OCR
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CAMBRIDGE NATIONALS

Examiners' report

ENGINEERING MANUFACTURE

J832, J842

R109 January 2022 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 untiered, 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 answers and includes synoptic assessment and assessment of the quality of written communication.

Candidates' preparedness for this session seemed good and most candidates attempted all questions. The number of instances of no response was decreased from the last session this unit was sat, January 2021, and appeared to be commensurate with pre-pandemic 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 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. Although many 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, there were still a large proportion of candidates who answered every question on the word processor even when it when it may have been more appropriate to answer on the paper. Notable examples of this included when candidates reproduced a table from the question paper for their answer, when simply ticking the relevant boxes on the paper would have been much quicker, simpler, and less likely to transpose an error. 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 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. This would help candidates to organise their responses so that it is clearer and easier for the candidate to produce and check their responses.

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. 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 and 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 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, 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.	• Lacked basic knowledge and understanding of materials, for example confusing mechanical properties with characteristics of the materials. • 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. • 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 additional guidance, where given, in the response lines.

	**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 knife and fork.

Fig. 1

(i) Circle the material from the list below, which is commonly used to make the knife and fork.

carbon fibre **stainless steel** **epoxy resin** **lead** **[1]**

This question was designed to be accessible to all candidates to help them to settle into the exam. Consequently there were very, very few examples of incorrect answers given.

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

Question 1 (a) (ii)

(ii) Give **two** reasons why the material chosen is suitable for the knife and fork.

1 .....

.....

2 .....

.....

[2]

This question was also designed to be accessible at all grades and candidates scored highly. The word "reasons" in the stem of the question opened up the mark scheme, meaning that there were many responses that would gain credit. The most common responses to gain credit were corrosion resistance / does not rust, hard, relatively low cost (compared with silver).

	AfL	"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.

	AfL	If a question asks for "reasons" about a material, candidates are more likely to gain the marks if they answer about the properties or characteristics of the material.

Question 1 (b) (i)

(b) **Fig. 2** shows several transparent chess pieces.

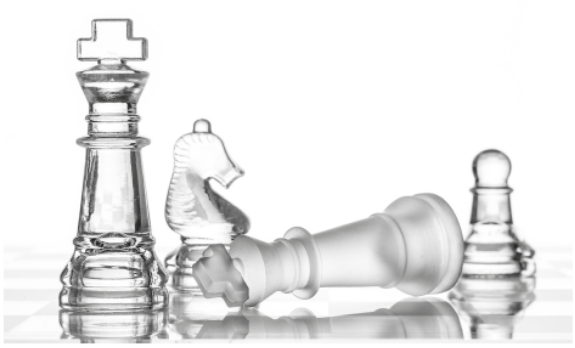


Fig. 2

(i) Circle the material from the list below, which is used to make the chess pieces.

tin **brass** **polyester resin** **Glass Reinforced Plastic (GRP)** **[1]**

The majority of candidates correctly identified the material as polyester resin. By far the most common incorrect response was GRP.

Question 1 (b) (ii)

(ii) Circle the term from the list below which describes the type of material used to produce the chess pieces shown in **Fig. 2**.

pure metal **ceramic** **thermosetting plastic** **composite** **[1]**

Again the majority of candidates correctly identified the material as thermosetting. For candidates incorrectly circling GRP in 1 (b) (i) composite was allowed as an error carried forward.

Question 1 (b) (iii)

(iii) Name **one** process that could be used to produce the chess pieces.

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

By contrast relatively few candidates were able to name casting as a process to produce the chess pieces.

	AfL	This is another example of a question type that many students 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 that the correct question number, answer, and formatting are used, results in greater likelihood of errors.

Question 1 (b) (iv)

(iv) State why injection moulding is **not** a suitable process to make the chess pieces.

.....

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

The vast majority of candidates were not able to relate the liquid resin being thermosetting as the reason why injection moulding is not suitable.

Question 1 (c) (i)

(c) **Fig. 3** shows a child's plastic ball, with a diameter of 150 mm, made from thermoplastic material.

Ball

Fig. 3

(i) Name a suitable process that could be used to produce the plastic ball.

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

A large majority of candidates responded correctly with blow moulding and a smaller number gained credit for rotational moulding. Many candidates who seemed to be unsure of the correct response named injection moulding. Presumably because they had read it in Question 1 (b) (iv).

Question 1 (c) (ii)

(ii) Give **two** reasons why plastic is a suitable material for the ball.

1 .....

.....

2 .....

.....

[2]

Again the word "reasons" in the stem of the question meant that there were a wide variety of responses that would gain credit here. The most common ones given being, lightweight, available in a range of colours and durable / weather resistant.

	**AfL**	When giving "reasons" for a material being used for an application candidates should be encouraged to give properties or characteristics of the material. Not only are they more likely to gain the marks but are also better prepared for questions asking for a property or characteristic.

