

# WOOD

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## Objectives

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At the end of this chapter you should:

- have a basic knowledge of the main problems affecting the condition and longevity of objects made wholly or partially from wood;
- have an awareness of the differences between softwoods and hardwoods, and heartwood and sapwood; and
- be able to protect wooden objects during storage, display and handling.

## Introduction

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Wood is a material with which we are all familiar. Its extensive everyday use for furniture, walls, flooring, ceilings, structural supports in buildings, cooking utensils and garden tools builds an image of the nature of wood in our minds.

We know that wood is a strong, flexible, versatile and workable material. Items in our homes often withstand rough use or handling over many years and still survive. All these factors can create the impression that wooden artefacts in our collections don't need much care.

This is not the case. We must care for wood as we are for other objects. For wooden objects to maintain their condition and survive without damage, they must be given the right environment and be handled appropriately.

Wooden artefacts found in collections can vary greatly. They include such items as furniture, sculpture, technological and industrial artefacts and archaeological pieces. They can range in size from tiny, intricate carvings to horse-drawn vehicles and whole buildings.

Although at first glance these objects seem to have little in common with each other, the use of wood in their manufacture means that they respond to environmental changes in similar ways. These responses are also associated with the type of wood from which the object is made—the type of tree, the part of the tree from which the wood was originally cut, and the conditions under which the wood was seasoned.

This section gives a brief overview of the nature of wood, and provides basic information about the steps you can take to protect the wooden items in your collections.

## An introduction to the anatomy and chemistry of wood

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To understand how wood behaves, it helps to have some understanding of the structure of the living tree.

Wood in a living tree is composed of cells—with cell walls made of cellulose—which transport food and waste products through the tree.

As the tree grows, new cell layers are added to its outer circumference, forming seasonal—generally annual—growth rings.

Eventually the older cells in the inner part of the tree produce lignin in the cell walls and die.

This creates an area of wood in the centre of the tree stem which is comparatively dry—it still has bound water—and is free of sap. This is known as heartwood.

The outer, moister portion of the wood is called sapwood.

The differences between the types of cells and their relationship to each other determine the characteristics of particular species of trees, such as their colour, grain and strength.

Many trees also contain other chemicals such as resins and oils which affect the nature and appearance of their wood.

To help with identification, timbers are divided into two distinct groups, which are based on their botanical order:

- softwoods are derived from conifers—gymnosperms. Softwoods have a more uniform structure than hardwoods, but are not necessarily softer; balsa wood, the softest timber, is actually a hardwood; and
- hardwoods are derived from dicotyledons or broad-leaved trees—angiosperms.

There are significant structural differences between softwoods and hardwoods. These allow them to be distinguished from each other by microscopic examination. Every timber species has a characteristic arrangement of cells and tissues which enables it to be specifically identified. The tree structure determines the properties of the resultant timber—for example, strength, degree of shrinkage, durability, resistance to biological attack, porosity and moisture permeability.

The susceptibility of wood to damage from a number of factors depends on the chemical composition of the wood—that is, the percentages of the various components, such as cellulose, lignin and resins. This composition varies, depending on the original species of tree, the part of the tree used and the seasoning process.

When trees are cut for timber, the moisture which was present in the living wood dries out, until the wood reaches its equilibrium moisture content; this is called seasoning.

The equilibrium moisture content—EMC—of a particular piece of wood varies according to the relative humidity of its environment.

If the relative humidity increases wood will absorb water and its EMC will rise. The absorption of water causes wood to swell. If the relative humidity decreases, the wood's EMC drops and it shrinks.

If wood is seasoned too quickly, the sapwood dries and shrinks faster than the inner heartwood—this causes the sapwood to crack.

How much the wood shrinks when it dries depends also on where, within the tree, the wood comes from.

Wood perpendicular to the grain shrinks substantially more, that is, it shrinks across the grain rather than down the length of the grain.

Wood warps when it swells and shrinks at different rates.

