

CAMBRIDGE NATIONALS

Examiners' report

ENGINEERING MANUFACTURE

J832, J842

R109 Summer 2022 series

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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.

Advance Information for Summer 2022 assessments

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R109 series overview

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

Candidates seemed less well prepared for this session than they were for the January 2022 session, especially in terms of certain aspects of the specification, such as Just-in-Time, finishing and smart materials to name a few. It was clear that many candidates did not gain basic knowledge marks from specification content. The number of instances of no response was also increased from the last series. Candidates used their time appropriately and nearly 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 usually clearly and accurately labelled indicating the question that the extra response referred to.

A number of centres enabled candidates to make use of the Equality Act by using exam access arrangements, most obviously through use of word-processed answer sheets. In general, candidates' word-processing responses were answered on the exam paper where it was most suitable to do so and used the word-processed sheets to support their written responses. There was still a proportion of candidates who answered every question on the word processor even when it may have been quicker and simpler to answer on the paper. For future sessions, it would benefit candidates with exam access arrangements if they were well-practised in which types of questions are best answered on the paper and which to use word processing for. 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, and clearly labelled which question their response referred to. 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 help candidates to organise their responses so that it is clearer and easier for the candidate to produce and check their responses.

This report covers every question in the paper. However, because the higher tariff (4-mark plus, written response) questions have the biggest influence on improving candidate performance in this component, the exemplars given concentrate on these questions and so do not appear until towards the end of the report.

A wide range of marks were given in this paper. In many cases it was clear that some candidates had transferred synoptic knowledge and understanding gained practically in the centre assessed units or from wider afield. Indeed some candidates had a clear and in-depth practical knowledge/experience of the processes and manufacturing methods they were writing 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 taken into account 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:
<ul style="list-style-type: none"> • had detailed knowledge and understanding of engineering manufacture especially with respect to properties and uses of materials • read the question carefully, understood what the question was asking and responded accordingly • 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, give, 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. 	<ul style="list-style-type: none"> • lacked basic knowledge and understanding of materials, for example confusing mechanical properties with characteristics of the materials • had not read the question carefully enough, answering what they thought they had read instead of what the question was actually asking • limited the marks available to them by not offering a response to questions • found it difficult to apply what they had learned to different scenarios and instead gave responses that were simply a repeat or rewording of what was given in the stem of the question • repeated the same single point in different ways when answering the longer written responses • limited the marks available to them by not answering all aspects of the question by not using the extra guidance, where given, in the response lines.

Assessment for learning



Centres can encourage their candidates to practice deconstructing 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 can be taught explicitly by instead of asking the candidate for the response to a question, to ask for an example of what the response 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) A list of different types of engineering materials is given below.

- brass
- lead
- polypropylene
- steel
- titanium
- urea-formaldehyde

Item	Material	Material group			
		Ferrous	Non ferrous	Thermoplastic	Thermosetting
Electrical socket Item removed due to third party copyright restrictions	urea-formaldehyde				✓
Food can Item removed due to third party copyright restrictions					
Glasses frame Item removed due to third party copyright restrictions					
Sports drink bottle Item removed due to third party copyright restrictions					
Trumpet Item removed due to third party copyright restrictions					

(i) Select a material from the list above that is used in the production of each item shown in the table below.

Write the name in the 'Material' column, next to the item.

[4]

This question was designed as a relatively easy question to settle candidates into the exam. In general suitable materials for the sports drink bottle and trumpet were given correctly but less, approximately just over half, gave correct materials for the glasses frames and food can. A larger than might be expected number of candidates either gave materials that were not in the list and did not gain credit for these or did not select any material at all and left that space blank.

Assessment for learning



This is an example of a type of question that candidates using word-processing to support their access to this exam could answer on the paper and although many did, a surprising number typed their response which not only uses up valuable time but also makes it harder for candidates to check their work.

