GCE A LEVEL MARKING SCHEME

SUMMER 2019

A LEVEL (NEW)
DESIGN AND TECHNOLOGY - PRODUCT DESIGN
A602U10-1

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INTRODUCTION

This marking scheme was used by WJEC for the 2019 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.

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GCE A LEVEL DESIGN AND TECHNOLOGY

SUMMER 2019 MARK SCHEME

COMPONENT 1 - PRODUCT DESIGN

Question 1

Below is a picture of a racing drone. It has been made from a composite material.

(a) Name a composite material that could have been used. [1]

(b) Explain why this composite is a suitable choice of material for use in this application. [3]

(c) State the name of the quality assurance mark that would be displayed on the product to show that it has passed stringent standard safety tests for use within the UK. [1]

(d) Products that are certified by the British Standards Institute (BSI) have passed specific tests before being available to the consumer.

Describe a test that the drone would need to pass before being made available to the consumer. [3]

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

Candidates should demonstrate knowledge and be awarded 1 mark for:

- Carbon fibre reinforced plastic

Also accept:
- Glass fibre
- Silicone fibre

Credit any other appropriate response.

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1 (b)	✓						2	1			**3**

Candidates should demonstrate understanding and be awarded up to 3 marks.

Look for responses relating to the application of the drone

- High strength to weight ratio [1]. The chassis is lightweight yet strong [1], as it is lightweight the drone can fly faster and higher [1].
- Rigidity [1]. The frame does not flex when being flown [1]. This is important as a flexible material would change the orientation and position of the 4 motors which would affect the flight direction/speed [1].
- Fatigue Resistance [1]. A drone flown at high speeds and with sharp, sudden changes of direction will put stress on the chassis [1].

Award one mark for correct identification of property and up to two for justification related to the use for a drone.

Credit any other appropriate response.

1 (c)						1					**1**

Candidates should demonstrate knowledge and be awarded 1 mark for:

British Standard Kite Mark (accept labels that make reference to ISO numbers or CE symbol) It informs the customer that the product has passed all the required standard tests for safety in relation to its proper use.

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1 (d)							2	1			3

Candidates should demonstrate understanding and be awarded up to 3 marks based on description of an appropriate test, such as:

Impact test
Impact testing is testing an object's ability to resist high-rate loading. An impact test is a test for determining the energy absorbed in fracturing a test piece at high speed [1]. This might simulate how the drone would react to hitting a stationary object at high speed such as a tree or building [1]. Test rigs are set up to allow the frame to be projected against the static substrate at varying speeds and the frame is then analysed for failure in its structure [1]

Fatigue test
Fatigue testing is applying cyclic loading to a test specimen to understand how it will perform under similar conditions in actual use [1]. Fatigue occurs what a material is subjected to repeated loading and unloading [1]. A fatigue test can happen thousands of times to simulate real use before product launch [1]

Torsion test
Torsion tests can be performed by applying only a rotational motion or by applying both axial (tension or compression) and torsional forces [1]. The drone frame will be clamped between two opposing twisting chucks to test for fractures for expected and extreme use [1]. It is used to check that the product is suitable for normal use [1].

Flexure test
The flexure test method measures behaviour of materials subjected to simple beam loading [1]. Maximum stress and maximum strain are calculated for varying increments of load. Results are plotted in a graph [1]. The frame is tested for stress and fracture points at various loads to make sure it is suitable for normal use [1].

All of these tests can be carried out ‘to failure’ meaning the material is tested to its breaking point in order understand its limitations.

Award one mark for correctly identifying a test and up to two marks for a description of the test in the context of the product.

Credit any other appropriate response.

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Question 2

The 3D component shown below (fig. 1) is to be printed on a standard desktop 3D printer using a reel of filament (fig. 2). All dimensions are in mm.

