1 New and emerging technologies

1 Repetitive tasks can be carried out by robots or computer-controlled machinery. The use of automation can speed up tasks and ensure that tasks are completed with precision and consistency. Machinery can be left to run continuously for hours or days as human input is not needed.

2 This is where products are sold on the internet.

3 Any relevant example, for example, the Apple iPad.

4 Designers should ensure that they design products that are accessible to everyone in society. People change as they age: the ability to see and hear and the range of movement alters. Designers should consider whether their products can still be used by all groups of people, the elderly being just one example. Designers should consider different cultural groups and take care to avoid offending when they design their products.

5 JIT stands for ‘just in time’ production and is when a manufacturer ensures that the parts needed to make a product are delivered onto the production line just in time for assembly. This means that they do not need to store items in warehouses.

2 Energy generation and storage

1 Fuel is burnt.
Water is heated to make steam.
Steam is used to turn turbines.
Turbines turn generators.
Electrical power is produced.

2 Burning plants as a fuel source can release harmful gases into the atmosphere and cause pollution.

3 Clockwork is based upon the principle of a spring being wound tightly and being forced into a smaller space. This means potential energy is stored and released using system of gears.

3 Developments in new materials

1 Anodising

2 Renewable – therefore we will not run out of this material.

Environmentally friendly – the growing and processing of corn starch polymers does not negatively affect the environment.
Bio-degradable – if sent to landfill corn starch polymers will rot down.
Food safe – corn starch polymers do not affect the food in anyway.
Cost effective – corn starch polymers are less expensive that polymers derived from oil.

3 A smart material is a material that reacts to environmental changes.

4 Strength – CFRP is very strong as it has a mesh of carbon fibre impregnated with resin.
Mouldability – CFRP can be moulded into virtually any shape.
Weight – CFRP has a low mass when compared to metals.
Water and chemical resistance – CFRP does not react or degrade when in contact with water or most chemicals

5 Gore-Tex – walking jackets
Microfibres – sports clothing
Kevlar – body armour
Fire-resistant fabrics – firefighters’ uniforms
E-textiles – fencing jacket

4 Systems approach to designing

1 Light-dependant resistor
Thermistor
Switches

2 The flow of the electrical current alters depending upon the amount of light it is exposed to.

3 Passive infrared detector (PIR)

4 A microcontroller takes the input signal from an input device and processes this information to control an output device.

5 LED
Buzzer
Speaker

5 Mechanical devices

1 A pendulum on a clock

2 A wheelbarrow
3 A rotational force that is exerted on a shaft
4 A cam is attached to a shaft and turns around.
   The cam has a lobe or an eccentric on its outer edge.
   As the cam turns, it pushes against a follower.
   The cam has a rotary motion and the follower has a reciprocating motion.
5 The larger driven pulley will rotate slower than the driver pulley but have a greater torque.

6 Materials and their working properties
1 Corrugated card has a fluted layer which gives the material strength but means it is still lightweight.
2 Student’s own answer.
3 They have needles not leaves.
   The stay green all year round.
   The have cones not fruit.
   They are relatively quick growing.
   They produce softwood.
4 PET
5 It is lightweight/low mass
   It has a good strength to weight ratio.
   It does not rust.
6 Synthetic fibres are mostly made from oil-based chemicals.
7 Reasons for blending fibres:
   To make a fabric with specific qualities for the product
   To make fabrics more crease resistant
   To make fabrics easier to care for
   To reduce the cost of the fabric
   To make a fabric stronger
   To allow fabrics to be heat set.

7 Paper and boards
1 Recycle – to shred and re-process paper and card products back into sheet material to be made into new products (for example, packaging).
   Reduce – use less paper and card in packaging so that less raw material is needed.
   Reuse – use the paper or card product in its original form for a different purpose so that no processing is needed.
   Repair – mend or fix a product so that a new one doesn’t need to be bought.
   Refuse – consumers refuse to buy products (for example, card or paper products that do not use FSC raw materials).
2 Rethink – designers look at new ways to design products to reduce the impact they have on the environment.
3 A registration mark is used in printing to ensure that the layers of colour (CMYK) are in alignment with one another and don’t cast shadows. This will make sure the image that is printed is clear.
4 Insulation would need to be a property that is considered as the pizza would need to say warm when transported.
   The ability to be printed onto would also need to be a consideration as the company would want to advertise their product.

