Cambridge National

Engineering

R038/01: Engineering Design: Principles of engineering design

Level 1/2 Cambridge National Certificate/Award

Mark Scheme for January 2024

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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.

MARKING INSTRUCTIONS

PREPARATION FOR MARKING
RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **number of required** standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or the RM Assessor messaging system, or by email.

5. **Crossed Out Responses**
   Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

   Rubric Error Responses – Optional Questions
   Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the

highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

Multiple Choice Question Responses
When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).
When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses
When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**)
Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth **two or more marks**)
If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)
Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add a tick to confirm that the work has been seen.

7. Award No Response (NR) if:
    - there is nothing written in the answer space

Award Zero '0' if:

- anything is written in the answer space and is not worthy of credit (this includes text and symbols).

Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The RM Assessor **comments box** is used by your team leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
If you have any questions or comments for your team leader, use the phone, the RM Assessor messaging system, or e-mail.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:
    a. **To determine the level** – start at the highest level and work down until you reach the level that matches the answer
    b. **To determine the mark within the level**, consider the following

Descriptor	Award mark
On the borderline of this level and the one below	At bottom of level
Just enough achievement on balance for this level	Above bottom and either below middle or at middle of level (depending on number of marks available)
Meets the criteria but with some slight inconsistency	Above middle and either below top of level or at middle of level (depending on number of marks available)
Consistently meets the criteria for this level	At top of level

11. **Annotations**

Annotation	Meaning
	Blank page
	Vague
	Tick – correct 1 tick per mark
	Incorrect, or noted but no credit given
	Unclear – cannot read
	Repeated content
	Benefit of doubt
Annotations to be used for Question 15c only, are below (note NO Ticks are used on this question part).	
	Level 1 - See mark scheme pages for level descriptors
	Level 2 - See mark scheme pages for level descriptors
	Level 3 - See mark scheme pages for level descriptors

For additional extra pages to the exam booklet, use **BP** where the page is completely blank (extra pages only)

Question			Answer	Mark	Guidance
1			(b) Canned food	1	Correct answer only
2			(b) Front, right side, top	1	Correct answer only
3			(c) Refusing to use an unsustainable raw material	1	Correct answer only
4			(a) A measurement of eye level	1	Correct answer only
5			(a) 3D printing	1	Correct answer only

Question			Answer	Mark	Guidance
6			(c) Card	1	Correct answer only
7			(b) Cost	1	Correct answer only
8			(d) To present initial concept design ideas	1	Correct answer only
9			(c) Designers adding a new feature in response to consumer feedback	1	Correct answer only
10			(d) Routing a channel in a piece of wood	1	Correct answer only

Question			Answer	Mark	Guidance
11	(a)	(i)	Product safety – • Error proofing (1) • No sharp parts (1) • Meeting regulations and standards (1) • Product labelling (1) • No choking hazards / loose parts (1) • No Finger traps (1) • Secure / locked battery / electrical compartment (1) • Safe to use by a range of user groups (1) Material safety – • Non-toxic (1) • Impact / shatter resistant (1) • Wipe clean (1) • Lightweight (1) • Soft material (1) • Smooth material (1) • Durable (1) • Waterproof (1) • Corrosion / rust resistant (1) • Non-conductive (1) • Protective finish (1) Manufacturing requirements - • Ease of manufacturing (1) • Assembly (1)	5	Do not awarded repeated answers.

Question			Answer	Mark	Guidance
			• Scale of production [able to be mass / batch produced – mention of a manufacturing scale] (1) • Cost effective to manufacture (cheap) (1) • Environmentally safe / recyclable / sustainable material (1) • Produced at speed to meet demand / made quickly (1) • Repeatability (1) • Availability of appropriate power source (1) **Award credit for any other appropriate response.**		
11	**(a)**	**(ii)**	Any one from: • Interviews (1) • Questionnaires (1) • Surveys with consumers (1) • Focus groups (1) • Consumer trials (1) • Product disassembly (1) **Award credit for any other appropriate response.**	**1**	

