



---

# **GCSE MARKING SCHEME**

---

**SUMMER 2023**

**GCSE  
DESIGN AND TECHNOLOGY –  
ENGINEERING DESIGN  
3601U10-1**

## **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.

# WJEC GCSE DESIGN AND TECHNOLOGY – ENGINEERING DESIGN

## 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 points and 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 level 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 is, 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.

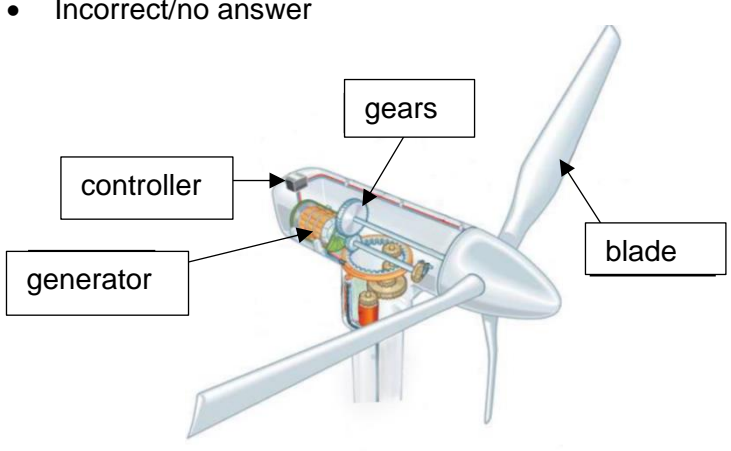
#### Stage 2 – Deciding on the mark

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				
	Study the Life Cycle Analysis diagram below.	AO3	AO4	Marks
(a)	Complete the <b>two</b> missing stages of a Life Cycle Analysis.		✓	2 x [1]
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>• Incorrect/no answer</li> <li>• Packaging/ boxing up / protecting</li> <li>• Disposal / recycling / landfill / end of useful life / waste</li> </ul> <p>One mark each correct answer.</p>			<p>0</p> <p>1</p> <p>1</p>
(b)	Describe <b>one</b> advantage and <b>one</b> disadvantage of the use of packaging to carry products from a factory to the retailers or customers.		✓	2x [2]
	<p><b>Guidance for marking</b></p> <p>Advantages:</p> <ul style="list-style-type: none"> <li>• Prevents damage and breakage in transit</li> <li>• Makes shipping easier</li> <li>• Packaging such as card is easily recyclable</li> <li>• Can be used for advertising</li> <li>• Can be used to display information about product inside</li> </ul> <p>Disadvantages:</p> <ul style="list-style-type: none"> <li>• Packaging requires additional space when shipping</li> <li>• Additional cost to product pricing</li> <li>• Can be difficult to dispose</li> <li>• Over packaging uses more resources.</li> <li>• Customer disposal choice may have negative impact to environment.</li> </ul> <p>Incorrect/no answer</p> <p>Brief explanation with little detail e.g. Packaging makes it easier to ship products.</p> <p>More detailed description e.g. Packaging makes it easier to ship products as most boxes are rectangular making it easier to stack the geometric shapes.</p>			<p>0</p> <p>1</p> <p>2</p>

(c)	The image below shows a commonly used AA battery found in a torch.			
(i)	Explain how the disposal of a battery in landfill will have a negative impact on the environment.		✓	[2]
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>Batteries corrode and leech chemicals.</li> <li>Chemicals such as lead, lithium, cadmium, and mercury can be introduced into the ground</li> <li>Chemicals poison and pose dangerous health issues to humans and animals.</li> <li>Chemicals can enter water sources.</li> <li>Risk of fire/explosion from Lithium Ion and Lipo batteries if knocked around too much.</li> </ul> <p>Incorrect/no answer</p> <p>Brief explanation with little detail e.g. Chemicals can be introduced into the ground or water.</p> <p>More detailed description e.g. Chemicals such as lead, lithium, cadmium, and mercury can be introduced into the ground. These are poisonous and pose dangerous health issues to humans and animals.</p>			0 1 2
(ii)	Describe an alternative portable power source that would be more environmentally friendly for use in a torch.		✓	[2]
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>Rechargeable batteries can be reused over and over therefore less waste for landfill.</li> <li>Solar power is a renewable energy that could charge a battery in the day to use in the dark.</li> <li>A Dynamo (wind up torch) is a renewable energy that can be used to charge the torch when needed.</li> </ul> <p>Incorrect/no answer</p> <p>Brief explanation with little detail e.g. Rechargeable batteries can be reused over and over.</p> <p>More detailed description e.g. Rechargeable batteries can be reused several times over therefore batteries will be thrown away less waste resulting in low rate of materials being disposed of frequently.</p> <p><i>One mark for any of the above or similar.</i></p>			0 1 2
<b>TOTAL</b>				<b>10</b>