Question 1 (a) (ii)

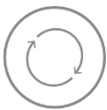
(ii) Place a tick (✓) to show which material group the selected material belongs to.

One has been completed for you.

[4]

Correct responses followed a similar pattern for the material groups. Most candidates correctly ticked the material groups for the water bottle and trumpet. Far fewer candidates gained marks for the food can and the glasses frames. The mark scheme allowed for error carried forward in that if an incorrect material was given in Question 1 (a) (i), but the correct material group for that material was given, then the mark was given. However, candidates who had left the material blank were not able to gain a mark here for identifying a material group. A significant number of candidates did not gain credit because they ticked more than one material group for the material.

Assessment for learning



The question is the clue to the candidates that there should be only one tick per row. There were instances of marks being lost because of more than one tick in a row and no ticks in other rows. Centres should encourage candidates to carefully check their responses to this type of question to avoid such simple errors.

Question 1 (b) (i)

(b) (i) State which group of materials epoxy resin belongs to.

..... [1]

The vast majority candidates gained the mark here for correctly identifying epoxy resin as a thermosetting plastic. Being early in the paper and intended for high accessibility, polymer and plastic were also allowed for the mark. Thermoplastic was not allowed being the most common incorrect response.

Question 1 (b) (ii)

(ii) State **one** use for epoxy resin.

..... [1]

The vast majority of candidates gained this mark, the most common correct response being as an adhesive/glue. Other correct responses, although much less frequent were as a filler, filling cracks or, less frequent still, as a surface coat.

Question 2 (a) (i)

2 (a) Fig. 1 shows a toolbox made from mild sheet steel.

Fig. 1



(i) State **one** method that could be used to join the mild sheet steel at the corner of the toolbox where indicated, without using heat.

..... [1]

(Pop)rivets was a very common response although adhesive/glue/epoxy resin also appeared relatively often. The later potentially prompted by Question 1 (b). The most common incorrect response was screws, most candidates not appreciating the stick hazard this would present.

Question 2 (a) (ii)

- (ii) Explain why it would not be appropriate to put a continuous weld on the sides of the toolbox.

.....


.....

.....

..... [2]

In general this question was a good indicator of candidates' understanding of the welding process. Candidates who gained both of these marks were in a significant minority. Candidates who gained 1 of the marks normally did so for recognising that a continuous weld would distort or warp the tool box. Marks were not given for general responses, such as "damage".

Misconception

 A very common misconception was that the continuous weld was being added around the lid of the assembled tool box and that this would prevent access into the tool box.

Question 2 (a) (iii)

- (iii) State **two** alternative appropriate materials that the toolbox could be made from.

1

2 [2]

There were a wide range of materials that would gain credit here. Many incorrect responses were for giving a material that would not be appropriate, for example due to its cost or density. The majority of candidates gained at least 1 mark here and aluminium was by far the most common correct response. Titanium was the most common incorrect response possibly because it was given as a material in Question 1 (a) (i).

Question 2 (a) (iv)

- (iv) Give **one** property for **each** material in **part (a)(iii)**.

1

2 [2]

Marks were only given in Question 2 (a) (iv) if at least one appropriate material was given in (iii). The vast majority of candidates gained at least 1 mark here and most gained 2. There was a wide range of properties that would gain credit and marks were lost often either for repeating the same property using synonyms or for giving a characteristic of the material.

Assessment for learning



This is another example of a question type that many candidates using word processing could most likely answer on the paper. As well as taking at least as long to type, the increased cognitive load of ensuring the correct question number, response and formatting result in greater likelihood of errors.

Assessment for learning



“non-corrosive”, was a common error that caused candidates to lose marks, presumably using vocabulary they have learned in science. Candidates should be encouraged to use corrosion resistant to pick up these early marks.

Question 2 (b)

(b) Fig. 2 shows a car door being assembled using spot welding.

Fig. 2



State why welding at small points along the corner joint is used instead of a continuous seam weld.

