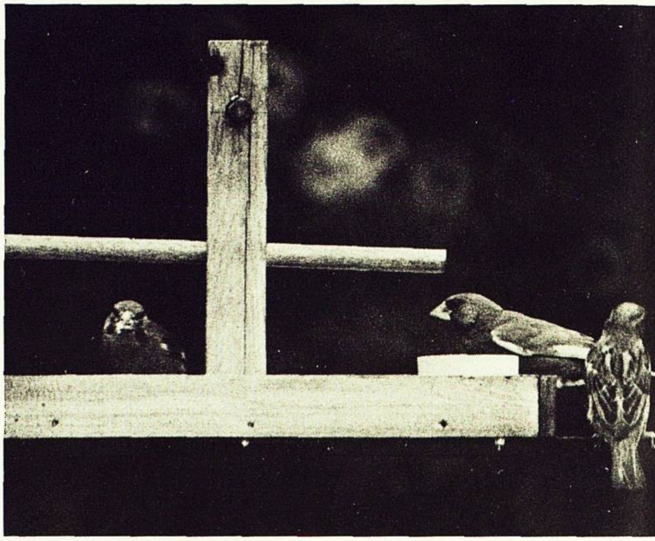
# BIRDS



Birds flew long before man made his flying machines.
Birds fly in every part of our world: woodlands, meadows, mountains, seas, rivers, marshes, cities, hot lands and cold lands.
Birds live in our gardens, parks, towns and school grounds.
You will enjoy watching and learning about birds.
You do not need much equipment for this fascinating hobby.
To be a bird-watcher you need your eyes and ears.
You must be able to keep quiet and still.
A pair of binoculars would help your observations.
What can you find out about the birds around your school and home?
What birds are to be seen where you live?

These children made a bird-table.
The birds came for the food.
The group then made careful observations from inside school.

# BIRD STUDIES

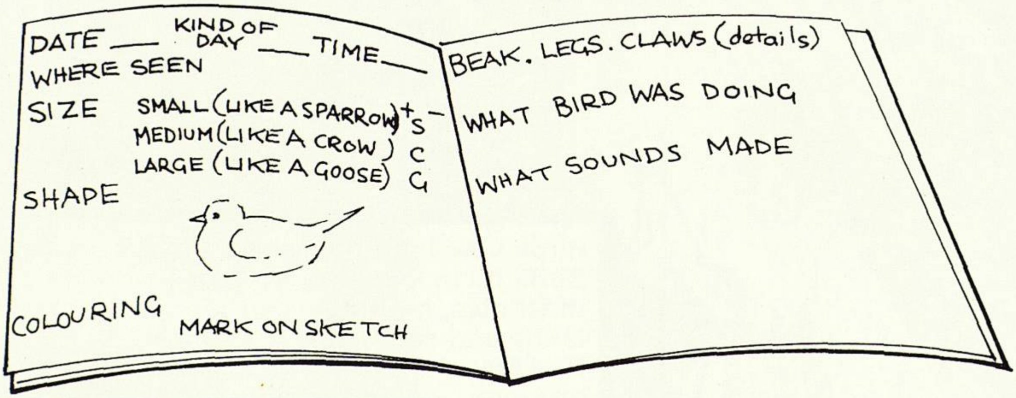


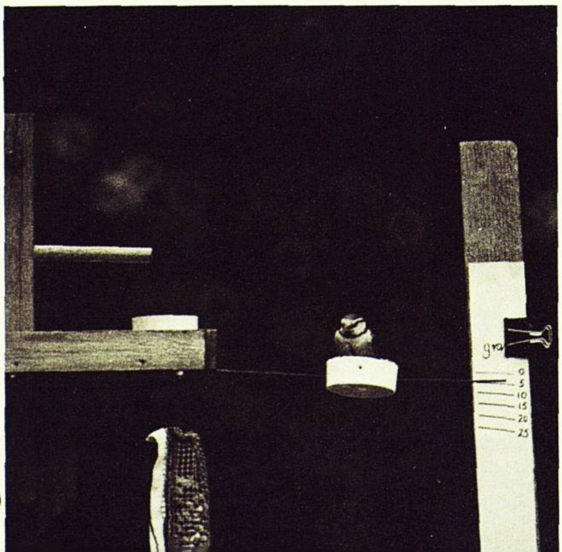
Choose a good place to watch birds.
Choose a place where you can see but not be seen.
Remember, birds will take fright at sudden movements and noise.

**1 What different birds can be seen?**
**2 Where are they?**
(on the ground - on a bush - in the air?)
**3 How many can be seen?**
**4 What are they doing?**

**1 What different birds can you spot?**

You will know the names of some of the birds.
If there is one you do not know, record everything you notice about it.
You can then use your notes, with a bird book, to identify it.
Your notebook should be ready to fill in.
Something like this:

