MATERIALS AND THEIR PROPERTIES
Age 7-8 (year 3)

A. Grouping and classifying materials (simple material properties)
B. Changing materials: mixing, heating, cooling
C. Separating mixtures of materials

14 lessons

A. Grouping and classifying materials (simple material properties)

8 Lessons:
1. Sorting/classifying materials
2. Recognising materials
3. Hard or harder?
4. Strong or stronger?
5. Flexibility
6. Floating and sinking
7. Soaking up water
8. Magnetic materials

<u>1. Sorting/classifying materials</u>

Collect a random set of objects made from a variety of materials, preferably with at least two from the various material groups e.g. metal, paper, plastic, wood, fabric, rock, wax. You could use a plastic ruler and plastic cup, piece of paper and paper towel, wooden block and small plank, small stones of different types, a sock and a handkerchief, wax candle and crayon, metal spoon and keys.

Discuss the basic division of objects is into living or non-living (discuss briefly 'how do we know something is alive?'). All the objects in this exercise are non-living. Don't sort them inot material groups yet – keep them mixed up.

Study your set of objects and describe them. Encourage your child to think about and describe what each object is like, steering him towards investigating **properties** such as mass, hardness and flexibility.

Write each of these properties on a piece of card: e.g.

hard/soft
weak (breaks easily)/ strong (doesn't break easily)
heavy/light
rigid/ flexible (bendy)
smooth/rough

Taking each object in turn, work out which property it possesses from each of the property pairs in your list. Place the chosen property cards next to the object as you decide. Record the name of each object (perhaps with a drawing) and its properties in your book.

Finally, make a new set of cards identifying the specific material from which your objects are made (e.g. metal, paper, plastic, wood, fabric, rock, wool, cotton). Have the child sort all the objects into the correct category. What did he notice about objects which possessed similar properties such as hard and smooth: did they fall into the same material categories or not?

Extension: Lead into a discussion preceding the next lesson: "How do we know which material an object is made of?" e.g. "How do we know the spoon is metal?" (because it possesses the characteristic properties of metal).

2. Recognising materials

Make a new collection of objects if possible (or use the same one), grouped by material with several examples in each group. The object is to identify the distinctive properties i.e. what makes something metal? Analyse the objects in each set and discuss their properties as before. This time you'll make a record of your findings.

Divide an A4 page (landscape format) into 9 rows and two columns (1 small, 1 very large).
Label the small column **'Material'**. Label the large column **'Description of the material'**
Label the rows as follows:

wood
plastic
paper
glass
fabric
metal
rubber
rock

Help the child list all the properties he can identify for each group of objects – what do all the metal objects have in common? What do all the plastic objects have in common? And so on..

When this is done, put a few objects in a 'feely' bag (or blindfold the child!) and see if he can identify an object's material specifically by identifying its properties.

Extension: Some objects will be a mixture of two materials – these could be placed in a Venn diagram. Objects could be identified by a 'yes/no' key depending on their properties (e.g. draw the object or write its name. Ask, is it hard? If yes, go to..., if no, go to.... You should end up at the correct material).

3. Hard or harder?

Some materials are obviously harder than others. Explain that we can measure hardness by a 'scratch test'. Give the child two examples of wood, a metal object, something rubber, a pebble, a brick, some clay and a couple of types of plastic. Also give him some scratching materials e.g. coin, match, sharp stone, cut hard plastic, nail, sharp twig

Discus what we mean when we say something is hard or soft. Give him something hard and something soft to test. Explain that we are talking about how much an object *yields to pressure*/pushing. Explain the difference between hard and strong (something can be soft and strong, like some fabrics, or hard and weak, like a cracker).

Make a table with rows and columns depending on how many materials and 'tools' (scratchers) you have. Taking each object/material in turn, try to scratch it with each tool in turn. Record your findings.

Study your findings to record the following results:
- which material was marked by the most tools?
- which tool scratched most materials?
- which material is the hardest?
- which material is the softest?
- list and number all the materials from softest to hardest

Extension: read about the Mohs scale which chemists use to record hardness of materials and research the question: What is the hardest material know to man?

4. Strong or stronger?

Ask your child what he or she thinks 'strong' means. Explain that the strength of a material depends on three things:
- how well it resists breaking or tearing
- how well it resists the force of other materials
- how well it can support weight.

Give a few materials – e.g. a piece of paper, a piece of wood, a piece of fabric, piece of metal such as a kitchen tray). Ask your child to try and tear or break each object with his hands. Are they all strong enough to resist him? Make a 'bridge' with each material (e.g. suspend between two piles of blocks). Taking each material in turn, try to place a wooden block (or equivalent) on top of your 'bridge'. Can they all hold its weight? (the paper should collapse, and perhaps the fabric depending on its strength). For those materials which could hold one block, try adding another block and then another....which material is the strongest and which the weakest? (wood and metal may be recorded as being equally strong).