## **What are the most common causes and types of damage?**

Rapid fluctuations in relative humidity can result in:

- warping;
- joints in objects pulling apart;

- twisting;
- panels distorting;
- splitting;
- cracking;
- cleavage and loss of paint and other surface layers; and
- veneer can lifting up or popping off.

For more information

For more information about the adverse effects caused by fluctuations in humidity, please see *Damage and Decay*.

Wood is also very susceptible to biological damage. Wood's susceptibility to biological attack from mould, bacteria and insects depends on its moisture content and so can be related to the relative humidity levels of the surrounding environment.

Fungal attack can cause:

- damage to wood fibres;
- structural breakdown of the surface; and
- staining.

Bacterial attack causes slow deterioration of wood, accompanied by a putrid smell. This is most likely to happen when wood is in constant contact with water or mud.

Insects are the most serious pests affecting wooden objects in Australia. Insect attack usually results in structural damage. This damage can be severe.

For more information

For more information about the effects on wood of fungi and insects, please see the chapter on Biological Pests in *Damage and Decay*. For more information about brown rot, dry rot and soft rot, please see the section More About Wood later in this chapter.

Other damage which must be considered includes:

- physical damage caused by falls, knocks and continued use;
- fading and discolouration caused by exposure to light and UV radiation; and
- burning or fire damage.

## Common causes of damage

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All the most common types of damage are caused by:

- poor handling;
- poor storage methods;
- inappropriate display methods;
- chemical and physical changes in the objects themselves; and
- a combination of any or all of these.

The following sections outline practical steps you can take to minimise this type of damage.

## The do's and don'ts of handling wooden objects

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Handling wood objects with care and commonsense helps to prevent damage. It is best to handle items as little as possible. It is also important to fully support objects when handling them.

Examine each object carefully to find the strongest, most stable part—and handle it there.

Avoid lifting wooden items by their handles or other weak points such as the backs of chairs, table tops and damaged areas. Lift them by holding the legs, or the lowest, strongest structural member such as under the seat rail of a chair. Pick up and carry furniture, rather than pushing or pulling it. Pushing and pulling furniture puts severe strain on the structure. Secure all drawers and doors before moving furniture, and check for loose decorations and members before moving it.

If objects are painted, avoid touching these areas.

Don't try to carry furniture alone—you risk damaging the furniture and injuring yourself.

## Some basic do's and don'ts of repair and cleaning

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Repair small pieces which have broken off or become detached, or store the pieces with the object until a conservator can carry out the

repairs. When repairing wooden objects, use only an adhesive which can be removed easily in the future, such as:

- a traditional animal glue which is applied warm; or,
- a conservation-quality, white glue such as Rhoplex AC-33.

White or yellow woodworking adhesives available in hardware stores are not ideal; but they are preferable to epoxy adhesives like Araldite or the superglues because it is virtually impossible to remove these without damaging the underlying wood.

Be aware that the finishes on wood can be affected by the adhesive—so use as little glue as possible near the edges of the break.

If you are unsure about what glue to use, or if the damage is extensive, contact a conservator for help and advice.

Use soft, cotton cloths to gently dust varnished furniture and wooden objects. For wooden objects with more delicate surfaces, for example, those painted or decorated with inlay, gently brush surfaces with a Japanese Hake brush. If the surfaces are flaking or unstable, do not brush them at all.

### CAUTION:

Do not use feather dusters because the feathers often get caught in cracks and crevices and can cause the wood to splinter.

## Ideal conditions for storing and displaying wooden objects

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This section outlines the best long-term storage and display environment for wooden objects. But please note that if an ideal environment cannot be created, the emphasis should be on providing a stable environment.

Ideally, all wooden objects should be stored in an environment where temperature is constant and moderate—in the range of 18–20°C. Changing temperatures affect relative humidity levels; so if temperatures are generally outside this range in your area, it is important to try to keep fluctuations to a minimum and to ensure that they

are gradual. High temperatures can accelerate degradation reactions, and cause wood to dry out and become brittle.

Relative humidity should be constant and in the range of 50–60%. For composite objects, a compromise may have to be reached between a relative humidity that is ideal for the wooden components and the preferred relative humidity for the other component materials, for example, metals.

