

## **Cambridge National**

### **ENGINEERING DESIGN**

LEVEL 1/2 CAMBRIDGE NATIONAL AWARD/CERTIFICATE IN ENGINEERING  
DESIGN

R105/01 Design briefs, design specification and user requirements

### **Mark Scheme for Jan 2020**

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

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

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

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Question		Answer	Mark	Guidance					
1	(a)	<p>One mark awarded for each correct answer in the correct order</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: center;"><b>B</b></td> <td style="text-align: center;"><b>D</b></td> <td style="text-align: center;"><b>C</b></td> <td style="text-align: center;"><b>A</b></td> <td style="text-align: center;"><b>E</b></td> </tr> </table>	<b>B</b>	<b>D</b>	<b>C</b>	<b>A</b>	<b>E</b>	4	
<b>B</b>	<b>D</b>	<b>C</b>	<b>A</b>	<b>E</b>					
	(b)	<p>Award one mark for each valid response</p> <ul style="list-style-type: none"> <li>• Focus group (1)</li> <li>• Research on the internet (1)</li> <li>• Analyse existing products</li> <li>• Product reviews (1)</li> <li>• Survey (1)</li> <li>• Poll (1)</li> <li>• Questionnaire (1)</li> <li>• Interviews (1)</li> <li>• Books / reference materials / magazines (1)</li> <li>• Examine the market / sales / market gap (1)</li> <li>• Social media (1)</li> </ul>	3	<p>Do not award 'primary' or 'secondary' research unless qualified with a specific example e.g. primary research – survey</p> <p>Do not award "ask other designers"</p> <p>Do not award "trends" unless qualified</p>					
	(c)	<p>Award up to 3 marks for a valid response</p> <ul style="list-style-type: none"> <li>• Designers may find part of the design has an error (1) or changes to the market may mean the design has to change (1). Further research might highlight new materials, processes or trends that can fix the error. (1)</li> <li>• A prototype might be produced that does not work as expected (1) or does not conform to the specification (1) so further research can be used to help find a solution to the problem (1).</li> <li>• Changes by the customer may be made throughout the process (1) as a result of market changes or cost (1) that require investigation to ensure the design meets the new requirements and will be successful when launched to the market. (1)</li> </ul>	3						

			<ul style="list-style-type: none"> <li>• Elements of a design may prove more complex than expected (1) so a designer may need to carry out further research to find a solution such as a new material or process (1) to ensure the product can be manufactured / function (1)</li> </ul>		
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Question			Answer	Mark	Guidance
2	(a)	(i)	Award up to two marks for a valid response <ul style="list-style-type: none"> <li>• The speaker could be used outdoors (1) so may need to be water resistant. (1)</li> <li>• The speaker is portable so must be durable (1) so it can be transported (1).</li> <li>• May be in constant use (1) so should continue to function and not break through use (1).</li> <li>• Should be made from a durable material (1) so it does not break easily if dropped. (1)</li> <li>• Should be easily cleaned (1) as it may get dirty through use (1)</li> <li>• Non-slip base/rubber feet (1) to be stable on different surfaces (1)</li> </ul>	2	Do not award references to features unless they are related to the 'working environment e.g. <ul style="list-style-type: none"> <li>• Small enough to carry around</li> <li>• Lightweight</li> <li>• Ergonomics</li> <li>• Re-charging</li> <li>• Sound, volume, or connectivity.</li> </ul>
		(ii)	Award up to two marks for a valid response <ul style="list-style-type: none"> <li>• The speaker will need to be easy to operate for a range of users (1) who can pick up / carry / operate the speaker without difficulty. (1)</li> <li>• There are buttons that need to be pressed in order for the speaker to function (1) so they should be big enough to be pressed easily. (1)</li> <li>• Buttons should be designed at an appropriate size (1) in relation to the users fingers. (1)</li> <li>• Feel comfortable (1) and easy to hold (1)</li> <li>• Lightweight / small &amp; compact (1) to carry around (1)</li> <li>• Clear symbols may be added to the buttons or speaker (1) to guide ease of operation (1)</li> </ul>	2	Do not award marks related to size unless qualified by the impact on ergonomics  Do not award 'sharp edges' unless qualified and related to ergonomics.

