Mark scheme

Q1)

Marks	Description
9 – 12 marks	Full use of the information concerning the two water bottles has been made to form justified analytical and evaluative statements. Detailed technical knowledge and understanding beyond the information provided is given and related to the suitability for sports use and large-scale production. There will be clear reference to product function, manufacturing processes (injection moulding and deep drawing), and material properties of polypropylene and stainless steel. There may be some minor irrelevant comments or lack of clarity in places but this will not detract from the overall quality of the response.
5 – 8 marks	Most of the information concerning the two water bottles has been utilised to form analytical statements. Some technical detail beyond the information provided is given with reference to product function, manufacturing processes and suitability for sports use. At the lower end of the band there may be limited expansion on some of the information given. The majority of comments will be relevant.
1 – 4 marks	Basic use of the information has been made to compare the two water bottles with limited expansion to show further knowledge and understanding. Comments will mainly describe the information given, such as basic material or manufacturing differences, with little reference to sports suitability or production methods.
0 marks	No response or nothing worthy of credit.

Indicative content:

Plastic water bottle

- Polypropylene is a thermoplastic, so it can be repeatedly melted and reformed, making it suitable for mass production and recycling
- Lightweight material, making it easy to carry during sport and reducing user fatigue
- Flexible and slightly impact resistant, so it is less likely to shatter if dropped compared to metal or glass

- Injection moulding allows fast, automated, high-volume production, making the bottle cheap to manufacture per unit
- Injection moulding produces consistent, accurate shapes with smooth finishes and good repeatability for large-scale production
- Can be easily coloured or made translucent during manufacturing for aesthetic appeal and visibility of liquid level
- Lower thermal insulation than metal, so drinks may change temperature more quickly during use
- May be less durable over long-term heavy use compared to stainless steel, as it can scratch or deform under stress
- Suitable for sports due to low weight, ease of grip, and portability
- Can be designed with ergonomic features (e.g. squeeze sections or sports caps) due to mouldability

Metal water bottle

- Stainless steel is a strong, rigid material with high durability, making it suitable for repeated long-term use in demanding environments such as sport
- It is corrosion resistant, so it does not rust easily when exposed to water or sweat, improving product lifespan
- Deep drawing is used to form the bottle from a metal sheet, involving stretching and shaping the metal into a seamless container
- Deep drawing is suitable for producing strong, seamless products with good structural integrity and fewer weak points compared to joined structures
- Metal bottles generally require more energy and time to manufacture compared to plastic injection moulding, making them more expensive per unit
- Stainless steel provides good thermal insulation compared to plastic, especially if double-walled, helping to keep drinks hot or cold for longer
- Heavier than polypropylene, which can make it less convenient for some sports activities where weight is important
- Does not absorb flavours or odours, improving hygiene and drink quality over time
- Highly impact resistant and less likely to crack or deform under pressure compared to plastic
- Suitable for premium or outdoor sports use where durability and temperature control are more important than weight

Q2)

Gradient:
$(18 - 14) \div (1500 - 1200) = 4 \div 300 = 1/75$

Change from 1200 to 800:
$1200 - 800 = 400$

Density change:
$400 \div 75 = 16/3$

Final density:
$14 - 16/3 = 42/3 - 16/3 = 26/3 = 8.67\ kg/m^3$

Q3)

5 -6 marks	The candidate has a clear understanding of the importance of jigs in commercial production They produce a thorough discussion in relation to the question by explaining the importance of jigs and why they are used. The explanation related to commercial production is clear and well-developed.
3 – 4 marks	The candidate has a reasonable understanding of the importance of jigs in commercial production. They produce a sound discussion in relation to the question by explaining the importance of jigs and why they are used. The explanation is sufficient although one or two opportunities are missed.
1 – 2 marks	The candidate has a basic knowledge of the importance of jigs in commercial production. Any reference is descriptive in nature and has little appreciation of importance (the why!). The response contains no analysis or evaluation.
0 marks	No rewardable content

Indicative content:

- Speeds up production as there is no time wasted measuring and marking out. This is important for commercial production as it reduces costs because less time is needed to manufacture each part, so the time in the factories is less and a smaller, less skilled work force is required.
- Ensures quality and accuracy as commercial products should be made exactly the same to prevent errors. Without jigs there is a greater chance of human error. This is very important as consumer complaints

could lead to negative brand association and a fall in sales. Safety could also be compromised which would lead to huge implications for the manufacturer.
- Reduces waste from incorrectly made parts.
- Any other valid suggestion.

