



GCE AS MARKING SCHEME

SUMMER 2023

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

INTRODUCTION

This marking scheme was used by WJEC for the 2023 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

GCE DESIGN & TECHNOLOGY
ENGINEERING DESIGN - UNIT 1
SUMMER 2023 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.

Q	Specification content	Marks for section	Sub-question mark breakdown	Principles	Section	AO
1	2.1(d) 2.1(e) 2.3.1(c) 2.4(f)	8	2,4,2	Core & In-depth (Ed)	AS & A Level	AO4
2	2.1(a) 2.1(e) 2.3.1(d) 2.4(f)	8	3,3,2	Core & In-depth (Ed)	AS & A Level	AO3
3	2.3.1(b) 2.4(b)	8	8	In-depth (Ed)	AS & A Level	AO4
4	2.3.1(a) 2.3.1(d) 2.3.1(e) 2.3.1(j)	8	4,2,2	In-depth (Ed)	AS & A Level	AO4
5	2.3.1(f) 2.3.1(g)	8	2,2,4	In-depth (Ed)	AS & A Level	AO4
6	2.1(a) 2.1(b) 2.1(c) 2.3.1(a) 2.3.1(e) 2.3.1(h) 2.3.1(i) 2.3.1(j) 2.4(c)	40	8,8,16,4,4	Designing & making Core & In-depth (Ed)	AS & A Level	AO3 / AO4

Question 1				
The Printed Circuit Board shown in fig(i) has been developed as a prototype. The board shown in fig(ii) is a commercial product that has been made by batch production.		AO3	AO4	Mark
(a)	Describe a feature of the circuit in fig(ii) that would enable components to be added by batch production at reduced cost.		✓	2
	<ul style="list-style-type: none"> The commercial board uses SMT. This reduces waste material as drilling is not necessary. SMT saves time when manufacturing in large quantities because there is a reduction in the number of holes being drilled. The commercial board uses track isolation so that very little copper is removed from the board. This is more sustainable because it reduces the amount of machining or etching and less waste material is produced. The commercial board is given a solder mask so that components can be quickly and accurately attached using reflow soldering. <p>Guidance to markers</p> <p>Incorrect or no answer</p> <p>Basic answer. The batch produced board uses SMT technology.</p> <p>Detailed answer. The batch produced PCB uses SMT technology which requires very little drilling, this speeds up the manufacture of the board.</p>			0 1 2
(b)	Ferric Chloride and Sodium Hydroxide are two potentially dangerous chemicals that are often used in the production of printed circuit boards. Complete the Five Step Risk Assessment below, justifying each of the steps needed when working with potentially dangerous chemicals. <i>Step 1 has been completed for you.</i>		✓	4
	<p>The following steps should be identified and justified:</p> <p>Step 2: Decide who may be harmed, and how.</p> <ul style="list-style-type: none"> The user involved in producing PCB's could be harmed by corrosive materials through splashing, inhalation etc. <p>Step 3: Assess the risks and take action</p> <ul style="list-style-type: none"> The risk of contact with the skin and eyes is high unless appropriate action is taken. Rubber or plastic gloves should be worn at all times when using chemicals. Eye protection and face masks should be available and must be used. Training must be provided for anybody using these processes and appropriate warning signs should be in place. It is also important that the correct procedures are in place for the safe disposal of waste materials. 			

	<p>Step 4: Make a record of the findings.</p> <ul style="list-style-type: none"> Operational procedure should be documented and recorded. All users should have access to the documentation and should sign to acknowledge that they are familiar and compliant with the content. <p>Step 5: Review the risk assessment.</p> <ul style="list-style-type: none"> The operational procedure should be reviewed on a regular basis. Dates for review need to be established and updates need to be circulated. Reviews need to be signed and dated. <p>Award 1 mark for each justified step.</p> <p>Accept other appropriate responses.</p> <p>Do not penalise for incorrect order.</p>			
(c)	Describe how a CNC machine could be used to produce a Printed Circuit Board (PCB).		✓	2
	<p>The layout diagram work would need to be produced in CAD or a similar program.</p> <p>The program needs to be post-processed in order to produce a file that can be used to control the X, Y, and Z axis movements of the CNC machine.</p> <p>The CNC cuts through the copper layer on the board to remove unwanted material.</p> <p>Accept answers that relate to laser etched PCBs</p> <p>Guidance to markers</p> <p>Incorrect or no answer</p> <p>Basic answer. The circuit diagram could be produced in CAD and cut by the machine.</p> <p>Detailed answer. The circuit diagram could be produced in CAD. The CAD data is post processed and the downloaded to the CNC machine which then cuts the PCB.</p>			0 1 2
Total				8