(a) (i) Calculate the overall volume of the component in fig.1 using the sizes provided.
Show all calculations. [3]

(ii) The component is to be printed at 10% density (including surface area).
Calculate the volume based on this 10% density. [1]

(iii) If 1cm of filament prints 125mm³, calculate how many centimetres of filament will be needed to complete 4 of these prints. Show all calculations. [2]

(b) The manufacturer requires a logo to be spray-painted onto the component for modelling purposes. Explain how the use of a template would be beneficial. [2]

(c) Describe **one** advantage of producing the component shown in fig.1 on a 3D printer, rather than producing it by hand. [2]

(d) Discuss the environmental impact of using plastic material for pre-production models. [4]

Q 2	Science	Maths		**AO3**		**AO4**					**Total**
				2a	2b	1a	1b	1c	2a	2b	
2 (a)		6					6				**6**

Candidates should demonstrate understanding and be awarded up to 6 marks based on appropriate mathematical calculations such as:

(i) Area of parallelogram = W x H
120 x 75 = 9000
To get volume, multiply by Depth
9000 x 25 = 225000 [1]

Work out volume of cylinder = v=pi r squared x h
3.14 * 225 * 25 = 17662.5 [1]

Subtract volume of cylinder from parallelogram
225000 – 17662.5
Volume = 207337.5 mm3 [1]

(ii) 207337.5 * 10/100 = 20733.75 mm3 [1]

(iii) 20733.75 / 125 = 165.87cm of printer reel per model. [1]
165.87 x 4 = 663.48cm of reel for 4 prints. [1]

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

Accept any other mathematical method to achieve the answer.

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2 (b)									2		**2**

Candidates should demonstrate understanding and be awarded up to 2 marks based on an explanation of the use of templates in this context, such as:

- Allows for accurate placement of the logo [1] as the edge of the template could be aligned with a datum edge [1]
- The same template can be re-used on later models [1] this will allow for greater consistency between models [1].

One mark for each correct description of how the template can be used.

Credit any other appropriate response.

2 (c)							2				**2**

Candidates should demonstrate understanding and be awarded up to 2 marks based on:
A description of one advantage of 3D printing a model rather than producing one by hand.

- The 3D printer will use the 3D CAD model file so there will be no misunderstanding between the designer and manufacturer [1]. The drawing does not need to be 'interpreted' by a third party/manufacturer, reducing labour time and cost [1].
- The 3D printer can be left to print over-night so that there is no loss of development time to designers during normal working hours [1]. As 'downtime' is used for printing, iterations of the design can happen at a much quicker pace in the project [1].
- The printers make economical use of material (redistribution process) so there is little or no waste material [1], this helps make the design process more economical [1].
- Complex shapes can be created with ease after the 3D drawing has been created, so more complex shapes can be achieved [1], therefore high-level model making skills are not required to 'realise' the design [1].
- Accurate way of showing what the final product will look like after production without the need for expensive moulds to be made [1], this means judgements on shape, form, function, ergonomics etc can be made with much more confidence [1]
- 3D printed models can be produced with tight tolerances better reflecting the final production product [1], the model is a better reflection of what the final produced product will look like [1].

Credit any other appropriate response.

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2 (d)	✓							4			4

Candidates should demonstrate application of knowledge and understanding and be awarded up to 4 marks based on the selection the impact of using plastic for pre-production models.

Discussion points may include:

- Most plastics come from a non-renewable source [1]
- 3D printing is a re-distribution process which means there is little or no wasted material [1]
- 3D printers use thermoplastics, which are generally recyclable so the models can be re-used at the end of their life [1]
- The 3D printed models allow for accurate user and stress testing of concepts leading to designs that are stronger and longer lasting [1]
- PLA is often used for desktop 3D printers. PLA is a bio plastic and so is made from renewable plant products like corn and sugarcane [1]

One mark for each discussion point with explanation.

Credit any other appropriate response.

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Question 3

The outer casing of the bluetooth headphones shown is made from a thermoplastic and has been injection moulded.

