



GCSE

Design and Technology
Electronic Products

45401 Unit 1 Written Paper
Mark scheme

45401
June 2016

Version: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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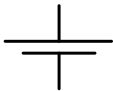
FOR EXAMINERS – PLEASE NOTE THAT IF YOU ARE UNSURE HOW TO AWARD A RESPONSE FROM A CANDIDATE, PLEASE SEEK CLARIFICATION OR ADVICE FROM YOUR TEAM LEADER OR THE PRINCIPAL EXAMINER.


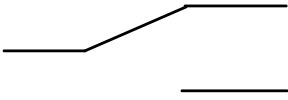
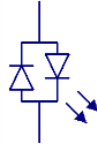
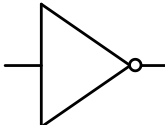
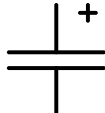
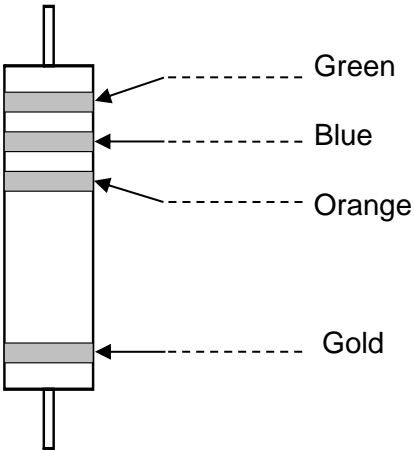
Section A

Question	Part	Sub Part	Marking Guidance	Marks
1	a		<p>Design requirements for the target game – <i>up to 4 marks</i></p> <p>1 mark for each requirement – up to 2 marks</p> <p>1 mark for each relevant explanation – up to 2 marks</p> <p>Examples of requirements worth 1 mark each:</p> <ul style="list-style-type: none"> • The game should be bright and colourful • The game should be tough and durable • It should be no bigger than 300mm by 200mm by 60mm • It should have a very loud buzzer • The circuit needs to be securely fixed. <p>Examples of explained requirements worth 2 marks each:</p> <ul style="list-style-type: none"> • The game should be bright and colourful to make it visually appealing for the user. • The game should be tough and durable as it needs to withstand having objects thrown at it. • It should be no bigger than 300mm by 200mm by 60mm so it is portable and easy to store • It should have a very loud buzzer so it can be heard from several metres away. • The circuit needs to be securely fixed so that it doesn't get damaged. 	<p>Total (4 marks)</p>
1	b		<p>Design ideas for the target game – <i>up to 8 marks.</i></p> <p>It must be borne in mind that candidates only have around 8 minutes to respond to this question.</p> <p>This question is to be marked for the quality and detail of the response as follows:</p> <p>0 marks: no answer worthy of credit.</p> <p>1-2 marks: The candidate has generated 1 or 2 very basic sketches with little or no clarity of communication regarding the purpose of</p>	

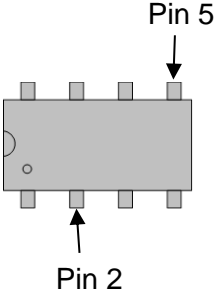
		<p>the game. The ideas show little coherence, and there is very limited reference to creativity or visual appeal. The candidate has made no reference to how the level of difficulty can be changed, and there may be only basic references to components.</p> <p>3-5 marks: The candidate has generated 2 ideas, but there is limited evidence of creativity and visual appeal, either through drawing or notes. The product could be a simple cuboid shape with no further development of features to promote visual appeal. The aim of the game is not very clear. The input and output components are referred to, but are not in a coherent location. The candidate has demonstrated some designing skills, but there may be some repetition in the ideas.</p> <p>(A candidate has access to 3-5 marks if only one idea has been generated, but with the detail and quality as shown below).</p> <p>6-8 marks: The candidate has sketched 2 different, creative and visually appealing games, and the designs reflect a coherent and workable idea. Creativity has been demonstrated, and could include reference to the shape of the product, the choice of inputs and outputs, or an innovative concept for the game. Visual appeal has been clearly communicated through use of logos, images, reference to colour or shape. It is clear, either through drawings or notes, how the level of difficulty can be adjusted. This may include changing the sizes of projectiles or targets, or by changing distance. The location of input and outputs are clearly shown, and are in a realistic location.</p>	<p>Total (8 marks)</p>
<p>1</p>	<p>c</p>	<p>A system diagram – <i>up to 3 marks</i></p> <p>The component does not need to be referenced in the original design drawn in 1(b).</p> <p>1 mark for each specific component named.</p> <p>Input components could include PTM, LDR, tilt switch, micro-switch, or other suitable input. (Note: <i>Do not</i> accept motion sensor, light sensor as they are vague references and not specific components)</p> <p>Process components could include 555, monostable, thyristor, microcontroller, PIC, 4026 or other suitable processes.</p>	

