GCSE Design and Technology: Electronic Products

Schemes of work

Schemes of work are suggestions and ideas about how you might deliver GCSE Design and Technology: Electronic Products. You can use these suggestions, adapt them to better suit your students or use your own schemes of work.

However you deliver GCSE Design and Technology: Electronic Products, you can rely on AQA's comprehensive support package – online, on paper and in person – including resources, specimen exam questions, training meetings, continuing professional development (CPD), guidance and advice.

This guide to *Schemes of work* is part of your invaluable **Teacher Resource Bank**, which includes a *Resource list*, *Getting started*, *Summary of changes* and more.

If you have any enquiries about GCSE Design and Technology you can speak directly to the AQA Design and Technology team by e-mail **dandt@aqa.org.uk** or telephone **0161 957 3644**.

GCSE Design and Technology: Electronic Products

This suggested Scheme of work for Electronic Products should allow students to cover the specification and allow them access to all levels of attainment, for both controlled assessment and the written paper. It can be done by a combination of design and theory work, modelling using both real and virtual methods and mini projects. It is recommended that students should experience at least once the processes required to produce a piece of controlled assessment work.

Centres will have different experiences of Design & Technology work covered at KS3, some will have covered aspects of the specification by the time students start KS4 whilst, some may have little experience of Electronic Products until starting the GCSE specification. In addition, centres will have different proportions of timetable allocation. This will influence how you cover the Scheme of work, but it will be important that all elements are covered by whatever process.

In the Scheme of work there are links from one process area to another, such as with 'Bistables' where you can investigate how logic, PICs and relays can be configured to perform the same function. You can also link to 'switches' to check that you are covering the required range of switches, or cross check with the specification.

Design aspects of 'Electronic Products' can be covered by mini projects and product analysis exercises. It is important for the student to realise that the 'controlled assessment' criteria states that the needs of the target market and the potential for the electronic product to be commercially viable are important specification points – this should be emphasised in any design/product analysis exercise.

Centres should be aware of the 'Level of Control' criteria set out in the specification, which are applicable to the 'controlled assessment', but work covering the syllabus is not done under these conditions. It is suggested that a lot of the product design analysis and investigation can be done out of class, and the electronics theory and practical exercises in class.

Activities described below can be carried out as an investigation on paper, modelled on breadboards and on ICT systems such as Circuit Wizard; they can also be extended into mini projects where students can experience producing completed products.

Activities described in the Scheme of work should be cross-checked against the AQA DT Electronic Products specification and can be supported by the Nelson Thorne textbook Electronic Products, due to be published in summer 2009.

The layout of the Scheme of work is based on the assumption that a centre will be working on a two year model for Year 10 & 11, but the Scheme of work should be flexible enough for other curriculum models.

Timing is based on 6 – 7 week sessions for Year 10.

In Year 11 the controlled assessment and revision governs the use of time.

Centres will have activities such as work experience, activity days/weeks, internal exams which will need to be accommodated; the Scheme of work has a model of 30 – 35 weeks to cover Year 10 which should deliver the required degree of flexibility.

If starting the controlled assessment in September of Year 11, as a guide, it is recommended that 'Making' starts a month before Christmas; this will give spare time in case of unforeseen events.

April is the suggested time for internal moderation and submission of marks to AQA.

