GCSE (9–1)

Design and Technology

J310/01: Principles of design and technology

General Certificate of Secondary Education

Mark Scheme for June 2019

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

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

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

Annotations

Annotation	Meaning
BP	Blank page
✔	Point where mark is awarded
L1	Level one response
L2	Level two response
L3	Level three response
REP	Repetition
SEEN	Noted, but no credit given

Subject-specific Marking Instructions

INTRODUCTION

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

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

You should ensure that you have copies of these materials.

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

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

LEVELS OF RESPONSE QUESTIONS:

The indicative content indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance.

Using 'best-fit', decide first which set of level descriptors best describes the overall quality of the answer. Once the level is located, adjust the mark concentrating on features of the answer which make it stronger or weaker following the guidelines for refinement.
Highest mark: If clear evidence of all the qualities in the level descriptors is shown, the HIGHEST mark should be awarded.
Lowest mark: If the answer shows the candidate to be borderline (i.e. they have achieved all the qualities of the levels below and show limited evidence of meeting the criteria of the level in question) the LOWEST mark should be awarded.
Middle mark: This mark should be used for candidates who are secure in the level. They are not 'borderline' but they have only achieved some of the qualities in the level descriptors.

Be prepared to use the full range of marks. Do not reserve (e.g.) highest level marks 'in case' something turns up of a quality you have not yet seen. If an answer gives clear evidence of the qualities described in the level descriptors, reward appropriately.

	Breakdown of Assessment Objectives Assessment Objective
AO3	**Analyse and evaluate –** • **design decisions and outcomes, including for prototypes made by themselves and others** • **wider issues in design and technology**
AO3.1a	Analyse design decisions and outcomes, including for prototypes made by themselves and others
AO3.1b	Evaluate design decisions and outcomes, including for prototypes made by themselves and others
AO3.2a	Analyse wider issues in design and technology
AO3.2b	Evaluate wider issues in design and technology
AO4	**Demonstrate and apply knowledge and understanding of –** • **technical principles** • **design and making principles**
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 design and making principles
AO4.2b	Demonstrate understanding of design and making principles
AO4.2c	Apply knowledge and understanding of design and making principles

Section A

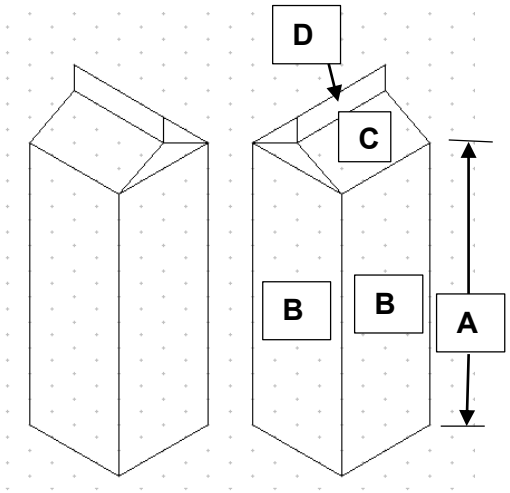
			Answer	Marks	Guidance
1	(a)	(i)	**One** from e.g.: Ash, Beech, Birch or Oak, Balsa wood, Mahogany, Teak **Award credit for any other named hardwood.**	1	Answers do **not** need to be suitable for the context. Do **not** accept any softwood e.g. pine, cedar, spruce.
1	(a)	(ii)	**Two** from: • Strong **in small sections** (must be qualified) • Aesthetically pleasing/attractive e.g. colour/grain • Durable, hard wearing • Doesn't conduct electricity **Award credit for any other appropriate response**	2	1 mark for identifying characteristics of a hard wood that makes it suitable for the base of the lamp. Answers must be **appropriate** for the context in the question: a lamp base Do not accept: 'Strong' or 'tough' on its own or good strength to weight ratio.
1	(b)		**Two** from: • Environmental e.g.: sustainable materials • Social and ethical factors e.g.: Fairtrade • Usability/Functionality • Marketing and branding • Anthropometrics/ergonomics • Target audience • Availability / Cost of materials • Aesthetics	2	Do **not** allow 'fashion/style/trend' this is given in the question.
1	(c)		Up to **two** marks for an explanation e.g.: • To provide directional light/ to allow the lamp to be used in different places (1) for reading/ambience/to be on a desk/shelf/bedside etc. (1) **Award credit for any other appropriate response**	2	Answers must be **appropriate** for the context in the question: the adjustability of the table lamp One mark for why it is adjusted, one mark for a specific use/benefit. Do not credit repeat answers

Question			Answer	Marks	Guidance
1	(d)		**One** from: • It can be finished in a variety of ways e.g. plated, painted (1) • Strong/durable/good strength to weight ratio As stainless steel given in the question **allow** Does not rust or corrode (1)	1	Answers must relate to the use in the adjustable table lamp.
1	(e)		Up to **two** marks for an explanation e.g.: • The standard components/ bulb fittings/switches/parts can be purchased in bulk (1) which will keep manufacturing costs down. (1) • Manufacturing the lamps will quicker (1) as less parts are needed to be made by the manufacturer. (1) • Widely available (1) same components can be supplied by different manufacturers (1)	2	Cheaper or low cost needs to be correctly qualifying to be awarded marks.
1	(f)		**Two** from: • LEDs do not heat so are cool to touch/ won't burn or scorch items. (1) • LEDs are unlikely to break/ are durable/ not made of glass. (1) • Available in different colours, colour changing LEDs. (1) • Low energy, uses less electricity (1) • Brighter/last longer than normal bulbs (1)	1	Do not accept: Answers relating to recycling
1	(g)		**One** from: • Can be cut, bent and formed into shape easily. (1) • Can be printed on or laminated with other materials to achieve a surface finish. (1) • Available in different colours. (1) • Low cost material and will keep the cost of the shade down. (1) • Laminate gives some protection from wet/damp/wear and tear.(1) • Can be glued easily.(1) • Lightweight (1) • Diffuses/softens the light (1) • Can be wiped clean (1)	1	Answers must be **appropriate** for the context in the question: a lamp shade Do **not** accept: • **Waterproof** unless qualified that the laminate gives 'some' protection from water • **Cheap** unless qualified • **Fireproof**

