Section 1: Core knowledge and understanding

1. Automation means many of the jobs previously done by workers are now being done by computer-controlled machinery. Automated processes increase productivity as they operate continuously over a 24-hour period; however, this is at the expense of jobs for workers. Many automated more menial jobs have replaced manual labour but this also means that the quality produced by machinery is often much higher.

2. A consumer is entitled to compensation when a service does not meet expectations – for example, if the catering agreed for a special occasion party falls short of what was originally agreed and cannot be rectified immediately.

3. Carbon neutral means there is no net release of carbon dioxide into the atmosphere – for example, CO₂ is released when biomass wood is burned but absorbed through planting and growing of new trees.

4. **Advantage:** In the long term, wind power is a freely available source of energy which could lead to significantly lower energy bills for consumers.  
**Disadvantage:** It is unreliable as wind is not constant. If the wind drops and the turbines cannot operate, energy cannot be harvested.

5. The circular economy uses as few new resources as possible and relies on the continual reusing and recycling of materials from existing products that have reached the end of their initial first use. This means there is less of a drain on new materials, which preserves the world’s natural resources. It also means less going into landfill which contributes to environmental damage.

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WJEC GCSE Design and Technology

1. Antiseptics or antibiotics encapsulated into dressings go directly to the points of need in fighting infection. Dressings don’t need to be changed so often, meaning wounds heal quicker, thus benefiting the patient.

2. When polymorph granules are heated in water they produce a soft, pliable material that can be moulded by hand. This allows designers to model concepts and is particularly useful for developing ergonomic features. Polymorph solidifies on cooling, which allows designers to test an idea, but if the idea doesn’t work, polymorph can be reheated and is mouldable once again – enabling a concept to be redeveloped.

3. Designers studied the structure and shape of eagles’ wings, which led to the Airbus’ wing tips being installed, without which the aircraft’s wingspan would be too big for most airports to accommodate.

4. Apple products are easily recognisable by their style – consistent shapes, limited in the number of colours they use and using a limited range of materials.

5. Dyson replaced the bag that was used to collect dust in traditional vacuum cleaners with the more effective use of cyclonic technology. This is a far more efficient system and, unlike traditional vacuum cleaners, does not lose power/suction. This system revolutionised the industry, leading to many more competitor companies producing their own vacuum cleaners which use the same technical principles as the DC01.

6. Miyamoto pioneered the joystick and user interfaces on games console handsets which are still commonplace today. The buttons on the handset on the Nintendo Entertainment System (NES) allowed greater functionality for the characters in the games. This created a significantly better user experience. Current handsets are still based on the same principles.

7. Fabrics could include the following:  
   - Stella McCartney uses recycled polyester, which has been developed to imitate leather but is cruelty free and sustainable.  
   - Instead of using virgin cashmere she developed re-engineered cashmere made from waste. This has similar qualities but without the environmental impact.  
   - She uses wool in her collections but only if the supplier of the wool can prove the welfare of the animals that it comes from.

8. Orla Kiely’s designs are inspired by natural organic forms, in bold repeat formations for her printed designs. The colours she uses are inspired by her childhood – for example, olive green from the cupboards in her home, the blues and greens of the sea and the yellows from the gorse in the countryside in Ireland where she grew up.
The 'Laura Ashley look' was a popular style in the late 1970s. It consisted of the iconic Victorian-inspired full-length dress with high collar and leg-of-mutton sleeves teamed with a soft, floppy felt hat with wide brim.

Examples of features could include:
- Feature 1: Bethan Gray uses high-quality materials such as brass, marble and hardwoods.
- Feature 2: she uses traditional craft skills to manufacture her products.
- Feature 3: many pieces are inspired by architecture.

Section 2: Engineering design

Examples of input sensing components include light-dependent resistor (LDR), thermistor, switch.

A digital signal has only two values, e.g. on or off. An analogue signal can have any value between a minimum and a maximum.

Embedding means writing a program for a microcontroller which is dedicated to a specific product and placing the microcontroller permanently in the product.

Identify a suitable input sensor (e.g. tilt switch) and explain how the sensor produces a signal in response to a bike being stolen (e.g. when the bike is moved, the tilt switch turns on and this sends a signal to the microcontroller).

Identify a suitable output device (e.g. siren). Draw a correct system diagram, with input sensor, microcontroller, output and signal arrows.

