Version 2
This version confirms that there will be no further January assessments.

WJEC CBAC

GCE

Examinations from 2009

First AS Award: Summer 2009

First A Level Award: Summer 2010

Computing

Contents

WJEC AS GCE in Computing
WJEC A Level GCE in Computing

First AS Award - Summer 2009
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GCE Computing

Subject/Option Entry Codes	
Advanced Subsidiary (AS) "Cash in" entry *A Level (A)"Cash in" entry*	*2101* *3101*
CG1 : Computing Theory Paper 1	1101
CG2 : Computing Extended Task	1102
CG3 : Computing Theory Paper 2	1103
CG4 : Computing Extended Project	1104

When making entries, the following option codes should be entered after the four digit unit or cash-in code to indicate English medium or Welsh medium entries:

English medium 01
Welsh medium W1

Availability of Assessment Units			
Unit	**January 2009**	**June 2009**	**June 2010 & each subsequent year**
CG1	✓	✓	✓
CG2		✓	✓
CG3			✓
CG4			✓

Qualification Accreditation Numbers

Advanced Subsidiary: 500/3081/4
Advanced: 500/3040/1

SUMMARY OF ASSESSMENT

This specification is divided into a total of 4 units, 2 AS units and 2 A2 units. Weightings noted below are expressed in terms of the full A Level qualification.

AS (2 units)

CG1	32.5 %	3 hours	Written Paper	100 marks (130 UMS)
A written paper of one section, presented in a question-and-answer booklet format. There are no optional questions. Quality of Written Communication is assessed in one question only.				
CG2	17.5%		Internal Assessment (Task)	100 marks (70 UMS)
Candidates analyse, design, implement, test and evaluate a solution to a *given* problem requiring the production of original code (programming).				

A LEVEL (the above plus a further 2 units)

CG3	32.5%	3 hours	Written Paper	100 marks (130 UMS)
A written paper of one section, presented as a question paper requiring a separate answer booklet. There are no optional questions. Quality of Written Communication is assessed in one question only.				
CG4	17.5 %		Internal Assessment (Project)	100 marks (70 UMS)
Candidates analyse, design, implement, test and evaluate a solution to a substantial problem of their choice requiring the production of original code (programming). This is a substantial piece of work, undertaken over an extended period of time.				

COMPUTING

1 INTRODUCTION

1. 1 Criteria for AS and A Level GCE

This specification has been designed to meet the general criteria for GCE Advanced Subsidiary (AS) and A level (A) and the subject criteria for AS/A *Computing* as issued by the regulators [2006]. The qualifications will comply with the grading, awarding and certification requirements of the Code of Practice for 'general' qualifications (including GCE).

The AS qualification will be reported on a five-grade scale of A, B, C, D, E. The A level qualification will be reported on a six-grade scale of A*, A, B, C, D, E. The award of A* at A level will provide recognition of the additional demands presented by the A2 units in term of 'stretch and challenge' and 'synoptic' requirements. Candidates who fail to reach the minimum standard for grade E are recorded as U (unclassified), and do not receive a certificate. The level of demand of the AS examination is that expected of candidates half way through a full A Level course.

The AS assessment units will have equal weighting with the second half of the qualification (A2) when these are aggregated to produce the A Level award. AS consists of two assessment units, referred to in this specification as CG1 and CG2. A2 also consists of two units and these are referred to as CG3 and CG4.

Assessment units may be retaken prior to certification for the AS or A Level qualifications, in which case the better result will be used for the qualification award. Individual assessment unit results, prior to certification for a qualification, have a shelf-life limited only by the shelf-life of the specification.

The specification and assessment materials are available in English and Welsh.

1.2 Prior learning

Whilst it is anticipated that candidates will probably have acquired a general appreciation of the use of computers in their previous studies, the specification does not assume that candidates have had any prior formal instruction in Computing or Information and Communication Technology as a specialised subject.

1.3 Progression

The four part structure of this specification (2 units for AS, and an additional 2 for the full A Level) allows for both staged and end-of-course assessment and thus allows candidates to defer decisions about progression from AS to the full A Level qualification.

This specification provides a suitable foundation for the study of *Computing* or a related area through a range of higher education / vocational courses (e.g. Computer Science, Computing, Software Engineering) or direct entry into employment. In addition, the specification provides a coherent, satisfying and worthwhile course of study for candidates who do not progress to further study in this subject.

1.4 Rationale

Computing is a subject that by its nature requires candidates to consider individual, moral, ethical, social, cultural and contemporary issues. The specification provides a framework for exploration of such issues and includes specific content through which individual courses may address these issues.

Computers are widely used in all aspects of government, business, industry, education, leisure and the home. In this increasingly technological age a study of Computing, and particularly how computers are used in the solution of a variety of problems, is not only valuable to the students themselves but also essential to the future well being of the country.

Computing integrates well with subjects across the curriculum. It demands both logical discipline and imaginative creativity in the selection and design of algorithms and the writing, testing and debugging of programs; it relies on an understanding of the rules of language at a simple level; it encourages an awareness of the management and organisation of computer systems; it extends the students' horizons beyond the school or college environment in the appreciation of the effects of computer applications on society and individuals. For these reasons, computing is as relevant to a student studying Arts subjects, as it is to one studying Science subjects.

The study of Computing encompasses a substantial accepted body of knowledge. A purpose of the A Level and AS examinations in Computing is to recognise this with a reputable qualification that is relevant to a student who intends to pursue a career in either the Arts or Sciences, as well as Computing.

1.5 The Wider Curriculum

The specification provides opportunities for candidates to develop an understanding of spiritual, moral, ethical, social, legislative, economic and cultural issues and health and safety considerations for example, CG1.8 (Consequences of the current trends in the uses of computers); CG1.9 (Privacy and security); CG3.10 (Typical applications of computers and communications systems); CG3.11 (Data security and integrity processes).

1.6 Prohibited combinations and overlap

Every specification is assigned a national classification code indicating the subject area to which it belongs. Centres should be aware that candidates who enter for more than one GCE qualification with the same classification code will only have one grade (the highest) counted for the purpose of the School and College Performance Tables. The classification code for this specification is 2610.

1.7 Equality and Fair Assessment

AS/A levels often require assessment of a broad range of competences. This is because they are general qualifications and, as such, prepare candidates for a wide range of occupations and higher level courses.

The revised AS/A level qualification and subject criteria were reviewed to identify whether any of the competences required by the subject presented a potential barrier to any disabled candidates. If this was the case, the situation was reviewed again to ensure that such competences were included only where essential to the subject. The findings of this process were discussed with disability groups and with disabled people.

Reasonable adjustments are made for disabled candidates in order to enable them to access the assessments. For this reason, very few candidates will have a complete barrier to any part of the assessment. Information on reasonable adjustments is found in the Joint Council for Qualifications document *Regulations and Guidance Relating to Candidates who are eligible for Adjustments in Examinations.* This document is available on the JCQ website (www.jcq.org.uk).

Candidates who are still unable to access a significant part of the assessment, even after exploring all possibilities through reasonable adjustments, may still be able to receive an award. They would be given a grade on the parts of the assessment they have taken and there would be an indication on their certificate that not all of the competences have been addressed. This will be kept under review and may be amended in future.

1.8 Facilities required

In order to provide a satisfactory course in preparation for the examination, a centre should have sufficient computing support to provide candidates with frequent access to a computer on a regular basis throughout the course. Each candidate is likely to require about three hours of computer contact time per week.

Centres should provide access to a range of generic software packages, which must include spreadsheet programs with macro facilities, relational database management software with a programming capacity, and word processing/DTP software.

High-level language facilities must be available to support all of the software engineering constructs described in the specification, including case structures and subprogram libraries.

Computer systems must provide facilities for generating hard copy.

Centres choosing to submit CG2 and/or CG4 electronically (see Section 8.3 for full details) will require suitable software to convert their word processed work into portable document format.

Private candidates will be expected to have access to the same computing facilities as those detailed above.

2 AIMS

This specification encourages candidates to develop a broad range of skills and knowledge of computing as a basis for progression into further learning, including progression from AS to A2, and/or employment in computing-related fields. Specifically, it encourages candidates to develop:

- the capacity for thinking creatively, innovatively, analytically, logically and critically;
- an understanding of the organisation of computer systems including software, hardware, data, communications and people;
- the ability to apply skills, knowledge and understanding of computing, including programming, in a range of contexts to solve problems;
- project and time management skills;
- the capacity to see relationships between different aspects of the subject and perceive their field of study in a broader perspective;
- an understanding of the consequences of uses of computing, including social, legal, ethical and other issues;
- an awareness of emerging technologies and an appreciation of their potential impact on society.

3 ASSESSMENT OBJECTIVES

The AS and A level specifications have the same assessment objectives. In the A level specification, the assessment objectives related to the skills of analysing, designing, implementing, testing and evaluating systems are given a higher weighting because of the increased emphasis on students developing their own computer-based solutions to real problems.

Knowledge, understanding and skills in computing are closely linked. This specification requires that students demonstrate the following assessment objectives in the context of the content and skills prescribed in Section 4.

AO1 Knowledge and understanding

Candidates should be able to:

- describe and explain the purpose and characteristics of a range of computing applications and show an understanding of the characteristics of computer systems (hardware, software and communication) which allow effective solutions to be achieved;
- describe and explain the need for and the use of various forms of data organisation and processing to support the requirements of a computer-based solution;
- describe and explain the systematic development of high quality solutions to problems and the techniques for implementing such solutions, including the use of a programming language;
- comment critically on the consequences of current uses of computing, including economic, social, legal and ethical issues.

AO2 Skills

Candidates should be able to:

- analyse a problem and identify the parts which are appropriate for a computer-based solution;
- select, justify and apply appropriate techniques and principles to develop data structures and algorithms for the solution of problems;
- design, implement and document an effective solution using appropriate hardware and software, including the use of a programming language.

Weightings

Assessment objective weightings are shown below as a % of the full A level, with AS weightings in brackets.

Unit	%	AO1%	AO2%
CG1	32.5 [65]	27.5 [55]	5 [10]
CG2	17.5 [35]	0 [0]	17.5 [35]
CG3	32.5	22.5	10
CG4	17.5	0	17.5
Total	**100**	**50**	**50**

4 SPECIFICATION CONTENT

AS and A level units must be read in conjunction in order to understand the depth and detail required.

It is expected that in the teaching and learning process, the knowledge and understanding of computer systems will be interwoven with a consideration of their applications and effects.

Candidates will be required to understand and use computer terminology and notation correctly. In the written papers, the definitions contained in The BCS Glossary of ICT and Computing Terms (published by Pearson/Prentice Hall on behalf of the British Computer Society) will apply. Care should be taken to use the edition current at the beginning of the academic year preceding the examination.

AS

4.1 Unit CG1

This unit is about acquiring knowledge and understanding of software, system development, data and applications, which are assessed by means of a three hour written examination. However, candidates will also draw upon this knowledge during their practical work for Unit CG2.

This unit also acts as a foundation for Unit CG3 for those candidates going on to A Level.

The TOPIC column lists the essential knowledge and understanding associated with this unit: the AMPLIFICATION column expands upon this with notes for teachers delivering the specification. Appendix A provides information about the conventions used in the AMPLIFICATION column.

