THE PROPERTIES OF MATERIALS
and their everyday uses

Science background for teachers

VOCABULARY

Words to describe properties: Hard, soft, strong, weak, tough, brittle, stiff, rigid-flexible, absorbent, waterproof, magnetic, non-magnetic, wear and tear, smooth, rough, transparent, opaque, translucent

Names of a variety of materials: wood, metals – copper, tin, steel, gold, silver, aluminium, chrome, plastic – polythene, polystyrene, PVC, fabrics – cotton, silk, polyester, wool, acrylic, foam, glass, rubber

Children need to have experience of, and explore as many different materials (substances) as possible in order to make sense of their world. Understanding how materials behave in their natural state and under certain conditions will help them to understand why objects are made of specific materials. Some properties are easily observable features, such as transparency, which they explore as younger children, others are less obvious and need to have tests carried out on them.

In carrying out comparative tests on different materials, children develop an understanding of suitability for different purposes. They then begin to develop the skills themselves to choose the best materials for certain tasks. When testing materials for properties, precise vocabulary becomes important because children (and adults) sometimes confuse scientific terms, which they use in a general way in their everyday speech.

Hardness Resistance to scratching and pressure. Hardwood does not mark as easily as softwood.

Strength Amount of force needed to break a material usually by pushing or pulling down.

Toughness Resistance to breaking by cracking, opposite to 'brittle'.

Stiffness Amount of force needed to change the shape of a material, opposite to flexible.

Elasticity Ability to return its original shape when a force is removed eg rubber band.

Plasticity Ability to retain the new shape when a force is removed eg plasticene.

Absorbency Ability of a material to soak up a liquid.

Waterproof Resistance to liquids, repels water.

A material can be described in a variety of ways for example it may be strong but brittle, and the combination of its properties may determine its use. The property of a material can change according to how the material is treated; clay is very different once it has been fired, rolled up newspaper is very different to a sheet of newspaper.

SKILLS

- Recognising and carrying out a fair test, repeating a procedure.
- Measuring length with a degree of accuracy.
- Constructing a bar graph.
- Careful observation.
- Working cooperatively.
- Recording carefully.
- Use of ICT for graph drawing.

Key ideas and activities

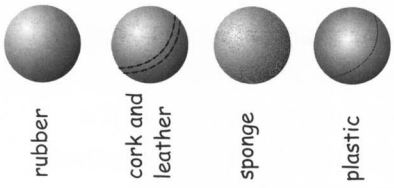
Younger children should have spent time experiencing some testing of the simple properties of materials. The activities offered here try to build on that experience and give the opportunity to develop the skills of investigating, whilst tackling the testing of properties. Certain materials have properties that are appropriate for specific uses and by comparing these, the idea is introduced that whilst some materials are reasonable for the use, others might do the job better.

Some materials can be changed in shape, a property suited to specific uses

(a) Balls are made from a variety of materials Investigate

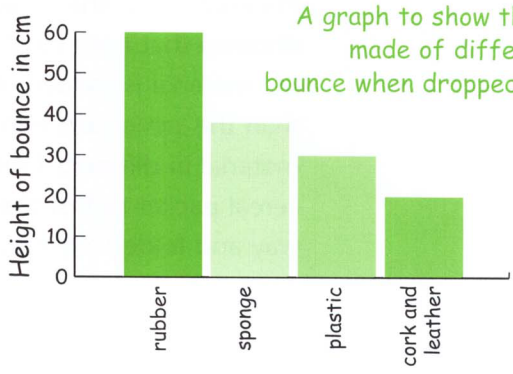
Which is the bounciest ball? Look at balls made from a variety of materials and discuss the different uses and properties, including sizes. The children can decide what they want to test eg, 'the bounciest football', 'the bounciest small ball'. What do they think 'bounciest' means? A ball that bounces the highest, or one that bounces for the longest time? The possibilities and variables are numerous, so they need to be made more specific. This is where the children learn to plan. The results will make a good bar graph.

Graphing package



Choose balls that are the same size. How high did they bounce?