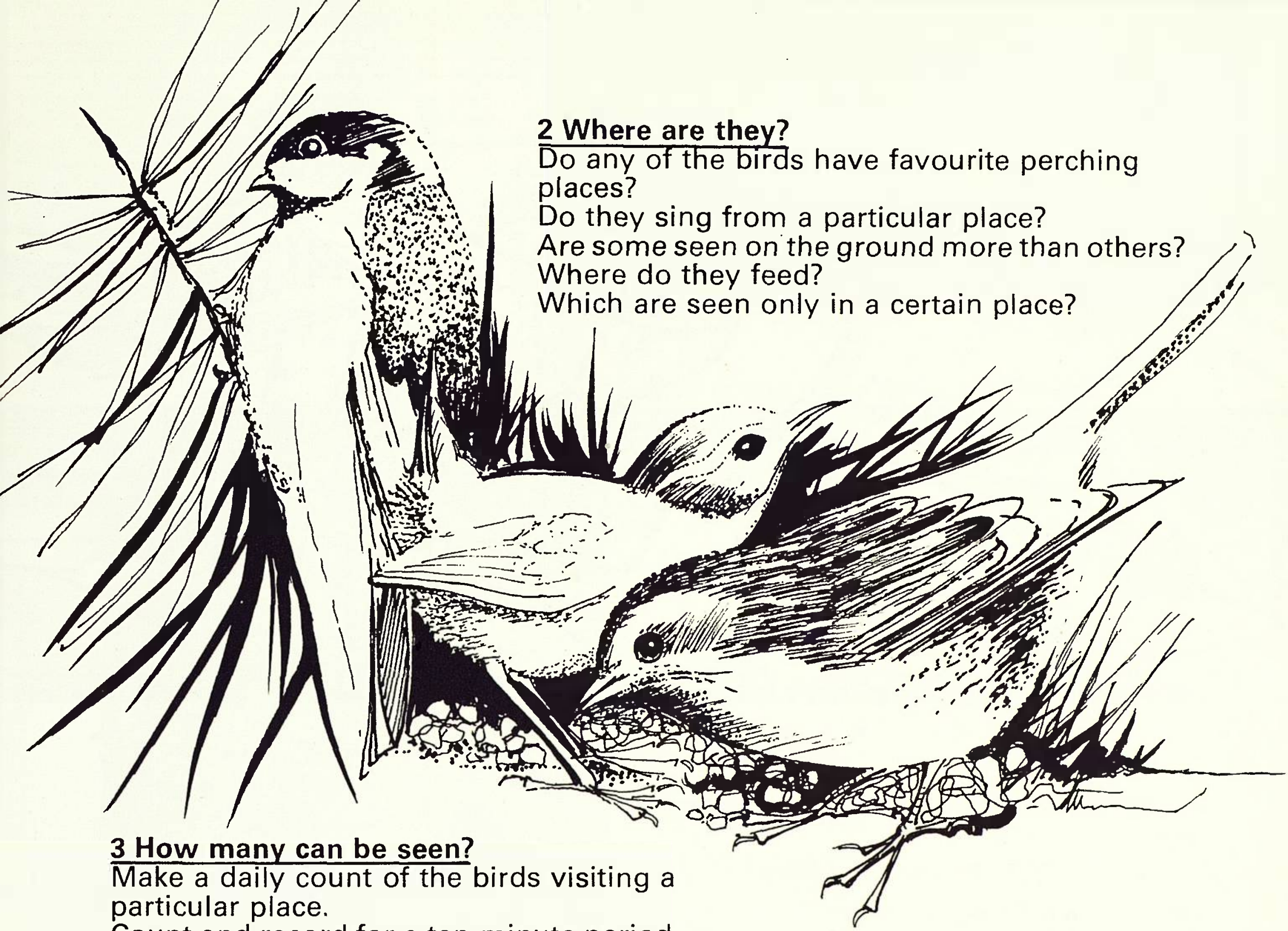


Do not ignore the common birds.
Even sparrows and starlings can make exciting studies.

1 List the differences between male and female sparrows.
2 Can you work out a way to weigh a sparrow as it visits a bird table?
3 How far is one 'sparrow hop'?
4 Can you estimate the size of a sparrow?
5 Can a sparrow stand on a slope? How steep a slope?

**2 Where are they?**
Do any of the birds have favourite perching places?
Do they sing from a particular place?
Are some seen on the ground more than others?
Where do they feed?
Which are seen only in a certain place?



**3 How many can be seen?**
Make a daily count of the birds visiting a particular place.
Count and record for a ten-minute period each day.
Do this at the same time each day.

| Place | | |
|---|---|---|
| Name of bird | Count | Total |
| | | |

Also record for that date:
- the weather (heavy rain – drizzle – dull – sunny)
- the temperature (degree Centigrade)
- the wind direction (N. NW. W. SW. S. SE. E. NE.)
- the cloud cover (cloud-cover of sky in eighths)

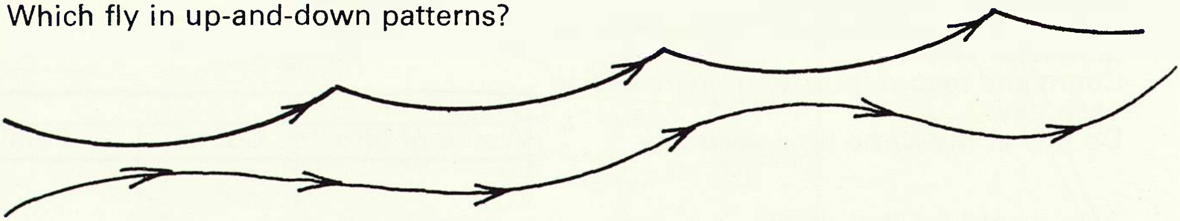
Keep your records over a period. You may be able to use these to find answers to some interesting questions:
- Is there any link between the temperature and the bird visitors?
- Is there a link between wind direction and any of the bird visitors?
- Are there different birds at different times of the year?
- Are there different numbers at different seasons?
- What difference does weather make to the records?

**4 What do they do?**
Try to observe one bird for ten minutes, or longer if possible.
Record and time its movements and restings.
On a sketch map record where it moves.
Did it feed? – where? – how? – on what? – at what height?
How did it move in the air?
Record other things it does – like preening, bathing, and calling.

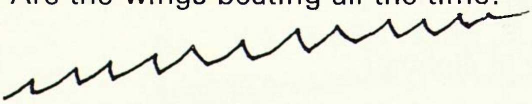
# BIRDS' WINGS

Watch carefully how birds fly.
Look for patterns in their flight.
Which fly in straight lines?

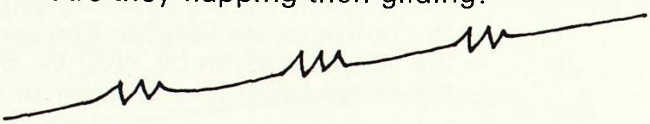
Which fly in up-and-down patterns?



How do they use their wings?
Are the wings beating all the time?



Are they flapping then gliding?

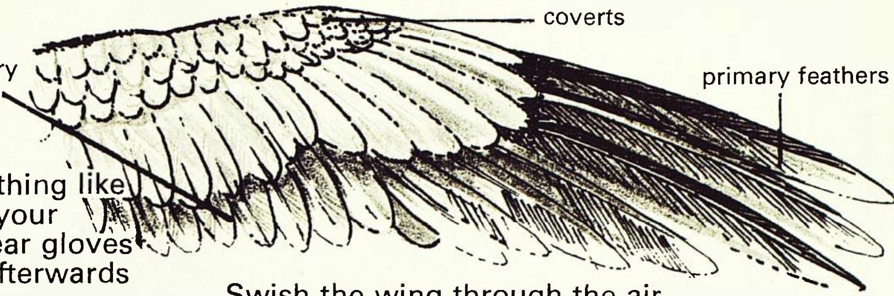


Make flight pattern drawings like these.
Record the kinds of flight you observe.

Look for wing shapes in the sky.
Draw the shapes you see.
Cut them out. Make a chart for others to see.

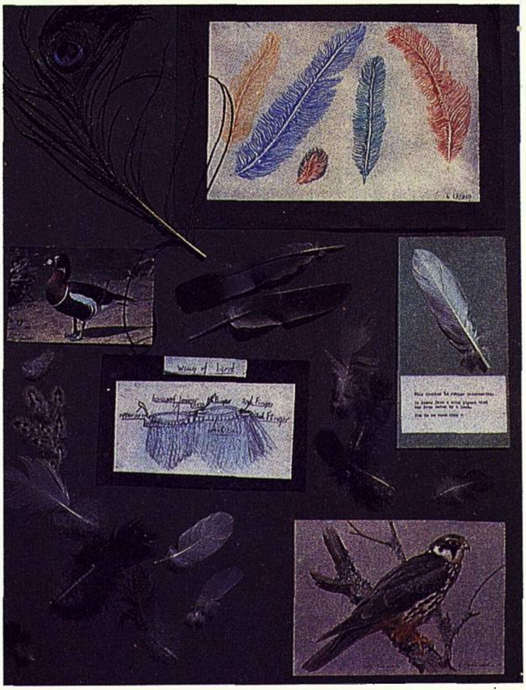
The bird's wings lift the bird.
Those who designed the first aeroplanes learned a lot from the birds.
They looked very carefully at their wings.