(a) Describe the sequence of steps used in the injection moulding process. [4]

(b) Explain in detail why moulds for injection moulding are often made from steel. [4]

Q 3	Science	Maths		AO3		AO4					Total
				2a	2b	1a	1b	1c	2a	2b	
3 (a)						4					**4**

Candidates demonstrate knowledge are awarded up to 4 x 1 marks

Award marks for points relating to:

- Plastic granules or pellets are either hand fed or automatically fed into a hopper [1].
- The granules/pellets drop to Archimedes screw which turns forcing them along the barrel [1].
- As they travel along the screw through the barrel the granules are heated due to friction and external heaters [1].
- The granules turn from a solid to a liquid as they travel along the barrel to the head [1]
- The liquid plastic is injected into the mould where it cools back to a solid state [1].
- The mould opens and the product is released [1]

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

Credit any other appropriate response.

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3 (b)									4		**4**

Candidates demonstrate knowledge and are awarded up to 4 marks.

Award marks for:

- Steel moulds can be shaped using CNC milling machines which means detailed shapes can be achieved [1]
- The steel can be highly polished which means the final products will also be highly polished [1]
- Steel moulds are hard-wearing and durable allowing for thousands of the same product to be made before the mould needs to be replaced [1]
- Channels can be cut into the moulds to allow cold water to run through them so that the products cool quicker reducing production cycle times [1]
- Good resistance to corrosion, this is important as if moulds are water cooled to speed up production cycle times they will not rust [1]
- They have a high melting point (much higher than the plastic melting point) which means they won't melt or warp during long production runs of 50,000 plus [1]
- Good thermal stability which means the mould will not change shape during the injection moulding process ensuring consistent outcomes. [1]

One mark for each fully explained point

Credit any other appropriate response.

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Question 4

Cell production systems are typically used when manufacturing consumer electronics such as e-readers.

(a) Describe **two** benefits of cell production to the manufacturer. [4]

(b) A manufacturer pays production staff £15.32 per hour, and the cell production manager £17.32 per hour. There are 6 people in the production team (which includes the manager) and they each work an 8 hour shift. It takes 3 shifts for the production cell to complete their specified job. Work out how much it costs to pay the whole workforce for this specific job. Show all calculations. [4]

(c) (i) The workforce completed the job ahead of time and is eligible for a 3.7% pay bonus. Work out how much extra money each member of the team would be paid, including the cell production manager. Show all calculations. [4]

(ii) Calculate how much more the cell production manager will be paid after the bonus in comparison to the cell production staff. Show your answer as a percentage. [1]

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

Candidates should demonstrate knowledge and understanding and are awarded up to 2 marks per benefit (to a maximum of 4 marks) based on the description of the benefits of cell production to the manufacturer.

Advantages of cell production:

- Processes, defects, scheduling and maintenance can be managed more efficiently and cost-effectively [1] because the production cell takes responsibility for the quality control of their manufactured parts [1].
- Workers become multi-skilled [1] which means they are consequently more adaptable and flexible to the changes in the business [1]
- Seeing the product from start to finish may create greater 'pride' and job satisfaction [1] resulting in higher quality and more consistent products [1]
- Staff feel more involved in decision-making [1] and the variety of work and greater responsibility generally results in better motivation [1]
- Quality improves because each cell has 'ownership' over production [1] therefore cells often aim for 'zero defects' and the elimination of waste [1]

Credit any other appropriate response.

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4 (b) i								4			4

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

£15.32 per hour for production staff
£17.32 per hour for production manager

6 staff including manager, 8 hour shift. Three shifts are required:
15.32 x 5 = 76.60 x 8 = 612.80 [1]
17.32 x 1 = 17.32 x 8 = 138.56 [1]

Cost per shift: £612.80 + £138.56 = £751.36 [1]

Three shifts to complete the job = £2254.08 [1]

Credit any other appropriate response.

4 (c) i								4			4

Each shift worker gets the following:
15.32 per hour x 8 hours per shift x 3 shifts to complete the job total per worker = £367.68

3.7% bonus
367.68 x 3.7/100 = 13.60 [1]
367.68 + 13.60 = £381.28 [1]

Production Cell Manager gets the following:
17.32 per hour x 8 hours per shift x 3 shifts to complete the job. Total = £415.68

3.7% bonus
415.68 x 3.7/100 = 15.38 [1]
415.68 + 15.38 = £431.06 [1]

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.