Question			Answer	Mark	Guidance
11	**(b)**		Any appropriate points related to product suitability for the customer: • Ensuring the design is inclusive (1) gender-neutral related theme will make the toy suitable for boys and girls (1) • Implement child friendly features (1) such as bright colours, and rounded corners to prevent injury (1) • Using a user-centred design approach to assess the design outcomes (1) consulting users / parents (1) • Make sure the design is safe for the intended age group (1) such as no choking hazards for 3 years and under (1) • Giving children a sample (1) and seeing if they like it (1) Feedback shows users like the toy / it is suitable (1) • Make it easy to use / play with (1) • Aesthetically pleasing (1) • Tested for product safely /adheres to legislation (1)	**2**	Two points made or a justified response.

Question			Answer	Mark	Guidance
			• Evaluation against the customer / user requirements / design brief / specification (1) • Use of anthropometric data (1) **Award credit for any other appropriate response.**		
11	**(c)**		Limitations e.g.: • Not permanent, cannot be saved (1) • Cannot be shared, emailed (1) • You have to have all the physical components unlike simulation which has a library of components to try out (1) • Components can get lost or damaged trying them (1) • More difficult to see errors (1) Benefits of on-screen simulation, e.g.: • Simulation can be easier to change the design (1) • On-screen simulation is not limited by the size of the board / cannot run out of space (1) • Extensive range of components available on-screen (1) • On-screen has more design features, viewing features (1) • Can print your on-screen design (1) **Award credit for any other appropriate response.**	**2**	Award marks on benefits of on-screen simulation.

Question			Answer	Mark	Guidance
12	(a)	(i)	• Knurl / diamond knurl	1	Correct answer only.
12	(a)	(ii)	Correct representation of knurled feature: 	1	Correct answer only. Centreline is not required.
12	(a)	(iii)	Any three valid points relating to ergonomic influence: • Knurling gives the user more grip (1) making the product easier to use and less chance of fingers slipping on the surface (1) such as when used with oily hands (1) • Easier to use (1) gives more grip (1) • It has ridges so it is easier to hold / grip (1) **Award credit for any other appropriate response.**	3	Do not award marks for answers about the overall size of the tool. Award 1 mark for use of the mechanical feature (e.g. grip) Award 1 mark for the benefit or use of the given feature Award 1 mark for a justification, i.e.: how the feature helps the user use of the tool (i.e. comfortable etc.)

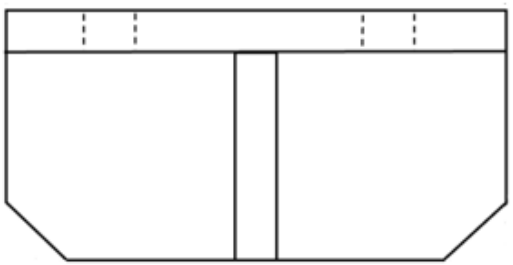
Question			Answer	Mark	Guidance
12	**(a)**	**(iv)**	Any appropriate reason for applying surface finish: • Surface finish may be added to enhance the aesthetics of a product / looks better quality (1) • To provide a protective coating / finish (1) • Prevent corrosion / rusting / make it last longer (1) • Increase durability / hardening (1) • To change the appearance of the material used (1) • To change the texture of the material used (1) • Make it easier to clean (1) **Award credit for any other appropriate response.**	**1**	This question part is about the application of surface finishes, and is not specifically related to the knurling in part (a)(iii).
12	**(b)**		Any correct feature shown by hidden lines: • Hole or bore / drilling (1) • Threaded hole (1) • Recess for a seal (1) • To show an edge behind a face / rebate (1) **Award credit for any other appropriate response.**	**1**	

