ENGINEERING MANUFACTURE

INCLUDED ON THE
KS4 PERFORMANCE TABLES

Examiners' report

OCR Level 1/Level 2

Cambridge National in

Engineering Manufacture

J823

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R014 January 2024 series

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Contents

Introduction 4
R014 series overview 5
Section A overview 6
Question 1 6
Question 2 6
Question 3 7
Question 4 7
Question 5 8
Question 6 8
Question 7 9
Question 8 9
Question 9 9
Question 10 10
Section B overview 11
Question 11 (a) (i) 12
Question 11 (a) (ii) 13
Question 11 (b) (i) 13
Question 11 (b) (ii) 13
Question 11 (b) (iii) 14
Question 11 (c) (i) 14
Question 11 (c) (ii) 14
Question 12 (a) 15
Question 12 (b) (i) 16
Question 12 (b) (ii) 16
Question 12 (c) 17
Question 13 (a) 18
Question 13 (b) 19
Question 13 (c) 19
Question 13 (d) 20
Question 14 (a) and (b) 20
Question 14 (c) 21
Question 15 (a) 23
Question 15 (b) 24
Question 15 (c) 25

Question 16 (a) 26
Question 16 (b) 27
Question 16 (c) 27
Copyright information 28

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 Teach Cambridge.

R014 series overview

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

- identify and explain the features of a Centre Lathe and surrounding safety considerations
- demonstrate an understanding of the injection moulding process and associated materials
- demonstrate their understanding of composites, in particular the forming processes applied to carbon fibre
- identify the standard drawing conventions of technical drawings and determine the suitability of manufacturing methods for a specified part
- demonstrate an understanding of how to ensure consistency in manufacturing processes
- demonstrate an understanding of the scales of manufacture and identify the related categories of waste.

To do well in this paper candidates needed a fundamental understanding of material properties and their associated manufacturing methods, in particular ABS and carbon fibre, the safe use of a centre lathe and ensuring consistency across various scales of manufacture. Candidates also needed to be able to accurately justify the suitability of suggested manufacturing methods.

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 suggested alternative methods 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 centre lathe • were able to appropriately explain and justify their responses when required • demonstrated a good knowledge of the properties of ABS and carbon fibre • showed a good understanding of how to ensure consistency during 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 • demonstrated little awareness of how to ensure consistency when manufacturing products • struggled to identify and explain appropriate manufacturing processes • demonstrated little awareness of how a centre lathe operates and the associated manufacturing limitations.

Section A overview

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

Question 1

1 Which type of process is sand casting?

(a) Forming ☐

(b) Joining ☐

(c) Shaping ☐

(d) Wasting ☐

[1]

While the majority of candidates were able to correctly identify "shaping" as the correct response, a large number often selected "forming".

Question 2

2 Which of these means the ability to withstand abrasion without surface damage?

(a) Ductility ☐

(b) Elasticity ☐

(c) Hardness ☐

(d) Sustainability ☐

[1]

The majority of candidates were able to correctly identify "hardness".

Question 3

3 Which of these is a shaping process?

(a) Brazing ☐

(b) Forging ☐

(c) Powder metallurgy of ceramic products ☐

(d) Strip heating of polymers ☐

[1]

Candidates often struggled with this particular question and a range of responses were seen.

Question 4

4 Which of these polymers is thermosetting?

(a) Acrylonitrile-Butadiene-Styrene (ABS) ☐

(b) Epoxy resin ☐

(c) Polycarbonate ☐

(d) Polylactic acid (PLA) ☐

[1]

Epoxy resin was correctly selected by the vast majority of candidates.

Question 5

5 What kind of material is silicon carbide?

(a) Ceramic ☐

(b) Composite ☐

(c) Metal ☐

(d) Polymer ☐

[1]

Candidates often incorrectly selected "composite".

Misconception

? Silicon carbide is often a component material used within composites but standalone is a ceramic.

Question 6

6 What does the abbreviation CL mean on an orthographic drawing?

(a) Centre lathe ☐

(b) Centre line ☐

(c) Contour line ☐

(d) Controlled link ☐

[1]

The majority of candidates correctly selected "centre line".

