Contents

WJEC GCSE in ELECTRONICS

For Examination from 2009

ELECTRONICS

SUMMARY OF ASSESSMENT

This specification contains staged assessments.

There are 2 tiers of entry for this examination.

Higher Tier: Grades A* - D
Foundation Tier: Grades C - G

All candidates are required to sit 2 module tests, a final written examination paper and submit a project on practical Electronics.

The timing and weightings of the components are as follows:

Module Test E1	Summer	12½%
Module Test E2	January/Summer	12½%
Final Examination	Summer	50%
Coursework	Summer	25%

Subject/Option Entry Codes	
Foundation Tier	298 01
Higher Tier	298 02

Availability of Assessment Units	
January	Summer
E2	All modules

ELECTRONICS

1 INTRODUCTION

Criteria for GCSE

This specification meets the General Criteria for GCSE issued by ACCAC/QCA (March 2000). Assessment for this qualification is carried out according to codes of practice published by the regulatory authorities. The qualification may be undertaken either through the medium of English or of Welsh.

GCSE qualifications are reported on an eight-point scale from A* to G, where A* is the highest grade. Candidates who fail to reach the minimum standard for a grade to be awarded are recorded as U (unclassified) and do not receive a qualification certificate.

GCSE qualifications are expected to show broad equivalence to General National Vocational Qualifications in the following terms:

two GCSEs at grade D to G and two GCSEs at grade A* to C are equivalent to one three-unit GNVQ at foundation and intermediate level respectively;
four GCSEs at grades D to G and four GCSEs at grade A* to C are equivalent to one six-unit GNVQ at foundation level and intermediate level respectively.

Rationale

This specification is intended to provide a framework around which courses can be planned to meet the needs and aspirations of students entering a progressively more technological society.

A systems approach is adopted to complex problem solving. Underlying this philosophy is the breaking-down of a task into manageable blocks, each of which performs its own unique function.

The blocks themselves may be considered at two levels. At the systems level, it is the terminal properties of the block that are of interest and not the detail of how these properties are arrived at within the block itself. At the circuit level, however, the engineer is primarily concerned with the design of the circuit contained within the block to produce the required terminal properties. The circuit level is treated on those occasions when a greater knowledge of the circuitry within a block itself is deemed necessary for the more effective use of the block.

It is fully intended that courses based around the specification will be directed towards design, where solutions to a given task are conceived through a systems approach and subsequently built as experimental models.

Electronics is a practically based subject where practical skills must be developed alongside theory to allow candidates to attain a deeper understanding. This specification is structured to allow prominence to be given to technological aspects of studying electronics. The direction of development should start with real applications of electronics and then move towards the principles necessary to understand these applications and not vice versa. It is intended to develop candidates' capability through a flexible and broad-based approach.

Candidates should be given practical experience of electronic systems being used to solve specific design problems from the earliest stages of the course. Wherever possible, individual components should be treated in terms of their function as part of an electronic building block or sub-system rather than in terms of the physics of their behaviour.

This specification encourages the investigation and study of electronics in a variety of contexts - home, school, recreation, community, business and industry. Candidates from all cultures and both genders can develop their interest in, enjoyment of, and critical reflection about electronics as an integral part of modern society. Candidates should have the opportunity to analyse and evaluate situations, design and make electronic products and then appraise their performance. They should be provided with the opportunity to work with a range of components. Candidates should be encouraged to consider the relationship between electronics and society.

Some of the material covered may appear in other GCSE specifications. This should add strength through reinforcement and should broaden horizons by giving alternative viewpoints to similar concepts, thus providing a more enriching educational experience.

Consideration of safety inevitably arises in Electronics necessitating that emphasis be placed on working practices that promote safety consciousness at all times. Safety is a recurring theme and it is fully intended that due importance be given to it when setting examination questions.

Prior Learning

Although there is no specific requirement for prior learning, this specification builds upon the Programmes of Study for Science and Technology in Key Stage 3.

Progression

This specification provides a basis for the study of Electronics at Advanced Subsidiary, Advanced GCE, AVCE and other vocational qualifications.

Overlap and Restrictions on Entry

There is substantial overlap between this specification and the GCSE specification in Electronics (Short Course). These two examinations may not be taken at the same examination sitting.

The classification code for this specification is 1730.

Centres should be aware that candidates who enter for more than one qualification with the same classification code will have only one grade (the highest) counted for the purpose of the School and College Performance Tables.

Resit Rules

Candidates who wish to resit this qualification may carry forward, from one year to the next, their marks for coursework and Tests E1 and E2. They **must**, however, retake the Final Examination Paper. Any candidate may, of course, resit either or both of the Assessment Units E1 and E2 once only and enhance their coursework or submit a completely new project. The shelf-life of individual units is limited only by shelf-life of the qualification.

Candidates with Particular Requirements

Details of the special arrangements and special consideration for candidates with particular requirements are contained in the Joint Council for General Qualifications document *Candidates with Special Assessment Needs: Regulations and Guidance.* Copies of this document are available from WJEC.

2 AIMS

2.1 General Aims

The aims set out below describe the educational purposes of the course for GCSE examinations in Electronics. Some of these aims are reflected in the assessment objectives; others cannot readily be assessed.

1. To provide, through well designed studies of practical work, a worthwhile educational experience for all pupils whether or not they go on to study Electronics beyond this level and, in particular, to enable them to acquire sufficient understanding and knowledge:

   1.1 to become confident citizens in a technological world, and be able to take or develop an informed interest in matters relating to Electronics;

   1.2 to recognise the usefulness and limitations of the 'systems approach' and appreciate its applicability in other disciplines and in everyday life;

   1.3 to be suitably prepared for studies beyond the GCSE level in courses involving Electronics.

2. To develop abilities and skills that:

   2.1 are relevant to the study and practice of a technological subject;

   2.2 are useful in everyday life;

   2.3 encourage safe practice.

3. To simulate:

   3.1 curiosity, interest and enjoyment in problem solving;

   3.2 interest in, and care for, the environment.

2.2 The spiritual, moral, ethical and cultural dimension

This specification provides opportunities for candidates to develop an understanding of spiritual, moral, ethical, social and cultural issues as they relate to the electronics designer, manufacturer or user. For example, in Section 3.3 candidates are required to *appreciate the social, economic, ethical and cultural implications of this technology for improving the quality of life, employment and leisure.*

The specification provides a framework and includes specific content through which individual courses may address these issues. Project work may serve to extend understanding of these issues in order that a balanced appreciation of the conflicts and dilemmas involved in the design and manufacture of electronic products or systems be encouraged. Health and safety issues are at the core of all work in electronics, as indicated in Assessment Objectives 1.2 and 2.1 and the section on safe working provision on page 28 and coursework criteria 5A (page 40). Candidates are expected to consider these factors when designing and making their own electronic product or system in the project and the project assessment criteria reflect this.

The specification also provides opportunities to promote enterprise and entrepreneurial skills through the process of identifying an opportunity to design an electronic product or system to meet a specific need, investigating the work of professional engineers and the electronics industry, developing their own product or system and finally evaluating the whole process. The project provides opportunities to develop independent thinking skills, through candidates identifying relevant sources of information and developing specific performance criteria for their designs to guide their thinking.

2.3 Citizenship

In this context citizenship is taken to include the development of social and moral responsibility, participation in community activity and development of political literacy. This specification is designed to make a contribution to the development of the knowledge, skills and understanding of citizenship. In particular, the coursework element will encourage pupils to take an effective part in school-based and community-based activities, showing a willingness and commitment to evaluate such activities critically. Aspects of the project, for example, could be directly related to the needs of the school or local community, which would provide candidates with the opportunity to tackle problems which are real and meaningful to themselves. In doing so, they will be encouraged to demonstrate personal and group responsibility in their attitudes to themselves and others: they would also need to consider critically and constructively the views of others when developing and evaluating proposed solutions.

2.4 The European dimension

This specification, where appropriate (for example in section 3.3) supports environmental education, the European dimension and health education, consistent with current EC agreements.

The approach used in constructing the specification lends itself to the establishment of links with other areas of study, particularly those involving problem solving or the use of ICT.

The above approach conforms with the aspirations expressed in the 1998 Resolutions of the European Community and the Ministers of Education meeting within the Council, concerning the European dimension in education and environmental education, particularly those intended at the level of member states.

2.5 Opportunities for use of ICT

The specification offers a broad range of opportunities for the use of ICT. Candidates may use DTP or word processing software in the production of their project report, or CAD systems in the production of associated diagrams. The Internet provides a valuable resource for finding out about the performance, characteristics, availability and cost of commercially produced components.

There are a number of proprietary software packages available which facilitate the development of electronic circuits on screen and well as allowing the candidate to directly output PCB layouts for subsequent etching and manufacture.

This course in Electronics offers an opportunity in the curriculum for candidates to identify and solve real problems by designing and making electronic products or systems in a wide range of contexts relating to their personal interests. Electronics develops candidates' interdisciplinary skills, all six Key Skills and their capacity for imaginative, innovative thinking, creativity and independence.

3 ASSESSMENT OBJECTIVES

3.1 Broad Objectives

This GCSE specification:

(a) is intended to be of interest to a wide range of candidates including those intending to study electronics at AS or Advanced level, some of whom may go on to follow a higher education course or career in an associated area. Those with other interests and aspirations can also benefit from the many transferable skills inherent in the study of electronics;

(b) builds upon the knowledge, understanding and skills established by the National Curriculum Key Stage 3;

(c) promotes progression through GCSE level and provides a suitable foundation for the study of electronics, or a related area of study, at AS or Advanced level and / or preparation for future employment and the world of work;

(d) provides opportunities for candidates to gain a broad understanding of the skills, understanding and knowledge inherent in electronics;

(e) encourages candidates to develop their critical thinking, to see the relationships between designer, manufacturer and user and to perceive electronics within the world in which we live;

(f) provides opportunities to develop their Key Skills, particularly those in problem solving, use of IT and communication. They will also have opportunities to develop their skills in application of number, working with others and improving own learning and performance;

(g) may be taken alongside GCSE Design and Technology or a GCSE (Short Course) in Design and Technology by candidates with interests in this area of the curriculum;

(h) is available through the medium of English and Welsh.

