

Mark scheme

Q1a)

- Blockboard (1)
- Laminboard (1)
- Battenboard (1)
- Plywood (1)
- MDF (1)
- Sterlingboard (1)

Q1b)

- A single piece of board can be manufactured as required (1) with uniform thickness and quality (1) which is not limited by the size of natural timber boards (1)
- Manufactured boards tend to be of equal strength in all directions (1) therefore reducing the chances of short grain (1)
- Manufactured boards do not warp/shrink/twist/cup/split as much as natural timber (1) therefore making the boards more stable in large sizes (1)
- The cost of manufactured boards tends to be less than natural timber (1) making the cost of the final product lower (1)
- Reduction of knots (1) affecting aesthetics (1)
- An expensive appearance (1) can be gained by using a limited amount of expensive material (1)

Q2a)

- Preservatives help prevent water absorption (1) reducing the chances of the timber rotting, swelling, or warping in outdoor conditions (1)
- Preservatives protect the timber from insect attack or fungal decay (1) which increases the durability and lifespan of the decking (1)
- Preservatives improve weather resistance (1) allowing the decking to maintain its structural integrity and appearance over time (1)
- Preservatives reduce the need for frequent maintenance (1) making the decking more cost-effective and easier to look after (1)

Q2b)

- Use of Pythagoras' Theorem with correct substitution:
→ $\text{Length}^2 = 2675^2 + 2024^2$ (1)
- Correct calculation of squared values and their sum:
→ $7155625 + 4096256 = 11251881$ (1)
- Correct square root and final answer:
→ $\sqrt{11251881} \approx 3353.65 \text{ mm} \rightarrow \text{Answer: } 3354 \text{ mm}$ (1)

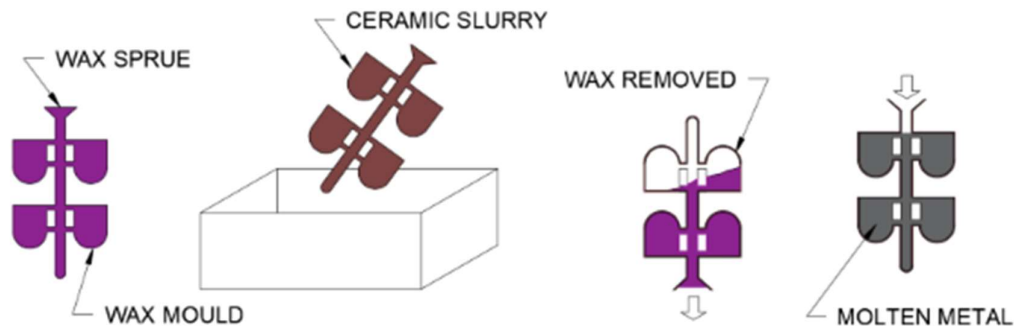
Q2c)

- Calculate the volume of one concrete beam using cross-section and length
→ e.g. $250 \times 550 \times 6000 = 825,000,000 \text{ mm}^3 = 0.825 \text{ m}^3$ (1)
- Calculate the volume of 6 steel rebars (each 36 mm diameter and 6000 mm long)
→ Use $\pi r^2 h = \pi \times 18^2 \times 6000 \approx 6.11 \times 10^6 \text{ mm}^3$ (1)
→ Multiply by 6 rebars = approx. $36.66 \times 10^6 \text{ mm}^3 = 0.03666 \text{ m}^3$
- Subtract rebar volume from concrete beam volume
→ $0.825 - 0.03666 = 0.78834 \text{ m}^3$ (1)
- Multiply by 2 to find total for both beams
→ $0.78834 \times 2 = \boxed{1.58 \text{ m}^3}$ (1)

Q3a)

- Stainless steel has a high resistance to corrosion (1) which is essential for engine components exposed to heat, moisture, and chemicals (1)
- Stainless steel maintains its strength at high temperatures (1) making it suitable for engine parts that experience constant heat and stress (1)
- Stainless steel has excellent wear resistance (1) which improves durability and reduces the need for replacement in demanding engine environments (1)

Q3b)



- A wax pattern of the engine part is produced using a mould for accuracy and repeatability (1)
- Several wax patterns are joined to a central runner forming a “tree” for batch casting (1)
- The wax assembly is dipped into ceramic slurry and coated with fine refractory sand (1)
- The dipping and drying process is repeated to build a strong ceramic shell around the wax (1)
- The wax is melted out by heating in a kiln or autoclave to leave a hollow ceramic mould (1)
- Molten stainless steel is poured into the preheated ceramic mould and allowed to cool and solidify (1)
- The ceramic shell is broken away and the cast parts are removed and cleaned/finished (1)

