Rewarding Learning

General Certificate of Secondary Education
2024

Engineering and Manufacturing

Unit 3

assessing

Materials, Processes and Systems

[GEM31]

THURSDAY 6 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)** **(i)** linkage
(1 × [1]) [1]

All relevant, valid responses will be given credit.

(ii) Aluminium alloy has a high strength to weight ratio [1]
Can be easily moulded or machined into complex shapes [1]
(1 × [2]) [2]

All relevant, valid responses will be given credit.

(b) **(i)** Stiffness is resistance to deformation [1]
by bending forces [1]
(1 × [2]) [2]

All relevant, valid responses will be given credit.

(ii) Fixtures are used to hold the component in a precise orientation for machining operations
(1 × [1]) [1]

All relevant, valid responses will be given credit.

(c) Main features may include:
Reservoir of molten metal.
Shot sleeve with ram.
Fixed and moveable dies.
Mould cavity.
Ejector pins.

Annotation may include:
Indication of suitable materials to be cast.
An outline of the moulding cycle.
Identification of the parts of the sketch.

Response type	Description	Marks
	Level of response not worthy of credit	**[0]**
Basic	A basic sketch of the main features of the pressure die casting process with some labels on the components of the process.	**[1]**
Satisfactory	A satisfactory sketch of the main features of the pressure die casting process with some appropriate annotation.	**[2]**
Good	A good sketch of the main features of the pressure die casting process with some appropriate annotation that is helpful in explaining the main features of the process.	**[3]**
Excellent	An excellent sketch of the main features of the pressure die casting process with some appropriate annotation that is helpful in explaining the main features of the process.	**[4]**

[4] 10

All relevant, valid responses will be given credit.

AVAILABLE MARKS

					AVAILABLE MARKS
2	**(a)**	**(i)**	Any **one** from the list below: • Electrical insulator • Tough material – impact resistant (1 × [1])	[1]	
			All relevant, valid responses will be given credit.		
		(ii)	Injection moulding. (1 × [1])	[1]	
			All relevant, valid responses will be given credit.		
		(iii)	Any **two** from the list below: • Wear eye protection • Ensure guards are correctly positioned • Check blade is in good condition (2 × [1])	[2]	
			All relevant, valid responses will be given credit.		
	(b)	**(i)**	A - Low carbon steel B - Aluminium alloy C - Nylon (3 × [1])	[3]	
			All relevant, valid responses will be given credit.		
		(ii)	80mm × 1.6 = 128mm (1 × [1])	[1]	8
3	**(a)**		£8000 + £430 + £470 = £8900 [1] £8900 / 2000 = £4.45 [1] £8000 × 0.85 = £6800 [1] £470 × 1.2 = £564 [1] £6800 + £564 + £430 = £7794 [1] £7794 / 2000 = £3.90 [1] £4.45 − £3.90 = £0.55 [1] (7 × [1])	[7]	
	(b)		2.7g × 120 = 324g [1] 5000g / 324g [1] = 15.432 = 15 Scroll saw tables. [1] (3 × [1])	[3]	10

4 Possible solutions could include:

- Attachments that allow the blade to pivot at each end.
- Consideration of blades with and without pins.
- Spring or tension system to adjust tension in the blade.
- A method to clamp or grip the blade at each end.

All relevant, valid responses will be given credit.

Response Type	Description	Mark Band
	Level of response not worthy of credit	**[0]**
Basic	Basic detail of how the blade is fitted with few relevant points. Basic quality sketches of the method used to attach the blade. Basic annotation and use of technical vocabulary.	**[1]–[3]**
Satisfactory	Satisfactory detail of how the blade is fitted with some relevant points. Satisfactory quality sketches of the method used to attach the blade. Satisfactory annotation and use of technical vocabulary.	**[4]–[6]**
Good	Good detail of how the blade is fitted with most relevant points. Good quality sketches of the method used to attach the blade. Good annotation and use of technical vocabulary.	**[7]–[9]**
Excellent	Excellent detail of how the blade is fitted with all relevant points. Excellent quality sketches of the method used to attach the blade. Excellent annotation and use of technical vocabulary.	**[10]–[12]**

[12]

AVAILABLE MARKS

12

5 Indicative content:

AVAILABLE MARKS

Advantages of CAD:
- Easy to edit, it will be much easier to make any changes.
- Reduction in errors in drawing due to error checking features in the software.
- Easier to save and store the files and share copies via email.

Disadvantages of CAD:
- Work can be lost because of the sudden breakdown of computers.
- High purchase cost for new systems.
- Time and cost of training the staff.

Advantages of CAM:
- Very efficient, reduces time taken to produce parts.
- Labour costs are lower.
- Can use CAD drawings to create parts with minimal programming.

Disadvantages of CAM:
- Initial cost of purchasing CAM is high.
- Expensive and lengthy training on how to use CAM machinery.
- May lead to changes in the labour force causing job losses.

Advantages of Robotics:
- Robotics can perform repetitive tasks for long periods of time, without errors.
- Robotic automation produces items to a higher standard of consistency.
- Robotic systems can operate in situations that are harmful to humans, removing the risk to human health.

Disadvantages of Robotics:
- A comprehensive business case must be built when considering the implementation of robotics to ensure the high cost can be recovered in an acceptable time span.
- Manufacturers may find it difficult to source skilled staff members to fill the specialised roles in their factories.
- Robotics will produce an increased volume of higher quality parts, but other areas of the business may not be able to keep up causing scheduling problems in the production.

All relevant, valid responses will be given credit.

