

GCE

Design and Technology

H406/02: Problem solving in Product Design

A Level

Mark Scheme for June 2025

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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MARKING INSTRUCTIONS

PREPARATION FOR MARKING

RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training: OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are available in RM Assessor
3. Log-in to RM Assessor and mark the **required number** of practice responses (“scripts”) and the **required number** of standardisation responses.

MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the RM Assessor messaging system.
5. **Crossed-Out Responses**
Where a candidate has crossed out a response and provided a clear alternative then the crossed-out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed-out response where legible.

Rubric Error Responses – Optional Questions

Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM Assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

Multiple-Choice Question Responses

When a multiple-choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).

When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses

When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only one mark per response)

Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth two or more marks)

If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space).

Longer Answer Questions (requiring a developed response)

Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add the annotation 'SEEN' to confirm that the work has been seen and mark any responses using the annotations in section 11.
7. There is a NR (**No Response**) option. Award NR (No Response):
 - if there is nothing written at all in the answer space
 - OR if there is a comment which does not in any way relate to the question (e.g., 'can't do', 'don't know')
 - OR if there is a mark (e.g., a dash, a question mark) which is not an attempt at the question.

Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The RM Assessor **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.
10. For answers marked by levels of response:
- To determine the level** – start at the highest level and work down until you reach the level that matches the answer
 - To determine the mark within the level**, consider the following:

Descriptor	Award mark
On the borderline of this level and the one below	At bottom of level
Just enough achievement on balance for this level	Above bottom and either below middle or at middle of level (depending on number of marks available)
Meets the criteria but with some slight inconsistency	Above middle and either below top of level or at middle of level (depending on number of marks available)
Consistently meets the criteria for this level	At top of level

11. Annotations

Annotation	Meaning
	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
	Tick
	Benefit of doubt
	Error carried forward
	Noted but no credit given
	Level 1 response
	Level 2 response
	Level 3 response
	Level 4 response
	Highlighter for Level responses

12. Subject Specific Marking Instructions

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet Instructions for Examiners. If you are examining for the first time, please read carefully Appendix 5 Introduction to Script Marking: Notes for New Examiners.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

Question	Answer	Mark		Guidance
1	Indicative Content: Carer and parents Marketing Methods for Carers and Parents Family-Friendly Promotions: - To keep the cost of visiting down, introduce membership packages that offer unlimited access to the museum and its interactive play areas. This can encourage repeat visits and foster a sense of community among members. Discounted Family Tickets: Offer discounted family tickets or packages that make it more affordable for families to visit the museum. This can include special rates for larger families or multi-visit passes. - Attract new families with low-cost opportunities that make a visit attractive. Offer discounts or free entry for children to attract more families. Membership Benefits: Provide membership options that offer long-term benefits, such as unlimited visits, discounts on food and merchandise, and exclusive access to special events. - Host special events such as family days, themed weekends, and holiday celebrations that feature the interactive play activities. Engaging and Educational Content: Interactive Workshops: Organize workshops and activities that engage both children and their carers, focusing on	8	All responses should be in relation to the information provided. Candidates may extract information from the Resource Booklet. Any such lifted information can be used in support of the discussion but no marks should be awarded simply for duplicating text. There is no analysis or evaluation in Level 1.	Level 4 (7-8 marks) A comprehensive critical examination of marketing methods. Comprehensive understanding of typically the two stakeholder groups specified in question. Information in RB is used effectively to fully exemplify the points being made. Well-constructed response in relation to question with a clear and developed narrative. Level 3 (5-6 marks) A good critical examination of marketing methods. Good understanding of typically the two stakeholder groups specified in question. Information in RB is used for the most part effectively to exemplify points being made although one or two opportunities are missed. Well-constructed response in relation to question although one or two opportunities not taken to develop narrative. Level 2 (3-4 marks) A sufficient critical examination of marketing methods. Sufficient understanding of typically at least one of the stakeholder groups specified in question. Information in RB is used to exemplify some points being made although much more could have been done to exploit the stimulus material available. Reasonable response in relation to the question although narrative at times lacks depth and cohesion. Level 1 (1-2 marks) A limited coverage of marketing methods. Limited understanding of typically one stakeholder group specified in question. Use of information from

Question	Answer	Mark		Guidance
	educational and fun experiences. These can include arts and crafts, science experiments, and storytelling sessions. • Educational Programs: Develop programs that align with school curriculums, making the museum an attractive destination for school trips and educational outings. • Collaborate with local schools to organise field trips and educational programs that incorporate the interactive play activities. This can help in building long-term relationships and ensuring a steady stream of visitors. Convenience and Accessibility: • Facilities and Amenities: Ensure the museum is equipped with family-friendly facilities such as baby changing stations, nursing rooms, and accessible restrooms. Comfortable seating areas and cafes can also enhance the visitor experience. • Ensure the activities are safe and educational, providing value for money. Highlight these aspects in marketing materials. • Easy Access: Provide clear information on transportation options, parking facilities, and stroller-friendly routes within the museum. Community Engagement: • Local Partnerships: Partner with local schools, daycare centres, and community organisations to promote the museum and its activities. This can include special events, group discounts, and collaborative projects. • Parent Groups and Forums: Engage with parent groups and online forums to share information about the museum's offerings and gather feedback to improve services. Digital Marketing and Social Media:			the RB is used in a simplistic way and adds limited value to the points being made. Limited response in relation to question. Narrative is basic and unstructured. 0 marks = No response or no response worthy of credit.

Question	Answer	Mark		Guidance
	• Targeted Advertising: Use targeted online advertising to reach parents and carers, highlighting the educational and entertainment value of the museum's interactive play activities. • Targeted adverts such as posters, letters, flyers, leaflets can be distributed via schools, community groups and can reach parents and carers in the local area directly. • Social Media Campaigns: Create engaging social media content that showcases the museum's activities, facilities, and special events. Encourage parents to share their experiences and reviews online. • Utilise platforms like Facebook, Instagram, and Twitter to share engaging content about the new interactive play activities. This can include videos, photos, and testimonials from families who have enjoyed the activities. Benefits for Carers and Parents • Educational Value: The museum's interactive play activities provide educational benefits, promoting creativity, imagination, and problem-solving skills in children. • Family Bonding: The museum offers a space for families to spend quality time together, participating in activities that are enjoyable for both children and adults. • Convenience and Comfort: By providing family-friendly facilities and amenities, the museum ensures a comfortable and stress-free visit for carers and parents. • Community Connection: Engaging with local communities and parent groups helps build a sense of belonging and support, making the museum a valued part of the community. Commercial partners			

Question	Answer	Mark		Guidance
	- Offer opportunities for brand visibility and association with educational and family-friendly initiatives. Joint promotions can be beneficial. Collaborative Marketing Campaigns: - Joint Promotions: Partner with local businesses, such as cafes, bookstores, and toy stores, to create joint promotions. For example, a discount on museum tickets with a purchase from a partner store. - Cross-Promotions: Feature partner products or services within the museum, such as branded play areas or sponsored events, to create a mutually beneficial relationship. Sponsorship Opportunities: - Event Sponsorship: Offer commercial partners the opportunity to sponsor events, such as special exhibitions, workshops, or seasonal activities. This can increase their brand visibility and association with educational and family-friendly activities. - Equipment Sponsorship: Allow partners to sponsor specific interactive play equipment, with their branding displayed prominently. This can enhance their corporate social responsibility profile. Digital Marketing and Social Media - Co-Branded Content: Create co-branded content for social media and digital platforms, highlighting the partnership and the benefits of visiting the museum. This can include videos, blog posts, and social media takeovers. - Influencer Collaborations: Work with influencers who align with both the museum's and the partner's brand values to promote the interactive play activities and the partnership.			