	TOPIC	AMPLIFICATION
		Candidates should be able to:
CG1.1	**Hardware and communication**	Identify and describe the hardware elements of contemporary computer systems and how they are connected.
	Processor	Describe the main components of a processor: control unit, buses, arithmetic and logic unit and the registers. Explain the role of the data-bus and address-bus for communication.
		Explain the terms bit, byte and word.
	Memory	Distinguish between RAM and ROM and be able to describe their roles and also describe the type of data that might be stored in each.
		Describe RAM cache and disc cache memories.

	Secondary storage	Compare the functional characteristics of contemporary secondary storage devices with respect to their speed of access, cost per unit of storage, durability and portability.
	Analogue / digital data	Describe analogue and digital data, their appropriateness for different applications, why conversion between the two is required and identify situations where conversion is required.
	Input / output	Describe the use of contemporary methods and their associated devices for input and output including handwriting recognition, voice recognition and optical scanning. Explain the use of these methods and devices in contemporary computer systems including embedded systems, portable devices and security systems. Describe and differentiate between voice input for command and control systems to operate a computer system and vocabulary dictation systems for general input.
	Interfacing	Explain the role of handshaking.
	Networks	Describe the topologies of bus, ring and star networks. Explain the benefits and drawbacks of each.
	Protocols	Describe the use made of contemporary protocols including HTTP, FTP, SMTP, VoIP and wireless communication protocols.
	Connecting portable devices	Identify and describe applications where connecting a portable device to a network is desirable. Describe the hardware required to make a wireless connection and explain how this might be achieved using contemporary wireless technologies.
CG1.2	**Organisation and structure of data**	Explain the purpose of files in data processing and distinguish between master and transaction files.
	Files, records and fields	Define a file in terms of records and fields. Explain fixed and variable length fields and records and give examples of the appropriate use of each type.
	File design	Describe how files may be created, organised, updated and processed by programs. Design files and records appropriate for a particular application.
	File access	Describe serial and sequential file access methods, distinguishing between them and their use in computer applications. (Candidates will not be expected to describe these in detail) Describe algorithms for sequential file access and update. (Candidates will not be expected to reproduce detailed algorithms.) Select and justify the appropriate form of file access for a particular application.

	Database Systems	Explain the role of a Database Management System. Describe the benefits and drawbacks of using a database. Identify data that is suitable for storing in a database, including the selection of a suitable simple primary key field. Explain how the data can be manipulated to provide the user with useful information.
	Data validation and verification	Explain the purpose of data validation and data verification and identify where each would be required. Describe and apply appropriate techniques for data validation: range check, presence check, length check, type check, format check and look-up check. Describe and apply appropriate techniques for data verification: double-entry verification, screen verification and check digits.
CG1.3	**Data types & data structures**	Describe the different primitive data types: Boolean, character, string, integer and real. Describe the storage requirements for each data type. Describe the manipulation of records and arrays up to two dimensions. Identify and justify the correct data structure (record or array) for a given situation.
CG1.4	**Algorithms and programming**	Follow simple algorithms written in pseudo-code and make simple alterations to such algorithms.
	Searching and sorting	Explain non-recursive sorting algorithms. Explain and apply a linear search algorithm. Explain and apply the binary search algorithm. Describe appropriate circumstances for the use of each technique.
	Problem analysis	Analyse a problem using a top-down design approach, identifying individual modules, and breaking down tasks successively into simpler sub-tasks.
	Algorithm and programming constructs	Identify, explain and use selection and repetition in algorithms and programs. Identify, explain and use counts and rogue values in algorithms and programs. Identify and explain the use of standard functions, standard modules and user-defined subprograms. Select and use appropriate data to dry run an algorithm.

Algorithm testing	Describe the use of alpha, beta and acceptance testing.
Scope of variables	Identify the scope of variables and distinguish between local and global identifiers.
Constants and variables	Identify and explain the use of constants and variables in algorithms and programs.
Logical operations	Recognise logical operations AND, OR, NOT and XOR and apply them to algorithms.
Levels of computer language	Describe the differences between high-level and low-level languages. Identify and describe situations that require the use of a high-level or a low-level language. Describe the distinguishing features of contemporary high-level languages, including procedural, event-driven, visual and mark-up languages.
Types of computer language	Identify and justify which type of language would be best suited to develop a solution to a given problem.
Methodology and practice	Explain the need to organise a program into small, clearly documented sections. Describe why the use of self-documenting identifiers, annotation and program layout are important in programs. Give examples of self-documenting identifiers, annotation and appropriate program layout.

CG1.5 Nature and type of software

Application Software

Facilities	Describe how a programmer would use the following application package facilities: mail-merge, macros, templates, formulae, look up tables, if function, pivot tables and absolute and relative cell referencing.
Email	Describe the facilities provided by electronic mail systems. Identify situations where email is the most suitable method of communication and situations where it is not suitable. Justify using email as a method of communication.

System software

Managing resources	Describe the role of the operating system in managing resources: peripherals, processes, memory protection and backing store.
Providing an interface	Describe the role of the operating system in providing an interface between the user and the hardware.

Managing backing store	Explain the hierarchical structure of a directory. Describe file attributes.
Data storage on disc	Explain fragmentation and its consequences and describe the need for defragmentation. Explain data compression and why it is used.
Modes of operation	Describe the main features of batch processing, real time control and real time transaction systems. Identify and describe applications that would be suitable to these modes of operation.
Spooling	Describe the purpose of spooling and how it can be managed.

CG1.6 Systems analysis and design

Feasibility study	Describe the purpose of a feasibility study and describe the processes that an analyst would carry out during a feasibility study. Explain that proposed solutions must be cost-effective, developed to an agreed time-scale and within an agreed budget.
Analysis and design	Describe the different methods of investigation: interviews, observation, document inspection and questionnaires and justify the use of each method. Describe the data that needs to be held and processed. Describe suitable means of capturing input data and of presenting output data. Describe the factors that will have to be taken into account when designing forms for input and reports for output. Design forms and reports for typical computer applications. Describe the selection of suitable software and hardware components to produce an appropriate system configuration. Explain the benefits and drawbacks of team working compared to an individual working alone. Represent and interpret systems in an appropriate diagrammatic form showing the flow of data and the information processing requirements. [See appendix A for further details]

	Changeover	Describe the various methods of changeover: direct, pilot, phased and parallel and identify the most suitable in a given situation. Describe the relative merits of each of the methods, or combinations of the methods.
	Maintenance	Describe the nature and use made of perfective, adaptive and corrective maintenance.
	Human-Computer Interfaces	Explain the need to design systems that are appropriate to the variety of different users at all levels and in different environments.
	Documentation	Explain at which stage of the development each piece of documentation would be produced. Describe the contents and use made of user documentation and maintenance documentation. Describe the people likely to use each type of documentation for typical computer applications. Describe the factors that influence the content of user documentation and be able to describe the content of a typical user manual. Describe the following components of maintenance documentation: annotated listings, algorithms and data dictionaries. Explain how each piece of documentation might be used.
CG1.7	**Characteristics of computer applications**	Describe the main processes of a variety of computer applications: monthly payroll, billing systems, aeroplane control systems, process control systems, booking systems, computer-based learning.
	Internet, Intranet and Extranet	Explain how business and private individuals make use of the Internet, intranets, extranets, chat rooms and forums.
CG1.8	**Consequences of current trends in the uses** of **computers**	Describe the social and economic changes occurring as a result of developments in computing and computer use, and their ethical, legal and other consequences.
	The Internet	Describe the benefits and inherent dangers of widespread use of the Internet, chat rooms and forums. Describe security issues and consequences associated with the widespread use of email.
	Health and safety	Describe the health and safety issues arising from computer use.
	Professional behaviour	Describe the role of codes of conduct in promoting professional behaviour.
	Effect on employment	Describe the possible effects of computers on the nature of employment.

CG1.9	**Privacy and security**	Describe the dangers that are inherent in the use of computers to manage files of personal data and describe simple processes that protect the security and integrity of data.
	Malicious and accidental damage	Describe malicious and accidental damage to data and identify situations where either could occur. Describe contemporary processes that protect the security and integrity of data including standard clerical procedures, passwords, levels of permitted access and write-protect mechanisms.
	Back up and recovery	Describe different procedures for backing up data. Explain how data might be recovered if lost.
	Legislation	Explain how **current** legislation relating to data protection and freedom of information prevents mis-use of personal data.

4.2 Unit CG2

This unit is designed to develop the practical aspects of Computing in a way that would not be possible through a written examination. The unit examines knowledge and understanding as well as skills applied in a practical way.

The main objective of this unit will be the analysis, design, software development, documentation, testing and evaluation of a system leading to a solution to the given problem. The unit is also designed to prepare candidates for Unit CG4 which requires the integration of these skills in the production of a solution to a problem identified by the candidate.

The system proposed by the candidate may consist of one integrated program or a suite of related programs or may use an applications package together with an underlying programming language.

Candidates are expected to demonstrate the ability to:

- determine the requirements for a computer solution, specify possible solution(s) and select an appropriate solution;
- select and apply appropriate techniques and principles to design and develop a solution of the problem;
- implement the proposed solution;
- produce appropriate systems documentation;
- test and evaluate the solution.

Candidates will be expected to produce a word processed description of the development of the system. This work may be submitted on paper or electronically (see Internal Assessment Guidelines). The report should be written so that it will be intelligible to someone who is familiar with the content of the specification but has not observed the work being carried out.

The work produced will be assessed for analysis, design, implementation, systems documentation, testing and evaluation.

Details of the requirements of the proposed system to satisfy this unit are given below:

	TOPIC	AMPLIFICATION
		Candidates should:
CG2.1	**Analysis and Design**	
	Problem Definition	Describe the broad aims of the project specifying possible limitations to the solution of the problem.
	Objectives	Describe what the intended solution will actually do in terms of the tasks that can be carried out.
	Justification of the proposed solution	Discuss the use of either a programming language or the programming facilities available to tailor applications software. Evaluate the suitability of each method. Justify the chosen method in relation to the specified problem.
	Data structures and methods of access	Design and document the data structures that will be required to produce the output for the solution to the given problem together with the method of accessing the data in that data structure.
	User interface	Specify and document data capture documents, screen layouts, reports and other forms of output required to create the user interface.
	Hardware and software requirements	Specify in general terms the hardware and software required for the solution to the given problem.
	Processing stages	As appropriate: design programming routines to be used to handle and process data within the proposed solution to the given problem; or design programming routines to tailor applications software to be used to handle and process data within the proposed solution to the given problem.
	Evaluation criteria	Produce a set of criteria to be used to evaluate the success or otherwise of the finished system.
CG2.2	**Software development**	Implement the design for the solution to the given problem. The solution must include a significant amount of original code written by the candidate. Use and exploit the facilities available in the programming language or the programming facilities available to tailor the applications software.

CG2.3 Program Documentation

The reader of the documentation will need to have expert knowledge. The documentation must be sufficient to allow easy maintenance of the software solution.

