<table>
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<tr>
<th>Unit/topic</th>
<th>Task number</th>
<th>Description</th>
<th>Resources</th>
<th>Health and safety</th>
<th>Practical selected?</th>
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<tbody>
<tr>
<td>7Aa</td>
<td>Exploring 8</td>
<td><strong>Leaf skeletons</strong>&lt;br&gt;As a teacher demonstration only, prepare leaf skeletons to show the xylem tubes in a leaf. Thin leaves such as oak work best. Add 150 g of sodium carbonate to 500 cm³ of water. Then add 136 g of calcium hydroxide. Boil for 15 minutes. Pour the liquid through a sieve to remove any bits. Pour the liquid back into the pan/beaker and add the leaves. Boil for one hour (making sure that the solution does not boil dry) and then remove the leaf skeletons with forceps— they are very delicate.</td>
<td><strong>Resources</strong>&lt;br&gt;Thin leaves (e.g. oak); large glass beaker or pan; 150 g sodium carbonate; 136 g calcium hydroxide; sieve; heating apparatus.</td>
<td>Calcium hydroxide is an irritant. Avoid raising dust.</td>
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<tr>
<td>7Aa</td>
<td>Plenary 3</td>
<td><strong>Heart dissection</strong>&lt;br&gt;Show pupils a sheep’s heart (or similar) and ask them to identify different tissues. Ask pupils what sort of tissue is being eaten when people eat ‘meat’.</td>
<td><strong>Resources</strong>&lt;br&gt;Sheep’s heart (or similar); scalpel.</td>
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<tr>
<td>7Ab</td>
<td>Exploring 2</td>
<td><strong>Looking through a microscope</strong>&lt;br&gt;Pupils could look at prepared slides. It is suggested that pupils keep both eyes open whilst looking down the microscope. This will take practice but will mean that their eyes will become less tired and stories of strange objects swimming across the slides (eyelashes) will be less common! Practice using the microscope could involve looking at hair, fish scales, newsprint, etc. Pupils then look at prepared slides of tissues such as onion skin (for lower-attaining pupils) or move on to Exploring 7 (for other pupils). Encourage pupils to draw or write about what they see.</td>
<td><strong>Resources (per group)</strong>&lt;br&gt;Microscope; slides of hair, fish scales, etc.; Skills Sheet 45.</td>
<td>Do not allow pupils to angle the mirrors towards the Sun, as this can seriously damage eyesight.</td>
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If using microscopes with mirrors then it is best to use a lamp (with adjustable positioning) that the pupils can angle towards the mirrors; overhead lighting is rarely bright enough. Many microscopes have a small fine-focusing wheel in addition to the larger coarse-focusing wheel. The fine control should be used at higher magnifications (objective lenses ×10 and above) to prevent the lens being driven into the slide and breaking it. More complex microscopes will have a diaphragm under the stage to control the light intensity. This is best altered by the teacher, if necessary. It must be remembered that cells are three-dimensional objects and focusing through the layer of cells will make structures (like the nuclei) appear and disappear; not all the nuclei lie conveniently in one plane. Confusion may be caused if using microscopes with pointers in the eyepiece lens. Pupils should be warned about this before using the microscopes and should avoid drawing in the pointers.

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<tr>
<th>7Ab</th>
<th>Exploring 3</th>
<th><strong>Estimating size</strong></th>
<th><strong>Resources (per group)</strong></th>
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<tbody>
<tr>
<td></td>
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<td>Higher-attaining pupils could use microscopes and measure the diameter of the field of view and therefore estimate the size of an object seen through the microscope. Full instructions are given on Skills Sheet 46. Prepared slides should be used for this, with water fleas, hair or other reasonably large specimens. Pupils could look at their own hair by pulling out a hair and fixing it to a microscope slide using sticky tape.</td>
<td>Microscope; prepared slides of quite large specimens; transparent ruler with millimetre scale or eyepiece graticules and stage micrometers (the latter can be eyepiece graticules secured to microscope slides); Skills Sheets 45 and 46.</td>
</tr>
<tr>
<td>7Ab</td>
<td>Exploring 7</td>
<td><strong>Onion cell slides</strong></td>
<td><strong>Resources (per pupil/group)</strong></td>
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<tr>
<td></td>
<td></td>
<td>If pupils are to make their own slides, ask them</td>
<td>Piece of onion; forceps/tweezers;</td>
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<td></td>
<td></td>
<td><strong>A mounted needle is a better way of</strong></td>
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Do not allow pupils to angle the mirrors towards the Sun, as this can seriously damage eyesight.
to follow the guidelines given on page 11 of the Pupil’s Book (or Skills Sheet 44). Pupils should not try to flatten their slides by pressing on the coverslip. This often results in the coverslip breaking. Methylene blue is a suitable stain to use instead of plain water. It will help the cell walls and nuclei to show up better. Alternatively, use red onions. Pupils should be encouraged to draw and label what they see. At this stage pupils don’t need to know that these are cells but should be encouraged to think about what they are seeing. They should also write down the magnification that they have used. Once pupils have made drawings, display some of these and ask pupils what they think they are. Mention that these are called cells (about which more will be learnt in the next topic).

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<thead>
<tr>
<th>7Ab</th>
<th>Exploring 8</th>
<th>More cells</th>
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<tr>
<td>Exploring 7 can be repeated using a variety of other tissues. Encourage pupils to try a range of different tissues and to discover which is the easiest to view clearly, and to explain why this is the easiest to view. Sheets of rhubarb cells can be obtained by snapping a rhubarb leaf stalk in half and peeling away thin layers. Inner layers will show xylem cells. Leaf cells can be examined using a whole moss leaf or painting clear nail varnish onto the surface of a leaf. Once the nail varnish is dry, peel it away from the rest of the leaf with a pair of forceps. It is best to use monocotyledonous leaves for this (grasses, lilies, palms) since these have more regular box-like cells.</td>
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<th>Resources (per pupil/group)</th>
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<tr>
<td>Rhubarb stems; clear nail varnish; moss leaves/plant or monocot leaves; forceps/tweezers; slide; coverslip; water (or 10% methylene blue stain); pipette; microscope; Skills Sheets 44 and 45. Optional: mounted needle.</td>
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<tr>
<th>Slide demonstration</th>
<th>Resources</th>
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<tr>
<td>Resources</td>
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<tr>
<td>7Ac</td>
<td>Exploring 1</td>
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<tr>
<th>7Ac</th>
<th>Exploring 2</th>
<th><strong>Human cheek cells</strong></th>
<th>Resources (per pupil)</th>
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<td></td>
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<td>The Practical box on page 12 of the Pupil’s Book challenges pupils to plan an investigation to look at some of their own cells. It is expected that most pupils should be able to produce their own plans, basing them on work done in Topic 7Ab. Encourage pupils to plan for staying safe. Lower-attaining pupils may need to follow the plan on Worksheet 7Ac(3). To obtain cheek cells, no real scraping of the inside of the cheek is required – the cells come off very easily if only lightly touched with a clean cotton bud or tongue depressor.</td>
<td>Autoclaved tongue depressor (or lolly stick or clean cotton bud); microscope slide; coverslip; 10% methylene blue stain; pipette; access to microscope; Worksheet 7Ac(3); Skills Sheets 44, 45.</td>
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All contaminated items (buds, microscope slides) should be placed in a beaker and autoclaved (preferable) or placed into disinfectant (e.g. 1% Virkon®).
<table>
<thead>
<tr>
<th>7Ac</th>
<th>Exploring 3</th>
<th><strong>Which stain is best?</strong> Higher-attaining pupils could conduct a simple investigation to determine which stain is best. They could do this using their own cheek cells from Exploring 2 or use onion cells. They should be able to plan the investigation for themselves. Stains that may be used are methylene blue (stains nuclei blue), iodine/potassium iodide solution (stains starch – formed in chloroplasts), toluidine blue (blue nuclei), eosin Y (pink cytoplasm, red cell walls). Worksheet 7Ac(4) can be used for results recording, consideration and evaluation.</th>
<th><strong>Resources (per group)</strong> Source of animal/plant cells; forceps/tweezers; slides; coverslips; pipettes; microscope; selection of stains (iodine solution, 10% methylene blue, 1% toluidine blue, 5% eosin Y); Worksheet 7Ac(4); Skills Sheets 44, 45.</th>
<th>Methylene blue, iodine, eosin and toluidine are all harmful or irritants as solids. Eye protection should be worn when stains are being handled.</th>
</tr>
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<tbody>
<tr>
<td>7Ac</td>
<td>Explaining 3</td>
<td><strong>Model cells</strong> Build a 3D plant cell model, using a cardboard box with some holes in it (cell wall), cling film (cell membrane), small sausage-shaped balloon (vacuole), green card discs (chloroplasts) and a round ball of Plasticine® (nucleus). Either show the completed model to the class and ask them to say what they think each bit represents, or discuss with the class how you are going to build it and demonstrate this step by step. Explain what each part of the finished cell does. Higher-attaining pupils could build their own models.</td>
<td><strong>Resources</strong> Scissors; coloured pens/pencils; glue; small cardboard box (e.g. shoebox); cling film; sausage-shaped balloon; card; Plasticine®.</td>
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<tr>
<td>7Ad</td>
<td>Exploring 1</td>
<td><strong>Looking at tissues</strong> Pupils look at various prepared slides of tissues using a microscope. Suggested slides are ciliated epithelial, nerve, muscle, xylem and palisade tissues. These can be drawn and labelled (using Worksheet 7Ac(2) from the previous topic if desired). This practical could be made into a ‘guess the tissue’ game if the slide labels are covered up. Higher-attaining pupils</td>
<td><strong>Resources (per pupils/group)</strong> Microscope; prepared slides (ciliated epithelial, nerve, muscle, xylem, palisade tissues); Worksheet 7Ac(2); Skills Sheet 45.</td>
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</table>
could look for different cell types and tissues, and relate this to the structure of the leaf, by looking at, for example, a transverse section of a privet leaf.

| 7Ad | Exploring 2 | **Preparing tissue slides**  
Following the guidelines given on page 11 of the Pupil’s Book (or Skills Sheet 44), slides could be made of various tissues. This might include vertical stem sections to show xylem tissue in rhubarb or root hair tissue from freshly germinated mustard/cress. Vertical leaf sections (difficult) could be used to show the layers of tissue in a leaf. Muscle fibres from raw beef braising/stewing steak can be teased out in 0.5 mol dm–3 NaCl solution. Cavity slides are best used for all of these. |
| Resources (per pupil/group)  
Rhubarb stem; freshly-germinated mustard/cress; thick leaves; braising/stewing steak; scalpel; forceps/tweezers; cavity slides; coverslips; water (or 10% methylene blue stain); pipette; microscope; 0.5 mol dm–3 NaCl solution; Plasticine®; Worksheet 7Ac(2); Skills Sheets 44 and 45. |
| If pupils are to make their own tissue sections, they will need sharp cutting implements, such as scalpels. You should consider whether scalpels are safe to use in some classes. Materials to be cut can be held in Plasticine®. |

| 7Ad | Explaining 2 | **Displaying tissues**  
If a video camera attached to a microscope is available then various prepared slides of tissues can be shown to pupils. Vertical sections through leaves and stems will show palisade and xylem tissues. Ciliated epithelial, muscle and nerve tissue sections are also useful. Equally useful are large photographs or photographic slides of these tissues. Explain to pupils that the tissues look different to each other because they contain different cells, but that each tissue contains a group of the same cells. Show pupils individual cells and explain their functions. |
| Resources  
Video microscope and display screen; prepared slides of tissues. |

| 7Ae | Exploring 1 | **Water loss by leaves**  
The Practical box on page 19 of the Pupil’s Book asks pupils to plan an investigation to find out how much water a leaf loses in different weather conditions. This practical can be used |
| Resources (per group)  
3 or 4 thin leaves with stalks; retort stands; lengths of cotton to tie to each leaf (approx 5 cm long); marker pen to mark leaves; hair |
to carry out an AT1 Investigation. A sheet of level descriptions is provided on page 33 of the ASP. Worksheets 7Ae(3) and 7Ae(4) will guide pupils through doing this practical and/or planning it. The use of these sheets will limit the amount of AT1 assessment that can be done: Note that strange results can sometimes be obtained in the lab because, without enough light, the stomata close, with the result that water loss may not be as predicted.

- **Must:** the help sheet (7Ae(3)) assumes only one measurement is taken after about 30 minutes, which should be enough time to see a clear difference between the leaf under the hairdryer and the others.
- **Should:** pupils using Worksheet 7Ae(4) should be encouraged to plan how they will create the various conditions needed. Conditions might include warm and windy (using a fan), hot and windy (using a hairdryer), warm and still (in a room), hot and still (using a radiator or similar). The masses of the leaves could be measured every 20–30 minutes.
- **Could:** as an extension, pupils could work out the mean water loss per cm² of leaf area, since their leaves are unlikely to be exactly the same size. Using squared or graph paper, a leaf is drawn round and then the total number of squares that it has covered is counted. This exercise is also useful for filling in time between taking measurements. The leaves should be thin and flat at without any waxy covering (e.g. oak leaf). Pupils could also investigate the condition variable more accurately using thermometers and anemometers.

dryer, fan; (thermometer, anemometer); Worksheets 7Ae(3), 7Ae(4); Skills Sheet 12, 27–32 and 36; access to balances.
### 7Ae Explaining 1

**Water loss by whole plants**

A good way to demonstrate water loss in whole plants is to put a small plant in water inside a conical flask (as shown on Worksheet 7Ae(10)). The water is covered with a layer of cooking oil (to prevent evaporation) and the water level is marked on the side of the flask. The stem of the plant is supported by putting sponge inside the neck of the flask. You set up a series of different plants and vary the conditions as for Exploring 1. Readings of the water level could be taken over a period of days or each plant could be placed on a balance linked to a datalogging device. The amount of water lost is 1 cm³ for each 1 g mass decrease.

**Resources (for demonstration)**
- 2 or 3 conical flasks; 2 or 3 small plants; 2 or 3 sponge stoppers; marker pen; cooking oil; Worksheet 7Ae(10). Optional: balance; datalogger.

### 7Ba Exploring 2

**Frog development**

Depending on the time of year, it may be possible to obtain some frogspawn and watch the development of fertilised frog egg cells. These should be placed in de-chlorinated water in an aquarium with a rock sticking up above the surface of the water to allow any young frogs to climb out of the water. The aquarium should be fitted with an air bubbler. Only very small amounts of frogspawn should be taken. Feeding the tadpoles is easy – use freshly boiled lettuce or spinach (not cabbage) or alternatively crushed rabbit food pellets. Feed small amounts twice a day. Tadpoles will hatch in 1–2 weeks (depending on species and water temperature). After their hind legs have started to develop, they need a change of diet because they now become carnivorous. Dried ant eggs (from a pet shop) or chopped liver (cooked or raw) are both suitable. You may consider returning the tadpoles to where they were found at this stage.

**Resources (for demonstration)**
- Aquarium or large fl at pan; frogspawn; de-chlorinated water; rabbit food pellets/lettuce/spinach; digital camera (optional).

Wash hands as soon after collecting as possible.
<table>
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<tr>
<th></th>
<th>Explaining 3</th>
<th>Emotional changes survey</th>
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<tbody>
<tr>
<td>Small frogs will take about 12 weeks to develop. Encourage pupils to make drawings or take digital photographs of the different stages of development. Always release any tadpoles or frogs back into the same place from which the spawn was taken. This will help prevent the spread of viral and fungal diseases.</td>
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<tr>
<td>Resources</td>
<td></td>
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<tr>
<td>Plasticine®, poppy seed.</td>
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</table>
| Exploring 4 | Modelling a foetus  
The size of a foetus at one month can be demonstrated using a simple Plasticine® model 5 mm in length. The model should look a bit like a curled up crescent with no human features. The heart is formed at this stage and is pumping but is about the size of a poppy seed. |  |
| Emotional changes can be demonstrated using a survey. Pupils conduct a survey in which a moral dilemma is posed: ‘A man has a very ill wife who is in a great deal of pain. He can’t really afford the medicine that she needs to relieve the pain and so he breaks into a doctor’s surgery and steals the medicine. Was he right to do this?’ If this question is asked to pupils in, say, Year 5, their responses will be seen to be very black and white, often tending to be ‘No, it’s always wrong to steal’ or ‘Yes, he was only trying to help’. Many pupils in Year 7 will see that there is not a clear choice and a variety of options must be weighed up. This is an example of emotional changes in action. The data collected could be displayed in a variety of ways using tables, charts and graphs. This practical can be used to carry out an AT1 Investigation. A sheet of level descriptions is provided on pages 62–63 of the ASP. However, if this activity is |  |
| 7Be | Exploring 5 | **Growth measurements (AB/AT)**  
Pupils measure the heights of others in their class and pool their results using a tally chart. They then plot a bar chart to show the numbers of pupils in different height groups. Height groups should not overlap (e.g. 120–124 cm and 125–129 cm, rather than 120–125 cm and 125–130 cm). Masses and waist sizes could also be measured. This practical also links to topic work in Topic 7Da and you could use the data on Worksheet 7Da(10) instead of measuring heights.  
• **Must:** pupils use the second AT spreadsheet link on page 33 which opens *Height chart*.  
Pupils fill in the heights they record and the spreadsheet automatically draws a bar chart.  
• **Should:** pupils follow the instructions on Worksheet 7Be(4).  
• **Could:** pupils are told to draw a bar chart of pupils’ heights in the class. They need to plan and carry out the practical on their own. | **Resources**  
Metre ruler or tape measure; large blank sheet of paper; sticky tape or Blu-tack®. | Many pupils are sensitive about their heights and especially their masses or waist sizes. Teachers need to handle such work with tact, pointing out that there is always a great deal of variation and the concept of ‘normal’ is not helpful. |
| 7Ca | Exploring 1 | **Assessing a habitat**  
Tell pupils that they are going to visit two habitats, both of which have plans for building work nearby. Tell them that they need to do an environmental impact assessment on each habitat (e.g. woodland and pond). Two copies of Worksheet 7Ca(3) may be useful as a basis for taking notes.  
Pupils could begin by identifying the main | **Resources (per pupil)**  
Access to pooters; hand lenses; light meters, anemometers, pH meters, moisture meters and any other relevant measuring devices; 2 copies of Worksheet 7Ca(3); Skills Sheets 51 and 52. | Pupils should wash their hands after handling live organisms (including plants). Pooter mouthpieces need to be disinfected before and after use (soak in Milton® for 30 |
differences between the two habitats, both in terms of physical environmental factors and what lives there. This could lead on to the examination of physical environmental factors in various places around each habitat. Various pieces of equipment could be used to measure these factors (light meters, anemometers, moisture meters pH meters).

