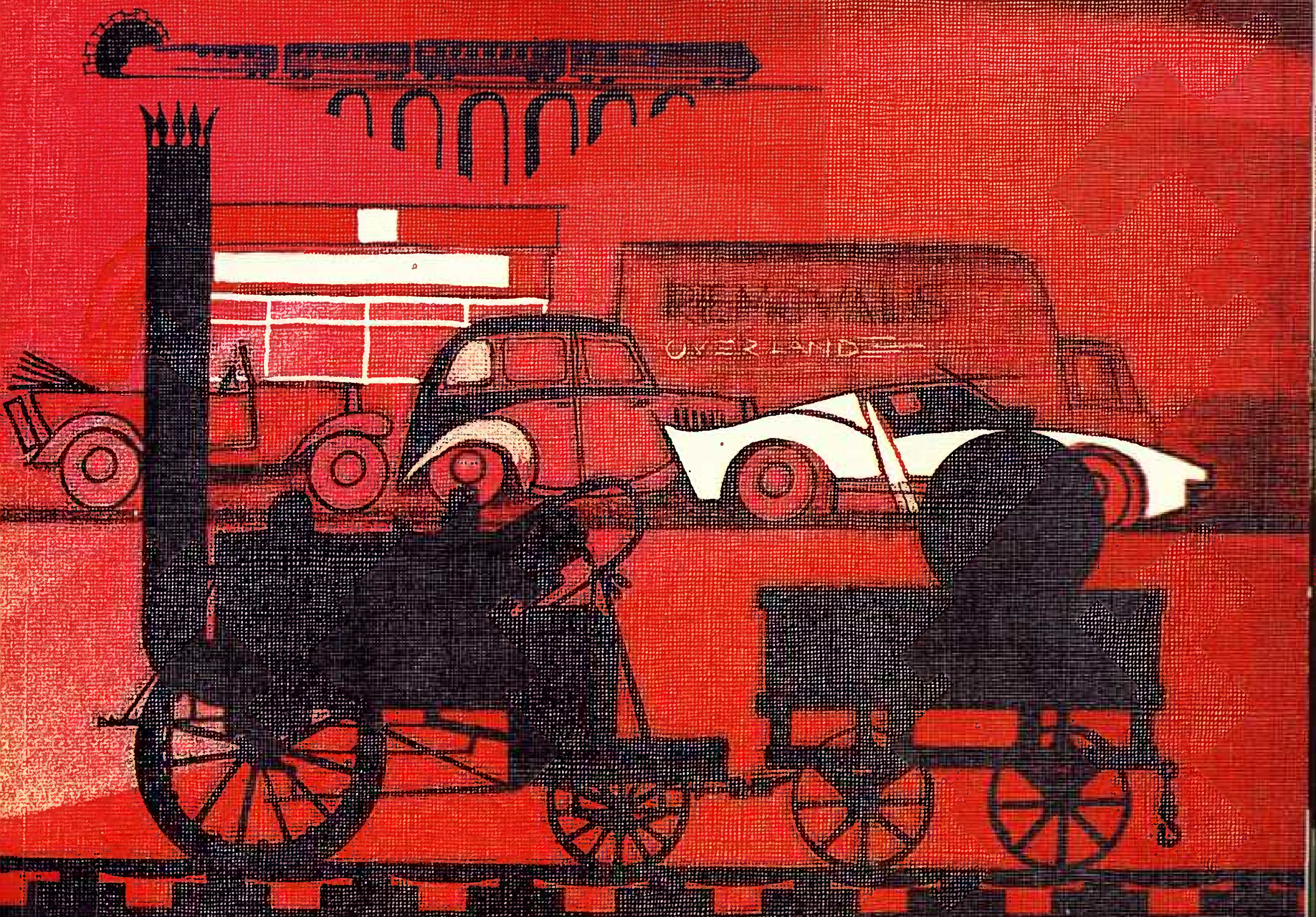
SCIENCE IN A TOPIC

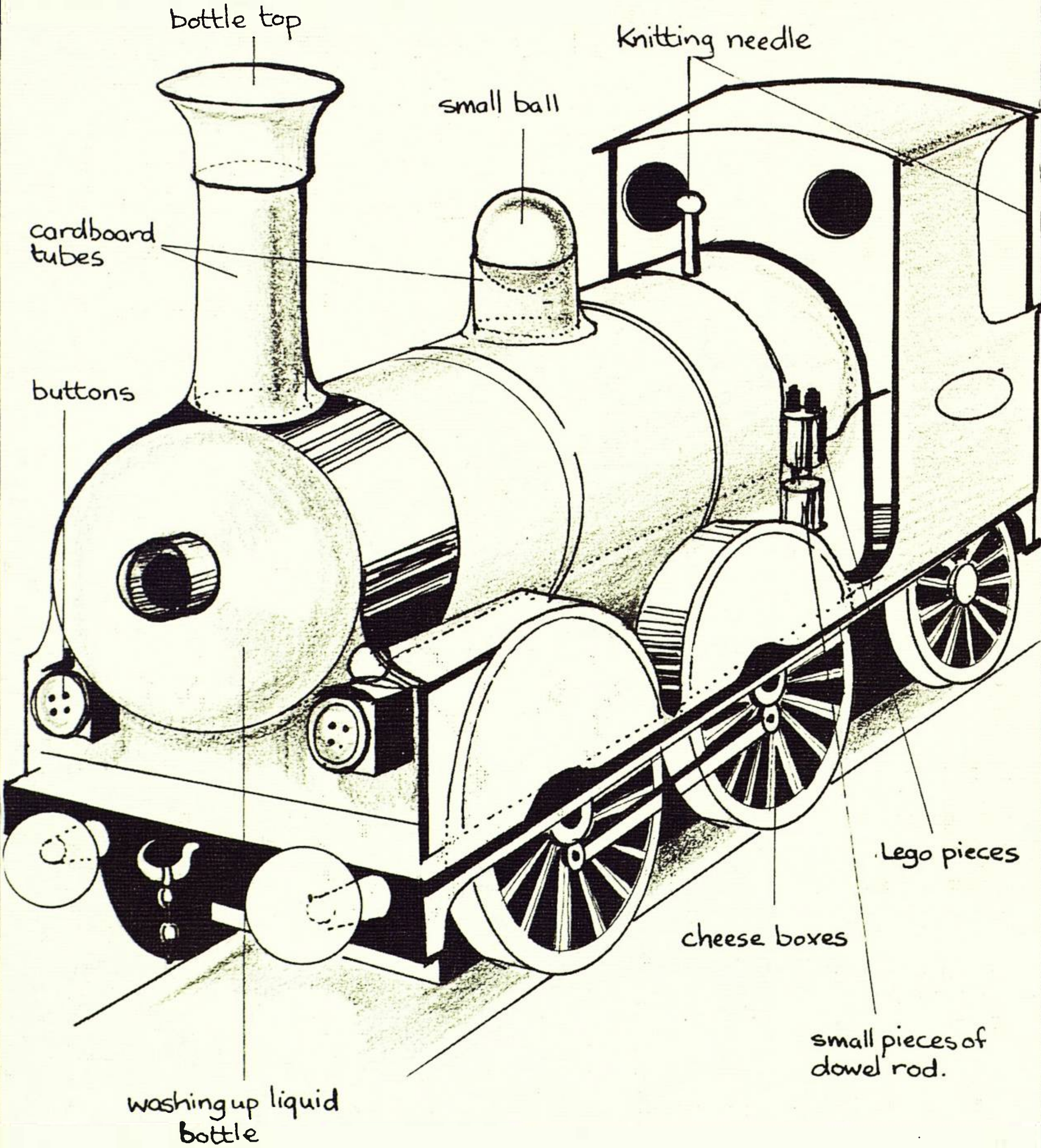
MOVING ON LAND



Doug Kincaid
Peter S. Coles

HULTON

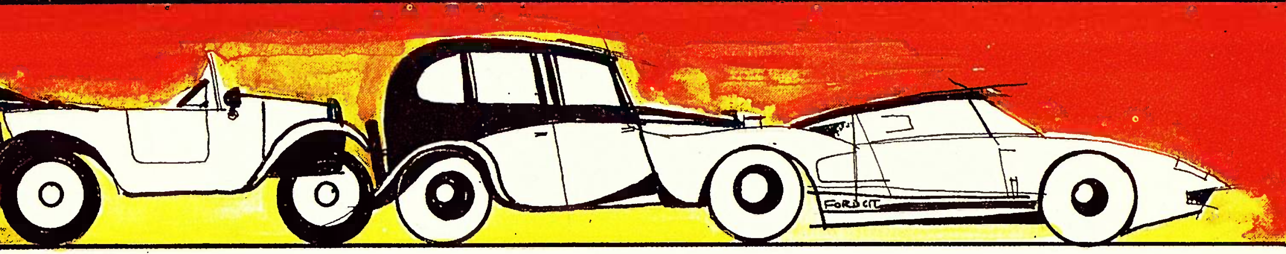
MODEL MAKING~A Steam Locomotive

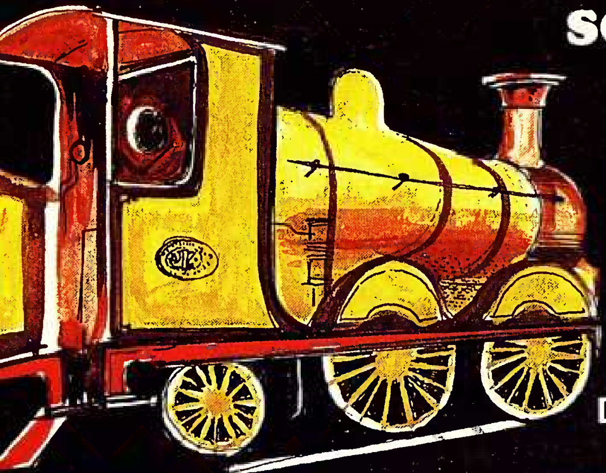


Study pictures of steam locomotives. Look at the shapes that build them.

Look around your home for old packets and containers. A washing-up liquid bottle could be the boiler. Cheese boxes can be used for making the wheel housing and wheels. Funnels and domes could be assembled from cardboard tubes, bottle tops and stoppers. Card scraps and strong glue would complete the model. Finally, careful painting would make an authentic-looking model.

Other land transport models – cars, lorries, buses, trams, etc. – could be constructed in a similar way.





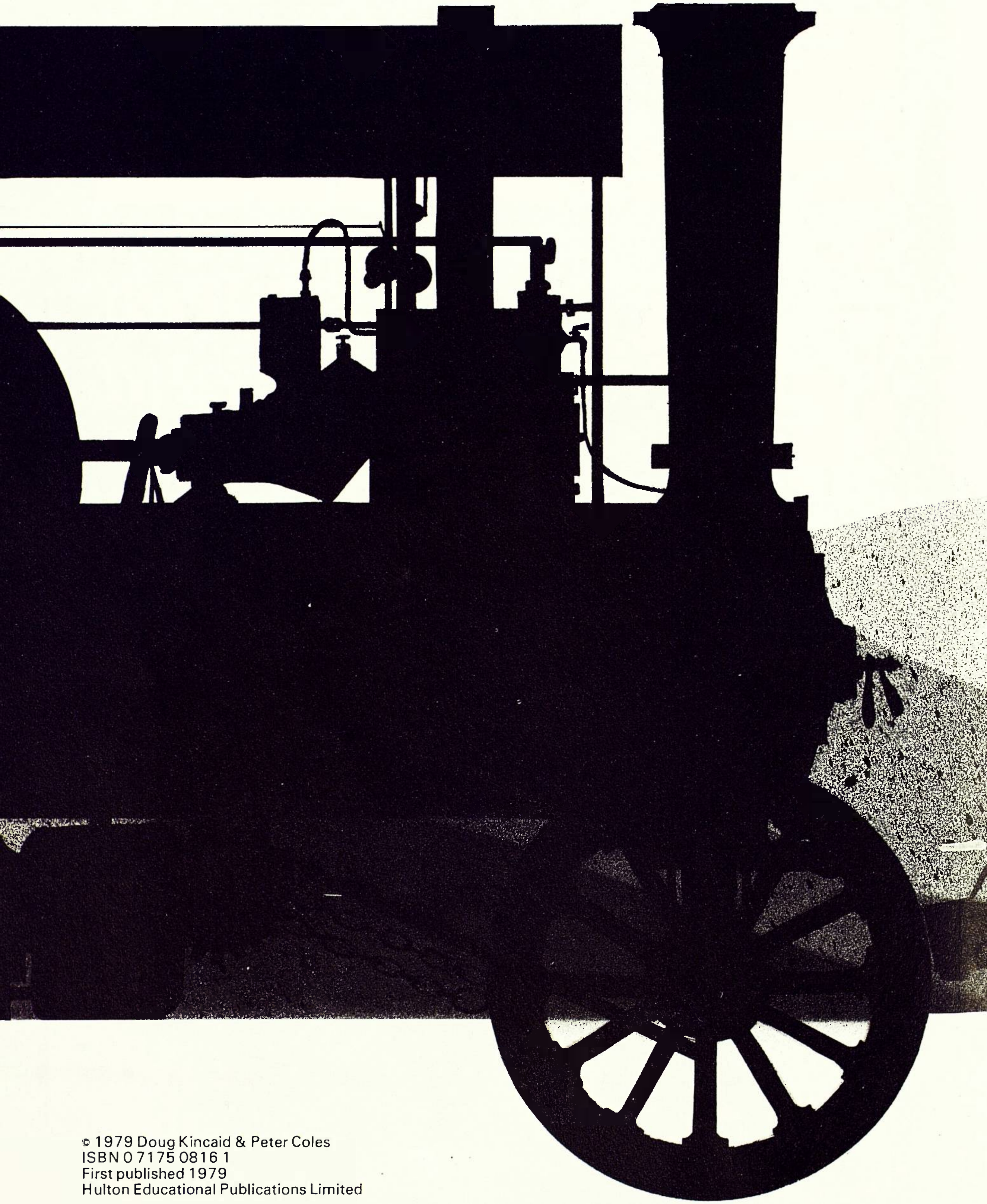
SCIENCE IN A TOPIC

MOVING ON LAND

Doug Kincaid
Peter S. Coles

Designed & Illustrated by John Hill

HULTON



ISBN 0 7175 0816 1
First published 1979
Hulton Educational Publications Limited

SCIENCE IN A TOPIC

MOVING ON LAND

About this book

This book is different from most others because:

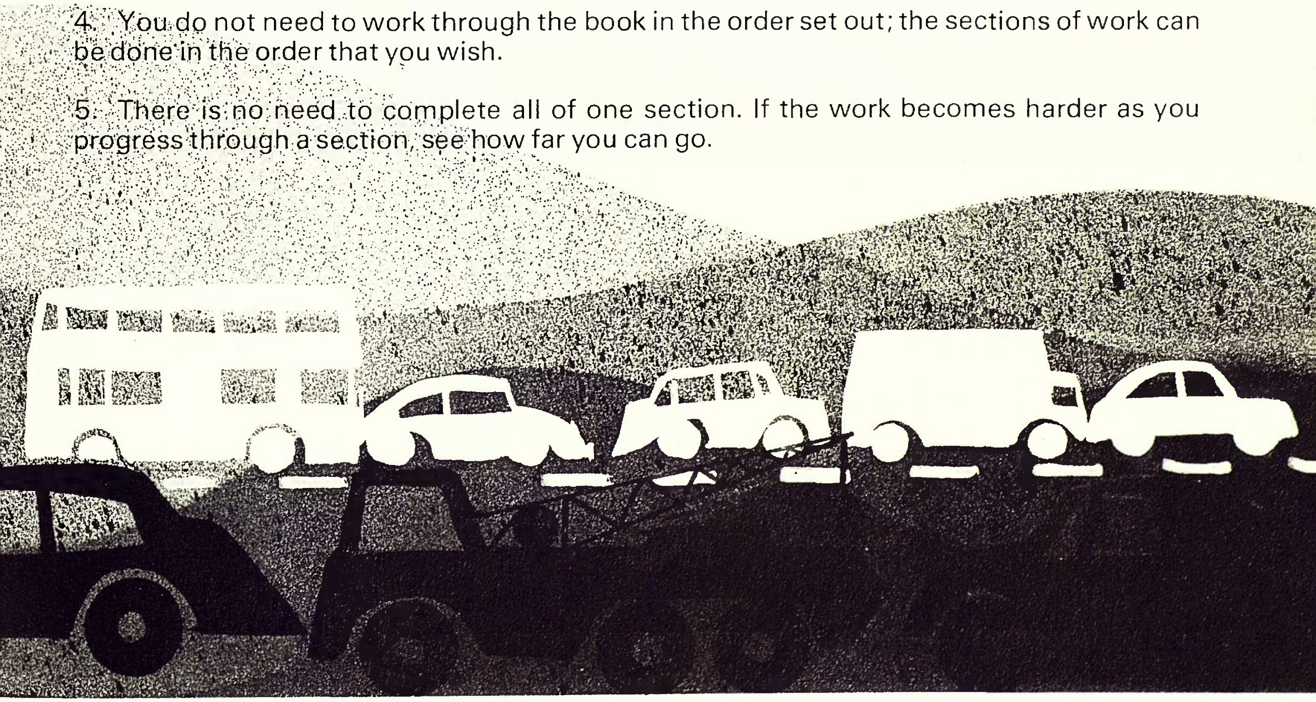
1. It is not complete, but only part of a study – the science part. There will be a need to use many other books to find out about other aspects of the topic – history, geography . . .

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

SCIENCE IN A TOPIC SERIES

by Doug Kincaid, County Staff Advisory Teacher, Science, Buckinghamshire.
Peter S. Coles, B.Sc., Chief Adviser, Berkshire.

Other Titles: Ships
Houses and Homes
Clothes and Costume
Communication
Food
Roads, Bridges and Tunnels

Published by Hulton Educational Publications Ltd., Raans Road, Amersham, Bucks.

Printed by Martin's of Berwick

ON THE MOVE

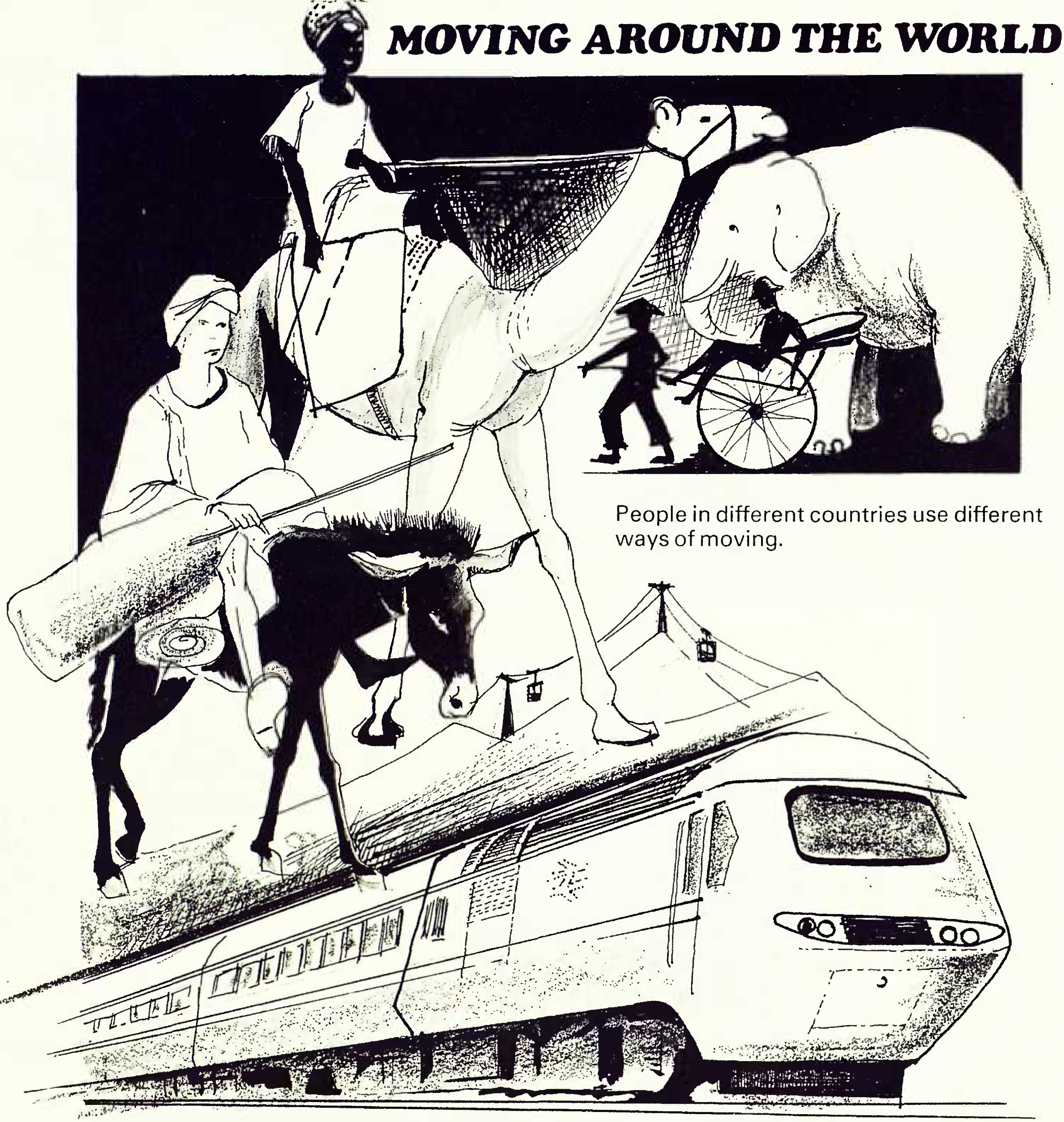
Using our legs is one way we move on land.
Some inventions help.
List the ways we use legs to move.

Some animals move people and loads.
Name animals that are used for this.

The invention of engines has helped.
We can now move heavier loads.
We can now move more quickly.
What is the world land speed record?

SECTION ONE

MOVING AROUND THE WORLD



People in different countries use different ways of moving.

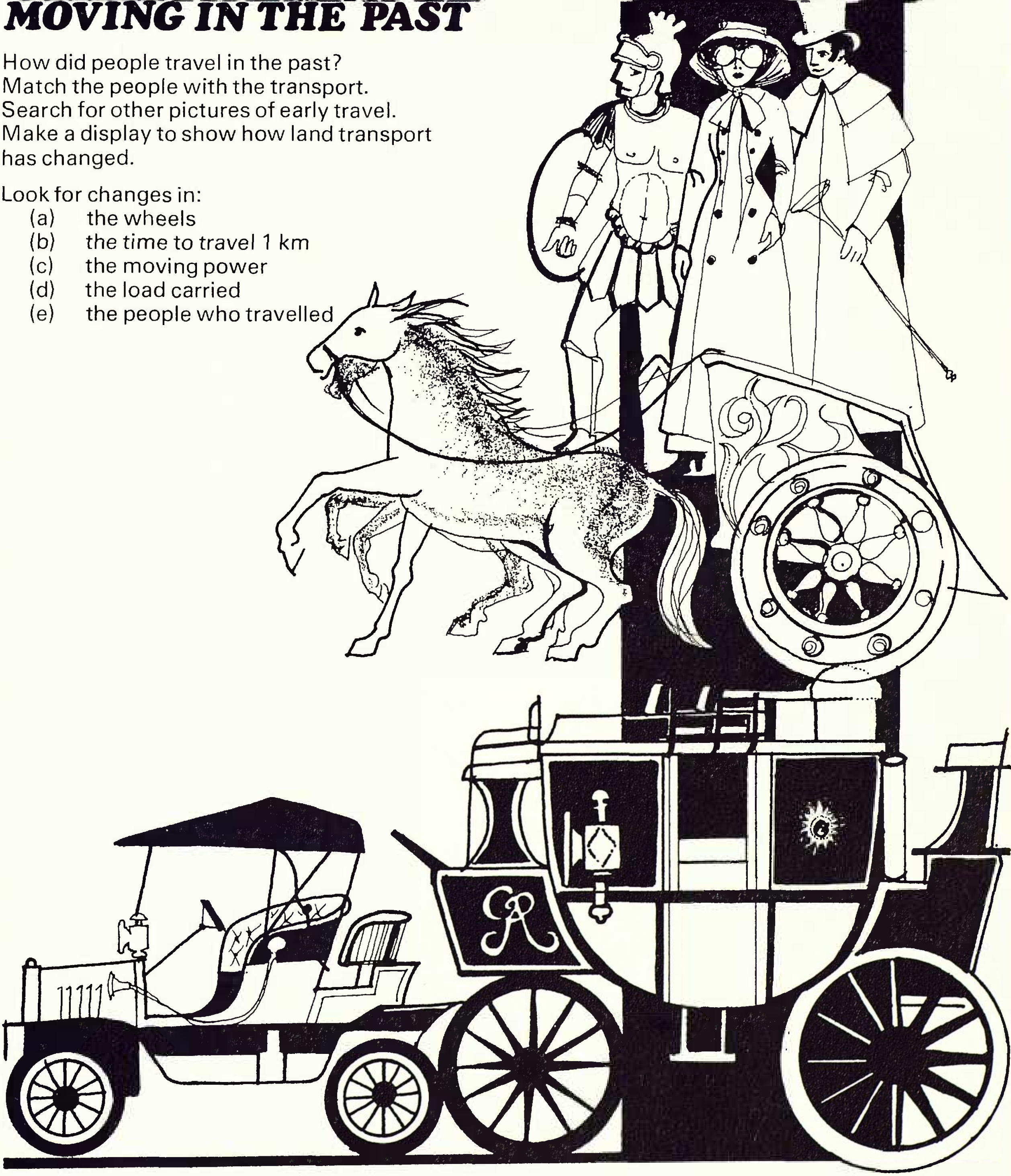
Jules Verne wrote a story called *Around the World in Eighty Days.*
The hero used many different ways of travelling.
Imagine you are travelling around the world.
Where would you find these?

Find other pictures.
Make a display to show transport around the world.

MOVING IN THE PAST

How did people travel in the past?
Match the people with the transport.
Search for other pictures of early travel.
Make a display to show how land transport has changed.

Look for changes in:
(a) the wheels
(b) the time to travel 1 km
(c) the moving power
(d) the load carried
(e) the people who travelled



A visit to a transport museum will give you a lot to see and study.

There are interesting collections at:

The National Railway Museum,
York YO2 4XJ.

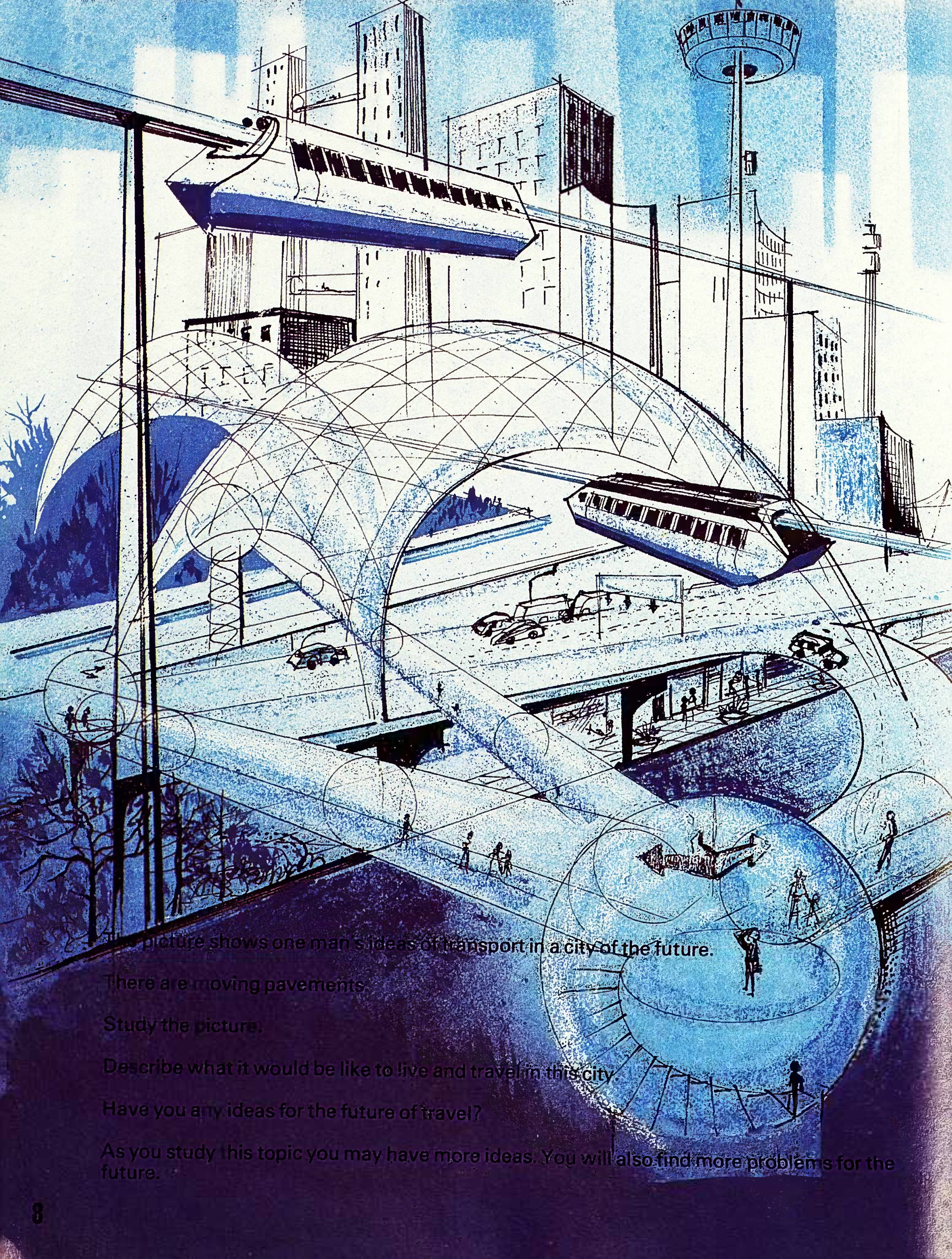
The Science Museum,
South Kensington,
London SW7 2DD.

