



GCE AS MARKING SCHEME

SUMMER 2024

**AS
DESIGN & TECHNOLOGY – ENGINEERING DESIGN
2601U10-1**

About this marking scheme

The purpose of this marking scheme is to provide teachers, learners, and other interested parties, with an understanding of the assessment criteria used to assess this specific assessment.

This marking scheme reflects the criteria by which this assessment was marked in a live series and was finalised following detailed discussion at an examiners' conference. A team of qualified examiners were trained specifically in the application of this marking scheme. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners. It may not be possible, or appropriate, to capture every variation that a candidate may present in their responses within this marking scheme. However, during the training conference, examiners were guided in using their professional judgement to credit alternative valid responses as instructed by the document, and through reviewing exemplar responses.

Without the benefit of participation in the examiners' conference, teachers, learners and other users, may have different views on certain matters of detail or interpretation. Therefore, it is strongly recommended that this marking scheme is used alongside other guidance, such as published exemplar materials or Guidance for Teaching. This marking scheme is final and will not be changed, unless in the event that a clear error is identified, as it reflects the criteria used to assess candidate responses during the live series.

GCE AS DESIGN & TECHNOLOGY

ENGINEERING DESIGN - UNIT 1

SUMMER 2024 MARK SCHEME

Guidance for examiners

Positive marking

It should be remembered that learners are writing under examination conditions and credit should be given for what the learner writes, rather than adopting the approach of penalising him/her for any omissions. It should be possible for a very good response to achieve full marks and a very poor one to achieve zero marks. Marks should not be deducted for a less than perfect answer if it satisfies the criteria of the mark scheme.

For questions that are objective or points-based the mark scheme should be applied precisely. Marks should be awarded as indicated and no further subdivision made.

Banded mark schemes

For band marked questions mark schemes are in two parts, the indicative content and the assessment grid.

The indicative content suggests the range of issues which may be included in the learner's answers. It can be used to assess the quality of the learner's response. Indicative content is not intended to be exhaustive and learners **do not** have to include all the indicative content to reach the highest level of the mark scheme.

In order to reach the highest levels of the mark scheme a learner need not cover all of the points mentioned in the indicative content but must meet the requirements of the highest mark band. Where a response is not creditworthy, that it contains nothing of any significance to the mark scheme, or where no response has been provided, no marks should be awarded.

In Design and Technology, each question addresses one assessment objective: either AO3 or AO4. The assessment grid sub-divides the total mark to allocate for a question. These are shown in bands in the mark scheme. For each question, descriptors will indicate the different skills and qualities at the appropriate level.

Examiners should first read and place a tick in the learner's answer/s to indicate the evidence that is being assessed in that question; the mark scheme can then be applied. This is done as a two-stage process.

Stage 1 – Deciding on the band

Beginning at the lowest band, examiners should look at the learner's answer and check whether it matches the descriptors for that band. If the descriptors at the lowest band are satisfied, examiners should move up to the next band and repeat this process for each band until the descriptors match the answer.

If an answer covers different aspects of different bands within the mark scheme, a 'best fit' approach should be adopted to decide on the band and then the learner's response should be used to decide on the mark within the band. For instance, if a response is mainly in band 2 but with a limited amount of band 3 content, the answer would be placed in band 2, but the mark awarded would be close to the top of band 2 as a result of the band 3 content.

Examiners should not seek to mark learners down as a result of small omissions in minor areas of an answer.

Stage 2 – Deciding on the mark

During standardising (marking conference), detailed advice from the Principal Examiner on the qualities of each mark band will be given. Examiners will then receive examples of answers in each mark band that have been awarded a mark by the Principal Examiner. Examiners should mark the examples and compare their marks with those of the Principal Examiner.

When marking, examiners can use these examples to decide whether a learner's response is of a superior, inferior or comparable standard to the example. Examiners are reminded of the need to revisit the answer as they apply the mark scheme in order to confirm that the band and the mark allocated is appropriate to the response provided.