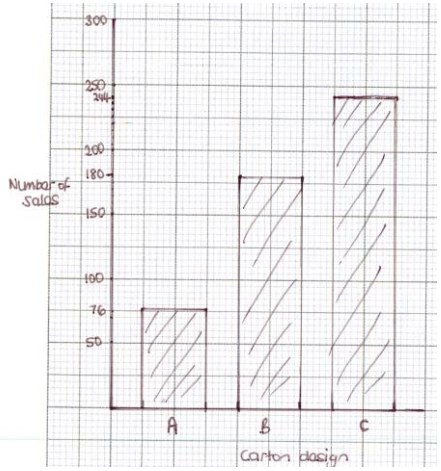
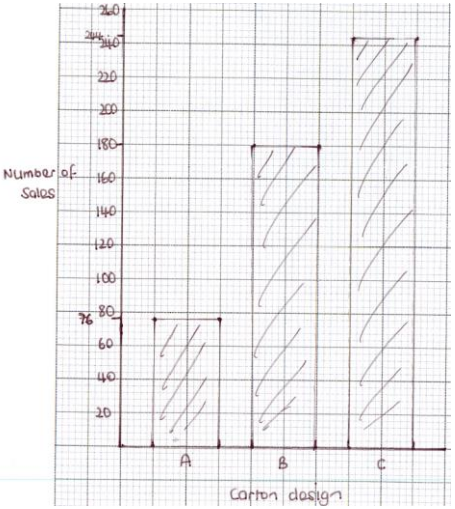
Question			Answer	Marks	Guidance
1	(h)		Why self-assembly products are popular e.g.: • Ease of transport • Low cost compared to pre-made products • Availability • Ease of assemble/disassemble • Less packaging • DIY culture gives the consumer a sense of achievement Up to **three** marks for an explanation e.g.: • They can be taken home immediately (1) consumers don't have to wait for delivery (1) as self-assembly products can often fit into cars/be transported home easily. (1) • Consumers are able to assemble/disassemble the product themselves (1) which makes transporting/moving/storing products (1) easier than pre-made products. (1) • Consumers take the product home immediately (1) they don't have to wait for the product to be made to order/to be delivered (1) as it is easier for the retailer to carry more stock of self-assemble products. (1) **Award credit for any other appropriate response**	**3**	Up to two marks for identifying why self-assembly is popular and third mark for an explanation or One mark for identifying why self-assembly is popular and up to two marks for explaining it.

Question			Answer	Marks	Guidance	
					Content	Levels of response
1	(i)*		Discussion could include e.g. : • Rethink • Reuse • Recycle • Repair • Reduce • Refuse • sustainability principles • cradle to cradle design • circular economy Answers should be supported by examples for example if the lamp is used answers might refer to the materials used such as wood, LED bulb, cardboard, stainless steel which can all be recycled or reused. That wood is sustainable as it regrows. That the product can be easily disassembled and its minimal design means it is made using fewer materials. Choice of non-toxic, sustainable or recycled material e.g. manufactured boards, timber, sustainable materials that are ethically sourced e.g. IKEA has its own forests. Use of waste wood chippings and particles and young trees used to thin forests to make manufactured boards, recycled ocean waste used in footwear or clothing e.g. parley shoes for Adidas.	8	Candidates should be drawing on examples of products and materials to support their answer. If no examples are used, they should not be awarded marks higher than a Level 2. _____	**Level 3 (6–8 marks)** The candidate will demonstrate good knowledge and understanding of sustainability drawing on the six Rs or other principles of sustainability. They will be able to undertake a thorough evaluation of how designers' assess sustainability when designing and developing products. Candidates will be drawing on their wider understanding/experience of the whole subject through their exemplification. A variety of relevant examples are used to effectively support the discussion. There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated with the use of examples. **Level 2 (3-5 marks)** The candidate will demonstrate good knowledge and understanding of sustainability and may draw on the six Rs or other principles of sustainability. They will be limited evaluation of how designers' assess sustainability when designing and developing products. Any evaluation will be one-sided or limited to one factor. Candidates could be drawing on some of their wider understanding/experience of the whole subject through their exemplification and evaluation. Some relevant examples may be used to support the discussion.

Question			Answer	Marks	Guidance	
					Content	Levels of response
			Make assembly and disassembly easy, less complex manufacture in factory increases production levels and efficiency. Reduces fuel used to transport as takes less space on vehicle. Less energy used to manufacture as processes are simpler and items faster to make. Less storage space needed in factory or warehouse. Disassembly allows for reuse of product and if disposed of it takes less room in landfill. Fittings can be reused and recycled. Parts can be replaced or repaired easily **Award credit for any other appropriate response**			There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence. **Level 1 (1–2 marks)** The candidate will show limited knowledge of what sustainability is. There will be basic or no reference to understanding of how sustainability or the six Rs relate to designers' decisions when designing and developing products. There is no attempt at evaluation. Examples are not used to support the discussion or may not be relevant. The information has some relevance and is presented with limited structure or detail The information is supported by limited evidence. **Level 0 (0 marks)** No response or no response worthy of credit

Question			Answer	Marks	Guidance
2	(a)	(i)	1 mark for correct height of side (11 dots) **A** 1 mark for both vertical sides correctly drawn (don't double penalise if height incorrect) **B** 1 mark for correctly drawn triangular part/sloping sides **C** 1 mark for correct top tab (correct to candidates solution) **D**  	4	
2	(a)	(ii)	Area = length x width **OR** (80+80+80+80+15) 335 mm x 310 mm **103,850** (mm^2)	2	Award **two** marks if correct answer seen. Credit one mark if length x width part of the formula is correct (310 x 335) but candidate has made error with allowance.
2	(a)	(iii)	**One** mark: • Two	1	Correct answer only

