Cambridge National

Engineering

R105/01: Engineering Design: Design briefs, design specifications and user requirements, written

Level 1/2 Cambridge National Certificate/Award

Mark Scheme for January 2022

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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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This document consists of 14 pages

1. These are the annotations, (including abbreviations), including those used in scoris, which are used when Marking

Annotation	Meaning of annotation
BP	Blank page
VG	Vague
✓	Tick
?	Unclear
REP	Repeat
BOD	Benefit of doubt
SEEN	Noted but no credit given (use for incorrect answers for whole part question, and when the mark awarded is NR [No Response])
DEV	Development (Only to be used for Q5c*)
K	Knowledge (Only to be used for Q5c*)
L1	Level 1 (Only to be used for Q5c*)
L2	Level 2 (Only to be used for Q5c*)

L3	Level 3 (Only to be used for Q5c*)

2. **Subject Specific Marking Instructions**

Mark all questions using a tick when answer is correct, BOD (benefit of doubt) may be awarded on some occasions.

Where work is presented but it is incorrect use SEEN to shown that the answer has been read.

Q4b the candidate is expected to discuss knowledge of the question. When knowledge points are valid this should be shown by inserting a K above the written text. If the knowledge point is explained/justified then DEV (development of point) should be added above the written text. Once the candidates answer has been read it should be awarded a level for the response according to the descriptors in the body of this mark scheme which should be indicated as L1, L2, L3 with an appropriate mark awarded.

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>1</td><td>(a)</td><td></td><td>One mark awarded for each correct answer (in any order)

<table><tr><td>1</td><td>Recycle (1)</td></tr><tr><td>2</td><td></td></tr><tr><td>3</td><td>Repair (1)</td></tr><tr><td>4</td><td></td></tr><tr><td>5</td><td>Reduce (1)</td></tr><tr><td>6</td><td></td></tr></table></td><td>3</td><td>Award marks even if responses are not in the same order.

Only award marks for these exact terms.</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>Award two marks for a valid response e.g.

• Refuse to purchase products that are not necessary (1) this minimises unnecessary resources being used (1)
• Refuse to manufacture products that are not required (1) to reduce energy / resources (1)
• Refuse to purchase products (1) or refuse to manufacture products unnecessarily (1)
• Refuse to buy the non-sustainable product (1) as it can harm the environment/pollute the atmosphere/environment (1)</td><td>2</td><td>Two valid points or one justified response.

Award a mark for specific examples.</td></tr>
<tr><td></td><td>(b)</td><td>(ii)</td><td>Award two marks for a valid response e.g.

• Rethink about the way the product is made, (1) the materials / processes used to reduce its impact (1)
• Rethink about the way the product is made, such as using different materials (1) or allow it to be easily disassembled (1)
• Rethink about the material /processes used (1) and if these harm the environment (1)</td><td>2</td><td>Two valid points or justified response.
Award a mark for specific examples.

We have accepted the use of the term ‘Environmental friendly’ for this question part only as BoD.</td></tr>
</table>

Question			Answer/Indicative content	Mark	Guidance
	(c)		Award up to 3 marks for a valid response e.g. • Material being sent to landfill (1) which adds to pollution. (1) It also means new material needs to be extracted from the earth. (1) Award similar responses that contain: • Non-recyclable materials impact negatively on the Environment (1) • Non-recyclable materials pollute/harm natural habitats (1) • Can harm wildlife (1) • Pollute the ocean (1) • Cause contamination (1) • When non-recyclable materials are incinerated/burnt create pollution (1) • Release toxins (1) • Contribute to greenhouse gases (1) • CO2 emission (1).	3	Award marks for specific examples, i.e., impact of plastic straws/bags.
			Total	**[10]**	

Question			Answer/Indicative content	Mark	Guidance
2	(a)	(i)	Award one mark for a correct answer e.g. • Allows the product to be made with just two parts (1) • Minimal number of materials (1) • Quick /ease of assembly of the handle (1) • Shape allows easy removal from the mould (1) • Only one material used (1)	1	DO not award: • ‘Fast’ / ’Quick to produce’ • ‘simple’ and ‘cheap’ • Do not award ’mass production’ • ‘the shape’ Do not award answers that relate to recycling.
	(a)	(ii)	Award one mark for each valid response e.g. • Creates complex shapes components/in one piece (1)	2	Do not award ‘quick’ ‘low cost/cheap’ or ‘efficient’ without some justification.

