



GCE AS MARKING SCHEME

SUMMER 2018

**AS (NEW)
DESIGN AND TECHNOLOGY - UNIT 1
ENGINEERING DESIGN
2601U10-1**

INTRODUCTION

This marking scheme was used by WJEC for the 2018 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 GCE AS DESIGN AND TECHNOLOGY

UNIT 1 ENGINEERING DESIGN

MARK SCHEME SUMMER 2018

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.

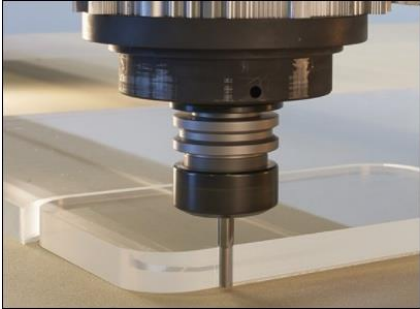

When marking, examiners can use these examples to decide whether a learner's response is of a superior, inferior or comparable standard to the example. Examiners are reminded of the need to revisit the answer as they apply the mark scheme in order to confirm that the band and the mark allocated is appropriate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

Question 1				
Computers are increasingly being used when both developing and manufacturing products.		AO3	AO4	Mark
(a)	Explain in detail one benefit of using solid modelling to the designer.		✓	2
<p>Answers that demonstrate an understanding of solid modelling should be awarded up to 2 marks based on:</p> <ul style="list-style-type: none"> • Visualising the product before production. • Solid models can be viewed by more than one engineer at the same time and in different locations. • Data can be rapidly processed which will aid the production process. • The image can be easily manipulated on the screen allowing the engineer to look from different angles. • Modifications can be made quickly and easily. • Images can be sent to clients for approval and feedback. • Standardised components can be easily accessed which aids the designing process. <p>Accept any other response that explains the benefits. Allow for candidates who make reference to computer models and or 3D models.</p> <p>Guidance to markers</p> <p>No answer or an incorrect answer. 0 marks</p> <p>A simple response for example: Solid modelling allows the engineer to see the product easily. 1 mark</p> <p>A more developed response for example: Solid modelling allows the engineer to see the product easily in both 2D and 3D forms. 2 marks</p>				
(b)	Explain why computer aided manufacture (CAM) is used in preference to traditional manufacturing methods.		✓	2
<p>Answers that demonstrate an understanding of computer aided manufacturing should be awarded up to 2 marks based on:</p> <ul style="list-style-type: none"> ▪ Reduced or no need for tooling, jigs and fixtures. ▪ Speed/time of production is seen to be quicker in the production of the finished article. ▪ Easier to make changes to the programs that would facilitate the production of individualised products. ▪ Quality control and quality assurance is easier. <p>Accept any other justified or appropriate response.</p> <p>Award up to 2 marks for a fully justified response.</p>				

	<p>Guidance to markers</p> <p>No answer or an incorrect answer. 0 marks</p> <p>A simple response for example: Computer added manufacturing is seen to be quicker and more efficient. 1 mark</p> <p>A more developed response for example: 2 Computer added manufacturing is seen to be quicker than manual processes and once the program has been set, a number of identical products can be produced. 2 marks</p>			
(c)	When making incremental developments to existing products engineers often use digital 3D scanning to capture data for analysis. Give two reasons why this is considered to be beneficial in the development of products.		✓	2X2
	<p>Guidance to markers</p> <p>Award up to two marks each for two appropriate responses.</p> <p>3D Laser Scanning is a non-contact, non-destructive technology that digitally captures the shape of physical objects using a line of laser light. It is a way to capture a physical object's exact size and shape into the computer world as a digital 3-dimensional representation.</p> <p>Advantages include:</p> <ul style="list-style-type: none"> • It is used in reverse engineering in order to identify any aspects that could be improved or further developed without have to physically dismantle or damage the product. • Existing products can be accurately scanned in order that other complementary components can be manufactured to an exact fit. This has been particularly beneficial to the medical industry where bespoke body parts can be manufactured from a digital image. • Parts that have been scanned can undergo virtual modifications prior to being reproduced to a higher standard. • Styling and aesthetics of a product can be easily modified. • Parts that have failed can be improved and replaced easily from a digital scan. • Finite element analysis is much easier. 			
			Total	8