Question	Answer	Mark		Guidance
	Membership and Loyalty Programs • Exclusive Offers: Provide exclusive offers and discounts to members of partner organisations, encouraging repeat visits and fostering loyalty. • Joint Memberships: Develop joint membership programs with commercial partners, offering combined benefits that appeal to families and frequent visitors. Community Engagement and Outreach • Educational Programs: Collaborate with partners to develop educational programs and workshops that can be held at the museum, enhancing the museum's educational value and the partner's community involvement. • Local Events: Participate in local community events and fairs with partners to promote the museum and its interactive play activities, reaching a broader audience. Benefits for Commercial Partners: • Increased Brand Exposure: By associating with a family-friendly and educational institution, partners can enhance their brand image and reach a targeted audience of families and children. • Corporate Social Responsibility: Sponsoring educational and interactive play activities aligns with corporate social responsibility goals, promoting community engagement and support for educational initiatives. • Customer Loyalty: Joint promotions and exclusive offers can increase customer loyalty for both the museum and the commercial partners, encouraging repeat visits and long-term engagement. Any other valid suggestion.			

Question	Answer	Mark		Guidance
2 *	Indicative content: Inclusivity Age, ability and developmental suitability: - Design activities that cater to children of varying abilities, ensuring that all children can participate and enjoy the activities. This may involve creating accessible play equipment and considering sensory needs. - Ensure the activities are engaging for the entire age range, from 5 to 10 years old. This might require a variety of activities that appeal to different interests and developmental stages. - Create activities that are engaging for both younger and older children within the 5 to 10 age range, possibly through adjustable difficulty levels. Accessibility: - Ensure the design accommodates children with disabilities, such as providing wheelchair-accessible play areas and sensory-friendly activities.	12	All responses should be in relation to the information provided. Responses are likely to include evidence of all bullet points (see examples). Candidates may extract information from the Resource Booklet. Any	Level 4 (10-12 marks) A comprehensive critical examination of the challenges that would be faced in providing and operating new equipment that provides interactive play activities for this age group. A comprehensive analysis of these challenges and how they relate to this age group is evident. Comprehensive understanding of typically the three elements specified in question. Information in RB is used effectively to fully exemplify the points being made. Well-constructed response in relation to question with a clear and developed narrative. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 3 (7-9 marks) A good critical examination of the challenges that would be faced in providing and operating new equipment that provides interactive play activities for this age group.

Question	Answer	Mark		Guidance
	- Parental Guidance: Provide resources and guidance for parents to help them support their children's play and learning experiences. This can include tips on how to engage with the activities, safety guidelines, and educational information. - Feedback Mechanisms: Establish feedback mechanisms to gather input from parents and children about their experiences with the play equipment. This can help identify areas for improvement and ensure the activities remain relevant and enjoyable. Cultural sensitivity: - Diverse Themes: Design play activities that reflect a variety of cultures and backgrounds to ensure all children feel represented and included. This can involve incorporating multicultural elements into the themes and stories used in the play equipment. - Language Accessibility: Provide multilingual instructions and signage to cater to families who speak different languages. This can help non-native speakers feel more comfortable and included. Adaptive play equipment: - Modular Design: Create modular play equipment that can be easily adjusted or reconfigured to suit different needs and preferences. This allows for a more personalised play experience and can accommodate a wider range of abilities and interests. - Sensory Integration: Incorporate sensory-rich elements such as textures, sounds, and lights to engage children with		such lifted information can be used in support of the discussion but no marks should be awarded simply for duplicating text. There is no analysis or evaluation in Level 1.	A good analysis of these challenges and how they relate to this age group is evident. Good understanding of typically at least two elements specified in question. Information in RB is used for the most part effectively to exemplify points being made although one or two opportunities are missed. Well-constructed response in relation to question although one or two opportunities missed to develop narrative. <i>There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.</i> Level 2 (4-6 marks) A sufficient critical examination of the challenges that would be faced in providing and operating new equipment that provides interactive play activities for this age group. A sufficient analysis of these challenges and how they relate to this age group is evident. Sufficient understanding of typically two of the elements specified in question. Information in RB is used to exemplify some points being made although much more could have been done to exploit the stimulus material available. Reasonable response in relation to the question although narrative at times lacks depth and cohesion. <i>The information has some relevance and is presented with limited structure. The information is supported by limited evidence.</i> Level 1 (1-3 marks)

Question	Answer	Mark	Guidance
	sensory processing differences. This can make the play experience more enjoyable and accessible for all children. Maintenance Durability and Longevity: • High-Quality Materials: Use durable, high-quality materials that can withstand heavy use and various weather conditions. This reduces the frequency of repairs and replacements, ensuring the equipment remains safe and functional for longer periods. • Weather Resistance: Ensure that outdoor play equipment is designed to resist weather-related wear and tear, such as UV radiation, rain, and temperature fluctuations. This can help maintain the equipment's integrity and appearance over time. • Regular checks and repairs are essential to ensure the safety and longevity of the equipment. This includes daily inspections and a schedule for more thorough maintenance. • Consider the cost and logistics of maintaining the equipment, including sourcing replacement parts and hiring trained staff for repairs. • Budget for ongoing maintenance costs, including replacement parts and labour, to avoid unexpected expenses. • Regular checks to mitigate against any unforeseen issues such as vandalism. Health and Safety Hygiene and Cleanliness • Sanitisation Protocols: Establish regular sanitization protocols to keep the play equipment clean and hygienic. This is		A limited critical examination of the challenges that would be faced in providing and operating new equipment that provides interactive play activities for this age group. Limited understanding is evident. Limited understanding of typically one element specified in question. Use of information from the RB is used in a simplistic way and adds limited value to the points being made. Limited response in relation to question. Narrative is basic and unstructured. <i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i> 0 marks = No response or no response worthy of credit.

Question	Answer	Mark		Guidance
	especially important in preventing the spread of illnesses among children. - Antimicrobial Surfaces: Use materials with antimicrobial properties to reduce the risk of bacterial and viral contamination on frequently touched surfaces. Risk Management - Compliance with safety standards is crucial. This involves using non-toxic materials, ensuring equipment is free from sharp edges, and providing adequate supervision. - Risk Assessments: Conduct thorough risk assessments for all play equipment to identify potential hazards and implement measures to mitigate them. This includes evaluating the equipment's design, installation, and usage. - Safety Training: Provide comprehensive safety training for staff to ensure they are equipped to handle emergencies and maintain a safe environment. This includes first aid training, emergency response procedures, and regular safety drills. - Develop and implement emergency procedures, including first aid training for staff and clear signage for emergency exits. - Implement safety protocols such as soft flooring to cushion falls, clear signage, and trained staff to supervise the play areas. In all cases any other valid suggestion.			