3.2 Assessment Objectives

Candidates are expected to demonstrate

1 knowledge and understanding of:

- **1.1** the systems approach to problem solving;
- **1.2** the requirements of safe working practice and the scientific factors which influence the design of safe electronic systems;
- **1.3** the functions governing the relationships and constraints of the basic blocks from which electronic systems can be constructed;
- **1.4** the implications of scientific phenomena, concepts, laws, relationships and facts which influence the behaviour of electronic systems, circuits, and components;
- **1.5** the efficient selection, operation and safe use of appropriate test instruments;
- **1.6** the vocabulary, terminology and conventions so that they are able to communicate observations and ideas in this subject area;
- **1.7** the applications and social, economic and environmental implications of modern electronic systems.

2 the skills and abilities to:

- **2.1** follow instructions accurately to ensure safe practice;
- **2.2** clearly define the electronic requirements of the system needed to solve a problem;
- **2.3** devise and carry out appropriate experiments and test procedures;
- **2.4** observe, measure and record accurately and systematically while maintaining an awareness of the variability and unreliability in experimental measurements;
- **2.5** translate information from one form to another;

2.6 extract from available information, data relevant to a particular context;
2.7 draw conclusions from, and evaluate critically, experimental observations and other data;
2.8 use experimental data, recognise patterns in such data, form hypotheses and deduce relationships;
2.9 outline and evaluate possible solutions to a design problem;
2.10 explain both familiar and unfamiliar facts, observations and phenomena in terms of appropriate laws, concepts and theories;
2.11 solve qualitative and quantitative problems in both familiar and unfamiliar situations;
2.12 make decisions based on the examination of evidence and arguments;
2.13 recognise that the study and practice of technology are subject to various limitations and uncertainties.

RELATIONSHIP BETWEEN ASSESSMENT OBJECTIVES AND EXAMINATION COMPONENTS

For the purpose of teaching and making assessments, the assessment objectives are grouped into the skills and abilities indicated in the following table. The assessment of technical, social and environmental applications will pervade all components and will account for about 10% of the total marks for the assessment scheme as a whole.

	Weighting	***Method of Assessment***	***Assessment objectives***
Knowledge and understanding.	50%	Module tests and terminal examination.	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7.
Process skills.	25%	Module tests, terminal examination and final project.	2.3, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13.
Practical skills and abilities.	25%	Final project.	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.12, 2.13.

4 SCHEME OF ASSESSMENT

INTRODUCTION

Two tiers targeted at the following overlapping ranges of grades will be offered.

Foundation Tier	-	grades G to C
Higher Tier	-	grades D to A*

Where items appear in bold type in the subject content, these items will only be assessed in Higher Tier components of the assessment scheme.

The scheme of assessment will consist of the following:

Module Test E1 (12.5%)

One externally set and marked module test to be attempted per tier as follows:

Foundation Tier	-	45 minutes
Higher Tier	-	45 minutes

Module Test E2 (12.5%)

One externally set and marked module test to be attempted per tier as follows:

Foundation Tier	-	45 minutes
Higher Tier	-	45 minutes

Terminal Examination (50%)

One externally set and marked module test to be attempted per tier as follows:

Foundation Tier	-	75 minutes
Higher Tier	-	75 minutes

This examination will contain the assessment of module E3 amounting to 25%. It will also provide further assessment of modules E1 and E2 (approximately 12.5% each).

NB Candidates may enter for a single tier only, in any particular examination sitting.

Coursework Project (25%)

Internally assessed.

Module Tests

These tests will each account for 12.5% of the total available credit. They will assess the knowledge, skills and understanding as specified in the subject content for the specification and through them assessment objectives 1.1 to 1.7 and 2.3, 2.5 to 2.13.

Each test will contain about 8 short answer and structured questions. Some questions will be common to both tiers.

Terminal Examination

The terminal examination will account for 50% of the total available credit. It will assess the knowledge, skills and understanding as specified in the subject content of the specification and through them the assessment objectives 1.1 to 1.7 and 2.3, 2.5 to 2.13.

This examination will contain questions requiring short answers and responses to structured questions, based on modules E1, E2 and E3

Coursework (25%)

All candidates will be required to carry out a major project occupying approximately 25 hours of teaching time. The topic chosen for the project should allow an investigative approach to problem solving to be demonstrated. Project work will be assessed by the subject teacher using the prescribed marking scheme (available from the Board) and this assessment will be moderated through inspection by an external moderator.

Please note: **All** written papers (i.e. Module Tests and Terminal Papers) are to be taken adhering to WJEC 'Examination regulations'.

ASSESSMENT SCHEDULE

End of Module Tests will be set on specified dates each year. Each test will be set, marked and standardised by the board.

The assessment calendar is shown below:

Date	**Test available**
Summer	E1
January/Summer	E2

ENTRY OPTIONS

Candidates should be entered so that the grade a candidate is expected to reach lies within the range of targeted grades for the option. Where this coincides with overlap of the targeted grades for the Foundation and Higher Tiers, i.e. C or D, candidates should be entered for either option depending on the confidence with which the expected grade is estimated.

AWARDING AND REPORTING

Candidates' results will be reported on an eight point grade scale from A* to G. A GCSE grade will be awarded subject to the candidates reaching the required standard for the assessment options for which they were entered.

Candidates failing to reach grade G in the Foundation Tier will be awarded a U and will not receive a GCSE certificate. Candidates failing to reach Grade E in the Higher Tier will also be awarded a U and will not receive a GCSE certificate.

MODERATION PROCEDURES

Coursework will be moderated by inspection. Detailed instructions are provided on page 29: *Instructions and Guidance for Teachers on Assessment Procedures and Moderation*.

QUALITY OF WRITTEN COMMUNICATION

Marking criteria for 'quality of written communication in GCSE Examinations' as agreed by ACCAC/QCA will apply to the coursework project (see page 31).

MATHEMATICAL CONTENT

The following mathematical understanding and abilities will be expected of all candidates, unless emboldened. The emboldened abilities will only be expected of the more able candidates i.e. those entered for the Higher Tier.

1. The ability to perform simple mathematical operations involving the four basic rules of addition, subtraction, multiplication and division.
2. The ability to use vulgar and decimal fractions.
3. **The ability to use percentages in calculations.**
4. **An understanding of the ideas of direct and inverse proportions.**
5. The ability to draw and interpret graphs.
6. The ability to use the prefixes mega, kilo, centi, milli, micro, nano and pico.
7. The ability to use and understand the binary representation of the positive integers.
8. The ability to use and rearrange simple formulae.

5 SPECIFICATION CONTENT

DETAILED ASSESSMENT OBJECTIVES: SUBJECT CONTENT
Items which appear in bold type will only be assessed in the Higher Option examinations

MODULE E1: SYSTEMS AND CIRCUITS

TOPIC	On completion of this module, candidates should be able to:
1.1 ELECTRONIC SYSTEMS	apply a systems approach to electronics; understand that electronic systems can be divided up into three sections: input sensor(s); signal processing and output transducer(s); provide examples of electronic systems that are encountered in everyday life; identify the input, process and output sections in such systems; describe possible applications of an electronic system from a block diagram; produce a block diagram for a system consisting of 4 or less processing blocks to solve a given problem; **produce a block diagram for a system consisting of 5 or more processing blocks to solve a given problem;** design and test electronic systems.
1.2 ELECTRONIC SUB-SYSTEMS	describe the function, and suggest practical applications for the following types of input units: *light, temperature, position, magnetic, moisture, pressure and pulse generator;* use a multimeter or logic probe to investigate signal levels within an electronic system; describe the function, and suggest practical applications for the following types of output devices: *lamp, buzzer, motor, solenoid and LED ;* describe the function of the following types of signal processing sub-systems: *inverter, AND gate, OR gate, latch, time delay and comparator;* state the function of a transducer driver.

TOPIC	On completion of this module, candidates should be able to:
1.3 COMPONENTS IN SENSING CIRCUITS	
1.3.1 RESISTORS	understand that resistance can be increased by connecting resistors in series; understand that resistance can be decreased by connecting resistors in parallel; perform calculations involving the combined resistance of two resistors in series; **perform calculations involving the combined resistance of two resistors in parallel;** describe how fixed and variable resistors can be used in voltage dividers; **describe how potentiometers can be used as variable resistors and voltage dividers;** use the colour and printed code to work out the value and tolerance of a resistor; appreciate that, and explain why, only certain preferred values of resistors are available;
1.3.2 LIGHT DEPENDENT RESISTORS (LDRs)	state that the resistance of an LDR falls as light intensity increases (non-linear);
1.3.3 NTC THERMISTORS	state that the resistance of ntc thermistors decreases as temperature increases (non-linear);
1.3.4 SWITCHES	distinguish between the following types of mechanical switches: *push, toggle, reed, micro, tilt.*

TOPIC	**On completion of this module, candidates should be able to:**
1.4 DESIGNING SENSING CIRCUITS	incorporate sensors into voltage divider circuits to sense: *light, temperature, position, magnetism, moisture and pressure (force);* **incorporate a variable resistor in voltage divider circuits which sense:** ***light, temperature and moisture.***
1.5 OUTPUT CIRCUITS	choose an appropriate output device for a given application from: *buzzer, lamp, led, motor, solenoid* ***and relay;*** calculate the value of current limiting resistor required when using a LED or other device on a given DC supply.