Q3c)

- Investment casting produces components with a much smoother surface finish (1) reducing or removing the need for post-casting machining or polishing (1)
- More intricate and complex shapes can be achieved with investment casting (1) allowing for the detailed internal and external features required on engine parts (1)
- Investment casting allows for tighter dimensional tolerances (1) resulting in more accurate and consistent parts (1)
- Thinner wall sections are possible with investment casting (1) which helps reduce weight while maintaining strength (1)

- Better material properties due to controlled solidification (1) improving structural performance under stress and heat (1)

Q3d)

- Correct method to calculate probability of $A \cap B \cap C$:
 $\rightarrow 0.02 \times 0.043 \times 0.005 = 0.0000043$ (1)
- Add to probability of D failing:
 $\rightarrow 0.0000043 + 0.012 = 0.0120043$ (1)
- Multiply by 20,000 to get expected failures:
 $\rightarrow 0.0120043 \times 20000 = 240.086$ (1)
- Final estimate rounded **up** to nearest whole number:
 $\rightarrow 241$ parts (1)

Q4a)

- The Intellectual Property Office (IPO)

Q4b)

- A patent legally protects a new invention (1) preventing others from making, using, or selling it without permission (1)
- It gives the inventor exclusive rights (1) which can be commercially valuable if the product is unique or in demand (1)
- A patent can help a designer secure investment (1) as it provides confidence that the idea is protected from theft or copying (1)
- The process of applying for a patent can be long and expensive (1) which may not be practical for small designers or startups (1)
- A patent does not guarantee commercial success (1) and legal action to defend it can be costly (1)
- Patent protection only lasts a limited time (1) so the designer may eventually lose exclusivity (1)

Q4c)

Advantages

- The use of the BSI Kitemark® inspires consumer confidence (1) as it signals that the product meets rigorous quality and safety checks (1)
- Improved brand reputation (1) can lead to increased customer loyalty and a competitive market advantage (1)

- Increased sales potential (1) particularly in markets or industries where BSI compliance is preferred or expected (1)
- Compliance can offer a measure of legal protection (1) as BSI standards are often accepted in law courts as best practice (1)
- Employees benefit from safer, more standardised working conditions (1) improving motivation and reducing absences (1)
- Increased productivity (1) due to efficient and consistent manufacturing processes (1)
- Reduces after-sales costs (1) as fewer defective or unsafe products are returned (1)
- BSI standards are internationally recognised (1) allowing easier access to overseas markets and partnerships (1)

Disadvantages

- High costs involved in changing manufacturing processes or retraining staff (1) may be a burden on small or emerging businesses (1)
- Many consumers are unaware of the significance of the Kitemark® (1) so the marketing advantage may not always be realised (1)
- Increased “red tape” within the business (1) due to additional documentation, assessments, and compliance checks (1)

Q4e)

- Calculate full rectangle area:
→ $1500 \times 1000 = 1,500,000 \text{ mm}^2$ (1)
- Calculate area of quarter circle correctly:
→ $\frac{1}{4}\pi \times 250^2 \approx 49087.39 \text{ mm}^2$ (1)
- Subtract quarter circle from full area:
→ $1,500,000 - 49087.39 = 1,450,912.61 \text{ mm}^2$ (1)
- Multiply by thickness to get volume in mm^3 :
→ $1,450,912.61 \times 6 = 8,705,475.66 \text{ mm}^3$ (1)
- Convert to cm^3 and apply density:
→ $8705.48 \times 2.8 = 24375.34 \text{ g}$ (1)
- Convert to kg and give final answer:
→ **24.38 kg** (1)

Q5a)

Candidates might refer to the following in their responses:

- Use of colour
- Ease of cleaning
- Hygiene
- Health concerns
- Inert material
- Cost
- Realism / detail
- Toughness
- Durability
- Strength
- Weight
- Hand to mouth issues
- Learning aids

Q5b)

Users should be aware of the COSHH guidance that governs their use, storage and disposal.

- Users must store the adhesive in a COSHH cupboard when not in use.
- The adhesive may be irritant to skin so correct PPE should be worn eg gloves.
- The adhesive may be a liquid so correct PPE such as goggles should be worn.
- Vapours that can be released can be highly flammable so no naked flames should be present when using the adhesive.
- Users must ensure that instructions have been read and guidance is followed.
- Vapours can be released therefore the adhesive should be used in a well ventilated area.
- Users must identify and understand the COSHH symbol present which will both govern its use and disposal.