Wood swells and shrinks with changes in relative humidity. Wooden objects undergo dimensional changes when the relative humidity changes. This is generally a reversible process; but the speed of the process varies—drying takes longer than moisture absorption.

Avoiding rapid or excessive fluctuations in relative humidity is critical. It is better to leave a wooden object in a non-ideal relative humidity environment to which it has acclimatised than to suddenly change the relative humidity.

If relative humidity changes significantly, then swelling or shrinking can cause irreversible damage to a wooden object—this can include warping, twisting, splitting and cracking. Joints can pull apart, and panels distort. Cleavage and loss of paint can occur on painted, wooden items. This phenomenon is the most common and most preventable cause of damage to wooden objects.

Mould grows where relative humidity is continuously above 65%; but relative humidity levels of 60% and less are not favourable to mould growth.

Items which are at risk of drying out too quickly after they have come from moist conditions should be kept in an environment where the relative humidity is in the range of 50–60%. Items which are acclimatised to drier conditions should be kept in an environment where the relative humidity is in the range of 45–55%.

Light should be kept to the minimum necessary for the activity. Wherever possible, items which are not on display should be stored in the dark. If light is not required for viewing while the works are being stored, then there is no need for them to be illuminated. This reduces the risk of materials fading and becoming discoloured.

The brightness of the light should be below 250 lux.

For objects on display, the maximum exposure to light should be 650 kilolux hours in one year.

Ultraviolet radiation should be eliminated completely, because it causes irreversible changes to the appearance and structure of the wood surface and greatly accelerates degradation reactions. Ideally, the UV content of the light should be less than 30  $\mu\text{w}/\text{lm}$  and no greater than 75  $\mu\text{w}/\text{lm}$ .

Avoid exposure to the sun if possible. Research shows that after only three days' exposure to the sun, the lignin is completely broken down in the surface of a piece of wood. This affects both the colour and texture, as well as the strength of the wood, often resulting in wood fibres shedding off the surface.

Protect items from dust and pollutants.

For more information

For more information about adverse environmental effects, please see *Damage and Decay*.

## General storage and display guidelines

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Give careful consideration to the storage site and the storage system. In situations where you can achieve the ideal conditions, a good storage system in an appropriate storage site will give added protection to your collection. If the available facilities, or the local climate, make it difficult for you to achieve the ideal conditions, then the selection of the storage site and the maintenance of a good storage system are even more critical in preventing damage to the collections.

Wherever possible, the storage and display sites should be in a central area of the building, where they are buffered from the extremes of climatic fluctuations which are experienced near external walls or in basements and attics. Basements should also be avoided, because of the risk of flooding.

The storage site should not contain any water, drain or steam pipes, particularly at ceiling level. If these pipes were to leak, extensive damage could result.

Ventilate storage and display sites. This helps reduce the risk of insect and mould infestation.

Clean and inspect storage and display areas regularly. Thorough, regular cleaning and vigilance help greatly in controlling insects and mould.

Check objects regularly to detect insect infestations early. Signs of infestation include holes and frass—that is, wood powder left by borer insects.

Don't store items in sheds or directly on the floor. Polished surfaces should be protected from moisture.

Cover stored objects with cotton or Tyvek covers. They provide protection from dust and unnecessary exposure to light. These covers also provide some buffering against fluctuations in environmental conditions.

#### For more information

For more information about Tyvek, please see the chapter on Textiles in *Caring for Cultural Material 2*.

Always give items adequate support, and try to reduce the physical stresses which can cause damage. Ensure that the supports for painted items will not rub against painted areas and cause paint loss.

Small items can be supported on polystyrene-filled, cotton bags. This also allows the items to be well aired, preventing possible cracking through differential drying.

Ensure that light-sensitive items are adequately protected. They can be placed in covered storage boxes, or covered with cotton or Tyvek dust cloths, to reduce their exposure to light.

Rotate exhibitions—so objects are not on display constantly.