2	**(a)**	**(iv)**	One **mark** from: • Only one material needs to be sourced/bought in from a supplier. (1) • Waste will be limited (1) • Waste will be easy to dispose of and/or recycle (1) • Saves time joining materials during manufacture (1) • Minimises processes and resources required for joining dissimilar materials (1)	**1**	Do not accept: • Cheaper unless qualified • easier to cut out
2	**(b)**	**(i)**	Volume = 80mm x 80mm x 250mm = 1,600,000 mm^3 In cm^3 = **1,600** (cm^3)	**2**	Award **two** marks if correct answer seen. Award one mark if formula seen or implied or no conversion from mm^3 to cm^3.
2	**(b)**	**(ii)**	**1.5** (litre/s)	**1**	Allow error carried forward if (b)(i) calculated incorrectly.
2	**(c)**	**(i)**	**69**	**1**	Design A 46% of 150
2	**(c)**	**(ii)**	**24%**	**1**	36/150 x 100

Question			Answer	Marks	Guidance
2	(d)		Up to **three** marks e.g.:   	3	Up to **three** marks: One mark for labelling axes One mark for a sensible scale on y axis i.e. • 1cm = 20 sales or • 2cm = 50 sales One mark for all 3 bars correctly drawn + or – 1 small square : • Carton design A: 76 • Carton design B: 180 • Carton design C: 244 Maths marks are for: • Construct bar chart from data (labelling axes as appropriate for a bar chart) • Plot data (sensible scale) • Extract information (take data and draw correct bars)

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3</td><td>(a)</td><td></td><td>One mark for each correct answer:

<table>
<tr><th>Function</th><th>Input or Output</th><th>Electronic component</th></tr>
<tr><td>Turns device on.</td><td>Input (1)</td><td>Switch (1)</td></tr>
<tr><td>Provides sound to play music.</td><td>Output (1)</td><td>Speaker (1)</td></tr>
<tr><td>Illuminates to show when the device is switched on.</td><td>Output (1)</td><td>LED</td></tr>
<tr><td>Listens to the human voice.</td><td>Input (1)</td><td>Microphone</td></tr>
</table></td><td>6</td><td>These are the only acceptable answers.

‘Incorrect/correct’ answer no marks eg. Button/switch or plug/switch

Accept ‘push button switch’</td></tr>
<tr><td>3</td><td>(b)</td><td></td><td>Up to two marks for an explanation e.g.:

Microcontrollers take information from sensors and other inputs (1) then process this information to control outputs such as speakers, lights or movement. (1)

They carry out specific tasks/ functions (1) for example in a kettle a microcontroller switches on the heating element until it senses the water has reached boiling point.(1)

Award credit for any other appropriate response or examples</td><td>2</td><td>One mark for what a microcontroller does, one mark explaining it – accept suitable examples of products using a microcontroller.

Award one mark for a reference to function or functionality</td></tr>
</table>

3	(c)		Up to **two** marks e.g.: **Robotics or AI** (1) • automate household products e.g. a robotic vacuum cleaner or lawn mower (1) • Driverless cars (1) • hands-free/remote control of devices e.g. Alexa and other smart speakers controlling heating control systems etc. (1) **Biometrics** (1) • Increasing security when accessing systems e.g. fingerprint scanners/face ID/ eye recognition used for locks/alarm systems/to unlock smart phones. (1) **Virtual reality (VR)** (1) • enhancing online shopping so you can imagine you are in store, sell holidays or experiences. (1) • uses in gaming (1) **Drones** (1) • Cameras used for aerial shots and going into dangerous environments. (1) **Wireless / Bluetooth Technologies (1)** • Wireless charging , keyless ignition in cars etc (1) **Nano technology (1)** • Self healing paint, self cleaning coatings etc. fibres protecting against fungus and odour - medical textiles, fighting bacteria. (1) **Smart Alloys / Carbon fibre composites (1)** • Car bodies, medical and dental products (1) **Technical textiles -geo textiles, medical textiles (1)** • Nomex – heat/ flame resistant material used for protective clothing for racing drivers, firemen, astronauts; (1) • Kevlar - resistant to abrasion -bullet proof vests, motorcycle clothing, tyres, protective gloves (1) • Coolmax - wicks water away from body and improves breathability. bedding, sportswear, uniforms and underwear.(1) • Fastskin - mimics the skin of a shark giving a streamlining effect	**2**	One mark for a correct example of emerging technology that enhances the function of a product. One mark for saying how it enhances the function.

Question			Answer	Marks	Guidance	
					Content	Levels of response
3	(d)		Discussion should include knowledge and understanding of the impact of 3D printing on traditional manufacturing. e.g.: 3D printing will 'digitise' some manufacturing, allowing production to take place closer to the customer, with potential for local and even mobile manufacturing, possibilities of 3D printing within our homes or in local centres might mean in the future we can download products, print them and avoid the need for transportation and deliveries, reducing environmental impacts of distribution processes 3D printing allows us to produce customised products for a fraction of the cost. The development of affordable 3D printers, 3D scanners and CAD software has enabled small companies to offer bespoke customised designs, footwear companies such as Adidas and New Balance are exploring methods to print trainers and footwear to support feet, by customising to different runners' needs. Ford is exploring 3D printing to make tooling and prototypes, which can be tested just hours after their initial design. rapid prototyping and direct digital manufacturing (DDM). 3D printing to directly fabricate final products or parts. Ford is researching the use of DDM to manufacture parts that can be used in cars. In the future we might find ourselves	6	Look for evidence of how 3D printing has changed how things are manufactured and how this 'expanded' production capacity and possibilities. Candidate responses that focus on the discussion of technological advances vs loss of jobs should not be awarded marks higher than a Level 2.	**Level 3 (5–6 marks)** The candidate will demonstrate an excellent understanding of 3D printing and its impact on traditional manufacturing. They will be able to discuss this convincingly, using examples of products and/or different materials to analyse and/or evaluate the impact. **Level 2 (3–4 marks)** The candidate will demonstrate some understanding of 3D printing. They will be able to discuss this, to analyse or evaluate its impact on manufacturing. (see examples opposite) **Level 1 (1–2 marks)** The candidate will give a basic answer showing limited understanding of 3D printing and its impact on manufacturing. Any examples given may not be appropriate and will be most likely related to school use. Any attempt at analysis or evaluation will be limited and not be worthy of credit. **Level 0 (0 marks)** No response or no response worthy of credit.