Q6)

Advantages:

- Able to react to or instigate changes quickly / respond to market changes, trends, or demand / produce a wider range of products / process more than one product style at a time (1)
- Shorter lead times / products reach the market faster (1)
- Increased market share or sales due to faster responsiveness (1)
- Batch sizes can match demand more closely (1)
- Reduced stockholding / less capital tied up in inventory or storage (1)
- Ability to offer customised products (1)
- Lower labour costs due to automation or efficiency (1)

Disadvantages:

- High setup or maintenance costs (1)
- Production rate is slower than dedicated automated machinery (1)
- Staff are expensive to employ / need to be trained or retrained (1)
- Downtime can occur due to reprogramming of equipment (1)
- A larger amount of managing / pre-planning / process mapping is required and can be complex (1)
- Can result in a higher product cost (1)

Q7)

Candidates might refer to the following in their responses:

- Unity and harmony across the various fine arts and crafts
- Establishment of 'modern' urban life
- Designers appreciated the benefits of mass production
- Embraced technological advances of the time
- Embraced the aesthetic possibilities of new materials including glass and stained glass
- High standards of craftsmanship and design to everyday objects
- The form of an object should be expressed through its function and function should be expressed through decorative forms
- Influenced by natural forms
- Elongated curvy 'whiplash' lines
- Stylised flowers/leaves/roots/buds/seedpods
- Exotic insects and peacock feathers

- Use of the female form/languid female figures/long flowing hair
- Influenced by the arts and artefacts of Japan
- Vertical lines and height
- Celtic/Arabian/Ancient Greek patterns provided inspiration for intertwined ribbon patterns

Q8a)

- The pigment glows in the dark or low light (1) making the sign visible during a power cut or in smoke (1) which improves safety and helps people locate exits or equipment (1)
- It absorbs both natural and artificial light (1) which makes it suitable for indoor environments with variable lighting (1) and ensures it charges effectively during the day (1)
- It doesn't need a continuous electrical power supply (1) so it will still function if electricity is cut during a fire or emergency (1) reducing reliance on backup systems (1)
- Signs can be placed anywhere without wiring (1) as they don't require a power connection (1) offering flexibility in placement and easier installation (1)
- Signage can be moved without causing damage (1) since no rewiring or fixing to electrical systems is required (1) making it cost-effective and reusable (1)
- The pigment must be charged by light beforehand (1) or else the glow effect will not work (1) which could be dangerous if the sign is kept in darkness before use (1)
- Light output is low intensity (1) so it's only clearly visible up close (1) which may slow evacuation or location of safety equipment (1)

Q8b)

- It identifies the shortest possible time needed to complete a project (1)
- It highlights the critical tasks that must be completed on time to avoid delaying the project (1)
- It shows the sequence and dependencies of tasks within the project (1)
- It allows for the identification of non-critical tasks that have float/slack time (1)
- It is typically presented as a network diagram (1)
- It supports project planning and resource allocation decisions (1)

Q9)

- PDM manages product design data like CAD files, BOMs, and version control (1) so design teams can maintain accurate and up-to-date product records (1)
- ERP systems manage business-wide functions such as inventory, finance, procurement, and scheduling (1) ensuring coordinated business operations (1)
- Integration allows seamless transfer of design data (e.g. BOMs) from PDM to ERP (1) which reduces manual data entry and human error (1)
- Real-time updates across systems ensure all departments work with the latest product information (1) leading to fewer delays and rework (1)
- Supports better inventory and procurement decisions (1) because ERP systems can automatically respond to product design changes (1)
- Improves time-to-market (1) by speeding up the transition from design to production (1)
- Reduces miscommunication between departments (1) supporting leaner, more coordinated manufacturing (1)
- Helps meet compliance and traceability requirements (1) by maintaining a consistent data trail from design to delivery (1)

Q10)

Candidates might refer to the following in their responses:

Aesthetics:

- Futuristic, premium appearance; blue and silver colour scheme may appeal to style-conscious consumers.
- Bold, industrial design reflects Dyson's brand identity and innovative image.
- Integrated air purification mask is highly visible—may divide opinion in public/social settings.

User Requirements:

- Combines audio playback with air purification—suitable for urban users concerned about pollution and noise.
- Likely to offer noise cancellation and high-quality sound for commuting and office use.

- Bulk and visual impact may reduce appeal for portability or casual daily wear.
- Air filter component may offer tangible health benefits in polluted environments but could be seen as excessive or uncomfortable by some users.

Functionality:

- Multifunctional design integrates multiple technologies, increasing convenience.
- May include smart features (e.g., voice control, air quality sensors).
- Rechargeable components require power management; battery life may impact usage patterns.
- Potentially heavy or awkward for long periods—ergonomics and comfort are crucial for long-term wear.

END OF MARK SCHEME