Section 1

In this section you will learn about the following:

1.1 Materials and their applications
1.2 Performance characteristics of materials
1.3 Methods of joining and using components
1.4 The use of finishes
1.5 Enhancement of materials
1.6 Modern industrial and commercial practice
1.7 Digital design and manufacture
1.8 The requirements for textile, and fashion design and development
1.9 Health and safety
1.10 Protecting designs and intellectual property (A-level)
1.11 Design for manufacturing, maintenance, repair and disposal
1.12 Feasibility studies
1.13 Enterprise and marketing in the development of products
1.14 Design communication
Imagine a world without fabrics. Textile materials are all around us and used for many different products including clothing, furnishings, medical applications, car interiors and engines, roads and buildings, industrial applications and safety and security products. The range of new textile materials and applications is developing all the time. Choosing the right textile material for the product is a complex process because there are many inter-related factors that must be taken into account, and choices will vary according to the type of product being made and the intended user.

For example, a fabric to be used for a school shirt will need to be strong and hardwearing, easy to care for, yet comfortable enough for a young person to wear during the school day. In contrast, the aesthetic appearance of a fabric used for a special occasion dress will probably be more important than how well it washes and if it is likely to last for a long time.

**Properties, characteristics, function and aesthetics**

The properties of textile materials vary depending on the fibres used, and the way that the fabrics are made and finished. Functional properties such as strength and resistance to abrasion, absorbency, ability to insulate, elasticity, drape, stiffness, flammability, ease of care, colour fastness, and the ability to be heat-set are important to different degrees in different types of product. For some products, the aesthetics of a fabric are as important as how well it functions. Aesthetics is about personal taste, and what one person finds attractive may be unappealing to another.
The fibre chart below gives a general guide to fibre properties.

**Table 1.1.1 General guide to fibre properties.**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Absorbency</th>
<th>Crease resistance</th>
<th>Tensile strength</th>
<th>Abrasion resistance</th>
<th>Flame resistance</th>
<th>Insulation qualities</th>
<th>Lustre</th>
<th>Resistance to build up static electricity</th>
<th>Resistance to damage by chlorine bleach</th>
<th>Resistance to damage by sunlight</th>
<th>Resistance to damage by sunlight</th>
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<td>N/A</td>
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</tr>
</tbody>
</table>

Key: ✓✓✓✓ = very good; ✓✓✓ = good; ✓✓ = average; ✓ = poor

**Cost**

The cost may dictate whether a fabric is appropriate for a specific application, especially in industrial manufacture where the manufacturer has to meet the cost of materials and manufacturing processes, while also making a profit. Some fibres and fabrics are scarcer or more difficult to make so will cost more, for example silk and wool are more expensive than cotton and synthetic fibres, complex weaving and knitting processes will be costlier and special finishes put on to fabrics will add to the price of materials.

**Manufacture and disposal**

How a product is to be manufactured may have an impact on the choice of fabrics; the use of a luxury fabric to make a bespoke outfit for a celebrity may be justifiable, but would not be appropriate for bulk manufactured fashion garments. The need for special manufacturing techniques or equipment may mean that certain fabrics are inappropriate.

Today, many people are concerned about the environmental impact of textiles, and therefore want products to be made from materials that are sustainable and can be recycled or are biodegradable. Many new developments in the source and processing of textile materials are helping to make textile products less environmentally damaging when disposed of at the end of their useful life.

The designer needs to take all of these factors into account when putting together a fabric specification and selecting fabrics for a particular product.

**KEY TERMS**

**Fibre:** a fine hair-like thread that can be spun with others to make a yarn.

**Synthetic fibre:** a fibre made entirely from synthetic polymers based on oil.

**Sustainable:** ensuring that all aspects of design and manufacturing activity do not have a negative impact on the environment or the lives of humans.

**Biodegradable:** a substance that can be decomposed naturally by bacteria or other living organisms.
1.1 Materials and their applications

ACTIVITY
Write a five-point fabric specification for each of the following textile products:
• a winter jacket
• sofa cushions
• a small rucksack.

MATHS LINK
Calculating of quantities of materials, sizes and costs
A shirt requires 2.35 metres of fabric that is 115cm wide, or 1.55 metres of fabric that is 150cm wide.
• The 115cm-wide fabric costs £4.78 per metre
• The 150cm-wide fabric costs £5.89 per metre.
A manufacturer is making 4,500 shirts. Calculate the percentage difference between the costs of the two fabrics.

