Mark scheme

Q1.

Non-ferrous

Q2.

Electrical conductivity

- The ability of a metal to allow the flow of electric current through it

Plasticity

- The ability of a metal to be permanently deformed without breaking, typically by bending or stretching

Q3.

Planned square edge

Q4.

- Selection of timber: A suitable type of hardwood (e.g. oak or ash) is chosen because it can bend without cracking when steamed.
- Soaking (optional): The timber may be soaked in water to increase moisture content, making it more pliable.
- Steaming: The timber is placed in a steam box where it is exposed to steam (typically around 100°C) for a set time—usually around 1 hour per 25mm of thickness. The heat and moisture soften the lignin in the wood.
- Bending: While hot, the timber is quickly removed from the steam box and clamped into a former or jig that defines the desired shape.
- Clamping and drying: The timber is held in the former until it cools and dries, which helps it retain the bent shape.
- Finishing: Once set, the timber is removed from the former and can be trimmed, sanded, and finished as needed.

Q5.

Column length^2 = 2675^2 + 2024^2 = 11,252,201mm

Column length = $\sqrt{}$ 11,252,201 = 3354.4mm

Q6.

- Strength and durability – Glulam is engineered from multiple layers of timber bonded together, giving it high structural strength. This allows it to span large distances and support heavy loads, ideal for outdoor frameworks.
- Ability to form curves – Glulam can be manufactured in curved shapes, unlike solid timber. This makes it perfect for the smooth, arching forms seen in the structure.
- Dimensional stability – Because it's made from multiple layers, glulam is less likely to warp, twist, or split compared to solid timber, especially in varying outdoor weather conditions.
- Weather resistance – When treated properly, glulam can resist moisture, rot, and decay, making it suitable for long-term outdoor use.
- Sustainability – Glulam is made from smaller timber sections, often from fast-growing trees, making it a more sustainable option than large solid beams.
- Aesthetic appeal – The layered timber gives an attractive, natural appearance that complements outdoor environments, enhancing the visual design of structures like pergolas and pavilions.

Q7.

- Improved efficiency – Garments are moved automatically between workstations, reducing handling time and speeding up production compared to manual systems.
- Reduced labour costs – UPS minimises the need for workers to carry or transport garments, allowing each operator to focus solely on their specific task.
- Better quality control – As each garment is produced individually, faults can be identified and corrected at specific stages, improving overall quality.
- Flexibility in production – UPS can be easily adjusted for different garment styles or sizes, making it suitable for short production runs or customised orders.

- Reduced work-in-progress – Only one garment is worked on at a time at each station, which reduces clutter and keeps production organised.
- Increased traceability – Each garment can be tracked through the system, helping monitor performance, identify bottlenecks, and improve workflow management.

Q8.

(A x B x C) + D = 0.0120043

0.0120043 x 20,000

240.1 (241)

Q9.

Thermochromic pigment

Q10.

- Designing the model (CAD) – The parts of the model are first designed using computer-aided design (CAD) software. The design includes all the slots, curves, and interlocking parts needed to assemble the structure.
- Preparing the file for the laser cutter – The CAD file is converted to a vector format (e.g. .dxf or .svg), with different colours or line types to indicate cutting and engraving paths.
- Setting up the laser cutter – A sheet of corrugated cardboard is placed on the laser bed. The machine settings (power, speed, and focus) are adjusted to suit the thickness and type of cardboard.
- Cutting the components – The laser follows the vector lines, precisely cutting out the parts without physical contact. This allows for clean edges and high accuracy, especially for the complex curves and slots in the model.
- Removing and sorting parts – Once cut, the parts are carefully removed from the laser bed. Excess material is discarded, and the components are sorted for assembly.

- Assembling the model – The parts are slotted together using the pre-cut notches. Because of the accuracy of the laser cutter, the components fit tightly and do not usually require glue.

Q11.

Advantages:

- Able to react to or instigate changes quickly; respond to market changes, trends, demand; produce a wider range of products; and process more than one product style at a time.
- Shorter lead times and faster to market.
- Increased market share or sales.
- Batch sizes can match demand.
- Reduced stock, capital, or storage tied up.
- Ability to offer customised products.
- Lower labour costs.

