

Cambridge National

Engineering

Unit **R105**: Design briefs, design specifications and user requirements

Level 1/2 Cambridge National Award/Certificate in Engineering Design
J831/J841

Mark Scheme for January 2019

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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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Annotations

Annotation	Meaning of annotation
	Blank page
	Vague
	Tick
	Noted but no credit given
	Unclear
	Repeat
	Benefit of doubt
	Cross
	Development
	Example/Reference
	Knowledge
	Level 1
	Level 2
	Level 3

Question			Answer		Mark	Guidance
1	(a)	(i)	One mark awarded for each correct answer		4	Do not award Oil or Wind – as answers are given in the question

Question			Answer	Mark	Guidance
1	(a)	(ii)	Award one mark for each valid way (maximum 2) • Renewable/clean/green/natural sources of energy that will not run out (1) • The sustainable resources in the table will reduce the carbon footprint of the product (1) • The sustainable resources in the table will reduce pollution (1) • The sustainable resources do not need to be transported by road/rail (1) • Sustainable resources reduce the use of finite/non-sustainable resources to generate power/electricity (1) • Sustainable energy sources allow product to function using renewable energy (1) • Production processes can be powered by renewable energy (1) • Sustainable energy is good for the environment / environmentally friendly (1) • Non-renewable energy sources like coal and oil will eventually run out (1)	2	Do not award repeat responses e.g. will not run out is only worth one mark
1	(b)		Award one mark for a valid stage (maximum 1) • Extraction of raw material (1) • Energy used during manufacture (1) • Manufacture / assembly of the product (1) • Transportation / distribution of the product (1) • Usable life of the product (1) • Energy used during use (1) • End of product life (1) • Disassembly of the product (1) • Recycling reuse of the components / material (1) • Disposal of the product / components / materials (1)	1	Do not award marks for answers related to the design cycle. Do not award marks for answers related to the marketing product life cycle

Question			Answer	Mark	Guidance
1	(c)		Award up to three marks for a detailed explanation • A Life Cycle Analysis (LCA) is when a designer / manufacturer / company will look at all of the stages of a products life (1) from the sourcing of raw material to the end of life. (1) They will use the information from testing and research to try and improve the energy usage and sustainability of the product. (1)	3	Do not award marks related to 'Life Cycle Analysis' from a marketing perspective

Question			Answer	Mark	Guidance
2	(a)		Award one mark for each correct requirement (max 2) • Budget (1) • Time constraints (1) • Material required / material source (1) • Manufacturing requirements / scale (1) • Size / weight of the product (1) • Target market (1) • Ergonomic requirements (1) • Aesthetic features (1) • Function / product use (1) • Sustainability / recycling / disposal (1) • Conformity to standard (1) •	2	Do not award repeat answers Accept examples of aesthetics e.g. colour Do not award vague response without clarification e.g. 'look appealing'
2	(b)		Award up to three marks for a detailed explanation • The initial brief may have changed due to the findings of market research, (1) the required manufacturing process (1) or the availability of the material / or legislation regulation conformity (1) • A range of factors may have influenced the design during the initial development phase. (1) This may have led to the requirement to evolve the initial brief so that the product still meets the client's expectations. (1) This would need to take place before a detailed design specification is written. (1)	3	Do not award repeat explanations e.g. 'the client happy with the design' / 'meets client expectations.' Responses to this question should relate to the design brief – not following the creation of a 'design' later in the process
2	(c)		Award one mark for each valid reason (maximum 2) • The client may realise that certain desirable features of the product do not fit within the overall budget. (1) • To ensure that the product can be sold with a affordable selling price for customers. (1) • Certain desirable features may not be possible with the manufacturing / assembly process required for the particular scale of production. (1)	2	Do not award vague answers e.g. 'not needed' / 'unnecessary' / 'easily assembled.'

