Science@School Book 3C

Properties of materials

Teacher's Guide

Support material for the pupil book
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1

Teacher's sheet: comprehension

See **pages 4 and 5** of *Properties of materials*

Answers

1. **An axe.**
2. **A = wood, B = gut, C = flint (stone).**
3. **Cutting wood, bones.**
4. **Clay, animal skins, bone, bark, wool, etc.**
5. **Gold, silver, copper, iron, steel, etc.**
6. **Oil.**

Complementary work

(a) Let the children use secondary sources to find out about natural and manufactured materials.

(b) The word 'material' is often confused with fabrics. Make sure the children are aware of this distinction and let them look at clothing through the ages and in different cultures.

Teaching notes

From time to time there are television programmes on people who are castaways and how they have to use the materials in their surroundings to survive. You may wish to show the children a suitable programme as an introduction. Alternatively, if you have been studying Romans or Vikings, you may like to focus on the materials that were used in daily life in those days and compare them with the materials in use today.

If you use a 'time line' approach, the first materials in use were bones, pebbles, sticks and animal skins. Over 40,000 years ago, flint was used to make tools and weapons; 25,000 years ago paint was used to decorate cave walls; 11,000 years ago clay was used to make pottery; 8,500 years ago people learnt how to weave cloth; 8,000 years ago brick-making was developed; 5,000 years ago glass-making was invented, and the Bronze Age began; about 3,550 years ago the Iron Age began; 2,055 years ago the Romans invented concrete; 1900 years ago the Chinese invented paper; in the early nineteenth century the waterproofing properties of rubber were first used on a large scale; in 1868 the first plastic was made but plastics did not really become widespread until after the middle of the twentieth century.

As new materials were developed the use of other materials became more restricted. For example, stone was once used for tools and building, then just for building. Today, as concrete has taken over, stone is used mainly for decorative purposes.

Teacher's sheet: activity

Based on **pages 4 and 5** of *Properties of materials*

Introducing the activity

(a) If you have taken a 'time line' approach to introducing materials you may like to ask the children what materials they can see in use today in their classroom. If they mention a few different materials, ask them how they can tell them apart and use the word properties to describe the features they are using for identification (see note (i)).

Using the sheet

(b) Give out the sheet and let the children fill in their names and form then go through tasks 1 to 4.

(c) Let the children complete their tasks (see note (ii)).

Completing the activity

(d) Let the children try tasks 5 and 6 (see note (iii)).

Take the children outside and let them make and fill in a table relating to the external structure of the school. Let them compare the materials used outside with those used inside (see note (iv)).

Conclusion

A wide range of materials are used to make the objects in our surroundings. Some objects are made from one material and some materials have a wide range of uses.

Teaching notes

(i) You may discuss why a material is used for a particular task after the children have performed some tests on properties. You may, however, wish to introduce the idea now and ask the children why they think a few of the materials are being used.

(ii) You may give extra paper to the faster or more able children so they can make another table and add extra objects and the materials they are made from.

(iii) The children may find that metal or plastic is the most widely used material. They may find that brick or wood is used in the largest amounts.

(iv) Make sure the children are supervised outside the school building.

2

Teacher's sheet: comprehension

See **pages 6 and 7** of *Properties of materials*

Answers

1. **H should be written on C, S should be written on B.**
2. **C.**
3. **None.**
4. **Diamond.**
5. **Because it is softer than paper and rubs off onto it.**
6. **Because it is harder than pencil lead and removes it from the paper, but is softer than the paper so it does not damage the paper.**

Complementary work

(a) You may demonstrate a Mohs Hardness Scale test set. They are available from educational suppliers.

Teaching notes

The idea that matter is made from particles is not a new one. It was first put forward in the time of the Ancient Greeks by a scholar named Democritus. He reasoned that every solid material could be divided into two, then each half divided into two, and so on many times until there came a time when the matter could no longer be divided. This indivisible particle he called an atom. It was not until the nineteenth century that the idea of atoms really took hold and today there are special microscopes that can see them. It is not necessary to tell the children about atoms, although they may discover the word from popular science. Particle theory, which describes solids, liquids and gases in terms of particles (groups of atoms), is a key stage 3 concept but sometimes teachers introduce it in upper primary school.