Data structures and variables	Document the variables and actual data structures used to produce the solution to the given problem.
User interface	Document the interface created to facilitate the use of the solution.
Annotated listings	As appropriate: Produce listings of each programming routine written for the system with appropriate comments; or produce listings of each routine written to tailor the applications software used in the system with appropriate comments.

CG2.4 Testing and evaluation

Test strategy	Develop and document a test strategy for the solution to the given problem that will test navigational paths, interactivity and the functionality of the solution.
Test data	Design and document the data that will be required to test the functionality of the system. This data set should include typical, extreme and erroneous data. The expected outcomes of the testing should be described.
Actual test runs	Produce annotated test runs using the test data specified, showing how the results are obtained.
Evaluation	Discuss the outcomes of the testing and evaluate the system against the evaluation criteria in light of the outcome of the testing process.

4.3 Unit CG3

This unit is about acquiring additional knowledge and understanding of software, system development, data and applications, which are assessed by means of a three hour written examination. However, candidates will also draw upon this knowledge during their practical work for Unit CG4.

This unit assumes a knowledge and understanding of units CG1 and CG2.

Appendix A provides information about the conventions used in the AMPLIFICATION column.

	TOPIC	AMPLIFICATION
		Candidates should be able to:
CG3.1	**Hardware**	
	Data transmission	Describe serial and parallel transmission, their advantages and disadvantages.
		Describe simplex, half-duplex and full duplex transmission methods.
		Explain the need for digital transmission of data.
		Explain the need for multiplexing and switching.
		(A knowledge of hardware implementation detail is not required.)
	Communication networks	Distinguish between the use of circuit switching and packet switching in communication networks.
		Describe the typical contents of a packet in packet switching.
		Explain the need for network protocols.
		Explain network collision detection and how these collisions are dealt with.
		Describe the function of routers.
	Communication standards	Explain why protocols are required.
	Internet	Explain the concepts of web page design.

CG3.2	**The operating system**	
	Types of system	Explain the following types of system: batch, single-user (standalone), multi-user (multi-access), multi-tasking and multi-programming. Explain the role of time-slicing and polling.
	Interrupts	Describe a range of conditions or events which could generate interrupts. Give a description of interrupt handling and the use of priorities. Describe the factors involved in allocating differing priorities.
	Memory management and buffering	Explain the reasons for, and possible consequences of, partitioning of main memory. Describe the use of main memory for buffering. Describe methods of data transfer including the use of buffers to allow for differences in speed of devices. Explain why double buffering is used.
	Scheduling	Describe the principles of high-level scheduling: processor allocation, allocation of devices and the significance of job priorities. Explain the three basic states of a process: running, ready and blocked.
CG3.3	**Data representation, data types and data structures**	
	Representation of data as bit patterns	Describe and use the binary number system and the hexadecimal notation as a shorthand for binary number patterns. Describe how characters and numbers are stored in binary form. Explain the representation of positive and negative integers in a fixed-length store using both two's complementation and sign/magnitude representation. Explain and use shift functions: logical and arithmetic shifts. Describe the need for standardised character sets. Explain the use and nature of the ASCII character set. (Knowledge of actual ASCII codes is not required)

		Describe the nature and uses of floating point form. State the advantages and disadvantages of representing numbers in integer and floating point formats. Convert a real number to floating point form. Describe truncation and rounding, and explain their effect upon accuracy. Describe the causes of overflow and underflow.
	Data types and data structures	Describe, interpret and manipulate data structures: stacks, queues, trees, linked lists, arrays (up to three dimensional) and records. Represent the operation of linked lists and trees using pointers or arrays. Select and justify appropriate data types and structures for given situations.
CG3.4	**File organisation**	Describe sequential, indexed sequential and direct (random) file access and their use. Explain the use of multi-level indexes. Explain the techniques used to manage overflow and the need for file re-organisation. Explain the purpose of, and be able to use, a hashing algorithm. Describe the need for file security, file backup, generations of files and transaction logs. Describe the need for archiving files. Describe the need for file privacy, passwords for access and the purpose of encryption.
CG3.5	**Logical operations**	Draw truth tables for the AND, OR, NOT and XOR logical operations. Apply these logical operations to combinations of conditions in programming and package use, in masking, in control systems and the use of XOR in encryption.

CG3.6	**Databases and distributed systems**	Explain what is meant by data consistency, data redundancy and data independence.
		Describe the relative advantages of the use of databases over flat files.
		Explain what is meant by relational database organisation and data normalisation (first, second and third normal forms).
		Explain entity relationship modelling and use it to analyse simple problems.
		Restructure data into third normal form.
		Describe the use of primary and foreign keys, indexes and links.
		Describe the advantages of different users having different views of the data in a database.
		Discuss different approaches to database security. Recognise that the individual user of a database may be prevented from accessing particular elements of the information.
		Explain what is meant by data warehousing and data mining, using examples from supermarkets and insurance companies.
		Explain the purpose of a database management system (DBMS), query languages and data dictionaries.
		Explain the role of the database administrator.
	Distributed systems	Explain that distribution can apply to both data and processing.
		Describe distributed databases and the advantages of such distribution.
CG3.7	**Algorithms**	
	Algorithm constructs	Explain the term algorithm and describe common methods of defining algorithms: pseudo-code, flowcharts and structured English.
		Explain the use of recursion in algorithms.
		Explain the purpose and effect of procedure calling, parameter passing and return, call by reference and call by value.
		Design algorithms involving sequence, selection, and repetition to solve simple non-standard problems.
	Algorithm testing and data	Explain the purpose of a given algorithm by showing the effects of test data.
		Select appropriate test data to identify possible errors in an algorithm.

Sorting	Explain the need for a variety of sorting algorithms. Describe the characteristics of sorting algorithms: bubble sort, insertion sort, quicksort. (Candidates will not be required to reproduce these algorithms.)

CG3.8 Software Engineering

Software tools	Describe the types of software tool that have been designed to assist the software engineering process. Explain the role of packages in systems analysis, systems specification, systems design and testing, and computer aided software engineering (CASE). Explain the role of and give examples of the use of software development tools in producing programs: editors, compilers, interpreters, debuggers, program design language checkers, application generators. Describe the use of program trace facilities, break points, variable watch, store dumps and error diagnostics as aids in debugging programs.
Computer languages	Explain the nature and relative advantages of procedural and non-procedural languages, and identify possible situations where they may be used. Explain the need for special purpose languages. Explain the potential uses of packages with programming capabilities. Explain fourth generation languages, including their ability to allow query, data manipulation and report generation. Describe the role of an object orientated approach to programming and the relationship between object, class and method. Explain the concept of developing objects using a visual language. Describe what is meant by a scripting language, with examples of its use. Describe the need for the standardisation of computer languages, and the potential difficulties involved in agreeing and implementing standards. Recognise ambiguities in natural language and explain the need for computer languages to have an unambiguous syntax. Interpret and use formal methods of expressing language syntax: syntax diagrams and Backus-Naur form (extended Backus-Naur form is not to be used) Explain the management of program versions.

Program translation	Describe the function of translation programs in making source programs executable by the computer. Describe the purpose and give examples of the use of compilers, interpreters and assemblers, and distinguish between them. Describe and explain the need for the principal stages involved in the compilation process: lexical analysis, symbol table construction, syntax analysis, semantic analysis, code generation, optimisation. Describe the purpose and give examples of the use of linkage editors and loaders. Distinguish between, recognise and give examples of translation, linking and execution errors.
Program construction	Explain the need to be able to compile separate modules of a program and subsequently combine them without unnecessary re-compilation. Explain the need for relocatable code. Explain the nature, purpose and possible benefits of standard modules and subprogram libraries. Explain the use of subprogram libraries in the production of programs regardless of the original language used to produce them. Explain the nature of parallel processing.

CG3.9 System design

Human-Computer interface	Discuss contemporary approaches to the problem of communication with computers, including text based interfaces, forms dialogue and free-format dialogue and graphical user interfaces (GUI), sound, dedicated keys, soft keys, pointing devices, voice synthesis and handwriting recognition. Describe the potential for a natural language interface. Describe the problems of ambiguity that can be associated with input that is spoken.
Design validation	Explain the need for a design review to: (i) check the correspondence between a design and its specification; (ii) confirm that the most appropriate techniques have been used; (iii) confirm that the user interface is appropriate.
Design evaluation	Describe criteria for the evaluation of computer based solutions.

CG3.10 Typical applications of computers and communications systems

Safety related systems	Explain that some computer applications are safety-related and require a high level of dependability, and hence that the development of safety-critical systems is a highly specialised field.
Industrial, technical and scientific	Describe the role of the computer in weather forecasting, computer aided design, robotics and the use of computer generated graphics and animation.
Control systems	State the nature and scope of computer control and automation. Describe the benefits and implications of automation.
Expert Systems	Explain the purpose, use and significance of expert systems. Discuss the possible effects of expert systems on professional groups and the wider community.

Internet, Intranet, Extranet	Describe the use of search engines on the Internet. Describe common contemporary applications, including web logs, instant messaging, virtual learning environments and ecommerce: the downloading of music, on-line auctions, on-line-banking, on-line shopping. Describe organisational use of intranets and extranets. Discuss the possible effects of the Internet upon professional groups and the wider community.

CG3.11 Data security and integrity processes

Data security	Explain the special security and integrity problems which can arise during on-line updating of files. Describe processes and strategies that protect the security and integrity of data. Describe the purpose and use of contemporary biometrics, including iris and retina scans, fingerprint recognition, face recognition, voiceprint recognition.
Disaster planning	Describe the various potential threats to computer systems. Describe contingency planning to recover from disasters.

4.4 Unit CG4

This unit requires the candidate to analyse, design, implement, test and evaluate a computer solution to a substantial problem of their own choice.

The system proposed by the candidate may consist of one integrated program or a suite of related programs or may use an applications package together with an underlying programming language.

Candidates are expected to demonstrate the ability to:

- make sensible use of computers to solve real problems;
- utilise analysis and design skills involved in problem solving using a computer;
- develop, document, implement and test the system produced;
- produce a word processed report on the work carried out;
- evaluate the computerised solution.

Candidates will be expected to produce a word processed description of the development of the system. This work may be submitted on paper or electronically (see Internal Assessment Guidelines). The report should be written to be intelligible to someone who is familiar with the content of the specification but has not observed the work being carried out.

The work produced will be assessed for analysis, design, implementation, documentation, testing and evaluation.

Details of the requirements of the proposed system to satisfy this unit are given below:

	TOPIC	AMPLIFICATION
		Candidates should:
CG4.1	**Analysis**	
	Background	Include introductory paragraphs setting the scene of the project area and the reasons why this area was selected. [General information about the chosen area should be included in this section of the report, for example where the business is situated, what it supplies/sells/produces, size and scale of the business.]
	Investigation and Analysis of the Current System	Complete a thorough investigation of the current system. [Appropriate use should be made of interviews, questionnaires, observations and document inspection.] Justify their chosen methods of investigation. Analyse data collected for input and processed by the existing system. Consider current system outputs. Identify processes carried out by the existing system. Describe the limitations of the present system.
	Problem Definition	Describe the broad aims of the project specifying possible limitations to the solution.
	Objectives	Describe what the intended solution will actually do in terms of the tasks that can be carried out. [A clear set of objectives should be created. These objectives should provide a link to the problem definition.]
CG4.2	**Design**	
	Output content and format	Identify and describe the data to be output from the system. [Candidates should give due consideration to the reasons for the data that is to be included in the output.] Design the output format. [Candidates should give due consideration to output forms, reports, screens and other appropriate forms of output.]

