Mark scheme

Q1.1)

1 mark for property, 1 mark for explanation

Thermal conductivity:

- The ability of a material to conduct heat energy, meaning how easily heat can pass through it.

Electrical conductivity:

- The ability of a material to allow electric current to flow, meaning how easily electricity passes through it.

Q1.2)

Original value = 0.5

New value = 0.2

Step 1: Find the decrease

0.5 − 0.2 = 0.3 **(1 mark)**

Step 2: Divide by original value

0.3 ÷ 0.5 = 0.6 **(1 mark)**

Step 3: Convert to percentage

0.6 × 100 = 60 **(1 mark)**

Final Answer: 60% reduction (1 mark)

Q2)

Marks	**Description**
5-6 marks	Clear and developed discussion showing strong connections between a wide range of factors. Demonstrates thorough understanding with effective application to the task.
3-4 marks	Reasonable discussion with some relevant connections between factors. Shows sound understanding with generally appropriate application to the task.
1-2 marks	Basic discussion with limited consideration of factors. Shows limited understanding with only partial application to the task.
0 marks	No response or no creditworthy content.

- UF is a thermal insulator which means it does not absorb heat easily, which will stop the plug overheating and potentially catching fire.
- UF is an electrical insulator which means it does not conduct electricity, which prevents electric shock when handling the plug.
- UF is a thermosetting plastic which means it does not soften or melt when heated, which helps the plug maintain its shape and remain safe under high temperatures.
- UF is hard and rigid which means it resists deformation and wear, which protects the internal components from damage.

Q3)

Marks	**Description**
5-6 marks	Clear and developed discussion showing strong connections between a wide range of factors. Demonstrates thorough understanding with effective application to the task.
3-4 marks	Reasonable discussion with some relevant connections between factors. Shows sound understanding with generally appropriate application to the task.
1-2 marks	Basic discussion with limited consideration of factors. Shows limited understanding with only partial application to the task.
0 marks	No response or no creditworthy content.

- 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.

Q4)

Marks	**Description**
5-6 marks	Clear and developed discussion showing strong connections between a wide range of factors. Demonstrates thorough understanding with effective application to the task.
3-4 marks	Reasonable discussion with some relevant connections between factors. Shows sound understanding with generally appropriate application to the task.
1-2 marks	Basic discussion with limited consideration of factors. Shows limited understanding with only partial application to the task.
0 marks	No response or no creditworthy content.

- Superelasticity / SMAs are extremely flexible allows them to spring back to their original shape / providing a close and comfortable fit making them suitable for a range of head shapes / sizes
- If bent or kinked they can return to their original shape by application of heat to the transition temperature / submersion in hot water
- Thin / discreet sections can be used / good strength to weight ratio reducing the weight of the spectacle frame so very comfortable to wear
- Good mechanical properties so resistant to typical spectacle damage therefore durable and long lasting

Q5)

Marks	**Description**
5-6 marks	Clear and developed discussion showing strong connections between a wide range of factors. Demonstrates thorough understanding with effective application to the task.

3-4 marks	Reasonable discussion with some relevant connections between factors. Shows sound understanding with generally appropriate application to the task.
1-2 marks	Basic discussion with limited consideration of factors. Shows limited understanding with only partial application to the task.
0 marks	No response or no creditworthy content.

- 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.

Q6)

Marks	**Description**
5-6 marks	Clear and developed discussion showing strong connections between a wide range of factors. Demonstrates thorough understanding with effective application to the task.
3-4 marks	Reasonable discussion with some relevant connections between factors. Shows sound understanding with generally appropriate application to the task.
1-2 marks	Basic discussion with limited consideration of factors. Shows limited understanding with only partial application to the task.
0 marks	No response or no creditworthy content.

- 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.

Q7.1)

Marks	**Description**
5-6 marks	The response demonstrates excellent justification and explanation of why CFD can be used to improve efficiency. Response directly refers to how factors such as time, cost and material usage are impacted by the use of CFD.
3-4 marks	The response provides good justification and explanation of why CFD can be used to improve efficiency. Response provides some evaluation of how efficiency is improved, with reference to factors such as time, cost and material usage.
1-2 marks	The response shows a basic justification of how CFD can be used to improve efficiency, but tends to be descriptive rather than evaluative.
0 marks	No response or nothing worthy of credit.

- CFD can help a designer identify a inefficiency in the design before time has been taken to produce a physical prototype.

