GCE AS MARKING SCHEME

SUMMER 2019

AS
DESIGN & TECHNOLOGY - ENGINEERING DESIGN
2601U10-1

INTRODUCTION

This marking scheme was used by WJEC for the 2019 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 2019 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.

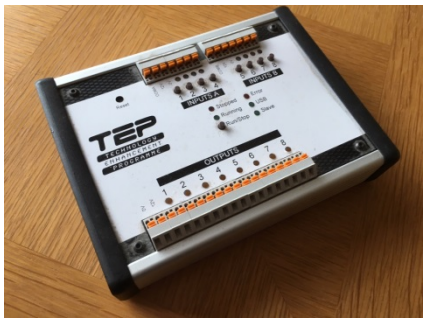
Examiners should not seek to mark learners down as a result of small omissions in minor areas of an answer.

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

		AO3	AO4	Mark
Automated manufacturing systems are often controlled by Programmable Logic Controllers (PLCs) similar to the one shown below using ladder logic.  				
(a)	Explain **two** reasons why PLCs have largely replaced discrete components such as relays when controlling automated manufacturing systems.		✓	4

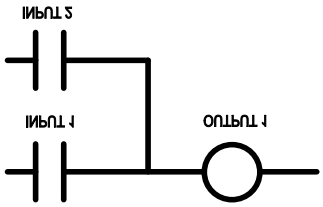
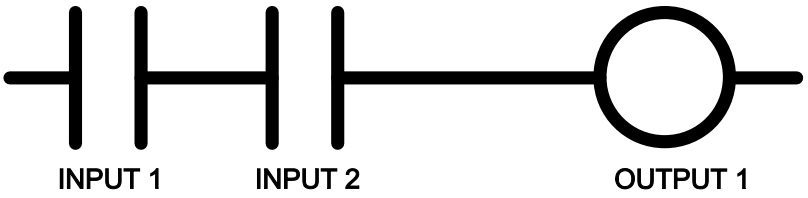
Fifty years ago automated manufacturing systems used complex networks of discrete components such relays and timers, joined together with hundreds of electric cables. Fault finding and maintenance of these systems was both difficult and time consuming. A PLC is an integrated device that contains inputs and outputs in one unit. They can be programmed using ladder logic. They are much easier to use, highly reliable and require little maintenance.

Award up to two marks each for any two of the following reasons:

- Fault finding is easier as less components are involved
- PLC's are more reliable
- PLC's require less maintenance
- Systems are more flexible as PLC's can be easily reprogrammed
- Inputs and outputs are integrated in one unit

Exemplar answers

- *1 mark* PLC's are more reliable.
- *2 mark* PLC's are more reliable because inputs and outputs are integrated in one unit.

(b) *(i)*	A simple ladder logic diagram is show below. Explain how the inputs in this system combine in order to control the output.  		✓	2
	In order to turn on the output, either Input 1 or Input 2 would need to be activated. This acts as an OR Gate. ***1 mark** recognition that either input 1 or input 2 needs to be activated in order to control the output.* ***2 mark** recognition that input 1 and input 2 act in combination as an OR Gate in order to control the output*			
(ii)	In the space below, use the symbols from the diagram in (i) to sketch a ladder logic diagram that will activate an output only when both inputs are turned on. **1 mark** all symbols illustrated but not in the correct sequence or not fully connected. **2 mark** both inputs in sequential order followed by an output. Exemplar answer:  			2
			Total	**8**

Question 2

		AO3	AO4	Mark
	Jonathan Ive has led Apple's Design Team since 1996 and became Chief Design Officer of Apple in 2015. He has been responsible for the design of many iconic products which have been described as 'functionally clean, aesthetically pleasing, and remarkably popular'. Evaluate the different products for which Jonathan Ive has been responsible and discuss the influences on his design thinking. Marks will be awarded for the content of the answer and the quality of written communication.	✓		8
	Award marks for discussion about the range of products that have been designed by Jonathan Ive and the factors that have influenced their simplistic shape, form and function. • London start up design agency called Tangerine where he designed a diverse array of products, such as microwave ovens, toilets, drills and toothbrushes. • Joined Apple he has been responsible for the development of the PowerBook, the IMac, the iPod, the MacBook and eventually the iPhone, the IPad and the Apple Watch. • All of the products designed by Ive have evolved as new technology has become available. The click wheel which was a feature of the iPod was replaced with the emergence of touch screen technology. • Influenced by the Bauhaus Design Movement which emerged in Germany during the 1920s and became a staple design approach adopted by the Ulm School of Design during the 1950s. The Bauhaus principle that form follows function and less is more is evident in his work. • Influenced by German industrial designer Dieter Rams (who served as chief designer for Braun from 1961 to 1995). When comparing products, similarities are evident between many of Ive's products and those previously produced by Braun. • Influenced greatly by the developing world and new technology. **Up to a maximum of 6 marks for discussing his products only without any reference to influences.**			

Guidance to markers

Level 1 0-2 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.