Question			Answer	Marks	Guidance	
					Content	Levels of response
			downloading and printing parts or consumer products. Airbus is now using 3D printed components in its aircraft, with its latest A350 XWB containing over 1,000 3D printed parts. In the automotive sector, 3D printing is used to make parts for F1 racing cars. A company called Local Motors is intending to launch a 3D printed car. A new type of 3D printer which fabricates 3D objects from soft fibres (wool and wool blend yarn) is being explored by Carnegie Mellon University and Disney. This extends 3D printing from typically hard and precise forms into soft and imprecise objects and provides a new capability to explore the use of materials in interactive products and moveable parts/ components. Rapid prototyping technology has been under research and development for over 30 years. The range of materials that can be printed is now wide, and includes plastics, paper, ceramics, metals, super alloys, wool and bio-materials. **Award credit for any other appropriate response**			

Section B

Question			Answer	Marks	Guidance
4	(a)	(i)	**Two** from: • Polymers can be moulded to shape easily. (1) • Polymers come in a range of bright colours. (1) • Polymers are easy to wash or wipe clean. (1) • Durability doesn't break easily. (1) • Suitable for volume production (1)	2	1 mark for each **physical** characteristic of a polymer identified that makes it suitable for the Lego bricks. Answers must be **appropriate** for the context in the question: Lego bricks
4	(a)	(ii)	**One** from: • It's a simple design. (1) • It is available in many colours so would suit boys or girls/unisex. (1) • Allows children to be creative/assemble blocks in different ways. (1) • An example of primary recycling/can be passed on to another child. (1) • It is durable and long lasting, handed down to younger siblings. (1) • Made popular by recent Lego films, produces bricks in-line with trends & fashion. (1)	1	Answers must be **appropriate** for the context in the question: Lego bricks Do not accept cheap (it isn't!)
4	(b)	(i)	**Two** from: • It is washable. (1) • The feel of the fibre is soft/comforting for a child. (1) • It will not cause irritation or rash. (1) • Durable / tough and hardwearing (1) • Can be dyed/coloured (1) • Won't melt/stick to the skin easily if catches fire (1) • Anti-static – doesn't build up static electricity	2	1 mark for reason identified of why a natural fibre is suitable for the teddy bear. Answers must be **appropriate** for the context in the question: teddy bear Do not award mark for Safe or Non-toxic.

4	**(b)**	**(ii)**	Why consumer choose fair trade products e.g.:
			
			• Help reduce poverty.
			• Know where the goods have come from.
			• Moral reasons e.g. they know that goods have been produced to fair trade standards:
			  • Workers/farmers have been treated fairly.
			  • Workers/farmers have better working conditions.
			  • No child labour/exploitation.
			  • Proper management of waste/water/energy.
			  • Consumer trends
			
			Up to **three** marks e.g.:
			• People buy Fairtrade to help reduce poverty (1) as they know that farmers are given a fair wage (1) and workers have good working conditions. (1)
			• They know where the goods have come from (1) and that any farmers and workers have been treated fairly (1) and there will be no child labour. (1)
				3	Up to 3 marks for the quality of explanation.
					
					Award two marks for reasons and one for explanation.

Question			Answer	Marks	Guidance	
5	(a)		Please refer to table that follows for **Indicative content** of the most likely specific areas covered. Answers should show reference to different aspects of lifecycle e.g.: The lifecycle begins when raw materials are extracted or harvested. Raw materials then go through a number of manufacturing steps until the product is delivered to a customer. The product is used and at the end of its life disposed of or recycled. All products or systems are created from raw materials. Energy is used to extract oil, ores and timber, environmental impact of mining, deforestation etc. The transporting raw materials, nationally and internationally and the impact e.g. oil tanker disasters and pollution of the air by fuel emissions. Processing raw materials uses energy and causes environmental effects when transforming raw materials by chemical or physical processing methods, for example, smelting and converting ores into usable materials, making polymers from oil. Manufacturing the product: Most products require machine processing. The manufacturing industry requires energy for machines, lighting, heating, etc. Often manufacturing doesn't take place in	9	Candidates explanations should cover the different stages of LCA to demonstrate their understanding of • The main materials used and its source • Energy used in the different stages of the lifecycle • The disposal and recycling of the product. _____	**Level 3 (7-9 marks)** The candidate demonstrates they have fully analysed the information given on the Insert and considered the various stages of their products lifecycle. The candidate's response will be fully detailed using appropriate terminology or detail to demonstrate an excellent understanding of LCA. They will demonstrate a thorough understanding of the main material used and its source, energy used in the various stages of the life cycle and the disposal and recycling of the product. **Level 2 (4–6 marks)** The candidate has adequately analysed the information given on the Insert in that they have recognised some details of the various stages of their products lifecycle. The candidate's response will offer some detail and use of appropriate terminology to demonstrate adequate understanding of LCA. They will demonstrate a good understanding of the main material used and its source, energy used in the various stages of the life cycle and the disposal and recycling of the product.