- CFD allows designers to test how different shapes/aerodynamics could be used without the expense of producing various iterations of a prototype.
- Inappropriate designs can be discounted at an early stage of development saving time and resources and allowing designers to work more efficiently.
- A degree of speed testing can take place with instant feedback without the cost and time that would be needed if third party companies were used.
- CFD can be undertaken throughout the development process allowing manufacturers to refine individual components before manufacture.
- Testing can take place and maximum working speeds calculated.
- There is no need for destructive testing to take place and therefore reducing the material used to make numerous physical prototypes.
- Simulations in different environmental conditions can take place such as extremes of temperature/wind, reducing the need for costly testing facilities.

Q7.2)

$\text{Time} \propto 1 / \text{speed}$

$$t_{new} = 12 \times \frac{2.5}{4.0}$$

$t_{new} = 12 \times \frac{2.5}{4.0}$

$$t_{new} = 7.5 \text{ hours}$$

Q8.1)
One mark per response

- Check blade tension / movement / damage
- Use a guard / adjust the blade guard and top guides as close as possible to the workpiece
- Use of a push stick for straight cuts / narrow workpiece
- Replace blunt blades to avoid having to use too much forward force
- Keep fingers / thumbs well clear of blade
- Tie back long hair / secure loose clothing / remove gloves
- Check position and operation of emergency stop / kick stop

- Switch off immediately if a blade breaks / becomes jammed / requires clearing
- Use a slide fence for cross cuts
- Always keep the workpiece flat on the table
- Only cut materials that can be fully supported on the bed of the table/do not cut cylindrical materials
- A marked exclusion zone around the machine should be clear of people before starting work.
- Use extraction equipment
- Only used by trained operatives
- Switch off after use
- Lower blade guard after use
- Avoid working alone / work under supervision
- Ensure the area around the machine is clean and clear of clutter / debris

Q8.2)

Marks	**Description**
5-6 marks	Comprehensive discussion that makes effective links between a wide range of factors, demonstrating thorough understanding. Considered and effective application of understanding to the context of the question.
3-4 marks	Coherent discussion that makes some relevant links between a sufficient range of factors, demonstrating competent understanding. Generally sound application of understanding to the context of the question.
1-2 marks	Superficial discussion that considers a narrow range of factors, demonstrating limited understanding. Partial application of understanding to the context of the question.
0 marks	No response or nothing worthy of credit.

Candidates might refer to the following in their responses:

- Requirements for a safety policy
- Risk assessments
- Method statements
- Safety officer requirements
- Union representation

- Staff training and certification
- Authority of the safety officer
- Ultimate responsibility of owners / directors
- Role of the Health and Safety Executive (HSE)
- Improvement notices (HSE)
- Prohibition notices (HSE)
- Withdrawing approvals, licences or exemptions (HSE)
- HSE cautions
- Prosecution – unlimited fines or imprisonment
- Company reputation
- Difficulties recruiting new employees
- Blacklisting / loss of consumer confidence
- Negative publicity / reputation loss
- Difficulties obtaining employers liability insurance
- Increased costs to the company

Q9)

Marks	**Description**
5-6 marks	Comprehensive discussion that makes effective links between a wide range of factors, demonstrating thorough understanding. Considered and effective application of understanding to the context of the question.
3-4 marks	Coherent discussion that makes some relevant links between a sufficient range of factors, demonstrating competent understanding. Generally sound application of understanding to the context of the question.
1-2 marks	Superficial discussion that considers a narrow range of factors, demonstrating limited understanding. Partial application of understanding to the context of the question.
0 marks	No response or nothing worthy of credit.

- Consumer rights act
- Sale of goods act
- Goods should be fit for purpose including any specific purpose made known to the retailer at the time of purchase

- Goods should be what a reasonable person would consider to be satisfactory quality for the goods in question ie higher expectations of luxury/high end products
- Goods should be as described or any samples shown at the time of purchase
- Does not apply if the buyer was aware of the defects at the time of purchase
- Consumer has rights / can claim against the retailer
- Remedies under the act include return and refund, repair, and replacement
- Defects assumed to be present at the time of purchase if notified within 6 months
- Right to reject goods for a refund within 30 days if criteria is not met
- After 30 days retailer has the choice of repair or refund
- Defects assumed to be present at the time of purchase if notified within 6 months unless proved otherwise by the retailer
- After 6 months the purchaser needs to prove that the defect was present at the time of sale
- Can make a claim within the first six years
- Special rules apply to digital content
- Also covers delivery rights, services and unfair contract terms