# FEATHERS




Examine a bird's wing.

When doing anything like this, always ask your teacher first. Always wear gloves and wash your hands afterwards with disinfectant.

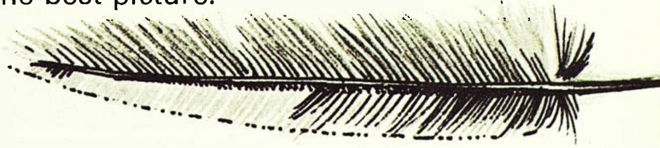


Swish the wing through the air.
Feel the lift.
Look carefully at the feathers.
Notice the different kinds of feather in the wing.

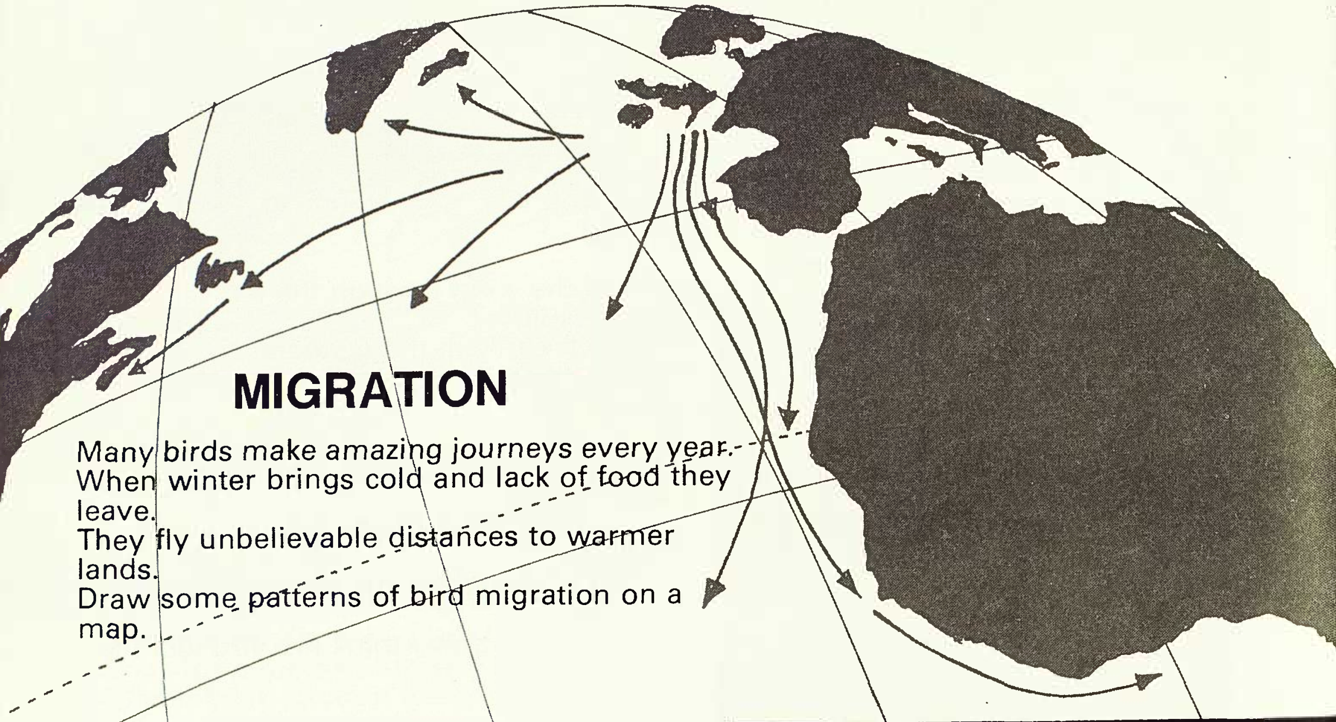
A feather collection can be useful and attractive:

- What bird did the feather come from?
- What part of the bird did it come from?
- How do you think the bird lost the feather?

Use your lens or microscope to examine the feather closely.
Draw what you see.
Think about the tools you will use to make the best picture.



We know the bird uses its feather to fly.
What else are its feathers used for?
Can you think of four other uses?
Here are some clues.



# MIGRATION

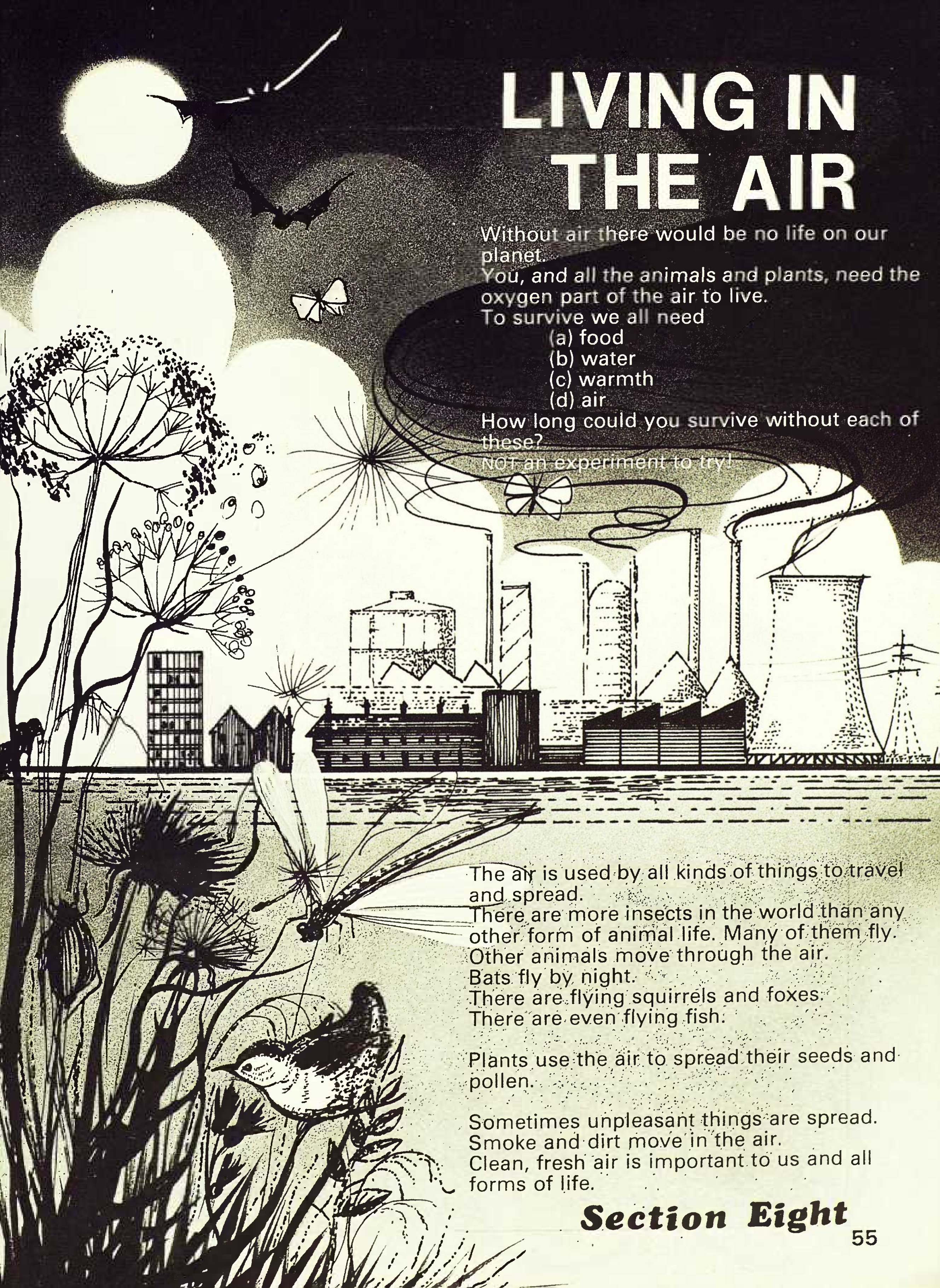
Many birds make amazing journeys every year. When winter brings cold and lack of food they leave.
They fly unbelievable distances to warmer lands.
Draw some patterns of bird migration on a map.

