Rewarding Learning

General Certificate of Secondary Education

Engineering and Manufacturing

Unit 3

assessing

Materials, Processes and Systems

[GEM31]

Assessment

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, teachers 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, teachers are expected to use their professional judgement to assess the validity of answers. You must not draw inferences or interpret what you think the candidate has meant. Teachers should carefully read and consider every response.

Positive marking
Teachers 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. Teachers 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. Teachers are encouraged to use the full range of marks available.

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.

Bands of response
Tasks and questions requiring candidates to respond in extended writing are marked in terms of bands of response. In deciding which mark to award, teachers 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 band to award to any response, teachers are expected to use their professional judgement. The following guidance is provided to assist teachers.

- **Level 1:** Response which merits inclusion in the band and should be awarded one mark.
- **Level 2:** Response which merits inclusion in the band and should be awarded two marks.

Marking calculations
In marking answers involving calculations, teachers should apply the "error carried forward rule" so that candidates are not penalised more than once for a computational error. Award full marks if a candidate gives the correct answer but does not show the working out.

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 bands of response. The description for each band of response includes reference to the quality of written communication.

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

Band 1: Quality of written communication is basic.
Band 2: Quality of written communication is satisfactory.
Band 3: Quality of written communication is good.
Band 4: Quality of written communication is excellent.

In interpreting these level descriptions, teachers should refer to the more detailed guidance in question 5.

		AVAILABLE MARKS
1	**(a)** Any **two** from the list below: • High tensile strength • Lightweight • Available in a range of colours that make it visible • Waterproof • Durability: Good resistance to wear and tear (2 × [1]) [2] **Correct alternative responses should be given credit.**	
	(b) Any **one** from the list below: • Easily shaped • Semi-transparent/Transparent • Widely available • Electric insulator (1 × [1]) [1] **Correct alternative responses should be given credit.**	
	(c) **(i)**  (1 × [1]) [1]	
	(ii) Any **two** from the list below: • Longer service life • Lower power requirement • A red LED can be used as a warning light with no need for a coloured covering • LEDs are less sensitive to vibration • LEDs would be brighter than a single bulb and make the bicycle trailer more visible to other road users • The LEDs can be made to flash on and off, which increases the visibility of the bicycle trailer to other road users. • Low maintenance (2 × [1]) [2] **Correct alternative responses should be given credit.**	
	(d) **(i)** Vacuum forming (1 × [1]) [1]	
	(ii) Any **one** from the list below: • Suitable for thermoplastic • Multiple light covers could be made from one sheet of acrylic • Easy to produce a basic mould from medium density fibreboard (MDF) of the light cover • It is suitable for producing small numbers of units (1 × [1]) [1] **Correct alternative responses should be given credit.**	8
2	**(a)** Any **one** from the list below: • Extrusion produces a uniform cross sectional profile • Long lengths can be produced • It is good for self-assembly	

			AVAILABLE MARKS
	• Extruded tubing has a clean inside surface which enables the tubes to be sleeved together (1 × [1])	[1]	
	Correct alternative responses should be given credit.		
(b)	Any **two** from the list below: • Reduced raw material costs • It can be shaped and bent accurately as required • Reduces the weight of the bicycle trailer • Lightweight trailer is easier to tow • High stiffness • Good strength to weight ratio • Lower transport costs for the manufacturer (2 × [1])	[2]	
	Correct alternative responses should be given credit.		
(c) **(i)**	29.8 mm [1] – 30.2 mm [1] (2 × [1])	[2]	
(ii)	Any **two** from the list below: • External micrometer/micrometer • Vernier calipers • Go/no go gauge (2 × [1])	[2]	
	Correct alternative responses should be given credit.		
(iii)	• To ensure the acceptable accuracy of the product • To ensure the product parts fit together in an assembly • To ensure the product parts are interchangeable Any statement that reflects any of these answers is acceptable. (1 × [1])	[1]	8
	Correct alternative responses should be given credit.		
3 **(a)**	12 × £80 × 5 [1] = £4800 [1] Award full marks for a correct answer that does not show any working out. (2 × [1])	[2]	
(b)	£8760 + £1450 + £520 = £10730 [1] 8% of 10730 = £858.40 [1] Award full marks for a correct answer that does not show any working out. (2 × [1])	[2]	
(c)	£18400/46 = £400 [1] 20% of £400 = £80 [1] Price £480 [1] (3 × [1])		
	or		
	£18400/5 = £3680 [1] (£18400 + £3680)/46 [1] = £480 [1] Award full marks for a correct answer that does not show any working out. (3 × [1])	[3]	

(d) $\pi\ 10^2$ = [1] × 1200 = 376 991 mm^3 [1]
Assume π to be within the range 3.14 to 3.142
Award full marks for a correct answer that does not show any working out.
(2 × [1]) [2]

(e) Total material per piece = 115 + 2.4 = 117.4 [1]

1200/117.4 = 10 pieces [1]
1200 −1174 = 26 mm [1]
Award full marks for a correct answer that does not show any working out.
(3 × [1]) [3]

AVAILABLE MARKS

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4 Possible solutions could be:

- Spring loaded slide and pin mechanism
- Interlocking tubular bars – clip or locating clamp

Correct alternative responses should be given credit.