Answer
First, you need to work out how much fabric is needed to produce 4,500 shirts using each fabric.
Using the 115cm-wide fabric:
4,500 × 2.35 = 10,575 metres
Using the 150cm-wide fabric:
4,500 × 1.55 = 6,975 metres
Then you need to work out the cost of producing 4,500 shirts using each fabric.
Using the 115cm-wide fabric:
10,575 × 4.78 = £50,548.50
Using the 150cm-wide fabric:
6,975 × 5.89 = £41,082.75
It is cheaper to produce 4,500 shirts using the 150cm-wide fabric.
To work out the percentage difference between the two costs, first work out the actual difference between the two costs:
50,548.50 – 41,082.75 = £9,465.75
Then divide the difference by the cost of the (more expensive) 115 cm-wide fabric and multiply by 100:
\[
\frac{9465.75}{50548.50} \times 100 = 18.73\%
\]
Using the 150-cm fabric is 18.73% cheaper than using the 115cm-wide fabric.

Classification of materials
Fibres are very fine, hair-like threads and are the basic building blocks of fabrics. All fibres – regardless of their source – are made up of atoms that are joined together to make molecules. Molecules can link together to form long chains called polymers.

All textile fibres are made from long-chain molecules, but the combination of atoms in the molecules will vary for the different fibre types. They will usually include carbon, hydrogen and oxygen. Fibres are made from natural or man-made polymers, and have different properties according to where they come from.
Fibres must be twisted (spun) together to make a **yarn** before they can be made into a woven or knitted fabric.

![Diagram](image)

**Figure 1.1.3** Fibres must be spun together to make a yarn before they can be made into a woven or knitted fabric.

The tables in the following sections show the classification of fibres in common use, including some brand names of fibres belonging to the fibre group.

**Natural fibres**

Natural fibres come from plant and animal sources. Plant fibres are made from cellulose and animal fibres are made from protein.

<table>
<thead>
<tr>
<th>Table 1.1.2 Natural fibres.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural fibres</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Natural plant/cellulosic fibres</td>
</tr>
<tr>
<td>linen</td>
</tr>
<tr>
<td>ramie</td>
</tr>
</tbody>
</table>

As technologists strive to find more sustainable alternatives to the established fibres such as cotton, other sources of natural fibres are beginning to be used to make textile products, for example bamboo, pineapple and banana leaf fibres. Alginate fibres from seaweed are used in medical applications.

**Manufactured fibres**

Manufactured fibres (including **regenerated fibres** and lyocell fibres) are mostly made from natural cellulose from wood pulp, or waste cotton fibres that are too short to be spun into a yarn. They have been chemically treated to modify the cellulose so that it can be made into fibres.

Regenerated fibres are first generation manufactured fibres, and were known by names such as viscose and rayon. Modal® and lyocell fibres are second generation fibres, and the most recent in the development in this type of fibre. Each time the fibre is developed the strength, softness and crease resistance has been improved. Lyocells are more environmentally friendly fibres because they are manufactured using a closed-loop system that reuses the chemicals used in the processing.

<table>
<thead>
<tr>
<th>Table 1.1.3 Manufactured regenerated fibres.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufactured fibres</td>
</tr>
<tr>
<td>regenerated fibres</td>
</tr>
<tr>
<td>viscose (made from wood pulp)</td>
</tr>
<tr>
<td>acetate (made from cotton waste)</td>
</tr>
</tbody>
</table>
1.1 Materials and their applications

Synthetic fibres

Man-made fibres are made from synthetic polymers that come mainly from oil. The synthetic polymers are made by joining smaller molecules together to form a long chain. This process is called polymerisation.

Table 1.1.4 Synthetic fibres.

<table>
<thead>
<tr>
<th>Synthetic fibres</th>
<th>Chlorofibres (A-level only)</th>
<th>Aramid fibres (A-level only)</th>
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</thead>
<tbody>
<tr>
<td>polyamide (nylon)</td>
<td>polyvinyl</td>
<td>Kevlar®</td>
</tr>
<tr>
<td>polyester</td>
<td>fluorofibres [PTFE]</td>
<td>Nomex®</td>
</tr>
<tr>
<td>acrylic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>elastomeric (Lycra®)</td>
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</tbody>
</table>

Aramid fibres have been developed from polyamide fibres. They are technical fibres that have additional strength and durability, and are stab- and tear-resistant. Kevlar® is used to make stab-proof and bulletproof vests worn as protective wear.