We still do not know how they find their way. This migration is mainly studied by 'ringing'. Only specially trained naturalists are allowed to do this.
The bird is caught. A special ring is put on the bird's leg.
The bird is sometimes found again. The finder returns the ring and so a journey is traced.

Try to visit a study centre where birds are ringed.

Read to find out how scientists study the way birds can **navigate**.

As well as ringing they
- (a) use radar
- (b) observe homing pigeons
- (c) alter birds' 'time clocks'
- (d) use magnets
- (e) relate migration patterns to the positions of the sun and stars.



# LIVING IN THE AIR

Without air there would be no life on our planet.
You, and all the animals and plants, need the oxygen part of the air to live.
To survive we all need

- (a) food
- (b) water
- (c) warmth
- (d) air

How long could you survive without each of these?
*NOT an experiment to try!*

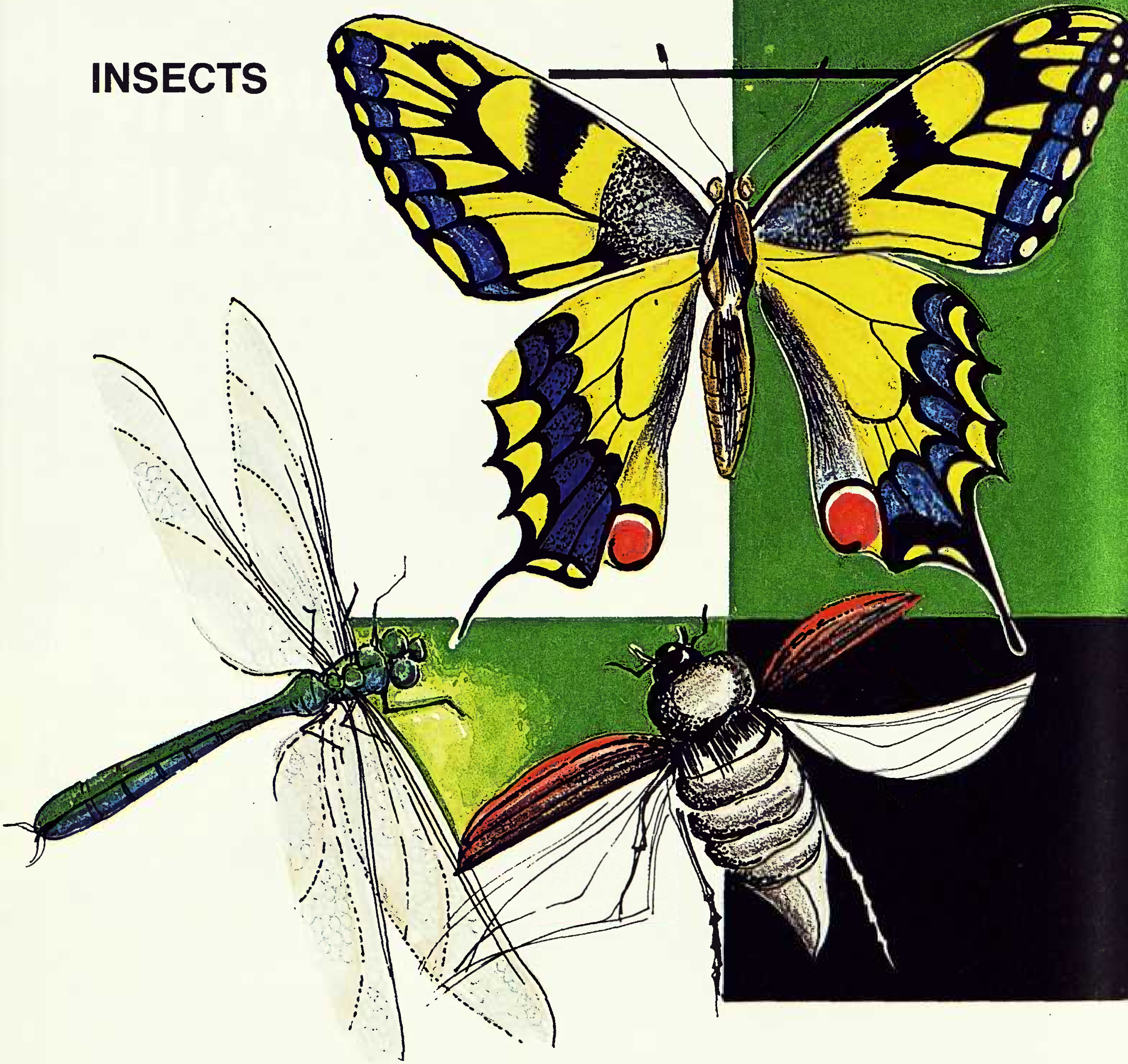
The air is used by all kinds of things to travel and spread.
There are more insects in the world than any other form of animal life. Many of them fly.
Other animals move through the air.
Bats fly by night.
There are flying squirrels and foxes.
There are even flying fish.

Plants use the air to spread their seeds and pollen.

