OCR
Oxford Cambridge and RSA

CAMBRIDGE NATIONALS

Examiners' report

ENGINEERING MANUFACTURE

J832, J842

R109 January 2021 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 are 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.

R109 series overview

R109 is an un-tiered, externally examined, mandatory unit of J832 and J842, these being the Award and Certificate respectively, in Engineering Manufacture. This unit assesses candidates' knowledge and understanding of engineering materials and processes. The paper requires short and extended written answers and includes synoptic assessment and assessment of the quality of written communication.

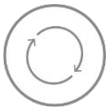
Candidates' preparedness for this session was variable and while most candidates attempted all questions, there appeared to be a greater number of instances of no response than in previous sessions. Candidates used their time appropriately and virtually all candidates completed the paper within the allocated time. Very few candidates used extra pages/continuation sheets but where they were used these extra pages were in nearly all cases clearly and accurately labelled indicating the question that the additional response was referring to.

A number of centres enabled candidates to make use of the Equality Act by using exam access arrangements, most obviously through the use of word-processed answer sheets. In many but not all cases candidates answered on the question paper where it was most suitable to do so and used the word-processed sheets to support their written responses. It would benefit candidates in future sessions if they were well practised in which types of questions are best answered on the paper and which to use word processing. This will save these candidates time and also reduce the potential for errors when working across two answer sheets. Some candidates organised their word-processed responses well and produced answer sheets that were very clear and easy to follow. This was however not always the case; centres could help candidates who answer using a word processor by training them to make good use of line spacing and white space to organise their responses.

A wide range of marks were gained in this paper. Often it was clear that some candidates had transferred synoptic knowledge and understanding gained practically in the centre assessed units. Indeed some candidates had a clear and in-depth practical knowledge/experience of the processes and manufacturing methods they were answering about. There were also clear differentials between candidates who had learned subject content from across the whole of the specification relating to R109 and those who had not. It should be borne in mind that direct questions can be asked of any of the unit content that is shown with an 'i.e.'. The success of candidate responses can be generalised as follows:

Candidates who did well on this paper generally did the following:	***Candidates who did less well on this paper generally did the following:***
• Had detailed knowledge and understanding of engineering manufacture especially with respect to properties and uses of materials. • Showed broad knowledge drawn from across the whole of the R109 specification statements. • Demonstrated an understanding and familiarity with the different command verbs, e.g. identify, describe, explain and discuss. • Gave broad and balanced responses that incorporated several points in conjunction with key vocabulary, which were often developed, when answering the longer written answer questions. • Used the guidance, where given, in the response lines to help make sure they answered all parts of the question.	• Lacked basic knowledge and understanding of materials, for example confusing properties such as malleability and ductility. • Found it difficult to apply what they had learned to different scenarios and instead gave answers that were simply a repeat or rewording of what was given in the stem of the question. • Lacked specificity with reference to properties such as strength. Some materials may be strong in compression but not so in tension. • Repeated the same single point in different ways when answering the longer written responses. • Limited the marks available to them by not answering all aspect of the question by not

Candidates who did well on this paper generally did the following:	*Candidates who did less well on this paper generally did the following:*
• Were able to name manufacturing processes.	using the additional guidance, where given, in the response lines. • Simply referred to named tools or machines instead of named processes.

	**AfL**	Centres can train their candidates to deconstruct questions, paying attention to locating the command verbs; the exact meaning of command verbs and the demand that the command verb requires in the response. The last point for example can be taught explicitly by instead of asking the candidate for the answer to a question, to ask for an example of what the answer would look like. This can be done for a variety of command words with increasing demand, e.g. name/state, suggest, describe, explain, evaluate etc., while keeping the remaining stem of the equation the same as far as possible.

Question 1 (a) (i)

1 (a) Fig. 1 shows a lead fishing weight.

Fig. 1

(i) Give **two** reasons why lead is suitable for the fishing weight.

1 .....

.....

2 .....

.....

