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General Certificate of Secondary Education
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Design and Technology: Electronic Products 45401

(Specification 4540)

Unit 1: Written Paper

Post-Standardisation

Mark Scheme

Mark schemes are prepared by the Principal Examiner 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 examiners 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 examiner understands and applies it in the same correct way. As preparation for standardisation each examiner 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, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

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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COMPONENT NUMBER: 45401

COMPONENT NAME:
New Specification - GCSE Design and Technology (Electronic Products)

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		Alternative 1-1 mark for each correct or suitable response **Accept all responses <u>not</u> duplicated** **Where several responses are tabled in a box accept first response** Input : LDR, Switch, PTM, PTB, Micro switch, Photo transistor, photodiode, Reflective Opto-switch, Process: PIC, Microcontroller, 4017, 4026, Op Amp summing amplifier, Decade Counter Output: LEDs, LCD, Seven Segment Display, Lamps, Bulbs, Buzzer, Loudspeaker Alternative 2 -1 mark for each correct or suitable response Input: LDR, Switch, PTM, PTB, Micro switch, Photo transistor, photodiode, Reflective opto switch Process: PIC, Microcontroller, 4017, 4026, Op Amp summing amplifier Output: LEDs, LCD, Seven Segment Display, Lamps, Bulbs, Buzzer, Loudspeaker	1 mark 1 mark 1 mark 1 mark 1 mark 1 mark **Total 6 marks**
1	b		1 mark each for the following features: Visual appealing product A space or location indicated for battery A clearly shown on /off switch location A clamp/bracket or fixture to attach to a table or board A clearly indicated gap or space through which balls roll An organised diagram or sketch with notes/annotation	 1 mark 1 mark 1 mark 1 mark 1 mark 1 mark **Total 6 marks**

1	c		Candidates might show: A system diagram, block diagram or circuit schematic A. The system can count functionally and will feature any of the following: • a 4026 counter • a 4017 counter • a microcontroller For a **second** mark they will detail or expand on the above with a drawing or notes: • a pin out diagram • comments about how it counts • mention of de-bounce • mention of suitable input device B. The system can be set/reset using a featured PTM or similar switch **OR** A simple reference to reset switch For a **second** mark the reset pin on the chip or block diagram is connected to a reset switch. OR is described as 'earthing' the pin to 0 volts or is shown connected via a pull up or pull down resistor C. Output pin(s) are shown to an audio output **and** visual output eg: speaker, buzzer, piezo sounder, 7 segment, LEDs, lamps They may also be described rather than drawn 1 mark for each output shown	1 marks 1 mark 1 mark 1 mark 1-2 marks **Total 6 marks**

1	d		**Constructional details** Each of the following constructional details featured as images and or words: • Material eg: Polystyrene, PVC, Acrylic, • Process eg: Vacuum forming, injection moulding, fabrication • Reference to size and dimensions in mm • Location and retention of components eg: LED bezel, PCB pillars, battery clip, screws and washers • Access to battery eg: compartment or lid • Fixing to table top game eg: screw, clamp, sucker **Circuit operation details** In each case components drawn and identified • Input drawn and described – basic 1 mark detailed and justified 2 marks eg: sensor and detection • Process drawn and described – basic 1 mark detailed and justified 2 marks • Output drawn and described – basic 1 mark detailed and justified 2 marks **Communication of the design** any one of the following: • Basic drawing method used with **no** annotation • 2 and/or 3D drawing method clear but with very little or no annotation or limited notes • Detailed drawing / section view or breakout view with annotation	1 mark 1 mark 1 mark 1 mark 1 mark 1 mark 1-2 marks 1-2 marks 1-2 marks 1 mark 2 marks 3 marks **Total 15 marks**