Pupils should learn that different organisms are found in different areas of a habitat, depending on the environmental conditions. This may lead onto the fact that various organisms are adapted to living in certain conditions and not others. Skills Sheets 51 and 52 contain a series of drawings that pupils can use to help with identification. Pupils often ask about some of the plants in a habitat and what they are. A selection of books is useful (see Background information) and the pupils can be encouraged to look things up for themselves. Pupils should record the animals and plants that they find and the environmental conditions that they are found in. The idea of using a key could also be covered.

For their reports, pupils should list the organisms found in each habitat and state what effects the building work will have on those organisms. They should consider also whether they think the building works should go ahead and give their reasons.

Visiting an area before taking pupils is essential to see what organisms are found there and if there are any hazards. Pupils should be reminded that all organisms should be handled with great care and returned to where they were found. They should also appreciate that litter

minutes). As for any field trip, there must be an appropriate pupil : adult ratio (check your school’s policy for guidance).
and excessive noise can damage a habitat.

| 7Ca | Exploring 2 | The weather station  
To monitor physical environmental changes in the school grounds, pupils could set up a simple weather station, taking readings at the same time each day or using datalogging and computer equipment. | Resources  
Thermometer; anemometer.  
Optional: datalogger. |
| 7Ca | Exploring 4 | Plants and environmental factors  
The initiator for this practical is on page 36 of the Pupil’s Book. This practical can be used to carry out an AT1 Investigation. A sheet of level descriptions is provided on pages 86–87 of the ASP. This practical could also be used in Unit 8D. Factors that could be investigated include soil moisture, light intensity, soil pH, wind strength, relative temperature and aspect. Pupils should carry out preliminary work to make sure that useful data can be obtained (e.g. by measuring moisture levels at random around the area to be studied and looking to see if there are changes in the numbers of one species of plant across the area). Full instructions for investigating soil moisture are given on Worksheet 7Ca(2), which is a help sheet. Be aware that most moisture meters are very inaccurate. This provides a good evaluation point and you could challenge pupils to come up with a better way of measuring moisture content (e.g. take soil samples, measure masses, dry in a low-heat oven, measure masses again). | Resources (per group)  
Quadrat; access to moisture meter, pH meter, light meter, anemometer, compass; Worksheet 7Ca(2).  
Pupils should wash their hands after this investigation – plants and soil may both be contaminated with animal urine and/or faeces. |
| 7Cb | Exploring 5 | Salty ponds  
Initiated from the Practical box on page 38. Duckweed (any free-floating species will do, e.g. common duckweed, *Lemna minor*) can be | Resources (per group):  
Common duckweed (*Lemna minor* or other free-floating variety); 250 cm³ beakers; common salt  
Pupils should wash their hands after contact with any plant material. |
grown in beakers containing various concentrations of common salt. The idea is that pupils will discover that the plants are adapted to living in fresh water and die in salty water. A range of salt concentrations can be used from 0.5–30 g/l, although the plants will not survive for very long in the more concentrated solutions (above 5 g/l); the leaves will start to blacken within about 48 hours. Worksheet 7Cb(2) is a help sheet.

<table>
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<tr>
<th>7Cc</th>
<th>Exploring 3</th>
<th>Water flea activity</th>
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|     | From the suggestion in the Pupil’s Book on page 40, pupils could observe how water fleas (or brine shrimps) change their activity between light and darkness. **Must:** this is simply done using large beakers and a light source. The water fleas are closer to the surface and more active in the light; less active and lower in the water during darkness. A light bulb could be positioned over the beaker to observe this, whilst darkness is best achieved using a thick black bin liner to cover the beaker. This should be left for at least 5 minutes before being removed and the water fleas observed straight away. Worksheet 7Cc(2) can be used to help with planning. **Should:** pupils could try to get quantitative results by altering the light intensity (and measuring it using a light meter) and measuring how far up the beaker most of the water fleas are. It is often quite difficult to get meaningful results but pupils could then consider whether there is a certain light intensity below which water fleas go to the bottom, or whether there is a gradual change in the position of the water fleas depending on light intensity. Larger

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<th>Resources (per group)</th>
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<td>One large beaker of water fleas (<em>Daphnia</em>) or brine shrimps (which could be obtained from a pond in the case of <em>Daphnia</em> or from a biological supply company); light source; hand lens and possibly a light meter and a ruler; Worksheet 7Cc(2).</td>
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If pupils are to collect their own water fleas, they should be returned to the pond they were taken from. Pupils should wash their hands after handling pond water. appropriate adult : pupil ratio and take great care around ponds (consult your school's policy on field trips for guidance).
<table>
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<tr>
<th>7Cc</th>
<th>Explaining 3</th>
<th><strong>Looking at different flower habits</strong></th>
<th><strong>Resources</strong></th>
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<td>Wood sorrel or evening primrose flowers can be used to show that some flowers are open at night, compared to daisy flowers that are shut at night. If you have two sets of these plants, with one set under a lightproof box, it should be possible to show the different states of the flowers.</td>
<td>Flowers that are shut during the day (e.g. wood sorrel or evening primrose); flowers that are shut at night (e.g. daisy).</td>
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<thead>
<tr>
<th>7Cc</th>
<th>Explaining 4</th>
<th><strong>How plants survive the winter</strong></th>
<th><strong>Resources</strong></th>
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</table>
|     |              | Show pupils a selection of overwintering structures. Ask pupils what they think each one is and then explain why they are needed. | Selection of overwintering structures *
|     |              | **Should:** examples include potato tubers, onion bulbs, carrot tap roots, budded twigs (these can be frozen for use later in the year). | **Could:** examples include pupae, rhizomes. |

<table>
<thead>
<tr>
<th>7Cd</th>
<th>Exploring 2</th>
<th><strong>Choice chambers</strong></th>
<th><strong>Resources (per group)</strong></th>
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<td>Most choice chambers have two sections in the bottom half. One can be filled with water and the other with a thin layer of anhydrous calcium chloride (or other suitable desiccant), which dries the air above it. The gauze is then put in place and the lid pushed on firmly. The woodlice can be gently placed into the chamber by pouring them through a wide bore funnel into the hole in the top of the chamber. Pupils should be encouraged to say how they will look after their woodlice. <strong>Must:</strong> the numbers of woodlice in each half should be observed after 15 minutes. Bar charts can be drawn for the number of woodlice in each half over 15–20 minutes.</td>
<td>Choice chamber; 10–15 woodlice; wide bore funnel; plastic container for woodlice; anhydrous calcium chloride; water; card; Worksheet 7Cd(3).</td>
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Anhydrous calcium chloride is an irritant and should not be handled with bare hands. Eye protection must be worn when handling it. If pupils collect their own woodlice, they must be returned to the place they were found after the experiment. Pupils should wash their hands after handling woodlice. Hands
• **Should:** the practical can be simply extended by placing some card over one half of the chamber creating the following conditions: dry/dark, dry/light, damp/dark, damp/light.

• **Could:** some pupils might be challenged to think up and answer further questions: ‘How could you show that one half of the chamber is moist and the other half dry?’ (use blue cobalt chloride paper), ‘Why are the woodlice different sizes?’ (age and species).

<table>
<thead>
<tr>
<th>7Cd</th>
<th>Exploring 3</th>
<th>Camouflage</th>
</tr>
</thead>
<tbody>
<tr>
<td>In pairs, pupils can be given 20–30 coloured buttons with the number of each colour known. One pupil spreads the items in a set area in some grass (1 m² is sufficient). The set areas can be marked out using quadrats or with string. The other pupil then has 30 seconds to find as many as possible, picking them up using forceps/tweezers only and each time placing the item found in a plastic beaker. Variations on this game include making the pupils run a set distance between each pick-up. Pupils should then be asked to say why the greener ones were less likely to be spotted. This will help to reinforce the idea that camouflage is an important adaptation for animals that are prey.</td>
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</table>

<table>
<thead>
<tr>
<th>Resources (per pair)</th>
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<tbody>
<tr>
<td>20–30 coloured buttons (different colours, particularly different shades of green); forceps; plastic beaker; quadrat or string.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>7Cd</th>
<th>Exploring 4</th>
<th>Beak shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupils investigate how the shape of a bird’s beak can be adapted for different seed sizes. Pupils use fine and blunt-ended forceps/tweezers to transfer a selection of different sized seeds from one container to another, one at a time, in a set length of time (e.g. a minute). Pupils should then evaluate whether they have used enough seeds or time in order to get</td>
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<table>
<thead>
<tr>
<th>Resources (per group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to small seeds (e.g. carrot); access to medium-sized seeds (e.g. poppy); access to large seeds (e.g. pea); plastic cups; blunt-ended forceps/tweezers; fine forceps/tweezers; stop clock.</td>
</tr>
</tbody>
</table>

should also be washed if cobalt chloride paper has been handled.

Seeds may be treated with antifungal agents. Wash hands thoroughly afterwards. If possible, seeds should be bought from a health
| 7Ce | Exploring 1 | **Food chains in leaf litter**
Samples of leaf litter can be collected in large plastic trays, with pupils using a paint brush to lift the leaves and gently move any small animals into an area in which they can be examined or collected with a pooter. Alternatively, this practical could be done outside with pupils collecting organisms from other areas, apart from leaf litter (e.g. using tree beating). Pupils should be encouraged to record any observations that identify a food source and to note any protective features that plants may have to deter herbivores. The information collected could be used to construct a database (or added to the one constructed in 7Cb Exploring 4). Recording the numbers of each species may be useful for Unit 8D.

• **Must:** pupils identify the animals using secondary sources (including Skills Sheet 51).

• **Should:** in general terms, the size of the individual organisms increases and the number of each species decreases as you progress along a food chain. Armed with these generalisations, pupils could construct food chains of animals in leaf litter. They should then do some research using books and/or the internet to see if their food chains are correct. | **Resources (per group)**
Leaf litter in a large plastic tray; hand lens; paint brush; pooter; Skills Sheet 51; library/internet access. | Food/organic shop, which will have untreated seeds. |

| 7Ce | Exploring 4 | **The food web**
This practical is also suggested as part of Unit 8D. It is best done outside or in a hall, with | **Resources**
Long strands of wool (1–5 m lengths). | All organisms and leaf litter should be returned to where they were taken from. Pooter mouthpieces should be disinfected before and after use by putting them in Milton® for 30 minutes. Pupils should wash their hands after handling leaf litter. |
pupils representing organisms in a food web, but can be done using pieces of paper. Before starting, pupils may be encouraged to choose an animal and research it to find out where it lives and what it feeds on. Different webs can be constructed for different habitats. A web is constructed using pupils joined by holding long strands of wool in their hands (1–5 m lengths). The woollen links represent links in a food web. One pupil is then told that his/her animal is now dead, the pupils predict what will happen and then the ‘dead animal’ sits down. Other pupils could then say how this has affected them (whether they felt the wool tug as the ‘dead animal’ sat down) and consider whether their predictions were correct.

| 7Ce | Explaining 2 | **Owl pellets**  
Take an owl pellet and tease out the various parts of the pellet with cocktail sticks or fine forceps/tweezers. Point out the different sorts of bone that are found. *Owl puke* by Jane Hammerslough (ISBN 978-0761131861) is excellent – and includes a sterilised owl pellet to dissect. Owl pellets are also available from Blades Biological Ltd (Ref PBA 027). For details of the website see the weblink at the beginning of this unit. With any up-close demonstration like this, it is useful to have a video camera and display equipment so that the whole class can see properly. |
| Resources | Owl pellet; cocktail sticks and/or fine forceps/tweezers; video camera and display equipment. | Sterilising owl pellets by autoclaving is a sensible precaution, and should be done before examining any pellets found in the local surroundings. |

| 7Da | Starter 3 | **Grouping things**  
Give pupils items to sort into groups and sub-groups. The groupings could be displayed in the form of written tables, Venn diagrams or as posters. Pupils could be encouraged to bring |
| Resources (per group) | Scissors; glue; paper for posters; selection of items to sort or cards from Worksheet 7Da(4). |  |
things brought from home (e.g. cleaned empty food packaging/labels). Books, CDs, collectors' stickers, plastic animal models, preserved specimens, leaves might also be used. Worksheet 7Da(4) contains a variety of CDs to sort. These CD cards could be photocopied, laminated and cut out or pupils could cut out pictures to be glued onto a poster in relevant groups.

<table>
<thead>
<tr>
<th>7Da</th>
<th>Exploring 1</th>
<th>Observing differences</th>
<th>Resources (for circus)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Provide a selection of photographs or objects – pupils have to observe and describe the differences. A circus of objects to look at could be set up around the room, with pupils identifying the best features that could be used to tell the different things apart. Skills Sheet 17 could be used to introduce ideas about things to look for.</td>
<td>Selection of objects with differences (e.g. CD covers, books, stationery, lab glassware, coins). Optional: Skills Sheet 17.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7Da</th>
<th>Exploring 2</th>
<th>Variation graphs</th>
<th>Resources (per group)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>This practical concentrates on the differences between similar things. A wealth of different things can be measured and plotted on graphs and charts. Possibilities include variations between pupils (heights, arm spans, eye colour, middle finger lengths) and lengths, volumes and/or masses of fruits. Measuring the volumes of fruits using the water displacement method will provide a link to Unit 7K. • Could: encourage pupils who have studied page 52 in the Pupil’s Book to say whether their collected data show continuous or discontinuous variation and how closely their results show normal distribution.</td>
<td>May include fruits; leaves; ruler; metre rule; measuring cylinder; displacement can; access to water; access to balance. Optional: Skills Sheets 27–32; Worksheet 7Da(9).</td>
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<table>
<thead>
<tr>
<th>7Da</th>
<th>Exploring 3</th>
<th>Relationships and variation (AB/AT)</th>
<th>Resources (per group)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>This practical links to the Practical box on page</td>
<td>Selection (about 20) of different</td>
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</table>

You should be aware that some pupils may not wish to provide personal information. Beware of measuring pupils’ weights because some can be very sensitive about this. The height information from Worksheet 7Da(10) could be used.
<table>
<thead>
<tr>
<th>51 of the Pupil’s Book.</th>
<th>7Db</th>
<th>Exploring 4</th>
<th>Growing algae with fertilisers</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <strong>Must:</strong> pupils use Worksheet 7Da(3).</td>
<td><strong>Growing algae with fertilisers</strong></td>
<td>Pond water contains a variety of different algae and can be used directly for this practical. Alternatively, liquid cultures of algae (e.g. <em>Scenedesmus, Chlorella</em>) can be obtained from</td>
<td><strong>Resources (per group)</strong></td>
</tr>
<tr>
<td>• <strong>Should:</strong> ask pupils to measure holly leaves to answer the question. They should be encouraged to show their data using line graphs and these could be generated using a spreadsheet application. An alternative to doing actual practical work is to get pupils to use the third AT spreadsheet link on page 51, which opens <em>Prickly leaves</em>.</td>
<td></td>
<td><strong>2–4 beakers (100 cm³ are suggested); 10% diluted commercial fertiliser solutions; pipette; pond water (or tap water</strong></td>
<td><strong>Wash hands thoroughly after handling cultures. Beware of <em>Leptospira</em> contamination of</strong></td>
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<tr>
<td>• <strong>Could:</strong> ask pupils to suggest a relationship of their own to investigate and write a report on. These suggestions may be based on observations from <em>Exploring 3</em>. Possible questions for investigation include ‘Do longer pea pods contain more peas?’, ‘Do taller people have longer forearms?’, ‘Are people with blond hair more likely to have blue eyes?’, etc. Using a spreadsheet to produce different graphs of the same data will give pupils an opportunity to decide which charts and graphs are best to use for different sorts of data. The idea that bigger sample sizes might be needed to draw a firm conclusion should also be looked at and pupils asked to say how confident they are of their conclusions, based on sample size. Pupils should also say how strong a relationship/correlation they have found. They may also have data which shows a normal distribution and should be encouraged to identify this.</td>
<td></td>
<td><strong>and suitable gloves must be worn when collecting. Wash hands afterwards.</strong></td>
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</table>
commercial suppliers and made into ‘pond water’ using tap water – leave this in an open vessel for 24 hours to allow the chlorine to escape. (NB: Do not use algae supplied on agar slopes or *Spirogyra*, or other filamentous algae, since they form clumps.) The suggested approach involves taking beakers of ‘pond water’ and adding different numbers of drops of a diluted commercially available fertiliser (e.g. 10% diluted Baby Bio®). The beakers of pond water should then be placed in a well-lit area and monitored. As the algae grow, the water will become more cloudy. Qualitative results may be obtained by determining which beakers are more ‘cloudy’. Quantitative results can be obtained in various ways. A piece of paper or card with different intensities of shading on it could be used. The cloudiness of the water will determine which marks can be seen through a beaker of pond water placed on top of the paper. Alternatively, an ‘X’ could be drawn on the bottom of a measuring cylinder with the water being poured in until the ‘X’ can no longer be seen. A light meter could also be used with a cardboard tube being placed around the beaker and a light shone underneath. The light meter is held above the surface of the water inside the tube. This works best if a photographic ‘light box’ is available, the surface of which should be protected by clear plastic. A better option is to use a colorimeter with shaken samples of water. The results can be recorded daily or after a certain time period. This practical can be used to carry out an AT1 Investigation. A set of level descriptions is provided on pages 111–112 of *Exploring Science*.
| 7Db | Exploring 5 | **Bramble leaves**  
Give pupils bramble leaves from well-lit areas and from dark areas and ask them to comment on the differences between them. They could work out the surface areas of the leaves using squared paper. Ask pupils to think of a theory to explain their results. Many plants have bigger leaves when grown in shaded areas compared with brightly lit areas in order to maximise the amount of photosynthesis for food production. | **Resources (per group)**  
Bramble leaves from shaded area; bramble leaves from well-lit area; squared paper. | Beware of bramble thorns. |
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<td><strong>Must:</strong></td>
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<td><strong>Should:</strong></td>
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<tr>
<td><strong>Could:</strong></td>
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</tbody>
</table>
| 7Dc | Exploring 2 | **Observing differences**  
Provide pupils with living specimens and/or a range of pictures to look at. Worksheet 7Dc(2) provides a range of pictures of vertebrate animals for pupils to consider and Worksheet 7Dd(2) (from the next topic) provides invertebrate examples. You may wish pupils to collect their own organisms to observe, and pooters, sweepnets and dipping nets could all be used. Pupils should be encouraged to use scientific words when describing the parts of animals. Pupils will need their recorded observations for Topics 7Dd and 7De.  
**Must:** pupils use Worksheet 7Dc(3) to record observations for three or four different organisms. Pupils should discuss which features are the best to tell the different organisms apart.  
**Should:** pupils should design their own tables | **Resources (per group)**  
Viewing access to some living organisms (e.g. mouse, snail, earthworm, fish, woodlouse); Worksheets 7Dc(2) and 7Dc(3); Skills Sheets 51 and 52. Optional: pooter; sweepnet; dipping net | Pupils should be taught to handle any animal in a safe and careful manner. Pooter mouthpieces should be sterilised before and after use by putting them in Milton® for 30 minutes. Any organisms that are taken from a local habitat should be housed and fed appropriately, and returned to the place they were found. Pupils should wash their hands after |
### 7Dc Exploring 4