[2]

This question was generally answered well by candidates who tended to give responses relating to useful properties for lead as a fishing weight such as its density, corrosion resistance and resistance to water damage. Other responses related to useful characteristics such as the material's relatively low cost or its ability to be easily moulded. A common incorrect response was heavy, whereas density is a key property that was looked for. A number of other candidates confused corrosion resistance with the chemical property of corrosive/non-corrosive.

Question 1 (a) (ii)

(ii) Give **one** reason why lead weights are banned in some areas and alternative materials have to be used.

.....

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

A large majority of candidates were aware of lead's toxicity referring to this in their response. A number of candidates however did not gain credit in this question by providing answers that were too general and not specific enough, for example "bad for the environment".

Question 1 (b) (i)

(b) Fig. 2 shows a boat propeller.

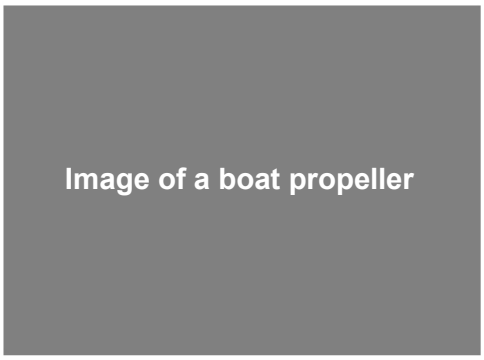


Fig. 2

(i) Circle the material commonly used to make a boat propeller.

bronze **mild steel** **glass reinforced plastic (GRP)** **epoxy resin**

[1]

Approximately half of the candidates correctly identified bronze but a surprising number incorrectly identified mild steel as a material used to manufacture boat propellers, indicating those candidates didn't know the rusting properties of mild steel. Good examination technique was demonstrated where answers were changed, as it was nearly always clear the response that was intended to be marked. There were very few instance of candidates circling more than one answer

Question 1 (b) (ii)

(ii) Circle the term from the list below which describes the type of material used in the casting process used to manufacture the boat propeller.

ferrous metal **alloy** **ceramic** **composite**

[1]

Not all of the candidates who correctly circled bronze above were able to identify it as an alloy, incorrectly identifying it as a ferrous metal, thereby indicating a lack of subject knowledge.

Question 1 (b) (iii)

(iii) Give **two** reasons why the material is suitable for the propeller.

1 .....

.....

2 .....

.....

[2]

The majority of candidates who gained marks in the two proceeding questions were able to state that bronze was corrosion resistant and easily cast/moulded into shape. Some candidates also stated that bronze was strong but did not gain credit for this because they were not explicit enough about bronze's tensile strength.

Question 1 (c) (i)

(c) Fig. 3 shows a toy tipper truck.

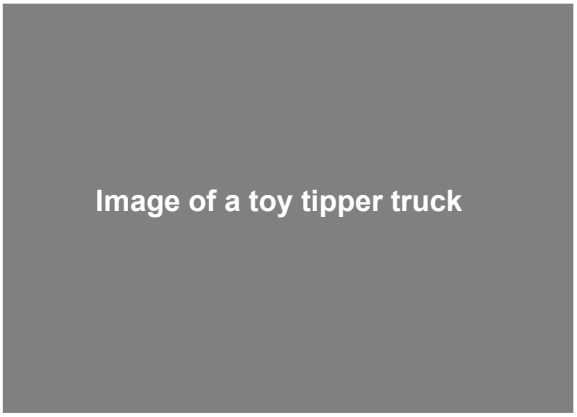


Fig. 3

(i) Circle the material commonly used to make the body of the toy tipper truck.

zinc **Acrylonitrile-Butadiene-Styrene (ABS)** **iron** **polyester resin**

[1]

As might be expected the vast majority of candidates correctly circled ABS. In the few instances where an incorrect response was given, polyester resin was the response circled.

Question 1 (c) (ii)

(ii) Give **two** reasons why the material chosen is suitable for the body of the toy tipper truck.

1 .....

.....

2 .....

.....

