Cambridge Nationals

Engineering

Level 1/2 Cambridge National Awards in Engineering **J830-3**

Level 1/2 Cambridge National Certificates in Engineering **J840-3**

OCR Report to Centres January 2016

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This report on the examination provides information on the performance of candidates which it is hoped will be useful to teachers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding of the specification content, of the operation of the scheme of assessment and of the application of assessment criteria.

Reports should be read in conjunction with the published question papers and mark schemes for the examination.

OCR will not enter into any discussion or correspondence in connection with this report.

CONTENTS

Cambridge Nationals

Engineering J830-3 – J840-3

Level 1/2 Cambridge National Award in Principles in Engineering and Engineering Business J830
Level 1/2 Cambridge National Certificate in Principles in Engineering and Engineering Business J840

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

Level 1/2 Cambridge National Award in Engineering Manufacturing J832
Level 1/2 Cambridge National Certificate in Engineering Manufacturing J842

Level 1/2 Cambridge National Award in Systems Control in Engineering J833
Level 1/2 Cambridge National Certificate in Systems Control in Engineering J843

OCR REPORT TO CENTRES

Content **Page**

R105 Design briefs, design specifications and user requirements

General Comments

This was the third series of the R105: *Assessing client briefs, specifications and user requirements* exam paper. Although the unit and qualification is only in its second year of existence, a large number of candidates were able to successfully access the paper. In addition, the paper was successful in discriminating across the ability ranges.

It is worth emphasizing here that centres should cover the entirety of the content set out in the specification. Once the content has been covered it is advised that centres spend some time preparing students for the examination using the specimen paper and, with growing availability, the past papers for the examination. This should allow students to answer the whole paper with sufficient understanding and depth. There are key areas of the specification where candidates' understanding is not as fully developed as it needs to be to access the questions.

Centres must also ensure that they prepare candidates with an understanding of the command verbs that are used within questions. As in the first two series of this paper, this is still a recurring element of improvement evidenced in the answers provided. At times it is clear that students are not always answering questions in the style expected of the command verb. For example; when a question command verb is 'Explain' or 'Describe' candidates are answering with one-word answers which limit their ability to access the full marks available for the question.

Comments on Individual Questions:

Question No. 1

Part 1a of this question requires candidates to join client requirements to product features for a pair of headphones. On the whole candidates answered this question successfully but as per previous sessions it is advised that candidates spend time carefully looking at the criteria before joining the options together. Some candidates appear to have made decisions on their selections very quickly which resulted in lots of lines drawn on the question, making the identification of marks difficult, or resulting in mistakes being made and marks being lost. In general however, the question was answered well.

For part 1b, candidates were required to give two ways that corporate branding could be included into the headphone design. The question was answered well on the whole. Where candidates failed to achieve marks, answers were generally too vague and candidates failed to state a specific method or position where corporate branding could be included in the design.

In part 1c, candidates were asked to state two methods of research that could be used by the headphone manufacturer. This was a strongly answered question. Most candidates were able to consider and provide multiple methods of gathering research. The question required responses that gave specific activities. Where candidates did not achieve full marks, responses were related to the overall categories such as primary and secondary research and therefore not specific enough to gain all the marks.

Question 1d, required candidates to describe how a manufacturer's budget could influence the design of the headphones. Generally responses to this question were good with a wide range of candidates understanding the impact the budget can have on material selection. A broader range of different answers would be valuable to show that candidates understand the wider impact on manufacturing processes or component selection. Where answers lacked clarity this

was generally due to candidates focusing on the operational performance of the headphones based on cost not on the manufacturing decisions.

Question No. 2

In part 2ai of this question, candidates had to give two design specification points for an electric toothbrush. On the whole this question was answered relatively well, but as per other questions in the paper when answers were not awarded marks, candidates gave very general or vague responses or statements that were not specific enough to qualify as a specification point. Candidates tended to focus on the size of the head or handle of the product rather than focusing on the specific features or design.

Part 2aii, asked candidates to develop the specification points given in part 2ai. Candidates were awarded marks here for good explanations of specification points even if answers in part 2ai may have been too vague. On the whole answers given here were good but full marks were not always awarded as candidates failed to action the 'explain' command verb in the question and gave shorter statements as responses rather than written explanations.

Question 2b asked candidates about two stages of the design cycle. Candidates had to list the activities undertaken by the designer in the 'design' (part 2bi) and 'optimise' (part 2bii) phases of the design cycle. On the whole candidates were able to answer part 2bi effectively, stating multiple activities that are undertaken by the designer in the design phase of the cycle. In part 2bii, answers were generally not as strong showing that candidates were not as familiar with the optimise phase of the design cycle. Centres are reminded to ensure that the whole specification is covered in detail so candidates can effectively discuss all elements of the unit. The design cycle is a critical part of any design development process and should form a major part of content for delivery.

