



GCE A LEVEL MARKING SCHEME

SUMMER 2023

**A LEVEL
DESIGN AND TECHNOLOGY - UNIT 3
ENGINEERING DESIGN
1601U30-1**

INTRODUCTION

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

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

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

GCE A LEVEL DESIGN AND TECHNOLOGY

UNIT 3 – ENGINEERING DESIGN

SUMMER 2023 MARK SCHEME

Question 1		AO3	AO4	Mark
Study the images of two electric hand dryers shown below.				
(a)	Describe how cost and performance are related when developing the two electric hand dryers shown above.		✓	[3]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response It is more expensive when more complex.			1
	More detailed response The automatic dryer requires a sensing system so will be more expensive.			2
	A clear and detailed response The existing button operated dryer is far more simplistic in terms of components, control system, size and amount of materials for the casing. The replacement automatic hand dryer is far larger, much more complex in terms of function, and requires more material and internal circuitry.			3
	Guidance: Candidates must identify how cost and performance are related.			
(b)	Explain how the replacement hand dryer can be considered a 'radically new' replacement for the existing hand dryer.		✓	[5]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response. The new hand dryer is much different to the old one.			1
	More detailed response. The new dryer functions in a different way.			2
	A clear and detailed response. The replacement hand dryer will activate automatically so no need for the push button.			3
	A clear and detailed response with analysis of impact. The replacement hand dryer will activate automatically when the users hands are placed down inside. There is no longer any need for the push button as in the older dryer. There existing dryer is wall mounted requiring installation / fixing, but the replacement if floor mounted so does not need a wall for mounting.			4
	A clear and detailed response with full analysis of impact. The replacement hand dryer is completely different in terms of size, materials and function. The new dryer will activate automatically when the users' hands are placed down inside using a sensor. This is a more complex control system requiring additional components to the simplistic original hand dryer. The new dryer is far more sophisticated, aesthetic and unobtrusive, where the original is very basic and entry level budget looking. There is no longer any need for the push button as in the older dryer.			5
Total				8

Question 2

Study the images below of a prototype electronic circuit constructed on stripboard.		AO3	AO4	Mark
(a) (i)	Describe two benefits to the designer of using stripboard to construct the prototype electronic circuit.		✓	2 x [2]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response. Stripboard is cheap and readily available. Or Any circuit can be constructed on stripboard.			1
	More detailed response. Stripboard offers a cheap and quick way to construct prototype circuits to test them to see if they function as required. Or Stripboard is very generic and any circuit can be constructed on this allowing the designer a non-specialist solution.			1
	More detailed response. Stripboard offers a cheap and quick way to construct prototype circuits to test them to see if they function as required.			2
	More detailed response. Stripboard offers a cheap and quick way to construct prototype circuits to test them to see if they function as required.			2
	Guidance: Responses can include any benefit of using stripboard to prototype electronic circuits.			
(ii)	Explain in detail why the surface of the stripboard has been removed in Figure 2 .		✓	[4]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response. The copper track would conduct IC legs together. Or To make the circuit function properly.			1
	More detailed response. The 8 pin IC requires all 8 legs to be soldered in isolation, so the tracks need to be separated.			1
	More detailed response. The 8 pin IC requires all 8 legs to be soldered in isolation, so the tracks need to be separated.			2
	A detailed response. The chip needs 8 individual connections, so the copper tracks are removed to achieve this, in order for the circuit to function properly. Each of the 8 legs / pins on the IC requires separate connections, so the vertical track requires interruption.			2
	A detailed response. The chip needs 8 individual connections, so the copper tracks are removed to achieve this, in order for the circuit to function properly. Each of the 8 legs / pins on the IC requires separate connections, so the vertical track requires interruption.			3
	A clear and fully detailed response. Stripboard has generic tracks that run vertically (or horizontally) on the board. This circuit uses an 8 pin IC and needs 8 individual connections, so the copper tracks are removed using a removal tool to achieve this in order for the circuit to function properly, otherwise opposite legs would conduct.			4