There is a scale of hardness used in the identification of minerals. It was devised in 1822 by Frederich Mohs, who was a German mineralogist. No mineral in the scale can be scratched by minerals lower in the scale but can be scratched by those higher in the scale. The hardness of a mineral is found by scratching it with several minerals and scratching it on several minerals until its place in the scale is found. You may use this scale in your work on rocks and soils.

People consider the property of hardness in a relative way. They select a material because its hardness meets a particular need. When several materials could provide the same hardness for a task the cost factor becomes important and the cheapest material may be selected.

2

Teacher's sheet: activity

Based on **pages 6 and 7** of *Properties of materials*

Introducing the activity

(a) You may begin the activity by letting the children try the activity on page 7 (see note (i)).

(b) Show the children the selection of floor coverings and the three items for testing their hardness (see note (ii)).

Using the sheet

(c) Give out the sheet, let the children fill in their names and form, then go through tasks 1 to 5.

(d) Let the children carry out tasks 1 to 4, then check their work (see note (iii)).

(e) Let the children construct the table in task 5 and check it before they carry out their practical work (see note (iv)).

(f) Let the children carry out the practical work.

(g) The children should carry out task 6 and evaluate their prediction with their results.

Completing the activity

(h) The children may compare their results and assess each other's skill in predictions. They could present their results as a report for the school governors advising them on the best and worst floor coverings for a particular area of the school.

Conclusion

The hardness of different materials can be compared by scratching them or by dropping things onto them.

Teaching notes

(i) Give the children some small pieces of Plasticine, a nail and a weight and let them make their test. This will help them focus on the work to be done.

(ii) The nail is used for making a scratch, the Plasticine is dropped from the same height onto different coverings and its deformation is measured. A weight, such as a ball bearing, is dropped down a cardboard tube (for safety) onto the floor covering and the size of the indentation is examined.

(iii) Look for evidence of a fair test. For example, using the same height for dropping both the Plasticine and the weight, and the same person making the scratches each time.

(iv) The table should have a column for listing the floor covering and a column in which to record the results. This may be a simple comparison of the depths of the scratches or indentations (10 for the deepest and one for the shallowest, for example) or it may be a measurement of the width of the Plasticine after it has hit the floor covering.

3 Teacher's sheet: comprehension

See **pages 8 and 9** of *Properties of materials*

Answers

1. **A bent and broken material is drawn under a weight at B.**
2. **Stone, rubber.**
3. **Hold it over the end of a table and put a weight on the end.**
4. **If it is strong it will not bend. If it is weak it will bend.**
5. **Stick them together with wallpaper paste. Use a balloon to support them. When the paper and paste have dried let the air out of the balloon.**

Complementary work

(a) The children could tie a small bucket (from the infant department) to a thread and suspend it close to the ground. Weights could be put in the bucket until the thread snapped, then the weight which caused the snap could be recorded by putting the bucket on a weighing scale or balance. Use both natural and manufactured fibres. Not all may break with the range of weights used, and this can be used as an example of the limitations of the test.

(b) Use secondary sources to find out how the strength of a material is tested.

Teaching notes

When talking about the space shuttle launch you can relate the strength of the materials to the pushing and pulling forces on the whole structure as it vibrates due to the action of the rocket engines. The children may have seen films involved with space launches and be familiar with the sight of astronauts being shaken about. This is an opportunity to talk about forces, such as gravity, and to remind children that they occur everywhere.

In discussing bridge building you may ask the children what materials they would select to make a bridge. Look for the use of branches and how they may test them before putting them over the water. You may like to show children pictures of rope bridges and ask them for their reactions if they had to use one. This could lead on to complementary work testing the strength of threads.