Section B

Question	Part	Sub Part	Marking Guidance	Marks
2	a	i	Drain	1 mark
		ii	Gate	1 mark
		iii	Source	1 mark
				Total 3 marks
2	b		Simple response eg: low output for device / voltage or current / protect the IC OR Qualified response: • as an interface to protect the IC • increase output current or voltage • match power required in circuit	1 mark 2 marks **Total 2 marks**
2	c	i	Diode symbol correct OR Correct diode symbol and polarity inserted between TR1 and Vcc 9 supply rail	1 mark 2 marks **Total 2 marks**
2	c	ii	Simple response: • to separate two circuits/ interface two circuits OR Detailed response: – • to separate circuits at different voltages • to increase operating voltage between circuits • allow a small voltage to control a large voltage	1 mark 2 marks **Total 2 marks**
2	c	iii	Part response – any of the following: • to switch higher loads • to increase gain • amplify input • Darlington pair/ emitter follower pair • power switching • Increase current to match or drive the load • Increased sensitivity Complete response – Any two of the above	1 mark 2 marks **Total 2 marks**

3	a	i	Bread boarding: Any response from list below Any two comments made or one explained in detail Advantages – • Components can be swapped/changed • Real world sizes and values used • Circuit currents/voltages can be tested Easily • No need to solder or make PCB • Spread over a larger area than a PCB for • ease of test and probing Or other suitable response	1 mark 2 marks **Total 2 marks**
3	a	ii	CAD: Any response from list below Any two comments made Advantages - • Easy to model quickly or substitute • Real world PCB sizes established • Components can be tested without damage • Unavailable components can be used • Reduced development time • Prompts faults • Wide choice of alternatives can be explored • Speed of prototyping Or other suitable response	1 mark 2 marks **Total 2 marks**
3	b		Simple response from any of below : • Reduced production time • Lower costs (see last point) • Smaller sized assemblies/ smaller components • Improved reliability • Lower resistance values • Automation • Reasoned response as to why it costs less Detailed response covering any two points above or a fully justified single response	1 mark 2 marks **Total 2 marks**

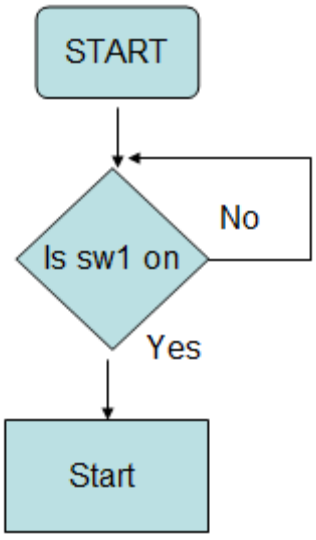
3	c		Placement : • Using a pick and place machine • Bandolier and insertion arm • Tweezers Any above response: Attachment: • Wave soldering • Reflow soldering (using solder paste) • Reflow gun OR oven • **Also accept –** soldered in place Any above response:	1 mark 1 mark **Total 2 marks**
3	d		Reasons : • Components are small and difficult to handle • Components cannot be replaced easily • Components do not fit breadboard • Wide range of components not available • No oven/ reflow facility available Any single reason from above 1 mark Any two reasons detailed from above 2 marks	1 mark 1 mark **Total 2 marks**

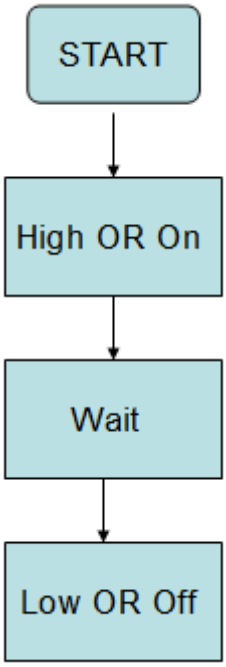
3	e		NB: ignore the stated method Table for photo etched PCB **Award marks for any correct responses only in sequence** 1 **PCB layout** from CAD **or** hand drawn **onto Acetate** 2 Acetate and sensitised copper (FR4) **exposed to UV** 3 **PCB developed** in Sodium Hydroxide 4 **PCB etched in** Ferric Chloride (FE3 CL) 5 Rinse stage 6 **Drill** • Additional or alternative stages • Check for etching faults Table for machined PCB 1 **PCB layout** from CAD 2 CAD converted to CNC machine code 3 Clamp material to bed 4 Dry Copper coated board mounted **on CNC** table 5 Engrave using a 'Vee' cutter used to **machine tracks** 6 Drill to 'pop' and/or **drill component holes** Any of above in sequence for 1 mark each	 1 mark 1 mark 1 mark 1 mark 1 mark 1 mark 1 mark OR 1 mark 1 mark 1 mark 1 mark 1 mark 1 mark **Total** **6 marks**
4	a		Simple response: 1 mark A material that can change its state / or behaviour Detailed response: 2 marks Material that changes its properties or behaviour in response to external influence/stimulus Giving an example eg: smart wire, nitinol, thermochromic film	 1-2 marks **Total** **2 marks**