Question 2

		AO3	AO4	Mark
(a)	Explain the purpose of a five step risk assessment when producing either a mechanical or an electronic product.		✓	2
	<p>Guidance to markers</p> <p>Answers that demonstrate an understanding of the purpose of a five step risk assessment should be awarded two marks based on:</p> <p>The HSE require employers to undertake a risk assessment when manufacturing products in order to reduce the risk of injury to those involved in production.</p> <p>This is a legal requirement for any organisation employing more than five people.</p> <p>Award one mark - 'to comply with HSE legislation'.</p> <p>Award two marks – 'to comply with HSE legislation in order to reduce the risk of injury to those involved in production'.</p>			
(b)	State any three steps in a five step risk assessment.		✓	3
	<p>Guidance to markers</p> <p>Award one mark each for any three of the following steps in any order.</p> <ul style="list-style-type: none"> • Identify hazards, i.e. anything that may cause harm. • Decide who may be harmed, and how. • Assess the risks and take action. • Make a record of the findings. • Review the assessment and update if necessary. 			

(c)	The images below show a CNC router. Suggest three features that would need to be added to the machine in order to ensure that it complies with health and safety legislation.		✓	3
<div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p>Guidance to markers</p> <p>Award one mark each for three of the following appropriate features:</p> <ul style="list-style-type: none"> • The rotating spindle would need to be guarded. • A dust extraction system would need to be fitted (LEV). • The machine should not operate until the safety guards or doors are closed. • There should be an automatic electrical brake provided for the tool spindle so that it stops within ten seconds. • A clamping device should be provided so that the work is held securely in position. • Machine may have safety instruction on display. 				
Total			8	

Question 3

In order to make products such as mobile phones more sustainable they are increasingly being designed for disassembly.		AO3	AO4	Mark
(a)	Explain why products that are easily disassembled are considered to be more sustainable.		✓	2
<p>Guidance to markers</p> <p>Answers that demonstrate an understanding of disassembly and sustainability can be awarded two marks based on:</p> <p>Exemplar answer 2 Marks Products that are easily disassembled are more sustainable as they can be easily taken apart and separated into different materials prior to reuse or recycling.</p> <p>Exemplar answer 1 mark Products that can be easily disassembled are more likely to be recycled or reused.</p> <p>Accept answers that make reference to disassembly for repair.</p>				
(b)	Discuss how products can be designed in order that they can be easily disassembled.		✓	6
<p>Answers that demonstrate an understanding of how products are designed for disassembly can be awarded up to six marks based on:</p> <ul style="list-style-type: none"> • Materials should not be joined with adhesives which would prevent them from being easily separated. • Click together fittings are better than using screws, nuts and bolts as they can be easily undone. • When screws are used they should be easily accessible and reduced to a minimum. Where possible one screw should be used to hold as many parts as possible. • Each material should be clearly labelled so that it can be easily identified and sorted into different types. • The product should be labelled with an appropriate symbol to show its suitability for recycling. <p>Guidance to markers</p> <p>No response or inappropriate response. 0 Mark</p> <p>Brief discussion covering relevant issues. 1-2 marks</p> <p>Good discussion covering relevant issues. 3-4 marks</p> <p>Detailed discussion covering relevant issues. 5-6 marks</p>				
			Total	8

Question 4		AO3	AO4	Mark
The image below shows the structure of a railway bridge based on a simple Warren Truss. As a train moves across the bridge it is subject to forces of tension, compression, torsion and shear.				
Evaluate and explain how the bridge structure reacts to and withstands the applied forces.			✓	8
<p>Candidates are required to appraise and/or make judgements about how the bridge has been designed to withstand static and dynamic forces. Answers that demonstrate an understanding of static and dynamic forces should be awarded up to 8 marks based on:</p> <p>Forces acting on the structure include tension, compression, torsion and shear. A full response would need to give consideration as to how the different parts of the bridge have been designed to withstand these forces. This could include reference to triangulation in the frame and an understanding that different parts can act as either struts or ties as the dynamic forces change. In order to ensure against structural failure a factor of safety must also be applied to the design, candidates may also make reference to stress analysis and factors related to fatigue and creep.</p> <p>Guidance to markers</p> <ul style="list-style-type: none"> • Little or no understanding. 0 marks • Basic appraisal and/or judgements of how bridge withstands either static or dynamic forces. 1-2 marks • Satisfactory appraisal and/or judgements of how bridge withstands either static or dynamic forces. 3-4 marks • Good appraisal and/or judgements of how bridge withstands both static and dynamic forces. 5-6 marks • Very good appraisal and/or judgements of how the structure withstands both static and dynamic forces. 7-8 marks <p>Exemplar answer 8 Marks</p> <p>In order to retain stability as the train moves across the bridge the forces acting upon it must be counteracted by forces that are equal and opposite. [1mark] The top rails of the structure are known as struts and are subjected to compression. [1mark] The side rails are subjected to forces of tension and are known as ties. [1mark] The bottom rails are subjected to tension but also need to withstand bending as the train moves along the structure. [1mark] A bending force is a combination of both tension and compression as the material distorts within its elastic limit. [1mark] Prevailing weather conditions also exert forces of torsion on the bridge. [1mark] Shear forces are also present where the component parts have been joined by fabrication. At these points steel gussets could be added to increase the strength. [1mark] The structure would need to be tested prior to construction and a factor of safety should be applied to ensure that it does not fail. [1mark]</p>				
			Total	8