Question 2				
	Study the picture of the wind turbine farm below.	AO3	AO4	Marks
(a)	Explain <b>one</b> reason for the importance of considering the location of the wind turbine before installation.		✓	[2]
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>• Wind turbines often are in exposed areas where the wind is often strong and constant to produce energy efficiently.</li> <li>• An area with too strong wind flow can result in over generation and possible explosion on the turbine.</li> <li>• A built-up area or with high vegetation would obscure the flow of wind.</li> <li>• Wind turbines can be noisy therefore are erected away from built-up areas.</li> </ul> <p><i>Areas such as the coast, at the top of large hills and out at sea.</i></p> <p>Incorrect/no answer 0</p> <p>Brief explanation with little detail e.g. The wind turbines will not produce energy if there is not enough wind. 1</p> <p>More detailed description e.g. The wind turbines require a strong and constant flow of wind to produce energy. If this is not present the turbine will be less efficient or will not produce electricity. 2</p>			
(b)	Use the words below to label the image of the wind turbine.		✓	4 x [1]
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>• Incorrect/no answer 0</li> </ul>  <p>One mark for each correct answer</p>			<p>0</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>

(c)	Explain <b>one</b> advantage and <b>one</b> disadvantage of using a wind turbine for the generation of electricity.		✓	<b>2 x [2]</b>
<p><b>Guidance for marking</b></p> <p><i>Advantages:</i></p> <ul style="list-style-type: none"> <li>• It is a renewable/sustainable energy source</li> <li>• It produces clean and environmentally friendly energy</li> <li>• Cost effective – after setting up costs the energy is free</li> <li>• Can be used domestically and commercially</li> <li>• Does not create carbon emissions</li> <li>• No carbon footprint after manufacture/after payback.</li> </ul> <p><i>Disadvantages:</i></p> <ul style="list-style-type: none"> <li>• Fluctuation in wind can result in reduced or no energy production</li> <li>• Noise pollution</li> <li>• Aesthetics – can be seen as a visual eye sore</li> <li>• An area with too strong wind flow can result in over generation and possible damage to the turbine blades and the generator.</li> <li>• Sourcing suitable locations with strong and consistent winds</li> <li>• Wildlife has proven to be an issue i.e. birds being killed by the blades</li> <li>• Set up cost</li> <li>• Manufacture and transportation of wind turbines produce carbon emissions.</li> </ul> <p>Incorrect/no answer 0</p> <p>Brief explanation with little detail e.g. It is a renewable energy source. 1</p> <p>More detailed description e.g. It is a renewable energy source which will continue to produce electricity and does not create or emit carbon emissions. 2</p> <p style="text-align: right;"><b>2 X 2</b></p>				
<b>TOTAL</b>		<b>10</b>		