Input content, capture and format	Describe how the necessary data will be collected and entered into the system. [If applicable, sample input documents should be produced.] Describe and justify the input method chosen. Design input screens and data capture forms as appropriate.
Files and/or data structures, methods of access	Design and document each data structure/file to be used together with the method of access.
Validation	Design the validation routines to be carried out on data entered into the system.
Processing stages	Design programming routines to be used to handle and process data within the proposed solution to the stated problem; or design programming routines to tailor applications software to be used to handle and process data within the proposed solution to the stated problem. [The interconnection between the programs and the files they access should be clearly shown.]
Evaluation criteria	Produce a set of quantifiable criteria to be used to evaluate the success or otherwise of the finished system at the evaluation stage of the project.

CG4.3 Software development

Implement the design for the solution to the chosen problem.

[The solution must include a significant amount of original code written by the candidate.]

Use and exploit the facilities available in the programming language or the programming facilities available to tailor the applications software chosen.

CG4.4 Maintenance Documentation

Annotated listing	Produce listings of each programming routine written for the system with appropriate comments; or produce listings of each routine written to tailor the applications software used in the system with appropriate comments.
Procedures / subroutines details	Describe the purpose of any subprograms or modules used in the system. [Any parameters passed need to be explained and the purpose of any local variables should be explained.]
List of variables used	List all the variables used, the programs or modules they appear in, together with an explanation of their purpose.

CG4.5 Testing

Testing strategy	Describe the method to be adopted to test the system, including full testing of all validation routines. [Candidates should consider a full range of the available testing methods when devising a suitable strategy.]
Test plan / data	Design, with justification, the data to be used to test the system, including any validation routines, together with details of the results this data should produce. [Typical, extreme and erroneous data should be included.]
Actual test runs	Produce annotated test runs using the test data specified.

CG4.6 Evaluation

Evaluation of the system	Evaluate the test results produced by the system. Evaluate the system against the original objectives. Evaluate the system against the evaluation criteria. Suggest realistic, potential future improvements to the system.

CG4.7 User Documentation

Installation	Produce user documentation which describes how to install the system.
Use	Produce a tutorial based on the new system to help minimise post implementation costs.

5 SCHEME OF ASSESSMENT

AS and A level qualifications are available to candidates following this specification.

AS

The AS is the first half of an A level course. It will contribute 50% of the total A Level marks. Candidates must complete the following **two units** in order to gain an AS qualification.

		Weighting Within AS	Weighting Within A Level
CG1	Written Paper	65%	32.5%
CG2	Computing Task	35%	17.5%

CG1: Written Paper (3 hours)

Candidates are required to answer all questions in this externally set and externally marked examination paper, which is presented in a question-and-answer booklet format. The paper is designed to assess breadth and depth of knowledge of the CG1 specification content shown on pages 10 to 16.

Quality of written communication is assessed in this unit.

CG2: Internal Assessment (Computing Task)

Candidates are required to analyse, design, implement, test and evaluate a solution to a given problem requiring the production of original code (programming).

The unit stands alone as a flexible, worthwhile experience, providing candidates who do not progress beyond AS the opportunity to demonstrate high quality computing skills in a practical way. For those going on to A Level, the unit offers preparation ahead of the main project in unit CG4.

Quality of written communication is assessed in this unit.

This internally assessed unit is marked by the centre and moderated by the WJEC.

A Level

The A Level specification consists of two parts: Part 1 (AS) and Part 2 (A2).

Part 1 (AS) may be taken separately and added to A2 at a further examination sitting to achieve an A Level qualification, or alternatively, both the AS and A2 may be taken at the same sitting.

Candidates must complete the AS units outlined above plus a further two units to complete A Level Computing. The A2 units will contribute 50% of the total A Level marks.

		Weighting within A2	Weighting within A Level
CG3*	Written Paper	65%	32.5%
CG4*	Computing Project	35%	17.5%

*Includes synoptic assessment

CG3: Written Paper (3 hours)

Candidates are required to answer all questions in this externally set and externally marked examination paper, which is presented as a question paper requiring a separate answer booklet. The paper is designed to assess breadth and depth of knowledge of the CG3 specification content shown on pages 20 to 27 and will include some questions of a synoptic nature.

Quality of written communication is assessed in this unit.

CG4: Internal assessment (Computing Project)

Candidates are required to analyse, design, implement, test and evaluate a solution to a substantial problem of their choice requiring the production of original code (programming).

This is a substantial piece of work, undertaken over an extended period of time.

Quality of written communication is assessed in this unit.

This internally assessed unit is marked by the centre and moderated by the WJEC.

Synoptic Assessment

Synoptic assessment, testing candidates' understanding of the connections between the different elements of the subject and their holistic understanding of the subject, is a requirement of all A Level specifications. In the context of this specification, synoptic assessment is addressed by the links between:

- the content examined in CG1 which is examined in greater depth in CG3
- aspects of the assessment criteria included in CG2 which are extended in CG4.

Quality of Written Communication

Candidates will be required to demonstrate their competence in written communication in all assessment units, both AS and A2, where they are required to produce extended written material. Mark schemes for all units include the following specific criteria for the assessment of written communication.

- legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning;
- selection of a form and style of writing appropriate to purpose and to complexity of subject matter;
- organisation of information clearly and coherently; use of specialist vocabulary where appropriate.

Both assessment objectives subsume the use of written communication. Use of appropriate language, punctuation and grammar is expected as the means by which ideas can be expressed (e.g. in CG2 and CG4) and logical argument shown in answers to questions (e.g. CG1 and CG3). Marks will not be awarded unless the meaning is clearly conveyed. Mark schemes therefore will, where appropriate, be constructed to allow for the presentation of coherent accounts, cogent argument, appropriate format, use of computing terminology and clarity.

Availability of Units

The table below summarises the availability of all units, along with the first assessment opportunity for each.

Availability of Assessment Units			
Unit	**January 2009**	**June 2009**	**June 2010 & each subsequent year**
CG1	✓	✓	✓
CG2		✓	✓
CG3			✓
CG4			✓

Awarding, Reporting and Re-sitting

The overall grades for the GCE AS qualification will be recorded as a grade on a scale from A to E. The overall grades for the GCE A level qualification will be recorded on a grade scale from A* to E. Results not attaining the minimum standard for the award of a grade will be reported as U (Unclassified). Individual unit results and the overall subject award will be expressed as a uniform mark on a scale common to all GCE qualifications (see table below). The grade equivalence will be reported as a lower case letter ((a) to (e)) on results slips, but not on certificates:

	Max. UMS	A*	A	B	C	D	E
Units CG1 and CG3 (weighting 65%)	130		104	91	78	65	52
Units CG2 and CG4 (weighting 35%)	70		56	49	42	35	28
AS Qualification	200		160	140	120	100	80
A Qualification	400		320	280	240	200	160

At A level, Grade A* will be awarded to candidates who have achieved a Grade A in the overall A level qualification and 90% of the total uniform marks for the A2 units.

Candidates may re-sit units prior to certification for the qualification, with the best of the results achieved contributing to the qualification. Individual unit results, prior to certification of the qualification have a shelf-life limited only by the shelf-life of the specification.

6 KEY SKILLS

Key Skills are integral to the study of AS/A Level Computing and may be assessed through the course content and the related scheme of assessment as defined in the specification. The following key skills can be developed through this specification at level 3:

- Communication
- Application of Number
- Problem Solving
- Information and Communication Technology
- Working with Others
- Improving Own Learning and Performance

Mapping of opportunities for the development of these skills against Key Skills evidence requirement is provided in 'Exemplification of Key Skills for Computing' available on the WJEC website.

7 PERFORMANCE DESCRIPTIONS

Introduction

Performance descriptions have been created for all GCE subjects. They describe the learning outcomes and levels of attainment likely to be demonstrated by a representative candidate performing at the A/B and E/U boundaries for AS and A2.

In practice most candidates will show uneven profiles across the attainments listed, with strengths in some areas compensating in the award process for weaknesses or omissions elsewhere. Performance descriptions illustrate expectations at the A/B and E/U boundaries of the AS and A2 as a whole; they have not been written at unit level.

Grade A/B and E/U boundaries should be set using professional judgement. The judgement should reflect the quality of candidates' work, informed by the available technical and statistical evidence. Performance descriptions are designed to assist examiners in exercising their professional judgement. They should be interpreted and applied in the context of individual specifications and their associated units. However, performance descriptions are not designed to define the content of specifications and units.

The requirement for all AS and A level specifications to assess candidates' quality of written communication will be met through one or more of the assessment objectives.

The performance descriptions have been produced by the regulatory authorities in collaboration with the awarding bodies.

AS performance descriptions for computing

	Assessment objective 1	**Assessment objective 2**
Assessment objectives	**Knowledge and understanding** Candidates should be able to: • Describe and explain the purpose and characteristics of a range of computing applications and show an understanding of the characteristics of computer systems (hardware, software and communication) that allow effective solutions to be achieved • Describe and explain the need for and the use of various forms of data organisation and processing to support the requirements of a computer-based solution • Describe and explain the systematic development of high-quality solutions to problems and the techniques for implementing such solutions, including the use of a programming language • Comment critically on the consequences of current uses of computing, including economic, social, legal and ethical issues.	**Skills** Candidates should be able to: • Analyse a problem and identify the parts that are appropriate for a computer-based solution • Select, justify and apply appropriate techniques and principles to develop data structures and algorithms for the solution of problems • Design, implement and document an effective solution using appropriate hardware and software, including the use of a programming language.
A/B boundary performance descriptions	Candidates characteristically: a) understand the purpose and characteristics of a range of computing applications b) demonstrate knowledge of the characteristics of the main hardware, software and communication components of computer systems and how they allow effective solutions to be achieved c) understand the need to organise data appropriately and process it efficiently in order to solve problems using computers d) understand the need to adopt a systematic approach when developing high quality solutions to problems e) show knowledge of appropriate techniques to implement solutions, including the use of a programming language f) demonstrate a critical understanding of the consequences of current uses of computing, including economic, social, legal and ethical issues.	Candidates characteristically: a) use subject-specific terminology appropriately and accurately b) analyse a complex problem and identify the parts that are appropriate for a computer-based solution c) derive most of the user and information requirements of a system to solve a problem d) select and use appropriate techniques to develop a solution with suitable data structures and algorithms e) choose and justify appropriate hardware and software with which to solve a problem, including the use of a programming language f) design an effective solution and document it appropriately g) implement a workable solution, testing and documenting it appropriately.
E/U boundary performance descriptions	Candidates characteristically: a) demonstrate some understanding of the purpose and characteristics of a limited range of computing applications b) show a limited knowledge of the characteristics of the main hardware, software and communication components of computer systems c) have some understanding of the need to organise data appropriately and process it efficiently in order to solve problems using computers d) demonstrate some understanding of the need to adopt a systematic approach when developing high-quality solutions to problems e) show a limited knowledge of appropriate techniques to implement solutions, including the use of a programming language f) have a limited understanding of the consequences of current uses of computing, including some economic, social, legal and ethical issues.	Candidates characteristically: a) use subject-specific terminology b) analyse a problem and identify parts that are appropriate for a computer-based solution c) derive some of the user and information requirements of a system to solve a problem d) select and use some appropriate techniques to develop a solution with generally suitable data structures and algorithms e) choose hardware and software with which to solve a problem, including the use of a programming language f) design a simple solution, and document it to a limited extent g) produce a solution, with limited testing and documentation.