Question 5

In developing a wide range of consumer products Dyson UK uses an iterative design process with emphasis on free hand sketching and cardboard modelling.	AO3	AO4	Mark
<p>Describe the way in which this process has enabled Design Engineers at Dyson to make both radical and incremental developments.</p> <p>Marks will be awarded for the content of the answer and the quality of written communication.</p>	✓		8
<ul style="list-style-type: none"> • Dyson engineers are always thinking about how things can be made better. The engineers communicate their ideas by sketching. • At this stage they're just thinking about the new idea, and don't have a fully formed vision of how the product will look or work. Research goes on throughout the early stages of the design process. • Engineers often find that existing products are slow, unhygienic or inefficient. • They believe that a three-dimensional model can tell you so much more than any 3D drawing. • Cardboard modelling is a cheap and easy way to show how something will look and work. They use these models to experiment with new ways of solving problems. • The next stage in the design process is to produce a design specification which provides a detailed list of what is required from the final product. • Factors considered include durability, hygiene, speed, size, maintenance, and environmental standards. • The whole team works towards these criteria. From this point developments are slow but steady. • An iterative approach to design is used, which means making one small change at a time. In this way they know whether a modification has brought about an improvement or not. • Often thousands of prototypes are produced from cardboard before more refined ideas are produced by rapid prototyping. These design proposals are then tested again against the criteria identified in the specification. • After further refinement the product is finally ready for production. • Even then the engineers continue to evaluate the product during its life cycle and further modifications are made when new improved versions are released onto the market. <p>Note: accept answers that could relate to solid modelling, 3D visualisation, virtual testing etc.</p> <p>The candidates could make reference to Dyson products such as the Airblade Hand Dryer, Desktop Fans and Washing Machines etc.</p>			

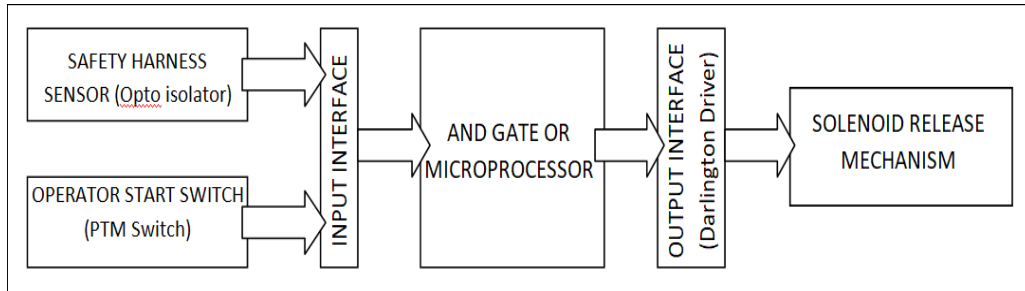
<p>Guidance to markers</p> <p>Level 1 0-2 marks</p> <ul style="list-style-type: none"> • Candidate has a simplistic knowledge of the issues associated with the question. • The use of terminology and technical language is basic. • The candidate has limited knowledge in relation to the context. • The candidate 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>Level 2 3-4 marks</p> <ul style="list-style-type: none"> • The candidate has a basic understanding of the issues associated with the question. • The use of terminology and technical language is variable. • The candidate has some general knowledge of the form and function of products, trends and styles in relation to the context. • The candidate will express straightforward ideas clearly, if not always fluently. Answers may deviate from the question or be weakly presented. • There may be some errors of grammar, punctuation and spelling but is still able to communicate the issues. <p>Level 3 5-6 marks</p> <ul style="list-style-type: none"> • The candidate demonstrates a clear understanding of the issues associated with the question. • The use of terminology and technical language is reasonably accurate. • The candidate has demonstrated knowledge of the form and function of products, trends and styles associated to the context. • The candidate will express moderately complex ideas clearly and fluently, through well linked sentences and paragraphs. Answers will be generally relevant and structured. • There may be occasional errors of grammar, punctuation and spelling. <p>Level 4 7-8 marks</p> <ul style="list-style-type: none"> • The candidate demonstrates a specific ability to analyse the question, takes into account a wide range of factors and has a clear understanding of the associated issues. • Uses correct terminology and technical language. • The candidate has developed a detailed knowledge of the form and function of a products, trends and styles associated to the context. • The candidate will express complex ideas extremely fluently. Sentences and paragraphs will follow on from each other smoothly and logically. Answers will be consistently relevant and structured. • There will be few, if any, errors of grammar, punctuation and spelling. 			
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Total	8		

