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# **GCE AS MARKING SCHEME**

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**SUMMER 2022**

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

## **INTRODUCTION**

This marking scheme was used by WJEC for the 2022 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 2022 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.

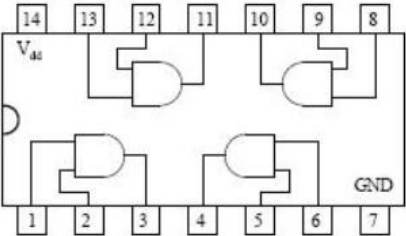
## Stage 2 – Deciding on the mark

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.

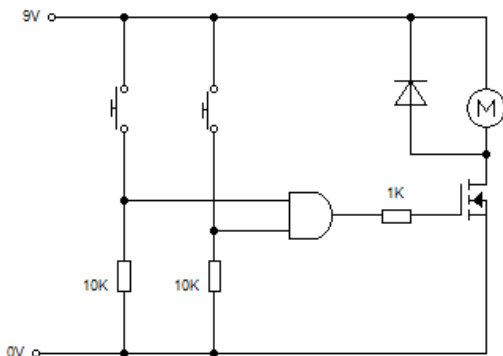
When marking, examiners can use these examples to decide whether a learner's response is of a superior, inferior or comparable standard to the example. Examiners are reminded of the need to revisit the answer as they apply the mark scheme in order to confirm that the band and the mark allocated is appropriate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

Q	Specification content	Marks for section	Suggested sub-question mark breakdown	Principles	Section	AO
1	2.3.1 (e) (j) (a)	8	4,2,2	In-depth (Ed)	AS & A Level	AO4
2	2.3.1 (g)	8	6,2	In-depth (Ed)	AS & A Level	AO4
3	2.1 (a) 2.4 (b)	8	8	Core	AS & A Level	AO3
4	2.1 (c) (d) 2.3.1 (c) 2.4 (f)	8	8	Core	AS & A Level	AO3
5	2.3.1 (e) 2.3.1 (i) (d) (e)	8	4,4	Designing & making	AS & A Level	AO4
6	2.1(b) 2.4(a) 2.3.1(d) (g) (a)	40	6,10,10,8,6	Designing & making	AS & A Level	AO4

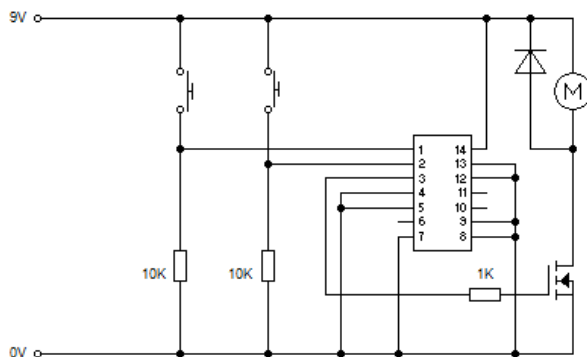
**Question 1**

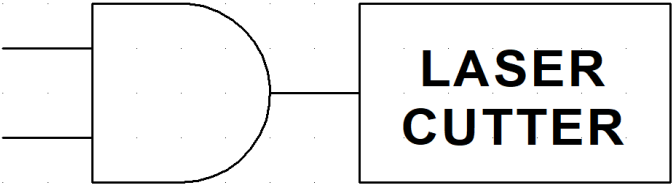
	AO3	AO4	Mark
<p>Laser cutters like the one shown below must include a number of features to ensure that they are safe to use.</p> <p>(a) The Laser Cutter should not operate until the safety guard has been closed and the extraction system has been turned on.</p> <p>The Quad Input AND gate integrated circuit (IC) is shown below.</p>  <p>In the box below draw a circuit diagram that uses this IC to ensure that the machine will not operate until two sensors have been activated.</p>		✓	4