Question	Answer	Mark		Guidance
3 *	Indicative content Materials The Dodecahedron: Uses melamine laminate marine plywood and stainless steel. - It uses a much larger amount of melamine laminated marine plywood than The Gherkin. - Melamine laminate marine plywood: Durable but has a high environmental footprint due to the energy-intensive production process. Melamine is a thermo-setting polymer from finite oil sources. - Melamine-Urea-Formaldehyde (MUF): This adhesive is commonly used due to its water resistance and strong	16	All responses should be in relation to the information provided. Candidates may extract information from the Resource Booklet. Any such lifted information can be used in	Level 4 (13-16 marks) A comprehensive analysis of the two products focusing on the environmental impact. Comprehensive understanding of typically the four aspects specified in question. Information in RB is used effectively to fully exemplify the points being made. Well-constructed response in relation to question with a clear and developed narrative. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 3 (9-12 marks)

Question	Answer	Mark		Guidance
	bonding properties. It is suitable for exterior applications where moisture exposure is a concern. • MUF adhesives release formaldehyde, a volatile organic compound (VOC) that can contribute to indoor air pollution and has potential health risks, including respiratory issues and cancer. • The production of MUF resin is energy-intensive, contributing to greenhouse gas emissions. • The manufacturing process can result in local formaldehyde emissions, which are harmful to aquatic and terrestrial ecosystems. • Phenol-Formaldehyde (PF): Known for its excellent water resistance and durability, phenol-formaldehyde is often used in high-quality marine plywood. It can withstand prolonged exposure to water without delaminating. • Similar to MUF, PF adhesives release formaldehyde, posing health risks and contributing to indoor air pollution. • PF adhesives have a higher global warming potential compared to some other adhesives, with significant CO₂ emissions during production. • While PF adhesives are highly durable and water-resistant, their production involves significant energy use and environmental impact. • Stainless steel: Highly durable and recyclable, but its production is energy-intensive and emits significant CO₂. The Gherkin: • Mild steel: Recyclable but energy-intensive to produce and emits significant CO₂. • Nylon rope: Synthetic, non-biodegradable, and contributes to plastic pollution. • Melamine laminated marine plywood is used in much smaller quantities than in the Dodecahedron.		support of the discussion but no marks should be awarded simply for duplicating text. There is no analysis or evaluation in Level 1.	A good analysis of the two products focusing on the environmental impact. Good understanding of typically at least three aspects specified in question. Information in RB is used for the most part effectively to exemplify points being made although one or two opportunities are missed. Well-constructed response in relation to question although one or two opportunities not taken to develop narrative. <i>There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.</i> Level 2 (5-8 marks) A sufficient analysis of the two products focusing on the environmental impact. Sufficient understanding of typically at least two aspects specified in question. Information in RB is used to exemplify some points being made although much more could have been done to exploit the stimulus material available. Reasonable response in relation to the question although narrative at times lacks depth and cohesion. <i>The information has some relevance and is presented with limited structure. The information is supported by limited evidence.</i> Level 1 (1-4 marks) A limited understanding of the two products focusing on the environmental impact. Limited understanding of typically one aspect specified in question.

Question	Answer	Mark		Guidance
	Manufacturing processes Dodecahedron: • TIG welding is precise but time consuming and energy-intensive, contributing to higher energy consumption and CO2 emissions. • Melamine laminated marine plywood boards will have been pressed in a factory, the laminates are bonded using then likely cut from standard sheets into the pentagons by CNC Routing. CNC routing is precise but an energy-consuming processes. • Stainless steel sheet is rolled which is an energy intensive process. • The stainless-steel corner plates are likely to have been laser cut, drilled and welded with jigs, or press formed, blanked, pierced, stamped and pressed. Laser-cutting is precise but an energy-consuming processes. Pressing and rolling of stainless steel also require significant energy. • Stainless steel tubes are extruded. • CNC routing and laser cutting produce minimal waste. The Gherkin: • MIG welding is faster but also consumes significant energy, leading to high energy consumption and CO2 emissions. • The large diameter mild steel tubes are likely to have thick wall thicknesses, similar scaffold tubes, and be extruded. • Smaller tubes may be made from rolled mild steel sheet that has been electric resistance welded. • Extrusion and electric resistance welding of mild steel are energy intensive. • Extrusion and welding processes generate some waste, including metal scraps and welding by-products.			Use of information from the RB is used in a simplistic way and adds limited value to the points being made. Limited response in relation to question. Narrative is basic and unstructured. <i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i> 0 marks = No response or no response worthy of credit.

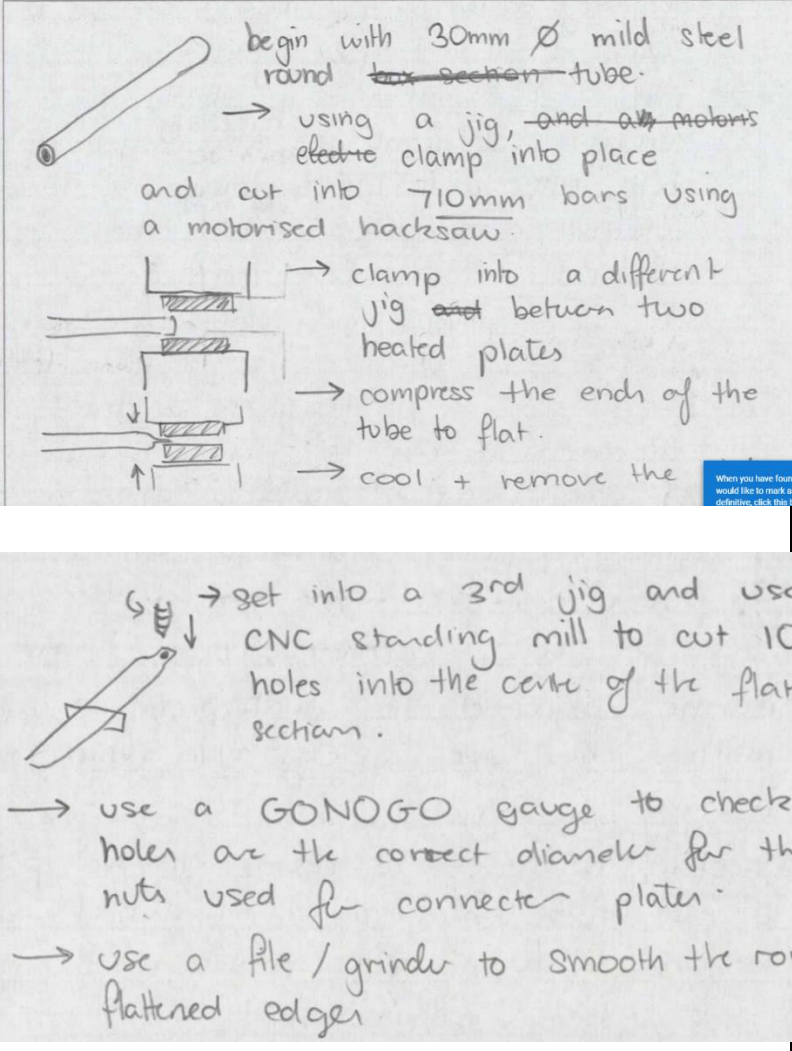
Question	Answer	Mark		Guidance
	- The roof is made from mild steel sheet that has been formed into a dome. This is likely to have been press-formed. Press-forming the roof involves substantial energy use. Surface finishes Dodecahedron: - Stainless steel is self-finished and does not require an additional surface finish. Thus, energy, materials and associated emissions are avoided. - Melamine laminated marine plywood is self-finished, the colour is added during manufacture. The Gherkin: - Powder coating is durable and has a lower environmental impact compared to liquid coatings, as it emits fewer volatile organic compounds (VOCs). - Galvanizing provides long-term rust protection but involves the use of chemicals and energy, which can have a negative environmental impact. Disposal Dodecahedron: - Stainless steel tubes and corner plates are recyclable and can be melted back down and reformed. - Disassembly looks easier to do than The Gherkin. It may be as simple as unbolting the corner plates and any support plates.			