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Year 10

Process	Components/ design elements	Time/ lessons	Activity	Key words/ process	Links to subject content
Bistable – a bistable circuit counts an individual event and stores this temporary input					
A bistable circuit stores an event such as stepping on a pressure pad or breaking a light beam. The input is extremely sensitive, it can be triggered by a switch, sensors or vibration/ sound; it can drive a range of outputs, but feedback diodes must be used with motors/relays/solenoids and pulsed outputs must use 'smoothing' capacitors. The off switch needs to be a switch, such as a PTM, which makes a perfect contact. The thyristor is a bistable circuit, sometimes referred to as a latch or flip flop.	Thyristor Resistors Capacitors Diodes PTM's SPST Piezo's LEDs Buzzers Motors Moisture sensors Piezo's	Wk 1–2	Draw thyristor latching circuit with Led output and PTM's to trigger circuit and reset. Discuss possible different input signals. Discuss possible outputs such as buzzers and motors and the use of diodes and smoothing capacitors. Investigate the use a piezo as a trigger. Design a stripboard layout and PCB for the circuit and discuss pros and cons for manufacture. Calculation: use V=IR to calculate the value of protective resistor needed for the output LED.	Bistable, flipflop, latch Flash EMF Smoothing capacitors Anode Cathode Gate	PIC Logic Relay Components – Resistors controlling current Switches LED's Buzzers Motors Input transducers
Design					
Product analysis	Analysis, specification, research	Wk 2	Investigate products that use keypads to control/activate outputs.	Form, function, user requirements, performance, material and component requirements, scale of production and cost, sustainability.	Controlled assessment – Investigating the Context.

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Process	Components/ design elements	Time/ lessons	Activity	Key words/ process	Links to subject content
Electronic switches and amplification					
Use transistors as electronic switches, current amplifiers and as transducer drivers. Field Effect Transistors (FET) – know how and when the use of a FET is appropriate. Use sensors in potential dividers to switch transistors/FETs.	Transistor FETs Relays LDR Thermistor Potentiometer Variable resistor	Wk 3–4	Look at how a fixed resistor in series, or a potentiometer, can bias the transistor to give a high or low signal. Investigate single transistor (high gain) circuit with LDR in a PD as sensor input and with an LED output. Investigate a Darlington driver transistor circuit (high gain and current) with thermistor in a PD as sensor input and with a motor or relay as output. Calculation – using Vo = R2/R1 + R2 x Vs to calculate variable resistor value. If modeling use a multi meter to measure Vo as sensor conditions change.	NPN – collector, base emitter Transistor bias Gain/ amplification FET – drain, gate, source PD – potential divider	Components – Resistors as sensors Variable Resistors Potentiometers EMF Testing using multi meters
Design					
Specification		Wk 4	Write a specification for an everyday object found and used in school or at home.	Objective statements, values Justification "it will"	Controlled assessment – Investigating the Context.
Monostable					
Electronic monostable circuits can be used to provide short term on and off time delays.	555 DIL IC Resistors – fixed and variable Capacitors LEDs	Wk 5	Investigate the circuit for a 555 IC to produce a monostable time delay. Investigate the use of a resistor and capacitor in series. Investigate how different values create a range of time delays. Examine how the circuit can be triggered using PTM's and sensors. Calculation: T in seconds = C x R	DIL IC Trigger Sink source	Discrete components – LED's Capacitors Variable resistors

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Process	Components/ design elements	Time/ lessons	Activity	Key words/ process	Links to subject content
Astables					
Astables produce pulsed signals which can control flashing lights and audible outputs	555 IC Speaker Relay	Wk 6	Investigate how to use a 555 IC as a pulse generator to flash LED's on and off at different rates. Investigate how a high frequency can produce sound through a speaker. Connect a 555 mono to a 555 astable to enable a set number of pulses to be delivered. Investigate control of motor speed. Calculation: F = 1.44/ (R1+2R2) C	Digital Pulse generator Mark and space Frequency / duration Hertz PWM	
Design					
Analysis		Wk 6	Give a set situation and brief and then analyse it to identify specification factors and those for research.		Controlled assessment – Investigating the Context.
Half term – October					
Counters Counters can be used to count events (such as people passing through doors), measure timed sequences and select 'random' numbers.					
Understand that the 4026 IC is a dedicated chip used to decode the pulsed signal and to enable a seven segment display to display numbers in sequence.	IC 4026	Wk 7–8	Use a 555 astable with a 4026IC to count from 0 – 9 using a seven segment display and be able to cascade the IC to count to 99.	Debounce Cascade Reset Enable	PIC's The use of PIC's to display numbers on seven segment displays and the use of PIC's for generating 'random' numbers.
Understand that a 4017IC has ten outputs and it produces a sequential output that can be cascaded, or limited to less than the maximum outputs.	IC 4017	Wk 9	Use a 555 astable to pulse signals to a 4017 IC to turn on LEDs in sequence and then cascade the signal; investigate how to count to 49.		

