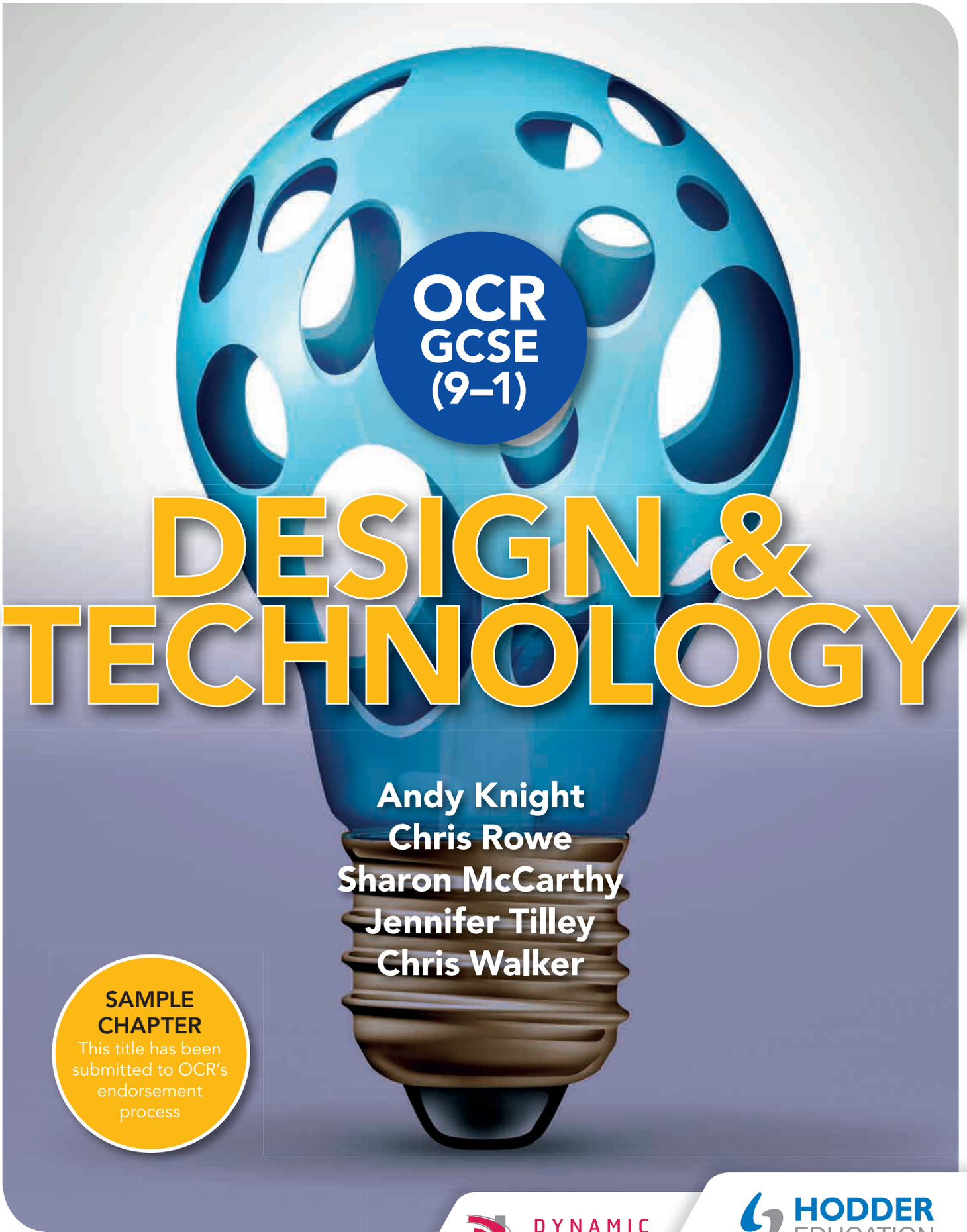

OCR GCSE (9–1)

# DESIGN & TECHNOLOGY

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Sharon McCarthy
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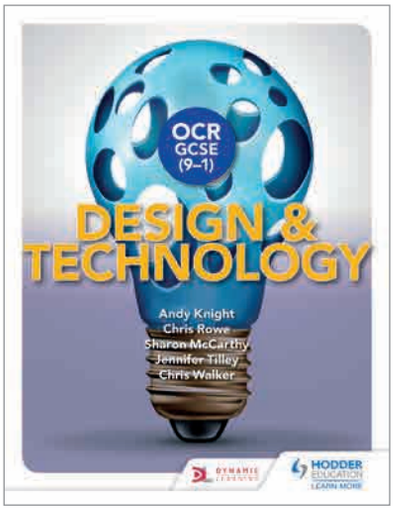


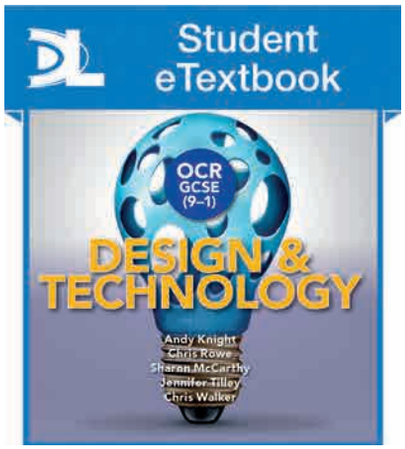


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# Core principles of design and technology

This section looks at the core principles of design and technology that you must know and understand in order to make informed decisions as a designer.

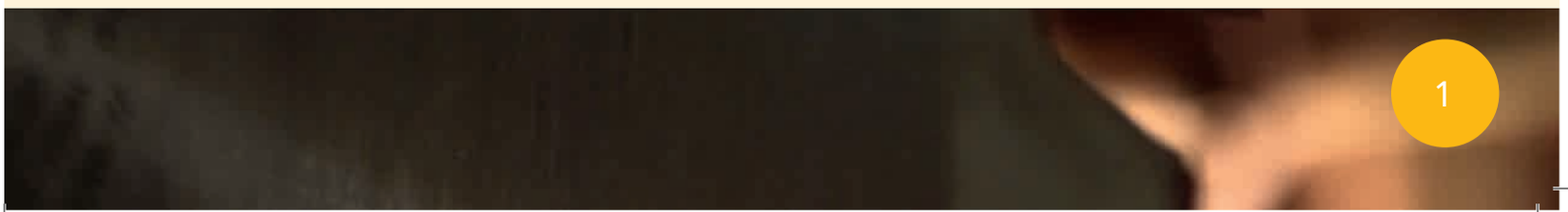
All students will need knowledge and understanding of the principles considered in this section.

