



GCE A LEVEL MARKING SCHEME

AUTUMN 2021

**A LEVEL
DESIGN AND TECHNOLOGY – PRODUCT DESIGN
A602U10-1**

INTRODUCTION

This marking scheme was used by WJEC for the 2021 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

GCE A LEVEL DESIGN AND TECHNOLOGY

COMPONENT 1 - PRODUCT DESIGN

AUTUMN 2021 MARK SCHEME

Question 1

Shown below are a range of consumer products evident in most homes.
(Images are not to scale)

- (a) Describe **two** ways in which the designer can consider ease of maintenance by the consumer in products such as those shown above. [4]
- (b) Explain how making a product easy to maintain can help build brand loyalty with the consumer. [4]

Q1	Science	Maths		AO3		AO4				Total
				2a	2b	1a	1b	1c		
(a)						2	2			4

Candidates should demonstrate knowledge and understanding and be awarded up to 4 marks for:

Examples can include:

- Vacuum bin can be removed and cleaned for easy dust disposal [1]. It is also dishwasher safe meaning it is easy to wash. [1]
- Vacuum cleaner has easy to open hatches that are colour coded to let the user know they are accessible and can be removed. [1] Hatches have large screwdriver slots that can be opened with 10p or 50p coins so the user does not even need tools to maintain and clean the item. Parts that break due to wear and tear can be replaced easily without any specialist knowledge or skill set. [1]
- Parts are easy to remove so that users can order replacement parts online and fit them themselves. [1] Often companies include videos on their YouTube videos demonstrating how maintenance can be carried out. [1]
- In the example of the tablet, software updates can be downloaded to improve the functionality of the product. [1] These can be done automatically so that the user is not even aware. Often operating software is automatically updated to deal with new improved security features. This is also possible for any product connected to the internet (IoT). [1]
- For the washing machine components such as the heating element are 'self-contained' and are mounted at the back of the machine outside of the main body. [1] Temporary joining methods are used (such as screws), they are accessible with standard tools such as screwdrivers making them easy to maintain and repair. [1]
- For the washing machine, all parts that require regular (daily/weekly) maintenance are positioned on the front of the machine within easy reach, e.g. lint tray, water tray
- Standard components are used so that if parts fail, or fittings go missing they can easily be replaced without the need for specialist fittings or tools. [1]

Credit any other appropriate response.

(b)	✓					2	2			4
Candidates should demonstrate knowledge and understanding and be awarded up to 4 marks for: • Products that are easy to maintain can last longer. Consumers will look to buy products that have a long life so that they do not have to replace them regularly. [1] • Products that have a long life gain a reputation for reliability, an important factor for many consumers when considering product purchase. [1] • Products that are easy to maintain gain a reputation for being more environmentally friendly (rather than contributing to a throw-away society), making repeat purchases more likely [1] • Any components that do fail during the normal life span of the product can be replaced, usually as a purchase directly from the brand ensuring repeat business. [1] <i>Credit any other appropriate response.</i>										

Question 2

Below is a table showing anthropometric information for hand lengths of boys aged 13-16 in the United Kingdom.

- (a) (i) Calculate the range of hand lengths that would need to be included to cover boys from the 5th to the 95th percentile. (*Show all calculations.*) [3]
- (ii) Gloves will be made from a material that could stretch 15mm in hand length. Calculate the maximum sample that could be accommodated for a single glove as a percentage. (*Show all calculations state your answer to the nearest whole number.*) [3]
- (b) Describe the relationship between anthropometric data and ergonomic design. [2]
- (c) Explain where it would be appropriate to use the data for the 5th percentile the 95th percentile data when designing products. [2]
- (d) Discuss the importance to the designer of applying ergonomic principles when designing a wireless computer mouse. [4]

Q2	Science	Maths		AO3		AO4					Total
				2a	2b	1a	1b	1c	2a	2b	
(a) (i)		✓							3		3

Candidates should demonstrate understanding and be awarded up to 3 marks based on appropriate mathematical calculations such as:

Calculate the sample size

$$7+10+13+18+36+79+98+79+36+18+13+10+7 = 424$$

Calculate 5th %ile

$$424 \times 0.05 = 21 \text{ people}$$

1 mark

Calculate 95th %ile

$$424 \times 0.95 = 403 \text{ people}$$

1 mark

Answer 156mm to 200mm

1 mark

(ii)		✓							3		3
------	--	---	--	--	--	--	--	--	---	--	---

Candidates should demonstrate understanding and be awarded up to 3 marks based on appropriate mathematical calculations such as:

15mm of movement, so 171-185 includes the biggest number of people. **1 mark**

$$79+98+79 = 256 \text{ **1 mark**}$$

$$256/424 \times 100 = 60.3773585, \text{ so answer is } 60\% \text{ **1 mark**}$$

(b)	✓								2	2
Candidates should demonstrate understanding and be awarded up to 2 marks based on an explanation of the relationship between anthropometrics and ergonomics, such as: Anthropometrics is the study of human sizes and capacities. Ergonomics is also referred to as human factors, is defined as the scientific study of people and their working conditions. It deals with the fit between people, their environment and their products. [1] Anthropometric data is often used to help define the size, shape and form of products to make sure that they are easy, comfortable and efficient to use. [1] <i>No marks for simple definition if the link between the two is not explained</i> <i>Credit any other appropriate response.</i>										
(c)	✓								2	2
Candidates should demonstrate understanding and be awarded up to 2 marks based on an appropriate example of the use of each data group. Examples could include: 95thile data could be used for a door frame to make sure that there was sufficient height for the tallest users. [1] 5th and 95thile data is often used in the design of car cabins. Seats, driving columns etc can all be adjusted to account for the tallest/biggest and smallest users within a given user group making them appealing to a wider range of users. [1] <i>Credit any other appropriate response.</i>										
(d)								4		4
Candidates should demonstrate application of knowledge and understanding and be awarded up to 4 marks based on the understanding of the link between ergonomics and anthropometrics. Discussion points may include: • To ensure a good physical fit between the person and the product allowing for safe and secure operation of the product. [1] • To make sure that there is an even distribution of weight to make sure there is no unnecessary or uncomfortable strain on the user when using the product [1] • To select materials that allow for easy and secure grip of the product [1] • To encourage a positive working posture, reducing risk of injury [1] • To help reduce strain when carrying out repetitive work (avoiding RSI) [1] • To layout functioning elements of the product in such a way that they are easy to access and are as 'intuitive' as possible.[1] One mark for each discussion point with explanation. <i>Credit any other appropriate response.</i>										

Question 3

The image below shows a cylinder head for a motorcycle.

- (a) Describe in detail the sequences of high pressure die casting used to produce the cylinder head shown above. [6]
- (b) Explain why sand casting is suitable for one-off or very low volume components. [2]

Q3	Science	Maths		AO3		AO4					Total
				2a	2b	1a	1b	1c	2a	2b	
(a)	✓					6					6

Candidates demonstrate knowledge are awarded up to 6 x 1 mark for a correct sequence.

Award marks for points relating to:

- Molten metal is stored in a chamber [1]
- A pneumatic (or hydraulic) plunge forces the molten metal through a goose neck and into the die [1]
- The plunge stays in position while the molten metal in the die cools to a solid [1]
- Due to the pressure, fine details in the die can be filled [1]
- The die is allowed to cool before separating into at least two parts [1]
- Ejector pins separate the die sections allowing the part to be removed. [1]
- The plunge retracts allowing residual molten to flow back through the gooseneck [1]

Only award up to a maximum of 2 marks for an incorrect sequence

Credit any other appropriate response.

(b)									2		2
-----	--	--	--	--	--	--	--	--	---	--	---

Candidates demonstrate knowledge and are awarded up to 4 marks.

Award marks for:

- The process is slow and labour intensive, [1] making it an expensive method of manufacture. The process cannot be automated and so the cost per unit is high [1]
- The process does not give a high-quality finish (the molten metal picks up the grain texture of the sand) [1] and this means that machining or additional finishing may be required [1]

One mark for each fully explained point

Credit any other appropriate response.

Question 4

The table below which shows the densities of metals commonly used for jewellery.