(b)	Following the prototyping stage, the final circuit is produced in volume using a Just-In-Time (JIT) manufacturing system.	AO3	AO4	Mark
	Explain the meaning of JIT and how this system impacts on the manufacturer.		✓	[4]
	<p>No answer or no relevant information presented or discussed.</p> <p>Simplistic or basic response.</p> <p>JIT is when components are ordered when needed.</p> <p>Or</p> <p>It is cheaper for the manufacturer to order items when needed.</p> <p>More detailed response</p> <p>JIT is when components or parts are ordered when required. This is more efficient than keeping stock items.</p> <p>A clear and detailed response.</p> <p>JIT is an efficient way of producing the final circuit because the manufacturer will only order what is required, when required, therefore there is no waste or surplus components and no handling / storage.</p> <p>A clear and fully detailed response.</p> <p>JIT is an efficient and economical way of ordering the exact amount of components or parts at the correct time for production. This saves time, money, storage space and handling, which increases efficiency, streamlines production and reduces costs. JIT prevents stock or surplus components or parts, and requires no storage space / returns of unwanted parts.</p> <p>Guidance:</p> <p>Candidates may identify other considerations which may include:</p> <ul style="list-style-type: none"> • Reducing production flow times • Workflow methodology • Helps control variability in production • Helps increase productivity and lower costs • Continuously low inventory levels • Faster turnaround of stock 			<p>0</p> <p>1</p> <p>1</p> <p>2</p> <p>3</p> <p>4</p>
		Total		12

Question 3

The mechanical log splitter shown below is designed to provide a quieter and safer alternative to using sharp tools or powered machinery.		AO3	AO4	Mark
(a) (i)	In the space below, produce a detailed block diagram to represent the mechanical log splitter.		✓	[3]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response. Diagram of INPUT - PROCESS – OUTPUT with no other detail. Or One correctly identified aspect of the log splitter.			1
	More detailed response. Diagram of INPUT - PROCESS – OUTPUT with some correct detail. Or Two correctly identified aspects of the log splitter.			2
	Fully detailed block diagram with 3 correct aspects of the log splitter. <div style="text-align: center;"> INPUT - PROCESS - OUTPUT Log inserted into position Foot pushes down Log is split/separated </div>			3
(ii)	Name three different forces, describing how they will occur when using the mechanical log splitter.		✓	3 x [2]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response. Tension would occur in the black bar. Or Compression would occur in the short link / in the log. Or A shear force would occur in the nut and bolt / pivot.			1
	Or A bending force will be present in the top bar.			1
	Or Frictional force to stop the splitter moving			1
	A detailed response A tension force would be acting on the top black bar when the foot is pressed down. Or A compression force would act on the log as the foot pushes down on the black bar 'squashing' the log.			2
	Or A bending force will act on the top back bar because it is fixed at the left-hand side and pivots around the link – Class 2 lever. Or A shear force will act on the pivot point / nut and bolt when the log is in place and the foot presses down.			2

		AO3	AO4	Mark
(b)	Explain the difference between static and dynamic forces when using the mechanical log splitter.		✓	[3]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response. Static forces stay still, dynamic forces are moving.			1
	More detailed response. The static forces are stationery forces acting on the log splitter, dynamic forces occur when it is being used.			2
	A clear and detailed response. A static force refers to a constant force applied to a stationary object, when the log is mounted into the splitter. A dynamic force can be closely described as the amount of acceleration/velocity needed to move an object. Dynamic force is the process by which the energy from an action increases or decreases. This is when the foot pushing down on the log splitter input created the compression force to split the log.			3
		Total		12