Question 7

7 Which of these is a property of polylactic acid (PLA)?

(a) High brittleness ☐

(b) High conductivity ☐

(c) High ductility ☐

(d) High toughness ☐

[1]

This question drew a range of responses with candidates often split between "high brittleness" (correct), "high ductility" and "high toughness".

Question 8

8 Which of these is a mechanical fastening?

(a) Brazing ☐

(b) MAG welding ☐

(c) Nuts and bolts ☐

(d) Press forming ☐

[1]

The vast majority of candidates were able to correctly identify "nuts and bolts" as a mechanical fastening.

Question 9

9 Which of these uses molten material to form complex shapes?

(a) Fixture ☐

(b) Jig ☐

(c) Mould ☐

(d) Template ☐

[1]

The vast majority of candidates correctly identified "mould".

Question 10

10 A dimension is given on an engineering drawing as 20.00 mm ±0.05.

Which is the maximum allowed dimension?

(a) 19.95 mm ☐

(b) 20.05 mm ☐

(c) 20.10 mm ☐

(d) 20.50 mm ☐

[1]

The vast majority of candidates correctly identified (b) 20.05 but on occasion candidates would select (a) 19.95, demonstrating that the question was not fully read and understood.

Section B overview

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

Identify 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 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) (i)

11 You have been asked to manufacture the component shown in **Fig. 1**.

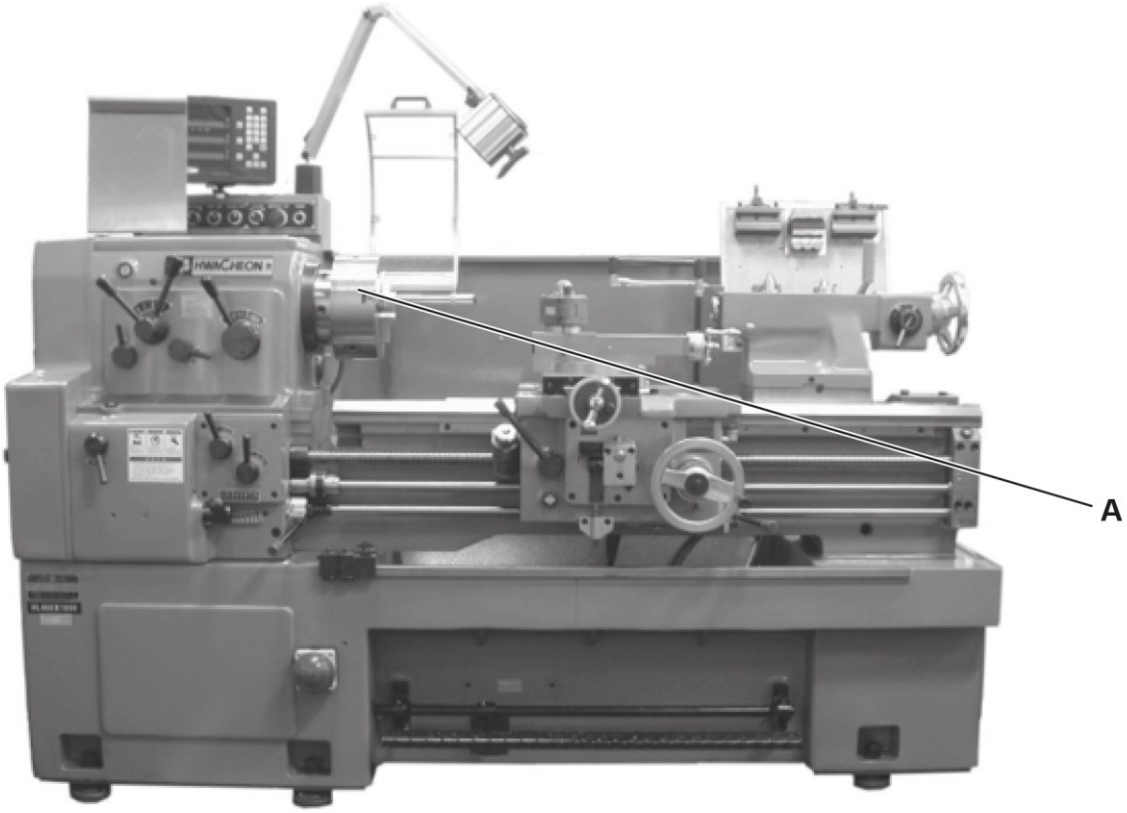
It will be manufactured from a 20 mm diameter low carbon steel rod.