**Example Answer 1**

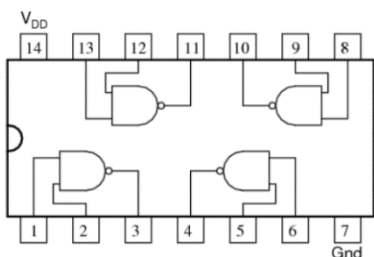


**Example Answer 2**



	<p><b>Acceptable Alternative Output</b></p>  <p><b>Guidance to markers</b></p> <p>No answer or an incorrect answer</p> <p>A simple circuit which shows some understanding</p> <p>An acceptable response showing clear understanding</p> <p>A developed circuit with few technical errors</p> <p>A fully developed solution</p>		<p><b>0</b></p> <p><b>1</b></p> <p><b>2</b></p> <p><b>3</b></p> <p><b>4</b></p>	
(b)	<p>Explain why ICs that contain NAND gates are often used in preference to those that contain AND, OR and NOT gates.</p> <p>NAND Gates can be used in combination to build other gates so often less components are required.</p> <p>Because NAND Gate Microchips are manufactured in bigger quantities they tend to be cheaper.</p> <p>Award one mark for any acceptable response Award two marks for any detailed explanation</p>		✓	2

(c) The pinout diagram for a Quad NAND gate IC is shown below.



Complete the truth table below for a NAND Gate.

Input A	Input B	Output Q
0	0	1
1	0	1

Award one mark for each row if fully correct

Input A	Input B	Output Q
0	0	1
<b>0</b>	<b>1</b>	<b>1</b>
1	0	1
<b>1</b>	<b>1</b>	<b>0</b>

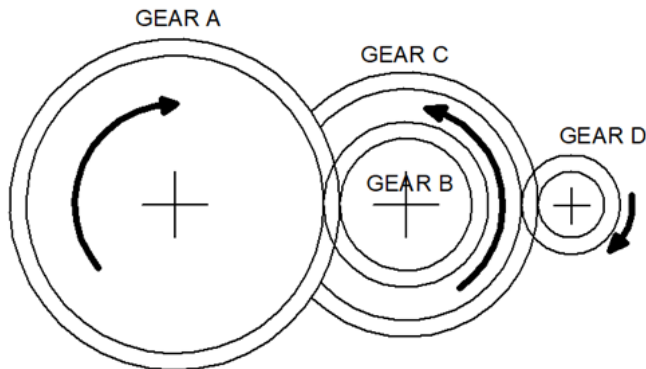
✓	2
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Total	8
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**Question 2**

The illustration shows a compound gear train that is used to drive the headstock of a metal turning lathe.



GEAR A	GEAR B	GEAR C	GEAR D
120 Teeth	40 Teeth	80 Teeth	20 Teeth

**AO3**

**AO4**

**Mark**

The driven GEAR A rotates in a clockwise direction at 180 rpm. In the space below calculate the velocity ratio (VR) for the compound gear train and the rotational velocity (RV) of the driver GEAR D.

*Show all your workings.*

✓

6

Velocity Ratio = No of teeth on driven gear / No of teeth on driver gear **2 marks**

$$VR = (120/40) \times (80/20)$$

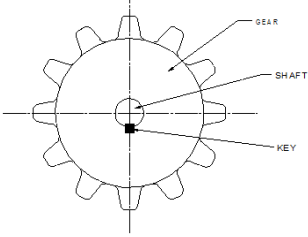
$$= 12:1 \quad \mathbf{2 \text{ marks}}$$

$$\text{Speed of Gear D} = 12 \times 180$$

$$= 2160 \text{ RPM} \quad \mathbf{2 \text{ marks}}$$

Accept any other appropriate calculation



(b)	Each gear needs to be secured to its shaft so that it will not slip when subjected to a rotational force. Use the space below to show how this can be achieved.		✓	2
<p>The solution needs to show a key and a key way or another acceptable solution.</p> <p>Acceptable Solution    <b>1 mark</b></p>  <p>Clear communication, conventionally correct    <b>1 mark</b></p>				
<b>Total</b>				<b>8</b>

**Question 3**

When developing new products engineers often use morphological analysis and reverse engineering. To develop the product shown below Dyson UK used an iterative process, producing over 600 prototypes.