Question No. 3

Question number 3 focused on three areas of consideration that influenced the design of a school chair. Candidates had to consider a plastic school chair in relation to product safety, cost of production and ergonomics. On the whole this question was answered well. Most candidates were able to give valid responses in relation to product safety and the strength or stability of the chair and design. The cost of production element of the question received some good responses but it is worth highlighting again that responses including 'cheap' were utilised without significant exemplification of how the initial cost of manufacturing is offset through high volume manufacture. Centres are reminded that references to cost should be explained and justified to achieve marks. Finally, responses related to ergonomics were generally awarded marks although responses were on the whole focused on ensuring the chair is comfortable to sit on when there was opportunity for candidates to focus on the geometry and design of the chair and how ergonomic considerations had been incorporated into the design.

Part 3b required candidates to describe the product lifecycle considerations that have influenced the school chair. It is clear that candidates understood product lifecycle and the considerations associated with it. There are increased opportunities for candidates to consider the wider considerations of product lifecycle management such as the sourcing of raw material or use and operation. Candidates' answers were generally focused on the end of use and disposal or recycling of the product.

In part 3c, candidates were asked to give two performance requirements of the school chair. This question was answered well with most candidates able to access the marks. Most responses focused on the strength and durability of the chair but it is worth centres ensuring that

the breadth of depth of performance requirements is covered in detail through teaching so candidates can apply this knowledge to a wealth of products.

Question No. 4

Question number four begins with a figure of a plastic clip. Candidates have to give two reasons why plastic is a suitable material for the manufacture of the clip. Most candidates were able to give valid answers here and therefore marks were generally accessible to most. Many responses related to the cost of plastic and the subsequent affordability of the product because of this. It is important to remind centres here that answers relating to plastic and its perceived 'low cost' always need to be quantified with reference to the reduction in unit price following high, initial tooling investment.

Part 4b, asked candidates to give four ways in which the design of the clip has been influenced by manufacturing considerations. This question, on the whole, was not answered well. Many responses given were related to the operational performance of the clip and how the properties of the material allowed it to function. Candidates were required to consider how the design of the clip and its geometry had been influenced by the manufacturing technique. Those candidates that gave excellent responses were able to identify that the part is plastic moulded and therefore referenced the quantity of production, reduced unit cost following high initial investment, how the features of the component made it suitable for moulding and the associated benefits of manufacturing the part in this way.

In question 4c, candidates were asked to explain why high-volume production is suitable for the manufacture of plastic products. As per responses to 4b, this question was not answered well by a large number of candidates. Responses again focused on cost but failed to quantify how the cost only reduces per unit once the high initial investment in tooling has been offset.

Part 4d generally prompted good responses from candidates. Candidates were able to make the link between the requirements for a consistent supply of material in order to sustain high levels of production output. Reponses that failed to gain full marks were generally because the candidate did not action the command verb in the question and provide a detailed enough explanation to gain the second mark.

Question No. 5

Part 5ai required candidates to give examples of standard components. It is clear that in this series, candidates had a better understanding of standard parts with the vast majority of responses containing valid examples.

Question 5aii extended the knowledge of standard parts required for part 5ai by asking candidates to explain why the use of standard components in design can reduce production costs. On the whole candidates were able to answer this question well, showing an understanding of how the bulk purchase and associated large scale manufacture with guaranteed quality were useful factors in the management of costs when assembling or producing products. Where answers were less successful, candidates gave responses stating that standard parts were cheap and as with previous answers qualify the response with reference to the quantity of manufacture and the subsequent ability to purchase in bulk, reducing the unit cost of individual components.

In part 5b, candidates were asked to explain how designers consider product maintenance when designing products. This question generally provided good responses even though many candidates did not gain the full three available marks due to shorter statements being given rather than a more extended explanation. On the whole, candidates were able to mention

design for disassembly, ease of access of components and the ability to replace parts. In some cases candidates gave responses that referenced a company's reputation with customers and how successful maintenance may improve this. Although in some cases some valid points were made, this moved away from the real focus of the question which was aimed at the design of products to assist in maintenance not the subsequent effect.

Part 5c asked candidates to explain why tolerances were an important consideration when designing components. Tolerance is a subject that has appeared throughout the other series of this paper and as in those previous series, responses to this question varied dramatically. On the whole a fully detailed understanding of tolerances has not been developed with candidates failing to explain how making things to exact measurements is extremely difficult and highly expensive. In some cases, candidates are confusing tolerance with the components ability to withstand stress which, in the context of this question, is not accurate.