3 Teacher's sheet: activity

Based on **pages 8 and 9** of *Properties of materials*

Introducing the activity

(a) Begin by reminding the children about the activity on page 9 of the pupil book, which showed how paper could be made stronger. Ask the children how the strength of paper could be measured and steer them towards the method on the sheet (see note (i)).

Using the sheet

(b) Give out the sheets and let the children fill in their names and form, then go through tasks 1 to 4.

(c) Let the children carry out tasks 1 to 4.

(d) Go through tasks 5 to 8 with the children.

(e) Let the children carry out tasks 5 to 8.

(f) Check that the children have completed tasks 1 to 8 correctly, then let them complete task 9.

Completing the activity

(g) The children can then present a report of their investigation to the rest of the class. In this, they could construct a bar chart from the data in their table.

Conclusion

The strength of paper can be tested by suspending weights from a rolled up sample. Different papers have different strengths. The strength of a paper depends on the materials that are added to it during its manufacture and also on its thickness.

Teaching notes

(i) An alternative is to spread the sheet out over the open top of a can or plastic jar and secure it to the top with a strong elastic band. The yoghurt pot is then put on the centre of the sheet and loaded with weights until the paper tears. This arrangement can also be used with wet paper, to test the effect of water on strength (see page 47 of this book).

Teacher's sheet: comprehension

See **pages 10 and 11** of *Properties of materials*

Answers

1. **In B, a spring should be drawn stretched. In C the spring should be the same length as the one in A.**
2. **It returns to its original shape.**
3. **The elastic band pulling back on you.**
4. **Tights, socks.**
5. **Making a seal around the door.**
6. **In a weighing machine or on a door to make it close automatically.**

Complementary work

(a) You could provide the children with a set of similar sized balls. One set could be similar to the size of a tennis ball and include a solid rubber ball, a solid wood ball, a solid plastic ball and a hollow plastic ball. A second set could be similar in size to a table tennis ball. Let the children perform a fair test on the bounciness of the balls, which is due to their elasticity. A sheet of paper may be stuck to a wall and each ball dropped from the same height. The height of the bounce is marked on the paper. The results may be recorded in a table and presented as a bar chart.

(b) Secondary sources can be used to find out about the sources of rubber and the manufacture of rubber objects such as Wellingtons or car tyres.

Teaching notes

The study of springy materials provides an opportunity to mention the pulling and pushing forces involved, which will reinforce the work done specifically on forces in other parts of the curriculum.

The way that rubber 'memory' works is due to the arrangement of its molecules. They form very long threads which are folded upon themselves and each other. At certain points along their length they are linked together. When rubber is stretched, the molecules straighten out and the connecting links prevent them from sliding away from each other. Tension develops in the links and when the stretching force on the rubber is removed, the tension force in the links (the 'memory') pulls the molecules back together again. Metals do not have long molecules. They have a crystalline structure, but a tension force also develops in the metal which acts as the 'memory'.

Incidentally, it is correct to call a rubber band an elastic band because it is not made of rubber but of an elastic plastic.

4 Teacher's sheet: activity

Based on **pages 10 and 11** of *Properties of materials*

Introducing the activity

(a) Ask the children what it would be like to wear socks and tights that did not stretch. Let them assess the usefulness of the property of stretchiness.

(b) Show the children the tights they are to test and ask them how they think they will do it. During the discussion, elicit from them the idea of measuring the length of the tights, then adding a weight to the tights and measuring the extension (see note (i)). This is followed by removing the weight and re-measuring the 'resting' length. This should be tried until a weight is found at which the tights will no longer stretch further (see note (ii)).

Using the sheet

(c) Give out the sheet and let the children fill in their names and form, then let them complete tasks 2 and 3.

(d) Check the children's plans and table before you let them try task 4.

(e) Let the children try task 4.

(f) Let the children try task 5 (see note (iii)).

Completing the activity

(g) The children can construct bar charts from their results and compare them. If differences are found when the same type of tights are tested, then the way the tests were carried out can be compared. Finally, you may introduce a pair of tights that are different from the ones the children have tested and ask them to predict their stretchability. You could test their prediction as a teacher demonstration, assisted by some of the children.