Inorganic fibres come from glass, metal, ceramics and carbon, and are used for specialist applications such as micro-encapsulated and nano-fibres.

Smart materials

Smart materials or intelligent materials are able to react to external stimuli or changes in their environment without human intervention. They are able to sense and react to conditions around them, for example light, heat and power. This area of textiles technology is developing all the time, especially wearable electronics that allow people to interact with their environment. Some examples of this are outlined below:

- Reactive materials include those that react to changes, such as loss of heat or presence of pollutants. Many of these fabrics are used in health and safety or sportswear applications.
- Photochromic fabrics are dyed using specific types of dye that respond to changes in UV light. This type of fabric may be used in garments that warn the wearer of the need for sun protection.
- Phase changing materials are able to help regulate body temperature, cooling down in hot conditions and warming up when it gets cooler. These materials are used for garments worn in extreme climates such as those worn by mountaineers.

Modern textile materials

Modern textile materials are constantly being updated and new ones developed. New fibres can be engineered to have properties needed for specific purposes.

Below are some examples of new developments – there are many more.

Microfibres

Microfibres are extremely fine synthetic fibres, mainly polyester and polyamide.

Microfibres are very lightweight, soft, drape well and are used for a variety of clothing products. They are often blended with natural fibres to give high
performance fabrics for outdoor and sports use. **Tactel®** is a polyamide microfibre, for example Tactel Aquator® and Tactel Diablo®.

**Nano-fibres**

Nano-fibres are very tiny, varying in size from one micron to a single polymer molecule. (A micron is one-millionth of a metre; 100 microns is the width of a single human hair.) Nano-fibres are very lightweight but strong, fine and delicate to touch. When applied to a fabric as a finish, they protect it from grease and water-borne stains. They can also make a fibre more absorbent, and can be sprayed on to the human body to make a very fine, seamless skin covering.

Nano-fibres are still being developed; they open up all sorts of exciting possibilities for textiles in the future.

**Micro-encapsulated fibres and fabrics**

These contain various health and cosmetic chemicals that can help to make daily life more comfortable and healthier. When the fibres are rubbed, the chemicals are released slowly and absorbed through the skin of the wearer. The chemicals break down slowly, so the effects last for a long time. For example, caffeine-encapsulated tights can help to stimulate leg veins, which reduces the risk of deep vein thrombosis (DVT).

**Methods for investigating and testing materials**

When selecting possible fabrics for a product, manufacturers may carry out tests to check that potential fabrics have the performance properties required. Many of the requirements will be recommended by the British Standards Institute (BSI). There are over 10,000 British standards for almost every industry – from food to building construction and textiles to children’s toys. These state the essential technical requirements – or **performance codes** – for a product, material or process to be fit for its intended purpose. For example:

- waterproof clothing really will keep the wearer dry
- fabric to be used for hotel sheets and duvet covers will stand up to repeated laundering.

Designers give fabric specifications for the product, but the method of testing must be reliable and consistent if the results are to be accurate and have the same meaning to everyone involved. BSI set standards for the test methods to be used for different performance qualities, and these are used all over the world.

To be reliable, it must be possible to repeat the test in the same laboratory conditions, using the same fabrics and obtain virtually the same results every time the test is performed. The size of the piece of fabric to be tested may affect the data obtained – a small piece may not give the same results as a larger piece. The test may need to be repeated on the same fabric or product to obtain reliable results, for example sheets need to be washed many times before any signs of wear are seen.
Industrial testing of fabrics requires specialist equipment and conditions which are unlikely to be available in the school or college workshop. However, it is possible to set up fairly reliable tests that mimic BSI tests using basic equipment. When setting up a test, there must be a logical and consistent approach. It must be clear:

- what is being tested
- how the test will be set up
- how it will be carried out
- how the data will be recorded
- how the results will be interpreted
- how results will be compared with a control.

**Flammability**

It is very difficult to predict how a fabric will burn in a real situation because there are so many variables such as the style of the product, the source of ignition and whether or not there is air flow to fan the flames. In industry, a number of different tests are used to assess how a fabric will behave when burning. The following three are the most important ones used to assess how flammable a fabric is, however they do not test whether it is safe to use for a specific application.