A graph to show the height balls made of different materials bounce when dropped from 1 metre

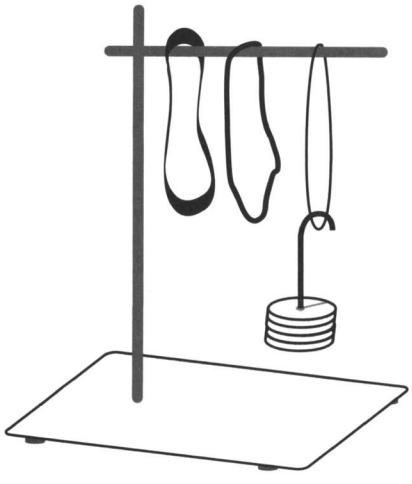


Materials from which the balls were made

(b) Elastic bands Investigate

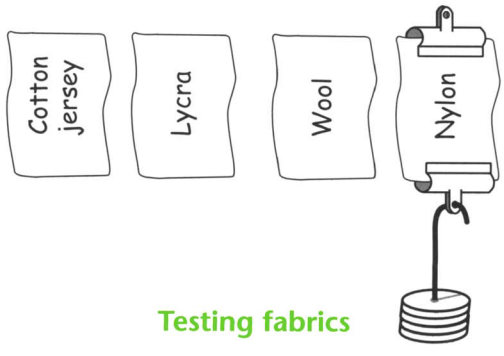
elastic bands with older children. Stretching them to their breaking point is too dangerous! Try comparing different thicknesses of the same band circumference with a fixed weight eg 500 gram. Carry out this experiment on the floor. Hold the band and weight against a ruler to see which stretches the most.

Testing different thicknesses of rubber bands with weights



Safety!

- Goggles should be worn when testing elastic bands.
- Care should be taken when using 'scratching' tools.
- Care should be taken when using weights.
- Great care should be taken and children closely supervised when using hot wax.

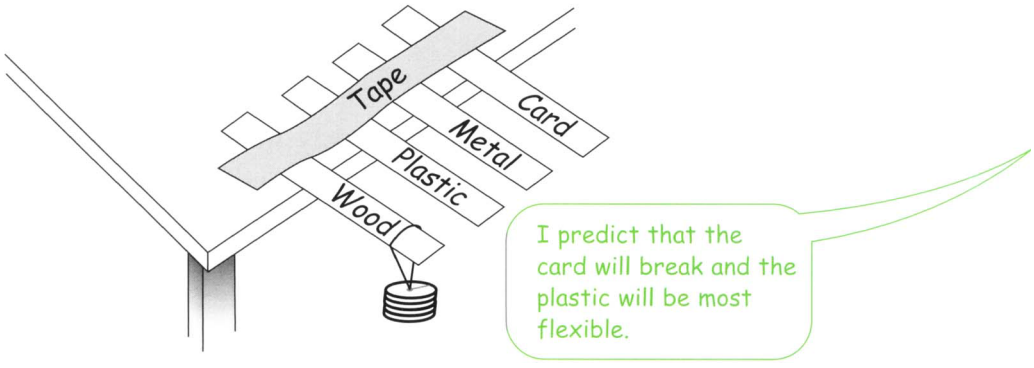


Testing fabrics

(c) Stretchy materials Sometimes we want a material (fabric) to have some elasticity because of the garment it will be used to make, for example, a pair of tights. Different fabrics can be tested for this, but pupils must remember that we want the fabric to return to its original shape and size. Strips of fabric can have weights hung onto them. What length is the fabric at the start? To what length does it stretch? What length does it return to? Use bulldog clips to support the weights or cut a hole in the fabric to hang the weights through.

(d) Flexibility Some usually rigid materials need to be able to 'give' a little and not break, to accommodate different situations for example a bridge carrying heavy traffic. Different materials can be tested eg identical lengths of wood, plastic, metal (use rulers) and card to **investigate** how much they will bend by hanging weights from string onto the end or sticking weights on the top with Blu-Tack®. Since the intention is not to break all your material samples, use a light weight and **investigate** 'which material bends the most using a 100 gram weight?' Measure the distance that each ruler bends. Another consideration is the way the material is formed. A card tube, for example, is less flexible than the same card unrolled. Children can **investigate** one material in different forms. Cut the card from both sides of a cereal packet to test the card flat, rolled the long way, the short way and folded zig-zag, then put the weights on the top.