Example flowchart:

Start

- Read sensor

  - No
  - Is movement detected?
    - Yes
      - Turn on light
      - Wait 30 s
      - Turn off light
    - No

1 Electroluminescent material does not generate heat so is safer for use than other lighting methods. Electroluminescent material is flexible and can be applied to flat or curved surfaces to suit the style and shape needed.

Other possible advantages include: very thin material; lightweight; high strength makes it almost unbreakable; efficient when used for lighting; longevity; low power consumption.

2 Linear motion, e.g. a moving vehicle.

Rotary motion, e.g. an electric whisk.

Reciprocating motion, e.g. a sewing machine needle.

Oscillating motion, e.g. a pendulum.

3 50 revolutions.

4 6.25 s.

5 Effort

<table>
<thead>
<tr>
<th>Input arm</th>
<th>Effort</th>
<th>Fulcrum</th>
<th>Load</th>
<th>Output arm</th>
</tr>
</thead>
</table>

6 (a) Crank and slider converts rotary motion to reciprocating motion.

(b) Rack and pinion converts rotary motion to linear motion.

(c) Bell crank converts linear motion to linear motion in a different direction.

7 Examples of two similarities: transfers rotary motion between shafts; can provide increase/decrease of rotational velocity and torque.

Examples of two differences: gears reverse the direction of rotation, belt/pulleys do not; belt/pulleys allow the shafts to be separated by a larger distance than when using gears.

1 (a)

(b) Output from light sensor: analogue.

Output from switch: digital.

Output from microcontroller: digital.

(c) 350 Ω.

(d) A resistor is needed to limit the current through the LED to a safe value, otherwise the LED will be damaged.
2 (a) Op-amp: operational amplifier. A specialised amplifier IC which can be used to build amplifier circuits.

(b) MOSFET: an amplifier which turns a small signal into a bigger one.

(c) Relay: allows a high-voltage (or a high-current) output transducer to be controlled from a low-voltage (or low-current) circuit.

6 SMT components are very small so electronic products can be miniaturised. SMT components can be assembled at high speed by robotic machines, reducing production costs.

7 • A casing can protect components from the environment, such as the casing for an outdoor security lamp.
• A casing can improve the aesthetics of the product, such as a domestic product like a TV.

8 Examples include: pipe, angle and box section.

9 • The designer will not receive any profit from future sales.
• A high level of skill or expertise is often needed to design and develop the product.

10 • A mould will be designed and manufactured, perhaps using a CNC machine.
• The mould will be closed and held with clamps.
• Pewter will be melted and then poured into the mould.
• After cooling, the mould will be split open, the part removed and the sprue cut off. The part may be polished to a high-quality finish.

11 • Brazing usually takes place at a lower temperature than welding.
• Brazing uses a filler material to make the joint. In welding, the actual material melts to form the joint.
• Brazing can join dissimilar materials.

12 • The steel is cleaned by shot blasting.
• Powdered paint is sprayed onto the wheel using electrostatics to help the paint to stick.
• The wheel is baked in an oven, causing the powdered paint to fuse and form an even coating.

Section 3: Fashion and textiles

1 A microfibre is a synthetic fibre (manmade fibre) which is finer than one denier or a diameter less than ten micrometres (0.01 mm) or approximately 100 times finer than a human hair. Microfibres have specific characteristics, such as softness, toughness, absorption and water repellency. Marks can also be awarded for naming an example: polyester, nylon, Tactel®, Modal and Tencel™ (Lyocell).

2 Rhovyl is an anti-bacterial fibre that is also quick drying and when woven into cloth has the ability to wick away moisture such as perspiration following exercise. These combined properties would keep the athlete more comfortable during physical activity.

3 Once cooled and set in a particular shape, thermosetting polymers cannot be reheated or reshaped; this means they cannot be broken down and recycled.
4 Example 1: LED lights on a cycling jacket work on the basis of an electric current travelling through a conductive thread from a power source (battery) to light the LEDs. This allows the cyclist to be seen more clearly, especially in poor visibility.

Example 2: Heating elements integrated into textile fabrics rely on the conductive threads to transfer the electric current from a power source (battery) to the heating element. The element heats up, keeping the wearer warm.

5 Thermochromic dyes change colour in response to heat. An infected wound generates heat, so a colour change in a dressing would indicate this, prompting action. Further medication is needed to control the infection, but the patient heals better.