Q4)

Award 1 mark for each ergonomic feature up to a maximum of 4:

- buttons to open lid easy to see/use/locate
- comfortable or rounded handle
- light that turns on/off for when water is boiling/boiled
- viewing window for seeing if kettle needs refilling
- handle and steam spout are on opposite sides, so user won't get hurt

Any other valid answer

Q5)

1 mark per relevant point (max 4)

Indicative content:

- You are able to gain a range of views on a product which is not possible from a single user
- Designers are able to gain constructive criticism prior to production of the design
- It saves costs as changes during the development stage are much cheaper than during production.
- Focus groups can be held with specific demographics relevant to the product being assessed
- If the product being designed is for a demographic group you are unfamiliar with it is essential to apply a User Centred Design approach. This list is not exhaustive. Accept any other valid responses.

Q6)

5 -6 marks	Responses clearly outline and explain relevant methods used by design teams to reduce time from idea conception to product release. There is accurate use of methods such as rapid prototyping (e.g. 3D printing), concurrent engineering, CAD/virtual modelling, project management systems, critical

	path analysis, and effective primary research. Explanations are clearly linked to how each method reduces lead time by identifying errors early, improving communication, reducing redesign, and improving planning efficiency. The response is well structured, technically accurate, and mostly fully developed.
3 – 4 marks	Responses outline some valid methods used to reduce development time, with some explanation. There may be reference to techniques such as CAD, prototyping, or teamwork tools, but links to time reduction are sometimes general or not fully developed. Some understanding of project management or collaboration may be shown, but detail is inconsistent and explanations may be partially incomplete.
1 – 2 marks	Responses show limited awareness of methods used in product development. Simple references may be made to ideas such as making prototypes or using computers, but there is little explanation of how these reduce time to market. Answers are mainly descriptive with minimal technical detail and weak links to the question.
0 marks	No rewardable content

Candidates might refer to the following in their responses:

- Focus groups and effective primary research ensures that concepts meet consumer demands.
- Rapid prototyping using 3D printing techniques allows clients and consumers to visualise concepts and make adjustments early on in the development process.
- Use of online shared documents to enable collaboration between workers.
- The use of concurrent engineering to ensure all members of the team are involved throughout the development will reduce lead time as errors can be found earlier.
- The use of critical path analysis allows the team to predict log jams and allocate staffing accordingly to prevent delays, this also ensures that all processes are started as promptly and early as possible.
- The use of a project management system to check the progress of all elements at regular intervals and redistribute staffing accordingly increases efficiency, (SCRUM).
- The use of a project management system to analyse all processes and reduce errors, (Six sigma).

- The use of virtual modelling of concepts prior to production reduces monetary investment and time in production processes that may be incorrect.

Q7)

Stage 1 (calculate the number of rivet guns required)
235 / (6 x 60/2) = 1.305
= 2 guns required
(accept other valid ways of calculating the number of rivet guns)

Stage 2 (calculate the number of rivets required including waste allowance)
235 + (235 x 7.5/100) =
235 + 17.625 = 252.625 or 253 (1)

Stage 3 (calculate the cost of full packs of rivets)
253 / 50 = 5.06 (6 packs)
6 x £2.50 = £15.00 (1)

Stage 4 (calculate cost of rivet guns)
£38.25 x 2 = £76.50 (1)

Stage 5 (calculate total cost)
£76.50 + £15.00 = £91.50

Q8)

5 -6 marks	• Comprehensive response demonstrating thorough knowledge of a wide range of relevant factors. • Makes effective connections between factors discussed, demonstrating a thorough understanding of the design concept.