Question			Answer	Marks	Guidance	
			the same area as material processing. Transporting materials, components and completed products for distribution involves considerable energy use. Using the product: Some products require no further energy in usage. Many products, such as electrical items use significant amounts of energy. Some products are reused or cleaned; Detergents used may have an environmental impact. Disposal and recycling: the collection of waste requires energy. Incineration centres use energy to dispose of waste. Landfill systems may impact on the environment. Often, recycling materials can use significant amounts of energy, but this will use fewer raw materials and conserve valuable natural resources.			**Level 1 (1–3 marks)** The candidate has not fully analysed the information given in the Insert and recognised limited details of the stages of their products lifecycle and its and the disposal and recycling. The candidate's response will lack full details or depth and demonstrate a limited understanding of LCA, there will be limited use of appropriate terminology or detail. They will demonstrate limited understanding of the main material used and its source or the energy used in the various stages of the life cycle or the disposal and recycling of the product. **Level 0 (0 marks)** No response or no response worthy of credit.

Question 5 (a) indicative content

Product	Sourcing of raw materials	Processing raw material and manufacturing product	Energy used during products use	After products use disposal and recycling
Product 1: Pop up book (papers and boards)	**Main material:** Thin card (280gsm) Card is made from paper or recycled paper/card, which is made from trees. Many of these forests will be in Northern Europe, Scandinavia or Russia. The trees will be cut down and transported to a factory to be turned into a pulp.	Paper is made of fibres called "cellulose." This comes from trees; the raw wood must first be turned into "pulp." Wood pulp is a watery “soup" of cellulose wood fibers, lignin, water, and the chemicals used during the pulping process. Either mechanical or chemical pulping will be used. If recycled paper is used it’s usually mixed with virgin wood chippings as fibres get shorter when recycled. Card is made by layering wet pulp to make thicker layers.	Product uses no energy however it the cover might be cleaned using water and detergent.	After its useful life it will end up either being recycled or disposed of in landfill. The recycling process can also use lots of energy and when recycling paper the fibres get shorter and weaker so the recycling process is not indefinite. The varnished board will make recycling harder so the book might be reused and passed to younger siblings but then will end up in landfill
Product	**Sourcing of raw materials**	**Processing raw material and manufacturing product**	**Energy used during products use**	**After products use disposal and recycling**
Product 2: Interactive play mat (fibres and fabrics)	**Main material**: Cotton/polyester cotton and polyester fibres mixed into yarn Polyester fibres, polymers based produced from crude oil. Oil extraction releases	Distilled oil is shipped to a manufacturer, who creates polymer pellets. These are then manufactured into polyester fibres. The filament fibres cut into staple lengths to improve their qualities, or given a finish such	During the product’s life it may be cleaned and washed in a washing machine.	After its useful life, it will end up either being recycled or disposed of in landfill. In recycling, the polycotton because it’s synthetic will take time to break down and degrade, 100s of years. Primary recycling involves passing the textile product on and secondary and tertiary recycling processes can use lots of

	greenhouse gases, and harms habitats and the environment. After the oil has been extracted it is transported to a refinery. Cotton tends to be intensively farmed from the seed pod (boll) of the cotton plant and uses large volumes of water. Once picked, the cotton goes through the ginning process, which separates the fibre from the seed.	as crimping, texturing or bulking – all of which use energy – to improve their handle. Fibres are spun to make yarn which can be knitted or woven into fabric. They can be printed with a decoration or given a special finish – uses energy and chemicals which impact on the environment. Raw cotton bales are dried to remove any moisture. The cotton first goes through dryers to reduce moisture content and then through cleaning equipment. All processes involve the use of water and energy. Once cotton has been baled it is sent to a mill for spinning or weaving into fabric. Dyes, prints or special finishes are added.– chemicals – and heat / energy.		energy to wash and shred fabrics to make them into new items, such as padding for chairs and car seats. Where a product is made from more than one material like the mat with polyester padding it is likely to end up in landfill as it's often hard to separate.

Product	Sourcing of raw materials	Processing raw material and manufacturing product	Energy used during products use	After products use disposal and recycling
Product 3: Musical microphone (design engineering)	**Main material**: Paper reinforced resin circuit board and components. PCBs contain a lot of components like resistors, transistors, microcontrollers, integrated circuits etc. As well as copper tracks and components.	Resin cannot be recycled and this is reinforcing the circuit board. The process of manufacturing this board uses a paper material derived from trees and resin produced from crude oil. Oil extraction releases greenhouse gases, and harms habitats and the environment.	The toy uses batteries throughout its life to supply power – they also need to be considered at the end of their life, batteries are made from many different - zinc is used in AA batteries which would be used to power this toy, rechargeable batteries create less waste but need recharging regularly.	After its useful life, the toy it will end up either being recycled or disposed of in landfill. In recycling, the ABS polymer is shredded and washed, then melted down and reformed into pellets that can be made into new products. The recycling process can also use lots of energy. Once Electrical and Electronic Equipment (EEE) becomes obsolete; Electronic Components (EC) in the PCB remains unaltered. These ECs can be reused based on their status. PCBs are burnt, and acid leaching is used to recover valuable metals from it, however, residues can end up in landfill.
Product 4: Ride on toy (polymers)	**Main material**: Polypropylene (PP) Polypropylene polymer, produced from crude oil. Oil extraction releases greenhouse gases, and harms habitats and the environment. After the oil has been extracted it is transported to a refinery.	Distilled oil is shipped to manufacturer, who creates polymer pellets. These are then manufactured into the plastic toy using rotational moulding, a mould has to be made usually from concrete, wood or aluminum but this is reused	No energy is used to operate product However, it will be cleaned, and detergents might be used.	After its useful life, it will end up either being recycled or disposed of in landfill. In recycling, the PP polymer is shredded and washed, then melted down and reformed into pellets that can be made into new products. The recycling process can also use lots of energy. The steel pins will have to be separated from the body and recycled separately