6 Polyester is a thermoforming polymer, which means it can be moulded or pleated into a given shape when heated. Once heated in a pleat shape, polyester retains this new shape, i.e. it retains the pleats when cooled down.

7 Reason 1: Nomex is flame resistant and is primarily used for products where resistance to heat and flames is essential, as in a firefighter’s uniform.

Reason 2: Nomex fabric is engineered to be extremely strong, meaning it can withstand exposure to extreme conditions, making it ideal for heavy-duty workwear.

Section 4: Product design

1 Thermal insulation in boats, caravans and buildings, as Styrofoam has excellent heat retention properties.

Packaging, as it has excellent impact resistance.

2 A thermoforming polymer can be reheated and reformed.

A thermosetting polymer cannot be reheated and reformed once it has set.

3 Super calendering takes place during the paper-making process. Paper is passed through a series of hard- and soft-faced rollers under pressure to give it a finer and higher quality surface finish.

4 Tested using a magnet: only ferrous metals will be attracted to the magnet.

Tested by exposing to moisture/elements: ferrous metals will rust, non-ferrous metals will not.

5 A suitable natural timber would be beech because it is a strong, close-grained hardwood that is durable and does not splinter.
• Destroying animal habitats upsets the balance of nature and has other effects (animals we rely on are dying out).
• Hardwood trees require extensive seasoning. This involves using a kiln to produce heat and circulate air to gradually dry out the wood. This produces high levels of heat for prolonged periods of time, which requires energy for the burning of wood and also contributes to global warming.
• Transportation of the hardwood from the forest to elsewhere around the world causes further pollution.

3 Any two of the following: waterproof/weatherproof; rigid so won’t bend; lightweight (so won’t weigh down the sign); easy to cut and print onto.

4 Each time paper is recycled the fibres get shorter and shorter. This makes the paper weaker and of lower quality. After the fibres have been recycled five or six times, they become too short to be recycled again.

5 Advantages include:
• Thermoforming polymers can be reheated and reshaped a number of times.
• Thermosetting polymers, once heated and shaped, cannot be reshaped and will melt if reheated.

p 121
1 Newly-felled natural timber is known as green timber. It contains a lot of moisture and if it is not seasoned it will twist, warp, cup and split. It will also be prone to insect and fungal attack and is very difficult to work with.
2 The solvent in the adhesive melts and dissolves the plastic foam.

3 Two from:
• riveting
• soft soldering
• hard soldering
• brazing
• welding.

4 Two from:
• nuts and bolts
• set screws
• self-tapping screws.

5 • Place the mould onto the platen.
• Lower the platen.
• Clamp the polymer sheet onto the machine.
• Heat the sheet until soft.
• Blow a dome (only necessary for tall moulds).
• Raise the platen.
• Switch on the vacuum.
• Remove the heat and allow to cool.
• Remove the mould from the former polymer sheet and trim.

6 KD fittings, such as the cam lock fitting, allow wooden furniture to be sold as flat pack. This reduces the cost to the manufacturer who does not have to assemble the product. This makes the furniture easy to transport from the factory to the store and it makes it easy to store in the warehouse. The relatively low cost allows the customer to change their furniture more often and the flat-pack nature allows them to transport the furniture home in the back of a car. Assembling your own furniture can be a rewarding/frustrating experience for the customer.

7 • Clean the metal for oil and dirt.
• Heat the metal to approximately 200°C in a kiln.
• Dip the hot metal component into a fluidising bath filled with granules of a thermoforming polymer such as PVC.
• Allow the dipped metal component to cool.

8 • First a two-part former needs to be produced.
• Place the natural timber into the steam box.
• Leave the timber for several hours.
• When the timber is pliable, remove it from the steam box.
• Place it into the two-part former and clamp together.
• Allow the timber to fully cool.

9 • Polymers are self-coloured.
• Polymers have a smooth surface.
• Polymers are not affected by water.
• Many polymers are not affected by chemicals.

10 • A pilot hole is a small hole drilled before a large hole.
• The pilot hole guides the larger drill, increasing the accuracy of the final hole.
• The pilot hole makes drilling the large hole easier and reduces both friction and heat.