	**AfL**	Candidates should also be trained to not give two reasons that are too similar, for example durable and weather resistant, because this increases the chance of not gaining marks due to repetition of the same marking point.

Question 2 (a) (i)

2 **(a)** A list of engineering materials is given below.

bronze
carbon steel
concrete
glass
high speed steel
Quantum Tunnelling Composite (QTC)
shape-memory alloy
tungsten carbide

(i) Select **two** materials from the list that are ferrous metals.

1 .....

2 .....

[2]

The vast majority of candidates gained both marks here. If an incorrect response was given it was most commonly tungsten carbide which of course is a ceramic.

Question 2 (a) (ii)

(ii) Select **two** materials from the list that are ceramics.

1 .....

2 .....

[2]

Likewise many candidates gained both marks here although there were more incorrect responses than for Question 2 (a) (i). The vast majority of candidates correctly selected glass but concrete was a common incorrect response.

Question 2 (a) (iii)

(iii) Select **two** smart materials from the list.

1 .....

2 .....

[2]

The vast majority of candidates gained both marks here. Where both marks were not given, tungsten carbide was often given as an incorrect response.

Question 2 (b)

(b) Describe **one** use for a smart material from the list.

.....

.....

.....

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

The vast majority of the candidates gained the first mark by identifying a use of a smart material. By far the most common response was (dental) braces although membrane switches also featured frequently. For the second mark a description of the use was required. Most frequently this mark was gained by candidates describing dental braces, presumably due to their greater familiarity with them.

Question 2 (c)

(c) Explain why a non-ferrous metal might be used instead of a ferrous metal to make an engineered product.

.....

.....

.....

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

The vast majority of candidates gained the first mark for identifying that non-ferrous metals do not rust. Other responses could also gain credit here including properties such as magnetism, conductivity, or machinability. Similar to Question 2 (b), candidates who gave the easier answer (does not rust) found it much easier to gain the second mark relating to use (extended use) outside / in wet conditions. Candidates who gave the other properties tended to find the second mark more difficult to access.

Question 3 (a)

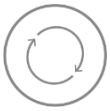
3 (a) Complete the table below by placing a tick (✓) to show the correct example for each of the processes listed.

One has been completed for you.

	Examples of Engineering Processes				
	linishing	**filing**	**brazing**	**nitriding**	**bending**
material removal		✓			
joining					
heat treatment					
surface finishing					
hand forming					

[4]

The vast majority of candidates were able to identify brazing, nitriding, surface finishing and bending in that order.

	**AfL**	This is a third question type where word processing candidates are more likely to be quicker, more accurate and better able to check their answers by answering on the paper. There were examples of some candidates reproducing the table on the word processor, this is absolutely not necessary.

	**AfL**	"**the** correct example" in the stem of the question is the clue to 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 3 (b)

(b) State **three** properties that should be considered when selecting materials for an engineered product.

One example is machinability.

1 .....

2 .....

3 .....

[3]

Many candidates scored well on this question, gaining credit by giving three examples from a considerable list of properties. Where candidates did not gain full marks they either gave characteristics of the materials, such as cost or forms of supply, etc., or gave different words for the opposite end of the same property, such as toughness and brittleness.

Question 3 (c)

(c) Copper sheet becomes work hardened when being hit with a mallet. It needs to be regularly softened (annealed).

Describe the process of annealing a copper disc, with a diameter of 125 mm.

.....

.....

.....

.....

.....

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

This question was an excellent differentiator and a wide range of marks was given. From candidates who had no idea about annealing, but quite rightly did not wish to leave the question space blank, to candidates who produced an accurate and succinct response. Most candidates were aware that the copper needed to be heated and gained the first mark. Far fewer responded a (cherry) red colour. While most knew that the copper need to be cooled, only very few stated by quenching in water.

A large number of candidates confused annealing with forging and wrote about hitting the copper with the mallet once it was heated.

Question 4 (a)

4 **Fig. 4** shows a key fob made in the workshop from 75 × 20 × 3 mild steel.

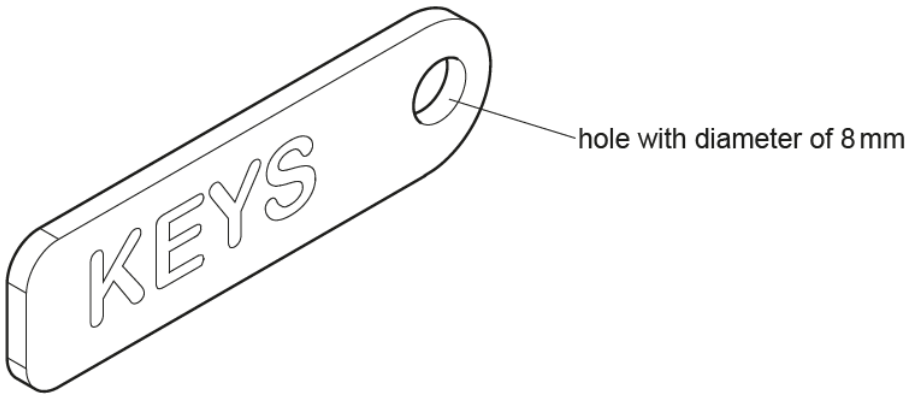


Fig. 4

(a) The table below shows the stages involved in making the key fob.