Spreadsheets



Comparing everyday materials for strength

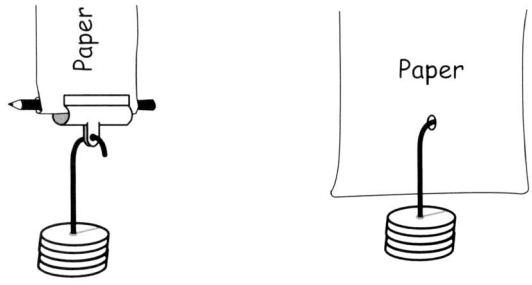
Most materials need to be strong. They need to withstand the forces of pulling or pushing without breaking or tearing and withstand 'wear and tear' if they are materials to be made into clothing.

(a) The strongest paper Papers are made of different qualities, young children may have carried out the simple test for the best drawing paper. This is another one for younger children. Paper is often used for wrapping parcels and needs to be flexible and strong. **investigate** Which type of paper is strong? Can they think of a way to test the strength of paper? Collect sheets of different types of paper and make them the same size. Make a hole in each sheet not too near the edge and hang a weight

carrier onto it. Carefully add weights until it tears. A sheet of A4 computer paper held 650 g before tearing.

Tip If weight carriers are not available use a strong bulldog clip with a pot attached to it by thread going through the hole. Clip this to the sheet of paper and gradually add weights to the pot. The bulldog clip sometimes slips off the paper, so wrap the end of the paper around a pencil and the bulldog clip will grip this.

Wrap the end of the paper around a pencil to stop the bulldog clip from slipping off.



Make a bridge with paper Older children can try making a bridge using different types of paper and putting weights on the top. What happens if the paper is folded into a concertina shape?

(b) Testing threads Many fabrics are made from woven or twisted threads and their strength is important. Strings and ropes made from such fibres may hold heavy weights, peoples' lives may depend on their strength. **Investigate** the strength of threads by suspending weights from equal lengths of threads and seeing the weight they will hold until they break.

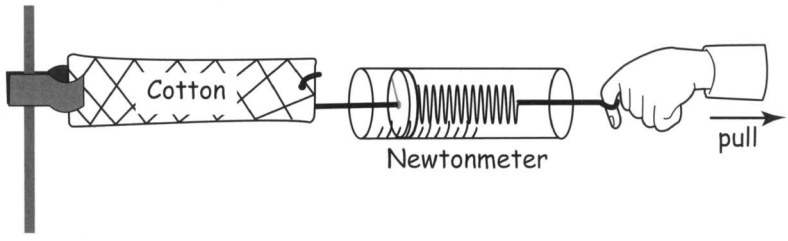
Tip Weight carriers can be used, but threads are surprisingly strong, a length of cotton held 1100 g, polyester and nylon will hold much more. Try tying the threads to the leg of a table turned on its side, tie a small, light plastic bucket (plasticene tub) to the thread being tested and gradually add weights. The container allows large weights to be added. Threads may also be tested using a newtonmeter, (forcemeter), but it is less accurate as it is often difficult to see exactly where the thread breaks because the spring returns too quickly.

(c) Testing fabrics for strength Fabrics used for items such as work clothes, sheeting, bags etc need to be strong to withstand being pulled around, for example by your friends! The strength of fabrics can be tested in various ways, similar to the testing of threads. See if the children can suggest ways in which this might be done. Equal strips of fabric can have a newtonmeter attached to the end. As it is pulled, the force will register on the scale to the point where the fabric tears. As fabric tears slower than thread breaks, this method works quite well.

Tip Alternatively, by using a pot as the container or a weight carrier, the weights can be hung through a hole in the fabric until it tears (some fabrics are very strong and can take many weights, use thin fabric strips). **Investigate** 'Which is the strongest fabric?' You may

discuss with the children whether it is fair to include 'elastic' fabrics in this test that also have the 'stretch' property.

Slowly pull the newtonmeter to see how much force it takes to tear the fabric.

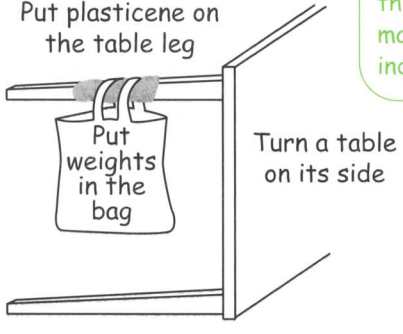


(d) **Hard wearing fabric** Clothes must withstand the wear and tear that comes from sitting on the floor or playground tumbles, (who has had tears in their trouser knees?) rather like friction wear. Discuss this with the children and see if they can think of a way to test this. If you stick a piece of coarse grade sandpaper onto a wood block and rub this onto fabric you can count how many times you can rub before the fabric shows wearing or a hole. Choosing the same child to rub makes it fairer, although a little tiring!