Response Type	Description	Mark Band
	Level of response not worthy of credit	**[0]**
Basic	Basic discussion of the advantages and disadvantages of CAD, CAM and robotics. 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 advantages and disadvantages of CAD, CAM and robotics. 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 discussion of the advantages and disadvantages of CAD, CAM and robotics. 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 discussion of the advantages and disadvantages of CAD, CAM and robotics 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	**[9]–[10]**

[10] 10

Section A **50**

AVAILABLE MARKS

Section B

AVAILABLE MARKS

6 **(a)** No unauthorised access. [1]
Single acting cylinder (SAC). [1]
Shuttle valve. [1]
Seven segment display. [1]
(4 × [1]) [4]

All relevant, valid responses will be given credit.

(b) **(i)** Explanation – A shape-memory alloy (SMA) is an alloy that can be deformed when cold [1] but returns to its pre-deformed shape when heated. [1]
(2 × [1]) [2]

All relevant, valid responses will be given credit.

Application, e.g. – Any **one** from the list below:
Fire security systems. [1]
Dental wires. [1]
(1 × [1]) [1]

All relevant, valid responses will be given credit.

(ii) Any **two** main benefits of using smart materials for example:
- Can be less expensive than other alternatives. [1]
- Can reduce the weight in a design. [1]
- Can reduce the size and complexity of the product. [1]

(2 × [1]) [2] 9

All relevant, valid responses will be given credit.

7 **(a)** **(i)** Milling Machine. [1]
(1 × [1]) [1]

(ii) Explanation may include:
Apply engineering blue to the surface [1]
Using a steel rule, engineer's square and scriber locate the position of the hole. [1]
Use a centre punch to mark the position for drilling. [1]
(2 × [1]) [2]

All relevant, valid responses will be given credit.

(b) **(i)** Depth gauge.
(1 × [1]) [1]

(ii) Vernier calipers. [1]
(1 × [1]) [1]

All relevant, valid responses will be given credit.

			AVAILABLE MARKS
	(c)	**(i)** Any **two** reasons for the use of tolerances in the manufacture of product for example: • They improve the fit of parts. [1] • Can reduce costs – when tolerances are defined the manufacture of the component is only as precise as it needs to be. [1] • Using tolerances can reduce the need to remake parts later. [1] (2 × [1]) [2]	
		(ii) Explanation – A quality control chart is a graphic that shows whether products or processes are meeting their intended specification [1] and if not, the chart will show the degree by which they vary from the specification**.** [1] (2 × [1]) [2]	9
		All relevant, valid responses will be given credit.	
8	**(a)**	Sand casting [1] Welding [1] Finger joint (comb) [1] Extrusion [1] (4 × [1]) [4]	
		All relevant, valid responses will be given credit.	
	(b)	Any **two** reasons why cast iron is a suitable material for the metalwork vice, for example: • Cast iron is very durable. • Cast iron is tough and can absorb a lot of energy. • Cast iron is a cost-effective material. (2 × [1]) [2]	
		All relevant, valid responses will be given credit.	
	(c)	Any **two** characteristics associated with mass production for example: • Making products in large quantities. • Productions of standardised products, usually along an assembly line. • The division and specialisation of human labour. (2 × [1]) [2]	8
		All relevant, valid responses will be given credit.	
9	**(a)**	Square section V = L×W×H 400 × 3 × 3 = 3600ccm^3 [1] Triangular section V = ½ base × height × length ½ × 4 × 3 × 350 = 2100cm^3 [1] Difference 3600cm³ − 2100cm³ = 1500cm³ [3]	
	(b)	1 length 500mm + 1 saw cut 3mm = 503mm [1] 4000mm / 503 = 7 whole lengths [1] 4000 − (503 × 7) = 479mm [1] (3 × [1]) [3]	

				AVAILABLE MARKS
	(c)	**(i)**	Cost per metre £32 / 6.4 = £5.00 [1]	
		(ii)	Percentage of left over material 896mm / 6400mm × 100 = 14% [1]	
		(iii)	Cost of left over material £32 × 0.14 = £4.48 [1] (3 × [1]) [3]	9
10	**(a)**	**(i)**	A ductile material will show a large deformation before fracture [1] and under extreme loads will allow the material to bend rather than fracture suddenly. [1] (2 × [1]) [2]	
			All relevant, valid responses will be given credit.	
		(ii)	A brittle material which, when subjected to stress, will break [1] with little elastic or plastic deformation. [1] (2 × [1]) [2]	
			All relevant, valid responses will be given credit.	
		(iii)	The elastic limit is the maximum stress or force that a material can withstand [1] before the onset of permanent deformation. [1] (2 × [1]) [2]	
	(b)		Cleaning cycle by caustic cleaning, pickling and fluxing. [1] The frame is immersed in molten zinc [1] and withdrawn slowly from the tank whereby the excess zinc is removed before being left to cool. [1] (3 × [1]) [3]	9
			All relevant, valid responses will be given credit.	
11	**(a)**		Any **two** advantages that pick and place machines offer manufacturers for example: • They can perform tasks at great speed. • Pick and place machines work at a very high level of accuracy. • They are extremely flexible as they can be easily programmed. (2 × [1]) [2]	
			All relevant, valid responses will be given credit.	
	(b)		New manufacturing technologies can reduce process steps, material usage, or part counts and impact on reducing energy costs. [1] New design and process tools can enable selection of a manufacturing process to meet energy consumption requirements and influence costs. [1] (2 × [1]) [2]	
			All relevant, valid responses will be given credit.	

		AVAILABLE MARKS
(c)	Computer-aided engineering (CAE) is the process of solving engineering problems [1] through the use of sophisticated, interactive graphical software. [1] (2 × [1]) [2]	6
	All relevant, valid responses will be given credit.	
	Section B	**50**
	Total	**100**