ENGINEERING MANUFACTURE

INCLUDED ON THE **KS4 PERFORMANCE TABLES**

Examiners' report

OCR Level 1/Level 2

Cambridge National in

Engineering Manufacture

J823

For first teaching in 2022 | Version 1

R014 Summer 2024 series

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Contents

Introduction

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

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

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

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

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R014 series overview

This paper contained two sections of questions covering the principles of engineering manufacture. Section A comprised ten multiple choice questions relating to manufacturing processes, material properties and communication techniques. Section B comprised six sets of questions where candidates were required to:

- identify and explain the features and safe operation of a pillar drill
- demonstrate an understanding of metals and sand casting
- demonstrate their understanding of different material types, in particular smart materials
- identify standard drawing conventions of technical drawings and determine the suitability of manufacturing methods for a specified part
- demonstrate an understanding of computer aided manufacture
- demonstrate an understanding of the principles of lean manufacture.

To do well in this paper candidates needed a fundamental understanding of material properties and their associated manufacturing methods, the safe use of a pillar drill and the application of Computer Aided Manufacture for different scales of manufacture. Candidates also needed to be able identify the principles of lean manufacture.

To do well in extended writing responses, candidates needed to make sure that the points made were justified, for example, when stating points relating to whether they agreed or disagreed with suggested manufacturing processes, they explain why the process is suitable or not rather than simply agreeing or not. Many excellent responses detailed the manufacturing process of the part to support their reasoning.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• were able to successfully identify material groups and properties • were able to identify manufacturing processes • demonstrated good knowledge of material properties in relation to their selection • demonstrated a clear understanding of the safety considerations surrounding a pillar drill • were able to appropriately explain and justify their responses when required • demonstrated a good knowledge of smart materials • showed a good understanding regarding the use of CAM for both mass and one-off manufacture.	• gave generic responses that did not relate to the context of the question • overlooked the specifics of questions that related to particular parts of the stimulus • struggled to identify material properties • struggled to identify and explain appropriate manufacturing processes • demonstrated little awareness of the principles of lean manufacture.

Section A overview

Section A contained ten multiple choice questions requiring candidates to identify one correct answer for each question.

Question 1

1 Which of these joining processes needs heat?

(a) Brazing ☐

(b) Nuts and bolts ☐

(c) Pop rivets ☐

(d) Self-tapping screws ☐

[1]

The vast majority of candidates correctly identified 'Brazing'.

Question 2

2 What type of process is shearing?

(a) Forming ☐

(b) Joining ☐

(c) Shaping ☐

(d) Wasting ☐

[1]

Whilst the majority of candidates were able to correctly identify 'Wasting' as the correct response, a large number often selected 'Shaping'.

Question 3

3 Which of these means the ability to be drawn into wires?

(a) Compressive ☐

(b) Ductility ☐

(c) Elasticity ☐

(d) Malleability ☐

[1]

The majority of candidates were able to correctly identify 'Ductility'.

Question 4

4 Which of these is a forming process?

(a) Die casting ☐

(b) Forging ☐

(c) Injection moulding ☐

(d) Powder metallurgy of ceramic products ☐

[1]

This question drew a range of responses with candidates often split between 'Forging' (correct) and 'Injection moulding'.

Question 5

5 Which of these is a thermoplastic?

(a) Acrylonitrile-Butadiene-Styrene ☐

(b) Melamine formaldehyde ☐

(c) Polyester resin ☐

(d) Urea formaldehyde ☐

[1]

This question drew a range of responses with candidates often split between 'Acrylonitrile-Butadiene-Styrene' (correct) and 'Polyester Resin'.

Question 6

6 What kind of material is glass reinforced polymer?

(a) Ceramic ☐

(b) Composite ☐

(c) Metal ☐

(d) Smart material ☐

[1]

The majority of candidates correctly identified 'Composite' however 'Ceramic' or 'Smart material' were often incorrectly identified.

Question 7

7 What type of line is this on an orthographic drawing?

(a) Dimension ☐

(b) Leader line ☐

(c) Outline ☐

(d) Projection ☐

[1]

The vast majority of candidates were able to correctly identify 'Dimension' as the correct answer.