A2 performance descriptions for computing

	Assessment objective 1	Assessment objective 2
Assessment objectives	**Knowledge and understanding** Candidates should be able to: • Describe and explain the purpose and characteristics of a range of computing applications and show an understanding of the characteristics of computer systems (hardware, software and communication) that allow effective solutions to be achieved • Describe and explain the need for and the use of various forms of data organisation and processing to support the requirements of a computer-based solution • Describe and explain the systematic development of high-quality solutions to problems and the techniques for implementing such solutions, including the use of a programming language • Comment critically on the consequences of current uses of computing, including economic, social, legal and ethical issues.	**Skills** Candidates should be able to: • Analyse a problem and identify the parts that are appropriate for a computer-based solution • Select, justify and apply appropriate techniques and principles to develop data structures and algorithms for the solution of problems • Design, implement and document an effective solution using appropriate hardware and software, including the use of a programming language.
A/B boundary performance descriptions	Candidates characteristically: a) demonstrate a thorough understanding of the purpose and characteristics of a wide range of computing applications b) show an extensive knowledge of the characteristics of a wide range of hardware, software and communication components of computer systems c) have a thorough understanding of the need to organise data appropriately and process it efficiently in order to solve problems using computers d) demonstrate a thorough understanding of the need to adopt a systematic approach when developing high quality solutions to problems e) show an extensive knowledge of appropriate techniques to implement solutions, including the advanced use of a programming language f) have an in-depth understanding of the consequences of current uses of computing, including a wide range of economic, social, legal and ethical issues.	Candidates characteristically: a) use subject-specific terminology appropriately and accurately b) analyse a complex problem and identify the parts that are appropriate for a computer-based solution c) derive the user and information requirements of a system to solve a problem d) select and use appropriate techniques to develop an effective solution with suitable data structures and algorithms e) choose and justify the most appropriate hardware and software with which to solve a problem, including the use of a programming language f) design an effective and efficient solution and document it thoroughly g) implement an efficient solution, testing and documenting it thoroughly.
E/U boundary performance descriptions	Candidates characteristically: a) demonstrate a basic understanding of the purpose and characteristics of some computing applications b) show a basic knowledge of the characteristics of a range of hardware, software and communication components of computer systems c) understand the need to organise data appropriately and process it efficiently in order to solve problems using computers d) understand the need to adopt a systematic approach when developing solutions to problems e) demonstrate a basic knowledge of appropriate techniques to implement solutions, including the advanced use of a programming language f) show some understanding of the consequences of current uses of computing, including a range of economic, social, legal and ethical issues.	Candidates characteristically: a) use a basic range of subject-specific terminology b) analyse a fairly straightforward problem and identify the parts that are appropriate for a computer-based solution c) derive some of the user and information requirements of a system to solve a problem d) select and use appropriate techniques to develop a solution with suitable data structures and algorithms e) choose and justify some appropriate hardware and software with which to solve a problem, including the use of a programming language f) design a workable solution and document it to some extent g) implement a workable solution, testing and documenting it to some extent

8 INTERNAL ASSESSMENT GUIDELINES

8.1 Introduction

These instructions are provided to help teachers in the supervision and assessment of units CG2 and CG4. They consist of the following sections:

8.2 Definition and Nature of the internally assessed units

Unit CG2 for the AS examination requires the candidate to analyse, design, implement and document a computerised solution **to a given problem**.

Unit CG4 for the A level examination requires the candidate to analyse, design, implement and document a computerised solution to **a problem of their own choice**.

Unit CG2
The main objective of this unit will be the analysis, design, implementation and documentation of a solution to a given problem. It should serve to emphasise the analysis, design, implementation and documentation skills involved in problem solving using a computer and include the development of a piece of work, for a given problem, over an extended period of time under controlled conditions. The candidate should produce a word processed report of the work carried out.

Unit CG4
The work undertaken in this unit will be the analysis, design, implementation and documentation of a solution to a problem chosen by the candidate. It should demonstrate the analysis, design, implementation and documentation skills involved in problem solving using a computer and include the development of a piece of work over an extended period of time. The candidate should produce a word processed report of the work carried out.

The work, for units CG2 and CG4, **must** include the development of software in either a general purpose or a special purpose high-level language. The system proposed by the candidate may consist of one integrated program or a suite of related programs or may use an applications package together with any underlying programming language.

The task produced for unit CG2 will carry 35% of the total marks for the AS examination. For the A-level examination, unit CG2 will carry 17.5% and unit CG4 will carry 17.5% of the marks.

It should be noted that the units will be moderated by an external moderator who may have no knowledge of the computer system used by the candidate or the background to the problem tackled. Documentation and annotation must, therefore, provide sufficient information for the external moderator to be able to assess the work. The candidate's teacher will be expected to mark the candidate's work and note on the *Centre Mark Sheet (Form CG2a* or *Form CG4a)* the nature of any assistance given and the extent to which the solution actually works as stated in the report.

8.3 Submission of work for CG2 and CG4

This word processed work prepared by the candidates for both Units CG2 and CG4 may be submitted as a paper based document or electronically.

When work is submitted electronically, candidates should make use of the electronic front sheet (Form CG2e or Form CG4e) saved in html format. Each heading on the sheet should be hyperlinked to a pdf version of the write up for that particular requirement of the specification.

Each candidate's work should be saved in a separate folder labelled with the centre number, candidate number and the first two initials of the candidates' surname and the first initial of the candidate's first name. For example Diane Jones, Centre number 68999, candidate number 11111 would store her work in a folder named 68999_11111_JO_D.

The candidate may wish to use sub folders to organise their work for each section and must ensure that the front sheet is stored in such a way that the hyperlinks allow the assessor and moderator to access the relevant pdf documents.

The centre assessor should store the candidate's assessment documentation using the same naming convention as above. For example Diane Jones' CG2a would be stored as CG2a_68999_11111_JO_D.

8.4 Annotation and supporting evidence

Centres are required to provide information that enables the moderator to check the work against the Assessment Criteria. This information should be given on the *Centre Mark Sheet* (*Form CG2a* or *Form CG4a*).

Annotation should, therefore:

- describe, in all necessary detail, practical work that is not available, together with comments from the teacher;
- explain where candidates have received help beyond the normal learning support that may influence the assessments;
- highlight those key areas that have led to the recognition of particular criteria. Reference to the Assessment Criteria is particularly helpful;
- include any other notes that will help the moderator to assess the unit.

8.5 Supervision and authentication

Unfair Practice

Before the course starts, the teacher is responsible for informing candidates of the WJEC's regulations concerning malpractice. Candidates must not take part in any unfair practice in the preparation of work required for assessment in the examination. They must understand that to present material copied directly from books or other sources without acknowledgement will be regarded as deliberate deception. Centres must report suspected malpractice to the Board.

If the WJEC is satisfied that the Regulations have been breached, the candidate may be disqualified from all subjects. Candidates will be required to certify that they have read and understood the regulations relating to unfair practice by signing *Form CG2a* or *CG4a*.

Supervision of Work

Centres must assure the WJEC that the assessments submitted are the work of the candidates concerned. All of the work for unit CG2 must be undertaken under the direct supervision of teachers, for unit CG4 as much work as possible must be undertaken under the direct supervision of teachers.

The teacher responsible for the supervision of the candidate's work must complete a declaration (on *Form CG2a* or *Form CG4a*), certifying that the marks submitted were awarded in accordance with the specification and Instructions and Guidance for Teachers and that she/he is entirely satisfied that the work submitted is that of the candidate concerned.

It is perfectly acceptable for parts of a candidate's work to be taken from other sources as long as all such cases are clearly identified in the text and fully acknowledged either on the *Centre Mark Sheet (Form CG2a* or *Form CG4a)* or in the supporting evidence. Where phrases, sentences or longer passages are quoted directly from a source, candidates should use quotation marks.

Centres entering candidates for Computing (AS) and Computing (A Level) must accept the obligation to provide sufficient supervision to enable them to give an assurance that every step has been taken to ensure that the work submitted is that of the candidate concerned. When a candidate has need of assistance in completing a particular piece of work, such assistance should be given but the teacher must add appropriate comments on the *Centre Mark Sheet (Form CG2a* or *Form CG4a)*.

It is expected that the teacher will be involved at the following stages:

- Initial discussion at the time when the unit is being introduced and work is being planned. The final choice of the proposed method of solution should be that of the individual candidate, but the teacher will be expected to discuss the proposed choice so that guidance can be given about suitability and appropriateness before work begins. It is anticipated that such advice will ensure that the solution attempted is neither trivial nor over-ambitious.

- Periodic supervision and discussion as appropriate, e.g. discussion of the availability and use of material, suitable annotations on the work.

- Guidance on the presentation of the unit, including the information to be given on the *Centre Mark Sheet (Form CG2a* or *Form CG4a).*

WJEC recognises that the problem of authentication is increased by the nature of such work. An essential feature of the work is the use by the candidate of the techniques of research and investigation, including use of abilities to discover information, to discriminate amongst a variety of sources of information, to marshal evidence and to present all the available relevant evidence as part of the presentation of the topic and as the basis for conclusions. The candidate will often be expected to search for and utilise, information assembled by others. There is, however, an important distinction between plagiarism and the acquisition of information by research. The distinction lies in the use made by the candidate of the information obtained and the extent to which findings are presented as the result of his/her researches or as his/her own data or conclusions. To assist the teacher in the authentication, candidates must be instructed to provide a clear and comprehensive statement of the sources of information on the *Centre Mark Sheet (Form CG2a* or *Form CG4a)* provided by the WJEC. It is also expected that the teacher will make full use of discussions with the candidate regarding his/her work as an effective method of establishing its authenticity.

8.6 Assessment of internally assessed units

Each unit will be assessed in accordance with the guidelines set out below. The teacher will mark the unit and ensure that there is sufficient annotation and documentation to enable the moderator to assess the unit accurately.

8.7 Criteria for the Assessment of Unit CG2 and Unit CG4

Teachers should use the following mark criteria for the assessment of their candidates' work. The criteria are listed point by point for each category. After considering the criteria, the teacher should be able to make a reasonable assessment of where a candidate falls in the overall range of marks, and a mark should be entered on the appropriate form (*either Form CG2a for unit CG2 or Form CG4a for unit CG4)*. This is not a mathematical exercise but one of making a judgement of the balance of points satisfied.

Unless stated otherwise, where a candidate meets a criterion but has done so with assistance or, in the case of unit CG4, because of attempting a less substantial problem, the mark should be in a category below that of the relevant statement and a note made on *Centre Mark Sheet.*

Unit CG2 The following categories are used in the assessment of this unit.