			• Can be produced in large numbers/mass (1) • Allows parts/products to be reliably produced repeatedly (1) • Low-cost per unit *when producing in large quantities* (1) • Can be produced in multiple colours (1) • Identical parts, accurately and efficiently (1) • Less waste (1)		
2	**(a)**	**(iii)**	Award one mark for each valid response • Die casting (1) • Sand casting (1) • Machining / CNC (1) • Blow moulding / Moulding (1) • Press forming (1) • Rotational moulding (1) • Forging (1) • Automated /robotic assembly (1) • Laser cutting (1) • Printing (1) offset lithography (1) • Pick and place (1) • 3D Printing (1) • Vacuum forming (1)	**3**	Award other valid responses Award 3D printing (a generic term of which some additive manufacturing is used in mass production). Only award 1 given example of machining/CNC Or drilling/sawing Do not award simply 'forming'
	(b)		Award up to four marks for a valid explanation e.g. • Specific processes can require components to be designed in a particular way. (1) The shape of the component may be defined by the tooling (1) or the ability of the process to create certain shapes / geometry (1) which means the designer must develop the design to ensure it can be successfully manufactured by the chosen process (1) • Some manufacturing processes are too expensive (1) to for the scale of production (1) or for the chosen materials (1) it may be necessary to reconsider the design for ease of manufacturing (1)	**4**	Award 1 mark for a naming a specific manufacturing process.

			• Manufacturing processes can determine the material used (1) as some materials require specific methods for shaping and joining (1) such as injection moulding (1) allows complex shapes to be used in the design (1). • Some surface finishes can only be achieved using specific processes (1) or with certain materials (1) so the designer must use a specific material that can be used with the process (1) or consider an alternative material (1) Award marks for similar answers that correctly relate to the following: • Scale • Shape • Geometry • Complexity • Manufacturing costs • Manufacturing processes • Materials used • Surface finish • Assembly methods • Production rate, volume and time, • Intricate designs, simple one piece vs. multiple components, • Tolerances • Design features that help assembly.		
			Total	**[10]**	

Question			Answer/Indicative content	Mark	Guidance
3	**(a)**		Award one mark for each valid response e.g. • Environmental impact e.g. - Finite materials (1)	**3**	Answers must relate to sustainable design. Do not award 'Environmentally friendly'

			- Material extraction, transport from source (1) - Pollution in manufacture or in product in use (1) - Material processing (1) • Energy usage / emissions (1) • Economic impact (1) • Lifecycle impact / end of life e.g. - Recyclable (1) - ease of reuse, repair (1) - disassembly (1) - disposal (1) - maintenance to extend life (1) • Ethical / Social impact (1)		
	(b)		Award one mark for each valid response e.g. • Justification of design decisions (1) • Market testing / user/client feedback (1) • Product testing/Virtual / physical testing (1) • Evaluation of the solution against the brief and specification (1) • Focus group (1) • Life cycle analysis (LCA) (1)	**2**	Award: • 'testing' • 'feedback' Only award marks for one example of testing. Do not award: • 'Error proofing' • 'Prototyping /modelling' as these takes place in the Optimise phase.
	(c)		Award one mark for each valid response: • Identify (1) • Design (1) • Optimise (1)	**1**	Award these terms only.
	(d)		Award up to four marks for a valid explanation e.g. • Evaluation ensures the product works correctly/tests /if there are problems to be fixed (1) and safe to use (1). It ensures that the product will meet the needs of the user /	**4**	Award other valid responses – must relate to the 'validate' phase – do not award answers about higher sales, successful product, or the manufacture process.

