

GCSE



CCEA GCSE Exemplifying Examination Performance

Engineering and Manufacturing

This is an exemplification of candidates' performance in GCSE examinations (Summer 2019) to support the teaching and learning of the Engineering and Manufacturing specification.



Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright holders may have been unsuccessful and CCEA will be happy to rectify any omissions of acknowledgement in future if notified.

EXEMPLIFYING EXAMINATION PERFORMANCE

GCSE Engineering and Manufacturing

Introduction

These materials illustrate aspects of performance from the 2019 summer GCSE examination series of CCEA's revised GCSE Specification in 2017.

Students' grade A responses are reproduced verbatim and accompanied by commentaries written by senior examiners. The commentaries draw attention to the strengths of the students' responses and indicate, where appropriate, deficiencies and how improvements could be made.

It is intended that the materials should provide a benchmark of candidate performance and help teachers and students to raise standards.

For further details of our support package, please visit our website at www.ccea.org.uk

Best wishes

Judith Ryan

Education Manager, Engineering and Manufacturing

Email: jryan@ccea.org.uk

Telephone: 028 9026 1200 ext. 2133

GCSE: Engineering and Manufacturing

Unit 3: Materials, Processes and Systems

Grade: A Exemplar

Answer **all** questions

Section A

Questions in this section refer to the pre-release material.

Q1a(i) State a property that makes extruded low carbon steel a suitable material choice for the main frame of the rowing machine. [1]

Student's response

Chemical resistance, can resist rusting time

Examiner's comments

The candidate has provided two properties in response to the question asking for a single property. Neither response is worthy of credit in the context of the rowing machine.

Q1a(ii) Suggest an appropriate finish, other than paint, for the main frame of the rowing machine. [1]

Student's response

polishing

Examiner's comments

The candidate's response is not worthy of credit. The response is not appropriate for the mainframe of the rowing machine.

Q1b The rowing machine is labelled to specify a maximum load of 150 kg. This allows for a factor of safety of 1.5. Explain the term factor of safety. [2]

Student's response

how a much stronger a system is than it needs to be in order to withstand a certain force

Examiner's comments

The candidate has indicated that factor of safety is beyond the normal system limit, however, they have not indicated that it relates to a maximum load carrying capacity. One mark awarded.

Q1c The rowing machine is labelled with the symbol shown in Fig. 1.



Fig. 1

© iStock 1051709694

Q1c(i) State the name of the symbol shown in **Fig. 1**. [1]

Student's response

the european standard

Examiner's comments

The candidate has not correctly stated the name of the symbol as specified in the specification. The response is not worthy of credit.

Q1c(ii) Give **one** reason why a customer would want to buy a product labelled with the symbol shown in **Fig. 1**. [1]

Student's response

it proves that it has reach certain European standards and is a safe purchase

Examiner's comments

The candidate has provided one reason why a customer would want to buy a product labelled with the symbol shown in Figure 1. One mark awarded.

Q1d The digital display for the rowing machine contains a number of electronic components. **Fig. 2** shows a picture of a seven-segment display.



Fig. 2

© r5c257c16_981_iStock_Thinkstock

Q1d(i) Give **one** application, other than in a rowing machine, for a seven-segment display in an electronic product. [1]

Student's response

a digital clock / watch

Examiner's comments

The candidate has correctly given one example of 7 segment display use in an electronic product. One mark awarded.

Q1d(ii) Fig. 3 shows the segment layout of a seven-segment display.

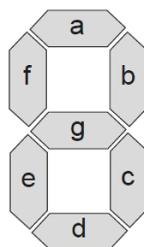


Fig. 3

© LEBERUS Stock illustration ID: 498952339

Complete **Table 1** by inserting a series of ticks indicating the appropriate segment letters as shown in **Fig. 3** to illuminate the seven-segment display with the digit 5. [1]

Student's response

Table 1

Segment Letter	Tick as appropriate
a	✓
b	
c	✓
d	✓
e	
f	✓
g	✓

Examiner's comments

The candidate has correctly completed the table using a series of ticks to indicate how to illuminate the seven segment display with the digit 5. One mark awarded.

Q2a Nuts, bolts and machine screws are examples of standard parts. State **two** reasons for using standard parts to assemble the rowing machine.

Student's response

1. *it reduces the production time* [1]
2. *it reduces the direct material cost* [1]

Examiner's comments

The candidate responses are not worthy of credit. The candidate has not stated reasons for using standard parts to assemble the rowing machine.