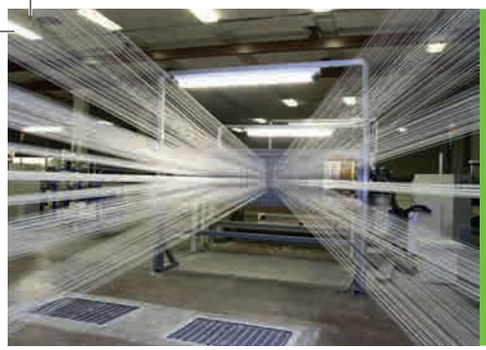
The section explores the following questions outlined in the OCR specification:

**1.1** How can exploring the context a design solution is intended for inform decisions and outcomes?
**1.2** Why is usability an important consideration when designing prototypes?
**2.1** What are the opportunities and constraints that influence design and making requirements?
**2.2** How do developments in design technology influence design decisions and practice?
**3.1** What are the impacts of new and emerging technologies when developing design solutions?
**3.2** How do designers choose appropriate sources of energy to make products and power systems?
**4.1** How can design solutions be communicated to demonstrate their suitability?
**4.2** How do designers source information and thinking when problem solving?
**5.1** What are the main categories of materials available to designers when developing design solutions?
**5.2** Why is it important to consider the characteristics and properties of materials and/or system components when designing?
**6.3** How do we introduce controlled movement to products and systems?
**6.4** How do electronic systems provide functionality to products and processes?
**7.5** How do new and emerging technologies have an impact on production techniques and systems?

These questions are considered in the following chapters:







# CHAPTER 5
# Material considerations

## LEARNING OUTCOMES

By the end of this section you should know and understand:

- that products are predominantly made from multiple materials
- about the main categories of materials.
- the developments in materials, including modern and smart materials, composite materials and technical textiles.

Clear learning objectives for each chapter so students can monitor their understanding.

This chapter looks at the main categories of materials available to designers when developing design solutions. It provides an overview and introduces the design considerations when selecting materials. Specific categories of materials are looked at in more detail in Chapters 8–13.

## Categories of materials

### Paper and boards

Paper and boards are widely used by designers for a range of purposes, from sketching, drawing and planning of ideas through to modelling and prototyping of design solutions.

Paper and boards come in a wide range of different thicknesses, sizes and types.

In Europe the thickness of paper is known as its 'weight'; this is measured in grams per square metre, often abbreviated as g/m2 or **gsm**. This is the weight in grams of a single sheet of paper measuring 1 m × 1 m in size.

Common weights of paper used by designers are:

- 80 gsm
- 90 gsm
- 100 gsm
- 120 gsm
- 130 gsm
- 150 gsm
- 170 gsm.

A weight greater than 170 gsm is classified as a board rather than paper.

Boards are usually classified by thickness as well as by weight. This is because, depending on the type of board, different sheets may be the same thickness but of different weights. For example, a sheet of corrugated cardboard and a sheet of mounting board could both be the same thickness but have different weights.

The thickness of board is measured in **microns**.

**KEY TERMS**

**gsm** – grams per square metre. Used to classify the weights of paper and card.

**Micron** – one thousandth of a millimetre. Used to classify the thickness of paper and card.

**Figure 5.1** **Newspapers and magazines are a common use of paper.**

### Paper

Paper is a familiar material that we come into contact with every day. Newspapers, magazines, comics, bus tickets, receipts and even toilet paper are common uses of different types of paper. Paper types include:

- layout paper
- copier paper
- cartridge paper
- bleedproof paper
- sugar paper.

For more information on different paper types, see Chapter 8.

## Card and cardboard

### *Card*

Card and cardboard are thicker than paper, but are also commonly encountered in everyday life. Thin card is slightly thicker than paper, around 180 to 300 gsm in weight. Like paper it is available in a wide range of colours, sizes and finishes, including metallic and holographic shades. Thin card is easy to fold, cut and print on, which makes it ideal for greetings cards, paperback book covers and so on, as well as simple modelling applications.

### *Cardboard*

Cardboard is available in many different sizes and surface finishes, with thickness ranging from around 300 microns upwards. Cardboard is widely used for packaging because it is relatively inexpensive and can easily be cut, folded and printed on; examples include cereal boxes, tissue boxes, sandwich packets etc. Cardboard can be used to model design ideas; it is often used to make templates for parts and pieces of products which once correct can then be made from metal or other more-resistant materials.

### *Corrugated cardboard*

Corrugated cardboard is a strong but lightweight type of card that is made from two layers of card with another fluted sheet in between. It is available in thicknesses ranging from 3 mm (3000 microns) upwards. The fluted construction makes it very stiff and difficult to bend or fold, especially when folding across the flutes. Because of the spaces between the two layers created by the fluted sheet, corrugated card can absorb knocks and bumps which makes it ideal for packaging fragile or delicate items that need protection during transportation. It is also widely used as packaging for takeaway foods such as pizza boxes as the fluted construction gives it good heat-insulating properties compared to normal cardboard.


**Figure 5.2 Corrugated cardboard is stiff and often used as packaging for takeaway foods.**

Double-wall corrugated card is twice as thick as corrugated card and gives extra strength and damage resistance.

For more information on cardboard, see Chapter 8.

## Board sheets

Mounting board is a rigid type of card with a thickness of around 1.4mm (1400 microns) and a smooth surface. It is available in different colours but white and black are the most commonly available and used colours. Mounting board is often used for picture framing mounts and architectural modelling.

For more information on board sheets, see Chapter 8.

## Laminated layers

### *Foam board*

'Laminated layers' include various other materials that come in sheet form, like paper and cardboard, and can be used in similar ways. Foam board is a lightweight board made of polystyrene foam sandwiched between two pieces of thin card or paper. It has a smooth surface and is available in a range of colours, sheet sizes and thicknesses with 5 mm (5000 microns) being the most common. Foam board is a very lightweight but rigid material and is ideal for modelling and point-of-sale displays. It is easy to cut and straightforward to fold using the correct technique.