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

Relatively few candidates gained this mark and the most common correct response was that spot welding was quicker. Of the candidates that did give a correct response a few, mainly the ones that gained a mark in Question 2 (a) (ii) stated that spot welding would be less likely to distort or warp the door.

Misconception



Not being able to open the door if it was welded shut was a common misconception.

Question 2 (c)

(c) State the meaning of ductility and conductivity:

ductility

.....
.....

conductivity

.....
.....

[2]

Generally more candidates were able to correctly state the meaning of conductivity than ductility. With ductility responses ranged from wrong to responses with lack of specificity, e.g., “Can be stretched”.

Specificity was also a very common reason for marks being lost for the meaning of conductivity. Often candidates simply responded with the stem of the question “the ability to conduct” without stating what conductivity actually means.

Question 3 (a)

3 (a) Complete the table by selecting an appropriate surface finish from the list below.

electroplating galvanising linishing polishing powder coating

Each surface finish may be selected once, or not at all.

Item	Surface finish
Alloy car wheel <div style="background-color: #cccccc; padding: 10px; text-align: center;"> Item removed due to third party copyright restrictions </div>	
Chrome mixer tap <div style="background-color: #cccccc; padding: 10px; text-align: center;"> Item removed due to third party copyright restrictions </div>	
Copper bracelet <div style="background-color: #cccccc; padding: 10px; text-align: center;"> Item removed due to third party copyright restrictions </div>	
Mild steel garden incinerator <div style="background-color: #cccccc; padding: 10px; text-align: center;"> Item removed due to third party copyright restrictions </div>	

[4]

Over half of the candidates correctly gained marks for the surface finish applied to alloy wheels and the garden incinerator. Far fewer candidates assigned polishing to the copper bracelet and even fewer were aware that electroplating was an appropriate finish to chrome mixer taps. Linishing appeared as an incorrect response relatively frequently possibly prompted by Questions 3 (b) and 3 (c).

Question 3 (b)

(b) Explain what is meant by the term 'finishing'.

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

It was clear that the vast majority of candidates did not know what finishing was. Many candidates did not offer a response for this question. Of those that did, very few gained marks.

Question 3 (c)

(c) Give one example when finishing may be used.

..... [1]

There were far fewer cases of candidates not offering a response compared to Question 3 (b) but given that the vast majority of candidates seemed to not know what finishing is, the wide variety of incorrect responses given and that very few candidates gained marks, it is most likely that the increased responses were simply down to guesswork.

Question 3 (d) (i)

(d) State one use for each of the following smart materials.

(i) Quantum Tunnelling Composite (QTC)

..... [1]

A significant number of candidates did not know what a quantum tunnelling composite was, evident by the relatively large number of responses related to ground works or with no response. Of the candidates who did know about QTC, approximately half gave good responses, the most common being buttons on devices such as mobile phones. There was also number of responses that did not gain marks due to lack of specificity, for example "buttons".

Question 3 (d) (ii)

(ii) Thermochromic material

..... [1]

By contrast to Question 3 (d) (i), 3 (d) (ii) had more correct responses. By far the biggest reason for loss of marks here was lack of specificity. For example “baby bottles” did not gain a mark because they must be “colour changing baby bottles”.

Question 3 (d) (iii)

