



Rewarding Learning

**General Certificate of Secondary Education
2023**

Engineering and Manufacturing

Unit 3

assessing

Materials, Processes and Systems

[GEM31]

WEDNESDAY 21 JUNE, MORNING

**MARK
SCHEME**

General Marking Instructions

Introduction

Mark schemes are intended to ensure that the GCSE examinations are marked consistently and fairly. The mark schemes provide markers with an indication of the nature and range of candidates' responses likely to be worthy of credit. They also set out the criteria which they should apply in allocating marks to candidates' responses. The mark schemes should be read in conjunction with these general marking instructions.

Assessment objectives

Below are the assessment objectives for GCSE Engineering and Manufacturing.

Candidates must:

- AO1** Recall, select and communicate their knowledge and understanding of engineering and manufacturing in a range of contexts;
- AO2** Apply skills, knowledge and understanding, including quality standards in a variety of design contexts. Plan and carry out investigations and making tasks involving an appropriate range of tools, equipment, materials and processes; and
- AO3** Analyse and evaluate evidence, design proposals and outcomes, make reasoned judgements and present conclusions and recommendations.

Quality of candidates' responses

In marking the examination papers, examiners should be looking for a quality of response reflecting the level of maturity which may reasonably be expected of a 16-year-old which is the age at which the majority of candidates sit their GCSE examinations.

Flexibility in marking

Mark schemes are not intended to be totally prescriptive. No mark scheme can cover all the responses which candidates may produce. In the event of unanticipated answers, examiners are expected to use their professional judgement to assess the validity of answers. If an answer is particularly problematic, then examiners should seek the guidance of the Supervising Examiner.

Positive marking

Examiners are encouraged to be positive in their marking, giving appropriate credit for what candidates know, understand and can do rather than penalising candidates for errors or omissions. Examiners should make use of the whole of the available mark range for any particular question and be prepared to award full marks for a response which is as good as might reasonably be expected of a 16-year-old GCSE candidate.

Awarding zero marks

Marks should only be awarded for valid responses and no marks should be awarded for an answer which is completely incorrect or inappropriate.

Types of mark schemes

Mark schemes for tasks or questions which require candidates to respond in extended written form are marked on the basis of levels of response which take account of the quality of written communication.

Other questions which require only short answers are marked on a point for point basis with marks awarded for each valid piece of information provided.

Levels of response

Tasks and questions requiring candidates to respond in extended writing are marked in terms of levels of response. In deciding which level of response to award, examiners should look for the 'best fit' bearing in mind that weakness in one area may be compensated for by strength in another. In deciding which mark within a particular level to award to any response, examiners are expected to use their professional judgement. The following guidance is provided to assist examiners.

- **Threshold performance:** Response which just merits inclusion in the level and should be awarded a mark at or near the bottom of the range.
- **Intermediate performance:** Response which clearly merits inclusion in the level and should be awarded a mark at or near the middle of the range.
- **High performance:** Response which fully satisfies the level description and should be awarded a mark at or near the top of the range.

Marking calculations

In marking answers involving calculations, examiners should apply the "own figure rule" so that candidates are not penalised more than once for a computational error.

Quality of written communication

Quality of written communication is taken into account in assessing candidates' responses to all tasks and questions that require them to respond in extended written form. These tasks and questions are marked on the basis of levels of response. The description for each level of response includes reference to the quality of written communication.

For conciseness, quality of written communication is distinguished within levels of response as follows:

Level 1: Quality of written communication is basic.

Level 2: Quality of written communication is satisfactory.

Level 3: Quality of written communication is good.

Level 4: Quality of written communication is excellent.

In interpreting these level descriptions, examiners should refer to the more detailed guidance provided below:

Level 1 (Basic): The level of accuracy of the candidate's spelling, grammar and punctuation is basic. The candidate makes a limited selection and use of an appropriate form and style of writing. There is little use of specialist vocabulary.

Level 2 (Satisfactory): The level of accuracy of the candidate's spelling, grammar and punctuation is satisfactory. The candidate makes a satisfactory selection and use of an appropriate form and style of writing. There is some use of specialist vocabulary.