Analysis and Design	35 marks
Software development	30 marks
Program documentation	15 marks
Testing and evaluation	20 marks

The criteria for awarding marks for these categories are listed below. The unit is marked out of a total of 100.

	TOPIC			AMPLIFICATION
CG2.1	**ANALYSIS AND DESIGN**		**35 marks**	
	Problem Definition	**[3]**	3 marks	The candidate has provided a full description of the broad aims and limitations of the project.
			2 marks	The candidate has identified the aims of the project and has included some description of these aims.
			1 mark	The candidate has identified some of the aims of the project and has given a brief description of the identified aims.
	Objectives	**[4]**	4 marks	The candidate has provided a comprehensive description of the intended system in terms of the tasks to be carried out.
			3 marks	The candidate has provided a description of the intended solution in terms of the tasks to be carried out.
			2 marks	The candidate has described the intended system in terms of most of the tasks to be carried out.
			1 mark	The candidate has briefly described some tasks that the intended system should carry out.
	Justification of the proposed solution	**[3]**	3 marks	The candidate has technically justified their chosen method of solution fully in terms of the programming facilities of the language or applications software chosen.
			2 marks	The candidate has provided a justification of their chosen method of solution in terms of some of the programming facilities of the language or applications software chosen.
			1 mark	The candidate has provided a brief but non-specific justification of the chosen method of solution.
	Data structures and methods of access	**[5]**	5 marks	The candidate has identified all the required data structures and has fully defined them in terms of fieldnames, data types, key fields and requirements for validation. The candidate has considered and fully described methods of access.
			4 marks	The candidate has identified all the required data structures and has defined them in sufficient detail for implementation by a competent third party. The candidate has considered and described methods of access.

		3 marks	The candidate has identified most of the required data structures and has defined them in sufficient detail for implementation by a competent third party. The candidate has briefly described methods of access.
		2 marks	The candidate has identified some of the required data structures and has provided some details of the structure. There is a brief consideration of methods of access.
		1 mark	The candidate has identified at least one data structure and has provided some technical detail.
User interface	**[5]**	5 marks	The candidate has identified all requirements for the user interface including data capture documents, screen layouts, reports and other forms of output and has documented them in detail. The designs of the elements of the interface demonstrate an astute sense of audience and purpose.
		4 marks	The candidate has identified the requirements for the user interface including data capture documents, screen layouts and other forms of output and has documented them in sufficient detail for implementation by a competent third party. The designs for the elements of the interface demonstrate a sound sense of audience and purpose.
		3 marks	The candidate has identified most of the requirements for the user interface including all essential elements and has documented them in some detail. The designs for the elements of the interface demonstrate a sense of audience and purpose.
		2 marks	The candidate has identified some of the requirements for the user interface and has documented them but has omitted some necessary elements. The designs for the elements demonstrate some sense of audience and purpose.
		1 mark	The candidate has identified some of the requirements for the user interface but has not documented all essential elements. The design of the elements demonstrates a lack of sense of audience and purpose.
Hardware and software requirements	**[2]**	2 marks	The candidate has identified the hardware and software requirements specific to the given problem.
		1 mark	The candidate has identified some hardware and software but has not related it to the given problem.

Processing stages	**[10]**	9 – 10 marks	The candidate has identified all processes needed to provide a comprehensive solution to the given problem.
		Either	The relationships between the data and the processes or programs to be written using the programming language to manipulate and transform the data are clearly defined and described.
		Or	The relationships between the data and processes and routines to be written to tailor the applications software to manipulate and transform the data are clearly defined and described.
		7 – 8 marks	The candidate has identified the processes needed to provide an effective solution to the given problem.
		Either	The relationships between the data and the process or programs to be written using the programming language to manipulate and transform the data are defined and described.
		Or	The relationships between the data and processes and routines to be written to tailor the applications software to manipulate and transform the data are defined and described.
		5 – 6 marks	The candidate has identified a sufficient number of processes to provide a working solution to the given problem.
		Either	There is some description of the relationships between the data and the processes or programs to be written using the programming language to manipulate and transform the data.
		Or	There is some description of the relationships between the data and the processes and routines to be written to tailor the applications software to manipulate and transform the data.
		3 – 4 marks	The candidate has identified some of the process that are required to create a working solution to the problem.
		Either	There is some consideration of the relationships between the data and the processes or programs to be written using the programming language to manipulate and transform the data. The candidate has attempted to describe some of the routines.

		Or	There is some consideration of the relationships between the data and the processes or routines to be written to tailor the applications software to manipulate and transform the data. The candidate has attempted to describe some of the routines.
		1 – 2 marks	The candidate has identified more than one of the processes that would be included in a working solution to the problem.
		Either	There is a brief description of the relationships between the data and the processes or programs to be written using the programming language to manipulate and transform the data. There is a brief description of the routines.
		Or	There is a brief description of the relationship between the data and the processes or routines to be written to tailor the applications software to manipulate and transform the data. There is a brief description of the routines.
Evaluation criteria	**[3]**	3 marks	The candidate has produced a comprehensive set of evaluation criteria that will allow the performance of the finished system to be measured.
		2 marks	The candidate has produced a set of evaluation criteria that can be used to measure the performance of the finished system.
		1 mark	The candidate has produced some evaluation criteria that will allow some features of the finished system to be measured.

CG2.2 SOFTWARE DEVELOPMENT 30 marks

28 – 30 marks	The candidate has produced a fully functioning solution to the given problem. The user interface demonstrates an astute sense of audience and purpose.
Either	The candidate has used and fully exploited, as appropriate, the facilities of the programming language and has demonstrated a sound understanding of the appropriate tools and techniques available to them.
Or	The candidate has used and fully exploited, as appropriate, the programming facilities of the chosen package to write routines to tailor the applications software and has demonstrated a sound understanding of the appropriate tools and techniques available to them.

25 – 27 marks	The candidate has produced a fully functioning solution to the given problem. The user interface demonstrates an astute sense of audience and purpose.
Either	The candidate has used and exploited, as appropriate, the facilities of the programming language and has demonstrated a sound understanding of the tools and techniques used.
Or	The candidate has used and exploited, as appropriate, the programming facilities of the chosen package to write routines to tailor the applications software and has demonstrated a sound understanding of the tools and techniques used.
21 – 24 marks	The candidate has produced a functional solution to the given problem. The user interface demonstrates a sound awareness of audience and purpose.
Either	The candidate has used and exploited, as appropriate, the facilities of the programming language and has demonstrated an understanding of the tools and techniques used.
Or	The candidate has used and exploited, as appropriate, the programming facilities of the chosen package to write routines to tailor the applications software and has demonstrated an understanding of the tools and techniques used.
18 – 21 marks	The candidate has produced a functional solution to the given problem. The user interface demonstrates a sound awareness of audience and purpose.
Either	The candidate has used and exploited the facilities of the programming language and has demonstrated some understanding of the tools and techniques used.
Or	The candidate has used and exploited the programming facilities of the chosen package to write routines to tailor the applications software and has demonstrated some understanding of the tools and techniques used.
15 – 17 marks	The candidate has produced a solution to the problem that provides the majority of the required functionality. The interface demonstrates some sense of audience and purpose.

Either	The candidate has used a range of the facilities of the programming language and has demonstrated an understanding of the tools and techniques used.
Or	The candidate has used a range of the programming facilities of the chosen package to write routines to tailor the applications software and has demonstrated an understanding of the tools and techniques used.
12 – 14 marks	The candidate has produced a solution to the problem that provides the majority of the required functionality. The interface demonstrates some sense of audience.
Either	The candidate has used a range of the facilities of the programming language and has demonstrated some understanding of the tools and techniques used.
Or	The candidate has used a range of the programming facilities of the chosen package to write routines to tailor the applications software and has demonstrated some understanding of the tools and techniques used.
9 – 11 marks	The candidate has produced a solution to the problem that is functional in parts. The user interface demonstrates some sense of audience and purpose.
Either	The candidate has used some of the facilities of the programming language and has demonstrated some understanding of the tools and techniques used.
Or	The candidate has used some of the programming facilities of the chosen package to write routines to tailor the applications software and has demonstrated some understanding of the tools and techniques used.
6 – 8 marks	The candidate has produced a solution to the problem that is functional in parts. The user interface demonstrates some sense of audience and purpose.
Either	The candidate has used some of the facilities of the programming language but has demonstrated a limited understanding of the tools and techniques used.
Or	The candidate has used some of the programming facilities of the chosen package to write routines to tailor the applications software but has demonstrated a limited understanding of the tools and techniques used.

3 – 5 marks	The candidate has produced a limited solution to the given problem. The user interface demonstrates a lack of sense of audience or purpose.
Either	The candidate has made limited use of the facilities of the programming language available to them, demonstrating a limited understanding of the tools and techniques used.
Or	The candidate has made limited use of the programming facilities of the chosen package to write routines to tailor the applications software, demonstrating a limited understanding of the tools and techniques used.
1 – 2 marks	The candidate has produced a limited solution to the given problem. The user interface demonstrates little sense of audience or purpose.
Either	The candidate has made limited use of the facilities of the programming language, demonstrating little understanding of the tools and techniques available to them.
Or	The candidate has made limited use of the programming facilities of the chosen package to write routines to tailor the applications package, demonstrating little understanding of the tools and techniques available to them.

CG2.3 PROGRAM DOCUMENTATION 15 marks

The reader of the documentation will need to have expert knowledge. The documentation must be sufficient to allow easy maintenance of the software solution.

Data structures and variables [3]	3 marks	The candidate has fully documented the variables and actual data structures used to create the solution to the given problem. The candidate has used appropriate self documenting identifiers.
	2 marks	The candidate has documented the variables and actual data structures used to create the solution to the given problem. In general, the candidate has used appropriate self documenting identifiers.
	1 mark	The candidate has attempted to document the variables and actual data structures. There has been an attempt to use self documenting identifiers.

User interface	**[2]**	2 marks	The candidate has included evidence of the completed user interface including a full description of the features that make it fit for audience and purpose.
		1 mark	The candidate has provided evidence of the completed user interface with a limited description of the features used to make it fit for audience and purpose.
Annotated listings	**[10]**	9 – 10 marks	The candidate has produced listings of each programming routine. These listings should be appropriately laid out and contain self documenting code. The candidate has included sufficient annotation to demonstrate a sound understanding of the programming code used.
		7 – 8 marks	The candidate has produced listings of each programming routine. In general these listings should be appropriately laid out and contain self documenting identifiers and code. The candidate has included sufficient annotation to demonstrate an understanding of the programming code used.
		5 – 6 marks	The candidate has produced listings of all major and most minor programming routines and/or routines for tailoring applications software. There is some evidence of the use of self documenting identifiers and code. The candidate has included some annotation that demonstrates some understanding of the language or applications package used.
		3 – 4 marks	The candidate has produced some listings of the programming routines or routines to tailor applications packages. These routines demonstrate some use of self documenting identifiers and code. The candidate has included some annotation that demonstrates a limited understanding of language or package used.
		1 – 2 marks	The candidate has produced some listings of the programming routines or the routines used for tailoring applications software. There is little evidence of the use of self documenting identifiers or code. The candidate has included little annotation that suggests an understanding of the language or package used.