	<b>(iii)</b>	<p>Award up to two marks for a valid response</p> <ul style="list-style-type: none"> <li>• Should be able to be disassembled at the end of its life (1) so materials and components can be recycled / replaced. (1)</li> <li>• Should be rechargeable (1) so that disposable batteries are not used (1)</li> <li>• Manufactured using renewable / sustainable energy (1) to reduce use of fossil fuels / emissions during production (1)</li> <li>• Source raw materials from sustainable resources (1) and / or ensure they can be recycled (1)</li> <li>• Reduce amount of material in the product (1) to minimise resources requirements (1)</li> <li>• Ensure the product can be easily disposed of (1) through disassembly (1)</li> </ul>	2	Do not award marks for 'long lasting' or "durable" unless qualified e.g. can be maintained to extend life, reduce extraction etc.
	<b>(b)</b>	<p>Award one mark for a valid answer</p> <ul style="list-style-type: none"> <li>• How the speaker functions (1)</li> <li>• What features the speaker has (1)</li> <li>• How the speaker performs / performance requirements (1)</li> <li>• What is the target group / intended users (1)</li> <li>• What are the limitations constraints of the speaker / size / weight / functional limitations (1)</li> <li>• What should the speaker look like / appearance / aesthetics (1)</li> </ul>	1	Do not award specific features e.g. loud, charging, or sustainability, user needs, safety, cost etc.
	<b>(c)</b>	<p>Award up to three marks for a valid description</p> <ul style="list-style-type: none"> <li>• It ensures that all details of the product are set out (1) this means that the manufacturer knows exactly what they have to make (1) and the client will get a product that meets their expectations. (1)</li> <li>• The specification is a set of criteria / check list that the product must meet (1) which ensures that the product is manufactured in line with the customers' expectations (1) and can be successfully placed on the market. (1)</li> </ul>	3	Only award a maximum of 2 marks if the response relates to design specification points only and does not refer to manufacturing.

Question		Answer	Mark	Guidance
3	(a)	<p>Award one mark for each valid reason</p> <ul style="list-style-type: none"> <li>• To ensure it functions correctly (1)</li> <li>• To make sure it meets customer requirements (1)</li> <li>• To ensure it is safe</li> <li>• To ensure It is free from errors (1)</li> <li>• To avoid legal disputes (1)</li> <li>• To test durability (1) strength (1)</li> <li>• To ensure it meets regulations (1)</li> <li>• To ensure it can be sold (1)</li> <li>• To identify any improvements (1)</li> </ul>	2	<p>Do not award marks for specific tests e.g.</p> <ul style="list-style-type: none"> <li>• Drop test</li> <li>• Check if waterproof</li> <li>• Using it</li> <li>• Make long lasting</li> </ul>
3	(b)	<p>Award one mark for each valid method</p> <ul style="list-style-type: none"> <li>• Physical / functional test (1)</li> <li>• Virtual test / simulation / use CAD (1)</li> <li>• Allow a focus group to use / try the product (1)</li> <li>• Prototyping (1)</li> <li>• Destructive / impact test, durability (1)</li> <li>• Non-destructive / X ray / dye penetrative (1)</li> <li>• Safety test / quality (1)</li> <li>• Chemical resistance (1) / mechanical (1) / temperature (1)</li> </ul>	2	<p>Do not award error proofing unless qualified.</p> <p>Model or prototype – do not award both, only award one.</p>