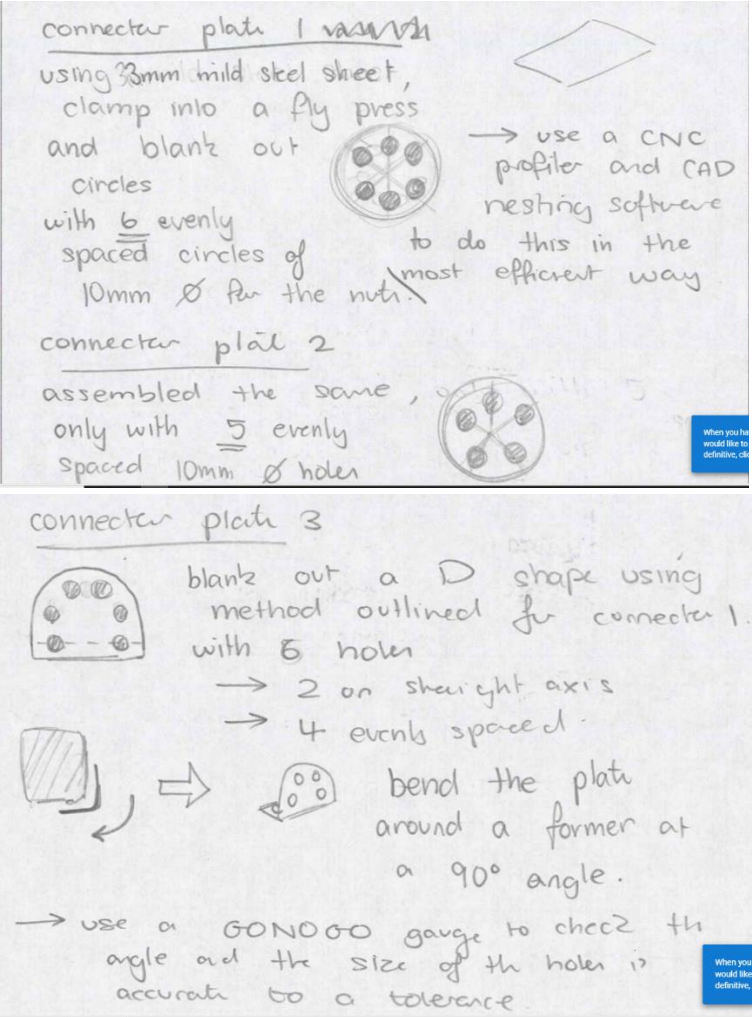
Question	Answer	Mark		Guidance
	- Disassembly may be possible without the use of energy intensive machinery as the majority of the dodecahedron is close to the ground and only a low-level work platform may be required to work from. This will need to be transported to and from the site. - Power tools will be required to remove nuts and bolts, some cutting may be necessary on site, but most components are of a size for ease of transportation in most standard sized works vans/flat-bed trucks. - Standard components such as nuts and bolts can be recycled. It is unlikely that they would be used again though. - Melamine laminate marine plywood planes can be put to another use but cannot be recycled. Melamine is a thermosetting polymer and non-recyclable. The Gherkin: - Mild steel is recyclable and can be melted back down and reformed. Powder coating may need to be sand blasted to remove it. It is difficult to dispose of this and contain the polymer particles from entering atmosphere and water courses. - Standard components such as nuts and bolts can be recycled. It is unlikely that they would be used again though. - Melamine laminate marine plywood planes can be put to another use but cannot be recycled. Melamine is a thermosetting polymer and non-recyclable. - Nylon rope is recyclable but contributes to plastic pollution if not recycled correctly, posing an environmental hazard. - The size of The Gherkin would necessitate the use of high level access equipment such as scaffold towers or scissor lifts. Both of these would lead to greater levels of energy consumption relative to the dismantling of the dodecahedron. Scaffold towers are likely to be made of galvanized, heavy steel tubes that need to be transported to and from the site on			

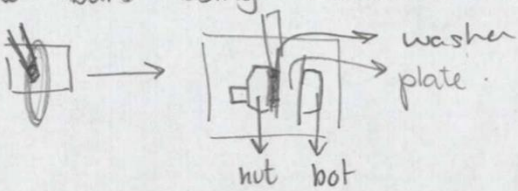
Question	Answer	Mark		Guidance
	large energy and fuel thirsty vehicles. Powered access platforms require energy to power them. Disposal is likely to necessitate the need to cut many of the large, welded components into pieces using angle grinders. This requires on-site energy in the form of batteries, or generators. Award credit for any other valid suggestion.			
4	Indicative content: Materials Tubes: - Galvanized mild steel or aluminium. - Both materials are strong, durable, and suitable for outdoor use. Aluminium is lighter and more resistant to corrosion, while mild steel is more cost-effective. - Accept other materials that would have the structural capabilities, Carbon fibre, PEEK, specific properties of polymers such as stabilisers.	12	Responses should include details of materials, manufacturing processes, surface finishes and disposal. Candidates can draw on	Level 4 (10-12 marks) A comprehensive demonstration of methods of manufacture for the geodesic climbing frame. Comprehensive understanding of typically the three elements specified in question. Information in RB is used effectively to fully exemplify the points being made. Well-constructed response in relation to question with a clear and developed narrative. The methods will be technically accurate and clear in the way they are explained. Level 3 (7-9 marks) A good demonstration of methods of manufacture for the geodesic climbing frame.