Q2b State **two** benefits of using an assembly line in the production of the rowing machine.

Student's response

1. *the works don't need to be skilled* [1]
2. *can produce near identical products each time* [1]

Examiner's comments

The candidate has correctly stated two benefits of using an assembly line in the production of a rowing machine. Two marks awarded.

Q2c(i) Outline what is meant by the term direct cost in relation to the manufacture of products. [1]

Student's response

It refers to the cost of purchasing materials and paying the labour force. Those that directly make the product.

Examiner's comments

The candidate has correctly outlined what is meant by the term direct cost in relation to the manufacture of products. One mark awarded.

Q2c(ii) Give **one** example of a direct cost associated with the manufacture of the rowing machine. [1]

Student's response

the cost of the low carbon steel

Examiner's comments

The candidate has correctly identified materials as an example of direct costs associated with the manufacture of the rowing machine. One mark awarded

Q2d(i) Outline what is meant by the term indirect cost in relation to the manufacture of products. [1]

Student's response

The indirect cost comes from manufacturing overheads and those not directly involved in the physical manufacture of the product.

Examiner's comments

The candidate has correctly outlined what is meant by the term indirect costs in relation to the manufacture of products. One mark awarded.

Q2d(ii) Give **one** example of an indirect cost associated with the manufacture of the rowing machine. [1]

Student's response

digital design team

Examiner's comments

The candidate has correctly identified design costs as an indirect cost in the manufacture of the rowing machine. One mark awarded.

Q3a A subcontractor manufactures the guards for the flywheel on the rowing machine. Each week, to manufacture 10 000 guards, the subcontractor spends £6500 on materials, £800 on labour, and other costs associated with the guards are £11 700.

Calculate the unit cost for **one guard**. [2]

Show your working out in the space below.

$$6500 + 800 + 11700 = 19000$$

$$19000 \div 10000 = 1.9$$

Student's response

Answer £ 1.90

Examiner's comments

The candidate has correctly calculated the unit cost of one guard. The candidate has correctly calculated the total expenditure per week and divided that by the number of products made per week. Two marks awarded.

Q3b The company purchases a sheet of stainless steel at a cost of £65.
 Each hour they use 10 sheets.
 During manufacturing 5% of the material is wasted.
 Calculate how much money is lost per 8 hour shift as a result of
 wasted stainless steel. [3]

Show your working out in the space below.

$$65 \times 10 = \frac{650}{100} \text{ per hour}$$

$$650 \times 8 = \text{£}5200 \text{ per 8 hour shift}$$

$$\frac{5200}{100} \times 5 = \frac{52}{200}$$

$$52 \times 5 = 260 \text{ waste per 8 hour shift}$$

Student's response

Answer £ 260

Examiner's comments

The candidate has correctly identified how much money is lost per 8 hour shift as a result of the wasted stainless steel. The candidate has correctly identified how much material will be used per hour; what amount of material will be wasted as a result of 5% wastage; and multiplied this to calculate the total material wasted per 8 hour shift. Three marks awarded.

Q3c The company uses extruded low carbon steel for the main frame of the rowing machine. **Fig. 4** shows the end profile of the extruded tubular low carbon steel main frame. [4]



(not to scale)

Fig. 4

The external size is 88 mm by 48 mm. The wall thickness of the material is 4 mm and each rowing machine uses a 2400 mm length. Calculate the volume of material saved when making 10 rowing machines using material with the profile shown in **Fig. 4** rather than with 88 mm by 48 mm solid rectangular bar.

Show your working out in the space below.

total volume of rectangular bar = $0.088 \times 0.048 \times 2.4 = 0.0101376 \text{ m}^3 = 1 \text{ unit}$

volume of hollow centre = $0.08 \times 0.04 \times 2.4 = 0.00768 \text{ m}^3 = 1 \text{ unit}$

$10 \times 0.00768 = 0.0768 = 10 \text{ units}$

volume of rectangular bar tube = $0.0101376 - 0.0768 = 0.024516 \text{ m}^3$

$88 - 8 = 80$
 $48 - 8 = 40$
 $4 + 4 = 8$

Student's response

Answer 0.0768 m³

Examiner's comments

The candidate has correctly calculated the volume of material saved when making the rowing machines using the material with the profile shown in Figure 4 rather than with 88 mm by 48 mm solid rectangular bar. Four marks awarded.

