Part 1 Technical principles

1.1 Materials and their applications

<table>
<thead>
<tr>
<th>Natural cellulose</th>
<th>Natural protein</th>
<th>Regenerated</th>
<th>Synthetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linen</td>
<td>Silk</td>
<td>Modal</td>
<td>Polartec</td>
</tr>
<tr>
<td>Ramie</td>
<td>Tencel</td>
<td>Acrylic</td>
<td>Tactel</td>
</tr>
</tbody>
</table>

2 Inorganic fibres are part of the man-made fibre classification. They are created from natural elements such as metals but need processing at high temperatures to transform them into fibres.

3 New generation lyocell fibres are stronger and more environmentally friendly. They are made using cellulose from sustainably grown trees and fibres such as lyocell use a closed-loop manufacturing system, which recovers and recycles the chemicals needed to modify the cellulose.

4 A smart material has physical properties that change in response to an input or a change in the environment, such as electricity, pressure, temperature or light. Examples of smart materials include thermochromic dyes (react to heat), photochromic dyes (react to sunlight), phosphorescent pigments (glow in the dark) and phase-changing materials (ability to absorb and release heat, e.g. Outlast).

5 Simple workshop tests use basic tools and equipment that can be found in any workshop. Material samples are measured with workshop equipment to make sure they are the same size. Industrial tests are usually carried out in a laboratory with specific testing machinery, using standardised test pieces of materials.

6 When setting up tests, the process and parameters must be consistently fair. It must be clear:
   - what is being tested
   - how the test will be set up and carried out
   - how the data obtained from the test will be recorded
   - how the results will be interpreted and compared with a control.

7 Percentage shrinkage = distance before − distance after ÷ original length × 100. For example:
   \[10 - \frac{9.5}{10} \times 100 = 5\%\]

8 A workshop test for pilling can be set up as follows.
   - Fabric samples are stapled onto a wooden block.
   - Glass paper is stapled onto a smaller wooden block.
   - The glass paper block is rubbed over the surface of the fabric to simulate wear.
   - The number of passes required for pills to start forming on the surface of the fabric is recorded.

9 Non-woven fabrics can be cut in any direction, they have no straight grain.

1.2 Performance characteristics of materials

1 Technical or modern materials are not ‘smart materials’ because they do not react to external change. Modern materials are new or existing materials that have been developed through the invention of new or improved manufacturing processes. Examples of modern materials are microfibres and nano-fibres. Examples of smart materials are photochromic pigment that...
responds to changes in UV light and phase-changing materials such as Outlast that respond to changes in body heat to regulate a person’s microclimate.

2 Kevlar has a very high tensile strength – it is five times stronger and one-fifth lighter than steel. The very fine Kevlar fibres can be tightly woven to produce a fabric that is difficult for a bladed weapon to penetrate. The fabric is also lightweight and flexible, giving ease of movement to users of stab-resistant vests.

3 Examples of first generation fibres are acetate and viscose. These earlier fibres are not as strong or as environmentally friendly as new generation modal and lyocell fibres, which are totally biodegradable, use cellulose from sustainable sources and are made in manufacturing processes that are more sustainable.

4 Blends are achieved by spinning two or more different fibres together to make a yarn. In a yarn, a mixture usually means it contains several elements, for example core-spun yarns made from elastomers like Lycra and many other fibre types. A fabric mixture usually means the warp and weft yarns are made from different fibres, for example the warp could be 100% cotton and the weft 100% polyester.

Reasons for blending fibres include:
- to improve the performance properties of the fabric
- to improve the aesthetic appeal of the fabric
- to reduce costs by including a cheaper fibre.

5 Bonded, non-woven fabrics are made using synthetic fibres. Adhesives or heat are used to hold or fuse the synthetic fibre webs together. Felted, non-woven fabrics can be made from webs of natural protein fibres such as wool fibres using the felting process. Needle felt is manufactured using barbed needles to matt together webs of man-made fibres such as acrylic, acetate and nylon.

1.3 Methods of joining and use of components

1 Edge finishing techniques include edge stitching, overlocking, pinking and binding.

2 Napped fabrics look different colour shades from different angles. A with nap layout is needed as all pattern pieces must be laid on the fabric so the nap runs in the same direction otherwise a garment will look like it was made from two different coloured fabrics. A walking foot should be used to stop seams from moving when napped fabric is machine stitched. A fine, sharp needle should be used to prevent snagging, and the fabric should be ironed on the wrong side.