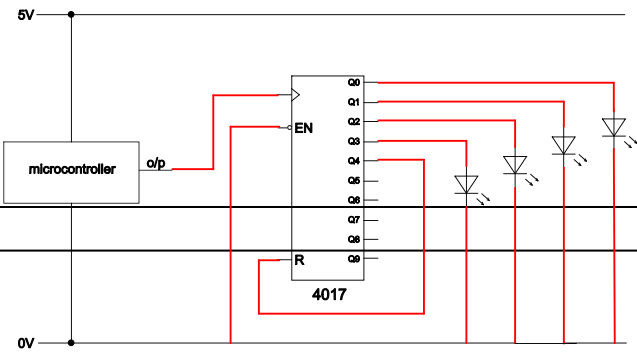
			Output components could include lamp, buzzer, bell, speaker, LED, bi-colour LED, 7 segment displays or other suitable output.	Total (3 marks)
1	d		<p>A circuit diagram to explain how the system works – up to 8 marks</p> <p>This question is to be marked for the quality and detail of the response as follows:</p> <p>0 marks: no answer worthy of credit.</p> <p>1-2 marks: The candidate has produced an incomplete circuit idea, or a circuit that shows little understanding of the function of components. The quality of the diagram is poor, but there are components drawn, and there are notes or labels.</p> <p>3-5 marks: The candidate has produced a clear diagram for a circuit. Parts of the circuit would work. Symbols have been drawn with some regard to accuracy, and there are some notes or labelled components.</p> <p>6-8 marks: A neatly drawn circuit diagram with clear notes. The circuit is complete and would work, with perhaps only a minor error. Some components are labelled or there is a reference to component values. The candidate has demonstrated a good level of knowledge, either through the diagram, or with some details in notes.</p>	Total (8 marks)
1	e		<p>A detailed design of the case – up to 6 marks</p> <p>Materials – up to 2 marks 1 mark for reference to a generic material e.g wood, metal, plastic. 2 marks for a specific appropriate material e.g. HIPS, polystyrene, acrylic, ABS, or similar suitable material.</p> <p>Case construction details – up to 2 marks 1 mark for each reference to a detail e.g. vacuum forming, injection moulding, gluing, joints, dimensions, hinge, screws.</p> <p>Quality of communication – up to 2 marks Award 0 marks for a drawing with such limited detail it is worthy of no marks. 1 mark for a sketch which is difficult to interpret with little or no annotation.</p>	

			2 marks for a clear sketch and some detailed annotation.	Total (6 marks)
1	f		<p>Ideas for the inside of the case – <i>up to 5 marks</i></p> <p><i>Securing the battery – up to 2 marks</i> 1 mark for a method that holds a battery in place, but may not be very secure or is not sufficiently detailed e.g. a note referring to “clip”.</p> <p>2 marks for a well explained / communicated secure method or a method reflecting good practice e.g. battery clip, line-bent acrylic holder, purchased battery holder, compact battery compartment.</p> <p><i>Securing the circuit/wiring – up to 2 marks</i> 1 mark for a method that secures the circuit or wiring, but may not be very secure or well-explained e.g. “glued in place”. 2 marks for a method reflecting good practice or a secure method e.g. PCB pillars, screws, use of spiral wrap for wires, strain relief holes, clips, clamping grips.</p> <p><i>Securing an output component – 1 mark</i> 1 mark for a reference to LED clip, using screws to secure a lamp holder or buzzer, a coherent method of securing a loudspeaker or similar suitable response.</p>	Total (5 marks)
				Total for Question 1: (34 marks)
			Section B	
Question	Part	Sub Part	Marking Guidance	Marks
2	a		<p>1 mark for each correct response – <i>up to 6 marks.</i></p> <p>Symbols drawn as per the specification</p> <div style="display: flex; align-items: center; justify-content: center;">  <div style="margin-left: 20px;"> <p>Cell – 1 mark (ignore a + or – sign)</p> </div> </div>	