**Fingerprinting**

Get pupils to make their own ‘ink pads’ by rubbing a soft pencil on a piece of paper. Fingertips are pressed onto the pencil rubbing and sticky tape is then stuck onto the fingertips. This is removed, stuck to white paper and examined. This practical links to the Practical box on page 57 of the Pupil’s Book. Pupils should work in groups and examine each other’s fingerprints, developing a way of grouping the different print types. Alternatively, use this task as an extension of Exploring 3 with pupils observing their own fingerprints and classifying them into one of the groups that they identified in Exploring 3.

- **Must:** pupils produce a simple chart showing an example of each different type of fingerprint.
- **Should:** once pupils have developed a classification system, challenge them to think of a question to do with fingerprints that they could

**Resources (per pupil)**

Soft pencil; sticky tape; plain white sheets of paper. Optional: pupils’ classifications from *Exploring 3; Skills Sheet 38.*
investigate. Suitable questions include ‘Are boys’ fingerprints different to girls?’ and ‘Which is the most common type of fingerprint?’.
Questions of a quantitative type can be answered in terms of percentages (Skills Sheet 38).

<table>
<thead>
<tr>
<th>7Dd</th>
<th>Exploring 1</th>
<th><strong>Drawing vertebrates</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Supply pupils with specimens, models or photographs of vertebrates and ask them to make drawings of them. On each drawing they need to label the various features that allow the animal to be classified in one of the vertebrate groups. This could be extended to looking at the ways in which animals are portrayed in art, either realistically or more abstractly (e.g. Picasso’s bulls, Keith Haring’s dogs). What is it about the abstract animals that makes them recognisable as those animals?</td>
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<td></td>
<td></td>
<td><strong>Must</strong>: pupils label the drawings on Worksheet 7Dc(2) (from the last topic) to show features that allow classification into one of the vertebrate groups.</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>7Dd</th>
<th>Explaining 2</th>
<th><strong>Vertebrate skeletons</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Demonstrate a vertebrate skeleton to illustrate the backbone. Point out that all vertebrates have a full internal skeleton, not just a backbone. Tell pupils that the skeletons of all vertebrates are similar, but those that are in the same group (e.g. mammals) have very similar skeletons. For instance, all mammals have four limbs that end in five digits – including humans, bats and whales. These are not obvious when you look at the bodies but are apparent by examining the skeletons. If the skeletons you are using are small, a video camera may be</td>
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<thead>
<tr>
<th>Resources</th>
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<tbody>
<tr>
<td>Range of specimens, models or photographs of vertebrates and/or Worksheet 7Dc(2); plain paper.</td>
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<thead>
<tr>
<th>Resources</th>
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<tbody>
<tr>
<td>One or more vertebrate skeletons. Optional: video camera; video screen.</td>
</tr>
</tbody>
</table>
| 7De | Starter 1 | **Sorting invertebrates**
This is essentially the same as Starter 3 in Topic 7Dd. Pupils sort the invertebrates on Worksheet 7Dd(2) (from the previous topic) into sets. You could also use the pictures on Skills Sheets 51 and 52. The sets can then be subdivided into smaller and smaller groupings, ending up with small groups of animals that share similar features. The pictures can be photocopied and laminated or cut out and stuck onto a poster. Pupils could be encouraged to write down the various steps they have taken in this process.
It is worth stressing to pupils who have come up with groupings different to the scientifically accepted invertebrate groups that their groupings are not necessarily wrong, and that there are many different ways of grouping organisms. We normally use the invertebrate groups identified in the Pupil’s Book, as scientists need a common way of grouping things if the classification is to be useful.
• **Must:** organisms are simply grouped in sets.
• **Should:** pupils use their sets to design a branching key.
• **Could:** ask pupils to sort the invertebrates in more than one way. |
| 7De | Exploring 1 | **Invertebrates**
Pupils collect invertebrates from leaf litter, under hedges, logs or stones and in flowerbeds. A sample from each area could be provided for each group in a tray or pupils could do this ‘in the field’. Using their knowledge and/or the animal pictures on Skills Sheet 51 they identify |
|       |       | **Resources (per group)**
Sample of soil/leaf litter from distinct sites; pooter; specimen tubes; hand lens; Worksheet 7De(3); Skills Sheet 51. |
|       |       | Pupils should wash their hands after handling leaf litter/invertebrates. Pooter mouthpiece tubes should be sterilised in Milton® for 30 |

Downloaded from www.pearsonschools.co.uk/exploringscience 2011
their discoveries. Hand lenses may be used to examine the finds more closely and some drawings could be made.

- **Should:** encourage pupils to classify the animals that they find into the different groups (e.g. invertebrate, arthropod, insect).

<table>
<thead>
<tr>
<th>7De</th>
<th>Explaining 3</th>
<th>External skeletons</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Demonstrates that arthropods have jointed legs and external skeletons using prawns or crabs (unpeeled frozen prawns are good – allow them to defrost overnight and use straight away). You could extend this by comparing prawns with mussels (a mollusc). The jointed legs can be a bit difficult to see, so a video camera may be useful to put a larger image up on a screen.</td>
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<thead>
<tr>
<th>7Ea</th>
<th>Starter 5</th>
<th>Action of concentrated sulphuric acid</th>
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<tbody>
<tr>
<td></td>
<td>Demonstrates this is a spectacular demonstration of the effect of a corrosive substance on everyday materials. Fill a beaker (or jam jar – it is likely to be written off) about one third to one half full with granulated sugar. Pour concentrated sulphuric acid over it so that it just covers the sugar. The sugar will darken immediately. Stir the mixture carefully and leave it to stand – the reaction will become more vigorous after about a minute. Black carbon is formed, and the reaction is sufficiently exothermic to turn the water that is formed into steam, which pushes the sugar up out of the beaker in a black, sausage-shaped foam, which then hardens. Paper towels placed in a beaker of concentrated sulphuric acid will blacken very quickly – the beaker will get warm. You could also demonstrate the action of acid on cotton.</td>
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<th></th>
<th>Resources</th>
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<tbody>
<tr>
<td></td>
<td>Frozen arthropods (e.g. prawns) and/or mussels – thawed overnight. Optional: video camera; video screen.</td>
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</table>

|        | Wash hands after handling shellfish. |

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<thead>
<tr>
<th>7Ea</th>
<th>Starter 5</th>
<th>Action of concentrated sulphuric acid</th>
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</thead>
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<th>Resources</th>
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<tbody>
<tr>
<td></td>
<td>Jam jar or 250 cm³ beaker; granulated sugar; concentrated sulphuric acid (corrosive); glass rod; fume cupboard. Optional: paper towels; piece of cotton material.</td>
</tr>
</tbody>
</table>

<p>|        | This demonstration should be carried out in a fume cupboard because of the production of carbon monoxide (extremely flammable and toxic) and sulphur dioxide (toxic) as possible by-products in the reaction. Concentrated sulphuric acid is corrosive. |</p>
<table>
<thead>
<tr>
<th>7Ea</th>
<th>Exploring 3</th>
<th><strong>Comparing acids</strong></th>
<th><strong>Resources (per group)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupils compare the hazardous nature of different acids by reference to simple observations linked to chemical reactivity.</td>
<td><strong>Must:</strong> test tube rack plus at least 3 test tubes; 3 pieces of magnesium ribbon (about 1 cm length); 3 marble chips (small enough to fit comfortably into the test tube); thermometer; dilute hydrochloric acid at concentrations 1 mol dm⁻³, 0.1 mol dm⁻³ and 0.01 mol dm⁻³ labelled (at random) X, Y and Z; Worksheet 7Ea(2).</td>
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<tr>
<td><strong>Must:</strong> only three acids are used, and the tests are restricted to those that can give a clear visual indication. The instructions are on Worksheet 7Ea(2).</td>
<td><strong>Should:</strong> instructions are given on Worksheet 7Ea(3). Pupils use another acid and a more subtle test (the reaction with sodium hydroxide solution) is introduced. Given the corrosive nature of sodium hydroxide if it is at a concentration likely to give a measurable temperature rise, this version should only be attempted if you are confident of the practical abilities and behaviour of the group. If digital temperature probes capable of reading to 0.1 °C are available, this may allow the concentration of the sodium hydroxide to be reduced to 0.4 mol dm⁻³ (irritant) while still getting useful and observable results. An alternative would be to set up four temperature probes linked to a datalogger for this part of the experiment, which would then effectively become a demonstration.</td>
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<tr>
<td><strong>Could:</strong> present pupils with extracts from the relevant CLEAPSS Student Safety Sheets, and ask them to discuss the risks involved before starting any practical work.</td>
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<table>
<thead>
<tr>
<th>7Eb</th>
<th>Exploring 1</th>
<th><strong>Taste tests</strong></th>
<th><strong>Resources (per group or class, depending on the method used)</strong></th>
</tr>
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<tr>
<td>This activity depends on being able to carry out the test under hygienic conditions. Working in pairs or small groups, pupils take a ‘blind test’ in which they are asked to describe and identify a number of liquids. The liquids could be stored in plastic drinking cups, and dispensed using the</td>
<td><strong>Set of clean, disposable plastic drinking cups containing a selection of liquids (vinegar, salt water, tonic water, lemon juice, fizzy orange, 1 mol dm⁻³ sodium hydroxide is corrosive. Eye protection should be worn.</strong></td>
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<tr>
<td><strong>Resources (per group or class, depending on the method used)</strong></td>
<td><strong>Set of clean, disposable plastic drinking cups containing a selection of liquids (vinegar, salt water, tonic water, lemon juice, fizzy orange, 1 mol dm⁻³ sodium hydroxide is corrosive. Eye protection should be worn.</strong></td>
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</table>

This experiment is best done in the food technology room or the dining area. If a laboratory has to be used then the exceptional nature of
end of a drinking straw (which is easily disposable if it becomes contaminated). Include some liquids which are acidic, as well as a range of contrasting tastes. Alternatively, you could dispense the liquids to pupils while they are working on another written task.

- **Must**: pupils use the framework on Worksheet 7Eb(2) to record their results.
- **Should**: Worksheet 7Eb(3) provides guidance but pupils design their own table for recording results.
- **Could**: Worksheet 7Eb(3) provides an extension activity where pupils explore which areas of the tongue are most sensitive to acids.

<table>
<thead>
<tr>
<th>7Ec</th>
<th>Starter 1</th>
<th>Water into ‘wine’</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>Use the ‘water into wine’ trick as a starter demonstration. Pour a beaker of ‘water’ (in fact dilute sodium hydroxide solution) into an apparently empty beaker (which has a few drops of phenolphthalein indicator at the bottom of the beaker). When the alkaline solution touches the indicator, there is a change from colourless to pink/purple. Ask pupils to speculate how the effect is achieved. Tell them that they will be able to produce similar colour transformations by the end of the topic.</td>
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<tr>
<th>7Ec</th>
<th>Exploring 1</th>
<th>Using red cabbage as an indicator (AB/AT)</th>
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<td></td>
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<td>This practical is in two parts: pupils first extract the colour from red cabbage leaves by crushing, dissolving and filtering. The solution obtained from this process is then used to test a variety of household chemicals. The experiment could be introduced as an exercise in deductive reasoning – demonstrate the effect of the cabbage juice with a named acid (e.g. milk, sugar water) labelled L1, L2, L3, etc; plastic drinking straws – one per pupil per cup; blindfold; Worksheets 7Eb(2) and 7Eb(3).</td>
</tr>
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</table>

| Resources | Beaker/wine glass; dilute sodium hydroxide solution (irritant) (0.1 mol dm⁻³); phenolphthalein indicator (highly flammable). |

| Resources (per group) | red cabbage; blackberries or other strongly coloured fruit/vegetable; pestle and mortar; filter paper and funnel; access to kettle; Worksheet 7Ec(3). (If overnight storage is needed: boiling tubes/small conical flask with bung or screw cap (McCartney) bottle.) |

Eye protection should be worn. There should be no tasting of food and drink (this is just after a tasting lesson!).
hydrochloric) and then ask pupils to use the indicator to classify the substances being tested. Alternatively, you can use this task in an inductive way, with pupils first looking for colour changes. Once the results are summarised, the acids can be defined as that group of substances which turns the indicator red. Worksheet 7Ec(3) gives all the practical instructions. Worksheet 7Ec(4) is a follow-up sheet to revise the key words and processes from the practical procedure. This could be used in class, or as a homework after the experiment has been completed. An alternative use could be as a starter activity in the next topic to reinforce prior learning.

• The first AT document link on page 68 opens *Red Cabbage Indicator* – a set of sample results which pupils are asked to add to a table.

**Part 2:** dropping pipettes; spotting tiles; a variety of common substances e.g. vinegar, salt, sugar, lemonade, toothpaste, lemon juice, flour, Milk of Magnesia, washing powder, scouring powder; coloured extract from part 1; eye protection.

| 7Ed | Starter 2 | **Laboratory indicators** Use this demonstration to introduce pupils to the idea that there are several laboratory indicators. Set up a row of test tubes in pairs, with a different indicator in each pair. Show what happens when the indicators are mixed together. • **Must/should:** pour a little strong acid (e.g. dilute HCl) into one of each pair and note the colour change; repeat with alkali (NaOH). • **Could:** show the colour in acid and ask pupils to predict the alkaline colour given their understanding of colour mixing (e.g. methyl orange is red in acid, so pupils may be able to predict that the alkaline colour has to be yellow to give the orange colour overall). | **Resources** Rack with boiling tubes; hydrochloric acid (0.1 mol dm\(^{-3}\)) (irritant); sodium hydroxide (0.1 mol dm\(^{-3}\)); samples of indicators, e.g. methyl orange, thymol blue. | Eye protection should be worn. Some indicators may be highly flammable, depending on the solvent. |
| 7Ed | Exploring 1 | **Testing the pH of substances** | **Resources (per group)** | Eye protection should |
Ask pupils to test substances using universal indicator solution or paper. Make sure that the colour chart the pupils work from matches the type of indicator being used – paper and solution are significantly different in the range of colours and pH values.

- **Must:** pupils follow the instructions on Worksheet 7Ed(3) and record their results on it.
- **Should:** pupils follow the instructions on Worksheet 7Ed(4).
- **Could:** ask pupils to check the values obtained with universal indicator solution against a pH meter. There are a number of small, solid state meters on the market which do not require extensive and time-consuming calibration, and give a direct readout of pH to within 0.1.

**Resources**
- Dropping pipettes; spotting tiles; a variety of common substances (e.g. vinegar, salt, sugar, lemonade, toothpaste, lemon juice, flour, Milk of Magnesia, bleach, washing powder, scouring powder); universal indicator solution and colour charts; pH meter; eye protection; Worksheet 7Ed(3) or 7Ed(4).

**7Ed Exploring 3**

**The dilution challenge**
Ask pupils to predict what effect making an acid more dilute would have on pH. The predictions could be investigated or demonstrated. Pupils could also be asked if the acid would become more or less corrosive. Alternatively, set this exercise as a challenge – show pupils that the acid is pH 1, and ask them to find out how much water they would need to add to make it pH 2. In theory, the general rule is that a ten-fold dilution causes a shift in pH by one unit, but the key learning objective here should be accurate planning, experimentation and data analysis, rather than any specific knowledge outcomes.