3 Components should be chosen with care, as they need to be:
- suitable for the style and function of the textile product
- compatible with the fibre content, structure, weight and aftercare of the fabric used
- safe and efficient when meeting the needs of the end user
- within budget and readily obtainable
- suitable for use with existing manufacturing equipment and machinery

4 Velcro is easy for children to use, giving them independence when dressing. It is safe to use, as there are no small parts as the tapes can be permanently sewn onto clothing. It is durable and can withstand repeated laundering, and there is only minimal decline in its effectiveness after many fastenings and unfastenings.

5 Possible problems might include:
- selecting the appropriate weight and size of components in relation to the type of base fabric, its weight, opacity and complexity of construction
- matching the colour of component to other components and fabrics to achieve colour continuity in the product
- choosing an interfacing in areas that need stabilising
- using pre-manufactured components, which involves sourcing suppliers and checking delivery lead times and JIT considerations
- keeping the cost of the components within budget
- reviewing the cost of procedures, special equipment and workforce training that may be needed for specialist processes
- checking whether the components are safe to attach and safe for the end user.

1.4 The use of finishes

1 Fabric finishes are used so that:
- fabrics are fit for their intended use to meet consumer expectations
- the disadvantages found in most fibres can be cancelled out by applying one or more finishes
- the aesthetic qualities of fabrics can be further enhanced
- textile products can be marketed as having ‘added value’ and sold at increased cost.

2 Explanations include:
- Finishes make a product more expensive and not all finishes are permanent.
- They are an additional process which will increase the lead-time in getting a product to market.
- Some fabrics need several finishes to make them suitable for their intended use and some finishes can degrade the fabric.
- The chemicals used in finishes and their application can have a negative effect on the environment and the health and well-being of factory workers.

3 Examples include:
- Mechanical brushing breaks the surface of a fabric to create a napped (hairy) appearance. This weakens the structure of the fabric as well as making it more flammable due to the presence of trapped air between the raised fibres.
- Chemical flame-retardant finishes such as Proban make fabric stiff and reduce its strength.

4 Calendaring is a mechanical finish that uses smooth, rotating heated rollers to produce a smooth, lustrous appearance on the surface of a fabric. Embossing is a calendaring process that uses heated rollers engraved with a pattern to create raised or sunken patterns and textures on the surface of a fabric.

5 A Gore-Tex membrane is a very thin, non-woven polytetrafluoroethylene (PTFE) film with billions of microscopic holes (pores). Sympatex polyester membranes are poreless and hydrophilic (water-attracting). This membrane attracts, draws and holds moisture away from the body to transport it to the outside so it can evaporate. Both membrane structures are breathable and prevent rain and wind from getting through but allow body vapour to escape.

1.5 Enhancement of materials

1 Vat dyeing is the process of dyeing textiles in a large container or vat. It can be done whenever a solid even shade of the same colour over the entire textile is wanted. Discharge dyeing removes colour from a dyed fabric using a colour-destroying deactivator that bleaches out white or light patterns on the darker coloured background.

2 Dye can be applied during:
- dope or spin dyeing
- stock dyeing
- yarn dyeing
- piece or fabric dyeing
- garment dyeing.

3 Dye fastness is the ability of a fibre or fabric to retain dye. Colourfastness is the ability of a fabric to retain dye fastness during the manufacturing processes and when it is washed or exposed to sunlight.

4 The choice of printing technique depends on:
- the amount of fabric to be printed
- the print effect required
- budget constraints.

5 The differences between rotary screen printing and flatbed screen printing are illustrated in the diagrams below and on the next page.
1.6 Modern industrial and commercial practice

1 Manufacturers will take into account the number of items to be made, the product type and the speed of delivery when deciding which production system to use.

2 Levels of quality control:
   - In one-off production there are high levels of quality control throughout the whole process and at every stage of construction.
   - In batch production, planned quality control checks are implemented during construction but only a specified number of products from each batch will be checked.
   - In mass production, planned manual or automated quality control checks are implemented at key stages of construction. This keeps costs down by ensuring quality-related problems are identified immediately and not at a later test stage when large quantities of the product have been manufactured.

3 Vertical in-house production.

4 Buying in standardised components has the following advantages:
   - There is a wide range to choose from.
   - Components can bought in bulk to reduce unit cost.
   - JIT stock-control systems can be used to buy components as and when needed.
   - Efficient use is made of manufacturing systems as machines are programmed to deal with the pre-set sizes.

5 Contract manufacturing companies make products for different brands. They are technologically organised, have capacity, and can respond with speed and quality. The main advantages are they are usually located in developing countries and can set up high-volume production runs to make products at a low unit cost. Retailers therefore do not have to invest in their own manufacturing facilities or workforce and can use contractors to produce pilot runs of products for test-marketing purposes. Contractors give retailers an operational advantage as short-term increases in demand can be met by hiring additional production capacity. The main disadvantages are that some consumers disapprove of retailers profiting from perceived or real exploitative labour in overseas sweatshops. There are also environmental concerns over the transportation of goods from faraway places. Retailers may increase the risk of losing sensitive commercial or technical information by working with contractors who may also make products for their competitors.

