GCE AS MARKING SCHEME

SUMMER 2019

AS (NEW)
DESIGN AND TECHNOLOGY - PRODUCT DESIGN
B602U10-1

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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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EDUQAS GCE AS DESIGN AND TECHNOLOGY - COMPONENT 1

PRODUCT DESIGN

SUMMER 2019 MARK SCHEME

Marking guidance for examiners

Summary of assessment objectives for Component 1

The questions on this exam paper assess aspects of AO3 and all of AO4.

Within AO3, this exam paper assesses:

Analyse and evaluate –

- *wider issues in design and technology*

Within AO4, this exam paper assesses:

Demonstrate and apply knowledge and understanding of –

- *technical principles*
- *design and making principles*

In the mark grids, the marks allocated to assessment objectives are shown with respect to specific elements:

AO3 2a analyse wider issues in design and technology
AO3 2b evaluate wider issues in design and technology

AO4 1a demonstrate knowledge of technical principles
AO4 1b demonstrate understanding of technical principles
AO4 1c apply knowledge and understanding of technical principles

AO4 2a demonstrate knowledge of designing and making principles
AO4 2b demonstrate understanding of designing and making principles
AO4 2c apply knowledge and understanding of designing and making principles

The structure of the mark scheme

In low-tariff questions, the mark scheme includes indicative content which should be used to assess the quality of the candidate's response. The content is not prescriptive and candidates are not expected to mention all material referred to. Examiners should seek to credit any further relevant evidence offered by the candidates.

In high-tariff questions, the mark scheme has two parts:

- An assessment grid showing bands and associated marks that should be allocated to responses which demonstrate the characteristics required by the appropriate assessment objectives relevant to the question

- Indicative content which should be used to assess the quality of the specific response. The content is not prescriptive and candidates are not expected to mention all material referred to. Examiners should seek to credit any further relevant evidence offered by the candidates.

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Applying the mark scheme

Stage 1 - Deciding on the band

Beginning at the lowest band, examiners should look at the candidate's response and check whether it matches the descriptor for that band. If the descriptor at the lowest band is satisfied, examiners should move up to the next band and repeat this process for each band until the descriptor matches the answer. Examiners should not seek to mark candidates down as a result of small omissions in minor areas of an answer.

Stage 2 - Deciding on the mark

During standardising (marking conference), detailed advice from the Principal Examiner on the qualities of each mark band will be given. Examiners will then receive examples of answers in each mark band that have been awarded a mark by the Principal Examiner. Examiners should mark the examples and compare their marks with those of the Principal Examiner.

When marking, examiners can use these examples to decide whether a candidate's response is of a superior, inferior or comparable standard to the example. Examiners are reminded of the need to revisit the answer as they apply the mark scheme in order to confirm that the band and the mark allocated is appropriate to the response provided.

Indicative content is also provided for banded mark schemes. Indicative content is not exhaustive, and any other valid points must be credited. In order to reach the highest bands of the mark scheme a candidate need not cover all of the points mentioned in the indicative content but must meet the requirements of the highest mark band. Where a response is not creditworthy, that is contains nothing of any significance to the mark scheme, or where no response has been provided, no marks should be awarded.

Where questions target multiple assessment objectives, an answer may deserve to be awarded marks from different bands for different assessment objectives. Where questions target more than one element within an assessment objective, and those elements are conflated and not considered separately within the mark scheme, examiners must not attempt to apportion marks within that assessment objective by element.

In summary:

- the first stage for an examiner is to use both the indicative content and the assessment grid to decide the overall band;
- the second stage is to decide how firmly the characteristics expected for that band are displayed;
- thirdly, a mark for the question is awarded.

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COMPONENT 1

MARK SCHEME

Mark Scheme AS Design and Technology
Product Design Sample Paper

Section A

Question 1

The image below shows a mass produced television remote control made from ABS [Acrylonitrile Butadiene Styrene].

(a) Describe **two** properties of ABS [Acrylonitrile Butadiene Styrene] plastic that make it appropriate for the remote control.

(b) Effective aesthetic qualities are critical when designing products

Explain **two** aesthetic qualities to be considered when designing the remote control.

(c) Rapid Prototyping is essential when designing successful products.

Explain **one** advantage of using rapid prototyping when designing the television remote control.

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

Learners should demonstrate understanding and are awarded up to 4 marks

Award 1 mark for each property of abs that makes it appropriate for the remote control and 1 mark for the justification up to a total of 4 marks.