8 Timber-based materials
1 Teak – a hard, durable wood that will cope with the demands of being sat on and moved around the garden. It is weather resistant due to the natural oils it contains therefore it will be able to stay out in all weathers. It has a dark reddish-brown colour that is aesthetically appealing.
2 Air seasoning – air is allowed to flow around the stacked timber and gradually dries out the timber. This process can take a number of years.
3 A KD fitting is a pre-manufactured component.
   It allows you to assemble your furniture at home.
   It allows you to disassemble your furniture when moving house.
   It reduces the cost of the product.
   It makes transportation easier.
4 Stage 1: Take the piece of wood that is to be bent and mark out a series of lines across the grain.
   Stage 2: Clamp the work firmly to the bench and use a tenon saw to produce saw cuts along the lines.
   Stage 3: Insert PVA glue into the saw cuts, bend into a curve and leave to set.
5 A exterior door needs to be protected from the weather and also needs to look aesthetically pleasing.
9 Metal-based materials

1. Bauxite extracted → Alumina refining → Primary smelting → Ingot casting → Remelting → Fabrication → Can manufacturing → Recycling is sorted → Can is recycled → Cans used

Lifecycle of an aluminium can

2. Riveting
   Soldering
   Welding
   Gluing

3. Screwing
   Nuts and bolts

4. Tolerance is the acceptable difference between the upper and lower sizes of a metal component.

5. The metal is fully cleaned and then placed into an oven and heated to a temperature of 2000°C. The metal is then sprayed with a layer of powdered polyethylene from an electrostatic spray gun. The electrostatic spray gun ensures an even coating over the metal. The metal is then placed back into the oven to cure.

10 Polymers

1. Crude oil

2. Crude oil is heated.
   The vapour rises up the cooling tower.
   As it rises it begins to condense.

Different chemicals will then condense at different temperatures and are then separated.

3. Thermofoming polymer
   Thermosetting polymer

4. PET is a food-safe polymer and is therefore ideal for use as a drinks bottle.
   It is suitable for mass production and therefore enables the bottle to be quickly produced.
   It can be manufactured at a very low cost.
   It can be transparent which enables you to see the content.
   It is strong and durable and will therefore not break when being transported/dropped.
   It is waterproof.

5. Polymer granules are fed into a hopper, which in turn feeds the granules into the heating chamber.
   An Archimedean screw then transports the polymer granules along the heating chamber where they gradually become molten.
   A hydraulic ram then forces the molten polymer through a sprue gate and into the mould.
   The mould is then rapidly cooled with water to set the polymer. The mould is then opened and the injection-moulded product is removed.
Now test yourself – Answers

11 Textile-based materials

1 Using organic cotton that is grown without the use of chemical pesticides and fertilisers.
   Using more sustainable regenerated fibres such as Tencel and modal to replace cotton.
   Replace traditional polyester made from petrochemicals with Ingeo, a biodegradable fibre,
   or polyester made from recycled plastic bottles.
   Grow cotton fibres already coloured or use newer disperse dyes that use very little water in their
   application and do not wash out of the fabric during laundering. This will reduce the chemicals
   and water used in traditional dyeing methods as well as the pollution of waterways.
   Avoid the use of chemical finishes and treatments such as stain resistance if possible and make
   sure that waste from these processes is disposed of properly so as not to pollute waterways.
   Where possible, make products near to where they are to be sold and use more ecological forms
   of transport and fuel to help preserve the earth’s finite supply of oil and reduce carbon emissions
   into the environment.
   Reuse, recycle and repair textile products to help reduce waste sent to landfill.

2 Stretch fabrics containing elastane
   Lightweight Polartec
   Lightweight breathable fabrics made with microfibres

Moisture management fabrics, for example, Coolmax
   Breathable and windproof waterproof fabrics such as Gore-Tex
   Strong, heat-resistant fabrics such as Kevlar and Nomex
   Neoprene – a synthetic rubber
   Microencapsulated fabrics
   Interactive fabrics with wearable electronics

3 The warp yarns are fixed in the loom and run down the length of the fabric. The weft yarns
   interlace at right angles with the warp yarns and run across the width of the fabric.