TOPIC	On completion of this module, candidates should be able to:
1.6 SWITCHING CIRCUITS	
1.6.1 INTRODUCTION	understand that switching circuits are often used: as an interface between analogue and digital sub-systems, as a tranducer driver to drive output devices;
1.6.2 TRANSISTOR SWITCHES (npn only)	use data sheets to: identify the base, collector and emitter leads on specific transistors; **select transistors in terms of current gain and collector current;** state that a small base current can be used to control a much larger collector current; apply the following rules to a given transistor switching circuit: *for $V_{IN} < 0{\cdot}7V$, $V_{BE} = V_{IN}$ and V_{CE} = Supply Voltage,* *for $V_{IN} > 0{\cdot}7V$, $V_{BE} = 0{\cdot}7V$ and $V_{CE} = 0V$;* **design transistor switching circuits which cause output devices to respond to information from sensors;** **state that $I_C = h_{FE} . I_B$ until saturation is reached**; **calculate values for resistors and input switching voltages in transistor switching circuits;**
1.6.3 VOLTAGE COMPARATORS	know that comparators have greater sensitivity than transistor switches; use data sheets to identify pin connections on a dedicated comparator IC; predict the output voltage given the input voltages in a comparator circuit; design comparator circuits which cause output devices to respond to information from sensors; appreciate the current driving limitations of comparators; **design circuits to increase the output capabilities of a comparator circuit by the addition of a transistor switch;**

TOPIC	**On completion of this module, candidates should be able to:**
1.6.4 DIODE PROTECTION	understand that a diode will only conduct when forward biased; appreciate that the forward volt drop across a forward biased silicon diode is about 0·7V; state that a diode is used to protect transistors and comparators for circuits which drive motors, solenoids **and relays;** Incorporate diode protection for circuits which drive motors, solenoids **and relays.**

TOPIC	**On completion of this module, candidates should be able to:**
1.7 CIRCUIT CONCEPTS	recognise standard symbols for components included within the module; apply the *current at a junction* rule; apply the *voltage divider rule;* explain how voltage at a point can be indicated relative to a 0V reference; appreciate that resistance is the opposition to current flow and that it is measured in ohms; demonstrate an understanding of the relationship between current, voltage and resistance in qualitative terms; apply Ohm's law in the calculation of current, voltage and resistance; **select suitable multimeter ranges to measure current, voltage and resistance;** recognise the differences between analogue and digital signals; state that power is dissipated when current flows through resistance and is measured in watts; demonstrate an understanding of the relationship between current, voltage and power in qualitative terms; perform calculations involving $P = V.I,\ \mathbf{P = I^2.R},\ \mathbf{P = V^2/R}$; recognise and use the following multiple and sub-multiple indicators: *p, n, μ, m, k and M.*

MODULE E2: DIGITAL SYSTEMS

TOPIC	On completion of this module, candidates should be able to:
2.1 COMBINATIONAL LOGIC SYSTEMS	
2.1.1 LOGIC	appreciate that logic systems are decision making circuits; recognise high/low, 1/0 as two-state logic levels;
2.1.2 TRUTH TABLES	draw symbols and construct truth tables for AND, OR, NOT, NOR and NAND gates; **draw the symbol and construct the truth table for a two input EXOR gate;** produce a truth table for a system of three or less gates; **produce a truth table for a system of four or more gates;** devise a system of gates from a truth table; design simple systems using logic gates; **use Boolean notation as a shorthand method of expressing a truth table;**
2.1.3 USE OF DATA SHEETS	use data sheets to: select a logic IC for given applications; identify pin connections of logic gates;
2.1.4 NAND GATE IMPLEMENTATION	**show how other gates can be made up from NAND gates;** **implement a given logic circuit using NAND gates;** **remove double inversions;**
2.1.5 PROGRAMMABLE LOGIC	understand the procedure needed to write and read content at memory addresses; design and analyse systems that use a memory IC as a programmable logic device.

TOPIC	On completion of this module, candidates should be able to:
2.2 TIMING CIRCUITS	
2.2.1 RESISTOR - CAPACITOR NETWORK	appreciate that capacitors store charge; know that a capacitor-resistor network can be used to produce a time delay, and explain in qualitative terms how a time delay may be changed; appreciate that a time delay circuit has to be buffered to be of practical use;
2.2.2 MONOSTABLE CIRCUITS	appreciate that a monostable produces a single pulse when triggered; describe a range of applications for a monostable; know that a 555 timer can be configured as a monostable; explain in qualitative terms how the time delay may be changed; **use timing charts to select external components to produce a given delay;** **perform calculations to find the delay period from a given formula;**
2.2.3 ASTABLE CIRCUITS	appreciate that an astable produces a continuous train of OFF-ON pulses; describe a range of applications for an astable; know that a 555 timer can be configured as an astable; explain in qualitative terms how the frequency may be changed; measure the amplitude and period of the output waveform from an oscilloscope trace or graph; **calculate the frequency of an astable from an oscilloscope trace or graph;** **perform calculations given the formula for the frequency of an astable.**

TOPIC	On completion of this module, candidates should be able to:
2.3 SEQUENTIAL SYSTEMS	
2.3.1 D-TYPE FLIP-FLOPS	describe the action of a rising edge triggered D-type flip-flop; draw a timing diagram for a D-type flip-flop used for data transfer; draw a circuit diagram showing how a D-type flip-flop can be set up to form a latch, including a reset; describe a range of applications for latches;
2.3.2 BINARY COUNTERS	explain, and illustrate, how a D-type flip-flop can be set up to produce a divide-by-two function; complete timing diagrams for a 1-bit counter; **show how two D-types flip flops can be connected together to form a 2-bit binary up-counter;** **complete timing diagrams for a 2-bit counter;** realise that counters are available in a number of formats e.g. up/down, binary/BCD/decade; design and analyse simple systems that use a counter and combinational logic to produce a sequence of events; make a counter reset at a given value;
2.3.3 BCD COUNTER	explain the function of BCD counters; complete a truth table to show the signals needed to display a given character on a 7-segment display; realise that dedicated decoder/driver ICs are available in a number of formats to drive common cathode/common anode 7-segment displays; recognise and analyse the block diagram for a single digit decimal counting system; **recognise and analyse the block diagram for a two digit decimal counting system.**

TOPIC	On completion of this module, candidates should be able to:
2.4 INTERFACING LOGIC SYSTEMS	
2.4.1 INTRODUCTION	know that the sensing circuits and output devices listed in Module E1 can be interfaced to logic systems.
2.4.2 INTERFACING TO INPUTS	appreciate that a switching circuit (transistor, comparator, or Schmitt inverter) is usually needed to interface an analogue sensor to a logic circuit; state that a Schmitt inverter gate has two different input levels which must be crossed alternately for its output to change; explain why a Schmitt inverter is required to interface mechanical switches and analogue sensors to a counting system;
2.4.3 INTERFACING TO OUTPUTS	draw a circuit diagram to show how an npn transistor switching circuit can be used to interface a logic system to an output device; **draw a circuit diagram to show how a simple n-channel MOSFET transistor switching circuit can be used as a transducer driver;** **explain why a MOSFET should be used to drive heavy loads due to the limited output capability of logic systems;** draw a circuit diagram to show how a thyristor can be used as a self latching transducer driver.

MODULE E3: COMMUNICATIONS AND CONTROL SYSTEMS

TOPIC	On completion of this module, candidates should be able to:
3.1 ANALOGUE COMMUNICATIONS	
3.1.1 GENERAL AMPLIFIER SYSTEMS	understand that amplifiers increase the power (VI) of signals; describe the function of the following sub-systems of a typical amplifier system: *signal source (eg microphone)* *preamplifier (ie voltage amplifier)* *mixer* *power (current) amplifier* *loudspeaker;* interpret information about signals in terms of loudness and pitch; **describe the relationship between tone, harmonic content and bandwidth;** use the formula A=Vout/Vin; understand what is meant by the bandwidth of an amplifier; **measure the bandwidth of an amplifier from a graph of voltage gain against frequency;** select an appropriate amplifier from a data-sheet, in terms of frequency response, gain and power handling; **explain the meaning of 'clipping';** **understand the trade-off between gain and bandwidth and the role of multiple stage voltage amplifiers in retaining bandwidth;**
3.1.2.OP-AMP VOLTAGE AMPLIFIERS	draw the circuit diagram for a non-inverting amplifier; use the formula $A = 1 + \frac{R_f}{R_1}$ **draw the circuit diagram for an inverting amplifier;** **use the formula** $\mathbf{A = -\frac{R_f}{R_{in}}}$ **in each case, use the gain formulae to calculate the gain for a given circuit or to select resistors to produce a given gain;** interpret and produce graphs showing input and output signals;

TOPIC	On completion of this module, candidates should be able to:
3.1.3 MIXING SIGNALS	**draw a circuit for a mixer based on an op-amp summing amplifier;** **use the gain formula to calculate the output voltage for a given summing amplifier circuit;**
3.1.4 RADIOWAVE COMMUNICATIONS IN FREE SPACE	state the need for a carrier frequency; describe the nature of Frequency Division Multiplexing (FDM); understand the nature of, and draw signal diagrams for amplitude and frequency modulation; draw block **and circuit diagrams** for a simple AM radio receiver consisting of aerial, tuned circuit, demodulator, output device; describe the function of each of these sub-systems of this AM receiver.
3.2 DIGITAL COMMUNICATIONS	
3.2.1 INTRODUCTION	describe advantages of modern digital communications;
3.2.2 DIGITISING ANALOGUE SIGNALS	state the advantages of converting analogue information into digital form before storage or transmission; describe the process of digitisation as: sampling, to produce a pulse amplitude modulated (PAM) signal followed by analogue to digital conversion (ADC); apply this process of digitisation to a given analogue signal;
3.2.3 SYNCHRONOUS DATA TRANSFER	**describe how Time Division Multiplexing (TDM) can be used to combine several Pulse code modulated (PCM) signals onto a communications link;** **explain the need to synchronise the transmitter and receiver.**

TOPIC	On completion of this module, candidates should be able to:
3.3 SOFTWARE-BASED CONTROL SYSTEMS	know that simple control systems consist of software, computer or micro-controller, interface, input sensors and output devices; describe how the sensing circuits and output devices listed in modules E1 and E2 can be interfaced to a computer or micro-controller; understand the advantages of using feedback in control applications; design and analyse flowcharts for simple programs to make output devices: perform a sequence of actions, respond to information from sensors, make use of feedback; describe a range of applications of software-based control systems; appreciate the social, economic, ethical and cultural implication of this technology for improving the quality of life, employment and leisure.