Figure 5.3 **Styrofoam™ is strong, lightweight, water-resistant and a good heat insulator.**

### *Styrofoam*

Styrofoam™ is a trade name for expanded polystyrene foam. It is available in a wide range of sizes and thicknesses but can be identified by its blue colour. Styrofoam has a structure of uniformly small, closed cells that make it easy to cut, shape and sand to a smooth finish. Styrofoam is strong and lightweight, as well as being water-resistant and having good heat insulation properties. It is used as a wall insulation material in caravans, boats and lorries, but it is also ideal for creating three-dimensional models and moulds for vacuum-formed or glass-fibre products.


Figure 5.4 **Corriflute is often used for outdoor signs.**

### *Corriflute*

Corriflute is an extruded corrugated polymer sheet similar in structure and thickness to corrugated cardboard. It is made from a high-impact polypropylene resin and available in a wide range of colours and sheet sizes. Corriflute is rigid and lightweight as well as being extremely waterproof. It is easy to cut but can be difficult to fold especially across the flutes. Corriflute is often used for outside signs such as 'For Sale' signs on houses, car forecourts or outside shops. It is also used for plastic containers, packaging, point-of-sale displays and for modelling purposes.

For more information on laminated layers, see Chapter 8.

Short activities help to reinforce understanding and knowledge as students read through each chapter.

**ACTIVITY**

Copy and complete the following sentences using the words below.

cartridge foam weight blue microns gsm receipts shape

Newspapers, magazines, bus tickets, and toilet paper are examples of different uses of paper. Common paper types include layout paper, copier paper, paper, bleed proof paper and sugar paper.

The thickness of paper is known as its and this is measured in grams per square metre (g/m2 or ).

Paper with a weight greater than 170 gsm is classified as a board. The thickness of board is measured in . Examples of board are cardboard, corrugated cardboard and board.

Styrofoam is in colour. It is ideal for creating 3D models because it is easy to cut, and sand to a smooth finish.

## Natural and manufactured timber

For thousands of years, trees have provided us with wood, a natural material used to make a wide variety of products. Wood is a natural material and timber is the general name given to wood materials once they have been processed into useable forms such as planks and strips. There are three main types of timber: hardwoods, softwoods and manufactured boards.

Figure 5.5 **Trees are cut down into logs.**

Figure 5.6 **Logs are cut into timber.**

## Hardwoods

**Hardwoods** come from broad-leafed, deciduous trees like oak, birch and teak, which lose their leaves over winter. These trees grow slowly and as a result the timber obtained from them tends to be dense, hard and heavy. They come in many different colours and are generally used for high-quality items such as furniture.

Figure 5.7 **An oak tree**

Figure 5.8 **An oak chair**

## Softwoods

**Softwoods** come from conifers – evergreen trees like pine, cedar and spruce which keep their needles all year round. They grow faster than hardwood trees and the wood is usually lighter in colour. They are cheaper than hardwoods and are usually used in the building industry for roof, wall and door frames.

**KEY POINT**

The terms 'hardwood' and 'softwood' are used to describe the type of tree the wood came from. It does not necessarily mean that the wood is hard or soft. For example, balsa wood (a very soft and lightweight wood) is actually classified as a hardwood.

Figure 5.9 **A pine tree**

Figure 5.10 **A roof frame on a house**

## Manufactured boards

**Manufactured boards** are sheets of timber made by gluing wood fibres or wood layers together. This is a good way of making large flat boards that are stable and easy to work with as natural timber can twist and warp. Examples of manufactured boards are MDF, plywood and chipboard or block board.

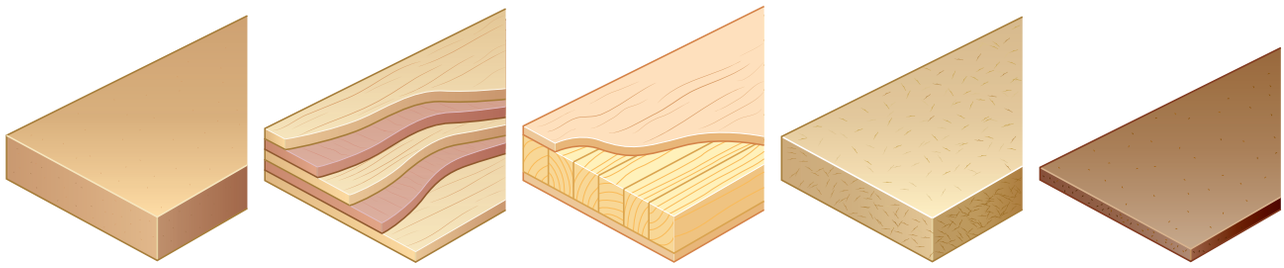



**Figure 5.11 There are several different types of manufactured boards.**

**KEY TERMS**

**Hardwoods** – woods that come from broad-leafed, deciduous trees.

**Softwoods** – woods that come from conifers.

**Manufactured boards** – sheets of timber made by gluing wood fibres or layers together.

Key terms throughout the text clarify technical vocabulary for each material.

**Figure 5.12 A table made from MDF**

**ACTIVITY**

1. Match the terms below with the correct definitions.

| | |
|---|---|
| Timber | Sheets of timber made by gluing wood fibres or wood layers together. |
| Softwoods | Woods that come from deciduous trees. |
| Hardwoods | The name given to wood materials once they have been processed into useable forms. |
| Manufactured boards | Woods that come from evergreen trees. |

2. Decide whether each of the following is a hardwood, softwood or manufactured board.
   - a) Oak
   - b) Plywood
   - c) Pine
   - d) MDF
   - e) Spruce
   - f) Teak

More information on timber can be found in Chapter 9.

## Metals

Metal is made by extracting metal ores from rocks in the Earth's crust by mining. The metal ore is then processed and refined to create a more usable material with improved properties.

There are two main types of metals:

- **ferrous metals** – metals that contain iron
- **non-ferrous metals** – metals that do not contain iron.

Both types of metals are available in a wide variety of shapes and sizes.