**Dyson Supersonic Hair Dryer**

**AO3**

**AO4**

**Mark**

Explain how morphological analysis and reverse engineering benefits the iterative development process.

✓

8

Reverse Engineering involves the deconstruction of a product in order to see how it works and how it has been manufactured. Through this process engineering designers can analyse an existing product before making improvements.

Morphological Analysis is a methodical method of exploring all possible solutions to complex problems. It involves splitting the problem into partial problems and looking at possible options for each part. By looking at as many different alternatives as possible a wide range of solutions become evident.

Used together reverse engineering and morphological analysis will enable designers to make structured and methodical iterative developments.

Answers should refer to and show a clear understanding of both morphological analysis and reverse engineering. Candidates that use specific examples of both may be awarded higher marks.

**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.

	<p><b>Level 2 3-4 marks</b></p> <ul style="list-style-type: none"> <li>• The candidate has a basic understanding of the issues associated with the question.</li> <li>• The use of terminology and technical language is variable.</li> <li>• The candidate has some general knowledge of the form and function of products, trends and styles in relation to the context.</li> <li>• The candidate will express straightforward ideas clearly, if not always fluently. Answers may deviate from the question or be weakly presented.</li> <li>• There may be some errors of grammar, punctuation and spelling but is still able to communicate the issues.</li> </ul> <p><b>Level 3 5-6 marks</b></p> <ul style="list-style-type: none"> <li>• The candidate demonstrates a clear understanding of the issues associated with the question.</li> <li>• The use of terminology and technical language is reasonably accurate.</li> <li>• The candidate has demonstrated knowledge of the form and function of products, trends and styles associated to the context.</li> <li>• The candidate will express moderately complex ideas clearly and fluently, through well linked sentences and paragraphs. Answers will be generally relevant and structured.</li> <li>• There may be occasional errors of grammar, punctuation and spelling.</li> </ul> <p><b>Level 4 7-8 marks</b></p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• Uses correct terminology and technical language.</li> <li>• The candidate has developed a detailed knowledge of the form and function of a products, trends and styles associated to the context.</li> <li>• 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.</li> <li>• There will be few, if any, errors of grammar, punctuation and spelling.</li> </ul>	
	<b>Total</b>	<b>8</b>

**Question 4**

The bespoke training shoe shown below has been custom made for a client using Computer Aided Design (CAD) and Computer Aided Manufacture (CAM).



**AO3**

**AO4**

**Mark**

Evaluate the advantages to the client and the manufacturer of using CAD and CAM to produce bespoke custom-made products.

✓

8

To obtain higher level marks candidates should evaluate the advantages of CAD and CAM in relation to:

Needs of the client

3

Needs of the manufacturer

3

Award a further 2 marks for quality of communication.

**Exemplar answer 8 marks**

The training shoe in the illustration has been manufactured by Continuous Liquid Interface Production. This is a rapid manufacturing process that that enables functional products to be produced to meet individual needs directly from a computer.



For the client this means that the product can be made to an exact fit by first scanning their feet and then printing a bespoke product. This is particularly beneficial to anybody with specific requirements. It also enables individuals to choose customised colour schemes. The shoes are lighter in weight because they have been made from a honeycomb type structure and are more comfortable.

For the manufacturer the necessity to store and transport large quantities of training shoes is eliminated. The shoes are made as and when required, thus reducing transportation and storage costs. The amount of material required to produce each shoe is also reduced and unlike other manufacturing processes there is no wastage. The financial advantages to the manufacturer also impact on the environment. Fewer raw materials are being used, less energy is required and the need to recycle waste material is eliminated. This all contributes to a sustainable product where the use of materials has been optimised in a way that was not previously possible.