The National Motor Museum,
Beaulieu, Hants.,
SO4 7ZN.

The North of England Open Air Museum,
Beamish,
Co. Durham.

Crich Tramway Museum,
near Matlock,
Derbyshire.

MOVING IN THE FUTURE



The picture shows one man's ideas of transport in a city of the future.

There are moving pavements.

Study the picture.

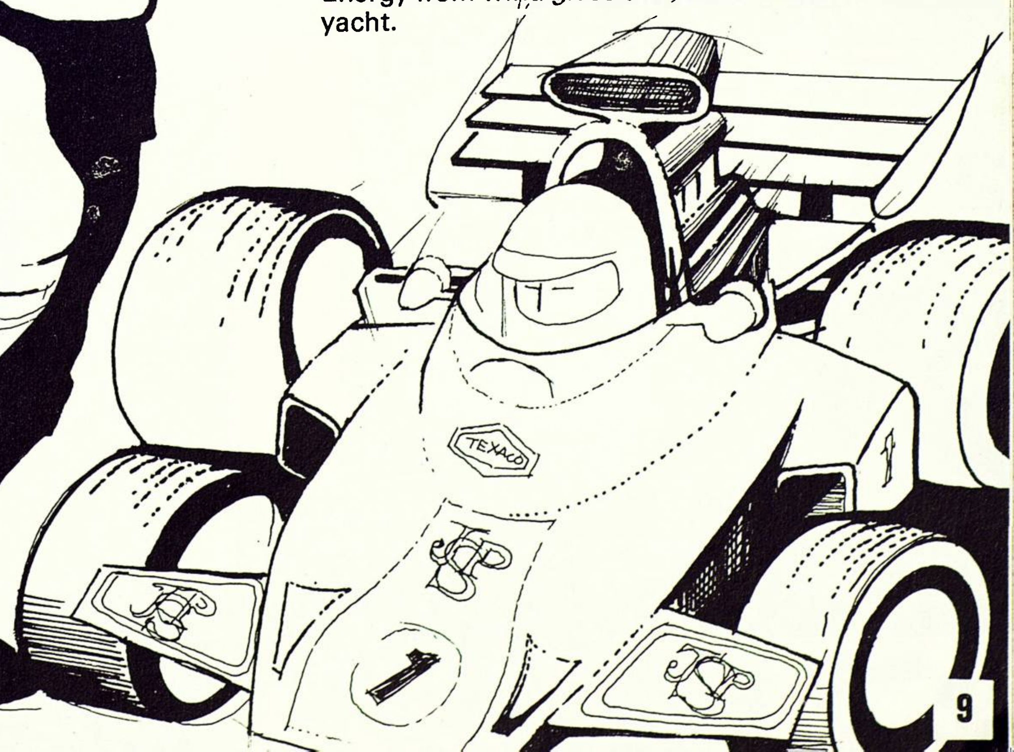
Describe what it would be like to live and travel in this city.

Have you any ideas for the future of travel?

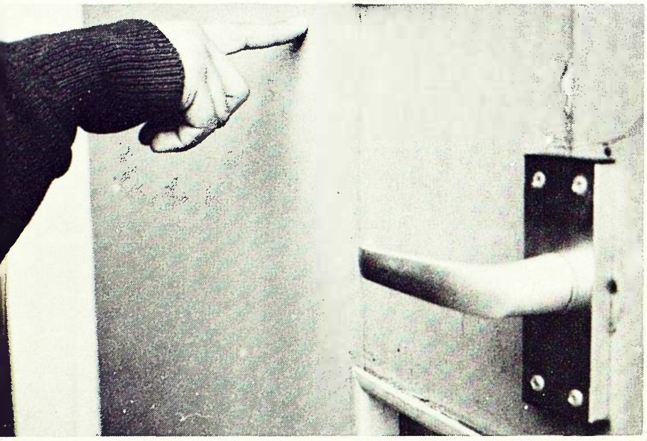
As you study this topic you may have more ideas. You will also find more problems for the future.

ENERGY
SECTION TWO

Energy gives the GO to make things move.
Energy in food gives the **GO** for muscle movement.
Energy in oil gives the **GO** for engines.
Electrical energy gives the **GO** for trains.
Heat energy gives the **GO** for the steam engine.
Energy from wind gives the **GO** for the land yacht.



PUSHES, PULLS AND TWISTS

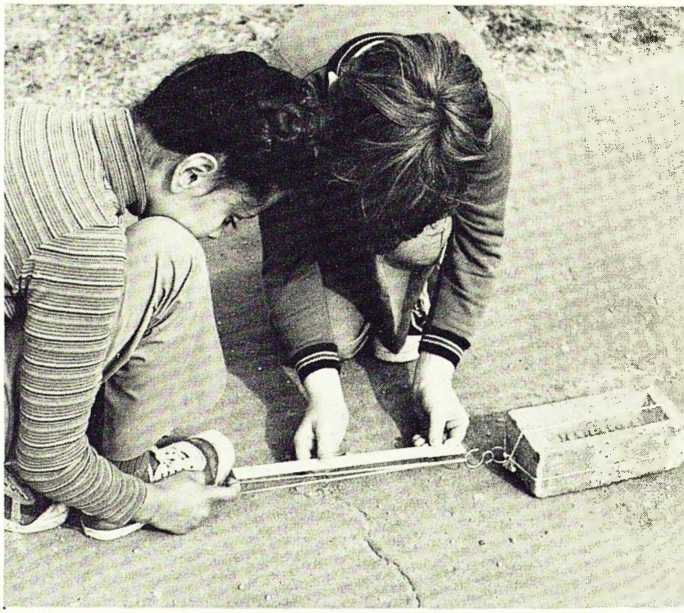


To move a thing we push it, pull it or twist it.
The push, pull or twist is called a FORCE.

Feel some forces:

(a) Push a brick along the ground.
(b) Pull along a friend who is on roller skates or a skateboard.
(c) Twist a door handle.
(d) Open the door by pulling the door handle.
(e) Shut the door by pushing here.
(f) Do it again by pushing here.
(g) Arrange with a car-owner for you to push it with him inside.

These pushes, pulls and twists are forces at work.
Which do you think needed the biggest force?
Which do you think needed the smallest force?
Here are two young scientists using the stretch of a rubber band to compare forces.



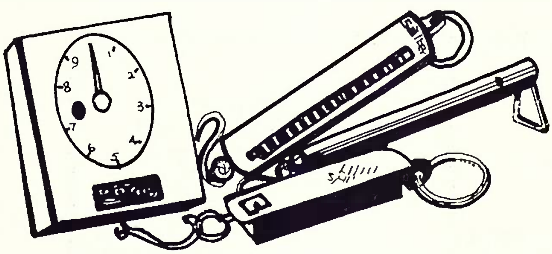
When you move things there are forces acting against you.
These depend on such things as:
how heavy it is
what it moves on
what it moves over
what it moves through
where it moves

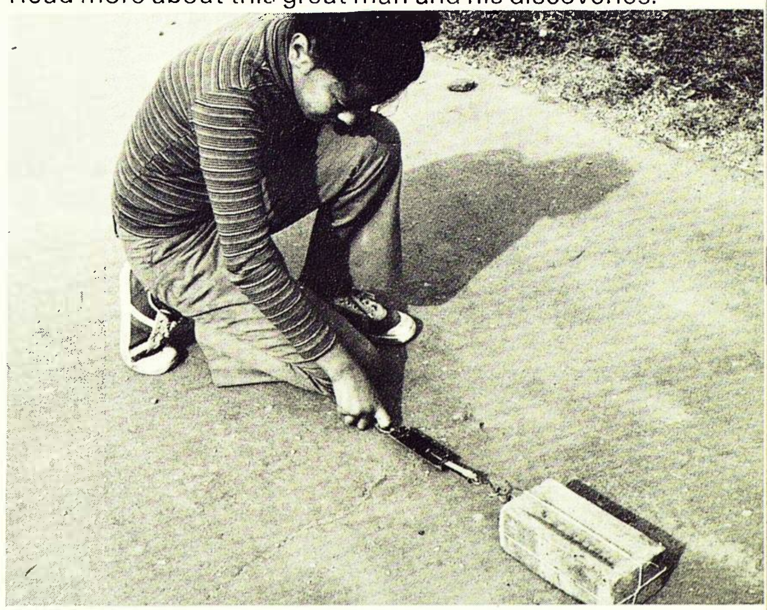
MEASURING PUSHES AND PULLS

Forces are measured in *newtons*.
This unit of measurement is named after Sir Isaac Newton.
Most people know the story of Newton and the falling apple.
He was a great scientist
A lot of his work was about forces and moving things.
Read more about this great man and his discoveries.

Hold an apple in your hand.
The apple pushes down with a force of about one newton.
You are pushing it up with a force of about one newton.

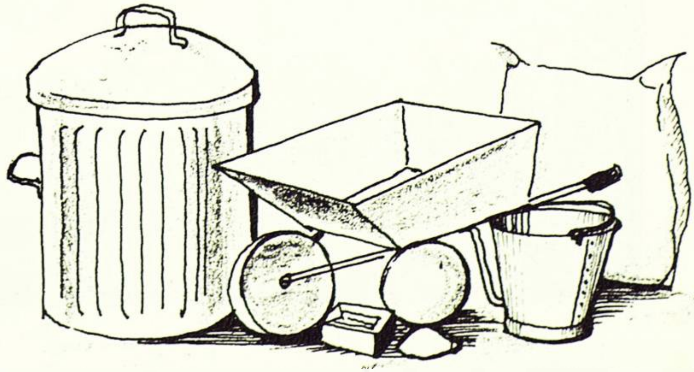
These are for measuring forces.
They are *force meters*.





These children are using force meters to measure pushes and pulls.
They measure these forces in *newtons*.

Move other things by pushing and pulling.
Measure the force you used.



SOURCES OF ENERGY

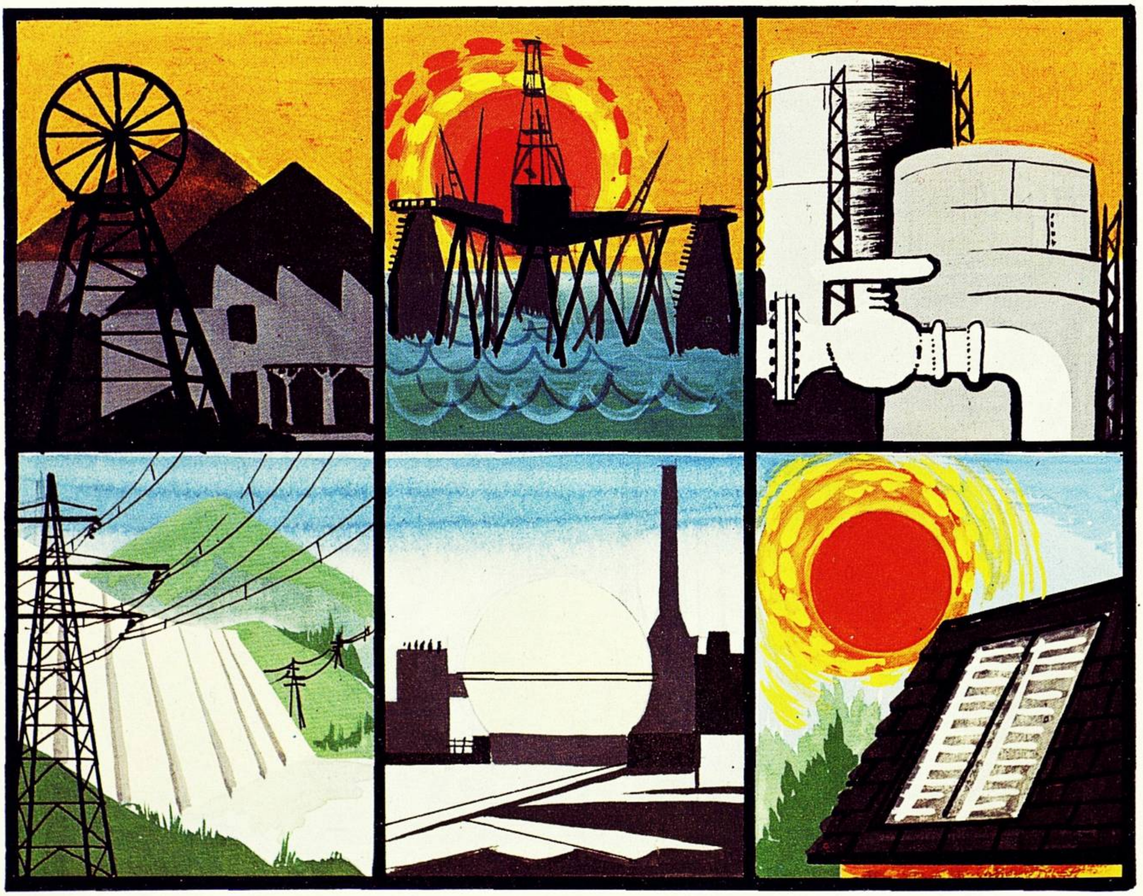
The energy you have used to move things came from using your muscles.
This energy came from the food you ate.

Where did the energy come from for the food to grow?

The energy of our muscle power is quite small.

Today we need lots of energy to move ourselves and our goods about the world.
Where do we find all this energy?
Here are some clues:

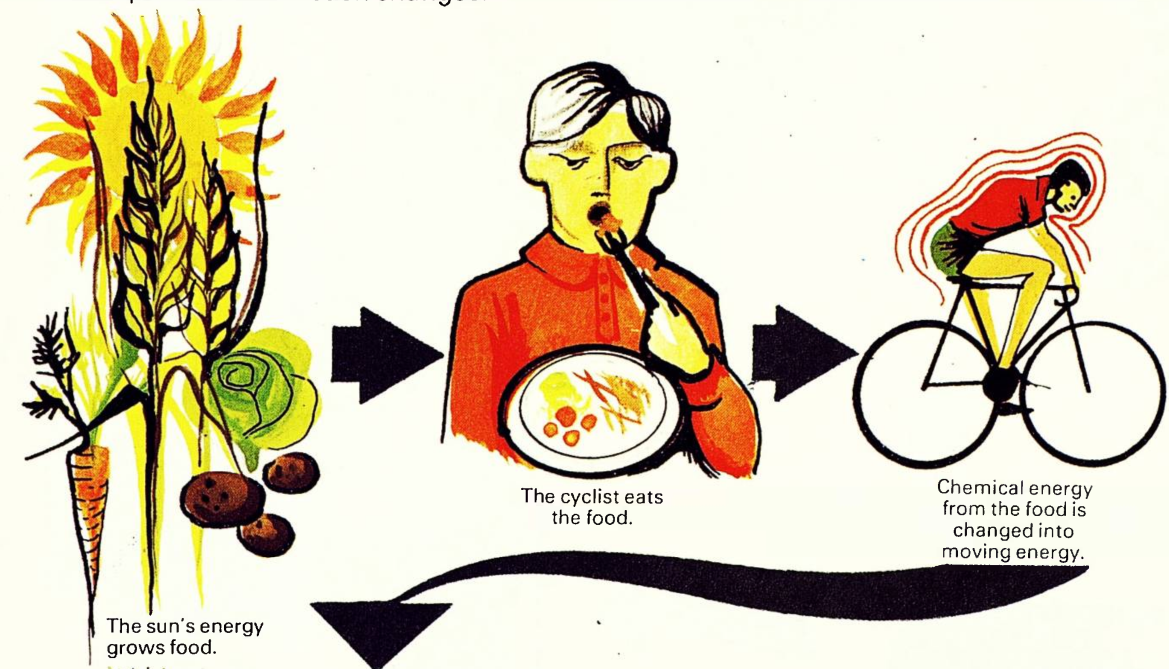
1 Try to find out where the world's supply of that source of energy is.
2 Try to find out how long supplies will last.
3 Which of these are used for transport?



USING ENERGY

Energy is used when it is changed from one sort to another.
We cannot make energy.
We can only change it from one kind to another.
We can move things when energy is being changed.

These pictures show such changes.

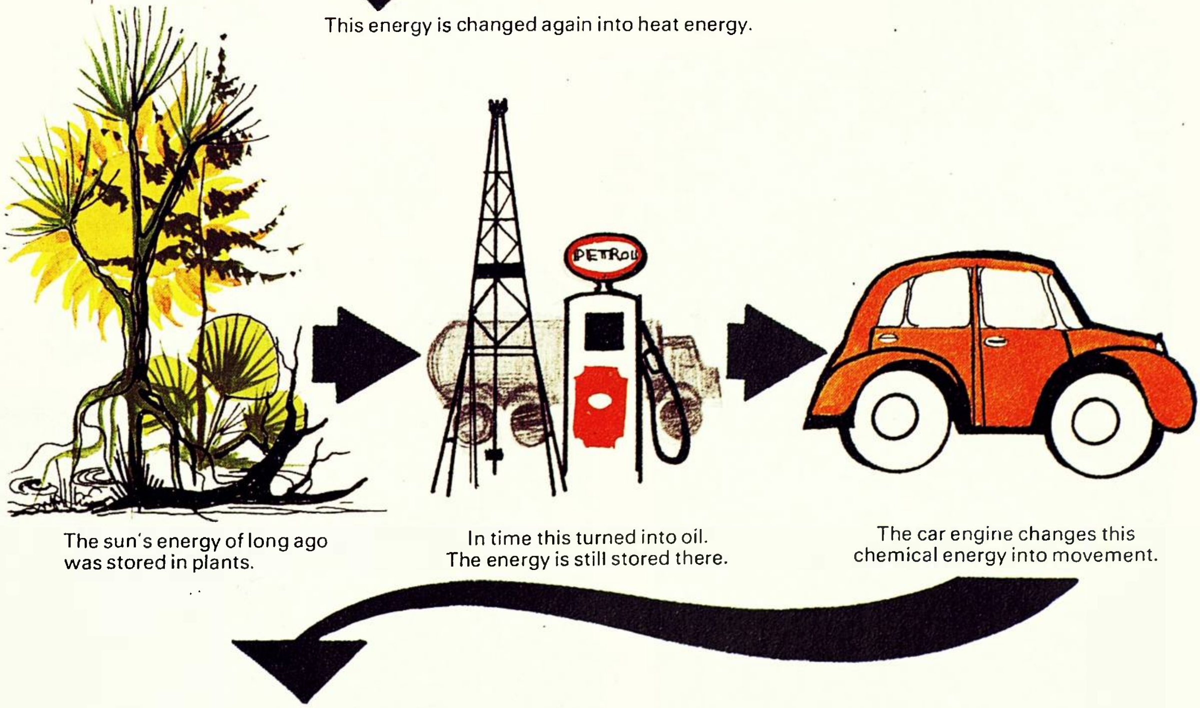


The sun's energy grows food.

The cyclist eats the food.

Chemical energy from the food is changed into moving energy.

This energy is changed again into heat energy.

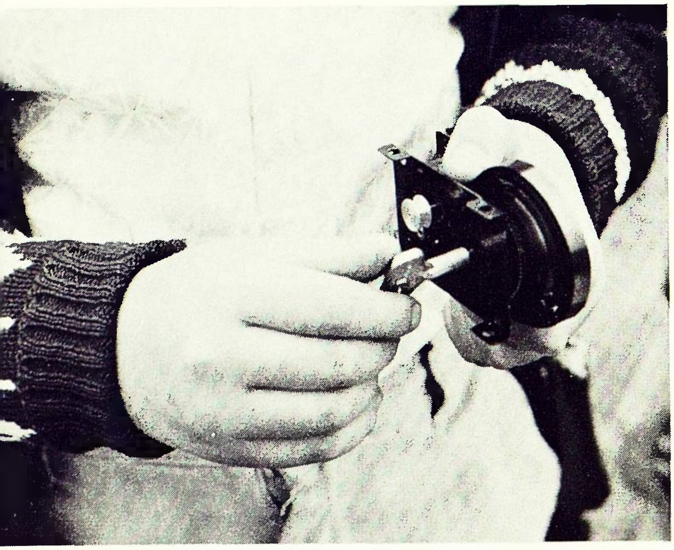


The sun's energy of long ago was stored in plants.

In time this turned into oil. The energy is still stored there.

The car engine changes this chemical energy into movement.

The energy is changed again into heat and sound.

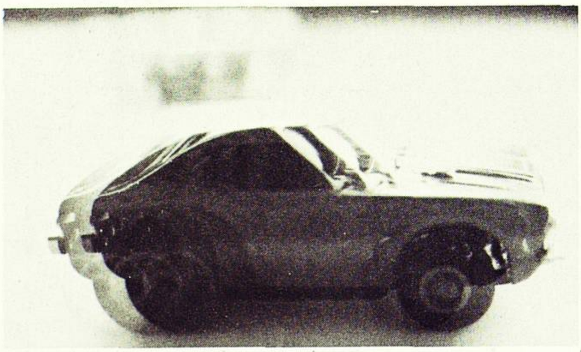


ENERGY CHAINS

When we change energy we can get movement.
We can also get light
or electricity
or heat
or sound
or magnetism
or stored-up energy

When energy moves something, a chain of changes happens.
Here is an energy chain.

A boy is playing with a clockwork car.



Draw the story of some energy chains:
(a) using a model train set
(b) playing with this toy car game.
(c) a diesel electric train (see page 54)

ENERGY AND WORK

When we move people or things we do WORK.

ENERGY can do **WORK.**

ENERGY is **WORK.**

ENERGY = WORK.

Work is done when a force moves.

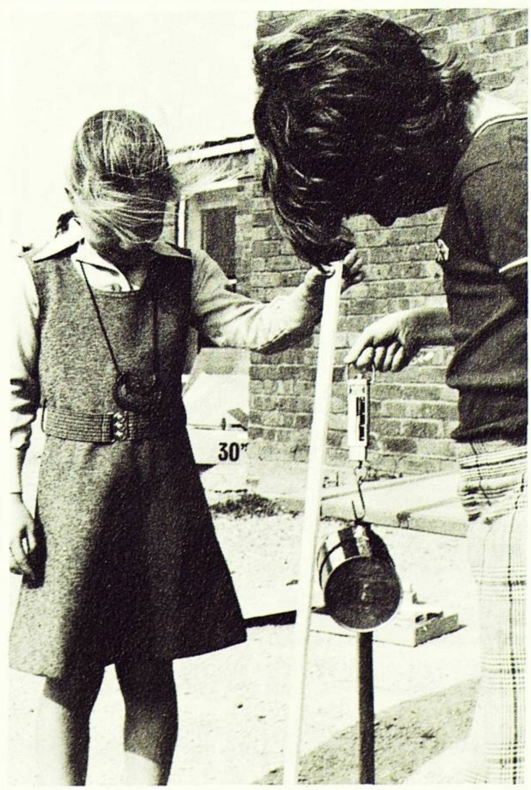
WORK is measured by knowing:
the size of the force
how far it moves.

WORK measured in	**= FORCE**	×	**DISTANCE**
joules	**newtons**		**metres**

These children are lifting a load on to a 'lorry'.
They are measuring the number of newtons on the force meter.
They have measured the distance.
They have measured the **WORK.**
WORK = ENERGY
ENERGY is measured in joules.
They can now calculate how many joules of ENERGY they have used.
This is equal to the **WORK** they have done.

Do this work measurement for yourself.

There can be push and pull forces but if no movement happens, no **WORK** is done.



USING AND WASTING ENERGY

Think about our sources of energy:

COAL
OIL
GAS
NUCLEAR
WATER
(hydro-electric, tides and waves)
WIND
PLANTS
(fuel and food)
THE SUN.

We are using up some supplies of energy sources fast.
Which sources can we not replace?
Which sources will last for ever?

How well do we use this energy?

An electric train can carry a thousand people.

A diesel-electric train will use twice as much energy to carry the same number of passengers the same distance.

Private cars use fifty times as much energy to carry the same number of passengers the same distance.

By the year 2000 there may be no petrol left for motor cars.

What ideas have you for the future?

Can we save energy by using it well?

Can we save energy by not wasting it?

WHEELS

SECTION THREE

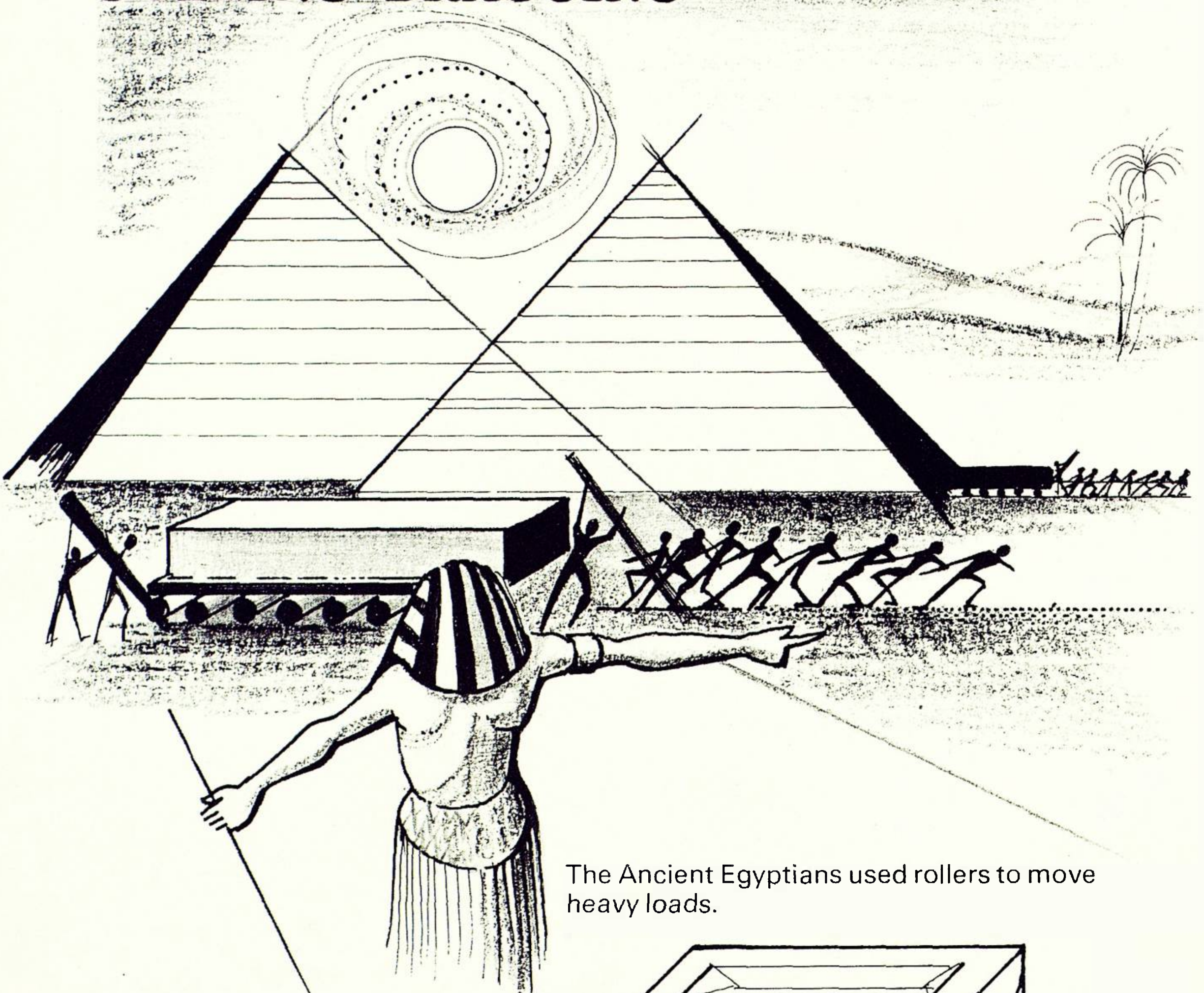
No one knows who made the first wheel.

It has been said that it is one of the world's greatest discoveries.

Do you agree?

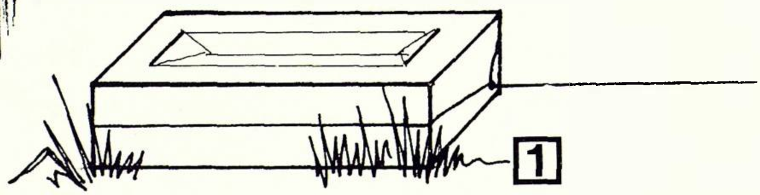
What are these wheels?

PULLING • DRAGGING •

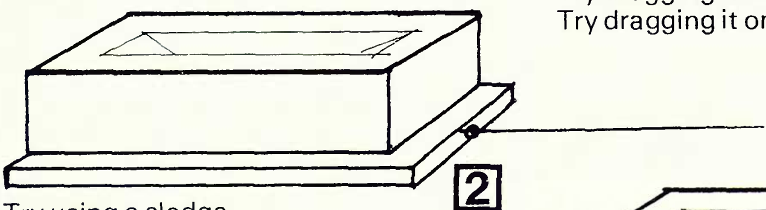


The Ancient Egyptians used rollers to move *heavy loads*.