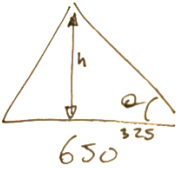
Question	Answer	Mark		Guidance
	Connector Plates: - Galvanized mild steel or stainless steel. - Stainless steel is highly resistant to corrosion and provides the necessary strength for the joints. - Accept polymer but with an explanation, for use. Methods of manufacture Tubes: - Cutting: Tubes can be cut to the required lengths using a CNC tube cutter. This ensures precision and consistency in the lengths of the tubes. - Manually operated chop saw, or slitting saw may be used instead. To ensure cuts are at 90 degrees to the tube, blade will be set using a try square and test cuts undertaken. - Pressing: The tube ends are pressed to create the flattened ends. - Drilling: The end of the tubes should be drilled to create the holes that are used to bolt them to the connector plates. Tube ends should be located in a drilling jig to ensure repeat accuracy of position. - Compression moulded, injection moulded (connector plates) - Extrusion. Connector Plates: - Cutting: Stainless steel sheets can be laser cut into the required shapes for the connector plates. Laser cutting is precise and can handle complex shapes with high accuracy. - Drilling: Holes for the bolts can be drilled using a CNC drilling machine, or laser-cut. This ensures that the holes are accurately positioned and of the correct diameter.		practical experience to support responses. Candidates are expected to demonstrate understanding of the processes through annotated sketches and/or notes.	Good understanding of typically at least two elements specified in question. Information in RB is used for the most part effectively to exemplify points being made although one or two opportunities are missed. Sketches will for the most part be clear and supported with relevant notes. The methods will be technically accurate and for the most part be clear in the way they are explained. Level 2 (4-6 marks) A sufficient demonstration of methods of manufacture for the geodesic climbing frame. Sufficient understanding of typically two of the elements specified in question. Information in RB is used to exemplify some points being made although much more could have been done to exploit the stimulus material available. Sketches will be adequate and supported with notes. The methods will not always be technically accurate with some knowledge gaps evident. Level 1 (1-3 marks) A limited demonstration of methods of manufacture for the geodesic climbing frame. Limited understanding of typically one element specified in question. Use of information from the RB is used in a simplistic way and adds limited value to the points being made. Sketches if used will be unclear with only basic notes to accompany them. The methods may lack technical detail and be basic in nature.

Question	Answer	Mark		Guidance
	- Finishing: The edges of the connector plates can be deburred and polished to remove any sharp edges and improve the aesthetic quality. Accuracy of dimensions Tubes: - Length: The tubes must be cut to precise lengths to ensure that the equilateral triangles fit together correctly. Tolerances should be kept within ± 1 mm. If cut manually by chop or slitting saw, a repeat stop should be set for repeat cutting accuracy and checked periodically against a template e.g. every 50 cuts. - Angle of cut: When using a chop saw or slitting saw, accuracy of cutting checks will be needed on a periodic basis e.g. every 50 cuts. To ensure cuts are at 90 degrees to the tube, blade will be set using a try square and test cuts undertaken. - Visual check. Connector Plates: - Shape and Size: The plates must be cut to precise shapes and sizes to fit the tubes correctly. The use of laser cutting will ensure accuracy. Components can be checked against a master template and/or go no-go templates for accuracy. - Hole Positioning: The holes for the bolts must be accurately positioned to ensure that the tubes can be securely attached. The positions of holes can be checked with go no-go templates. Award credit for any other valid suggestion.			0 marks = No response or no response worthy of credit.

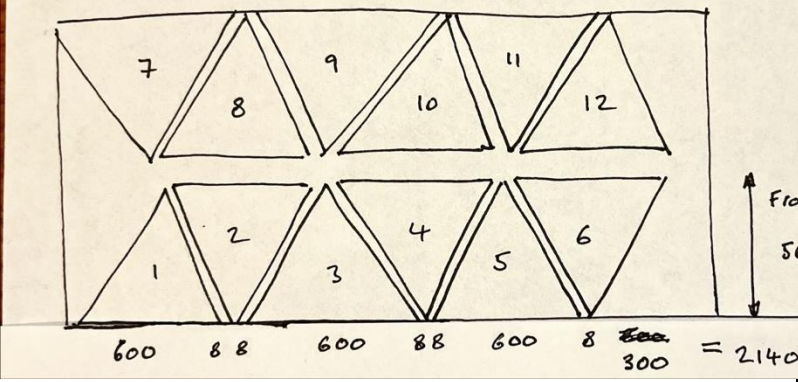
Question	Answer	Mark		Guidance
	 begin with 30mm $\varnothing$ mild steel round bar section tube. → using a jig, and a motorised electric clamp into place and cut into 710mm bars using a motorised hacksaw. → clamp into a different jig and between two heated plates → compress the ends of the tube to flat. → cool + remove the → set into a 3rd jig and use CNC standing mill to cut 10 holes into the centre of the flat section. → use a GONOGO gauge to check holes are the correct diameter for the nuts used for connector plates. → use a file / grinder to smooth the rounded flattened edges			

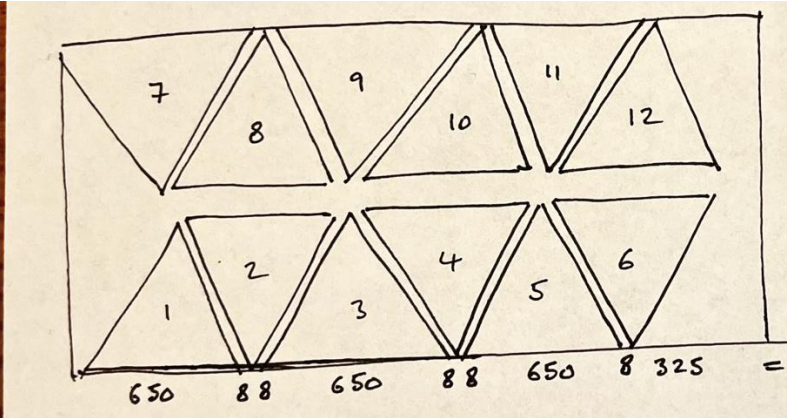
Question	Answer	Mark		Guidance
	connector plate 1 was made using 3mm mild steel sheet, clamp into a fly press and blank out circles with <u>6</u> evenly spaced circles of 10mm $\varnothing$ for the nuts. → use a CNC profiler and CAD nesting software to do this in the most efficient way. connector plate 2 assembled the same, only with <u>5</u> evenly spaced 10mm $\varnothing$ holes. connector plate 3 blank out a D shape using method outlined for connector 1. with 6 holes → 2 on straight axis → 4 evenly spaced. bend the plate around a former at a 90° angle. → use a GONOGO gauge to check the angle and the size of the holes is accurate to a tolerance. 			

Question	Answer	Mark		Guidance
	• the connector plates can be connected the bars using standard nuts, washers and bolts.  • each piece would likely be powder coated before assembly to reduce weather wear. ① degreased w/ white spirit ② clamped + given a negative charge ③ sprayed with triely charged powder. ④ fired to produce a hard, e ⑤ checked visually for missed section.			