1.7 Digital design and manufacture

1 The advantages include:
   - Saves time and money, and improves accuracy.
   - Designs can be edited rather than redrawn by hand from scratch.
Experimental changes can be made quickly on screen.
Pattern design systems (PDS) can draft and grade pattern pieces, produce lay plans and send the information to a computer-integrated automated cutting system.
Virtual modelling software replaces the need to hand make physical samples, making it better for the environment.
Designs and development are more accurate. Pattern pieces can be retrieved from a database and printed out in pristine condition.

A pattern design system (PDS) is a computer program that makes pattern templates automatically from a 3D model. It produces efficient and accurate pattern lay plans and sends the information to a computer-integrated automated cutting system. PDS can also present images and virtual prototypes to clients.

CAM can speed up garment manufacture during fabric construction and the fabric coloration or printing stages. For example, automated weaving looms are programmed to lift the correct warp yarns to allow the insertion of weft yarns to create different weaves. During screen printing, CAM usually controls the movement of the fabric, the supply of dye and the movement of the screens. CAM can be used to speed up the cutting process. Computer-controlled machinery can automatically spread many layers of fabrics to be cut out at the same time. The cut-out pieces can be automatically bundled, labelled with a barcode then sent for sewing.
Automated processes such as buttonholing, making and sewing of pockets, seam stitching, application of decorative processes, and the pressing of parts or the finished garment can also speed up garment manufacture.

Virtual prototypes and virtual modelling are used in the development of designs and in the customisation of standard designs to meet an individual customer’s needs.
Virtual prototypes are used when presenting designs to clients. The prototype is modelled on a computer in 3D but is not actually made. CAD is used to simulate fabric texture, drape and garment fit on realistic virtual body forms.
Virtual modelling facilitates mass customisation of standard designs and can also be used in a different way to simulate a proposed production system to check whether production is possible and indicate how long it will take to manufacture a product.

Electronic point of sale (EPOS) is a computer-based scanned barcode system used to read barcode information as well as capture data when products are purchased. EPOS systems monitor stock levels and automatically reorder products if stock levels become low. They support a sustainable manufacturing system, as there is no unnecessary over-production of products. Money is saved, as shops do not need storage facilities as reordered products go straight onto the shop floor. EPOS data can be analysed and used by marketing departments to inform the development of new products and marketing strategies.

A barcode is an optical, machine-readable label that uses black lines to represent data. Barcodes:
- track the progress of products throughout the manufacturing and distribution stages
- identify the price, item reference number, size etc. of the product
- may include a hyperlink to a retailer’s webpage.

Barcodes on loyalty cards identify individual consumers, enabling retailers to customise their marketing based on a shopper’s purchasing patterns.

1.8 The requirements of textile and fashion design and development

Product developers deliver new textile and fashion designs to consumers. They critically analyse designs to address consumer needs and improve existing designs. They identify and update best-selling designs to give them a fresh appeal and meet forecasted trends. They also analyse competitors’ ranges to consider incorporating other successful features into their designs.

Any four from:
- intended use
- target market
- aesthetics
- ergonomics
- construction techniques and production processes used
- fabrics used
- components used
- scale of production
- environmental issues
- care instructions
- social or moral issues related to manufacturing the product.

The design specification.

Aesthetics is concerned with how a product looks. Anthropometrics is the study of the sizes of people in relation to products. Ergonomics is the study of the ways in which a product, the user and the environment it is used in, affect each other.
Clothing can be made more inclusive if an empathic design approach is used to create attractive, fashionable garments that are accessible and usable by as wide a range of people as possible. Adaptive construction techniques and components can be used in clothing to make it easier for elderly or disabled people to dress independently. For example, magnetic closures and Velcro seams can be used in garments to ease fit. Mainstream fashions can be adapted to include panels that discreetly accommodate or provide access for medical equipment and procedures. Androgynous and gender-neutral lines such as Zara’s ‘Ungendered’ range can use style and colour to challenge gender stereotypes.

1.9 Health and safety

1 The Health and Safety at Work Act states that employers (so far as is reasonably practicable) must protect the health, safety and welfare of all employees and visitors. It is also a legal requirement for employers to carry out risk assessments and put in place sensible measures to control risk, making sure any identified risk stays controlled.

2 The Health and Safety Executive (HSE) is responsible for enforcing the Health and Safety at Work Act. It is an independent watchdog and its role is to:
- support compliance with health and safety duties through advice and guidance to employers
- carry out inspections and investigations to make sure health and safety regulations are being followed
- take enforcement action to prevent harm and hold those who break the law to account.