Question 6

		AO3	AO4	Mark
A theme park has a new roller coaster attraction. The roller coaster car from the new attraction is shown below and holds up to four people.				
(a)	<p>In the space below write four justified specification points that would need to be included when designing the roller coaster car.</p> <p>Guidance to markers</p> <p>Award up to two marks for each fully justified point.</p> <p>Award one mark for a relevant specification point that has not been justified up to a total of 4 marks.</p> <p>Points could include:</p> <ul style="list-style-type: none"> • The car should not corrode when exposed to poor weather conditions as corrosion could result in structural failure. • The wheels should ensure that the car remains on the track when it is subjected to both vertical and lateral forces. • The safety harness should lock in position and should only be released automatically when the ride finishes. This will prevent the users being thrown from the car. • The seats should be ergonomically designed to support the user in a comfortable position that will prevent injury. • The shape and appearance of the vehicle should appeal to the user in order that they are attracted to the ride. • The car should use an electromagnetic braking system that will ensure that it avoids collision with other vehicles. • The car should have sensors that will ensure it will not move if overloaded. 	✓		8
(b)	<p>(i) The roller coaster uses an electronic system to ensure that the car will not move until it is safe to do so. This includes sensors to check the following:</p> <ul style="list-style-type: none"> • The safety harness for each seat has been fully closed. • The operator has activated the start switch that releases the vehicle. <p>In the box below, draw a detailed block diagram explaining the requirements for a suitable system that includes both sensors, process components and an output device.</p> <p>Guidance to markers</p> <p>Detailed block diagram is required which should include:</p> <p>Accept any appropriate diagram. 1 mark</p> <p>Two suitable input devices. 4 marks</p> <p>A suitable process system using combinational logic or a microprocessor. 1 marks i.e. mentioning a microprocessor, I.C., logic gate etc.</p> <p>Connection to a suitable output device such as a relay which will activate a motor or solenoid. 2 marks</p> <p>Accept a warning indicator for 1 mark only.</p>	✓		8

Suitable input devices could include push to make switch, opto isolator, phototransistor, SPST switch.
Process devices need to be interfaced to the output using a suitable system such as a Darlington Driver or an MOSFET.

Exemplar Answer



(ii) The safety harness for each seat consists of a padded tubular steel bar which can be closed around each rider. The bar should lock in position until it is automatically released when the car stops at the end of the ride.

✓

8

In the box below, draw a detailed annotated diagram of a suitable mechanical system that can be used to lock and unlock the safety harness.

The question requires a detailed diagram of a system that would lock the harness in position until it is automatically released.

Details should include:

- All components correctly identified/named. May include a Ratchet and Pawl, a Cam or any other appropriate system.
- The device must be adjustable so that it locks in different positions to accommodate different size users.

Guidance to markers

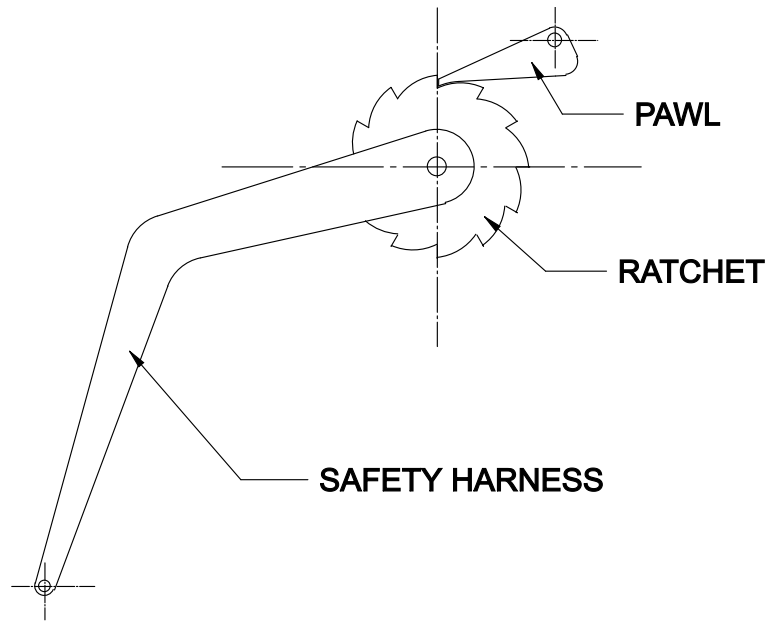
Mechanical diagram that has little detail or supporting annotation. **1-2 marks**