[2]

There was a wide range of acceptable responses that gained credit in this question and this was reflected in most candidates gaining 2 marks. Responses that frequently did not gain credit here were related to the catch-all unqualified answer "strength/strong" but not qualifying in tension or compression for example. Responses such as "safe" or "not harmful" did not gain credit because they are not specific enough; while ABS is non-toxic it can still be a choking hazard.

Question 2 (a)

2 A list of engineering materials is given below.

polyester resin **copper** **concrete** **glass**

nylon **stainless steel** **polyvinyl chloride (PVC)**

(a) Select a suitable material from the list to complete the following statements.

(i) ..... is a non-ferrous metal.

(ii) ..... is a ferrous metal.

(iii) ..... is a ceramic.

(iv) ..... is a thermosetting plastic.

(v) ..... is a thermoplastic.

[5]

For what at first sight seems a relatively simple question there were a wide range of marks gained for this question. Many, but not all, candidates correctly identified copper and stainless steel for (i) and (ii) respectively. Concrete was a relatively common incorrect response for (iii) and a relatively large proportion of candidates were not able to identify polyester resin as a thermosetting plastic, these candidates typically responded nylon of PVC. With there being 2 correct responses for (v) most candidates were able to gain this mark.

There were examples of candidates changing their responses and in the overwhelming majority of cases it was clear as to what the intended changes were.

Question 2 (b) (i)

(b) (i) Explain what is meant by the term 'composite material'.

.....

.....

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

The vast majority of candidates gained credit for the first marking point relating to a material made of 2 (or more) other materials, however, there were a considerable number of instances of candidates not gaining credit for the referring to 2 or more metals. Far fewer candidates gained credit for the second marking point by referring to improved properties of the resulting material.

Question 2 (b) (ii)

(ii) Name **one** composite material and state **one** use for the material.

Composite material .....

Use .....

.....

[2]

There was a range of credit worthy responses and the most commonly given correct responses were carbon fibre or concrete. Where candidates gave a correct composite material the overwhelming majority also gave a suitable use. The use had to be related to the material given and in the cases were a candidate either gave an incorrect material or no material at all it was not possible to achieve the second marking point.

Question 2 (b) (iii)

(iii) Give **one** property of the material that makes it suitable for the use identified in **2(b)(ii)**.

.....

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

There were a range of creditworthy response that could be accepted for this question and the majority of candidates who named a suitable material were able to gain this mark too.

Question 3 (a)

3 Material removal, joining and surface treatment are all engineering processes.

(a) Name **two** hand methods used for material removal.

1 .....

2 .....

[2]

The vast majority of candidates gained at least 1 mark for this question and most managed two. The most common correct answers being sawing and filing. Common answers from candidates that did not gain credit were to name tools, not processes or to name manual machine processes not hand processes.

Question 3 (b)

(b) Name **two** CNC processes that could be used for material removal.

1 .....

2 .....

[2]

Similar to 3(a) a common mistake in responses to this question was to name machines and not processes. Candidates should be encouraged to use the terms such as "turning" when referring to processes done on a lathe.

Question 3 (c)

(c) Name **two** processes used when joining metals.

1 .....

2 .....

[2]

As a rule this question was answered well by candidates with the most common correct responses being soldering, brazing and welding.

Question 3 (d)

(d) A piece of mild steel plate 100 mm × 25 mm × 3 mm is to be surface treated by plastic coating. Describe how this would be carried out.

.....

.....

.....

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

It was clearly evident from candidate responses that candidates either had experience of this technique and gained all or most of the marks or conversely struggled to gain any marks at all.

Exemplar 1

the mild steel would be placed onto the ~~coating machine~~ ~~heater~~ oven where it would then be ~~a~~ plastic coated by a ~~machine~~ heated to 250° ~~like~~. then it would be diped into the plastic coating machine, covering the steel, and left to coat and cool **[3]**

This is a particularly good response as it is clear, logical and sequentially correct. It reads as though the candidate has experience of this process. All 3 marks were given.

Question 3 (e)

(e) Name **one** surface treatment, other than plastic coating, that could be applied to mild steel.