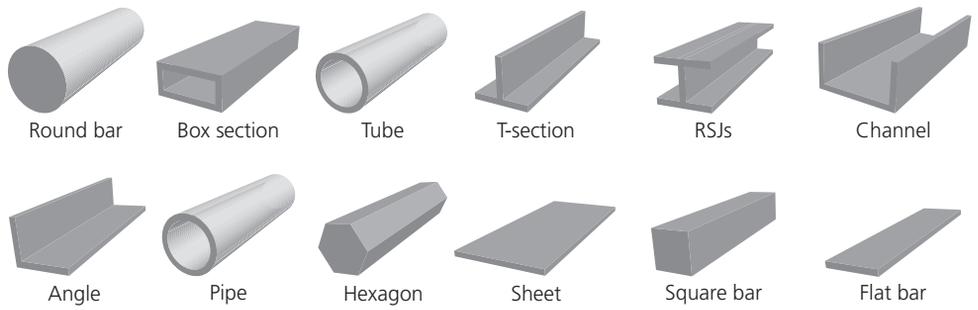



**Figure 5.13 Standard metal forms**

**KEY TERMS**

**Ferrous metal** – a metal that contains iron.

**Non-ferrous metal** – a metal that does not contain iron.

### Ferrous metals

A ferrous metal is a metal that contains iron.
Ferrous metals corrode quickly and easily because of their iron content unless they are treated with a suitable surface coating such as paint, oil or wax. The majority of ferrous metals are also magnetic so will be attracted to a magnetic force.

Ferrous metals include:

- mild steel
- carbon steel
- stainless steel
- cast iron
- wrought iron.

For more information on ferrous metals, see Chapter 10.

**Figure 5.14 Mild steel is widely used for building and engineering – for example, in steel joists and girders.**

**Figure 5.15 Stainless steel is resistant to corrosion and is used for cutlery.**

**Figure 5.16 Cast iron is heavy and strong and is used to make kitchen saucepans.**

## Non-ferrous metals

Non-ferrous metals do not contain iron. Non-ferrous metals are much more resistant to corrosion and many are significantly better electrical conductors than ferrous metals. Generally non-ferrous metals are also more expensive than ferrous metals.

Non-ferrous metals include:

- aluminium
- copper
- tin.

For more information on non-ferrous metals, see Chapter 10.

**Figure 5.17** **Aluminium has a wide range of uses, including ladders.**

**Figure 5.18** **Tin is often used for food containers, or 'tin' cans.**

**KEY TERMS**

**Alloy** – a metal made by combining two or more metals to give greater strength or resistance to corrosion.

## Alloys

An alloy is a metal that is mixed or combined with other substances to make it stronger, harder, lighter or better in some other way.

Alloys include:

- brass
- bronze
- pewter
- lead/tin solder.

**Figure 5.19** **Brass is often used in decorative products such as this door knocker.**

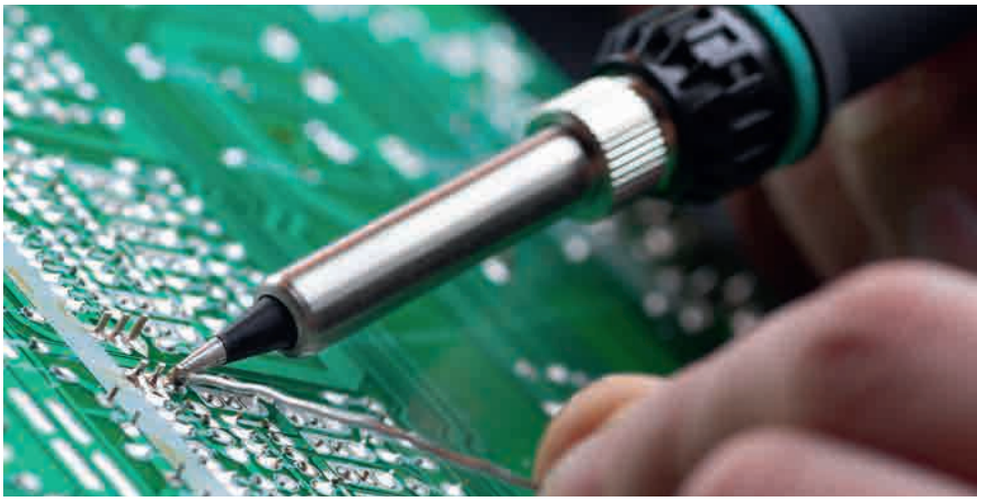


**Figure 5.20** **Solder is used for electrical connections on printed circuit boards.**

For more information on alloys, see Chapter 10.

## ACTIVITY

Complete the table by adding the missing information.

| Category | Definition | Example 1 | Example 2 | Example 3 |
|---|---|---|---|---|
| Ferrous metals | | Mild steel | | |
| | Metals that do not contain iron | Copper | | |
| Alloys | | Brass | | |

## STRETCH AND CHALLENGE

How can a magnet help to identify what type of metal a product is made from?

Questions to challenge students and help build higher-level understanding.

## Thermo and thermosetting polymers

A polymer is a very large, chain-like molecule made up of monomers, which are small molecules. Polymers can occur naturally or we can manufacture them. Examples of naturally occurring polymers include silk, wool, hair and even animal horn.

Manufactured polymers are commonly referred to as 'plastics' and are derived from petroleum oil. Different types include nylon, polyethylene and acrylic. Rubber items are also a type of polymer.

There are two families of polymers: **thermo polymers** and **thermosetting polymers**.

**Figure 5.21** **This Viking drinking horn is a made from a naturally occurring polymer.**

### Thermo polymers

PET, HDPE, PVC, LDPE, PS, PP, ABS, acrylic and TPE are all examples of thermo polymers. They soften when they are heated and can be moulded into shape. They harden again once they have cooled. This can be repeated many times, which means thermo polymers can be recycled. When reheated, these plastics will try to return to their original shape. This is called **plastic memory**.

**Figure 5.22** **These products are made from a manufactured polymer.**

Examples of thermo polymers include:

- polyethylene terephthalate (PET)
- high-density polyethylene (HDPE)
- polyvinyl chloride (PVC)
- low-density polyethylene (LDPE)
- polystyrene (PS)
- polypropylene (PP)
- acrylonitrile butadiene styrene (ABS)
- acrylic
- thermoplastic elastomer (TPE).