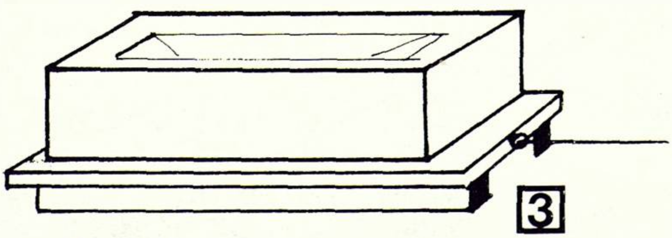
Try moving a load in these ways.
Measure the force used for each.
Use a force meter.
Measure the force in newtons.
A brick will do for your load.



Try dragging it over grass.
Try dragging it on the playground.

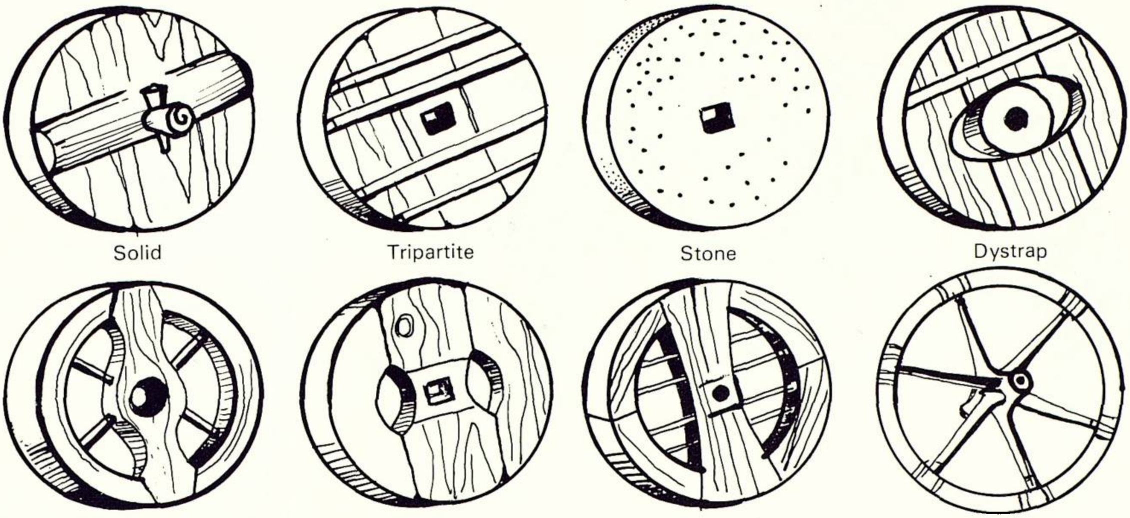


Try using a sledge.



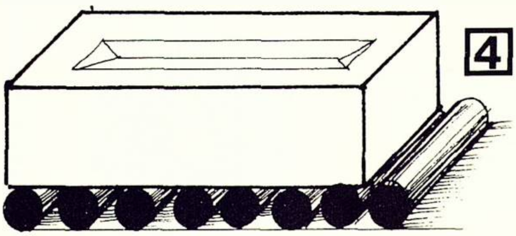
Try adding runners to your sledge.

PULLING AND ROLLING



Solid, Tripartite, Stone, Dystrap, Crossbar type, Yorkshire Clog, Egyptian

These pictures show how the wheel developed.



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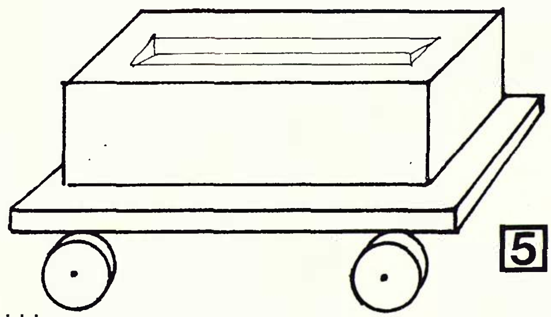
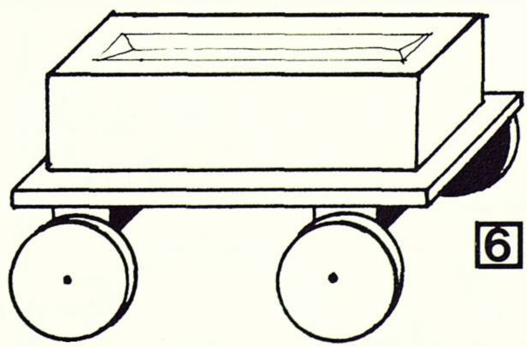


5

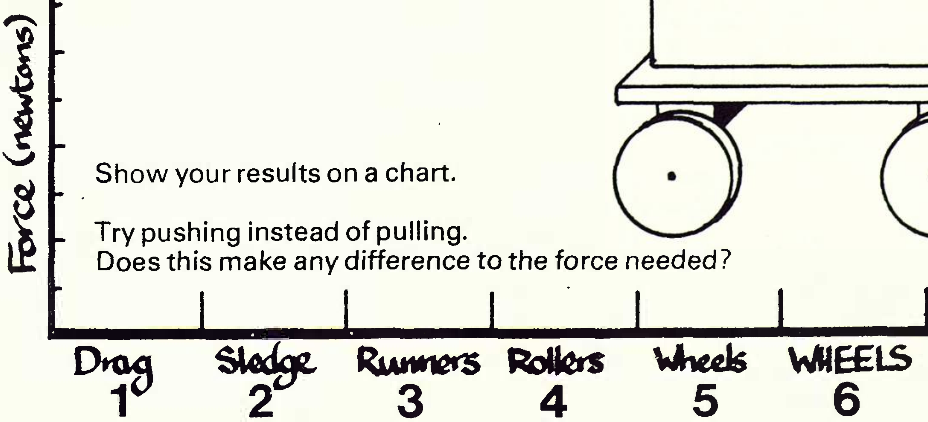
Try using rollers to help move your load . . .
Now try wheels . . .
Try larger wheels . . .



6

Show your results on a chart.

Try pushing instead of pulling.
Does this make any difference to the force needed?

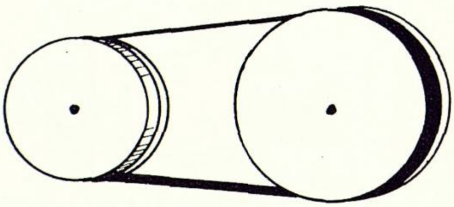


DRIVING THE WHEEL

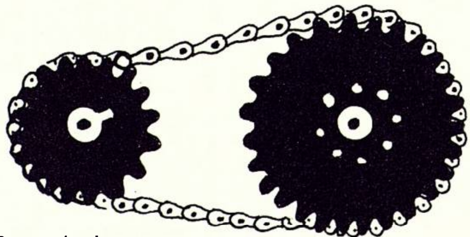
The first wheels were driven by muscle power.
Men pushed or pulled the load.
Animals hauled the cart or carriage.

In the eighteenth century a steam engine was invented.
In the nineteenth century the petrol engine was invented.
So then came railways and motor cars.
Wheels had now to be driven by engines.
New ways had to be found to turn the wheels.

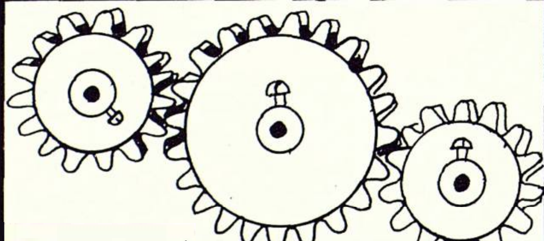
Here are some of the ways:



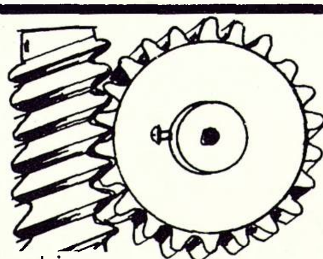
1 a belt



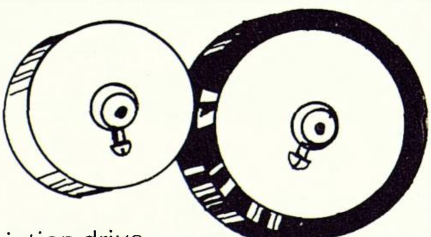
2 a chain



3 *cog-wheels*



4 a worm drive



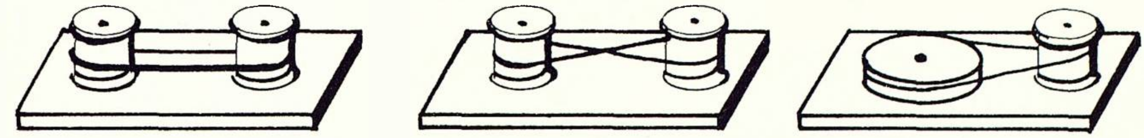
5 friction drive

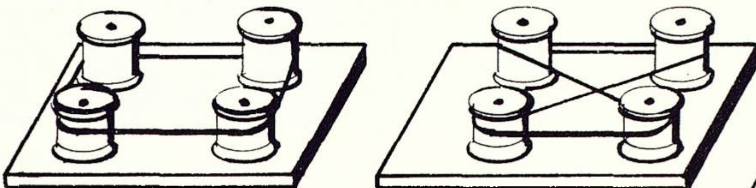
See if you can find an example of each in use.
Look at a bicycle, toys, cars, motor-cycles, watches and other machines.

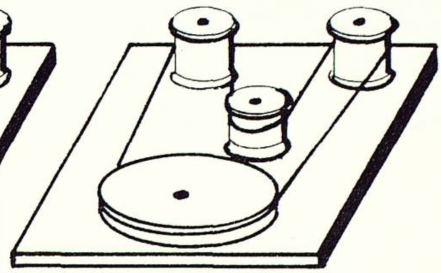
DRIVING THE WHEEL

Experiment with these ways of driving wheels.
Experiment first with a belt drive:

you could use Meccano or Fischer Technik
you could use cotton reels, tins and rubber bands.



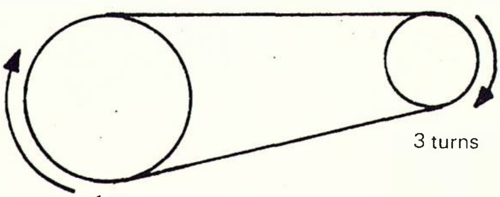




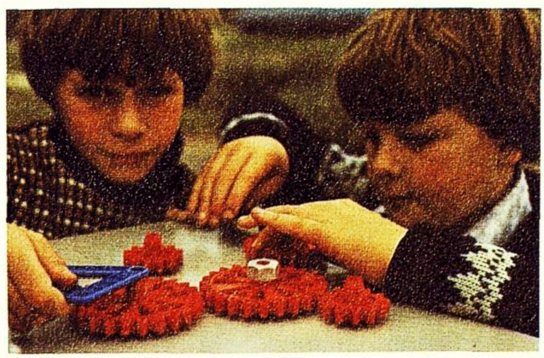
Before you turn the drive-wheel, guess:

1 which way the other wheels will turn
2 whether it will go faster or slower
3 how many times faster or slower it will go.

Now observe what happens when you turn the drive-wheel.



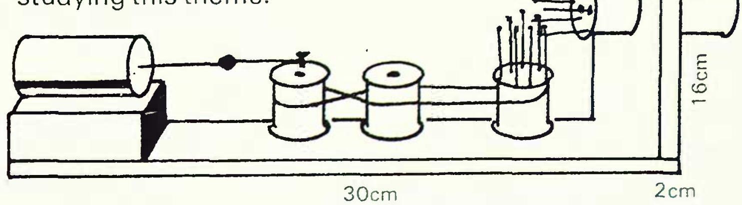
Record your results with drawings, arrows and numbers.



Experiment with cog-wheel drives in the same way.

Again observe and record the direction and speed of each wheel.

Here is a model made in a class studying this theme.

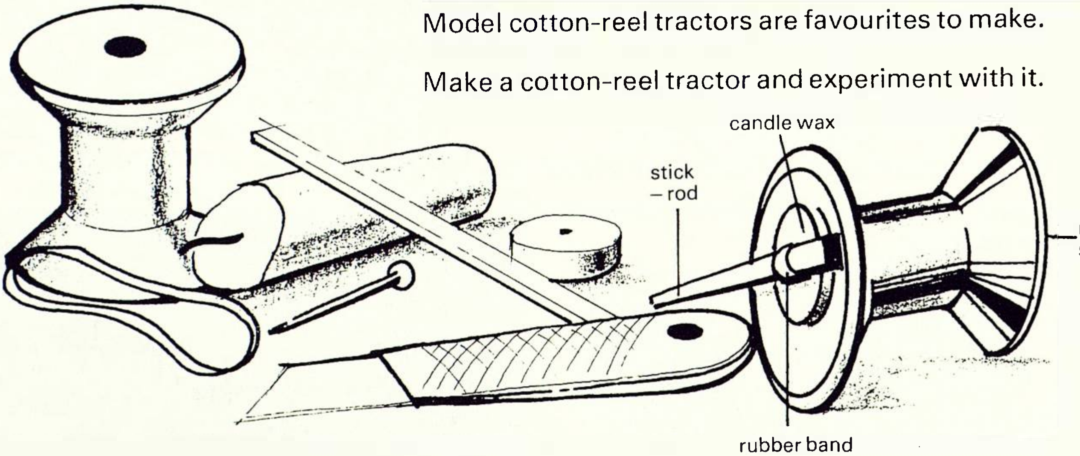


TRACTORS

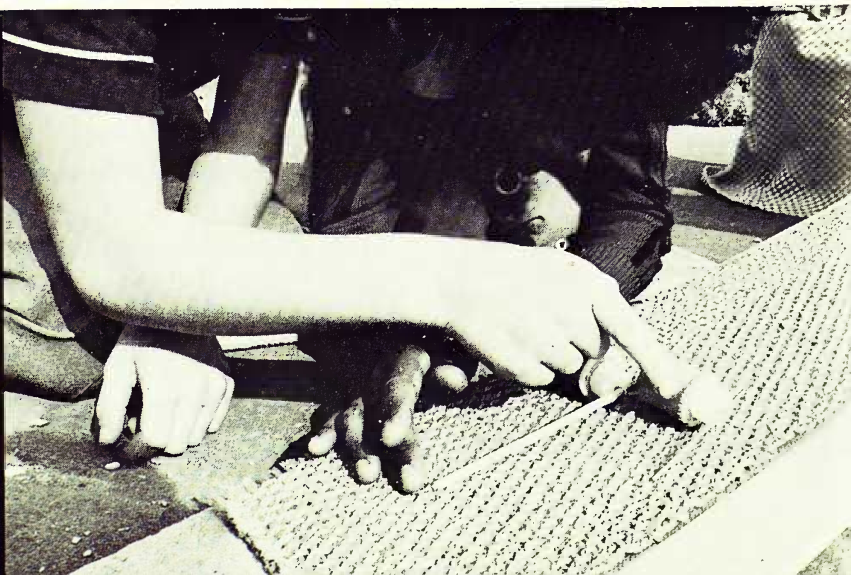
Farmers use the big wheels of the tractor to work their land.

Model cotton-reel tractors are favourites to make.

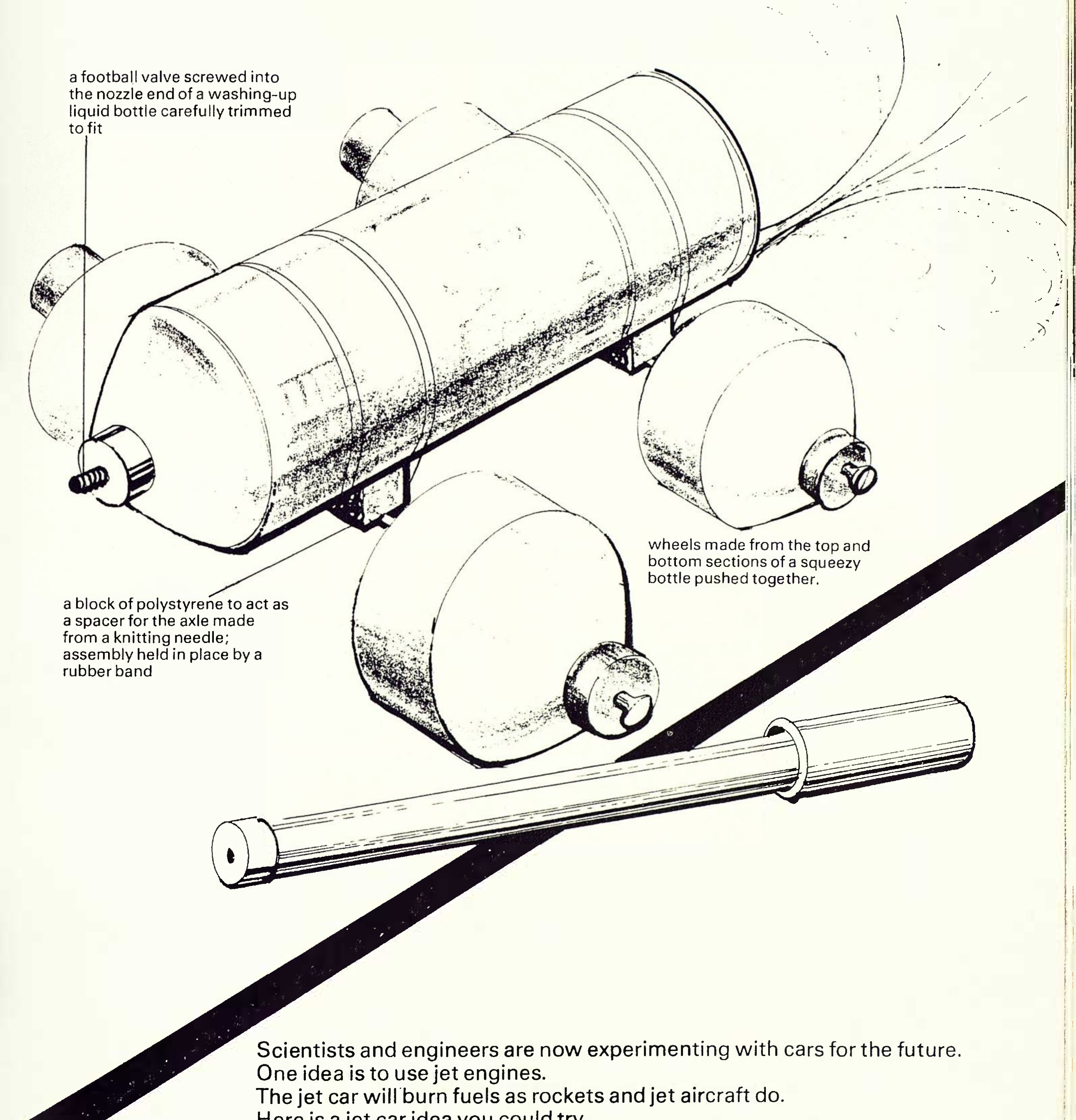
Make a cotton-reel tractor and experiment with it.



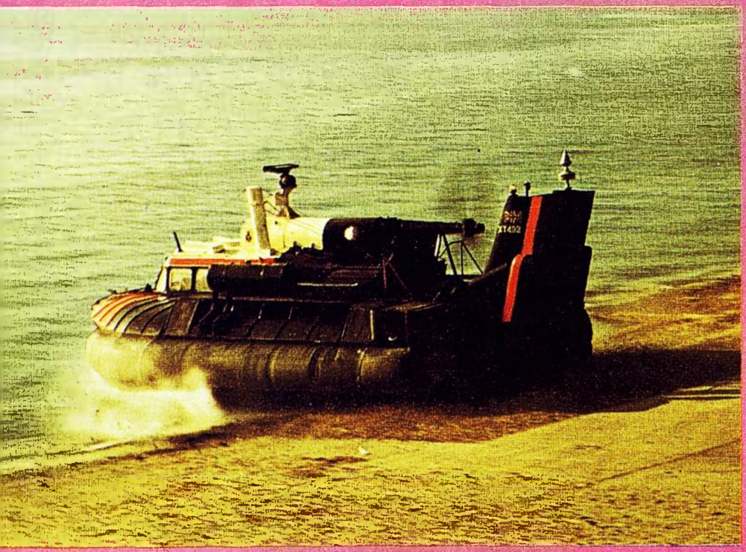
Try leaving the cotton-reel edge smooth.
Try notching another one.
Does the notched track help it to climb steeper slopes?
Does the notched track help it to cover rough country?



WATER JET CAR



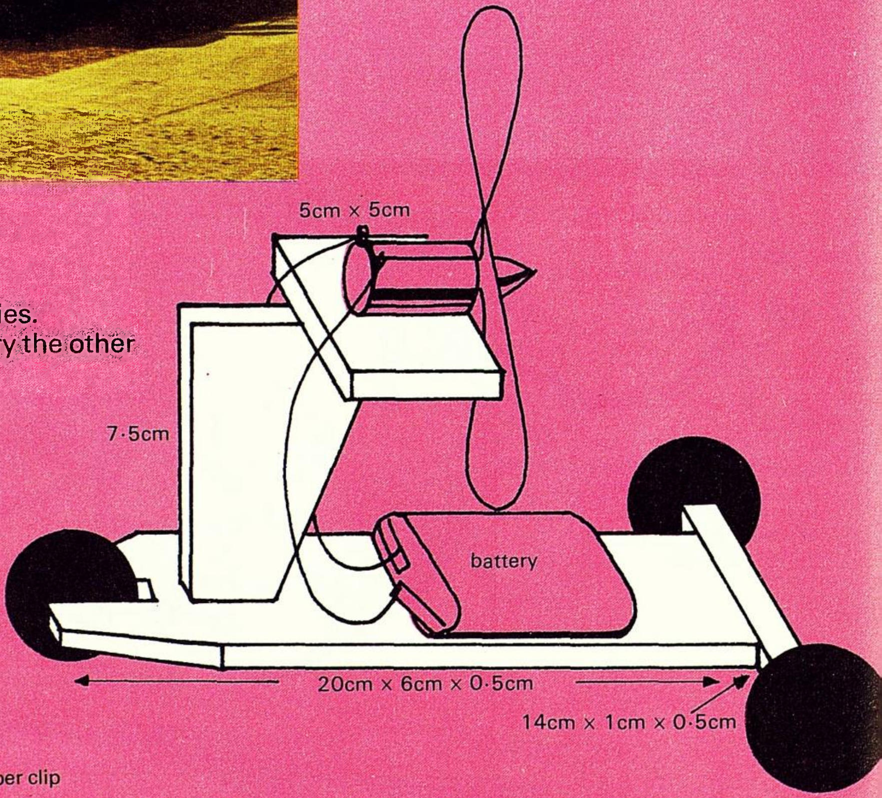
Scientists and engineers are now experimenting with cars for the future.
One idea is to use jet engines.
The jet car will burn fuels as rockets and jet aircraft do.
Here is a jet car idea you could try.
It is made from 'squeezy' bottles.
This jet uses air and water.
It can be a wet and rather messy experiment. Test and try outside.



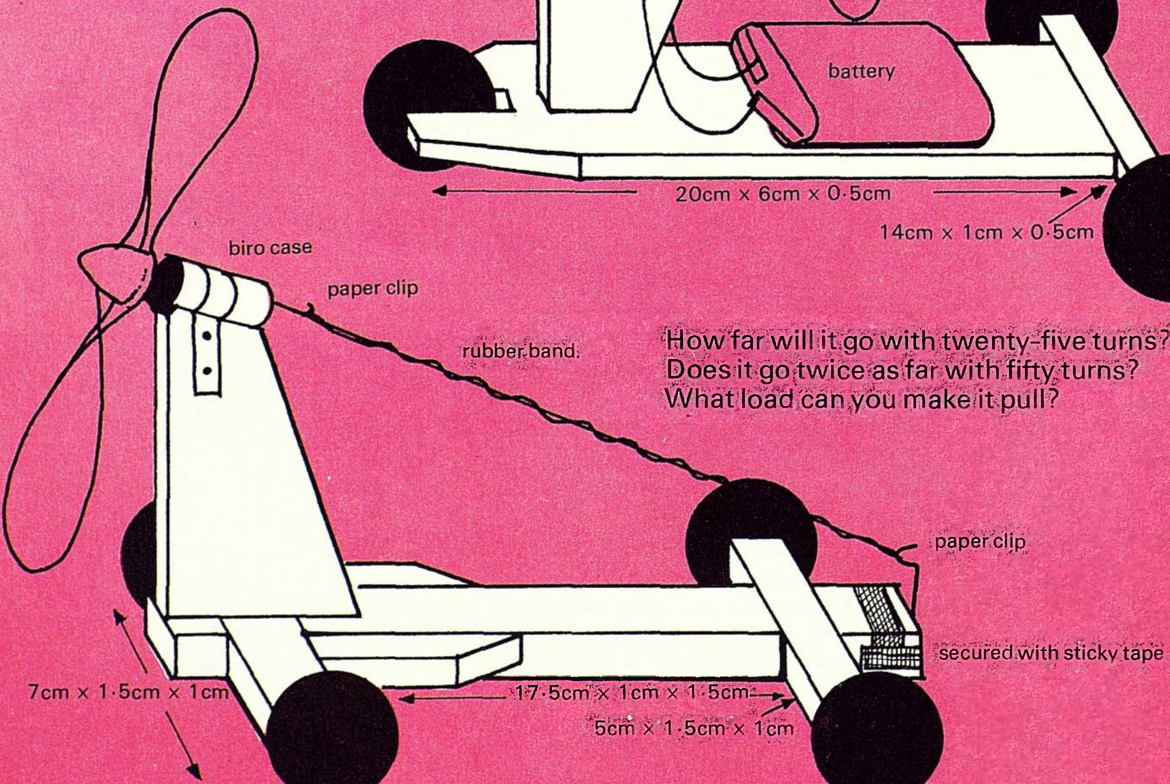
PROPELLERS

This hovercraft is moved by a propeller.
You could use a propeller to drive a model.
Here are two models that use propellers.

Try using different batteries.
Try connecting the battery the other way round.



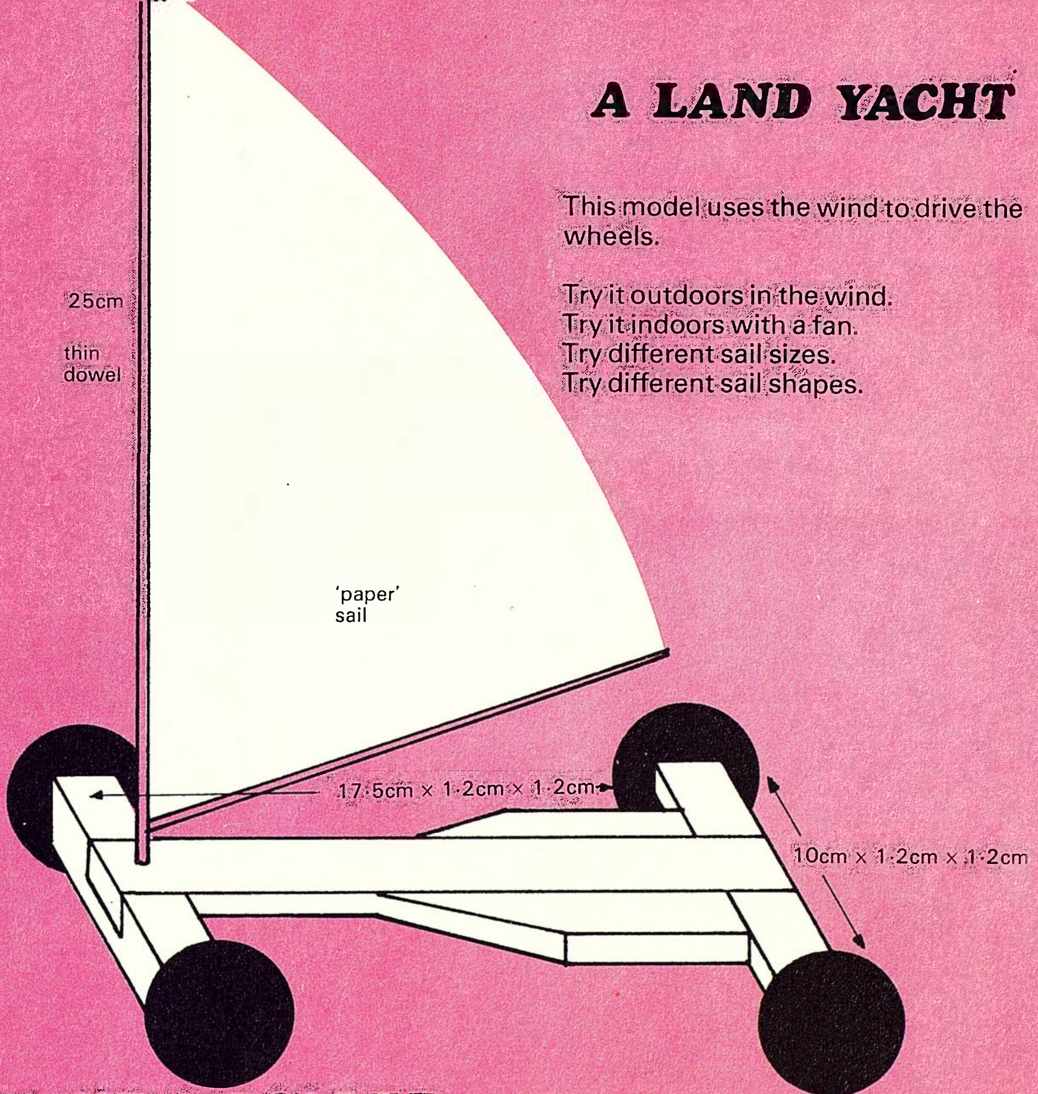
How far will it go with twenty-five turns?
Does it go twice as far with fifty turns?
What load can you make it pull?