- ABS is a relatively cheap material [1] therefore reducing the costs to the manufacturer and the consumer [1].
- ABS is a hard/tough material [1] that is ideal for the wear the product will go through over time/can take being dropped or knocked. [1]
- ABS can be moulded easily [1] therefore making it ideal for manufacturing the product and producing more complex shapes [1]
- ABS has good insulation properties [1] making the product safer to the consumer [1]
- Injection moulding ABS is appropriate for mass production [1] with identical products made in volume with little waste [1]

Do not except Strong.

Credit any other appropriate response.

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				AO3		AO4					
						1a	1b	1c			
1 (b)	✓						4				4

Learners should demonstrate application of knowledge and understanding and are awarded up to 2 marks.

Award 1 mark for a description and 1 mark for a justification or appropriate supporting comment up to a total of 2 marks.

- The product shape/contour needs to be considered [1] such as curves to enable the user to hold it correctly and comfortably/ shaped buttons to enable easier use of certain key buttons [1].
- The product texture needs to be considered [1] such as a smooth surface to enable it to be held comfortably/spot textures to enable easier use of certain key buttons/accessibility for poor sighted users [1].
- The button positioning needs to be considered [1] to conform to user expectations and to increase ease of use and familiarity [1]
- The colour of the buttons should be considered [1] to increase the ease of use for the user [1]
- The dark grey/ black body colour is a suitable colour [1] as it will match the colour of a range of televisions [1]
- The dark body contrasts well with the buttons [1] to allow the user to focus on the buttons [1]

Credit any other appropriate response.

				AO3		AO4					
						1a	1b	1c			
1 (c)						2					2

Learners should demonstrate knowledge and are awarded up to 2 marks

Award 1 mark for an advanatge and 1 mark for a justification or appropriate supporting comment up to a total of 2 marks.

Rapid Prototyping is a quick method to produce a model in 3D [1], therefore reducing product development costs [1]
Rapid Prototyping is an automated process [1] therefore requires less skilled workers and reduces staff costs.
Rapid Prototyping can produce a quick 3D model that can be held [1] enabling consumer testing to take place [1]

Credit any other appropriate response.

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Question 2

Fitness for purpose is critical to the eventual success of a final product.

With reference to the design and production of the car shown answer the following.

(a) Explain **two** factors that the manufacturer must consider to ensure fitness for purpose and eventual success of the car.

(b) Explain **one** example of primary processing undertaken during the manufacture of a car.

(c) The graph and table shows the top five car manufacturers' monthly salesfor January 2018 to June 2018.

(i) Calculate the mean (average) number of car sales during the 6 month period.

(ii) Calculate the percentage share Manufacturer B has of the total sales of the top five brands.

(iii) In January, February, March and April 2019 there has been a 4% increase in car sales.

In May and June there has been a 8% increase in car sales.

Calculate the new mean (average) for January to June 2019 rounded to the nearest whole number.

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

Learners should demonstrate application of knowledge and understanding and are awarded up to 2 marks.
1 mark for a naming a fitness for purpose and 1 mark for a justification or supporting reason up to a total of 4 marks

Price [1] has to be targeted at the correct level to ensure customers can afford to purchase the car [1]
Performance [1] the car must perform well in terms of fuel economy, speed, comfort, user needs to ensure customers want to purchase the car/ensure it performs well for the customer [1]
Aesthetic appeal [1] the car must meet customers' needs and likes in terms of colour, styling and shape to ensure successful sales of the car [1]
Reliability [1] the car must be reliable in terms of usage to ensure the customer may stay with that brand [1]

Credit any other appropriate response.

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				AO3		AO4					
						1a	1b	1c	2a		
2 (b)						2					2

Learners should demonstrate application of knowledge and understanding and are awarded up to 2 marks.
1 mark for an example of primary processing and 1 mark for a justification or supporting reason up to a total of 2 marks

Materials are processed to create the components such as moulded into shapes [1] ready for assembly and secondary processing such as the bumper or interior parts [1]
Materials are welded together [1] to create permanent joints such as the body of the car [1]
Materials are cut, formed, bent and stamped into shape [1] ready for assembly and secondary processing such as the body parts [1]

Credit any other appropriate response.

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				AO3		AO4					
						1b					
2 (c) i		2				2					2
2 (c) ii		2				2					2
2 (c) iii		4				4					4

2 (c) (i)
Learners should demonstrate understanding and be awarded up to 2 marks based on:

Adding up total sales

65776
36774
189966
66867
79543
101689

540615
1 mark

540615 ÷ 6 = 90102.5

Mean = 90102.5 ***1 mark***

Credit any other appropriate mathematical response.