3 The four stages in a risk assessment cycle are:
- Identify hazards.
- Assess the risk.
- Plan and implement control measures.
- Monitor and review.

4 Any three from:
- No loose threads which could get wrapped around fingers or toes causing a tourniquet effect restricting blood circulation.
- No zips in trousers for boys under the age of five.
- No components such as buttons that look or smell like food.
- No hoods on sleepwear for babies less than 12 months, to prevent overheating.
- Consideration must be given to the restriction in vision and hearing a hood may cause in garments for older children.
- Children’s nightwear must comply with the Nightwear (Safety) Regulations 1985.

5 The three requirements are:
- Goods are to be of satisfactory quality; commensurate to the price paid.
- Goods are to be fit for purpose; they must be fit for the purpose they were supplied for.
- Goods are to be as described, matching any description given or models or samples shown.

1.10 Protecting design and intellectual property (A-level only)

1 Intellectual property (IP) refers to creations of the mind – ideas, artistic work or physical creations that are entitled to protection for the originator in the form of copyright, design rights, patent, registered design or trademark.

2 Copyright is an unregistered right that legally protects the use of a designer’s artwork, illustration or photograph once it has been physically expressed. Design right is a registered right that protects against the copying of a textile design for 15 years after its creation and for 10 years after it is first sold. Design rights are granted through a formal registration process. Unlike copyright, which is free, design right registration requires the creator to pay a fee. Design ownership is hard to prove if designs are unregistered.

3 Copyright, patents, trademarks.

4 Examples may include:
- Patents protect novel inventions of working designs such as the hook and loop tape used in Velcro.
- Trademarks protect company logos, slogans and names, such as Zara.
- Copyright protects the use of a designer’s artwork, illustrations or photographs.
- Registered designs protect the appearance of products such as Gucci handbags.

5 Symbol for copyright = ©
Symbol for registered trademark = ®
Symbol for unregistered trademark = ™
1.11 Design for manufacture, maintenance, disposal and repair

1 True. A stable fabric is one that has ‘dimensional stability’, or the potential to retain its original shape or colour after repeated use and laundering. Dimensional stability is a fabric’s resistance to, for example, shrinkage, bubbling or sagging. Hot-setting of thermoplastic fibres, for example pressed pleats, can improve a fabric’s dimensional stability.

2 Potential hazards include:
   - Alkaline detergents, which can damage fabrics made from protein fibres such as silk and wool.
   - Enzyme-based detergents, which can affect colour brightness and damage protein fibres.
   - Bleaching agents contained in most detergents, which can cause physical damage to cotton. Not recommended for use on natural silk, wool or nylon fibres.
   - Biological detergents, which can cause skin irritation.

3 There would be a reduction in the use of petroleum to create new fibres, the need for chemicals used in the manufacture of new textiles and pollution caused by manufacturing processes.

4 Any three from:
   - bamboo
   - hemp
   - organic cotton
   - green silk
   - ramie.

5 Land, water, energy.

1.12 Feasibility studies (A-level only)

1 A pattern grader is someone who scans or traces the design pattern and marks additional measurements at key points. These are used to adjust the pattern’s proportions, to give a range of different sizes from the same pattern.

2 Prototypes can be tested, and the test results can lead to changes and refinements in the design, and new prototypes can be tested. This process is intended to eventually improve quality and performance to reach an optimal design.

3 Feasibility studies establish the viability of an idea, for example whether a textile product will be technically or financially feasible to manufacture.

1.13 Enterprise and marketing in the development of products

1 A start-up enterprise is a newly begun business that aims to develop a feasible product to meet a market demand. Start-ups are often started by fashion graduates.

2 Retailers can use modern technology such as EPOS systems, customer service recording systems and online tracking of customers on their websites to collect, store and analyse large amounts of data in a consumer database. The data can then be used to create individual customer profiles. Companies can also purchase customer data from, or sell it to, third-party sources.

3 The information on fabric care labels includes washing and care instructions, fibre composition and country of origin. Swing tickets include price, size and EPOS barcodes with stock information. Packaging labels include information to promote the brand and build brand loyalty.

4 Advantages of designers working collaboratively include:
   - combines the skills and experiences of different designers
   - reduces business costs as workspace, facilities and specialist equipment can be shared
   - fosters brand identity and develops customer base
   - supports promising designers who benefit from up-to-date ideas
   - generates and encourages originality.

5 The ‘Free Swing Tennis Bra’ was the first commercially available sports bra, introduced in 1975 by Glamorise Foundations, Inc. In 1977, Lisa Lindahl and Polly Smith invented a general exercise bra called the ‘Jogbra’. In 1990, Playtex purchased ‘Jogbra’ from Lindahl. The phenomenon of the sports bra has grown, largely due to the growing participation of women in sport, and they are now manufactured by many different companies.

