OCR
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CAMBRIDGE NATIONALS

Examiners' report

ENGINEERING DESIGN

J831, J841

R105 January 2023 series

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

R105 series overview

R105 is one of four units that make up the Cambridge National in Engineering Design. Candidates will either work towards the Award to complete R105 and R106, or the Certificate, R105, R106, R107, and R108. Unit R105 is the only externally examined unit with the other units being centre assessed. To do well on this examination paper, candidates will have needed to have gained and demonstrated knowledge and understanding of the design cycle phases and activities that take place within each stage, design requirements for ergonomic design and ergonomic features, types of scale of production, and how these can influence manufacturing costs, and knowledge of new and emerging technologies such as robotic manufacturing and assembly, and cloud computing.

Candidates that performed well will have demonstrated knowledge of wider influences on designs including recycling, upcycling and accessing and using non-renewable and eco-friendly resources. Candidates should be able to apply this knowledge in a written description, explanation, or discussion. Candidates will have a good understanding of design and manufacturing processes and considerations, and how scale of production can impact on the design.

Additional teaching content was added to the specification first teach in September 2020. Candidate responses provide some evidence of gaps in teaching for this added content, such as robotic manufacturing and assembly, and cloud computing.

Candidates' understanding and use of some key terms/meaning such as 'error proofing', 'pre-manufactured parts', 'cloud computing' and to some extent, 'scale of production' was lacking.

Many candidates attempted all the questions on the paper, however there was a relatively high omission rate for question parts Question 6 (c) (i) and (c) (ii). It is not uncommon for candidates at the lower end of the performance range to omit the 6-mark question designed to assess quality of written communication and the specification content knowledge and understanding. Question 5 (c)* in this series was no exception. Within preparation for the written exam, teachers should encourage all candidates to make some attempt to answer all question parts, not least the QWC question, which carries six marks, 10% of the total paper.

Candidate performance varied across the ability range. Some part questions were well- answered across the ability range and likewise there were parts which were less well answered by many candidates, which included Question 1 (b) (iii), Question 5 (c)* and Question 6 (b). As with previous series, candidates did not always read the questions thoroughly. Most candidates answered Question 1 (b) (ii) in the context of the user, instead of the manufacturer as stated, resulting in very few correct responses for this part. Many candidates gave answers to Question 3 (d) related to the use or production of products using non-renewable materials, instead of the extraction process.

Candidate understanding and use of some key terms/meanings and the ability to use these in the correct context impacted on performance across many question parts including Question 1(b) (i), (ii), and (iii), Question 3 (b), Question 4 (d) and Question 6 (c) (i) and (ii). These include 'error proofing', 'pre-manufactured components', 'cloud computing' and to some extent 'scale of production'.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• understood key terms used within the questions • understood the sequence of the design cycle phases and activities that take place within each stage • understood design requirements for ergonomic design, and ergonomic features • demonstrated knowledge of the wider influences of design using non-renewable and eco-friendly resourcing • were able to explain with an example, how anthropometrics are used in the design of products • understood types of scale of production, and how these can impact manufacturing costs.	• showed limited understanding of error proofing • showed limited understanding of scale of production within Question 5 (c)* • gave simplistic responses such as 'has a handle', 'saves time' 'cheap/cheaper' and 'effective' without some justification to show understanding in Question 4 (a), Question 4 (b), Question 6 (a) (i) and Question 6 (b). • gave responses limited to material quantity within their discussion without including the cost of processes used to produce at a scale, i.e. equipment/automation, moulds, storage, offsetting costs. • did not correctly give responses related to the terms used within the specification. These include 'upcycling', 'anthropometrics', 'extraction' (non-renewable materials) • did not always read the question carefully to present responses in the correct context.