- (a) (i) The pendant shown above is produced in silver and pewter. Calculate the difference in weight. (*Show all calculations.*) [4]
- (ii) When casting the jewellery in pewter 3 in every 100 fail to pour correctly and 2 in every 100 tarnish because of the mould properties. These outcomes are independent of one another. State the probability of one cast suffering from both of the issues. [1]
- (b) A manufacturer has decided to laser cut the pendants from a sheet of aluminium. Calculate the maximum number of pendants that can be laser cut from a sheet 0.5m x 0.7m. (*Show all calculations.*) [4]
- (c) Qualitative testing and quantitative testing must be considered when selecting materials and processes for the design and manufacture of jewellery products.
- Explain what you understand by both qualitative testing and quantitative testing in relation to jewellery products. [4]

Q4	Science	Maths		AO3		AO4					Total
				2a	2b	1a	1b	1c	2a	2b	
(a) (i)	✓	✓							4		4

Candidates should apply knowledge and understanding and are awarded up to 4 marks based on:

Step 1

Work out volume of pendant

$$40 \times 40 \times 3 = 4,800 \text{ mm}^3$$

1 mark

Step 2

(volume of component in mm³) x (density of pewter in g/mm³)

$$4,800 \times 0.00728 = 34.944 \text{ grams}$$

1 mark

Step 3

(volume of component in mm³) x (density of silver in g/mm³)

$$4,800 \times 0.01049 = 50.352$$

1 mark

Step 4

$$50.352 - 34.944 = 15.408 \text{ grams}$$

1 mark

Do not penalise for any errors carried forward. Continue to award marks if you can clearly see the mathematical method used by the candidate.

Credit any other appropriate response.

(a) (ii)	✓	✓							1		1
Candidates should apply knowledge and understanding and are awarded up to 1 mark based on: Probability of pouring failure: 3/100 Probability of mould failure: 2/100 Probability of both failures (3/100) x (2/100) = 0.0006 <i>Do not penalise for any errors carried forward. Continue to award marks if you can clearly see the mathematical method used by the candidate.</i> <i>Credit any other appropriate response.</i>											
(b)	✓	✓							4		4
Candidates should apply knowledge and understanding and are awarded up to 4 marks based on: Step 1 Conversion of metres to millimetres = 500mm and 700mm 1 mark Step 2 Calculating number of pendants that fit across sheet, 500/40 = 12.5 (12 whole pendants) 1 mark Step 3 Calculating number of pendants that fit down sheet, 700/40 = 17.5 (17 whole pendants) 1 mark Step 4 Total number of pendants able to be cut from sheet 12x17 = 204 Answer is 204 pendants. 1 mark <i>Do not penalise for any errors carried forward. Continue to award marks if you can clearly see the mathematical method used by the candidate.</i> <i>Credit any other appropriate response.</i>											

(c)							4				4
Candidates should demonstrate knowledge and understanding and are awarded up to 2 marks per explanation of qualitative and quantitative testing. Descriptions must relate to jewellery products to be awarded credit. Quantitative testing are objective, measurable criteria, which can be assessed against specific performance measurable objectives. Material weight, hardness, torsion, shear and tension strength are all examples of properties that can be measured with quantifiable data.[1] Materials can be tested to make sure that they do not break or wear away too quickly in what is deemed to be normal use, or in the case of jewellery be too heavy to wear. [1] Qualitative testing will reflect the intended quality of certain defined aspects of a material's specification. They are a more subjective form of criteria.[1] An example could be how aesthetically pleasing the target market find the material and whether it adds a sense of quality to the product, important in the jewellery industry.[1] <i>Credit any other appropriate response.</i>											

Question 5

The home cinema projector shown below has been designed considering both the needs and wants of the target market.

- (a) Describe the importance of using a specification when designing a product such as the home cinema projector. [5]
- (b) Explain the importance of a 'User Centred Design' approach to investigating design opportunities for products such as the home cinema projector. [5]

Q 5	Science	Maths		AO3		AO4					Total
				2a	2b	1a	1b	1c			
(a)							5				5

Candidates should demonstrate understanding and are awarded up to 5 marks.

- Specifications are a list of criteria that outline the features a product must have in order to be successful. Some of these are essential, others are desirable (must, should, could). For example, the projector must include speakers so that audio can be heard [1]
- The specification is usually generated as result of result of research that might include consultation with a client, target market, reverse engineering etc and so the criteria listed is based on sound knowledge of the requirements to make the product successful. [1]
- The specification is used to generate the development of ideas and is used as a touch point to ensure the designs are on track making and appropriate for the application. i.e. helps avoid 'scope creep' [1]
- The specification is used for ongoing as well as summative evaluation in order to determine whether the solution meets the needs originally identified as being important. [1]
- The specification acts as a 'common hymn sheet' for teams of people to work to so that they can coordinate their work making sure they are all aiming for the same end goal. This would be important for a product such as the projector because you would have different teams working on different parts of the product e.g. electronics and casing design. [1]

Credit any other appropriate response.