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

By far the most common correct answers given were painting and galvanising. Common incorrect answer were linishing and polishing.

Question 4 (a)

4 Fig. 4 shows a vacuum forming machine.

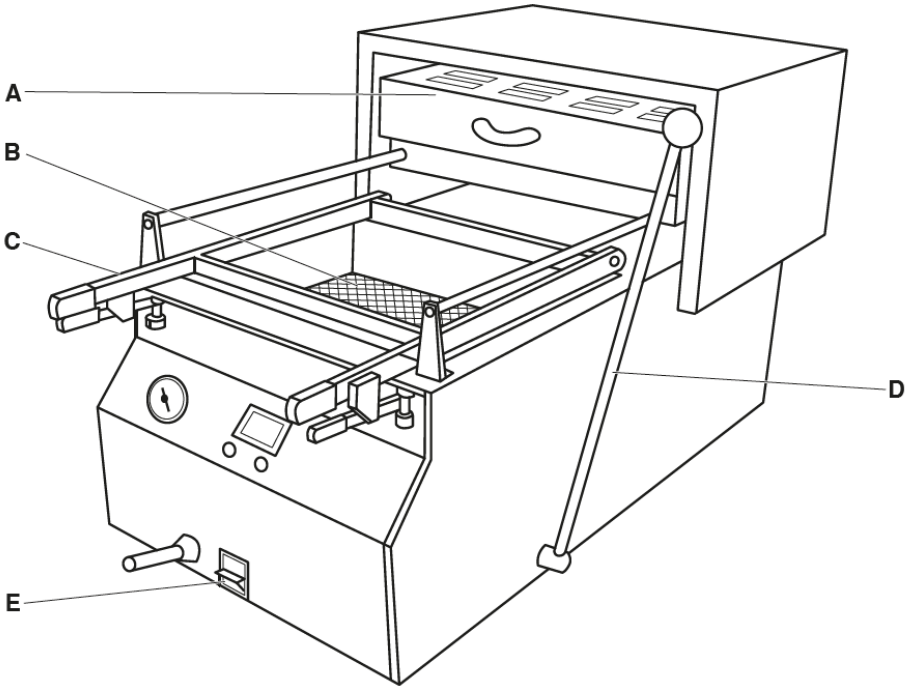


Fig. 4

(a) Select the parts from the list below that have been labelled in Fig. 4.

vacuum pressure gauge **clamping frame** **mould shelf** **heater**

vacuum pump switch **shelf lever** **toggle clamp** **sliding bars**

A .....

B .....

C .....

D .....

E .....

[5]

Across the cohort, a wide range of marks were given for this question, reflecting the different experiences/teaching candidates may have had with the vacuum forming process. The vast majority of candidates were able to identify parts D and E correctly. Many candidates, perhaps a third, gave the answers to A and B reversed.

Exemplar 2

A ~~Shelf lever~~ Heater

B mould Shelf

C ~~toggle clamp~~ Clamping frame

D Shelf lever

E vaccum pump switch

[5]

In this example the candidate has secured all 5 marks. It is clear to see that they have made use of crossing out words from the list that are either not correct or have been used. By doing so the candidate has been able to identify a mistake in their response and correct it. It is clear from the response which part of the response is to be ignored.

Question 4 (b)

(b) The table below shows the stages involved in vacuum forming a shape.

Stage	Process
F	Place the mould in the vacuum former.
G	Raise the shelf and switch on the vacuum pump.
H	Heat the plastic sheet until it is flexible.
I	Lower the shelf supporting the mould.
J	Clamp a sheet of plastic into position.
K	Leave the plastic sheet to cool and then remove from the vacuum former.

Put the stages in the correct order. Two have been completed for you.

F					K

[3]

Candidates either scored relatively well on this question, or achieved very few marks. Approximately half the candidates put all 4 steps in the correct order and gained 3 marks. Of the candidates who did not gain full marks, most of these correctly placed H for 1 mark.

Question 4 (c)

(c) State **two** processes, other than vacuum forming, of moulding plastic sheet.