Section overview

In January 2023, R105/01 followed the same format as all previous series, having six questions with a total of 10 marks each, covering all three learning outcomes in R105. There were 27 component parts within the six questions. These were made up of short answer, single statement answers, 'describe' short answer, and 'explain' type questions. It is expected that candidates will give some justification for statements made within the describe and explain questions to access the full marks available. Question 5 (c)* is an extended response 'discuss' question where the quality of written communication is assessed, and marked with a level, ranging from Level 1 to 3, with Level 3 being the highest attaining, for up to 6 marks.

Question 1 (a) (i) and (ii)

1 The design cycle consists of **four** phases:

Design phase **Identify phase** **Optimise phase** **Validate phase**

(a) Complete the table below by:

(i) Putting the design cycle phases in the correct order.

(ii) State **one** activity that takes place in each phase.

One of each has been completed for you.

Order	Design Cycle Phase	Activity
1st		
2nd	**Design phase**	**Development of a range of design ideas.**
3rd		
4th		

[6]

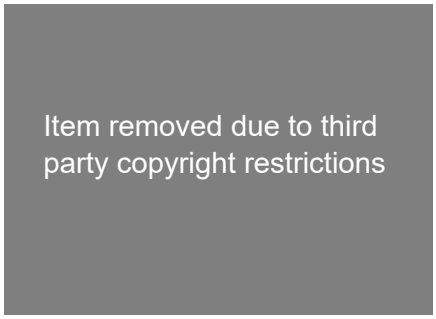
Candidates found this to be a straightforward question; most gave the correct order of the design phases and gave a good range of responses for the types of activity in each phase. This question part was generally answered well across the range. Some candidates placed the given terms for optimise and validate in the incorrect order. Error carried forward was allowed where the correct activity matched the respective phase. There were very few omissions.

Question 1 (b) (i)

Error proofing is an important part of design and manufacture.

Fig. 1 shows a 3 pin plug and socket.

Fig. 1



(b) (i) State how error proofing is used in the design of the 3 pin plug and socket shown in **Fig. 1**.

.....

..... **[1]**

Many candidates were able to recognise the most obvious error proofing feature of the plug and socket, in that it is only possible to fit the plug into the socket one way. Many less successful responses including having insulation to prevent electrocution, plastic covering, and the socket having a switch.

Question 1 (b) (ii)

(ii) State why error proofing is used in manufacturing.

.....

..... **[1]**

This question part was answered incorrectly by most candidates with relatively very few correct answers. Candidates did not read the question properly and missed the emphasis that the question was error proofing used in manufacturing (i.e. the manufacturing process). Answers given were typically (incorrectly) related to user safety, or user experience.

Question 1 (b) (iii)

(iii) Explain why error proofing is important to the user.

.....

.....

.....

..... **[2]**

Most candidates were able to achieve at least 1 mark for giving correct responses about user safety, ease of use, and preventing damage to the product.

Question 2 (a) (i) and (ii)

2 **(a)** When presenting a design brief, state what is meant by the following terms:

(i) Client

.....

..... **[1]**

Question 2 (a) (ii)

(ii) Designer

.....

..... **[1]**

While most candidates were able to correctly state what was meant by the terms 'client' and 'designer', there was some misinterpretation of the term 'client' which candidates interpreted this to mean 'customer', which is not a term included within the specification. Candidates should read the question carefully to make sure they can give the answer in the correct context.

Question 2 (b) (i) and (ii)

(b) (i) Give **two** reasons why corporate branding is important.

1 .....

2 .....

[2]

(ii) State **two** ways corporate branding can be shown on a product.

1 .....

2 .....

[2]

These question parts were generally answered well with candidates across the ranges having a good understanding of corporate branding. There were some incorrect responses to part (b)(ii) incorrectly giving answers such as 'copyright', and 'trademarks', due to lack of understanding of the term 'corporate branding'. A small number of candidates appeared to have misunderstood part (ii), incorrectly interpreting this as meaning two different corporate brands having both brands represented on the product (i.e. two different logos).

Question 2 (c)

(c) State **two** ways a focus group can help to inform market research.

1 .....

2 .....