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Debounce					
Understand that mechanical switches when used in electronic circuits can cause switch bounce – In a counting circuit switch bounce can cause a single count to be registered as several counts.	555 IC Logic gates 4093 IC and 40106 IC	Wk 10	Use a 555 IC monostable to control switch bounce. Use a Schmitt Trigger to control bounce.		
Op amps					
Understand that an op amp is used to compare and amplify the difference between two input voltages. Understand because of its speed of switching it becomes an ADC. Negative feedback can be used to control the gain of an op amp and avoid clipping.	Op Amp CA 3140 IC	Wk 11 – 12	Create a PD with a sensor and a PD which acts as a reference voltage and use to compare the difference between to input voltages, and investigate how little difference in voltage is needed to switch the output from positive to negative. Use an op amp to switch a transistor, control a 555 IC astable, or trigger a 555 IC monostable. Use negative feedback to control the gain of an op amp.	Reference voltage ADC Clipping Inverting/non inverting input	
Christmas					

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Process	Components/ design elements	Time/ lessons	Activity	Key words/ process	Links to subject content
Design & manufacture					
Generate an idea for an electronic product – circuit and enclosure – from Term 1 work. Design a PCB and prototype enclosure.	Modeling tools, 'virtual and real' such as Circuit Wizard, Pro/Desktop, breadboards. Model an enclosure using card, foam, sustainable/ recyclable materials. The design of the electronic product should lay emphasis upon it's purpose and should be reflected in the completed piece of work.	Wk 13–19	Students produce: electronics – a brief, systems analysis, specification, circuit diagram, model on breadboard, design a PCB design – research for prototype enclosures, generate design ideas, produce a solution (the PCB should be designed to fit the enclosure) model, or make, the enclosure and circuit; the finished product should allow for testing and evaluation.	Brief Analysis Specification Research Ideas Modeling PCB Prototype Test Evaluation	Controlled assessment
February half term					
Logic Logic gates are digital, make decisions based on the condition of signals at their inputs – candidates should understand that logic is used when a circuit requires more than one input.					
Understand that logic is used when a circuit requires more than one input; be able to use AND, OR and NOT logic gates, recognise their symbols and construct their truth tables, understand that logic gates respond to, and output, digital signals.	CMOC IC's 4071 (OR), 4081 (AND), 4049 (inverter), 4069 (inverter)	Wk 20–21	Investigate logic diagrams for systems which use microswitches for control; do further investigations into control systems in the home which use logic, such as central heating boilers.	Digital signals, AND, OR, NOT, Truth tables, CMOS, TTL, Logic levels, DIL Floating gates Pull up/pull down resistor	Understand that logic is used when a circuit requires more than one input; be able to use AND, OR and NOT logic gates, recognise their symbols and construct their truth tables, understand that logic gates respond to, and output, digital signals.