Q3d The company employs 6 employees to assemble the parts of the rowing machine. Each employee works a continuous 8 hour shift, excluding breaks. Each rowing machine takes an employee 48 minutes to assemble.

Calculate the total number of rowing machines completely assembled per shift. [3]

Show your working out in the space below.

$$6 \times 8 = 480 \text{ mins} = \frac{\text{total employee work time}}{\text{a single employee work time}}$$
$$\frac{480}{48} = 10 \text{ rowing machines per employee shift}$$
$$6 \times 10 = 60$$

Student's response

Answer 60 rowing machines

Examiner's comments

The candidate has correctly calculated the total number of rowing machines completed per shift. Three marks awarded.

Q4 Fig. 5 shows the digital display unit of the rowing machine. The digital display unit is powered by a battery.



Fig. 5

© Bulgaci/Stock/638407726

The digital display unit needs to be removable from the rowing machine for maintenance and battery replacement. In the space provided, use 2D, assembly and exploded annotated sketches, with appropriate terminology to show how the digital display unit could be attached and detached.

Marks will be awarded for:

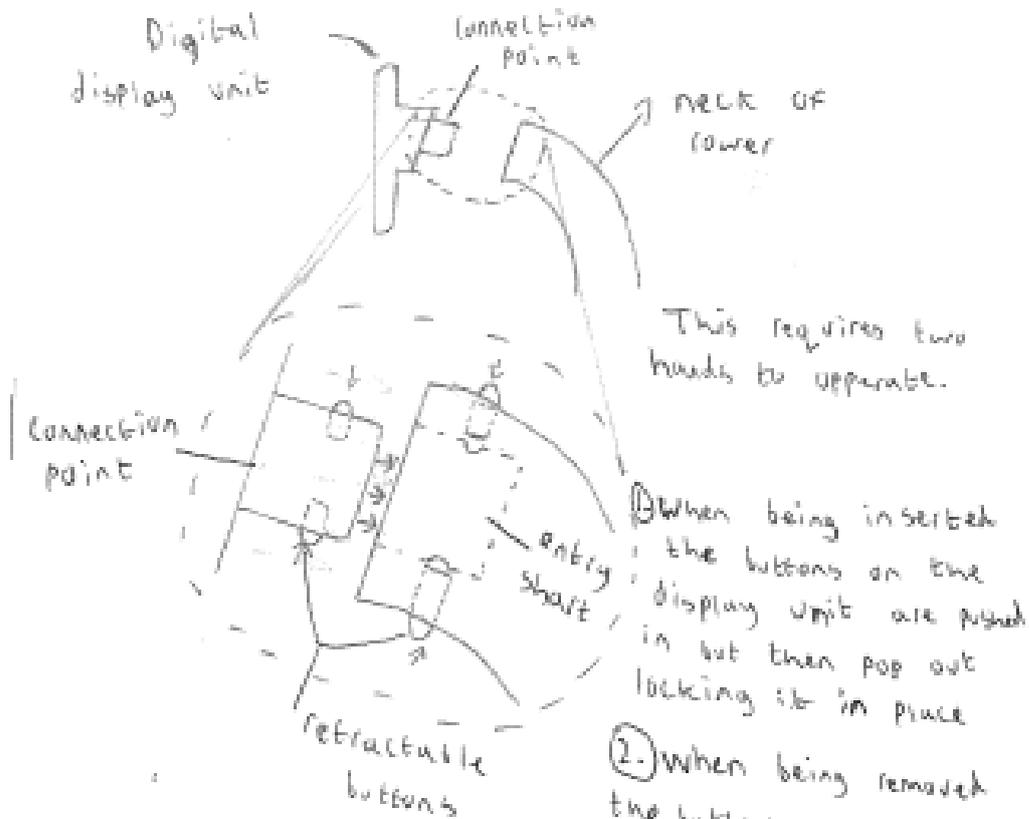
Detail contained in the sketches [4]

Quality of sketches [4]

Annotation [4]

Show your response to Question 4 in the space below.