11 Reasons could include:
• to protect it from the weather
• to enhance its appearance.

12 • Iron ore (haematite) is mined from the Earth’s crust.
• Haematite is then transported to a smelting plant.
• The haematite is smelted in a blast furnace to produce iron.
• Iron is alloyed with carbon to produce steel.
• A can is manufactured from the steel.
• The can is filled with a product and shipped to the customer.
• Once used, the steel can is placed in the recycling bin.
• The steel is sent for recycling by the refuse department.

13 Food packaging can become contaminated by the food inside, such as grease and sauce. This means the paper cannot be re-pulped as
the contaminants prevent the paper pulping properly. For example, pizza boxes made from corrugated card soak up grease from the cheese and oil on the pizza and this means they cannot be recycled.

Section 5: Core skills

p 123
1 Any three from: environmental factors; ergonomic/anthropometric factors; trends and fashion; the design context; cost of materials; availability of materials.

p 124
1 Surveys and questionnaires
   User tests
   Interviews
2 Advantages: secondary data is data that has been collected by somebody else; it is easier and quicker to collect than carrying out the research yourself; it is much cheaper than doing the research yourself.
   Disadvantages: data collected is not always specific to the designer’s exact needs as it may have been collected for a slightly different purpose or from a slightly different user group; the data may be out of date.

p 125
1 The design brief is a concise description of what the client wants or the task the designer must undertake.
   The specification is a detailed list of criteria the product must meet or constraints it must fit into.
2 Using focus groups to get the perceptions and views of different people.
   Look at existing solutions and consider which aspects work well.
   Biomimicry – look at existing structures and aspects within the natural world and consider how these forms and shapes could be incorporated.

p 127
1 Anthropometrics is the study of the sizes of people in relation to products to make sure products ‘fit’ the main user group as well as possible.
   Ergonomics is about making products as comfortable and easy to use as possible.
   Ergonomics uses anthropometric data to do this.
2 Positive impacts:
   • Allow us to communicate via calling or texting, which enables us to stay in touch with people.
   • Can be used to access the internet to find out things quickly and easily.
   • Take and send pictures and videos to people enabling us to share moments with loved ones and friends.
   • Contain useful apps such as sat nav and barcode scanners which help us do many day-to-day tasks.

Negative aspects:
• Social media apps on mobile phones mean people who you may not wish to speak to can get in touch through social media.
• Phones are very expensive and easy to steal, so people are sometimes mugged/robbed for their phone.
• Excessive use of phones to communicate can cause people to rely too heavily on them for social contact instead of meeting and having ‘real’ conversations with people.

p 128
1 Any four from:
   • Product function – does it do what it is supposed to do?
   • Aesthetics – does it look appealing?
   • Anthropometrics and ergonomics – is it easy to use?
   • Cost – is the cost of the product acceptable?
   • Materials – are the materials easy to source?
   • Construction methods – is the product well made?
   • Health and safety – is the product safe to use? Does it meet safety standards?
   • Environmental considerations – are the processes/materials used in manufacturing the product harmful to the environment?

2 By looking at natural structures or objects and using these to help solve the problem.
   A designer may study birds’ wings to see how they work when designing wings for an airplane.
   A designer may study the shape of a shell when designing a building.

p 129
1 Benefits:
   • Designers can get different people’s perspectives on a problem, which can lead them down different design avenues they may not have investigated.
   • One person’s ideas can often feed and inspire another person’s, leading to faster development of ideas.
   • Ideas can be bounced back and forth and elements are gradually developed and refined as this occurs.

Drawbacks:
• Designers may have totally different ideas of the direction of the design and this can slow down the process.
Designers may have to compromise ideas and concepts, which may lead to a product none of the designers are completely happy with.

2 Specify the context of use.
Specify the requirements.
Create design solutions.
Evaluate designs.

p 135
1 Oblique, isometric and perspective drawing.
2 A system diagram shows the functional subsystems, how they are interconnected and the signals flowing between them. A schematic diagram indicates the connections between individual electronic components and the values of the components.
3 Models can be used to:
- test the function of a component
- test the finish on a material
- check the fit of a garment.