The final component will be 20 mm long and have a 3 mm hole drilled through the centre as shown.

Fig. 1

You will be using the machine in **Fig. 2** for the manufacture.

Fig. 2



(a)
(i) Identify the machine in **Fig. 2**.

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

Candidates responded well to this question. Most candidates correctly identified centre lathe or lathe.

Question 11 (a) (ii)

(ii) Explain why the machine is suitable for producing the component shown in **Fig. 1**.

.....

.....

.....

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

Candidates typically achieved 2 marks for this question by suggesting either two relevant reasons or one relevant reason accompanied by a suitable justification.

Question 11 (b) (i)

(b) Part of the machine has been labelled.

(i) Identify **part A** and describe its function.

Part A .....

Function .....

.....

[2]

This question was generally answered well with the majority of candidates correctly identifying the chuck and its function being to hold/grip or turn/rotate the workpiece.

Question 11 (b) (ii)

(ii) Other than making sure the safety screen is down, identify **one** other safety measure that **must** be used for **part A**.

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

Candidates often gave responses that did not specifically relate to part A and were therefore not given the mark. It is important that candidates pay close attention to the parts of the question in bold.

Question 11 (b) (iii)

(iii) Explain why the safety measure you have identified in **part (b)(ii)** is important.

.....

.....

.....

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

Candidates typically responded well here and so long as their explanation linked to their response provided in the previous question, they were able to access both marks. A similar approach to Question 11 (a) part (ii) was taken when awarding marks; either two relevant reasons or one relevant reason accompanied by a suitable justification would meet the criteria for 2 marks to be given.

Question 11 (c) (i)

(c) Safety gloves should be worn for **some tasks** when using the machine in **Fig. 2**.

(i) Identify **one** task where safety gloves should be worn when using the machine.

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

This question was generally answered well with candidates often correctly identifying that gloves should be worn when removing swarf or potentially hot parts after manufacture.

Question 11 (c) (ii)

(ii) State why it would **not** always be appropriate to wear safety gloves when using the machine.

.....

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

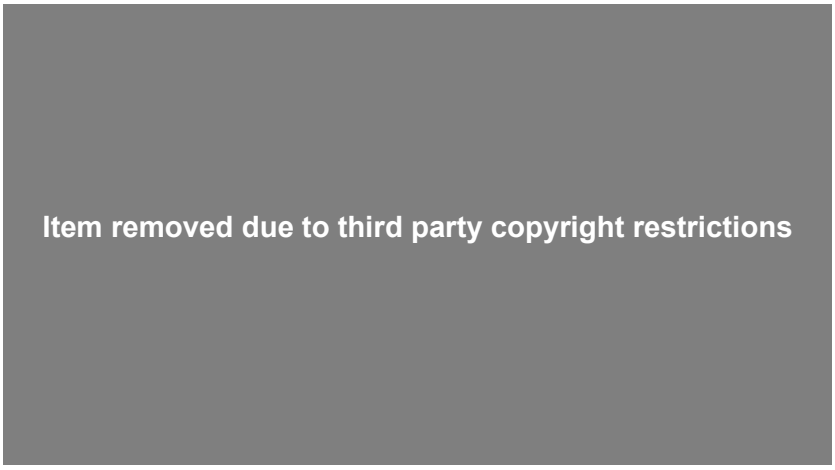
Again, this question was generally answered well with candidates referring to reduced dexterity or the fact that the excess material could get caught in the machine.

Question 12 (a)

12 An engineering company is using injection moulding to manufacture childrens' toy bricks from Acrylonitrile-Butadiene-Styrene (ABS).

An example of the toy bricks is shown in **Fig. 3**.

Fig. 3



(a) Identify, in the correct sequence, any **three** of the steps required in the injection moulding process.