Product	Sourcing of raw materials	Processing raw material and manufacturing product	Energy used during products use	After products use disposal and recycling
Product 5: Tricycle (metals)	**Main material**: Mild steel Steel is made from iron ore. Ores are dug out of the ground by mining, but in order to be turned into a metal form that can be used; they must be separated from whatever they are mixed with. This process is known as extraction. A mixture of iron ore and coal is then heated in a blast furnace to produce molten iron, or pig iron, from which steel is made. Molten steel from the furnaces passes through continuous casters and is formed into slabs, and billets. The steel is then processed and rolled to form the tubular steel lengths.	These will be transported to a manufacturing facility where the steel bar is cut, formed, welded and riveted to form the chassis of the trike. This is then spray painted to protect from rust.	During its life it can be repaired or resprayed if needed.	At the end of its useful life the steel can be recycled once the painted finish is removed. The wheels would need to be removed and might be reused. The PVC streamers could be recycled but may end up in landfill

Product	Sourcing of raw materials	Processing raw material and manufacturing product	Energy used during products use	After products use disposal and recycling
Product 6: Toy train (timbers)	**Main material**: Beech When a tree has been cut down, it is cut roughly into boards, planks or veneer (conversion). Timber contains a lot of moisture which needs to be dried out before use, a process called seasoning. The planks of wood are stacked on top of each air can circulate between them and reduce the amount of moisture; usually done outdoors, this can take years but timber can be dried faster using a kiln. Cutting trees down can lead to deforestation and soil erosion, forests need to be replanted to be sustainable.	The toy is made using machinery to cut and shape the pieces and is glued together and painted/stained with non-toxic paint.	During its life it can be repaired or repainted if needed.	After its useful life it could be sanded down to remove any painted surface and remade into something else or burned to create electricity. The painted surface makes it harder to recycle and it may end up in landfill. The steel pins would need to be removed before recycling but can be recycled separately.

Question			Answer	Marks	Guidance
5	(b)		Up to **two** marks for each of two descriptions e.g.: • Using fewer raw materials (1) by removing parts and/or reducing the amount of different materials. (1) • Sourcing materials and manufacturing locally (1) to reduce shipping and transportation/carbon footprint. (1) • Using recycled/reused materials/sustainable sources/materials that can be recycled/reused easily (1) examples such as sustainable forests or by using bio plastics derived from plants e.g. sugar cane polyester fibres from recycled bottles (1) • Making the product easy to repair and or maintain (1) so it lasts longer. (1) • Avoiding surface finishes such as paint or special coatings on fabrics (1) to aid recycling/biodegrading (1) • Make products easy to disassemble (1) to improve ease of recycling. (1) • Cotton fibres – use irrigation systems (1) to reduce water waste and avoid contamination (1) • Reduce the use of pesticides and fertilisers, use natural predators to control pests (1) to avoid pollution/contamination of the environment (1) • Make fabrics suitable to wash at low temperatures (1) to reduce energy consumption (1) • Use less energy (eg. Handmade), energy efficient machinery or renewable energy (1) during the manufacturing process to lessen the production of emissions (1) **Award credit for other appropriate response**	**4**	1 mark for identifying a way e.g. less material, material that can be recycled etc. 1 mark for description related to the chosen product. e.g. making the trike easy to disassemble, using an aluminium alloy that can be recycled without the need for a surface finish. Using a bioplastic instead of an oil-based polymer for the panel or ride on toy, avoiding special finishes on textile materials. Answers must be **appropriate** for the context in the question: in relation to the chosen product – minimising its effects on the environment.

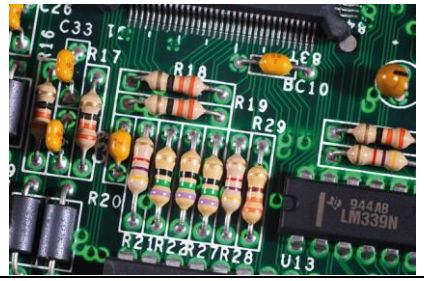
Question			Answer	Marks	Guidance	
					Content	Levels of response
5	(c)		Please refer to table that follows for **Indicative content** relating to each product. Identification of **manufacturing processes** that could be used to make quantities of 5000 or more. Description of the **manufacturing processes identified**. **Product 1:** Pop up book **Main part**: Pages and pop ups • Die cut and assembled, varnish coated and printed(offset lithography or flexography **Product 2:** Interactive play mat **Main part:** Base mat • Quilting and stitching **Product 3:** Musical microphone **Main part**: PCB board Circuit PCB multi-layered, etched, SMT technology **Product 4:** Ride on toy **Main part**: Body • Rotationally/Blow moulded **Product 5:** Tricycle **Main part:** Frame • Bending tubes, welding riveting	9	Candidates can refer to manual, machine or CAD/CAM processes, but they must be appropriate for industrial manufacture. Candidates may use sketches to support their answer. Marks are awarded for showing knowledge and understanding of the manufacturing process, not the quality of the sketches. _____ If response only describes candidate's own workshop experiences and knowledge of tools and processes rather than a commercial level of production then should not be awarded marks higher than a Level 1.	**Level 3 (7-9 marks)** The candidate demonstrates they have fully analysed the information given on the insert recognising all details required for making their chosen product commercially. Their process(es) description will be comprehensive demonstrating excellent understanding of the commercial manufacture process, diagrams will support this. The candidate's response will be fully detailed using appropriate terminology to demonstrate an excellent understanding of the commercial manufacturing techniques and processes required to make their chosen product commercially. They will demonstrate thorough knowledge of how to work with specific tools and application of digital technology should be used (if appropriate) diagrams will support this. Specific process(es) will have been clearly identified that are fully appropriate for both the processes being used and the product being commercially produced. **Level 2 (4-6 marks)** The candidate has adequately analysed the information given on the insert in that they have recognised some details required to make the product commercially. Their description of processes will be clear demonstrating a good understanding of the