**Industrial test 1**

A sample of the fabric is held in a metal frame and a small flame from a Bunsen burner is applied to the fabric.

Test 1 shows how easy it is for a fabric to catch fire. The flame is applied to the fabric 6 cm from the bottom edge, to see how long it takes for the fabric to set alight. The flame touches the fabric for two seconds and is then removed. The test is complete if the fabric burns for more than one second. If the fabric does not set on fire, the contact with the flame is increased to three, four, six, eight and ten seconds, until it does catch fire.

**Industrial test 2**

Test 2 assesses how far a flame spreads when the source of ignition is removed. The test is for fabrics that have low flammability, and measures the size of the hole burned into the fabric.

A flame is applied to a sample for ten seconds. The duration of the flaming and whether the flame reaches one of the edges are recorded. The size of the hole is measured and the duration of the afterglow is noted, as well as whether any flaming debris has fallen from the sample.

**Industrial test 3**

Test 3 measures how quickly a flame spreads. A large sample of fabric is placed in the frame and three cotton trip threads attached to timers are placed at regular intervals above the flame. The flame is applied to the bottom of the sample for ten seconds, and as each thread burns through, its timer will stop. This shows how quickly the flames burned through the fabric.
Workshop testing

For safety reasons, any workshop test for flammability must be carried out by a teacher, and done in a science fume cupboard with a fire extinguisher nearby.

Use 3 × 25 cm samples of fabrics. Attach them to a retort stand with a bulldog clip or by making a loop in the fabric with a stapler. Use a second retort stand to hold a wire marker 20 cm from the bottom of the fabric sample. Figure 1.1.4 below shows how to set up the equipment.

![Diagram of setup for workshop testing](image)

**Figure 1.1.4** Setting up the equipment to test for flammability.

Ignite the fabric with a small flame on a Bunsen burner or use a paper fuse. Record what happens when the flame comes into contact with the fabric. Record the results in a table like the one below.

<table>
<thead>
<tr>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
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<tbody>
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<td>Fibre content</td>
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<tr>
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<td>Weight of fabric</td>
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<td>Time for burning to reach wire marker (in seconds)</td>
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<tr>
<td>Duration of any afterglow</td>
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<tr>
<td>Area of hole burned (mm²)</td>
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<tr>
<td>Type of residue, e.g. ash, hard bead</td>
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Crease resistance

Industrial testing

An industrial test for crease resistance involves creasing the fabric and measuring how quickly it recovers from the creasing. Twenty or more 1.5 × 4 cm samples of the fabric are left in standard room conditions of humidity and temperature. Once they have been conditioned, the samples
1.1 Materials and their applications

are folded in half, with a slip of paper or foil inside to prevent the two sides of fabric sticking together. The samples are put under a 1,019 kg weight for 5 minutes – this gives a force of 10 newtons. The sample is transferred to a device that measures the angle of recovery after 5 minutes. The larger the angle of recovery, the better the crease resistance.

Workshop testing

A simplified version of this test can be used in the workshop. Glue a piece of millimetre graph paper to a smooth block of wood, making sure that it is square to the edges. Push a large pin into the wood on one of the main vertical grid lines, making sure that the pin projects at a 90-degree angle. Mark a horizontal scale in millimetres about 2 cm below the pin.

Cut 1.5 × 4 cm samples of fabric and fold them in half, with a slip of paper or foil inside. Place the sample on a smooth surface and cover with a small piece of card, leaving the cut ends sticking out slightly. Place a 1 kg weight on top for 5 minutes – use a stop watch for all timings.

Use tweezers to pick up the fabric sample at the cut ends, and carefully place it over the pin so that the crease lies along the pin. The sample should be close to – but not touching – the graph paper. Leave the sample to recover for five minutes, then read off the distance between the two ends on the horizontal scale.

Shrink resistance

Shrinkage can be a significant problem with certain fabrics and products, for example many curtain fabrics shrink by as much as 10–15 per cent when washed.

As the fabric may fray when carrying out an industrial test for shrinkage, a template is used to mark precise reference points on the fabric in permanent ink. These points are later measured and compared with the original, to assess if a fabric has shrunk. A larger piece of fabric is used and the raw edges overlocked.