4 The pattern will be checked:
   to make sure that the size of the pattern is correct,
   to ensure that the repeat along the length and across the width of the fabric is accurate,
   to check that the colour is consistent throughout,
   to make sure that different parts of the pattern are placed accurately on the fabric.

5 a) Double machined seam
   b) It is strong, flat, decorative.

12 Electrical and mechanical systems

1 It reduces the flow of current.
   It protects electrical components.

2 Chain
   Sprocket

3 Produce a circuit using a software program.
   Print onto a sheet of acetate.
   Photo etch onto the PCB.
   Etch the PCB.
   Clean the PCB.

4 Pick and place machines are used to accurately position the components.
   The components stick to the board with a solder/flux paste.
   The boards are then heated.
   The components are soldered to the board by flow soldering.

5 It reduces friction.
   It disperses heat.
   It enables mechanical systems to run more quietly.
   It enables mechanical systems to run more smoothly.
   It makes mechanical systems energy efficient.
   It reduces wear.
13 Investigation, primary and secondary data

1 Taking photographs of products you might use as inspiration
Gathering feedback through a questionnaire
Interviewing a client
2 Anthropometrics are the measurements of the human body, collected to help designers size products correctly for their target audience. Ergonomics is the consideration of ‘man’ in his environment and how user-friendly/efficient a product can be designed.
3 Lists of materials needed
Scale drawing of the product
Tools and equipment to be used
4 Physiological
Psychological
Sociological
5 New information might be gained from the client which could alter the product outcome.

14 Environmental, social and economic challenge

1 Pollution and harmful gases are changing the Earth’s atmosphere and are preventing the heat of the sun from escaping back into space, meaning these gases are trapped and heating the Earth and increasing the planet’s climate.
2 Consumables such as coffee and chocolate
3 Material that comes from managed forests like those with the FSC logo on them, mean that every effort goes into ensuring that trees are replanted and resources will not run out. This means that the products they are made into are not impacting on the environment by depleting the material resource.
4 Fair trade aims to give fair and better trading opportunities to producers in developing countries, gaining them the highest price for the products they export.
5 A designer can minimise the impact their product has on the environment by considering the product’s life cycle from materials used, energy needed in its use and ultimately the way it would be disposed. Designers should remember the six R’s when designing. They would decide what appropriate and responsibly sourced materials could be used to manufacture the product, such as FSC timbers or maximising the use of recycled wood/pulp/paper.

15 The work of others

1 He was a student and teacher at the Bauhaus in Germany.
An iconic product he designed is the Wassily chair.
Breuer used new materials and technologies in his work.
He used tubular steel extensively in his work as it was easy to use in mass production and was affordable.
2 Philippe Starck designed the Juicy Salif
3 Student’s own answer
4 Post modernism – 1970-90. Products were designed in a way that sparked interest and controversy. Postmodernist designers such as those from the Memphis Movement produced products that were complex and contradictory.
5 Sir Alec Issigonis designed the mini which was small, compact and reliable. It could still seat four passengers as the engine was turned so that it sat ‘transverse’ making more space. The car was inexpensive and fuel-efficient meaning it was accessible to a larger target audience.

16 Design strategies

1 Collaboration – working with others
User centred-design – having a client at the centre of the design process
Natural form (biomimicry) – using nature as inspiration
2 Using the client throughout the design process means that they can offer ideas and feedback to help a design idea develop. The client can assist with analysing the task and offering opinions about design ideas. This feedback allows designers to improve existing products.
3 Designing as a group means that a wider range of ideas and possibilities can be explored and discussed and a greater understanding of what is required for the design can be achieved.

17 Communication of design ideas

1 Plan view, front elevation, side elevation
2 The product drawn looks realistic.
3 Cardboard – inexpensive, readily available
Foam board – good for structural modelling
Styrofoam – can give a 3D representation of the size/shape of a product
MDF – easy to work with
Clay – easily moulded and can test ergonomics
CAD allows a prototype to be accurately drawn and shown on a computer. It can show all aspects of a prototype and can suggest the aesthetics. Programmes such as Photoshop, SketchUp and ProDESKTOP can allow a designer to quickly draw in 3D and render a product.

18 Prototype development

1 CAD is used to produce virtual prototypes of the final product. These can be shown to the client and feedback gained. The aesthetics of the product can be developed further and options given to the client very quickly and easily without a physical model being made.