[2]

This question was generally answered well by most candidates without difficulty.

Question 2 (d)

(d) Describe what is meant by the term 'consumer trends'.

.....

.....

.....

..... **[2]**

This question was well-answered with most candidates achieving at least 1 mark. Candidates correctly described the meaning of 'consumer trends', with some candidates giving good examples.

Question 3 (a)

3 Products can be upcycled at the end of their life.

(a) Describe how a product can be upcycled.

.....

.....

.....

..... **[2]**

Candidates were less clear about the meaning of the term 'upcycling'. Many responses described recycling, although most candidates were able to achieve 1 mark for part of their answer in line with the mark scheme.

Question 3 (b)

(b) Name **two** other processes that avoid the disposal of products at the end of their life.

1 .....

2 .....

[2]

Most candidates achieved at least 1 mark for correctly naming processes other than upcycling that avoid disposal. Some responses were less clear about the difference between different uses of materials at end of (product) life. Teachers should advise candidates to only use the key terms included within the specification, for example, 'repurposing', an answer often given, is not included.

Question 3 (c)

(c) State **two** benefits of using eco-friendly materials.

1 .....

2 .....

[2]

The most common correct responses stated that eco-friendly materials do not harm the environment. However, there were also a range of vague responses given that were marked as incorrect. Vague responses included 'good for the planet', 'doesn't harm the planet' and 'less CO2/global warning'. Additionally, candidates demonstrated a misconception/generalisation that eco-friendly materials are necessarily recyclable or reusable.

Exemplar 1

(c) State **two** benefits of using eco-friendly materials.

1 reduce carbon footprint.

2 People like/ knowing prefer to buy eco-friendly products

[2]

Exemplar 1 shows a response where the candidate gives a vague or incorrect answer using terms not on the specification. The use of 'carbon footprint' was not included within the mark scheme but does include an extensive list of correct answers related to either environmental, user or manufacturing benefits.

Question 3 (d)

(d) Explain the effects that extraction of non-renewable materials has on the environment.

.....

.....

.....

.....

.....

..... **[4]**

Many candidates appear not to have read the question properly to understand that the question is about the extraction of renewable material. Candidate responses often incorrectly focused on the material use, or production, or material disposal and the environmental impact of these, instead of the extraction process. Therefore, many candidates have not achieved as many marks as anticipated for this question part. Candidates who correctly interpreted the question gave good answers demonstrating a good understanding of the effect of extraction, and were often able to achieve 3 marks, or full marks.

Exemplar 2

(d) Explain the effects that extraction of non-renewable materials has on the environment.

The effects that extraction of non-renewable materials have on the environment include polluting water sources, destroying ecosystems and Polluting water sources is caused when once the materials are extracted the site has not been cleaned thoroughly leading some waste to go into water sources. **[4]**

Exemplar 2 shows a reasonably well-constructed response that clearly answers the question, specifically about the effects of extraction of non-renewable materials on the environment. Marks were given for the following points:

- polluting water sources, destroying eco-systems
- once the materials are extracted the site is not cleaned thoroughly
- (justification) this leads to / leading to some waste going into water sources.

Question 4 (a) and (b)

4 **(a)** Give the meaning of the term 'ergonomics'.

.....

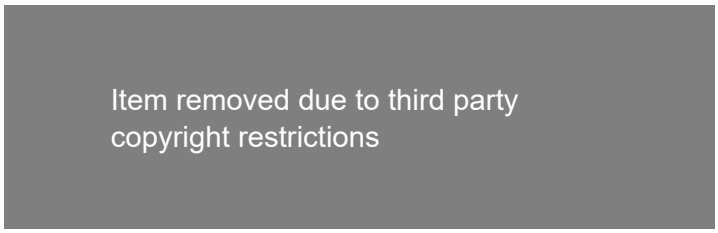
.....

.....

..... **[2]**

Fig. 2 shows a toothbrush.

Fig. 2



(b) State **two** ergonomic features considered in the design of the toothbrush shown in **Fig. 2**.