Question No. 6

Question 6 consisted of three parts. The first part required candidates to give an example of a modern material and a product that it was used in. Despite the range of materials given in responses being generally limited, candidates were, on the whole, able to give a valid example of a modern material and a product where it is used. Where responses did not achieve marks, candidates generally named generic materials that would not be classed as modern materials.

Part 6aii extended the response from question 6ai by asking candidates to give one benefit of using the material in the product they had given. As with responses to 6ai, candidates were able to state benefits of using the material in their chosen application. In the vast majority of cases this related to weight saving or increased strength properties provided by the inclusion of the new material. Where candidate struggled to access the marks, this was generally because the material selected in part 6ai did not give them the scope to be able to discuss the subsequent benefits when utilised in the product.

In part 6b, candidates were generally able to gain marks but few gained marks towards the maximum available in this question. This was generally due to the lack of development given following each point and the unstructured nature of some responses that did not meet the requirement of the extended written response asked for in this type of question. In this particular example, some excellent responses were provided that detailed key considerations of sustainable design. In particular, candidates clearly understand end of life considerations related to disassembly, recycling and disposal. Centres are reminded to ensure they cover the full scope of the specification in depth to ensure candidates achieve maximum marks. As mentioned previously, centres are reminded to develop candidates' ability to write extended responses. Some responses were written in bullet point format which, although some excellent points were made, candidates are also being assessed on their ability to write extended prose and therefore may not have achieved the maximum marks they were capable of.

R109 Engineering materials, processes and production

General Comments:

Candidates had been generally well prepared for the examination and, in most cases, had attempted all of the questions on the paper. In a number of cases however, candidates' knowledge of some sections of the specification appeared to be rather limited.

Responses to questions relating to engineering materials were generally rather varied, as were those dealing with the more advanced production processes. In questions where candidates are asked to describe or explain processes or procedures, it should be noted that simplistic answers are not suitable responses. This was often the reason for candidates failing to score the higher marks in questions relating to modern technologies.

There was some evidence that candidates had not read questions carefully enough before giving their answers, resulting in a loss of marks. It is most important that candidates take the time to read through the question paper before attempting to answer questions.

Comments on Individual Questions:

Question No.

1(a) Most candidates scored marks on this question, but overall the results were very varied, with detailed knowledge of materials seeming to be quite limited. Aluminium was frequently given as an example of an alloy, and some candidates gave examples of products rather than actual materials. There was also some confusion between ferrous and non-ferrous metals in a number of cases. Only the higher achieving candidates scored full marks by giving suitable examples of all four material types.

1(b) This question was well answered by most candidates, with many scoring full marks with a correct description of an alloy.

2(a) A significant number of candidates failed to score any marks on this question, with many describing a thermochromic material incorrectly, and some suggesting that it contained chrome. A number of candidates did mention the material changing with temperature, but to gain both marks they needed to give details of the change that occurred.

2(b) Very few candidates scored two or more marks on this question, with many responses consisting of one-word statements rather than reasons. Where the factors stated were relevant, one mark was awarded overall, but a number of incorrect statements, such as 'malleable' were seen.

.

2(c) This question was generally well answered and most candidates scored full marks on it. Where marks were lost, this was often as a result of giving an incorrect example, such as wood. Metals and plastics were by far the most popular responses.

2(d) Some very good responses to this question were seen, but overall the responses were rather varied. The higher achieving candidates gave a suitably detailed description of a destructive test, normally tensile testing, and gained full marks. Some marks were lost where an important detail was omitted from an otherwise reasonable description, but a significant number of candidates missed the focus of the question completely and described a non-destructive test.

3(a)(i) The majority of candidates gave the generic name of 'screw' which was not awarded. A small number of candidates offered the technically correct name of self-tapping screw.

3(a)(ii) Most candidates attempted this question but few scored more than one mark for the response given. Many made reference to the fact that holes needed to be drilled, but then suggested that the holes should be threaded before inserting the self-tapping screw. One mark was awarded if the candidate had described using the screw as a 'self-cutting' screw, driving it through the two sheet metal parts.

3(b) This question was quite well answered, with welding, brazing and soldering being the most popular responses. A few candidates lost a mark by making simple reference to gluing, without specifying a cyanoacrylate (superglue) or an epoxy resin.

3(c) This question was not well answered on the whole, with very few candidates scoring more than one or two marks on it. The benefits of using forging to make metal parts were not well known, and the reduction in waste material and the strengthening of the structure appeared in less than half of candidate responses.