Question 2		AO3	AO4	Mark
Acrylonitrile Butadiene Styrene (ABS) is a material that will be used for the design the casing that will enclose an electronic product as shown below.				
(a) (i)	State three reasons why ABS would be a suitable material for the casing.		✓	3
<p>Reasons could include:</p> <ul style="list-style-type: none"> • High impact strength • Easily moulded or formed into complex shapes • Available in a range of colours with built in surface finish • Will not corrode and provides protection in damp environments • Can be recycled <p>Accept other appropriate reasons.</p> <p>Award 1 mark for each appropriate reason.</p>				
(ii)	The casing is made by injection moulding. Explain why injection moulding is an appropriate process to use in the manufacture of the casing.		✓	3
<p>Injection moulding is use in the production of the product because:</p> <ul style="list-style-type: none"> • The number of component parts is reduced • Complex moulding is possible • Manufacturing costs are reduced through batch production • Little waste material is produced • Surface finish is inbuilt <p>Accept other appropriate responses.</p> <p>Guidance to markers</p> <p>Incorrect or no answer</p> <p>Simple answer.</p> <p>Injection moulding is used because the casing can be made from one part Simple answer with some understanding.</p> <p>Injection moulding is used because the number of individual parts required is reduced. This reduces both time and cost. Clear and detailed answer with understanding.</p> <p>Injection moulding is used because the product can be repeatedly manufactured as an integrated moulding with a built-in high-quality surface finish. This reduces the need subsequent fabrication and complex assembly procedures. Savings are made in relation to both time and cost.</p>				0 1 2 3

(b)	Describe the ways in which the designer and manufacturer can reduce the environmental impact of using plastic materials in commercially produced products.		✓	2
<p>Issues could involve:</p> <ul style="list-style-type: none"> • Need to reduce the use of finite materials • Need to design products so that materials can be reused • Need to consider recycling options. Design for disassembly, material easily identified and labelled so that it can be sorted for recycling • Environmental issues concerned with the heat and toxic fumes produced during both extraction of raw materials, primary processing, secondary processing and subsequent recycling. • Damage to the environment if the products end up in land fill sites <p>Guidance to markers</p> <p>Incorrect or no answer 0</p> <p>Basic answer. 1</p> <p>The product should be designed to use as little material as possible Detailed answer. 2</p> <p>The amount of material used should be reduced by designing the product so that it is as light as possible. The product should be designed so that it can easily be disassembled for recycling. Materials used should be clearly marked so that they can be easily identified after disassembly.</p>				
Total			8	


Question 3

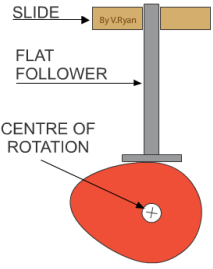
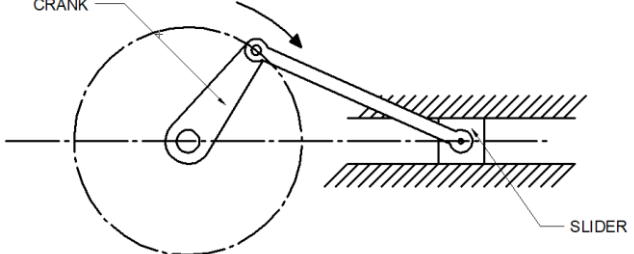
	AO3	AO4	Mark	
<p>Designers have developed products in response to both market pull and technology push such as the electric car shown below.</p> <p>Analyse how market pull and technology push have influenced the design and development of an electric car.</p>	✓		8	
<p>Market pull results from consumer demand. Technology push is the result of new technological developments. These factors often work together when new products are being developed.</p> <ul style="list-style-type: none"> • Technology push has resulted in reduced battery size and increased power • Smaller more integrated components are now available as a result of technology push • Consumers are demanding more cost-effective vehicles due to restricted budgets • Government policy on environmental issues creates a market pull for 'green energy' <p>Guidance to markers</p> <p>0 marks</p> <ul style="list-style-type: none"> • Incorrect/no answer <p>1–2 marks</p> <ul style="list-style-type: none"> • Limited understanding and application of knowledge and understanding of the relationship between market pull and technology push • Limited understanding and application of knowledge and understanding of designing and environmental issues in relation to the development of electric vehicles • There is limited evidence of relevant examples. • Quality of Written Communication is limited, material is presented with limited coherence, many errors of grammar, punctuation and spelling. Little evidence of reasoning <p>3–4 marks</p> <ul style="list-style-type: none"> • Generally good understanding and application of knowledge and understanding of the relationship between market pull and technology push • Generally good understanding and application of knowledge and understanding of designing and environmental issues in relation to the development of electric vehicles • There is a line of reasoning which is generally coherent and relevant. • Quality of Written Communication is basic, presenting occasional appropriate material with some coherence, some errors of grammar, punctuation and spelling. 				