A LAND YACHT

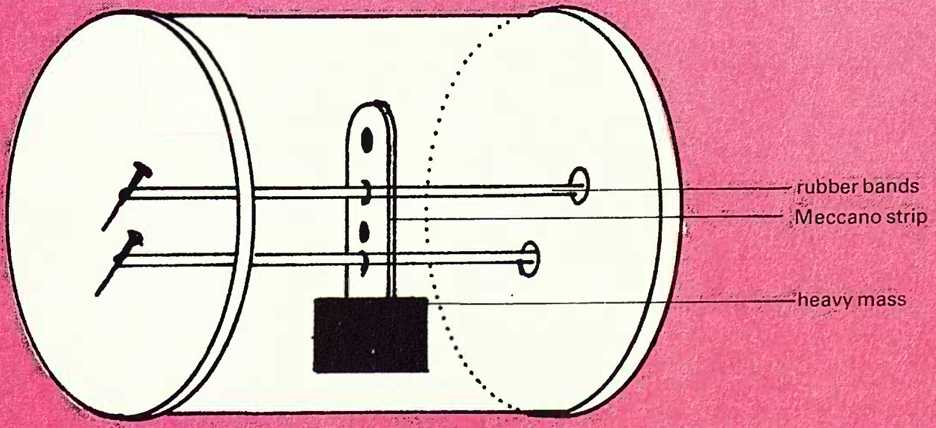
This model uses the wind to drive the wheels.

Try it outdoors in the wind.
Try it indoors with a fan.
Try different sail sizes.
Try different sail shapes.

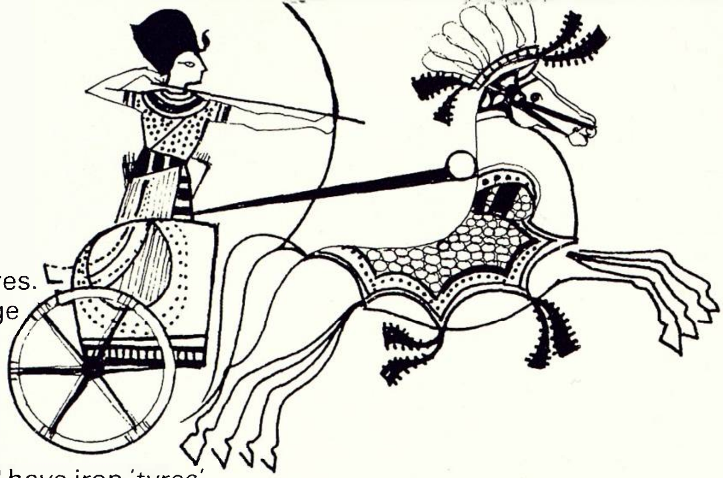


A RETURN ROLLER

Here is a toy drive to make.
It uses a tin can, rubber bands and a heavy mass.
When rolled along it will return.
Try it, and work out why.



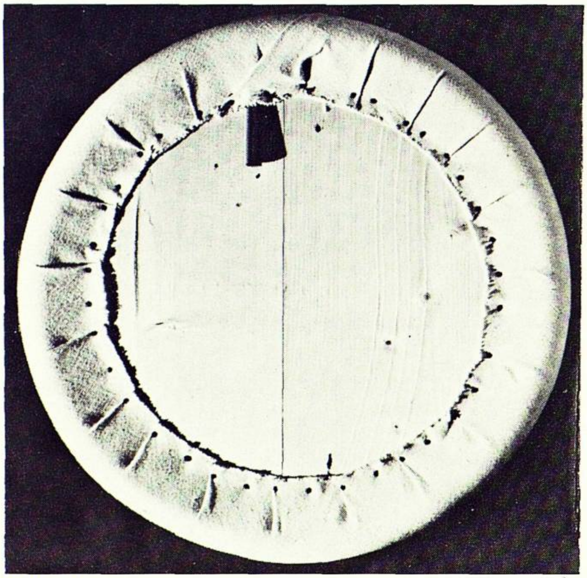
TYRES



Early wheels wore out and split.

The Egyptians fitted leather tyres to chariot wheels.
Iron tyres made a strong wheel.
The Greeks knew how to make iron tyres.
Iron tyre chariots were used in the siege of Troy.
Iron tyres have been used ever since.

Today farm carts and railway trains still have iron 'tyres'.



DUNLOP LTD

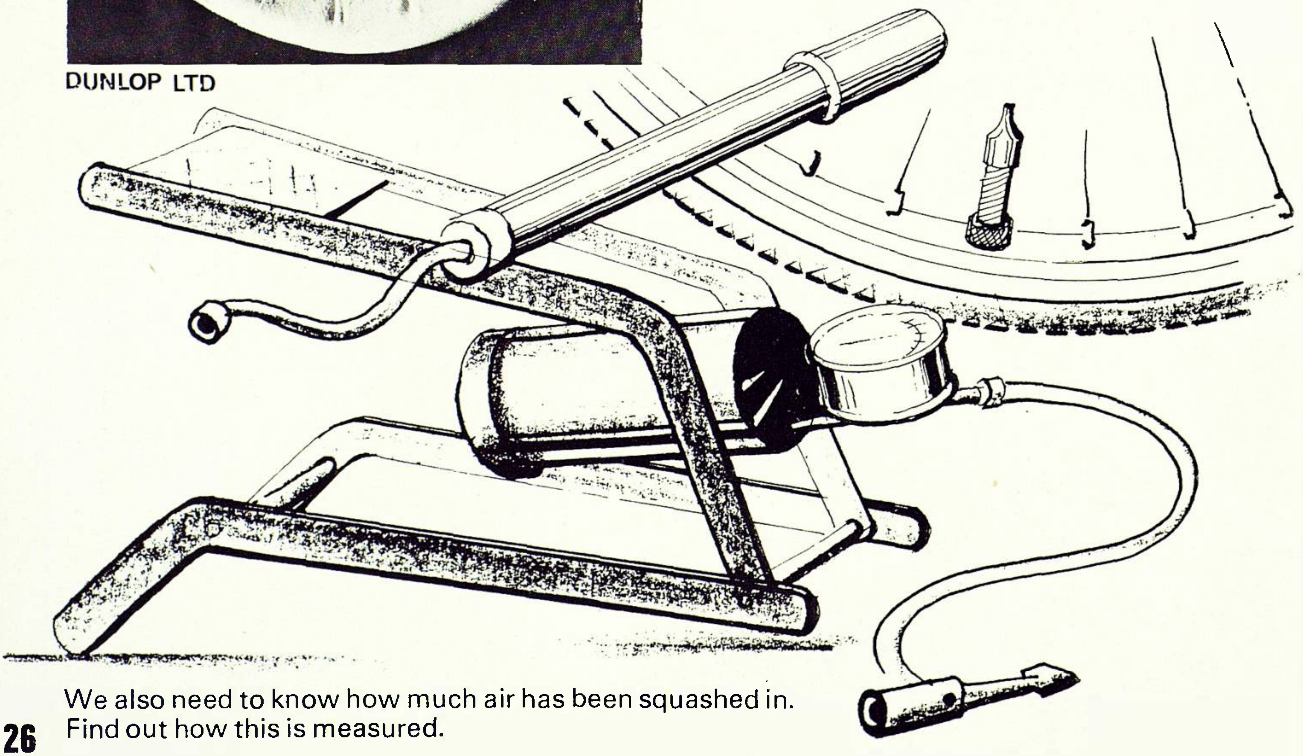
In 1888 a Scottish veterinary surgeon invented a new tyre.
His tyre was 'pneumatic'.
Pneumatic means filled with air.
Mr. Dunlop's new tyre gave a smoother and faster ride.

For a tyre to be filled with air other inventions were needed:

a pump to push the air in

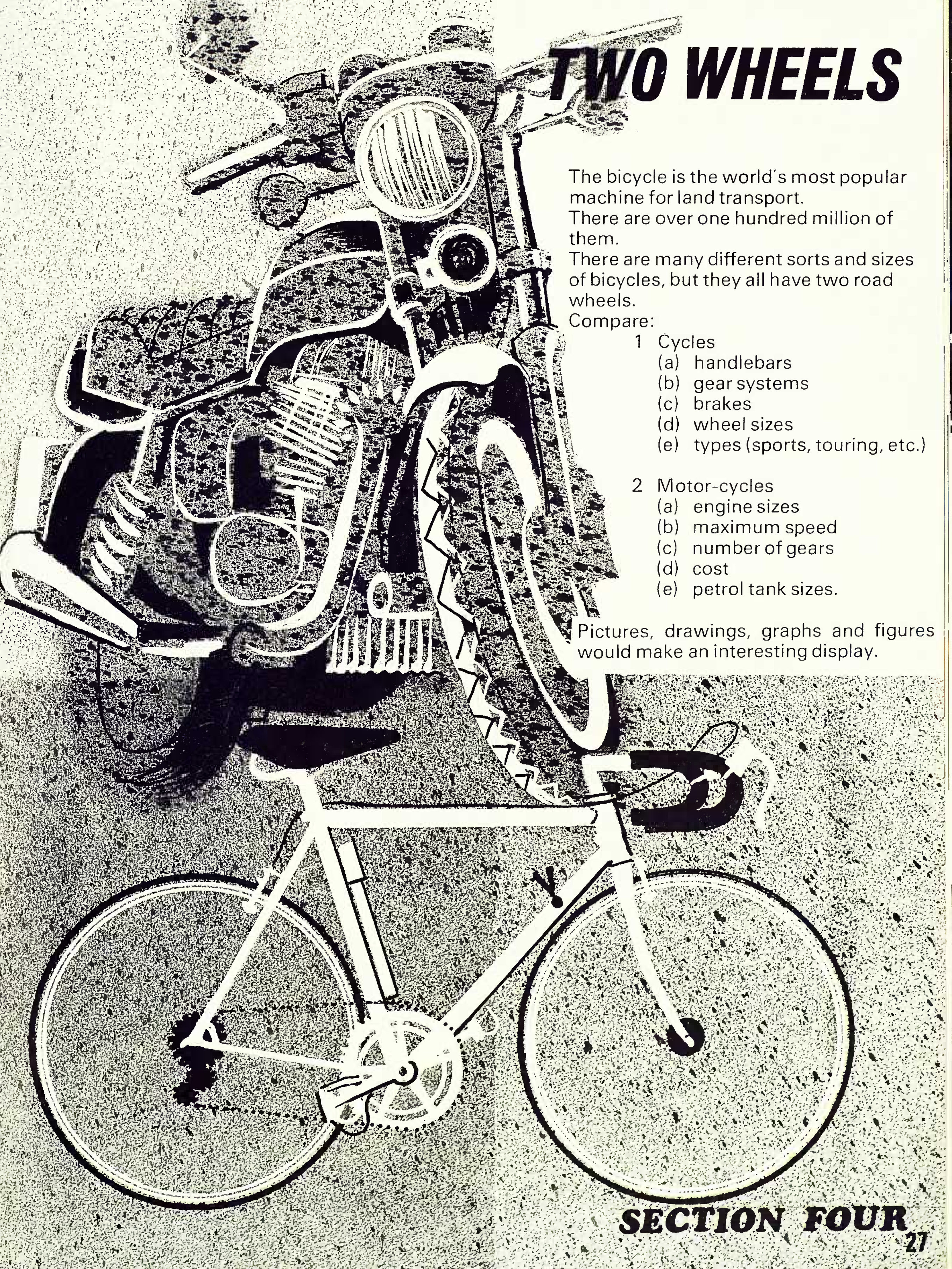
a valve to let it in but not out

Find how these work.



We also need to know how much air has been squashed in.
Find out how this is measured.

TWO WHEELS



The bicycle is the world's most popular machine for land transport.
There are over one hundred million of them.
There are many different sorts and sizes of bicycles, but they all have two road wheels.
Compare:

1 Cycles
- (a) handlebars
- (b) gear systems
- (c) brakes
- (d) wheel sizes
- (e) types (sports, touring, etc.)

2 Motor-cycles
- (a) engine sizes
- (b) maximum speed
- (c) number of gears
- (d) cost
- (e) petrol tank sizes.

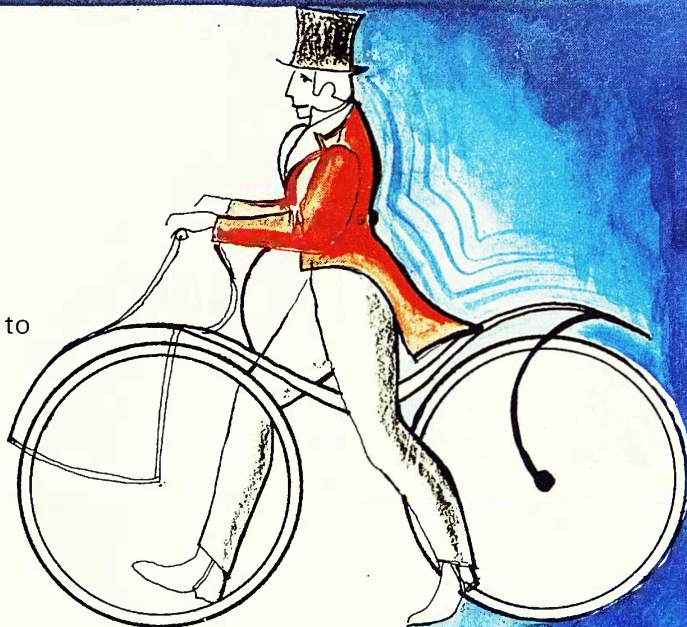
Pictures, drawings, graphs and figures would make an interesting display.

THE STORY OF THE BICYCLE

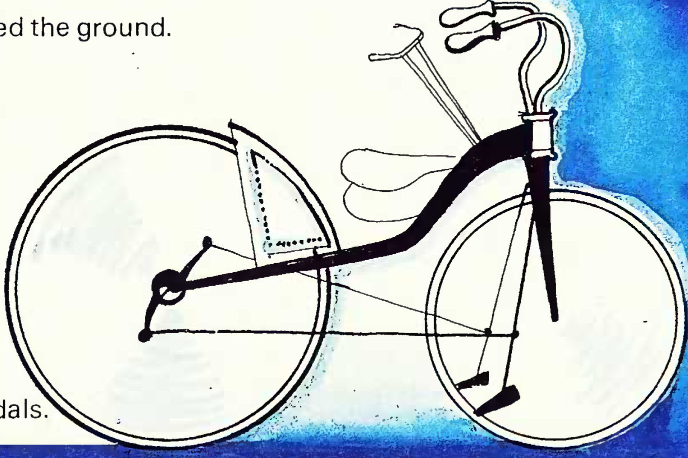
This is a picture of the earliest known bicycl
It is part of a stained glass window in Stoke
Poges Church, Buckinghamshire.

Which of the bicycles on these pages do you think would be the most difficult to learn to ride?
Which do you think would use more of your energy?
Why?

Look at each bicycle.
Imagine riding each at 10km an hour.
Discuss which would need most energy to reach that speed.



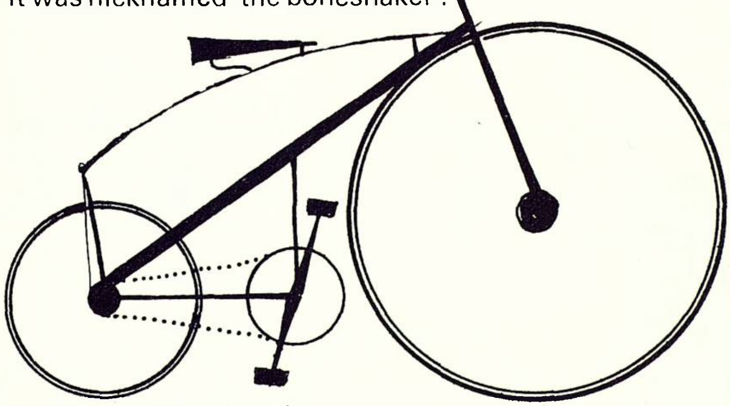
1818 The Hobby Horse
This was moved along as the rider kicked the ground.



1838 MacMillan's Bicycle
This was the first two-wheeler with pedals.

Look again at the very early bicycles.
One turn of the pedals made the drive-wheel go round once.
Some inventors thought that the larger the drive-wheel the faster the cycle would go.
Measure and find out about drive-wheels.

1868 The Velocipede.
This had thick wooden wheels with iron tyres.
It was nicknamed 'the boneshaker'.



1879 The 'Bicyclette'
A Mr. H. J. Lawson invented this first bicycle with a chain-drive.

How far will one turn of the drive wheel move the bicycle?
There are several ways to measure this distance.

1. Use a tape measure round the wheel.
2. Mark the wheel, turn once and measure.
3. Measure the radius (**r**).
   The circumference = $2\pi r$.

$$\pi \text{ is } \frac{\text{DISTANCE ROUND THE CIRCLE}}{\text{DISTANCE ACROSS THE CIRCLE}} = \frac{\text{CIRCUMFERENCE}}{\text{DIAMETER}}$$

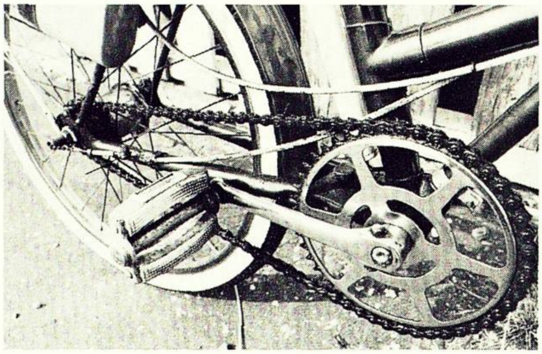
Try each way with one cycle wheel.
Do the three ways give the same result?
Measure different wheels.
How far will each cycle travel for one turn of the wheel?
Can you see now why the penny-farthing had a big drive-wheel?

1878 The Penny-farthing
This bicycle was nicknamed the penny-farthing. Why?

CHAINS AND TEETH

The 'safety' bicycle was so called because the wheels were made smaller. This meant the rider was not so far from the ground and did not fall off so easily. The rear wheel could now be driven by a chain-drive.

A modern bicycle still uses the chain-drive.
Look at the chain and cogs of a bicycle.
Count the number of teeth on the pedal wheel.
Count the number of teeth on the back wheel.
Turn the pedal wheel once.
How many times does the back wheel turn?
Look for a pattern.



A table like this will help.

A Number of teeth on pedal wheel.	**B** Number of teeth on back wheel.	A ÷ B	Number of turns of back wheel for one turn of pedal wheel.

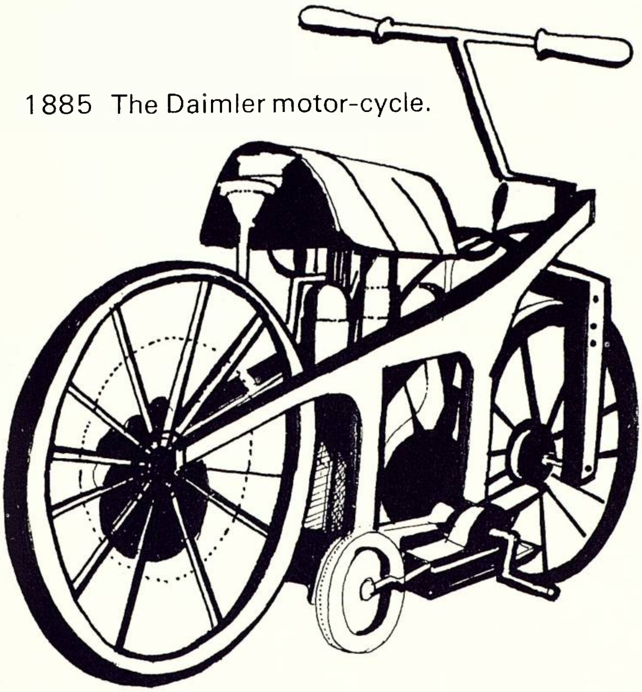
Look at a bicycle with a gear change.
Repeat the counting and measuring for this bicycle.
How many teeth does the top gear-wheel have?
How many teeth does the medium gear-wheel have?
How many teeth does the low gear-wheel have?
How many teeth does the bottom gear-wheel have?
What difference do the gears make?

A		B		A ÷ B	Number of turns of back wheel for one turn of pedal wheel
Number of teeth on pedal wheel		Number of teeth on top gear			
..		Number of teeth on medium gear			
..		Number of teeth on low gear			
..		Number of teeth on bottom gear			

Try to obtain old cycle or motor-cycle gears to take apart and explore.

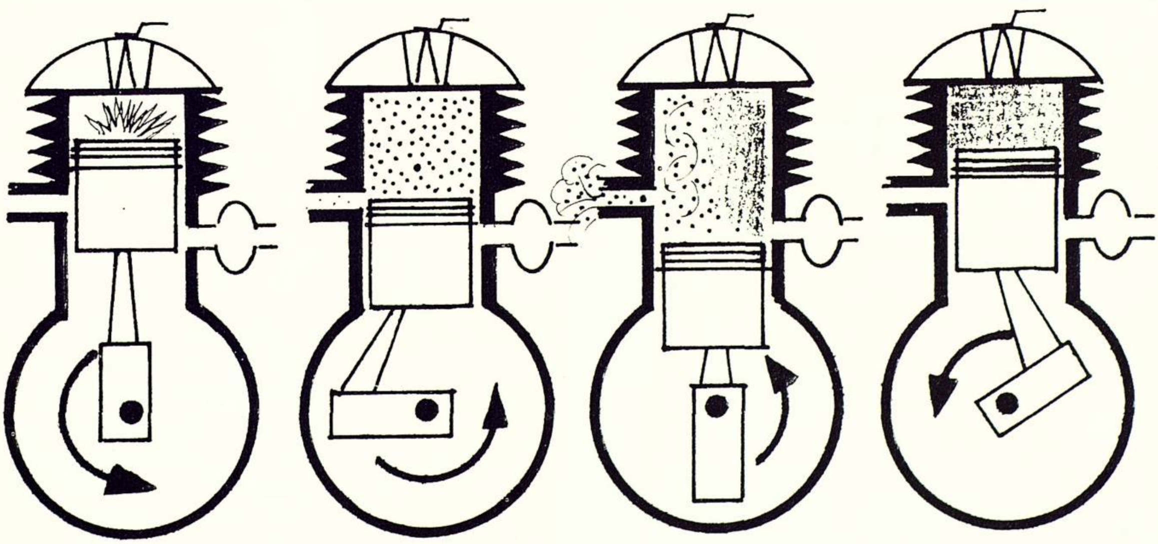
THE MOTOR-CYCLE ENGINE

1885 The Daimler motor-cycle.



This was one of the first cycles to be driven by an engine.

The motor-cycle engine uses petrol.
Burning petrol gives heat energy.
The petrol vapour mixed with air burns so quickly that it explodes.
This explosion is the driving force.
The explosion in the engine moves the piston.
The moving piston drives the 'pedal' wheel.
This turns the chain.
The chain drives the back wheel.



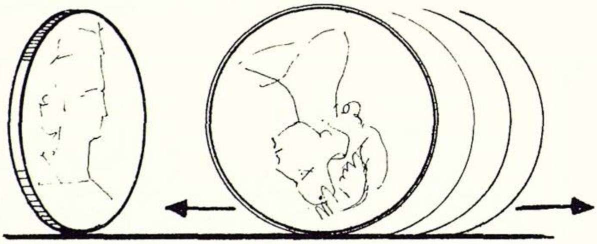
Explosions take place one after the other.
Each time the piston returns, another explosion fires it off again.

WHY DONT YOU FALL OFF?

If you just sit on a bicycle you will fall off.
Ride a bicycle going slower and slower.
How slow can you go?
Here is a slow bicycle 'race'.
When you are cycling along the spinning of the wheels keeps you from toppling over.
Here are some experiments with spinning things.
They show how spin stops things toppling over.

1 Take a coin.
Try standing it on its edge.
Roll it along the table:
(a) slowly
(b) quickly

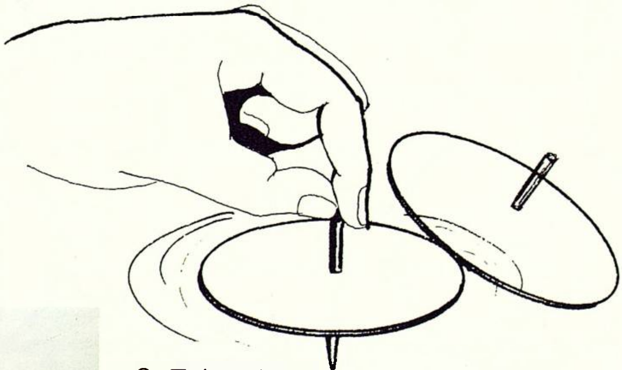
Spin it.



2 Take some tops.
Try balancing them on their points.

Spin them.

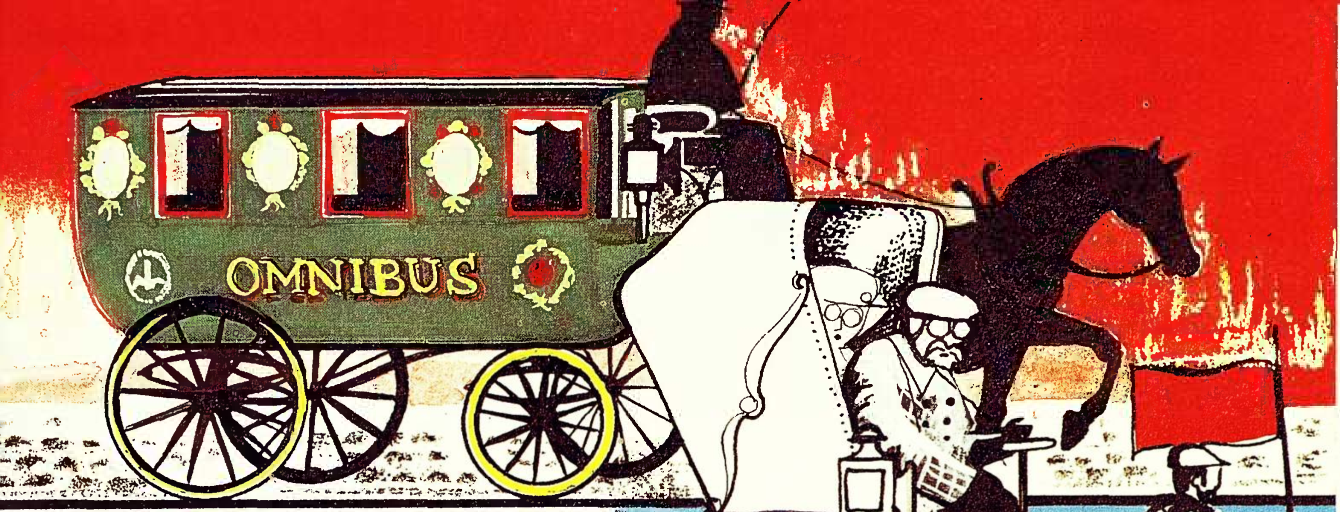
While spinning try touching gently to see if this will topple it.



3 Take a hoop.
Try standing it on its rim.
Try rolling it along:
(a) slowly
(b) quickly

While rolling try touching it.
Does this topple it?
Try throwing the hoop into the air.
Try giving it a spin. (As it leaves the hand give a sharp down jerk.)

All these experiments should help you to see and feel how spin helps balance.

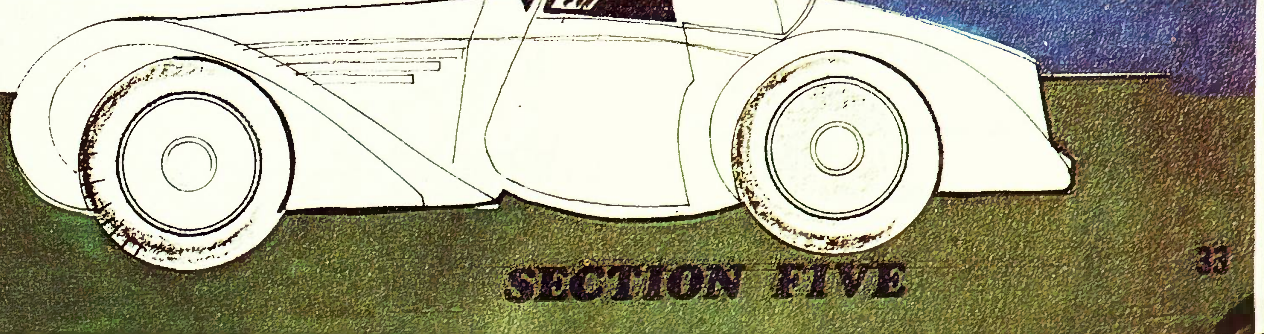


CARS, LORRIES AND BUSES

One hundred years ago there were no motor cars on the roads.
Until early this century goods were hauled by carts and wagons. These were pulled by teams of oxen or horses.
The modern lorry carries many tonnes of goods at high speeds.
Until the end of the nineteenth century people travelled by coach and horse.
In 1829 horses pulled the first London buses.
The modern coach carries fifty people on long journeys.
The invention of the motor car has changed the world.
Think about these changes.
Here are some words, which suggest some of the changes.

speed	motorways
convenience	noise
accidents	parking
exhaust fumes	garages
roads	jobs
holidays	sport

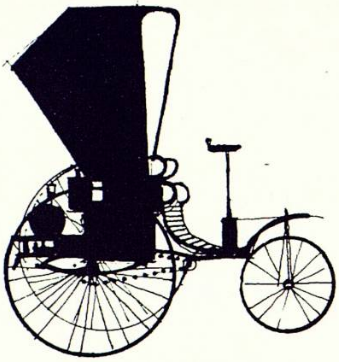
Discuss which have been good changes and which have been bad.