2 (c) (ii)
Learners should demonstrate understanding and be awarded up to 4 marks based on:

Manufacturer B Sales = 12579+ 7036 + 37843 + 14607 + 18097 + 23224 = 113386 **1 Mark**

(113386 * 100)/540615 = 20.97% **1 Mark**

Except rounding e.g. 21%

2 (c) (iii)
Learners should demonstrate understanding and be awarded up to 4 marks based on:

[Working out percentage increase of January, February, March and April]
65,776 + 36,774 + 189,966 + 66,867 = 359,383
(359,383 * 104)/100 = 373,758.32 ***1 mark***

[Working out percentage increase of May and June]
79,543 + 101,689 = 181,232

(181,232 * 108)/100 = 195,730.56 ***1 mark***

Mean = (373,758.32 + 195,730.56) /6 = 94,914.8467 **1 mark**

Rounded – 94,915 ***1 mark***

Credit any other appropriate mathematical response.

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Question 3
Study the image below showing a decorative modern USB powered lamp.

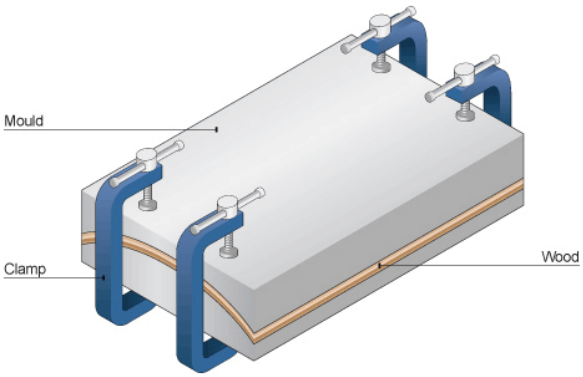
(a) Use notes and diagrams to describe how the lamp body has been made from plywood using the laminating and steam bending process.

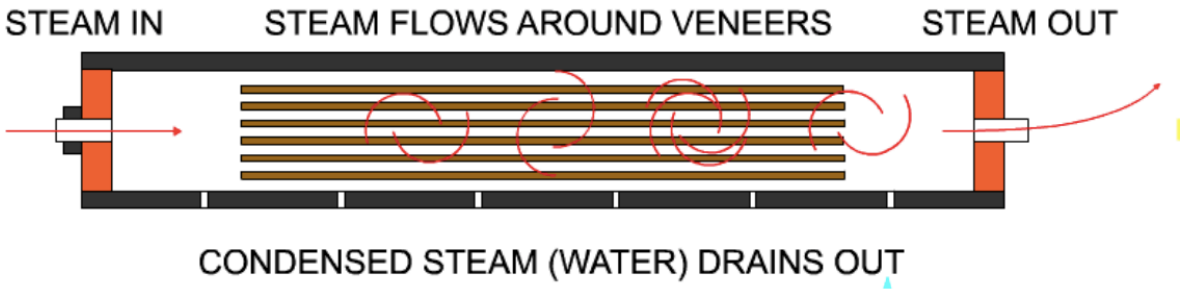
(b) Explain **two** properties that make plywood suitable for this product.

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

Learners should demonstrate knowledge and are awarded up to 4 marks.

The candidate should produce a diagram with appropriate supporting notes to be awarded the full 4 marks. Award up to 3 marks for appropriate notes without diagrams. Award up to 3 marks for detailed diagrams but without any appropriate notes.





This is the process of bonding different layers of materials with a bonding agent to form intricate shapes and forms that are usually stronger than the original material.

- Thin layers of veneer are steam treated first to make them soft and pliable
- Steam is introduced at one end, excess steam and pressure escapes at the other opposite end and condensed steam [water] drains away. As the steam flows moisture is absorbed into the veneer.
- Bend them into shape with the use of a former. Layers of veneer are clamped and removed, the veneers remain in the shape of the former.
- They are then glued together using PVA, resin or cascamite and clamped in the former until the glue has set.

Credit any other appropriate response.

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(b)	✓								4			4

Learners demonstrate knowledge and are awarded up to 4 marks based on:

Award 1 mark for each benefit and 1 mark for a justification or appropriate supporting comment up to a total of 4 marks.

Plywood offers all the inherent advantages of the parent wood plus enhanced properties in its laminated structure.

Plywood has high strength to weight ratio [1] making it stable and strong [1]
Plywood has good surface dimensional stability [1] making it ideal for steam bending.
Thin plywood is flexible [1] and can be formed into curved shapes
The smoothness of the surface [1] help to produce a high quality product [1]
Top grade plywood has a low number of defects [1] help to produce a high quality product [1]

Award no marks for saying that plywood is suitable because it can be laminated and steam bent.

Credit any other appropriate response.