Q10.1)
Two marks per explained point

- Registered design rights must be formally applied for and approved whereas unregistered design rights are automatically given when a design is created
- Registered design rights provide stronger legal protection whereas unregistered design rights offer more limited protection
- Registered design rights protect appearance such as shape, configuration and decoration whereas unregistered design rights mainly protect the shape and configuration only
- Registered design rights last longer (up to 25 years if renewed) whereas unregistered design rights last for a shorter time

Q10.2)

Probability a component **passes** = 1 − 0.1 = 0.9

Probability all 3 pass = 0.9 × 0.9 × 0.9 = 0.729 **(1 mark)**

Probability at least one fails = 1 − 0.729 = 0.271 **(1 mark)**

Final answer: 0.271 (1 mark)

Q11)

Marks	**Description**
7- 9 marks	The candidate has a clear understanding of the value of a feasibility study. They produce a thorough discussion in relation to the question. The explanation of reasons is clear and well-developed.
4-6 marks	The candidate has a reasonable understanding of the value of a feasibility study. They produce a reasonable discussion in relation to the question.
1-3 marks	The candidate has a basic knowledge of the value of a feasibility study. Any reference to this issue is descriptive in nature and has little appreciation of the aspects involved in a feasibility study and may just focus on one or two aspects and miss opportunities.
0 marks	No response or nothing worthy of credit.

Positive values feasibility studies have positive effect on a product as ensuring the following will create better profits through:

- The design solution's impact on user lifestyle: checks that the product will be beneficial to society, both ethically and safety. Increased sales increase profitability and then feasibility of the product.
- How well a product performs. The effectiveness of a product, ensure that the consumers are getting a quality product. This can then help the designer and manufacturer make decisions about the design.
- Technical difficulty of manufacture: This can be modelled on the computer and would have a direct impact on the cost of the product. This can then be assessed.
- Stock availability: Ability to source material for production, as materials that are hard or from unreliable sources to obtain may well be unsuitable.

- Costs and profits: Costs of the product and manufacture, hidden costs such a factory and lighting costs, are collated and compared to the price that the customer is charged.

Negative aspects might include:

- Cost of the study may raise the cost of the manufacture.
- The feasibility study will slow the progress of the product down as it might highlight areas that could be improved.
- Any other suitable response.

Q12)

Marks	**Description**
7- 9 marks	Comprehensive discussion that makes effective links between a wide range of factors, demonstrating thorough understanding. Considered and effective application of understanding to the context of the question.
4-6 marks	Coherent discussion that makes some relevant links between a sufficient range of factors, demonstrating competent understanding. Generally sound application of understanding to the context of the question.
1-3 marks	Superficial discussion that considers a narrow range of factors, demonstrating limited understanding. Partial application of understanding to the context of the question.
0 marks	No response or nothing worthy of credit.

Candidates might refer to the following in their responses:

- Minimisation of waste, and energy leakage
- 5Rs principles; reduce, reuse, refurbish, repair and recycle.
- Slowing, closing and narrowing material and energy loops
- Contrast to a linear economy which is a ‘take, make, dispose’ model of production
- Increase in repairability of designs
- Move away from the ‘built in obsolescence’ culture
- Products designed to be long lasting and durable
- Futureproofing designs
- Increased focus on upcycling
- A shift from fossil fuels to renewable energies
- Emphasises ‘cradle to cradle’ approach

- Optimisation of systems
- Circular framework
- Approach taken to deal with the end of the cheap oil and fossil fuels era
- Transition to a low carbon economy
- Prioritisation of regenerative resources
- Use waste as a resource
- Designing out waste from processes
- Designing for a lifetime and extended future use
- Preserving and extending what is already made
- Collaboration to create joint value
- Incorporation of digital technologies to track and optimise resource use
- Circular business models
- Increase in recycling, associated costs and benefits
- Requirement for recycling infrastructure
- Positive support from governments and environmental pressure groups
- Investment in waste recovery systems
- Increased use of repair and upgrade programmes including buyback programmes and supporting logistics
- Retains raw materials for future generations use
- Retains the potential for future generations to meet their needs

Q13)

