Wood is used to make a wide range of objects – from small boxes to tall ships, and photograph frames to timber frames for buildings.

The properties of wood make it suitable for many different purposes. It is **strong** and fairly **rigid**, but still has a little **flexibility**. It has **low density**, which means it is lightweight compared with other strong, rigid materials such as steel.

Unlike metals, plastics, glass or clay, wood can’t be moulded into shape. Separate pieces, large or small, must be cut to shape and joined together.

Marc works with large oak or Douglas-fir timbers, using a variety of cutting tools to shape the wood. You will work with small pieces of different woods, to compare them.

### Procedure: Investigating the properties of wood

In your team of three, each person will investigate one property, then share their results with the others.

#### A. Density

If two pieces of wood are the same size, but one is heavier than the other, then the heavier piece has a higher **density**. Carpenters need to know the densities of different types of wood – imagine they wanted to build something that’s really big but light. They would need to use wood with a low density.

1. Measure, in centimetres, the sides of a rectangular block of wood. Calculate the volume using:
   
   \[ \text{volume} = a \times b \times c \, \text{cm}^3 \]
2 Weigh the block to 0.01 g

3 Calculate the density, in grams per centimetre cube (g/cm³):
   
   \[
   \text{density} = \frac{\text{mass}}{\text{volume}}
   \]

4 Record your results in the table.

5 Repeat for other types of wood.

B. Hardness – cutting test

Use scrap pieces of wood and a saw, sharp knife or scalpel. (TAKE CARE!)

1 Firmly clamp a scrap piece of wood to hold it still while you test it.

2 Pressing only lightly, pull the blade across the surface of the wood, at right angles to the grain. Note how much it cuts into the surface.

3 Repeat with other types of wood. Try to use the same amount of force each time, so you can compare the effects.

4 Now try pressing harder along the same cut in each piece of wood.

5 Use the results to rate the woods in order of hardness. In the table, give each wood a rating: from 1 (= softest) to 5 (= hardest).

6 Repeat the whole procedure, cutting along the grain instead of across it.

Note: Carpenters use a chisel or saw, rather than a knife or scalpel, of course.
C. Hardness – nail test

Use the same size of nail each time.

1 Hold the nail, point downwards, on the surface of the wood.

2 Hit the nail once with the hammer – but not too hard, since you need to remove the nail afterwards.

3 Take the nail away and examine the size and depth of the dent in the wood. Soft wood will dent more easily, so the smaller the dent, the harder the wood.

4 Repeat with other types of wood. Try to hit them with the **same amount of force** each time, so you can compare the effects.

5 Use the results to rate the woods in order of hardness. In the table, give each wood a rating: from 1 (= softest) to 5 (= hardest).

**Results table**

<table>
<thead>
<tr>
<th>Type of wood</th>
<th>Density (g cm$^{-3}$)</th>
<th>Hardness (softest = 1, hardest = 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>cut across grain</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• Is there any relationship between density and hardness?
• Is it easier to cut across the grain, or along the grain?
• Are your results of both hardness tests the same?