MODULE E4: PROJECT

TOPIC	On completion of this module, candidates should be able to:
4.1 DESIGNING, PROTOTYPING, TESTING AND EVALUATING	define a problem; draw up a specification for an electronic solution to the problem; design appropriate electronic solutions, as a series of sub-systems; select the most appropriate solution; use a systems approach treating each sub-system block in a design, build, test, evaluate and redesign process.
4.2 TESTING SYSTEMS	design and carry out suitable tests for systems.
4.3 MANUFACTURING	produce a circuit layout design for stripboard or PCB construction; plan for testing by inclusion of test-points in layouts; cost the materials for an electronic product.
4.4 EVALUATION	evaluate an electronic product designed and made by the student.
4.5 DOCUMENTATION	write a detailed report on the development of the project.

SAFETY (to pervade all modules)

TOPIC	GUIDANCE
SAFE WORKING PRACTICE	In addition to compliance with Health & Safety guidelines for pupils working under supervision in a school workshop/laboratory, candidates should be aware of the following safety procedures applicable to adults working in such an area; the need for proper safety precautions regarding equipment used e.g. correct fusing, earthing, insulation and RCCD protection; the need for disconnection from mains before investigating ANY faults in mains-powered equipment; the importance of using British Standard approved equipment; the correct procedure for dealing with a victim of electrocution; the danger from charged large capacitors and the need to discharge through a resistor; the danger of explosion of electrolytic capacitors by connection with wrong polarity, even at low voltages; the knowledge that some components contain poisonous substances.

6 INSTRUCTIONS AND GUIDANCE FOR TEACHERS ON ASSESSMENT PROCEDURES AND MODERATION

PROJECT WORK

6.1 Approach

The aims set out for courses designed to satisfy this GCSE Electronics specification are particularly relevant to project work in which candidates use the skill and knowledge acquired during the course to solve real meaningful design problems. The structure for the assessment of the project work has been organised so as to encourage the development of a systems approach to problem solving and product development.

Candidates must produce a project report which documents the progress of the project. **Credit can only be given where there is documentary evidence.** This also provides the most appropriate place to assess the candidates' capability with spelling, punctuation and grammar.

It is expected by the Board that candidates do not design systems incorporating mains power or systems requiring Home Office approval. It is also expected that standard safe working practices will apply at all times.

Candidates should be encouraged to adopt a design task which imposes a challenge that is demanding, but not so demanding that there exists a risk of non-completion of the design, test and evaluation processes. It is far better that candidates have the opportunity to complete all these processes than to be excluded from the final test and evaluation processes by non-completion of the design section.

The assessment scheme has therefore been designed to allow two approaches. There is always a danger that candidates may waste precious time at a critical period in the examination season in hunting dry joints or layout problems on system designs which have already been proven in prototype form. This specification therefore makes it possible for candidates to demonstrate all of the design skills without doing any soldering. These candidates can, in a separate task, be provided with the circuit diagram of a proven design and asked to produce it on PCB or stripboard. The standard of layout and construction skills can then be assessed separately, with this assignment imposing no demand on the candidates for fault finding.

It is, however, also possible for a candidate to design and test an electronic system, and then go on to assemble and solder it, having layout and constructional skills assessed with a circuit of the candidate's own design. It is left to the discretion of the Centre to apply the more appropriate of these two models. An assembly task is available separately from the Board. Centres can also obtain from the Board a project report template which centres are encouraged to issue to candidates to document the progress of their projects.

6.2 Minimum requirement

To qualify for an award, photographic evidence of an artefact of minimal construction must accompany the project report with the artefact having at least one active device capable of being switched to a suitable power supply.

6.3 Supervision and authentication

6.3.1 Before the course starts, the supervising teacher is responsible for warning candidates of the WJEC regulations concerning malpractice. Candidates are forbidden to indulge in any unfair practice in the preparation of coursework required for assessment as part of the examination. Any candidate who uses, or is suspected of using or attempting to use, any unfair means is to be reported to the WJEC immediately. If the Board is satisfied that a breach of the regulations has occurred, the candidate will be liable to be disqualified in the whole of the current examination, including all work completed before and after the breach occurred. Candidates will be required to certify that they have read and understood the regulations regarding to unfair practice by completing the declaration on the front of the Coursework Mark Booklet.

6.3.2 Centres entering candidates will be expected to provide sufficient supervision to enable them to give an assurance that every step has been taken to ensure that the assessments submitted are the work of the candidates concerned. As much of the coursework as possible must be conducted in the laboratory under the direct supervision of teachers. If candidates undertake activities outside this supervision, some work associated with the activity must be undertaken under the direct supervision of teachers.

6.3.3 The teacher responsible for the supervision of the candidates' work will be required to certify, by completing a Project Assessment Form, that the marks submitted were awarded in accordance with the specification and that she/he is entirely satisfied that the work submitted is that of the candidate concerned.

6.3.4 It is accepted that certain parts of a candidate's coursework may be taken from other sources where these are relevant and appropriate (in some cases this is required by the assessment criteria). This is perfectly acceptable as long as all such cases are clearly identified in the text and fully acknowledged either on the Coursework mark Booklet or in the supporting evidence. Candidates will be required to certify that they have acknowledged all sources used and, apart from the assistance of teachers, all help given by others.

6.4 The marking and standardisation of the coursework project

6.4.1 The assessment scheme is divided up into eight areas:

1. Project brief and specification.
2. Preparatory investigation.
3. Project development.
4. Project performance.
5. Manufacturing.
6. Documentation.
7. Initiative.
8. Communication.

6.4.2 Where possible, the criteria in each section appear in hierarchical order. however, it is not intended that candidates be excluded from receiving credit for their achievements. One mark should be awarded for each positive response, regardless of any gaps in their performance. Centres will be required to annotate candidates' work so that the evidence for the mark awarded is clear.

6.4.3 Detailed project assessment criteria are specified in the Project Assessment Form (a master template is available from the board).

6.4.4 The communication area of the assessment scheme is used to assess the accuracy of written communication used in the project report. The following criteria is used to obtain a mark in the range 0-3 for candidates.

Threshold performance 1 mark	Candidates spell, punctuate and use the rules of grammar with reasonable accuracy; they use a limited range of specialist terms appropriately.
Intermediate performance 2 marks	Candidates spell, punctuate and use the rules of grammar with considerable accuracy; they use a good range of specialist terms with facility.
High performance 3 marks	Candidates spell, punctuate and use the rules of grammar with almost faultless accuracy, deploying a range of grammatical constructions; they use a wide range of specialist terms adeptly and with precision.

6.4.5 Where more than one supervisor is involved in the assessment, centres are responsible for standardising assessment across the supervisors and the teaching groups in order to produce a single attainment order of candidates for the centre as a whole.

6.5 Recording and submission of assessment

The final assessment at the end of the course must be recorded on the Project Assessment Form (see **6.3**). The completed form(s) will indicate for each candidate the mark for each skill together with the total mark.

6.6 Moderation and supporting evidence

6.6.1 It is necessary to provide some method of moderating internal assessment of candidates' work to ensure that no injustices occur to candidates as a result of variation in the standards applied by different centres. The internal assessment of coursework will be moderated by inspection.

6.6.2 The sample of candidates' work to be sent for moderation must consist of written work, photographic evidence (as necessary), completed project assessment forms and coursework cover sheets. Moderation of the internal assessments will take place on the basis of detailed scrutiny by a WJEC appointed moderator.

6.6.3 Centres will be informed of which candidates' work is required for moderation. The sample will be sent initially to the moderator. A moderation visit to the centre will be made where necessary to complete the moderation process. The circumstances in which visits may be made include cases where an adjustment of the marks seems to be needed, where the sample provided by the centre is unclear, confusing or problematic, or where problems have arisen previously.

The WJEC will provide centres with further details of the moderation procedures including arrangements for:

(a) selecting samples of candidates' coursework to cover the full range of assessments;

(b) calling for additional samples, or for all relevant work from all candidates;

(c) establishing whether a centre's assessments need adjustment, determining the nature of any required adjustment and making the necessary changes;

(d) giving centres details of, and where necessary, reasons for any adjustments made;

(e) providing further guidance where the WJEC judges that teachers are uncertain about coursework requirements.

If moderation suggests that a major adjustment to a centre's assessment are needed, the centre may be asked where practicable to review its assessment before moderation is continued.

6.6.4 For each candidate included in the sample, the work provided for inspection by the moderator must support the final mark submitted for each skill. The evidence must be presented in a clear and helpful way for the moderator.

An indication must be given on the front cover of the Coursework Mark Booklet of any guidance, given by the teacher (or other person), which has significant assessment implications.

6.6.5 Normally a centre's judgements about the attainment order of candidates will be accepted. Adjustment to the coursework assessments submitted by a centre made on the basis of the initial sample will normally ensure that the order or merit is unaltered, and will be made to bring centre's assessments into line with standards generally. Where major discrepancies are found, the WJEC reserves the right to alter the order and inform the centre accordingly.

6.6.6 The inspection of the work of additional candidates may be required in cases where the scrutiny of the initial sample indicates a particular inconsistency of standards.