(e) **Which is the best carrier bag? Investigation** for older children. Children bring in a collection of carrier bags. What do we mean by the best? The strongest? Handles that don't mark your fingers or both? Bags may be tested, by hanging them over a pole (or the leg of a table turned on its side). Weights are then carefully put into the bags (they take a lot, supplement with bricks). The 'best' bag will carry the heaviest load. A separate **investigation** may be carried out to test for handles that don't mark your fingers but older children can deal with both variables at once. Whilst testing for strength, put plasticene on the pole where the handles are to be hung. The handles cut into the plasticene as the bag becomes heavier. The amount the handles cut into the plasticene can be measured. The results can then be discussed. Which is the bag that is the strongest but marks your hands the least? Is there a compromise to be made?

The best bag holds the most weights, and makes the smallest indent in the plasticene.

Make the plasticene about 3 cm thick. How deep do the handles dig in?



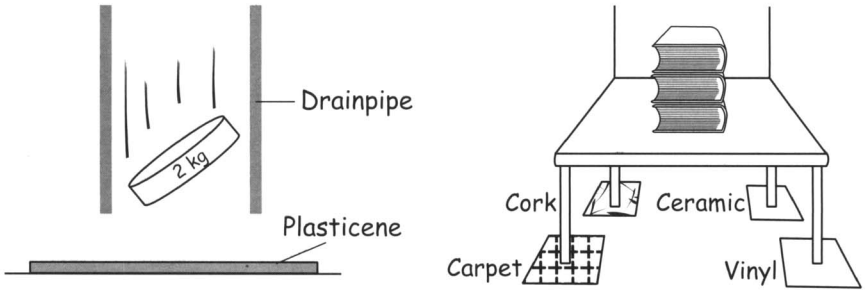
Comparing everyday materials for hardness

(a) **The scratch test** This test, which is used on different rocks (see Rocks and Soils section) can also be used on other materials such as different woods or different types of hard flooring such

as vinyl, linoleum and tiles. Discuss with the children the fact that flooring must withstand scuffs and scratches from shoes and scraping chairs and see if they can devise a test. Scratching can be done with a variety of objects from fingernails to metal nails on samples of the material to be tested. Discuss with the children the difficulty of measuring how hard to scratch. If the same child scratches each material as hard as possible it helps to make the test fair. Children will often come up with this conclusion themselves.

Investigate Which is the hardest wood?

(b) **Denting test** If you drop a metal weight on to a piece of flat plasticene it will leave a dent. What will it do to the floor? There are often notices in halls where there is a wooden floor about wearing stiletto heels. There are a variety of variables here for older children to consider apart from the material that is to be tested, the different weights, the different heights they may be dropped from and the different surface area of the weight. Drop weights through a wide drainpipe or cardboard tube for safety, onto squares of different types of flooring, cork, vinyl, carpet, wood and ceramic. Furniture often leaves marks on carpets and flooring, so you could test four pieces of flooring. Place different flooring under the four legs of a classroom chair and weight the seat of the chair with books or bricks. Leave for a few days then look to see if there are any marks.



Tip Ask the children to bring in samples of flooring from home since parents often keep 'off cuts' or try to get old samples to keep from a local builders merchant or DIY store.

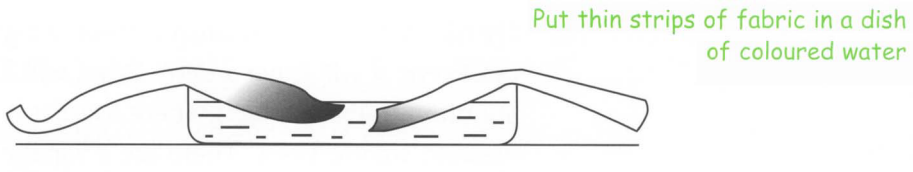
Comparing everyday materials for absorbency

Kitchen paper and disposable cloths are common items in most kitchens these days for doing many jobs, especially mopping up spills, but are all makes of paper as good as each other? Are some materials better than others? When carrying out these tests the children must consider how much water to use, the size of the material, how many pieces/wipes they use. A pipette or syringe dispenses accurate, small quantities of liquid, which can be coloured with vegetable dye for some of these tests.

