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 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

8 Metal-based materials

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

Lifecycle of an aluminium can

To reduce the cost of the fabric
To make a fabric stronger
To allow fabrics to be heat set.

7 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.
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.

9 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 Thermoforming 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 Archimedeans 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.

10 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.

11 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.

12 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.

13 Design strategies

1 Collaboration – working with others

User centred-design – having a client at the centre of the design process

2 Natural form (biomimicry) – using nature as inspiration

3 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.

4 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.

14 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

4 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.

15 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.

Modified 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.
16 Timber-based materials

1 Teak
2 PSE – planned square edge; PAR – planned all round
3 Timber is hygroscopic.
   It absorbs moisture and grows in size.
   It will dry out and shrink 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.

17 Metal-based materials

1 Stainless steel
2 Computer numerically control
3 Metal ruler, scribe, engineer’s square, surface plate, vee blocks, scribing 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

18 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.
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

19 Parallel motion linkage

20 1:4

21 Properties: lightweight, soft, easy to work  
   Uses: models, toy aeroplanes and fishing floats

22 A ferrous metal contains iron.  

23 Properties: hard, tough, corrosion resistant  
   Uses: kitchen sinks, cutlery

24 A

Specialist technical principles

1 B
2 C
3 B
4 C

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

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

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

8 Baulk cut  
   Through and through cut  
   Tangential cut  
   Quarter cut

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

10 Haematite
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.

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

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

Designing and making principles

1 They are designed specifically for the intended job and can be used to mark out the same shape a number of times.
2 Durable
   Non-toxic
   Splinter free

3 Planed both sides
4 To enhance its appearance
   To change its appearance
   To provide protection
5 D
6 A datum point is a reference point from which measurements can be taken.
7 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.
8 B
9 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.
10 UV stabilisers are added to the polymer