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Process	Components/ design elements	Time/ lessons	Activity	Key words/ process	Links to subject content
Microcontrollers PIC's can replicate any process that has been described in the above scheme of work and specification, but they still need inputs and outputs. The programming language enables the PIC to be a flexible processor, so it is important to be able to use the programming commands, whether it be using flowchart or basic language.					
Microcontrollers are Peripheral Interface Controllers; students should demonstrate an awareness that a programming language can be used to integrate sub-systems routines into one program. Through investigation, research and practical work candidates should be able to: understand that a PIC is an IC that can be programmed to respond to one or more inputs and control one or more outputs know that they have a low current output and need transducer driver; and also be aware that a sudden voltage drop can "scramble" the program and the use of decoupling and smoothing capacitors is recommended be aware that a PIC can replace a wide variety of traditional components and is a more flexible and efficient system know that PIC's need a Vs of 3 – 5.5 DC.	Choose your preferred system for delivery of PIC technology (if using PICAXE it is advised to select 8M, 14M, and 20M chips) 4.5 volt supply or 6 volt supply + diode Download board Turned pin DIL sockets for PIC's Chip extractor Input and output transducers. 100mf smoothing capacitors, 0.1 mf decoupling capacitor. Opto isolators L293D motor drivers	Wk 22 – 28 Half term to Easter	Suggested starting investigation: Using either Flow Charts or Basic as a programming language investigate how to turn on multiple LED outputs. Investigate how to trigger multiple outputs by a single input. Investigate IR control. Using a suitable PIC – Use a relay as an interface between low current control circuits and outputs that need a high working current. Use opto isolators to interface between a low current PIC circuit and a high current output. Use an L293D to drive motors – 6 volt high noise, or solar motors.	Decoupling and smoothing capacitors Download socket Digital Analogue Reset Programming – sub systems, routines, start, stop, output, wait, decision, compare, expression, increment, decrement, pulse, sound, count, infra red, end download, programming functions, decimal, binary, flow chart, basic, decoupling capacitor	
Easter					
The above Scheme of work broadly covers the Design and Technology: Electronic Products specification, but there is flexibility of time built in for centres to extend a particular specialization or interest before the start of the controlled assessment; it might be more work on PIC technology, or time spent researching manufacturing processes such as CAD/CAM or vacuum forming.					

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Process	Components/ design elements	Time/ lessons	Activity	Key words/ process	Links to subject content
Half term – May					
Revision of coursework – electronic and design.		2 weeks			
Controlled assessment design and make project – research and preparation.		4 weeks/ end of term			

Basic components	
Power supplies	Selection of a DC power source for a particular purpose – solar, zinc-carbon, alkaline/ manganese, NiCad, Ni-MH, button cells; the use of low voltage regulators.
Switches	Mechanical switches – recognise and use slide, toggle, rocker, PTM and PTB, key, micro, reed, rotary, membrane and tilt switches. Use switches connected in series and parallel. Know how to eliminate switch bounce.
Resistors	Understand and use resistors to control voltage and current; determine the value of resistors in series; use potentiometers and variable resistors within electronic circuits; understand the properties of LDRs and thermistors and that they are types of variable resistor; determine the value of fixed resistors.
Capacitors	Electrolytic and non electrolytic.
Diodes	Understand how, and use diodes to control current flow.
LEDs	Understand that LEDs have polarity and emit light and need to be protected with a current limiting resistor; be aware that LEDs are available as bi-colour, tri-colour and as IR emitters, 7 segment displays. Pick the appropriate type, size, colour, brightness and shape for a particular application. Calculate the value of the protective current limiting resistor used in series with an LED.
Relays	Through investigation, research and practical work candidates should be able to: (1) use relays as interface components between low current control circuits and outputs that need a high working current (2) use a relay as a latch. Candidates should understand that relays are used to interface between two circuits that have different voltage requirements and ensure they are isolated electronically.

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Year 11 (controlled assessment)

The candidates' coursework must reflect the aims of the syllabus; that is to produce an electronic product that satisfies the requirements of the target user and is commercially viable – this means that the 'enclosure' and circuit must meet these demands.

Controlled assessment must be supervised and completed within a 45 hour time limit; the suggested time allocations in the Scheme of work are based on the marks allocated for each of the assessment criteria.

Design process	Time	Objectives	Evidence	Tips
Investigating the design context				
Design context Research Analysis Design criteria Target market Consumer/user profile	5 hours	Students should be able to: select a design brief which will allow them to display a wide range of skills and address all assessment criteria analyse the design brief by using a word web or by key word analysis produce a systems analysis identify, generate and analyse research produce design criteria, ie a specification identify a target market and profile the intended consumer/user.	A concise, but realistic, situation and design brief, which reflects the choices that the EP specification makes available. Students will show that they have explored the brief by generating a wide range of questions, or "blue sky thinking" in their analysis from which they can bullet point a primary spec and recognise areas for research. Produce a systems analysis using input, process, output. A list of the key points that the candidate has uncovered during research. Think about and write down what possible features you would want if you purchased a similar product; and ensure important factors can only be related to your choice of design brief. Information that the design criteria proposals will meet, these criteria will need values from which you can objectively evaluate. A secondary electronic and product specification will further define the product. There will be information about likely end users.	Choose a design brief which allows you to use the content of the exam specification. Make sure the specification is as detailed as possible and incorporates the findings from your research. Ensure that the spec identifies as many electronic and product spec points as possible. Make sure you identify and ask potential end users about your design proposals.