(a) **Mopping up** Young children might drop a small, measured quantity of water onto a tray and put sheets of paper onto the

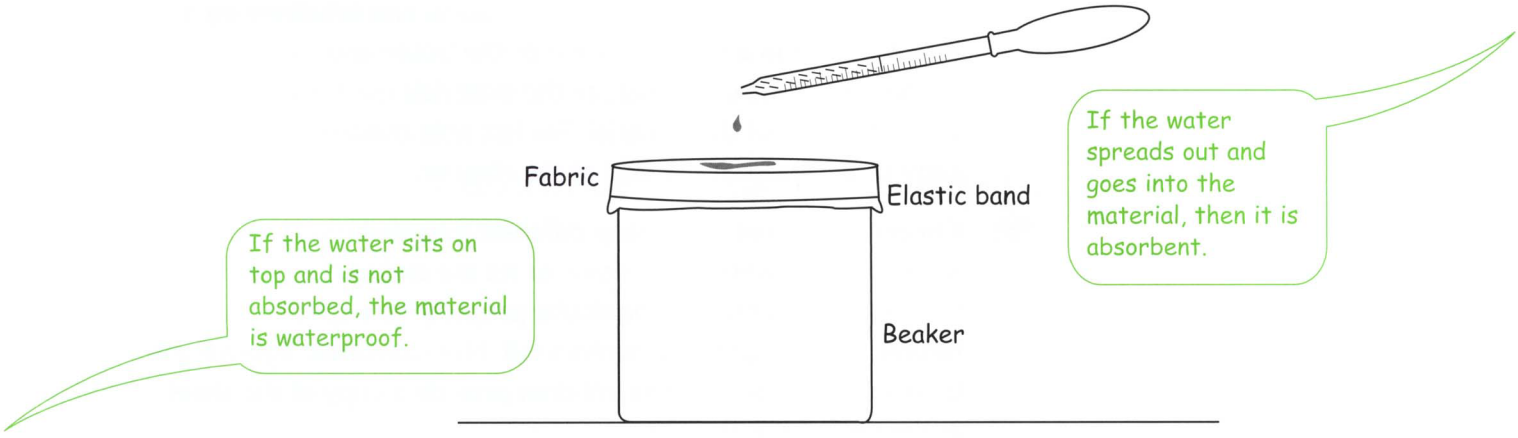
top until it is all absorbed. Alternatively, drop measured quantities onto the paper. **Investigate** which is the best kitchen paper?

(b) **Which material absorbs water the fastest?** Lay thin strips of equal lengths of different materials (include a waterproof strip) into a shallow tray. Pour coloured water into the tray, measure how fast and how far up the fabric it is absorbed. Discuss the different reasons why absorbent materials may need to be used.



(c) **Absorbent building materials** It does not always occur to children that 'hard' materials like wood and stone can absorb water. The knowledge of this fact is particularly important in understanding how building materials (or their toys!) need protection from the wet. Children can test a variety of materials eg plastics, metals, different types of wood and bricks for their absorbent property. Young children can put small objects eg tennis ball, wooden brick etc into very shallow dishes of coloured water to observe if any water is absorbed. Older children can use a dropper to measure out 5 cm^3 into each dish. Stand small pieces of material of the same size in the dishes eg cork, wood, metal and plastic to observe and time any absorption that might take place. If accurate scales are available, a quantitative and 'fair test activity' could be to **Investigate** which is the most absorbent brick or wood. Compare different types of bricks or wood of the same size, weigh before and after immersing in water (see also Rocks and Soils section). A bar graph can be constructed showing the volume of water absorbed by each type of wood.

(d) **Waterproofing** If materials do not absorb water at all they are said to be waterproof, a property that can be very useful for example in clothing, packaging and housing. A very simple activity for younger children is to drop water onto a variety of materials as in the 'absorbency' activity, to see if they absorb or repel the water. Older children can stretch pieces of cloth across jars to make them taut and using a dropper, drop water onto the cloth. The number of drops and the time they stay on the cloth before being absorbed, if at all, can be measured. Making the absorbent material 'waterproof' can then be tried with older children, by waxing it.



Batik The ancient craft of dying material using a wax resist could be done as an art activity. Molten wax is applied onto cotton through a special tool called a tjanting or painted with a brush. The cloth is then dyed and when it is dry, the wax is ironed out. Where the wax has been applied, the dye does not penetrate, so a pattern is formed. This is an extension of the wax drawing and wash technique often used with younger children.