Level 3 (Good): The level of accuracy of the candidate's spelling, grammar and punctuation is good. The candidate makes a good selection and use of an appropriate form and style of writing supported with good use of diagrams as required. There is good use of specialist vocabulary.

Level 4 (Excellent): The level of accuracy of the candidate's spelling, grammar and punctuation is excellent. The candidate successfully selects and uses the most appropriate form and style of writing. There is excellent use of appropriate specialist vocabulary.

Section A

**AVAILABLE
MARKS**

- 1 (a)** Any **one** from the list below:
- High strength to weight ratio
 - Can be easily shaped
- (1 × [1]) [1]

Accept:
durable, high tensile strength, strong

Do not accept:
tough, malleable, “non corrosive” or lightweight

Correct alternative responses will be given credit.

- (b) (i)** Any **one** from the list below:
- Manufactured as one piece
 - Quick to mass produce
- Accept:
large number of parts, complex shapes
quick/fast
(1 × [1]) [1]

Correct alternative responses will be given credit.

- (ii)** hopper [1], screw/heater [1], mould/ram [1], for labels [1]
(4 × [1]) [4]

- (c) (i)** Microswitch
(1 × [1]) [1]

- (ii)** Generates mechanical force in the form of rotation
any reference to blades spinning/turning or to power blade
(1 × [1]) [1]

Correct alternative responses will be given credit.

- (iii)** Any **two** from the list below:
- Lawnmower recall
 - Criminal prosecution
 - Legal action from consumers to recover damages
- (2 × [1]) [2]

Accept:
cost of fixing faulty goods
cost of repair/rework
could cause injury to the user

Correct alternative responses will be given credit.

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- 2 (a) Any **two** from the list below:
- High volume of lawnmowers produced
 - Low labour costs
 - Lawnmower manufacture is suited to automation
- (2 × [1]) [2]
- Accept:
quick, all products the same/similar
- Correct alternative responses will be given credit.**
- (b) Any **two** from the list below:
- Orders materials necessary for manufacture
 - Manages the positioning of materials and components to the correct points in the process
 - Quality control is tracked during each phase of development
- (2 × [1]) [2]
- Reference to designing not accepted
- Correct alternative responses will be given credit.**
- (c) (i) Tolerance is the acceptable deviation from an intended dimension.
(1 × [1]) [1]
- Correct alternative responses will be given credit.**
- (ii) Any **one** from the list below:
- To ensure parts fit together
 - To ensure the product works safely as designed
- (1 × [1]) [1]
- Do not accept:
parts being strong enough
- Correct alternative responses will be given credit.**
- (d) • Vernier calipers
• Micrometer
(2 × [1]) [2]
- Accept: digital calipers
Do not accept: go/no go gauge
- Correct alternative responses will be given credit.**
- 3 (a) $\frac{942}{3.14} = 300$ [1] – 10 = 290 [1]
(2 × [1]) [2]
- Using pi gets answer of 289.85. Mark as correct
- (b) 1.3m = 1300mm [1]
1 length = 2 long tubes
1 length = 4 short tubes [1]
5 lawnmowers = 10 long + 5 short [1]
Minimum required 7 lengths [1]
(4 × [1]) [4]
- (c) Unit cost when making 1 lawnmower = 20 + 17 + 35 = £72 [1]
Unit cost when making 200 lawnmowers = 12 + 9 + 24 = £45 [1]
Money saved = 72 – 45 = £27 [1]
Percentage saved = $(27/72) \times 100 = 37.5\%$ [1]
(4 × [1]) [4]

AVAILABLE
MARKS

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- 4 Possible solutions could include:
- Lever attached to offset rear wheels
 - Holes positioned in an arc formation providing adjustment heights
 - Spring or tension system to secure at various heights

Correct alternative responses will be given credit.

