activity outline

In this activity, pupils investigate the properties of different types of wood. They measure density and carry out two different hardness tests. There are also detailed instructions for an extension activity where pupils test the effectiveness of different methods of joining wood – such as nails, screws and glue.

You will need two lessons.

Pupils work in groups, investigating one property each and comparing results.

The pupil sheet provides an introduction and step-by-step instructions for each of these procedures as well as a results table.

This activity could usefully be taught with co-operation from the design-technology department, particularly with regards use of tools and sourcing pieces of wood. Joints for the Investigating joining wood extension activity could be made in technology lessons.

Teacher notes overview

1 **Curriculum links:** where this activity can fit with the 2008 KS3 Programme of Study and Scottish 5-14 Science Curriculum.

2 **The Video:** providing a synopsis of the video content and ideas for viewing.

3 **The Practical:** including Equipment lists, Health and safety notes, a Possible approach (a comprehensive, suggested way of planning the lessons) and an Underlying science section (providing detailed information about the various scientific principles involved).

4 **Possible extensions:** suggestions for other practical activities using the video, or extending the suggested activity.

5 **Associated jobs:** guidance on how to deliver a plenary activity (or, if you wish, a stand-alone activity) focusing on the video interviewee, including a photo of the interviewee to place at the centre of a spider diagram.
## Curriculum Links

This lesson can be used to help teach part of the 2008 Key Stage 3 Programme of Study (England and Wales):

- **Range and Content:** 3.2a
- **Attainment Targets:** AT1, AT3
- **Key Concepts:** 1.1a, 1.1b, 1.3, 1.4
- **Key Processes:** 2.1a-c, 2.2a, 2.3
- **Curriculum Opportunities:** 4a, c, g, k

This lesson can be used to help teach part of the Scottish 5-14 Science Curriculum:

**Main Curricular Links**
- E&S2 Materials from Earth

**Attainment Targets**

**Knowledge & Understanding:**

- **Level B**
  - Make observations of differences in the properties of common materials

- **Level E**
  - Describe the particulate nature of solids, liquids and gases and use this to explain their properties

**Investigating Skills:**

- **Level D**
  - Make an appropriate series of accurate measurements
  - Draw conclusions consistent with findings
The video

Synopsis of the video

Among other things, Marc makes these interesting points:

- The large wooden frames are assembled in the workshop, then they are taken apart, transported to site and reassembled by the same carpenters.
- Checking the frame will be able to take the various forces acting on it is done at the design stage.
- There are tables which provide information about the properties of different woods, but you have to compensate for the fact that no two pieces are exactly the same.
- There are a few steel elements – to secure frames to the ground, for example – but most joints are made using drilled holes and wooden pegs.

Watching the video

There are a number of things you might do before showing the video to your class.

1. Preview the video and write a few quick-fire questions. Then you can tell your class that they will be tested on their observation when it’s finished. This is an excellent way of encouraging them to pay attention!

2. Ask pupils to watch the video through once. Then ask them to generate one question that could be answered from the video and one question they would like to ask but the video did not answer. These questions are then exchanged with another pupil and the video is watched a second time. This gives pupils an opportunity to focus on something they may have missed first time, and provides a basis for discussion on what was learnt from the video, and what additional information is needed.

3. Ask pupils what sort of person might become a carpenter. Does anyone in the class think they’d like to work in construction? When the video has been watched, ask the questions again. Has anyone changed their mind/opinions?

4. Ask pupils to spot the science in the clip.
the practical

Equipment

(per group of three pupils)

- various sized rectangular blocks of several (labelled) varieties of wood – with as wide a range as possible of density and hardness (for non-destructive density measurements)

- scrap pieces of the same woods, with 10-50 cm² flat surface (for destructive cutting and nailing tests)

*The wood should be knot free, to avoid distorting the tests.*

- cm/mm ruler

- access to top pan balance weighing to 0.01 g

- G clamp, or other method of holding scrap wood firmly during cutting tests

- saw, scalpel or sharp knife (e.g. Stanley knife)  
  [Count at issue and return. **Risk assessment needed**]

- hammer and nail, 2.5 to 5 cm (point wide enough to leave easily visible dent when gently hammered on wood surface) [Count at issue and return]

**For teacher demonstration**

- chisel and mallet

**Possible source of wood samples**

Plunder CDT department scrap boxes for common wood varieties.

For other varieties, some wood flooring suppliers offer free samples for the cost of postage. Check websites.

**Health and safety**

- Each activity is performed by one pupil from the team of three. You may wish to control who performs Activity B, the cutting test. If this is considered inappropriate for your pupils, then demonstrate it.

- Closely supervise the use of carpentry tools. Count them at issue and return.

- For both hardness tests (B and C) pupils must clamp the wood, not hold it by hand.
Possible approach

You could set a preliminary task to be completed for homework before the lesson. Ask pupils to list current uses of wood around the home and elsewhere – and also former uses which have now been largely replaced by other materials such as plastics. Ask them to suggest why wood is, or was, used. Most uses relate to properties and/or appearance, and (traditionally) renewable supplies. Cost and ease of shaping are likely to be the main reasons for replacing wood with other materials.

Discuss wood’s useful combination of properties – low density, strength, rigidity with slight flexibility, and resilience. One disadvantage is that wood cannot be moulded. It must be cut to shape. The ease of cutting depends on hardness, which varies between types of wood.