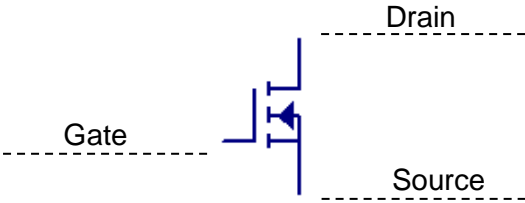
		 <p>Microphone – 1 mark (ignore connections or leads coming off the symbol)</p>  <p>Single pole double throw switch– 1 mark (accept other conventions of drawing symbol)</p> <p>Bi-colour LED – 1 mark or 2 colour LED</p>  <p>NOT gate, inverter, – 1 mark</p>  <p>Electrolytic capacitor – 1 mark (Accept polarised capacitor or simply capacitor)</p> 	<p>Total (6 marks)</p>
<p>2</p>	<p>b</p>	<p>Resistor colour code of a 56 k resistor – up to 3 marks.</p> <p>award 1 mark for first 2 bands Green and Blue</p> <p>award 1 mark for correct third band (multiplier)Orange</p> <p>award 1 mark for tolerance band..... Gold</p> 	<p>Total (3 marks)</p>

2	c	i	<p>Ohm's Law Calculation – <i>up to 5 marks</i></p> <p>1 mark for correct formula – potential difference = current x resistance or $V = I \times R$</p> <p>1 mark for evidence that the formula has been transposed correctly. e.g $R = V/I$</p> <p>Note: if candidate simply writes $R = V/I$, then award 2 marks. 1 for choosing correct formula, and 1 for the transposition.</p> <p>1 mark for identifying that V is 2.5</p> <p>1 mark for identifying that current I is 0.02 or 2/1000 or $R = 2.5/0.02$</p> <p>(still award the mark if the numbers are wrong, but there is evidence of formula transposition, and not just a vague guess).</p> <p>1 mark for correct answer 125 with units of R, ohms or Ω</p>	Total (5 marks)
2	c	ii	<p>Suitable E24 resistor – <i>up to 2 marks</i></p> <p>Award 1 mark for 130 (or 120 as it is in tolerance)</p> <p>Award 2 marks for 130R, or 130 ohms or 130Ω (or 120....)</p> <p>Note: Award marks if a suitable value is chosen from the E24 series to match the candidates' response in 2(c)(i)</p> <p>For example, if the answer to 2(c)(i) is 225R, accept 240R, as it is the next higher value, or 220R as it is in tolerance.</p> <p>The E24 series is:</p> <p>10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91</p>	Total (2 marks)

2	d	<p>Labelling location of pins on an IC – <i>up to 2 marks</i></p> <p>1 mark for each correctly labelled pin.</p> <div style="text-align: center;">  </div>	<p>Total (2 marks)</p>
2	e	<p>Reasons for using an IC socket – <i>up to 3 marks</i></p> <p>1 mark for each correct reason. Reasons could include;</p> <ul style="list-style-type: none"> • Easier to replace a faulty chip • Easier to change if the IC has been put in the wrong way • Heat from a soldering iron can damage an IC • ICs could be removed and used again in another circuit • Microcontrollers can be programmed on a project board, then moved to another PCB. • ICs can be removed to isolate them during testing. <p>Similar suitable responses.</p>	<p>Total (3 marks)</p>
			<p>Total for Question 2: (21 marks)</p>
3	a	<p>Function of the circuit</p> <p>1 mark for circling astable</p>	<p>Total (1 marks)</p>
3	b	<p>Adjusting the frequency – <i>up to 2 marks</i></p> <p>Award 1 mark for a simple statement Award 2 marks for a detailed response showing a deeper understanding.</p> <p>1 mark responses:</p> <ul style="list-style-type: none"> • Change the values of the resistor to change frequency • Change the value of the capacitor • Use a variable resistor • Change values higher or lower 	