**Resources**
- Hydrochloric acid (0.1 mol dm-3); universal indicator solution; pH meter (if available); test tubes; measuring cylinders.

**7Ed Exploring 5**

**Make your own universal indicator**
This activity could be suitable as an extension activity for those who have finished other

**Resources (per group)**
- Test tubes; dropping pipettes; spotting tiles; set of bottles of

Eye protection should be worn. No tasting of any chemicals should be allowed.
aspects of the work. Although pupils of all abilities may enjoy the challenge, higher-attaining pupils are more likely to be able to appreciate the necessary logic needed to make a sensible prediction. Give pupils bottles of a number of indicators and asked them to produce a mixture which has the maximum number and/or best range of colour changes. This problem could be approached simply on a trial and error basis, although it is also possible to predict the effect of a suitable mixture using data tables. There is no practical instruction sheet for this activity, but Worksheet 7Ed(8) covers linked work as an exercise in deduction for a homework activity.

different indicators (e.g. litmus, methyl orange, phenolphthalein (highly flammable), thymol blue, bromothymol blue); samples of solutions at a range of pH values (ideally buffers, but this is not critical) – e.g. hydrochloric acid (pH 1) (corrosive), ethanoic acid (pH 4–5) (irritant), water (pH 7) sodium hydrogen carbonate (pH 9), sodium hydroxide (pH 13) (corrosive).

| 7Ee | Exploring 1 | **Rainbow fizz** | **Resources (per group)**
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<td>This practical reinforces ideas about the pH scale, and also develops pupils’ ability in observation and following instructions. There is a real sense of achievement if this experiment works well, but it does need a degree of care. Over-enthusiastic mixing will mean that pupils lose their ‘rainbows’. You are advised to check this experiment out first. It is advisable to prepare tubes before the lesson.</td>
<td>Eye protection; test tube rack; boiling tube containing about 1 g anhydrous sodium carbonate (irritant); tube 1 – test tube containing about 2 cm³ water; tube 2 – test tube containing about 10 drops universal indicator; tube 3 – test tube containing about 2 cm³ approx. 0.5 mol dm⁻³ ethanoic acid; tube 4 – test tube containing about 2 cm³ approx. 0.5 mol dm⁻³ ethanoic acid; Worksheets 7Ee(2) and 7Ee(3).</td>
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<td>• <strong>Must:</strong> pupils can record their work using the framework provided in Worksheet 7Ee(3).</td>
<td>Make sure that pupils have been shown how to smell chemicals safely. Eye protection should be worn.</td>
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<td></td>
<td>• <strong>Should:</strong> pupils design their own format for recording results.</td>
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| 7Ee | Exploring 4 | **Testing indigestion remedies** | **Resources (per group)**
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<td>This is a quantitative comparison, which many pupils find quite difficult. While there are a number of valid ways of carrying out the investigation, keeping the mass of antacid fixed may be conceptually easier. Discussion of what</td>
<td>Access to samples of a selection of indigestion remedies; 0.1 mol dm⁻³ sulphuric acid; universal indicator solution; beakers or conical flasks; 25 cm³ measuring cylinder;</td>
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<td>makes the investigation.</td>
<td>Eye protection should be worn. There should be no tasting of the remedies. Check pupils’ plans before starting.</td>
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we mean by the 'best' antacid before experiments are planned is likely to improve the quality of the plans produced. This practical can be used to carry out an AT1 Investigation. A sheet of level descriptions is provided on pages 137–139 of the ASP.

<table>
<thead>
<tr>
<th>7Ee</th>
<th>Explaining 2</th>
<th>Following neutralisation</th>
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<tbody>
<tr>
<td></td>
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<td>You could demonstrate, using a pH probe and a datalogger, how the pH changes as an alkali is added to an acid drop by drop. Ask pupils to predict what will happen if more acid or alkali is added, and to check their predictions. Pupils could also be given prepared graphs and challenged to state what must have happened to cause any changes in pH shown.</td>
</tr>
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</table>

| Resources | 0.1 mol dm-3 hydrochloric acid (irritant); 0.1 mol dm-3 sodium hydroxide solution (irritant); measuring cylinders; burette; pH probe and datalogger; eye protection. |

| Eye protection should be worn. |

<table>
<thead>
<tr>
<th>7Fa</th>
<th>Starter 3</th>
<th>Demonstrating reactions</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Show pupils some reactions (outlined below) and discuss what they observe. Pupils should have encountered reversible and irreversible changes at KS2, and discussing these reactions is one way of assessing their prior knowledge. It may also be useful to show them a change that does not involve a chemical reaction, such as ice melting, to draw out the difference between a chemical reaction and a physical change.</td>
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| • Lead nitrate solution mixed with potassium iodide solution will give a vivid yellow precipitate of lead iodide. |
| • Pieces of zinc placed into a beaker of dilute hydrochloric acid will show some fizzing due to hydrogen gas being given off. |

| Resources | Lead nitrate solution (0.5 mol dm-3); potassium iodide solution (0.5 mol dm-3); boiling tubes or conical flasks; zinc granules; dilute hydrochloric acid (0.5 mol dm-3); ice cubes; beaker. |

| Lead nitrate solution and lead iodide are toxic. |

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<thead>
<tr>
<th>7Fa</th>
<th>Exploring 3</th>
<th>Is there a reaction?</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Pupils carry out a variety of experiments to decide whether there is no reaction, a reversible or an irreversible change. They should also</td>
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| Resources (per group) | Test tube rack with 6 tubes; beaker; lemon juice, bicarbonate of soda, baking powder, plaster of Paris, |

| Anhydrous copper sulphate is harmful. Plaster substitutes can get very hot. |
state if a change is physical or chemical including their reasons for deciding whether the changes are chemical or physical. Suitable experiments are:
- lemon juice and bicarbonate of soda (chemical reaction, irreversible)
- baking powder and water (chemical reaction, irreversible)
- plaster of Paris and water (chemical reaction, irreversible)
- heat zinc oxide (physical, colour change, reverses on cooling)
- iron wool with copper sulphate solution (chemical reaction, irreversible)
- water with anhydrous copper sulphate (intermediate case – likely to be regarded as chemical reaction in the context of this lesson, though can be reversed by heating).

**Must/Should:** Worksheet 7Fa(3) provides structured support for pupils with a framework to record their results.

**Could:** for pupils who are more competent in recording results independently, Worksheet 7Fa(4) will be more appropriate.

<table>
<thead>
<tr>
<th>7Fb</th>
<th>Starter 4</th>
<th>Testing gases</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td>Pupils may have seen reactions of acids producing gases during KS2 work, but are unlikely to have carried out the test for hydrogen. It may be useful to demonstrate this test before they attempt to carry out the test to identify the gaseous product of a reaction themselves. It is worth discussing with pupils the reason why the tube full of hydrogen should be kept inverted until it is tested (hydrogen, being less dense than air, will rise out of the</td>
</tr>
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</table>
tube if it is held with its open end upwards). The technique for carrying out a limewater test may also need to be shown. Carrying out a limewater test on a tube of carbon dioxide after first having extinguished a flame will, of course, simultaneously reduce the validity of the test while enhancing the chances of a positive result. This could be used as a point for discussion with pupils, with a modification of the method if necessary.

### 7Fb Exploring 1

**Testing for gases**

This practical gives pupils practice in setting up the apparatus needed to collect a gas over water. It also allows them to practice testing a gas using a lighted splint. Instructions are given on Worksheet 7Fb(3). Note that hydrogen evolved in metal–acid reactions can also be collected by carrying out the reaction in a test tube, and inverting a boiling tube over the top of it. Hydrogen, being less dense than air, will collect in the top of the boiling tube. The reverse is true for carbon dioxide, which can be ‘poured’ downwards into a tube containing limewater to give a positive result. Pupils will work in groups—a specific team working element could be introduced if pupils are allocated or asked to define specific roles such as setting up apparatus, reading instructions, recording results etc.

**Resources**

- Eye protection
- Boiling tube
- Test tube
- 250 cm³ beaker
- Bung and delivery tube
- Piece of magnesium (1 cm long) (highly flammable)
- Marble chip
- Test tube rack
- 50 cm³ measuring cylinder
- Dilute hydrochloric acid (0.4 mol dm⁻³)
- Bunsen burner
- Splints
- Test tube holder
- Worksheet 7Fb(3)

Eye protection should be worn. Keep careful control over the issuing of the magnesium ribbon.

### 7Fc Starter 1

**Burning magnesium**

Demonstrate the burning of magnesium ribbon in air. Keep the magnesium in the Bunsen flame. Ask pupils to discuss how they know a reaction is taking place. Get them to consider whether they think that energy has been put in

**Resources**

- Tongs
- Bunsen burner
- Heatproof mat
- Magnesium ribbon (highly flammable)
- Eye protection

Ensure that pupils are advised not to look directly at the flame when the magnesium is burning. They can
to the magnesium or been given out when the reaction takes place. Would the magnesium continue to burn if you took it out of the flame? Why? Why not? Repeat the demonstration again and remove the magnesium from the flame once it is alight to show that continuous heating is not required. Ask pupils to consider whether the magnesium would light with a burning splint.

<table>
<thead>
<tr>
<th>7Fc</th>
<th>Exploring 1</th>
<th>Flame tests</th>
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<tr>
<td></td>
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<td>The flame test experiment is intended to introduce a new practical technique, develop pupils’ practical and observational skills and show in the laboratory some of the background to the making of coloured fireworks. This is a simple experiment which has the ability to offer a ‘wow factor’. It is not intended that pupils will need to remember any of the colours produced by the metal ions. Instructions are given on Worksheet 7Fc(2). Only very small amounts of chemicals are needed for these tests – the pupils may err on the side of quantities which are too large, which will then mean that they could spend a disproportionate amount of time cleaning their wires. Sodium is a particularly persistent problem in this regard and the colour may interfere with subsequent tests. For this reason it may be useful to demonstrate the technique using sodium and get pupils to do the practical using other examples. It would also be preferable to keep the same wires with the same chemicals to avoid cross-contamination. Concentrated hydrochloric acid (corrosive) is more efficient than dilute at cleaning the wires and ensuring the volatility of the compounds, but for obvious reasons this should not be used.</td>
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<th>Resources (per group)</th>
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<td></td>
<td>Bunsen burner; heatproof mat; eye protection; metal wires (ideally platinum but other metals such as nichrome will give adequate results) mounted in insulating handles. Access to dilute hydrochloric acid (0.5 mol dm-3); solid powders/small crystals of sodium chloride, potassium chloride, calcium chloride (irritant), magnesium chloride, strontium chloride (irritant), barium chloride (toxic), copper chloride (harmful); Worksheets 7Fc(2) and 7Fc(3).</td>
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|     | Barium chloride is toxic. Although the amounts used are extremely small, if there is a risk that some pupils might ingest some of the solid then omit this example. |

look through a tiny gap between the fingers of a hand held in front of their eyes.
### 7Fc Explaining 1: Test for oxygen

Ask pupils what would happen to a burning splint put into oxygen, and then ask what would happen to a glowing splint. Demonstrate the effects and explain that a glowing splint can be used to test a gas to see if it is oxygen. This can be contrasted with the results for carbon dioxide obtained in Topic 7Fb.

**Resources**
- Boiling tubes of oxygen (oxidising);
- splint; matches or lit Bunsen burner;
- eye protection.

**Must:** use Worksheet 7Fc(3) to record results.

**Should:** pupils design their own table of results.

### 7Fd Exploring 1: Model fire extinguisher

The aim is to investigate the effect of either the volume of sulphuric acid or the mass of sodium hydrogen carbonate on the volume of carbon dioxide gas produced by the model fire extinguisher. The use of the apparatus shown in the Pupil’s Book will enable the collection of a stream of gas. Recommended quantities are 5 to 50 cm³ of dilute acid (concentration 0.1 mol dm⁻³); and 0.1 to 1 g of sodium hydrogen carbonate.

**Resources (per group)**
- Sodium hydrogen carbonate; 0.1 mol dm⁻³ sulphuric acid; 50 cm³ and 100 cm³ measuring cylinders; trough; beehive shelf; delivery tube and bung; conical flask; access to top pan balance; eye protection;
- Worksheets 7Fd(3), 7Fd(4), 7Fd(5), 7Fd(6).

**Must:** pupils use Worksheet 7Fd(3) and the

**Pupils should be shown how to assemble the apparatus, with particular care being taken to ensure the safe connection of the delivery tube, bung and flask if glass delivery tubes are used. Well-fitting eye protection must be worn.**

**Wear eye protection.**
| 7Fd | Explaining 2 | **7Fd Explaining 2**

This is a spectacular demonstration, and illustrates why water should not be used to put out an oil fire. An evaporating basin or tobacco tin (a nickel crucible is best) about half full (3 cm³) of cooking oil is heated over a Bunsen burner. Take care that the vessel chosen cannot be knocked over during the demonstration. A crucible is best because it can be secured in a pipewax triangle. The oil will take several minutes to heat up to ignition temperature, during which the principles of the fire triangle can be revised. Water can be effective at taking the heat out of a fire, but in this case there is a twin problem – it is more dense than the oil and will therefore sink (and fail to smother the flames), and the boiling point of water is less than the temperature of the hot oil, so the water will vaporise on contact, thus spreading the flame. Once the oil has lit, pour 5 cm³ of water from a test tube held at the end of a metre ruler on to the flame. A large flame will be formed by the mixture of burning oil and steam. Depending on the quantities used, the oil may burn itself out, but the opportunity could be taken to show how quickly the fire can be extinguished if it is

| **Resources**

Bunsen burner; tripod; gauze; evaporating dish or small tin; heatproof mats; safety screens; vegetable oil; wash bottle containing water; damp cloth; full-face shield.

Pupils should be kept 4 metres from the demonstration and safety screens should be in place between the apparatus and pupils. Heat resistant gloves, eye protection, and preferably a full-face shield should be worn by the demonstrator and pupils should wear goggles. Protective heatproof mats should be placed all over the bench where the demonstration will take place as burning oil will spill over the sides of the reaction vessel. Have a substantial damp cloth ready to cover the flame, with a fire

| **Structured response**

Worksheet 7Fd(4) for their results and conclusions.

- **Should**: pupils use Worksheet 7Fd(3), report their results using their own format for recording and use Worksheet 7Fd(5) to guide them with their analysis and evaluation.

- **Could**: pupils use Worksheet 7Fd(6) and plan an investigation that will allow them to see the effects of two variables (volume of acid and mass of soda).
| 7Fd | Explaining 4 | **Products of combustion**  
Explain that fossil fuels contain a lot of a chemical called carbon, and ask pupils what might be formed when fuels burn. If necessary, remind them of the work in Topic 7Fc on burning metals to form oxides. You could also explain that fossil fuels contain hydrogen. Many pupils may know the formula for water, and may be prompted to suggest that ‘hydrogen oxide’ may also be formed. The apparatus should be set up as shown in the Pupil’s Book and on the worksheets. Fuels are burnt so that the flame is under, but not inside, the funnel. This ensures that the pump draws the combustion products through the apparatus, whilst reducing the danger of the funnel cracking as it gets hot. The only quantitative data collected in this experiment will be the temperature. Different fuels should be used to show that they burn to produce the same products. If ethanol is used, the flame is difficult to see. The cooled U-tube is there to collect and condense any water vapour produced during the reaction. There is unlikely to be sufficient water to test, but pupils could be asked to think of a way to prove that any colourless liquid formed is actually water. It is possible that the water vapour may condense in the first empty flask. To avoid this possibility, ensure that the empty flask is set up close to the burning fuel, so that the water vapour does not have to travel far from the flame before reaching the flask – the heat of the flame will also help to ensure that no condensation occurs prematurely. | Resources  
Eye protection; samples of one or more fuels (e.g. wax, wood, ethanol); if necessary, suction pump U-tube; delivery tubes and bungs; boiling tube with limewater; thermometer; conical flask; trough of cold water; eye protection; Worksheet 7Fd(7). | **Eye protection must be worn throughout this experiment. If ethanol is used then it should be in a burner of safe design.** |
resources and time allow, this could be carried out as a pupil experiment.  
• **Must:** give pupils the first side of Worksheet 7Fd(7) only and ask them to label the diagram of the apparatus and fill in the results in the grid. Discuss with pupils the significance of the three results and ask them to annotate the table or write a sentence at the end to summarise what is shown by the results.  
• **Should/Could:** give pupils Worksheet 7Fd(7) and get them to follow up the experiment with a more detailed set of responses, including word equations for burning fuels.  

| 7Fe | Exploring 1 | **Candle burning investigation**  
This investigation provides an opportunity to emphasise that the answers we get from an investigation depend crucially on the questions we ask. This practical can be used to carry out an AT1 Investigation. A sheet of level descriptions is provided on pages 164–165 of the ASP.  
The simplest and most well-known investigation is that covered on Worksheet 7Fe(3). Instruction A is often identified by pupils as being very important to ensure a fair test, although it is virtually irrelevant to the results obtained. The results will show that the candle will burn for longer in the larger beaker, a result that is in accordance with the theory that oxygen is needed for burning. The assumption is often made that oxygen is therefore the critical variable in this investigation, and many pupils may say in their evaluation that they have ‘proved’ the oxygen theory using this experiment. With more able mathematicians, you may wish to explore the extent to which an | **Resources (per group)**  
Candles (various heights, or with knife to cut them to size); heatproof mat; beakers or jam jars large enough to accommodate candles (for experiment A, a pair of beakers with the same overall volume but different shapes will be needed); Plasticine®; stop clock; clamp and stand (experiment D); Worksheets 7Fe(3), 7Fe(4), 7Fe(5). |
oxygen depletion theory would predict a linear relationship, and whether this happens in practice. Worksheet 7Fe(4) asks pupils to think further about the consequences of their theory and to use it to predict the outcome in less familiar situations. These have been deliberately chosen to provoke discussion and thought – all the situations are very simple in terms of practical detail, but can induce real in-depth discussion of likely outcomes. It is an explicit objective to get pupils to consider critically whether their previous theory stands up to genuine scientific scrutiny. Pupils could choose an investigation to carry out, or the scenarios A–D could be allocated by the teacher, so that all possibilities are covered. Pupils may be operating out of their ‘comfort zone’ and there could be some lively debate as to what constitutes genuine evidence and what qualifies as an anomalous result. Worksheet 7Fe(5) takes the candle investigation one stage further and poses an explicit alternative theory to that which is normally advanced at this level, but which is also clearly rooted in the science studied during this unit. This sheet could be used as a freestanding exercise in data analysis, or in conjunction with the pupils’ own results that could be collected and collated centrally.