Level 3 5-6 marks

- 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.

Level 4 7-8 marks

- 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 3

		AO3	AO4	Mark
	Describe how the use of smart and modern materials has affected the design and marketability of named electronic and mechanical products.		✓	8

Answers could make reference to the use of modern composite materials and the development of products that interact through the internet

A range of smart and modern materials include:

- Organic LED's
- LCD
- QTC
- Piezoelectric transducers
- Thermochromic Materials
- Photochromic Materials
- Hydrochromic Materials
- SMA
- Aramid Fibres (Kevlar and Nomex)
- CFRP
- Nanomaterials
- Smart Grease
- Conductive polymers

Products that have been influenced by these technologies could include:

- Driverless and energy efficient vehicles
- Sports equipment and clothing
- Prosthetic body parts
- Smart Televisions
- Domestic appliances
- Mobile communication devices

Answers should make reference to:

- Improved efficiency
- Reduced size and weight
- Improved life cycle
- Interaction of products with each other and with the consumer
- Sustainable and environmental issues
- Improved mechanical properties
- Reduced cost

Little or no understanding	**0**
Basic understanding of the use of smart or modern materials	**1-2**
Satisfactory understanding of the use of smart and modern materials	**3-4**
Good judgemental understanding of the application of both smart and modern materials	**5-6**
Analytical understanding related to design and marketability including both smart and modern materials.	**7-8**
For full marks reference must be made to both named electronic and mechanical products and include reference to smart and modern materials	

Total	**8**

Question 4

Concurrent Engineering was pioneered by the Automotive and Aerospace industries in the 1990s. Today many manufacturing companies employ this strategy when developing products.	AO3	AO4	Mark
Discuss the benefits of using concurrent engineering in the design, manufacture and development of new products.		✓	8

Concurrent engineering, also known as simultaneous **engineering**, is a method of designing and developing products, in which the different stages run simultaneously, rather than consecutively. It decreases product development time and also the time to market, leading to improved productivity and reduced costs.

Concurrent Engineering is a long term business strategy, with long term benefits to business. Though initial implementation can be challenging, the competitive advantage means it is beneficial in the long term. It removes the need to have multiple design reworks, by creating an environment for designing a product right the first time round.

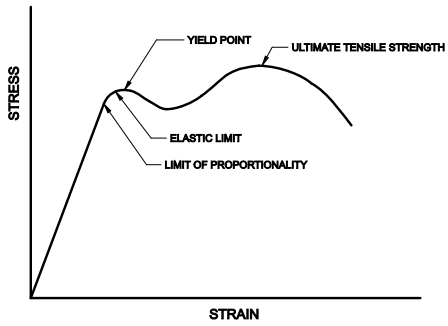
The notable business benefits of concurrent engineering make it a compelling strategy to adopt. Introducing concurrent engineering can lead to:

- **Competitive Advantage-** reduction in time to market means that businesses gain an edge over their competitors.
- **Enhanced Productivity-** earlier discoveries of design problems means potential issues can be corrected soon, rather than at a later stage in the development process.
- **Decrease Design and Development Time-** make products which match their customer's needs, in less time and at a reduced cost.
- It encourages multidisciplinary collaboration
- It makes the design process faster.
- It reduces costs and increases quality by supporting the entire project life cycle.
- It increases productivity by stopping mistakes in their tracks.
- It gives you a competitive advantage.