		<p>2 mark responses:</p> <ul style="list-style-type: none"> • Change R1 (or R2) to a variable resistor • Change the capacitor to a variable capacitor • Changing the resistors to higher values to reduce the frequency • Change the resistor to a lower value to increase the frequency. 	Total (2 marks)
3	c	<p>Calculation of time high – <i>up to 5 marks</i></p> <p>Formula – 1 mark for time high = $0.693 \times (R1 + R2) \times C$</p> <p>1 mark for correct substitution of both resistor values (100,000 + 10,000)</p> <p>1 mark for correct substitution of capacitor value 10/1,000,000 or 0.00001</p> <p>1 mark for correct answer 0.7623 or rounded to 2dp 0.76</p> <p>1 mark for units seconds or s.</p>	Total (5 marks)
3	d	<p>Completing the circuit diagram – <i>up to 5 marks</i></p> <p>1 mark for microcontroller output to clock input</p> <p>1 mark for Q0, Q1, Q2, Q3 to anodes of LEDs</p> <p>1 mark for cathodes of LEDs to 0V rail</p> <p>1 mark for enable pin to 0V</p> <p>1 mark for Q4 to reset pin.</p> <p>(Or the next output pin after the 4th LED. So, if the LEDs are connected to Q2, Q3, Q4 and Q5, award the mark if Q6 goes to reset).</p> <p>(NB: a candidate may draw series resistors with the LEDs. Still credit the answer if the anode and cathode connections are correct).</p> 	

				Total (5 marks)
3	e		<p>Describing use of CAD in design and manufacture – <i>up to 6 marks</i></p> <p>1 mark for a simple, unjustified response 2 marks for a justified response with some further, relevant detail.</p> <p>Examples of simple responses:</p> <ul style="list-style-type: none"> • Designing the circuit • Testing the circuit idea • Designing the case • Generating PCB track layouts • Writing and developing microcontroller programs <p>Examples of justified responses:</p> <ul style="list-style-type: none"> • Designing the circuit using Circuit Wizard or an equivalent package. • Testing the idea to see if the components are connected correctly and have the right values. • Designing a case and being able to visualise the product before it is made. • Design a case and send the design file to a laser cutter to cut out the plastic for the case • Design a PCB and send the design to a router for PCB routing. • Designing a circuit and then testing it to make sure it works. 	Total (6 marks)
				Total for Question 3: (19 marks)
4	a		<p>Explaining the function of the potentiometer B – <i>up to 2 marks</i></p> <p>1 mark for identifying/naming the component as a potentiometer or variable resistor.</p> <p>1 mark for further detail.</p> <ul style="list-style-type: none"> • Setting the light level at which the LED turns on • Controlling the voltage on the gate of the FET • Setting the threshold voltage • Part of a potential divider with the LDR/light sensor <p>Or suitable correct response.</p>	Total

<p>4</p>	<p>b</p>	<p>Naming the connections of a FET – <i>up to 3 marks</i></p> <p>1 mark for each correct response</p> <p>A – Gate</p> <p>B - Drain</p> <p>C - Source</p> 	<p>(2 marks)</p> <p>Total (3 marks)</p>
<p>4</p>	<p>c</p>	<p>Advantages and disadvantages of using a PV cell – <i>up to 4 marks</i></p> <p>1 mark for a simple, unjustified response</p> <p>2 marks for a justified or explained response.</p> <p>Advantages include: lower cost in the long term, maintenance free, no need to re-charge, no need for battery access, or similar.</p> <p>Disadvantages include: higher initial cost, product needs to be sited carefully, low-current output.</p> <p>Examples of simple response:</p> <p>Advantages</p> <ul style="list-style-type: none"> • Cheaper in the long run • You don't have to replace the battery • You don't have to charge it yourself <p>Disadvantages</p> <ul style="list-style-type: none"> • Expensive to buy • Won't work at night • The light needs to be in a sunny place <p>Examples of a justified response:</p> <p>Advantages</p>	

			<ul style="list-style-type: none"> Cheaper because you don't have to buy batteries once they have run-out You don't have to remove a battery to re-charge it as it is done with the battery in the case You won't need to bring the garden light in the house to re-charge it <p>Disadvantages</p> <ul style="list-style-type: none"> The product needs to be in a sunny place so the PV cell receives enough light The battery won't charge at night time due to a lack of light The PV cell adds cost to the product as you still need to buy a re-chargeable battery 	
				Total (4 marks)
4	d	i	<p>Prototype production – <i>up to 4 marks</i></p> <p>1 mark for each suitable specific material Materials include: acrylic, HIPS, rigid polystyrene, steel, ABS, PLA or other suitable response.</p> <p>1 mark for each suitable process that matches the material Processes include: vacuum forming, laser cutting, rapid prototyping, milling, routing, sawing and drilling/filing by hand.</p> <p>(Don't accept injection moulding as it is not suitable for prototyping).</p> <p>Up to 2 marks for explaining choice of process. (1 mark for a simple response, 2 marks for a justified or explained response).</p> <p>Examples of a simple response</p> <ul style="list-style-type: none"> Rapid prototyping can produce 3-D shapes HIPS and acrylic are low-cost materials Making by hand is quicker than using a laser Making by hand is faster than vacuum forming <p>Examples of justified responses:</p> <ul style="list-style-type: none"> Using CAD and the laser cutter means you can easily edit your design if the prototype is not right. Complex 3-D shapes can be produced using rapid prototyping and the design can be amended if changes are needed. Making products by hand doesn't require expensive 	