Question			Answer	Mark	Guidance
			• Certain materials / components required for a feature may not be available (1) • Some essential features for the product may prove to be more complex / expensive / time consuming to produce meaning that other desirable elements need to be sacrificed (1) • Legislation / regulation / safety standards may dictate that a certain feature needs to be added which has to be priority over other, desirable features (1) • Too many feature may increase the complexity of the product meaning it does not appeal to customers (1) • Reduce number of features to minimise chance of error (1) • To allow for future versions of the product with additional features to be released / built in obsolescence of current version (1) •		

Question			Answer	Mark	Guidance
2	(d)		Award up to three marks for a detailed explanation - The design geometry of the product may be directly influenced by the manufacturing process. (1) The designer will have to consider this in order to ensure the design can be effectively produced (1) in the correct material and scale of production. (1) - Certain manufacturing processes require particular details within the design of components. (1) The designer will have to consider this in the design stage to ensure that the product can be manufactured when it moves into the manufacturing stage. (1) Otherwise, costly modifications may need to occur late in the products development cycle. (1) - The designer may want to use standard or pre-manufactured components in the design. (1) These will need careful consideration in the early phase of design to ensure they can be incorporated (1) and that production can meet demand throughout the supply chain. (1) - To ensure the design is created so it can be assembled easily, (1) that appropriate materials are specified (1) and so that manufacturing costs can be assessed. (1) - This would be done during the design phase so that the manufacturing plan can be altered as the product is modified (1) due to prototyping or design changes. (1) This ensures the product will successfully be manufactured. (1)	3	

Question			Answer	Mark	Guidance
3	(a)		Award one mark for each valid reason (max 2) • The material has an excellent cost factor meaning it will be suitable for a prototype as it is relatively cheap. (1) • Material C has the highest score for being easy to process meaning it will be easily shaped for quick prototype production. (1) • It is the cheapest material (1) • It is the easiest to process (1) • The material is lightweight (1) making it suitable for a prototype / to transport	2	
3	(b)		Award one mark for a valid product and one mark for a new emerging technology used within it. Product • Self driving cars (1) • Electric vehicles (1) • New smart phones (1) • Games consoles (1) • Transport – advancements in cars / bikes (1) • Cosmetics (1) New and emerging technology • Intelligent sensors and GPS technology (1) • High power electric motors and fast charge battery packs (1) • Contactless payment systems / facial recognition (1) • Wireless connected devices e.g. headphones (1) • Touch screen technology (1) • High quality cameras in mobile devices (1) • Virtual / segmented reality games (1) • Advanced materials – carbon fibre / composites / smart materials (1) • Colour changing / eco-friendly cosmetic products (1)	2	Accept specific examples of phone e.g 'iPhone' Only award the marks for valid products where the technology can be applied.

Question		Answer	Mark	Guidance
3	(c)	Award one mark for each valid process (Max. 2) • Market research (1) • Developing a design specification (1) • Sketching of initial ideas (1) • Development of designs (1) • Final design creation (1) • Prototyping / model (1) • Developing manufacturing plans - consider manufacturing process / select material / consider sustainability (1)	2	Only award marks for examples in the 'design phase' of the cycle. Do not award activities from later or earlier cycles e.g. error proofing, testing, process planning. Prototyping is acceptable as may occur at other stages. Do not two marks for repeat answers e.g. 'research into existing products' / 'research into products to find improvements.' One mark awarded for 'research.' Research only awarded one mark even if two examples given 'Primary' or 'secondary' research – award one mark for research
3	(d)	Award one mark for a valid response • The appreciation of the way a product looks / how a product looks (1) • The appreciation of the observer that a product is 'beautiful' to look at (1) • How something feels / sounds / tastes / smells (1)	1	
3	(e)	Award up to three marks for a detailed explanation • A virtual prototype does not require any physical material (1) which will usually mean it can be produced more cost effectively (1) and give more rapid feedback on the designs performance (1) • A virtual prototype can be created without the need for machinery. (1) It can also be modified rapidly and variations tested (1) much more quickly than if multiple variants of a physical component / product needed to be created. (1) • A virtual prototype allows the design to be easily shown to the client to discuss changes. (1) These changes can be rapidly applied (1) and the virtual model easily shared across the world electronically. (1)	3	'Quicker', 'cheaper' or 'easier' only awarded if justified e.g. 'a virtual model may be cheaper than a physical prototype.'