		<b>Guidance</b>		<b>Answer/Indicative content</b>
3	(c)*	<p>Award up to six marks for a discussion on the why designers would evaluate a product during the validate phase of the design cycle.</p> <p><b>Level 3 (5–6 Marks)</b></p> <p>Candidates provide a thorough discussion of why designers would evaluate a product during the validate phase of the design cycle. They show a clear understanding of the required question material. Good examples used to discuss why designers would evaluate a product during the validate phase of the design cycle.</p> <p>Specialist language and terms would be used in the appropriate areas being discussed and the required information will be well structured in its presentation. Learners will demonstrate an accurate level of spelling, punctuation and grammar.</p> <p><b>Level 2 (3–4 Marks)</b></p> <p>Candidates provide an adequate discussion of why designers would evaluate a product during the validate phase of the design cycle. Some examples used to illustrate why designers would evaluate a product during this phase.</p> <p>Some evidence of the use of specialist language although not always in the appropriate areas being discussed. Information, for the most part, will be reasonably structured but may contain occasional errors in spelling, punctuation and grammar.</p> <p><b>Level 1 (1–2 Marks)</b></p>	6	<p>Examples and relevant points could include.</p> <ul style="list-style-type: none"> <li>• The validate phase is the last in the design cycle. At this point the designer will have a completed product which should be evaluated to learn from the process and judge its success against the original brief and specification.</li> <li>• Evaluation is important at this stage so designers can learn how they may be able to improve the process of product development in future projects.</li> <li>• By evaluating the design at this stage, the designer is able to ensure that any issues associated with mass production or final scale production have been mitigated. This will ensure a successful manufacturing process with limited issues.</li> <li>• Ensuring that the design is fit for purpose, meets the needs of the customer / user and is the correct quality is important to ensure that the design can be successfully sold on the market.</li> <li>• Evaluation is a reflective process that allows designers to improve their processes. It is also the last stage where if issues are found they can modify them prior to committing to full production.</li> <li>• The customer or client may form part of the evaluation process and give feedback on the design which may ultimately require further modification or improvement before the product is sold on the market.</li> <li>• Evaluating the operation of the product alongside testing in the validate phase of the design cycle can ensure that it meets all necessary standards and regulations to be sold or effectively operate.</li> </ul>

		<p>Candidates provide a basic discussion which shows some understanding of the question material. Few or no examples used to show understanding of why designers would evaluate a product during the validate phase of the design cycle.</p> <p>Little or no use of specialist language. Answers may be ambiguous or disjointed. Contains obvious errors in spelling, punctuation and grammar.</p> <p>0 marks = no response or no response worthy of credit. Annotate as 'Seen' at end of the response.</p> <p>NOTE: Award a maximum of 2 marks if the candidate merely produces a list of bullet points. – the quality of written response is an important contribution to the level and marks awarded for this question.</p>		
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Question			Answer	Mark	Guidance
4	(a)	(i)	Award one mark for a valid response <ul style="list-style-type: none"> <li>• Rapid prototyping / additive manufacturing machine (1)</li> <li>• 3D printer (1)</li> <li>• Manufacture by hand / use hand tools / handmade (1)</li> <li>• Manual machines (1)</li> <li>• Prototype (1)</li> <li>• Sand casting (1)</li> </ul>	1	Accept specific types of prototyping or additive manufacturing machine e.g. FDM, SLA, SLS  Do not award vacuum forming
		(ii)	Award one mark for a valid response <ul style="list-style-type: none"> <li>• Robotic assembly (1)</li> <li>• CNC techniques / machining (1)</li> <li>• Injection / blow moulding (1)</li> <li>• Forging (1)</li> </ul>	1	Do not award references to 'factory', 'conveyor belt' or 'assembly line' unless qualified with 'robotic assembly' or 'automation.'
	(b)	(i)	Award one mark for a valid response <ul style="list-style-type: none"> <li>• Satellite (1)</li> <li>• Bridges (1)</li> <li>• Ship (1)</li> <li>• Stadium / buildings (1)</li> <li>• Bespoke goods e.g. jewellery, furniture, suits/wedding dress/cake, piece of art, paintings (1)</li> <li>• Prosthetic limbs (1)</li> </ul>	1	Do not award cars unless qualified with a specific example, e.g. Formula 1 car, one-off Bugatti / Rolls-Royce, concept car  Do not award 'custom cars' / 'personalised cars' Do not award prototypes
		(ii)	Award one mark for a valid response <ul style="list-style-type: none"> <li>• Clothing / shoes (1)</li> <li>• Baked goods / bread (1)</li> <li>• Furniture (1)</li> <li>• Machine tools / jigs / fixtures (1)</li> <li>• Newspapers / magazines / books (1)</li> <li>• Watches (1)</li> <li>• Food and drink products (1)</li> <li>• Newspapers (1)</li> </ul>	1	Do not award 'cars'