Response Type	Description	Mark Band
	Level of response not worthy of credit	0
Basic	Basic detail of how the deck is moved and held at different heights with few relevant points. Basic quality sketches of the lever and deck height adjustment system. Basic annotation and use of technical vocabulary.	[1]–[3]
Satisfactory	Satisfactory detail of how the deck is moved and held at different heights with some relevant points. Satisfactory quality sketches of the lever and deck height adjustment system. Satisfactory annotation and use of technical vocabulary.	[4]–[6]
Good	Good detail of how the deck is moved and held at different heights with most relevant points. Good quality sketches of the lever and deck height adjustment system. Good annotation and use of technical vocabulary.	[7]–[9]
Excellent	Excellent detail of how the deck is moved and held at different heights with all relevant points. Excellent quality sketches of the lever and deck height adjustment system. Excellent annotation and use of technical vocabulary.	[10]–[12]

[12]

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AVAILABLE
MARKS

5 Indicative content:

Hardening process: The metal is heated [1] above upper critical limit [1] and immediately quenched [1] in water or oil.

Identification and discussion of appropriate reasons for hardening the blade

- Suitable for sharpening
- The hardened blade will retain its sharpness for longer
- The hardened blade edge will resist wear and indentation better.

[1] to identify [2] to discuss

Correct alternative responses will be given credit.

Response Type	Description	Mark Band
	Level of response not worthy of credit	0
Basic	Basic explanation of the process of hardening. Limited discussion of two reasons for hardening the blade. The level of accuracy of spelling, punctuation and grammar is basic in most cases. Form and style is generally inappropriate as is the use of specialist terms and technical vocabulary.	[1]–[3]
Satisfactory	Satisfactory explanation of the process of hardening. Some discussion of two reasons for hardening the blade. The level of accuracy of spelling, punctuation and grammar is satisfactory in most cases. Form and style is generally appropriate as is the use of specialist terms and technical vocabulary.	[4]–[5]
Good	Good explanation of the process of hardening. Good discussion of two reasons for hardening the blade. The level of accuracy of spelling, punctuation and grammar is good in most cases. Form and style is generally appropriate as is the use of specialist terms and technical vocabulary.	[6]–[8]
Excellent	Excellent explanation of the process of hardening. Excellent discussion of two reasons for hardening the blade. The level of accuracy of spelling, punctuation and grammar is excellent in most cases.	[9]–[10]

[10]

Section A

AVAILABLE MARKS

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Section B

AVAILABLE MARKS

- 6 (a) Buzzer
3rd class lever
Five port valve (5/2 valve)
1st class lever
(4 × [1]) [4]
- (b) (i) Microswitch
(ii) Compound gear system
(iii) Flow control valve
(iv) Linkage
(4 × [1]) [4]
- Allow “gear train” not “gear box”
Accept: flow regulator and unidirectional flow restrictor
Correct alternative responses will be given credit.
- (c) The function of a reservoir in a pneumatic circuit is to temporarily store air [1] in order to help to create a time delay [1].
(2 × [1]) [2]
- Correct alternative responses will be given credit.**
- 7 (a) $800\text{ N} \times 1.8\text{ m} = 1200\text{ N} \times X\text{ m}$
 $\frac{1440}{1200} = 1.2\text{ m}$ [1]
Answer = 120 cm [1]
(2 × [1]) [2]
- (b) The process involves using finely ground particles of pigment and resin. [1]
They are electrostatically charged and sprayed onto electrically grounded parts. [1]
The charged powder adheres to the part and are held there until melted and fused in a curing oven. [1]
“prepare surface”/“clean surface” [1]
(3 × [1]) [3]
- Correct alternative responses will be given credit.**
- (c) Give **two** main reasons why oak is a suitable material for the beam, for example:
 - Good strength.
 - A high level of water resistance.
 - Highly resistant to attack by insects or fungi.
(2 × [1]) [2]
- Accept: hard/durable/tough/aesthetically pleasing/long lasting
Correct alternative responses will be given credit.
- (d) **Two** specific industrial machine processes that the beam would undergo in order to achieve the desired profile.
 - Circular saw – to reduce from 16 cm to 13 cm. [1]
 - CNC/router – to generate the 1 cm radius profile. [1]
Accept: router/hand router
(2 × [1]) [2]
- Correct alternative responses will be given credit.**