Question 8

8 Which of these is a property of silicon carbide?

(a) High density ☐

(b) High ductility ☐

(c) High hardness ☐

(d) High machinability ☐

[1]

This question drew a range of responses with candidates often split between 'High Hardness' (correct) and 'High density'.

Question 9

9 Which of these is a specific shape used to draw around to help cut out other materials in a same shape and size?

(a) Fixture ☐

(b) Jig ☐

(c) Mould ☐

(d) Template ☐

[1]

The majority of candidates correctly identified 'Template'.

Question 10

10 Which of these is represented by a patterned surface on an orthographic drawing?

(a) Chamfer ☐

(b) Countersink ☐

(c) Hole ☐

(d) Knurl ☐

[1]

This question drew a range of responses with candidates often split between 'Knurl' (correct), 'Chamfer' and 'Hole'.

Section B overview

This section has a range of questions styles that generally fall into the following categories:

Identify or state a specific piece of information, image or reason for 1 mark. For these questions, candidates need to be able to demonstrate their knowledge by identifying or recognising a given item within a diagram/image, or use direct recall to answer a question, for example the properties of a material.

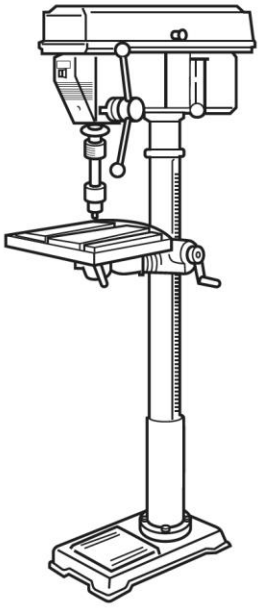
Describe, Explain and Discuss questions test candidates' understanding in greater depth than identification or recall style. Understanding will be demonstrated through answering how, why; reasons for, advantages, considerations of something to/in different contexts. For example:

- Describe how something might occur or describe how a particular circumstance will be affected or impacted by a situation for 2-3 marks. Examples are often sought in these questions with a mark being given for an appropriate example.
- Analyse an approach or explain the advantages of a manufacturing scenario or material application for 3-4 marks.
- Discuss: candidates would be expected to approach from more than one point of view. A higher tariff question, with up to 6 marks available and marked via the level of response given within the answer. Candidates should provide more than just a series of statements and be able to expand on these with reasoning, the impact of and or justification. Higher marks are given for answers that include a reasoned discussion / debate with appropriate use of terminology.

Question 11 (a)

11 You are manufacturing a product using the machine below.

(a) Add labels to the machine to identify the **chuck** and the **column**. **[2]**



Candidates responded well to this question. Most candidates were able to correctly identify at least one of the two required parts of the machine.

Question 11 (b)

(b) Identify **three** hazards when operating the machine above.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

Candidates often accessed at least 2 of the 3 marks available. Those responses that were not awarded credit often focused on the method of prevention rather than the hazard itself.

Question 11 (c)

(c) State **three different** pieces of PPE that should be worn when using this machine.

1 .....

2 .....

3 .....

[3]

This question was generally answered well however a significant number of responses incorrectly identified 'gloves' as a suitable piece of PPE that should be worn when using this machine.

Question 11 (d)

(d) State **two** safety features you would expect to find on or near this machine.

1 .....

2 .....

[2]

This question was generally answered well with the majority of candidates correctly identifying features such as emergency stop switches and chuck guards.

Question 12 (a)

12 An engineering company is using a non-ferrous metal to manufacture engine blocks like this.

(a) State **two** non-ferrous metals.

1 .....

2 .....

[2]

This question was generally answered well with candidates often correctly identifying two non-ferrous metals.

Question 12 (b)

(b) State **one** reason why a non-ferrous metal would be more suitable than a ferrous metal for this product.

.....

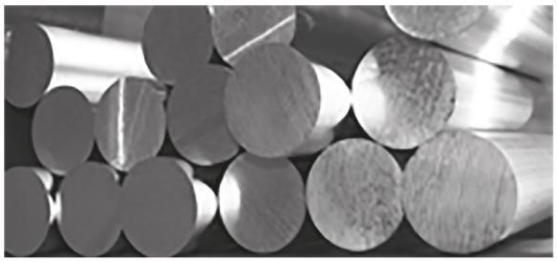
..... **[1]**

Again, this question was answered well with candidates able to correctly identify corrosion or magnetic related reasons.