4 (c) ii								1			1

Difference
431.06 – 381.28 = 49.78

49.78/381.28*100

13.05% more [1]

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.

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Question 5

The trampoline shown below has been made from several different materials, each of which was chosen for their respective working properties.

(a) Explain the difference between 'physical properties' and 'mechanical properties'. [2]

(b) The trampoline frame is made from galvanised mild steel tubing. Describe the mechanical properties of galvanised mild steel tubing that make it suitable for use in this product. [4]

(c) The protective sleeves on the upper frame have been made from high density foam. Describe the properties of high density foam that make it suitable for use in this product. [4]

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

Candidates should demonstrate knowledge and be awarded 1 mark for the correct explanation of each term.

Award 1 mark for each correct definition.

Mechanical properties are defined as those material properties that measure a material's reaction to external applied force, for example toughness, strength, malleability, hardness, ductility etc. [1]

A physical property is a property unaltered by an external force, i.e. properties that refer to the actual matter that make up the form of material for example density, conductivity (electrical and thermal) etc. [1]

Credit any other appropriate response.

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5 (b)							4				4

Candidates should demonstrate understanding and are awarded up to 4 marks.

Award up to 2 marks for a detailed description of a correct mechanical property that refer back to the trampoline in the question. Do not award marks for physical properties. Correct answers could include:

- Toughness [1] – the ability of the material to withstand a sudden impact without breaking or fracture this is important as a trampoline is subject to sudden impact through normal use (children jumping up and down on the trampoline mat) [1]
- Plasticity [1]– the ability of the material to be permanently changed in shape by external forces such as hammering or pressure such as pipe bending, the tube is bent at the top of the frame (holding the top of the netting) and at the bottom of the frame for the legs during manufacture and this would not be possible without this property [1]
- Durability [1]– the galvanised steel ability of the material to withstand wear and tear, corrosion, weathering or deterioration which is useful for products that are outside and exposed to the weather for many years [1]
- Stability [1] – The galvanised steel tubing is relatively stable and will resist changes to its size and shape due to its environment and weather conditions such as summer heat and cold wet winters [1]
- Tensile strength [1] – this is the materials ability to withstand stretching or pulling forces which is important as the trampoline will be exposed to these forces during normal use (children bouncing up and down) and the structure should not deform [1]
- Compressive strength [1] – this is the materials ability to resist pushing forces that attempt to crush the material which is important as the trampoline will be exposed to these forces during normal use (children bouncing up and down) and the structure should not deform [1]
- Bending strength [1] – this is the materials ability to withstand forces that seek to bend it. It is important for the material to have this property as the force of the children bouncing may deform the frame if it does not have sufficient bending strength [1]
- Torsion strength [1] – this is the materials ability to withstand twisting forces. Twisting forces are likely to be exerted on the trampoline frame through normal use when children are bouncing on the trampoline [1]

Do not award mark for ‘strength’ on its own.

Credit any other appropriate response.

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5 (c)							4				4

Candidates should demonstrate understanding and are awarded up to 4 marks.
Award two marks for each fully explained property

Correct responses could include:

- Density [1] – (mass per volume). Relative density is the ratio of the density of the substance to that of pure water at a temperature of 4°C. The high density foam will absorb some of the impact if a child were to stumble or fall while on the trampoline, providing protection from the galvanised steel tube frame [1].
- Resistant to water, oils and grease [1] this is important as the product is kept outside in all weathers and the user would not want the product to deteriorate over time. [1]
- Resistant to moisture [1], and also resists the growth of mildew, important as the trampoline will be kept outside even during autumn and winter months [1].
- Very good tear resistance [1] this is required as the children are likely to hold onto and pull against the foam while playing on the trampoline, it would be unacceptable if the foam were to tear during normal use.
- The foam is easy to fabricate [1] and can be moulded, cut into shape using abrasion, heat or foam cutting blades quickly and relatively cheaply [1].

Do not award marks for responses that repeat properties from 5(b)

Credit any other appropriate response.