4(a)(i) Most candidates scored well on this question, some gaining full marks for correctly naming all four injection moulding machine parts. A number of different names were suggested for the injector, but marks were awarded where suitably descriptive responses were given rather than the exact name.

4(a)(ii) This question was quite well answered, with many candidates giving three relevant moulding processes and gaining full marks. In a number of cases, however, candidates had repeated injection moulding as one of their responses, and marks were also lost where incorrect examples, such as 3D printing and plastic coating, were given.

4(b) **O**nly a limited number of candidates scored two marks or more. The most popular correct responses made reference to the range of colours available in plastics and the fact that they are very easy to mould into complex shapes. In many cases, responses were too simplistic to qualify for individual marks, and one mark overall was awarded if the three responses were relevant.

5(a)(i) Only a limited number of candidates were able to adequately describe an advantage of water jet cutting when compared to milling, and a significant number gained no marks at all on the question. The most frequently seen correct responses referred to the cleanness of the cut and the lack of distortion through heat, but references to the ease of producing complex shapes and the ability to cut hard materials were very rarely seen.

5(a)(ii) This question was not well answered in most cases, and only the higher achieving candidates scored marks on it. The 'multi-axis' feature was usually taken as referring to the three axes of conventional milling machines, and the ability to perform many different operations without changing machines was only mentioned by a small number of candidates.

5(b) A significant number of candidates did not offer a response to this question and knowledge of additive manufacturing appeared to be generally quite limited. Where responses were given, the most frequently seen correct example was 3D printing, but this was often accompanied by an incorrect response such as laser cutting or even welding. Where a correct second response was given, this was most frequently Selective Laser Sintering (SLS).

5(c) Many candidates failed to address the focus of this question and based their responses on the use of modern technologies in manufacturing rather than in the development of new products. In many cases a single mark was awarded for reference to the use of CAD in the design stage but only a limited number of candidates went on to cover other areas of development, such as 3D imaging and rapid prototyping.

6(a)(i) Most responses to this question took the form of a simple re-arrangement of the words in the question and less than half of the candidature scored any marks on it. Where responses were acceptable, they were often too simplistic to qualify for more than a single mark, and only the higher achieving candidates gained the full two marks for the question.

6(a)(ii) The majority of candidates were able to give at least one reason for using global manufacturing, and this was most commonly the low cost of labour in other countries. Full marks were awarded where candidates had also mentioned other factors, such as the proximity of raw materials or the extension of target markets for products.

6(b)* There was considerable variation in the type and quality of responses to this question and a considerable number of level one responses were seen. In a number of cases candidates had missed the focus of the question and gave responses that were simply generic references to the use of modern technologies in manufacturing. Where candidates had taken account of the need to relate the response to 'the effects on the workforce', they were able to provide suitable responses relating to such factors as the loss of jobs, the need for staff re-training and improvements in working conditions. Marks were awarded in this question for a candidate's quality of written communication, even though technical content might have been weak.

R110 Preparing and planning for manufacture

General Comments:

Samples from centres were received for moderation before the deadline date. All centres had included a signed copy of the Centre Authentication Form (CCS160) and an internal mark sheet (MS1). Each candidate had a Unit Record Sheet (URS). Centre administration was efficient.

Standard of assessment by centres was generally consistent. Marks had been entered on the URS and totalled; internal checking of totals by centres could help to avoid errors prior to transcription to MS1 and the submission of marks. The correct candidates had been included in the samples received.

Teacher commentary on the URS is welcomed and was generally useful, but would benefit from the inclusion of further commentary to assist with moderation. There was often no further evidence of annotation on candidates' work which would also help with the moderation process.

Centres should use the witness statement included with the Live Assessment for LO 1 – to validate the level of assistance required by the candidate as they identified appropriate tools, equipment and manufacturing processes; and for LO 2 - to corroborate the level of candidate independence as they applied appropriate working practices when using hand and machine processes, and how consistently candidates used tools and equipment safely during the making of the product. Centres might consider alternatives. Where witness statements had not been sent for moderation these were supplied following contact with the centre.

Centres are reminded that witness statements should be used to corroborate evidence generated by the candidate, and should not be used as a sole source of evidence.

Comments on Individual Learning Outcomes:

LO. 1a
Most candidates clearly and correctly identified key aspects of the 2D and 3D engineering drawings. Where candidates failed to access the higher mark bands there was minimal understanding of standard drawing conventions demonstrated, and labelling and annotation regarding relevant details and requirements appropriate to the making of a pre-production product was superficial.