Step 1 .....

Step 2 .....

Step 3 .....

[3]

This was a well answered question with candidates often able to identify, in an appropriate order, three steps within the injection moulding process.

Those candidates who did not perform as well generally referred solely to the manufacture of the mould, rather than the injection moulding process itself or gave generic responses such as "mould material".

Question 12 (b) (i)

(b)

(i) Identify **two** properties of ABS that make it suitable for childrens' toy bricks.

1 .....

2 .....

[2]

On the whole, this question was answered well with candidates often able to identify at least one suitable property of ABS.

Assessment for learning

When referring to the mechanical properties of materials candidates should avoid using the standalone term "strong". Instead candidates should aim to qualify the type of strength as detailed in the specification, i.e. tensile strength or yield strength for instance.

Question 12 (b) (ii)

(ii) Explain why the properties of ABS make it suitable for childrens' toy bricks.

.....

.....

.....

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

Candidates responded well to this question and often exemplified their response from the previous question.

Those candidates who did not perform so well on this question often referred to the size or shape of the brick rather than the properties of ABS.

Question 12 (c)

(c) ABS is available in different forms of supply.

State **one** form of supply that is suitable to manufacture the toy bricks and explain why your chosen form of supply is suitable.

Form of supply .....

Why suitable .....

.....

.....

.....

[3]

Responses to this question were varied. When candidates were able to correctly identify the form of supply they often continued to justify its suitability and access the full range of marks. When candidates incorrectly identified a suitable form of supply, such as "sheet form", they would struggle to access suitability marks.

Question 13 (a)

13 **Fig. 4** shows a bike frame that is manufactured from a carbon reinforced polymer (carbon fibre).

Carbon fibre is a composite material.

Fig. 4

(a) Identify **two** properties of carbon fibre that make it suitable for the bike frame.

1 .....

2 .....

[2]

Responses to this question were mostly good however similarly to Question 12 (b) part (i), candidates should aim to qualify the type of strength rather than simply state "strong".

Question 13 (b)

(b) Describe how the carbon fibre is formed into the shape of the bike frame.

.....

.....

.....

.....

.....

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

Responses to this question were varied with candidates often not referring to the "laying up" process used with carbon fibre and resin. Candidates often referred to the carbon fibre becoming molten and being injected into a mould rather than being laid up.

Question 13 (c)

(c) Describe, giving an example, the differences between a composite material and an alloy.

.....

.....

.....

.....

.....

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

This question was generally answered very well with the majority of candidates accessing 2 marks. For full marks on this question candidates needed to give a specific example for either an alloy or composite stating the correct component materials.

Question 13 (d)

(d) Identify **one** composite material **other** than carbon fibre.

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

On the whole, this question was answered well with candidates often stating glass reinforced polymer or concrete.