Question 3														
	The image below shows a biometric device for a computer.	AO3	AO4	Marks										
(a)	Explain <b>two</b> advantages of using biometric devices to access a computer.		✓	2 x [2]										
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>• Security – The use of passwords with numbers, letters, symbols, etc. which are becoming easy to hack every day. Biometric technology brings different types of solutions which are nearly impossible to hack unlike passwords.</li> <li>• Accuracy – Biometric works with your physical traits such as fingerprints, palm vein, retina amongst others that will always serve you accurately anywhere, anytime. These do not fail where other technology does i.e. smart cards, personal PINs.</li> <li>• Convenient – A person’s physical credentials are unique and there is no need to memorise or note down passwords, PINs etc.</li> <li>• More cost effective</li> <li>• Trustable – biometric solutions are more trustworthy than other solutions as the security data required is unique to an individual.</li> <li>• Save Time – Biometric solutions are highly time conserving. In most cases, a finger on a device or an eye scan on a retina device to pass the system.</li> </ul> <p>Incorrect/no answer 0</p> <p>Brief explanation with little detail e.g. It is faster to log onto the computer. 1</p> <p>More detailed description e.g. It is faster to log onto the computer, as the system scans a person’s features more quickly than typing in a password. 2</p> <p><b>2X2</b></p>													
(b)	Complete the table below to show whether the statements about biometrics are True or False.		✓	4 x [1]										
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>• Incorrect/no answer 0</li> </ul> <table border="1"> <thead> <tr> <th>Statements</th> <th>True or False</th> </tr> </thead> <tbody> <tr> <td>Biometrics are able to enhance security for devices.</td> <td>True</td> </tr> <tr> <td>A biometric sensor can detect characteristics such as a fingerprint for identification.</td> <td>True</td> </tr> <tr> <td>Biometrics are unable to recognise voice commands.</td> <td>False</td> </tr> <tr> <td>Airport security uses biometrics to identify a person by scanning their face.</td> <td>True</td> </tr> </tbody> </table> <p>One mark each correct answer.</p>	Statements	True or False	Biometrics are able to enhance security for devices.	True	A biometric sensor can detect characteristics such as a fingerprint for identification.	True	Biometrics are unable to recognise voice commands.	False	Airport security uses biometrics to identify a person by scanning their face.	True			0 1 1 1 1
Statements	True or False													
Biometrics are able to enhance security for devices.	True													
A biometric sensor can detect characteristics such as a fingerprint for identification.	True													
Biometrics are unable to recognise voice commands.	False													
Airport security uses biometrics to identify a person by scanning their face.	True													



(c)	The biometric device cable has a copper wire with a PVC coating.		✓	[4]
(i)	Explain why these materials have been selected.			
	<p><b>Guidance for marking</b></p> <p><b>Copper wire:</b></p> <ul style="list-style-type: none"> <li>• Excellent electrical conductor</li> <li>• Corrosion resistant</li> <li>• Easily joined / soldered</li> <li>• Malleable</li> <li>• Ductile</li> <li>• Flexibility</li> <li>• Recycled</li> <li>• Reused</li> </ul> <p><b>PVC coating:</b></p> <ul style="list-style-type: none"> <li>• Flexible</li> <li>• Easy to process</li> <li>• Ease to bend</li> <li>• Has flame-resistant properties</li> <li>• It is an excellent electrical insulation (highly flammable)</li> <li>• Resists chemicals, oil and grease.</li> <li>• Recycled</li> <li>• Reused</li> </ul> <p>Incorrect/no answer</p> <p>Brief explanation with little detail e.g. Copper is an excellent conductor.</p> <p>More detailed description e.g. Copper is an excellent conductor that is flexible, this enables the wire to bend without effecting its conductivity.</p> <p>Brief explanation with little detail e.g. PVC is an excellent electrical insulator.</p> <p>More detailed description e.g. PVC is an excellent electrical insulator to encase the conductive copper wire keeping the electricity safely within the cable.</p>			<p>0</p> <p>1</p> <p>2</p> <p>1</p> <p>2</p>

(ii)	Explain the disadvantages of using biometrics in a product.		✓	<b>[3]</b>
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>• Cost of hardware/devices</li> <li>• Cost of software and programming</li> <li>• Cost of running through security servers</li> <li>• Maintenance costs</li> <li>• Level of maintenance/insulation expertise required</li> <li>• Repair costs</li> <li>• In high demand: delays can be longer than other security methods e.g. security at airports, large companies /schools/colleges using ID entry/registers</li> <li>• Highly technical and complex system requiring trained mechanics to repair or upgrade</li> <li>• Unhygienic in the case of fingerprint/palm vein scanners</li> <li>• Environment and Usage can affect the measurements taken e.g. temperature, humidity etc.</li> <li>• People may not want personal data stored</li> </ul> <p>Incorrect/no answer</p> <p>Brief explanation with little detail e.g. The cost of the hardware/devices is high.</p> <p>More detailed description e.g. The initial set up cost of the hardware and software is high as they are specialised products.</p> <p>More than one detailed description e.g. The initial set up cost of the hardware and software is high as they are specialised products. This also makes the maintenance and repair cost expensive as professional engineers are required to carry out the work.</p>			<p>0</p> <p>1</p> <p>2</p> <p>3</p>
<b>TOTAL</b>		<b>15</b>		