		<b>(iii)</b>	<p>Award one mark for a valid response</p> <ul style="list-style-type: none"> <li>Automotive / cars (1)</li> <li>Standard parts e.g. nuts, bolts (1)</li> <li>Phones (1)</li> <li>Electronic devices e.g. laptops (1)</li> <li>Packaging / bottles (1)</li> <li>Food / drinks (1)</li> <li>Clothing (1))</li> </ul>	1	
	<b>(c)</b>		<p>Award one mark for a valid reason</p> <ul style="list-style-type: none"> <li>Impact on resources required</li> <li>To define machinery requirement (1)</li> <li>To ensure appropriate labour / skills</li> <li>To check material availability (1)</li> <li>Calculate timescales involved (1)</li> <li>May impact component / product shape / geometry (1)</li> <li>Tooling will need to be considered / designed (1)</li> <li>Could affect overall product cost / budget (1)</li> </ul>	1	Do not award 'so they know how many to produce' or similar.
	<b>(d)</b>		<p>Award up to four marks for a valid explanation</p> <ul style="list-style-type: none"> <li>Mass production processes allow for repeatability and limited customisation, through the use of tools / jigs / fixture / programs (1) that are very expensive to purchase / generate in the first instance (1). This initial cost is offset by the quantity of products produced (1) which cannot be the case for a one-off making it too expensive (1).</li> </ul>	4	

Question		Answer	Mark	Guidance
5	(a)	<p>Award one mark for each valid response</p> <ul style="list-style-type: none"> <li>• Nano particles / nano materials / carbon nano tubes (1)</li> <li>• High performance alloys (1)</li> <li>• 3D printed metals (1)</li> <li>• Advanced composites e.g. carbon fibre / reinforced carbon fibre (1) Graphene (1) Kevlar (1)</li> <li>• Carbon ceramic (1)</li> <li>• Smart materials e.g. thermochromic (1) / photochromic (1) / memory metals (1)</li> <li>• Conductive touchscreen materials (1)</li> <li>• Plant / starch based / biodegradable polymers (1)</li> </ul>	3	
	(b)	<p>Award up to three marks for a valid description</p> <ul style="list-style-type: none"> <li>• Advanced composites such as new carbon fibre materials are used in high-end motorsport such as Formula 1 (1) this allows cars to be much lighter (1) increasing performance but maintaining strength and safety (1)</li> <li>• Racing bikes (1) using carbon fibre frame (1) to improve power to weight ratio / speed (1)</li> <li>• Plant based polymers are being used to create single use utensils e.g. forks (1) that can be thrown away after use but biodegrade (1) unlike fossil-fuel based plastic which does not decompose (1).</li> </ul>	3	<p>Award one mark for the example product and the remaining marks for the explanation.</p> <p>Only award a maximum of two marks if no product example or incorrect example is given.</p>