	<p>5–6 marks</p> <ul style="list-style-type: none"> • Very good understanding and application of knowledge and understanding of the relationship between market pull and technology push • Very good understanding and application of knowledge and understanding of designing and environmental issues in relation to the development of electric vehicles • There is a sustained line of reasoning which is generally coherent, relevant and substantiated. • Quality of Written Communication is good, presenting mainly appropriate material in a coherent manner, few errors of grammar, punctuation and spelling. <p>7–8 marks</p> <ul style="list-style-type: none"> • Excellent understanding and application of knowledge and understanding of the relationship between market pull and technology push • Excellent understanding and application of knowledge and understanding of designing and environmental issues in relation to the development of electric vehicles • There is a sustained line of reasoning which is coherent, relevant and substantiated. • Quality of Written Communication is excellent, presenting wholly appropriate material in a coherent and logical manner, hardly any errors of grammar, punctuation and spelling 	
Total		8

Question 4		AO3	AO4	Mark
The circuit diagram shows how an operational amplifier is used to automatically turn on the garden lights when the light level drops below a predetermined level.				
(i)	Describe in detail how the operational amplifier controls the garden lights.		✓	4
	<p>The operational amplifier compares two input voltages. If the reference inverting input has a higher voltage than the non-inverting input the output will be -9V and relay will be switched off. As the level of light falls the voltage to the non-inverting input increases. When it goes above the reference voltage the output turns on and the NPN Transistor activates the relay, which turns on the patio lights.</p> <p>Fully detailed description</p> <p>A description which is accurate in most respects</p> <p>A description which provides an outline of the interaction between inputs and outputs</p> <p>Evidence of some understanding</p>			4 3 2 1
(ii)	Describe the purpose of the component labelled D1 on the circuit diagram.		✓	2
	<p>Component D1 is a reverse diode which protects the transistor from back emf and prevents it from burning out.</p> <p>Detailed understanding</p> <p>Some understanding and component recognition</p>			2 1
(iii)	The filament bulbs shown in the circuit diagram are increasingly being replaced by LEDs. Explain why this is the case.		✓	2
	<p>Reasons could include:</p> <ul style="list-style-type: none"> • LEDs use less energy • LEDs are longer lasting • Modern LED's are very much brighter than filament bulbs • LEDs are often cheaper than filament bulbs <p>Any two acceptable reasons</p> <p>One acceptable reason</p>			2 1
			Total	8