4 Input/output:

Decision:

Process:

5 CAD software can simulate the effect of applying forces to a design, to check for points of weakness.
- 2D CAD software can output directly to a CNC machine such as a laser cutter, allowing parts to be manufactured easily.

p 137
1 An early model of a product or part of a product to see how it will look or function.
An accurate 3D model of a design, which closely represents the final product.
2 A low-fidelity prototype is a quickly made basic prototype of a product that gives a basic idea of the product’s look or function.
A high-fidelity prototype is a much more detailed and accurate prototype, which will closely resemble the final product.

p 139
1 Charts; graphs; tables.
2 Any two from: observations; focus groups; interviews; archive materials.
Section 1: Core knowledge and understanding

1 (a) Fitness is an important part of daily life for many people, so there is a demand for new products which will support their fitness regime – market pull. Fitness trackers, which often have multiple functions, fulfil this demand and help people keep on track of their fitness. Technology must be sufficiently developed in order to create products such as fitness trackers, which consumers may not even know they want or need until they become available – technology push. As new technology is introduced, market forces demand products that do more, hence the latest trackers are much improved from earlier versions.

(b) Studying a graph that outlines a product’s life cycle helps identify the success or otherwise of a product. If a product continues to sell or remains popular over a long period of time, features of that product could be incorporated into new products to ensure those are equally successful.

A product’s life cycle helps manufacturers to identify when products need to be replaced or more need to be manufactured in response to demand.

2 (a) Sustainable design means making informed choices when designing a product, for example, choice of materials, reducing waste and using renewable sources to build products that last, in order to reduce the negative impact of a product on the environment.

(b) The principle of the circular economy is about maximising the use of materials and reducing waste which puts a strain on natural resources and the environment. Keeping materials in the manufacturing system by recycling and reusing materials as much as possible reduces waste going to landfill, which in turn reduces pollution and the impact on eco-systems.

3 (a) Shape memory alloys appear to have a memory which allows them to return to their original state when heated.

(b) Thermochromic pigment reacts and changes colour as a reaction to heat. Benefits to the user include a warning that a product is hot or its temperature is increasing. Products which might use thermochromic pigments include baby bottles, cups, mugs and kettles, as well as clothing that indicates a rise in body temperature, as a result of exercise or from another external source of heat.

4 (a) Risks or problems could be more easily identified with continual monitoring and would indicate a need for the wearer to seek medical attention.

(b) Example 1: Microscopic antibiotics/antiseptics can be encapsulated into medical dressings that are delivered directly to wounds, reducing the need to change dressings quite so often and therefore the risk of infection.

Example 2: Therapeutic oils or moisturisers can be encapsulated into dressings/clothing to treat patients with severe skin conditions. The healing oils are released through friction when in contact with the skin and absorbed by the skin, helping the healing process.

5 The iterative process of design and developing products is based on the concept of modelling ideas, testing them and identifying strengths and weaknesses. The process is repeated as many times as needed to refine and improve the design and ensure it is fit for its intended purpose. James Dyson is renowned for the number of times this process is repeated, until he is satisfied the product functions perfectly and as intended. All individual but equally critical component parts go through the same testing process. Several prototypes might be made before a product is approved. The original cyclonic vacuum cleaner went through 5127 prototypes before Dyson was satisfied with its performance.

Section 2: Engineering design

1 (a) As the temperature of an NTC thermistor rises, its resistance decreases.

(b) A thermistor is an analogue sensor because its can have any value, depending on its temperature, which means a thermistor can measure temperature rather than just responding to a hot/cold situation.

(c) A microcontroller can be embedded into a product to provide functionality and to enhance the performance of the product, which improves the experience for the user.
Microcontrollers can be reprogrammed, which is useful during product development or for product upgrades once the product is out in the market.

(d) (i) Feedback in a control system is when a signal from the output is taken and fed back into the input of the process subsystem.

(ii) Feedback allows a system to more precisely control its output.

2 (a) Linear motion; reciprocating motion (or oscillating motion).

(b) Diagram of a simple gear train or a belt and pulley drive system (or any other appropriate gear system).
   - Input/output gears (or pulleys) of different sizes.
   - Input gear (or pulley) smaller than output gear.

(c) To direct a force to the place where it is needed. To change the magnitude (size) of an input force.

3 (a) LEDs are far more efficient than filament lamps. They consume less electricity for the same light output.

(b) 382 mA (rounded to nearest mA)

(c) (i) The security light casing will need to protect the electronics from rain. The security light must work over a wide range of temperatures experienced throughout the year.