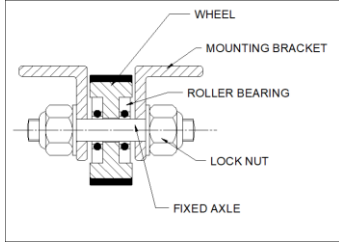
Mechanical diagram with some supporting annotation that is broadly relevant to the design. **3-4 marks**

Mechanical diagram with supporting annotation, relevant to the design and demonstrates a clear understanding of the problem. **5-6 marks**

Detailed mechanical diagram, labelled with supporting annotation that is clearly relevant to the design and demonstrates a thorough understanding of the problem. **7-8 marks**

Exemplar Answer



<p>(c)</p>	<p>To ensure that the roller coaster car does not leave the rails it requires wheels that are located above, below and to the side of the track. Potential wheel arrangements are shown in the illustrations below.</p> <div style="display: flex; justify-content: space-around;">   </div> <p>In the box below, produce a suitable design for one of the wheels and a method of attaching it to a stub axle. Your design must include constructional details and named materials from which the components will be manufactured.</p>	<p>✓</p>	<p>8</p>
<p>Candidates' designs could be in a 2D or 3D form.</p> <p>The design should show:</p> <ul style="list-style-type: none"> • How the wheel is able to turn easily using a suitable bearing. • How the wheel is securely held onto its axle. • Named materials from which each component part could be manufactured. <p>Guidance to markers</p> <p>The design includes:</p> <p>Simple constructional details and some supporting annotation, but with little or no fixing details shown and no suitable materials identified. 1-2 marks</p> <p>Mostly suitable constructional details with supporting annotation that is relevant to the context, some fixing details shown and generally suitable material(s) identified. 3-4 marks</p> <p>Well communicated, suitable constructional details with supporting annotation relevant to the context, detailed consideration of fixing arrangements and suitable material(s) identified. 5-6 marks</p> <p>Clearly communicated, entirely suitable constructional details with thorough annotation relevant to the context, detailed consideration of highly-appropriate fixing arrangements and suitable material(s) identified. 7-8 marks</p> <p>Exemplar Answer</p> <p>Possible materials: Axle and Nuts – High Tensile Stainless Steel Mounting Bracket – Cadmium Plated Mild Steel Wheel – Drop Forged Alloy Steel Tires - Polyurethane</p> <div style="text-align: right;">  </div>			

(d)	Discuss the way in which ergonomic and anthropometric factors play critical roles in the design of a new roller coaster.		✓	8
<p>Candidates need to demonstrate a clear understanding of the importance of ergonomic issues in relation to the design of roller coasters.</p> <p>Responses could include:</p> <p>Anthropometric data being used to establish seating requirements, entry to and exit from the car. [1mark]</p> <p>The product being designed to accommodate people between the fifth and ninety-fifth percentile of all potential users. [1mark]</p> <p>The body of the user will be subjected to extreme forces that could result in serious injury if appropriate support is not provided. [1mark]</p> <p>Consideration given to the diameter of any grips or rails that need to be hand held. [1mark]</p> <p>Materials and appropriate finishes used for parts that will be touched by the user to given careful consideration as the ride will be used on both hot and cold days. [1mark]</p> <p>Non slip surfaces will also be required as people enter and exit the car. [1mark]</p> <p>Sharp edges and corners should be avoided as people could injure themselves when using the ride. [1mark]</p> <ul style="list-style-type: none"> • Incorrect/no answer. 0 marks • Brief description of the issues that the designer may consider, but with little reference to anthropometric data. 1-2 marks • More detailed description of issues the designer may consider, with some reference to anthropometric data. 3-4 marks • Structured description of issues the designer may consider, with mostly relevant reasons why these issues are important. 5-6 marks • Structured and detailed description of issues the designer may consider, with clear and relevant reasons why these issues are important. 7 - 8 marks 				
Total			40	