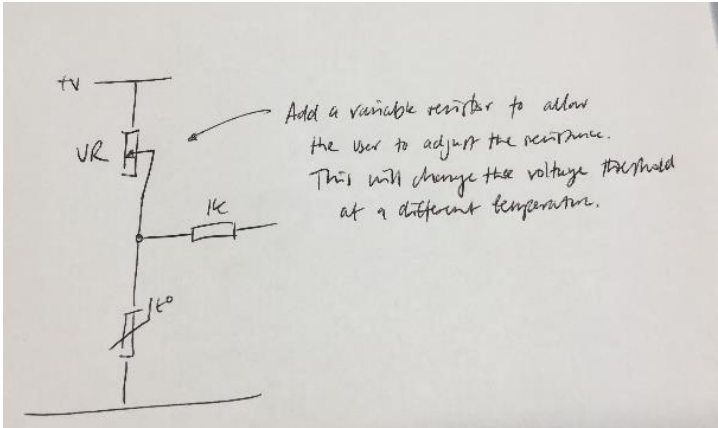
Question 4

A new personal computer has been launched following market research into users of tablets and laptops.		AO3	AO4	Mark
(a)	Describe how 'market segmentation' allows the designer to ensure the success of the new personal computer.		✓	[4]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response. It allows the designer to identify specific customers.			1
	Or It allows customers to be divided into sub-groups of common factors.			1
	More detailed response. This allows designers to split potential customers up into smaller groups with common interests to focus on their specifics.			2
	A detailed response. This allows designers to split potential customers up into smaller groups with common interests, to focus on their specifics. This ensures that the product matches their requirements.			3
	A clear and fully detailed response. Market segmentation is the process of dividing a market of potential customers into groups, or segments, based on different characteristics. The segments created are composed of consumers who will respond similarly to marketing strategies and who share traits such as similar interests, needs, or locations. This allows the designers to establish a clear understanding of the target market, and their needs, wants and values to focus designing.			4

		AO3	AO4	Mark
(b)	Explain how the 4 Ps (Product, Price, Place, Promotion) can affect the success of the new personal computer.		✓	[8]
	No answer or no relevant information presented or discussed.			0
	<p>Guidance: ALL 4 Ps must be covered in the response to gain full marks</p> <p>Simplistic or basic, lower-level response only covering some of the 4P's and how they affect success of the new personal computer. The product itself must be a good product, needed by the users, and the price must be affordable for purchasing.</p> <p>More detailed response covering some of the Ps and some depth explaining how they impact on success. The product itself must be a good product with some innovative and creative features, needed by the users. The price must be affordable and accessible for purchasing by the target market, and competitive within the price range of other similar products.</p> <p>A clear and detailed response covering most of the Ps and in-depth explaining how they impact on success. The product itself must be a good product with some innovative and creative features, needed by the users. The price must be affordable and accessible for purchasing by the target market, and competitive within the price range of other similar products. The product will need to be promoted so that the target market is aware of its availability and can make the purchase effectively.</p> <p>A clear and fully detailed response covering all 4Ps and explaining in detail how each affects the success of the new p.c. The product must be innovative, creative and contain USPs that make it better than its rivals. This will make it more desirable to the target market. The price is important because it must reflect the high quality of the product, but at the same time remain competitive against rivals and also attractive to purchase. The placement of the product must be effective so that it is available to the target market, through the correct retail streams. This will help secure high number of sales. Promoting the new product is critical to ensure that exposure is effective and the target market are fully aware of the new pc. This will ensure sales quickly grow and the product will become popular.</p>			1-2
				3-4
				5-6
				7-8
				Total
				12

Question 5

The CAD simulation below shows an electronic control system.		AO3	AO4	Mark
(a)	Describe how the sensing system functions as the input.		✓	[2]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response The thermistor's resistance will change.			1
	More detailed response The thermistor is in a potential divider with a 120K fixed resistor. As the temperature changes, the thermistor's value changes, and the voltage in the potential divider changes. Guidance: Candidates will not be able to tell whether the thermistor is a negative or positive co-efficient, so identifying the resistance changing with temperature is sufficient.			2
(b)	State the name of Component A and describe its role in the system.		✓	[3]
	No answer or no relevant information presented or discussed.			0
	Transistor (accept NPN Transistor)			1
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response The transistor switches the buzzer on or off. Or This controls when the buzzer is activated / sounds. More detailed response The transistor is an insulator, keeping the buzzer silent until 0.7V is at the base, when the transistor conducts and activates the buzzer.			2