3 – 4 marks	• Coherent response demonstrating competent knowledge of a sufficient range of relevant factors. • Makes sound connections between factors discussed, demonstrating a competent understanding of the design concept.
1 – 2 marks	• Superficial response that demonstrates basic knowledge of a narrow range of relevant factors. • Makes tentative connections between factors discussed, demonstrating a limited understanding of the design concept.
0 marks	No rewardable content

Candidates might refer to the following in their responses:

- Form follows function
- Simplicity – removal of clutter
- Aimed to be affordable – Within reach of the masses, but rarely achieved
- Proportion – suitable size for current living conditions / not oversized
- Minimal decoration – humble / simple construction / rustic
- Experimentation with materials / techniques
- Preference for natural materials / beauty of natural materials
- Use unusual materials and precious metals
- Natural forms – plants / birds / animals
- Stylisation / symbolism / patterning / Medieval styles / stylised flowers / Celtic motifs / hearts / sailing ships
- Colour – used to provide unity and focus / highly decorated / coloured small areas
- Link between colour and nature
- Empowered people to design / make their own products / handmade
- Splendour and simplicity
- Were against industrially produced bland designs
- High quality / long lasting / handed down.

Q9.1)

The three roles within the scrum team, 3 marks:

- Product owner
- Scrum master / project leader / project manager

- Developers / development team / designers

Q9.2)

5 -6 marks	Responses clearly outline and explain the key features of the scrum process. There is accurate use of relevant terminology such as sprints, timeboxing, iterative development, daily scrum meetings, self-organisation, and the role of the scrum master. Explanations show clear understanding of how scrum supports teamwork, communication, feedback, and continuous improvement through short development cycles and regular evaluation. The response is well-structured, technically accurate, and most points are developed.
3 – 4 marks	Responses outline some features of the scrum process, with some correct terminology used. There may be reference to ideas such as teamwork, meetings, or iterative development, but explanations are often general or only partially developed. Some understanding of roles or sprint-based working may be shown, but links to how scrum improves project management or efficiency are inconsistent.
1 – 2 marks	Responses show limited awareness of scrum, with basic statements about teamwork or meetings. There is little understanding of how the process works as a structured system. Any references to scrum features are vague, with minimal use of technical language and little or no explanation of purpose or benefit.
0 marks	No rewardable content

Indicative content

- Holistic project management strategy
- Teamwork is at the centre of the process
- Control over the empirical process (transparency, evaluation and adaptation)
- Self-organisation (increases the level of independence of the team) / feedback from workers / daily team meetings / scrum sessions
- Assessment of team performance
- Team goals
- Led by scrum master / leader / project manager
- Collaboration (awareness, clarity and distribution)

- Feedback at every stage
- Value based prioritisation (value and importance to end users and the manufacturer to determine order of completion)
- Timeboxing (allocating and scheduling time to activities)
- Sprints (short release cycles with planning, daily monitoring and reviews) to achieve smaller broken down tasks
- Iterative development (constant/ongoing adjustment and revision of design to create the best product possible) continuous improvement
- Scrum values: commitment, courage, focus, openness and respect
- Consumer feedback to update designs

Q10)

BSI Kitemark
(DO NOT accept BSI Logo)

Q11)
Method 1

Stage 1 (calculate the area of the top and bottom flange) (1)
10 x 125 x 2 = 2500 mm2

Stage 2 (calculate area of the web) (1)
(175 – (2 x 10)) x 10 = 1550 mm2

Stage 3 (calculate the total area) (1)
2500 + 1550 = 4050 mm2

Stage 4 (conversion of units) (1)
4050 /(1000x1000) = 0.00405 m2

Stage 5 (0.0041m2 answer shown to 4dp) (1)

Method 2

Stage 1 (calculate the area of the rectangle) (1)

125 x 175 = 21875 mm2

Stage 2 (calculate area of the two voids)
(1)
2x((175 – (2 x 10)) x ((125-10)/2)) =
17825 mm2

Stage 3 (calculate the total area) (1)
21875 - 17825 = 4050 mm2

Stage 4 (conversion of units) (1)
4050 /(1000x1000) = 0.00405 m2

Stage 5 (0.0041m2 answer shown to
4dp)
(1)