The fabric samples are put into a washing machine, with pieces of polyester fabric to complete the load so that the test replicates a normal wash. The wash temperature, type of agitation, rinse and spin cycles are recorded. The samples are dried on a line, in a tumble dryer, laid flat on a rack or ironed dry. The samples are then measured between the reference points to see if there are any changes.

The percentage change in size is calculated using the following formula:

$\text{Percentage change} = \frac{\text{original length or width} - \text{final length or width}}{\text{original length or width}}$

If the fabric has shrunk, for example the length or width has reduced in size, the result is given with a minus sign, for example -10 per cent. If the end result has a positive sign, it means that the fabric has stretched.

A workshop test can replicate the industrial test, washing samples at different temperatures and with different types of agitation.
**Colour fastness**

Colour fastness is the ability of a fabric to retain dye when washed or exposed to sunlight for any length of time. There are other types of fastness, but these are the two most important ones.

**Industrial testing**

An industrial test to assess fastness compares an untreated sample with one that has been washed or exposed to UV light. They are compared using a set of grey cards called a grey scale – the grey cards show differences in the intensity of colour. The fastness is rated from one (when the colour has disappeared altogether) up to five (where there is no change of colour).

To test for fastness to light, two-thirds of the sample is covered with an opaque cover. The sample is then exposed to daylight and artificial light for a prolonged length of time before the two areas of the sample are compared using the grey scale.

When testing for wash fastness, the sample is placed between two pieces of white cotton or nylon fabric, and the layers are sewn together around all four sides. The sample is washed for 30 minutes before being compared with the grey scale, to see if there has been a change in colour or if the white fabric is stained.

**Workshop testing**

Workshop tests can replicate the industrial test, but testing for light fastness may take weeks or even months before any differences are seen. Therefore it will not be possible to make sure that the light intensity remains the same for the duration of the test.

**Strength**

The strength of fabrics depends on the fibres used, and the way the yarn and fabric are made.

**Industrial testing**

Industrial tests for testing the breaking strength of woven fabrics involve stretching a 5 cm wide strip of the fabric until it breaks. The machine is able to exert a strong pressure on the fabric using very heavy weights. A pen recorder on the machine automatically marks the increasing force on graph paper until the fabric breaks. The sample is cut on the straight grain and at 7 cm wide, so that it can be fringed back to 5 cm along its length. This makes sure that all the threads in the sample run along its entire length. The test is repeated with samples cut in the warp and weft directions.

This method cannot be used for knitted fabrics because they have too much stretch. The test for these fabrics measures their bursting strength. A circle of the fabric is placed over a rubber diaphragm and clamped in place. Air or water is pumped in under pressure until the fabric bursts. The pressure needed to burst the fabric is called its bursting strength.
Workshop testing

A workshop test for strength will need to be relatively simple because it is not possible to achieve the large forces needed to break the fabrics. A basic test might involve cutting similar sized samples of the fabric and making a small nick at the warp, weft and bias edges. The samples can then be torn to see which tears the most easily.

Although it is not possible to get specific results from this test, it will show the differences between different types of fabric.

Pilling

One of the biggest causes of fabric wearing out is abrasion caused by friction when fabrics rub against each other or hard surfaces. Friction causes fibres to rub off the fabric surface until it wears into a hole. Very strong fibres such as polyamide do not break into holes; instead, small balls of the fibre tend to remain trapped on the surface of the fabric. This is called pilling.

Pilling tends to occur most in fabrics made from blended yarns, where a strong fibre is able to hold the weaker one on the surface of the fabric.

Industrial testing

In industry, the Martindale abrasion machine is used to test the abrasion resistance of fabrics. Circular samples of the fabric are clamped on to the machine’s four discs and a weight is put into each disc. Each of the test samples sits on a larger sample of plain woven worsted wool fabric, which acts as an abradant (an abrasive fabric). The test samples are rubbed in an even pattern against the abradant, and the machine counts the number of rubbing cycles made. The samples are examined under a magnifying glass at regular intervals, to see if the fabric is beginning to break down or if there are signs of wear leading to pilling.

Workshop testing

In the workshop, a simple wear machine can be made using a course round file inserted into a hand drill. A load can be made by putting about 1.5 kg of dry sand into a strong plastic bag with a string loop tied around the top so it can be hung from the end of the fabric sample. The drill is clipped to a board so that the handle can be turned to rotate the file. The diagram below shows how to assemble the wear machine.
Figure 1.1.10 A wear machine that can be used in the workshop.