Question 1

The wing of the Airbus A350 airliner shown below is one of the largest single part products to be made entirely from Carbon Fibre Reinforced Polymer (CFRP).		AO3	AO4	Mark
(a)	<p>Give three reasons why CFRP has been used to make this product.</p> <ul style="list-style-type: none"> • the material can be easily moulded into complex shapes • unsurpassed strength-to-weight ratio, and low weight • It's a stiff, rigid material which has minimal deflection under stress • It is corrosion resistant and chemically stable • high dimensional stability, low coefficient of thermal expansion • In built surface finish • Improved durability <p><i>Credit any other suitable response</i></p> <p>Award 2 marks each for three detailed reasons</p> <p><i>The material has a good strength to weight ration which means that the aircraft will be lighter and use less fuel.</i></p> <p>Award 1 mark for a reason which lacks detail</p> <p><i>The material is light weight.</i></p>		✓	3 x [2]
(b)	<p>Name two other products that have been improved by using CFRP in their design and manufacture.</p> <p>Products could include:</p> <ul style="list-style-type: none"> • High performance bicycles • Sports equipment such as tennis rackets, golf clubs, hockey sticks and fishing rods • Monocoque chassis for motorsport • Safety equipment such as crash helmets <p><i>Credit any other suitable response</i></p> <p>Award 1 mark for each specific product</p>		✓	2 x [1]
		Total		8

Question 2

Two examples of the landing gear used on modern airliners are shown below.		AO3	AO4	Mark
(a)	Evaluate the forces that are likely to be present in the landing gear when the aircraft touches down		✓	4
<p>Exemplar answer: When an aircraft touches down the rotation of the wheels will exert torsional forces on their axles. These forces are reduced by the use of bearings. The supporting struts are subjected to compression when the aircraft impacts on the runway, and bending forces as it continues to move forward. In order to prevent buckling or collapse, the compression forces in the struts are counteracted by tension forces in the ties. Forces due to friction will also be present as the rubber tyre moves along the runway. To prevent collapse the landing gear will also have been designed with a built-in factor of safety.</p> <p><i>Credit any other suitable response</i></p> <p>4 marks - Detailed evaluative analysis of the forces involved 3 marks - Detailed description lacking evaluative analysis 2 marks - Brief description of several forces 1 mark - Some reference to at least one force that will act on the landing gear.</p>				
(b)	Suggest two ways in which the impact of these forces can be absorbed by the landing gear.		✓	2
<ul style="list-style-type: none"> • On landing hydraulic pistons compress and absorb the impact (shock absorber) • Aircraft use strong, flexible materials like steel, aluminum, or composites to help absorb the impact of a landing. As the plane touches down, the springs flex upward, dissipating and transferring the impact load to the airframe. • Forces are absorbed by compression of the pneumatic tyres as the weight of the aircraft pushes down. <p><i>Credit any other suitable response</i></p> <p>Award one mark each for two acceptable methods</p>				
(c)	Explain why the landing gear that is used in most commercial aircraft is retractable			2
<p>Exemplar answer: Retractable landing gear is designed to streamline the airplane (reduce the drag) by allowing the landing gear to be stowed inside the structure during cruising flight. Fixed landing gear is common with slow, smaller aircraft but most commercial airliners use retractable landing gear.</p> <p>Accept responses relating to efficiency, aerodynamics, cruising speed.</p> <p>2 marks - Detailed explanation 1 mark - Brief explanation showing some understanding.</p>				
Total				8

Question 3

	Additive manufacturing is a process where computer-controlled machines manufacture products by adding material. This process is often referred to as 3D Printing. More traditional manufacturing methods often involve producing products by reducing the amount of material (wasting).	AO3	AO4	Mark
(a)	<p>Describe two reasons why additive manufacturing is more sustainable than traditional production methods.</p> <ul style="list-style-type: none"> • With additive manufacturing there is little if any waste material. • Energy used in fabricating and assembling multiple components is reduced as products can be manufactured as one part. • The need to produce expensive and complex production tooling is reduced • Transportation is reduced as products can be manufactured at remote locations and in the environment where they will be used, simply by sending files electronically. • Energy used in large warehouses is reduced as component parts do not need to be stored. • Smaller production runs are far more environmentally friendly. • Changes and modifications can be made more easily if parts need to be replaced. This reduces the need to have spare parts manufactured in advance. <p><i>Credit any other suitable response</i></p> <p>Award 2 marks for each justified reason</p> <p>Award 1 mark for each reason that is valid but not fully explained.</p> <p>Exemplar Answer for 1 mark: With additive manufacturing there is little if any waste material.</p> <p>Exemplar Answer for 2 marks: With additive manufacturing there is little if any waste material. This reduces the amount of energy that needs to be used when recycling materials and reduces the pollution that is created if the surplus material is sent to landfill.</p>		✓	2 x [2]