**Total**

**8**

**Question 5**

Electronic products that interact with the environment are being increasingly used to benefit consumers. Piezoelectric transducers can be used to measure changes in pressure, acceleration, temperature, strain, or force by converting signals into an electrical charge.	AO3	AO4	Mark
<p>Describe how this type of technology has been used to improve the performance of <b>the two</b> named products shown below.</p> <p>Humanoid Robot</p>  <p>Voice Controlled Smart Speaker</p> 	✓		2x[4]
<p>Award up to 4 marks for a description of how piezoelectric devices could be used in each product.</p> <p>Humanoid Robot could include:</p> <ul style="list-style-type: none"> <li>• Pressure sensors to detect touch and impact</li> <li>• Accelerometers to detect and control movement</li> <li>• Changes in temperature</li> <li>• Microphones for sound input and voice recognition</li> <li>• Devices that amplify sound output</li> </ul> <p>Smart Speaker could include:</p> <ul style="list-style-type: none"> <li>• Microphones for voice recognition</li> <li>• Loud speakers for sound amplification</li> <li>• Setting the frequency for timing devices</li> <li>• Providing audible alarms and alerts for the user</li> </ul>			

<b>Guidance to markers</b>		
For each product:		
Basic understanding with reference to one basic system.		<b>1</b>
Clear understanding with detailed reference to two or more systems.		<b>2</b>
Detailed understanding with reference to the interaction of appropriate systems with the user and / or the environment.		<b>3</b>
A fully developed response showing in depth understanding with analytical comment.		<b>4</b>
<b>Total</b>		<b>8</b>

**Question 6**

The images below show a traditional mobility scooter and a modern revitalised scooter that has been created to replace the traditional product.



**AO3**

**AO4**

**Mark**

(a) Analyse the modern revitalised scooter on the right and discuss **four** specification points that have led to the design of this product.

✓

12

Anticipated answers could include:

- Low centre of gravity giving increased stability
- Larger wheels which would allow the vehicle to move more easily over undulating and soft ground
- Four-wheel steering which gives more manoeuvrability. This is particularly beneficial indoors and in confined spaces
- Joystick assisted manual steering
- Use of modern composite materials making a product which is lighter in weight and more visually attractive
- Improved head lights, tail lights and directional indication
- Increased comfort
- Safety
- Durability
- Enhanced appearance

Award one mark for each acceptable point and up to two marks for appropriate justification.

***Exemplar answer:***

Specification Point 1: The scooter should be safe to use.

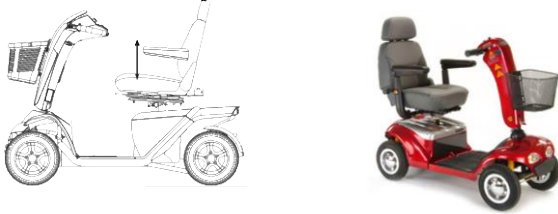
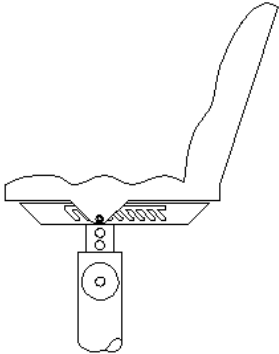
The product must be safe for both the user and other people. It must conform to electrical safety standards, should be made from fire retardant materials, It should stop within a specified distance when the brakes are applied. The chair should not have any sharp edges which could harm the user or other people in the event of a collision. It must not roll freely when the power supply is turned off.

Specification Point 2: The scooter would be easier to operate by those with limited dexterity

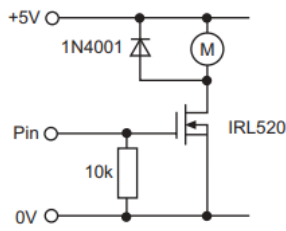
The controls should be designed so that they can be easily reached and activated by the user. Directional control should require minimal physical effort and the vehicle should stop under braking without causing discomfort.