**Figure 5.23** **Drinks coaster made from recycled plastic (HDPE)**

**KEY TERMS**

**Thermo polymer** – a polymer that softens when heated and can be moulded into shape. This can be repeated many times.

**Thermosetting polymer** – a polymer that, when heated, becomes hard and rigid. Once set it cannot be reheated and remoulded.

**Plastic memory** – the ability of thermo polymers to return to their original state after reheating.

### Thermosetting polymers

Silicone, polyester resin and epoxy resin are types of thermosetting polymers. These types of polymer undergo a chemical change when heated to become hard. Once they have 'set' they cannot be reheated and remoulded so they cannot be recycled.

**Figure 5.24 A silicone cake mould**

**ACTIVITY**

Use the internet to gather a range of images of polymer products and try to identify the polymers used. Think about the following:

- What does the product do?
- How is the product used?
- Where is it used?

More information about polymers can be found in Chapter 11.

## Textile fibres and fabrics

Fibres are the starting point for all textile materials. They are tiny hair-like structures, which are spun (twisted) together to make yarns. These yarns are then woven or knitted together to create fabrics that can be used in a variety of contexts from clothing to tents to buildings.

**Figure 5.25 Fibres are spun together to make yarns and then woven or knitted together to create fabric.**

## Natural fibres

Nature provides us with a huge variety of fibres, which are found in both plants and animals. These are called natural fibres. Examples of natural fibres include cotton, wool and silk.

**Figure 5.26** Seed casings of the cotton plant

**Figure 5.27** Silk worms wrap themselves in silk fibre to form a cocoon.

**KEY POINT**

Natural fibres share many of the same properties. It is important to make sure you know the few properties that make each fibre different.

**Figure 5.28** Wool fleece is sheared from a sheep.

## Synthetic fibres

**Synthetic fibres** are man made and come from a range of sources including coal, oil, minerals and other petrochemicals. These fibres are mostly non-biodegradable and are therefore not sustainable. They can be engineered to give them a range of useful properties including flame resistance, crease resistance and stain resistance.

Examples of synthetic fibres include:

- polyester
- nylon (polyamide)
- acrylic
- elastane.

Some synthetic fibres are made from cellulose taken from plants; these can also be known as **regenerated fibres**. Viscose is an example of a regenerated fibre.

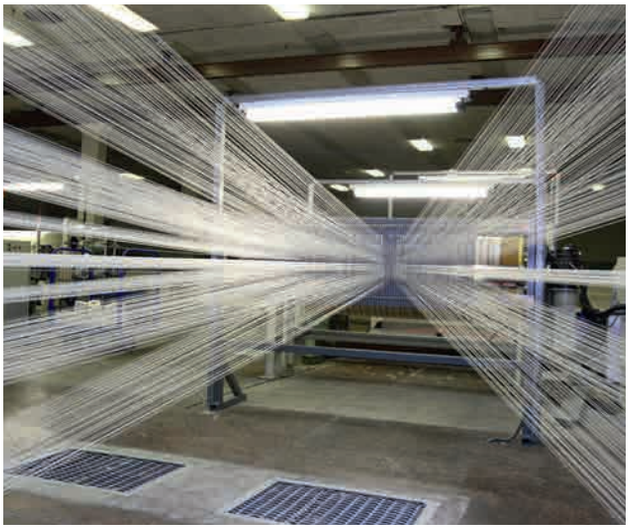


**Figure 5.29** Oil is used to make synthetic fibres.

**KEY TERMS**

**Natural cellulose fibres** – plant fibres which come from seeds or stems.

**Natural protein fibres** – animal fibres which come from hair, fur or excretions.

**Synthetic fibres** – manufactured fibres from a range of sources including coal, oil, minerals and other petrochemicals.

**Regenerated fibres** – synthetic fibres made from cellulose taken from plants.

**KEY TERMS**

**Mixed fibres** – fibres made by adding yarns of different fibres together during the production process.

**Blended fibres** – fibres made by blowing different fibres together before they are spun into yarns.

## Mixed/blended fibres

Fibres can be mixed or blended together to improve the quality, aesthetics, function or cost of the final fabric.

Fibres are mixed by adding yarns of different fibres together during the production process. For example, a small percentage of elastane yarns may be mixed with cotton yarns during the weaving process to add strength to the weave and provide some elasticity. Fibres may be mixed for aesthetic reasons, such as mixing fibres of varying lustre or colour, giving a variable effect. The mixing of fibres happens after yarns are spun.

**Blending** of fibres is commonplace within the textiles industry. Fibres are blown together before they are spun into yarns. Popular blends include polyester cotton; this blend of polyester and cotton fibres is often used to produce shirts, and gives the finished fabric strength, breathability, absorbency and crease resistance. The blend also lowers the overall cost of the fabric.

**Figure 5.30 Polyester cotton is a popular blended fibre.**

**ACTIVITY**

Complete the table by adding the missing information.

| Category | Definition | Example |
|---|---|---|
| Natural cellulose fibres | Plant fibres which come from seeds or stems | |
| | Animal fibres which come from hair, fur or excretions | Silk |
| Synthetic fibres | | Polyester |
| Mixed fibres | Fibres produced by adding yarns of different fibres together during the production process | |
| | Fibres made by blowing different fibres together before they are spun into yarns | |

## Woven, non-woven and knitted fabrics

### *Woven fabrics*

**Woven** fabrics are produced on manual or automatic looms. A woven fabric consists of warp and weft yarns. The warp yarns run vertically and the weft yarns are woven horizontally in an under–over configuration.

Different types of weave are produced for various uses. There is more on different types of weave in Chapter 12.

Figure 5.31 **Woven fabrics are produced on looms.**

## *Non-woven fabrics*

**Non-woven** fabrics lack the strength of woven or knitted fabrics and are usually used for decorative or disposable products. These fabrics fall into two categories: **bonded** and **felted**.

Bonded fabrics are manufactured by applying pressure and heat or adhesives to bond the fibres together and are often used in disposable textiles such as wet wipes, tea bags, surgical masks, dressings and nappies. These fabrics lose their strength and structure once wet, so they are usually only suitable for one use.

Felted fabrics are produced by applying heat, pressure and friction to a web of fibres, which matt together. The most commonly used fibres are wool and acrylic. Felt is often used for decorative purposes, such as appliqué, and is historically applied to the surface of pool and snooker tables. Felt is also used for cushioning and insulating various products.