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Question 4

The metal corner brackets pictured below are designed to strengthen corner joints in wooden structures.

(a) Explain why mild steel is a suitable material for these corner brackets.

(b) (i) Using the information on the diagram below, calculate the length of side A of a simple corner bracket.

(ii) The diagrams show a 2D working drawing and a 3D CAD drawing of a simple corner bracket with drilled holes for screw fixing. (Drawing not to scale)

Calculate the external total surface area of the bracket in mm^2.
Round your answer to a whole number.

(c) Describe why the mild steel would need to be galvanised if it were to be used on an outdoor wooden product

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

4 (a) Learners should demonstrate knowledge and are awarded up to 2 marks.
Award 1 mark explaining the purpose and 1 mark for a justification or appropriate supporting comment up to a total of 2 marks.

Mild Steel is tough [1] providing the product with good longevity [1]
Mild steel is ductile and malleable [1] so that the bracket can be bent during manufacturing [1]

Tough, ductile, malleable, good tensile strength [1] and can withstand drilling and bending during construction and is less likely to fatigue [1]

Credit any other appropriate response.

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4 (b) (i) Learners should demonstrate knowledge and understanding and be awarded up to 3 marks based on:

cos (angle) = adjacent/hypotenuse **1 Mark**
cos (57) = A/178
A = 178 x cos(57)
A = 96.94574 **1 Mark**

Rounded = 97 **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.

(ii) Learners should demonstrate knowledge and understanding and be awarded up to 4 marks based on:

Calculating total surface area of all sides
Surface Area of Longer rectangle 150 x 48 = 7200^2
Surface Area of smaller rectangle 97 x 48 = 4656^2
Surface Area of Triangular section 150 x 97 = 14550^2
$14550/2 = 7275^2$ **1 Mark**

Calculating total Surface Area of holes **1 Mark**
$C = pi * r^2$
$r^2=16$
C=pi x 16

$C = 50.26548^2$ **1 Mark**

Calculating whole Surface Area = Triangle + Longer Rectangle + Smaller Rectangle – (3 x holes)
7275+7200+4656 = 19131
19131 – (50.26548 x3) = 18980.2305mm^2 **1 Mark**

Answer Rounded to a whole number 18980mm^2 **1 Mark**

Allow for rounding errors through the calculations.

Do not penalise for any errors carried forward. Continue to award marks if you can clearly see the mathematical method used by the candidate. Only accept correct answer if mm^2 .

4 (c) Learners should demonstrate an understanding and are awarded up to 2 marks.

Award 1 mark for a benefit and 1 mark for a justification or appropriate supporting comment up to a total of 2 marks.

Galvanization or galvanizing is the process of applying a protective zinc coating to steel, to prevent rusting. The most common method is hot-dip galvanizing, in which parts are submerged in a bath of molten zinc.
Brackets are galvanised to apply a finish [1] that protects the mild steel from rusting [1] improves the durability of the product [1]

Credit any other appropriate response.

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Question 5

(a) Explain the meaning of the term Reverse Engineering.

(b) The bracelets below are made from aluminium and have been anodised.

Describe **two** reasons why anodising is a suitable finish for this product.

(c) Products such as the soft drink cans shown in the image are mass-produced.

Describe **two** advantages of using mass production when manufacturing the soft drinks can.

Q 5	Science	Maths		**AO3**		**AO4**					**Total**
						1a	1b	1c			
5 (a)						2					2
(b)							4				4
(c)							4				4

5 (a) Learners should demonstrate knowledge and are awarded up to 2 marks.

Award 1 mark for an explanation and 1 mark for a justification or appropriate supporting comment up to a total of 2 marks.

A design strategy where a product is taken apart to see how it works [1] to enable the designer to evaluate the good and bad points of the product [1] to see how things work [1]
To provide information to help with the designing stage [1] to see if a product can be improved upon [1]

Credit any other appropriate response.

(b) Learners should demonstrate understanding and be awarded 4 marks

Award 1 mark for each description and 1 mark for a justification or appropriate supporting comment up to a total of 4 marks.

The most common anodising processes, for example sulfuric acid on aluminium [1], produce a porous surface which can accept dyes easily. [1]
Dyes are usually sealed [1] to increase corrosion resistance and dye retention. [1]
Sulphuric acid is an electrochemical process [1] that converts the aluminium surface into a decorative/corrosion resistant finish. [1]
This aluminium oxide is not applied to the surface like paint or plating but is fully integrated [1] so it cannot chip or peel. [1]

Credit any other appropriate response.

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(c) Learners should demonstrate understanding and be awarded 4 marks

Award 1 mark for each description and 1 mark for a justification or appropriate supporting comment up to a total of 4 marks.