6 The industrial trend is mostly black clothing with military-style influences. Other influences include anti-establishment, post-apocalyptic or sci-fi with hints of punk goth, steampunk and fetish.

1.14 Design communication

1 Information about a design proposal can be communicated visually, using written methods, or numerically, or by using combinations of all three. For example, the manufacturing specifications might include information in the
form of technical drawings (visual), annotations (written) and tables (numerical). The design aesthetics might be communicated using mood boards (visual), photographs (visual) and market research graphs (numerical).

2 Charts are a visual representation of factual/statistical data collected through research and testing. They are used to make large quantities of data easier to read.

3 The Pantone colour-matching system is recognised globally. It communicates the exact colour by providing a clear reference point, which enables a universal understanding. It facilitates colour matching, for example of components.

4 Working drawings should include details such as:
   - the front and back view
   - the design features
   - accurate measurements (length, width and depth of each part, and tolerances)
   - the position of pockets, buttons, zips
   - close-ups to show fine detail
   - details of stitching and trims.

Including such details provides the standard for checking the accuracy of the finished product. The fact that the data are largely visual and numerical is an advantage in a working drawing as it is readily understood and facilitates global manufacture.

2.2 Design theory

1 Art Nouveau was known as the ‘Stile Liberty’ in Italy due to the popularity of the printed fabric designs from the Liberty department store in London. These designs featured stylised, organic flower shapes.

2 Answers might include a discussion of: non-conformist expressionism, unemployment, anti-establishment, politics, inverted snobbery, economic inequality, bourgeois hypocrisy and the neglect of working people. Punk visual art often includes political messages. Many punks wear second-hand clothing, partly as an anti-consumerist statement. On religious issues, punk is mostly atheist or agnostic.

3 Art Nouveau fashions used fabrics that draped such as silk crêpe (georgette), charmeuse (a lightweight silk satin), silk chiffon, and wool batiste. These were popular for tea dresses and evening gowns. Cotton batiste was often used for lingerie. Dresses made of lace, or embroidered cotton or silk combined with lace, were fashionable for warm weather. Firmer fabrics such as wool and cotton duck were used for tailored wear.

Pop art fabrics and materials included shiny, wet-look PVC, easy-care acrylics and polyesters and paper. Designs used bold bright colours, and trademark imagery borrowed from adverts, packaging, billboards, cartoons, comics, film and music.

4 Vivienne Westwood’s mini-crini was a bell-shaped skirt inspired by Victorian crinoline skirts, which she updated and shortened, following the silhouette of a child’s party dress.

5 The Pirate collection was in step with the New Romantic movement in the 1980s and included clothes that conjured an age of highwaymen, dandies and buccaneers. It featured jackets and sashes printed in boldly geometric African-style patterns, loose-bottomed, wide-striped buccaneer trousers, and oversized shirts worn with draped sashes.

6 Poiret’s passion for all things exotic and his use of bright colours embodied the first part of the Art Deco period. He was influenced by the orientalism of Diaghilev’s Ballet Russes, which arrived in Paris in 1909. He collected Fauve paintings, which inspired his used of purples, pinks, blues, greens and golds. His interest in chinoiserie and European peasant and North African designs led to loose-fitting styles with exotic ornamentation, for example kimono coats,
tunic dresses, harem pantaloons and turbans. Using velvets, silks, furs, lace and embroidery, Poiret’s dresses were decadent and luxurious, reflecting the glamour of the Art Deco period.

2.3 How technology and cultural changes can impact the work of designers

1 Although there had been significant changes in women’s clothing during the period 1900–1910, little change was seen in men’s clothing since the standard outfit of trousers, shirt and jacket was established in the Victorian era. Only minor variations were seen, such as the cut of trousers and jackets, the height of shirt collars and changes in hat shapes.

2 The new silhouette seen on younger women during the period 1910–20 was thought shocking as it was more revealing. More energetic lifestyles had led to easier-fitting clothes, with the breasts less obvious, simple round or V necks, and waists freer and looser. Legs became the focal point, and dance crazes of the time required looser-fitting dresses for ease of movement with slits, transparent bodices, and dresses revealing calves and knees. This had an effect on day wear, raising hemlines.

3 ‘Make do and mend’ was the title of a pamphlet issued by the British Ministry of Information during the Second World War. It provided housewives with helpful suggestions on how to be thrifty yet stylish in times of rationing. Suggestions included patching, unpicking knitwear and re-inventing new clothes, turning men’s clothes into women’s, darning and trying to avoid moth damage.