Prior to production, designers at Dyson UK use 3D Printing to manufacture prototypes that show iterative progression. This is often referred to as rapid prototyping and has been used to develop many of the parts for the product shown below.				
(b)	Explain the ways in which prototypes made using this method can reduce the lead time during product development.		✓	4
<p>Many manufacturing companies report a reduction to lead in times of between 70 and 95% by the use of rapid prototyping. This is because:</p> <ul style="list-style-type: none"> • Accurate models can be made quickly and easily, directly from CAD drawings. • Changes and modifications can be made after evaluation and further models produced at greatly reduced costs • Communication with and feedback from potential consumers is quicker as files can be sent electronically. This helps when designing products for the global market. • Finalised designs can be sent directly to the manufacturer prior to automated production. The time needed to produce specialised tooling is reduced or eliminated. <p><i>Credit any other suitable response</i></p> <p>Award 4 marks for a detailed evaluation of at least two ways in which lead times can be reduced through the use of prototypes</p> <p>Award 3 marks for a partial evaluation of at least two ways in which lead times can be reduced through the use of rapid prototyping</p> <p>Award 2 marks for a detailed evaluation of one way in which lead times can be reduced through the use of prototypes</p> <p>Award 1 mark for a partial explanation which demonstrates limited understanding</p> <p>Exemplar Answer for 4 marks: Rapid prototyping can be used to reduce lead times during product development as accurate models can be made quickly and easily from CAD drawings. These models can be quickly sent to potential consumers for evaluation and feedback. Modifications can be easily made by the designer and revised models easily produced without the need for expensive tooling and manufacturing processes. After modifications have been approved the final design can be sent electronically to the manufacturer prior to automated production.</p> <p>Exemplar Answer for 3 marks: Prototypes made by this method can be produced quickly and easily. Models can be sent by email to potential clients for evaluation and feedback. After further development manufacturers will be able to make the products using CAM directly from the CAD drawings.</p> <p>Exemplar answer for 2 marks: Prototypes made by this method can be made quickly so that modifications can be viewed by the designer.</p> <p>Exemplar answer for 1 mark: Prototypes made by this method can be made very quickly.</p>				
			Total	8

Question 4

The wireless headphones shown below have been designed to interact with the user.	AO3	AO4	Mark
Analyse the ergonomic factors that have been taken into consideration by the design engineer as the product has been developed. <i>Marks will be awarded for the content of the answer and the quality of written communication</i>	✓		8

Ergonomic factors are concerned with the way in which the user interacts with the product. This will include:

- The ease with which the product can be handled when it is taken from its case and inserted into the ear.
- The way in which the product is designed to fit comfortably into the ear without falling out.
- Touch sensitive control which can be customised by the user.
- Voice recognition
- Sensors which detect when the headphones are removed from the ear.
- Volume control which will restrict sound to a level that will not damage the users hearing.

Credit any other suitable response

Guidance to markers

Level 1 1-2 marks

- Candidate has a simplistic knowledge of the issues associated with the question.
- The use of terminology and technical language is basic.
- The candidate has limited knowledge in relation to the context.
- The candidate will express ideas clearly, if not always fluently. Answers may deviate from the question or not be relevant.
- Grammar, punctuation and spelling may be weak, impacting on effective communication.

Level 2 3-4 marks

- The candidate has a basic understanding of the issues associated with the question.
- The use of terminology and technical language is variable.
- The candidate has some general knowledge of the form and function of products, trends and styles in relation to the context.
- The candidate will express straightforward ideas clearly, if not always fluently. Answers may deviate from the question or be weakly presented.
- There may be some errors of grammar, punctuation and spelling but is still able to communicate the issues.

	<p>Level 3 5-6 marks</p> <ul style="list-style-type: none"> • The candidate demonstrates a clear understanding of the issues associated with the question. • The use of terminology and technical language is reasonably accurate. • The candidate has demonstrated knowledge of the form and function of products, trends and styles associated to the context. • The candidate will express moderately complex ideas clearly and fluently, through well linked sentences and paragraphs. Answers will be generally relevant and structured. • There may be occasional errors of grammar, punctuation and spelling. <p>Level 4 7-8 marks</p> <ul style="list-style-type: none"> • The candidate demonstrates a specific ability to analyse the question, takes into account a wide range of factors and has a clear understanding of the associated issues. • Uses correct terminology and technical language. • The candidate has developed a detailed knowledge of the form and function of a products, trends and styles associated to the context. • The candidate will express complex ideas extremely fluently. Sentences and paragraphs will follow on from each other smoothly and logically. Answers will be consistently relevant and structured. • There will be few, if any, errors of grammar, punctuation and spelling. 	
Total		8