Figure 5.32 **Disposable textiles such as surgical masks are made from bonded fabrics.**


Figure 5.33 **Felt is applied to the surface of snooker tables.**

**KEY TERMS**

**Woven** – a fabric consisting of warp and weft yarns and produced on a loom.

**Non-woven** – a fabric made directly from fibres held together by pressure, heat or adhesives rather than yarn.

**Bonded** – a fabric manufactured by applying pressure and heat or adhesives to bond fibres together.

**Felted** – a fabric produced by applying heat, pressure and friction to a web of fibres, which matt together.

### *Knitted fabrics*

Knitted fabrics are made up of rows of interlocking loops, also known as stitches. The most commonly used knits are weft and warp.

For more information on different types of knitted fabric, see Chapter 12.

**Figure 5.34 Knitted fabrics are made up of rows of interlocking stitches.**

**KEY TERM**

**Modern materials** – materials that are continually being developed through the invention of new or improved processes.

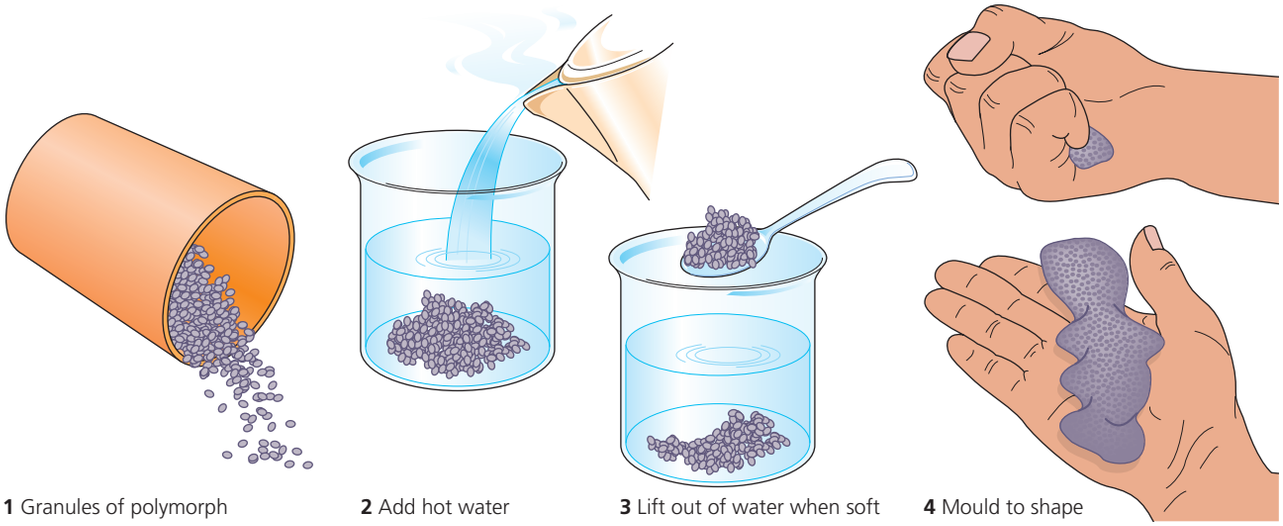
## Modern and smart materials

### Modern materials

**Modern materials** are those that are continually being developed through the invention of new or improved processes. Some will have practical applications for your projects in Design and Technology; others will be more suited to a specific commercial or industrial use. Below are some examples of modern materials.

### *Polymorph*

Polymorph comes in the form of polymer granules. When heated to 60 °C in warm water the granules melt and can be moulded into shape. You can reheat it again using warm water or a hairdryer.



**1** Granules of polymorph **2** Add hot water **3** Lift out of water when soft **4** Mould to shape

**Figure 5.35 The stages of using polymorph**

### *Teflon*

Teflon is mainly used as a non-stick coating in cookware but it is also used in paints, fabrics, carpets and clothing to repel liquids.

### *Lenticular plastic sheet*

Lenticular plastic sheet is smooth on one side while the other side is made of small lenses. These lenses transform 2D images into a variety of visual illusions.

### *Flexiply*

Flexiply is a form of plywood that is extremely flexible and can be bent into various shapes quite easily.

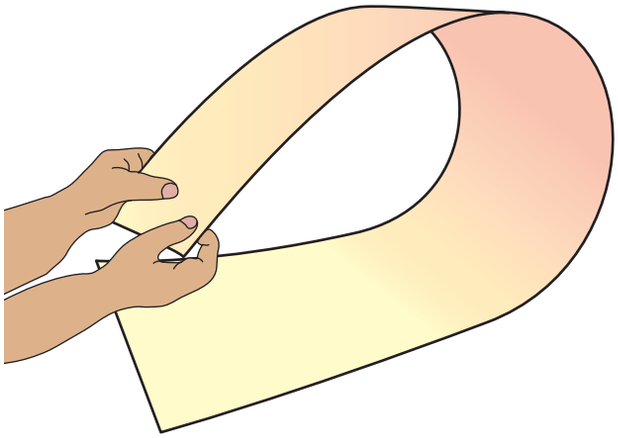


**Figure 5.37** **Flexiply**

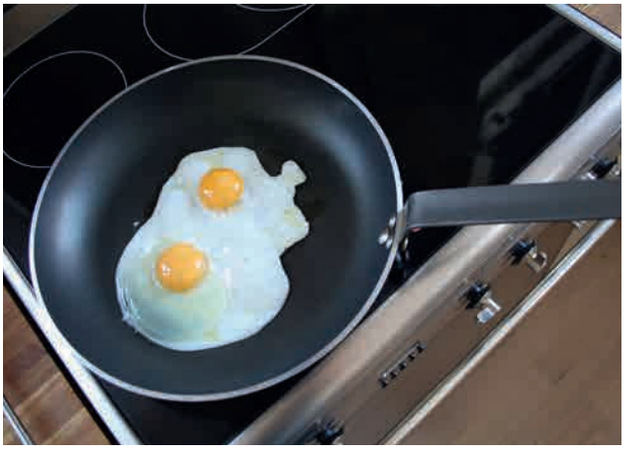


**Figure 5.36** **Teflon-coated pans are non-stick.**

### *Precious metal clay*

Precious metal clay (PMC) is made from 99% silver or gold and 1% clay. It can be shaped at room temperature then heated in a kiln to produce jewellery.