Conclusion

Tights vary in the amount they stretch. The stretchiness is due to the structure of the tights.

Teaching notes

(i) A box should be placed under the tights to collect any weights that fall off the tights. Alternatively, you could put the weights inside the tights. The box also keeps the children's feet away from an area where the weights may fall.

(ii) Due to the stretchiness of some tights, it may not be safe to add enough weights to find their maximum stretch. To prevent this occurrence, test the tights before the activity. Those worn by babies or toddlers may not stretch as much as tights for older people.

(iii) Look for the children who relate stretchiness to the thickness of the tights.

5 Teacher's sheet: comprehension

See **pages 12 and 13** of *Properties of materials*

Answers

1. **The rod stays bent.**
2. **The sheet.**
3. **A long thin rod.**
4. **Because it is made of long thin rods or fibres.**
5. **In cables carrying telephone messages.**
6. **In cables carrying electricity.**

Complementary work

(a) The children can use secondary sources to find out about how cloth is made. They should consider spinning, weaving and knitting.

(b) The children could consider flexible materials in their everyday life and reflect on how life would be different if items such as clothes were not flexible.

(c) The children could tease out some fibres in cotton wool and twist them or roll them together to make a short length of yarn.

(d) If a microscope is available, cut out a piece from some nylon tights that is the size of a postage stamp. Put the piece on a microscope slide and let the children look at it under the microscope. Stretch the piece and hold it down on the slide with sticky paper. Let the children look again and see how the pattern changes as the fibres and the structure is stretched.

Teaching notes

One way of thinking about the internal structure of a material is to think of it having parts hooked together. A large, thick block will have many parts, with many hooks, and the combined strength of the hooks may be too strong for a bending force to unhook them. A thinner piece of material will have fewer parts with hooks and they will have less strength against a bending force. The material can be thought of as staying in its bent position because of the parts which have not been unhooked. When a material is straightened, the unhooked parts become hooked up again.

5 Teacher's sheet: activity

Based on **pages 12 and 13** of *Properties of materials*

Introducing the activity

(a) Remind the children about the fibres that were mentioned on page 13 of the pupil book. Ask them to look at their clothes to see if they can see any threads.

(b) Tell the children that, although the threads may look small, they are actually made of even smaller threads, called fibres, which have been twisted together (see note (i)).

Using the sheet

(c) Give out the sheet, let the children fill in their names and form, then go through tasks 1 to 5 with them (see note (ii)).

(d) Let the children carry out their tasks.

Completing the activity

(e) Give the children a sample of felt and ask them to compare it with the other fabrics they have observed (see note (iii)).

Conclusion

The fibres which make up our clothes, and give them flexibility, are very small. They are twisted together to make larger, rod-like flexible structures called threads, which can be joined together to make flexible sheets of fabric.

Teaching notes

(i) Natural fibres like wool and cotton are not long and could not be used to make a width of a piece of cloth. Also, they are quite weak, so the fibres are twisted together to make a longer, stronger thread.

(ii) In task 2, it is sufficient for the children to describe the yarns as going over and under each other. They should attempt to make a scale drawing in task 4 showing the difference in width between the yarn and a fibre. In task 5 they should see that the cotton yarn is much thinner than the woollen yarn and its fibres are smaller. They should also observe that the threads are arranged over and under each other in a different pattern because they are woven together while the woollen fabric was knitted.

(iii) Felt is made of fibres which have been pressed together.

6 Teacher's sheet: comprehension

See **pages 14 and 15** of *Properties of materials*

Answers

1. **The brick should be drawn in pieces.**
2. **Because it is brittle.**
3. **It snaps.**
4. **Twisting, pulling, striking.**
5. **It has steel rods put in it.**
6. **A sheet of plastic is put between two sheets of glass.**

Complementary work

(a) If none of the children has an allergy to nuts you could demonstrate the brittleness of the casing around a nut by using a nut cracker.