			client (1) and matches the criteria set out in the brief and specification (1). Award marks for the following points made: • Evaluation can show potential improvements (1) • Opportunity to inform future projects (1) • Meeting specific specification points (1) or regulation requirements (1) • Test to ensure the product performs as expected (1)		Candidates may give **examples** in their answers and a justification of the impact of not evaluating, that can be awarded marks.
			Total	**[10]**	

Question			Answer/Indicative content	Mark	Guidance
4	**(a)**		Award one mark for each valid response e.g. • Manufacturer does not have to make them on site (1) • High quality/consistency from a specialist supplier (1) • Can use specialist manufacturers (1) • Reduces equipment/resources/labour / machinery on site (1) • Ease of assembly (1) • Speeds up assembly /manufacture/saves time (1) • More cost effective than making them in-house (1) • Allows changes/replacement without redesign (1) • Allows for unit repair (1)	**2**	Do not award 'easy to use' 'low cost/cheap, cost less', 'efficient/quick' without some justification. The answers should relate to Pre-manufactured not Standard components. Do not award bought in bulk, already made.
	(b)	**(i)**	Award one mark for each valid response e.g. • Check fit / test function (1)	**2**	Answers must relate to advantages of what is gained/learnt from prototyping.

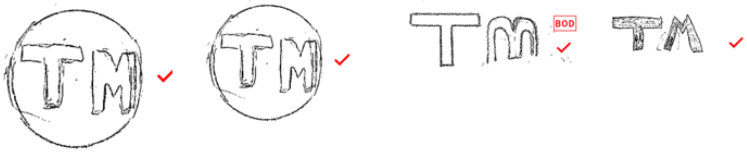
			• Check ergonomics/sizes (1) • Make sure it can be assembled (1) • Check aesthetics/ real-life view (1) • Show the client / user (1) • Shows if changes/improvements need to be made (1) • Evaluate the design before final production (1) • Product safety (1)		
	(b)	**(ii)**	Award one mark for each valid response e.g. • 3D printing (1) • Fused deposition modelling FDM (1) • Selective Laser Sintering SLS (1) • Stereolithography Apparatus SLA (1) • Electron Beam Melting EBM (1) • Powder Bed Fusion (1)	**2**	Accept abbreviations
	(c)		Award up to four marks for a valid explanation e.g. • The supply chain will have to be able to supply components within a given timeframe. (1) Designers will have to ensure the supply chain have the equipment / materials required, (1) that they can meet the demand (1) and can transport components / products to the manufacturer. (1) Answers may include: • Designers need to consider material availability (1) • Require readily available supply (1) • Important to have reliable supply chain (1) • Delays in the supply chain will delay production (1) • delays cause causing loss in productivity/or not be able to meet demand • Loss of reputation with customers (1) • Delays cause financial impact on the manufacturer (1). • Some materials may be scarcer/harder to source than others (1) therefore cost more (1) • Some materials in high demand at certain times (1)	**4**	Do not award marks for ease of manufacture, using pre-manufactured components and their benefits.

			• Consider sustainability impact of transporting materials (1)		
			Total	**[10]**	

			Answer/Indicative content	Mark	
5	**(a)**		Award one mark for each valid response e.g. Virtual • Computer Aided Design CAD (1) • Simulation / Virtual reality (1) • 3D modelling/3D design (1) Physical • Destructive / non-destructive testing (1) • Types of testing e.g. tensile test / impact test (1) • Sampling by focus group (1) • Prototyping (1) • Wind tunnel (1) • Modelling (1)	**2**	Answers should focus on method of testing, not what is being testing. Do not award: • simply “testing” • ‘to see what it looks like virtually’ • ‘durable’/durability’ • ‘Error proofing’ • ‘use the product’ Award “strength” as BoD
	(b)		Award one mark for each valid response e.g. • To improve quality /materials /sustainability (1) • To respond to user / client feedback (1) • To fix faults found in testing (1) • To ensure the product meets the specification/appeal to the target audience (1) • To improve safety (1) • Identify ways to reduce cost of manufacture (1) • Identify ways to allow ease manufacture (1) • Add features and benefits/changes (1) • Finalise the design in the final stages of development (1)	**2**	Do not award ‘saves money’ ‘less cost’, more sales, Allow specific design aspects such as: - “To improve: • Improve the product • Ergonomics • Safety • Features

