Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2019

Engineering and Manufacturing

Unit 3

assessing

Materials, Processes and Systems

GEM31

[GEM31]

THURSDAY 13 JUNE, MORNING

TIME

2 hours.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Write your answers in the spaces provided in this question paper.
Answer **all eleven** questions.
Answer **all** questions in Sections **A** and **B**.
Questions 1, 2, 3, 4 and 5 of Section A refer to the pre-release material, a copy of which has been provided for you.

You may use a calculator for this paper.
Quality of written communication will be assessed in Question **5**.

INFORMATION FOR CANDIDATES

The total mark for this paper is **100**.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each part question.

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
Total Marks	

Answer **all** questions

Examiner Only	
Marks	Remark

Section A

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

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

_____ [1]

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

_____ [1]

(b) 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]

(c) The rowing machine is labelled with the symbol shown in **Fig. 1**.

Fig. 1

© undefined undefined / istock / Thinkstock

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

_____ [1]

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

_____

_____ [1]

Examiner Only	
Marks	Remark

(d) 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

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

_____ [1]

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

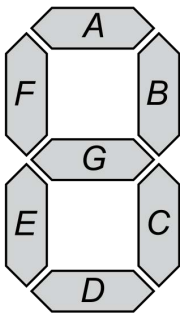

Fig. 3

Source: Public Domain https://commons.wikimedia.org/wiki/File:7_Segment_Display_with_Labeled_Segments.svg

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.

Table 1

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

[1]

Examiner Only	
Marks	Remark

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

1. _____

_____ [1]

2. _____

_____ [1]

(b) State **two** benefits of using an assembly line in the production of the rowing machine.

1. _____

_____ [1]

2. _____

_____ [1]

(c) **(i)** Outline what is meant by the term direct cost in relation to the manufacture of products.

_____

_____

_____ [1]

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

_____ [1]

(d) (i) Outline what is meant by the term indirect cost in relation to the manufacture of products.

_____

_____

_____ [1]

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

_____ [1]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

3 **(a)** 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**.

Show your working out in the space below.

Answer £ _____ [2]

(b) 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.

Show your working out in the space below.

Answer £ _____ [3]

(c) 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.

(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.

Answer _____ m^3 [4]

Examiner Only	
Marks	Remark

(d) 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.

Show your working out in the space below.

Answer _____ [3]

Examiner Only	
Marks	Remark

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(Questions continue overleaf)

Examiner Only	
Marks	Remark

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

Fig. 5

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.

Examiner Only	
Marks	Remark

5 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.

Quality of written communication will be assessed in this question.

[10]

Examiner Only	
Marks	Remark

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(Questions continue overleaf)

Section B

Examiner Only	
Marks	Remark

6 **(a)** State the name of the mechanical components shown in **Fig. 6**.

Fig. 6

_____ [1]

(b) **Fig. 7** shows a symbol of mechanical components.

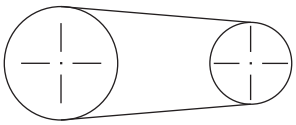


Fig. 7

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

_____ [1]

(c) 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.

1. _____

_____ [1]

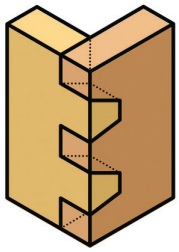
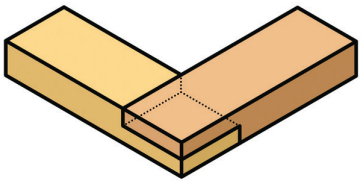
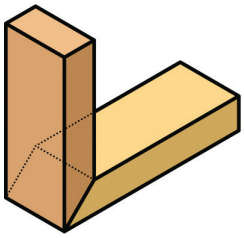
2. _____

_____ [1]

(d) Complete **Table 2** by stating the name of each of the wood joints.

Examiner Only	
Marks	Remark

Table 2

	Wood Joint	Name of Wood Joint
(i)	 © ZernLiew / iStock	[1]
(ii)	 © ZernLiew / iStock	[1]
(iii)	 © ZernLiew / iStock	[1]

Examiner Only	
Marks	Remark

7 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

(a) What type of polymer is melamine formaldehyde?

_____ [1]

(b) Give **one** reason why this type of polymer is suitable for a kitchen work surface.

_____ [1]

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

1. _____

_____ [1]

2. _____

_____ [1]

(d) The total kitchen work surface measures 600 mm wide by 2.4 m long. Calculate the total surface area of the work surface.

Show your working out in the space below.