Little or no understanding	**0**
Basic appraisal and/or judgements of how concurrent engineering can improve productivity and reduce costs	**1-2**
Satisfactory appraisal and/or judgements of the ways in which concurrent engineering can result in an improved product	**3-4**
Good appraisal and/or judgements of the impact of current engineering on specified products.	**5-6**
Very good appraisal and/or judgements of the impact that concurrent engineering might have on a range of specified products.	**7-8**

Total	**8**

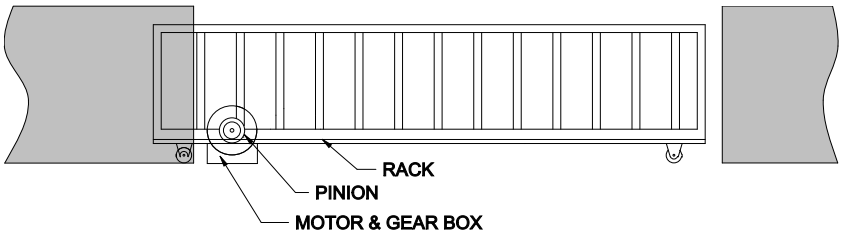
Question 5

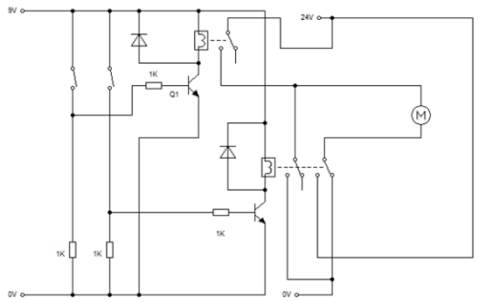
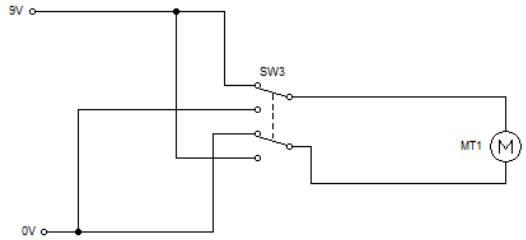
		AO3	AO4	Mark
In engineering design materials are tested under control conditions. The graph below shows the results of a tensile test on a ductile material. 				
(a)	Explain what is happening at each point on the graph. (i) The Limit of Proportionality (ii) The Elastic Limit (iii) The Yield Point (iv) The Ultimate Tensile Strength	✓		4
	Limit of Proportionality When a sample is loaded and testing is carried out the stress is initially proportional to the strain. The limit of proportionality is the point where the stress continues to increase but is no longer proportional to the strain and permanent deformation takes place. This is the basis of Hooke's Law.			**1**
	Elastic Limit Within the elastic range when the sample under test is loaded the material begins to stretch. Below the elastic limit when the load is removed the material will return to its original length and cross sectional area**.**			**1**
	Yield Point This is where the material under test is extended without any real increase in force. If the loading is removed at this point the material will exhibit elastic properties but the length and cross sectional area of the sample may be different from the original sample i.e. the bar may be longer.			**1**
	Ultimate Tensile Strength Ultimate tensile strength is the maximum stress that a material can withstand while being stretched or pulled before breaking.			**1**

(b)	Name a material that would be described as ductile and explain why it would be suitable for use in the manufacture of a specific engineered product.	4
	Examples of ductile materials are copper, aluminium alloys such as duralumin and mild steel. These materials can be drawn into wire and complex deep drawn containers. It is this property that makes them suitable for drink cans, food cans and kitchenware such as saucepans. Mild steel is used for general structural engineering. Copper and aluminium alloys are used for electrical wire as both materials are also good conductors and resist corrosion. Accept any appropriate ductile material.	
	Incorrect material identified	**0**
	Correct material identified but inappropriate product	**1**
	Correct material and appropriate product identified with some explanation	**2**
	Correct material and appropriate product identified with reasonable explanation	**3**
	Correct material and appropriate product identified with detailed justified explanation	**4**
	Total	**8**