(b)							5				5
-----	--	--	--	--	--	--	---	--	--	--	---

Candidates should demonstrate understanding and are awarded up to 5 marks.

Award two marks for each fully explained point.

Correct responses could include:

- User centred design places the end user at the centre of the design process, this means that their needs are considered from the outset of any design journey. [1]
- The end user is 'consulted' throughout the process to make sure that design ideas, models and prototypes are in line with their needs. [1]
- Models and prototypes are tested by the users throughout the process and their comments and opinions are fed back into the design process to continue idea iteration. [1]
- Keeping the user at the centre of the design process means that the product is likely to function as the user would like it to, and ultimately it will appeal to them. [1]
- A user centred design approach is cyclical, even after product launch the user comments are used to inform future developments/versions of the product [1]

Credit any other appropriate response.

Question 6

Every year a number of innovative products are brought to market.

Explain why innovation is important to the success of commercial products. [5]

	Science	Maths		AO3		AO4				Total
				2a	2b	2a	2b	2c		
Q6								5		5

Candidates should demonstrate understanding and are awarded up to 5 marks.

Explanations must make reference to the commercial aspect of product success. Award one mark for each correct point.

- Innovation is developing better solutions to existing problems, existing market needs, or new and emerging needs. An innovative product is a new and original idea. As such this originality attracts the attention of consumers. [1]
- Innovative features set products apart from their competitors and attract sales and recognition from the target market. [1]
- Innovative features can often attract a premium price tag which consumers are often willing to pay. [1]
- Innovative features can serve to reinforce a brands position as a market leader so that they become the 'go to' brand for consumers in a given sector. [1]
- Innovative features can be protected by IP, giving the brand some level of protection so that competitors do not copy their ideas. [1]
- Innovations can include the way a product looks, works, materials used or how it is manufactured. These innovations can themselves spark ideas for other new developments. [1]

Credit any other appropriate response.

Question 7

Study the image of the chair shown below which has been cut using a CNC router.

- (a) Analyse the benefits of using a CNC router to cut out the chair frame. [6]
- (b) Evaluate the environmental impact of using CNC machines to produce commercial products. [6]

Q7	Science	Maths		AO3		AO4					Total
				2a	2b	1b	1c	2a	2b	2c	
(a)				4						2	6

Candidates should show evidence of logical reasoning or deconstructing information and applying this to be awarded 6 marks.

- Design files can be saved so that the chair can be produced again at some time in the future with minimal set-up effort and time. [1]
- If the chair is produced again in the future the quality of the manufacture will be the same as the original [1]
- The final product will be more accurate (provided CAD drawings are drawn accurately) than if it were produced by hand, it also requires a lower level of skill and training to run the CNC machine that to produce a high-quality product by hand [1]
- Small changes can be made to the files relatively easily allowing for efficient design evolution or adaptation for different clients and markets [1]
- Files can be shared relatively easily via the internet so that communication between designer, manufacturer and client is quick and easy. [1]
- The chair will take less time to produce and so less labour intensive, therefore unit cost will be less [1]
- Lower risk of error during manufacture meaning that time and materials are being used for economically, reducing unit cost [1]
- Workers can complete other jobs as the chair is being cut out allowing for multi-tasking, this makes the whole process more efficient [1]
- Designs can be easily tessellated making most efficient use of the materials reducing waste and allowing more parts to be cut from each sheet, reducing cost [1]

Credit any other appropriate response.