Question 4				
	The images below show a pair of headphones that were sold in the year 2000 and a set of earphones that were released in 2019.	AO3	AO4	Marks
(a)	Study <b>each</b> of the products and analyse how these have developed due to social and environmental forces. <i>Marks will be awarded for the content of the answer and the quality of written communication.</i>	✓		[10]
	<p>Answers that indicate an understanding of packaging, sustainability, and his com should be awarded up to 10 marks based on:</p> <p>2000 headphones:</p> <ul style="list-style-type: none"> <li>• Wired headphone with good communication.</li> <li>• Wire is coiled to ensure wire stay neat and tidy.</li> <li>• Coiled wire helped prevent entanglement.</li> <li>• Jack socket is required to use.</li> <li>• Bluetooth technology was first released in devices (mobile phones and laptops) this year therefore demand was low, and the technology was not widely known about (first stage of Life Cycle Analysis – Introduction).</li> <li>• The headphone would have been used with CD players,</li> <li>• Headphones could have been used on MP3 players (released in late 1990’s) and other devices.</li> <li>• The headphones and music devices were larger in 2000’s and were less likely to be listened to whilst commuting.</li> <li>• Headphone’s were used in and around the home.</li> <li>• No wireless charging/ or batteries needed to use headphones.</li> <li>• No wireless listening technology present.</li> <li>• More materials were used to manufacture the headphones.</li> <li>• Copper and PVC/ other polymers were used for the wire of the headphone.</li> <li>• Packaging for the product would have used more materials due to the size of the headphones.</li> </ul> <p>2019 earphones:</p> <ul style="list-style-type: none"> <li>• Technology on devices such as phone, tablets, watches etc. demand earphones.</li> <li>• Music is played through mobile phones as one of the main devices.</li> <li>• The development of the internet has enabled phones to play, download and stream music therefore the customer demand for discrete listening accessories is high.</li> <li>• People use device daily whilst commuting, exercising etc. as devices such as phones with music app are smaller and more easily transportable than larger 1990’s - early 2000’s CD players etc.</li> <li>• Smaller earphones are more suitably portable for use out of the home.</li> <li>• Many newer devices rely on Bluetooth technology instead of using a jack socket for headphone/earphones.</li> <li>• Technology push for wireless listening technology.</li> <li>• Technology push for wireless charging technology.</li> </ul>			

	<ul style="list-style-type: none"> <li>• Technology has advanced (Moore’s Law) therefore technology/PCBs are now manufactured smaller with a greater quantity of technology included in them.</li> <li>• Shipping of batteries requires additional attention to ensure the product is protected correctly.</li> <li>• Packaging requires the RoSH mark and ‘The Crossed-Out Wheelie Bin Symbol’ - Battery Directive.</li> <li>• Disposal of the product must meet the Battery Directive which is part of UK Law, 2008.</li> <li>• Small earphone using less materials.</li> <li>• Storage case to prevent earphone pieces from getting lost.</li> <li>• Battery life is limited therefore will require repair or replacement.</li> </ul> <p><b>Guidance for marking</b></p> <p>Incorrect/no answer</p> <p>Brief analysis with little detail of each of the headphones/earphones and the social and environmental forces. Quality of Written Communication is limited, presenting material with limited coherence, many errors of grammar, punctuation and spelling. e.g. One or two point from the above list conveyed in a very simple fashion. See list above.</p> <p>More detailed analysis, with some explanation and detail of each of the headphones/earphones and the social and environmental forces. Quality of Written Communication is basic, presenting occasionally appropriate material with some coherence, some errors of grammar, punctuation and spelling. e.g. Several (3-4 points) conveyed in a simple fashion. See list above.</p> <p>Detailed analysis and explanation of each of the headphones/earphones and the social and environmental forces. Quality of Written Communication is good, presenting mainly appropriate material in a coherent manner, few errors of grammar, punctuation and spelling. e.g. A good range of points conveyed clearly and well. See list above.</p> <p>Clear and detailed analysis and explanation of each of the headphones/earphones and the social and environmental forces. Quality of Written Communication is excellent, presenting wholly appropriate material in a coherent and logical manner, hardly any errors of grammar, punctuation and spelling. e.g. Many points conveyed articulately (8 or more) See list above.</p>			<p>0</p> <p>1-2</p> <p>3-4</p> <p>5-7</p> <p>8-10</p>
--	--	--	--	---