Question 12 (c)

(c) Metal is available in a variety of forms of supply.

Identify these forms.



1 .....

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2 .....

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3 .....

[3]

This was a well answered question with candidates often able to identify at least two correct forms of supply.

Those candidates who did not perform as well generally identified 'sheet' correctly for item 3 but often referred to items 1 and 2 as 'cylinders' or 'hollow cylinders'.

Question 12 (d) (i), (ii) and (iii)

(d) The engine blocks will be manufactured by sand casting.

(i) Explain why the stock form is **not** important when sand casting.

.....

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

(ii) Explain why products manufactured by **sand casting** need further finishing once removed from the mould.

.....

.....

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

(iii) Explain why sand casting produces very little wasted metal even though a large proportion of defective products are made.

.....

.....

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

On the whole, these three parts were answered well but candidates often struggled to support their answer for part (ii) to gain both of the available marks. Candidates often correctly referenced the fact the stock form becomes molten for part (i) and subsequently any defective parts could be re-melted and re-used to support their answer for part (iii).

Explain questions

When considering their response to an explain question, candidates should be encouraged to support the point they are making with a relevant example or justification in order to access the full range of marks available.

Question 13 (a)

13 Different types of materials can be used in engineering.

(a) Use the materials below to identify an example of each type of engineering material.

Not all the example materials are used.

One has been completed for you.

Carbon Fibre **~~Cast Iron~~** **Silicon Carbide**

Titanium **Quantum Tunnelling Composite**

Type of engineering material	Example materials
Engineering Ceramic	
Ferrous metal	Cast iron
Smart material	

[2]

Candidates responded well to this question and often correctly identified both of the required materials.

Those candidates who did not perform so well on this question often stated Quantum Tunnelling Composite as an Engineering Ceramic and Silicon Carbide as a Smart material.

Question 13 (b) (i)

(b) These bath toys contain a smart material which changes colour when put into warm water.

(i) Explain what a **smart material** is.

.....

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

Candidates often correctly identified that a smart material has the ability to 'change' its properties or appearance and were awarded 1 mark however they often did not clearly identify that this would be as a result of a stimulus or environmental change.

Question 13 (b) (ii)

(ii) Identify the type of smart material used in the bath toys.

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

Responses were varied to this question. When candidates were able to correctly explain the term smart material they often correctly identified the correct type. When candidates incorrectly identified the definition of a smart material they would often struggle to correctly identify the type.

Question 13 (c)

(c) Identify **one** use of **tungsten carbide** and state **one** property that makes it suitable for this use.

Use .....

Property .....

[2]

Candidates generally responded well to this question with a rage of appropriate uses and accompanying properties. Those candidates who performed less well identified uses and properties of smart materials rather than tungsten carbide.

Question 13 (d)

(d) Identify **one** use of a **shape memory alloy** and explain why it is suitable for this use.

Use .....

Why it is suitable .....

.....

.....

.....

.....

[3]

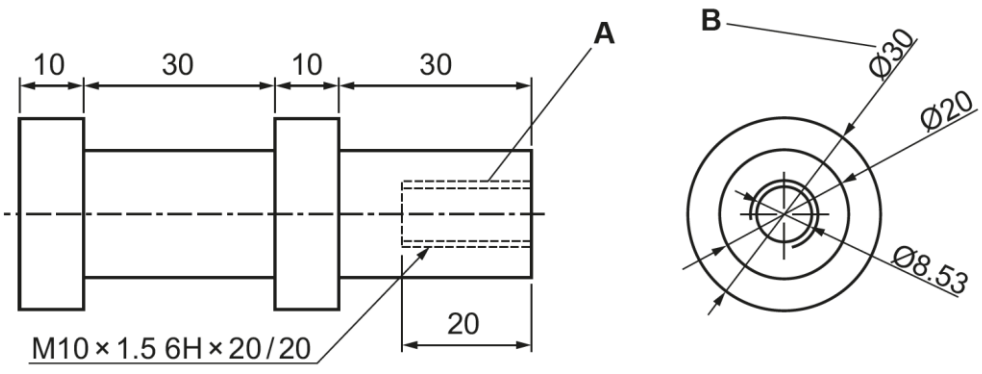
Responses to this question were varied with candidates often referring to uses of 'alloys' rather than the smart material 'shape memory alloy'. Those candidates who answered well often referred to the use with dental braces or fire alarm systems.