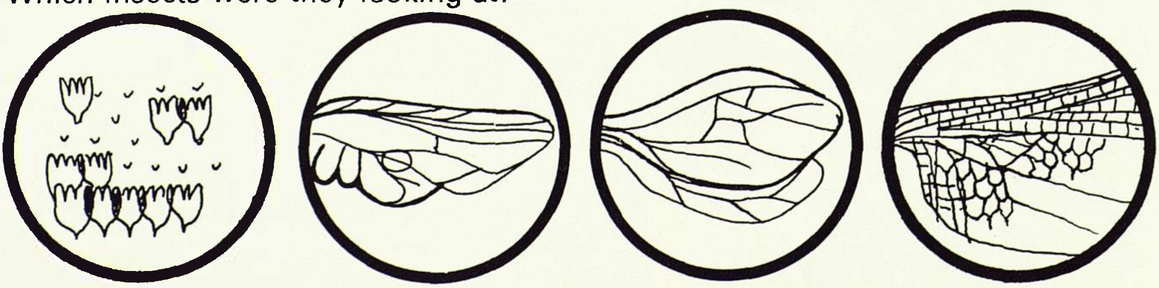
Sometimes unpleasant things are spread.
Smoke and dirt move in the air.
Clean, fresh air is important to us and all forms of life.

***Section Eight***

# INSECTS



Most, but not all, insects have wings.
Not all of them fly.
Butterflies have scaled wings.
Dragonflies have delicate lace-like wings.
Beetles' front wings are hard and leathery and protect the delicate hind wings.
It is fascinating to look at the wings of insects with your microscope.
Here are some drawings by girls and boys who have done this.
Which insects were they looking at?



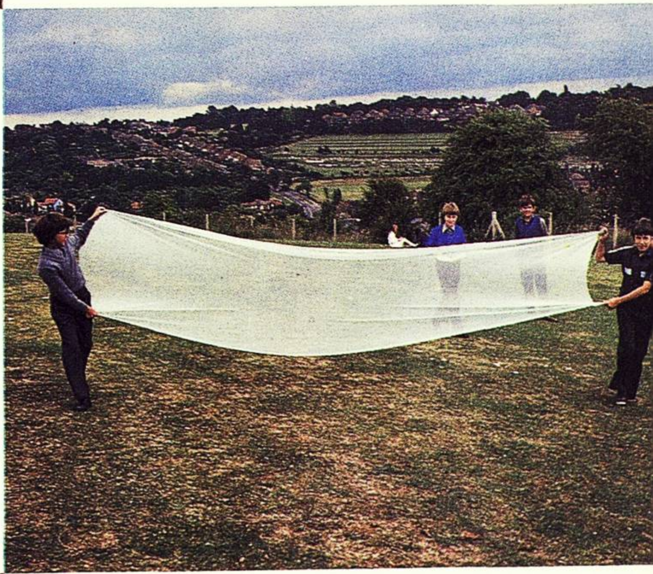
Insects can be found in many different places:

- in ponds
- in rivers and streams
- on plants
- on the ground
- among leaf litter
- in the air

Search for insects and record which can be found in which kind of place.

As this topic is about the air, start the search there.

These boys used a large sheet to find which insects were in the air.



This group used a large piece of board painted white, smeared with grease.

Record your catches and counts.

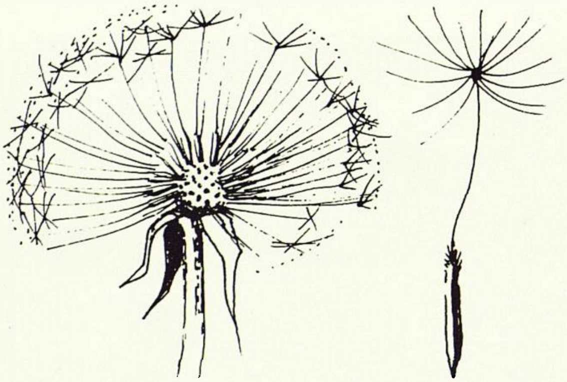
- Try different times of day.
- Try different kinds of day.
- Try different times of the year.
- Try days of different winds.

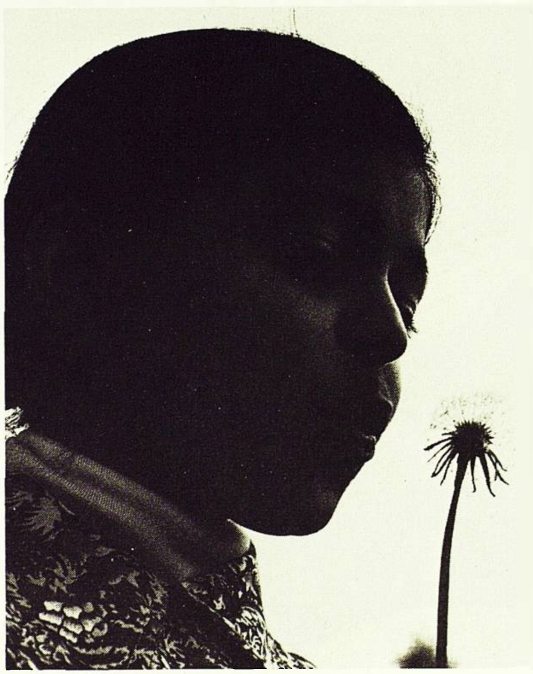
Can you find any links between counts, times and conditions?

# PLANT PARACHUTES AND PLUMES

Plants use the air.
Many plants use the air to spread their seeds.
Some seeds have plumes that carry them in the wind.

Collect some of these plumed seeds.
Experiment with them.
Separate a single plumed seed.





Let some seeds go, one at a time, outdoors.
Watch each one carefully and plot its journey.
How far does it travel?
In which direction does it travel?
Having once reached the ground does it stay or take off again?
Does the height vary?

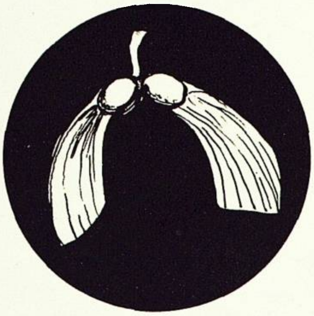
Try other kinds of plumed seed.
Do they travel the same journey?
Does the kind of day make a difference?
Try a well-dried seed. (Keep in a box in a warm place.)
Try a damp seed. (Leave in a jar with damp cotton wool.)
Does the ground they land on matter?
Do windy days matter?
Try placing seeds on:

- a tray of dry soil
- a tray of damp soil
- a tray of grass
- a tray of stones
- a tray of hard pressed soil.

Use a hair dryer or fan on them. Do they take off again?

# WINGS AND SPINNERS

Some trees have winged seeds.
These seeds spin away from the parent tree and so spread.
This means they can reach places where there is more space and light to grow.