(ii) Example method of producing a prototype box:
   - Mark out the net for the box on the steel sheet, using a marker pen.
   - Cut out the sheet using a nibbler tool or tin snips.
   - Finish the cut edges with a file.
   - Fold the sheet into a box using a folding tool, or folding bars in a vice. Use of a former to check bend angles.
   - Clean the box using wet/dry paper.
   - Apply a paint finish by spraying. Start with a primer layer, then finish with two coats of the required colour.

(d) The product will be made from as few individual parts and as few different materials as possible. This will enable the product to be more easily recycled at the end of its life.

Section 3: Fashion and textiles

1 (a) Bias line (diagonal)

(b) Different types of weave alter the structure of a fabric, changing its properties.
   Different weaves mean fabrics can be used for different purposes, which allow products to function more effectively.

(c) The main characteristic of knitted fabrics is their ability to stretch, making them far more comfortable to wear as they stretch to fit. Knitted fabrics are far less restricting during wear, making them ideal for casual leisure clothing.

2 (a) Silk, linen.

(b) The cotton fibre has a hollow centre, which retains moisture, making cotton absorbent.

(c) Fibre blends and mixes consist of two or more different fibres either spun together in the yarn then woven, or knitted into a fabric. This brings together the best properties of both fibres to the new yarn/cloth. The combination of fibres improves the overall quality of the new yarn/fabric as the improved blended yarns have a wider range of properties. When choosing fabrics, blended/mixed yarns improve the fabrics’ overall functionality, making them suitable for a wider range of purposes.

3 (a) Synthetic fibres are not biodegradable, meaning they will not decompose if added
to landfill. Toxic gases are released into the atmosphere, increasing pollution levels, while harmful chemicals from landfill can contaminate the land damaging the delicate eco-system.

(b) Cotton crops need vast amounts of water to grow, which is often taken from arable land needed for farming for food crops or livestock. This is often in places where water is a scarce commodity. Pesticides that are sprayed on to cotton to boost growth also damage the delicate eco-system.

(c) Fuel derived from fossil fuels provides the energy source used in the transportation of textile goods, whether by air or in land freight. Burning of this fuel releases the greenhouse gas CO₂ into the atmosphere, adding to global warming and our carbon footprint.

(d) (i) Workers in developing countries are often paid low wages and work in poor conditions. This enables manufacturers to keep costs low in order to provide cheap products. These products are then readily disposed of when new cheap products become available.

(ii) Products that are easily disposed of often end up in landfill, which causes environmental issues including pollution. The materials used to produce ‘throwaway products’ may not be easy to replace, putting a strain on the world’s resources.

4 (a) A Scotchguard™ finish prevents marks from permanently spoiling fabric, which in turn increases the life expectancy and aesthetics of the fabric.

(b) The process of brushing raises and fluffs up the surface of the cotton fabric. The brushing creates air pockets on the surface of the fabric, which trap heat, making the brushed fabric warmer to wear and improving its functionality.

5 (a) Piping can strengthen the edge of a textile product improving its structural integrity. Piping can be in a contrast colour which enhances a product’s aesthetic appeal.

(b) (i) The circumference of a circle is $2\pi r$
   Diameter is 70 cm, radius is 35 cm
   $2 \times 3.142 \times 35 \text{ cm} = 220 \text{ cm}$
   $220 \times 2 = 440 \text{ cm}$ or $4.40 \text{ m}$ (base and top of cushion)

(ii) Circumference of the circle shape is $2.20 + 0.22 = 2.42 \text{ m}$
   Height of cushion is $30 \text{ cm} + 3 \text{ cm} = 33 \text{ cm}$

Note: 1.5 cm allowance needs to be added to both ends of the length and width

6 (a) Woollen coats are seasonal products and as the product is aimed at children, the quantity or demand would be limited. Trends and fashion change, so new styles may be needed, reducing demand for the coats.

(b) A bespoke product is made specifically for an individual client.
   The client can have a direct input into the design, which may be unique.
   The product will be personalised to fit the client’s measurements.
   The quality of construction will be much higher than a readily-available product.

7 (a)

- Tailor’s tacks are used to mark specific points on a pattern template that need transferring to the fabric in order to align different parts of a product during manufacture.
- Specialist CAD programs are used by manufacturers to organise a lay plan of all the templates needed to make a specific product that might include multiple sizes.
   CAD programs allow the templates to be moved around on screen and tessellated to find the most efficient lay plan that maximises the use of fabric and reduce waste.
   As this is a digital process, the plan that has been developed onscreen can be sent directly to the cutting table once the fabric has been prepared. The automated cutting tools cut the fabric in accordance with the digital lay plan.