(b)					4		2			6
Candidates should show clear evidence of appraisal and/or <u>making judgements</u> and <u>applying</u> this to technical principles to be awarded up to 6 marks. • CNC machines generally take more energy to run than traditional machine or hand tools, this higher energy use has a negative impact in the environment [1]. Conversely, it can be argued that as CNC machines generally work more quickly and efficiently than 'humans with machine tools', that the overall energy expenditure is less per product (unit) [1]. In addition to this there is also 'idle energy use' with CNC devices where machines are left on longer than they are needed, expending more energy than is necessary [1] • Dust extraction attached to machine stops more particles from entering workshop atmosphere. This dust extraction is more powerful and efficient than that of hand held power tools meaning the immediate environment is better for workers [1] • Cutting fluid/lubricant used for some CNC machines, particularly when cutting metals, also has impact on environment particularly when it comes to disposal of such substances. Substances are difficult to dispose of safely [1] • CNC machines do not require heated workshops, so while energy usage may be higher for the machine, some saving might be made through reduced heat/light requirements [1] • CNC machines come in many sizes, if a company purchases large CNC machines but only produces small parts then energy will be unnecessarily expended which is bad for the environment [1] • CNC machines can allow production to be much more efficient allowing for some manufacturing companies to move from a 5 day to a 4-day production week. They have reported a 5% energy saving on the same volume output by producing their products in this way [1] Credit any other appropriate response.										

Question 8

Client profiles are used by designers when developing design proposals.

Describe the type of information that is gathered when creating a client profile and analyse why this information is useful to designers. [9]

Q8	Science	Maths		AO3		AO4					Total
				2a	2b	2a	2b	2c			
				6				3			9

Candidates should provide evidence of logical reasoning or deconstructing information and applying this to be awarded up to 9 marks. Focus should be on the analysis of the factors, though candidates are expected to apply knowledge and understanding of designing and making principles in the deconstruction of information and discussion.

A client profiles group together people according to a number of different factors. These may include for example age, sex, level of income, level of education, geographic area, marital status or any combination of these.

Information that could be gathered may include:

Shopping habits. This might include the proportion of online versus traditional or 'mail order' shopping. Knowing where consumers shop can give designers information on the types of brands a consumer buys – allowing conclusions to be drawn on the value they place on perceived quality, cost vs quality as well as giving information on how to market and communicate with them at the point of purchase e.g. with POS stands, posters or pop up internet adverts.

Attitude to the environment. A strong attitude to environmental issues can often influence the purchase of products. Knowing the environmental factors that consumers consider to be most important means designers can build these considerations their design work, making the products more appealing. Use of recycled/recyclable or reusable packaging for example can influence a decision to buy for lower value items.

Dietary habits. Some consumers like to eat out at restaurants on a regular basis. This can tell designers and marketers a lot about the consumer in terms of their disposable income and their attitudes towards healthy eating. Understanding frequency and value of restaurant visits can also identify possible purchase patterns of the consumer. For example, at which point in the month are consumers most likely to spend on non-essential items? For some, the beginning of the month is more lavish as it follows a monthly pay cycle, for others spending is more even which would point to a weekly pay pattern or even a higher disposable income (where luxury item purchases are no necessarily dependant on the next pay packet – these types of consumers tend to have higher disposable income). Modern consumer habits have moved towards home delivery of a range of take-away items (e.g. Deliveroo, Uber Eats) and away from one type of food (e.g. pizza), these new internet/App order platforms have given rise to new advertising opportunities for brands looking to target certain consumers. National (and international) coverage and local service has given rise to considerable opportunities for large and small brands alike.

Television/online viewing habits. Knowing which TV shows your target market watch can provide a number of benefits, these include knowing when to place advertisements (in ad-breaks for example). In more recent times, products and brands have 'sponsored' programmes allowing adverts to be placed at the start and end of ad-breaks meaning that even if the consumer fast-forwards through the rest of the advertisements they will still catch the adverts. Recent 'binge watching' habits allow for high-frequency viewing of advertisements such as these adverts meaning greater recall and much higher impact than was the case with traditional TV advertising. While viewing figures for modern programmes tend to be lower than those for shows that were aired in 1990s (for example) when there were really only 5 channels, the audience tends to be more concentrated in a particular demographic meaning less 'waste' when it comes to advertising revenue. Knowing the TV shows and viewing habits also allows advertisers to approach certain stars (actors, sports persons, musicians etc) for sponsorship deals.

Level of disposable income. Understanding level of disposable income indicates how much people may be able to spend on luxury or non-essential items. This gives designers and marketers information to guide product price points. Linked to this could be number of dependents, if the consumer has children for example then, generally, the priority will be to first spend income on essential/desirable items for their children.

Favourite brands. Understanding the favoured brands of consumers can give valuable information on the values of your potential target market. By understanding the brands users purchase conclusions can be drawn about the level of disposable income, the importance or priority they place on certain products and the play-off between perceived value and quality. Designers and marketers who understand these parameters can pitch their own products at a suitable level to encourage purchasing action from their consumers.