Question 14 (a)

14 This is an orthographic drawing that will be used to manufacture a component.

The component will be manufactured from 30 mm stainless steel rod.

All dimensions are in mm.



(a) State **two** mechanical features shown by label **A**.

1 .....

2 .....

[2]

This particular question drew a range of responses from candidates. The vast majority were often able to correctly identify 'hole' as a correct answer to gain one mark but struggled with a second mechanical feature.

Question 14 (b)

(b) State the dimension shown by label **B**.

30 mm ..... **[1]**

This question was generally answered very well with the majority of candidates correctly identifying 'diameter'.

Question 14 (c)

(c) State **one** machining process that could be used to manufacture the component in the orthographic drawing above.

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

Responses to this question were varied with candidates often referring to a particular type of machine rather than the machining process.

Question 14 (d)

(d) Consider the following statement:

Both a lathe and a press brake machine are needed to make the component in the orthographic drawing on **Page 12**.

How far do you agree with this statement? Give reasons for your answer.

.....

.....

.....

.....

.....

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

Responses were varied for this question. In order to achieve full marks candidates would typically identify that a lathe would be used and would be suitable to solely manufacture the component shown, how this would be achieved and then finally state that a press brake would be unsuitable and why. Candidates could also refer to or suggest alternative manufacturing methods such as drilling if a tailstock was not used.

Those candidates who did not do so well on this question often attempted to justify how or why the press brake would be an appropriate method of manufacture.

Exemplar 1

I disagree as a ~~Huage cutting tool~~ parting tool could be used on a lathe to create the two 30mm sections at 20mm diameter. and a ~~cutt~~ knife edge cutting tool could be used to face off the material and parallell turn it. There fore a press brake machine would be unnesscary. The 20mm ~~internal thread could be~~ hole for the internal thread could also be carried out using a drill bit on ~~a~~ the lathe. ~~To make the~~ To cut the internal thread I would ~~you~~ use a tap and tap wrench. Personally I think a press brake machine is not needed to make this component as all ~~apart from~~ the machining processes can be carried out on the lathe. ~~Brak~~ press brake machine would be a waste of money, reducing profit. [6]

Exemplar 1 shows a 6 mark response where the candidate has clearly met the criteria set out in the mark scheme. The candidate identifies the lathe as suitable with justification alongside the manufacturing processes/steps required. The candidate also identifies press brake as unsuitable as all processes can be carried out on the lathe.

Question 15 (a)

15 A multi-axis machine is one example of a machine used in Computer Aided Manufacturing (CAM).

This is a multi-axis machine being used to manufacture a product.

(a) What is **Computer Aided Manufacturing** (CAM)?

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

This question was generally answered well however in order to gain credit candidates were required to reference the fact that the machine would be controlled by a computer.

Question 15 (b)

(b) Identify **one** CAM machine that can be used for **wasting processes**, other than a multi-axis machine.

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

Candidates responded well to this question. Most candidates correctly identified a suitable CAM machine that can be used for wasting processes.

Question 15 (c) and (d)

(c) Identify **one** product which can be **mass** manufactured using CAM.

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

(d) Identify **one** product that is **batch** manufactured using CAM.

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

Candidates responded well to the 15 (c) and (d). Most candidates correctly identified a suitable product for both mass and batch manufacture using CAM.

Question 15 (e)

(e) CAM is often used for mass manufacture.

Discuss the advantages and disadvantages of using CAM in **both** mass **and** one-off manufacturing.

.....

.....

.....

.....

.....

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

Level 3 responses were able to clearly identify different advantages and disadvantages of using CAM in both mass and one-off manufacturing. Typically, these responses detailed how CAM would benefit in terms of scale, accuracy and pace of production. Cost and the requirement for a specialist workforce were often identified as potential disadvantages.

Level 2 responses tended to identify and explain both advantages and disadvantages but did not offer sufficient clarity as to the relationship of these to either mass or one-off.

Level 1 responses often either focused solely on advantages or disadvantages of using CAM for either mass or one-off manufacture.