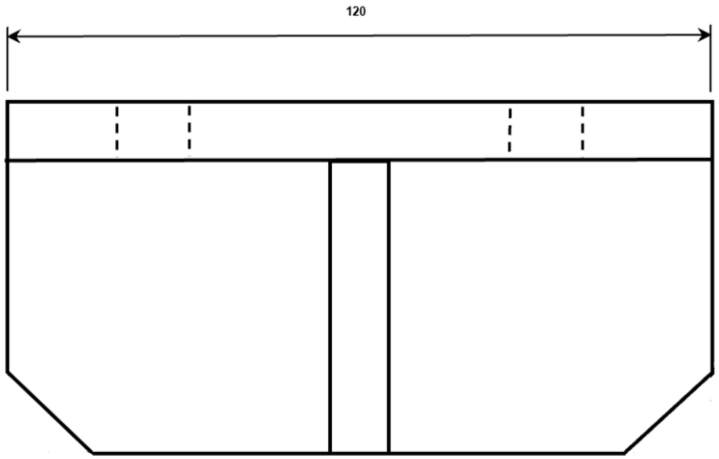
Question			Answer	Mark	Guidance
12	**(c)**		Appropriate points relating to function and design: • To remove material, the cutting edge of a saw (1) will need to be high quality / hardened (1) to work well and stay sharp / last a long time (1) • Tools used for digging (shovel) (1) will need to be ergonomically designed (1) to fit a range of users (1) • Tools for sanding / filing, (chiselling) (1) will have a handle that can be gripped comfortably (1) and be used for a task that take a prolonged time (1) • A soldering iron (1) must be designed to be held in a stand (1) to avoid burning (1) • A hammer (1) would need to have strength (1) to withstand the force of hitting objects (1) **Award credit for any other appropriate response.**	**3**	Three points made or a justified response. Award 1 mark for a specific named or type of tool [example] Award 1 mark for a specific feature or property i.e.; magnetic, rubber handle, hardened / strength etc. Award 1 mark for justification i.e.: how the design or feature helps the user / use of the tool to fulfil its purpose.
13	**(a)**	**(i)**	Any two from: • Analysis of data / trends (1) • Internet research (1) • Books, literature, trade journals (1) • Manuals, brochures, datasheets (1) • Images, media / drawings (1)	**2**	Answers must be a specific type of secondary research method to be awarded a mark. Award one mark for an attempted anthropometric measurement example

Question			Answer	Mark	Guidance
			• Anthropometric data (1) • Product reviews (1) **Award credit for any other appropriate response.**		
13	**(a)**	**(ii)**	Any appropriate way secondary research can be used: • Research shows what designs are popular or in demand (1) such as a colour or shape, style trend (1) • Analysis of what is selling / popular (1), and applying the same style / colour theme (1) • After researching current products, designers may want to design something that looks different (1) to appeal to a new audience (1). • Designers may research iconic styles (1) and use these / improve on these for the new product (1) • Research use of materials (1) and using this information to support texture, shape or processes (1) **Award credit for any other appropriate response.**	**2**	Two points made or a justified response. Answers must relate to aesthetics to be awarded marks.

Question			Answer	Mark	Guidance
13	**(a)**	**(iii)**	Any appropriate explanation with referenced to specific engineering processes e.g.: (any three from) • Plastics can be formed in a single process (1) into complex shapes (1) reducing the number of components needed (1) • Moulding / casting allows complex shapes to be one piece (1) which reduces joining processes (1) and makes assembly easier / more efficient (1) • Fasteners can be moulded to allow components to snap together (1) so you do not need screws (1) which saves time and materials (1) • Some processes such as moulding / sewing (1) could be competed using machinery / automation (1) allowing for larger scale manufacture / increasing accuracy / speed of production (1) • The base could be cast in aluminium for the base (1) as a single piece (1) that can be polished without other finishing processes needed (1) • Casting / moulding allows manufacturing in quantity (1) and reduces material removal processes (1) and with less waste material (1)	**3**	Do not award marks for answers that only relate to scale of production rather than manufacturing processes. Award 1 mark for an example process Award 1 mark how the process is used to produce the design e.g. shape etc. Award 1 mark for justification, i.e.: the benefit of using the process to produce the design e.g. repeatability / efficiently / one or few piece design etc.