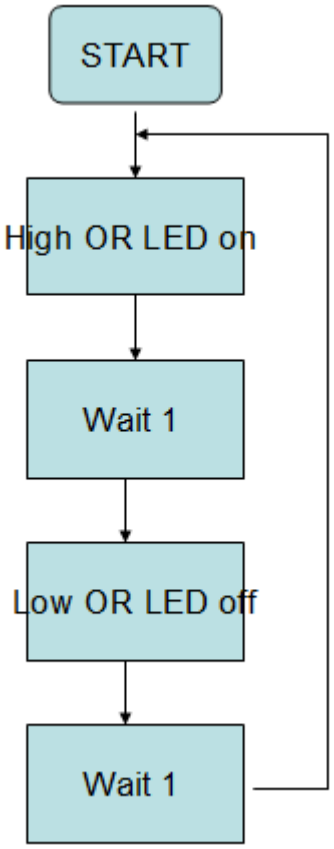
4	b		Mark this answer **across** the two boxes as 'application' and 'properties' are often misplaced or misunderstood by candidates QTC Any response similar to below Application: • Use as a pressure switch • Use as a variable resistor • Use as a gas sensor • In cable or sheet form as a vibration sensor Property: • An insulator(non-conductor) that becomes a • conductor • When pressed it behaves as a variable resistor EL Any response similar to below Application: • As a backlight in products • Low intensity illumination • As a controlled decorative surface Property: • Electroluminescence • Thin film EL zinc coated • Glows when a high voltage (50+ volts) is applied PV (Photovoltaic Cells) Any response similar to below Application: • Used to charge batteries or capacitors in • sunlight • Garden lighting • Low cost charging units for camping • Powering devices in remote locations eg: • Desert, roadside, oceanic, space Property: • Generating electric power from solar energy • Solar sensitive P-N diode junction (sensitive to light) • Solar radiation induces a voltage between poles	1 mark 1 mark 1 mark 1 mark 1 mark **Total 6 marks**

4	c	i	Simple response (one of the following only) • products designed to fail • products with limited lifespan • Value engineered products (that will fail materially) • Products designed to fail after a period of time • Designed and sold to be outdated by new products • Style/fashion or built-in obsolescence Detailed response of one point or commentary detailing two points	1 -2 marks **Total 2 marks**
4	c	ii	Any simple response from below • Products that can be recycled • Use/own the product for a longer than planned period • Repair rather than dispose of a faulty product • Products that continue to be used • Products that are refused • Any 6R's relevant comment • Upgrade aspects of the product eg: software/apps Any detailed response covering two of the above	1 mark OR 2 marks **Total 2 marks**
5	a a a	i ii iii	Astable An electronic device with two stable states Monostable	1 mark 2 marks 1 mark **Total 4 marks**
5	b	i	1 mark each for the following: • Correct LED symbol(s) • Correctly sinking to pin 3 • Correctly sourcing from pin 3 • 1-2 limiting resistors correctly positioned • Both LEDs will alternately flash **(output will work)** Note : No R value required	1 mark 1 mark 1 mark 1 mark 1 mark **Total 5 marks**
5	b	ii	Diagram showing • A square wave or similar • Space arrowed • Mark arrowed • Period (Mark + Space) arrowed	1 mark 1 mark 1 mark 1 mark **Total 4 marks**