$700 \times 400 = 280{,}000\,\text{mm}^2$ **(1 mark)**

$h = \frac{250}{\tan(51.5^\circ)} = 198.4\,\text{mm}$ **(1 mark)**

$\frac{1}{2} \times 500 \times 198.4 = 49{,}600\,\text{mm}^2$ **(1 mark)**

$280{,}000 - 49{,}600 = 230{,}400\,\text{mm}^2 = 0.2304\,\text{m}^2$ **(1 mark)**

$0.2304 \times 6 \times 20 = 27.648\,\text{m}^3$ **(1 mark)**

$27.648 \times 7750 = 214{,}272\,\text{kg}$ **(1 mark)**

Q14)

Marks	**Description**
9-12 marks	Clear, detailed evaluation with well-supported judgements. Ideas are developed and consistently linked to the question.

5-8 marks	Some evaluation with generally appropriate judgements. There is some development, but it may be inconsistent or not fully clear throughout.
1-4 marks	Basic comments with little real evaluation. Mainly descriptive with limited or weak judgement.
0 marks	No response worthy of credit.

Indicative content:

Ergonomics	• Ergonomic handle on polymer kettle allowing firm safe grip • Polymer construction is an insulator and prevents transfer of heat and burns • Carrying handle is away (opposite side) from steam outlet on polymer kettle unlike other two when hot steam rises and may burn you • Polymer could make use of thermochromic pigment to indicate when contents are hot • Whistling kettle gives audible sound when water is boiling • Polymer kettle has viewing window so user can see if kettle needs re filling • Awkward carrying position with handle over the top of the main kettle body for whistling kettle
Functionality	• No trailing flex with the iron stove top kettle – less chance of being pulled off stove surface • Hinged lid on polymer kettle for ease of closure and resealing • Docking unit means kettle flex an plug do not go anywhere near water which would be a possible risk of electric shock

	• Light weight for elderly and less able body to carry and manipulate • Thermostatic trip when the water has boiled, preventing kettle from boiling dry • Risk of electric shock if kettle develops a fault or water accesses the electrics • Difficult to gauge how much water you are boiling, which may lead to heating too much water • Polymer kettle MUST be near an electrical point • Whistling kettle MUST be near a gas/electric/inductive hob
Innovation	• Viewing window so you can see exactly how much water you are boiling • Viewing window has water level marks to indicate precise capacity • Trip switch to turn polymer kettle off and save electricity • Polymer kettle acts as an insulator and will keep the water hotter for longer requiring less frequent boiling • Use of lighter materials • Use of materials that insulate and keep the water warmer for longer • The polymer and whistling kettle consider the safety more effectively • The polymer and whistling kettles consider the ease of use more effectively than the cast iron kettle • The use of new materials has allowed for kettle development to consider the aesthetics of the product rather than just the function • Modern kettles consider energy efficiency far more than the cast iron style kettle • Just plug into electricity supply • The polymer kettle MUST have a (240v) electric supply to work

Q15)
One mark per correct point

Indicative content:

- Symbol / insignia / logo / icon
- Word / phrase / slogan
- Name / initials
- Device / design / style
- Sounds / jingle
- Colour schemes

Q16.1)

- Mid point result 3+9+6+4+3=25/2=12.5 (M1)
- Median failure load = 13th result = 400 (A1) (Newtons)

Q16.2)

- (380x3)+(390x9)+(400x6)+(410x4)+(420x3) (M1)
- 1140+3510+2400+1640+1260 =9950 (A1)
- 9950/(3+9+6+4+3) 9950/25 (M1)
- 398 (Newtons) (A1)

Q17)
1 mark for a ferrous metal which could be treated by hardening accept: medium and high carbon steel (do not accept low carbon steel unless case hardening is referred to). 1 mark for a relevant product: accept any appropriate product, such as screwdriver blades, chisels, drill bits, saw blades etc.

Two marks for reasons:

- reference to need to keep a sharp edge when working with the product
- resisting wear from abrasion.

Q18)
One mark per correct benefit of stock forms to the manufacturer.

Indicative content:

- Uniformity of material sizes across countries and suppliers.
- The use of a stock form reduces extra costs for manufacturers associated with machining to a specific size.

- Less expensive than custom sizes due to the large quantity produced.
- Allows for efficient planning of manufacture to minimise waste.
- Allows manufacturers to plan for the efficient storage of raw materials.
- Less likely to have any delays in manufacture than a custom size.

END OF MARK SCHEME