Disadvantages:

- High setup and maintenance costs.
- Production rate is slower than with dedicated automated machinery.
- Staff are expensive and need to be trained or retrained.
- Downtime can occur due to reprogramming.
- Managing, pre-planning, and mapping are more complex and require more effort.
- Higher product cost.

Q12.

- Controlled via a central or on-board computer.
- Programmed route or fixed route/path.
- Radio frequency wires or magnetic strip embedded in the factory floor.
- Painted line or floor-mounted strip.
- Input sensors.
- Laser guidance.
- GPS guidance.
- Inertial (gyroscopic) navigation.

- Automated failsafe systems embedded in guidance systems or for collision control.
- Barcode scanning.

Q13.

1.2 x 2 x 5 x 4

Volume = 48m3

Water needed = 16m3

Q14.

- Wax Pattern Creation: A wax replica of the part is made using an injection mould. Multiple wax patterns can be assembled into a tree for batch casting.
- Shell Building: The wax pattern is repeatedly dipped into a ceramic slurry and coated with fine sand. This process is repeated several times to build a strong ceramic shell around the wax.
- Wax Removal: The ceramic-coated wax is placed in a furnace or autoclave to melt out the wax, leaving a hollow ceramic shell — hence "lost-wax" process.
- Metal Pouring: Molten metal (e.g., aluminium or stainless steel) is poured into the preheated ceramic shell, filling the cavity left by the wax.
- Shell Removal: Once the metal solidifies, the ceramic shell is broken away using vibration or blasting to reveal the metal casting.
- Finishing: The cast part is cut from the tree, then machined, ground, and finished to achieve precise dimensions and surface finish.

Q15.

Exploded view:

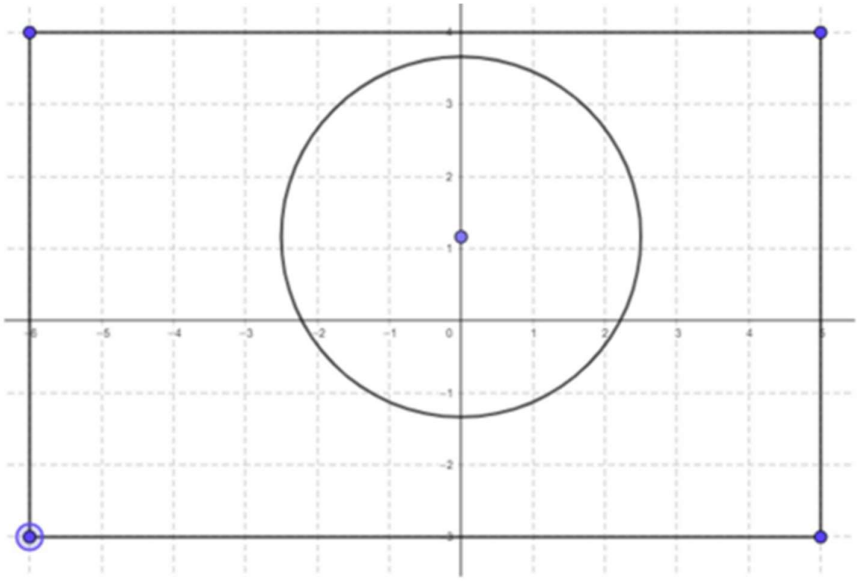
- Designers may use exploded views to produce assembly instruction booklets for flat pack furniture to assist the consumer.

- Exploded views allow the viewer to see all components within a product clearly.
- Exploded views can be used on assembly lines to assist during production.
- Exploded views may be used to communication information on internal assemblies to a client during a design meeting.
- Using CAD software allows a designer to create an exploded view on screen and re-assemble a product virtually when working with a client so all components can be seen.
- Exploded views allow consumers to identify and order replacement parts.