			<p>machinery.</p> <ul style="list-style-type: none"> • Making by hand is quicker than using a laser as you don't need to design the part on the computer • Making it with hand tools is faster than vacuum forming as you don't need to produce a former. 	Total (4 marks)
4	d	ii	<p>High volume production – <i>up to 4 marks</i></p> <p>1 mark for each simple or unjustified statement.</p> <p>2 marks for each justified and relevant statement.</p> <p>Processes include injection moulding, vacuum forming, CNC milling/turning, casting, pressing, laser cutting.</p> <p>Examples of a simple response:</p> <ul style="list-style-type: none"> • You can use injection moulding • The component could be vacuum formed. <p>Examples of responses with further detail:</p> <ul style="list-style-type: none"> • A mould can be made, and the part could be injection moulded. • A program could be written, and the part can be made using CNC milling. • The part could be made from acrylic using an injection moulding machine. <p>So, if a suitable process is named, give 1 mark.</p> <p>Award a mark for any further qualifying comments that apply to the process relating to;</p> <ul style="list-style-type: none"> • Repeatability • Speed of production • Wastage of material • Energy efficiency • Other suitable responses 	

			Give credit where 2 processes are compared.	Total (4 marks)
				Total for Question 4: (17 marks)
5	a		<p>Writing a microcontroller program – <i>up to 7 marks</i></p> <p>Basic, flowchart-based or other program systems acceptable.</p> <p>[simple re-writes of the question, giving no evidence of a programming system – award no marks]</p> <p>Award: 1 mark for 3 second delay at the start</p> <p>1 mark for the wait 3 only occurring once, when circuit first switched on. i.e. any loop back from the decision must exclude the wait 3 command.</p> <p>1 mark for a first decision for tilt switch with correct yes/no routes</p> <p>1 mark for second decision for tilt switch with correct yes/no routes</p> <p>1 mark for G0, G2 on, or sound/light on</p> <p>1 mark for wait 60 seconds</p> <p>1 mark for G2 off or sound off.</p> <p>Note: ignore a STOP or END or loop back to the start.</p> <p>Example of flowchart solution:</p> <pre> graph TD Start([Start]) --> Wait3[Wait 3] Wait3 --> G1{G1 On?} G1 -- Y --> HighG0_2_1[/High G0,2/] HighG0_2_1 --> Wait60_1[Wait 60] Wait60_1 --> HighG0_1[/High G0/] HighG0_1 --> G1 G1 -- N --> G3{G3 On?} G3 -- Y --> HighG0_2_2[/High G0,2/] HighG0_2_2 --> Wait60_2[Wait 60] Wait60_2 --> HighG0_2[/High G0/] HighG0_2 --> G1 G3 -- N --> G1 </pre>	Total (7 marks)

			<p>Example of a basic solution:</p> <pre> main: pause 3000 label_2: if pin1 = 1 then label 4 if pin3 = 1 then label_5 goto label_2 label_5: high 0 high 2 pause 60000 label_8: low 2 goto label_8 label_4: high 0 high 2 pause 60000 goto label_8 </pre>	Total (7 marks)
5	b	i	<p>Use of a voltage regulator – <i>up to 2 marks</i></p> <p>1 mark for each simple, unjustified response 2 marks for a justified response</p> <p>Examples of a simple response:</p> <ul style="list-style-type: none"> • protect the microcontroller • to regulate the voltage • to get the right amount of voltage for the circuit. <p>Examples of a justified response</p> <ul style="list-style-type: none"> • the microcontroller cannot handle more than 5v so a regulator needed. • To stabilise the voltage for the circuit to 5v <p>A sudden voltage drop can interfere or scramble the program.</p>	Total (2 marks)
5	b	ii	<p>Use of a Darlington driver array – <i>up to 2 marks</i></p> <p>1 mark for a simple, unjustified response</p>	