6.6.7 After results have been issued, centres will be notified of any adjustments made. Where major adjustments are made to a centre's recommendations or where the order of merit is changed, a report will be sent to the centre explaining the reasons for these changes.

6.6.8 Samples of coursework will be returned to centres by the autumn term following the examination.

6.7 Problems with individual candidates

6.7.1 In a scheme of internal assessment of candidates' work, teachers should be able to accommodate occasional absence by ensuring that the opportunity is given for candidates to make up assessment missed by absence.

6.7.2 The marks for candidates where no assessment can be made for one or more skills should be aggregated, using a zero where no assessment is possible. Where it is not possible to make any assessment for a candidate for the coursework as a whole, no mark should be awarded and 'ABS' should be recorded on the Project Assessment form.

6.7.3 Where, as a result of illness or other exceptional circumstances, the work available from a candidate does not meet the scheme requirements or where it meets requirements but does not support the mark which the centre feels appropriate for the candidate, the centre should provide all relevant information about the circumstances of the assessment made by submitting a request for special consideration to the WJEC office, using the relevant form, accompanied, where appropriate, by medical evidence. A similar procedure should be followed in cases where a candidate has completed work but suffers from some form of disability or handicap which may have affected his/her work.

6.7.4 Where work is misplaced in circumstances beyond the candidate's control, the WJEC should be notified immediately of the date of the loss, how it occurred and upon whom responsibility for the loss rests. The WJEC will provide details of the procedures to be followed in such a case.

6.7.5 Where special help which goes beyond the normal learning support is given, the WJEC must be informed so that account can be taken of such help when assessment and moderation takes place.

6.7.6 Candidates who move from one centre to another during the course sometimes present a problem for a scheme of internal assessment. Possible courses of action depend upon the stage at which such a move takes place. If the move occurs early in the course, the candidate should be able to be accommodated at the centre to which she/he moves. If the move occurs late in the course, it might be possible to accept the assessment made at the previous centre. In a situation in which a candidate transfers from one centre to another and the action to be taken is unclear, the WJEC should be informed as soon as possible by the centre to which the candidate has been transferred so that consideration can be given to the particular case and to the most appropriate course of action. Centres are advised to contact the WJEC at the earliest possible stage to discuss arrangements for individual candidates who are transferred from one centre to another.

67.7 It is appreciated that problems can arise with a scheme of internal assessment in a situation where a teacher leaves a centre during the period of assessment. It is hoped that the keeping of complete and effective records of assessment will reduce the problems arising from a change of teaching staff and should enable another teacher to take over.

6.8 Retention of evidence and re-use of marks

6.8.1 Centres are asked to retain candidates' marked coursework under secure conditions, as far as practicable, until 31 October following the examination, to allow for the possibility of enquiry about results or a request for a review of results.

6.8.2 Candidates who repeat the examination may carry forward their coursework marks. The credit may be reused only once and within a twelve month period. However, in the majority of cases, it is anticipated that improvements will have been made to the coursework. Where any changes are made to the assessment or to the accompanying work, the normal procedures will apply.

7 GRADE DESCRIPTIONS

Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by candidates awarded particular grades. The description must be interpreted in relation to the content specified by the specification; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the candidate has met assessment objectives overall. Shortcomings in some aspects of candidates' performance in the examination may be balanced by better performance in others.

GRADE F

Candidate should be able to:

- Appreciate the function of simple Electronic systems.
- Show some understanding of the function of each block within a system.
- Appreciate in qualitative terms the effect of changing certain component values within a system block.
- Apply simple quantitative relationships.
- Recognise standard circuit symbols.
- Identify components.
- Take readings from test instruments providing the ranges have been preset.
- Construct a simple circuit prototype board and printed circuit board(or strip board) given the appropriate layout diagram.
- Evaluate simple system design bearing in mind the purpose for which it is intended.

GRADE C

Candidate should be able to:

- Define a simple problem and propose a suitable solution consisting of an electronic circuit.
- Appreciate the function of simple electronic systems in respect of the processing of signals.
- Account for some of the factors relating to the interfacing of system blocks when designing simple systems.
- Appreciate in quantitative terms the effect of changing the value of certain components within a system block.

- Identify components and determine their functions.
- Take readings from a test instrument after making sensible adjustments.
- Design simple test procedures.
- Construct with reasonable reliability a circuit on prototype board or printed circuit board (or strip board) from a given circuit diagram.
- Evaluate system designs in use and identify ways of improving them.

GRADE A

Candidate should be able to:

- Define a problem in terms of an electronic system and offer a number of solutions in suitable cases.
- Appreciate the function of electronic systems in relation to the processing of both analogue and digital signals.
- Account for the most significant factors relating to the interfacing of system blocks when designing a system.
- Predict the effect of changing component values in a functional system block.
- Apply quantitative relationships in familiar and unfamiliar contexts.
- Design and carry out suitable tests on moderately complex systems.
- Construct reliably and effectively a circuit on prototype board or printed circuit board (or strip board) from a given circuit diagram.
- Evaluate system designs by identifying a range of criteria for consideration.

DIFFERENTIATION

The scheme of assessment is designed to ensure that all candidates are provided with the opportunity to demonstrate what they know, understand and can do. To this end differentiation is achieved by the means described below:

Written Examination Papers

Each of the two module tests and terminal examinations are provided in two tiered overlapping papers covering the grades G to C and D to A*. Within the range of grades for which they are designed, questions will be selected so that candidates are given the opportunity to succeed. Each paper will include a variety of question types including structured questions. Differentiated papers will enable candidates entered for the appropriate tier to show positive achievement.

Coursework Project

Assessment will consist of a suitable combination of differentiation by task and differentiation by outcome.

WELSH JOINT EDUCATION COMMITTEE
General Certificate Of Secondary Education

CYD-BWYLLGOR ADDYSG CYMRU
Tystysgrif Gyffredinol Addysg Uwchradd

Coursework Mark Booklet

Electronics (Modular)

ES2

Centre Name _____

Centre Number _____

Candidate's name (in full) _____

Candidate's ID number _____

A. Have you received any help or information from anyone other than your subject teacher in the production of this work?
Please answer yes/no

B. If the answer is yes, give the name(s) of the person(s) who helped you.

_____

_____

C. What help did they give you?

_____

_____

Declaration by teacher or lecturer	Declaration by candidate
I certify that the candidate has been properly supervised during the preparation of this coursework. I also certify that, to the best of my knowledge, with the exceptions stated, this is the candidate's own unaided work. Signature: ..... Date: 2003	The attached coursework, with the exception stated, is my own unaided work. Signature: .....Date:..... 2003

Where possible, the criteria in each section appear in hierarchical order. However, it is NOT intended that this prevent candidates from receiving credit for their achievements. One mark should be awarded for each criterion satisfied, regardless of any gaps in their performance.

The project report must contain evidence to support the awarding of marks.

1. Project brief and specification:

	The report contains:	**Mark 1 per box**	**See report page(s)**
a	a title for the project;		
b	a statement of the problem;		
c	any form of specification for the solution to the problem;		
d	a partial specification in both qualitative and quantitative terms;		
e	a detailed specification with most aspects of the problem considered.		

2. Preparatory Investigation:

The candidate has:

a	identified a possible electronic solution to the problem;		
b	identified at least one realistic electronic solution to the problem;		
c	described at least one realistic alternative electronic solution;		
d	given valid reason(s) for selection of the chosen solution.		

3. Project development:

The candidate has:

a	developed the solution as a series of sub-systems, working from a block diagram;		
b	set up and tested prototypes for at least one sub-system;		
c	set up and tested prototypes for at least three sub-systems;		
d	set up and tested prototypes for at least five sub-systems;		
e	set up and tested a prototype for the complete system;		

4. Project performance:

a	At least one sub-system worked at some time;		
b	At least three sub-systems worked at some time;		
c	At least five sub-systems worked at some time;		
d	The complete system worked reliably.		

5. Manufacturing:

	The circuit soldered by the candidate:	**Mark 1 per box**	**See report page(s)**
a	was produced observing all necessary safety procedures;		
b	shows some attempt to plan the layout;		
c	shows a good standard of planning of the layout;		
d	is free from redundant material and solder spills;		
e	has some components soldered to an acceptable standard;		
f	has all components soldered to an acceptable standard;		
g	has all wire connections made to an acceptable standard;		
h	shows a satisfactory standard of construction;		
i	shows a high standard of construction.		

6. Documentation:

The candidate produced a project report which included:

a	a block diagram of the chosen solution;		
b	a block diagram of an alternative solution;		
c	at least one sub-system circuit diagram;		
d	at least three sub-system circuit diagrams;		
e	at least five sub-system circuit diagrams;		
f	a circuit diagram for the complete system;		
g	an account, with results, of testing at least one sub-system;		
h	an account, with results, of testing at least three sub-systems;		
i	an account, with results, of testing at least five sub-systems;		
j	an account, with results, of testing the complete system;		
k	an evaluation of the performance of the complete system which was valid in some respects;		
l	an evaluation of the performance of the complete system which was valid in most respects;		
m	a description of how the system works;		
n	a costed component list;		
o	full acknowledgement of sources of information.		

7. Initiative :

The candidate:

a	worked with little or no assistance / prompting;		
b	attempted a design brief which was more demanding than the minimum required;		
c	made some decisions relevant to the project;		
d	made most of the decisions relevant to the project;		
e	demonstrated flair or depth of investigation deserving additional credit.		

8. Communication:

The candidate has:

a	submitted an outline account of the work done, demonstrating threshold performance in spelling, punctuation and grammar and using a limited range of specialist terms appropriately;		
b	submitted a well-presented, and structured account of the work done, demonstrating considerable accuracy in spelling, punctuation and grammar, and using a good range of specialist terms appropriately;		
c	submitted a well-presented and structured account of the work done, demonstrating good use of technical terminology, with accurate spelling and punctuation, and correct use of the rules of grammar.		