(c) (i)	Describe what is meant by the term 'obsolescence' in the life of a product.		✓	[2]
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>• Time and state in which a product ceases to be used</li> <li>• Product is not useful any longer and is discontinued</li> <li>• Company stops producing and marketing a product</li> <li>• The end of a Product Life Cycle</li> </ul> <p>Incorrect/no answer</p> <p>Brief explanation with little detail e.g. obsolescence refers to the time and state in which a piece of technology or product ceases to be useful.</p> <p>More detailed description e.g. obsolescence refers to the time and state in which a piece of technology or product ceases to be useful, productive or compatible. Obsolescence may occur when a company stops producing, marketing or supporting a sold or developed product.</p>			0 1 2
(ii)	Explain <b>one</b> advantage of obsolescence to the headphone/earphone manufacturer.		✓	[2]
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>• Manufacturer is able to push the market</li> <li>• Manufacturer is able to re-introduce modified product before the past product declines in sales.</li> <li>• Manufacturer maintains a steady flow of sales of newer products.</li> <li>• Manufacturer continues to make profit.</li> <li>• Customer interest in the product is maintained.</li> <li>• Customer is loyal to brand and new technology therefore continues to purchase product.</li> </ul> <p>Incorrect/no answer</p> <p>Brief explanation with little detail e.g. The manufacturer is able to re-introduce modified products before the past product declines in sales.</p> <p>More detailed description e.g. The manufacturer is able to re-introduce modified products before the past product declines in sales This enables the manufacturer to maintain a steady flow of sales and profit</p>			0 1 2
<b>TOTAL</b>		<b>20</b>		

<b>Question 5</b>				
	The photograph and the cut away drawing shown below are of a spanner and a bolt.	<b>AO3</b>	<b>AO4</b>	<b>Marks</b>
(a)	There are two mechanical components on the spanner. The worm barrel is labelled A.			
(i)	Circle the correct name of the mechanical part labelled B.		✓	<b>[1]</b>
	<b>Guidance for marking</b> <ul style="list-style-type: none"> <li>• Incorrect/no answer</li> <li>• Rack gear</li> </ul>			0 1
(ii)	Describe <b>one</b> advantage of the spanner above.		✓	<b>[2]</b>
	<b>Guidance for marking</b> <ul style="list-style-type: none"> <li>• Adjustable</li> <li>• Can save money as fewer spanners need to be bought.</li> </ul> <p>Incorrect/no answer</p> <p>Brief explanation with little detail e.g. The size can be changed.</p> <p>More detailed description e.g. The size of the spanner can be adjusted for different sized nuts and bolts. The user would only need to purchase one spanner rather than a set of different sizes.</p>			0 1 2
(iii)	State and justify the manufacturing process used to produce the main body of the spanner.		✓	<b>[2]</b>
	<b>Guidance for marking</b> <ul style="list-style-type: none"> <li>• Accurate</li> <li>• High tolerance</li> <li>• Quality surface finishes</li> <li>• Cast complex shapes</li> <li>• Can use die/mould to cast several times over</li> <li>• High degree of uniformity</li> <li>• Mass production method</li> </ul> <p>Incorrect/no answer</p> <p>Casting / drop forging</p> <p>Brief explanation with little detail e.g. Die casting is an accurate process for manufacturing complex parts/products.</p>			0 1 1