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Design process	Time	Objectives	Evidence	Tips
Development of design proposal				
Ideas Design strategy Issues Development work Components/materials Product/manufacturing specification	17 hours	Students should be able to: produce ideas based on electronic building blocks and develop them into innovative ones by demonstrating creativity, flair and originality in the way in which they combine and refine them present a coherent and appropriate design strategy, with clear evidence of a planned approach describe the implications of a wide range of issues including social, moral, and environmental sustainability produce development work through experimentation in order to produce a final design solution produce a detailed and justified production specification, with the inclusion of H&S and Risk Assessment factors choose components and materials chosen with full regard to their working properties.	Consideration of the wider effects of design proposals. Evidence of modelling and experimentation. A plan of manufacture will be produced that will allow a third party to be able produce it. Evidence of appropriate choice of materials and components.	Show your developed electronics and "enclosure" solutions in detail and with sufficient information that a third party could make it. State the advantages your product/system will give to end users and how you have considered its long-term production in terms of sustainability. Keep a record of everything you do; digital photographs are an excellent way of doing this. Show evidence of considering materials, tools, machines, processes, time needed. List the choices you have as regards materials and why have you come to your decision on the chosen material.

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Design process	Time	Objectives	Evidence	Tips
Making				
Making/modelling/ finishing skills and accuracy Selection and use of tools and processes Independent work and outcome Quality controls Commercial viability and suitability for target market	17 hours	Students should be able to: produce a final outcome to demonstrate making, modelling and finishing skills demonstrate that quality controls are evident throughout the project produce an outcome that is suitable for a target market.	A finished functioning product/system which shows attention to detail, is accurate and neat/tidy in appearance. A list of, or record of, what was done to ensure a fully functioning product/system. A finished product/system that fulfils the design criteria	Choose a project, which is within your capability, which lends itself to development, and ensure you leave enough time to finish making your product/system. Students should highlight industrial processes such as CAD/CAM, vacuum forming, use of jigs, etc; a photographic diary is a good way of evidencing this, along with other quality controls. Leave enough time to make sure that all parts of the system function and it can be fitted to it's 'enclosure'.
Testing & evaluation				
Formative and summative evaluation taking into account of client/user or third party opinion Final outcome tested against all criteria Improvement and modifications	6 hours	Students should be able to: test and evaluate as appropriate throughout the designing and making process test aspects of the final outcome against the design criteria and specification evaluate and justify the need for modifications to their product.	Evidence of evaluating design ideas against the specification, final evaluation of finished product/system. A record of modifications made as design has progressed, and proposals for future modifications in light of tests carried out on the 'prototype'. A record to justify design changes and show that reference is made back to the specification to ensure they are meeting the design criteria.	Always explain the choices you make with your designs and refer back to your design criteria as often as possible. A very detailed specification to enable you to evaluate thoroughly; apart from a primary spec, a secondary spec for the electronics and the product can be written.

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Design process	Time	Objectives	Evidence	Tips
Communication				
Design folder content Communication Legibility, grammar, punctuation and spelling		Students should be able to: produce a concise and relevant design folder that demonstrates an appropriate selection of material for inclusion communicate decisions in a clear and coherent manner with use of technical language produce legible text that is easily understood and shows a grasp of grammar, punctuation and spelling.	Use of appropriate, subject relevant software and digital images and knowledge of drawing conventions. Good written communication. Good graphical communication. Good grammar, punctuation and spelling.	Your folder should contain only information and material that is fully relevant to your design; a contents page is always helpful. Use bullet points and highlight key/important decisions. Avoid terms such as glue, wood, metal, plastic; be very precise and accurate in how a material is described. Read back through all written material.

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