<table>
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<tr>
<th>7Ga</th>
<th>Exploring 1</th>
<th>Circus of observations</th>
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<tbody>
<tr>
<td></td>
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<td>Provide a collection of solids, liquids and gases (detailed below) for pupils to examine, and record their findings on Worksheet 7Ga(2). Depending on pupil numbers, you may wish to set up two or three sets of identical stations.</td>
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<th>Resources (per pupil)</th>
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<tbody>
<tr>
<td>Worksheet 7Ga(2).</td>
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<tr>
<th>Resources (per station)</th>
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<tbody>
<tr>
<td>Solids: range of solid materials such as wooden block, iron (metal) block, rock, syringe with solid inside.</td>
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| Ethanol is highly flammable. Avoid naked flames. |
| 7Ga | Exploring 2 | **Classifying difficult substances**  
Provide a selection of substances that are difficult to classify, and ask pupils to decide if they are solids, liquids or gases, giving their reasons. The substances can be set out around the classroom, with pupils moving from one to another, or each group can be provided with their own samples. | **Resources (per group)**  
One sample of each of the following (if possible): rubber (an eraser will do), hot runny custard, cold set custard, jelly, sand, honey, toothpaste, tomato sauce, sugar, jam, Plasticine®, foam rubber. | Pupils must not be allowed to eat any of the samples. |
| 7Ga | Exploring 3 | **Change in viscosity with temperature**  
Pupils time how long it takes a set volume of different liquids to go through a filter funnel (see list below). Ask each group to investigate one  | **Resources (per group)**  
Filter funnel; clamp and stand; stop clock; thermometer; boiling tube; beaker; measuring cylinder; liquids | Only use new engine oil (that has not been used in a vehicle) and avoid contact |

**Solids:** include a range of solid materials, including a syringe with a piece of wood (or similar) inside it so pupils can attempt to squash it. If the syringe has a rubber end to the plunger it should be removed as it will be slightly compressible and may confuse pupils.

**Liquids:** provide several examples of liquids and some spare containers of various sizes so pupils can pour them from one beaker to another. Include a syringe with its end sealed, filled with coloured water.

**Gases:** include a syringe full of air – the end can be sealed, or pupils can seal the end themselves with a finger when attempting to compress the air (sealing the end prevents it being used for squirting water!) Also provide a large plastic bag full of air, tied tightly, for pupils to gently squash to observe the change of shape, and a bottle of dilute ammonia solution or perfume for pupils to observe that the gas spreads out. You may need to discuss with pupils the fact that some of the liquid evaporates, providing the smell.

**Liquids:** range of liquids such as water, ethanol, cooking oil, assorted items of glassware (boiling tubes, small beakers, Petri dishes); syringe full of coloured water with sealed end.

**Gases:** syringe full of air with sealed end; large plastic bag full of air (tied tightly); open bottle of dilute ammonia solution or perfume.
<table>
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<tr>
<th>7Gb</th>
<th>Exploring 2</th>
<th>Dilution</th>
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<tbody>
<tr>
<td>Pupils carry out an activity on dilution, which could be done with blackcurrant juice but potassium manganate (VII) is chosen because of the intense colour. Worksheets 7Gb(2) and 7Gb(3) provide descriptive and quantitative approaches respectively.</td>
<td>Resources (per group)</td>
<td>1 g dm$^{-3}$ potassium manganate (VII) solution (10 cm$^3$); boiling tube rack with at least 5 boiling tubes; 10 cm$^3$ measuring cylinder; (dropping pipette); eye protection; Worksheets 7Gb(2) or 7Gb(3).</td>
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<tr>
<th>7Gb</th>
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| Demonstrate the phenomena shown in the Pupil’s Book. Repeat or refer to the use of syringes in the previous topic to demonstrate that gases are compressible and solids and liquids can pool the results. If you do this a method should be agreed so that all groups obtain results that can be compared.  
  • **Should:** the word viscosity need not be mentioned to pupils.  
  • **Could:** when planning the experiment explain to pupils that reliable evidence is evidence that you can be certain of. Ask them how they would collect reliable evidence, eliciting the idea that repeated measurements are a good way of doing this. to test e.g. treacle, honey, detergent (of the type used on the floor in schools by cleaners), new engine oil; access to water bath(s) at preset temperatures agreed with pupils, or access to plastic bowls and supplies of hot water to make own water baths; iced water.  
  with the skin. Pupils should not be allowed to heat oil or sugary solutions using a Bunsen burner, even with eye protection. The use of a water bath prevents the formation of pockets of gas which eject the hot liquid as they rise to the surface. However, this may mean that forward planning is required and pupils should be recommended to start with the higher temperatures first – any of the liquids can be cooled quite easily by standing in a trough of iced water. |
| Resources (for demonstrations) | Potassium manganate (VII); tweezers; large beaker; hot water; 3 sealed syringes containing a solid, water and air; orange squash; Perform the exploding can demonstration behind a safety screen. Potassium |

Solid potassium manganate (VII) is oxidising and harmful, and will stain skin. Use forceps. Wear eye protection.
| 7Gc  | Starter 3 | **Modelling particles**
Put some marbles or peas into the arrangements of particles shown for solids, liquids and gases on page 96 of the Pupil’s Book. Use a tray with high sides so that the marbles/peas do not fall off. Tell pupils that a theory for why solids, liquids and gases have different properties is called the particle theory. Explain that all materials are made out of particles but solids, liquids and gases have different arrangements of these particles. Invite pupils to say which of the marble/pea arrangements they think corresponds to each state of matter, and why they think that. Or give pupils marbles/peas and ask them to arrange them how they would be arranged in a variety of named materials (e.g. water, steel, air). Alternatively, use a vibration generator, showing pupils how the particles move at three different speeds. With a big class it may be useful to use a video camera so that a large image of the
| **Resources**
Marbles or peas (dried if pupils are to use them); tray with high sides (or shallow box); or a vibration generator. Optional: video camera; video screen. | If pupils do this practical it will need good supervision to prevent peas/marbles from ending up all over the floor. |
| 7Gc   | Explaining 2 | **Chalk dust**  
Puff a little chalk dust into the beam of an OHP or slide projector in a darkened room. Pupils should be able to see random movements of the particles. Ask pupils why the chalk dust behaves in this way. Explain that it’s because air particles are hitting the dust. | **Resources**  
OHP projector or slide projector; chalk or talcum powder. |
| 7Gc   | Explaining 3 | **Structure of a solid**  
Use a space-filling model (polystyrene spheres glued together) to demonstrate each of the properties the pupils considered earlier – it doesn’t flow, squash or change shape but it has a fixed shape and fixed volume, and is dense because of the close packing of the spheres (particles). | **Resources**  
Model of a solid made from polystyrene spheres glued together (or similar). |
| 7Gc   | Explaining 4 | **Kinetic theory model**  
Kinetic theory models typically consist of a closed container containing small spheres, and a motor that can make the base of the container vibrate. If such a model is available, use it to reinforce explanations of the differences in particle arrangement and movement between the three states of matter. | **Resources**  
Kinetic theory model. |
| 7Gd   | Starter 3    | **Diffusion**  
Have a container of a strong-smelling substance placed in the room just before the pupils enter. It is useful if this can be placed in an area in which the entry of the pupils is not going to cause air currents. Some pupils may comment on the smell, and others also notice that the smell has not reached all areas of the room. Discuss the reasons for this and introduce the term ‘diffusion’. Dilute ammonia solution, perfume or after-shave are suitable substances. | **Resources**  
Dish; strong smelling substance.  
If using a chemical from the prep room, consult safety documentation to ensure that it is not hazardous to breathe! |
| 7Gd | Exploring 1 | **Diffusion of smells**  
The initiator for this practical is in the Practical box on page 98 of the Pupil’s Book.  
• **Must:** at its simplest, this could just be an activity where members of the class put their hands up as soon as they can smell a perfume that has been placed in a dish at the front of the room. This would be sufficient to establish that the smell spreads out around the room.  
• **Should:** a slightly higher level of sophistication might be to have a prepared class plan, with pupils filling in the rank order of the places where the smell could be detected after the start of the experiment. This is likely to show that while the general trend is for the particles to move outwards from the centre, this motion is not necessarily uniform. This option is an example of an experiment where it is not easy to control any variables, but which may nevertheless yield useful, semi-quantitative data.  
• **Could:** you could assemble a number of pupils at different, known distances from the perfume. Each pupil would be given a stop clock and told to stop it as soon as he or she notices the smell. Results can be tabulated and a graph of distance against time can be drawn. The gradient of the graph will be an estimate of the speed of diffusion. This is a good opportunity to practise skills of planning the number and range of measurements to be taken, and of drawing lines of best fit through data that is likely to have quite a large scatter. | **Resources**  
Must: small, screw top bottle containing cotton wool impregnated with a perfume or other strong smelling liquid.  
Should: as Must plus overhead transparency of class plan, plus copies for pupils.  
Could: as Must plus stop clocks; measuring tape. | If using a chemical from the prep room, consult safety documentation to ensure that it is not hazardous to breathe! |
| 7Gd | Exploring 2 | **Observing diffusion in liquids (AT)**  
This could also be carried out as a homework experiment. A spoonful of Bovril® placed in a | **Resources (per group)**  
Beaker (250 cm³); water; Bovril® or similar substance; stop clock; | Any water from a kettle should not be boiling and should be |
| 7Gd | Exploring 3 | **Fizzy drinks**  
The diffusion of gases out of a fizzy drink also provides an opportunity to elicit pupils’ understanding of their ideas on the masses of gases. Pupils are invited to choose between three alternative models when making their predictions, and then carry out a demonstration experiment to test their ideas. Results can be recorded manually or, if suitable apparatus is available, via a data logger. See Worksheet 7Gd(4). This practical can be used to carry out an AT1 investigation. A sheet of level descriptions is provided on pages 189–190 of the ASP. | **Resources (per group)**  
Can or bottle of fizzy drink; balance capable of reading to nearest 0.01 g; stop clock; Worksheet 7Gd(4). Optional: data logger and computer. |
| --- | --- | --- | --- |
| 7Gd | Exploring 4 | **Diffusion of hydrogen chloride and ammonia**  
This is a teacher demonstration of the ‘traditional’ experiment with diffusion of hydrogen chloride. Worksheet 7Gd(5) sets the scene and asks pupils to make a prediction of | **Resources**  
Glass tube about 1 m long and 3–5 cm diameter (dimensions not critical); cotton wool; tweezers/forceps; conc.  
**Concentrated hydrochloric acid is a corrosive solution which releases a corrosive and toxic** |
| 7Gd | Explaining 2 | Demonstration of diffusion | Find the volume of a gas jar by filling with water and emptying it into measuring cylinder. Thoroughly dry the gas jar and place 1–2 g of copper turnings in the bottom. Add 0.8 cm³ of concentrated nitric acid per 100 cm³ of gas jar volume and place a greased lid on the jar. The reaction produces nitrogen dioxide gas which, if the correct volume of acid has been used, will just fill the jar. Explain why this happens, using | Hydrochloric acid; conc. ammonia solution (alternatively, cotton wool impregnated with each solution can be prepared and stored in a small, stoppered container that will fit inside the glass tube); eye protection; Worksheet 7Gd(5). | gas (hydrogen chloride). Concentrated ammonia is a corrosive solution which releases a toxic gas. This demonstration should only be carried out by a teacher in a well-ventilated laboratory. The cotton wool should be handled with tongs or tweezers, and the release of any fumes into the laboratory should be kept to a minimum. The ‘prepared’ method suggested reduces the risk to pupils even further. All solutions can then be handled in the prep room in a fume cupboard. |

| Resources (for demonstration) | Fume cupboard; measuring cylinder; 1-2 g copper turnings; concentrated nitric acid; greased gas jar with lids; eye protection. | This demonstration must be done in a fume cupboard and eye protection must be worn. Nitrogen dioxide is toxic and corrosive. Concentrated nitric acid is oxidising and corrosive and is best |
| 7Gd | Explaining 4 | **Modelling diffusion**  
This is similar to Starter 3 in Topic 7Gc. Put some marbles or peas into the arrangements of particles shown for liquids and/or gases on page 96 of the Pupil’s Book. Use a tray with high sides, so that the marbles/peas do not fall off. Next add marbles/peas of a different colour to one side of the tray. Now shake the tray so that the marbles/peas move and the differently coloured marbles/peas will be seen to diffuse into the others. Use the model to illustrate why diffusion in liquids takes longer than diffusion in gases. | Resources (for demonstration)  
Marbles or peas (dried if pupils are to use them); tray with high sides (or shallow box). |
| 7Ge | Starter 1 | **Collapsing cans and expanding marshmallows**  
Connect a vacuum pump to a sealed, empty can, or to an empty plastic drink bottle. Observe what happens when most of the air is removed and ask pupils to explain in terms of air pressure. At this stage in the topic, it does not matter if they cannot think of the correct explanation. Pupils may initially explain the collapsing can in terms of the vacuum pump sucking the sides in, as opposed to the air outside pushing the sides in. You can extend this by connecting the vacuum pump to a clear, rigid bottle filled with marshmallows. The marshmallows will increase markedly in size. Make sure the vacuum pump tube is protected by a gauze (to stop any errant... | Resources  
Empty can or plastic drinks bottle; vacuum pump; bored cork/ bung; glass tube; marshmallows; clear rigid bottle; gauze.  
Ensure that marshmallows are not eaten. |
| 7Ge | Starter 2 | **Magdeburg hemispheres**  
This is particularly effective if the hemispheres have been prepared before the lesson. Ask a pupil to try to pull the two hemispheres apart. If you can then let air in without being observed, you can demonstrate that you can separate the spheres using just your little fingers, whereas the pupil could not separate them with their full strength. Again, this practical should be repeated later in the lesson when pupils should be able to explain what happens in terms of particles and air pressure. Petroleum jelly smeared around the contact surfaces will help to ensure a good seal. If you don't have any Magdeburg hemispheres there are some demonstrations available on YouTube. | **Resources**  
Magdeburg hemispheres; petroleum jelly; vacuum pump. |
| 7Ge | Exploring 1 | **Syringes**  
Give pupils syringes, ask them to seal the end with a finger, and press in the plunger. Ask them how the force needed to press the plunger changes as it moves further in. Ask pupils to submit ideas as to why this happens and then discuss the ideas in groups, with each group then submitting a final idea to discuss as a class. Once the class has reached its decision, confirm the correct answer (the same number of particles is being forced into a smaller space, so they collide with the walls more often and the pressure increases). | **Resources (per group)**  
Syringes. |
| 7Ge | Explaining 4 | **Inverted glass**  
Fill a glass completely with water, put a piece of card on top and invert the glass. The card should stay attached to the glass. Explain the | **Resources**  
Drinking glass or other container with a flat rim; card.  
Mop up any spills straight away. |
role of air pressure in keeping the card up. This will not work with beakers or any other containers that have a lip shaped for pouring. It is suggested that this is a teacher demonstration only, for reasons of mess rather than safety!

**7Ge Explaining 5**

**Water-filled barometer**
Use a long glass tube sealed at one end, fill it with water and invert it into a trough of water. The water should stay in the tube. Explain to pupils why the water stays up. This is not actually a barometer— to be used as such the glass tube would have to be long enough to form a vacuum at the top (about 10 m long!) Worksheets 7Ge(5) and 7Ge(8) make use of this idea, and the drawings from those sheets may help explanations.

**Resources**
Long glass tube sealed at one end; trough.

**7Ha Exploring 1**

**Examining rocks**
Give pupils a range of labelled rock specimens and ask them to describe their appearances in as much detail as they can. Worksheet 7Ha(2) can be used to record their descriptions. Pupils may need reminding how to use a hand lens – Skills Sheet 43 provides instructions. Pupils can also be encouraged to sort the rocks into categories of their own choosing, describing the features they have used to classify the rocks. At this stage it is most important that they distinguish between sedimentary rocks and other rocks, but most pupils should be encouraged to identify the differences between igneous rock (such as basalt, granite and gabbro) and metamorphic rocks (such as gneiss and schist).