Total mark (Maximum 50)		

6 KEY SKILLS

Key skills are integral to the study of Electronics and a number of them may be assessed in the context of the subject as indicated in the Appendix to the specification. In particular, candidates may be assessed on their ability to organise and present information, ideas, descriptions and arguments clearly and logically, to plan and interpret information from different types of sources including a large data set, to carry out multi-stage calculations, interpret results of calculations and to present findings. In addition, candidates will have the opportunity for developing and, where appropriate, being assessed on the wider key skills of Working with Others, Improving Own Learning and Performance, and Problem Solving.

EXEMPLIFICATION OF KEY SKILLS

Note: If producing certain types of evidence creates difficulties, due to disability or other factors, the student may be able to use other ways to show achievement. The student should ask the tutor or supervisor for further information.

COMMUNICATION

COMMUNICATION: LEVEL 1			
C1.1 TAKE PART IN A DISCUSSION			
C1.1 Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Take part in a **one-to-one** discussion and a **group** discussion about different, straightforward subjects.	• Provide information that is relevant to the subject and purpose of the discussion; • Speak clearly in a way that suits the situation; • Listen and respond appropriately to what others say.	**Discussion** Records from an assessor who observed each discussion and noted how the student met the requirements of the Unit, or an audio/video tape of the discussions.	Brain storming possible solutions to design problems;
C1.2 READ AND OBTAIN INFORMATION			
C1.2 Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Read and obtain information from **two** different types of documents about straightforward subjects, including at least **one** image.	• Read relevant material; • Identify accurately the main points and ideas in material; • Use the information to suit the purpose.	**Reading** A record of what the student reads and why, including a note or copy of the image. Notes, highlighted text or answers to questions about the material read. Records of how the student used the information. E.g. in discussions for **C1.1** or writing for **C1.3**.	Use of data sheets to select components; Use of pin out diagrams to identify IC terminals;
C1.3 WRITE TWO DIFFERENT TYPES OF DOCUMENT			
C1.3 Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Write **two** different types of documents about straightforward subjects. Include at least **one** image in one of the documents.	• Present relevant information in a form that suits the purpose; • Ensure text is legible, and make sure that spelling, punctuation and grammar are accurate so that the meaning is clear.	**Writing** Two different documents might include a letter, a short report or essay, with an image such as a chart or sketch.	Report on a set of test results for a constructed circuit, with circuit diagram; Design brief for a task;

COMMUNICATION: LEVEL 2			
C2.1a CONTRIBUTE TO A DISCUSSION			
C2.1a Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Contribute to a discussion about a straightforward subject.	• Make clear and relevant contributions in a way that suits the purpose and situation; • Listen and respond appropriately to what others say; • Help to move the discussion forward.	**Discussion** A record from an assessor who observed the discussion and noted how the student met the requirements of the Unit, or an audio/video tape of the discussion.	Debate about social implications of computer control in industry;
C2.1b GIVE A SHORT TALK			
C2.1b Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Give a short talk about a straightforward subject, using an image.	• Speak clearly in a way that suits the subject, purpose and situation; • Keep to the subject and structure the talk to help listeners follow what the student says; • Use an image to illustrate clearly the main points.	**Short talk** A record from an assessor who observed the talk, or an audio/video tape of the talk. Notes from preparing and giving the talk. A copy of the image used.	Presentation of a preferred solution to a design brief;
C2.2 READ AND SUMMARISE INFORMATION			
C2.2 Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Read and summarise information from **two** extended documents about a straightforward subject. One of the documents should include at least **one** image.	• Select and read relevant material; • Identify accurately the lines of reasoning and main points from text and images; • Summarise the information to suit the purpose.	**Reading** A record of what is read and why, including a note or copy of the image. Notes, highlighted text or answers to questions about the material read. Evidence of summarising information could include the student's notes for the talk, or one of the documents written.	Research a topic such as radio, using a text book, and using the Internet;
C2.3 WRITE DIFFERENT TYPES OF DOCUMENT			
C2.3 Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Write **two** different types of documents about straightforward subjects. One piece of writing should be an extended document and include at least **one** image.	• Present relevant information in an appropriate form; • Use a structure and style of writing to suit the purpose; • Ensure the text is legible and that spelling, punctuation and grammar are accurate, so the meaning is clear.	**Writing** Two different documents might include a report or an essay, with an image such as a chart, graph or diagram, a business letter or notes.	Classroom notes following a discussion; Report on a practice coursework project, including tables of test results and block and circuit diagrams;

APPLICATION OF NUMBER

APPLICATION OF NUMBER: LEVEL 1			
N1.1 INTERPRET STRAIGHTFORWARD INFORMATION			
N1.1 Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Interpret straightforward information from **two** different sources. At least **one** source should be a table, chart, diagram or line graph.	• Obtain the information needed to meet the purpose of the task; • Identify suitable calculations to get the results needed.	**Interpret information** Interpret straightforward information from **two** different sources. At least **one** source should be a table, chart, diagram or line graph. A statement from an assessor who checked the accuracy of the student's measurements or observations (if this was done). Records of the information obtained and the types of calculations identified to get the results needed.	Use of a characteristic curve for a thermistor to obtain the resistance at a particular temperature; Obtain the current gain for a transistor used in a circuit from the manufacturer's data sheet;
N1.2 CARRY OUT STRAIGHTFORWARD CALCULATIONS			
N1.2 Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Carry out straightforward calculations to do with: a. amounts and sizes; b. scales and proportion; c. handling statistics.	• Carry out calculations to the levels of accuracy the student has been given; • Check the results make sense.	**Carry out calculations** Records of the calculations (for a, b and c) and how the student checked them.	Use Kirchhoff's law to calculate the current flowing out of a circuit node; Use Ohm's law to argue the effect of increased resistance on current flow; Average a number of readings taken in an experiment;
N1.3 INTERPRET THE RESULTS OF CALCULATIONS			
N1.3 Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Interpret the results of the calculations and present her/his findings. The student must use **one** chart and **one** diagram.	• Choose suitable ways to present findings; • Present findings clearly; • Describe how the results of the calculations meet the purpose of the task.	**Interpret results and present findings** Descriptions of the findings and how the results of the calculations met the purpose of the tasks. At least one chart and one diagram presenting the findings.	Present the results of an experiment looking at the variation of resistance with light intensity for a LDR in both tabular form and as a graph and draw a suitable conclusion;

APPLICATION OF NUMBER: LEVEL 2

The student must carry through at least one substantial activity that includes straightforward tasks for N2.1, N2.2 and N2.3.

N2.1 INTERPRET INFORMATION			
N2.1 Candidates must:	**Evidence must show that students can:**	**Example of evidence**	**Suggested context -**
Interpret information from **two** different sources, including material containing a graph.	• Choose how to obtain the information needed to meet the purpose of the activity; • Obtain the relevant information; • Select appropriate methods to get the results needed.	**Interpret information** A description of the substantial activity. Copies of source material, including the graph, and/or a statement from someone who has checked the accuracy of the student's measurements and observations. Records of the information obtained and the methods selected for getting the results needed.	Use information from the characteristic curve for a LED, and the E12 resistor series to select a suitable value for a protective resistor;
N2.2 CARRY OUT CALCULATIONS			
N2.2 Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Carry out calculations to do with: a. amounts and sizes; b. scales and proportion; c. handling statistics; d. using formulae.	• Carry out calculations, clearly showing methods and levels of accuracy; • Check methods to identify and correct any errors, and making sure the results make sense.	**Carry out calculations** Records of calculations (for a, b, c and d), showing methods used and levels of accuracy. Notes on how the student checked methods and results.	Ohm's law calculations; Using relative size of resistors in a voltage divider to calculate the voltages across them; Calculating the average for a series of measurements;
N2.3 INTERPRETING THE RESULTS OF CALCULATIONS			
N2.3 Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Interpret the results of calculations and present findings. The student must use at least **one** graph, **one** chart and **one** diagram.	• Select effective ways of presenting findings; • Present findings clearly and describing methods; • Explain how the results of the calculations meet the purpose of the study.	**Interpret results and present findings** Descriptions of findings and methods. Notes on how the results from the calculations met the purpose of the activity. At least one graph, one chart and one diagram presenting the findings.	Presenting the results of an experiment to measure the current gain of a transistor, including tabulated measurements, a graph of input voltage against collector - emitter voltage, and a calculation of the result from this graph.