Question			Answer	Mark	Guidance
			• Steel sheet can be formed by stamping in the desired shape (1) making panels accurately and quickly (1) ready to be joined together (1) • Assembly (1) component parts put together (1) Jigs/fixtures (1) **Award credit for any other appropriate response.**		
13	**(b)**		Any appropriate way user testing would be used. User testing can be used to (any three from): • If the design is liked or what is not liked (1) • Test if the design functions as the user requires / expects (1) • Test if users would purchase the product (1) • User testing identifies further modifications that could be made / could be changed / improved (1) • Test if the design can be used as intended (1) • Test if the design can be used incorrectly (1) • Test the ergonomics, feel / comfort / accessibility (1) • Test user opinion of the aesthetics / appeal (1) • User feedback (1)	**3**	Award marks for specific examples, e.g.: • Test the height range of the chair • Comfort, materials • Safety • Award a mark for justification of user testing e.g.: Identify additional features users want – chair to be able to recline / swivel etc.]

Question			Answer	Mark	Guidance
14	(a)	(i)	 • Orthographic drawing (1) • Correct orientation (1) • Holes / drillings in the correct position (1)	3	Markers to stack ticks for each mark point awarded. The drawing does not need to be to scale. Holes must be drawn as a hidden detail to be awarded the mark.

Question			Answer	Mark	Guidance
14	(a)	(ii)	 Any four from: • The horizontal dimension line will be of the overall length of the bracket (above or below the shape) (1) • The dimension measurement (120) should be central and above the dimension line (1) • Leader lines should not touch the component (1) • The arrow heads should have solid points (1) • Arrows should touch the inside of the leader lines (1)	4	Units are not required. The dimension line must have solid arrows to gain full marks (otherwise maximum of 3 marks).

Question			Answer	Mark	Guidance
14	(a)	(iii)	Any two from: • Scale (1) • Title block content: (date / drawing number / name) (1) • Border lines • Units of measurement (1) • Material (1) • Tolerances (1) • Mechanical features i.e.: threads etc. (1) • Third angle projection symbol (1) • Angles (1) • Named other view/face (i.e. top / side / right) (1) • Sections, sectional view (1) • Surface finish (1) • Centreline (1)	2	
14	(b)		One mark for: • AF	1	Correct answer only.

Question			Answer	Mark	Guidance
15	(a)		Any appropriate two ways that contribute to sustainable design, e.g.: • By using renewable energy sources/solar power (1) • Be able to be recharged instead of disposing of batteries (1) • Extended battery life (1) • Use LEDs instead of incandescent lamps (1) • Making electrical products repairable to extend use (1) • Durability to avoid damage and need for repair (1) • Use sustainable materials (1) • Use recyclable / reusable materials /components (1) • Reduce the use of plastics and non-renewable resources (1) • Low or reduced power modes (1) • Regenerative use of energy from product (1) **Award credit for any other appropriate response.**	**2**	Award marks for approaches to sustainable design in general, rather than those that would only be relevant to electrical products. Award marks for specific energy saving examples.
15	(b)		Any appropriate two ways legislation impacts on design: • Requirement to conform with safety standards (1) • Disposal requirements (WEEE etc.) (1) • Requirement to dispose of responsibly (1)	**2**	Two different points made or one justified. Award marks for a specific safety / conformity feature if given e.g.: Fuses

Question			Answer	Mark	Guidance
			• Restriction of using hazardous substances (1) • Right to repair (1) **Award credit for any other appropriate response.**		Earthing Water / splash zones (IP44 etc.)

Question			Answer	Mark	Guidance
15	**(c)**		**Level 3 (5–6 marks)** A **thorough** discussion of the sustainability considerations for importing materials, including the impact on the environment, showing understanding of all the points stated. **Consistent** use of appropriate terminology. Typically, 2 or more points developed with a discussion, debate or pros and cons. **Level 2 (3–4 marks)** An **adequate** discussion with some discussion of the sustainability considerations for importing materials, including the impact on the environment, showing understanding of **some** of the points stated. **Some** use of appropriate terminology. Typically, 1 or 2 valid points with some justification / development	**6**	Up to six marks for a discussion or detailed explanation of sustainability considerations of **importing materials**, including the impact on the environment. Responses may include reference to: • By importing materials from overseas, the materials will have further to travel from the source to the factory. • This could include multiple modes of transport and multiple journeys, each journey leaving a carbon footprint. • Likely to be use fossil fuels for the whole journey. • Part of sustainable design is reducing carbon footprint and impact on the environment including reducing transport miles