(b) The children could test eggshell halves themselves by covering the eggshell with a cloth and dropping weights onto it through a cardboard tube. They may like to test eggs from hens reared in different ways.

Teaching notes

It is a mistake to think that brittle materials are weak. Many are very strong if they are given a load slowly. A brick can support a wall of bricks above it, yet shatters if it is given a sharp blow. It is the speed and size of the force delivered to a brittle material that makes it snap. Holes in the road are covered by cast iron which can support the weight of a juggernaut rolling over it, yet if it is hit with a sledge hammer it will crack.

Brittle materials are widely used because the advantages of their other properties outweigh the disadvantage of their brittleness, but economics is also important. For example, baked clay is a very cheap material which can be made to hold liquids and have a hard, easy to clean surface for using as plates. These properties, together with its cheapness, outweigh the disadvantages of its brittleness.

Brittle materials, like tiles, can be snapped by the scoring of their surface to create a line of weakness, then bending the material along this line so that it snaps cleanly. Ceramics are brittle materials, but they are shaped before firing when the clay is soft.

It may be thought that the use of sweets is at odds with the encouragement of a healthy diet, which may be a feature of your curriculum at this level. However, sweets are a feature of everyday life for many people and a good everyday example of brittleness.

6 Teacher's sheet: activity

Based on **pages 14 and 15** of *Properties of materials*

Introducing the activity

(a) Begin by asking the children if they have heard, in a story book or in a film or television programme, where the snapping of a twig gave away the position of the hero or the villain. Ask the children what caused the twig to snap (see note (i)) and ask them about the property that caused it to snap (see note (ii)). This observation may lead to the idea that all twigs are brittle and will snap.

(b) Show the children a collection of twigs (see note (iii)). Ask the children how they can test the twigs for brittleness and look for the answer: by bending them.

Using the sheet

(c) Give out the sheets, let the children write their names and form on them and go through tasks 1 to 2 (see note (iv)).

(d) Let the children carry out tasks 1 and 2.

(e) Go through tasks 3 and 4 with the children.

(f) Let the children carry out tasks 3 and 4.

(g) Go through task 5 (see note (v)).

(h) Let the children carry out tasks 5 and 6.

Completing the activity

(i) Let the children carry out tasks 7 and 8 and compare their results.

Conclusion

Dead twigs are brittle but live ones are flexible. Dead twigs are dry while live twigs are wet. Thin dry dead wood is brittle while thin, wet, living wood is not. The wood of conifer trees is more flexible than that of broad-leaved trees (see note (vi)).

Teaching notes

(i) The twig snapped because of the force put on it by a foot standing on it.

(ii) It was brittle.

(iii) In the collection, you should have twigs from broad-leaved trees which are alive and dead, and twigs from coniferous trees (not the larch) which are alive and dead. Check that at least some of the living twigs are not brittle.

(iv) Although this is an everyday example of brittleness, you may wish the children to use eye protection.

(v) The children should just bend each twig once. Dead twigs will snap but some of the living twigs will only bend. The children should not keep straightening and bending the twigs until they break.

(vi) Most conifers keep their leaves all year. They have to endure snow on their leaves and strong storms, so are more flexible than broad-leaved trees which are deciduous and cannot live in the harsh conditions to which conifers are adapted.

7 Teacher's sheet: comprehension

See **pages 16 and 17** of *Properties of materials*

Answers

1. **Thermometer A.**
2. **Because the material under A is thinner and heat escapes through it faster than it does through the material under B.**
3. **Insulator.**
4. **Air.**
5. **To keep drinks hot for longer.**
6. **Metal.**

Complementary work

(a) The concept of air as an insulator could be investigated by wrapping a string vest round one hot water bottle, then a cotton or nylon material around both hot water bottles, and leaving them for an hour.

(b) The children could use secondary sources to find advice for what clothing to wear when walking in the countryside.

(c) The children could use secondary sources to find out what mountaineers wear.