		AO3	AO4	Mark
(c)	Produce an annotated diagram modifying the electronic control system to allow the user to adjust the threshold of the circuit and describe how this works.		✓	[3]
	No answer or no relevant information presented or discussed.			0
	Simple diagram only or simple description only. Drawing of a variable resistor or potentiometer.			1
	More detailed response. Simple diagram and simple description. Clear diagram of a variable resistor or potentiometer.			2
	Detailed response. Accurate diagram of a variable resistor or potentiometer replacing the 120k resistor. Clear description.			3
				3
		Total		8

Question 6

A baby soother has been re-designed to include a digital electronic temperature monitoring facility.		AO3	AO4	Mark
(i)	Describe one creative thinking strategy that has been used by the designer of the baby soother to create an innovative product.		✓	[2]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response The designer has combined two functions together Or The designer has made the baby soother multi-functioning			1
	More detailed response A SCAMPER technique has allowed the designer to combine two functions in the baby soother product. Or The designer has used divergent thinking / lateral thinking around the needs / wants of the parent / baby and combined two needs.			1
				2
(ii)	Identify one aesthetic factor that would have been included in the design specification.		✓	[2]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response for benefit. The temperature display must change colour.			1
	More detailed response. The temperature display must be green when the temperature is OK, but must illuminate red to warn the parent that the temperature has risen above the preset temperature.			2
	Guidance: There may be other aesthetic qualities such as colour scheme white / blue, form and shape that deserve credit.			
(iii)	Explain how the interaction of modern technology and existing design needs has contributed towards the development of the baby soother.		✓	[4]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response. A temperature display is added.			1
	More detailed response. The electronic display is small and fits in the soother.			2
	A detailed response. The electronic display is small and compact, fitting inside the soother and does not increase the size of the soother.			3
	A clear and detailed response. Advanced technology that allows the soother to be exactly the same size but also include a complex temperature control system, providing an additional dimension for the product function. The electronics are small enough to have no impact on the overall size and shape of the soother.			4
Total				8

Question 7

A transparency for a printed circuit board (PCB) is shown below.		AO3	AO4	Mark
(a) (i)	Give one reason for using a laser printer to directly print the PCB design onto a transparency.		✓	[2]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response. To get a good quality transparency.			1
	More detailed response. The laser printer will provide a crisp and line free PCB mask which will allow a high-quality PCB.			2
	<p>Guidance:</p> <ul style="list-style-type: none"> • Sometimes, PCB designs are printed onto cartridge paper and photocopied onto transparency which loses quality. • Inkjet printers generate lines, which do not give solid print quality PCB designs. 			
(ii)	Describe in detail, naming all equipment and resources, how the transparency above can be used in a school workshop to produce a high-quality PCB.		✓	[6]
	No answer or no relevant information presented or discussed.			0
	<p>Guidance:</p> <ol style="list-style-type: none"> 1. The transparency is used with a UV box to project the PCB mask onto photo-resist PCB board (exposure times vary). 2. The photo-resist board is then developed using a chemical solution. The strength of the solution dictates the time required to develop the high-quality image required. The board is then rinsed thoroughly removing all developer (some PCB tanks have an additional basket and slot for this, some do not). 3. The developed photo-resist board is placed in an etching tank, ferric chloride (or similar) is used to remove all copper other than the PCB design which was developed (and fixed). Times vary due to age, strength and type of etchant. 4. Once all copper is removed and the PCB design is remaining, the photo-resist board is removed from the etchant, rinsed thoroughly and dried ready for drilling and populating. 			
	Simplistic or basic response covering some detail of the process. A photo-resist board the same size as the transparency is needed. This will need to be etched to create the PCB.			1-2
	More detailed response including many details of the process. Cut a piece of photo-resist board slightly larger than the transparency. This is then exposed to UV light to transfer the image of the PCB. This is then developed and etched in the etching tank until ready.			3-4
	A clear and detailed response with comprehensive details of the process. Prepare a piece of photo-resist board to fit the transparency. Place transparency onto the cleaned glass surface of the UV box. Remove protective film and place photo resist onto transparency. Expose to UV light for recommended time. Apply developer solution until there is a bright copper finish and black PCB outline. Rinse thoroughly before placing into etching tank with temperature to desired setting.			5-6