(e) **Make a waterproof hat/bag** A design technology activity.

Comparing everyday materials for magnetism

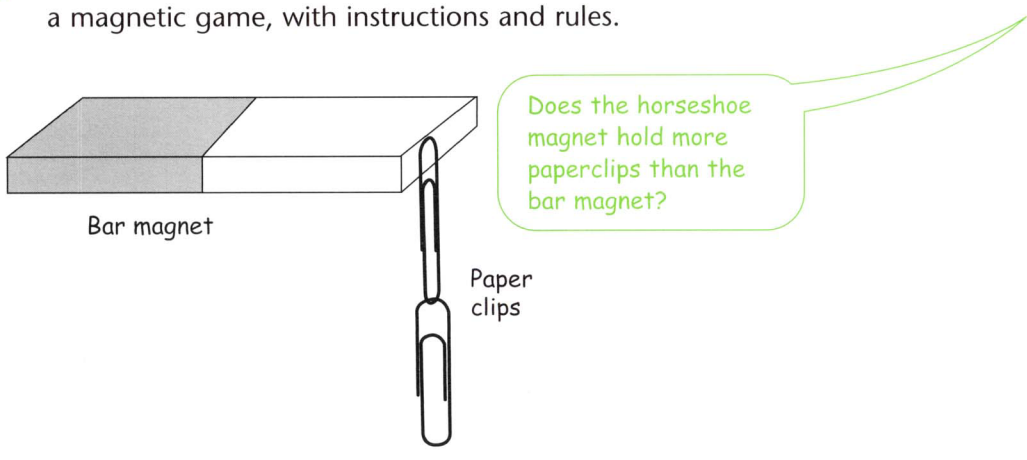
(a) **Is it magnetic?** Younger children may carry out a simple classification activity to see which materials are magnetic.

(b) **Will magnets work through all materials?** This can be a simple classification activity or **investigate** which materials magnets work through the best? Does thickness matter?

Branching database

(c) **Which is the best magnet** Using different types of magnets get the children to plan and **investigate** this.

(d) **Make a magnetic game** A design technology activity to make a magnetic game, with instructions and rules.



MATERIAL FACT FILE

To 'round off' and consolidate this work, or as an introduction or research for older children (homework) here are some suggested 'pencil and paper' activities:

(a) Choose a large object with many materials and functions eg a bicycle, room in a house, outside of the house and get the children to construct a chart of the materials used, the function and properties of the material. For less able children provide a copy of the sheet at the end of the chapter.

(b) Choose a material with many different uses and properties such as aluminium, write them down or let the children research for themselves and match a particular property to a specific use eg flexible, lightweight – aluminium foil. Non-corrosive, lightweight-bicycle frame. For less able children provide a copy of the sheet at the end of the chapter.

Bag Words A poem that plays with words, what are bags made of?

Scary Sausage-fingers That's what carrier bags do to your fingers if you have lots of shopping.

Night-time Kitchen Which is the most important material in the kitchen? See page 10.

Rubber Dubber Rubber is 'elastic' and used for making bouncy balls, what else is it used for? See page 10.

Bag Words

Today we are learning about bags.

If a paper bag is made of paper
is a handbag made of hands?
is a sandbag made of sand?

An air bag is full of air
so I suppose a plastic bag
is full of plastic.

A carrier bag carries,
so a sick bag is sick.

I know what mailbags
look like
but what do bags of fun
look like?
And can you pack the bags
under your eyes?

I know who let the cat
out of the bag
but who put it in?
I just hope there aren't any cats
in the bags under your eyes!

I've heard there's a
bag of nerves
and a
bag of bones.
Why not put them
in together
with some blood, muscles and skin
and you could have
a bag of person?

All this I understand
But why do people
keep saying
'It's in the bag'?

What's in the bag?
The cat?
The sick?

And while I think about it
which bag is 'it' in?
One of those bags of fun, perhaps?

Shouldn't they say
what they mean
and instead of saying
'It's in the bag'
couldn't they say
what they are talking about
like
'The hand is in the handbag'
or
'The cat is in the bag of nerves'.

And then we'd all know
what they're talking about.

Scary Sausage-fingers

Hey!
Psst!
I got a trick.
Do you want to know my trick?
I'll tell it to you.