CAM and the use of rapid prototyping means that complex and working models can be produced quickly and accurately from less expensive materials.

2 Complex and moving parts can be printed to give a very accurate representation of the final product.

3 Designers and manufacturers can tell if their product is fit for purpose.

Modifications can be made in light of client feedback.

Rigorous testing for safety can be carried out.

4 Prototypes are tested to check their functionality, their fitness for purpose and their safe and efficient manufacture.

19 Paper and boards

1 By placing the shapes or nets as close to one another on a sheet of material there is less material wasted and the maximum number of products produced.

2 Many shapes/nets can be cut together.

3 Precision and accuracy can be achieved to cut out intricate designs.

4 Tolerance is the allowable variation of a dimension.

5 Encapsulation is a way to finish papers and boards. The sheet of material is placed between two polymer layers which are then heated to encase the sheet of paper and board inside. This gives the paper/board a shiny and waterproof layer.

20 Timber-based materials

1 Teak

2 PSE – planned square edge; PAR – planned all round

3 Timber is hydroscopic.

It absorbs moisture and grows in size.

4 Produce a mould of the curve that is to be created.

Apply PVA or resin-based glue to the surfaces of the wood veneers.

Position the veneers over the mould and place into the vacuum bag.

Seal the bag and switch on the vacuum.

Once dry, remove the mould from the bag and trim the curved veneers.

5 Varnishing, oiling, lacquering, staining.

21 Metal-based materials

1 Stainless steel

2 Computer numerically control

3 Metal ruler, scriber, engineer’s square, surface plate, vee blocks, scribbling block, angle plates

4 Metal is chemically cleaned, dipped into molten zinc. The process can be repeated to create a thicker protective layer.

5 Anodised, lacquer

22 Polymers

1 Urea formaldehyde

2 Once the mould is ready, it is placed on the platen (table) of the vacuum former and lowered into the machine.

A sheet of HIPS is then clamped over the top of the machine and heat is applied.

After a short time, the HIPS sheet will become soft. Care should be taken not to overheat the HIPS sheet, as it will not form properly and webbing may occur.

The sheet is then raised up into the hot HIPS sheet and immediately the air is sucked out to the machine by tuning on the vacuum pump.

Once formed, the sheet should be allowed to cool then removed from the vacuum former and trimmed.

3 A stabiliser changes a property of a polymer and helps to protect it from external influences such as UV degradation.

23 Textile-based materials

1 They must all face in the same direction.

2 For example, fabric must be washable as they are likely to be worn for leisure activities; hard-wearing so that they last at least one season; abrasion resistant so that they do not wear out at the knees; thermoplastic so pleats/creases can be heat set; stain resistant so that they stay clean.
for longer; lightweight so they can be used for active leisure pursuits.

3 Fabric will not hang correctly; patterns in the fabric will not be ‘straight’ and pleasing to look at.

4 To make sure that work is flat and ready for the next process.

5 A ball point needle.

24 Electrical and mechanical systems

1 99.75 mm and 100.25 mm

2 Wear an apron to protect your clothes. Wear goggles to protect your eyes from splashes.

Wear gloves to protect your hands from the chemicals.

Ensure you are working in a well-ventilated area.

3 Silicon, epoxy resin, acrylic or polyurethane

4 It make it a faster process.

The circuit can be virtually tested.

The software will ensure the circuit is as compact as possible.

5 A thermoforming polymer

The vacuum-forming process
Core technical principles

1 A
2 A
3 C
4 C
5 B
6 C
7 D

8 One way to enhance the properties of paper and card is by encapsulating them in a polymer. Paper and card can be placed in between two sheets of a polymer and heated to soften the polymer and fuse the edges together. This provides a waterproof finish to the paper/card and provides a shiny, wipe-clean finish making it ideal for use on menus, for example.

9 Polyamide is strong, abrasion resistant, lightweight, non-absorbent.

10 Cotton, linen, wool.

11 They can shrink when washed, take a long time to dry, can irritate the skin.

12 They are very stretchy, give a close fit to the body, allow freedom of movement.

13 The fabric burns fiercely at high temperature; gives off toxic black smoke; the polyester fibres melt and drip which can cause serious skin burns.