(b)	The images below show two different sized spanners.			
(i)	Explain which spanner would have the greater mechanical advantage when loosening a tightly fixed bolt.		✓	[2]
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>Spanner B is longer than spanner A.</li> <li>Spanner B has a greater mechanical advantage due to its additional length.</li> </ul> <p>Incorrect/no answer</p> <p>Correct answer: Spanner B</p> <p>Brief explanation with little detail e.g. Spanner B is longer than spanner A.</p>			0 1 1
(ii)	Study the image of the spanner below, calculate the turning moment of the spanner in Nm.		✓	[3]
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>Incorrect/no answer</li> </ul> <p>300mm = 0.30m (convert mm to m) : <math>300/1000 = 0.30</math>  Moment = <math>40 * 0.30</math>  Moment = 12Nm</p> <p><b>OR</b></p> <p>Moment = <math>40 * 300</math>  Moment = 1200  Moment = <math>1200/1000</math>  Moment = 12Nm</p> <p><i>One mark for each step.</i></p>			0 1 1 1
(c)	The images below are of a cordless impact wrench in use on a car wheel. The diagram on the right-hand side shows a compound gear train used within the wrench.			
(i)	Describe the benefits of the impact wrench being cordless.		✓	[2]
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>No cable</li> <li>Easy of movement when in use</li> <li>Ease of use without obstruction</li> <li>Rechargeable</li> <li>Portable</li> </ul> <p>Incorrect/no answer</p> <p>Brief explanation with little detail e.g. The wrench can be moved around with ease.</p> <p>More detailed description e.g. The wrench can be moved around without any tangling up of cables. This makes it faster and convenient to use on engineered products that are large.</p>			0 1 2

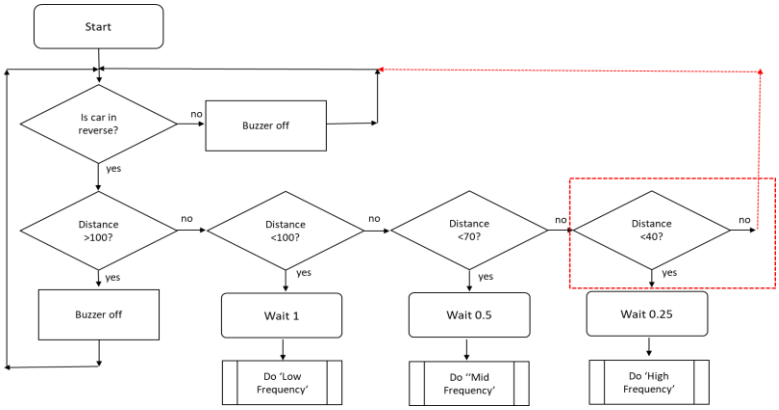
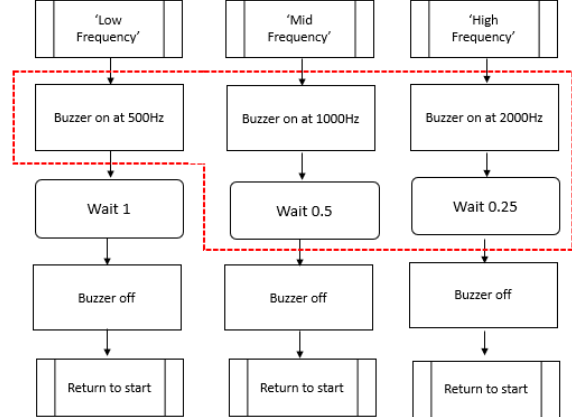


(ii)	Using the diagram, calculate the rotational speed of the chuck. Show all workings.		✓	<b>[6]</b>
	<p><b>Guidance for marking</b></p> <p>Incorrect/no answer</p> <ul style="list-style-type: none"> <li>• <math>VR=DN/DR</math>  <math>VR=20/10</math>  2:1  2  <math>30,000/2 = 15,000 \text{ RPM}</math></li> <li>• <math>VR=DN/DR</math>  <math>VR=60/30</math>  6/3  2:1  2  <math>15,000/2 = 7,500 \text{ RPM}</math></li> <li>• <math>VR=DN/DR</math>  <math>VR=30/10</math>  3:1  3  <math>7,500/3 = \mathbf{2,500 \text{ RPM}}</math></li> </ul> <p><i>One mark each correct procedure with answer. Accept any other mathematical methods.</i></p>			0  1 1   1 1   1 1
(iii)	The image below shows the socket fixing for the wrench.  High-speed steel (HSS) is used for the socket fixing of the wrench. Explain why this is a suitable material for this component.		✓	<b>[2]</b>
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>• Medium-carbon steel with tungsten, chromium and vanadium</li> <li>• Retains hardness at high temperatures</li> <li>• Resistant to high levels of friction heat</li> <li>• Rust resistant</li> <li>• High tensile strength</li> </ul> <p>Incorrect/no answer</p> <p>Brief explanation with little detail e.g. High-speed steel is resistant to high levels of friction heat.</p> <p>More detailed description e.g. High-speed steel is resistant to high levels of friction heat. As the socket will be turning with a high level of force the friction will be high on this part of the product.</p>			0  1  2
<b>Total marks</b>				<b>20</b>