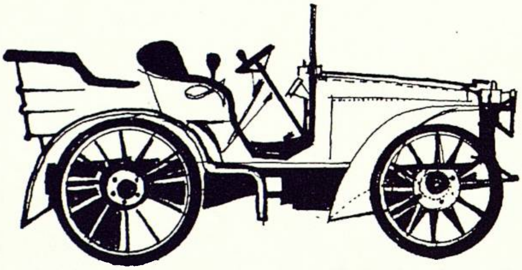
THE STORY OF THE MOTOR CAR

The story of the car shows the work of scientists, inventors and engineers.
There are thousands of different parts in a motor car.
All these inventions and improvements have been made in one life span.

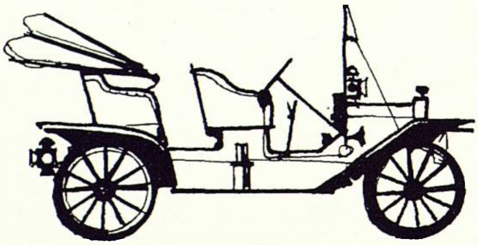
Here are some important ones.



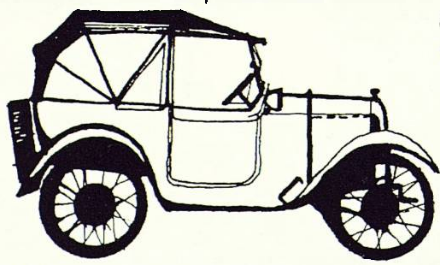
1885 The first petrol-driven car.
Who invented this?



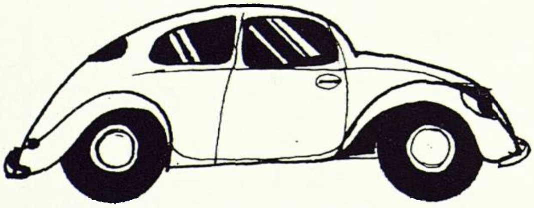
1901 A Mercedes – the first 'modern' car.
Why is this called the 'first modern car'?



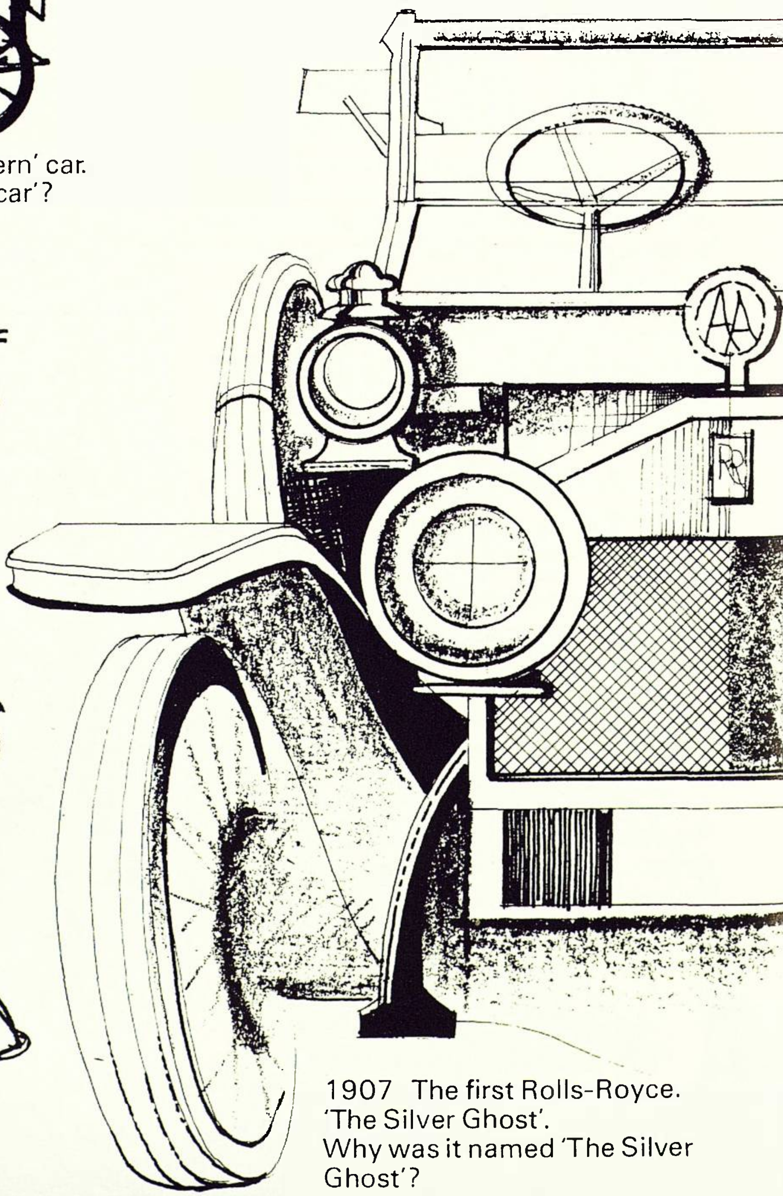
1908 The Ford 'Model T'.
The first mass-produced car.
What does mass-produced mean?



1922 The first 'mini' car.
This was called a 'Baby Austin'.
What did this cost in 1922?



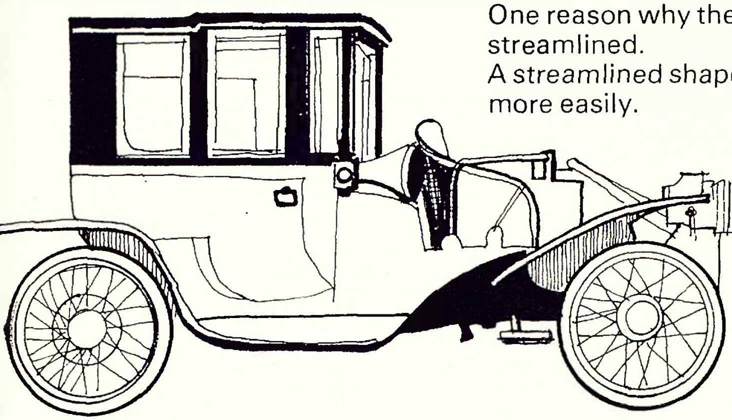
1935 The first Volkswagen.
What does the name Volkswagen mean?



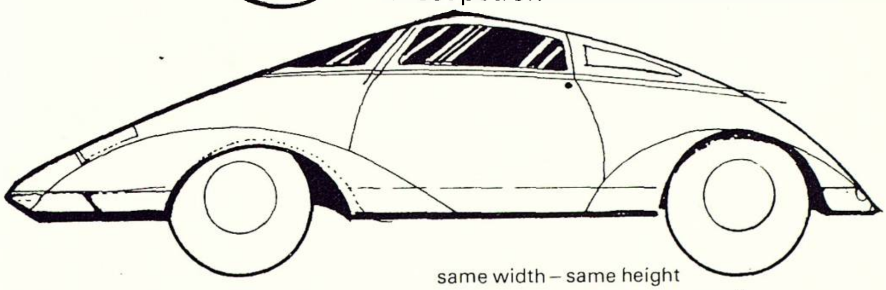
1907 The first Rolls-Royce.
'The Silver Ghost'.
Why was it named 'The Silver Ghost'?

CAR SHAPES

Look how the shapes of cars have changed.
One reason why they have changed is to make the shape streamlined.
A *streamlined* shape is one that can move through the air more easily.

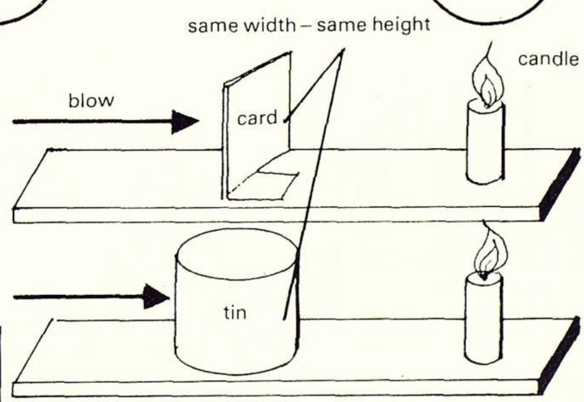


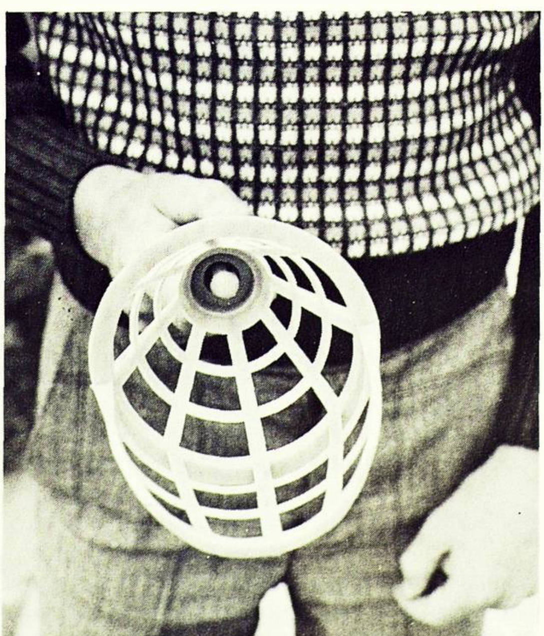
Which of these will move through the air most easily?
Which one will the air push back most?
Which one could travel fastest?
If they were car shapes with the same engine, which would use the most petrol?



These experiments will help you find out about air flow.

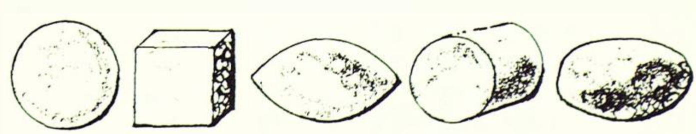
1 Make your experiment fair. Think about the height and width of the tin and the card.



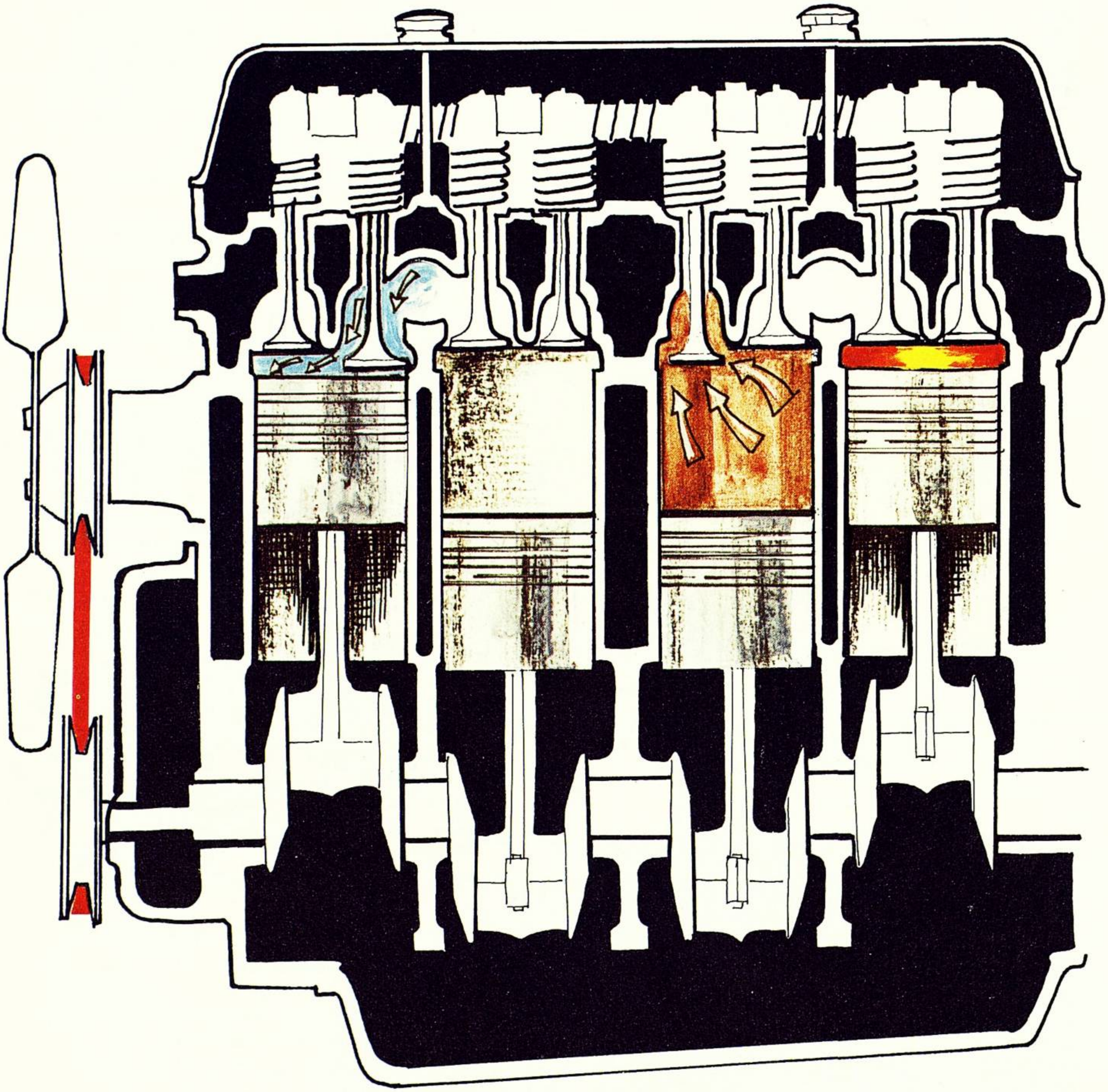


2 Try shooting shapes from a ball-firer. Use pieces of polystyrene.

Which one of these will move through the air most easily?
Which one will the air push back most?
Which one could travel fastest?
If they were car shapes, with the same engine, which would use the most petrol?



THE ENGINE



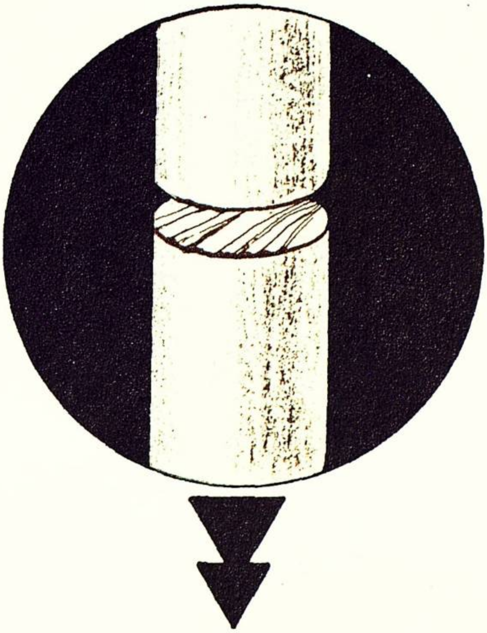
Some things for you to find out:
(Use books, films, people and catalogues.)
Why is this called an internal combustion engine?
In what order do things happen?
Put these in the right order:

(a)	spark	(e)	exhaust out
(b)	piston down	(f)	valves move
(c)	explosion	(g)	piston rises
(d)	petrol and air drawn in		

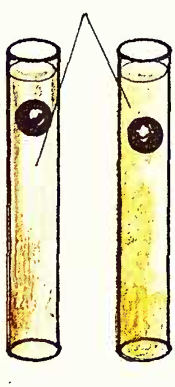
What is the fan for?
This car engine has four cylinders.
What other arrangements are there?

WEARING OUT~OIL

Brakes and braking need friction. (page 40)
Other parts of the car do *not* want friction.



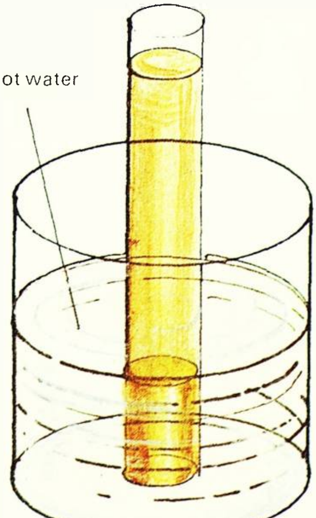
The moving parts of the engine need to slide over each other easily and not rub and grip.
The cogs and shafts that turn the wheels need to spin easily.
How can we make the friction less?



Here are two parts of a moving engine, seen under a powerful microscope.
To reduce friction (make it less) the car engineer:

1. makes the surfaces as smooth as possible (See page 40.)
2. uses something to fill in the roughness

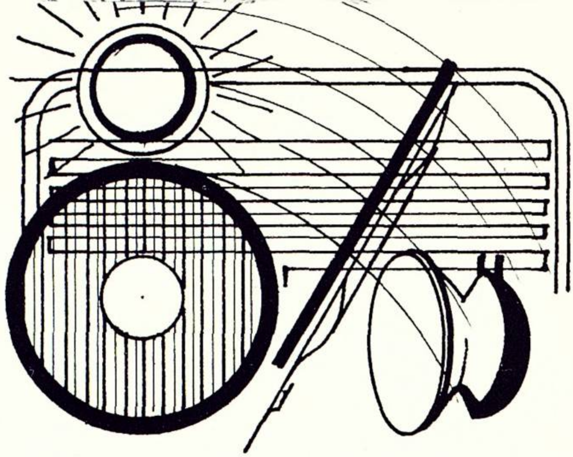
Oil is used to reduce friction.
Experiment with oils.
Some oils are thick.
Some oils are thin.
Some oils run easily.
Some oils are 'sticky'.

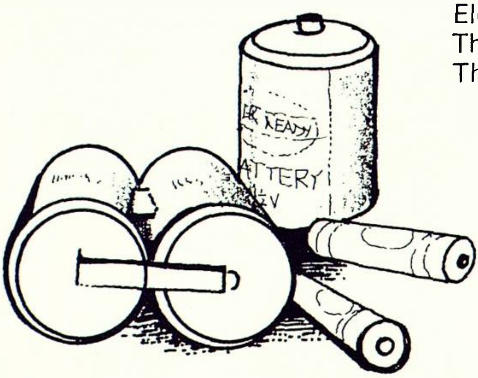


The engine oil needs to be thin.
It has to flow between the moving parts.
It must not flow to where it is not wanted.
It must stay where it is needed.
It must not be too 'runny'.
Compare the **viscosity** of different oils. This means how 'sticky' or 'runny' they are.
Time a small steel ball falling through the oil.
(You can get the ball back with a strong magnet.)
Find if temperature changes the viscosity.

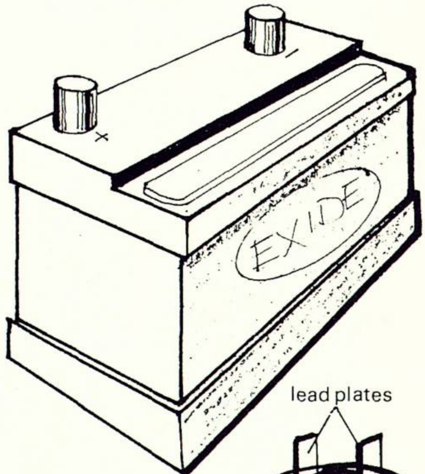
ELECTRICS

The invention of the motor car would have been impossible without the discovery of electricity.
The engine will not work without electricity.
Electricity makes the spark to fire the explosive mixture.
What other parts of the car need electricity to work?
Here are some clues.



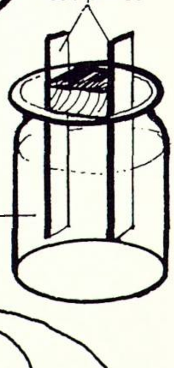


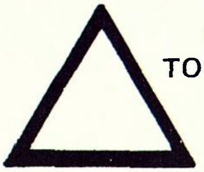
Electricity is stored in the battery.
These batteries make electrical energy from chemicals.
They cannot be recharged.



The car battery (accumulator) stores electrical energy.
This electrical energy is made by a dynamo.
(See *Houses and Homes* page 54.)
The dynamo is turned by the engine.

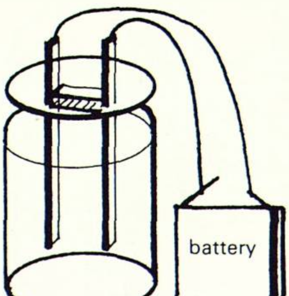
Try making a small accumulator.



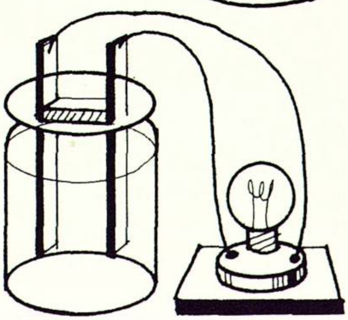


THIS NEEDS SULPHURIC ACID.
TO BE DONE WITH YOUR TEACHER.
ACID IS DANGEROUS
NO NAKED FLAME

Charge your accumulator from a $4\frac{1}{2}$ volt or 6 volt battery for one hour.
Disconnect the battery.
Connect the accumulator to a bulb.
How long does the bulb stay alight?
Try the charge for $\frac{1}{4}$ hour, $\frac{1}{2}$ hour, 2 hours.
Say how long you think the light will last.
Try two bulbs in series.
Try two bulbs in parallel. (See *Houses and Homes* page 49.)

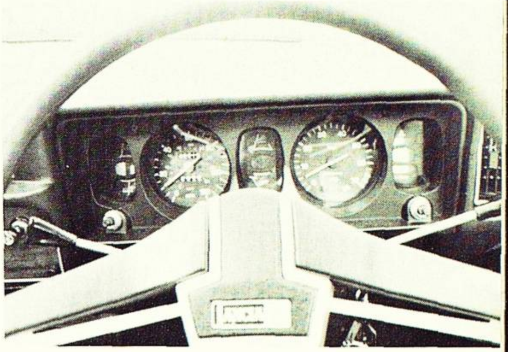


charge from a battery



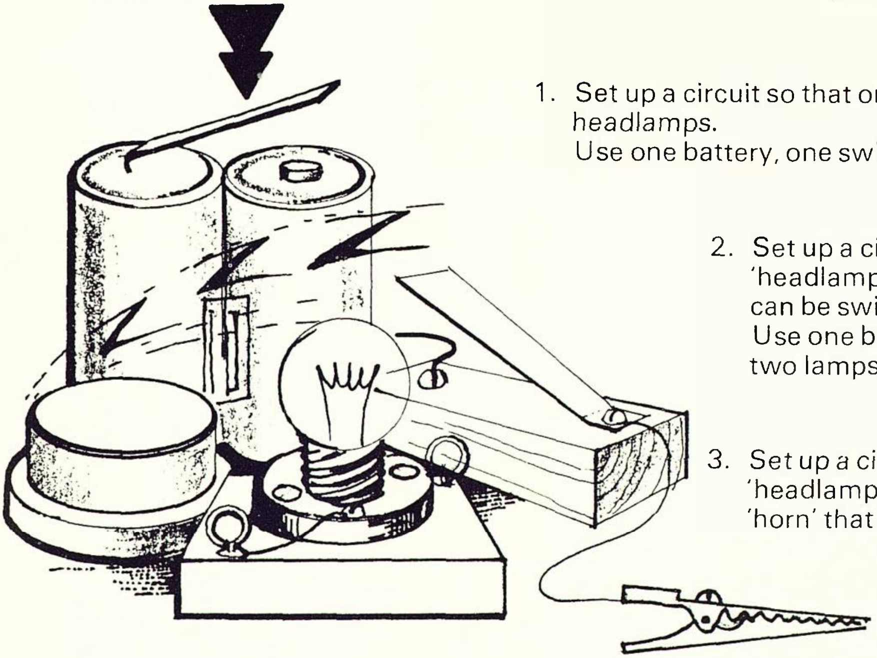
connect to a bulb?

ELECTRICS SWITCED ON



The electricity must be controlled.
Lights must be switched on and off.
The horn must work at a touch.
Indicators must flash on and off.
Spark plugs must spark each in turn.

Experiment with switches.
You need:

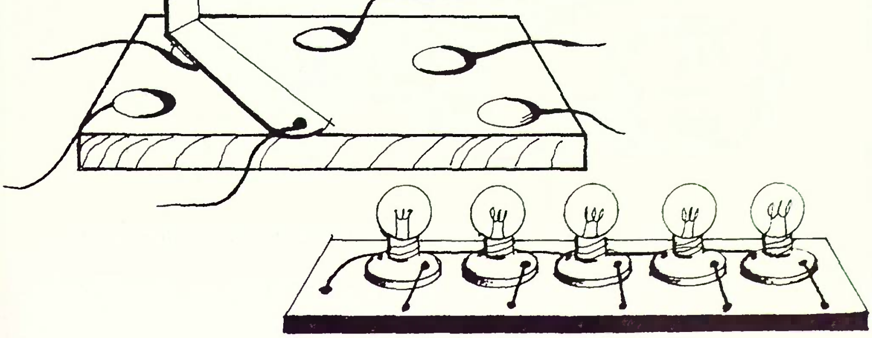


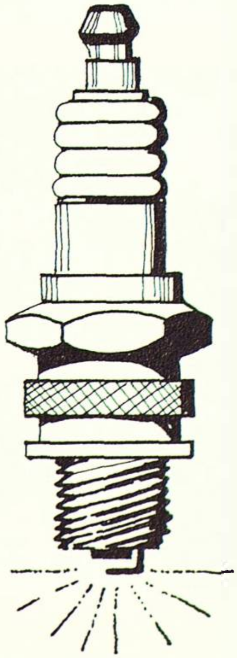
1. Set up a circuit so that one switch will put on two headlamps.
   Use one battery, one switch to light two lamps.

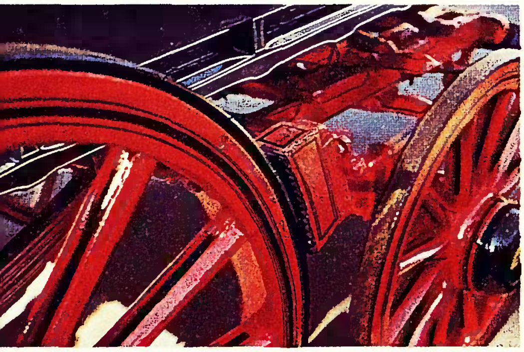
2. Set up a circuit with two 'headlamps' so that either or both can be switched on.
   Use one battery, two switches and two lamps

3. Set up a circuit with two 'headlamps' switched on, and a 'horn' that can be sounded at will.

The electrical energy has to be switched to each spark plug in turn.
This needs a special switch.
You could make this kind of switch and work it.
The way of connecting is left for you to work out.
You have to get each lamp to 'spark' in turn.

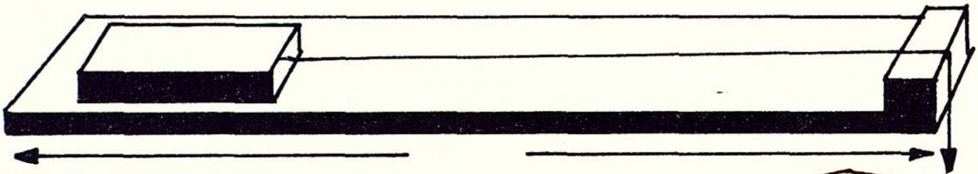






BRAKES AND BRAKING

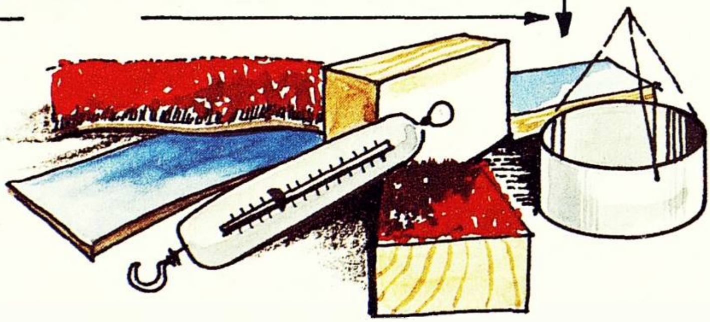
A safe car needs good brakes.
Here is a brake on an early wheel.
It works by a block rubbing on its rim.
The name for this rubbing is **FRICTION.**
Find out about friction.
What kinds of surface have most friction?
(It is a good idea to make more than one measurement.)



blocks 15cm x 17.5cm x 5cm faced with various materials —lino, carpet, rubber, metal, sandpaper, polished wood, rough wood

pull with force meter or use a tin to load

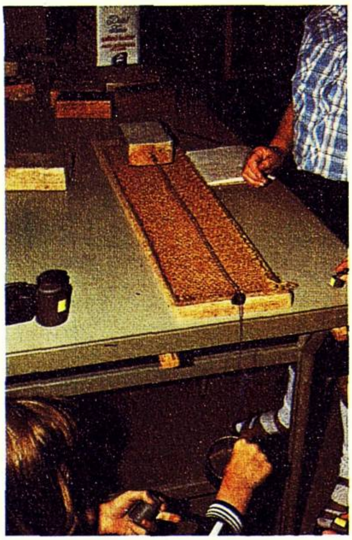
strips of material to place on board —carpet, hardboard, lino, rubber underlay, sandpaper

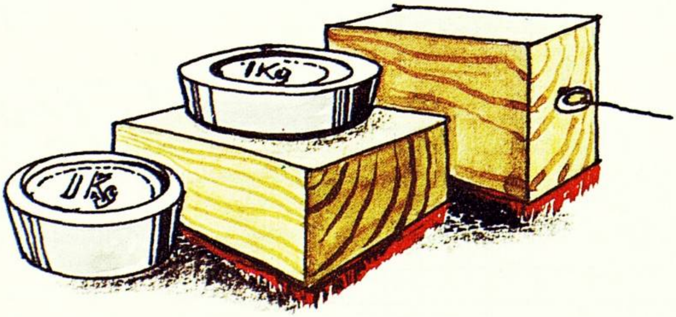


Record:

Block surface	'Road' surface	Force needed to move
		newtons

What happens if the load is heavier?
Does the area touching make any difference?
(Use one block – the surfaces must be the same.)