Question	Guidance	Mark	Answer/Indicative content Guidance
(c) *	Award up to six marks for a discussion, using examples, how error proofing is used in the design of products. **Level 3 (5–6 Marks)** Learners provide a thorough discussion, using examples, how error proofing is used in the design of 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. Good examples used to discuss how error proofing is used in the design of products. Learners will demonstrate an accurate level of spelling, punctuation and grammar. **Level 2 (3–4 Marks)** Learners provide an adequate discussion, using examples, how error proofing is used in the design of products. Some examples used. 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. **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. *Continued next page..*	6	Examples and relevant points could include: • Error proofing is used in the Optimise phase of the design cycle • Error proofing ensures that products cannot be used or assembled incorrectly • Key features can be added to stop the product being used incorrectly. This may include colour coded features or mechanisms • Error proofing can stop products being used incorrectly which avoids damage to the product or components • Error proofing can also improve safety by stopping the user interacting with a product when it may be in operation • Error proofing can be implemented in manufacturing through a principle called Poke Yoke. This means components are designed to be assembled only one way which improves quality during manufacturing. • Examples of error proofing may include; o USB connectors are designed in a way so they can only be inserted in one orientation o Components in automotive manufacturing may have colour coded stickers applied to show which way round it should be assembled o Plastic moulded components can include asymmetrical clips or locating pins which means they can only be put together one way o 3-pin plugs are designed so they can only be put into the socket one way o Audio cables are colour coded and correspond to connectors with the same colour, so left or right channels are connected to the correct place o Washing machines / microwaves / kettles / food processors will have mechanisms that stops them being operated unless the lid / door is closed. • Error proofing can make some products easier to use.

			Few or no examples used to show understanding of error proofing. 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.		• Customers may find products that do not incorporate error proofing difficult to use or assemble, leading to customer dissatisfaction. • Error proofing makes user assembly easier which can save assembly time.
			Total	**[10]**	

Question			Answer/Indicative content	Mark	Guidance
6	**(a)**		Award one mark for each valid response Symbol A • Recycling, Mobius loop (1) Symbol B • Fairtrade (1)	**2**	Accept 'recycle' 'recycling symbol', or 'Recycling' without mobius. Accept Fair Trade.
	(b)	**(i)**	Award one mark for the correct symbol TM ®	**1**	Award mark for either symbol. Trademark can be with or without the circle. Registered must be in a circle. Award  Do not award

		(ii)	Award one mark for a valid response i.e.: • Copyright symbol (1) • Registered Design (1)	1	Only accept answers relating to symbols and not to, e.g. 'patents' Answer must be different to the answer given in 6(b)i **"Safeguard"** in the context of this question means intellectual property, protecting the design rights etc. – NOT safety.
	(c)		Award one mark for each valid response e.g. • Safety information (1) • Age restrictions (1) • Material information (1) • Disposal guidance (1) • Product information (1) • Legal requirement /meets standards (1) • Vegan/Vegetarian /dietary information (1) • Sustainable sourcing (1)	2	Award other valid responses e.g. checked safe to use. Inform the buyer what they can do with the product? BOD? Award 'material information' Do not award 'international understanding' 'understood by different languages' or similar. Do not award quality made product
	(d)	(i)	Award one mark for a valid response • European Conformity / "Conformité Européene" (1)CE mark (1)	1	Award spelling errors, and close attempts at Conformité Award European standards BOD Do not award european confirment european union committee

		(ii)	Award up to three marks for a valid explanation e.g. • CE mark is applied to products that are sold in the European Economic Area (EEA). (1) - allow 'Europe' 'EU' • It signifies that the product has been assessed / checked/tested to meet health, safety and environmental requirements/standards (1). • Shows the product is safe to use (1) • that the manufacturer declares that the product meets legal requirements. (1)	**3**	Award a correct use example of the CE mark being applied. Do not award: • 'shows it is high/good quality' • 'It shows it's made in Europe'
			Total	**[10]**	

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