Working in teams of three, pupils perform activities A, B and C to compare the density and hardness of different woods.

A photograph to show the grain may be useful:

![Wood grain](image)

Underlying science: Basic principles

- **Density and hardness**
  These depend on the internal structure of the wood, which depends on species and growing conditions. It is variation in conditions across the year that produces tree rings, which are seen as grain in longitudinal sections.

  With more able classes, it may be worth mentioning dendrochronology. Not only do rings show the age of a tree, the pattern of comparative ring widths can show when (over which span of years) the tree was growing. It’s used to date wooden objects hundreds of years old.

  **Note:** Make clear to pupils that the common distinction between ‘hardwood’ (from broad leaved species) and ‘softwood’ (from conifers) does not necessarily indicate the physical hardness of the timber. Yew, a British softwood, is harder than many ‘hardwoods’.

- **Cutting**
  Wood is a fibrous material (cellulose fibres surrounded by lignin). Cutting along the fibres, effectively separating them, is easier than cutting across them.
possible extensions

1 Uses and other properties of wood
Research, and draw up a table of, uses and other properties of various types of wood. Use databases, but restrict the table to more common or familiar types of wood. Try to relate specific uses to differences in properties.

[Warn pupils that data may quote densities in kg m\(^{-3}\), giving values 1000 times larger than g cm\(^{-3}\).]

http://www.newcastlehardwood.com/brownpaperstudios/timbers.html is an extensive, illustrated database, but beware of inconsistent non SI units for properties.

Discuss why, for many traditional uses, wood has been replaced by other materials – particularly plastics.

2 How is wood hardness actually measured?
Databases give values for hardness. So, how are these measured? Discuss outline details of indentation hardness testing, e.g. Brinell method (the British Standard test) or Janka method (specifically for wood flooring).

3 Investigating joining wood
A) Carpenters’ joints
Show pupils examples of joining methods. Where possible, actual examples should be shown, in addition to illustrations.

Discuss applications of the various types in relation to their uses, and the forces involved.

Examples:
- butt joint (with or without dowels)
- mitre joint
- housing joint
- mortise and tenon
- finger (or comb) joint
- dovetail
- corner block (used with self-assembly flat-pack furniture)

Continued >
Each team member might study two different joints and write a brief report on:

- common uses of the joints
- why each joint is used for those particular purposes

**B) Joining wood**

With help from the technology department, pupils could try making and testing joints: it requires advance preparation and organisation. They might try:

- **a** one nail, screw or peg in the centre
- **b** two nails, screws or pegs placed diagonally
- **c** a lap joint (using the pre cut wood) with a single nail, screw or peg

Unless you have extra time, each pupil will assemble only one joint.

To expedite the lesson, gather together sets of six pieces of wood and fixing materials in advance.

Pupils can test the joints by twisting, so the angle is more than or less than 90°, then compare how well each joint resists twisting (see Fig 2).
Equipment

A) Carpenters’ joints
- examples of common types of woodworking joints + multiple copies of illustrations for pupils to study. (Some may be found within the laboratory in doors, drawers, shelves, boxes etc.)

Joint illustrations
http://www.deyes.sefton.sch.uk/technology/Keystage3/wood_joints.htm
http://www.technologystudent.com/joints/joindex.htm (animated diagrams)

B) Joining wood
- six lengths of flat scrap wood – size not critical, but should be:
  - of similar dimensions (for fair comparison)
  - thick enough to allow ends to be pre cut to half thickness ready for lap jointing
  - robust enough to allow joints to be tested, by twisting by hand, without the wood breaking
- two of the six lengths need to be cut for lap jointing
- four nails or screws or wooden pegs (dowel)
  - length about ¾ x thickness of two pieces of wood to be joined
- hammer or screwdriver (as appropriate) [Count at issue and return]

Health and safety

When testing joint, pupils should be warned against using too much force. The objective is to compare how much the joints twist – not how easily they can be destroyed. Sudden snapping of the wood could be dangerous.
A STEM (Science, Technology, Engineering and Maths) education provides pupils with skills and knowledge that are useful in all sorts of careers. The video demonstrates how Marc, a carpenter working with large timber frames, uses such skills on a daily basis.

Marc works with numerous people – some directly, some indirectly. Some use STEM skills, others don’t. By exploring this network of associated jobs, pupils will, hopefully, begin to see that even those in non-STEM jobs will find STEM skills useful – if they’re communicating with someone “in-STEM”, for example, some knowledge of their work will be a great help.

Marc’s spider diagram

Try placing Marc at the centre of a spider diagram (we’ve provided a photo of Marc which you could use – see overleaf). You could either create worksheets for pupils to complete themselves, or create the diagram on your whiteboard and then pool ideas.

Ask pupils: “who does Marc work with”. They may draw information from the video – he talks about the designers, and we see other carpenters in the workshop – or they may come up with new ideas, such as the people who supply the timber, or the various other construction workers who would be needed to finish a project (builders, electricians, plumbers, etc.). Other, less obvious, suggestions might include architects, or people from the Forestry Commission who make sure the wood is from a sustainable source.

Now ask pupils which of those jobs are clearly “in-STEM”. Who else might find some STEM skills helpful? Why?

You could extend this by taking any one of the associated jobs and placing them at the centre of a spider diagram, and starting the process again.
Marc Watson, Carpenter, The Timber Frame Company

Studying science and maths can transform your career options. Future Morph: become someone.