INFORMATION TECHNOLOGY

INFORMATION TECHNOLOGY: LEVEL 1			
IT1.1 FINDING, EXPLORING AND DEVELOPING INFORMATION			
IT1.1 Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Find, explore and develop information for **two** different purposes.	• Find and select relevant information; • Enter and bring in information, using formats that help development; • Explore and develop information to meet the student's purpose.	**Find and develop information** Print-outs and copies of the information the student selects to use. A record from an assessor who observed the student using IT when exploring and developing information or working drafts with notes of how the student met the requirements of the Unit.	Use a CD ROM to find data on an IC; Use a spreadsheet to obtain the total cost of the components in a circuit;
IT1.2 PRESENTING INFORMATION			
IT1.2 Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Present information for **two** different purposes. The student's work must include at least **one** example of text, **one** example of images, and **one** example of numbers.	• Use appropriate layouts for presenting information in a consistent way; • Develop the presentation so it is accurate, clear and meets the purpose; • Save information so it can be found easily.	**Present information** Working drafts showing how the student developed the presentation or records from an assessor who saw the presentation or records from an assessor who saw the student's screen displays. Print-outs or prints of a static or dynamic screen display of the student'' final work, including examples of text, images and numbers. Records of how the student saved information.	Word processed report on the findings of an investigation, including a picture obtained with a digital camera of the apparatus; Spreadsheet to process experimental data obtained in an investigation;

INFORMATION TECHNOLOGY: LEVEL 2			
IT2.1 SEARCHING FOR AND SELECTING INFORMATION			
IT2.1 Students must:	**Evidence must show students can:-**	**Examples of evidence**	**Suggested context:**
Search for and select information for **two** different purposes.	• Identify the information needed and suitable sources; • Carry out effective searches; • Select information that is relevant to the student's purpose.	**Search for and select information** Print-outs of the relevant information with notes of sources and how the student made searches, or a record from an assessor who observed the student using IT when searching for information.	Use Internet to research background information in preparation for a project; Use data on manufacturers' CD ROM to select appropriate components for a circuit;
IT2.2 EXPLORING AND DEVELOPING INFORMATION			
IT2.2 Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Explore and develop information, and derive new information, for **two** different purposes.	• Enter and bring together information using formats that help developments; • Explore information as needed for the purpose; • Develop information and derive new information as appropriate.	**Develop information** Print-outs, or a record from an assessor who observed the student using IT, with notes to show how the student explored and developed information and derived new information.	Use of circuit simulation packages to investigate effect of different resistor values on the behaviour of a transistor switch circuit; Use of virtual CRO to obtain amplitude, period and frequency of an astable circuit;
IT2.3 PRESENT COMBINED INFORMATION			
IT2.3 Students must:	**Evidence must show students can:**	**Examples of evidence**	**Suggested context:**
Present combined information for **two** different purposes. The student's work must include at least **one** example of text, **one** example of images and **one** example of numbers.	• Select and use appropriate layouts for presenting combined information in a consistent way; • Develop the presentation to suit the purpose and the types of information; • Ensure the work is accurate, clear and saved appropriately.	**Present information** Working drafts, or a record from an assessor who observed the screen displays, with notes to show how the student developed content and presentation. Print-outs, or prints of static or dynamic screen displays, of the final work, including examples of text, images and numbers. Records of how the information was saved.	Word processed report on the outcome of an experiment on astable circuits, including print-out from virtual CRO, with analysis of results; File containing results of circuit simulation exercise on the transistor switch, including tabulated data, processed and displayed graphically;

WORKING WITH OTHERS

WORKING WITH OTHERS LEVEL 1

Students must carry through at least:

- **one** straightforward activity in a one-to-one situation;
- **one** straightforward activity in a group situation.

Each activity must include tasks for WO1.1, WO1.2 and WO1.3.

Students must:	Evidence must show students can:	Examples of evidence	Suggested context :
WO1.1 Plan with others what needs to be done to achieve given objectives, and confirm understanding of responsibilities and working arrangements.	• Check understanding of the objectives the student has been given for the activity; • Identify what needs to be done to achieve them and suggest ways the student could help; • Make sure that the student is clear about her/ his responsibilities and working arrangements.	**Planning activities** Records from an assessor who observed the student's discussions with others or audio/video tapes. Notes of the objectives, responsibilities and working arrangements for each activity.	Paired activity in planning a prototyped circuit; Group exercise in producing market research information on a topic;
WO1.2 Work with others towards achieving the given objectives, carrying out tasks to meet responsibilities.	• Carry out tasks to meet responsibilities; • Work safely, and accurately follow the working methods the student has been given; • Ask for help and offer support to others, when appropriate.	**Working towards objectives** Records of how the student carried out tasks to meet responsibilities. Notes of the help given and the support the student offered others. These records could include a log, statements written by others with whom the student worked, audio/video tape recordings, photographs with notes and assessor records.	Paired activity in constructing and testing a prototyped circuit; Group exercise in producing market research information on a topic;
WO1.3 Identify progress and ways of improving work with others to help achieve given objectives.	• Identify own and other's opinions on what has gone well and less well in carrying out the activity. • Report any difficulties in meeting own responsibilities and what was done about them; • Identify ways of improving work with others to help achieve objectives.	**Identifying progress** Statements from both the student and others on progress (written or recorded). Records of answers to questions from an assessor about any difficulties and what the student did about them. Notes of ways to improve work with others.	Paired activity in evaluating a prototyped circuit; Group exercise in producing market research information on a topic;

WORKING WITH OTHERS LEVEL 2

Students must carry through at least:

- **one** straightforward activity in a one-to-one situation;
- **one** straightforward activity in a group situation.

Each activity must include tasks for WO2.1, WO2.2 and WO2.3.

Students must:-	Evidence must show students can:	Examples of evidence	Suggested context:
WO2.1 Plan the activity with others, identifying objectives and helping to allocate responsibilities and confirm working arrangements.	• Identify the objectives of the activity and what needs to be done to achieve them; • Provide relevant information to help allocate responsibilities; • Confirm working arrangements with those involved.	**Planning activities** Records from an assessor who observed the student's discussions with others or audio/video tapes. Note of the information provided, with details of the identified objectives, responsibilities and working arrangements for each activity.	Paired activity in planning a prototyped circuit; Group exercise in producing market research information on a topic;
WO2.2 Work with others towards achieving the identified objectives, organising tasks to meet responsibilities, and support co-operative working.	• Organise own tasks so the student can be effective in meeting responsibilities; • Carry out tasks accurately and safely, using appropriate working methods; • Support co-operative ways of working, seeking advice from an appropriate person when needed.	**Working towards objectives** Records of how the student organised and carried out tasks, supported co-operative work and sought advice. These records could include a log, statements written by others with whom the student worked, audio/video tape recordings, photographs with notes and assessor records.	Paired activity in constructing and testing a prototyped circuit; Group exercise in producing market research information on a topic;
WO2.3 Exchange information on progress and agree ways of improving work with other to help achieve objectives.	• Provide information on what has gone well and less well in carrying out the activity, including the quality of work; • Listen and respond appropriately to progress reports from others; • Agree ways of improving work with others to help achieve objectives.	**Exchanging information on progress** Statements on progress (written or recorded) including details about the quality of work and how the student responded to other reports on progress. Notes of what the student agreed to do to improve work with others and help achieve objectives.	Paired activity in evaluating a prototyped circuit; Group exercise in producing market research information on a topic;

IMPROVING OWN LEARNING AND PERFORMANCE

IMPROVING OWN LEARNING AND PERFORMANCE LEVEL 1

Students must carry through at least:

- **one** example of study-based learning;
- **one** example of activity-based learning.

The whole process must be completed twice.

Students must:	Evidence must show students can:	Examples of evidence -	Suggested context:
LP1.1 Confirm understanding of targets and how these will be met, with the person setting them.	• Make sure targets clearly show what is wanted to be achieved; • Identify action points and deadlines for each target; • Make sure the dates for reviewing progress and how to get support needed are known.	**Understanding targets** Records of discussions which show the student checked her/his understanding of targets and knew how to get the support needed.	Discussion of module test results with teacher; Review with the teacher the progress on coursework;
LP1.2 Follow plans, using support given by others to help meet targets.	• Work through the action points to complete tasks on time; • Use support and ways of learning given by others to help in the meeting of targets; • Make changes suggested by the person supervising the student, when needed.	**Following plans** A log of study-based and activity-based learning, with notes of the support given. Records from those who have seen the work and which shows the tasks were completed on time and how any suggested changes were made.	Action plan formulated after module test results discussion; Formulate step-by-step timetable for completion of project;
LP1.3 Review achievements and progress in meeting targets, with help from an appropriate person.	• Say what it is thought has gone well and less well, what was learned and ways learning took place; • Identify targets met and evidence of achievements; • Check that the student understood how to improve her/his performance.	**Reviewing progress** Records of discussions which show what the student said about her/his progress and had checked s/he knew how to improve performance. Examples of work which show the student learned from two study-based and two activity-based activities. Notes on action plans to show targets met.	Periodic meetings to check on preparation for next module test; Discussion with teacher, as significant stages in the coursework are reached, to review progress;

IMPROVING OWN LEARNING AND PERFORMANCE LEVEL 2

Students must carry through tasks for LP2,1, LP2.2 and LP2.3 that include at least:

- **one** example of study-based learning;
- **one** example of activity-based learning.

The student must complete this whole process twice and include at least **one** example of working without close supervision and **one** example of using learning from one task to meet the demands of a new situation.

Students must:	**Evidence must show students can:**	**Examples of evidence -**	**Suggested context:**
LP2.1 Help set targets with an appropriate person and plan how these will be met.	• Provide accurate information to help set realistic targets for achieving what is to be done; • Identify appropriate action points for each target; • Plan how time will be used effectively to meet targets, including use of support and a date for reviewing progress.	**Setting targets** Records of discussions which show the information provided to help set targets. Two action plans with action points, timetable and notes of support needed.	Discussion of module test results with teacher; Review with the teacher the progress on coursework;
LP2.2 Use plans, identifying support from others to help meet targets, and take responsibility for some decisions about own learning.	• Use personal timetable and action points to help manage time well and complete tasks; • Identify when support is needed and use this effectively to help the meeting of targets; • Take responsibility for some decisions about own learning, using suitable approaches and methods and make any changes to plans when needed.,	**Using plans** A log of the study-based and activity-based learning, with notes of: • When the student asked for support and it was used; • When and how the student took responsibility for own learning; • How own learning from one task was used to meet the demands of a new situation; • Any changes made to the plan.. • Records from those who saw the work which show the student managed her/his time well and completed tasks.	Action plan formulated after module test results discussion; Formulate step-by-step timetable for completion of project;
LP2.3 Review progress with an appropriate person and provide examples of evidence of achievements.	• Provide information on what has gone well, problems met, what was learned and ways learned; • Identify targets met, and examples of evidence of achievements; • Identify ways of improving own performance.	**Reviewing progress** Records of information provided on progress and ways of improving performance. Examples of work which show what was learned from two study-based and two activity-based learning activities. Notes on personal action plans to show targets met.	Periodic meetings to check on preparation for next module test; Discussion with teacher, as significant stages in the coursework are reached, to review progress;

PROBLEM SOLVING

PROBLEM SOLVING LEVEL 1

The student must: carry through a straightforward activity, which includes tasks for PS1.1, PS1.2 and PS1.3, for each of **two** given problems.