The product will need to be relatively simplistic [1] to ensure speed of production. [1]
The product is usually in high demand [1] and needs to be cheap for the consumer particularly in terms of packaging products.
There is usually few components [1] enabling the product to be easily and quickly made/assembled. [1]
There is usually few materials [1] enabling the product to be easily and quickly made/assembled. [1]

All justifications can be substituted with labour costs are very cheap/ not many skilled workers will be required.

Credit any other appropriate response.

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Question 6

Explain how conducting effective risk assessments can protect employees in factory situations like the one shown below.

	Science	Maths		AO3	AO4					Total
					1a	1b	1c	2a	2b	
							3		2	5

Learners should demonstrate understanding and are awarded up to 5 marks based on:

Risk assessment is the careful examination of what in the world of work could cause harm to people so that precautions can be put in place to mitigate risk and prevent harm [1] Risk assessment has to decide whether the hazard is significant and whether it is covered by satisfactory precautions so that the risk is small. [1] Risk Assessment is required by law and guidance provided by the Health and Safety Executive [1]

Five steps to risk assessment:
Step 1: look for the hazard in terms of the workplace and look at areas that might cause harm such as machinery and tools in the workplace setting [1]
Step 2: Decide who might be harmed and how such as workers in the factory setting/operators of machinery [1]
Step 3: Evaluate the risks and decide if existing measures are sufficient or more is needed [1] categorise the risk as high, medium or low, the aim being to make all risks as small as possible [1]
Step 4: Record your findings. Write down the hazards and conclusions [1] ensure that all employees have read the risk assessment and get them to sign that they have to ensure full protection to the employer and employee [1]
Step 5: Review your assessment on a regular basis and revise if necessary [1] good risk assessment has dates of next assessment on them [1]

Examples of solutions include PPE Personal Protective Equipment [1] adequate breaks to ensure workers are rested [1] regular machine maintenance and checks [1] training provided for workers on key equipment, processes and machines [1] appropriate signage [1]

Credit any other appropriate response.

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Question 7

Cardboard furniture can be used in emergency and disaster relief situations where homes are damaged and destroyed.

(a) Analyse and discuss the use of corrugated cardboard furniture in this context.

(b) Evaluate how the use of a laser cutter has benefited the manufacture of flat packed self-assembly furniture such as the product below.

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

7 (a) Candidates should show evidence of *deconstructing information to find connections and provide logical chains of reasoning,* and then *apply* this to be awarded up to 6 marks.

Corrugated card is also called corrugated fibreboard or combined board.

It is manufactured in a range of thicknesses providing the designer with a range of possibilities to improve compressive strength ideal for furniture. The strength and durability of the corrugated card is determined by the number of layers the final manufactured board has

Corrugated board is strong because it is composed of a top and bottom layer and in between there is a triangulated section. A triangular section is very strong compared to its weight.
Corrugated card can be recycled.

Corrugated cardboard is anisotropic ; many of its properties are highly directional. For example, edge crush, bending stiffness, tensile, and surface characteristics are different, depending on the orientation to the flutes and the machine direction of manufacture.

Advantages in this context:

- Can be made relatively quickly especially if the product has no further components or joining methods
- Can be shipped as a flat pack solution reducing transport costs and shipping costs ideal for getting aid to disaster areas.
- Disposable after use and can be recycled - temporary furniture solutions where speed of getting the aid there and easy disposal afterwards is key.
- The corrugated card has tear resistance
- The corrugated card has compressive stiffness along its edge making it ideal for slit-slot approach to designing
- Simple assembly required, with no need for specialist knowledge

Disadvantages in this context:

- During transport some of the surfaces of the cardboard can suffer damage as they are soft
- Without a coating the cardboard is not waterproof which can lead to damage – limiting its use to drier disaster areas
- Additional materials on corrugated card including wax coating (water proofing) and ‘stickies’ can clog the paper maker and contaminate the recycling process.

Credit any other appropriate response.

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Band	Marks	AO3 2a
2	**4-6**	Good analysis of the use corrugated cardboard. A sound discussion, which deconstructs information and provides adequate connections and reasoning. Generally well-considered and relevant factors used as a context for the discussion
		There is a line of reasoning which is generally coherent, mainly relevant and with some evidence and structure.
1	**1-3**	Limited analysis of the use corrugated cardboard. Little evidence of deconstructing information and limited connections are made. Few factors are identified.
		There is limited evidence of relevant examples or structure.
	0	No response or work that is worthy of a mark

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7 (b) Candidates should show clear evidence of appraisal and/or making judgements and then apply this to technical principles to be awarded up to 6 marks.