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Question 6

Explain how the use of composite boards has impacted on the design and manufacture of modern flat-pack furniture items. [5]

Q 6	Science	Maths		AO3		AO4					Total
				2a	2b	2a	2b				
6							5				**5**

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

Explanations must make reference to the flat-pack theme of the question. Award one mark for each correct point.

- Composite boards are supplied in large flat sheets which make manufacture quicker and cheaper than manufacturing with natural timber. This makes it suitable for production of high-volume production where jigs and fixtures would be used [1].
- Use of veneers can give the impression of a solid timber construction which gives an overall better aesthetic appeal [1].
- Manmade boards have equal strength in all directions which means that the manufacture does not have to worry about grain direction or the resulting strength [1].
- Good dimension stability – less prone to warping and twisting than natural timber which is useful when creating larger furniture items such as freestanding shelves [1]
- Thin sheets can be bent over formers to create organic shapes allowing the designer to be more creative in the shape/form of the final product [1].
- Can be made from offcuts and scrap or waste wood and so are considered environmentally friendly, as scrap/waste wood can be used it may also reduce the cost making the products more accessible to the consumer [1].

Credit any other appropriate response.

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Question 7

Study the image of the hand drill below.

(a) Analyse the ways in which the designer has considered consumers' safety in the design and manufacture of this product. [6]

(b) Many manufacturing plants that make consumer goods are investing in renewable energy to help power their factories. Evaluate the use of solar energy as the main power source to the manufacturing plant used to make products such as the hand drill. [6]

Q 7	Science	Maths		AO3		AO4					Total
				2a	2b	1b	1c	2a	2b	2c	
7 (a)	✓			4						2	**6**

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

Award up to two marks for each analysed design feature.

- Chuckless key. This means that the user cannot unintentionally leave the chuck key in when starting to operate the drill [1] removing risk of it being ejected during use and hitting the user or another person [1]
- Rubber hand grip creates greater friction when holding the drill [1]. The grip is less likely to slip in the hand of the user, giving them more control [1]
- Ergonomically shaped handle fits well in the hand of the consumer as anthropometric data had been applied to create an ergonomic shape [1]. The drill is comfortable to hold for operations that required extra physical force and/or extended work periods [1].
- Variable speed. The user can change the maximum speed/torque of the drill so that it is appropriate for the job at hand [1]. If the tool exerts too much speed/torque then the user may injure themselves [1].
- Electric breaks. The drill has electric breaks which stop the drill immediately with no 'wind down' of motors [1]. This reduces injury in the event of entanglement [1].
- Weight balance - the battery at the bottom of the drill and the motor at the top are almost the same weight which means the drill is evenly balanced either side of the users hand making the drill easy to control [1], and as a result of this balance there is less strain on the user's wrist [1].
- The cordless design removes the risk of the user tripping over the cord, or the cord getting tangled in the rotary motion of the drill [1] which could cause electrocution or a tripping hazard [1]
- The battery double lock ensures that the battery will only be removed when the user intends [1]. A single lock can accidentally get knocked allowing the battery to drop. This design (and most modern drills) have dual lock on the battery to avoid this [1].
- Neutral switch to avoid accidental switch-on. The drill has a single switch that can be toggled between forward, backward and neutral [1]. When not in use the switch can be moved to neutral so that the trigger cannot accidentally be pressed [1].
- The design utilises a dead-man switch so, as soon as the user lifts their finger off the trigger the drill stops (unlike a rocker switch used on some tools like orbital banders) [1]. This means there is no need for an additional emergency stop button; if the user gets into difficulty they can just lift their finger off the trigger to stop the operation [1].

Credit any other appropriate response.

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Q7 (b)					4		2				6

Candidates should show clear evidence of appraisal and/or *making judgements* and *applying* this to technical principles to be awarded up to 6 marks.

Benefits and limitations must both be addressed for full mark allocation, if only benefits **or** limitations have been addressed then only award up to 3 marks. Award one mark for each correct benefit/limitation. Discussion points could include:

Benefits

- Clean and renewable energy source [1].
- Cheaper long-term power supply (once installed then energy produced is free of charge) [1].
- Little or no maintenance is required [1].
- Solar energy causes no pollution [1].
- Solar energy does not create any noise [1].
- Option to sell power back to the National Grid if more energy is produced than is required [1].
- Factories tend to have a large roof surface area so there is greater potential to harness more energy [1].
- Use of solar power will help the company become greener which can be used as a marketing 'talk point' for the company [1].