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			AVAILABLE MARKS
8	<p>(a) The difference between a hardwood and a softwood is that hardwood comes from deciduous trees which lose their leaves annually [1]. Softwood comes from conifers, which usually remain evergreen [1]. (2 × [1])</p> <p>Correct alternative responses will be given credit.</p> <p>(b) Any two reasons why MDF is a suitable material for the computer desk, for example:</p> <ul style="list-style-type: none"> • Good strength. • MDF is easy to cut and screw into place. • MDF offers a great range of different laminate and veneer finishes. <p>(2 × [1])</p> <p>Accept: doesn't warp/stable/cheap/available in large sheets/durable</p> <p>Correct alternative responses will be given credit.</p> <p>(c) (i) Volume of the sheet = $2.4 \times 1.22 \times 0.012$ [1] Answer = 0.035 m^3 [1] (2 × [1])</p> <p>(ii) Density of the Plywood sheet = $20/0.05$ [1] Answer = 400 kg/m^3 [1] (2 × [1])</p>	<p>[2]</p> <p>[2]</p> <p>[2]</p> <p>[2]</p>	8
9	<p>(a) PVC Turning Aluminium alloy Blow moulding (4 × [1])</p> <p>Accept: polymer/plastic/other named thermoplastic material, lathe</p> <p>Correct alternative responses will be given credit.</p> <p>(b) Any two reasons why polypropylene is a suitable material for the plastic bottles, for example:</p> <ul style="list-style-type: none"> • It is a durable plastic. • It does not react with water or detergents. • It is a suitable plastic for the blow moulding process. <p>(2 × [1])</p> <p>Accept: lightweight/can be recycled/waterproof/leak proof Do not accept: tough or cheap</p> <p>Correct alternative responses will be given credit.</p> <p>(c) British Standards Institution</p> <p>(d) Any two properties of aluminium alloy for example:</p> <ul style="list-style-type: none"> • Good strength. • Lightweight material. • Durable <p>(2 × [1])</p> <p>Accept: corrosion resistant/weather resistant/tough Do not accept: hard(ness)</p> <p>Correct alternative responses will be given credit.</p>	<p>[4]</p> <p>[2]</p> <p>[1]</p> <p>[2]</p>	9

10 (a) Any **two** procedures which should be followed in the event of an accident, for example:

- Attend to the person by seeking medical assistance.
- Close-down and secure the site/equipment for further investigation.
- An accident report form should be completed.

(2 × [1]) [2]

“evacuate” must be qualified, not accepted on its own.

Correct alternative responses will be given credit.

(b) Go and no go gauges could use two female sections on a gauge to test the diameter of the bar. If the major diameter of the bar is too large, it will not fit in the GO end of the gauge at all (fail). [1] If it is too small, the fit is sloppy (fail). If the bar diameter has been cut too small, it fits in the no go end of the gauge (fail). [1]

(2 × [1]) [2]

Correct alternative responses will be given credit.

(c) (i) Direct costs

Identification [1] = Production workers wages £8,000
Materials £18,000

Answer = £26,000 [1]
 (2 × [1]) [2]

(ii) Indirect costs

Identification [1] = Heat, light maintenance £2,000
Marketing £3,000
Administration £2,400

Answer = £7,400 [1]
 (2 × [1]) [2]

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- 11 (a) • An assembly line is a manufacturing process in which parts are added to a product in a sequential manner to create the final product.
- The workers and machinery used to produce the item are stationary along the line and the product moves from start to finish.
 - The assembly line allows production to be carried out in small tasks.
- (2 × [1]) [2]

Accept: mistakes to be dealt with quickly to prevent stoppages
Do not accept: fast or quick

Correct alternative responses will be given credit.

- (b) Any **two** main benefits of using robotics in manufacturing, for example:
- They can complete tasks quickly and more efficiently.
 - They can undertake tasks deemed as too dangerous or laborious and repetitive for humans to carry out.
 - They can work 24/7.
- (2 × [1]) [2]

Do not accept: “workers don’t have to be paid” or similar reference.

Correct alternative responses will be given credit.

- (c) Any **two** factors related to the use of computer aided engineering, for example:
- Existing skills/training needs of the workforce.
 - Financial considerations.
 - Disruptions caused by the implementation of the new system.
- (2 × [1]) [2]

Correct alternative responses will be given credit.

Section B

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Total

100

**AVAILABLE
MARKS**

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