(iii) Shape-memory plastic

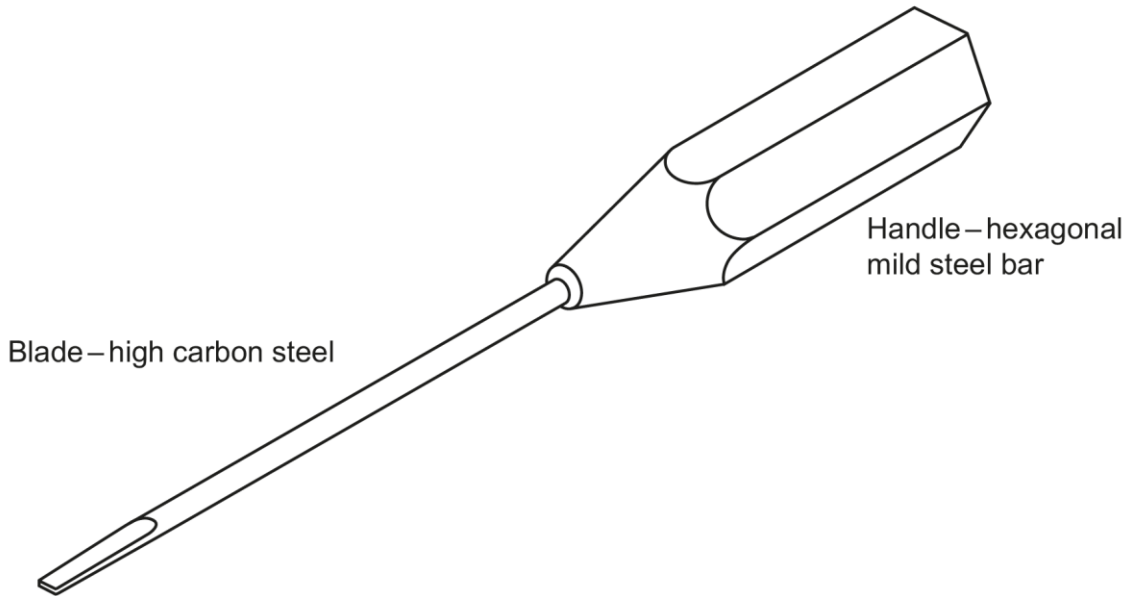
..... [1]

It was clear that many candidates answered this as if the question was regarding a shape memory “alloy”. The most common response that gained marks was “(dental) braces” although even this was not clear if a candidate had confused this with shape memory alloy.

Question 4 (a) (i)

4 (a) Fig. 3 shows a screwdriver that has been made in a school workshop.

Fig. 3



(i) Name the machine that can be used to cut the taper on the screwdriver handle.

..... [1]

Approximately half the candidates gained the mark for “(CNC centre) lathe”. There were many examples of poor spelling but candidates still gained the mark despite this. Another, but very rare example of a response that gained the mark was multi axis machine, although it is accepted that the majority of centres will not have this machinery available. Common incorrect responses were milling machines, laser cutters and water jet cutters.

Question 4 (a) (ii)

(ii) State which heat process can be used to join the screwdriver blade to the handle.

..... [1]

Candidates gaining this mark were in the minority. By far the most common incorrect response was welding, maybe because welding was in Question 2. Soldering was a less common incorrect response.

Question 4 (a) (iii)


(iii) The blade has been hardened but needs to be tempered.

Describe the process of tempering the screwdriver blade.


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

It was clear that the vast majority of candidates did not know what tempering was. Many candidates that gained a mark here did so for mentioning heating the screw driver blade, although it was clear that they did not understand the tempering process because they then went on to describe forging. The cooling part of the process was another aspect where a significant number of candidates gained a mark, although there were a number of instances where the mark was not given due to lack of specificity regarding how the cooling is done. In a very small number of exceptional responses, the candidate had correctly described the cleaning, heating and cooling stages of the process including the blue colour that shows the item is heated to the correct temperature.

Assessment for learning

 Word processing, for candidates that are entitled to it, was very effective for this kind of question. There is the advantage that the number of marks available is clearly shown at the bottom right of the question and this can be used to help candidates formulate a suitable length of response by having at least the same number of sentences as there are marks available.

Assessment for learning

 It is probably worth noting here that “efficiency” is most likely not detailed enough to gain marks and if candidates use the word efficiency in any responses they would be best to clarify exactly what they mean.

Question 5 (b)

(b) Name **two** types of CNC machines used in engineering production.