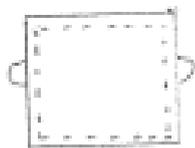
Student's response



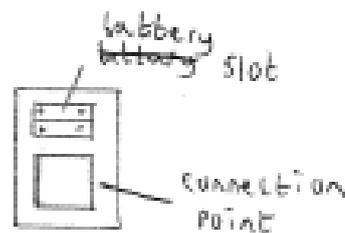
① When being inserted the buttons on the display unit are pushed in but then pop out locking it in place

② When being removed the buttons on the neck are pressed, this pushes in the display unit's buttons allowing it to be grabbed and pulled out.

③ The walls of the shaft keep the buttons of the display unit pushed in as it travels through.



The connection point and shaft are both empty this allows any electrical wiring to be hidden here if necessary



Examiner's comments

The candidate has provided excellent detail within the sketches to show how the display unit can be removed from the row machine. The quality of sketching and annotation shows good understanding of the removal and secure attachment of the digital display unit with mostly relevant points. There are good quality sketches of the component and good use of appropriate technical vocabulary. A total of 10 marks have been awarded.

Q5 The rowing machine is manufactured to meet strict quality control standards. Identify **two** quality control checks that could be carried out on the rowing machine by the manufacturer. Discuss how each check will help to ensure the safety of the user. [10]

Quality of written communication will be assessed in this question.

Student's response

Routin inspection of the rowing machine parts. Have a manufactur manager or designer measure and anylyses the parts of the machine at different stages of development. This way defects can easily be found and eliminated, as well as parts that are too loose and come apart too easily. This can prevent faulty or disfunctioning parts from reaching the consumer. This way accidents caused by the machines lack of quality rather than improper use can be avoided. Preforming practice test on a few machines from each batch can also give a general idea of the functionality of the whole group. The company could create and use legislated and standardised upper and lower limits to find out the best ratio for the machine. By performing practice test on parts as well as completed products they can ensure that the machine is not too weak or too resistant. Test can also ensure the product reaches a certain factor of safety. This ensure that consumers use the product won't be harmed while putting their whole weight onto the main frame.

Examiner's comments

The candidate has provided a good response to this question. They have identified two quality control checks that could be carried out on the rowing machine by the manufacturer. They have discussed in some detail how each check will help to ensure the safety of the user. There are some issues in relation to the accuracy of spelling and punctuation throughout. Eight marks awarded.

Section B

Q6a State the name of the mechanical components shown in **Fig. 6**. [1]



Fig. 6

© GLYPHstock/iStock ID: 678318770

Student's response

Gears

Examiner's comments

The candidate has correctly stated the name of the mechanical components shown in figure 6. One mark awarded.

Q6b Fig. 7 shows a symbol of mechanical components. [1]

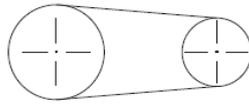


Fig. 7

© CCEA

Identify the mechanical components shown in **Fig. 7**.

Student's response

Pully and rope

Examiner's comments

The candidate has not correctly identified the mechanical components shown in figure 7. The response is not worthy of credit.

Q6c Outline **two** reasons why the mechanical components shown in **Fig. 7** are more suitable than the mechanical components in **Fig. 6** when used as the drive system within a pillar drill.

Student's response

1. *there is less friction and is thus easier to reverse direction* [1]
2. *requires less lubricant and maintenance* [1]

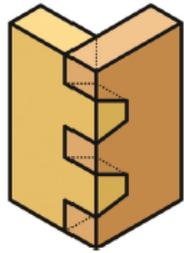
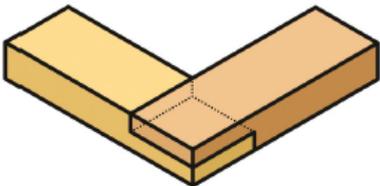
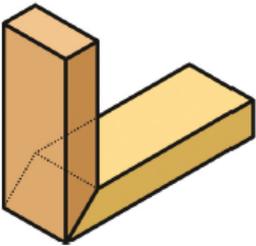
Examiner's comments

The candidate has correctly outlined one reason why the mechanical components shown in figure 7 are more suitable than the mechanical components shown in figure 6 when used as a drive system within a pillar drill. One mark awarded.

Q6d Complete **Table 2** by stating the name of each of the wood joints.