Commuter routes/method of commuting. Understanding how consumers travel back and forth to their place of work can provide 'touch points' for advertisers. These can include bus stops, bus boards, bill boards, posters etc. More modern advertising techniques can include 'push notifications' to Bluetooth 'discoverable' devices. As commuters tend to travel along the same routes each day, advertising in this way can have high-frequency and good recall of advertising messages.

Credit any other appropriate response.

Band	Marks	AO3 2a	Marks	AO4 2c
3	5-6	Excellent analysis of the way in which designers use consumer profile information when designing products. A thorough discussion, which deconstructs information and demonstrates logical connections and reasoning throughout. Well-considered, relevant functional factors and environmental factors used as a context for the discussion	3	Applies a thorough knowledge and understanding of the use of client profiles by designers and the impact these have on design decisions with well-considered relevant functional factors and environmental factors identified.
		There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.		
2	3-4	Good analysis of the way in which designers use consumer profile information when designing products. A generally sound discussion, which deconstructs information and provides adequate connections and reasoning. Generally well-considered and relevant factors used as a context for the discussion	2	Applies a generally sound knowledge and understanding of the use of client profiles by designers and the impact these have on design decisions, with generally well-considered factors identified.
		There is a line of reasoning which is generally coherent, mainly relevant and with some evidence and structure.		
1	1-2	Limited analysis of the way in which designers use consumer profile information when designing products. Little evidence of deconstructing information and limited connections are made. Few factors are identified.	1	Applies a basic knowledge and understanding of the use of client profiles by designers and the impact these have on design decisions.
		There is limited evidence of relevant examples or structure.		
	0	No response or work that is worthy of a mark		

Question 9

Explain how developments in modern material technology have had an impact on the design, manufacture and use of modern sports equipment.

[9]

Q9	Science	Maths		AO3		AO4					Total
				2a	2b	1a	1b	1c	2b	2c	
							5		4		9

Candidates should demonstrate knowledge and understanding of technical principles and design and making principles and apply this to be awarded up to 9 marks based on:

Candidate must discuss all three of design, manufacture and use to gain full marks.

Design:

- Modern and composite materials have enhanced properties which allow more freedom in the design, because of this new sporting equipment can be designed in a more ergonomic way allowing for a better fit between the user and the equipment.
- They have good strength to weight ratio meaning products can be made from less material without loss of strength making them even lighter when compared to traditional materials
- Other advantages include superior stiffness, toughness, bending/torsion/tensile strength etc can have benefit depending on the type of sporting equipment being discussed.
- They can have a range of surface treatments applied to enhance the aesthetic appeal of the product and even allow to detailed surface graphics to be applied such as sports brand logos
- They give designers almost unlimited flexibility when designing shapes and forms as they can be moulded into intricate shapes

Manufacture:

- Modern materials and composites can be moulded with a high degree of accuracy with regards to densities and chemical formulations, giving great consistency across manufactured batches
- Modern materials that have a low petroleum base are not subject to sharp price fluctuations meaning manufacture costs can be accurately estimated
- There is little waste when manufacturing modern and composite materials and therefore cost per unit is reduced
- Manufacturers are able to work to very tight tolerances with modern and composite product production leading to better overall product quality and less waste in the manufacture process by inaccurate and inconsistent manufacture
- Manufacture costs can be reduced as designers can engineer several previously assembled parts into a single component.
- As moulds can be manufactured with the desired surface finish, composites and modern materials do not necessarily need and post-process finishing.

Use:

- Modern and composite materials are durable and hard-wearing. As such they last a long time and do not need to be replaced regularly
- As they have advanced properties they can often give sports people competitive advantage, especially at the top end sporting competitions where small differences can have a big impact on competitive match outcomes
- Composite sports equipment can allow for better balance (weight) of the product such as a racket, making it easier to control, more manoeuvrable and more accurate in use

- Due to the enhanced properties of modern and composite materials, sporting equipment can be designed and made more aerodynamic, meaning the equipment is easier to use for longer periods of time and causes less stress and strain on the body of the athlete

Credit any other appropriate response.