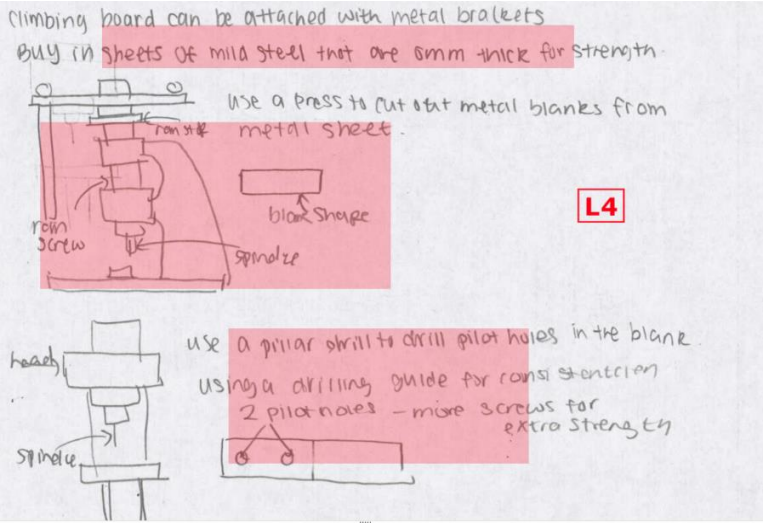
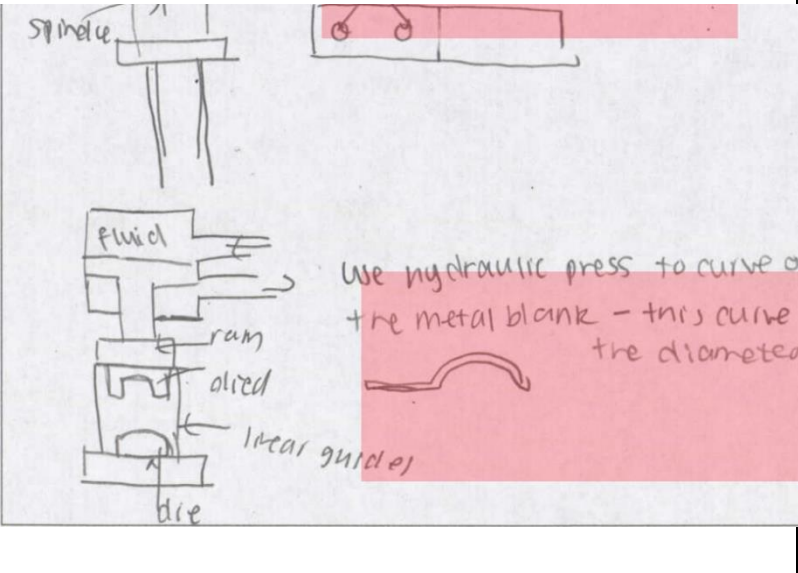
Question	Answer	Mark		Guidance
5 (a)	Two possible routes: <u>Trigonometry:</u> Recall of tan formulae: $\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$ [1] 	3		Award three marks as follows: One mark for determining correct formula to use. One mark for inserting correct values into formula. One mark for calculating h to 2 decimal places. If correct answer is given without working out shown award full marks.

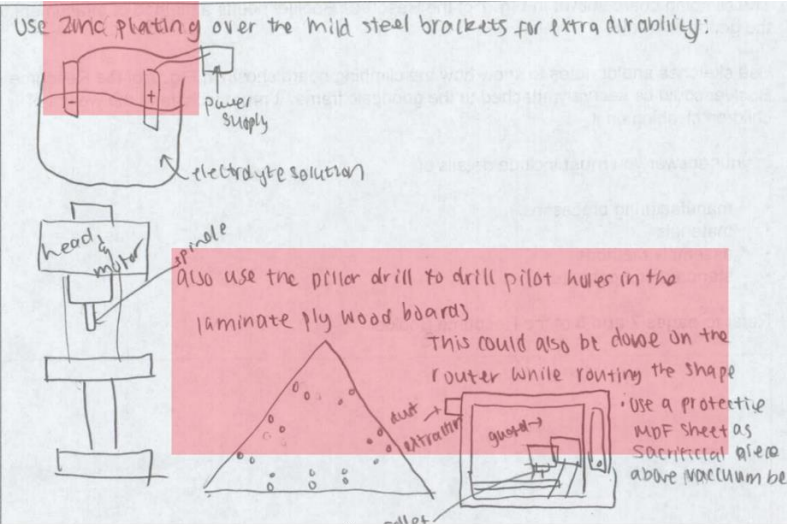
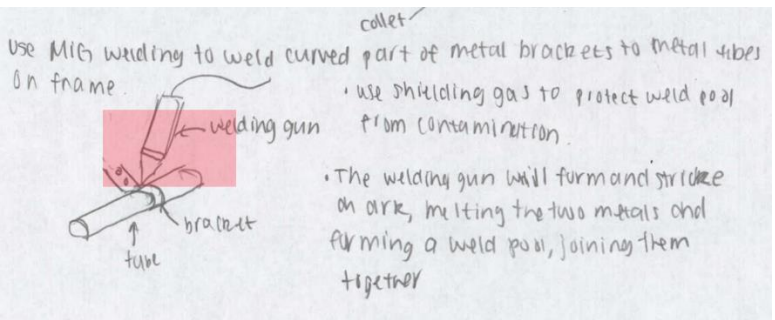
Question	Answer	Mark		Guidance
	opposite = $\tan \theta \times \text{adjacent}$ Substitute values: $h = \tan 60 \times 325 \text{ [1]} = 562.92\text{mm} \text{ [1]}$ Where h is the height required, and 325mm is half of the base of the triangle to find this <u>Pythagoras' Theorem:</u> Recall of Pythagoras' Theorem: $a^2 + b^2 = c^2 \text{ [1]}$ $h = \sqrt{c^2 - \left(\frac{b}{2}\right)^2}$ where b is the base of the triangle and c is the hypotenuse $h = \sqrt{650^2 - \left(\frac{650}{2}\right)^2} \text{ [1]} = 562.92\text{mm} \text{ [1]}$			Where an incorrect answer is given working out should be used to credit appropriate marks. *Allow error carried forward (ECF) where correct working out is shown. If trigonometry or Pythagoras are used with incorrect values to calculate the height, and answer is rounded to 2 decimal places then award two marks. Accept rounding variations when it comes to $\tan 60$.