Limitations

- High initial set-up cost so it may be several years before a return on investment is seen [1].
- Solar energy storage is expensive. The batteries are large and take up a lot of space [1].
- Weather dependant so less energy will be created on cloudier days and no energy will be created at night time [1].

Credit any other appropriate response.

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Question 8

Many companies are now reconsidering their environmental and sustainable credentials. When they design products they often 'design for maintenance' by the consumer in order to extend the product's life.

Using named examples, explain how designers are making products 'maintainable' by the consumer in order to extend the product's life and analyse how this impacts on the environment. [9]

Q 8	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.

Answers must be related to functional and environmental factors affected by a 'designed for maintenance' methodology.

Maximum of 6 marks if specific named product/s are not identified.

Ways in which manufacturers have designed for maintenance may include:

- Electronic products capable of having software updates to fix bugs
- Designed using common fixtures and fittings so the user can easily source replacements
- Make parts of the product that are likely to wear and tear easy to remove from the main product and replace. Effective design leading to intuitive fixing means consumers feel more confident fixing products rather than buying new. An example of this is the Dyson vacuum where colour coding is used to identify fixings that can be removed by the user without the use of specialist tools.
- Modular design using sealed units that can be 'clicked' together
- Reduced number of fixings and simpler design so it is easier to maintain
- Make it easy for the user to quickly identify faulty parts to ease with diagnosis
- Make it easy to source and order replacement parts
- Products may use industry standard fixings, or brand specific fixings that are the same across the product range, this will ensure replacement parts can be made available even if the product model is no longer in production
- Provision of maintenance guides for reference by the user. These can take any form from paper copy through to YouTube tutorials.
- Some companies offer cash-back for old products which means they are able to disassemble and recycle the materials
- Manufacturers are choosing stronger, more durable materials that are less likely to break

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Environmental impact, answers may include:

- Products being replaced less often leads to less going to land fill
- Smaller parts or sub-assemblies being purchased (rather than whole product) leads to smaller parcels for shipping –reduction of carbon foot print
- Products being replaced less often leads to less demand for raw materials
- Products that easily disassemble are easier to recycle

Credit any other appropriate response.

Band	Marks	AO3 2a	Marks	AO4 2c
3	**5-6**	Excellent analysis of the 'designed for maintenance' factors that need be considered when designing a named product. 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 designing and making principles to the selection of materials, fixings techniques for a 'maintainable' product, 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 'designed for maintenance' factors that need be considered when designing a named product. 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 designing and making principles to the selection of materials, fixings techniques for a 'maintainable' product, 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 'designed for maintenance' factors that need be considered when designing a named product. Little evidence of deconstructing information and limited connections are made. Few factors are identified.	**1**	Applies a basic knowledge and understanding of designing and making principles to the selection of materials, fixings techniques for a 'maintainable' product.
		There is limited evidence of relevant examples or structure.		
	0	No response or work that is worthy of a mark		

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Question 9

Explain how CAD/CAM technologies have facilitated a truly global workforce in terms of the design and manufacture of products. [9]

Q 9	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:

CAD

- Allows for design teams to work simultaneously on the same drawing from different locations
- CAD drawings using standard conventions such as BSI mean that language barriers can be avoided – translation to CAM manufacture leaves little room for misinterpretation
- Designs can be developed 24 hours a day, as a design team in one location may be ending their work day, another team may only be starting
- Digital documents can be accessed anywhere, anytime so designers do not need to be tied to a specific geographical location.
- Brands such as Alessi make use of global design talent – designers can live anywhere while manufacture happens mainly in Italy
- CAD allows for expertise to be identified and employed from any part of the globe rather than having to rely on talent relocating to a specific office
- Small changes and iterations can be made easily, making small changes required for different geographical locations more efficient. E.g. electronics such as DVD players