**Resources (per pupil)**
Labelled rock specimens (e.g. sandstone – if possible, more than one type with different grain sizes, conglomerate, limestone, schist, granite, basal, gabbro, gneiss, marble, chalk); hand lens; Worksheet 7Ha(2); Skills Sheet 43.
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<th>Describing sedimentary rocks</th>
<th>Resources (per pupil)</th>
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<td>Worksheet 7Ha(3) introduces pupils to some of the criteria used to describe sedimentary rocks that are made from fragments of silicate minerals (i.e. rocks such as sandstones and shales, as opposed to limestones). Ask pupils to describe sedimentary specimens in as much detail as they can, using the information on the worksheet. Keep them for Topic 7He, where they can interpret them in terms of how the rocks were formed. Skills Sheet 43 might be useful here. This exercise will be of most value if you have a range of rocks. Rock kits can be bought from school science equipment suppliers but you can also buy rocks from specialist geology suppliers such as UKGE Ltd (see their website). A suggested list would be mudstone, shale, red sandstone, millstone grit, greywacke, conglomerate and breccia.</td>
<td>Rock specimens (see above); hand lens; Worksheet 7Ha(3); Skills Sheet 43.</td>
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<th>Resources (for demonstration)</th>
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|     |             | Pupils investigate the permeability of rocks by finding how much water different rock specimens absorb. Pupils are asked to predict which rocks they think will absorb the most water, based on an examination of their textures, and then to work out the mass of water absorbed per unit mass of rock. It may be helpful to demonstrate the meaning of permeability using a sponge.  
• **Must**: instructions are given on Worksheet 7Ha(4).  
• **Should**: Worksheet 7Ha(5) provides questions to help pupils to plan their own investigations.  
• **Could**: pupils plan their own investigations using only the prompt in the Pupil's Book. | Sponge; bowl of water.  
**Resources (per group)**  
Labelled rock specimens (sandstone, limestone, chalk, granite, basalt); hand lens; beaker; access to balance; paper towels; Worksheet 7Ha(4) or 7Ha5). |
### Exploring 4
**Mohs' test for hardness**
This test depends on the fact that a hard mineral will scratch a softer one. Pupils select a pair of minerals and scratch one on the other to find out which is harder. These minerals can be compared to the hardness of established controls to enable a score to be attached to the hardness. Note that this scale is used for individual minerals, not for rocks.

**Resources (per group)**
- Copper coin; iron nail; access to piece of quartz; calcite; talc (solid, not powdered); expendable samples of minerals to test; Worksheet 7Ha(6).

### Explaining 2
**Demonstrating textures**
Use a 3D interlocking puzzle to illustrate interlocking textures, and a beaker full of marbles to illustrate non-interlocking textures. If a 3D model is not available, a 2D alternative is to cut interlocking shapes out of card and to lay them on an OHP to show them fitting together. The same exercise can then be repeated with a set of circles cut from card to show the gaps between rounded grains.

**Resources**
- 3D interlocking puzzle; beaker; marbles or interlocking card shapes; circles cut from card; OHP.

### Exploring 1
**Acid and limestone**
Pupils use droppers to drop hydrochloric acid on a range of rocks (to include limestone, marble and chalk as well as sandstone and some igneous and metamorphic rocks). Ask them to observe what happens when the acid is added to each different type of rock. Discuss with pupils the reason for using a much stronger acid than rain to show this effect. This will reinforce the statement in the Pupil's Book that limestone (and generally rocks made from calcium carbonate) react more readily with rainwater than most other rock types.

**Resources (per group)**
- Dilute hydrochloric acid (0.4 mol dm-3); dropper; samples of rocks (including limestone, marble, chalk, granite, gabbro, gneiss, sandstone); eye protection.

Eye protection should be worn when using acids because you may get a spray with some rocks.

### Exploring 2
**Best rock for statues**
This is an opportunity for pupils to carry out some simple experiments to discover some of

**Resources (per group)**
- Access to at least four different consumable samples of rock
the properties of different types of rock. Higher-attaining pupils should be encouraged to try to link the properties of a rock with its texture.

- Examination of texture using a hand lens. This may have been carried out already in Exploring 1 in Topic 7Ha.
- Hardness – some rocks are tougher than others. Do pupils think it will be easy/possible to carve the rock into the required shape?
- Reaction with acid – does the rock react immediately with a few drops of dilute hydrochloric acid?
- How much water does the rock absorb? The mass of a sample of rock is measured, then the rock is placed in a beaker of cold water for 10 minutes. The rock is removed and dabbed with a paper towel to remove any water from the surface. The mass is measured again to find out how much water has been soaked up. If pupils have carried out Exploring 3 in Topic 7Ha they could refer to their results instead of carrying out the same test again.

7Hb Exploring 3 Freeze–thaw action
This activity will need to take place over a period of about a week. Start by showing pupils a sealed plastic container that has been completely filled and then frozen. The ice should either have pushed the lid up or split the container (depending on the type of container used).

Pupils then soak cracked rock samples in water, and freeze them. The rocks are allowed to thaw out before being examined, then soaked and refrozen. This cycle may have to be repeated several times before appreciable changes are seen. If a digital camera is available it could be useful to take photographs before and after each cycle.

Resources (for demonstration)
- Sealed container full of water, frozen.

Resources (per group)
- Cracked pieces of rock; beaker; water; access to a freezer. Optional: digital camera.
| 7Hb | Explaining 3 | **Weathered rocks**  
Show pupils samples of weathered rock that have been broken. Discuss the difference in appearance between the broken (and therefore unweathered) surface and the surface that has been exposed to the effects of rainwater. | **Resources**  
Samples of weathered rock, broken to show unweathered surfaces. | **Do not attempt to break the samples of rock during the lesson. Samples should be prepared. Eye protection must be worn when breaking rock samples.** |
| 7Hb | Explaining 4 | **Rainwater**  
Collect a sample of rainwater and use a pH meter to demonstrate that the rain is acidic. | **Resources**  
Sample of rainwater; pH probe. |  |
| 7Hb | Explaining 5 | **Heating and cooling**  
Demonstrate the effect of repeated cycles of hot and cold. This can most easily be done using a glass rod, but it is more realistic if a corner of a chip of granite is heated and quenched in cold water repeatedly. | **Resources**  
Glass rod or granite chip; tongs; Bunsen burner; beaker of cold water; eye protection. | **Eye protection should be worn.** |
| 7Hb | Explaining 6 | **Weathering granite**  
Simulate the weathering of granite by using a 50:50 mixture of dilute hydrochloric acid and hydrogen peroxide. Place the sample in the solution and examine it regularly over a two-week period. If a digital camera is available it could be used to record the appearance of the sample daily, and the pictures combined to form a time-lapse sequence. | **Resources**  
Hydrochloric acid (1.5 mol dm–3); hydrogen peroxide (1.5 mol dm–3); large beaker; sample of granite; eye protection. Optional: digital camera. | **Hydrogen peroxide is an irritant. Eye protection should be worn.** |
| 7Hc | Starter 2 | **Moving water**  
This activity demonstrates the link between the speed of movement of water and the size of fragments that it will carry. Two-thirds fill a jam jar with water and then add a spoonful of sand. | **Resources**  
Jam jar; spoon; sand; gravel; water. |  |
Stir the water for one minute and then leave it to stand without moving it. Ask pupils what they see happening. Repeat after adding one spoonful of gravel, and ask pupils to describe how this is different. Elicit the idea that the size of fragments carried depends on the speed at which the water is moving.

| 7Hc  | Exploring 1 | **Erosion of rock fragments during transport**  
This activity is designed to show how a roughly shaped fragment of rock can be changed into a rounded grain of rock as it is carried down the river. Pupils measure the mass of a sugar cube and then place it in a jam jar and shake it vigorously for 30 seconds. After this time, the largest fragment is removed, examined and reweighed. The fragment is then returned to the jam jar and the process repeated until it is impossible to determine a largest fragment. Pupils can be asked to plot a graph showing the mass of the largest fragment against the length of time it has been shaken. This activity can also be carried out using plaster cubes. | **Resources (per group)**  
Sugar cube (or plaster cube); jam jar with lid; stop clock; access to top pan balance. | Do not allow pupils to taste the sugar cubes. |
| 7Hc  | Exploring 2 | **How far are grains carried?**  
Pupils investigate how far the grains and fragments that could make up a sample of soil are carried in a stream. This investigation requires pupils to make use of a model stream or flume. A flume consists of a length of channel, usually made from a piece of guttering, raised at one end with the lower end resting in a trough or tank. Sand and gravel are placed in the guttering, and water is introduced at the higher end. The size and number of flumes will depend on the materials you have available. | **Resources (per group)**  
Flume (e.g. plastic guttering); trough, tank or bucket; running water; sand; gravel; ruler; stop clock; Worksheets 7Hc(2) or 7Hc(3). | Mop up any acid spills straight away. |
### 7Hd Exploring 1

**Sand and sandstone**

This practical shows the effect of compaction and cementation on grains of sand. Pupils are provided with a tray of damp sand. They observe the structure of the sand grains closely using a hand lens and record their observations.

**Resources (per group)**

- Damp sand (ideally sharp sand as it has large grains);
- Samples of sandstone;
- Hand lens;
- Plaster of Paris;
- Clay;
- Plastic syringes with ends cut off;
- Petri dish;
- Disposable

Plaster of Paris can get hot when mixed with water.
They then take a handful of the damp sand and squeeze it tightly and observe the water which is released. Careful observation may reveal the presence of a white/shiny coating already present on some grains. These are mineral deposits, left behind when water has evaporated. Point out to pupils that over a long time, more of these deposits would form and would eventually cement the grains together. Different groups of pupils could extend this task further by producing pellets of sand mixed with water, clay or plaster of Paris and comparing them. Having observed the effects, pupils should examine samples of both sandstone and damp sand carefully, trying to identify the ‘glue’ which is often visible around the grains within the rock.

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<td>Pupils add a few drops of dilute hydrochloric acid to some calcium carbonate on a watch glass and observe the evolution of gas (carbon dioxide). The limewater test for carbon dioxide could be revised here if necessary. This practical is intended as a preliminary activity to introduce Exploring 3 and help pupils to design plans for an investigation.</td>
<td>Watch glass; dilute hydrochloric acid (0.4 mol dm−3); calcium carbonate; pipette; eye protection. Optional: limewater; means of collecting carbon dioxide from reacting rock sample.</td>
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<tr>
<th>7Hd</th>
<th>Exploring 3</th>
<th>Carbonate content of limestones</th>
<th>Resources (per group)</th>
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<td></td>
<td></td>
<td>Pupils plan and conduct an experiment to investigate the composition of different samples of limestone. A possible repeatable method includes measuring the mass of the sample of rock before and after reacting it with a known volume of acid. The loss in mass will reflect the amount of carbon dioxide released and hence the carbonate content of the rock. This will work</td>
<td>Crushed samples of two or three different samples of limestone; balance; dilute hydrochloric acid (0.4 mol dm−3); 100 cm³ measuring cylinder; spatula; 250 cm³ beaker; Worksheet 7Hd(4) or 7Hd(5).</td>
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| 7Hd | Explaining 4 | **Reactions of limestone**  
Demonstrate the sequence of reactions referred to on Worksheet 7Hd(6). Heat a piece of limestone strongly on a tripod and gauze for five minutes, then allow it to cool for five minutes. Heating converts some of the outside of the rock to calcium oxide. Then use tongs to put the lump of rock into a beaker half-full of water, and stir the water. This will convert some of the calcium oxide to calcium hydroxide, which partly dissolves in the water – this is limewater. Filter the water, then blow into the resulting solution with a straw. The carbon dioxide in your breath reacts with the calcium hydroxide to form limestone again, which is what makes the limewater go cloudy. | **Resources**  
Bunsen burner; tripod; gauze; heatproof mat; tongs; beaker; test tube; filter funnel and paper; conical flask; stirring rod; piece of limestone (1–2 cm3); eye protection. | Wear eye protection. |

| 7He | Starter 2 | **Explaining the layers**  
Show pupils photo A from page 14 of the Pupil’s Book and ask them to suggest how there came to be layers in the rocks. Follow this up by | **Resources**  
Different coloured sands; tall thin clear container, e.g. 25 mm diameter clear PVC pipe with bung; |
<table>
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<th>He Exploring 1</th>
<th>Different limestones (AB/AT)</th>
<th>Resources (per group)</th>
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<tr>
<td>Pupils examine samples of different limestones to arrive at a record of the observable differences between them. They should examine the appearance and grain size carefully using a hand lens, and note the presence or absence of fossils. Ask pupils to...</td>
<td>Samples of different limestones (to include chalk, brown limestone, fossiliferous limestone, oolitic limestone, coquina); hand lens.</td>
<td>plaster of Paris (for cementing layers together if making permanent display).</td>
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Showing pupils a jar or measuring cylinder full of water and ask them what it represents, and how it could vary (it represents a river or stream and the speed of movement of the water and its sediment load could change). Show them a spoonful of sand and ask what it represents (weathered fragments of rock). Elicit the information that weathering does not always happen at the same rate, so different amounts and types of sediment could be carried by the river at different times, and also that the flow rate will vary during the year as well as over longer periods of time. Model these variables by adding different amounts of different materials and allow pupils to watch layers being built up. If the amount of added material is varied, the thickness of the layers can be varied and a set of ‘rock’ strata built up. Different sands from the Isle of Wight are ideal for this activity, but it will work well with materials available at any good builder’s merchants.

(Optional extra – If a little plaster of Paris is added to each material before it is placed in the tube, the sediments will cement together giving a permanent display – if this is to work well it is better to add all of the layers of material on the same day. Note that if the demonstration is carried out in a measuring cylinder it will be almost impossible to return it to normal use.)
7He  Exploring 3  Sedimentary rocks in detail
Exploring 2 in Topic 7Ha asked pupils to describe sedimentary rocks in detail, including noting grain size, sorting and rounding. Give pupils the same rock samples again, and their notes, and ask them to suggest what their observations can tell them about how the rock was formed. The answers will depend on the rocks you have available, but some possible conclusions are:
- mudstones (with very fine grains) were laid down in very slowly moving water
- conglomerate and breccia (poorly sorted, with some large fragments) were deposited when fast-flowing water suddenly slowed down
- the rounded fragments that formed conglomerates must have been moved along a stream or river for some time, to become rounded
- the angular fragments in breccia could not have been abraded in water for very long
- fine-grained red sandstone could be a result of deposition in a desert or other hot environment.

Resources (per group)
Rock specimens (mudstone, shale, Permian (red) sandstone, millstone grit, greywacke, conglomerate, breccia); hand lens; Worksheet 7Ha(3).

7Ia  Exploring 2  Bunsen burners
Introduce the idea of natural gas as a fuel. If pupils have not yet used Bunsen burners this is a good opportunity to introduce them: see Skills Sheet 53. This is also an opportunity to reinforce basic lab safety procedures. Pupils

Resources (per group)
Bunsen burner; tripod; gauze; safety mat; beaker; thermometer; stop clock; eye protection; Skills Sheet 53.

Eye protection should be worn.
could investigate the amount of energy they get from natural gas with the Bunsen burner on different settings, by using different flames to heat water and measuring the temperature rise. This is a good opportunity for pupils to practise designing a fair test. They could also note the degree of soot on the beaker or test tube with a yellow flame.

**7la Exploring 3**

**Energy in solid fuels**

Pupils compare the energy obtained from different solid fuels.

- **Must:** pupils follow the instructions on Worksheet 7la(2), which also provides guidance on recording and considering results.
- **Should:** pupils use Worksheet 7la(3) to plan their investigation. Both worksheets assume that pupils will use each fuel to heat water for the same length of time (5 minutes), comparing the temperature rise. This will indicate how much energy each fuel releases in a given time. Pupils should consider other factors (e.g. ease of lighting) before deciding on the 'best' fuel. The fuels should just be left to burn out after the final temperature measurement is taken.

**Resources (per group)**

- Assorted fuels such as coal, coke, wood, charcoal, fire lighters, hexamine blocks; Bunsen burner; boiling tube; old tin lid; heatproof mat; thermometer; clamp stand; tongs; stop clock; eye protection; Worksheet 7la(2) or 7la(3).

Eye protection is essential. Small lumps of solid fuel samples should be cut before the lesson (such that the lumps will burn for just over 5 minutes). Some solid fuels can crack on heating and spit. Hexamine can break up if not dry (it should be kept in a desiccator). The smoke or fumes given off can cause problems for asthmatics. The lab should be well ventilated.

**7la Exploring 4**

**Energy in liquid fuels**

Compare ethanol and paraffin, using spirit burners to heat a fixed volume of water for a fixed time. This gives a more quantitative set of results than Exploring 3 because pupils can measure the mass of the burners before and after use to determine how much fuel has been used.

**Resources (per group)**

- Paraffin and ethanol/methanol each in a spirit burner; beaker; tripod; gauze; heatproof mat; thermometer; stop clock.