Issues that the learner could be discussing:

Laser Cutting:
The process can be automated.

- Laser cutting machine has high level of efficiency and required design replicas are exact copies of each other.
- As the section is produced, there isn't direct contact of the work-piece with a cutting tool, lowering the risk of damaging the material.
- Laser cutting is a versatile technology and can be used to cut or burn simple to more complex structures in one piece.
- The Laser cutting process is easily controlled by computer programs, which makes it very precise while saving considerable amount of work.
- Because the laser cutting machine doesn't require human intervention, except for inspections and repairs, the frequency of injuries and accidents is very low.
- Production rate isn't consistent. All depends on the type of material used, the thickness of the work-piece and the nature of laser cutting.
- Setting of the temperature and the distance laser can lead to the combustion of some cardboard.

Credit any other appropriate response.

Band	Marks	AO3 2b	Marks	AO4 2b
2	**3-4**	Good evaluation of the use corrugated cardboard. A 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 sound knowledge and understanding of technical principles to the context how the use of laser cutter can help to produce cardboard furniture. 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 how the use of Computer Aided Manufacture can help to produce cardboard furniture Little evidence of appraising or making judgements about how how the use of a laser cutter benefits the manufacture of flat packed self-assembly furniture.	**1**	Applies a basic knowledge and understanding of technical principles to the context of how the use of a laser cutter can help to produce cardboard furniture.
		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 8
Ergonomics and anthropometrics play an important part in the successful development of an office chair such as the one below.

Analyse the role ergonomics and anthropometrics play in the successful development and design of an office chair.

Q8	Science	Maths		AO3		AO4					Total
				2a		2a	2b	2c			
				5			4				9

Learners should provide evidence of *logical reasoning* or *deconstructing information* and *applying* this to be awarded up to 9 marks based on:

Learners could discuss:

When designing a product, designers consider human senses including sight, smell, touch, comfort, sound and temperature. Ergonomics is an applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely. Can also be called biotechnology, human engineering, human factors

If a product is ergonomically designed the chances are is that it will be a successful product. The user will be able to use the product comfortably. To ensure that products are comfortable and easy to use designers use anthropometric data to make sure that the product is suitable for human use. Anthropometrics is the Science of collecting statistical data about body measurements. Data is collected for Adults and children. Some people are outside of the Average range of body measurements. These are considered to be the 5th and 95th percentile, people who are bigger or smaller than average. The designer invariably designs to the average person.

Specific office chair considerations in terms of ergonomics and anthropometrics:
- Arms should be supported at all times to avoid strain on the muscles of the neck and shoulders.
- Head position is critical and the placement of the neck support should be correct to avoid craning the head and neck forward.
- A lumbar support should be used to avoid pressure on the discs and vertebrae of the back.
- The chair should enable the user to view the monitor of the computer in front of them to minimise movement of the head and neck.
- Feet should comfortably reach floor to avoid pressure on the back of the legs.

These could be applied in a design context by:
- Ensuring the seat is adjustable – usually 420-500mm BS5940
- The seat edge should be rounded to minimise pressure under the thigh and to increase the comfort for the user. The seat pan should tilt forwards and backwards [about 5°)
- The seat base should swivel and have a minimum of 5 or more castors for stability. Castors enable the user to make small movements and adjustments whilst working easily.
- The backrest should be adjustable and about 500mm in height. Contouring should be used to support the lumber curve of the back. It should also tilt in both a working and resting posture.
- The upholstery material should not cause sliding or sweating.
- Footrests should be provided to allow shorter people to adjust themselves to a desk or worktop.
- Armrests may prevent the user getting close to the desk but will assist them in resting their elbows. They should be designed at a measurement which enables them to still access their work area.

Credit any other appropriate response.

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Band	Marks	AO3 2a	Marks	AO4 2b
3	**4-5**	Excellent analysis of the role ergonomics and anthropometrics play in the development and design of an office chair. A thorough discussion, which deconstructs information and demonstrates logical connections and reasoning throughout. Well-considered, relevant examples used to support the discussion.	**3-4**	Demonstrates a thorough understanding of designing and making principles in the role that ergonomics and anthropometrics play in the development and design of an office chair.
		There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.		
2	**2-3**	Good analysis of the role ergonomics and anthropometrics play in the development and design of an office chair. A generally sound discussion, which deconstructs information and provides adequate connections and reasoning throughout. Generally well-considered, relevant examples used to support the discussion.	**2**	Demonstrates sound understanding of designing and making principles the role that ergonomics and anthropometrics play in the development and design of an office chair.
		There is a line of reasoning which is generally coherent, mainly relevant and with some evidence and structure.		
1	**1**	Limited analysis of the role ergonomics and anthropometrics play in the development and design of an office chair. Little evidence of deconstructing information and limited connections are made. Few examples used to support the discussion.	**1**	Demonstrates a basic understanding of designing and making principles in the role that ergonomics and anthropometrics play in the development and design of an office chair.
		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
The life cycle of a mobile phone can impact on the environment in many different ways.