	<b>(c)</b>	<p>Award one mark for each valid response</p> <ul style="list-style-type: none"> <li>• The material can be hard to process / machine (1), materials that are easy to process can lead to cost effective production (1)</li> <li>• Specialist machinery may be required for some materials (1) requiring additional investment (1)</li> <li>• Some materials may require additional pre-processing / post-processing requirements (1) these additional processes will require additional labour / processes / resource (1)</li> <li>• The material may need specialist tooling to process (1) which will need purchasing in order to use the material driving up costs (1)</li> <li>• The material may not be cost effective for the quantity required e.g. small or large scale (1)</li> <li>• The material, may be rare therefore increasing costs (1) incur import cost (1)</li> <li>• Transport and distribution cost (1) could make some materials unviable (1)</li> </ul>	2	<p>Reference to readily available or scarcely available should only be awarded 1 mark.</p> <p>Do not award marks about the cost of the material unless qualified with example answers given.</p>
	<b>(d)</b>	<p>Award one mark for each valid response</p> <ul style="list-style-type: none"> <li>• Labour / staff (1)</li> <li>• Manufacturing processes / components used e.g. standard components (1)</li> <li>• Timescale (1)</li> <li>• Machinery required (1)</li> <li>• Power / energy requirements (1)</li> <li>• Scale of production (1)</li> <li>• Product geometry / shape / complexity (1)</li> <li>• Tolerances / accuracy required / defects (1)</li> <li>• Transportation / distribution / storage (1)</li> </ul>	2	<p>Do not award reference to the following:</p> <ul style="list-style-type: none"> <li>• Size of the product</li> <li>• Quantity of material</li> <li>• Quantity of components</li> <li>• Material availability</li> <li>• Sustainability</li> </ul>

Question			Answer	Mark	Guidance
6	(a)	(i)	Award one mark for each valid response <ul style="list-style-type: none"> <li>• Pollution (1)</li> <li>• Plastic in the oceans / impact on marine life / animal habitats (1)</li> <li>• Use of fossil fuels / resource depletion in production and disposal (1)</li> <li>• Landfill sites and reduction of waste (1)</li> <li>• Global warming (1)</li> <li>• CO<sup>2</sup> emissions (1)</li> </ul>	2	Do not award 'recycling' or 'biodegradable' unless linked to 'landfill' or 'pollution'
		(ii)	Award one mark for each valid recommendation <ul style="list-style-type: none"> <li>• Change the material to be biodegradable (1)</li> <li>• Make the product multi-use (1)</li> <li>• Create a washable / moulded product that can be reused / refilled (1)</li> <li>• Ensure the plastic / cup used is recyclable (1)</li> <li>• Use recycled materials to make the cup (1)</li> <li>• Make it out of paper instead / cardboard or metal straw (1)</li> <li>• Make it out of a biodegradable material (1)</li> <li>• Modify the lid to remove the need for a straw (1)</li> </ul>	2	Do not award <ul style="list-style-type: none"> <li>• Make smaller so less resources used</li> <li>• 'Make it out of environmentally friendly / eco-friendly/sustainable materials' unless qualified i.e. made of paper etc.</li> </ul>
		(iii)	Award one mark for each valid response <ul style="list-style-type: none"> <li>• Must still be rigid / strong when full of liquid (1)</li> <li>• Lid must ensure no liquid can be spilt (1)</li> <li>• Must hold a set amount of liquid (1)</li> <li>• Material must not be porous / leak (1)</li> <li>• Must be cost effective in large quantities if not multi-use (1)</li> <li>• Straw must still be used as a drinking utensil (1)</li> <li>• Straw must not go 'soggy' / deteriorate (1)</li> <li>• Straw must still be able to bend slightly (1)</li> <li>• Must still be cost effective (1)</li> </ul>	2	Do not award <ul style="list-style-type: none"> <li>• Must be disposable</li> <li>• Must be able to perform its function</li> </ul> Do not award references to disposable / recycling / environmentally friendly / eco-friendly / sustainable.

6	(b)	Award up to four marks for a valid explanation <ul style="list-style-type: none"><li>Disposable cups and plastic drinking straws are manufactured in large quantities and need to be disposed of (1). The use of plastic in them means they do not biodegrade (1) and in many cases they cannot be recycled (1). This means they are damaging environments and causing pollution (1).</li></ul>	4	
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