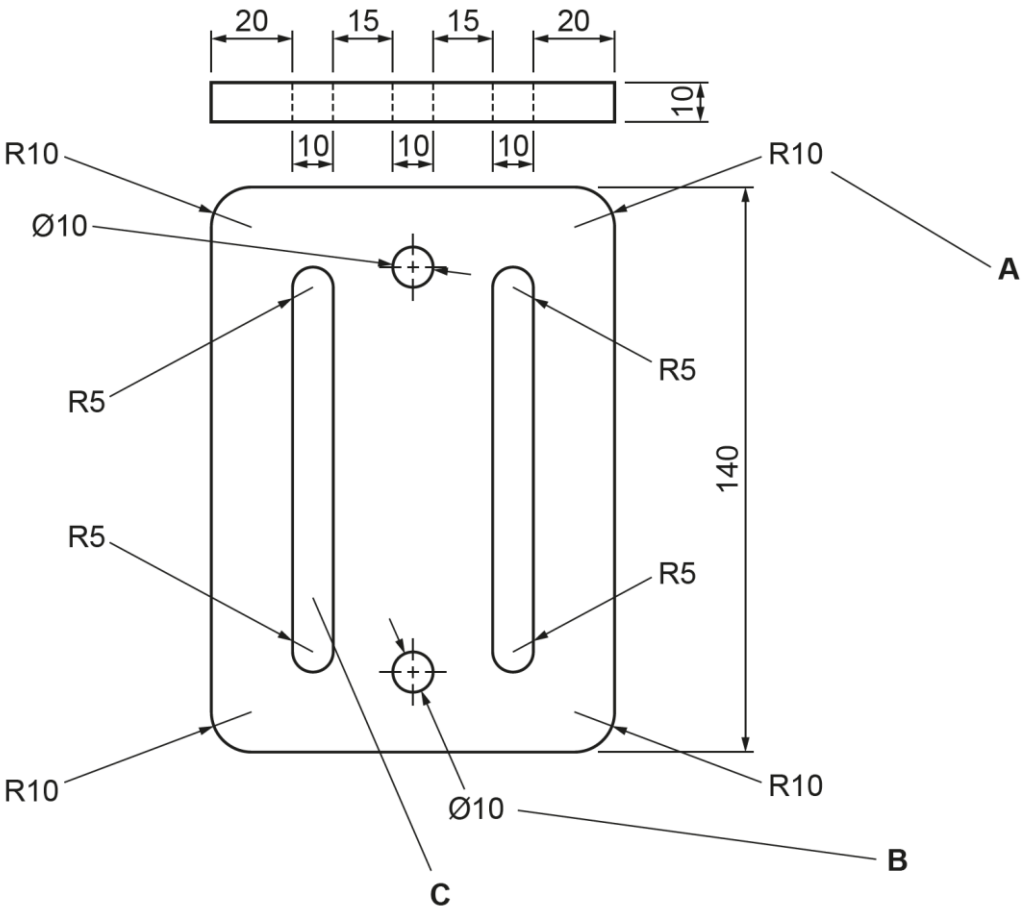
Question 14 (a) and (b)

14 **Fig. 5** shows part of an orthographic drawing that will be used to manufacture a slotted bracket.

The slotted bracket will be manufactured from a 10 mm thick low carbon steel sheet.

All dimensions are shown in mm.

Fig. 5



(a) Identify the standard drawing convention labelled **A**, giving the dimension shown.

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

(b) Identify the standard drawing convention labelled **B**, giving the dimension shown.

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

Candidates typically responded well here. It is important to note that candidates needed to identify both the labelled convention (Radius or Diameter/Hole) and the dimension 10(mm) to be given the full 2 marks on each question. The units (mm) did not need to be specified to gain full marks.

Question 14 (c)

(c) Consider the following statement:

A pillar drill and centre lathe are the machines that could be used to manufacture the slotted bracket shown in **Fig. 5** with **C** being made before **B**.

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

.....

.....

.....

.....

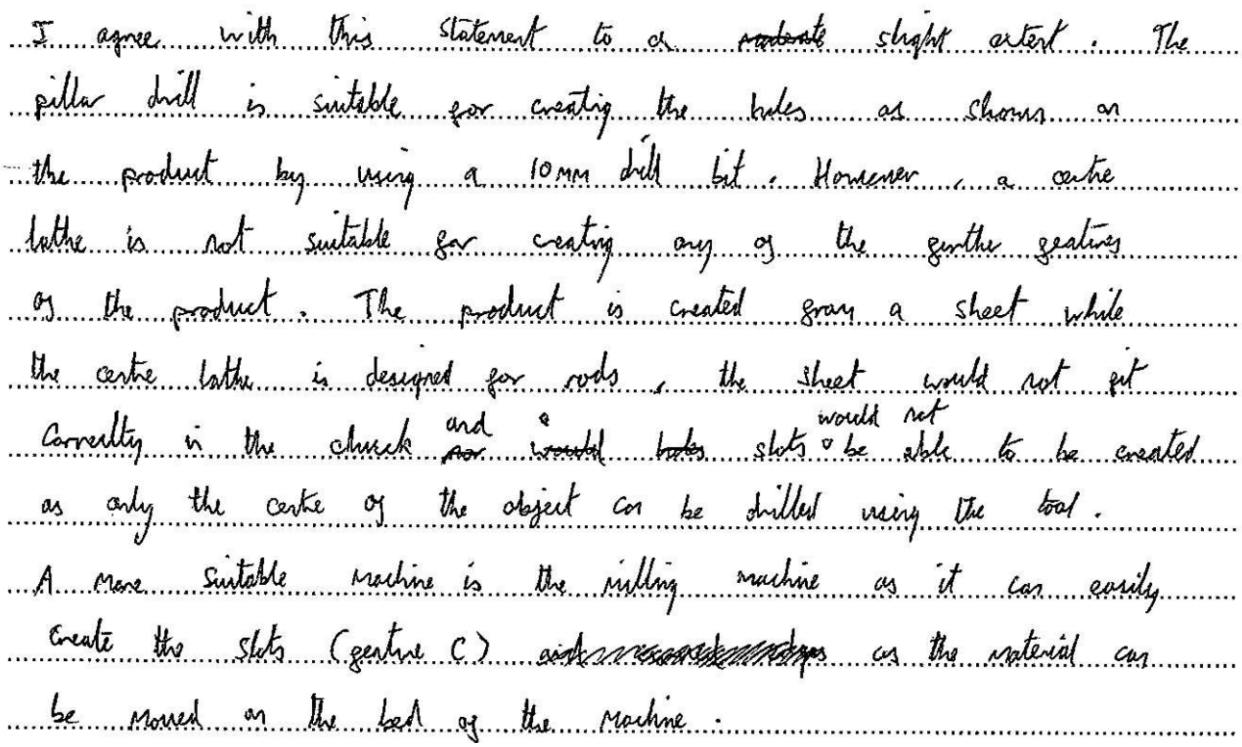
.....