Teaching notes

Heat moves by conduction (passed from particle to particle inside a material), convection (passed by the movement of hot particles in liquids and gases) and by radiation (as rays of heat through air and space). At this stage the children do not need to know about these different forms of heat transfer but the use of the word conductor, as a material which conducts heat, provides an introduction for development later. It is important to emphasise that materials can be divided into two groups: those that conduct heat and those that do not. The non-conductors are insulators. The children will come across these words in the study of electricity. If they already know these words in that context then they need to be aware of the use of the word in this context, too.

Air is an insulator and is used in the design of some plastic mugs. This is an example of a composite material like the papier-mâché on page 9 of the pupil book.

Teacher's sheet: activity

Based on **pages 16 and 17** of *Properties of materials*

Introducing the activity

(a) Begin by asking the children about what clothes they wear when they want to keep warm. Ask them about the properties of the materials (see note (i)).

Using the sheet

(b) Give out the sheet, let the children write their names and form, then go through tasks 1, 2 and 3 (see note (ii)).

(c) Let the children try tasks 1 and 2 and check their work before they start their investigation (see note (iii)).

(d) Let the children try out their plan (see note (iv)).

(e) Let the children try tasks 4 and 5.

Completing the activity

(f) The children should compare their results to see if they are similar. Any differences should be discussed to find out the cause. This can lead to reminding the children about the need for careful practical work.

Conclusion

The insulating properties of fabrics can be simply compared by wrapping them around the same volume of hot water for the same amount of time. Thicker fabrics are better insulators than thinner fabrics, and will keep the water hotter for longer.

Teaching notes

(i) They should mention that the materials are thick. It may be worth pointing out that the material is not solid, so air provides the extra insulation in a thick material.

(ii) The children may use a diagram to show how they would set up the apparatus.

(iii) The children will need one extra item – a clock, or they should be able to see a clock. Depending on the material you use and the ability of your class, you may wish to cut the fabrics to size before the lesson. The scissors then are only used for cutting the sticky tape to hold the fabric in place. If the children have cut their own fabric they should be sure to cover the bottom of the can. They should leave the top of the can uncovered.

(iv) Provide them with the warm water when they are ready for it.

8 Teacher's sheet: comprehension

See **pages 18 and 19** of *Properties of materials*

Answers

1. **The arrows radiate downwards from below the droplet.**
2. **Plastic.**
3. **Holes.**
4. **Kitchen towel, blotting paper, sponge, cotton.**
5. **It becomes water resistant.**
6. **The paper is coated with wax which stops the water from being absorbed.**

Complementary work

(a) You may compare the water absorbing properties of different papers by setting up the following experiment: Thread bulldog clips along a string. Connect strips of different paper to the bulldog clips. Secure the string above a tray of water so that the lower edges of the paper dip into it. Compare how the water rises up the different papers. You can colour the water with a water-based paint or dye to make it easier to see it rise up the paper. This may be done as a demonstration, or provided as an extra practical activity to show that a property can be investigated in different ways.

(b) Let the children use secondary sources to find out about the clothes worn by a lifeboat crew and the materials used to make wet suits for scuba diving.

Teaching notes

Water holds itself together by cohesive forces. When water comes into contact with substances like wax or grease the cohesive forces pull the water away from the surface and make the droplets rounder. Water also moves upwards against gravity if it is presented with a tube of the correct width. This upward movement is capillary action. A water-repellent material has no holes in it, so water cannot move into it by capillary action. A water-resistant material may have holes in it, but its fibres have been sprayed with a substance that makes the cohesive forces pull the water into large droplets that cannot pass through the holes. An absorbent material has holes of the correct size to draw water in and hold it there.

The children do not need to know about this detail but you may find it useful to help explain how water moves up the paper strips in the complementary work and why water does not come though an umbrella.

8

Teacher's sheet: activity

Based on **pages 18 and 19** of *Properties of materials*

Introducing the activity

(a) Begin by telling the children that they are going to test a number of fabrics (see note (i)) to see which are absorbent and which prevent water passing through them. Remind them that they can get ideas from the spread and let them look at it again for ideas for their plan.