Table 2

Student's response

	Wood Joint	Name of Wood Joint
(i)	 <p>© iStock 185314207</p>	<p><i>Tenon joint</i></p> <p>[1]</p>
(ii)	 <p>© iStock 185314207</p>	<p><i>half-cut joint</i></p> <p>[1]</p>
(iii)	 <p>© iStock 185314207</p>	<p><i>draft joint</i></p> <p>[1]</p>

Examiner's comments

- 6d(i)** The candidate has not successfully completed Table 2 by stating the name of the wood joint. The response is not worthy of credit.
- 6d(ii)** The candidate has not successfully completed Table 2 by stating the name of the wood joint. The response is not worthy of credit.
- 6d(iii)** The candidate has not successfully completed Table 2 by stating the name of the wood joint. The response is not worthy of credit.

Q7 Manufactured boards are often used in the construction of kitchen furniture. **Fig. 8** shows a kitchen work surface made from chipboard covered with melamine formaldehyde.



Fig. 8

Credit in4mal © iStock/Stock photo ID: 691683550

Q7a What type of polymer is melamine formaldehyde? [1]

Student's response

thermosetting plastic

Examiner's comments

The candidate has correctly identified melamine formaldehyde as a thermosetting plastic. One mark awarded.

Q7b Give **one** reason why this type of polymer is suitable for a kitchen work surface. [1]

Student's response

it is food hygenic

Examiner's comments

The candidate has not given one reason why this type of polymer is suitable for a kitchen work surface. The response is not worthy of credit.

Q7c Other than cost give **two** advantages of using manufactured board in the production of the kitchen work surface.

Student's response

1. *it is easy to work with and shape* [1]
2. *it can be given a number of desirable finishes* [1]

Examiner's comments

The candidate has provided one advantage of using manufactured board in the production of the kitchen work surface. Where the candidate has suggested that a number of desirable finishes can be applied, further information such as the use of veneers would accrue an additional mark. One mark awarded.

Q7d The total kitchen work surface measures 600 mm wide by 2.4 m long. Calculate the total surface area of the work surface. [2]

Show your working out in the space below.

$$600 \text{ mm} = 60 \text{ cm} = 0.6 \text{ m}$$

$$0.6 \times 2.4 = 1.44$$

Student's response

Answer 1.44 m^2

Examiner's comments

The candidate has correctly calculated the total surface area of the work surface. Two marks have been awarded.

Q8a Complete **Table 3** by stating a suitable material forming process for each of the examples given.

Student's response

Table 3

	Example	Material forming process
(i)	 <p>Lego Brick © natthanim/iStock/686481726</p>	<p><i>injection moulding</i></p> <p>[1]</p>
(ii)	 <p>PVC Pipes © Winai_Tepsuttinunun/iStock/185976574</p>	<p><i>horizontal extruding</i></p> <p>[1]</p>
(iii)	 <p>Plastic Sandwich Packaging © Anurug/iStock/186131219</p>	<p><i>rotational moulding</i></p> <p>[1]</p>
(iv)	 <p>Metal Toy Car © balsamert/iStock/91508235</p>	<p><i>casting</i></p> <p>[1]</p>

Examiner's comments

8a(i) The candidate has correctly completed Table 3 by stating a suitable material forming process for the example given. One mark awarded.

8a(ii) The candidate has correctly completed Table 3 by stating a suitable material forming process for the example given. One mark awarded.

8a(iii) The candidate has not correctly completed Table 3 by stating a suitable material forming process for the example given. The response is not worthy of credit.

8a(iv) The candidate has not correctly completed Table 3 by stating the specific material forming process for the example given. The response is not worthy of credit.

Q8b The toy car shown in **Fig. 9** is made from a metal alloy.



Fig. 9

© balsamert/iStock/91508235

Give **two** reasons why metals are alloyed.

Student's response

1. *to make metals with certain properties more affordable* [1]

2. *to give metals desired properties.* [1]

Examiner's comments

The candidate has given two reasons why metals are alloyed. Two marks awarded.

Q8c The watering can shown in **Fig. 10** has a galvanised finish applied to it. [4]



Fig. 10

Credit skodonnell © AlexRaths/Stock photo ID: 92364763

Describe the process of galvanising the metal watering can and briefly outline why it is a suitable finish. [4]

Student's response

Galvanising involves dipping the product in a bath of molten zinc. This coats the product in a layer of zinc. This creates a physical barrier that protects the product from weathering and can also prevent rusting by reacting instead of iron or steel through sacrificial protection.