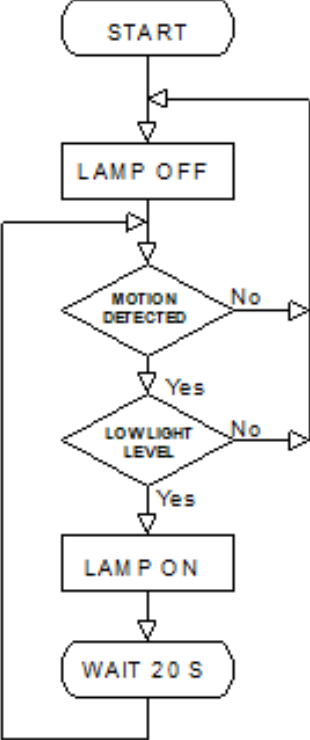
Question 5

		AO3	AO4	Mark
(a)	The images below show a traditional static baby bouncer and a more modern electronic version that can be operated using outputs from a mobile phone to create oscillating and reciprocating motion.			
(i)	The electronic baby bouncer moves with both oscillating and reciprocating motion. Explain the term oscillating motion		✓	2
	 <p>Oscillating motion occurs when a mechanism swings backward and forward through an arc, starting from and returning to fixed positions.</p> <p>Incorrect Answer</p> <p>Evidence of some understanding</p> <p>Clear understanding and explanation</p>			0 1 2
(ii)	Describe one force that the designer has had to consider when designing the traditional baby bouncer.		✓	2
	<p>The baby bouncer is subject to bending forces which are a combination of both tension and compression. Shear forces are likely to be present where the cradle is attached to the frame. As the baby moves the forces will be dynamic rather than static. As the result the structure is subject to fatigue and should be designed accordingly.</p> <p>Answers may involve descriptions of tension, compression, torsion or shear forces. If reference is made to bending candidates will need to make reference to the joint action of both tension and compression.</p> <p>Incorrect answer, type of force not identified</p> <p>Force clearly identified with basic understanding</p> <p>Force clearly identified with detailed description</p>			0 1 2

(b)	Use the space below, draw a cam or crank mechanism that could be used to convert rotary to reciprocating motion in the modern electronic baby bouncer.		✓	4
<p>Exemplar answers:</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Cam and Follower</p> </div> <div style="text-align: center;">  <p>Crank and Slider</p> </div> </div> <p>Guidance to markers</p> <p>Incorrect / no answer 0</p> <p>A very simple sketch lacking technical detail 1</p> <p>A reasonable sketch with more technical accuracy 2</p> <p>Sketch is technically correct showing a good level of understanding. 3</p> <p>Sketch is technically correct showing clear and detailed understanding to a very high level. 4</p>				
Total			8	

Question 6

The images show a vertical axis wind powered generator that has been developed to provide energy for bus stop shelters in remote locations.	AO3	AO4	Mark
(a) Evaluate the advantages to potential customers of having an electrical power source in a modern bus shelter.	✓		8
<p>Advantages could include:</p> <ul style="list-style-type: none">• Internal Lighting; to keep customers safe during periods of darkness• Heating• External visibility• Electronic Advertising• Electronic information, timetables and arrival times• Charging points for mobile devices <p>0 marks</p> <ul style="list-style-type: none">• Incorrect/no answer <p>1–2 marks</p> <ul style="list-style-type: none">• Candidate has a simplistic knowledge.• The use of terminology and technical language is basic.• Brief description of the advantages of an electrical energy source with little understanding evident.• Little evidence of appraisal. <p>3–4 marks</p> <ul style="list-style-type: none">• Candidate has some basic understanding of the issues associated with the question.• The use of terminology and technical language is variable.• Some detail in the description of how electrical energy could be beneficial; some understanding is evident.• The response shows some evidence of appraisal. <p>5–6 marks</p> <ul style="list-style-type: none">• The candidate has clear understanding of the issues associated with the question.• The use of terminology and technical language is mostly accurate.• More detailed description with understanding of the way in which electrical energy could be beneficial to potential customers is evident.• The response shows clear evidence of appraisal. <p>7–8 marks</p> <ul style="list-style-type: none">• The candidate demonstrates very clear understanding of the issues associated with the question.• Terminology and technical language is used correctly.• Full and detailed description and understanding of the advantages of using electrical energy to potential customers• Detailed evidence of appraisal.			