Eye protection must be worn. Liquid fuels should be placed in the burners before the lesson, and the burners should not be opened during the lesson.
used. A temperature rise per gram of fuel can then be worked out. The flames should be blown out after 5 minutes.
- **Must**: explain the procedure to pupils, or adapt Worksheet 7Ia(2) to provide instructions.
- **Should**: ask pupils to plan their own investigation based on the procedure used in *Exploring 3*.
- **Could**: pupils calculate the actual energy transferred using the equation: 
  \[ \text{energy (J)} = 4.2 \times \text{mass of water (g)} \times \text{temperature rise (°C)} \]

| 7Ib | Explaining 2 | **Burning and carbon dioxide**  
If pupils have not already studied Unit 7F, you could demonstrate that burning fuels does produce carbon dioxide. Some pupils will have heard of carbon dioxide at Key Stage 2 as the gas in fizzy drinks, or even as a gas we breathe out. Demonstrate that blowing into limewater makes it go cloudy and explain that it is the carbon dioxide in your breath that is doing this. Take a clean test tube and put limewater in the bottom. Hold an unlit splint in it to show that this has no effect. Then put a bung in the tube and shake it briefly. The limewater will remain clear and colourless. Next hold a burning splint part-way down the mouth of the tube until it goes out, then put a bung into the tube and shake it. The limewater should go cloudy. You may need to make the link between the wooden splint and the plants that eventually became coal, or just explain that all fuels that we burn contain carbon. | **Resources**  
2 test tubes; bung; limewater; straw; splint; Bunsen burner to light the splint. | Limewater is an irritant. Do not inhale. |

| 7Ic | Exploring 1 | **Renewable resources**  
Demonstrate examples of renewable resources | **Resources**  
Solar cell; motor; connecting wires; |
<table>
<thead>
<tr>
<th>Step</th>
<th>Activity</th>
<th>Resources (per group)</th>
<th>Notes</th>
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| 7lc Exploring 2 | Energy from plants  
Put grass or straw into a vacuum flask with a thermometer and seal with cotton wool or a bored cork. Measure the temperature every day for a week — it should start to rise. The worksheets ask pupils to set up a second flask containing nylon tights to demonstrate that the temperature does not go up on its own and to introduce the idea of a ‘control experiment’. Use datalogging equipment, if available. Make sure that pupils understand that the heat detected is given off by microorganisms as they digest the plant material. The heat shows that something is happening, and is not directly related to energy stored in any gas that is being produced.  
**Must:** Worksheet 7lc(4) provides instructions in the form of a missing words exercise.  
**Should:** Worksheet 7lc(5) provides notes to help pupils to plan their own investigation.  
**Could:** pupils plan their own investigation using the hints in the box on page 124. Skills Sheets 13 or 14 may be helpful. | 2 vacuum flasks; 2 thermometers; grass or straw; nylon; cotton wool (or bored corks to fit the flasks); Worksheet 7lc(4) or 7lc(5); Skills Sheets 13, 14. | Wash hands after handling grass or straw. |
| 7lc Exploring 3 | Solar panels  
Pupils find the best colour for a solar panel by using foil trays or old cans painted a variety of colours, and measuring the temperature rise of water inside them. Discuss fair ways to carry out | Painted foil trays or cans; thermometer; stop clock; water. |
<table>
<thead>
<tr>
<th>7Id</th>
<th>Exploring 1</th>
<th><strong>Energy in food</strong></th>
<th>Resources (per group)</th>
<th>This practical activity is often carried out using nuts. However, pupils allergic to nuts can suffer extreme reactions if they are in the same room as burning nuts. Even if allergic pupils are excluded from the room, you may have a pupil who does not know they are allergic. It is far safer to use crackers, crispbread or other foods. The lab must be well ventilated because smoke or fumes may cause problems for asthmatics. Pupils must not eat any of the foods.</th>
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<td></td>
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<td>Pupils compare at least three different foods to determine how much energy is stored in each type. The fairest comparison is given by using a known and fixed volume of water, holding the food a similar distance from the test tube each time, and using similar sized pieces of food. Ideally the pieces of food should be the same mass but this may be difficult at this level. This practical can be used to carry out an AT1 Investigation. A set of level descriptions is provided on pages 236–237 of the ASP.</td>
<td>Crisps, crackers, or ‘bite-sized’ cereals such as Shreddies, or other foods such as crispbreads, together with the packet (for energy information); measuring cylinder; boiling tube; clamp and stand; thermometer; water; pin; cork; Bunsen burner; heatproof mat; eye protection; Worksheet 7Id(2) or 7Id(3).</td>
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</table>
|     |             | • **Must:** pupils complete a missing words exercise on Worksheet 7Id(2) to help them to plan their investigation.  
• **Should:** Worksheet 7Id(3) provides guidance to help pupils to plan their own investigation.  
• **Could:** pupils could plan their own investigation using the hints in the Practical box on page 129 of the Pupil’s Book. | |
| 7Ja | Exploring 1 | **Testing materials (AT)** | Resources (per group) | |
|     |             | Ask pupils to test materials to see if they are conductors or insulators. Pupils set up a simple circuit with a cell/power pack, bulb and three wires, leaving a gap into which they insert the | Cells or power pack; 3 connecting wires; bulb in holder; range of materials. | |
|     |             | Resources (per group) | |

**7Id Exploring 1**

**Energy in food**

Pupils compare at least three different foods to determine how much energy is stored in each type. The fairest comparison is given by using a known and fixed volume of water, holding the food a similar distance from the test tube each time, and using similar sized pieces of food. Ideally the pieces of food should be the same mass but this may be difficult at this level. This practical can be used to carry out an AT1 Investigation. A set of level descriptions is provided on pages 236–237 of the ASP.

- **Must:** pupils complete a missing words exercise on Worksheet 7Id(2) to help them to plan their investigation.
- **Should:** Worksheet 7Id(3) provides guidance to help pupils to plan their own investigation.
- **Could:** pupils could plan their own investigation using the hints in the Practical box on page 129 of the Pupil’s Book.

**Resources (per group)**

- Crisps, crackers, or ‘bite-sized’ cereals such as Shreddies, or other foods such as crispbreads, together with the packet (for energy information);
- measuring cylinder;
- boiling tube;
- clamp and stand;
- thermometer;
- water;
- pin;
- cork;
- Bunsen burner;
- heatproof mat;
- eye protection;
- Worksheet 7Id(2) or 7Id(3).

**7Ja Exploring 1**

**Testing materials (AT)**

Ask pupils to test materials to see if they are conductors or insulators. Pupils set up a simple circuit with a cell/power pack, bulb and three wires, leaving a gap into which they insert the materials.
material to be tested. This practical is likely to have been done at KS2, but it may be worth repeating to reinforce ideas about conductors and insulators if pupils showed weakness in this area during the Starter tasks. The AT animation link on page 135 opens *Testing conductors and insulators* – this provides photos of various electrical components and asks pupils to name them, and then asks them to select the components needed to set up a circuit to test materials to see if they are electrical conductors or insulators. This activity could be carried out to help pupils to plan for themselves how they are going to test the different materials.

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<td><strong>7Ja Exploring 2</strong></td>
<td><strong>Testing wires</strong>&lt;br&gt;This is a good introductory practical for the unit if pupils can recall how to test materials, and can be used instead of or in addition to <em>Exploring 1</em>. Supply pupils with a set of insulated wires and ask them to check which ones work. The wires should have been prepared so that some of them have the metal broken inside and so will not conduct. Have the wires numbered and a separate list of which ones work, so that answers can be checked. This is a useful introduction to fault finding in electrical circuits. The circuit can be extended to include faulty bulbs.</td>
<td><strong>Resources (per group)</strong>&lt;br&gt;Cells or power pack; bulb; 3 connecting wires; two crocodile clips; set of ‘broken’ wires. Optional: faulty bulbs.</td>
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<tr>
<td><strong>7Ja Exploring 3</strong></td>
<td><strong>Measuring current</strong>&lt;br&gt;The aim of this practical is to give pupils practice in building circuits, and to demonstrate that the current is the same everywhere in a series circuit. This is important because many pupils have difficulty understanding how</td>
<td><strong>Resources (per group)</strong>&lt;br&gt;Cells or power pack; 2 bulbs; 3 ammeters; connecting wires; Worksheet 7Ja(3); Skills Sheet 55.</td>
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electricity can deliver energy if it is not used up (see Background information). If the pupils are asked to predict their results before carrying out the practical work, you will get a good idea of some of the misconceptions that you will have to deal with!
As the brightness of bulbs is often used as an indication of the size of current flowing, it may be helpful to set up a demonstration circuit first and ask pupils to observe the brightness of bulbs with different currents flowing. Worksheet 7Ja(3) assumes that only one ammeter is available per group. However this demonstration is most effective when two or three ammeters can be used at the same time.
- **Must**: it may be better to demonstrate.
- **Could**: pupils will probably manage with one ammeter and can build three separate circuits, measuring the current each time. It may be necessary to demonstrate the circuit after pupils have obtained their own readings, particularly if each group has only been able to use one ammeter.
Sometimes pupils can find that one bulb is brighter or dimmer than the others, and may question the idea that current is the same throughout the circuit. This effect is due to the fact that not all bulbs are identical – this can be demonstrated by changing the positions of the bulbs in the circuit. If time permits, bulbs can be tested before the lesson and the bulb holders labelled, so that all pupils get a set of bulbs of similar brightness.
It may be helpful to explain how to set up a circuit from a circuit diagram methodically, before pupils start the practical work. Skills
Sheet 55 may help. Ensure that pupils do not connect the ammeter in parallel with the battery, as this will produce a short circuit.

| 7Ja  | Exploring 4 | **Changing the current**  
|Pupils investigate the effect of adding more bulbs on the brightness of the bulbs and the current in a series circuit. It is worth getting pupils to examine a bulb carefully, and note how thin the wire is that forms the filament. If enough bulbs are available, this can be made into a competition by seeing how many bulbs different groups can put in their circuit and still see a glow from the filament. This practical can be extended by asking pupils to investigate the effects of different voltages on the brightness of bulbs. Ideally, cells with different voltages could be used, but cells in series could be used instead. If several cells are used, ensure that pupils know how to connect them positive to negative. Pupils should see that the higher the voltage rating, the brighter the bulbs and the bigger the current. | Resources (per group)  
Cells or power pack; connecting wires; bulbs; ammeter. |

| 7Ja  | Explaining 6 | **Current and resistance**  
Pupils should be familiar with the idea that if more bulbs are added in series to the circuit, they will be dimmer. However, it may be worth demonstrating this when discussing resistance. No formal numerical treatment of resistance is attempted in this topic – the intention is that pupils understand the qualitative relationship between resistance and current. | Resources  
Power pack; connecting wires; 3 or 4 bulbs in holders; ammeter. |

| 7Jb  | Starter 1 | **Heating effect of a current**  
Demonstrate the heating effect of a current. This can be done by holding a length of nichrome wire between two clamp stands, and |

Wear eye protection if there is any chance of melting the wires. Warn pupils not to
making it part of a circuit. When the wire has
been warmed up it can be used to cut paper –
the burnt edges of the paper will be visible.
This demonstration can be extended to show
how fuses work – if the same apparatus is used
to heat a thinner length of wire or a piece of
steel wool, it will melt. If a bulb has been
included in the circuit, pupils will see that the
bulb goes out when the ‘fuse’ melts.

| 7Jb | Exploring 1 | **Length of wire and resistance**  
Pupils investigate the effect of the length of a
wire on the current through it. The task is made
easier if the wires can be mounted on metre
rules which will hold the wire straight and make
measurement easier. Nichrome wire of around
0.3 mm diameter (SWG 30 or 32) is suitable. Discuss with pupils the difference between the
connecting wires (thick, and made of copper
which is a very good conductor) and the wire
they are investigating (nichrome does not
conduct as well as copper, and the wire is
thinner). It may also be necessary to explain to
pupils that the current will only flow through the
piece of wire between the crocodile clips. It is
not necessary to cut different lengths of wire;
moving the crocodile clips further apart will
suffice. Note that the resistance will change if
the wire gets hot, and crocodile clips can dent
the wire and effectively reduce the cross-
sectional area which will also affect the
resistance.  
• **Must:** instructions and prompts are provided
on Worksheet 7Jb(2).  
• **Should:** Worksheet 7Jb(3) provides prompts
to help pupils to plan their own investigation.
Alternatively, you may wish to use Explaining 4 |

| Resources (per group)  
Power pack; crocodile clips;  
connecting wires; ammeter; metre
rule; metre lengths of nichrome
wire; heatproof mat; Worksheet
7Jb(2) or 7Jb(3); graph paper. |

| Resistence wire can
get hot when high
currents flow. |
for planning purposes before carrying out this task.  
This practical can be used to carry out an AT1 Investigation. A sheet of level descriptions is provided on pages 259–261 of the ASP. If this is done, pupils should not be given instructions on the worksheets.

| 7Jb | Exploring 3 | **Thickness of wire and resistance**  
This is an extension of Exploring 1, which asked pupils to investigate the effect of the length of a wire on resistance. Ideally five different thicknesses of wire should be available. At this level the explanation that the resistance of thicker wires is lower because the electrons have more room to move along the wire is probably acceptable, although it is not strictly true (see Background information). Pupils should be encouraged to record and plot the actual diameters of the wires rather than the standard wire gauge numbers (wires are now sold marked with the diameter, but older stock may still have SWG numbers – equipment suppliers’ catalogues include conversion tables). Pupils measure the current through the different thicknesses of wire, keeping the length and voltage settings the same. | **Resources (per group)**  
Power pack; crocodile clips; connecting wires; ammeter; metre rule; 5 different thicknesses of nichrome wire; heatproof mat. | Resistance wire can get hot when high currents flow. |

| 7Jb | Exploring 4 | **Testing fuse wire**  
Provide pupils with lengths of fuse wire of different ratings, and ask them to find out the maximum current for each wire.  
• **Must**: instructions are provided on Worksheet 7Jb(4), which assumes that only two thicknesses of wire are provided. Pupils should be encouraged to work in pairs, with one pupil controlling the current and watching the wire. | **Resources (per group)**  
Power pack; bulb; ammeter; variable resistor; connecting wires; crocodile clips; heatproof mat; selection of low current fuse wires; eye protection. Optional: Worksheet 7Jb(4). | Choose fuse wires that will melt at a current lower than the maximum current for the bulbs in the circuit. Wear eye protection if there is any chance of wires melting. Provide |
and the other reading the voltmeter.

- **Should:** pupils should plan their own method, and could investigate several different thicknesses of wire.
- **Could:** encourage pupils to consider the inherent inaccuracy of attempting to determine the current at the exact moment that the wire melts, and ways of allowing for this, such as repeating the measurement several times.

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<th>7Jb</th>
<th>Exploring 5</th>
<th><strong>Wiring plugs (AB/AT)</strong></th>
<th><strong>Resources (per group)</strong></th>
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<td></td>
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<td>Pupils wire up a standard 3-pin plug. Higher-attaining and dexterous pupils can be given a length of 3-core cable and strip the insulation themselves, but for lower attainment pupils it would be useful to have at least the outer cable insulation stripped, and for some it might be better to strip the inner wire insulation as well. You may wish to use the AT activities described in <em>Explaining 3</em> before carrying out this task.</td>
<td>Plug; screwdriver; wire strippers; three-core cable.</td>
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<td>Pupils must not try out their plugs. The power supply in the lab must be turned off before starting this practical, in case any are tempted to try out their plugs. The earth pins should also be bent or otherwise disabled (e.g. with a bolt through them) so that the plugs cannot be put into sockets. Pupils should be warned never to wire plugs at home unless supervised by an adult. Pupils’ wiring must be checked and corrected if necessary, to ensure that they do not leave with a mistaken idea of how to wire plugs which they may...</td>
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| 7Jb | Exploring 6 | **Build a fire alarm**  
Demonstrate a bimetallic strip by heating it in a Bunsen burner and showing that it bends when heated and straightens again when it cools. It is also worth demonstrating again with the strip held the other way up, so that pupils do not think it always bends away (or towards) the source of heat. Instructions are provided on Worksheet 7Jb(5). You can use electric bells or buzzers instead of bulbs to make the activity more realistic, if you can stand the noise! | **Resources (per group)**  
Cells or power pack; crocodile clips; connecting wires; emery paper; bimetallic strip; bulb; Bunsen burner; 2 clamps and stands; Worksheet 7Jb(5). | Ensure that pupils keep the connecting wires well away from the Bunsen flame. It may be better to demonstrate this practical for lower-achieving or poorly behaved classes. Wear eye protection. |
| 7Jc | Exploring 2 | **The ‘counter model’**  
Have a large box or bucket full of counters, which will represent energy. You act as the cell. A line of pupils (electrons) walks past you, and each pupil is given one counter. One pupil acts as a bulb, and the ‘electrons’ hand over the counters as they pass him/her, and then return to you for more. Set up the arrangement without telling pupils what each part of the model represents, and ask them to suggest what you, they, the ‘bulb’ pupil and the counters represent. You could explain the analogy if pupils do not suggest the right answers, or you may wish to revisit this model after pupils have carried out Explaining 1, which describes some other models of circuits. | **Resources**  
Large bucket of counters or similar small objects. |  |
| 7Jd | Starter 2 | **Series and parallel circuits**  
Set up a series circuit with two bulbs and a parallel circuit with two bulbs and ask pupils to list the differences between them. Unscrew a bulb from each circuit and elicit the differences. You could also add another bulb to each circuit and elicit the differences again. Ask pupils to try | **Resources**  
Cells or power pack; 6 bulbs in holders; connecting wires. |  |
| 7Jd | Exploring 1 | **Investigating parallel circuits**  
Pupils investigate the characteristics of parallel circuits by contrasting the behaviour of a series and a parallel circuit with respect to brightness of bulbs, current and the use of switches. It may help to demonstrate how to set up parallel circuits before pupils start the practical work (by setting up a series circuit, and then adding additional branches. Skills Sheet 55 may help with this.  
**• Must:** pupils follow the directions on Worksheet 7Jd(2). If necessary, you could set up the circuits before the lesson as a circus. Some groups may find it difficult to make sufficiently accurate measurements of current to discover the rules for current flow in parallel circuits. It may be better to demonstrate the practicals for these groups, either instead of their own efforts or after they have attempted the practical work.  
**• Should:** pupils follow the directions on Worksheet 7Jd(3) and answer the questions on the sheet. | **Resources (per group)**  
Cells or power pack; connecting wires; ammeter, bulbs; Worksheets 7Jd(2) or 7Jd(3). Optional: Skills Sheet 55. |
|---|---|---|
| 7Jd | Exploring 3 | **Ring mains**  
Ask pupils to plan a circuit to light five rooms in a house. Ask them to evaluate their circuits in terms of what a real ring main does, i.e. provides lights of constant brightness that can all be switched independently. A diagram representing part of a ring main is provided as part of Worksheet 7Jd(8), and it may be worth discussing this with pupils after they have built their circuits. They may need help in relating the difference between mains and cell/low voltage circuits must be explained. Pupils should be cautioned to NEVER tamper with mains electricity. | **Resources (per group)**  
Power pack; 5 bulbs; 5 switches; connecting wires. Optional: Worksheet 7Jd(8). |
| 7Je | Exploring 1 | A **home-made cell**  
This task is best carried out after pupils have read pages 146–147 in the Pupil’s Book (Explaining 3). Build a reproduction of the first voltaic pile. The original ‘pile’ was a stack of alternating zinc and silver discs, with a brine-soaked piece of cardboard on top of each zinc disc. ‘Silver’ coins (e.g. 10p coins) and pieces of aluminium foil can be used in place of silver and zinc discs. |
| 7Ka | Exploring 1 | **Circus of forces**  
Place equipment around the lab, numbered to match Worksheet 7Ka(2).  
1 A pair of magnets.  
2 An ice cube and a similar sized block of wood, for pupils to push along the bench.  
3 A piece of natural string (the rougher the better) and a piece of plastic string, for pupils to tie knots with.  
4 A spring that can be stretched between the hands without exceeding its elastic limit. Pupils should be able to feel that the force exerted by the spring increases as the extension increases.  
5 A force meter and an object to weigh.  
6 Observing the time taken for a piece of paper to fall varying with the amount it is crumpled up. |
| 7Ka | Exploring 2 | **More forces**  
Give pupils practice using force meters by asking them to weigh a range of objects, and also to measure other forces, such as the force required to open a door, to drag a book or other |

**Resources (per group)**
- 7Je: ‘Silver’ coins; aluminium foil; cardboard discs; connecting wires; 2.5 V mounted bulb or a voltmeter; brine solution.
- 7Ka: 1 to 3 sets only if done as a circus, depending on class size): 1 2 bar magnets (N and S marked); 2 ice cube; similar sized block of wood; 3 piece of natural string; piece of plastic string; 4 spring; 5 force meter; object to weigh that can be hooked onto force meter; 6 sheets of paper; Worksheet 7Ka(2).
- 7Ka: Force meter; variety of objects to weigh and/or pull.