LO. 1b
Most candidates presented a production plan that set out an effective sequence of manufacturing operations to produce a pre-production product. Many candidates identified health and safety requirements, and at least one relevant quality control device. Weak plans contained generic terms when referencing tools and equipment and this limited access to the higher mark bands.

LO. 2a
There was good evidence of the specification being correctly interpreted by most candidates. Photographic diaries with commentary, supported by witness statements, helped to provide clear evidence of safe and appropriate working practices when using conventional (non-CNC) hand and machine processes. It would be beneficial for candidates to also produce photographic evidence of their completed outcome.

LO. 2b
Most candidates reviewed the quality of their outcomes, in many cases, by identifying where dimensions either met, or failed to meet agreed tolerances from their engineering drawing. It would be beneficial for candidates to identify the quality control tools they use to make measurements, and to explain how they come to decisions regarding the quality of the product.

LO. 3

This was perhaps the weakest LO for some centres. It requires modification of a production plan for a one-off pre-production product to reflect increased scale of production to 1000 items. Many candidates made reference to the use of Computer Numerical Control (CNC) processes rather than modifications to reflect the increased quantity.

Conclusion and Recommendations

Centres provided efficient administration with the correct paperwork and samples being submitted.

Level of detail on the URS, and candidates' work, might be improved which would assist with the moderation process.

In LO1 interpretation of the specification was, at times, superficial. A more thorough understanding of standard drawing conventions would be beneficial to candidates. Production planning could not only identify a sequence of operations, but greater detail referencing appropriate tools, equipment, manufacturing processes, quality control and health and safety considerations.

In LO2 there was good evidence of safe working practices when using hand and machine processes. Photographic diaries provide very good evidence of using tools and equipment safely during the making of the product. The review of the quality of the completed product should be thorough with reference to appropriate quality control checks.

In LO3 evidence did not always demonstrate that appropriate modifications to a production plan for a one-off product should be made to reflect increased scale of production. Candidates would benefit from reviewing the original production plan and then indicating the stages that could be modified to reflect increased scale of production, rather than look to CNC processes that could produce increased scale of production.

R113 Electronic principles

General comments

Most candidates attempted all questions.

In some cases candidates had clearly failed to read the question fully and went on to provide a response that was not actually relevant to the question. Candidates should be advised to read the complete question before attempting a response.

Comments on Individual Questions:

Question One
(a) Generally well answered by a majority of candidates.
(b) The majority of candidates could not identify the symbols shown as a filament lamp and a signal lamp.
(c)(i) Generally well answered by a majority of candidates.
(c)(ii) A number of candidates could not recall P = VI.
(d) Generally well answered by a majority of candidates.

Question Two
(a) The majority of candidates stated the correct meaning of Terminal Q and Terminal $\bar{Q}$ but very few candidates had any idea of the meaning of Terminal D and Terminal CK.
(b) The majority of candidates did not complete the timing diagram for a positive edge-triggered D type bistable correctly.
(c) A few candidates completed the timing diagram for a positive edge-triggered D type bistable correctly

Question Three
(a) The majority of candidates identified the NTC thermistor correctly.
(b) Generally well answered with a majority of candidates completing the circuit diagram correctly.
(c) Only a low proportion of candidates could label a transistor correctly with the terms emitter(e), collector(c) and base(b).
(d) Generally well answered by a majority of candidates but at a low level of technical language.

Question four
(a) A number of candidates correctly explained why the circuit is not in a dangerous condition when the fuse blows.
(b) Higher marks were achieved in this part of the question as compared to part (a) explaining why the circuit is still dangerous even though the fuse has blown.

(c)(i) Some candidates could not identify the device shown as a residual current device (RCD).
(c)(ii) Having answered part (c)(i) incorrectly a few candidates did however manage to gain marks.

Question five
(a) Generally well answered.
(b) Generally well answered with candidates explaining what is meant by the terms logic level1 and logic level 0 when used with logic gates.
(c) A number of candidates drew a correct diagram to show a NAND gate but did not complete the diagram correctly to show the gate being used as a NOT gate.
(d) Candidates struggled to answer this question, with very little knowledge being demonstrated about the main characteristics of an exclusive-OR gate.

Question Six
(a) A number of candidates described almost correctly the quality assurance method used during the production of a commercial printed circuit board.
(b) A high proportion of candidates attempted this question. However most responses only gave a basic discussion of the benefits and drawbacks to a manufacturer when using surface mount technology as compared to through hole technology when manufacturing circuits. A number of responses demonstrated poor quality of written communication.

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553