Using a life cycle analysis, evaluate the environmental impact of the mobile phone shown above.

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

Learners should provide evidence of either ***appraisal*** and/or ***making judgements*** and ***applying*** this to be awarded up to 9 marks based on:

Cell phones consist of nine basic parts, each of which has its own life cycle:

- Circuit board/printed wiring board
- Liquid crystal display (LCD)
- Battery
- Antenna
- Keypad
- Microphone
- Speaker
- Plastic casing
- Accessories (such as adapters, headsets, carrying cases, and decorative face plates)

Design The design of the product has an impact on its life cycle and environmental issues.

For example the manufacturer may choose more expensive materials as cheaper ones can be less durable resulting in the product having a shorter life. This inevitably increases the cost of the product to the consumer.

The manufacturer may use modular components that can easily be replaced, so that the product does not have to be thrown away which is an advantage to the consumer. The manufacturer can increase profits by selling replacement components likewise they may use planned obsolescence to make people want new phones which is not good for the environment.

mobile phone companies can design with “dematerialization” in mind (using less materials) for example by the decreasing size of today’s phones.

Materials Extraction and Processing The extraction and processing of raw materials to make components for the mobile phone can have an impact on the environment.

The manufacturer will produce pollution when extracting raw materials and will deplete natural resources especially as most are non renewable. Making components from recycled materials can reduce the impact on the environment. Transporting raw materials and global transporting has a detrimental impact on carbon emissions.

Processing materials such as plastics from oil release C02 emissions and pollution into the environment.

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Manufacturing The manufacture required to make the mobile phone take a great deal of energy to create and produces pollution. Global production has exacerbated the impact on the environment as materials and components are transported around the world.

Packaging & Transportation The use of packaging can protect products from damage, provide product information and can be used as a tool to entice consumers to purchase the product. However, it also consumes valuable resources and can be wasteful as the manufacturer attempts to attract the consumer. The use of recycled materials can be used to reduce this impact.

The final product has to be transported around the globe to different locations to be sold. All of these forms of transportation burn fossil fuels, which can contribute to global climate change.

Use The way in which products are used can detrimentally affect the environment.

Consumer considerations to limit the affects of mobile phones on the environment:

- Keeping the phone longer to reduce the number of phones going to waste
- Sensible usage of the phone and extending the lifespan by for example charging it correctly
- Reusing or recycling the phone including donating them to charity organisations that re-use them for third world users
- Take back programmes can have a positive affect on the environment as the manufacturers have more specialist knowledge and equipment to recycle parts and components.
- Extend the life of your phone by taking care of it—protecting it from damage by storing it in a case, avoiding dropping it, and keeping it out of extreme heat and cold and away from water and other liquids.

End of Life – reuse, recycling and disposal

Manufacturers use design obsolescence to attract the consumer to purchase a new model of phone; by adding features and changing the design. This can sometimes result in consumers changing their phone even though their original phone still works. Cell phones are only used for an average of 18 months before being replaced—even though they can function for much, much longer.
Throwing a product away means that it will end up in a land- fill or incinerator and will not be useful again. Smart phones contain metals, plastics, chemicals, and other potentially hazardous sub- stances.
Modern phones are complex to be recycled as a whole product as there are too many parts and components that would require stripping down.

Credit any other appropriate response.

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Band	Marks	AO3 2a	Marks	AO4 2c
3	**4-5**	Excellent analysis of the life cycle analysis of a smart phone. A thorough discussion, which deconstructs information and demonstrates logical connections and reasoning throughout. Well-considered, relevant examples used to support the discussion.	**3-4**	Applies a thorough knowledge and understanding of technical principles to the context of life cycle analysis. Well-considered, relevant wider issues identified.
		There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.		
2	**2-3**	Good analysis of the life cycle analysis of a smart phone. A generally sound discussion, which deconstructs information and provides adequate connections and reasoning throughout. Generally well-considered, relevant examples used to support the discussion.	**2**	Applies a generally sound knowledge and understanding of technical principles to the context of life cycle analysis. 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**	Limited analysis of the life cycle analysis of a smart phone. Little evidence of deconstructing information and limited connections are made. Few examples used to support the discussion.	**1**	Applies a basic knowledge and understanding of technical principles to the context of life cycle analysis.
		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
Smart materials have had a significant impact in the development of many modern products.