		AO3	AO4	Mark
(b)	Explain how the alternative PCB shown below has been produced.		✓	[4]
	<p>Guidance:</p> <ol style="list-style-type: none"> 1. A CAD drawing of the PCB has been produced. 2. The lines / tracks are cut into the surface of the copper-clad board by a CAM machine with a v-point tool or small diameter cutter. 3. The holes for the components are drilled right through the copper clad board with a 1 or 1.5mm diameter cutting tool. 4. The border of the PCB is cut through the copper- clad board removing it from the sheet. This is the PCB for soldering / populating. <p>No answer or no relevant information presented or discussed. 0</p> <p>Simplistic or basic response. 1-2</p> <p>The PCB is cut out / engraved from a CAD drawing by a CAM machine.</p> <p>More detailed response</p> <p>A CAD drawing of the PCB is produced and sent to a CAM machine (e.g. CAMM2) to be cut. Tracks are engraved through the copper layer but not through the whole board. Holes are cut through so that components can be inserted and through-hole soldered. A border is cut to remove the PCB from the sheet. 3-4</p>			
			Total	12

Question 8		AO3	AO4	Mark
The motion activated home security camera shown below includes built-in floodlights, a siren alarm, and a two-way talk feature.				
(a) (i)	Name a suitable thermoforming polymer and manufacturing process for the mass production of the home security camera shell.		✓	[2]
	No answer or no relevant information presented or discussed.			0
	ABS or Polystyrene (accept HIPs for vacuum forming)			1
	No answer or no relevant information presented or discussed.			0
	Injection Moulding Accept vacuum forming			1
(ii)	Explain how the home security camera allows the homeowner to view live images and communicate with others.		✓	[3]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response. The camera films image and sound and uses the mobile phone.			1
	More detailed response. The camera is linked to the mobile phone with a dedicated App using Wifi / internet connection.			2
	A detailed response. The user downloads the dedicated App compatible with the camera. The internet / wi-fi connection allows the camera to display image and sound and the mobile phone to act as a control unit.			3
(b)	Periodically, the manufacturer releases software updates. Describe the importance of this to the homeowner.		✓	[3]
	No answer or no relevant information presented or discussed.			0
	Simplistic or basic response. To make sure they are up to date. Or To make sure the product is working at its best.			1
	More detailed response. To fix any existing problems with current versions to improve performance.			2
	A detailed response. The manufacturer releases improved versions with bug fixes to solve existing issues and ensure that the product operates at optimum performance and efficiency. Sometimes new releases have improved features and different functions which provide enhanced usability.			3
Total				8