Using the sheet

(b) Give out the sheet, let the children fill in their names and form, then go through tasks 1 to 3.

(c) Let the children try tasks 1 to 3 (see note (ii)).

(d) Let the children try tasks 4 and 5.

Completing the activity

(e) The children can compare their results. If a wide range of materials has been used, and a few materials have been tested by different groups, all the results can be pooled to make a class result.

Conclusion

Fabrics can be tested for their absorbency by having water placed on them and left there for a period of time. If the fabric is absorbent, the water will pass through it and stain the paper underneath.

Teaching notes

(i) Show the children your collection of fabrics – they should be squares of material (about 10cm square) you have cut from old clothes, including outdoor clothes.

(ii) The test should take the form of placing each fabric on a separate sheet of white paper and pouring an equal volume of water into the centre of each fabric. The squares should each be left with the water on them for the same amount of time – perhaps 3 minutes, then the fabric removed and paper examined. If the paper is wet, this shows that the fabric has absorbed the water and it has soaked through to the paper. Some children may think about measuring the size of the stain to compare the absorbency of the fabrics. The table should have two columns headed fabric and condition of paper. This second column could be filled in by writing dry or wet or, in the case of quantifying stains, a comment such as 'stain 3cm across' could be used.

Fabric	Condition of paper

Teacher's sheet: comprehension

See **pages 20 and 21** of *Properties of materials*

Answers

1. **Steel (bolt), gold (coin), copper (wire), aluminium (can).**
2. **Steel.**
3. **It is strong.**
4. **Aluminium.**
5. **It is light (and does not rust).**
6. **(a) Steel; (b) It goes brown and flaky; (c) Coat it in paint or plastic.**

Complementary work

(a) Gold forms in rocks as they cool. It is released when the rocks erode and may be found in river sand. One way of collecting it is to pan for gold. In this process a shallow pan of sand and water is swirled around until the sand is carried over the edge leaving the heavier gold in the pan. If you cut up a few brass paper fasteners, and mix them in some sandy water, the children can pan for 'gold', using a shallow dish as a pan and large bowl to collect the water and sand as it spills out. They can compare this unusual way of separating solid materials with other methods that they study later.

(b) The reactivity of metals can be demonstrated by letting the children look at clean and tarnished silver or letting a piece of old silver become tarnished.

(c) The children can use secondary sources to find out about bronze and brass.

(d) Metals are made from crystals but these are not usually seen. Zinc is unusual. When it is used as a metallic coating to protect iron (galvanised iron) it forms large crystals. These can be seen on galvanised iron buckets and farm gates.

Teaching notes

Very few metals are found naturally in metallic form. Gold, silver and copper are exceptions – they can be found as metal nuggets. Some meteorites are almost solid iron. Most metals react with other chemicals in their surroundings and form substances called compounds. A metal ore is a compound of the metal in a rocky form. Ores have to be treated in special ways to get the metal out of them. For example, iron ore has to be treated with coke in a blast furnace to release the metal.

Metals can be melted and mixed together. These mixtures are called alloys and they have properties which are different from the metals from which they are made. Alloys are widely used. For example, copper coins are made from an alloy of copper, tin and zinc, and silver coins are made from an alloy of copper and zinc.

9 Teacher's sheet: activity

Based on **pages 20 and 21** of *Properties of materials*

Introducing the activity

(a) Ask the children if they think that all metals rust. Whatever their response, ask them how they could make a fair test with an iron nail to see if their answers were correct (see note (i)).

Using the sheet

(b) Give out the sheet and samples of different metals. You should give them a steel nail, a piece of aluminium foil and a piece of copper wire. Let the children fill in their names and form, then go through tasks 1 to 3.

(c) Let the children carry out tasks 1 to 3 (see note (ii)).

(d) Let the children complete task 4 (see note (iii)).

(e) Let the children complete task 5.

Completing the activity

(f) The children can compare their results. Differences may occur around the time interval selected. Some children may have had to extend their table. Other children may have had a long enough time interval that they missed out on the early stages of rusting. Children who had a long time interval for inspection, but then discover rusting to be taking place, could change their inspection to a daily basis to record how the rusting proceeded. The sensible use of time can be discussed and a revised plan made which you may try if time permits.