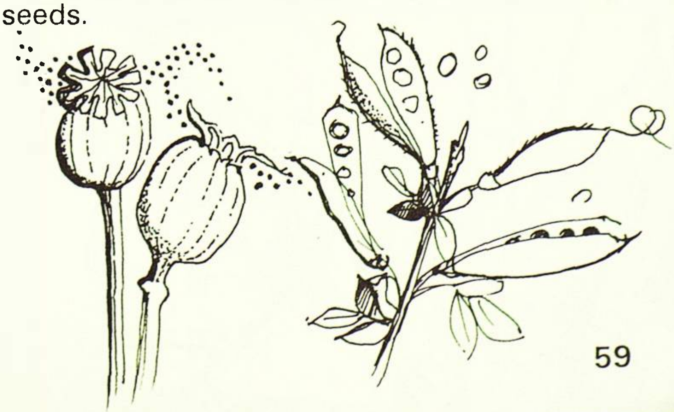
How well does this spinning help the plant to spread?
Find what difference the wing makes.
Try some time tests.
Use a seed with no wings.
Use a seed with wings.

**TAKE SPECIAL CARE IF YOU ARE HIGH UP.**

Are all the wings the same?
Sort some sycamore seeds.
Are some wider?
Are some longer.
Are some damaged?

Which sort will stay in the air the longest?
Think about the test - make it fair.
Release from the same place.

Other plants throw their seeds through the air.
The poppy does this by swaying to and fro in the wind.
The broom does it by splitting and throwing out seeds.

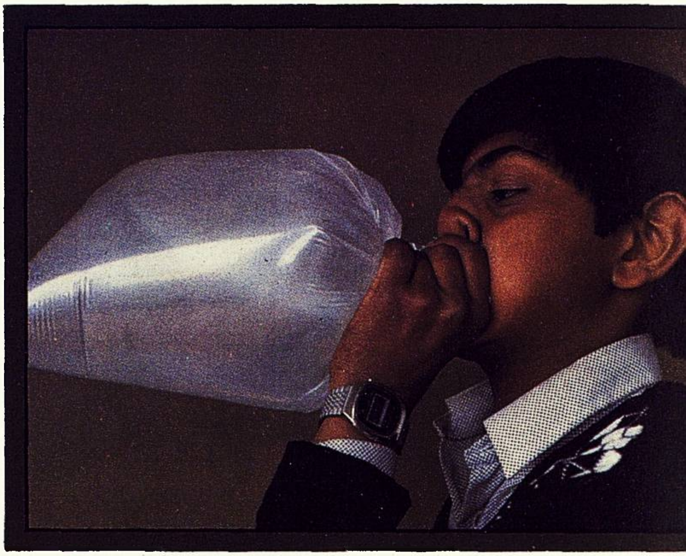


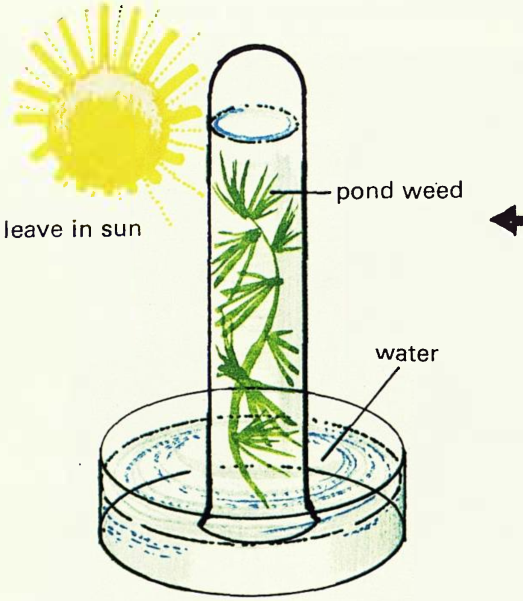
# AIR AND LIFE

You breathe in air.
You need the oxygen part of the air to live.
How much air do you breathe in one day?
As you breathe out, fill a polythene bag.
(Breathe normally; do not blow.)

How many times do you breathe out in one minute?
– in one hour?
– in one day?

How many bagfuls will this be?
Can you find what *volume* this is?





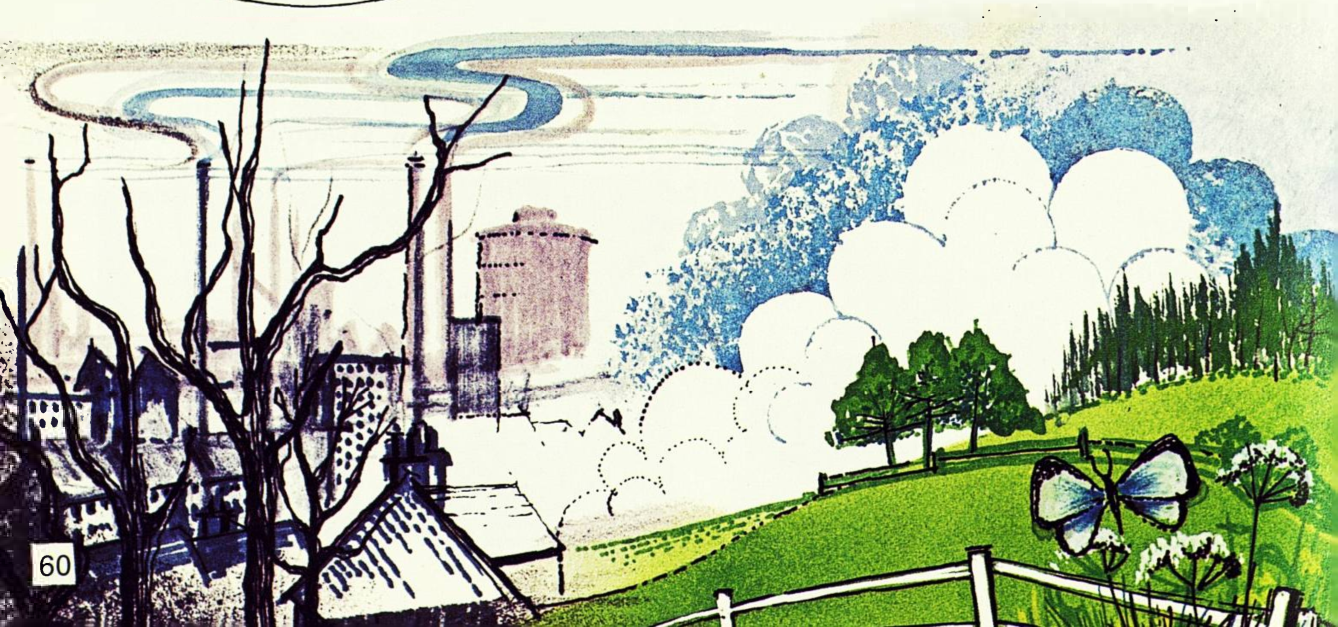

You may wonder why all the animals of the world have not used up all the oxygen. The green plants play an important part. They give off oxygen into the air.
You can watch this happen.

Some scientists are very concerned that we may be cutting down too many trees. If forests are destroyed the oxygen balance may alter!

Dirt and chemicals from the air can cover green leaves.
Then, the leaves cannot live properly.

Clean air is important for the plants as well as for us.

There are clean air laws now.



# OXYGEN

The higher we go the thinner the air. On a very high mountain the air is thinner and so there is less oxygen.