AVAILABLE MARKS

Band of Response	Marking Criteria	Marks
	Level of response is not worthy of credit.	**[0]**
Basic	Basic detail of the adjustment of the handle with few relevant points. Shows basic understanding of the securing method.	**[1]**
Satisfactory	Satisfactory detail of the adjustment of the handle with some relevant points. Shows satisfactory understanding of the securing method.	**[2]**
Good	Good detail of adjustment of the handle for different heights with most relevant points. Shows good understanding of the securing method.	**[3]**
Excellent	Excellent detail of the adjustment of the handle for different heights with all relevant points. Shows excellent understanding of the securing method.	**[4]**

Band of Response	Marking Criteria	Marks
	Level of response is not worthy of credit.	**[0]**
Basic	Basic quality sketches of the component.	**[1]**
Satisfactory	Satisfactory quality sketches of the component.	**[2]**
Good	Good quality sketches of the component.	**[3]**
Excellent	Excellent quality sketches of the component.	**[4]**

Band of Response	Marking Criteria	Marks
	Level of response is not worthy of credit.	**[0]**
Basic	Basic annotation and use of technical vocabulary.	**[1]**
Satisfactory	Satisfactory annotation and use of technical vocabulary.	**[2]**
Good	Good annotation and use of technical vocabulary.	**[3]**
Excellent	Excellent annotation and use of technical vocabulary.	**[4]**

[12] 12

5 Bands of response

AVAILABLE MARKS

Tasks and questions requiring candidates to respond in extended writing are marked in terms of bands of response. In deciding which mark to award, teachers 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 band to award to any response, teachers are expected to use their professional judgement. The following guidance is provided to assist teachers.

- **Level 1:** Response which merits inclusion in the band and should be awarded one mark.
- **Level 2:** Response which merits inclusion in the band and should be awarded two marks.

Indicative Content:
Identification of **two** safety features. Any **two** from the following:

1 Lighting system/wheel reflectors/flag
2 Safety harness
3 Steel frame
4 Universal coupler
5 Secure enclosed base of bicycle trailer
6 Enclosed compartment/cover for the user
7 Nylon cover
8 Axle location to ensure correct balance

(2 × [1]) [2]

Correct alternative responses should be given credit.

Safety for the user:

1 Clear visibility of users and other road users/traffic
2 Secure support of the users
3 Steel frame for security and may help prevent serious injury in the event of an accident. Providing protection to the occupant.
4 The bicycle trailer should be easy to securely attach and release from the bicycle. May help prevent serious injury in the event of an accident.
5 Reduce risk of user/clothing entanglement in wheel rotation
6 The user is encased and covered, to prevent injury to users (young children) hands.
7 Ease of removal of cover when needed/Protection from weather and debris from wheels and road/Reflective for cover for visibility to other road users.
8 Ease of use/stability.

Correct alternative responses should be given credit.

Band of Response	Marking Criteria	Marks
	Level of response is not worthy of credit.	**[0]**
Basic	Limited discussion points associated with the safety features and user safety are basic in content and explanation. 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]–[2]**
Satisfactory	Some discussion points associated with the safety features and user safety are satisfactory in content and explanation. 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.	**[3]–[4]**
Good	A range of discussion points associated with the safety features and user safety are good in content and explanation. 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.	**[5]–[6]**
Excellent	Detailed discussion points associated with the safety features and user safety are excellent in content and explanation. The level of accuracy of spelling, punctuation and grammar is excellent in most cases. Form and style is appropriate as is the use of specialist terms and technical vocabulary.	**[7]–[8]**

[8]

AVAILABLE MARKS

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Section B

AVAILABLE MARKS

6 **(a)** Valve A – Roller Trip **or** Roller [1]
Valve B – Plunger [1]
(2 × [1]) [2]

(b) Single acting cylinder **or** SAC
(1 × [1]) [1]

(c) The function of a shuttle valve is to allow air from either one [1] of two sources to engage with the next part of the circuit. [1]
(1 × [2]) [2]
Correct alternative responses should be given credit.

(d) The term 'factor of safety' refers to the margin (factor) above the calculated design load [1] to allow for unexpected events or overloading. [1]
(1 × [2]) [2]
Correct alternative responses should be given credit.