Conclusion

Only the steel nail rusts.

Teaching notes

(i) The children should point out that samples of other metals should be the same size as the nail. This will mean that the amount of copper wire and aluminium foil used should be comparable to that of the steel in the nail.

You may have to ask them where they have seen rusty metal and elicit that rust is associated with damp surroundings. Steer the children into wrapping their metal samples in wet paper towels.

(ii) The drawings should be large enough so they will have space to record accurately where the rust occurs. The metals wrapped in towels could be put on a board or a tray and kept in a cupboard. If the conditions are warm the rusting process will be accelerated.

(iii) The children do not have to examine the metals every day. If some want to, then let them. They may find that they have run out of table before the steel rusts. Other children may think that rusting is a slow process and select a longer time interval. Let them follow their plan.

10 Teacher's sheet: comprehension

See **pages 22 and 23** of *Properties of materials*

Answers

1. **A = handle, B = scraper, C = sponge.**
2. **To add water to the window.**
3. **To scrape dirt off the window.**
4. **Because plastic is easily moulded into precise shapes.**
5. **Polythene.**
6. **Light, strong, waterproof, transparent, recyclable.**

Complementary work

(a) The children could make a survey about how many plastic items they find in the kitchen, living room, bedroom and bathroom.

(b) Use secondary sources to find out how plastic objects are made and how they can be recycled.

Teaching notes

Most plastics are made from oil. There are many substances in oil which are made from molecules that you can think of as long chains. At an oil refinery, these substances are broken up into substances which have very short, chain molecules. One of these substances is ethene. Ethene molecules can be linked together to form a long, chain molecule which does not occur in nature. As the molecule is made from many ethene molecules, it is called polythene. Other plastics prefixed by 'poly' are similarly made from many small molecules joined to make a long chain.

Plastics can be divided into two groups according to how they behave with heat. One group, called thermoplastics, become soft when warmed and hard again when cooled. Polythene belongs to this group. Plastics in the second group stay hard even when they are hot. They are called thermosets. Melamine is one example.

10 Teacher's sheet: activity

Based on **pages 22 and 23** of *Properties of materials*

Introducing the activity

(a) Ask the children if they have ever been shopping with a member of the family when the plastic shopping bag broke. This should produce some anecdotes to set the investigation as relevant to an everyday problem. Ask the children how they could test the plastic in different bags. One suggestion may be just to fill different bags with weights and see when they stretch. As the weights could be considerable, you might demonstrate this to the children.

(b) Move the ideas on to a safer method and steer the children to measuring the strength of plastic strips (see note (i)).

Using the sheet

(c) Give out the sheet, let the children fill in their names and form and show them how to set up a strip as shown in the diagram (see note (ii)).

(d) Let the children try task 2 and check their work.

(e) Let the children try task 3 (see note (iii)).

(f) Let the children try tasks 4 and 5.

(g) The children should now repeat tasks 2 to 6 with the selection of plastic strips.

Completing the activity

(h) Let the children compare their results. Encourage them to offer some advice from their results such as, "Do not put heavy objects in bin liners and expect to carry them far".

Conclusion

The strength of a plastic sheet can be tested by hanging weights on a small strip of it.

Thinner sheets are weaker than thicker sheets.

Teaching notes

(i) Cut strips of plastic from a range of bags, including bin liners.

(ii) Use short strips and arrange for the bulldog clip to be suspended only a short distance above the ground, but with enough space to hang a yoghurt pot of weights and record the stretch of the material.

(iii) Some plastics may remain unstretched throughout the test, but bin liner plastic should show signs of stretching. This gives you an opportunity to show that some investigations have limitations and, provided that this is mentioned in discussing the results, this is scientifically acceptable. The weight of the pot and its weights should be found on a weighing scale or balance.

Children could measure the length of the strip both before and after stretching and add these measurements to their table.