1 .....

2 .....

[2]

Many candidates correctly stated blow moulding for 1 mark. Very few candidates managed to gain the second mark.

Question 5 (a)

5 (a) Explain, giving an example, what is meant by the term 'manually controlled production'.

.....

.....

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

The first marking point for this question was to explain the meaning of manual production. A response relating to production not controlled by computer or automation was required. A common reason for dropping marks in this question was the use of vocabulary from the stem of the question, most commonly "production done manually" instead of explaining what this actually meant. Additionally a significant number of candidates did not gain the second mark because they did not provide any form of example. A whole range of examples were accepted including processes, products and manual machines.

Question 5 (b) (i)

(b) Fig. 5 shows a wrench that has been produced using an additive manufacturing process.

Fig. 5

(i) Name **one** appropriate additive manufacturing process to make the wrench shown in Fig. 5.

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

There were a wide range of additive manufacturing processes that were acceptable responses for this question and so the large majority of candidates gained credit here. There were however a significant number of candidates who gave responses that were not additive, such as casting processes which either indicates a mis-reading of the question or lack of understanding of what an additive process is. By far the most common correct response here was 3D printing.

Question 5 (b) (ii)

(ii) Explain how the process named in **5(b)(i)** would be used to produce the wrench.

.....

.....

.....

.....

.....

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

Candidates who had not understood the meaning of additive manufacture and did not gain the marks in 5 (b) (i) did not score any marks in this question either, even though some gave excellent descriptions of processes that were not additive. The majority of candidates who did gain marks in the previous question went on to typically gain at least 2 marks in this question. Candidates who gave 3D printing before tended to score particularly well with this question, perhaps indicating the exposure students have to this technology in a majority of schools.

Exemplar 3

(ii) Explain how the process named in **5(b)(i)** would be used to produce the wrench.

- a piece of metal is placed into the CNC laser cutter
- the correct program is loaded
- the laser cutter cuts away all of the material that is not needed
- the wrench has been produced

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

This is a prime example of a candidate who had performed reasonably well across the rest of the paper and who in this question produced a fairly reasonable description of a process that was not additive.

Question 5 (c)

(c) Describe the advantages of using CNC machines rather than manual production.

.....

.....

.....

.....

.....

.....

.....

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

This question was generally answered well by candidates, most achieving at least 2 marks for the marking points relating to higher production rates and increased product quality. Candidates who achieved 3 marks for this question commonly included leaner labour requirements or reduced labour costs. The mark for improved safety was less commonly given.

Exemplar 4

CNC could mean no human error.
This could speed up production
This allows machine consistency.
This also could save money because less workers would be needed. **[4]**

While the language used in the exemplar is not the best, the candidate definitely includes three of the points from the mark scheme and so gains 3 of the 4 marks. The response could have been improved by including the safety benefits of CNC production or the potential for 24/7 working.

Question 6 (a)

6 **(a)** Using an example, describe the reasons for developing new and emerging engineering materials.

Example .....

Reasons .....

.....

.....

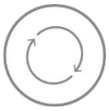
.....

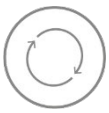
.....

[4]

This question required candidates to name a new and emerging engineering material and then give reasons for its use. There were a wide range of credit worthy materials that could gain credit here, including some very specialised materials that were beyond the scope of the specification.

The majority of candidate were able to name a new and emerging material. The reasons for use/development were required to be related to the material given and could be properties, characteristics or sector specific responses. Because the reasons had to be related to the material given the minority of candidate who were either unable to name a new and emerging engineering material or incorrectly named a material were not able to access these 3 marks.

	**AfL**	An effective strategy is to train candidates to relate the number of marks available for a question to the number of points that need to be made in the response. It should be made explicit to candidates that in general a list of 4 nouns (by way of example) will not be a good way of addressing 4 marking points unless the command verb in the question does ask for a list and instead they should be looking at writing at least 4 different sentences.