4 The Teddy Boy look was adopted by streetwise young men in Britain as their own take on the Edwardian gentleman look popular with wealthy young men after the Second World War. This subculture was strongly associated with the rock and roll era of the 1950s and became the first recognised ‘teenage’ group in Britain, helping to create a youth market.

Teddy Boy clothing included drape jackets trimmed with velvet collars and pocket flaps, high-necked loose-collared white shirts, narrow ‘Slim Jim’ ties, brocade waistcoats, and high-waist ‘drainpipe’ trousers, often exposing the socks. Greased-up hair with a front quiff and chunky brogues or suede, crepe-soled shoes completed the look.

5 The Peacock Revolution was a radical change in men’s fashions in the 1960s. Led by the Mods (Modernists), tailored suits were replaced by more individual and extravagant styles of dress. This ‘modern dandy’ look included frills, cravats, embroidery, printed shirts, vivid colours, wide ties, velvet lapels and clothing influenced by ethnic dress.

It was a revolution because it broadened the meaning of masculinity – gender-specific clothes seemed old fashioned, it helped to normalise ‘gay’ fashion, it let men rebel against gender expectations, and it introduced androgyny to future decades.

6 Wearable electronics have many useful sports, medical and military applications. The sensors in the fabric can be used to monitor heart rate, body temperature or behaviours, track locations, or protect against extreme conditions such as radiation or space travel. However, wearable electronics raise a broad range of potential legal and ethical issues concerning intellectual property (IP) protection and privacy and data protection.

Wearables with recording or location-tracking capabilities raise concerns about spying on people, taking secret photographs or videos. Wearables can potentially hold considerable amounts of data and data security is an important issue. If hacked, some wearables could reveal extensive personal data about an individual, such as their health, location and behaviours.

7 Marks & Spencer worked directly with manufacturers, encouraging them to invest in modern technology and more efficient methods of manufacture. In the 1930s, the company began to write manufacturing specifications and set up a design department to keep up- to-date with the latest trends.

8 Multifunctional clothing can be defined as clothing or clothing systems that allow different uses in different scenarios, or can be adapted to a wide range of social situations. For example, a waterproof coat that can convert to a sleeping bag, or clothing embedded with solar panels to charge mobile devices.

2.4 Design processes

1 Any three from: clients, suppliers, manufacturers, fashion and textile experts, consumers from the target market.

2 Moulage is the process of draping or moulding fabric around a mannequin to work out a garment design and the pattern pieces. The draping is carried out using muslin, calico or sometimes the final fabric.
3 To check that the jacket fits correctly at the bust, shoulder and elbow, you would check the neckline, the shape and position of the collar, the length, drape and armhole position of the sleeve, and the position of the darts.

Calico, some other easy-to-manipulate fabric or paper (newsprint) can be used to create a vertical, half-prototype of the jacket to check the details listed above.

2.5 Critical analysis and evaluation

1 Water repellence is a term used to describe the characteristic of both water-resistant and waterproof products once a durable water repellent (DWR) [e.g. Scotchgard or Teflon] is applied. A DWR is applied onto the exterior shell or infused with the fibres of a garment. DWR treated garments will need to be re-treated with the finish once in a while to keep the water-repellent compounds fresh and restored.

2 Testing and evaluation takes place throughout all the stages of development from initial design to the final product. The design of a product is analysed and evaluated as part of the iterative approach to design work. The commercial version is tested and evaluated to ensure it is fit for purpose and performs to required specifications.

3 The target market can be invited to sign up to take part in testing and evaluating a product through social media, for example Facebook and Twitter. Companies can promote their products online by advertising the product reviews from satisfied customers.

2.6 Selecting appropriate tools, equipment and processes

1 Collars, shirt sleeves, embroidered panels.

2 The automated processes are sewing cuffs, sewing on plackets, cloth cutting, pattern cutting, hem creasing, shirt pressing and digitising customers’ patterns. Automated processes are used for precision, speed and economic production.

2.7 Accuracy in design and manufacture

1 The six criteria are:
   - Work out the most efficient pattern layout, dovetailing if possible, to save fabric.
   - If using fabric with stripes, checks or repeating patterns, check that the pattern pieces match up.
   - Make sure seam and hem allowances have been included on the pattern pieces or allowed for on the pattern layout.
   - Cut out the pattern pieces on a flat and stable surface, for example a large table.
   - Place all the pattern pieces on the straight grain line.
   - After cutting, transfer the pattern markings using tailor’s chalk or tailor’s tacks.

2 The three standard widths are 115 cm, 145 cm and 150 cm.

3 Accurate cutting out is essential if a product is to hold its shape properly after construction. In the case of patchwork, the pieces need to be cut accurately so that they fit together to make the correct pattern.