**Figure 5.38** **An example of hand-made PMC jewellery**

### *Conductive polymers*

Conductive polymers are polymers that can conduct electricity.

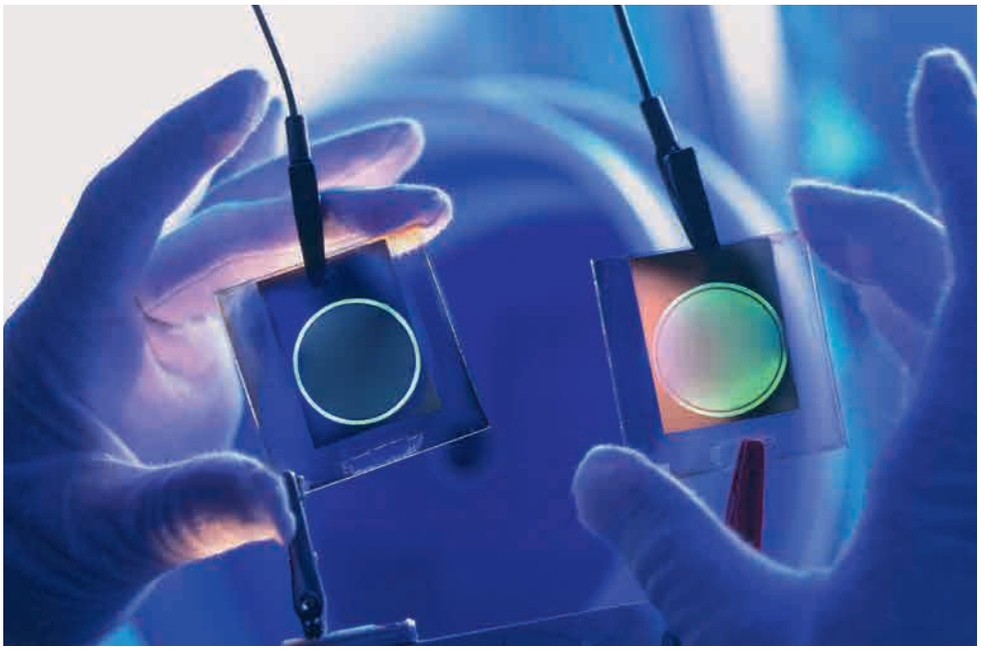


**Figure 5.39 Conductive polymers are plastic products that can conduct electricity.**

## Smart materials

**Smart materials** respond to differences in temperature or light and change in some way. They are called 'smart' because they sense conditions in the environment and respond to those conditions. Smart materials appear to 'think' and some have 'memory' as they can revert back to their original state

### *Shape memory alloy*

**Shape memory alloy (SMA)** 'remembers' its original shape when deformed and returns to it when heated. SMA can be used in many applications such as spectacle frames that return to their original shape when bent and as a simple and effective way to move parts in machines like cooling vents.

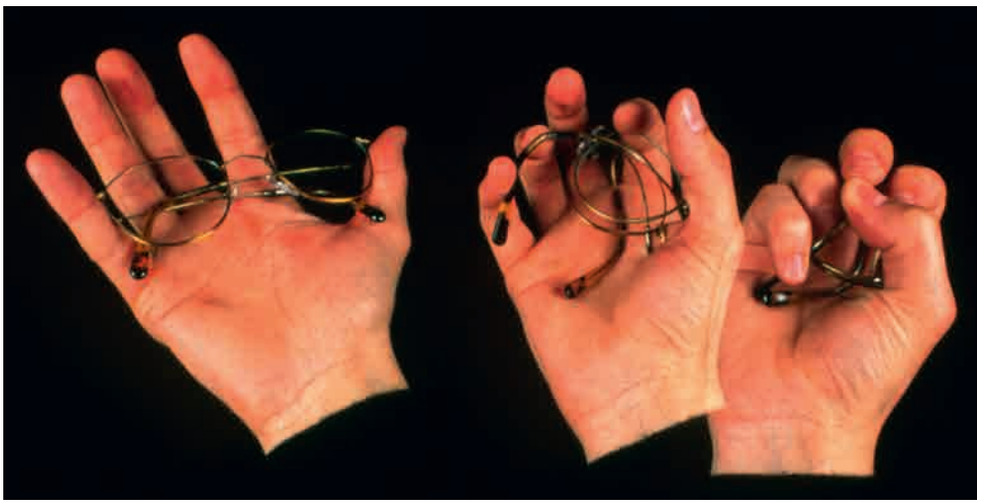


**Figure 5.40 Shape memory glasses**

### *Shape memory polymers*

Shape memory polymers can also be 'programmed' to remember their original shape when they are heated.

### *Thermochromic sheet*

**Thermochromic** sheet is printed with liquid crystal 'ink' that changes colour above 27 degrees. It is used in children's toys, jewellery and temperature indicators.

### *Thermochromic pigments*

Thermochromic pigments are often used on novelty mugs that reveal a design as hot water is poured into the mug. They can also be added to polymers so that the material reacts to heat such as colour-changing drinks stirrers and baby feeding spoons that warn you if food is too hot.

### *Photochromic materials*

**Photochromic** materials react to light. Spectacles that darken in bright sunlight use photochromic lenses.

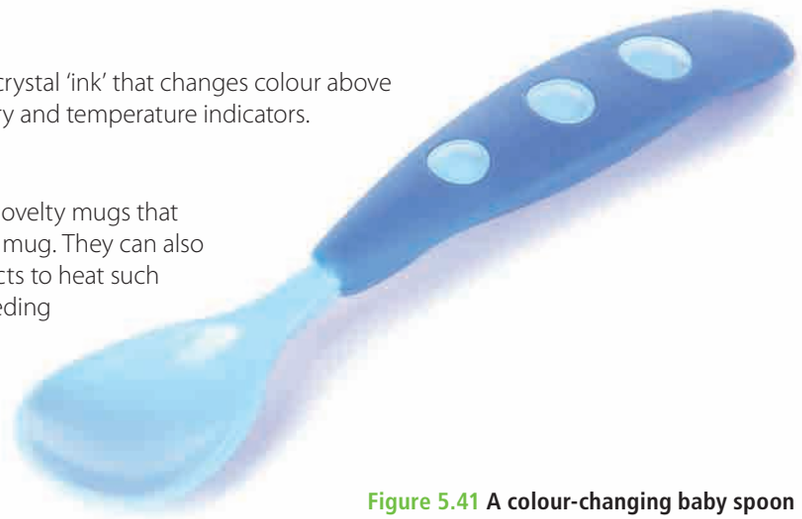


**Figure 5.41** A colour-changing baby spoon

**Figure 5.42** Light-reacting glasses

### *Self-healing materials*

Self-healing materials have the ability to detect and repair damage done to them. The first of these were polymers which had internal adhesive; these were used on products such as cutting mats. Self-healing materials can use embedded capsules that release an adhesive when the material cracks. Bioconcrete heals itself using bacteria that react with any water that gets into it and that produce limestone to fill any micro-cracks that appear.