8 (a) True statements:
   - Dip dyeing fabric gives a graduated effect to the colour.
   - Free machine embroidery allows the fabric to move freely while being stitched.
   - Batik involves using hot melted wax to outline a shape on fabric.

False statements:
   - Marbling is a resist method of adding colour to fabric.
   - Roller printing is another name for flatbed printing.

(b) CAD allows designers to manipulate images more easily, which includes copying and pasting patterns in repeat designs, re-colouring designs and re-sizing. Changes can be made more easily and errors can rectified quickly. CAD also facilitates developing coordinated ranges. Designs can be more intricate and detailed.

Now test yourself answers at www.hoddereducation.co.uk/myrevisionnotes
CAD designs can be sent directly to a digital printer to be printed straight onto fabric, either as a sample or a short length of fabric. The printed fabric can be evaluated immediately and improved and reprinted if required. The whole process is more efficient than designing by hand and sending designs off to be printed elsewhere. Changes in trends are facilitated more easily.

**Section 4: Product design**

1. Advantages include:
   - Manufactured boards can be made from recycled timber and therefore can be considered to be kinder to the environment.
   - Manufactured boards come in large sheets (2440 mm × 1220 mm), making it easier to make larger products such as wardrobes.
   - Manufactured boards have greater stability and are less likely to twist, warp or bow.
   - Manufactured boards are more suited to volume producing using CNC machinery.

2. Nitinol is one of the most common shape memory alloys made up of titanium and nickel.

3. Each time the paper is recycled the fibres become shorter. This makes the paper weaker and of lower quality. After the fibres have been recycled five or six times, they become too short to be recycled again.

4. Aluminium comes from an ore found in the ground called bauxite.
   - The ore is dug from the ground and transported to the refinery for smelting.
   - It is smelted from the ore in a reduction cell.
   - The aluminium is formed into sheet and transported to the canning factory.
   - The sheet aluminium is formed into a can and filled with drink.
   - The cans are transported to the shop, bought and used by the customer, then put into the recycling bin.
   - The used cans are then melted and reformed into sheet aluminium.

5. (a) Polyvinyl chlorine (PVC).
   (b) Extrusion produces a uniform cross-section of material. It is suitable for high-volume production. It is cost effective when there is a large demand for a product.

6. Paper is placed inside a clear plastic pouch which is then fed through heated rollers. Adhesive in the plastic pouch is activated by the heat and seals the paper inside the plastic. Laminating is done to:
   - improve strength and resistance to bending, creasing or ripping
   - waterproof the document, allowing it to be wiped clean and prevent it smudging or going soggy
   - improve the appearance of the document, for example by making it shiny
   - increase the lifespan of the printed document.

**Section 5: Core skills**

1. (a) Perspective drawing gives a more realistic 3D representation of a design than isometric drawing.
   (b) One advantage is that the designer can obtain feedback about the ergonomics of a model and can test the position of the controls on the proposed design. A CAD model cannot be handled.
   (c) Working drawings are formal drawings that contain enough detailed information to allow a third party to accurately manufacture the design.

   They are often 2D drawings, showing a front, side and plan view.

   They contain information such as dimensions, materials and details about component values.

2. Answers could include:
   - Use recycled materials rather than new ‘virgin’ materials which use up the Earth’s resources.
   - Reduce the amount of materials needed by using minimal design and not adding unnecessary design features.
   - Use manufacturing techniques that use less energy or use renewable energy sources rather than fossil fuels.
   - Ensure the products can be repaired or have parts replaced rather than throwing the whole thing away.
   - Ensure as much of the product as possible can be recycled to reduce the amount that goes to landfill.

3. (a) Products are designed to last a certain amount of time. Products may still work but not be compatible with newer devices. This is done deliberately by the manufacturer.
   (b) Many mobile phones are built with planned obsolescence. After two years the phone battery will no longer hold charge or the software in the phone will not be compatible with the latest apps. This means that although the phone still works, it no longer meets the needs of the user so they need to buy another phone. This means the manufacturer sells more products and makes more money.

4. The BSI kitemark or British Standards Institute kitemark. This means the product has been tested and inspected for safety, quality and fitness for purpose by the BSI and has met all the required standards.