Record all your findings in a table, listing and numbering the materials from strongest to weakest.

Extension: Where might we need strong materials in engineering and manufacture? Research materials commonly used in bridges, buildings, planes, furniture...and anything else of interest.

5. Flexibility

Ask the child what he thinks the word **flexibility** means. Explain that we mean some materials can be folded, twisted, bent or wrapped around things.

Provide a selection of flexible and inflexible objects e.g. inflexible might be a metal spoon, key, wooden block and spoon, coin, hard plastic ruler, plastic cup; flexible might be various types of paper, foil, leather, fabric, wire, string, rubber bands, clingfilm, plastic or rubber tubing, flexible plastic ruler if available. Try to give a few examples within each *material* if possible.

Handle and try to bend the objects, discussing how flexible they are. Sort the objects into two groups, flexible and inflexible. Then sort the objects by material type. What do you find? Metal and wood are inflexible – but what about tinfoil? Explain that aluminium/tin is only flexible when it is very thin. Plastic can be very flexible (clingfilm, tubing) or very inflexible (cup, ruler).

Devise a test to measure flexibility (e.g. wrap or twist around a pencil or a box). Test each object in the same way, then fill in a table naming the material and describing it under one of these headings:

not at all flexible **slightly flexible** **quite flexible** **very flexible**

Using the information you have gathered, complete these sentences:

Many flexible things are made of.............
Very few flexible things are made of................

Extension: Devise further tests for flexibility and apply them to your materials. Decide which is 'most flexible' and which 'least flexible'. What criterion could you use to decide? (e.g. proves flexible in all tests)

6. Floating and sinking

Fill a large see through tank/bowl with water.

To make sure your child understand the concepts of floating and sinking, give him a 'floating/sinking' selection of objects and have him predict if each will float of sink (try to include some which will float under the surface too – what does a sponge do?)

Next, give him a reasonably sized ball of plasticene. What happens when it is placed in the water? It should sink. Ask the child how he can make the plasticene float. Give him a while to think about this and mess around if he doesn't work it out straight away.

Once he has figured out that he needs to increase the surface area by making a sort of 'boat', ask him to see if his boat will hold a marble. If not, ask him how he might change the shape so that it will hold a marble. If he achieves this, ask him to add another marble and so on. How many marbles can he add before his boat sinks? Help him to record his findings on a chart, with drawings of his various boats to show which was the most successful shape (he might try a flatter base, or broader sides, or a long shape or a round shape). Let him have fun experimenting with different shapes.

Extension: Design a graph to show the results (e.g. comparing surface area of 'boat' to number of marbles held)

7. Soaking up water

To show that some materials can hold more water than others

Take pieces of several different materials (e.g. cotton, wool, nylon, paper towel, tissue) and wrap each around the top of a jam jar with an elastic band. In this experiment, you will carefully drop water from a dropper one drop ta a time onto the fabric until a drop gets through. Have your recording sheet ready to show which material you are testing and exactly how many drops are required to get water through the fabric. When you've tested all the materials, compare your results and list/number the materials from least absorbent (water went through quickly) to most absorbent (water took longest to get through). Discuss which materials you would choose for mopping up spills!

8. Magnetic materials

(Most work will be done on magnets in the physics part of the course)

The point here is to teach that while all materials which are attracted to a magnet are metal, not all metals are attracted to a magnet.

Provide a large magnet and a selection of objects including plastics, paper, rubber, string, fabric etc. and several metal items (paper clip, key, coin, wire). Give the child a sheet with the names of all the materials you have selected, and have him predict which he thinks will be attracted by a magnet and which will not (if he doesn't want to predict, just skip this and go straight to the experiment). Place each object near the magnet in turn and record the results. Were there any surprises? Which material group was the most easily attracted? (metals). Were all the metals attracted?

Taking out the magnetic objects, try the experiment again and record which were most strongly attracted. Explain that it is the **iron** in the metal which is attracted to the magnet – this explains why steel is attracted. What about aluminium cans? Devise a scale for magnetic attraction and number your objects on the scale.

Extension: Find out which materials around your house are magnetic (the fridge? The radiators? The lamp bases?) Try to predict the outcome before the test and record all your results.

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B. Changing materials: mixing, heating, cooling

4 lessons

1. When materials are mixed, changes occur
2. Heating solid materials
3. Freezing
4. Hot and cold

1. When materials are mixed, changes occur

If possible, buy a cheap set of test tubes with a stand: smaller amounts of material can be used, reactions can be easily observed and the children feel they are doing 'real' science'. If this isn't possible, you'll need several small transparent containers instead and perhaps larger quantities of materials for mixing to see the results clearly.

Materials for mixing include: cooking oil, food colouring, salt, bicarbonate of soda, plaster of Paris, custard powder, soil, cornflour. You'll also need spoons, kitchen towel, a measuring scale with millimetres, and a plastic jug for water.