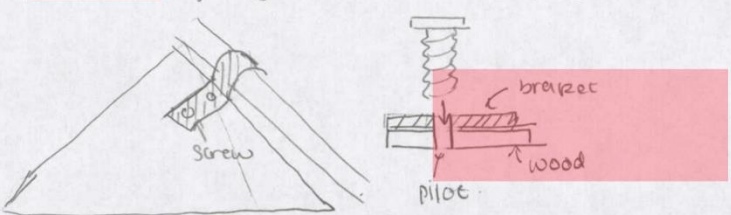
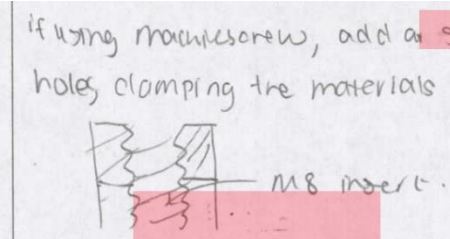
Question	Answer	Mark		Guidance
(b)	Candidates may base their response on 650mm or 600mm equilateral triangles. <u>For a 600mm equilateral triangle</u> the maximum number of climbing board panels is 12:  <u>For a 650mm equilateral triangle</u> the maximum number of climbing board panels is 12:	3		Award three marks as follows: One mark for an appropriate tessellation. One mark for correct workings on drawing (including cutting allowance). One mark for determining the maximum number of climbing board panels that can be machined from a single sheet of melamine laminate marine plywood. If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks. *One BOD - Allow a tessellation that reflects the calculation or the answer that the candidate offers. *Allow error carried forward (ECF) where correct working out is shown.

Question	Answer	Mark		Guidance
	 <u>*Error carried forward:</u> If the incorrect height of the triangle is used from 5a, candidates can still reach the correct answer if the height is between 398mm and 601mm. In cases where the height value from 5a is outside of this range of values, allow error carried forward (ECF) where correct working out is shown.			

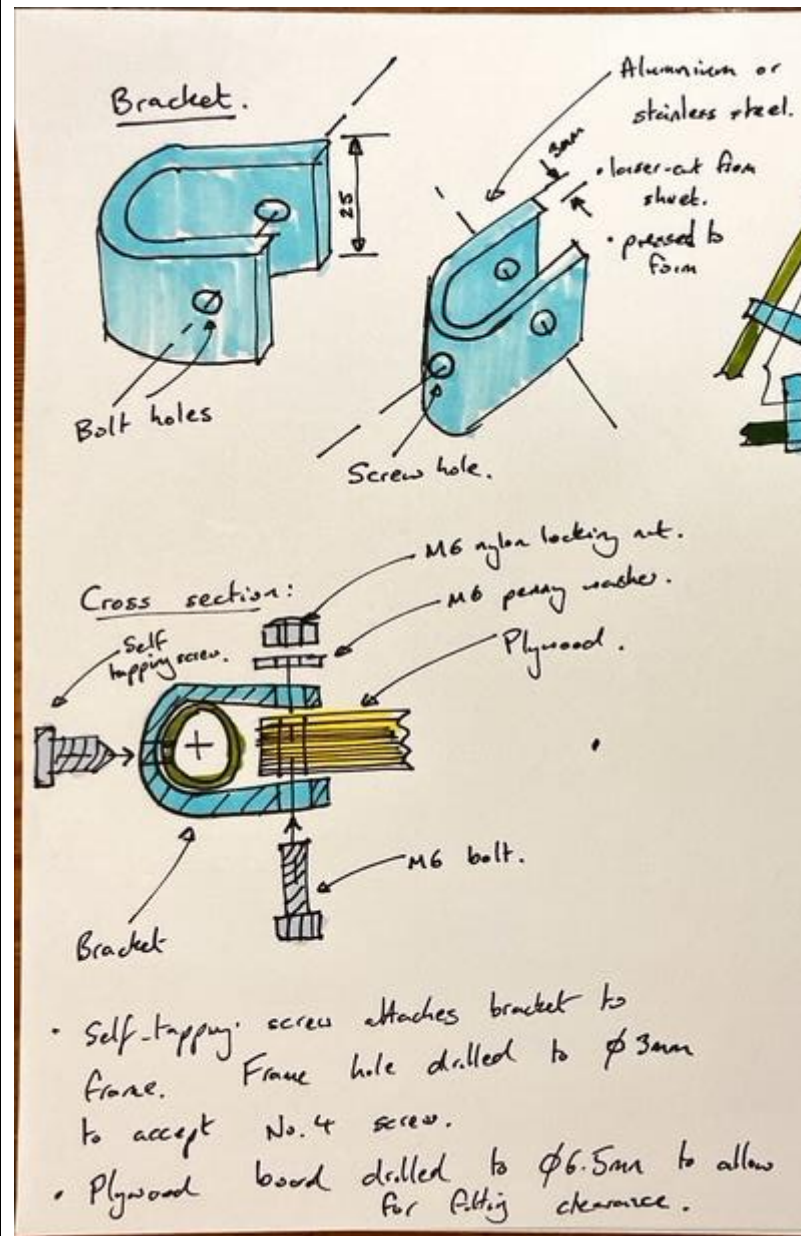
Question		Answer	Mark		Guidance
6		Indicative content:	16	All responses should be in relation to the information provided. Responses should address the	Level 4 (13-16 marks) A comprehensive demonstration of how the climbing board could be securely attached to the geodesic frame. Comprehensive understanding of the four aspects specified in question. Information in RB is used effectively to fully exemplify the points being made. Well-constructed response in relation to question with a clear and developed narrative.

Question	Answer	Mark		Guidance
	climbing board can be attached with metal brackets Buy in sheets of mild steel that are 6mm thick for strength.  Use a press to cut out metal blanks from metal sheet. blank shape spindle ram screw Use a pillar drill to drill pilot holes in the blank. using a drilling guide for consistency 2 pilot holes - more screws for extra strength  Use hydraulic press to curve the metal blank - this curve the diameter fluid ram die linear guide L4		four bullet points identified and provide details of methods of manufacture, materials, assembly methods and standard components. Answers should include solutions to each of the problems in the four bullet points in the question. Candidates can draw on practical experience to support responses. Candidates are expected to demonstrate solutions to	The methods will be technically accurate and clear in the way they are explained. Level 3 (9-12 marks) A good demonstration of how the climbing board could be securely attached to the geodesic frame. Good understanding of typically three aspects specified in question. Information in RB is used for the most part effectively to exemplify points being made although one or two opportunities are missed. Sketches will for the most part be clear and supported with relevant notes. The methods will be technically accurate and for the most part be clear in the way they are explained. Level 2 (5-8 marks) A sufficient demonstration of how the climbing board could be securely attached to the geodesic frame. Sufficient understanding of typically at least two aspects specified in question. Information in RB is used to exemplify some points being made although much more could have been done to exploit the stimulus material available. Sketches will be adequate and supported with notes. The methods will not always be technically accurate with some knowledge gaps evident. Level 1 (1-4 marks) A limited demonstration of how the climbing board could be securely attached to the geodesic frame. Limited understanding of typically one aspect specified in question.