CG2.4 TESTING AND EVALUATION 20 marks

Test strategy	**[2]**	2 marks	The candidate has devised an effective test strategy that will allow them to fully test navigational paths, interactivity and the functionality of the system. This design reflects the candidate's understanding of the system created and the need to evaluate that system against the evaluation criteria.
		1 mark	The candidate has devised a strategy that will allow them to test most of the navigational paths, interactivity and functionality of the system.
Test data	**[3]**	3 marks	The candidate has designed effective data to fully test the functionality of the system that demonstrates a sound understanding of the finished solution.
		2 marks	The candidate has designed data that will allow them to test the majority of the functionality of the finished solution.
		1 mark	The candidate's choice of test data will allow them to test some of the functionality of the system but the choice demonstrates a lack of understanding of the purpose of the completed solution.
Actual test runs	**[10]**	9 – 10 marks	The candidate has included extensive evidence of the thorough testing of the completed solution. The candidate has included an informed commentary of the testing process.
		7 – 8 marks	The candidate has included evidence of thorough testing of the completed solution. The candidate has included commentaries describing the testing process.
		5 – 6 marks	The candidate has included evidence of the testing of the majority of the functions of the completed solution. The candidate has included comments describing the testing process.
		3 – 4 marks	The candidate has included evidence of testing some of the functions of the completed solution. There are limited comments describing some features of the testing process.
		1 – 2 marks	The candidate has included brief evidence of the testing of some of the functions of the finished system. There are few comments relating to the testing process.

This section assesses the candidate's quality of written communication. Marks are awarded for the following criteria, but only if the candidate's response demonstrates:

- legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning;
- selection of a form and style of writing appropriate to purpose and to complexity of subject matter;
- organisation of information clearly and coherently; use of specialist vocabulary where appropriate.

Evaluation	**[5]**	5 marks	The candidate has described the outcomes of the testing process in detail demonstrating a sound understanding of the given problem, the original objectives and the finished solution. The candidate has provided an informed discussion of the performance of the finished system against the evaluation criteria. The candidate is able to make valid and detailed suggestions for further improvements to the solution.
		4 marks	The candidate has described the outcomes of the testing process demonstrating an understanding of the given problem, the original objective and the finished solution. The candidate has provided a discussion of the performance of the system against the evaluation criteria and has made some valid suggestions for further improvements to the solution.
		3 marks	The candidate has described the outcomes of the testing process demonstrating some understanding of the given problem, the original objectives and the finished solution. There is some discussion of the performance of the system, measured against the evaluation criteria. The candidate is able to make some suggestions for further improvements to the system.
		2 marks	The candidate has provided some discussion of the outcomes of the testing process. The candidate has attempted to measure the performance of the system against the evaluation criteria. There are some non-specific suggestions for improvements to the solution.
		1 mark	The candidate has provided a limited discussion of the testing process or may have considered the performance of the system against the evaluation criteria. There are few if any suggestions for improvement of the solution.

Unit CG4 The following categories are used in the assessment of this unit.

Analysis	10 marks
Design	20 marks
Software development	25 marks
Maintenance documentation	10 marks
Testing	20 marks
Evaluation	10 marks
User documentation	5 marks

The criteria for awarding marks for these categories are listed below. The unit is marked out of a total of 100.

	TOPIC			AMPLIFICATION
CG4.1	**ANALYSIS**	**10 marks**		
	Background	**[1]**	1 mark	The candidate has identified a realistic problem and consideration has been given to the reasons why the area was selected as the basis of the project.
	Investigation and Analysis	**[5]**	4 – 5 marks	The candidate has completed a thorough investigation of the current system. A variety of appropriate methods have been used to investigate the existing system. The data collected for input and processed by the existing system has been analysed. Current system outputs have been considered. Processes have been identified. The limitations of the current system have been considered.
			2 – 3 marks	The candidate has completed a reasonably detailed investigation of the current system. A limited variety of methods have been used to investigate the existing system. There is some evidence of analysis of the data to be input and the processing carried out by the existing system. Limited consideration of the current system processes and outputs. Limitations of the current system have been considered.
			1 mark	The analysis is weak. Very little consideration has been given to the data that is input and output by the existing system. No consideration has been given to the limitations of the current system.

Problem Definition	**[2]**	2 marks	The candidate has identified the aims of the project and has included a complete description of these aims and has specified possible limitations of the solution.
		1 mark	The candidate has identified some of the aims of the project. Brief consideration has been given to the limitations of the solution.
Objectives	**[2]**	2 marks	The candidate has described a clear set of objectives. The tasks to be carried out by the new system have been comprehensively described.
		1 mark	The candidate has created a limited set of objectives. There is a brief description of some of the tasks that the intended system should carry out.

CG4.2 DESIGN 20 marks

Output content and format	**[2]**	2 marks	The candidate has identified and described the data to be output from the system. The output to be produced by the system has been designed. Consideration has been given to the reasons for the data that is included in the output.
		1 mark	The candidate has produced a limited description of the data to be output from the system. The output to be produced by the system is poorly designed. Limited consideration has been given to the reasons for the data that is included in the output.
Input content, capture and format	**[2]**	2 marks	The candidate has indicated how the data will be collected and entered into the system. The input method chosen should have been described and justified. Input screens and data capture forms have been fully designed.
		1 mark	The candidate has produced a limited description of how the data will be collected and entered into the system. There is a limited justification of the chosen input method. Design of the input screens is incomplete.

Files and/or data structures, methods of access	**[4]**	4 marks	The candidate has fully described all the required files and/or data structures. The candidate has considered and fully described methods of access.
		2 – 3 marks	The candidate has partially described the required files and/or data structures. The candidate has briefly described methods of access.
		1 mark	The candidate has described some of the required files and/or data structures. There is limited consideration of the methods of access.
Validation	**[2]**	2 marks	The candidate has fully described the validation routines to be carried out on the data entered into the system.
		1 mark	The candidate has described some of the validation routines to be carried out on the data entered into the system.
Processing stages	**[8]**	7 – 8 marks	The candidate has identified all processes needed to provide a comprehensive solution to the given problem. The relationships between the data and the processes or programs that manipulate and transform the data are clearly defined. The routines are fully described using an appropriate recognised convention, and these could be implemented by a competent third party. The interconnection between the programs and the files they access has been clearly shown.
		6 marks	The candidate has identified the processes needed to provide an effective solution to the given problem. The relationships between the data and the process or programs that manipulate and transform the data are defined. The routines are described using an appropriate recognised convention and these could be implemented by a competent third party. The interconnection between the programs and the files they access has been shown.
		5 marks	The candidate has identified a sufficient number of processes to provide a working solution to the given problem. There is some description of the relationships between the data and the processes or programs that are used to manipulate and transform the data. The candidate has briefly described the routines using a recognised convention. The interconnection between the programs and the files they access has been considered.

			3 – 4 marks	The candidate has identified some of the processes that are required to create a working solution to the problem. There is some consideration of the relationships between the data and the processes of programs that are used to manipulate and transform the data. The candidate has attempted to describe some of the routines attempting to use a recognised convention.
			1 – 2 marks	The candidate has identified more than one of the processes that would be included in a working solution to the problem. There is a brief description of the relationships between the data and the processes or programs that are used to manipulate and transform the data. There is a brief description of the routines.
	Evaluation criteria	**[2]**	2 marks	The candidate has produced a comprehensive set of criteria that will allow the performance of the finished system to be evaluated.
			1 mark	The candidate has produced some criteria that will allow features of the finished system to be evaluated.
CG4.3	**Software development**		**25 marks**	
		[25]	22 – 25 marks	The candidate has produced a fully functioning solution to a highly demanding problem. The user interface demonstrates an astute sense of audience and purpose.
			Either	The candidate has used and fully exploited the programming facilities of the language and has demonstrated a sound understanding of the appropriate tools and techniques available to them. The solution includes a significant amount of original code. The code written is fully self documenting and well structured.
			Or	The candidate has used the programming facilities of the applications package and has demonstrated a sound understanding of the appropriate tools and techniques available to them. The solution includes a significant amount of original code. The code written is fully self documenting and well structured.
			18 – 21 marks	The candidate has produced a functioning solution to a demanding problem. The user interface demonstrates a sound awareness of audience and purpose.

Either	The candidate has used and exploited the programming facilities of the language and has demonstrated an understanding of the tools and techniques available to them. The solution includes a significant amount of original code. The code written is self documenting and well structured.
Or	The candidate has used and exploited the programming facilities of the applications package and has demonstrated an understanding of the tools and techniques available to them. The solution includes a significant amount of original code. The code written is self documenting and well structured
12 – 17 marks	The candidate has produced a solution to a substantial problem that provides the majority of the required functionality. The interface demonstrates some sense of audience and purpose.
Either	The candidate has used the programming facilities of the language and has demonstrated some understanding of the tools and techniques available to them. The solution includes a significant amount of original code. The code does not fully utilise the programming facilities of the language. The code is partially self documenting.
Or	The candidate has used the programming facilities of the applications package and has demonstrated some understanding of the tools and techniques available to them. The solution includes a significant amount of original code. The code does not fully utilise the programming facilities of the application package. The code is partially self documenting.
6 – 11 marks	The candidate has produced a partially functioning solution to a problem. The user interface demonstrates some sense of audience and purpose.
Either	The candidate has used some of the programming facilities of the language but has demonstrated a limited understanding of the tools and techniques available to them. The solution contains some original code. The candidate has not utilised many of the programming facilities of the language.
Or	The candidate has used some of the programming facilities of the applications package but has demonstrated a limited understanding of the tools and techniques available to them. The solution contains some original code. The candidate has not utilised many of the programming facilities of the application package.

1 – 5 marks	The candidate has produced a limited solution to a problem. The user interface demonstrates a lack of sense of audience or purpose.
Either	The candidate has made limited use of the programming facilities of the language. The candidate has produced some original code that is poorly developed.
Or	The candidate has made limited use of the programming facilities of the applications package. The candidate has produced some original code that is poorly developed.

CG4.4 MAINTENANCE DOCUMENTATION 10 marks

Annotated listing	**[5]**	4 – 5 marks	The candidate has produced a fully annotated listing of each programming routine written for the system. All complex routines have been fully explained using comments.
		2 – 3 marks	The candidate has produced an annotated listing of some of the program routines written for the system. Some of the complex routines have been explained using limited comments.
		1 mark	The candidate has produced a limited annotated listing. There is little evidence of any complex routines being explained.
Procedure / subroutine details	**[3]**	3 marks	The candidate has listed all the subprograms or modules in the system. The purpose of the subprograms / modules have been defined. Any parameter passing utilised within the solution has been explained. Any global/local variables have been identified and their purpose explained.
		2 marks	The candidate has listed some of the subprograms or modules in the system. The purpose of the subprograms / modules has not been clearly defined. There is a limited explanation of the local/global variables used.
		1 mark	The candidate has listed only a few of the subprograms / modules in the system.
List of variables	**[2]**	2 marks	The candidate has listed all the variables used in the program and explained their purpose.
		1 mark	The candidate has listed some of the variables used in the program. The explanation of their purpose is limited.