It's called Scary Sausage-Fingers.

I'll tell you how you do Scary
Sausage-Fingers.

You walk into a room
with Scary Sausage-Fingers,
you hold up your hands
and go:
"Look at me! I got Scary Sausage-Fingers!"
and everyone'll go, 'YAAAA!!!'

But first you've got to
make
Scary Sausage-Fingers

You go to the supermarket - without a bag.
You do loads and loads of shopping
You put it all into the bags
they give you
You carry it all home.

As you walk along
the handles of the bags
cut into your hands.

It's agony.

But you don't give up.

You walk on home.

The bags still cutting into your hands.

It's double-agony.

You get home
You drop the bags.

Now you've got
Scary Sausage-Fingers,
Big, fat, puffy fingers
with little narrow white bits
in the joints in between
the sausages.
So you rush into where
everyone's sitting quietly
having a nice time
and you hold up your hands
in the air and shout,
'Look! Scary Sausage-Fingers!'
and everyone'll go,'YAAAA!!!'

lightweight

expensive to produce

soft, easy to mould and shape

can be mixed with other metals to make it stronger

good thermal conductor

it does not rust

good electrical conductor

Match the Aluminium Facts

Rotary driers

Aluminium foil

Bicycle frames

Saucepans

Electrical cables

Window frames

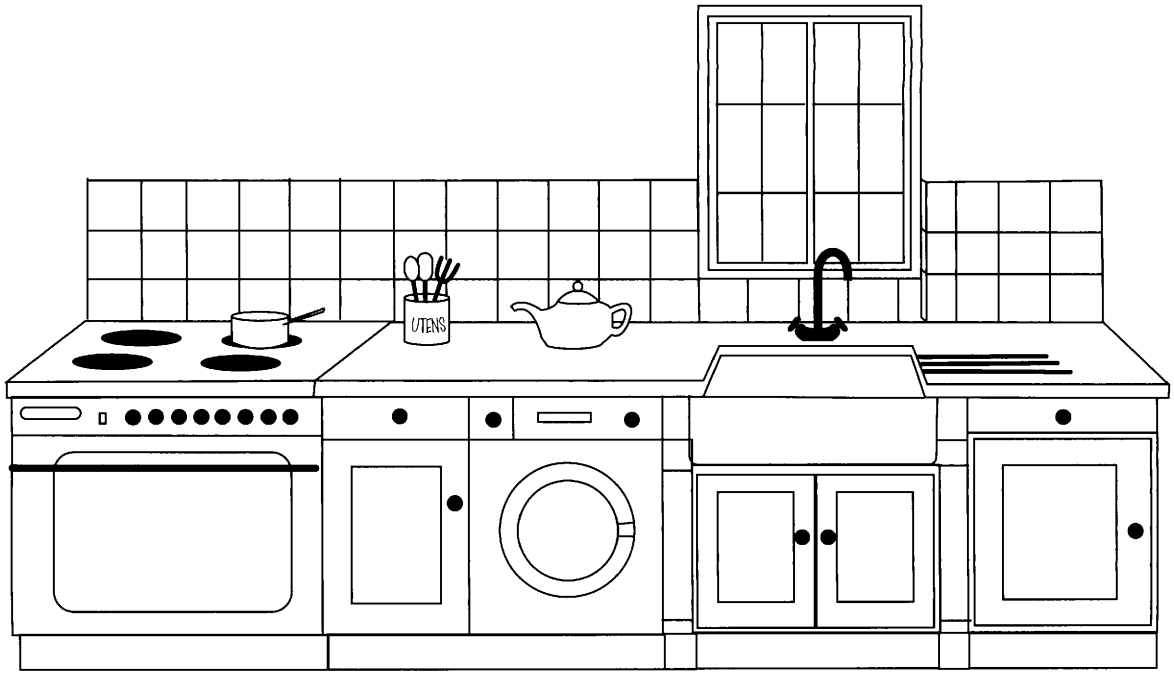
Toothpaste tubes

Mirrors

Watering cans

Milkbottle tops

Aircraft



Object	Material	Property	Use related to the property of the material
teapot	ceramic	rigid, waterproof resistant to hot liquids	holding hot liquids

Object	Task	Material	Why was it chosen?
sink	holding water, washing things	stainless steel	waterproof, strong, tough, easy to clean

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