Answer _____ m^2 [2]

Examiner Only	
Marks	Remark

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

Examiner Only	
Marks	Remark

Table 3

	Example	Material forming process
(i)	 Lego Brick © *natthanim / iStock*	[1]
(ii)	 PVC Pipes © *Winai_Tepsuttinun / iStock*	[1]
(iii)	 Plastic Sandwich Packaging © *Anurug / iStock*	[1]
(iv)	 Metal Toy Car © *balsamert / iStock*	[1]

(b) The toy car shown in **Fig. 9** is made from a metal alloy.

Examiner Only	
Marks	Remark

Fig. 9

© balsamert / iStock

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

1. _____

_____ [1]

2. _____

_____ [1]

(c) The watering can shown in **Fig. 10** has a galvanised finish applied to it.

Examiner Only	
Marks	Remark

Fig. 10

© AlexRaths / iStock

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

_____

_____

_____

_____

_____

_____

_____

_____ [4]

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(Questions continue overleaf)

Examiner Only	
Marks	Remark

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

Fig. 11

(a) State the name of the mechanical system used in the scale shown in **Fig. 11**.

_____ [1]

(b) Label the location of the fulcrum in **Fig. 11**. [1]

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

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

(d) 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.

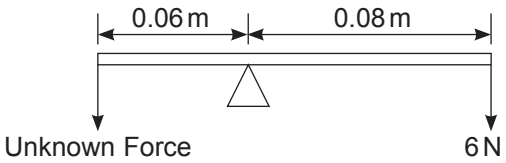

Fig. 12

Show your working out in the space below.

Answer _____ N [2]

(e) **Fig. 13** shows a component used to join parts of the traditional balance scale.

Fig. 13

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

_____ [1]

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

1. _____

_____ [1]

2. _____

_____ [1]

Examiner Only

Marks	Remark

10 (a) Complete **Table 4** by inserting the missing material type, process and items of equipment.

Examiner Only	
Marks	Remark

Table 4

Material Type	Process	Item of Equipment
Metal	Cut an internal thread	
	Mark a line parallel to a straight edge	Marking Gauge
Metal		Centre Punch
Wood	Apply force to wood chisel to cut tenon joint	

[4]

(b) 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.

1. _____

_____ [1]

2. _____

_____ [1]

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

1. _____

_____ [1]

2. _____

_____ [1]

3. _____

_____ [1]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

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

(a) (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.

1. _____

_____ [1]

2. _____

_____ [1]

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

1. _____ [1]

2. _____ [1]

(b) Other than improved accuracy, outline **two** specific advantages of using CNC machines to make parts for products compared to manually making them.

_____

_____

_____

_____ [2]

(c) Outline **three** reasons why a newly created manufacturing company may choose not to purchase CNC equipment within their first year of business.

_____

_____

_____

_____

_____ [3]

THIS IS THE END OF THE QUESTION PAPER

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THURSDAY 13 JUNE, MORNING

Pre-Release Material

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Fig. 1, **Fig. 2** and **Fig. 3** show a rowing machine.