1 .....

2 .....

[2]

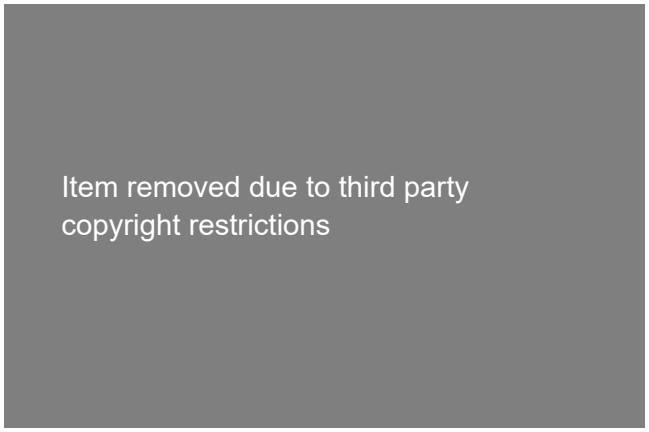
Candidates demonstrated a good understanding of ergonomics. In Question 4 (a) most candidates were able to gain 1 mark for stating 'comfortable', and there were relatively few candidates who did not achieve at least 1 mark. Some candidates gave an appropriate example of an ergonomic feature to demonstrate understanding, although this was not necessary to gain the 2 marks available. There were some instances of answers that showed confusion between ergonomics with anthropometrics which was also demonstrated in parts 4 (c) and 4 (d). For part (b), most candidates gave correct answers. Some lower ability candidates gave simplistic responses such as 'the handle', 'the bristles', 'the size'. Such responses were not given the mark as they are too vague to demonstrate understanding of ergonomic features.

Question 4 (c)

Fig. 3 shows a dining chair.

Ergonomic design and anthropometric data were used in the design of the dining chair.

Fig. 3



(c) Explain why ergonomic design is important when designing the dining chair shown in **Fig. 3**.

.....

.....

.....

.....

.....

..... **[3]**

There were some good attempts at this question. Some candidates showing clear and accurate knowledge of ergonomics and most candidates were able to achieve at least 1 mark. Some anthropometric examples were given, and there were some repeated answers from Question 4 (a).

Question 4 (d)

(d) Explain, using an example, how anthropometrics are used in the design of the dining chair.

.....

.....

.....

.....

.....

..... **[3]**

This question was less well-answered with many responses limited to 'average size' or simplistic responses that showed a lack of depth in knowledge and understanding. Relatively few candidates achieved full marks for this part.

Question 5 (a) (i) and (ii)

5 **(a)** State the meaning of each of the terms below, which are used in product requirements.

(i) Durability .....

..... **[1]**

(ii) Reliability .....

..... **[1]**

Candidates answered less well than anticipated across the ability range for parts 5 (a) (i) and (ii). Most candidates incorrectly stated that durability meant 'long lasting' or 'strong', or repeated the term as 'durable'. Candidates performed slightly better in part (ii) although there were some repeated answers such as 'how reliable the product is', 'rely on it' and 'long lasting'.

Question 5 (b)

(b) Explain why it is important to check material availability prior to commencing production.

.....

.....

.....

..... **[2]**

Most candidates were able to achieve 1 mark for a correct explanation of why it is important to check material availability. Mid- and higher-ability candidates provided a justification. Overall, candidates demonstrated a good understanding of material availability considerations.

Question 5 (c)*

(c)* Discuss how scale of production affects production costs.

.....

.....

.....

.....

.....

..... **[6]**

Scale of production, as part of the manufacturing considerations, is an important part of the specification from which candidates should be able to draw on a wide range of knowledge across the specification content to answer this question. Most responses were at Level 1 or Level 2 with relatively very few Level 3 responses achieving 5 or 6 marks. A high proportion of responses focused mainly on material usage (quality and quantity) and did not include references to different approaches including manufacturing scales using machinery, moulds, and systems, and the impact this has on associated costs. Candidates were given marks for an explanation of the different scales of manufacture, but there was little in the way of developing these as a discussion or to detail costs of production associated with scale.