Make a table listing each material with a description of its normal state (you'll need to help with this). Carefully, taking each material in turn, add just enough water to make a mixture (the amount will depend on the size of your container). Record each result as it appears. Ask prompting questions: was there any immediate reaction? Did the materials mix easily? Was there a change in colour? Can you still see both materials separately? Are there bubbles, and if so, why? Was a solid or semi-solid produced? Record all the results.

Extension: After you have left the mixtures for a while, go back and examine them again. Have any changed from your original observations at the point of mixing? If so, record the changes. Why do

you think this has happened?
Make a bicarbonate and vinegar 'volcano' (use play-dough around the test tube and red food colouring to produce a' volcanic reaction'. Cover the area with newspaper!

2. Heating solid materials

You'll need various materials to melt (e.g. lard, margarine, jelly, banana, bread, cheese, ice, wax), and several 'containers/boats' made out of tin foil.

In each 'boat' place a portion of your chosen material (they should be the same size if possible).

Make a table with the name of each material you will be using, leaving room for your observations. If your child is keen, have him/her predict what will happen.

You will need a large bowl filled with the hottest water you can safely use.

As simultaneously as possible, place the 'boats' with their objects into the water. Record what happens immediately, then again after 1 minutes, then 2 minutes, and so on until the water cools. Make a record of which materials were most affected by the heat and which least affected. Were any not affected at all? Did any materials change colour? Did any change again as the water cooled?

Point out whilst cooking how heating/cooking causes changes in food (cake mixture, boiled eggs etc. are quite obvious changes). You might point out that these changes are obviously irreversible!

Just for fun, melt chocolate and pour it into moulds to make shapes, or drizzle shapes/names onto greaseproof paper.

Extension: Can you identify any groups of materials which were affected in similar ways? If so, can you find any properties these materials shared before they were heated? Record what this tells you about the properties of the various materials.

3. Freezing

Provide some sample materials in transparent plastic bags e.g. lard, butter, washing up liquid, chocolate, soil, water, bread, paper clip, plastic block/cube, pebble, pencil, soap.

Discuss with the child what he/she thinks will happen. Will any of the materials be changed when the bags are put in the freezer? How will you know if freezing has occurred?

Make a table listing your materials and describing their normal appearance. After several hours of freezing (overnight is best), investigate what has happened. Prompt with questions such as: has the material changed its shape or colour? Does it feel different? Record your observations.

Group the materials in terms of e.g. not affected/changed from liquid to solid/ became harder.

Extension: After a few hours out of the freezer, record what happens. Are all the changes reversed?

4. Hot and cold

Discuss the terms hot, warm and cold. How can we decide if something is hot, warm or cold? By touching it? Touch a few surfaces and objects and try to determine which category they fall into. Try to show that different people might come up with a different answer – i.e. temperature can be felt differently and touch is not always an accurate measurement. To show this, conduct a simple experiment.

Place three bowls of water on the table: one as hot to touch as possible, one very cold (with ice cubes if possible) and one lukewarm. Have the child place one hand in each of the hot and cold bowls for about a minute. Then remove both hands and place both in the warm water bowl. What do you find? (each hand should record a different temperature). This shows that touch is not always an accurate recorder of temperature, and that is why we need more accurate ways of measuring – i.e. thermometers.

Extension: Thermometer use will be covered next year but if your child is interested, show him a thermometer and explain how it works.

C. Separating mixtures of materials

2 lessons
1. Making and sorting mixtures
2. Methods of sorting

1. Making and sorting mixtures

The aim of this lesson is to introduce the child to the idea of particles and composition of mixtures and that mixtures are made of up particles which can be sorted and separated. Make collections of various objects for sorting (e.g. buttons, nails, dice, counters, pebbles, shells, coins).

This is a timed experiment, so you will need to discuss and agree on a means of timing (e.g. stopwatch). Ask the child which collections he thinks will be easiest to sort into groups – e.g. by colour, size, type. Then have a go: find out which groups are easiest to sort. Try to steer the discussion around to questions such as: what is it that makes one mixture easier to sort? Is it a greater difference in particle size? Does colour help? Does it depend on how many different types of particle there are in the mixture? Record your answers.

Extension: Devise further timing tests. Using a measured amount of mixture each time (e.g. one cup), do extensive trialling to find out the fastest sorting time and the easiest mixture to sort. Graph the results.

2. Methods of sorting

Prepare several groups of mixtures each with three differing particle size (e.g. dried peas/beans, lentils, pebbles, rice, sand, pebbles, beads, marbles, small buttons, soil). You will need a variety of differently sized sieves and strainers and containers to collect sieved particles.

The aim is to separate the particles into their groups as easily as possible. Discuss possible approaches and results before hand. Which particles will need to be removed first? Which will be the best strainer to use for that purpose? Is the order in which particles are removed important? Will the child need to make an even finer sieves (perhaps out of muslin or nylon stockings) to separate the finest particles?

Extension: Work out methods for separating a mixture with 4, 5 or 6 different particle sizes.