1

2

[2]

A wide number of responses gained both of the marks.

Question 5 (c)

(c) State **two** disadvantages of introducing CNC machines to a production line.

1

.....

2

.....

[2]

The majority of candidates gained marks here for stating the obvious response regarding the costs associated with CNC machines. Need for retraining staff was a common response for the second mark. A common incorrect response was that the work force is reduced. Marks were also not given for stating that the CNC machines could break down, because this is too general, since manual machines can also break down. However, reference to requiring specialist maintenance was given a mark.

Question 5 (d)

(d) State **two** advantages for the workforce of introducing CNC machines.

1

.....

2

.....

[2]

Many candidates did not read and answer the question asked. They wrote about production being faster/more accurate, which of course is an advantage to the production line not the workforce. A significant number of responses talked about the workforce being made redundant/not needed, which is also not an advantage to the work force. Candidates who achieved both marks were in the minority and all three of the allowed responses (relating to safety, retraining/reskilling/higher wages, better working conditions/less manual labour) received roughly equal coverage across the responses.

Question 6 (a)

6 (a) Complete the following giving the meaning for **CAD**.

C A D [1]

A significant number of candidates did not gain the mark in what was intended to be a highly accessible mark in Question 6. Again, showing lack of knowledge of the specification content.

Exemplar 1

- One advantage is that it is more time and energy efficient as the machines ^{only} ~~are~~ ^{programmed} carry out tasks they are ~~expected~~ to do. They are also very precise and accurate, which allows them to consistently make the perfect product ^{every} ~~every~~ time.
- In addition, they are able to work constantly 24/7 while maintaining consistent quality, which ~~increases~~ increases production.
- However, they can be expensive and not all companies can afford them.
- As well as this, ~~some~~ the machines may not be suited for the task and would be better to use a human worker instead.
- Finally, if one of the machines stop working, then the company would need to get a specialist to ^{come} ~~over~~ ~~and~~ ~~fix~~ it, which ~~would~~ ~~completely~~ ~~stop~~ ~~production~~ [6] and Fix could completely stop production.

Exemplar 1 is a good example of a 6-mark response. The candidate has written about seven of the indicative content points from the mark scheme including some content from the clear understanding section. They have avoided repeating points that they make, having done this by giving a balanced argument by including the positive impacts that automation has on engineering production output and also the negative impacts such as the cost of the machines, requiring specialist maintenance and the impact on the production line if the machine goes down.

Exemplar 2

Automation has had a large impact on engineering and its production output. Automation has made it so instead of the machines relying on the men to work them, the workers rely on the machines constantly working. Production output has grown massively because of this as the machines do not get tired and it is ~~instructed~~^{instructed} to do another task automatically after finishing one. This means that there are hours of breaks caught up from the men by the machines. The machines speed and production is at a constant meaning that the ~~p~~ engineering production output is at that constant. It produces quicker meaning the product is completed quicker and handed over quicker. [6]

By contrast Exemplar 2 gained 3 of the 6 marks. There is an element of repetition of the same points, especially in the last third of the response. Consequently there is a limited amount of the indicative content covered, meaning that there is not a clear understanding of the impact of automation on engineering production. Balancing the discussion and writing about the negative impacts of automation would have improved the level of this response significantly.

Assessment for learning



Many candidates with exam access arrangements used word processing just for this level of response question. While this is a good idea it must be remembered that poor spelling and punctuation can limit a response to Level 1 so it is vital that candidates check their responses carefully in order that the marks of a good response are not limited by spelling and punctuation.

Unlike, for example, Question 6 (b) the number of marks in the bottom right hand corner does not necessarily correlate to the number of lines or points that should be written. With the response not being constructed in the exam paper EAA candidate will also lose some of the clues as to how long the response needs to be. Centres could help candidates prepare for this by having them type a handwritten response that fills the response lines. That way candidates will have a gauge for how long their response should be. They can of course make their responses longer if need be.

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