			<p>2 marks for a justified or explained response.</p> <p>Examples of a simple response:</p> <ul style="list-style-type: none"> • to drive the output components • the lamp and buzzer need a lot of power • small and easy to use • prevents back emf, or current flowing backwards. <p>Examples of a justified response:</p> <ul style="list-style-type: none"> • microcontrollers are low current devices and the buzzer and lamp need higher current • easier to install than separate transistors • more output components can be added to the circuit • takes up less space than individual transistors • reduces manufacturing time as only one component needs inserting <p>Note: Give credit for describing the purpose or function of transistors in the circuit.</p>	Total (2 marks)
5	c		<p>Modern house alarms turning off after a time – <i>up to 2 marks</i></p> <p>1 mark for each simple, unjustified response 2 marks for a justified or explained response</p> <p>Responses could include:</p> <ul style="list-style-type: none"> • so the neighbours don't get annoyed • noise pollution • saves the battery • it is the law that the sound must stop after a certain time. • Similar suitable response 	Total (2 marks)
				Total for Question 5: (13 marks)
6			<p>Advantages and disadvantages of using wireless technology – <i>up to 8 marks</i></p> <p>Advantages could include:</p> <ul style="list-style-type: none"> • Being able to call for help in an emergency • Being able to keep in touch with family and friends • Accessing maps for finding your way around • Finding information on shops, restaurants etc. • Being able to contact employers/employees whilst not in work <p>Any other suitable, similar responses.</p> <p>Disadvantages could include:</p>	

		<ul style="list-style-type: none"> • No rest from work as you are always in contact • High cost of connection charges • High cost of mobile phones and tablets • Noise pollution on trains and coaches • Peer pressure to have the latest gadget <p>Consider the technical content and quality of communication. Marks awarded as follows:</p> <p>0 marks – no answer worthy of credit.</p> <p><i>1-2 marks</i> Limited coverage. Just one issue discussed. Many spelling and punctuation mistakes. Limited use of technical vocabulary.</p> <p><i>3-4 marks</i> Discussion of advantages and disadvantages of two issues. Some spelling, punctuation or grammar errors. Poor structure of answer, and repetition made.</p> <p><i>5-6 marks</i> Good coverage and a well-structured response. Advantages and disadvantages for at least two issues discussed using specific terms and vocabulary. There may be one or two spelling or punctuation mistakes, or minor grammar error.</p> <p><i>7-8 marks</i> Excellent coverage and depth of answer, and a well-structured response. Several issues discussed in good detail. Excellent spelling, grammar and punctuation. Avoidance of repetition.</p>	Total (8 marks)
			Total for Question 6: (8 marks)
7	a	<p>The application of quality control – <i>up to 4 marks</i></p> <p>This question is about maintaining consistency and reliability during production – ensuring the manufacturing specification is being met during production. It is not about stating a design requirement.</p> <p>1 mark for each simple, unjustified response 2 marks for each justified or explained response.</p> <p>Examples of simple response:</p> <ul style="list-style-type: none"> • to make sure the console has no faults • to save time and money 	

			<ul style="list-style-type: none"> • similar suitable response <p>Examples of a justified response:</p> <ul style="list-style-type: none"> • the manufacturer’s reputation for making good quality products is not harmed so they will sell more • to save money as the console will not have to be repaired at a later time • it will save time as the manufacturer won’t need to spend time fixing or repairing the console • to make sure the console doesn’t contain a fault which can lead to compensation. 	Total (4 marks)
7	b		<p>Using pick and place component machines – <i>up to 4 marks</i></p> <p>1 mark for each simple, unjustified response 2 marks for each justified or explained response.</p> <p>Examples of simple response:</p> <ul style="list-style-type: none"> • faster production • cheaper circuit boards • don’t need to employ as many people <p>Examples of a justified response:</p> <ul style="list-style-type: none"> • the machine can place components on a board much faster than a person • the circuits could be much cheaper to produce as the manufacturer will not need to employ as many workers <p>much smaller components can be used on the circuit as the machine can handle very small SMT components</p>	Total (4 marks)
				Total for Question 7: (8 marks)
			•	TOTAL 120