4 Vacuum packing stabilises the multiple layers of fabric and ensures accurate cutting.

2.8 Responsible design

1 In a closed-loop production system, the solvents used in fibre production are recycled back into the start of the process. The aim is to minimise the impact of using toxic chemicals in the textile industry.

2 Waste resulting from packaging could be reduced by:
   - using minimal packaging in the first instance
   - making packaging biodegradable or recyclable
   - producing packaging as close as possible to where it will be required to reduce the energy costs of transport
   - using JIT systems so that packaging is produced only as required.

3 Modern methods in fibre development can eliminate the dyeing process altogether. For example, nano-technology has been used to make the structurally coloured fibres in Morphotex fabric. The fibres mimic the microscopic structure of the Morpho butterfly’s wings and have a shimmery blue colour but require no dyes or pigments.

4 ‘Cradle-to-cradle’ clothing is a design approach to clothing whereby all the materials and components used can be continually reused through recycling and reclaiming fibres. Garments are designed so that they are easy to repair and care for to extend their useful life and are made of fibres that can be reclaimed in a closed loop of fibre use – the textiles can be shredded into loose fibres and then spun into new yarns.
5 Dope dyeing is a shorter process than traditional dyeing so fewer chemicals and less energy are needed and less wastewater is produced. This allows direct savings on production costs and ensures a significant reduction in the environmental impact of the final products.

2.9 Design for manufacture and project management

1 Requires a list of the separate processes, the sequence of operations, length of each separate activity to calculate the total amount of time required to complete and usually displayed in a flow chart. Determines the shortest time possible

2 Quality assurance is focused on processes and concentrates on the prevention of faults.

Procedures and policies are planned to ensure good-quality products are manufactured. Quality control is focused on products and concentrates on the identification of faults. Specific quality control checks are undertaken during manufacture.

2.10 National and international standards in product design

1 The technical file would have to explain how production standards are maintained so that the product properly meets the requirements of European health, safety and environmental protection laws.

2 The bleaching, dyeing and printing stages of textile production have the biggest environmental impact in terms of water use and pollution.
Part 1 Technical principles

1 Examples of appropriate chemical finishes:
   - Teflon stain-resistant finish: helps to keep the fabric clean, makes it easier to launder and iron.
   - Anti-pill finish: prevents the appearance of the fabric from spoiling.
   - Hygienic anti-bacterial finish: prevents the build-up of bacteria on the fabric.
   - Proban or Pyrovatex finish: makes the fabric flame retardant.

Examples of appropriate mechanical finishes:
   - Heat setting to give permanent pleats or creases to maintain the shape of pleats in garments and creases in trousers.
   - Brushing/raising to make the fabric warmer and softer.

2 One yarn travels the width of the fabric. Each row of loops is drawn through the previous row. Horizontal rows are called courses and vertical rows are called wales.

![Weft knitted structure diagram]

3 Staple yarn is made from short staple fibres twisted together to form a yarn. The yarn is hairy; it is a good insulator and can give fabrics a soft, fuller handle. Examples of staple yarns are cotton, wool and any regenerated or synthetic filament fibres that have been cut into staple form before being spun into a yarn.

4 Examples of fancy yarns are bouclé, chenille, slub and metallic yarns.

5 The main methods are:
   - **False twist**: smooth thermoplastic filament yarn is tightly twisted, heat-set and then untwisted. The yarn will then have lots of wrinkles and snarls.
   - **Bulked continuous filament**: a jet of hot fluid pushes thermoplastic yarns against a cold surface. Once cool, the filaments retain a saw-tooth edge shape.

   - **Air-jet texturing**: a jet of compressed air creates loops and tangles in the yarn. This process does not depend on thermoplastic properties so it can be used on any filament yarn.

6 Elastane fibres cannot be cut into staple form and need to be stretched as they are spun into a yarn. Core spinning is needed to maintain the stretch qualities in the elastane. The sheath of yarn covering the core gives the core-spun yarn stability and provides other properties such as strength, durability and comfort.

7

<table>
<thead>
<tr>
<th>Natural cellulose</th>
<th>Natural protein</th>
<th>Regenerated</th>
<th>Synthetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bamboo</td>
<td>Mohair</td>
<td>Tencel</td>
<td>Nylon</td>
</tr>
<tr>
<td>Cotton</td>
<td>Acetate</td>
<td>Elastane</td>
<td></td>
</tr>
</tbody>
</table>

8 An industrial testing method should be described. The set-up of the test and method used, together with some indication of how the results are to be interpreted, should be included. The following is one example of an appropriate test (pilling).
   - Fabric samples are clamped or held in place on a weighted disc in a Martindale machine.
   - The test samples are rubbed in a controlled pattern against an abrasive fabric.
   - The machine controls and records the number of rubbing cycles.
   - The test samples are examined at regular intervals for the presence of wear leading to pilling.
   - On completion they are compared, in a light box, with the control sample.
   - An average reading will be given in the overall result.