Question 6				
	Study the photograph of a rear end of a car below.	AO3	AO4	Marks
(a)	Use the correct words to complete the sentences below.		✓	[2]
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>• Incorrect/no answer</li> </ul> <p>The car's rear light cases are made from <b>polycarbonate</b>. This choice of plastic is used as it is <b>translucent</b> and will allow light to shine through.</p>			0 1 1
(b)	Explain why polypropylene is a suitable material for the car bumper.		✓	[4]
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>• High strength to weight ratio</li> <li>• Good stiffness &amp; strength</li> <li>• Good chemical resistance and weldability</li> <li>• Good processability</li> <li>• Good impact resistance</li> <li>• Good stiffness</li> <li>• Suitable for corrosion resistant structures</li> <li>• Good stress crack resistance and low temperature toughness</li> <li>• High toughness</li> <li>• Easy to process in factory's i.e. injection moulding</li> <li>• Recyclable</li> </ul> <p>Incorrect/no answer</p> <p>Brief explanation with little detail e.g. Easy to mould into bumper shape. <i>e.g. One point from the above list conveyed in a very simple fashion.</i></p> <p>More detailed description e.g. It is a suitable material that can easily be injection moulded into accurate and complex shapes/parts. <i>e.g. One point from the above list conveyed in a with detail. Or, two points from the above list conveyed in a very simple fashion.</i></p> <p>Detailed description e.g. It is a suitable material that can easily be injection moulded into accurate and complex shapes/parts. It also has good impact resistance. <i>e.g. More than one point from the above list conveyed in a very simple fashion with one of these points explained in a with detail.</i></p> <p>Highly detailed description e.g. It is a suitable material that can easily be injection moulded into accurate and complex shapes/parts this enables the car to be designed more aerodynamically. It also has good impact resistance, improving the safety of the vehicle in-case of a collision with another car. <i>e.g. More than one point from the above list conveyed in a with detail.</i></p>			0 1 2 3 4

(c)	Evaluate the use of injection moulding to manufacture the car bumper.	✓		[5]
<p><b>Guidance for marking</b></p> <p><b>Advantages of injection moulding:</b></p> <ul style="list-style-type: none"> <li>• Fast production.</li> <li>• Low labour costs.</li> <li>• Design flexibility.</li> <li>• High-output production.</li> <li>• Can produce complex parts that are highly accurate.</li> <li>• Very high tolerances to ensure parts fit correctly.</li> <li>• Multiple materials can be used at the same time.</li> <li>• Can be used to produce very small parts.</li> <li>• Leaves little post-production scrap.</li> <li>• Ability to include inserts.</li> <li>• Good colour control.</li> <li>• Good product consistency.</li> <li>• Reduced requirements for finishing.</li> <li>• Good dimensional control.</li> <li>• Good surface finish</li> <li>• Variety of textured finishes can be applied.</li> </ul> <p><b>Disadvantages of injection moulding.</b></p> <ul style="list-style-type: none"> <li>• High initial tooling and machinery cost.</li> <li>• Part design restrictions.</li> <li>• Small runs of parts can be costly.</li> <li>• Requires a lot of energy</li> </ul> <p>• Incorrect/no answer</p> <p>• Simplistic evaluation but no reasoning limited understanding evident. E.g. Injection moulding can make car bumpers to a high standard.</p> <p>• Some evaluation evident and limited reasoning. Some understanding evident. E.g. Injection moulding can make car bumpers with a high level of accuracy and tight tolerances. However, to do this cost effectively the bumpers need to be mass produced to reduce cost.</p> <p>• Clear evaluations with detailed reasoning. Detailed understanding evident. E.g Injection moulding can make car bumpers with a high level of accuracy and tight tolerances. To do this cost effectively the bumpers need to be mass produced to reduce cost as the initial cost of the injection moulder and the manufacturing of the mould is expensive. However, once the mould is made the specific bumper can be made thousands of time over to the exact dimensions.</p>				
				0
				1
				2-3
				4-5