Define the term 'smart material' and using specific products, describe the contribution of the named smart material.

Q10	Science	Maths		AO3		AO4					Total
						1b	1c	2b	2c		
	✓					4		8			12

Learners should demonstrate knowledge and understanding of technical principles and designing and making principles and apply this to be awarded up to 12 marks based on:

Indicative content:
The term 'Smart material' is used to explain the properties of a special range of materials. Smart materials can react to its environment when introduced to outside stimuli without the interference of humans. These materials have given designers opportunities to design products that a few years ago would not be possible.

Smart Memory Alloy:
SMA sometimes called Nitinol is made from nickel and titanium. It has many of the properties of normal wire and can particularly be folded into complex shapes and can conduct electricity. The material can be programmed to remember a particular shape. Uses include a range of electronic and systems applications that include muscle wire and medical applications. SMA is very expensive compared to ordinary steel or copper wire.

The development of smart memory polymers is revolutionising many products as they can be moulded into complex shapes and are lightweight and durable. Many are also recyclable or biodegradable. More expensive than similar polymers and not unbreakable.

Thermochromatic materials, Thermochromic and phosphorescent pigments:
Thermochromatic materials and thermochromic and phosphorescent pigments are sensitive to temperature. They change colour when they are heated up or cooled down. Some changes colour when it is exposed directly to UV light or sunlight. Over time the ability to change will decay (this is called natural fatigue)

There are a wide range of applications including safety products to protect the consumer such as colour changing baby spoons, thermometers. For advertising purposes to reveal information on a product or packaging and to attract the consumer.

Phosphorescent pigments glow in the dark. They are able to absorb light energy and store it. This stored energy is released as light energy over a period of time.

Phosphorescent pigments are useful for watch faces that glow in the dark. They may also be used in fire safety signs placed near fire extinguishers. In the event of a fire, the position of the fire extinguishers can be seen, even if the lights fail.

Piezoeletics materials:
Piezoelectric materials convert electrical energy to mechanical energy, through mechanical stress such as compression. Squeeze certain crystals (such as quartz) and you can make electricity flow through them.

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For example, when you use some type of voice-recognition software, Siri the piezo crystal turns the sound energy in your voice, and changes it into electrical signals for your computer or your phone to interpret. Quantum Tunnelling technology incorporates piezoeletics in a wide range of applications including smart phone technology.

Magnetostrictive materials:
Similar to piezoelectric materials; they respond to changes in magnetic fields and can act as an actuator or sensor if deformed.

Hydrogels:
Hydrogels can be tailored to absorb and hold water, or other liquids, under certain environmental conditions. Hydrogels have been around for a long time, specifically in disposable nappies. A key feature however is the gels can be tailored chemically to respond to different stimuli.

Bi-Component Fibres:
Adaptive thermal insulation can enable smart clothing that can change its thermal properties based on the environment. The development of bi-component fibre technology where two different materials are co-extruded together to enable shape change depending on ambient temperature.

Credit any other appropriate response.

<table>
<tr><th>Band</th><th>Marks</th><th>AO4 1b and 1c</th><th>Marks</th><th>AO4 2b and 2c</th></tr>
<tr><td rowspan="2">3</td><td rowspan="2">3-4</td><td>Demonstrates and applies a thorough knowledge and understanding of technical principles related to the use of smart materials in the design and manufacture of products. Well-considered, relevant wider issues identified.</td><td>6-8</td><td>Demonstrates and applies a thorough knowledge and understanding of designing and making principles related to smart materials, drawing upon well-considered, relevant examples.</td></tr>
<tr><td colspan="3">There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">2</td><td>Demonstrates and applies a generally sound knowledge and understanding of technical principles related to the use of smart materials in the design and manufacture of products. Generally well-considered, relevant issues identified.</td><td>3-5</td><td>Demonstrates and applies a generally sound knowledge and understanding of designing and making principles related to smart materials. Generally well-considered examples are provided.</td></tr>
<tr><td colspan="3">There is a line of reasoning which is generally coherent, mainly relevant, and with some evidence and structure.</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">1</td><td>Demonstrates and applies a basic knowledge and understanding of technical principles related to the use of smart materials in the design and manufacture of products. Few issues are identified.</td><td>1-3</td><td>Demonstrates and applies a basic knowledge and understanding of designing and making principles related to smart materials. Few examples are provided.</td></tr>
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<tr><td></td><td>0</td><td colspan="3">No response or work that is worthy of a mark</td></tr>
</table>

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