Sectional view (Orthographic):

- Sectional views allow the viewer to see internal and hidden details within an assembly.
- Using 2D sectional views allows dimensions of hidden components to be added onto engineering drawings.
- Sectional views allow designers to visualise the interaction between separate hidden components.

Q16.



Q17.

- Recognisable welding gun/ torch / nozzle.
- The work is electrically connected to the earthing cable.
- Work is cleaned • An electrical spark.
- A filler wire / electrode is fed through the gun.
- The materials are melted / molten / fused together.
- Argon gas / gas shield is fed over the weld pool.

Q18.

- Critical assessment of existing products is essential in identifying weaknesses in existing products. A manufacturer would need to be confident that their product is better or more desirable than the current products on the market.
- The ergonomics of existing products can be tested and evaluated to identify desirable features that may be incorporated into a new product.
- The use of materials can be analysed to identify improvements or alternative materials that may be considered in product manufacture.
- Critical assessment can help identify why a competitor's product is successful and ensure that a comparative level of performance is achieved or exceeded.
- A manufacturer can analyse how a product is manufactured to identify improvements in the product manufacture or product assembly phase.
- The way in which a user interacts with a product can be analysed in order to improve the user experience or make the next iteration more instinctive.

Q19.

- Kevlar fibres are used in bicycle tyres to replace standard rubber. These fibres prevent punctures due to the resistance to sharp objects, thus reducing risk for cyclists when travelling at high speed. This also reduces the time lost from punctures during races for cyclists who see the added cost of the tyres as worthwhile.
- Kevlar fibres are used in personal protection equipment for motorcyclists and others as it protects against abrasion and cuts. It is much lighter than alternative materials, such as steel inserts and due to its thermal insulation properties the wearer is not at risk of burns through conduction.
- Kevlar fibres are used in high end trainers as a replacement for nylon due to the reduced elasticity. This means the laces will remain tight as Kevlar fibres stretch by 1% in comparison to 30% associated with Nylon.

Q20.

Material selection

- source
- quantity
- quality
- range
- recyclability
- biodegradability

Manufacture

- minimising energy use
- optimum use of materials / components
- simplification / streamlining of processes
- minimising waste
- scale of production

Distribution

- efficient / minimisation of packaging
- maximisation of product carried on each vehicle

Use

- energy efficient products

- ease of repair / maintenance

End of life

- design for disassembly
- recovered material feasibility
- potential for re-processing
- potential for energy recovery
- minimising elements to landfill

Q21.

Shape area = 14240.87cm2

Volume = 8544.52cm3 Mass = 23.92kg

Q22.

- For training so that all risks and safe procedures are covered
- Provides evidence that H&S legislation has been applied if accident occurs / HSE inspect / required in court
- Provides a basis for review so that any changes can be built upon existing good practice

Q23.

Advantages

- Use of symbol inspires consumer confidence
- Increased reputation
- Increased sales
- Compliance brings a measure of legal protection / standards accepted by law courts
- Employees have improved working conditions
- Less employee absence / more motivated employees
- Increased productivity
- Reduces after sales costs
- BSI standards internationally recognized

- Opens up trade with other BSI recognized businesses

Disadvantages

- High costs of setting up / changing to comply with standards
- Many consumers do not know the significance of kitemark®
- Increase the red-tape within business

Q24.

- Strong Legal Protection: A patent gives the holder exclusive legal rights to make, use, or sell the invention for up to 20 years, preventing others from copying it without permission.
- Encourages Innovation: By protecting original ideas, patents encourage designers and companies to invest time and money into developing new and improved products.
- Commercial Advantage: A patent can give a business a competitive edge by allowing them to dominate a market with a unique product or process.
- Cost and Time: Applying for a patent is expensive and time-consuming, often taking several years to be granted. This can be a barrier for small businesses or individual designers.
- Disclosure of Design: The patent application must publicly disclose how the invention works. This means competitors may find ways to work around the patent or improve on the idea once it's published.
- Limited Scope: A patent only protects the specific technical details of the invention, not the overall look. For aesthetic protection, a design right or registered design may be more appropriate.