Question			Answer	Marks	Guidance	
					Content	Levels of response
			Product 6: Toy train **Main part**: Body • Cutting • Wood joints • Shaping of parts possibly using the lathe Allow step-by-step plans or description of one or two production methods. A step-by-step plan or description of a process that may use diagrams to support this, should follow an appropriate order and should cover the following: **Materials and components**, e.g.; appropriate selection and preparation of specific materials and/or components. **Processes, techniques or skills, e.g.:** • *wasting methods* used to cut the materials (with allowances / tolerances as appropriate) – including accurate use of specific tools. • *deforming and reforming methods* used to shape/mould or strengthen materials and/or components – including accurate use of specific tools or equipment. • *methods of addition* used to join materials and/or components – including how to ensure accuracy.			commercial manufacturing process(es), diagrams may support this. The candidate's response will offer some detail and use of appropriate terminology to demonstrate adequate understanding of the commercial manufacturing techniques and processes required to make their chosen product, diagrams may support this. They will demonstrate a good knowledge of how to work with tools that may not always be specific and digital technology may be used (if appropriate). Specific process(es) will have been identified that are mostly appropriate for both the processes being used and the product being commercially produced. **Level 1 (1–3 marks)** The candidate has not fully analysed the information given in the Insert showing little knowledge of the commercial manufacturing process(es). The candidate's response will lack details and demonstrate a limited understanding of the manufacturing techniques and/or process(es) required to make their chosen product commercially. The response will demonstrate a basic level of knowledge of the candidate this may be in relation to their own workshop

Question			Answer	Marks	Guidance	
					Content	Levels of response
			Tools and digital technology, e.g.; all tools required to fulfil the processes and techniques being used.			experiences and knowledge of tools and processes rather than a commercial level of production. Specific process(es) and techniques may not be fully appropriate or identified. **Level 0 (0 marks)** No response or no response worthy of credit.

Question 5 (c) indicative content

Product	Specific materials and information given in Insert.	Description of manufacturing processes
Product 1: Pop up book **Main part**: Pages and pop ups (papers and boards)	Thin card (280gsm) Printed with soy based inks Varnished with aqueous varnish Five pages and pop ups 	• Printing using offset lithography rollers or flexography using four inks CMYK films are produced and then card passes through • Varnish coating applied – thin coat applied during printing stage • Creating a template or die, to cut and score/fold/crease – a die is produced. Preparing nets on a computer program, tessellated to avoid wastage could be laser cut or die cut. Die cutting – a die is lowered onto the paper and pressed to cut out the shape – glue tabs and folding
Product 2: Interactive play mat **Main part:** Base mat (fibres and fabrics)	Outer fabric: polyester/cotton blend Padding: polyester Padding approximately 15 mm thick The diameter of the play mat is 650 mm and the arch at the highest point is 500 mm. 	• Pattern pieces made, either by hand or using computer. Seam allowance added. • Pattern cutting pieces, for example with a band saw or computer controlled cutter / laser / water jet • Decoration added, for example screen printing / applique • Seaming with industrial sewing machine / overlocker the pieces could be considered to be patchworked together • The fish toy tape would be trapped between two sections of the playmat • Construcing the mat - The soft padding would be placed on the wrong side of the base section, and the completed top of the play mat would be placed right side down on top of the padding. The three layers would be sewn together round the outer edge using an overlocker / sewing machine, but a small section left unstitched so that the mat could be turned the right way out. Once right way out, the opening would be sewn up. Alternative – padding could be inserted through the hole after the top and base have been sewn together • Quilting done after the top and base have been stitched together. Automated press / press (steam dolly is only used for garments)

Product 3: Musical microphone **Main part**: PCB board (design engineering)	Paper reinforced phenolic resin with a bonded copper foil and components  	• Creating a PCB board, etching. • Could be multilayered • Heated soldering iron placed in contact with the track and the component and allowed to heat them up, solder can be applied. The solder should flow through and around the component and the track creating a soldered joint (float soldering.) • SMT and pick and place probably used as mass produced, parts held by a sticky solder paste then passed through a solder oven which melts the paste and solders components. • Optical recognition to inspect and electrical check carried out.

Product 4:
 	
Ride on toy
 	
Main part: Body
 	
(polymers)
	Polypropylene (PP)
	
	Hollow design
	
	 
		• Rotational/Blow moulding
		• Mould created
		  • Plastic powder/pellets loadied in hopper / fed into machine
		  • Heated mould is rotated/ polymers heated and extruded/blown into a tube.
		  • Liquid plastic coats the inside of the mould with an even layer of plastic.
		  • Cooled before opening.

Product 5: Tricycle **Main material**: Mild steel (metals)	Mild steel Frame has a painted finish. 	• Cutting and forming steel bars mechanical hacksaw/horizontal bandsaw/plasma cutters • Forming of tubes • Welding/MIG/pop riveting sections together • Use of jigs/templates • Description of painting process could include painting extraction booth, industrial spray applicator

Product 6: Toy train (timbers)	Beech Painted in non-toxic water based paint 	• Wood cut with bandsaw or CNC router and shaped, • Joints made • Use of jigs and templates • Lathe CNC or copy for funnels of train

Question			Answer	Marks	Guidance
6	(a)		Physical and working properties of specific materials: Choice of material will be indicated, working properties relate to manufacture of specific parts of the product chosen: **Thin card (280gsm)** (Pop up book) • Easy to cut and fold • Can be printed on • Available in different sizes of sheet **Mounting board (1400 microns)** (pop up book) • Rigid (difficult to bend – protects pages inside) • Can be printed on and cut to size easily **Cotton/polyester** (Interactive play mat) • Durable / hardwearing / strong in use will not pile or tear easily • Will not stretch out of shape • Easy to handle and sew • Washable, prolongs life of the product and makes it hygienic • Comfortable and interesting texture to stimulate the child **Polyester filling** (Interactive play mat) • Soft and lightweight • Easy to clean/wash • Easy to handle and sew • Tough and hardwearing • Insulating so more comfortable to lie on **Polycarbonate** (Interactive play mat) • Tough, high impact strength • Good chemical resistance **Paper reinforced phenolic resin** with a bonded **copper foil** and **components** (Musical Microphone) • Insulator	**2**	Materials given on insert and should be indicated, answers may relate specifically to the product or how it is manufactured. **For each award credit for any other appropriate response that relates to a property or characteristic of the material.** Identification of **any** physical property of the chosen material (1) The property identified makes it suitable for use on the chosen product (1)