Q12)

5 -6 marks	Responses clearly evaluate the impact of total quality management (TQM) on employees, showing balanced discussion of both advantages and disadvantages. There is accurate use of relevant concepts such as employee empowerment, team working, continuous improvement, and responsibility for quality. Points are developed and linked to clear outcomes such as motivation, job satisfaction, productivity, training opportunities, and potential increased stress or resistance to change. Judgements are made and supported with reasoning, showing clear understanding of how TQM affects employees overall.
3 – 4 marks	Responses describe some impacts of TQM on employees, with some attempt at explanation or evaluation. There may be reference to ideas such as teamwork, motivation, or responsibility for quality, but points may be one-sided or not fully developed. Some advantages and/or disadvantages are identified, but evaluation is limited or lacks clear judgement.
1 – 2 marks	Responses show basic awareness of TQM with simple statements about teamwork, quality, or employees being involved. There is little or no evaluation, and answers are mainly descriptive with minimal development or technical

	understanding. Links to employee impact are weak or unclear.
0 marks	No rewardable content

Indicative content:
Advantages

- Employees in departments have a supplier–customer relationship with other departments / improved communications.
- Employees are engaged in continuous improvement / encouraged to suggest improvements / take initiatives / simplify tasks.
- Employees are responsible for the quality of their own work.
- Employees are placed in teams.
- Improved worker moral / workers feel valued / happy / good job satisfaction / pride.
- Less employee absence.
- Employees are more motivated
- Employees are more productive / more efficient.
- Employees are empowered to make decisions / given more responsibility.
- Employees have improved health & safety / working conditions.
- Employees have increased job security.
- Opportunities for further training / increased skill levels.
- Opportunities for internal promotion.
- Employees receive competitive pay / improved standard of living.

Disadvantages

- Some employees may be put under additional stress / pressure / expected to work harder.
- Some employees are reluctant to embrace changes.
- Some may leave the business / become unemployed.

Q13)

1 mark per correct point

- Refuse
- Repair
- Rethink

Q14)

5 -6 marks	Responses clearly discuss the issues associated with the use of biomass and biofuels as alternative energy sources. There is accurate and relevant technical understanding of environmental, economic, and practical limitations, such as carbon emissions from production and processing, reduced land availability for food crops, lower efficiency compared to fossil fuels, and issues with availability and infrastructure. Points are developed and linked to sustainability, cost, and usability, with some evaluation of overall suitability as an energy source.
3 – 4 marks	Responses describe some issues related to biomass and biofuels with some explanation. There may be reference to environmental concerns, cost, efficiency, or land use, but points are not always fully developed or clearly linked to overall impact. Some understanding is shown, but coverage may be uneven or partially repetitive.
1 – 2 marks	Responses show basic awareness of biomass or biofuels with simple statements such as being expensive, polluting, or needing land. There is little development or explanation, and answers are mostly descriptive with limited technical detail or relevance to the question.
0 marks	No rewardable content

Indicative content

- The fuel used by agricultural machinery producing the crop / energy used in processing it, generates significant carbon emissions therefore it is far from carbon neutral.
- Agricultural land given over to biomass crops reduces the area available for growing food crops which may contribute to increased food costs / insufficient being available in some of the parts of the world.
- Biofuels are not are not as efficient as petroleum based fuels therefore more are needed to carry out the same task.
- Limited availability of biofuels due to the technology being in its infancy / so refuelling vehicles may be a problem.
- The burning of biomass still generates some carbon emissions further contributing to greenhouse gasses. / So cleaner combustion methods still need to be found.

- Deforestation / habitat destruction / ecological damage could happen when harvesting fuel so sustainable land management / forests are essential.
- Additional water is needed for irrigation and processing of biofuels. This increased demand for water can put an unsustainable burden on available supplies.
- Vehicle engines modifications needed to use fuel.
- Cost of biofuel is higher than comparable fuels. due to expensive processing procedures.
- Bad odours can be given off when using biomass.

Q15)

1 mark per correct point

- Nature
- Existing products
- Mood boards
- Client requirements

Any other appropriate response