CAM

- Manufacturing can happen in any geographical location and companies can make use of cheaper manufacturing costs in some locations (with awareness of moral and ethical considerations)
- CAD files can be read by CAM machines such as water jet cutters or CNC routers therefore increasing accuracy and making QC easier to control
- The speed of digital transfer allows manufacture to start almost instantly (save for set up time)

Candidates need to demonstrate knowledge and understanding of how CAD/CAM have impacted on a global company and a global workforce. Comparison with traditional methods of design/manufacture such as hand-drawn working drawings/hand manufacture can be used as an alternative. Do not accept unqualified assertions such as quicker, easier or faster.

Credit any other appropriate response.

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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 CAD/CAM 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 CAD/CAM, 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 CAD/CAM 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 CAD/CAM. 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 CAD/CAM theme. Few issues are identified.	**1**	Demonstrates and applies a basic knowledge and understanding of designing and making principles in the context of CAD/CAM. Few examples are provided.
		There is limited evidence of relevant examples or structure.		
	0	No response or work that is worthy of a mark		

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Question 10

Evaluate the advantages and disadvantages to the designer and manufacturer of using concurrent engineering for either high volume consumer products such as mobile phones or large complex one-off projects such as a modern ocean liner. [12]

Q 10	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:

With concurrent engineering multiple tasks are carried out at the same time rather than in sequence.
Possible responses may include:

Advantages

- Several people or teams of people work on the same project. These can be in the same or in different geographical locations depending on where the expertise is located.
- It encourages multi-disciplined teams to work together. In some cases working across teams in this way can lead to unique and novel approaches to product design solutions as 'standard' conventions can be challenged
- Concurrent engineering allows products to get to market quicker. For consumer products such as personal electronics, this will lead to a greater market share for the company as other companies rush to catch up
- Designers, Engineers researchers and manufacturers all work together from the start of the project. This means that no-one in the team is waiting for 'early' stages of the project to be completed (unlike a 'serial' design process). The whole process is more efficient
- Can reduce the cost of the project and increases the quality of the product as all expertise are involved from the outset and support the life cycle of the project. Production issues can be identified earlier in the design process
- Increases productivity as all parties are engaged in the project from the outset.

Disadvantages

- Communication between multidisciplinary teams can be difficult to manage, miscommunication or no communication can lead to additional costs and increased project timeline.
- Iterations in the product design may not be communicated to all interested parties efficiently.
- Compromises based on 'easy' fit of solution, rather than 'best fit' may filter through.

The following may be credited as either an advantage or a disadvantage depending on how the candidate uses them in their evaluation

- Good communication is essential to avoid misunderstanding that could lead to lengthening the design/manufacturing process
- Design and technical specifications are essential to make sure all teams and individuals are working to the same set of guidelines
- All are aware that one small change to their specific area of the project can have a knock-on effect to the other teams

Credit any other appropriate response.

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Band	Marks	AO3 2b	Marks	AO4 1c
3	**5-6**	Excellent evaluation of concurrent engineering used in the development of products. A thorough discussion, which appraises and/or makes judgements about the use of concurrent engineering in the development of domestic/one-off products. Well-considered, relevant wider issues used as a context for the discussion.	**5-6**	Applies a thorough knowledge and understanding of technical principles to the use of concurrent engineering in the development of domestic/ one-off products. 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 concurrent engineering used in the development of products. A generally sound discussion, which appraises and/or makes judgements about the use of concurrent engineering in the development of domestic/one-off products. Generally well-considered, relevant issues used as a context for the discussion.	**3-4**	Applies a generally sound knowledge and understanding of technical principles to the use of concurrent engineering in the development of domestic/ one-off products. 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 concurrent engineering used in the development of products. Little evidence of appraising or making judgements about the use of concurrent engineering in the development of domestic/ one-off products. Few issues are identified.	**1-2**	Applies a basic knowledge and understanding of technical principles to the use of concurrent engineering in the development of domestic/one-off products.
		There is limited evidence of relevant examples or structure.		
	0	No response or work that is worthy of a mark		

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