5	b	iii	Formulae used • 0.693 x R2 x C OR (.693RC) From table at front of paper Simple substitution Calculation = 0.693 x 100K x 10uF 1mark OR Full transposition of values Calculation = 100000 Ω x .00001 F 2 marks Value Time Low • 0.7 seconds rounded up OR 0.693seconds	1 mark 1-2 marks 1 mark **Total 4 marks**
6	a		Advantages 1 mark for each advantage stated of: • Can be reprogrammed to different frequencies • Less components required • More outputs available • More inputs available • Different /complex output sequences possible • Display can be updated easily • Smaller circuit possible • Lower power consumption possible • Microcontroller can also be changed	1 mark 1mark 1 mark **Total 3 marks**
6	b		Simple response from list - 1 mark Detailed response covering 2 points or justified single response - 2 marks • Prevents damage from the soldering iron • Ease of insertion and removal of IC • Allows for different IC's to be used or tested • Easier to test probe a socket	1-2 marks **Total 2 marks**

6	c	i	Typical voltage for powering microcontrollers 3-6 volts Note: Allow 3-6 volts for Some PIC and MSP devices are reported to operate at around 1 volt (these are <u>not typical</u> or in common use and rated use is 5 volts for most but students may have been taught and used other voltages).	1 mark
6	c	ii	Either of the following answers for 1 mark • Voltage regulator • 7805	1 mark **Total 1 mark**
6	d	i	Using lines, blocks or system shapes with labels the Chart may look similar to the following:  Any arrows used may help diagram understanding 1 mark for decision 1 mark for start 1 mark for loop back	1-3 marks **Total 3 marks**

6	d	ii	Using lines, blocks or system shapes with labels Any of the following in a viable sequence 1 mark for each or similar answer. Any shape of box acceptable.  	1-3 marks **Total 3 marks**

6	d	iii	Using lines, blocks or system shapes with labels Any of the following in a viable sequence Or any similar or suitable response 1 mark each for a high or on / wait / low or off / return loop NB: No mark available for 2nd wait  	1-3 marks **Total 4 marks**

7	a		**PCB testing** QWC question mark in one of the following bands: A high level response with a full and comprehensive explanation of all aspects of a suitable process. Response well structured with good use of appropriate design and technology terminology and showing a good grasp of grammar, punctuation and spelling. - (7– 8 marks) A medium level response with a good explanation of a Suitable process , however with some aspects of the process omitted. Response fairly well structured with some use of design and technology terminology with a small number of errors in grammar, punctuation. (5-6 marks) A low level response with a limited explanation of one part of the process with several errors. Response poorly structured with little or no use of design and technology terminology and with several errors in grammar, punctuation and spelling. (3-4 marks) An attempt at a response, no relevant description presented. No use of design and technology terminology and multiple errors in grammar, punctuation and spelling. (1-2 marks) Technical coverage will include some reference to several of these key words: Testing, bench-testing, destruction testing, continuity, resistance, multi-meter, magnifying glass, lamp test, probe, visual inspection, compare against original design Or other suitable or similar key words	1-8 marks **Total 8 marks**

7	b		Image 1 Any of the following for 1 mark Name: • Digital Probe • Signal Injector • Pulse injector • Test probe / logic probe (accept probe) Purpose: Any of the following for 1 mark • To test for voltage • To test for continuity • To test for or measure small signals eg: square wave, transients or logic levels Or similar/ suitable response Image 2 Name: Multi-meter (accept voltmeter) DVM Or similar/ suitable response Purpose: To check resistance/ voltage/current To check continuity To test voltages/levels To test components To check polarity	1 mark 1 mark 1 mark 1 mark **Total 4 marks**
7	c		Quality Control : Any simple response for 1 mark and combined responses and justification from list below 2 marks • Known as QC • Is about testing and measuring • Using 'methods' to check • Checking against a standard or specification • Is applied to products during manufacturing stages • Is to uncover defects or faults • Used to improve or optimise manufacture • Prevents sale/release of faulty parts/goods • To check batches • To help identify repairs and replacements for faulty production	1-2 marks **Total 2 marks**