Question 9

	AO3	AO4	Mark
<p>“Success is made of 99% failure.” James Dyson Analyse how this quote applies to the application of the iterative design process.</p>	✓		[10]
<p>No answer or no relevant information presented or discussed.</p> <p>Brief analysis of the meaning of the quote with no or little understanding of its application to the iterative design process.</p> <ul style="list-style-type: none"> • Success is about meeting the needs and wants of the users in a product or solution. • Sometimes ideas are not quite right and need to be improved. • The development of ideas involves identifying mistakes or errors to correct them. • To be successful, there has to be a lot of failure. 			0 1-3
<p>More detailed analysis of the meaning of the quote with some understanding of its application to the iterative design process</p> <ul style="list-style-type: none"> • Success is about meeting the needs and wants of the users in a product or solution – identifying brief and specification. • Sometimes, ideas are not quite right and need to be improved – early initial idea generation. • The development of ideas involves identifying mistakes or errors to correct them normally conducted through modelling and testing. • To be successful, there has to be a lot of failure in order to refine ideas. • Failure is not meeting specification criteria in the solution. • Designing expects a high percentage of failure or setbacks before progressing to the final solution stage. 			4-6
<p>A detailed and clear interpretation of the quote with a full and clear understanding of its application to the iterative design process</p> <ul style="list-style-type: none"> • Success is about meeting the needs and wants of the users in a product or solution – identifying brief and specification. • Sometimes, ideas are not quite right and need to be improved – early initial idea generation. • The development of ideas involves identifying mistakes or errors to correct them (normally conducted through modelling and testing). • To be successful, there is often a lot of failure in order to refine ideas. • Failure is not meeting specification criteria in the solution, retaining good features and eliminating unsuccessful aspects. • Designing expects a high percentage of failure or setbacks before progressing to the final solution stage. • Dyson DC01 – 5127 prototypes before arriving at final solution – lots of problems and issues! • Dyson states that we learn nothing from success, we only learn from failure! • 1% inspiration and 99% perspiration – hard work to get to the innovative and creative final solution that functions and looks as required. • The iterative design process requires a ‘think, test, analyse and repeat’ approach which requires patience and resilience <p>High level responses require clear understanding and analysis of the meaning of the quote together with specific analysis of how this can be aligned with the iterative design process. Do Not accept designer names / movements in isolation.</p>			7-10
		Total	10

Question 10			
	AO3	AO4	Mark
Evaluate the importance of environmental factors when designing, manufacturing, using and disposing of products.	✓		[10]
Mark will be awarded for the content of the answer and the quality of written communication.			
No answer or no relevant information presented or discussed.			0
Brief evaluation of the importance of knowing environmental factors, with little or no evaluation of how this impacts on designing, manufacturing, using and disposing of products.			
<ul style="list-style-type: none"> • 6R's approach • Reduce materials where not required • Recycled materials used where applicable • Energy efficiency helps product use • Reusing parts at end of life • Avoiding landfill • Quality of written communication is limited / basic, presenting material with limited / basic coherence, many errors of grammar, punctuation and spelling. 			1-3
More detailed evaluation of the meaning of knowing environmental factors, with some evaluation of how this impacts designing, manufacturing, using and disposing of products.			
<ul style="list-style-type: none"> • Discussion on 6R's of design • Selection of materials / power supplies / manufacturing methods • Carbon footprint of product during life • Energy efficiency and reliance • Reliability / planned obsolescence • Repairing / life expectancy / customer support • Cradle to grave approach • Cradle to cradle approach • Quality of written communication is good, presenting occasionally appropriate material with some coherence, some errors of grammar, punctuation and spelling. 			4-6
A detailed and clear evaluation of the meaning of knowing environmental factors, with clear and full evaluation of how this impacts on designing, manufacturing, using and disposing of products.			
<ul style="list-style-type: none"> • Discussion on 6R's of design and areas for sustainable decisions at designing level • Selection of materials / power supplies / manufacturing methods / materials, sources and origin • Carbon footprint of product during life • Energy efficiency and reliance • Reliability / planned obsolescence • Cost of running product / repair / replacement parts costs / disposal costs • Repairing / life expectancy / customer support / build quality • Cradle to grave approach • Cradle to cradle approach • Circular economy • Quality of written communication is excellent, presenting wholly appropriate material in a coherent manner, hardly any errors of grammar, punctuation and spelling. 			7-10
Guidance: High level responses require clear understanding and evaluation of the environmental factors when designing, manufacturing, using and disposing of products.			
		Total	10

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