Clear up any water spills from melting ice.
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<th>Exploring 3</th>
<th><strong>Mass and weight</strong></th>
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<tbody>
<tr>
<td><strong>7Ka</strong></td>
<td><strong>Exploring 3</strong></td>
<td><strong>Mass and weight</strong></td>
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<td>This practical is best carried out after Explaining 1. Ask pupils to weigh a range of objects using scales marked in both grams/kilograms and newtons. If such scales are not available, provide a range of labelled masses (slotted masses will do, but other objects could be used if their masses are measured before the lesson and marked on them). If possible, use bathroom scales to find the masses of the pupils themselves. Be aware that some pupils may be sensitive about their weight/mass. Ask pupils to compile a table of weight against mass. Pupils could be asked to plot graphs to show their results, and work out the weight of 1 g. Pupils can then use their graphs to work out the weight of other items of known mass.</td>
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<td>Resources (per group)</td>
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<td>Access to a range of items with masses marked; force meter; bathroom scales; graph paper.</td>
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<td></td>
<td>Explaining 3</td>
<td><strong>Bathroom scales</strong></td>
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<tr>
<td>7Ka</td>
<td>Explaining 3</td>
<td><strong>Bathroom scales</strong></td>
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<td>Remove the cover from a set of bathroom or kitchen scales (mechanical, not electronic) to find out how they work – there is usually a metal bar that deforms when someone stands on it, and a mechanism to transform the deformation into movement of the dial.</td>
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<td>Resources</td>
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<td></td>
<td>Set of mechanical bathroom or kitchen scales.</td>
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<td></td>
<td>Exploring 1</td>
<td><strong>Factors affecting friction</strong></td>
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<tr>
<td>7Kb</td>
<td>Exploring 1</td>
<td><strong>Factors affecting friction</strong></td>
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<td>Discuss with pupils the factors that could affect friction, and then ask pupils to plan their own investigation. You may wish to carry out Explaining 4 (an interactive activity asking pupils to spot mistakes in an investigation) or Explaining 5 (a practical demonstration with deliberate mistakes) to help them to think about fair testing before they plan their own</td>
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<td>Resources (per group)</td>
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<td>Blocks of wood of different sizes fitted with hooks; force meter; ramp; sheets of paper and sandpaper of different grades; drawing pins; set of slotted masses; stop clock; Worksheets 7Kb(2) or 7Kb(3); Skills Sheets 28, 29</td>
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<td>Take care that the block does not fall off the edge of the bench.</td>
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investigation. Pupils could investigate the size of the area in contact, the roughness of the surface, the force with which the two surfaces are pushed together, or the speed at which the block is pulled. The apparatus needed will depend on the pupils’ plans, but the list below should cover most eventualities. This practical can be used to carry out an AT1 Investigation. A sheet of level descriptions is provided on pages 286–287 of the ASP. Note that using Worksheet 7Kb(2) will limit pupils’ possible marks in the planning strand.  
- **Must:** pupils follow the directions on Worksheet 7Kb(2).
- **Should/Could:** pupils can plan their own investigation using the hints on Worksheet 7Kb(3). Skills Sheets 28 and 29 may be of use when presenting results.

<table>
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<tr>
<th>7Kb</th>
<th>Explaining 1</th>
<th><strong>Lubrication demonstration</strong></th>
<th>Resources</th>
<th>Clear up any spilled liquids.</th>
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<td></td>
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<td>Possible demonstrations are pulling an ice cube and a block of wood along the bench pointing out that the water from melting ice produces a lubricant, or use oil or washing up liquid to provide a lubricating film between the bench and a block of wood being pulled along it. You may wish pupils to push the blocks so they can feel the effects of the lubricant themselves, or use a force meter to quantify the different forces needed to pull lubricated and unlubricated blocks. Pupils can also be reminded of the practicals they carried out in Topic 7Ka with the block of wood and ice cube, or the two types of string (both parts of 7Ka Exploring 1), and asked why they think the objects behaved differently.</td>
<td><strong>Ice cube; wooden block; oil or washing up liquid; force meter.</strong></td>
<td></td>
</tr>
</tbody>
</table>
### 7Kb Explaining 5

**Spot the mistake**

Afl This is a practical alternative to *Explaining 2* (spotting mistakes in an investigation into friction). Demonstrate how to carry out an investigation, but include deliberate errors such as changing two variables at once. Ask pupils to point out the errors, and discuss ways of improving the method. Take the opportunity to discuss the need for repeat readings. The friction could be measured by finding the force needed to pull a block along at a steady speed, or finding the time taken for a block to slide down a ramp. The advantages and disadvantages of each method could be discussed. This task could be used to help pupils to plan their own investigation into the factors affecting friction (*Exploring 1*).

**Resources**

Blocks of wood of different sizes fitted with hooks; force meter; ramp; sheets of paper and sandpaper; drawing pins; set of slotted masses; stop clock.

**Take care that the block does not fall off the edge of the bench.**

### 7Kc Starter 2

**Float or sink?**

Show pupils a range of materials, and ask them to suggest what will happen if they are put into water. Ask how they can predict which ones will float or sink, and demonstrate – particularly if they have made incorrect predictions. Pupils are likely to predict that ‘heavy’ things will sink. If possible, have a small dense object (such as a ball bearing) and a large piece of less dense material (such as a piece of wood – but check it is not a dense hardwood that will sink) and show that the wood is heavier than the ball bearing, but still floats. Elicit the idea that it is the mass for a particular size that matters.

**Resources**

Large beaker or glass bowl full of water; variety of objects/materials, including one object that will float that is heavier than one of the non-floating objects (e.g. a block of wood and a small ball bearing).

**Clear up any spills straight away.**

### 7Kc Exploring 1

**Feeling upthrust**

Present pupils with a range of objects such as expanded polystyrene, or sealed, empty plastic drinks bottles. Submerge them in a sink or bowl of water or access to a sink; sealed empty plastic drinks bottle; expanded polystyrene.

**Resources (per group)**

Bowl of water or access to a sink; sealed empty plastic drinks bottle; expanded polystyrene.

**Clear up any spills straight away.**
<table>
<thead>
<tr>
<th>Exploring 2</th>
<th>Floating, sinking and density</th>
<th>Resources (per group)</th>
<th>Clear up any spills straight away.</th>
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</thead>
<tbody>
<tr>
<td>7Kc</td>
<td>Pupils measure the upthrust on various objects by finding the difference between their weight in air and their weight in water. They also calculate the density of each object, and investigate the link between density and floating/sinking. If irregular shaped objects are used, pupils may need help measuring the volumes (see Skills Sheet 22). Worksheet 7Kc(3) provides instructions.</td>
<td>Samples of different materials (include wood, expanded polystyrene, and at least two different metals); ruler; calculator; bowl; water; force meter; Worksheet 7Kc(3). Optional: Skills Sheet 22.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exploring 3</th>
<th>Upthrust in different liquids</th>
<th>Resources (per group)</th>
<th>Clear up any spills straight away.</th>
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<tbody>
<tr>
<td>7Kc</td>
<td>Pupils investigate the amount of upthrust provided by different liquids by measuring the change in weight when an object is suspended in the liquid. The choice of object will depend on the liquids being used – choose something which does not quite float in the densest liquid. A fair test actually only requires the same volume of object to be used each time – with higher-attaining pupils you could use objects of the same volume but different densities and compare results. You could limit the range of liquids supplied to varying concentrations of salty water. Encourage pupils to compare their results with each other, and use the comparisons as a basis for discussing the accuracy of their results. Skills Sheet 35 may help pupils with this evaluation process.</td>
<td>Force meter; string; selection of liquids (e.g. water, cooking oil, salty water); object small enough to fit in beaker that does not quite float in the densest liquid; beaker; balance; Worksheet 7Kc(4). Optional: Skills Sheet 35.</td>
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</tbody>
</table>

<table>
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<tr>
<th>Exploring 4</th>
<th>Plasticine boats</th>
<th>Resources (per group)</th>
<th>Clear up any spills straight away.</th>
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<tbody>
<tr>
<td>7Kc</td>
<td>Give each working group a piece of Plasticine®, and ask them to make it into a boat. This will be trial and error, and small masses (10 to 100 g stacking masses would do) should be provided</td>
<td>Lump of Plasticine®; 10–100 g masses; large empty ice cream or margarine tub; or other suitable water container.</td>
<td></td>
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</tbody>
</table>
### 7Kd Starter 1

**Balanced forces**

Demonstrate various situations where forces are balanced. Discuss the types of forces, and how pupils know they are balanced. Suitable demonstrations include: tie a paper clip to the base of a clamp stand using a piece of cotton thread, and position a magnet above it so that the paper clip appears to be suspended; a helium or hydrogen filled balloon tied to a mass to stop it rising; an object resting on a table; an object suspended from a string; a tug of war or arm wrestling contest (ask two sensible pupils to cooperate). Discuss what forces are present and point out that there are pairs of forces balancing each other. This could lead into work on stretching materials by showing a mass attached to a rubber band, and asking pupils what would happen if a larger mass were added, or if you used a thicker rubber band.

**Resources**

- Clamp and stand; cotton thread; magnet; balloon filled with helium or hydrogen (on a string); string; masses or other objects.

Ensure there are no flames in the laboratory if a hydrogen filled balloon is being used.

### 7Kd Exploring 1

**Making a force meter**

Pupils ‘calibrate’ a spring by producing a graph of weight against length, and use it to weigh another object. Before carrying out this practical the maximum load for the springs in use must be determined – the mass values on Worksheet 7Kd(2) may need to be changed if 5 N is beyond the elastic limit of the springs. If insufficient G-clamps are available to fasten stands to the bench, place a large mass on the base of each stand to stop it toppling over. Ensure that objects to be weighed are within the

**Resources (per group)**

- Retort stand and 2 clamps; metre rule; spring; mass holder and masses (100 g to 1000 g); G-clamp; object to weigh; graph paper; Worksheet 7Kd(2) or 7Kd(3).
- Optional: box with newspaper; eye protection.

Wear eye protection if springs are to be stretched to breaking point. Stand a waste bin or bucket lined with newspaper beneath the masses to ensure that they cannot fall on pupils’ feet. Clamp the base of the stand to the bench so it cannot fall...
<table>
<thead>
<tr>
<th>7Kd</th>
<th>Exploring 2</th>
<th>Stretching elastic bands</th>
<th>Resources (per group)</th>
<th>Wear eye protection if elastic bands or springs are to be stretched to breaking point. Stand a waste bin or bucket lined with newspaper beneath the masses to ensure that they cannot fall on pupils’ feet. Clamp the base of the stand to the bench so it cannot fall over.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>This practical is best done as a follow-up to Exploring 1. Ask pupils to find out if elastic bands stretch in a similar fashion to springs. Ask pupils to repeat their readings to provide more accurate measurements, and then to plot the results for springs and elastic bands on the same axes. Pupils should be encouraged to describe the differences between the two lines, and what this means in terms of the different way that springs and elastic bands stretch.</td>
<td>Retort stand and 2 clamps; metre rule; spring; mass holder and masses (100 g to 1000 g); G-clamp; object to weigh; elastic band; graph paper; box with newspapers; eye protection.</td>
<td></td>
</tr>
<tr>
<td>7Kd</td>
<td>Exploring 3</td>
<td>Two springs</td>
<td>Resources (per group)</td>
<td>Wear eye protection if springs are to be stretched to breaking point. Stand a waste bin or bucket lined with newspaper beneath the masses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This practical is best done as a follow-up to Exploring 1. Ask pupils what they think will happen if two similar springs are used together, either end to end or next to each other, and to explain their reasoning. Pupils can then plan and carry out a quick investigation to test their</td>
<td>Retort stand and 2 clamps; metre rule; 2 similar springs; short length of dowel; mass holder and masses (100 g to 1000 g); G-clamp; graph paper; box with newspapers; eye protection.</td>
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</table>

range covered in the experiment. This practical could be presented as a contest to see who can find the weight of an object most accurately.

- **Must**: pupils follow the directions on Worksheet 7Kd(2).
- **Should**: pupils follow the directions on Worksheet 7Kd(3).
- **Could**: ask pupils to find out what happens if too much force is applied to a spring. Eye protection will be needed in this case, and it is advisable to stand a waste bin or bucket with newspapers beneath the masses to keep toes out of the way and to deaden the noise if the spring breaks.
predictions. They should find that two springs fastened end to end produce twice the extension because the full force is applied to both springs and so both stretch. With two springs next to each other (as shown below), the extension should be half that of a single spring, as each spring is supporting only half of the weight.

(For a diagram giving further information, please see page 279 of the teacher’s guide)

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</table>
| **Day and night demonstration**
Use a globe to demonstrate day and night. A purpose-made globe is best. A strong light source such as a slide projector or overhead projector works best, in a darkened room. A blob of Plasticine® or similar stuck on top of the UK may help pupils remember which part of the globe they live on. Remember to spin the Earth in an anticlockwise direction so that the Sun appears to be rising in the east. | **Resources**
Globe; slide projector or overhead projector; Plasticine®. | **Keep all walkways clear of obstructions in darkened rooms. Do not look down light beams, or allow pupils to do so.** |

<table>
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<tr>
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| **Phases of the Moon**
Demonstrate the phases of the Moon using a torch or other light source to illuminate a sphere (a blown-up balloon will do). The room will need to be darkened. Group the pupils together, with the light source at one side of the room, and walk around them with the sphere, showing that the part of the Moon they can see is not always fully illuminated. Higher-attaining pupils can then be asked to draw the shapes they see when the ‘Moon’ is illuminated from different angles – many pupils find this difficult, particularly if the room cannot be made dark enough. | **Resources**
Torch or other light source; globe (balloon, football etc.). | **Keep all walkways clear of obstructions in darkened rooms. Don’t look down light beams, or allow pupils to do so.** |

<table>
<thead>
<tr>
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<tr>
<td><strong>Eclipses</strong></td>
<td><strong>Resources</strong></td>
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</table>
### Explaining 2: Seasons demonstration 1

Use a globe to demonstrate the seasons. A purpose-made globe is best as such globes are usually mounted at the correct angle to demonstrate the tilt of the Earth's axis. A strong light source such as a slide projector or overhead projector works best, in a darkened room. A blob of Plasticine® or similar stuck on top of the UK may help pupils remember which part of the globe they live on. Remember to spin the Earth in an anticlockwise direction so that the Sun appears to be rising in the east, and to maintain the tilt of the ‘Earth’ as you move it around its ‘orbit’ so that it is always tilted towards the same side of the room.

**Resources**
- Globe; slide projector or overhead projector; Plasticine®.

### Explaining 3: Seasons demonstration 2

As a follow up to Explaining 2 (demonstrating the seasons using a globe and strong light

**Resources**
- Globe; slide projector or overhead projector; light sensor and

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**Globe; slide projector or overhead projector; ball to represent Moon.**

**clear of obstructions in darkened rooms. Don’t look down light beams, or allow pupils to do so.**
(source), use a light sensor and datalogging equipment to record the length of the ‘day’ as you slowly turn the globe. Move the globe so its axis is tilted in a different direction relative to the light source, and repeat the measurement. Help pupils to relate the orientation of the axis to the ‘Sun’ with the lengths of the days measured. It is important to keep the speed of rotation of the globe the same for all measurements if a fair comparison is to be made. It may be worth discussing this aspect of the demonstration with pupils. Alternatively, if two light sensors are available, it should be possible to record data for (say) the UK and southern Australia at the same time, thus avoiding this difficulty.

- **Could:** ask pupils to predict the variation in day length in equatorial regions, and then test their predictions using the model.

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<tr>
<th>7Lc</th>
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<th>Concentrated rays</th>
<th>Resources</th>
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<td>Demonstrate the validity of the ‘concentrated rays’ explanation for the difference in temperatures between summer and winter by using three trays of sand inclined at different angles to the same source of light/heat. Temperature differences between the trays can be recorded using normal thermometers, or datalogging equipment with heat sensors. The latter method is easier and can produce better results.</td>
<td>3 trays of sand; blocks of wood or other means of tilting the trays; lamp; 3 thermometers. Optional: 3 heat sensors; datalogging equipment.</td>
</tr>
</tbody>
</table>