The tester should be clamped onto the work bench before being used. The number of turns of the drill should be recorded for each fabric sample.

**ACTIVITY**

Collect three 20 × 10 cm samples of the following fabrics:
- cotton denim
- polyester/cotton fabric – medium weight, woven with a printed design
- polyester fleece fabric
- viscose fabric – medium weight, woven

Describe the aesthetic qualities of each fabric.

Work in pairs and test each fabric sample for abrasion resistance, fastness to washing and crease resistance. Make a chart to record your results and compare them with those obtained by other students in your group.

Write a fabric specification for each of the following products:
- a school skirt for a child
- a fashion top
- casual trousers for a teenager.

Use your results to explain which fabric you would choose for each product, and compare it with one fabric that would not be suitable.
1.1 Materials and their applications

**MATHS LINK**

Analyser data obtained from testing: working out percentage shrinkage of fabrics from test results

A curtain measuring 140 cm long by 100 cm wide is washed in a washing machine. It is line dried and then measured again. The curtain is measured and its new size is 101 cm long by 88 cm wide. Calculate:

a) the percentage change in length of the curtain

b) the percentage change in width of the curtain

**Answer**

The percentage change in size is calculated using the following formula:

\[
\% \text{ change in length or width} = \frac{\text{original length or width} - \text{final length or width}}{\text{original length or width}}
\]

If the fabric has shrunk (i.e. the length or width has reduced in size), the result is given with a minus sign (e.g. -10%). If the end result has a positive sign it means that the fabric has stretched.

\[a) \quad \% \text{ change in length} = \frac{101 - 140}{140} = -0.28\%
\]

The curtain has shrunk in length by 0.28%

\[b) \quad \% \text{ change in width} = \frac{88 - 100}{100} = -0.12\%
\]

The curtain has shrunk in width by 0.12%

**KEY POINTS**

- Many factors affect the functionality of textile products.
- Fibres are classified according to their source.
- Fibres are the starting point for textile materials.
- Yarns are made by twisting many fibres together.
- The properties of fibres will vary according to where they come from.
- The main sources of fibres are natural cellulose, natural protein and synthetic polymers.
- Manufacturers test potential fabrics to check that they have the required performance characteristics.
- Many fabric requirements for products will be recommended by the BSI.
- Fabric tests must be done under controlled conditions, to make sure that the results are reliable.
Check your knowledge and understanding

1. Place each of the fibres listed below in the correct box of the table. Use each fibre only once.

<table>
<thead>
<tr>
<th>Natural cellulose</th>
<th>Natural protein</th>
<th>Manufactured</th>
<th>Synthetic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acrylic</td>
<td>Lyocell</td>
<td>Tactel</td>
</tr>
<tr>
<td></td>
<td>Cotton</td>
<td>Polyamide</td>
<td>Viscose</td>
</tr>
<tr>
<td></td>
<td>Linen</td>
<td>Polyester</td>
<td>Wool</td>
</tr>
<tr>
<td></td>
<td>Lycra</td>
<td>Silk</td>
<td></td>
</tr>
</tbody>
</table>

Table 1.1.6 Types of fibres.

2. What is meant by the term ‘manufactured fibres’?

3. What are reactive materials?

4. How do micro-encapsulated fabrics help people to live more comfortable daily lives?

5. What is meant by the term ‘colour fastness’?

Further reading

The performance characteristics of fibres, yarns and fabrics will be covered in more detail in Chapter 1.2 of this book.

Taylor, M A. *Technology of Textile Properties*

Baugh, G. *The Fashion Designer’s Textile Directory*


Udale, J. *Textiles and Fashion*

General information about standards: www.bsigroup.com

Information about a wide range of commercial textile tests: www.satrap.com/materials

Information about testing outwear: www.gore-tex.co.uk/experience.quality/testing-outwear

The following YouTube videos show a range of fabric tests (there are many others):

- Textile fibres burning test: https://youtu.be/kb4tCcnA6jo
- Pros and cons of common fabrics: https://youtu.be/9QmTnH1N8ro
- Learning about fabrics: the who, what and how: https://youtu.be/B4tduOQ7w
- Determination of fabric propensity to surface fuzzing and pilling (Martindale method): https://youtu.be/9g_jTohPjw
- Fabric shrinkage test: https://youtu.be/altMu9cbT5M