Question 5

Design engineers use both ball and roller bearings when developing mechanical products which are subject to rotational forces.		AO3	AO4	Mark
			✓	
(a)	(i) Name a specific product that uses a ball bearing: Possible products would include skateboards, food blenders, bicycles, DVD players and photocopiers.			1
	(ii) Justify the selection of a ball bearing for use in this product: Exemplar answer for 2 marks: Ball bearings are used when rotational parts need to move at high speed with minimal friction and low load. Exemplar answer for 1 mark: Ball bearings are used to reduce friction.			2
	(iii) Name a different specific product that uses a roller bearing: Possible products would include aviation cargo systems, engines, agriculture equipment, wind turbines, medical equipment, and automobiles.			1
	(iv) Justify the selection of a roller bearing for use in this product: Exemplar answer for 2 marks: Roller bearings are used when rotational parts are subject to heavy loads and moderate to high speed. Exemplar answer for 1 mark: Roller bearings are used with heavy equipment Note to examiners: Award up to 2 marks for a fully justified response to parts (ii) and (iv) but do not credit unjustified repetition. (e.g., reduces friction without explanation)			2

	Plain bearings, like the ones shown below, are often used for many applications as they are cheaper and require fewer moving parts.		✓	
(b)	Name a suitable specific material that could be used to manufacture a plain bearing bush and provide one reason for your selection.			2
	<p>Suitable materials could include phosphor bronze, brass, cast iron, babbitt alloys, PTFE or polyamide (nylon)</p> <p>Award 1 mark for a correctly identified material and 1 mark for a reason.</p> <p>Reasons could include:</p> <ul style="list-style-type: none"> • Low coefficients of friction • Self-lubricating • Corrosion resistance • Durability • Noise dampening / quieter in use 			
			Total	8

Question 6

To improve health, safety and security the manager of a retail outlet requires a system that will restrict the number of people entering the shop.

The flow chart shown is used to control the entry and exit system, ensuring that a maximum of ten customers are in the shop at any one time. A green light shows when the number of people in the shop is nine or less and a red light turns on when the number exceeds nine.

AO3**AO4****Mark**

(a)

Using the flow chart for reference, develop a five-point technical specification that would ensure that the system meets the design requirements.

Point 1 has been done for you.

Point 1

The system should numerically add one to the count when somebody enters the shop.

✓

4 x [2]

Additional points could include:

- The system should deduct one from the count when somebody leaves the shop
- The outputs should be displayed so that they are clearly visible to both clients and staff
- The input sensors should be mounted so that people entering and leaving the shop can be detected automatically.
- The system must comply with electrical safety standards.
- It should be maintenance free
- Outputs should be securely mounted in a position where they do not impede people who are using the shop

Award up to two marks for each specification point

Award only one mark for each point that lacks clarity

Award only one mark for each specification point where the criteria has been copied directly from the question.

Question 6

(b) In the space below design a detailed electronic circuit diagram that can be programmed to control the system.

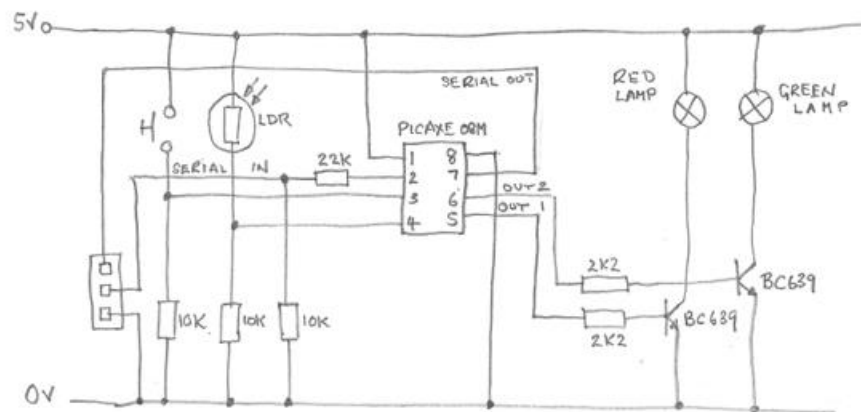
✓

12

The system must include:

- A suitable input sensor used to detect people entering the shop.
 - A suitable input sensor used to detect people leaving the shop.
 - Two suitable output devices correctly connected.
 - Correct representation of a suitable microcontroller.
- Any interface devices that are required.