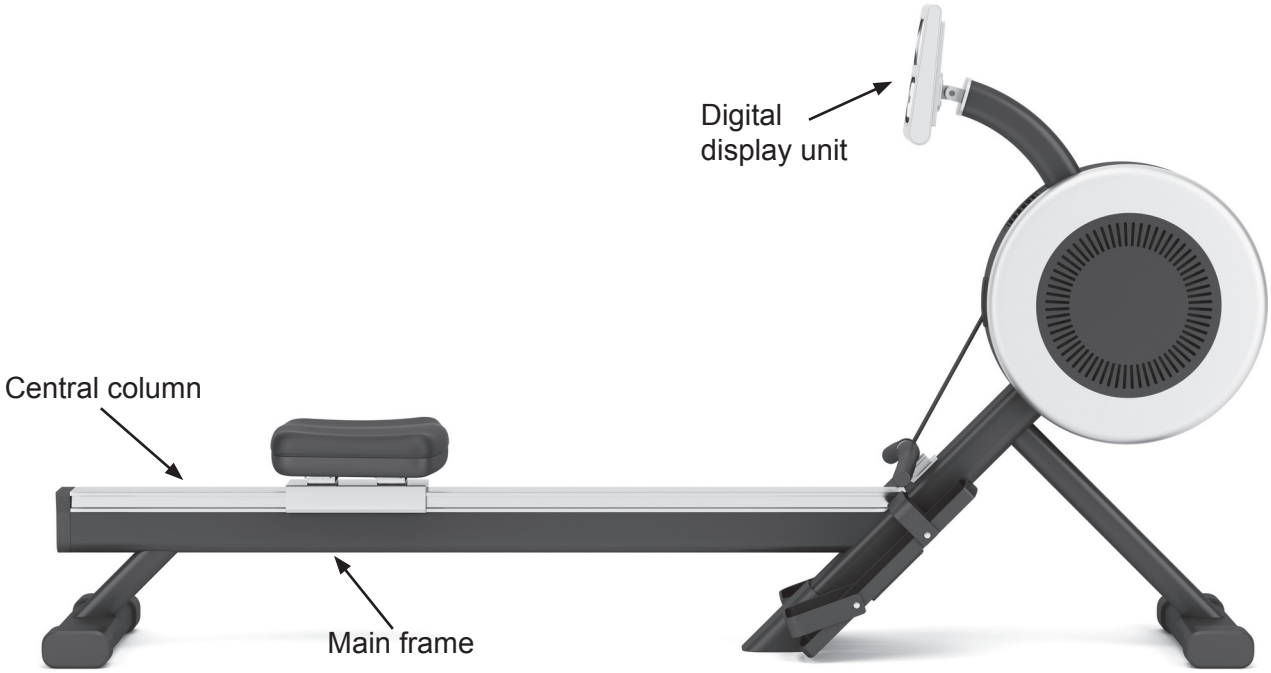

Fig. 1

Fig. 2

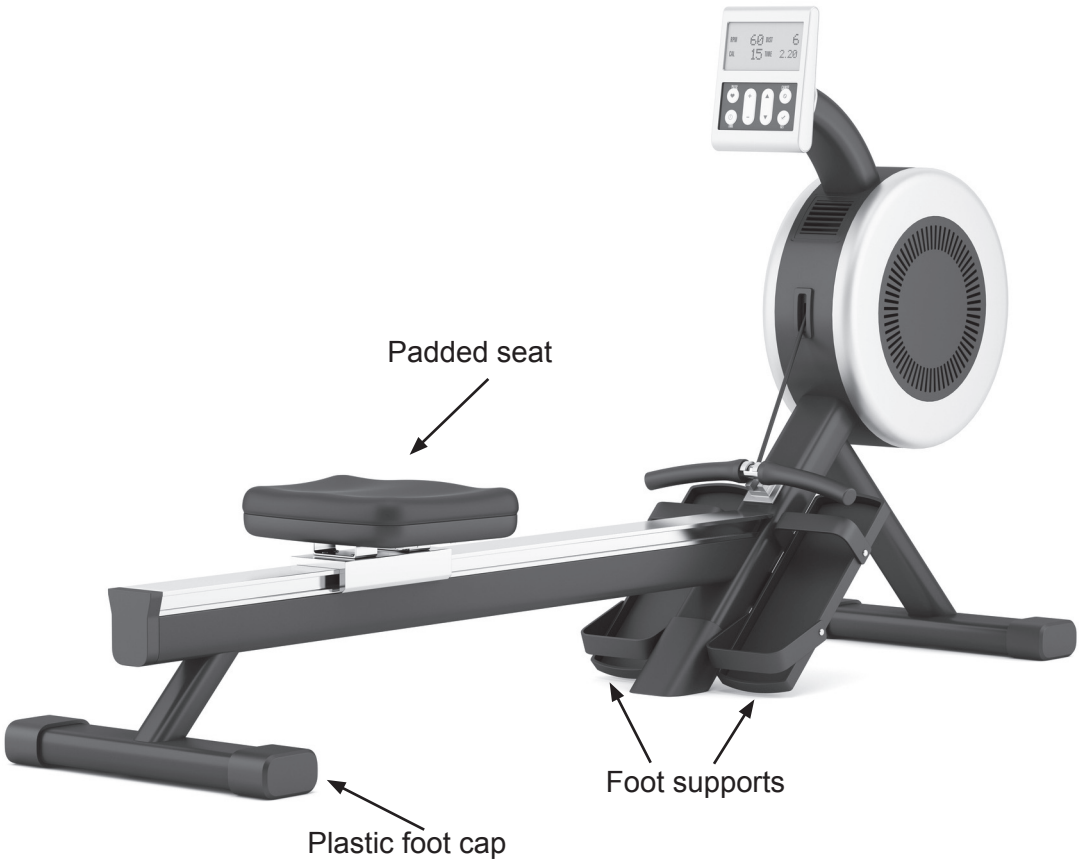

Fig. 3

Product features include:

- Extruded low carbon steel main frame;
- Padded seat that slides along a central low carbon steel column;
- Digital display unit;
- Plastic foot supports;
- Stainless steel flywheel guard;
- Eight-level digitally adjustable resistance system;
- Foam covered pull handle; and
- Dimensions (assembled) – Height (840 mm), Length (1340 mm), Width (410 mm).

Pre-release investigation:

You should investigate the possible impact and use of the following, where appropriate, in the design and production of the rowing machine:

- Materials and components: including application, properties, form, supply and types of finish;
- Manufacturing processes: including joining, assembly and the use of standard parts;
- Quality control and assurance; and
- Costing: including direct and indirect costs incurred in the manufacture of the rowing machine.