(d)	The car bumper is mass produced using automation.			
(i)	Circle the correct term for the use of automation when manufacturing.		✓	[1]
	<b>Guidance for marking</b> <ul style="list-style-type: none"> <li>• Incorrect/no answer</li> <li>• CAM</li> </ul>			0 1
(ii)	Evaluate the use of automation when mass producing vehicles.	✓		[5]
	<b>Guidance for marking</b> <p><b>Advantages of automation:</b></p> <ul style="list-style-type: none"> <li>• Increased efficiency - Industrial automated devices are able to complete certain tasks faster and better than people.</li> <li>• Automated devices are able to work 24hr per day 7 days a week without rest.</li> <li>• Automated devices can assemble part with a higher accuracy level at speed.</li> <li>• Automated devices can assemble and manufacture to very a higher quality.</li> <li>• Industrial automated devices are often used for performing tasks which are deemed as dangerous for humans.</li> <li>• Automated devices are used to perform highly laborious and repetitive tasks.</li> <li>• Automated devices do not get tired and make dangerous mistakes, neither do they suffer from repetitive strain injury.</li> <li>• Automated devices are programmable and can be re-programmed for a range of activities and tasks.</li> <li>• Once programmed and installed their running costs are inexpensive compared to a salary of a worker.</li> <li>• Improves safety.</li> </ul> <p><b>Disadvantages of automation:</b></p> <ul style="list-style-type: none"> <li>• High capital cost to install.</li> <li>• Expertise to initially set up.</li> <li>• Training to use/operate the hardware this is costly.</li> <li>• Experts or extensive training is required to service and maintain the machines.</li> <li>• Experts or extensive training is required to program the automated devices to perform their tasks.</li> <li>• Updates to automation can lead to job losses</li> </ul> <ul style="list-style-type: none"> <li>• Incorrect/no answer</li> <li>• Simplistic evaluation but no reasoning limited understanding evident. E.g. Automated manufacture is able to accurately construct and assemble parts onto a car.</li> <li>• Some evaluation evident and limited reasoning. Some understanding evident. E.g. Automated devices are able to accurately construct and assemble parts onto a car however; this would have to be programmed into the machine by an expert.</li> </ul>			0 1 2-3

	<ul style="list-style-type: none"> <li>Clear evaluations with detailed reasoning. Detailed understanding evident. E.g After installation of the machine has been programmed correctly which have high initial set up costs. The device is able to accurately assemble/manufacture a wide range of car parts with a high degree of accuracy and speed without rest.</li> </ul>			4-5
(e)	<p>Many modern cars use parking sensor technology. As a car reverses and gets closer to an object a beeper sounds. As the object gets closer the beeper sound speeds up and the pitch increases.</p> <p>Complete the flowcharts shown below using the statements provided, flowchart symbols and direction arrows.</p>		✓	[8]
	<p><b>Guidance for marking</b></p> <ul style="list-style-type: none"> <li>Incorrect/no answer</li> </ul>  <ul style="list-style-type: none"> <li><b>One</b> mark for correct positioning of command 'Distance &lt;40?'</li> <li><b>One</b> mark for correctly drawn decision symbol – Diamond shaped.</li> <li><b>One</b> mark for correct/suitable loop arrow from decision box.</li> <li><b>No marks are rewarded for yes and no on the direction arrows.</b></li> </ul>  <ul style="list-style-type: none"> <li><b>One</b> mark for each correctly positioned command. (up to <b>five</b> marks maximum).</li> </ul>			<p>0</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>

	<ul style="list-style-type: none"> <li>• <b>No marks for correct use of flowchart symbol in these sub-systems.</b></li> </ul> <p>One mark for decision in correct position. One mark for correct loop and 'yes/no' from decision.</p> <p>One mark for each correctly positioned command and delay (six in total).</p>			
<b>Total marks</b>		<b>25</b>		