Band	Marks	AO4 1b and 1c	Marks	AO4 2b and 2c
3	4-5	Demonstrates and applies a thorough knowledge and understanding of technical principles in the context of the modern material theme. Well-considered, relevant wider issues identified.	3-4	Demonstrates and applies a thorough knowledge and understanding of designing and making principles in the context of modern materials, drawing upon well-considered, relevant examples.
		There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.		
2	2-3	Demonstrates and applies a generally sound knowledge and understanding of technical principles to the context of the modern material theme. Generally well-considered, relevant issues identified.	2	Demonstrates and applies a generally sound knowledge and understanding of designing and making principles in the context of the modern materials. Generally well-considered examples are provided.
		There is a line of reasoning which is generally coherent, mainly relevant and with some evidence and structure.		
1	1	Demonstrates and applies a basic knowledge and understanding of technical principles to the context of the modern material theme. Few issues are identified.	1	Demonstrates and applies a basic knowledge and understanding of designing and making principles in the context of modern materials. Few examples are provided.
		There is limited evidence of relevant examples or structure.		
	0	No response or work that is worthy of a mark		

Question 10

Evaluate the ways in which a product designer can reduce the environmental impact of their products at each stage of the product life cycle. [12]

Q10	Science	Maths		AO3		AO4					Total
				2a	2b	1a	1b	1c			
	✓				6			6			12

Candidates should provide evidence of either appraisal and/or making judgements and applying this to be awarded up to 12 marks based on:

Each stage of the product life cycle must be considered. The candidate may identify specific reduction measures depending on a product example they provide.

Discussion points could include:

Extracting raw materials

- Minimise the amount of material needed for the product,
- Use recycled materials for all or part of the product
- Reduce the amount of different materials needed for the product

Manufacturing the product

- Manufacture takes place close to material extraction/ processing, reducing CO₂ emissions,
- Use of efficient manufacturing processes that require less components
- Use of renewable energy for power generation rather than fossil fuels
- Reduce use of leaded components
- Use of smart springs to allow for active disassembly of electronic components from polymer products
- Design/make the product to be easy for the consumer to maintain effectively extending the life of the product.

Distribution

- Packaging design that reduces waste and allows for a maximum amount of product per pallet. Therefore less 'lorry loads' are needed.
- Card or bio plastic inserts to replace traditional plastics
- Bio batch or other additives added to polymers to allow them to biodegrade
- Secondary use for the packaging so that it is not thrown away

Use

- Use of renewable energy for charging/running the product e.g. use of photovoltaic cells
- High quality parts so that they do not fail so quickly and therefore requiring replacement
- Ease of maintenance so that the user can carry out simple maintenance to maintain product life

Disposal

- Design product with classic styling so that it does not date with change in fashion which might encourage
- Use of internationally recognised recycling symbols on each of the components allowing ease of recycling at end of product use
- Use of one type (or reduced number) of materials will allow for easy recycling
- Use of surface mount technologies allowing for easy disassembly for recycling

Credit any other appropriate response.

Band	Mark s	AO3 2b	Mark s	AO4 1c
3	5-6	Excellent evaluation of the ways in which designers can reduce environmental impact at each stage of the life cycle. A thorough discussion, which appraises and/or makes judgements about the various methods used by designers to reduce their products' impact. Well-considered, relevant wider issues used as a context for the discussion.	5-6	Applies a thorough knowledge and understanding of technical principles relating the reduction of the environmental impact at each stage of the product life cycle. Well-considered, relevant wider issues identified.
		There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.		
2	3-4	Good evaluation of the ways in which designers can reduce environmental impact at each stage of the life cycle. A generally sound discussion, which appraises and/or makes judgements about the various methods used by designers to reduce their products' impact. Generally well-considered, relevant issues used as a context for the discussion.	3-4	Applies a generally sound knowledge and understanding of technical principles relating the reduction of the environmental impact at each stage of the product life cycle. Generally well-considered, relevant issues identified.
		There is a line of reasoning which is generally coherent, mainly relevant and with some evidence and structure.		
1	1-2	Limited evaluation of the ways in which designers can reduce environmental impact at each stage of the life cycle. Little evidence of appraising or making judgements about the various methods used by designers to reduce their products' impact. Few issues are identified.	1-2	Applies a basic knowledge and understanding of technical principles relating the reduction of the environmental impact at each stage of the product life cycle.
		There is limited evidence of relevant examples or structure.		
	0	No response or work that is worthy of a mark		