Examiner's comments

The candidate has correctly outlined why galvanizing is a suitable finish for the watering can. They have also correctly identified that galvanizing involves dipping the product in a bath of molten zinc. Two marks awarded. Further information regarding the galvanising process such as cleaning the surface of the watering can and allowing the watering can to dry once dipped in the molten zinc would accrue the additional marks.

Q9 A traditional balance scale, used for weighing, is shown in **Fig. 11**.

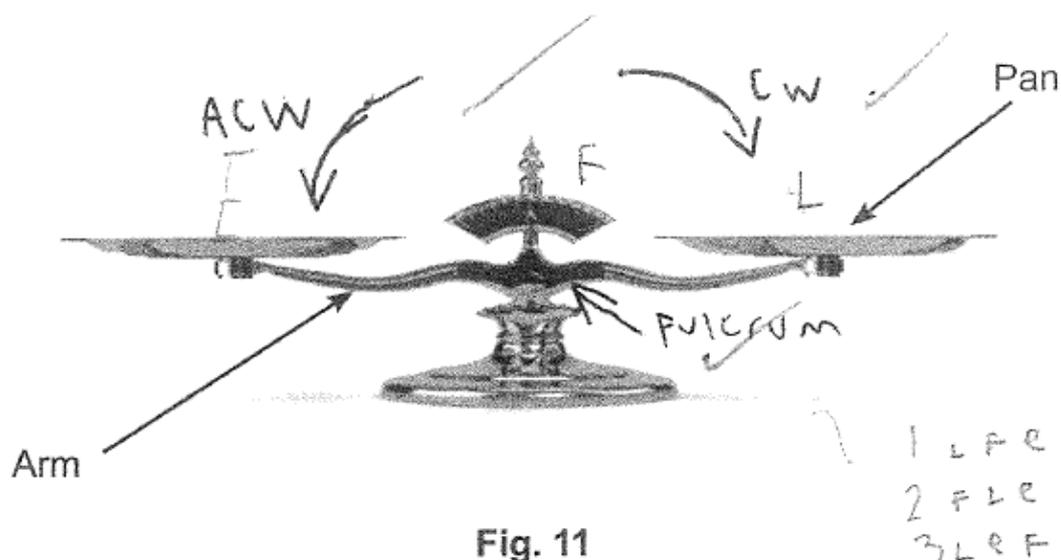


Fig. 11

© Bet_Noire Stock photo ID: 816223384

Q9a State the name of the mechanical system used in the scale shown in **Fig. 11**. [1]

Student's response

Type 1 lever

Examiner's comments

The candidate has correctly stated the name of the mechanical system used in the scale shown in Figure 11. One mark awarded.

Q9b Label the location of the fulcrum in **Fig. 11**. [1]

Examiner's comments

The candidate has correctly located the fulcrum in Figure 11. One mark awarded.

Q9c(i) Draw an arrow on **Fig. 11** to show the direction of the clockwise moment (CW) on the traditional scales. Label it CW. [1]

Examiner's comments

The candidate has correctly drawn an arrow on Figure 11 to show the direction of the clockwise moment on the traditional scales. One mark awarded.

Q9c(ii) Draw an arrow on **Fig. 11** to show the direction of the anticlockwise moment (ACW) on the traditional scales. Label it ACW. [1]

Examiner's comments

The candidate has correctly drawn an arrow on Figure 11 to show the direction of the anti-clockwise moment on the traditional scales. One mark awarded.

Q9d A beam is balanced in **Fig. 12**. A force of 6 N and an unknown force are positioned as shown.

Calculate the value of the unknown force when the beam is balanced. [2]

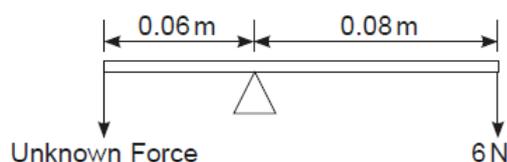


Fig. 12

© Chief Examiner

Show your working out in the space below.

$$\begin{aligned} \text{ACW} &= \text{CW} \\ 0.06 \times F &= 0.08 \times 6 \\ 0.06F &= 0.48 \\ F &= \frac{0.48}{0.06} = 8 \end{aligned}$$

Student's response

Answer 8 N

Examiner's comments

The candidate has correctly calculated the value of the unknown force in Figure 12 when the beam is balanced. Two marks awarded.

Q9e Fig. 13 shows a component used to join parts of the traditional balance scale.