Exemplar 2

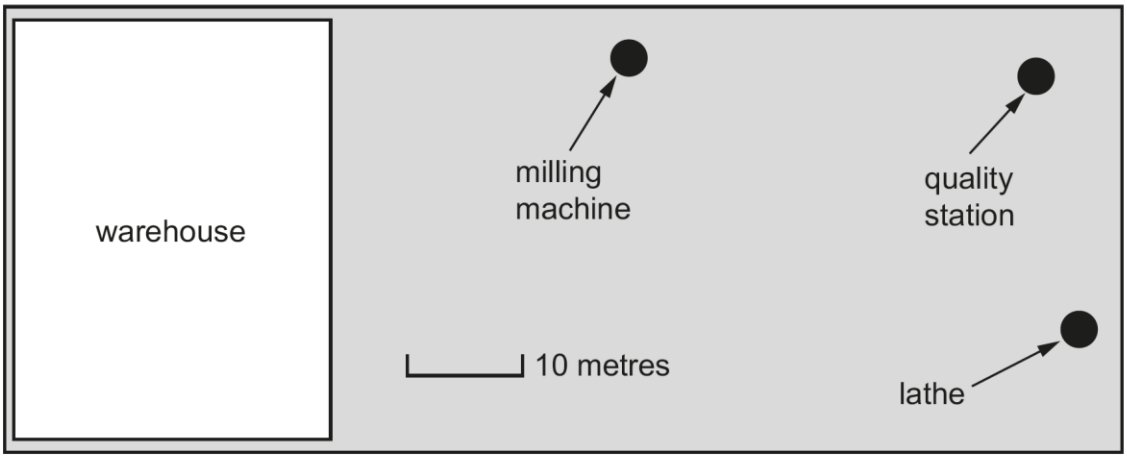
Using CAM for mass production is very effective as it increases the quality of all parts produced and it can make the manufacture process much faster. This means the rate products produced will increase. The initial cost of the machines is very expensive but the price is repaid by products over long term. Also decreases labor costs as less workers are required to operate and repair the machines.

Exemplar 2 shows an extract from a Level 3 response where the candidate clearly identifies the advantages and disadvantages of using CAM in mass manufacture. The response continues in the same style and clearly identifies and disadvantages for one-off manufacture.

Question 16 (a) (i)

16 Companies use **lean manufacturing** to increase profitability by reducing waste.

This is a plan of a large manufacturing facility viewed from above.



There are seven steps in the production plan:

1. Raw materials are stored in the warehouse.
2. Raw materials are taken from the warehouse to the lathe.
3. Raw materials are turned on the lathe.
4. The turned parts are taken to the milling machine.
5. The turned parts have material removed on the milling machine.
6. The finished parts are measured at the quality station to check that their dimensions are within tolerance.
7. The finished parts are stored in the warehouse until the customer buys them.

(a)
(i) Identify the category of waste in **Step 4** and explain **two** ways that this waste can be reduced.

Waste .....

How it can be reduced

1 .....

.....

2 .....

.....

[3]

Responses to this question were varied with candidates often incorrectly identifying the category of waste but often able to identify suitable ways it can be reduced. Candidates were able to pick up marks for the ways that waste can be reduced with popular responses including 'moving the machines closer together' and 'placing the machines in order of manufacture'.

Misconception

? 'Time' was often stated as a category of waste for this particular question. It is important that students cover the full range of the specification as part of their learning journey. The seven categories of waste in relation to lean manufacture are outlined in the specification document in Topic Area 4.2.

Question 16 (a) (ii)

(ii) The category of waste in **Steps 1** and **7** is **inventory**.

Explain **three** ways that **Just-In-Time** (JIT) will reduce inventory waste.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

Candidates generally responded well to this question however candidates often referred to the features of Just-In-Time without linking or referring to how their given point would reduce inventory waste.

Question 16 (b)

(b) Explain why **Step 6** is a **quality control** approach, and why it is **not quality assurance**.

.....

.....

.....

.....

.....

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

Responses to this question were varied with candidates often able to correctly identify why Step 6 is a quality control approach however a considerable number of responses did not explain why it is not quality assurance.

Those candidates who were able to demonstrate an understanding of quality control, quality assurance and the differences between them, accessed the full marks available for this question.

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