9 Examples include tie-dyeing, batik, tritik and resist printing.

10 Answers should refer to specific CAM processes involved in the manufacture and distribution of fashion garments and could include:
   - **Computer numerical control (CNC)** programs used to control machines used in fabric manufacture, fabric dyeing and printing printing and in producing embroidered logos.
   - Computer controlled spreading and cutting of fabric.
   - Highly specialised machines used to carry out identical operations that need to be repeated many times. For example, automatic buttonholers, dart sewers, automatic patch
pocket setters, pocket flap sewing, hemmers, edge binding and seam sewers.
- Fusible interfacing can be applied using a **conveyor fusing press** with the pressure, temperature and time controlled by computers to give a quality finish.
- Computer-controlled **steam dollies** press finished garments.

## Part 2 Designing and making principles

### 1
**a** A manufacturing specification gives key information about how a product is to be made and packaged. It includes precise information about the product: size; style (in a dimensioned working drawing); quality control and tolerance levels; fabrics and components to be used; processes and techniques to be used; quantities required; labelling and packaging to be used; and delivery dates. It forms part of the contract with the manufacturer and is used to check that the correct fabrics and components have been used and the standards of finish are acceptable.

**b** A gold seal standard is used with the product and manufacturing specifications to form a contract between the client and the manufacturer. It is a sample product, complete with packaging, taken from the production line once the client has agreed that the manufacturer is consistently producing products that meet all of the criteria in the product and manufacturing specifications. The gold seal standard is used to check subsequent garments for accuracy.

### 2
The five main care symbols are:

<table>
<thead>
<tr>
<th>1 Washing instructions</th>
<th>![40°C symbol]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Bleaching instructions</td>
<td>![Triangle symbol]</td>
</tr>
<tr>
<td>3 Drying instructions</td>
<td>![Square symbol]</td>
</tr>
</tbody>
</table>

### 3
A circular economy is an economic approach that aims to keep materials and products in use for as long as possible. It dramatically reduces dependency on sourcing new materials as the maximum use is extracted from existing products. A circular economy is important as it creates opportunities to:
- work against the unsustainable fast fashion ‘take, make, dispose’ culture
- reduce the use of finite resources such as oil which is used to make synthetic fibres and chemicals for manufacture
- reduce waste by repairing and upcycling a textile product until it has no further use
- avoid pollution and landfill by reclaiming fabric for alternative uses once a garment can be upcycled no further
- deliver a more competitive UK economy
- help reduce the environmental impact of our product manufacture and consumption.

### 4
**a** Darts.

**b** Any three from curved seams (princess seams), pleats, tucks, smocking, gathering, shirring.

### 5
A feasibility study allows a manufacturer to assess the potential issues that may arise with the development of a project. It can be carried out by using:
- spreadsheets to estimate production costs
- computer modelling to anticipate the time it takes for processes to be completed, for example CAM embroidery.

### 6
**a** Designers use feedback from market research to makes themselves aware of consumers’ preferred styles, colours and fabrics, how much they are willing to pay for products, seasonal trends and the popularity of design prototypes.

**b** Designers use prototypes to:
- get an idea of what the final product will look like and how it will perform
- test products by showing them to focus groups
7  a Primary research involves the designer self-gathering and collating new data or information. Secondary research involves the use of data already collected through the primary research of other people, for example information in books, reports or on the internet.

b Examples of primary research in the design of snowboarding gloves might include:
- the disassembly of commercially available snowboarding gloves to identify useful features
- gathering anthropometric data for the demographic who snowboard.
- carrying out tests on fabrics for properties such as durability, chill and water resistance
- using a focus group to test prototypes

8 Any three from:
- fibre content
- care instructions
- country of origin
- size/intended age group
- safety warnings, for example flammability
- brand name and special product features.

9  **Aesthetics** is concerned with how a product looks, its shape, form, symmetry, size, proportion, colour and texture.

**Ergonomics** is the study of the ways in which a product, the user and the environment it is designed for interact with one another. It applies anthropometric data to resolve design issues relating to the ergonomic needs of the user.

**Anthropometrics** relates to scientific measurements of the human body as applied to the design of products. Anthropometrics help designers take into consideration the range of sizes and abilities, such as grip capabilities, that exist within humans.


Product sales are measured over the lifetime of a product. They indicate what stage the product is in during its life cycle:
- In stage B, sales of the fashion product show a period of rapid market acceptance.
- In stage C, sales of the fashion product peak and start to slow down.
- In stage D, sales of the fashion product diminish; it is withdrawn from retail outlets or sold off at reduced prices in sales.