Keep light levels low when items are on display, and make sure lights are turned off after hours. Always avoid direct sunlight on your objects. Make sure that the heat produced by the lights does not affect your objects.

Refer to Handling, transportation, storage and display volume for more general information on storing and displaying wood.

## Coating wooden objects

Think carefully before deciding to apply a coating to the surface of a wooden object. All coatings require maintenance, and they generally attract dust more readily than unfinished surfaces, increasing housekeeping needs.

Many oils, polishes and waxes have been used over

the years to 'feed' or rejuvenate wooden surfaces. Wood does not need feeding; and products which claim to have this benefit are of dubious value.

It is most important to consider reversibility whenever applying anything to an object.

Oils—for example, linseed oil—applied to wood surfaces can crosslink as they age, becoming more and more difficult to remove, and frequently discolouring or darkening.

#### For more information

For information on crosslinking, please see the chapter on Common Deterioration Processes in *Damage and Decay*.

If the surface of a wooden object appears dry or patchy, it is better to use a microcrystalline wax polish such as Beckett's Clear Furniture Wax or Renaissance Wax. If necessary, these can be removed using white spirits at a later date.

#### CAUTION:

Never apply products containing silicone to a wooden object. And avoid colorants. Silicone and colorants are usually found in proprietary furniture cleaners.

Wax objects infrequently—once or twice a year at the most—with wax applied sparingly with a soft cloth. Polished items can be buffed lightly with a clean, soft cloth to maintain shine.

Consider refinishing an object as a last resort only. Remember that original and old finishes are as much a part of the object and its history as the wood from which it was made. It is appropriate that the surfaces of historical wooden objects have patina and look their age.

Many wooden ethnographic objects have very fragile surfaces—for example decorations painted in quite friable pigment. These objects should not be cleaned without the assistance or advice of a conservator. Neither should they be coated to consolidate the surface—such an action would cause considerable damage.

#### For more information

For information on how to care for ethnographic material see the chapter Aboriginal and Torres Strait Islander Cultural Material in this volume.

## Summary of conditions for storage and display

	Storage	Display
Temperature	18–20°C	18–20°C
Relative Humidity	50–60%	50–60%
Brightness of the Light	Dark storage is preferred. but if light is present it should be less than 250 lux.	Should be less than 250 lux.
UV Content of Light	Dark storage is preferred; otherwise, UV content should be less than 30µW/lm and no more than 75µW/lm.	Less than 30µW/lm and no more than 75µW/lm.

## Wooden objects in Australia's climatic zones

The climatic zones outlined below are broad categories. Conditions may vary within these categories, depending on the state of repair of your building and whether or not it is air conditioned.

### Arid

This climate is generally very dry, however, in arid areas, it is often very hot during the day and very cold at night. This wide fluctuation in temperature is matched by wide fluctuations in relative humidity, for example from 75%–20% in a day.

When caring for wooden objects in arid climates it is important to note:

- these items will tend to give out the water they contain - this can lead to some items becoming dry and brittle;
- wooden objects are particularly susceptible to damage from fluctuations in temperature and relative humidity; and
- as different parts of items release moisture at different rates, warping, dimensional change and flaking of paint can result.

Remember that even arid areas can have periods of higher relative humidity, even though the periods may only be very short.

High humidities will cause swelling and will increase the likelihood of insect and mould attack.

Dust can be a major problem in an arid climate. It is important that steps are taken to protect items from dust in storage and display.

Note: If your collections of wooden objects have been kept in an arid environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

## Temperate

A temperate climate is considered a moderate climate, however, temperate climates tend to have a greater range of temperatures than tropical climates and may include extreme climatic variations.

If you are redecorating or designing storage and display areas, consider using materials that will help to buffer these areas against rapid fluctuations and extremes of relative humidity and temperature. This will help to reduce the risk of damage due to the fluctuations and extremes that occur in temperate environments.

The system of layers of storage—boxes, boxes within cupboards and drawers, covering items on shelves, etc—will be very useful in helping to buffer against the extreme conditions that can occur in a temperate environment.