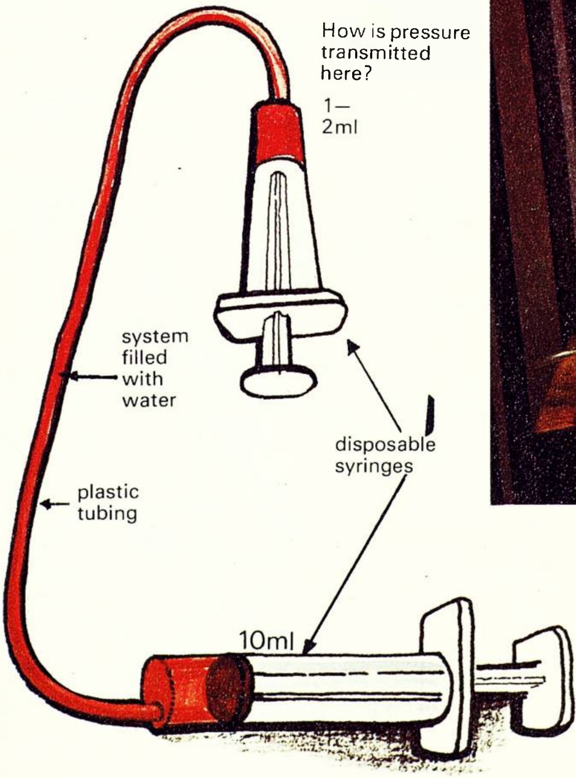
Wet some of the surfaces and measure any change in friction.
Think about what this means if a car is driven through water.

~BRAKES AND BRAKING

Early brakes used a lever to push the block on to the wheel.

A lever is used to pull a cable. This wire pulls the block on to the wheel.

The hand-brake of a car works like this.



The brakes of modern cars use **HYDRAULICS.**
Hydraulics mean that a liquid is used to push.
Try this for yourself.

The motor mechanic has to make sure there are no air bubbles. Why?
Try yours with an air bubble.

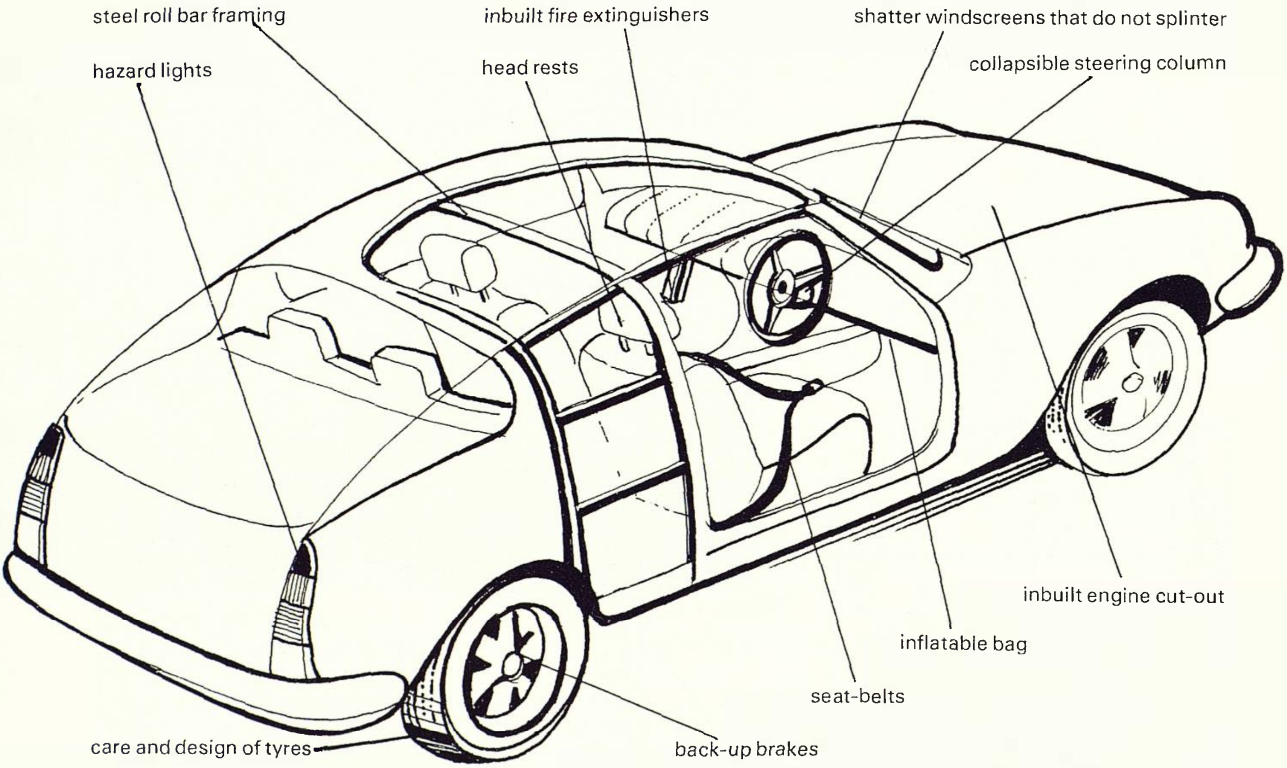
Can you use your model hydraulic idea to brake a wheel?

SAFETY FIRST

There are millions of road accidents every year.
In our world nearly two million people are killed or seriously injured every year.

Some people choose cars because they look good.
Some people buy cars because they go fast.
Some people choose cars because of the price.
Some people buy cars because they are a particular colour.

Do they choose the safest car?
Scientists and car-makers now think more about safety.
Here are some modern ideas to make a car more safe:



Experiment with some of these safety ideas.
(See also pages 44 and 45.)

The inflatable bag is a large plastic bag. It fills with air when the car is hit. This stops the driver crashing forward.
How well does it protect?
How full should the bag be?

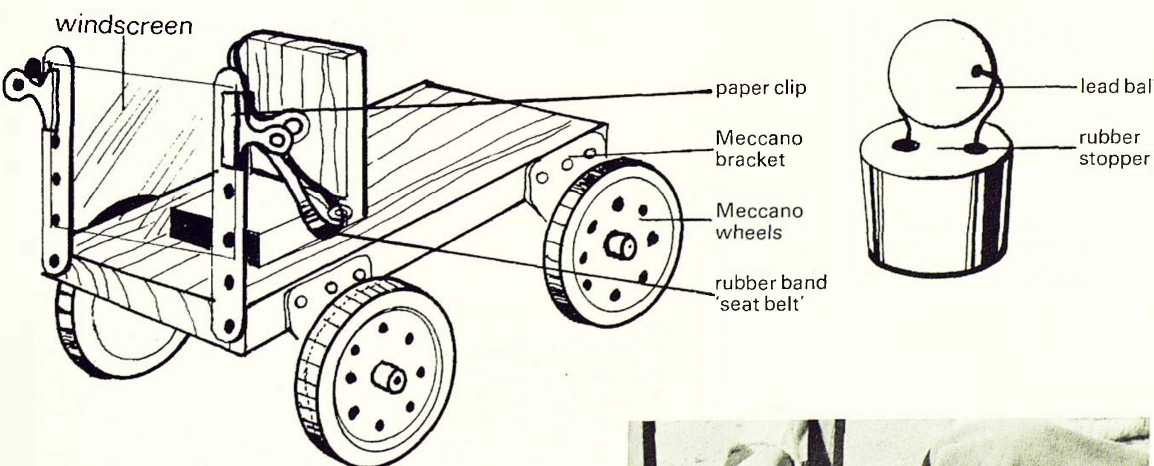
Drop a ball of plasticine.
Drop it on: (a) the hard floor
(b) a fully blown-up plastic bag
(c) a plastic bag nearly full of air

SAFETY FIRST–SEAT BELTS

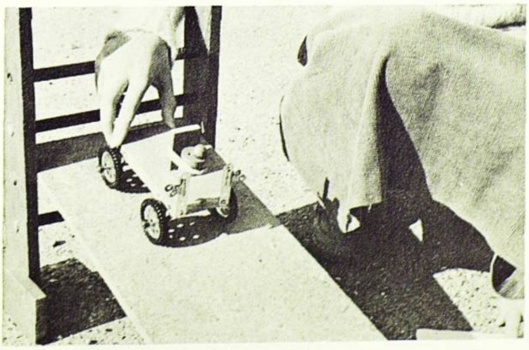
Drivers are urged to be safe.
One way is to wear seat-belts.
The great scientist Sir Isaac Newton (see page 11)
studied how things move.
He found out some important rules.
These are called Newton's 'Laws of Motion'.
The first law showed that anything moving will carry on moving unless a force stops it.

This means that if a car is stopped suddenly, things in it will go on moving. If there is a crash the driver will go on moving forward until he is stopped. This will be by smashing into the windscreen and steering-wheel.
This is why the driver should wear a *seat-belt*.
The belt will hold him back into his seat if he crashes.
This will protect him.
Here are some experiments to find out more about seat-belts.

Make a simple model car.
Make a model driver.

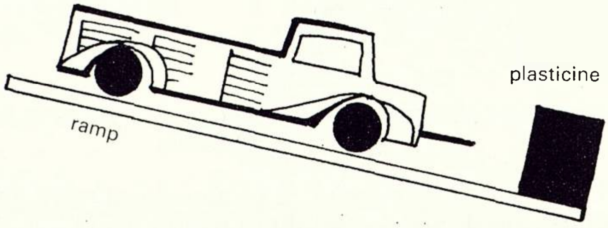


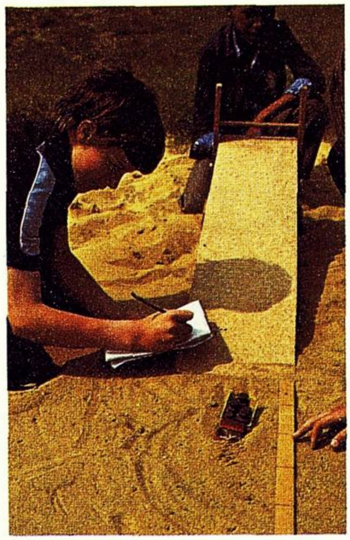
Sit the driver in the car with no seat-belt.
1. Run the car down 'the hill' into a crash. Observe what happens to the driver.
2. Repeat the experiment. This time use a seat-belt.
3. Try adding a head-rest to the seat.



THE RUNAWAY LORRY

This is a heavily loaded lorry whose brakes failed on a steep hill.
Use a model lorry to find out what happens.
You could try measuring the force of the runaway like this.

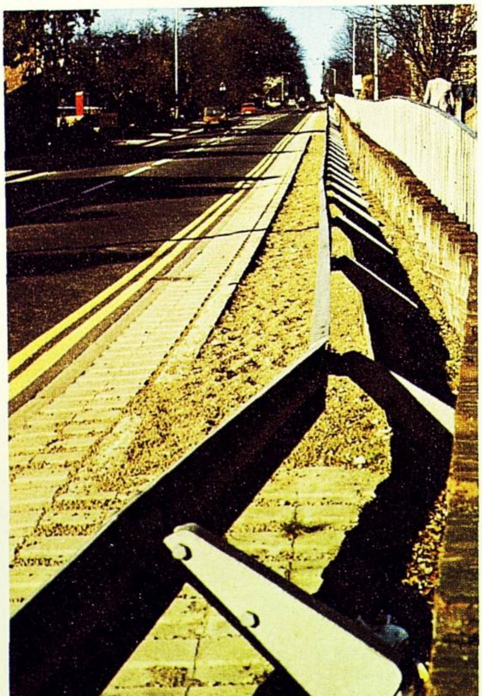




Another way is to measure how far an obstacle is pushed. (The obstacle could be a model car, side on.)
Find out:

(a) what difference the heaviness of the load makes
(b) what difference the slope of 'the hill' makes
(c) what difference the length of 'the hill' makes

Make a chart and draw a graph of your results.



Experiment to find out what happens if:
(a) only the front brakes fail
(b) only the back brakes fail
(c) if all wheels are braked
(use plasticine to jam the wheels.)

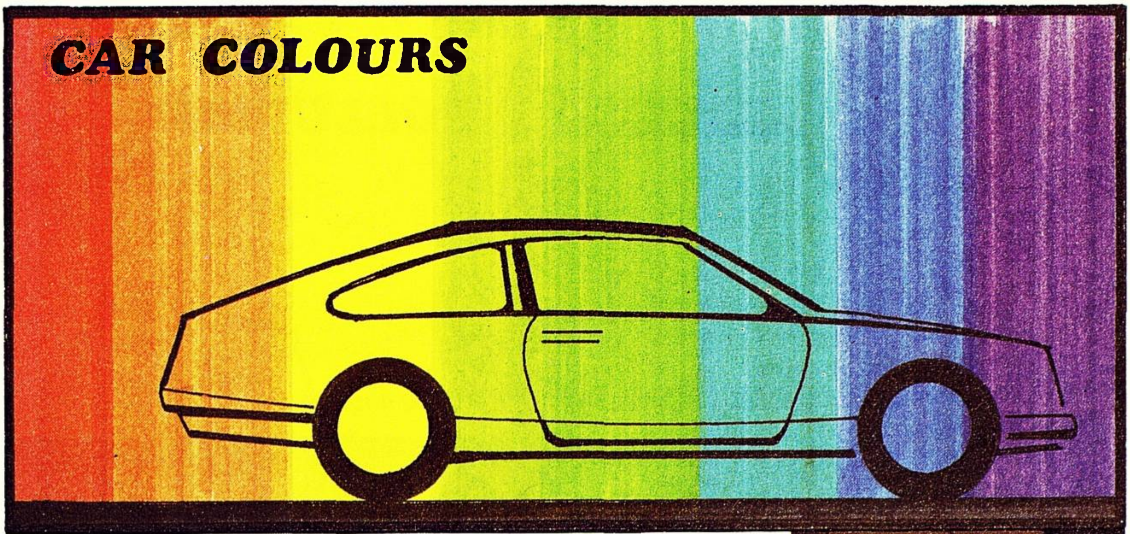
One way to slow down runaways is this soft track.

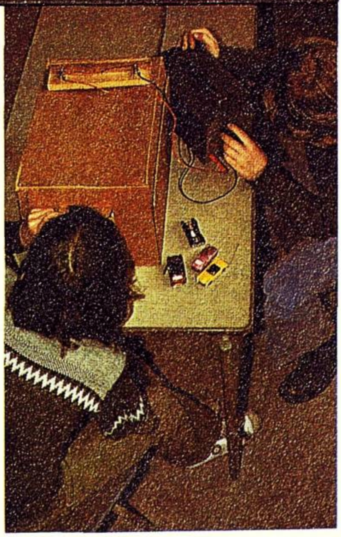
Try running your model into deep sand.
How well does this sand stop the lorry?

Try again altering

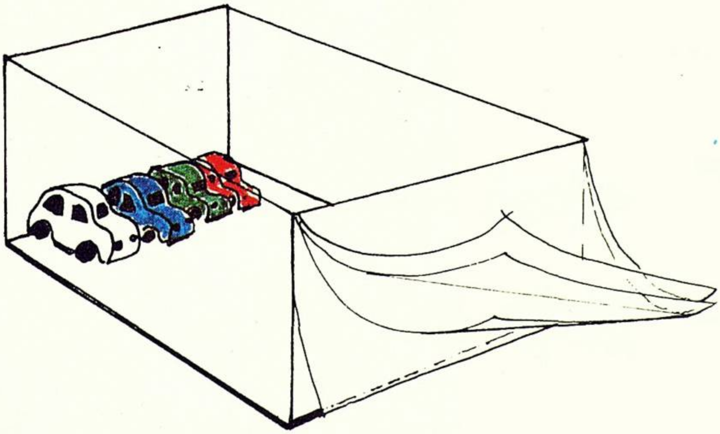
(a) the load
(b) the slope of 'the hill'
(c) the length of 'the hill'

CAR COLOURS





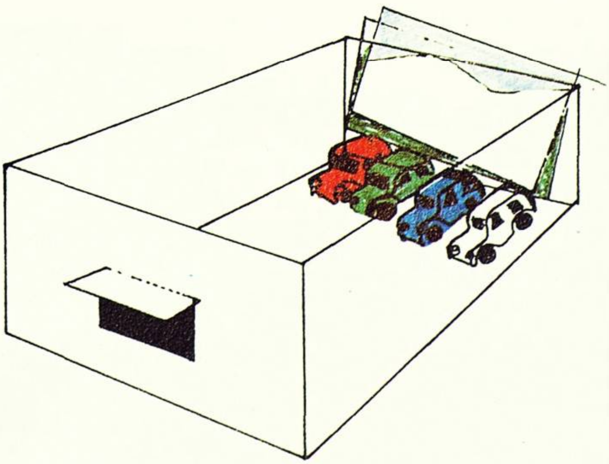
Perhaps some car colours are safer than others.
Here are some children trying to find out.
One group used a torch bulb.
This group used sheets of plastic.
They are trying to find the colour that shows up best.
They changed the background.

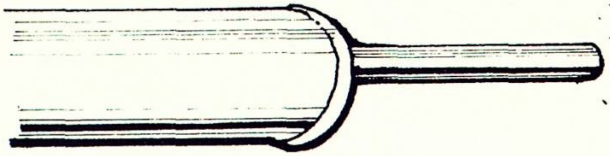


Find which colour is seen best against:

(a) hedgerows and trees
(b) snow
(c) in towns
(d) the black of night

Which colour would you choose as the best for most places?





POLLUTION

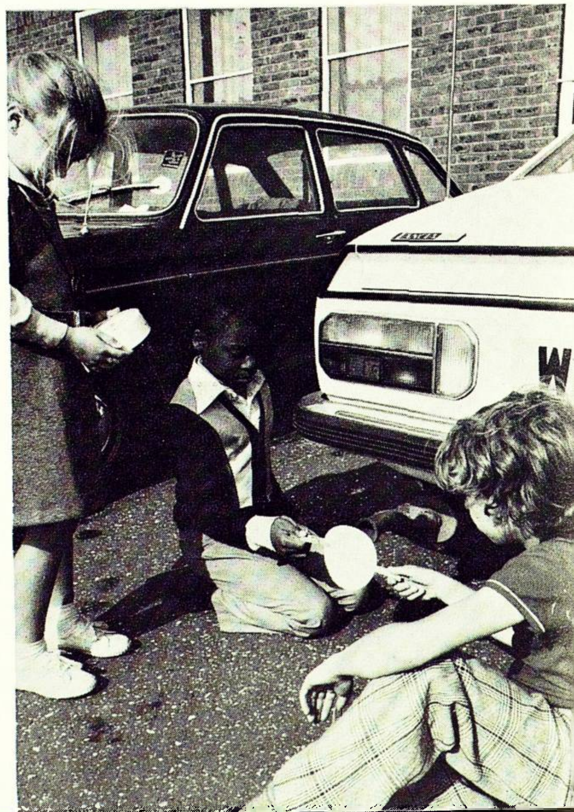
The motor car brings problems.
The car exhaust gives out the waste gases and dirt from the engine.
These gases and dirt can be harmful.
When this happens we say there is **pollution**.
See this for yourself.

1. Ask your teacher to help.
   Arrange for a car-owner to start and run the car engine for a short while.
   Hold a filter paper near the exhaust pipe for one minute.
   (Stand clear to one side.)
   Try different makes and ages of cars and compare.

2. Put out trays, lined with clean white blotting paper.
   Put these in different places:
   (a) near a main road
   (b) well away from any road

   (Make your test fair.)

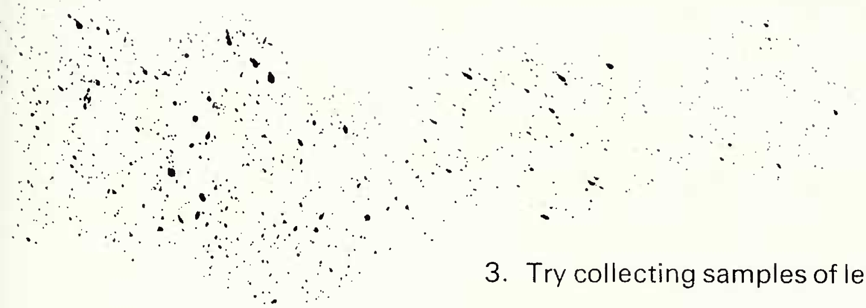
   Think about a good place.
   Think about the time left.



TESTING CAR EXHAUST

MEASURIN
NOI
LEV

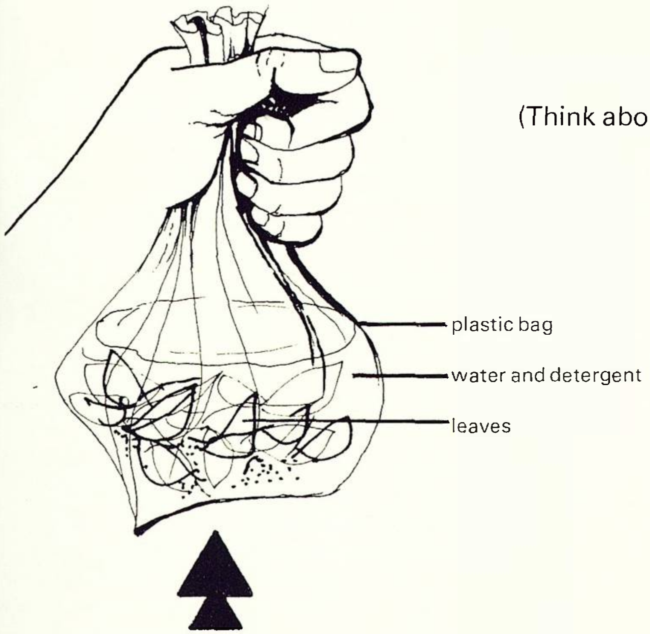
TESTING
FOR
DIRT BY A
ROADSIDE

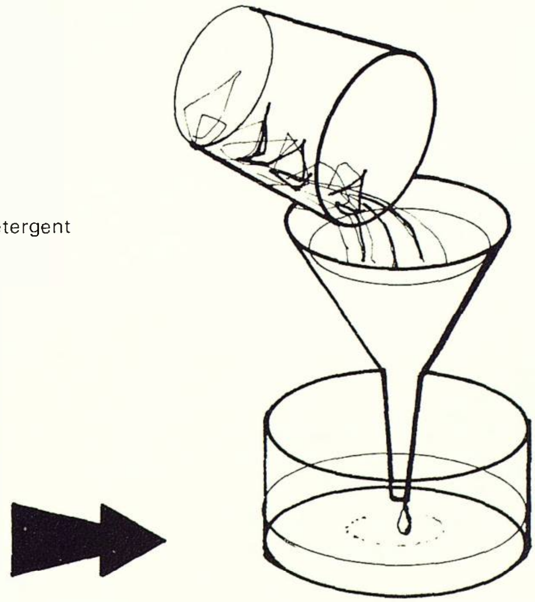


3. Try collecting samples of leaves from different places:

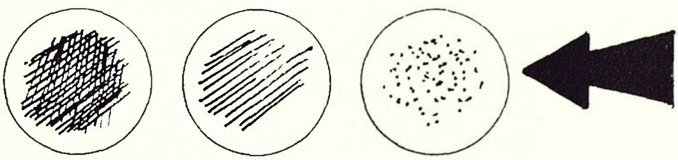
(a) trees alongside a busy road
(b) trees bordering a quiet road
(c) trees well away from any road

(Think about the sample you will collect for a fair test.)





Wash the leaves.
Filter the water and so collect any dirt on the filter paper.



Compare the results.

Another kind of pollution is noise.

These children are carrying out a traffic survey.
They are also measuring the noise with a noise meter.
They found:
(a) which kind of road transport made the most noise
(b) where the noisiest part of the town was
(c) when the noisiest time of day was
(They also found the noisiest class in school!)

FAST MODELS

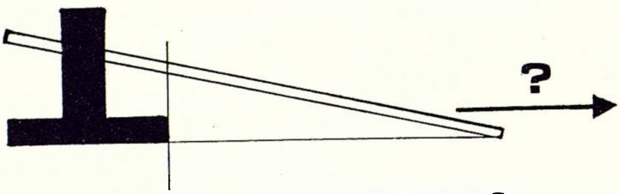
Many of you enjoy collecting and playing with toy cars.
Here is a collection.
Perhaps some of you could bring your toy cars to school.
How many kinds are there?
What makes them go?
To what scale are they made?
How accurate are the details?
What are they made of?
Put the cars into the following sets:

- metal cars
- plastic cars
- saloon cars
- racing cars
- toys
- scale models
- electric cars
- clockwork cars
- special cars
- cars you push
- veteran cars
- flywheel cars

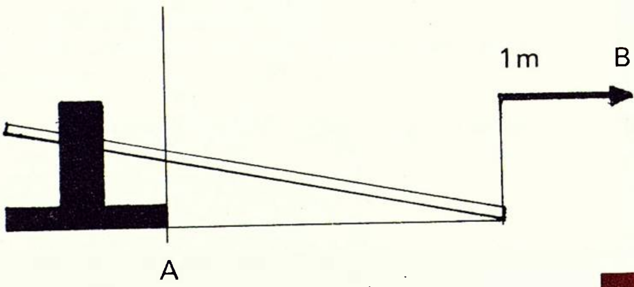
Which car is in the most sets?
Which is the fastest?
Which runs the furthest?

Do some trials.

1. Measure the distance travelled from the ramp.



2. Use a stop watch to time from A to B.



Choose one car.
Find:
1 what difference altering the slope makes
2 if oiling the axles helps
3 if an extra load makes a difference

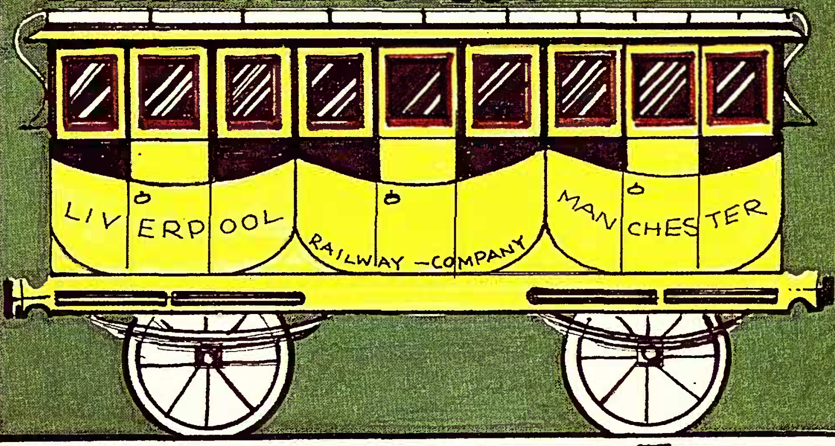
It is claimed that this model goes faster and further.

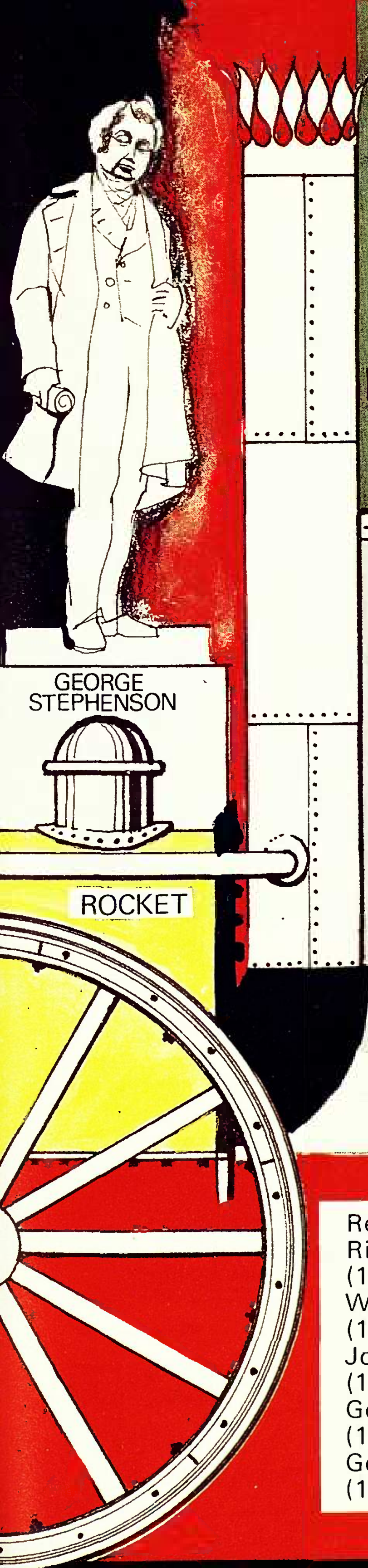
Try it.

Why is this?

Look at the axle bearings.
Try rubbing the axle bearing with a soft pencil 'lead.'