This mountaineer carries oxygen with him.

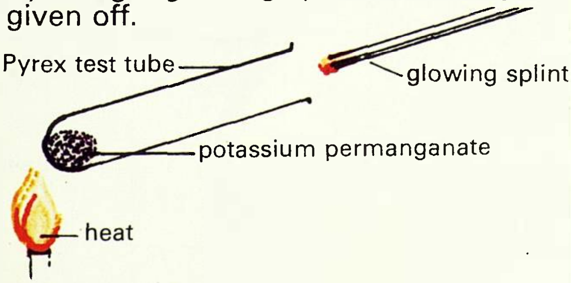
This pilot of a high-flying aircraft needs an oxygen mask.

Some patients in hospitals are too weak to breathe properly.
An oxygen tent or an oxygen mask can help save their lives.

You can make some oxygen.

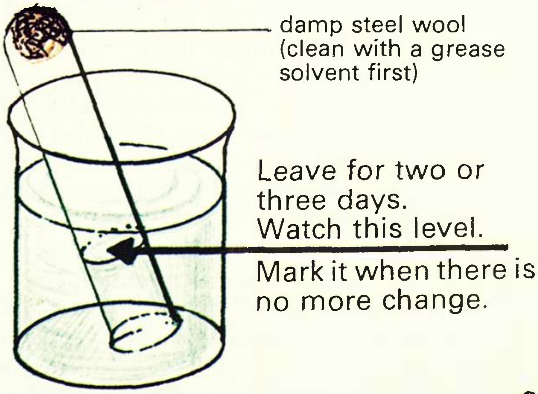
**ONLY DO THIS WITH YOUR TEACHER.**

Heat a little potassium permanganate in a Pyrex test tube.
By using a glowing splint, test the gas given off.




Burning and breathing both use oxygen.
How well did the splint burn?
When breathing is difficult extra oxygen can help us.

How much oxygen is there in our air?
Rusting also uses oxygen.
(See *Science in a Topic*: *Ships*, pages 30-31.)
Some children used this idea.
They found the proportion of oxygen there is in the air.

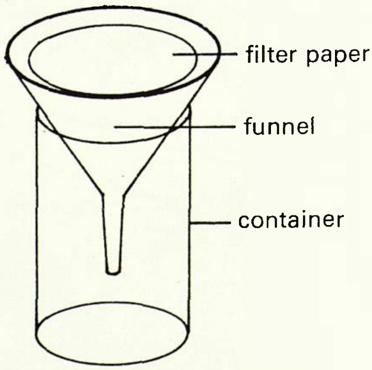


# POLLEN AND POLLUTION

Some things in the air can cause discomfort or illness.
We call this air pollution.
Because we breathe in air continually, dust and dirt can be breathed in too.
There can be serious harm to our health.
Dust can be blown up from the ground.

Here are some other things that pollute the air.
List the kind of pollution they cause.

Some people suffer from running eyes and sneezing when there is a high pollen count.
This count is the number of pollen grains in one cubic metre of air. It is measured, and broadcast on radio and television. Newspapers also give the count. This warns hay fever sufferers that they may need to stay indoors.
There can also be tiny spores and seeds from fungi, ferns and mosses drifting in the air.



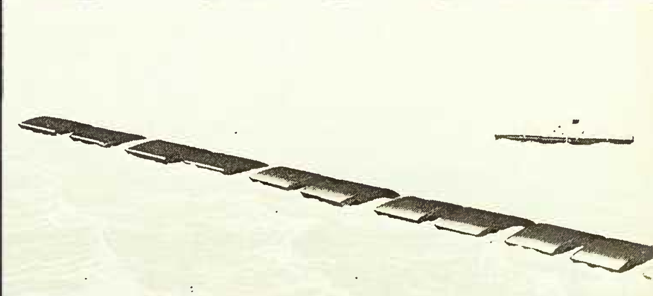

You can find out more about pollen and dirt in the air.
Here are some tests to try.
Set up this filter paper trap.
Leave it out during a rainy day.
The rain may wash down some of this dirt in the air.
If so, it will be caught on the filter paper.
Look at the paper with your microscope.
You might see – specks of soot, dust, ash and maybe some pollen grains.
Try putting traps in different places: – in towns – near factories – near roads – in gardens.
(Remember, if you find no signs, this is a good result.
It means there is clean healthy air for you to breathe.)
If you have a filter paper on which there are signs of something, try placing it on a saucer. Add a little liquid fertiliser. Cover it. See if anything grows.

# AIR – THE FUTURE

Moving air can destroy.
Moving air can help us, too.
As oil and coal are used up, wind may help by providing energy for us.
Scientists and engineers are now finding new ways to make the air work for us.
New-style windmills are being invented.

Try to devise a wind machine that will do work. For instance, it might light a bulb.

Wind makes waves on the sea. Must this wave energy be wasted?



wave powered generator

Man is now making journeys into places where there is no air.
Astronauts go well beyond the Earth's atmosphere.
Many important kinds of work are performed at the bottom of the oceans.
Men working in these conditions have to take their air with them.
Find out about the problems of breathing in space and at the bottom of the oceans.

What new ways of solving all these problems do you think there might be in the future?

# IN THE AIR

### MATHEMATICS

- Test Flights – How Far? How High? How Fast?
- Area – Wing Sizes, Comparisons
- Timing – Flight Duration
- The Mass of Air
- Weather Measurements – Sunshine Records, Rainfall Records, Wind Speeds, Visibility, Temperature
- Graphical Recording
- Lung Capacity
- Aircraft – Trim, Centre of Gravity

### ENGLISH

- Legends: Icarus, Bellerophon, Phoebus' Chariot, Winged Beasts
- Winds, Storms, e.g. in *David Copperfield*, *Wizard of Oz*
- *The Wind* (Ted Hughes)
- *The Wind's Song* (E. Thomas)
- *Ode to the West Wind* (P. B. Shelley)
- *The Snow Goose* (Gallico)
- *Jonathan Livingston, Seagull* (R. Bach)
- *Kes* (B. Hines)
- Word Study: 'Air Words'
- Writing: Travel by Air

### ART AND CRAFT

- Kites
- Models – Balsa Planes, Paper Planes, Windmills
- Mobiles
- A Model Airport
- Sky Pictures – Cloud Studies
- Plastic Kit Modelling
- Misty, Foggy, Sunny Effects
- Bird Studies, Insect Studies
- Collages – Birds, Insects, Flight
- Display of Vintage Aircraft Models

### MUSIC & R.E.

- Making Wind Instruments
- Wind Chimes
- Sound – Acoustics
- Making Storm Music
- *Thunder and Lightning Polka*
- *Pastoral Symphony: Storm*

- Gods of Air – Aeolus, Njord
- Roman Augury from Birds
- Winds and Storms in the Bible
- Birds of the Bible
- Insects of the Bible
- Plague of Locusts