As for all climatic areas regular inspection of storage and display areas, is important so that developing problems do not go unnoticed.

Remember that many of Australia's main cities and major regional centres are in temperate regions. These areas tend to be heavily polluted and this should be taken into account.

Note: If your collections of wooden objects have been kept in a temperate environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

## Tropical

These climates are characterised by heavy rainfall, high humidity and high temperatures.

When caring for wooden objects in tropical climates it is important to note that:

- insects and moulds thrive and reproduce readily;
- chemical deterioration reactions generally proceed faster at higher temperatures;
- items that have been in a tropical environment for some time will have a higher moisture content. If they are suddenly moved into a drier environment they are likely to suffer shrinkage and warping; and
- wooden objects are very reactive to changes in relative humidity.

Take steps to ensure that your storage and display spaces have good air flow.

Note: If your collections of wooden objects have been kept in a tropical environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

## MORE ABOUT WOOD

### Additional notes on fungal attack of wood

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Generally fungal attack can occur only when the equilibrium moisture content of the wood is greater than 20% and the temperature is below 40°C. Fungi attack sapwood faster than heartwood.

Some woods are naturally resistant to decay—because their heartwoods contain substances which inhibit fungal attack.

The presence of fungal fruiting bodies on the surface of wood indicates the presence of rot; but in many cases there is no visible sign of fungi. Affected wood can be soft and spongy, or brittle and powdery.

The term 'decay' when used in relation to wood specifically refers to attack by *Basidiomycete* fungi. These are grouped into two types which are particularly destructive to timber in buildings and other artefacts: brown rot and white rot. They are less likely to be a problem for indoor wooden objects.

Brown rot is a term which includes wet rot and dry rot—*Serpula lacrymans*. It attacks softwoods more commonly than hardwoods, destroying the cellulose and leaving the lignin behind. After attack, the wood is typically left stained and brown, with cuboidal cracking of the surface.

Dry rot is extremely destructive because the fungus can grow some distance away from its moisture source, producing long strands which can travel over large areas of masonry to infect new wood.

Dry rot is found only in cooler climates because it can't withstand temperatures greater than 40°C. It is less common in Australia than in Europe, where it causes extensive damage to buildings; but it has been found in Melbourne and Tasmania. If a dry rot outbreak is suspected, it should be dealt with immediately by a conservator experienced in dealing with dry rot.

White rot can destroy both the cellulose and lignin in wood. It is caused mainly by *Ascomycetes* fungi. After attack, the wood is a whitish colour and lighter in weight, with a stringy or fibrous appearance.

Soft rot occurs in wood that is continuously damp or in contact with the ground, for example, building timbers, archaeological wood, marine artefacts, or objects in exterior displays such as outdoor sculpture.

The fungus selectively attacks the cellulose from the outer surface of the wood, causing the surface to soften. After attack, the dried wood has a cracked appearance.

Soft rot can be avoided in wooden objects on outside display by ensuring that they are raised slightly off the ground on plinths or supports, so they are not in direct contact with the soil. Objects should be sheltered where possible, to ensure that water does not lie on their surfaces.

Numerous other fungi and moulds can grow on the surface of—or within—wooden objects, causing staining and possibly structural breakdown of the surface being colonised. These fungi and moulds are more commonly found on indoor objects than are the rots described above. They can cause staining, either by releasing pigments or through the presence of dark, fungal structures.

#### For more information

For more information about fungi and steps that can be taken to minimise the risk of fungal attack, please see the chapter on Biological Pests, in *Damage and Decay*.

**If you have a problem relating to the storage or display of wooden objects, contact a conservator. Conservators can offer advice and practical solutions.**

### For further reading

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Ashurst, John and Nicola et al 1989, 'Wood, Glass and Resins', *Practical Building Conservation English Heritage Technical Handbook*, Vol 5, Gower Technical Press, Aldershot, England.

Black, James et al (eds) 1987, *Recent Advances in the Conservation and Analysis of Artifacts*, Summer Schools Press, University of London Institute of Archaeology, London.