RAILWAYS SECTION SIX

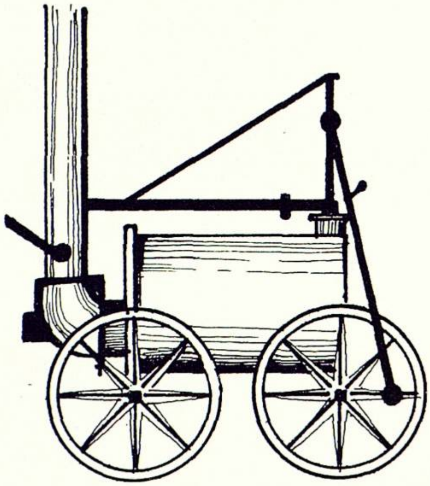




In the eighteenth century both Thomas Newcomen and James Watt had made a steam engine.
Could their engines move and pull loads?
The steam engine was put on rails. To begin with it was thought the wheels would not grip the rails.
A first idea was a rack railway. Then experiments showed that the smooth wheels *would* grip. Rails broke under the heavy loads so stronger rails were invented. More and more railways were built. There were problems. New ideas and inventions solved them.

Read about:
Richard Trevithick (1771–1833)
William Hedley (1779–1843)
John Blenkinsop (1783–1831)
George Stephenson (1781–1848)
George Hudson (1800–1871)

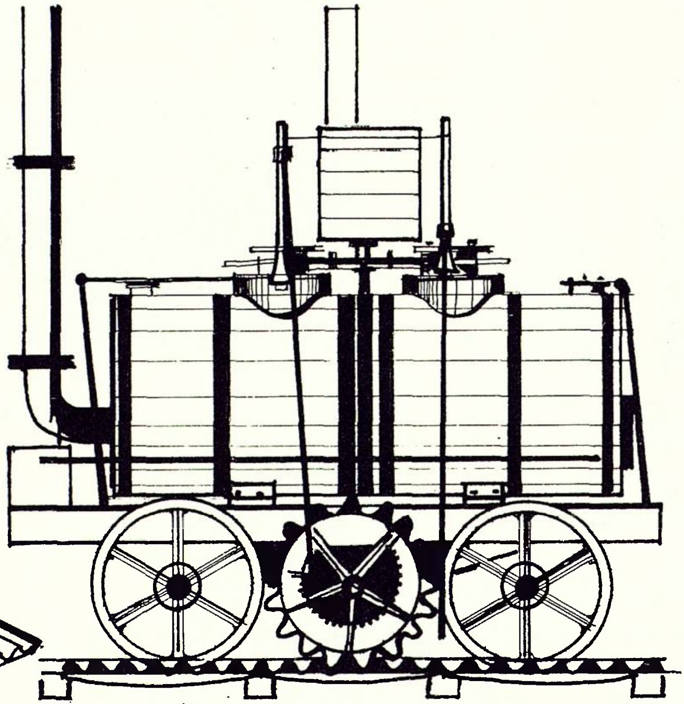
THE STORY OF RAILWAYS



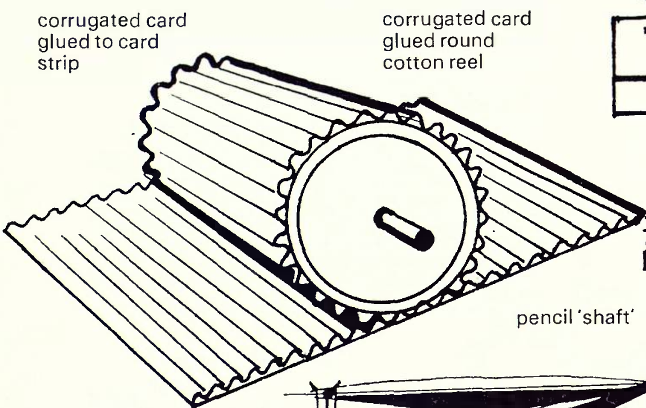
Richard Trevithick built the world's first railway locomotive.

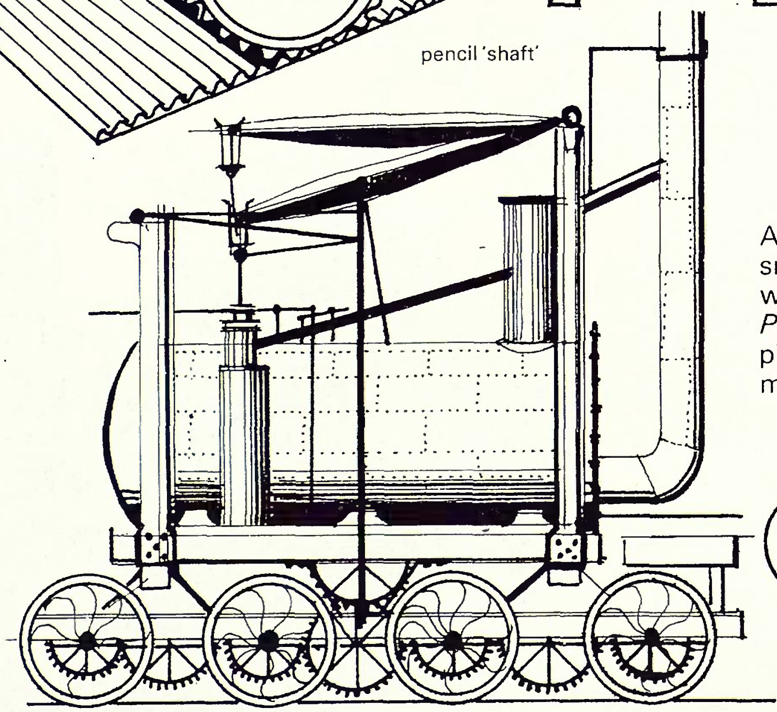
Trevithick's *Catch-me-who-Can*. 1803.

In 1812 John Blenkinsop invented the rack locomotive.

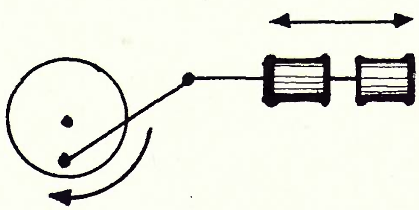


Make a model of a 'rack'.





After experiments to prove smooth wheels on smooth rails would grip, William Hedley built *Puffing Billy*. Make a model piston. This shows how to and fro movement can turn a wheel.



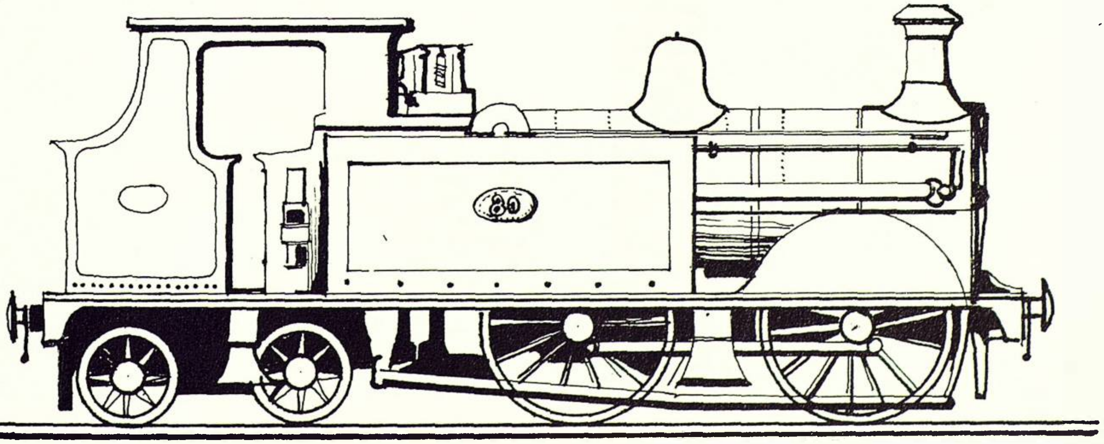
1829

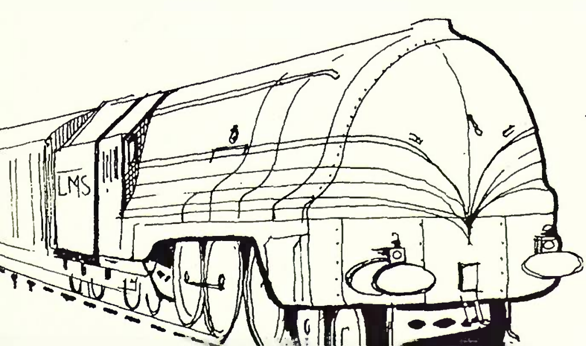
THE RAINHILL LOCOMOTIVE COMPETITION

In 1829 The Liverpool and Manchester Railway held a trial.
It was to be a fair test to find the best locomotive.
George Stephenson's *Rocket* was the only one that obeyed all the rules.
Some of the trial rules were:

1. It had to run on rails 4′ 8½″ apart.
2. It had to pull a load of twenty tons.
3. It had to travel at least 10 m.p.h.
4. It had to cost less than £550.
5. It had to weigh less than 6 tons.

What are these old measurements in metric units?
When you do tests and trials remember rules that will make the test fair.





The *Rocket* could travel about as fast as a race-horse.
By 1883 Robert Stephenson, the son of the *Rocket* builder, was building engines like this.
They could pull bigger loads twice as fast.

In 1937 the *Coronation Scot* reached the speed of 114 m.p.h.
This was one of the last of the great steam trains.

THE STEAM ENGINE

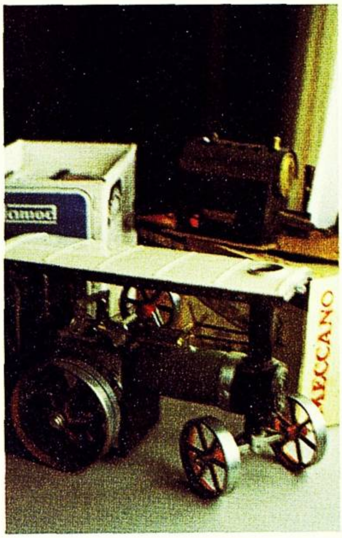
Early steam engines were used to pump water from mines. Thomas Newcomen invented this engine.
Find out how James Watt improved this early engine.

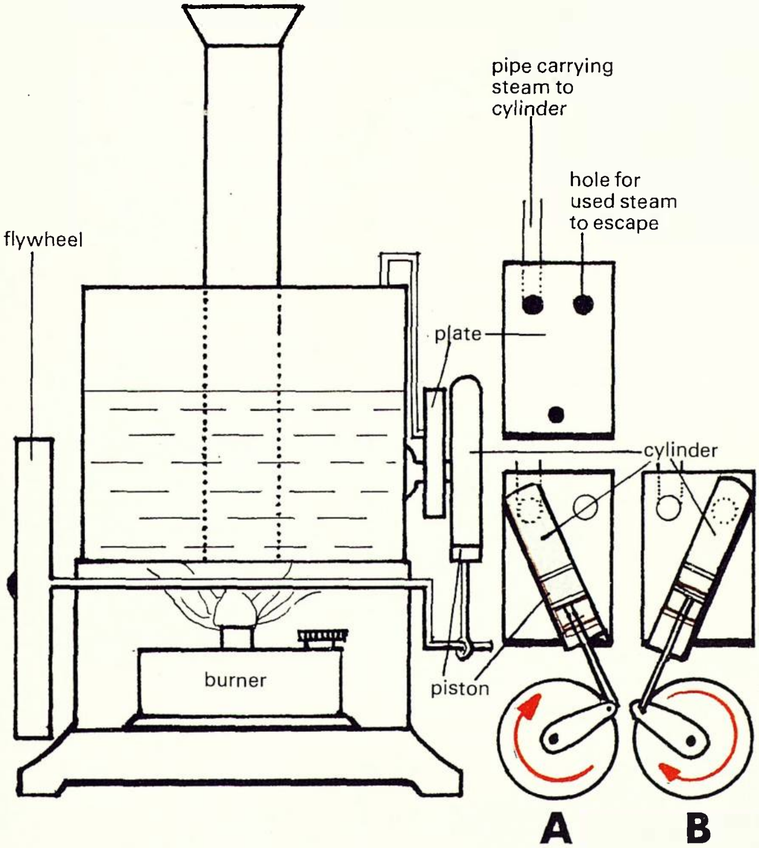
Energy from burning fuel makes water into steam.
Steam takes up a lot more room
(over one thousand times more).
It pushes to get out of the boiler.
This pushes the piston.
The moving piston does the work.
(There is a steam model to make in *Ships* page 47)

THE STEAM ENGINE

Your school may have a model steam engine.
If not, someone will be able to bring one to school.

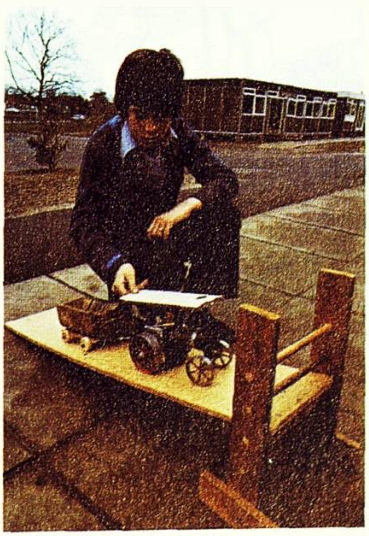
Here is how a model steam engine works.





Steam is made in the boiler.
A pipe takes it to the plate.
The plate has two holes.
There is a hole in the piston cylinder.
When in position A, steam goes into the cylinder.
The piston is pushed down.
In position B the piston has moved up.
The steam escapes.
This goes on and on as the flywheel turns.

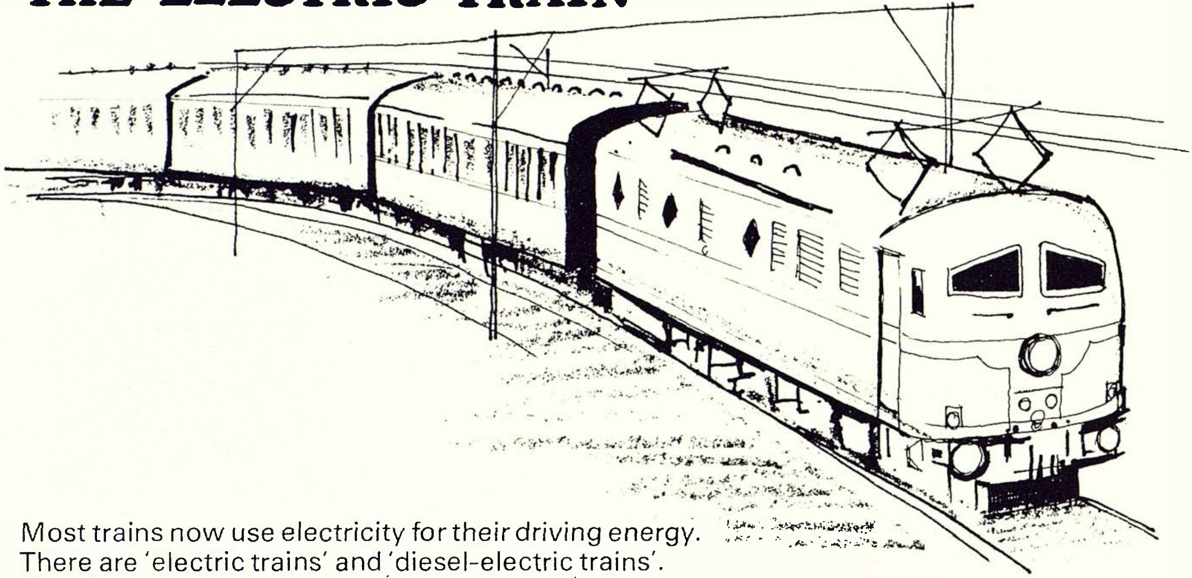
Use your model engine for experiments.
Here is a group using their model engine.
They are measuring the work the steam engine can do.
They are going to compare it with an electric motor (page 56).



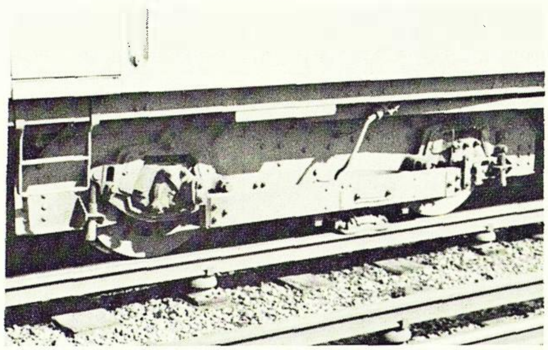
You could also use your model engine to:

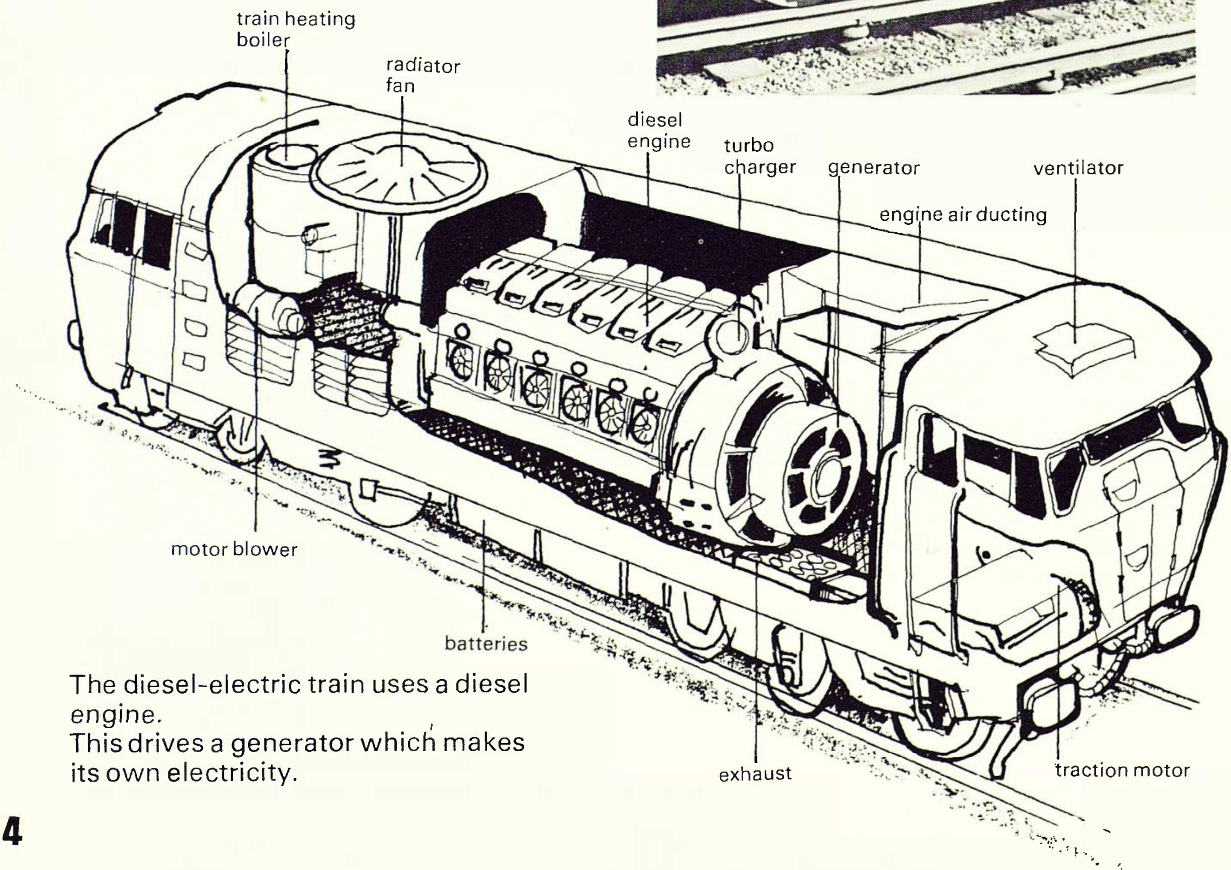
1 drive a dynamo – to light bulbs
2 pull a trolley up different slopes
3 move itself

THE ELECTRIC TRAIN



Most trains now use electricity for their driving energy.
There are 'electric trains' and 'diesel-electric trains'.
The electric trains pick up electricity.
This drives an electric motor.
This motor turns the wheels.
The electricity can be picked up from overhead wires.
It can be picked up from a 'live' rail below.
KEEP WELL AWAY. THESE RAILS AND WIRES CAN KILL.

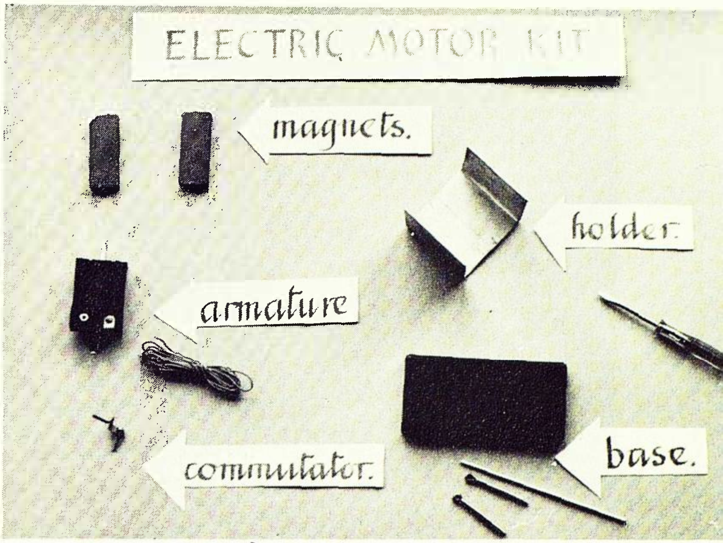




The diesel-electric train uses a diesel engine.
This drives a generator which makes its own electricity.

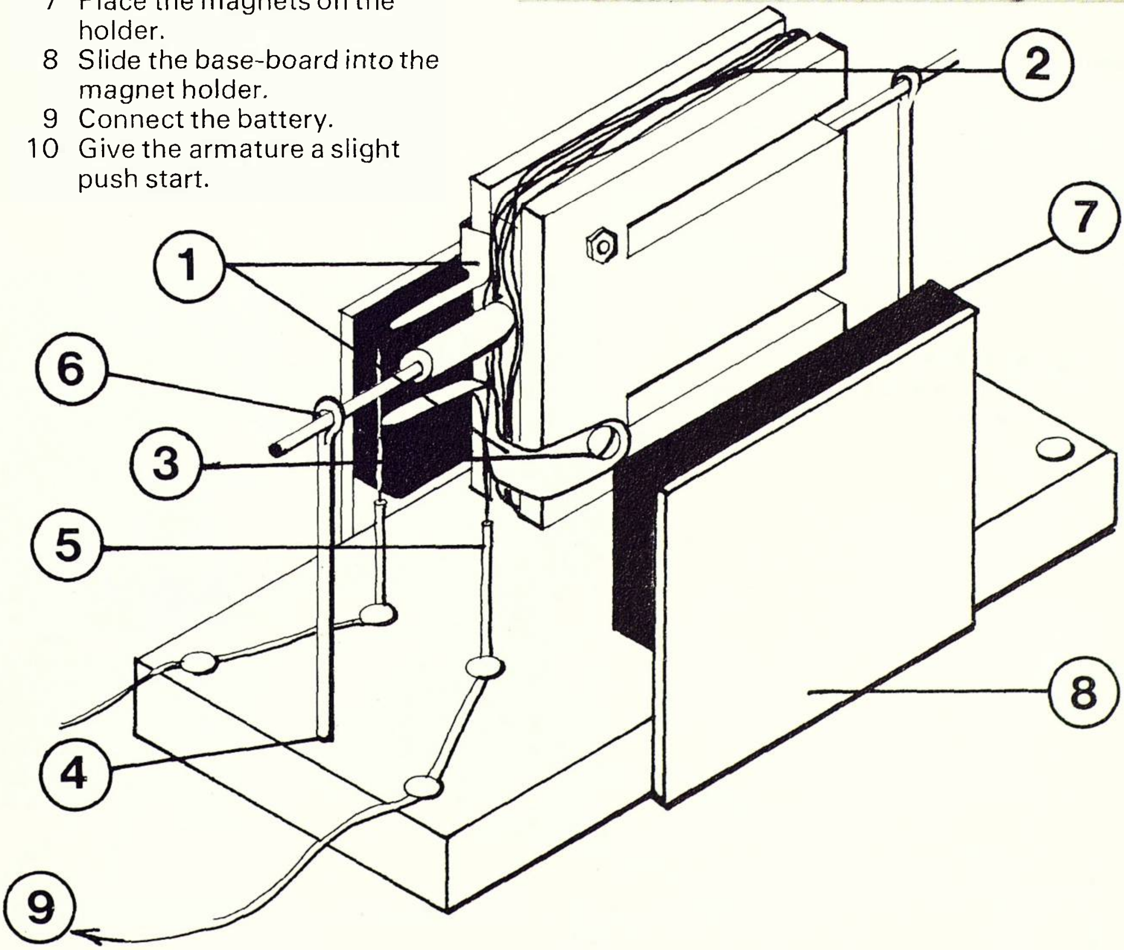
ELECTRIC MOTORS

Make an electric motor.
A good way to start is to use a kit.
Here is such a kit.



Instructions:

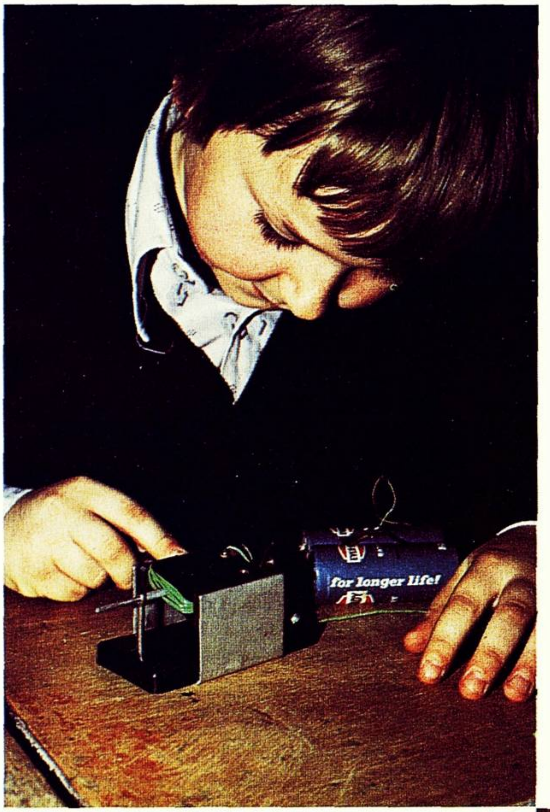
1 Screw these in place.
2 Wind ten turns of wire around the armature block.
3 Bare the ends and fix to the commutator screws.
4 Build the base-board like this.
5 Bend the upright wire like this to make a good contact.
6 Fix the armature block in position like this.
7 Place the magnets on the holder.
8 Slide the base-board into the magnet holder.
9 Connect the battery.
10 Give the armature a slight push start.



Trouble shooting:

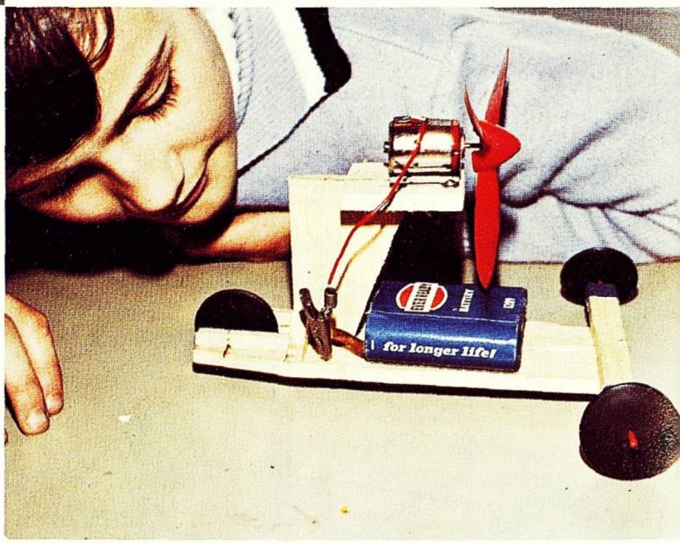
Are the magnets the 'right way' round?
Is there a good contact to the commutator parts?
Check the connections.
Is the battery dud?

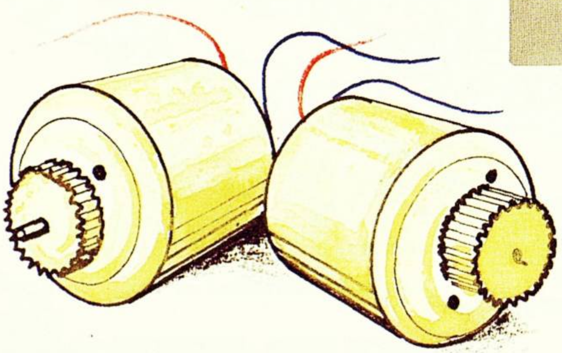
ELECTRIC MOTORS

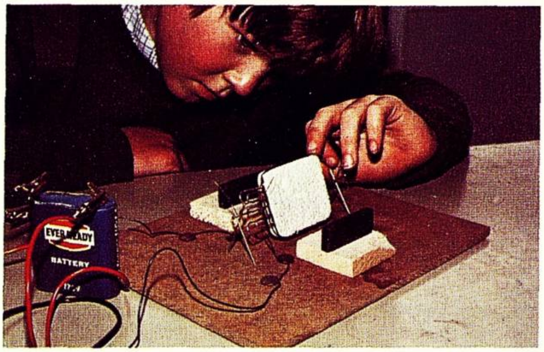


Use your model electric motor to find out:
- what happens if the leads to the battery are reversed
- what happens if the magnets are changed round
- what happens if the number of turns of wire are changed
- what happens if the voltage of the battery is changed

Toy electric motors are quite cheap.
Get some of these small motors.
What can you make electric motors do?
- Lift a load?
- Pull a load?
- Propel a car?
- Drive a train?
- Make a hovercraft?