Question			Answer	Mark	Guidance
			Level 1 (1–2 marks) A **brief** discussion stating only either sustainability considerations or impact on the environment, showing **limited** understanding. **Little** or no use of appropriate terminology. Typically, 1 or 2 brief points / statements with or without superficial expansion on these. 0 = a response that is irrelevant and/or not worthy of a mark. Annotate with 'Seen' at end of response.		• Use of road transport impacts increases demand for roads, impacting negatively on the environment; noise /air pollution • Air/by water transport produces air/water and or noise pollution Justifications may include: • Some sustainable materials such as bamboo, hemp, are only available via importing as it cannot be grown worldwide. • Some sustainable materials may not be available in the quantity required without importing. • There is a trade-off of using some sustainable material sourced in another part of the world compared to using locally non-sustainable materials available locally. • Customers are increasingly demanding sustainable products leading to the use of sustainable materials, some may need to be sources via importing. • Success of the product design may be linked to the use of sustainable resources.

Question			Answer	Mark	Guidance
16	(a)		Any appropriate way standards impact on product design, e.g.: • The design will need to meet minimum requirements (1) • Designer and manufacture cannot cut corners, some additional safety feature may be required (1) • Error proofing may be needed to ensure safety standards are met (1) • Requirement to comply with kitemarks to be able to be legally sold (1) • Will need recognised testing and BSI and or CE (1) • Designed so the product can meet as range of international standards, so not limited to UK or Europe (1) • Important to meet standards, as consumers look for safe products (1) • Standard fittings; bulbs, USB (1)	**2**	Two relevant points or one justified answer.

Question			Answer	Mark	Guidance
			Award credit for any other appropriate response.		
16	**(b)**	**(i)**	Any two from: Disassembly can show: • Materials used (1) • Joining methods (1) • Assembly methods (1) • Named manufacturing processes (1) • How mechanisms work / functional aspects / efficiency (1) • Error proofing (1) • New technology (1) • Allow designers to copy and or improve the design (1) **Award credit for any other appropriate response.**	**2**	

Question			Answer	Mark	Guidance
16	**(c)**	**(ii)**	Any appropriate example how labour cost affect assembly: • Manual labour may be cost effective for assembling by hand such as with screws (1) • Low volume / small scale / one-off production (1) • Manual labour cost for hand joining / assembly (1) may be too expensive for high volume / mass production (1) • Automation or using machines (1) may be more cost effective than manual labour (1) • Automation or using machines to weld (1) can work 24/7 costing less than employees assembling products with fasteners (1) • Machines can be used for riveting with just one operator (1) at less cost than workers screwing parts together (1) • Low-cost /low-skilled labour can be used to operate some machinery (1) • Automation can be used instead of highly-skilled workforce (1) • Highly skilled / specialist workforce will increase cost (1)	**2**	1 mark for an example 1 mark for justification

Question			Answer	Mark	Guidance
			Award credit for any other appropriate response.		
16	**(d)**		Any appropriate four points within the explanation: • It can be a closed loop economy (1) that results in sustainability (1) • In a sustainable model, you make the product, use, reuse and recycle (1) • The design avoids waste and pollution (1) • Keeping resources / materials in use (1) for a long as possible (1) • Aim for zero waste designs to eliminate waste (1) • Use waste to create something else (1) • Production to consumption (1) to reusing (1) • The wheels sent to landfill result in some materials being wasted / disposed of instead of being reused for something else (1) **Award credit for any other appropriate response.**	**4**	Three relevant points or two justified responses / explanation, and: Award the 4th mark for correctly identifying that the approach is not fully sustainable / does not fully meet the principles of a circular economy, as some materials are wasted / sent to landfill.

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