Question 6

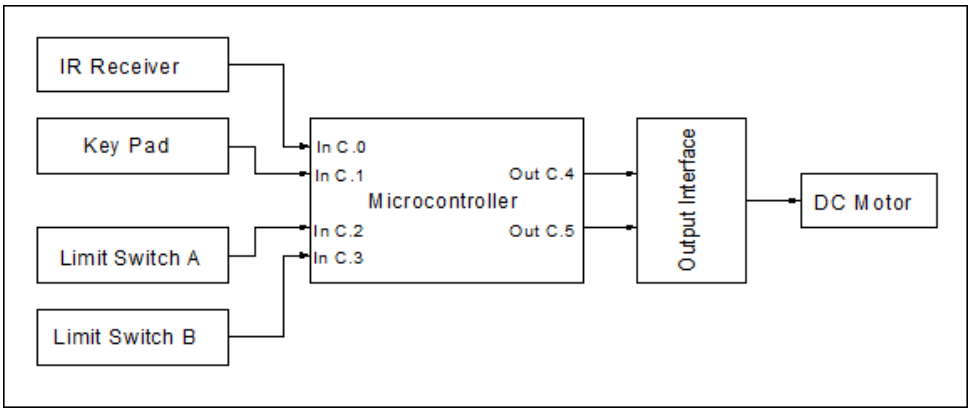
The image below shows a sliding gate that allows vehicles to access a property only when it is activated by the owner. The gate should open when a sensor is activated, remain open until the vehicle has passed and then close automatically as soon as it is safe to do so.		AO3	AO4	Mark
(a)	Analyse the following specification points and justify why they would be included when designing the sliding gate.	✓		4 x 2
	Award up to two marks for each fully justified point. Specification Point 1: The device should use a sustainable source of power In order to reduce energy consumption and reduce its impact on the environment. Specification Point 2: When closed the gate should automatically lock and remain locked until activated by the owner. The gate must be securely locked in order to deter intruders from entering the property Specification Point 3: The gate should be manufactured from durable materials. The gate should be made from durable materials as it will be exposed to varying weather conditions and subjected to regular use over many years. It will need to withstand impacted loading that might be anticipated from misuse. Specification Point 4: The gate should be safe to use by anyone who wishes to enter or exit the property. All moving parts need to be enclosed so that fingers cannot be caught in the mechanism. The gate should have sensors so that it will not close when people or vehicles could be trapped. All electrical components and systems should be tested to ensure that they comply with safety standards to prevent electric shock			**2** **2** **2** **2**

(b)	In the box below draw a detailed annotated diagram of a mechanical system that when activated would allow the gate to slide in either direction. Marks will be awarded for: • A suitable mechanical system • Justified selection of suitable materials	✓		8
	Exemplar Answer Gate could be made from nylon coated mild steel which would provide the strength and rigidity required. The coating would prevent corrosion  			
	The question requires a detailed diagram of a system that would enable the gate to move automatically in either direction. Details should include: • All components correctly identified/named. May include a rack and pinion or any other appropriate system • The weight of the gate should be supported at both ends in order that it can move easily **Guidance to markers** Mechanical diagram that has little detail or supporting annotation. Mechanical diagram with some supporting annotation and reference to suitable materials that is broadly relevant to the design. Mechanical diagram with supporting annotation, relevant to the design and demonstrates a clear understanding of the problem. Detailed mechanical diagram, labelled with supporting annotation that is clearly relevant to the design and demonstrates a thorough understanding of the problem.			**1-2** **3-4** **5-6** **7-8**

(c)	The mechanism that controls the gate is powered by a 24 Volt DC Motor. In the box below draw a circuit diagram that will enable the motor to be reversed.	8
	Exemplar Answer  ***Acceptable Answer***  The illustration is perfect answer to the solution. Candidates could offer a variety of acceptable solutions which would include the use of relays, a microcontroller, mechanical switches or a motor driver IC such as the L293D.	
	An inappropriate proposal with components unidentified.	**0**
	Some attempt to produce an appropriate circuit with some components correctly identified.	**1-2**
	A solution that could solve the problem but only one part of the circuit diagram evident that would enable the motor to be reversed.	**3-4**
	A functional solution with most parts of the circuit diagram evident which would enable the motor to be reversed.	**5-6**
	A detailed functional solution with nearly all parts of the circuit diagram considered to enable the motor to be reversed.	**7-8**

(d)	The gate mechanism is to be controlled by an Infrared Emitter held by the car driver, a Key Pad that can be used from inside the property and two Limit Switches. In the box below draw a block diagram that shows how the motor is activated and accurately controlled by the input sensors.	✓		8

Exemplar Answer



Guidance to markers

Detailed block diagram is required which should include:

Four suitable input devices (1 mark per input)	**4**
A suitable named process device.	**2**
Inputs correctly connected.	**1**
Connection to the motor.	**1**

(e)	Discuss the ways in which the sliding gate mechanism could be further developed to improve security for the owner.		✓	8
	Candidates may make reference to: • A suitable locking system that would prevent intruders from opening the gate. • Security cameras that would enable intruders to be seen and recorded. • Security lights with PIR sensors that would come on in the dark if anybody approaches the property. • Audible output. • Manual override for maintenance and exiting.			
	Incorrect / no answer			**0**
	Brief description of the issues that may be considered, but with little reference to improved security			**1-2**
	More detailed description of issues that may be considered with some reference to improved security			**3-4**
	Structured description of issues that may be considered with mostly relevant reasons why these issues are important			**5-6**
	Structured and detailed description of issues that may be considered, with clear and relevant reasons why these issues are important			**7-8**
		Total		**40**