**KEY TERMS**

**Smart materials** – materials that respond to differences in temperature or light and change in some way.

**Shape memory alloy (SMA)** – a material that remembers its original shape when deformed and returns to it when heated.

**Thermochromic** – materials that react to changes in temperature.

**Photochromic** – materials that react to light.

**KEY POINT**

Material science has developed rapidly over the past 20 years and will continue to move forward. It is difficult to keep up to date with current developments in this field and by the time you read this many more new materials are likely to have been developed and integrated into modern products. Try to keep up to date with current scientific progress as you study Design and Technology by following the news on television and recommended websites.

Clarification of important facts or points for students to explore further, to ensure fully rounded material knowledge.

Figure 5.43 **A GRP boat**

Figure 5.44 **A carbon fibre racing bike**

## Composite materials

**Composite materials** are produced by bonding different materials to produce a new one with improved properties. Several composite materials have been around for many years and new composites are being developed. Composites are increasingly used in place of metals in machine tools.

### *Glass-reinforced plastic*

Glass-reinforced plastic (GRP) is polyester resin reinforced with glass fibre strands. The glass fibre is available as woven fabric, matting or loose strands. It has all the properties of a polymer but it is much stronger. It is used for large structural items such as boats and car bodies

### *Carbon fibre*

Carbon fibre is similar to GRP but uses carbon fibres instead. This makes the material even stronger and also lighter in weight. It is used for protective helmets, high-end cycles and sporting equipment.

### *Kevlar*

Kevlar is similar to carbon fibre but has a stronger polymer woven in to it. It is even lighter and stronger than carbon fibre and is used for bullet-proof vests.


Figure 5.45 **A Kevlar bullet-proof vest**

### *Laminates*

Laminates are materials made up of layers. Since the layers are usually different materials, laminates are examples of composites. If a material is not strong or durable enough to survive by itself, you would combine it with one that was. For example, laminated glass has a thin layer of polymer sandwiched in the middle to make the glass stronger and tougher. A waterproof jacket is made from layers that stop wind and rain from getting in but allow moisture vapour out.

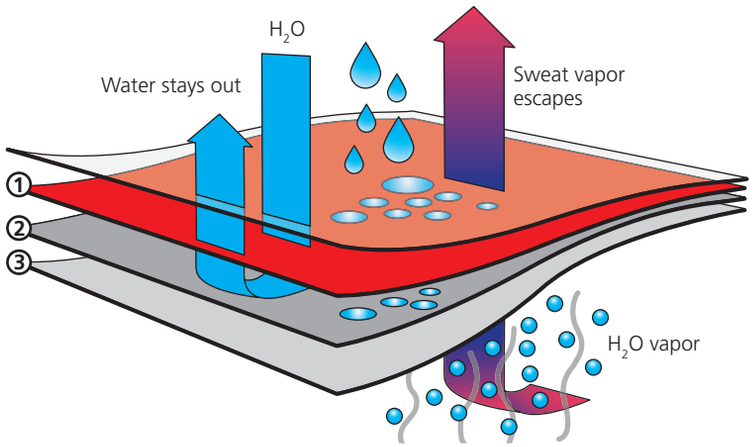



Figure 5.46 **Layers of fabric in a waterproof coat**

**KEY TERMS**

**Composite** – material produced by bonding different materials to produce a new one with improved properties.

**ACTIVITY**

Use the internet to research examples of composite materials and their uses.

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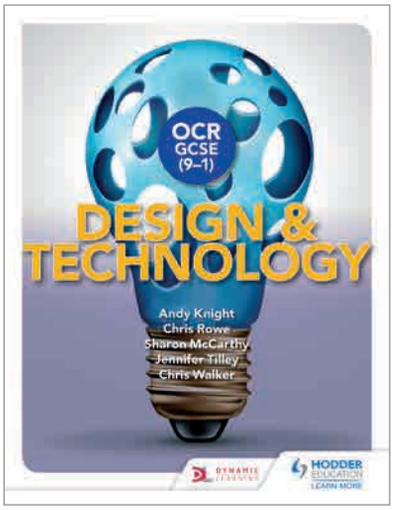


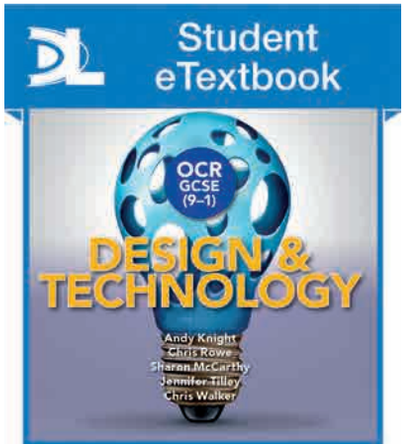



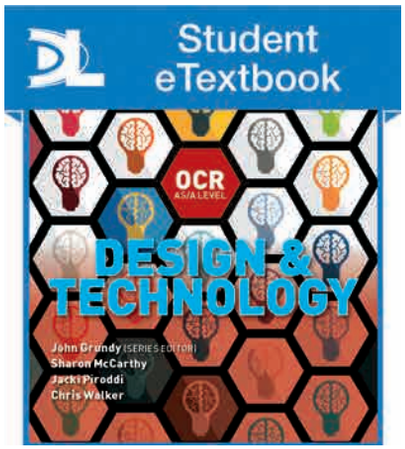


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