	**AfL**	Deconstructing the stem of Question 6(a) shows the response needs reasons described that are related to a named example. The response lines are set up to encourage this. Should a candidate not give a named example then it is impossible for them to gain any of the three description marks. Benefit would be gained from training candidates to use the guides in the response lines to help them construct their responses to avoid limiting the marks they can gain.

Exemplar 5

Example thermosetting

Reasons It would increase ways to make products with new materials and you could also test materials for best way to make product

[4]

This example shows clearly how not achieving the first mark precludes candidates from gaining the subsequent marks.

Exemplar 6

Example Carbon fibre

Reasons because its very light aswell as very strong and due to recent technological advancements its easier to produce ~~it is used for ...~~ making it also cheaper to produce as a result making more ~~...~~ available to manufacturers.

[4]

This example clearly shows a candidate giving an example of a new or emerging material and then providing two properties and a characteristic for the reason why it is used. This response gaining all 4 marks.

Question 6 (b)

(b)* Discuss the advantages and disadvantages to a manufacturer of introducing modern technology.

.....

.....

.....

.....

.....

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

The vast majority of candidates attempted this question and so the full range of marks were given across the cohort.

More than one point from the indicative response list in the mark scheme was required to achieve any marks. Awarded marks were limited to Level 1 if responses referred to only advantages or disadvantages of introducing modern technology. To move into Level 2 candidates were required to produce arguments relating to both advantages and disadvantages of introducing modern technology.

To achieve Level 3 marks candidates were expected to use appropriate terminology correctly, most likely referring to CNC, and produce a developed argument that considered both advantages and disadvantages. Some candidates were able to discuss the advantages giving and describing several examples but were unable to give more than one disadvantage, these candidates were limited to Level 2 because the responses were not well enough developed.

The question asked for discussion of advantages and disadvantaged to the manufacturer so responses relating to the advantage of a leaner workforce gained credit whereas responses that viewed this from the employer perspective, e.g. the disadvantage of unemployment, were ignored.

Exemplar 7

Some advantages of introducing modern technology to a manufacturer are as follows. Efficiency - products are made faster than humans are able to on a manual machine if CNC machines are bought. Less workers are needed to run the machine and these jobs are less dirty and unsafe when using modern tech. Due to more efficiency the company would have a much greater output, therefore increasing profit.* There are also a few disadvantages. Some workers will be put out of their job needing severence packs. Workers staying will need expensive training or new workers will be required. ~~These~~ These jobs will ~~require~~ require higher pay. The cost of the machines is large and may need maintaining and more space may be needed.

Overall it would be beneficial to introduce these modern technologies as the increased profit would surpass the costs of the disadvantages rendering them uneffective in the ~~long~~ long term. It is worth it, if the ~~upfro~~ upfront cost is spendable short term. [6]

* see extra paper

	* Star in line 7 of answer
6b	* Another advantage is that CNC machines can consistantly produce high quality products

This an excellent example of a candidate response which gives a well-developed, balanced discussion of the advantages and disadvantages to the manufacturer while using key vocabulary (CNC) and so gained the full 6 marks. There seven of the indicative points from the mark scheme, three of which are disadvantages. This exemplar also shows the candidate explicitly showing that the response continues on an additional sheet.

Exemplar 8

A advantage or Introducing modern technology In is that it Speeds up the manafacture fore example if you wanted to make a ratiod £1 wheel you could use a lathe and get it done in a couple of hours But if you Wast to get a humun to do it. it would take day if not weeks.

A disadvantage is that peaples Jobs are at risk this is because you can get a machine to do it faster and more presist and they can work all day and night this means there is no point in humans doing it because the machien can get more done in a qvicker time and it doest need a monthly/ weekly Salary so the techndogy is a more popular choise for manufactures [6]

By contrast with exemplar 8 this candidate response was given Level 1, 2 marks. The candidate shows evidence that the stem of the question has been deconstructed and has given responses relating to both advantages and disadvantages to the manufacturer, which would open up marks in Level 2. However, this candidate has not developed the response including enough points from the indicative list to move into Level 2 and so is limited to Level 1.

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