### GEOGRAPHY

- The Weather Map – Studies, Records, Balloons
- Weather and Climate
- Whirlwinds, Typhoons, Sirocco, Mistral, etc.
- The World's Air Routes
- Airports and Airlines
- Breathing – Forests: The World's Lungs
- Industry and Pollution
- Maps – Bird Populations, Migration Patterns
- Aerial Photography
- Cloud Formations
- Ascents of Everest

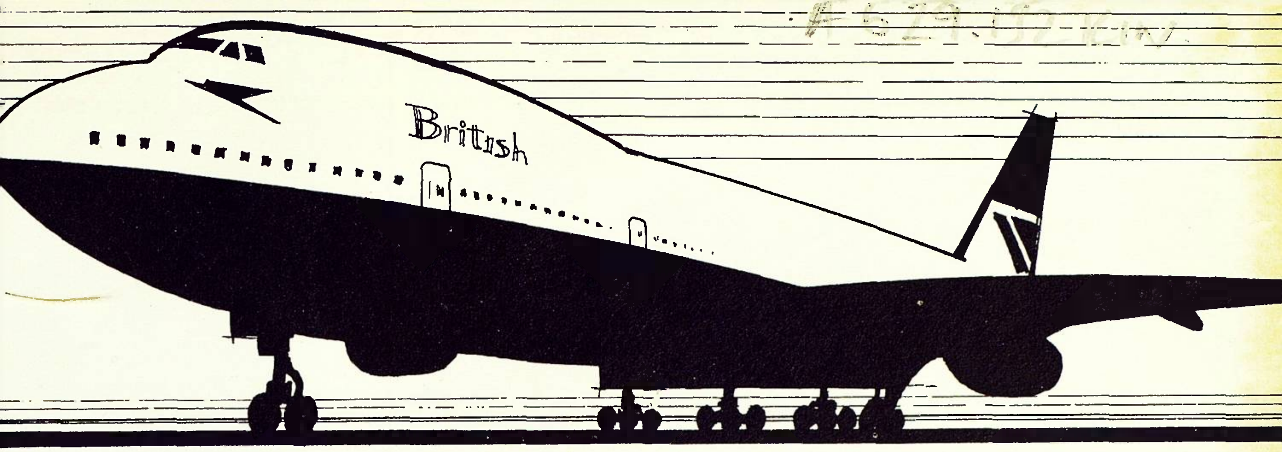
### HISTORY

- Von Guericke
- Lavoisier – Burning Experiments
- Leonardo da Vinci – Helicopters, Parachutes
- Balloons and Ballooning
- Pioneering Flights
- Famous Aviators
- World War I – R.F.C., Dog Fights
- Aviation between the Wars
- The Growth of Airlines
- The Battle of Britain
- Experiments in Man-Powered Flight
- Supersonic Flight


## ACKNOWLEDGEMENTS

The authors would like to express their thanks to the following for help in supplying copyright photographs:

NASA, globe (p5); Allan Cash, flood (p13); The Mansell Collection, Benjamin Franklin (p25); Christian Simpson, parachutist (p27); BBC Hulton Library, the 'Spirit of St. Louis' and flying boat (p34); British Airways, jet (p35); Alan Ward, paper helicopters (p46); Ursula Bowen, bird ringing (p54); Christian Bonington, mountaineer (p61); Royal Air Force Inspectorate of Recruiting, pilot (p61); Vickers, oxygen mask (p61); NASA, Astronaut (p63); Energy Technology Support Unit—AERE Harwell, wave powered generator (p63)




**SOME BOOKS THAT WILL HELP YOU**

*The Guinness Book of Air Facts and Feats*, by John W.R. Taylor, Michael H. Taylor and David Mondey, Guinness Superlatives Ltd.
*Balloons and Airships*, by Lennart Ege, Blandford Colour Series, Blandford Press.
*Helicopters and other Rotorcraft*, Blandford Colour Series, Blandford Press.
*Frontiers of Space*, by Phillip Bono and Kenneth Galland, Blandford Colour Series, Blandford Press. (See also other titles in this series.)
*The Life of Birds*, *Introduction to Nature Series*, 1, MacDonald Educational Ltd.
*The Life of Insects*, *Introduction to Nature Series*, 3 MacDonald Educational Ltd.
*Aircraft*, *Visual Books*, 1, MacDonald Educational Ltd.
*The Weather*, *Visual Books*, 13, MacDonald Educational Ltd.
*Airport*, *Insiders*, MacDonald Educational Ltd.
*The Pollution Handbook*, by Richard Mabey, Penguin Education.
*The Book of British Birds*, Drive Publications Ltd., for Readers Digest Association and Automobile Association.
*The Penguin Book of Kites*, by David Pelham, Penguin Books.
*Air and Flights*, by Jack Bainbridge, *Evans Integrated Themes*, Evans Brothers Ltd.
*The Air We Need*, by Eric Jones, *Blandford Approaches to Environmental Studies*, Blandford Press.
*The Red Balloon*, by A. Lamorisse, Allen & Unwin Ltd.
*Moving Through Air and in Space*, by Albert James, Schofield & Sims Ltd.
*The Story of Flight*, by Richard Bowood, *Ladybird Achievements Books*, Series 60, Wills and Hepworth Ltd.
*Aircraft*, *Picture Reference Series*, Brockhampton Press Ltd.
*A Brief History of Flying*, *from Myth to Space Travel*, by C.H. Gibbs-Smith, A Science Museum Booklet.
*Airports*, A Multi-Media Pack, B.P. Educational Service
*How to Make and Fly Paper Aircraft*, by Capt. R.S. Barnaby, Piccolo Pan Books Ltd.
*The Paper Aeroplane Book*, by Seymour Simon, Puffin, (Penguin Books)

**SOME PLACES TO VISIT**

**Bird Gallery**, British Museum (Natural History), Cromwell Road, London. SW7 2DD.
**Zoological Museum (Bird Galleries)**, Tring, Hertfordshire.
**Flamingo Gardens and Bird Zoo**, Weston Underwood, Olney, Bucks.
**The Royal Society for the Protection of Birds**, The Lodge, Sandy, Beds. SG19 2DL.
**The Wildfowl Trust**, Slimbridge, Glos.
**Royal Air Force Museum**, Colindale Avenue, Hendon, London. NW9 5LL.
**Fleet Air Arm Museum**, R.N.A.S. Yeovilton, Ilchester, Som.
**R.A.F. Aerospace Museum**, R.A.F. Cosford, Wolverhampton, West Midlands. WV7 3EX.
**National Aeronautical Collection**, Science Museum, S. Kensington, London. SW7 2DD.
**The Shuttleworth Collection**, Old Warden Aerodrome, Biggleswade, Beds.
**Aircraft Museum**, Duxford Airfield, Cambridgeshire.
**Historic Aircraft Museum**, Aviation Way, Southend, Essex.

Science in a Topic – IN THE AIR

ISBN 0 7175 0877 3