			• Can be etched • Strong and rigid **Acrylonitrile Butadiene Styrene (ABS) plastic** (Musical Microphone) • Can be injection moulded to achieve fine detail • Tough, high impact strength • Lightweight • Scratchproof • Good chemical resistance **Polypropylene (PP)** (Ride on toy) • Range of colours • Tough, flexible • Good chemical resistance • Can be rotationally moulded **High-density polythene (HDPE)** (Ride on toy) • Range of colours • Tough, flexible, rigid • Good chemical resistance • Can be moulded **Mild steel** (Tricycle – frame, wheels, handlebars / Ride on toy – joining pin/pivot Toy train – axle) • Inexpensive compared to other metals • Tough and durable • Easy to cut, drill and weld **Beech** (Toy train) • Very tough and durable • Hard and straight grained • Withstands wear and shock • Polishes well **Nylon cord (Toy train)** • High tensile strength		

			• Good abrasion resistance • Resistant to moisture • Ability to stretch by up to 25%		

Question			Answer	Marks	Guidance
6	(b)		**Two** from: • Parents/adult carers of children • Schools/playgroups that children attend • Health and safety executives • Retailer • Manufacturer	2	Answers must be **appropriate** for the context in the question: stakeholders for designing products for children under 10 years old. Do **not** accept children/ siblings/teenagers.
6	(c)		Up to **three** marks e.g.: Use of triangulation, reinforcements etc. Suggestions for each product: **Pop up book** Reinforced corners will mean pieces last longer when handled by children, use of triangulation and double thickness can reinforce pop-up pieces. Laminating layers for strength. Varnish coating prevents degradation and discolouring by handling. Outside cover uses Mounting board as its rigid, resistant to bending, durable and protects pages and pop ups inside. **Cotton/polyester interactive play mat with PC arches** Fabric can be layered / padded / quilted for comfort and reinforcing Interfacing is used to improve shape and add structure. Seams are overlocked / reinforced with double stitching. PC arches – used to make the arches stand up and allow the toys to dangle over the child on the mat Choice of hardwearing / strong / durable fabric - polyester cotton Applique - adds another layer of fabric, improving strength Use of metal clips instead of plastic to attach the toys - will hold them in place and withstand clipping and unclipping Safety mirror - has more flexibility and is more likely to bend than	3	Up to 3 mark for the quality of explanation Three identified points or two identified points and an explanation. Max one mark for a generic description that does not relate to the product they chose in Q5

			break. **Musical microphone casing** Use of honeycomb and ribbing can reinforce 3D pieces and keep weight down, use of a monocoque structure for 3D pieces, use of a monocoque structure for 3D pieces. Structure of casing clips together and houses circuit board securely, screws maybe used to hold circuit in place. **PP ride on toy** Reinforced corners will mean pieces last longer when handled by children, use of honeycomb and ribbing can reinforce 3D pieces and keep weight down, use of a monocoque structure for 3D pieces. UV stabilisers can be added to products used outdoors to absorb UV light and prevent degradation. **Mild steel Tricycle frame** Use of triangulation in frame, use of a hollow tube improves structural integrity and keeps weight to a minimum. Material can be annealed and then tempered using heat treatment. **Beech toy train** Timber has good tensile strength; Solid timber body (turned from one piece of timber improves strength, use of joints to create shape also creates structural integrity to reinforce moving parts, joining axles on wheels. High strength wood glues are stronger than the actual wood.		

Question			Answer	Marks	Guidance	
					Content	Levels of response
6	(d)*		Discussions should cover why ergonomics are important in the design of children's products. Ergonomics relates to any aspect of the interface between humans and the products/systems they interact with. Answers must relate to humans interacting with products and must cover why this is important in the design of children's products. e.g.: • User comfort • Ease of use • Ease of understanding • Use of colour **if** related to how it aids understanding and/or use • Forces required to operate, push, pull etc. • Layout of buttons • Size of text and fonts on screens/packages etc. • Use of anthropometrics to improve ergonomics for a wider audience, • Consideration of children at different ages/genders, possibly consideration those with disabilities. It should specifically focus on children and development perhaps understanding	8	Examples can be from any material area and may use examples of both good and bad use of ergonomics in children's products. Candidates should be drawing on examples to support their answer. If no examples are used they should not be rewarded with marks higher than a Level 1. The user interface must be discussed.	**Level 3 (6-8) marks** The candidate will demonstrate sound knowledge and understanding of ergonomics and its importance in the design of children's products. They will be able to undertake a thorough evaluation of the importance of considering ergonomics when designing children's products, identifying positive and negative implications. Candidates will be drawing on their wider understanding/experience of the whole subject through their exemplification and evaluation. A variety of relevant examples are used to effectively support the discussion. There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated with the use of examples. **Level 2 (3-5 marks)** The candidate will demonstrate sound knowledge and understanding ergonomics and its importance in the design of children's products There will be a basic attempt to evaluate the importance of considering ergonomics wen designing. It may not be wholly relevant to children's products. Evaluations will be one

Question			Answer	Marks	Guidance	
					Content	Levels of response
			through simplicity and use of colour, comfort, ease of use and safety.			sided, identifying positive or negative implications or limited to evaluating one factor. Candidates could be drawing on some of their wider understanding/experience of the whole subject through their exemplification and evaluation. Some relevant examples are used to support the discussion. There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence. **Maximum of 4 marks if no evaluation is evident.** **Level 1 (1–2 marks)** The candidate will show limited knowledge of what ergonomics is. There will be basic or no reference to understanding why considering ergonomics is important when designing children's products. There is no attempt at evaluation. If examples are used to support the discussion they may not be relevant. The information has some relevance and is presented with limited structure or detail. The information is supported by limited evidence **Level 0 (0 marks)** No response or no response worthy of credit.

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