Question			Answer	Mark	Guidance
			It allows for simulations to be carried out (1) that can apply loads / stresses to the component (1) without having to physically make the component (1)		

Question			Answer	Mark	Guidance
4	(a)	(i)	Award one mark for each correct benefit • Bottle B is designed to be multiple use / can be reused (1) • (Multiple use means) it will not be sent straight to landfill. (1) • Glass has less damaging impact on the environment if incorrectly disposed of / more environmentally friendly (1) • Glass can be repeatedly melted and turned into more glass (1) • Bottle B is made of glass which makes it easier to clean and sterilise than plastic. (1) • Bottle B does not impart any flavours in to the liquid which can be an issue with plastic.(1) • Bottle B is more rigid / does not deform. (1)	2	Do not award: • It will 'last longer' • 'Easier' to dispose • 'Strong' unless qualified e.g. 'rigid' • 'It is recyclable' – this applies to both bottles • 'Easier to recycle' – response should focus on reuse • 'Sustainable' needs qualifying
4	(a)	(ii)	Award one mark for a valid reason • Bottle A will not break as easily. (1) • Bottle A can be transported easier due to it not being as fragile. (1) • Bottle A is lighter meaning / it will cost less to transport(1) / it is easier to transport (1). • Bottle A is more cost effective per unit (1) • Bottle A has a simpler production process / easier to produce (1)	1	

4	(b)	Award one mark for each valid way (max. 4) • The connecting rod uses standard parts to connect to the crankshaft end together (1) • Standard parts are used in the connecting rod to hold it together (1) which are cost effective / readily available (1) • Standard parts allow the connecting rod to be assembled / disassembled (1) with common / standard tools (1) • The connecting rod has rounded edges which allowed for a better-quality casting process (1) • Cast component has less critical dimensions so does not require machining (1) • Casting is more cost effective as certain dimensions are less critical. (1) • The connecting rod has a recess along the centre arm, which reduces the material thickness and allows for a more effective casting (1) • The crankshaft connecting end has a high-precision, machined insert due to the high level of tolerance required (1) • Components are manufactured with high levels of precision (1) • The piston has been machined due to the high level of tolerance required (1) • The piston has a chamfer on the top edge to allow it to enter the cylinder easily (1) • The connecting rod is a separate assembly that can be assembled to the piston (1) • The connecting rod is larger at one end helping to ensure it cannot be assembled in the wrong way (1) • The connecting rod is a 'split' design allowing it to be assembled (1)	4	Do not accept vague responses e.g. 'easy to make'
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4	(c)	Award up to three marks for a detailed explanation • The manufacturing process will require specific geometry in order for it to be carried out correctly (1). Designers have to consider this to ensure their design meets these requirements (1) otherwise the component will not be able to be made. (1) • Certain scales of manufacture are made possible by particular manufacturing processes (1). These have specific requirements to allow for the scale of production to be possible (1) such as the use of mould tools or dies. (1) • To ensure the material is readily available (1) and can be produced within budget (1) and within an appropriate timescale (1) • To consider the environmental impact of the process (1) and ensure minimal energy is used (1) and pollution / emissions are minimised (1)	3	Do not accept vague responses e.g. 'to ensure the product is easy to make.' Only award material if related to 'availability.'
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Question			Answer	Mark	Guidance
5	(a)	(i)	Award one mark for each correct answer (max 2) Upper: 10.7 (1) Lower: 10.5 (1)	2	Do not accept the answers in the correct order
	(a)	(ii)	Award one mark for the correct answer - Angular dimensions have a plus or minus tolerance of 0° (1) with a maximum plus or minus 30 minutes allowed (1) - It can be higher or lower than the given angle by 0 degrees '30 - The acceptable margin of error (1)	2	Only award maximum of one mark for an understanding of the variance, plus or minus, of the angle e.g. 'how much, plus or minus, the angle can vary.' 1 mark 60 minutes = 1 degree so plus or minus 30 minutes = 0.5 degrees
5	(b)		Award one mark for a correct answer e.g. - May not function correctly (1) - The batch will be not be in line with the other products produced (1) - May not fit together properly (1) - May not fulfil the intended use (1) - May not be reliable (1) - If one of components is out of tolerance the whole batch maybe scrap (1) - Will not meet customer expectations (1)	1	Do not award one-word response e.g. 'accuracy' / 'function.'
5	(c)		Award one mark for a reason (max. 2) - Components do not have to be manufactured on the manufacturers site (1) - The manufacturer can save time in assembly by having pre-manufactured components delivered (1) - Manufacturers do not have to invest in machinery to make the components on their own site (1) - Specialist manufacturers can be sourced to provide the pre-manufactured components improving quality (1) - Pre-manufactured components can reduce inventory if delivered using just-in-time in a lean production system (1)	2	Do not award responses relating to 'cost' unless qualified e.g. reduces cost because manufacturers do not have to invest in machinery / make parts components themselves