(b)	The bus shelter needs an energy saving lamp that will turn on only when it is dark and the shelter is being used by potential passengers. The block diagram below shows how a microprocessor is used to control the system.			
(i)	<p>In the space provided design a flow chart that will enable the microprocessor to be programmed in order to control the lamp.</p> <p>Your design must:</p> <ul style="list-style-type: none"> • use a microprocessor to activate the lamp automatically when approached by a passenger • only operate in low light conditions • switch off the lamp after a time delay of 20 seconds when there is no movement detected in the bus shelter. 		✓	8
<p>Exemplar answer:</p>  <pre> graph TD Start([START]) --> LampOff[LAMP OFF] LampOff --> Motion{MOTION DETECTED} Motion -- No --> LampOff Motion -- Yes --> Light{LOWLIGHT LEVEL} Light -- No --> LampOff Light -- Yes --> LampOn[LAMP ON] LampOn --> Wait([WAIT 20 S]) Wait --> LampOff </pre> <p>Guidance to markers</p> <ul style="list-style-type: none"> • Two Process Boxes showing Lamp On and Lamp Off 1 mark • Decision box for Motion Sensor 1 mark • Decision box for Light Sensor 1 mark • Box showing time delay 1 mark • Two feedback loops with direction arrows correctly illustrated 2 marks • Conventionally correct symbols used 1 mark • Sequential order correct 1 mark <p>Light Sensor and Motion Sensor could be in reverse order</p>				

(ii)	<p>Design a suitable housing for the lamp that can be attached to the bus shelter</p> <p>Your design must:</p> <ul style="list-style-type: none"> • hold three 25mm diameter LEDs • be housed securely to prevent possible vandalism • open easily when required for maintenance • be securely attached to the bus shelter <p>Marks will be awarded for:</p> <ul style="list-style-type: none"> • sketching your initial ideas [4] • a well-developed final solution [6] • detailed notes that explain your thinking [4] • proposals for the appropriate use of materials and critical dimensions [2] 		✓	16
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Guidance to markers		
Initial Ideas		
Incorrect / no answer		0
Very simple sketches, technically lacking detail with limited reasoning and little development. Only one proposal evident		1
Reasonable sketches, technically more accurate with evidence of at least two alternatives		2
Sketches show a good level of understanding and a range of initial ideas with logical progression of at least one proposal		3
Sketches show an excellent level of understanding. A range of initial ideas have been considered with one idea developed in detail		4
Final Solution		
No answer		0
Some attempt to present a final proposal but lacking technical detail. The solution meets at least one of the design requirements		1 - 2
A final proposal which meets two or more of the design requirements. Further development is required		3 - 4
A well-developed solution which meets all of the design requirements.		5 - 6
Annotation		
No annotation		0
Some annotation evident which provides partial explanation		1
Annotation which makes reference to at least two of the design requirements		2
Detailed annotation which demonstrates technical understanding of the design requirements		3
Fully detailed annotation which demonstrates excellent understanding of the design requirements		4
Materials and Dimensions		
No reference to materials or dimensions		0
Some major dimensions evident and/or at least one suitable material identified		1
All major dimensions included and suitable materials selected		2

(c)	Explain two detailed reasons why wind power technology is increasingly used in new products such as the bus shelter.		✓	4			
	<p>Reasons could include:</p> <p>Mains electricity may not be available in some areas</p> <p>Wind power is a sustainable source of energy which is cost effective</p> <p>The shelter can be installed as one integrated unit without the need for external wiring</p> <p>The generation of mains electricity often results in the use of finite materials and the production of waste material which pollutes the environment</p> <p>Guidance to markers</p> <p>Incorrect / no answer</p> <p>Brief explanation of one reason which lacks detail</p> <p>Brief explanation of two reasons but lacking detail</p> <p>Description of two reasons but only one explained in detail</p> <p>A clear and very detailed explanation of two reasons</p>			0	1	2	3
(d)	Outline the disadvantages of using a wind powered generators as a means of providing energy for the bus shelter.		✓	4			
	<p>Wind powered generators are sometimes considered to be inappropriate because:</p> <ul style="list-style-type: none"> • They may not be able to be used if the wind is too strong • They will not work in sheltered locations • The noise generated can annoy local residents • They can be detrimental to wild life, particularly birds • They may be considered to be unsightly • They have a limited life and need to be replaced after about 25 years <p>Incorrect / no answer</p> <p>Brief description of one disadvantage with little understanding</p> <p>Brief description of two or more disadvantages</p> <p>Two or more disadvantages clearly identified with a good understanding of at least one issue</p> <p>Structured and detailed description of the disadvantages showing excellent understanding of two or more issues</p>			0	1	2	3
Total				40			