Stage	Process
A	Centre punch and drill 5 mm pilot hole
B	~~Cut the mild steel and file to size~~
C	~~Cut and file the curves of the key fob~~
D	Mark the shape and position of holes
E	Stamp letters KEYS and remove all sharp edges
F	Drill a hole, 8 mm in diameter

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

B				C	

[3]

Invariably this question was answered correctly by the vast majority of candidates.

Question 4 (b)

(b) State **two** safety precautions, other than PPE, that should be observed when using a drilling machine.

1 .....

.....

2 .....

.....

[2]

A wide variety of responses gained credit and most candidates who had worked in a machine shop were able to gain both marks here. If marks were lost, invariably this was due to either stating types of PPE or common sense such as not running in the workshop.

Question 4 (c)

(c) Name **two** surface finishes that could be applied to the mild steel key fob.

1 .....

2 .....

[2]

Galvanisation and painting were common correct responses here. Less common was powder / plastic dip coating. Also gaining a mark but given by candidates very infrequently was electroplating. Incorrect responses that appeared regularly were polishing and linishing. Polishing not being allowed, as the question clearly states that the key fob is to be manufactured from mild steel.

Question 4 (d) (i)

(d) (i) Name a CNC machine that could be used to produce the key fob.

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

The expected responses here were (CNC) milling machine or router. Water jet cutter was also accepted. Fewer candidates than might be expected gained this mark. Common incorrect responses were (centre) lathe, which is clearly completely inappropriate for this manufacture and laser cutter. Laser cutter not being accepted because of the detrimental effect of heating on a mild steel object of the dimensions given in the question.

Question 4 (d) (ii)

(ii) Explain why CNC manufacture would be more appropriate than hand manufacture.

.....

.....

.....

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

Candidates generally answered this question well with common correct responses explaining about the faster, more accurate manufacturing; the precision and quality of the manufacturing. To a lesser extent the ability to mass manufacture and the safety of CNC processes was given.

Question 5 (a) (i)

5 (a) **Fig. 5** shows a workpiece that is being manufactured on a multi-axis machining centre.

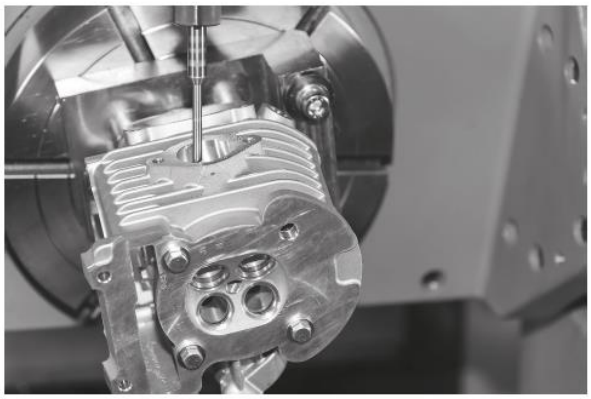


Fig. 5

(i) Describe the features of a multi-axis machining centre.

.....

.....

.....

.....

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

This was another question that differentiated the candidates well, with a wide range of marks given across the candidates. Common responses that gained credit were working on three (or more), or X, Y and Z axes, having two rotational axes, being computer controlled, having a variety of automatically changed tools, ability to manufacture complex, intricate detailing as well as decreased processing times and improved accuracy.

	AfL	A common theme of response that lost marks in this question was "working on multiple axes". This type of response did not gain credit because it is simply reflecting the stem of the question. While it is important to make it clear to your candidates to respond to all questions, it should also be emphasised this should be more than simply repeating the question.

	AfL	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 response by having at least the same number of sentences as there are marks available.

Exemplar 1

(i) Describe the features of a multi-axis machining centre.

A multi-axis machine can operate in 3 or more axis. It can move along the X, Y, Z and more axis.

[4]

This is a typical example of a response achieving 1 mark. The second line is given a mark for identifying a number of linear axes. Although X, Y and Z would on its own gain credit, it does not here because it is repeating the marking point in line 2. The remainder of line 3 is not specific or detailed enough to gain credit.

Exemplar 2

(i) Describe the features of a multi-axis machining centre.