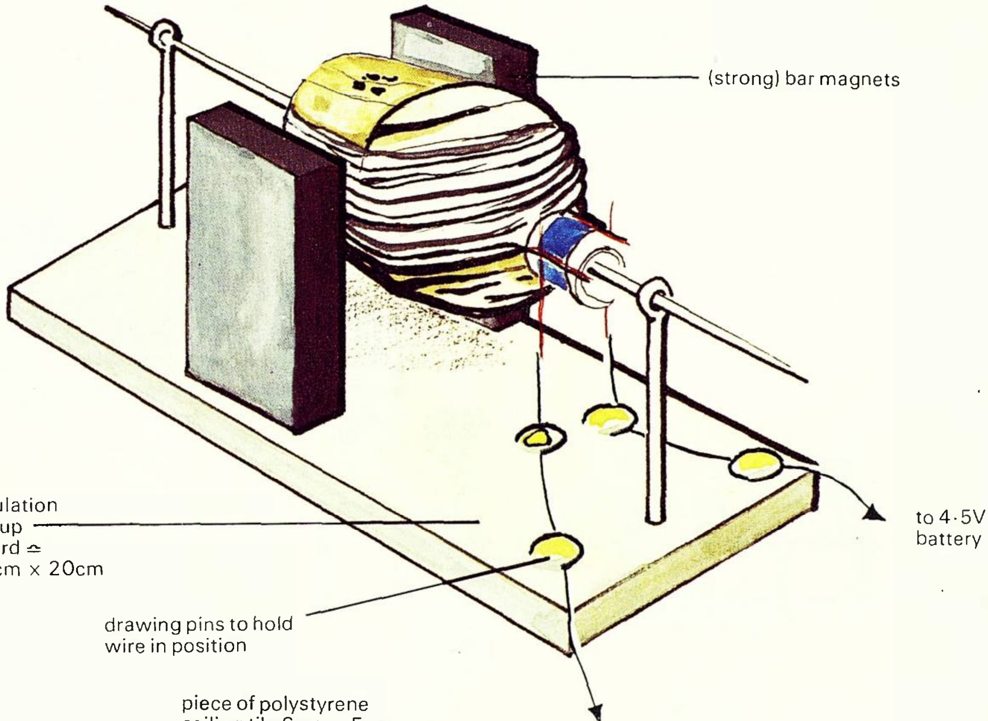


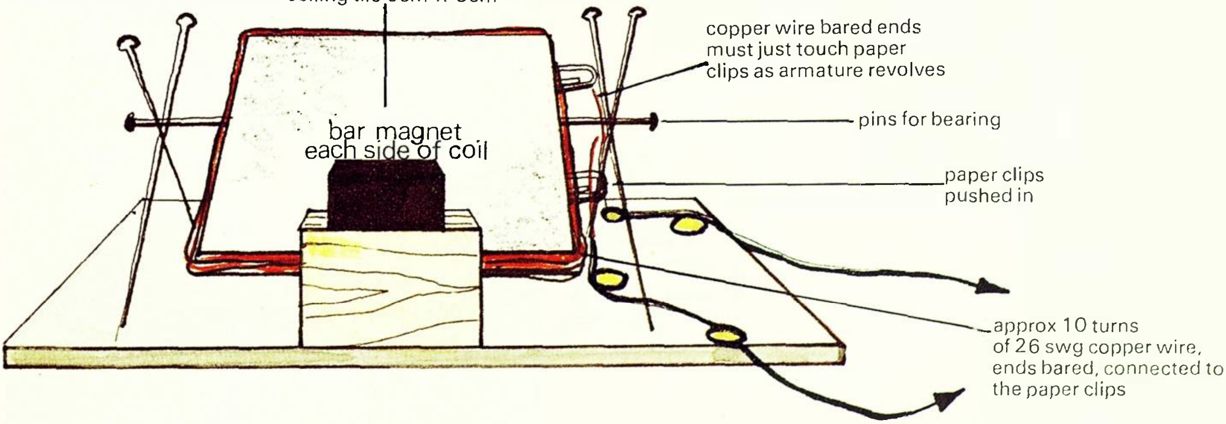
ELECTRIC MOTORS

Electric motors can also be made from odds and ends.

You might find these more difficult than using the kit.

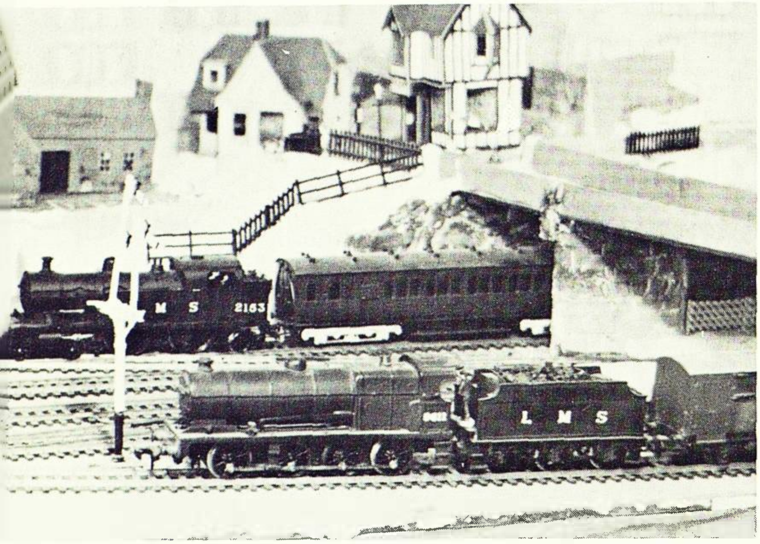
Here are two:





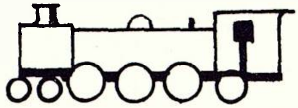
The electric motor uses electro-magnetism.
The magnetic forces push and pull.
These pushes and pulls are used to turn the motor.
There is more about magnets and electro-magnets on pages 44, 45, 46 and 47 in *Communication* and page 24 *Ships*.

MODEL TRAINS

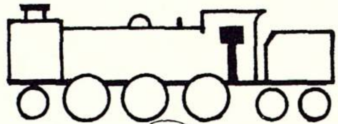


A model train set would be useful for study at school.

This is called a 4 6 2

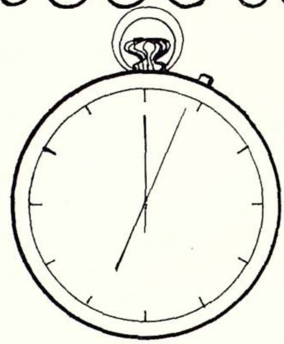


This is a 2 6 4



What wheel arrangements have your model engines?
Time one circuit of an engine on a track.
Compare:

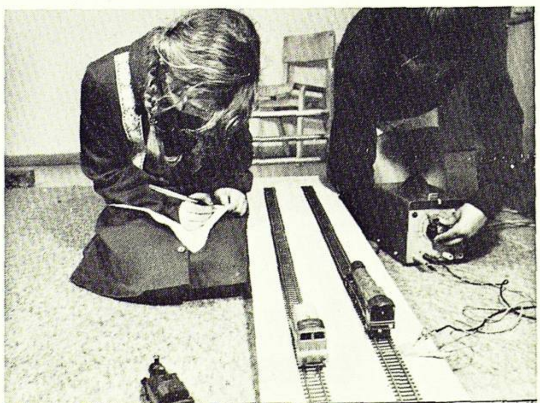
(a) different engines
(b) different control settings
(c) different loads pulled



Fix some track to a board.
Make the board slope.
Make the engine climb the slope.
Increase the slope gradually.
What is the steepest slope the engine can climb?
Do the wheels slip?

Here is a picture of a locomotive showing the small pipe that blows sand on to the rail.

Does sanding help your model?



SLEDGES, SKATES AND SKIS

In what countries would sledges, skates and skis be used?

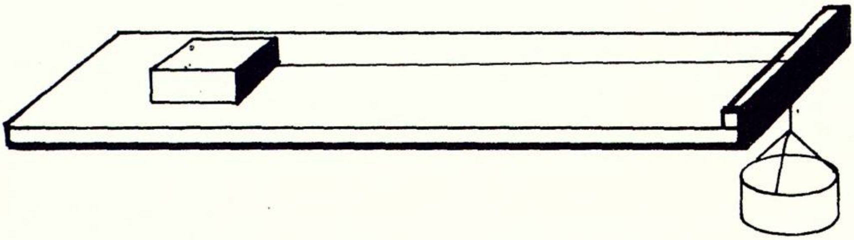
Polar explorers have used these ways of travelling.
Read about the journeys of:

- Roald Amundsen
- Robert Falcon Scott
- Sir Vivian Fuchs

SECTION SEVEN

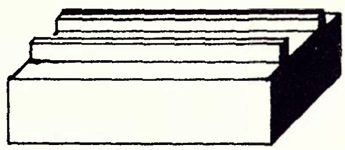
DRAGGING THE LOAD

On pages 18 and 19 there are experiments with different ways of moving loads.
One way is to use a sledge, with and without runners.
The early inventor of a sledge thought that if less of the body touched the ground it would be easier to move.
Is this true?
Does the area touching the ground change the force needed to move the sledge?

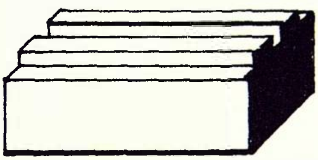


Use a tray or wood block for your sledge.
Use strips of hardboard, balsa wood or plastic as runners.
The control block will need to be completely covered with the material you use.

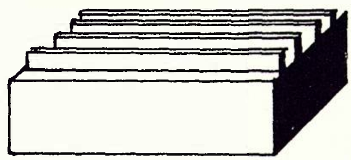
control block



2 thin strips



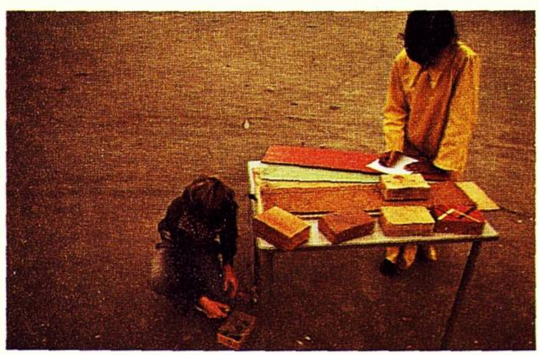
2 fat strips



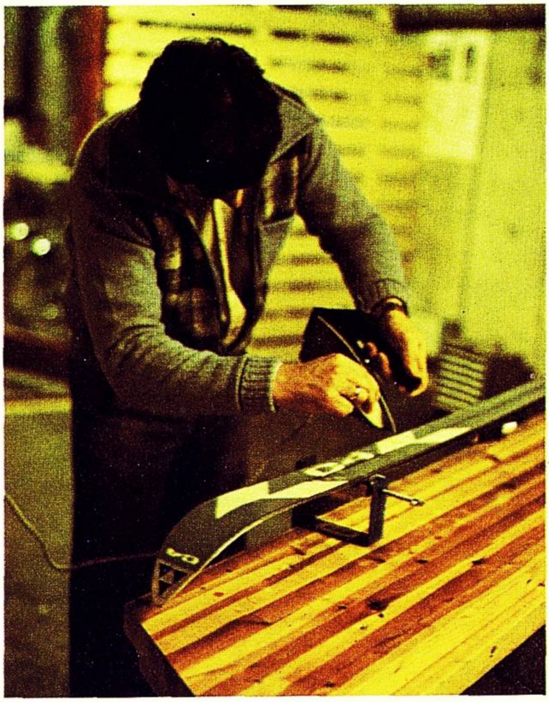
4 thin strips

Here is a group testing their sledges.
Record your observations.

Sledge	Moving force
	newtons



Do your experiments agree with the ideas of the early inventor?



SKIS AND SKIERS

Skiers wax their skis.
They say this helps them go faster.

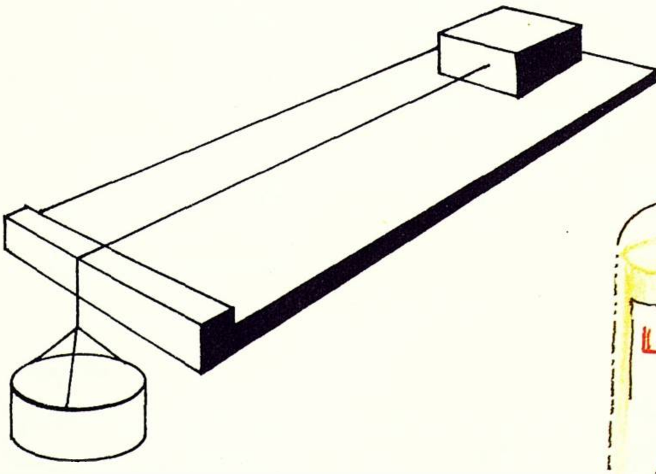
On page 40 you learned about **friction.**

The skiers are saying that waxing helps to make friction less.

Experiment to find how waxing and polishing help sliding and slipping.
Measure the force needed to move the control block.
Now try different polishing ideas:

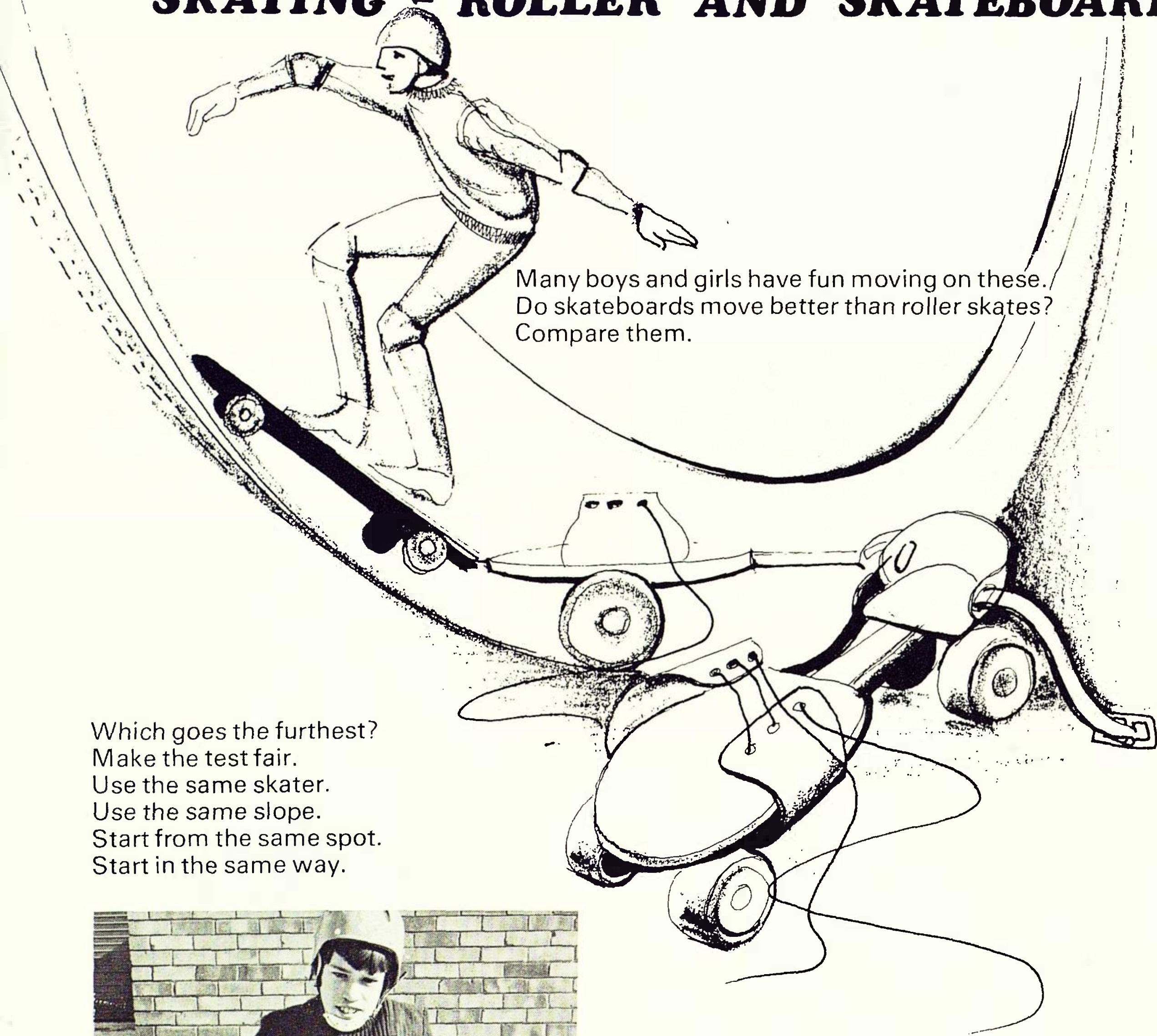
(a) wax furniture polish
(b) spray-on polish
(c) beeswax
(d) candle wax
(e) silicone furniture polish
(f) oil

Record your observations and results.



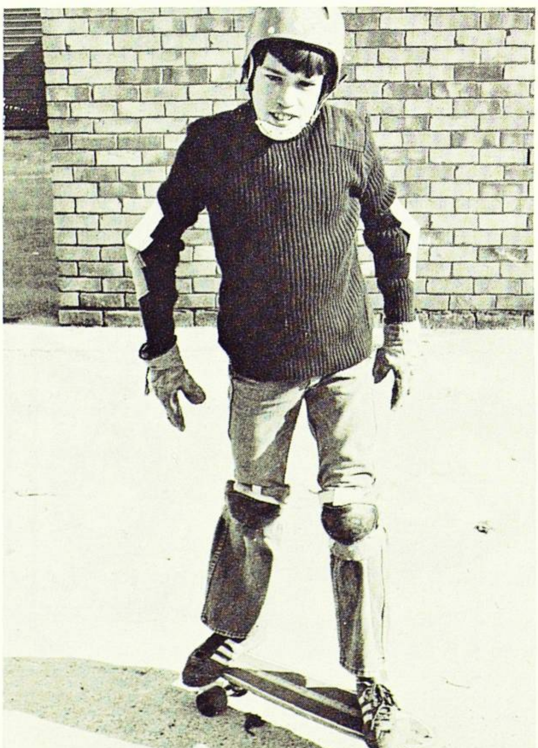
Expert skiers have different waxes.
Why do they change the type of wax they use?

SKATING – ROLLER AND SKATEBOARD



Many boys and girls have fun moving on these.
Do skateboards move better than roller skates?
Compare them.

Which goes the furthest?
Make the test fair.
Use the same skater.
Use the same slope.
Start from the same spot.
Start in the same way.

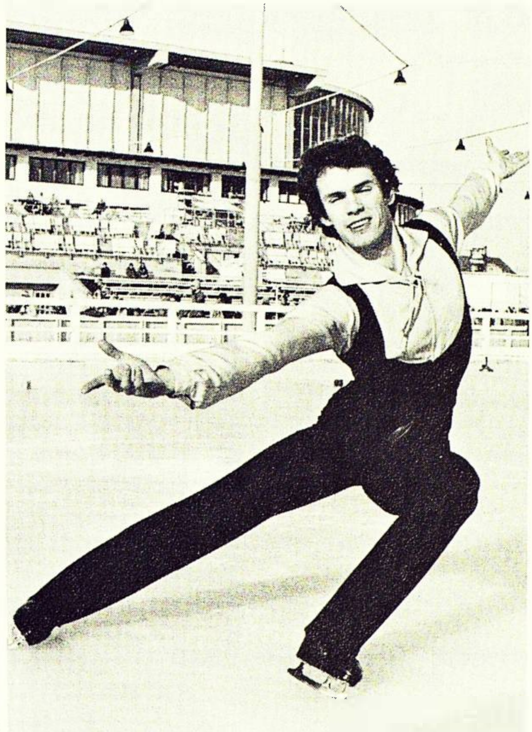


Now compare skateboards.
Experiment by placing yourself on different parts of the board.
Try:

in the middle
on the front
on the back

Racing cyclists and motor-cyclists always wear a crash helmet and protective clothing. There is the risk of falling at speed and breaking bones. Be sure that when you skateboard your arms, legs and head are well protected.

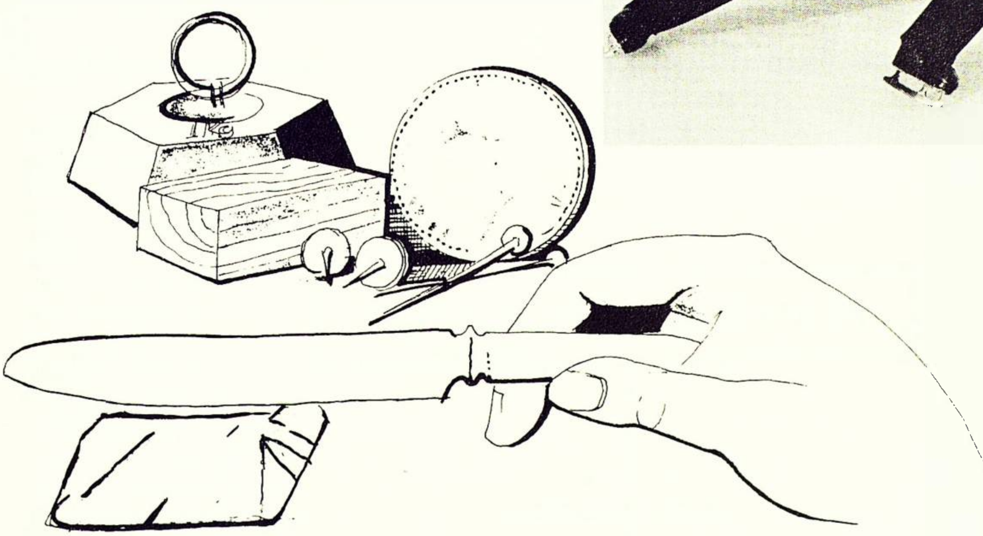
SKATING – ICE



Colorsport

What happens as the skater glides over the ice?
Experiment with some ice cubes.
Try putting different things on ice.
Try pressing different things on ice.
Try rubbing things on ice.

Which make a dent?
Which go into the ice?
Which have no effect?



Record:

What you used	What happened when put on	What happened when pressed	What happened when rubbed

An Integrated Study of Moving on Land

MOVING ON LAND

ART & CRAFT

Model Making
(static, moving)
Friezes
(historical, today)
Wheels Theme
Speed-and-Movement
Pictures
Rail Layouts
Collage – The Railway Age
Drawing – Cars and Bicycles

ENGLISH

Journeys in Poetry:
Night Mail (Auden)
Skimbleshanks (Eliot)
The Train (Anderson)
John Gilpin (Cowper)
How They Brought the Good News (Browning)
Travel Themes in Prose:
Tschiffely's Ride
Chitty Chitty Bang Bang
Three men on the Bummel
Word Study: 'Transport Words':
When and How Invented
School Journeys: Diaries
Creative writing: Travel in The Future

MUSIC, DRAMA & R.E.

Ride of the Valkyrie
Coronation Scot
London Suite (Coates)
Percussion Band – train, car effects
Ballad of Casey Jones
Dramatised stories of Marco Polo, Gulliver, etc.
Travellers 2000 Years Ago
St. Paul's Journeys
Ezekiel's Chariot
Exodus of Israelites
Pilgrimages to Mecca

HISTORY

Man and Animal Muscle
Roman Legions and Chariots
Pack Horses and Wagons
Litters and Sedan Chairs
Famous Travellers of the Past
Stage and Mail Coaches
19th-Century Inventions:
Railways, Bicycles, Cars
Ford, Daimler, Benz
Trams and Buses
Underground Trains
Land Speed Records
Transport Today:
Benefits and Problems

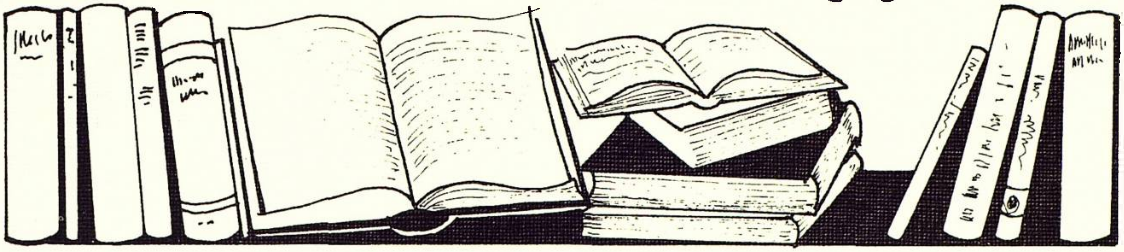
MATHEMATICS

Traffic Counts: Census
Finding Diameter, Radius, Circumference
Speed, Distance, Time
Acceleration
Estimating Running Costs – Car or Motor-cycle
Statistics, e.g. Bicycles Owned
Braking Distances
Force, Work, Power
Timetables
Linkages and Loci

GEOGRAPHY

Transport in Developed and Undeveloped Countries
Transport for Different Climates
Oil – Origins, Regions, Refining, Importance Today
Transport and World Trade
Geology of Energy
International Highways
Transcontinental Routes
The Car Industry
The Steel Industry

Some books that will help you



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Trains, Macdonald Visual Books – 5
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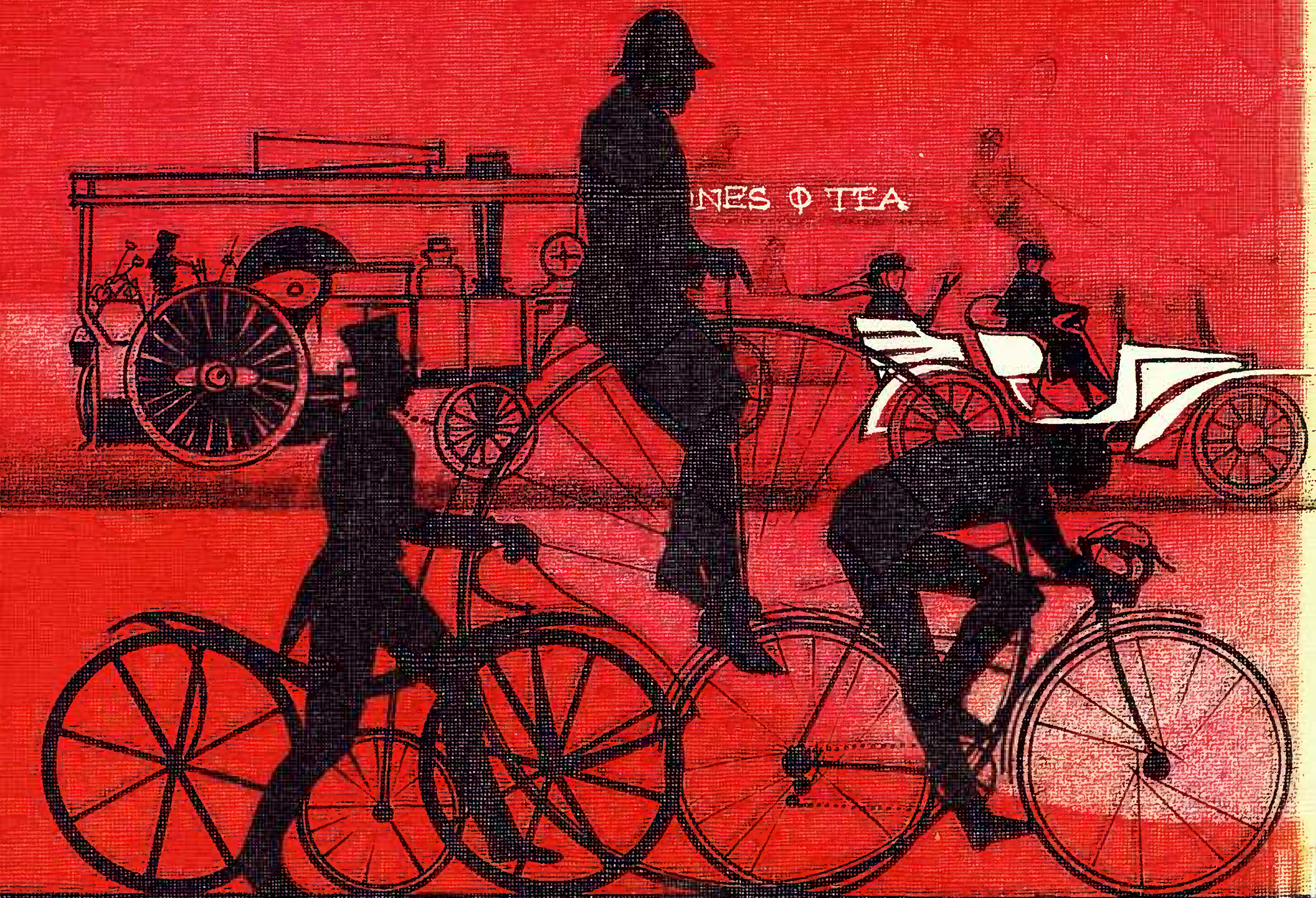
ACKNOWLEDGEMENTS

The authors would like to express their thanks to the following for help in supplying copyright photographs:
Mr. C. Jeavons, Hovercraft (page 24); The Science Museum, London.
Mr. Clive Pepper, model train layout (page 58); The Bucks Examiner, runaway lorry (page 44); Mr. P. Coombs, slow bicycle race (page 32)



SCIENCE IN A TOPIC—MOVING ON LAND

ISBN 0 7175 0816 1