(e) Any **two** main characteristics associated with batch production for example:
- Fixed quantities of a product are manufactured to order
- The production line can be changed quickly so that different products can be made
- General purpose machines are used
- The use of templates, jigs and fixtures are employed
- The products can be tailored to specific customers

(2 × [1]) [2] 9
Correct alternative responses should be given credit.

7 **(a)** **(i)** A metal that contains iron
(1 × [1]) [1]

(ii) A material that can be heated and reshaped/formed
(1 × [1]) [1]

(iii) A material that is made from two or more materials each with different properties
(1 × [1]) [1]

(b) A material that reacts/changes [1] to external stimulus [1] such as e.g: heat, moisture, pressure, chemical reaction.
(1 × [2]) [2]
Correct alternative responses should be given credit.

(c) **(i)** 13 in row 1 [1] 2 rows maximum on sheet 26 [1] 4 will fit on remainder of sheet [1] 26 + 4 = 30 [1]
Award full marks for a correct answer that does not show any working out.
(1 × [4]) [4]

(ii) $60 \times 120 = 720000\,mm^2$ [1]
Award full marks for a correct answer that does not show any working out.
(1 × [1]) 10

				AVAILABLE MARKS
8	(a)	(i)	Toughness [1]	
		(ii)	Elasticity [1]	
		(iii)	Malleability [1]	
			(3 × [1]) [3]	
	(b)		To increase its ductility and reduce its hardness so that it is easier to work with. (1 × [1]) [1] **Correct alternative responses should be given credit.**	
	(c)		To relieve internal stresses [1] and to normalise the internal grain structure [1] (1 × [2]) [2] **Correct alternative responses should be given credit.**	6
9	(a)	(i)	Polypropylene **or** rigid polystyrene **or** PVC **or** ABS **or** acrylic. Accept any thermoforming plastic (1 × [1]) [1]	
		(ii)	Stamping **or** punching (1 × [1]) [1]	
		(iii)	Folding **or** bending (1 × [1]) [1]	
	(b)		Draft angles incline/taper a part of the mould [1] this enables easy removal of the part from the mould. [1] (1 × [2]) [2] **Correct alternative responses should be given credit.**	
	(c)		Quality assurance focuses on the management system of a company [1] **or** it focuses on the management system of a production line [1] and; whereas quality control is a process that focuses on inspecting parts and products to ensure they meet the required specification throughout the manufacture process. [1] **or** whereas quality control is a process that focuses on the inspection, control and quality of the components manufactured. [1] **or** whereas quality control is focused on the product. [1] (1 × [2]) [2] **Correct alternative responses should be given credit.**	8

		AVAILABLE MARKS
10 **(a)**	Computer Integrated Manufacture (1 × [1]) [1]	
(b)	Lathe 3D printer Milling machine (3 × [1]) [3]	
(c) **(i)**	Direct costs include those costs that can be clearly linked to the production of a single product. [1] whereas indirect costs include those costs that cannot be clearly linked to the production of a single product but are required to support the function of the company. [1] Responses must refer to the difference between the costs to attract marks. (1 × [2]) [2] **Correct alternative responses should be given credit.**	
(ii)	Any **one** from the list below: materials **or** labour **or** wages. (1 × [1]) [1] **Correct alternative responses should be given credit.**	
(d)	Any **two** from the list below: • Prototypes can be manufactured quickly • Accuracy of a prototype/part • Improves lead time • Reduces the need for manufacturing personnel • Good for making complex parts • Used in Research and Development • Used in the design of components (2 × [1]) [2] **Correct alternative responses should be given credit.**	8
11 **(a)** **(i)**	Pear shaped cam (1 × [1]) [1]	
(ii)	Capacitor (1 × [1]) [1]	
(iii)	Variable resistor (1 × [1]) [1]	
(iv)	Light-Emitting Diode **or** LED (1 × [1]) [1]	
(b)	The term mechatronic combines various branches of engineering [1] Reference to any **two** of the following for the second mark. Electrical, pneumatic, computer control and mechanical systems. [1] (1 × [2]) [2] **Correct alternative responses should be given credit.**	

		AVAILABLE MARKS
(c) Any **three** advantages that robotics offers: • They can lift small components and place them on a circuit board with accuracy • High speed accurate manufacturing process • It reduces the number of people required in the assembly line • Highly automated process which enables mass production • The machines can inspect and quality control the products/parts as they are manufactured • The machines enables a high speed assembly line to operate • They can assemble the circuit board within the base casing • They are programmed to assemble the product parts into a product. • They can be programmed to change the specification of the product • There is a continuous production process (3 × [1])	[3]	9
Correct alternative responses should be given credit.		
Total		**100**