	<p>Specification Point 3: The product has a modern stylish appearance</p> <p>The product should appeal to all age groups. Traditional scooters of this type are often not used by those who would benefit from them because of a dated outward appearance.</p> <p>Specification Point 4: The scooter should be stable and move easily over rough ground.</p> <p>Larger wheels would enable the scooter to move more easily over soft and rough ground. This would also result in a lower centre of gravity making the scooter more stable.</p>	
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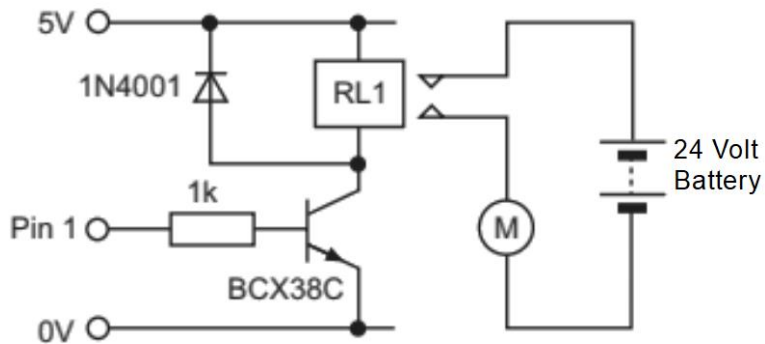


<p>(b)</p>	<p>The mobility scooter shown below is to be available for loan from a shop mobility centre. As it will be used by a wide range of people the seat must be easily adjusted both horizontally and vertically.</p> <div style="text-align: center;">  </div> <p>In the box below draw a detailed annotated diagram of a mechanical system that when activated would allow the seat to be moved and securely locked in position.</p> <p>Marks will be awarded for:</p> <p>(i) An appropriate method for adjusting the height. [4]  (ii) An appropriate proposal for horizontal adjustment. [4]  (iii) A suitable method for locking the seat in position. [2]  (iv) Justified selection of materials. [2]</p>	✓		12
<p><b>Guidance to markers</b></p> <p>Appropriate method proposed for height adjustment. <span style="float: right;"><b>4</b></span></p> <p>Appropriate proposal for horizontal adjustment. <span style="float: right;"><b>4</b></span></p> <p>A suitable method for locking the seat in position. <span style="float: right;"><b>2</b></span></p> <p>Justified selection of materials. <span style="float: right;"><b>2</b></span></p>				
<p><b>Exemplar Answer:</b></p> <div style="text-align: center;">  </div> <p>Vertical and horizontal brackets made from chromium plated mild steel to provide strength and to resist corrosion</p> <p>(appropriate materials identified but little or no justification – one mark only)</p> <p>Answers could include mechanical and/or hydraulic systems</p>				

(c) The mobility scooter is to be powered by a 24 Volt DC motor which is controlled by outputs from a Microcontroller. The circuit shown uses a MOSFET Transistor to control a 5 Volt Motor.



In the box below draw a circuit diagram that uses a relay to link the microcontroller circuit to a 24 Volt Motor.



- Some attempt to use a relay to interface two circuits. 2
- Relay drawn using correct convention with the field energised from the primary circuit. 2
- 24 Volt Motor connected to a power supply. 2
- Motor connected to the field contacts of an SPST Relay. 2
- Accurate illustration using correct convention for all components. 2

(d)	If the mobility scooter was to be used by more severely disabled people it would need further modifications. Discuss <b>three</b> electronic or mechanical systems that could be added to the scooter to meet the needs of people with specific disabilities.		✓	6
<p>Responses could include:</p> <ul style="list-style-type: none"> <li>• Modified controls which require reduced physical contact</li> <li>• Additional harness and support for those with upper body disability</li> <li>• Control through voice recognition</li> <li>• Angular and linear adjustment of the seat to help users get in and out of the scooter</li> <li>• Electronic emergency alert which will contact a designated person if the user has any difficulty</li> <li>• Tracking device which will enable friends and relatives to find the user</li> </ul> <p>Award 2 marks each for any three justified modifications</p>				
		<b>Total</b>	<b>40</b>	