Fig. 13

© Cuddy iStock photo ID: 863752890

Q9e(i) State the name of the joining method that uses the component shown in **Fig. 13**. [1]

Student's response

riveting

Examiner's comments

The candidate has correctly stated the name of the joining method that uses the components shown in Figure 13. One mark awarded.

Q9e(ii) Give **two** reasons why this method of joining may be suitable for attaching the pans to the arms of the traditional balance scale.

Student's response

1. *it is a permant method ensuring a strong, sturdy attachment* [1]
2. *it can easily attach one flat surface to another* [1]

Examiner's comments

The candidate has given two reasons why riveting maybe a suitable method of attachment for the pans to the arms on the traditional balance scale. Two marks awarded.

Q10a Complete **Table 4** by inserting the missing material type, process and items of equipment. [4]

Student's response

Table 4

Material Type	Process	Item of Equipment
Metal	Cut an internal thread	<i>Inside tap die</i>
<i>Wood</i>	Mark a line parallel to a straight edge	Marking Gauge
Metal	<i>creates an indent in the metal, by applying force with a hammer</i>	Centre Punch
Wood	Apply force to wood chisel to cut tenon joint	<i>rubber mallet</i>

Examiner's comments

The candidate has not identified the correct item of equipment used to cut an internal thread. The response is not worthy of credit.

The candidate has correctly identified wood as the material type used with a marking gauge. One mark awarded.

The candidate has correctly described the process of centre punching metal. One mark awarded.

The candidate has unsuccessfully identified the item of used to apply force to a wood chisel when cutting tenon joints. The response is not worthy of credit.

A total of two marks were awarded for this question.

Q10b Micrometers and vernier calipers are two items of equipment used to check the dimensional accuracy of products.
Outline **two** functional differences between micrometers and vernier calipers.

Student's response

1. *vernier calipers check outside width while micrometers check the inside width.*[1]
2. *Vernier calipers use two prongs to go around material while micrometers must fit inside a gap.* [1]

Examiner's comments

The candidate has outlined one functional difference between micrometers and vernier caliper. One mark awarded.

Q10c Dimensional tolerances are applied to many engineered products.
Explain **three** ways that wider dimensional tolerances can reduce production costs.

Student's response

1. *there are less defects that are removed so more products can be sold* [1]
2. *there is less waste produced by defects* [1]
3. *less caution is needed increasing speed of production* [1]

Examiner's comments

The candidate has explained one way that wider dimensional tolerances can reduce production costs. The additional responses offered by the candidate are not worthy of credit. Fewer defects are not a direct result of widening dimensional tolerances and in this case the responses offered by the candidate are insufficient. One mark awarded.

Q11 In the manufacturing industry, CNC machines are used to produce parts for products.

Q11a(i) One type of CNC machine is a laser cutter.

Give **two** specific disadvantages of using laser cutters to produce plastic parts compared to manually making them.

Student's response

1. *it sings and burns the material requirering an extra finish* [1]

2. *laser requires higher amounts of energy to create the needed temperature* [1]

Examiner's comments

The candidate has given one specific disadvantage of using laser cutters to produce plastic parts compared to manually making them. The response offered in relation to higher energy volumes is not worthy of credit. One mark awarded.

Q11a(ii) Other than laser cutters, state **two** CNC machines that are used in the manufacturing industry.

Student's response

1. *CNC latthes* [1]

2. *3D printers* [1]

Examiner's comments

The candidate has stated two CNC machines that are used in the manufacturing industry. Two marks awarded.

Q11b Other than improved accuracy, outline **two** specific advantages of using CNC machines to make parts for products compared to manually making them. [2]

Student's response

It can reduce waste as parts can be visualised before manufacture.

Less workers are needed reducing direct labour cost.

Examiner's comments

The candidate has correctly outlined one specific advantage of using CNC machines to make parts for products. The advantages offered through visualization before manufacture are as a result of the use of computer aided design not that of CNC machines. One mark awarded.

Q11c Outline **three** reasons why a newly created manufacturing company may choose not to purchase CNC equipment within their first year of business. [3]

Student's response

If one breaks down it can drastically slow production where as a different human could just be used. Expensive and requires large investment. Machines can't adapt and react to anomalies.

Examiner's comments

The candidate has outlined one reason why a newly created manufacturing company may choose not to purchase CNC equipment within their first year of business. Other elements of the response do not address the specifics of the question relating to the newly created manufacturing company. One mark awarded.