Students must:	**Evidence must show students can:**	**Examples of evidence -**	**Suggested context:**
PS1.1 Confirm understanding of the given problem and identify at least **two** options for solving it, with help from an appropriate person.	• Check with an appropriate person that the problem is understood, and how to succeed in solving it; • Identify different ways of tackling the problem; • Decide, with help, which options have a realistic chance of success.	**Confirm problems and identify options** Descriptions of the two problems and how success in solving the problem would be shown. Descriptions of ways for solving the two problems and the most realistic options to try. Records of help given.	Preparatory work on major project, in which several possible design problems are considered, and solutions developed;
PS1.2 Plan and try out at least **one** option for solving the problem, using given evidence and support.	• Confirm with an appropriate person the option to be tried for solving the problem; • Plan how to carry out this option; • Follow through the plan, making use of advice and support given by others to help in the tackling of the problem.	**Plan and try out options** Statements on how the student confirmed the options to be tried out. A plan for trying out each option. Records of what was done in following the plan, with notes on the advice and support given.	Evaluate the possible solutions to the coursework project, and list the advantages and disadvantages of each; Use circuit simulation software to examine viability of each solution;
PS1.3 Follow given methods to check whether the problem has been solved and describe the results, including ways to improve the approach.	• Follow accurately the methods given to check whether the problem has been solved successfully; • Describe clearly the results of the problem solving activity; • Identify ways of improving the approach to problem solving.	**Check and describe results** Records of the methods given and they were used. Descriptions of the results of the problem solving activities and ways to improve the approach to problem solving.	Evaluate the performance of a project against the parameters specified at the outset; Discuss further development of the system, and desirable modifications to the original specification;

PROBLEM SOLVING LEVEL 2

The student must carry through a straightforward activity, which includes tasks for PS2.1, PS2.2 and PS2.3, for each of **two** given problems.:

Students must:	**Evidence must show students can:**	**Examples of evidence -**	**Suggested context:**
PS2.1 Identify the problem and come up with at least **two** options for solving it.	• Identify with accuracy the main features of the problem and how the student will personally show success in solving it; • Come up with different ways of tackling the problem; • Decide which options have a realistic chance of success, using help from others when appropriate.	**Identify problems and options** Descriptions of the two given problems and how the student is going to show they have been solved successfully. Descriptions of ways for solving the two given problems and how these were arrived at. Records of how the student decided which options were most realistic, including the help obtained.	Preparatory work on major project, in which several possible design problems are considered, and solutions developed;
PS2.2 Plan and try out at least **one** option for solving the problem, obtaining support and making changes to the plan when necessary.	• Confirm with an appropriate person the option to be tried for solving the problem, and plan how to carry it out; • Follow the plan, organising the relevant tasks and making changes to the plan when necessary; • Obtain and effectively use support to help in tackling the problem.	**Plan and try out options** Statements on how the options were confirmed and tried out. A plan for trying out each option. Records of what was done, including any changes made to the plan. Notes of the support obtained and how this was used effectively.	Evaluate the possible solutions to the coursework project, and list the advantages and disadvantages of each; Use circuit simulation software to examine viability of each solution;
PS2.3 Apply given methods to check whether the problem has been solved and describe the results and explain the approach, including that to problem solving.	• Apply accurately the methods given to check whether the problem has been solved successfully • Describe clearly the results, and explain the decisions taken at each stage of tackling the problem; • Identify the strengths and weaknesses of the approach to problem solving and describe what would be done differently if a similar problem were met.	**Check and describe results** Records of the methods used, the results of the checks carried out and explanations of the decisions taken. Descriptions of the strengths and weaknesses of the approach to the problem solving activities, and what would be done differently.	Evaluate the performance of a project against the parameters specified at the outset; Discuss further development of the system, and desirable modifications to the original specifications;

OVERVIEW GRID

(✓ = opportunity for Key Skill provided: otherwise grid left blank)

Key Skills Level 2	Module E1	Module E2	Module E3	Module E4 Project
C2.1a Contribute to a Discussion	✓	✓	✓	✓
C2.1b Give a Short Talk	✓	✓	✓	✓
C2.2 Read/Summarise Information	✓	✓	✓	✓
C2.3 Write Different Types of Document	✓	✓	✓	✓
N2.1 Interpret Information	✓	✓	✓	✓
N2.2 Carry out Calculations	✓	✓	✓	✓
N2.3 Interpret Results of Calculations	✓	✓	✓	✓
IT2.1 Search for/Selecting Information	✓	✓	✓	✓
IT2.2 Explore/Developing Information	✓	✓	✓	✓
IT2.3 Present Combined Information	✓	✓	✓	✓
WO2.1 Planning Activities	✓	✓	✓	✓
WO2.2 Working Towards Objectives	✓	✓	✓	✓
WO2.3 Exchanging Information on Progress	✓	✓	✓	✓
LP2.1 Setting Targets	✓	✓	✓	✓
LP2.2 Using Plans	✓	✓	✓	✓
LP2.3 Reviewing Progress	✓	✓	✓	✓
PS2.1 Identify problems and options	✓	✓	✓	✓
PS2.2 Plan and try out options	✓	✓	✓	✓
PS2.3 Check and describe results	✓	✓	✓	✓

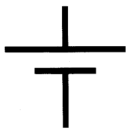
APPENDIX

Electrical Symbols

The symbols below will be used in GCSE and GCE Physics and Electronics examination papers. They are mainly in accord with the recommended symbols published by the Institution of Electrical Engineers at the time of printing of this specification. Further information about electrical symbols can be obtained from the IEE website www.iee.org.uk/schools.

It is expected that candidates will be familiar with the appropriate symbols to the extent of recognising them in circuit diagrams and drawing them.

This appendix is common to science specifications with a Physics component and Electronics specifications. It should be read alongside the specification content for information as to which symbols apply, e.g. the NPN transistor applies only to Electronics whereas the resistor applies to all specifications.



Electrical cell.
Also represents a battery of cells.

Fuse.

Junction of conductors.

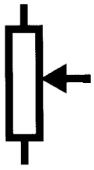
Heating element.

Resistor.

Indicator lamp.

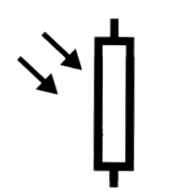
Variable resistor.

Filament lamp.



Potentiometer.

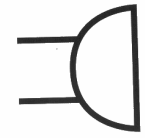
Switch.



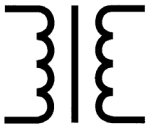
Light dependent resistor.

Push to make switch.

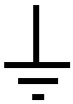
Thermistor.



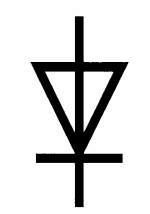
Buzzer.



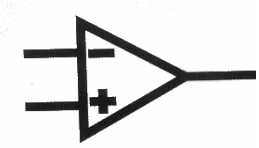
Transformer.



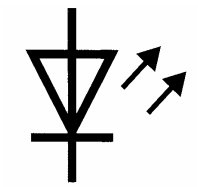
Earth.



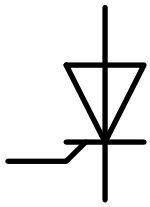
Diode.



Operational amplifier.



Light emitting diode.



Thyristor.

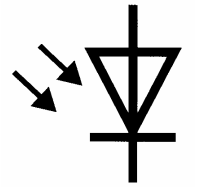
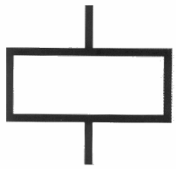


Photo diode.

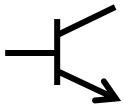


Relay coil.

Generator.

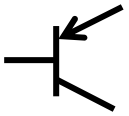
Ammeter.

Voltmeter.

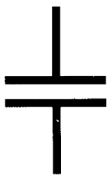


NPN transistor.

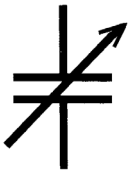
Motor.



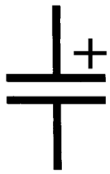
PNP transistor



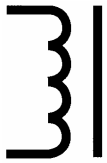
Capacitor.



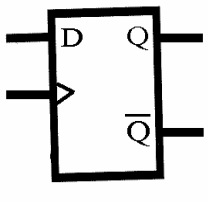
Variable capacitor.



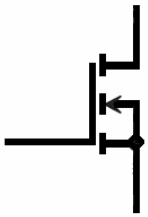
Polarised capacitor.



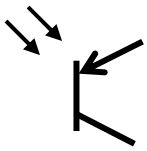
Inductor.



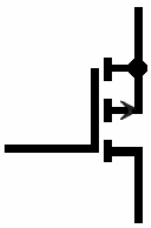
D-type
flip-flop.



MOSFET
n-channel



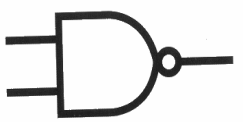
PNP
phototransistor



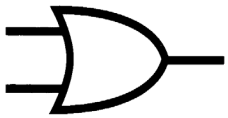
MOSFET
p-channel

Logic Gates

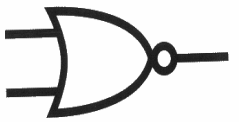
AND.



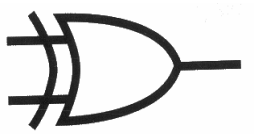
NAND.



OR.

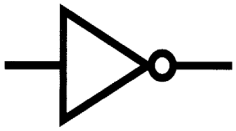


NOR.



Exclusive OR (XOR).

Exclusive NOR (XNOR)



NOT.