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

Responses to this question were varied. In order to achieve full marks candidates would typically identify that a pillar drill would be used and would be suitable for the features labelled (b), then state that a centre lathe would be unsuitable and why, followed by explaining why the order of manufacturing for the features would not necessarily be important. Candidates could also refer to or suggest alternative manufacturing methods such milling.

Less successful responses to this question often attempted to justify how or why the centre lathe would be an appropriate method of manufacture.

Exemplar 1



I agree with this statement to a ~~moderate~~ slight extent. The pillar drill is suitable for creating the holes as shown on the product by using a 10mm drill bit. However, a centre lathe is not suitable for creating any of the further features of the product. The product is created from a sheet while the centre lathe is designed for rods, the sheet would not fit correctly in the chuck ~~and~~ ~~would~~ ~~holes~~ slots would not be able to be created as only the centre of the object can be drilled using the tool. A more suitable machine is the milling machine as it can easily create the slots (feature C) ~~and~~ on the material can be moved on the bed of the machine.

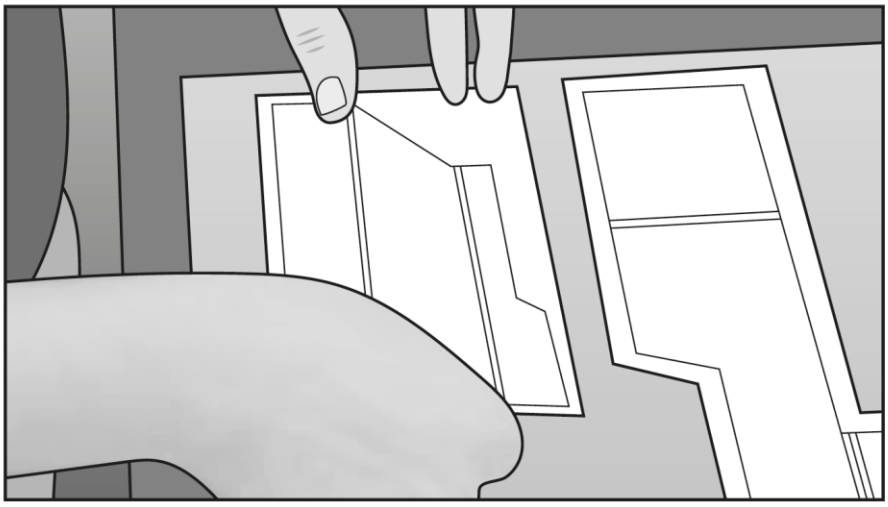
Exemplar 1 shows a 6 mark response where the candidate has clearly met the criteria set out in the mark scheme. The candidate identifies the pillar drill as suitable with justification, the centre lathe as unsuitable with justification and a more suitable alternative manufacturing method.