14 Linear
   Rotary
   Reciprocating
   Oscillating

15 A finite resource is one that will eventually run out.

16 Corn starch polymers are made from vegetables such as potatoes, corn and maze and are therefore renewable. Corn starch polymers are biodegradable. Corn starch polymers are food-safe.

17 A material that is made from 2 or more materials. It improves both the physical and mechanical properties of the original material.

18 Light dependant resistor (LDR)
   Thermistor
   Any type of switch

Specialist technical principles

1 B
2 B
3 C
4 D
5 C

6 Fewer trees will need to be cut down, which means that there is less risk of deforestation.

7 Sheet, roll and ply

8 Using stock forms allows products to be designed to ensure there is minimal waste when they are manufactured.

9 Deforestation occurs when trees are cut down and not replanted.

10 Wood then becomes a finite resource.
   Animals lose their habitat.
   Fertile soil is washed away.
   People lose their livelihood.

11 Marine life gets caught in polymer-based products.
   Marine life and birds eat the plastic and become ill or die.

12 Baulk cut
   Through and through cut
Exam practice – Answers

13 Seasoning dries out timber and prevents twisting, warping, cracking, splitting, fungal attack and insect attack.

14 Haematite

15 Mining ores leaves scars in the landscape. Fossil fuels are burned when mining and transporting metal ore. Fossil fuels are burned when smelting metal ore. Fossil fuels produce toxic gases that pollute the atmosphere.

16 Fractional distillation

17 C

18 Place the metal in a brazing hearth. Heat the metal with a brazing torch to 700°C. Allow to soak at this temperature for a while. Cool slowly, preferably buried in sand.

19 B

20 There are no dangerous chemicals involved. It is a quicker process. There are fewer stages involved. Holes can be drilled at the same time.

21 Speed up manufacture
Reduce human error
Lower unit cost
Safer working practice
Increase consistency
Increase accuracy
Reduce waste

22 C

Designing and making principles

1 For example, in the use of colour and pattern; interests of TMG such as music; influence of celebrities, religious beliefs of TMG.

2 For example, patchwork pieces; appliqué shapes; specific parts of a product where large differences will be noticeable, such as pockets; specific parts of a garment where other pieces need to fit accurately, such as collars on necklines.

3 The pattern template must be placed on the straight grain of the fabric (usually the warp yarn) so that the fabric will hang correctly as intended in the final product. This may cause garments to twist out of shape on the body. Patterns printed or woven into the fabric will appear to be crooked if the straight grain is not used accurately.

4 A separate line of manufacture for some parts of a product that are later added to the main assembly line

5 To prevent stretching; to strengthen it; to reinforce fabric behind fastenings

6 Student should describe preparation of fabric, tools and equipment used, detail of applying dye and effects achieved.

7 Batch manufacture. The tops will only be sold during the summer season before new styles come into season. The tops will be made in a range of sizes by workers who are skilled in the use of different machines and processes, so can easily change from making one type of product to a different one when fashions change. Using batch manufacture means that there will not be a lot of unsold stock at the end of the season, especially if computerised systems are used to monitor what is selling.

8 a) Ball point needle
b) Bodkin
9 Methods include pleats, tucks, gathers, darts. Description should include reference to measuring/marking of fabric, tools used, detail of method and effect created.

10 The thickness of the fabric; if the fabric frays a lot; whether the product will be washed.

11 They are designed specifically for the intended job and can be used to mark out the same shape a number of times.

12 Any of the following:
Printing using lithography
Embossing
Varnishing
Foil blocking

13 Durable
Non-toxic
Splinter free

14 Planed both sides

15 To enhance its appearance
To change its appearance
To provide protection

16 D

17 A datum point is a reference point from which measurements can be taken.

18 The aluminium is chemically cleaned. The aluminium is placed in an electrolytic solution. An electrical current is passed through the electrolytic solution. An oxidised layer coats the aluminium. An anodic die can be added to the electrolytic solution which colours the oxide layer. The aluminium is chemically cleaned.

19 B
20 A preheated tube of PET is dangled between the two halves of a steel mould. The two halves of the mould are closed. Air is blown into the tube. The tube expands to fill the cavity. The mould is cooled. The mould is opened and the bottle removed.

21 UV stabilisers are added to the polymer.