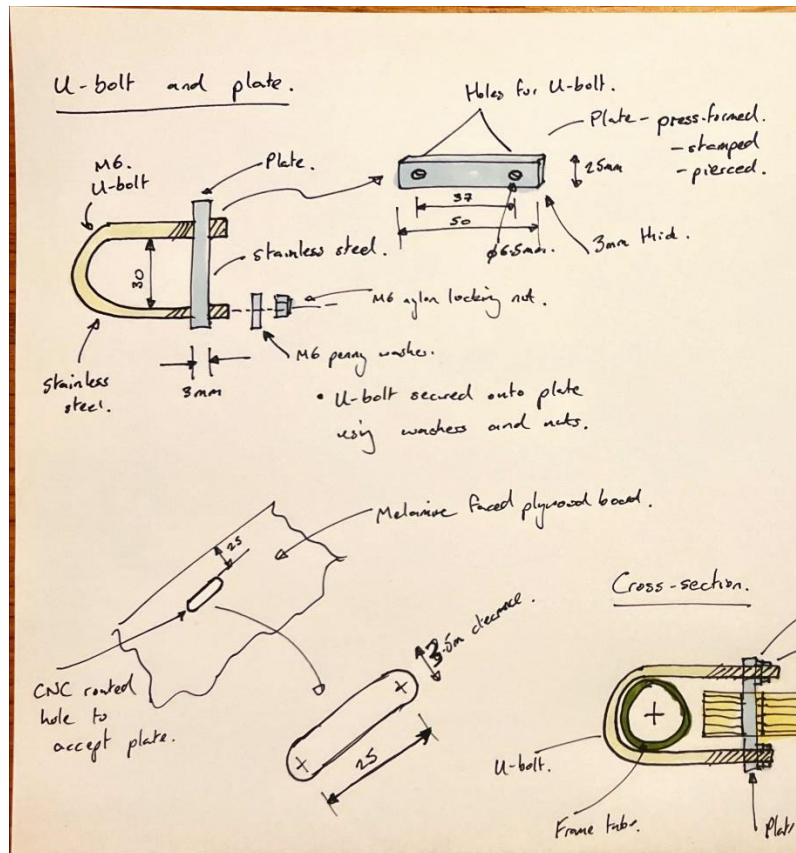
Question	Answer	Mark		Guidance
	Use Zinc plating over the mild steel brackets for extra durability:  Also use the pillar drill to drill pilot holes in the laminate ply wood boards This could also be done on the router while routing the shape Use a protective MDF sheet as sacrificial aluminium anode above vacuum bed Use MIG welding to weld curved part of metal brackets to metal tubes on frame.  Use shielding gas to protect weld pool from contamination. The welding gun will form and stroke on arc, melting the two metals and forming a weld pool, joining them together		the problems, as well as methods of manufacture, materials, assembly methods and standard components. and assembly through annotated sketches and/or notes.	Use of information from the RB is used in a simplistic way and adds limited value to the points being made. Sketches if used will be unclear with only basic notes to accompany them. The methods may lack technical detail and be basic in nature. 0 marks = No response or no response worthy of credit.

Question	Answer	Mark		Guidance
	To attach brackets to wood climbing board, use standard M8 screws, they can either be self-tapping or machine screw  if using machinescrew, add a standardised m8 insert to pilot holes, clamping the materials for parallel alignment  The screws should be either zinc or chrome coat mild steel.			

		Possible Methods to Attach the Climbing Board to the Frame:			
		<u>Bracket and Bolt Method:</u>			



Question	Answer	Mark		Guidance
	Materials: • Brackets: Stainless steel or aluminium sheet for durability and corrosion resistance. • Bolts and Nuts: Stainless steel for strength and corrosion resistance. Manufacturing Processes: • Brackets: Laser cutting and /or press formed. • Injection moulding • Accept 3d printing. Structural integrity and specific material would need to access higher level mark band. Assembly Methods: • Step 1: Attach metal brackets to the edges of the climbing board using countersunk screws. • Step 2: Position the climbing board within the equilateral triangle of the geodesic frame. • Step 3: Secure the brackets to the frame using bolts and nuts, ensuring a tight fit. Standard Components: • Stainless steel bolts, nuts, and washers. • Stainless steel or aluminium brackets.			

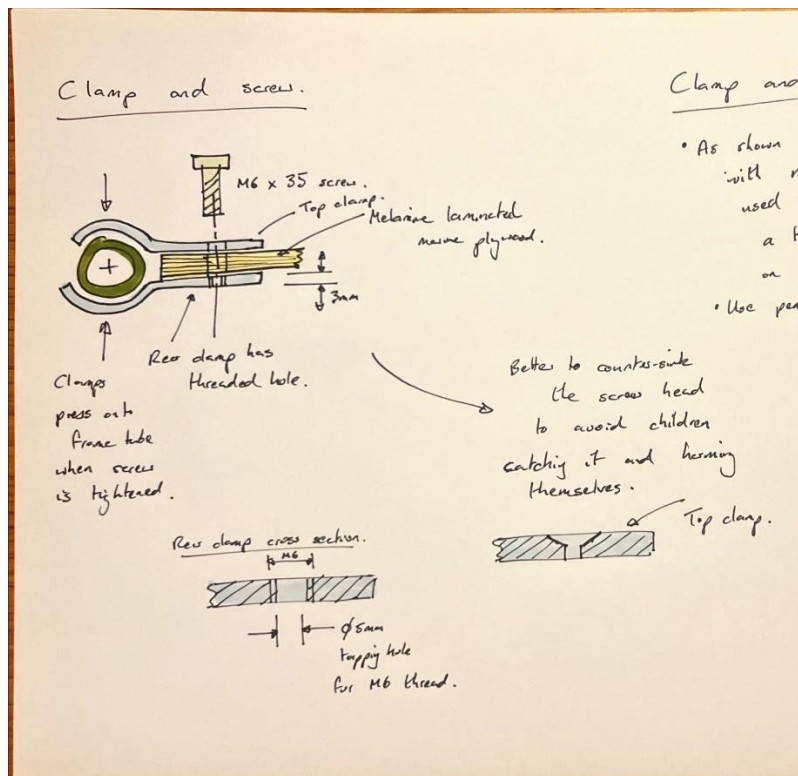
U-Bolt and Plate Method:**Materials:**

- **U-Bolts:** Stainless steel for strength and corrosion resistance.
- **Backing Plates:** Stainless steel or aluminium.

Manufacturing Processes:

- **U-Bolts:** Standard manufacturing.

Question	Answer	Mark		Guidance
	• Backing Plates: Laser cutting or stamped Assembly Methods: • Step 1: Drill holes in the climbing board to align with the U-bolts. • Step 2: Place the climbing board against the frame and insert U-bolts around the frame tubes. • Step 3: Secure the U-bolts with backing plates and nuts on the opposite side of the climbing board. Standard Components: • Stainless steel U-bolts, nuts, and washers. • Stainless steel or aluminium backing plates.			

Clamp and Screw Method:**Materials:**

- **Clamps:** Stainless steel or aluminium.
- **Screws:** Stainless steel.

Manufacturing Processes:

- **Clamps:** Laser-cut / press forming or casting.

Question	Answer	Mark		Guidance
	Assembly Methods: • Step 1: Attach clamps to the edges of the climbing board using screws. • Step 2: Position the climbing board within the frame. • Step 3: Tighten the clamps around the frame tubes to secure the board. Standard Components: • Stainless steel screws. • Stainless steel or aluminium clamps Award credit for any other valid suggestion.			

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