Bramwell, Martyn et al (eds) 1979, *The International Book of Wood*, Mitchell Beazley Publishers, London.

Caneva, Giulia, Nugari, Maria Pia and Salvadori, Ornella 1991, *Biology in the Conservation of Works of Art*, ICCROM, Rome.

Gilroy, David & Godfrey, Ian (eds) 1998, *Conservation and Care of Collections*. Western Australian Museum, Perth, Western Australia.

Grosso, Gerald H (ed.) 1977, *Pacific Northwest Wet Site Wood Conservation Conference*, September 19–22, 1976, P.O. Box 194, Neah Bay, Washington.

Hodges, Henry 1976, *Artefacts—An Introduction to Early Materials and Technology*, John Baker Publishers, London.

Plenderleith, H.J. and Werner, A.E.A. 1976, *The Conservation of Antiquities and Works of Art*, Oxford University Press, London.

Shelley, Marjorie 1987, *The Care and Handling of Art Objects—Practices in the Metropolitan Museum of Art*, The Metropolitan Museum of Art, New York.

Simpson, Mette and Huntley, Michael (eds) 1992, *Sotheby's Caring for Antiques: A Guide to Handling, Cleaning, Display and Restoration*, Conran Octopus Ltd, London.

Stolow, Nathan 1979, *Museum and Monuments, XVII: Conservation standards for works of art in transit and on exhibition*, UNESCO, Paris.

## Self-evaluation quiz

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### Question 1.

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Wood is susceptible to damage caused by:

- a) insects;
- b) fungal attack;
- c) fluctuations and extremes of relative humidity;
- d) exposure to light and UV radiation;
- e) none of the above—wood is a durable material.

### Question 2.

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Which of the following statements are true?

- a) There is no difference between sapwood and heartwood.
- b) Mould grows when the relative humidity is continuously above 65%.
- c) Differences in the amount of swelling and shrinkage within a piece of wood can lead to warping.
- d) The susceptibility of wood to damage from a number of factors depends on the chemical composition of the wood.
- e) None of the above.

### Question 3.

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When handling objects made from wood it is important to:

- a) examine each object to find the strongest, most stable part, so that you can handle it there;
- b) pick up and carry furniture rather than pushing or pulling it;
- c) fully support objects when handling them;
- d) try to touch them on unpainted areas, if they are painted;
- e) all of the above.

### Question 4.

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Which of the following statements is true. If you are carrying out repairs to wooden objects:

- a) use Superglue so you can be sure it will stick;
- b) only use an adhesive which can be easily removed in the future;
- c) avoid using epoxy adhesives, because they cannot be removed easily without causing damage;
- d) be aware that the finishes on wood can be affected by the adhesive, so use as little glue as possible near the edges of a break.

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### Question 5.

What are the ideal recommended conditions for storing wooden objects?

- a) 18–20°C, 50–60% relative humidity, dark storage
- b) 18–20°C, 20–40% relative humidity, dark storage
- c) 24–30°C, 50–60% relative humidity, dark storage
- d) 18–20°C, 50–60% relative humidity, in bright light.

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### Question 6.

When storing or displaying wooden objects:

- a) protect polished surfaces from moisture;
- b) keep the storage and display sites reasonably ventilated;
- c) always give items adequate support;
- d) ensure that light-sensitive items are adequately protected;
- e) if the ideals for temperature and relative humidity cannot be met or are inappropriate, the emphasis should be on providing a stable environment;
- f) all of the above.

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## Answers to self-evaluation quiz

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### Question 1.

Answer: a), b), c) and d).

e) is incorrect. Wood is a durable material, but it is still susceptible to damage and will not be durable unless it is cared for.

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### Question 2.

Answer: b), c) and d) are true.

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### Question 3.

Answer: e).

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### Question 4.

Answer: b), c) and d). a) is not correct. Superglues should be avoided because they cannot be reversed easily without causing damage to the underlying wood.

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### Question 5.

Answer: a).

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### Question 6.

Answer: f).