Exemplar Answer



Guidance to Markers

10 -12 Marks

Well drawn functional circuit diagram with nearly all components correctly identified

7 – 9 Marks

Well drawn functional circuit diagram with most components correctly identified

4 - 6 Marks

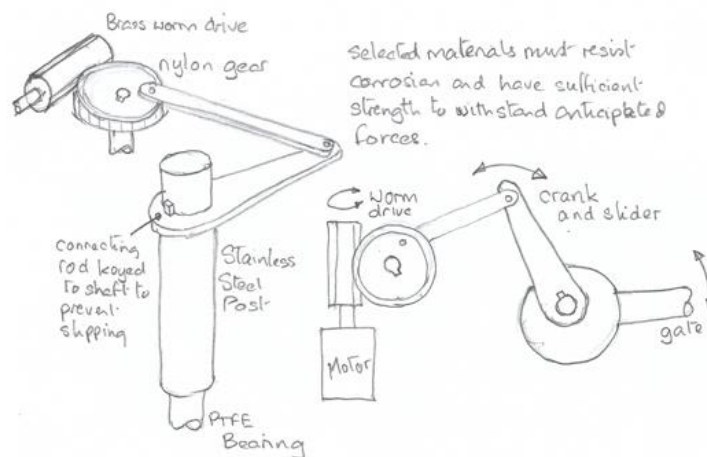
Circuit diagram which has the potential to solve the problem but requiring further development. Some components have been correctly identified

0 - 3 Marks

Some attempt has been made to draw a circuit diagram with a few components correctly identified

(c)	<p>To ensure that people comply with a one-way system, the shop is planning to install access barriers that allow people to enter and leave in one direction only. A possible solution is shown in below.</p> <p>In the space below design a suitable mechanism that will activate that the barrier.</p> <p>Your solution must include:</p> <ul style="list-style-type: none"> • A suitable mechanism • Appropriate technical annotation with all components correctly identified. • Justified selection of appropriate materials. • High quality graphic communication 	✓	8
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Exemplar answer



Answers could include rack and pinion, crank and slider, pawl and ratchet, worm drive, cams, belt drives, chain and sprocket or simple gear trains.

Guidance to markers

0 marks

Inappropriate or no response

1-2 marks

A viable solution which lacks detail and technical annotation

3-4 marks

A viable solution with appropriate annotation and some components correctly identified

5-6 marks

A well-drawn and illustrated solution which will solve the problem. Most components and materials have been correctly identified

7-8 marks

The proposal has been well drawn and graphic communication is of a high standard.

Nearly all components have been identified and material selection has been completed with detailed justified evidence

<p>(d)</p>	<p>Details of the two 24 Volt LED lights used to inform customers when it is safe to enter the shop are shown below.</p> <p>In the space provided on the next page, design a suitable housing that will hold the two 24 Volt LED Lights so that they can be easily seen by the customers.</p> <p>Your design must include:</p> <ul style="list-style-type: none"> • A suitable housing that will hold the two 24 Volt LED lights securely. • A suitable method that will enable the housing to be fixed to the access barrier. • Justification for the selection of appropriate materials. • Important dimensions. <ul style="list-style-type: none"> • Marks will be awarded for sketching your initial ideas, a well-developed final solution, detailed notes that explain your thinking, appropriate use of materials and important dimensions. 		✓	8
<p>Guidance to markers</p> <p>Initial Ideas</p> <p>0 marks Incorrect / no answer</p> <p>1 mark Very simple sketches, technically lacking detail with limited reasoning and little development. Only one or possibly two proposals evident</p> <p>2 marks Sketches show an excellent level of understanding. A range of initial ideas have been considered with one idea developed in detail</p> <p>Final Solution</p> <p>0 mark No answer</p> <p>1 mark Some attempt to present a final proposal but lacking technical detail. The solution meets at least one of the design requirements</p> <p>2 marks A well-developed solution which meets all of the design requirements.</p>				

	<p>Annotation</p> <p>0 marks No annotation</p> <p>1 mark Some annotation evident which provides partial explanation</p> <p>2 marks Fully detailed annotation which demonstrates excellent understanding of the design requirements</p> <p>Materials and Dimensions</p> <p>0 mark No reference to materials or dimensions</p> <p>1 mark Some major dimensions evident and/or at least one suitable material identified</p> <p>2 marks All major dimensions included and suitable materials selected</p>			
(e)	Evaluate the proposed entry system and suggest and justify two ways in which it could be improved to protect both staff and customers in the sudden event of an emergency.	✓		4
	<p>Possible responses may include:</p> <ul style="list-style-type: none"> • Refinements to the electronic circuit e.g. adding an alarm • Including an over-ride feature • Disabling the system quickly in an emergency • App / handset • Other features related to candidate design • Fixing entrance barrier to prevent people entering in an emergency • Other responses may deserve credit <p>0 marks Incorrect / no answer</p> <p>1 mark Brief descriptive comment with one improvement identified</p> <p>2 marks Brief descriptive comment with two improvements identified</p> <p>3 marks Evaluative comment with two proposed improvements</p> <p>4 marks Detailed evaluative analysis with two fully justified improvements identified</p>			
Total				40