Question 15 (a)

15 An engineering company is manufacturing a product from sheet metal.

Fig. 6 shows an engineer using a template to mark out and cut sheet metal.

Fig. 6



(a) Describe how using templates to provide consistency can reduce waste when producing identical products.

.....

.....

.....

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

Typically, this question was answered well and candidates were able to describe how a template can provide consistency.

Those candidates who did not answer the question as effectively tended to repeat or rephrase the question itself.

Question 15 (b)

(b) One method of ensuring consistency in the manufacturing process is by using CNC machines.

Identify **two other** methods of quality assurance.

1 .....

2 .....

[2]

Responses to this question were varied with candidates often confusing quality control methods with those of quality assurance.

Assessment for learning

Quality assurance as a preventative approach putting in place systems to reduce occurrence of defects.

Question 15 (c)

Fig. 7 shows sheet metal components cut using a laser cutter.

Fig. 7

(c) A company is considering using CNC machines to ensure consistency in the quality of its manufactured products.

Discuss the following statement:

The **approach** to achieving consistent quality will depend on the scale of manufacture and the value of the product.

.....

.....

.....

.....

.....

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

Level 3 responses were able to clearly identify how the approach to consistent quality would typically vary dependent on the scale of manufacture and value of the product. Typically, these responses detailed how small-scale manufacture such as bespoke or one-off pieces would generally incur higher levels of manual labour and intricate checks with higher value products and/or materials. As the scale of manufacture increased the consistency in quality would be dependent on the workforce and CNC machinery used. CNC allowing for repeatability but parts would need to checked at regular intervals to ensure consistent quality.

Level 2 responses tended to identify and explain how the scale of manufacture would influence the approach to achieving consistent quality. These responses typically did not refer to the value of the product.

Level 1 responses missed the focus of the question relating to the approaches to achieve consistent quality. Level 1 responses often focused on generic statements that were not always relevant to the question such as the use of CNC replacing the workforce.

Exemplar 2

This statement holds truth, CNC machines are accurate but prove a major expense for a company, the short term and long term impacts of installing CNC machines must be considered, especially concerning profits as a company may have to recover from the initial cost, of which has a risk as the company may run out of money before seeing profits*. The scale of manufacture not only changes the amount of CNC machines purchased, but requires an adjustment of the workforce as less manual effort is required for

Exemplar 2 shows an extract from a Level 2 response where the candidate clearly identifies a link between CNC machines and accuracy. The response continues and links the scale of manufacture to the amount of CNC machines purchased, resulting in an adjustment of the workforce.

Question 16 (a)

16 A company receives an order for 3000 drill bits.

The company manufactures the drill bits.

A – 4000 drill bits were manufactured.

B – 500 drill bits failed quality control.

(a) Identify the category of waste in **A** and describe how the category of waste identified impacts lean manufacturing performance.

Category of waste .....

How impacts lean manufacturing performance .....

.....

.....

.....

[3]

Responses to this question were varied with candidates often calculating how many drill bits were wasted rather than stating the category of waste as overproduction. Candidates were often able to pick up marks for the impacts by stating that there would have been an increased manufacturing time or wasted energy as a result even if the category of waste was not correctly identified.

Question 16 (b)

(b) Identify the category of waste in **B** and describe how the category of waste identified can be reduced.

Category of waste .....

How can be reduced .....

.....

.....

.....

[3]

Similarly to the previous question, candidates often included unnecessary calculations rather than identifying the category of waste. Positively however, candidates were often given 2 marks for how the number of defects could be reduced with a significant number of candidates correctly referring to quality assurance processes to prevent defects from occurring.

Question 16 (c)

(c) Describe how just in time (JIT) manufacturing can be used by the company to manage inventory.

.....

.....

.....

.....

.....

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

This question was generally answered very well. Most candidates referred to multiple elements of JIT manufacture and were able to connect their points to inventory management.

The less successful responses focused solely on the features of JIT manufacture rather than linking to how it can be used by a company to manage inventory.

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