A multi axis machining centre can move in four or more directions. Usually, it can move in all three dimensions (x, y and z) and can turn on all three axis (a, b and c). This means that it would be able to produce small and intricate parts to a high degree of efficiency and accuracy. Some can also perform turning [4]

By contrast this response gained all 4 marks. The third line gained credit for identifying three linear axes, The 4th line for identifying rotational axes. "Small and intricate (geometries)" gained credit for the third mark. High degree of (..) accuracy the 4th.

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

Question 5 (a) (ii)

(ii) State **two** ways that a multi-axis machine is safer to use than a manual machine.

1 .....

2 .....

[2]

Most candidates gained 1 mark for this question and this tended to be statements to the effect that human intervention is much less once the machine is set up and running. A common response that did not gain credit was that the machine has guards. This did not gain credit because manual machines can also have guards. More detail to the effect that the machine is enclosed was required. Another correct response that appeared very infrequently was that the machine automatically stops if there is a fault.

Question 5 (b)

(b) Explain **two** cost factors that should be considered before introducing modern technology into an engineering company.

1 .....

.....

.....

2 .....

.....

.....

[4]

Many candidates successfully identified at least one, but more often than not, two cost factors. These candidates did not progress beyond 1 or 2 marks because they did not explain about how the cost factors need to be considered.

Question 6 (a) (i)

6 (a) (i) Explain why the use of modern technology during production gets products to market faster.

.....

.....

.....

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

Many candidates gained marks in this question. Most often candidates gave 24/7 working or better product consistency / quality / accuracy. Also gaining credit was shorter process times. Faster should be avoided in questions like this because it is given in the stem of the question. Likewise, efficiency without qualification should be avoided because it is too vague.

Question 6 (a) (ii)

(ii) Explain why it is important to have a trained workforce to carry out modern engineering processes.

.....

.....

.....

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

The 2 marks for this question could be obtained from 3 marking points. Explaining that training is needed because: the machinery is complex and expensive, needs to be set up / maintained properly and lastly in order to prevent injury / damage to the machine / poor quality products. In the main most candidates managed to get at least 1 of these marks.

Question 6 (b)

(b)* Discuss the importance of quality control when manufacturing products using mass production processes.

.....

.....

.....

.....

.....

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

The LOR question is vitally important because it is worth 10% of the total marks for the paper. It was pleasing therefore to see that the number of candidates who did not respond to this question was very low indeed. There was a wide variety of indicative content that if included in candidates' responses would gain credit. This, and the levels achieved, are reviewed in the two exemplars below and is best read in conjunction with the mark scheme so indicative content can be seen.

Exemplar 3

(b)* Discuss the importance of quality control when manufacturing products using mass production processes.

Quality control is important as mass production processes produce identical and consistent products these products look the same and if something isn't right with the product then a lot of time and resources are wasted on faulty products. Quality control enables the products to be regularly checked for quality and consistency, allowing the products to be created correctly for their purpose. It may slow down the production a little amount however it makes sure that the production is right.

This candidate presents a detailed discussion. The quality of spelling punctuation and grammar is most definitely above what is expected for a Level 1 but there is an element of repetition of the same discussion, which detracts from the clarity of the discussion. Expanding the discussion with additional indicative content would have moved this response into a Level 3.

Exemplar 4

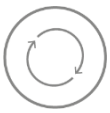
(b)* Discuss the importance of quality control when manufacturing products using mass production processes.

Quality control is one of the most important aspects of a products production line. It helps to ensure that all products that come out of the factory look precise and up to every customers standard. Quality control helps to identify defects ~~ex~~ during production. Quality control should take place after every stage of manufacturing, whether this is by random sampling or stratified sampling. Not every product needs to be checked

as that will be wasting valuable time. But checking every 3 products is a good thing to do. If a product is within tolerance and up to standards it's likely the next 2 are aswell. If a machine does malfunction and creates a product incorrectly it's unlikely only one product will be faulty. So quality control helps to identify the issue with the product and then also the machine. Without quality control ... **[6]**

6	b)	all products would go straight to customers unchecked. This means that any defects will go to customers. This could irritate the customer recieving the defect (it would irritate me), and cause the customer to leave a bad review, ask for a refund and create a bad reputation for the manufacturing company. You see how how important quality control is, and why without it manufacturing and producing perfect products could proove difficult for manufacturers

This is a clear example of a Level 3 response worthy of 6 marks. The candidate has produced a clear and detailed discussion of the advantages of quality control in mass production using many of the points in the indicative content from the mark scheme. The quality of spelling, punctuation and grammar is good. The exemplar also shows good use of continuation sheets.

	**AfL**	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 5 (a) (i), 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 question paper, an Exam Access Arrangements (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 answer that fills the response lines. That way candidates will have a gauge for how long their answer should be. They can of course make their responses longer if need be.

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