Question			Answer	Mark	Guidance
5	(d)		Award one mark for a valid example and up to two marks for a description • Health and well-being is an increasing cultural trend (1) with smart products such as watches or wearable devices (1) monitoring the user continually during use (1) • The rise of wearable smart technology (1) has seen an increase in designers including advanced, cloud connected technology (1) in wearable objects such as watches and clothes (1) • Cultural developments, such as the increased focus on inclusivity, (1) are ensuring that products are designed with accessibility in mind (1) without the need for further adaptation. (1) • The shift to cloud technology has seen an evolution in product design (1) which has resulted in designers being able to consider how fixed memory storage is used in devices. (1) The cloud has allowed large amount of accessible data to be accessed from anywhere (1) • The increased viewing of media on mobile devices has seen an increase in screen size (1) and the removal of buttons on the screen (1) to allow for the media to be viewed without obstruction. (1) • The use of social media and the distribution of images (1) has seen the technology of cameras within mobile devices improve (1) so that better images can be taken and shared immediately (1) • Designers have to be considerate of the views of different cultures (1) some cultures may respond to different colours / shapes / designs / aesthetics in different ways (1) affecting the products success in these places (1)	3	

Question		Answer	Mark	Guidance
6	(a)	Award one mark for the correct symbol 	1	
6	(b)	Award two marks for a valid response • Durability is a measurement of how long a products entire life is (1) whereas reliability refers to how likely the product will fail within a specific time period (1)	2	Awards marks for the following examples: Durability – How long a product will last – with stand conditions over time / Reliability – how trustworthy a product is Do not award 'strong' or 'tough' unless qualified
6	(c)	Award one mark for a valid way • Designers can assess the design of the product and ensure components are used that will not fail within the product lifespan (1) • Designers can use components that are easily replaceable by the user (1) • Designers can make the product easy to disassemble to allow component replacement (1) • Designers can rigorously test a product to ensure it will last for desired product life span (1) • Designers can improve the quality of material and components (1) • Ensure regular software upgrades (1)	1	Do not award 'error proofing.'

Question		Answer	Mark	Guidance
6	(d)*	Award up to six marks for a discussion on how copyright, patents, registered designs and trademarks influence the design of new products. Level 3 (5–6 Marks) Learners provide a thorough discussion of how copyright, patents, registered designs and trademarks influence the design of new products. They show a clear understanding of the required question material. 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. Level 2 (3–4 Marks) Learners provide an adequate discussion of how copyright, patents, registered designs and trademarks influence the design of new products. 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	6	Examples and relevant points could include. - Designers will avoid copying product features protected by copyright. Copyright is usually gained to protect original pieces of writing, choreography, sound or films. It again, protects the piece of work from others copying it and can be used in cases where copyright is breached to follow legal proceedings, and sue individuals or other business if they have copied the content. Copyright will last for a lifetime. - Patents protect inventions so designers cannot use an invention or idea that has a patent without factoring the cost of purchasing the patent. This may be a new machine, mechanism, process or product function. Patents give the owner the exclusive rights to the invention and stops anyone else using, making or selling the idea. A patent protects and invention for 20 years but cannot be renewed after this point. - A registered design protects the way a product looks. This may include the shape of the design, a particular pattern on the design or any decoration. This will allow the owner of the design to protect the way their design looks from others who may want to create a similar looking product. A registered design can sometimes be used in conjunction with a patent to protect both the look and function of a product. A registered design may last up to 25 years but has to be renewed every 5 years.

Question			Answer	Mark	Guidance
			Level 1 (1–2 Marks) Learners provide a basic discussion which shows some understanding of the question material but uses little or no specialist language. Answers may be ambiguous or disjointed. Contains obvious errors in spelling, punctuation and grammar. 0 marks = no response or no response worthy of credit. Annotate as 'Seen' at end of the response.		Designers will want to come up with a design that the company will gain recognition and using a trademark. A trademark protects a name, word, slogan, symbol or image that identifies a brand or particular company. This improves a person or company's ability to protect their brand from others copying the design and can be used to pursue legal action if required. Trademarks last for an unlimited amount of time but should generally renewed every 10 years.

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