Misconceptions

There was a common misconception throughout responses that mass production only involves low-cost products that lack complexity, low quality materials and low-skilled staff. A good example that teachers could relate to within their teaching is automotive manufacturing, where on a mass production scale, the products are innovative, highly complex, and the quality of materials and the overall product versus cost, is of the upmost importance.

Assessment for learning

OCR has produced teaching and learning resources that can help students understand production costs. Teachers could adapt these with an example of a larger more complex engineered product to support students' understanding of costs associated with production.

Production costs teaching activity

Additionally, a delivery guide is available that has useful teaching resources including three sections on manufacturing considerations, and a section on production costs.

Design briefs, design specifications and user requirements

Exemplar 3

(c)* Discuss how scale of production affects production costs.

Scale of production can affect ~~production~~ production costs as some products may need different scales of production ~~depending~~ on ~~what~~ to be as cost effective as possible. An example of this can be bread, which is ~~batched~~ produced rather than mass produced because if it was mass produced, it ~~will~~ will lead to wasted products, therefore wasted money. Another way production costs can be affected by the scale of production is the cost of machinery. For example one off over a long term is cheap, but the initial cost is very expensive. ~~Another~~ Labour costs are also a factor as the longer someone has to work on something, the more ~~they have~~ the customer has to pay. An example of this is one off production where the cost of labour is very expensive. [6]

Exemplar 3 shows a response that demonstrates some structure to develop the points being made. The response begins with an overarching statement that some products need a different scale of production to be cost effective. The response includes a correct example of a product typically produced in batches (bread) and the cost-related reason for this. The response continues with a discussion on the costs associated with machinery and labour. Overall, the response has a few knowledge points with some development of these.

Question 6 (a) (i) and (ii)

6 **Fig. 4** shows a robot arm used in manufacturing and assembly.

Fig. 4

(a) **(i)** State **two advantages** of using robots in manufacturing and assembly.

1 .....

.....

2 .....

.....

[2]

(ii) State **two disadvantages** of using robots in manufacturing and assembly.

1 .....

.....

2 .....

.....

[2]

Candidates demonstrated basic knowledge of introducing robots in manufacturing and assembly with most candidates achieving at least 1 mark. One of the most commonly given incorrect or vague responses was 'you don't have to pay them' (or similar). Candidates often gave very simple responses such as 'quicker' and 'efficient'. Overall, candidates were less knowledgeable about the disadvantages in part (ii), often giving simplistic responses and some generalisations such as 'the robot may breakdown', without stating what this means in terms of disadvantage compared to using human labour.

Question 6 (b)

(b) Give **two** reasons why pre-manufactured components may be used in the manufacture of products.

1 .....

.....

2 .....

.....

[2]

This question was not particularly well answered as many candidates across the range gave vague responses such as 'costs less', 'saves time', 'easier', with very few candidates achieving 2 marks. Candidates showed a lack of clear understanding of the difference between standard components, and pre-manufactured components. Many incorrect responses related to standard components.

Question 6 (c) (i) and (ii)

(c) **(i)** Explain what is meant by the term 'cloud computing'.

.....

.....

.....

..... **[2]**

(ii) State **two** advantages of using cloud computing.

1 .....

.....

2 .....

.....

[2]

Candidates demonstrated a basic knowledge of cloud computing, with most responses correctly containing a reference to storing/saving data in the cloud, although there was evidence in gaps in knowledge for many candidates on this part for the specification. Some candidates incorrectly interpreted the term to mean using CAD or other forms of software. For part (ii), there was some repetition between the answers given in part (i). Despite the extensive range of potential correct answers within the mark scheme, overall, candidates performed less well than expected. There was a very high omission rate across parts (c) (i) and (c) (ii), particularly for lower ability candidates.

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