CG4.5 TESTING 20 marks

Testing strategy	**[2]**	2 marks	The candidate has fully described the methods to be used to test the system. Due consideration has been given to the testing of the validation routines. A full range of appropriate testing methods has been incorporated in the test plan.
		1 mark	The candidate has provided a limited description of the methods to be used to test the system. A limited range of testing methods has been included in the test plan.
Test plan/data	**[4]**	4 marks	The candidate has devised a comprehensive test plan. The actual data to be used to test the system has been included. The choice of test data is appropriate. Expected results are provided. The test plan includes typical, extreme and erroneous data.
		2 – 3 marks	The candidate has devised an adequate test plan. The actual data to be used to test the system has been included. The choice of test data is not always appropriate. The test plan contains some examples of typical, extreme and erroneous data.
		1 mark	The candidate has devised a limited test plan. There is limited use of typical, extreme or erroneous data.
Actual test results	**[14]**	11 – 14 marks	The candidate has included detailed evidence of the thorough testing of the solution. The candidate has included informed commentaries of the testing process. The results produced include the use of typical, extreme and erroneous data. There is evidence of validation, interface and functional testing.
		7 – 10 marks	The candidate has included evidence of thorough testing of the solution. The candidate has included commentaries describing the testing process. There is use of typical, extreme or erroneous data during the testing process. There is some evidence of validation, interface and functional testing.
		5 – 6 marks	The candidate has included evidence of testing the majority of the functions of the solution. The candidate has included comments describing the testing process. There is limited use of typical, extreme or erroneous data within the testing process. There is limited evidence of validation, interface and functional testing.
		3 – 4 marks	The candidate has included some evidence of testing the functions of the solution. There are limited comments describing some features of the testing process. There is limited use of typical, extreme or erroneous data within the testing process.
		1 – 2 marks	The candidate has included brief evidence of testing the functions of the solution. There are few comments relating to the testing process.

This section assesses the candidate's quality of written communication. Marks are awarded for the following criteria, but only if the candidate's response demonstrates:

- legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning;
- selection of a form and style of writing appropriate to purpose and to complexity of subject matter;
- organisation of information clearly and coherently; use of specialist vocabulary where appropriate.

CG4.6 EVALUATION 10 marks

Evaluation of test results	**[2]**	2 marks	The candidate has evaluated the test results produced during system testing.
		1 mark	The candidate has produced a brief evaluation of the test results produced during system testing.
Solution satisfies the objectives	**[3]**	3 marks	The candidate has fully evaluated the solution against the objectives.
		2 marks	The candidate has evaluated the solution against the objectives.
		1 mark	The candidate has partially evaluated the solution against the objectives.
Solution satisfies the evaluation criteria	**[3]**	3 marks	The candidate has fully evaluated how closely the solution satisfies the evaluation criteria.
		2 marks	The candidate has evaluated how closely the solution satisfies the evaluation criteria.
		1 mark	The candidate has partially evaluated how closely the solution satisfies the evaluation criteria.
Future improvements	**[2]**	2 marks	The candidate has provided a detailed account of any potential future improvements.
		1 mark	The candidate has provided an account of any potential future improvements.

CG4.7 USER DOCUMENTATION 5 marks

Installation	**[1]**	1 mark	The candidate has provided instructions for the installation of the solution.
Use	**[4]**	3 – 4 marks	The candidate has produced a tutorial based on the facilities available to the user. This document should provide a comprehensive description of how to use the solution.
		1 – 2 mark	The candidate has produced a tutorial based on some of the facilities available to the user. The document produced is superficial and would not satisfy the needs of an inexperienced user.

8.9 The marking of units and standardisation

Internal Standardisation

Centres must apply a consistent standard of marking across different teachers and teaching groups. Where several teachers are involved in assessment, centres must standardise assessments across the teaching groups and provide a single rank order of candidates for the centre as a whole. Centres must confirm on the *Centre Mark Sheet,* that internal standardisation has taken place.

Many centres find that assessing common samples of work by individual teachers followed by discussion is the most effective means of achieving internal standardisation. After marks have been finalised by individual teachers, some sample cross marking combined with whole centre standardisation (where work is grouped into separate mark ranges and discussed across departments as a whole) is appropriate.

Exemplar Material

The WJEC will provide exemplar material for reference purposes. This material will include exemplars for unit CG2 and unit CG4 and explain how to apply the assessment criteria.

New Centres

Centres entering candidates for the first time should contact the WJEC **at the commencement of the course** if they require additional information on the required standards for unit CG2 and unit CG4.

8.10 Recording and Submission of Assessments

The following forms will be used for recording the assessment of candidate's work.

Unit CG2	*Composite Mark Sheet*	*Form CG2*
	Centre Mark Sheet	*Form CG2a*
Unit CG4	*Composite Mark Sheet*	*Form CG4*
	Centre Mark Sheet	*Form CG4a*

Copies of these forms are shown in appendix B

Completed forms and the accompanying work for **all** candidates should be sent to moderators by the date given in the examination timetable booklet**.**

The teacher should record on the *Centre Mark Sheet* the nature of any assistance given to candidates and to what extent the solution to the problem actually works and confirm that the work has not been submitted for assessment on a previous occasion.

8.11 Moderation and Supporting Evidence

Moderation of internal assessments of candidates' work is necessary to ensure that no injustice occurs to candidates because of variation in the standards applied by different centres. For this specification, moderation will be by inspection. This will take place on the basis of a detailed scrutiny, by WJEC moderators, of all the work of a sample of candidates.

Centres with up to 29 entries should send the work of **all** candidates, centres with 30 entries or more should send **a sample**, as given in the *Internal Assessment/Coursework Manual,* to the moderator by the date given in the examination timetables booklet; together with the relevant *Centre Mark sheets*. The coursework of each candidate must be accompanied by the *Composite Mark Sheet (CG2/CG4) and the Centre Mark Sheet (CG2a/CG4a).*

The moderator will select a sample of the work that will be remarked.

Adjustments to a centre's internal assessment will normally not alter the rank order, and will be made to bring the centre's assessments into line with standards generally. Where major discrepancies are found all of the work from a centre will be remarked and WJEC reserves the right to alter the rank order.

After results have been issued, centres will be notified of any adjustments made to their marks or changes to the order of merit. Feedback will be provided about the accuracy of assessments made and the reasons for any adjustments.

Moderators will return work submitted as hard copies to centres. WJEC will retain the CDs when work is submitted electronically.

8.12 Problems with individual candidates

Special consideration may be requested for candidates with particular assessment requirements. Further information is available from WJEC A Level section.

Teachers should be able to accommodate the occasional absence of candidates by ensuring that the opportunity is given for missed assessments to be made up.

Special consideration should be requested for candidates whose work has been affected by illness or other exceptional circumstances. All relevant information should be forwarded to WJEC office that deals with such matters for the centre concerned on the relevant forms.

If work is lost, WJEC should be notified immediately of the date of the loss, how it occurred and who was responsible for the loss. The WJEC will advise on the procedures to be followed in such cases.

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

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 new centre should take responsibility for assessment. WJEC will provide advice on the best course of action if required.

8.13 Change of teacher

It is appreciated that problems can arise in situations where a teacher leaves a centre during the period of assessment. It is hoped that the use of *Candidate Assessment Comment Forms* will reduce the problems arising from a change of teaching staff. The keeping of complete and effective records should enable another teacher to take over from the predecessor.

8.14 Retention of evidence and re-use of marks

The work of all candidates will be returned to centres at the earliest opportunity. Centres should retain candidates' work under secure conditions, following the examination to allow for the possibility of enquiry about the results or a request for a review of results.

Repeating candidates may carry forward the moderated mark for units CG2 and unit CG4 once only within a one-year period.

8.15 Special arrangements for private candidates

Private candidates must contact the WJEC before starting any work on units CG2 and CG4. Candidates must be clear that all the requirements for CG2 and CG4 can be met before embarking on the course.

APPENDIX A

Note 1
In general, the definitions and diagram conventions used will be those described in the current edition of 'The BCS Glossary of ICT and Computing Terms' (published by Pearson/Prentice Hall in association with the British Computer Society).

Note 2
When the word 'contemporary' is used in the specification, it indicates that the topic could change over time and it would be desirable to write exam questions about these changes.

When this happens, the new topics will be introduced gradually.

It is expected that candidates will be aware of developments in the areas of the specification where the word 'contemporary' has been used.

For example:

> *Compare the functional characteristics of contemporary secondary storage devices with respect to their speed of access, cost per unit of storage, durability and portability.*

New secondary storage devices may become commonplace and it would be desirable to write exam questions about these new devices.

Note 3
When the words 'contemporary' and 'including' followed by a list of items are used in the specification, it is intended that the list could change over time as computing inevitably progresses and changes.

For example:

> *Describe the use of contemporary methods and their associated devices for input and output including handwriting recognition, voice recognition and optical scanning.*

Other methods of input and output may become commonplace and it would be desirable to write exam questions about these new methods.

When this happens, the new topics will be introduced gradually.

It is expected that candidates will be aware of developments in the areas of the specification where this wording is used.

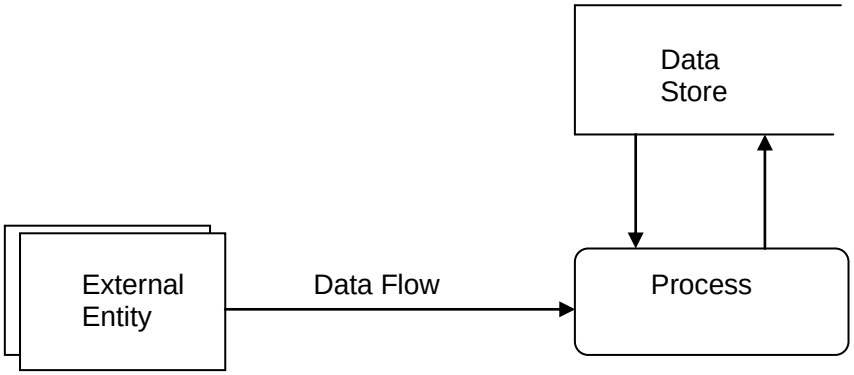
Note 4
When a list is preceded by a colon in the specification, it is intended that the list is exhaustive and only items in the list will be examined.

For example:

> *Describe the different primitive data types: Boolean, character, string, integer and real*

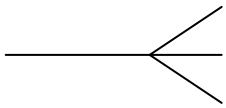
Note 5
In general, the diagram conventions used will be those described in the current edition of 'The BCS Glossary of ICT and Computing Terms' (published by Pearson/Prentice Hall in association with the British Computer Society.

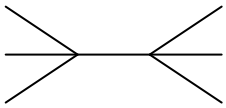
In the case of data flow diagrams, where no generally accepted symbols currently exist, candidates should be familiar with the following symbols, used in a number of current GCE textbooks:



Note 6
The following symbols are used for entities and relationships.

Entity 

One-To-Many Relationship 

Many-To-Many Relationship 

APPENDIX B

WJEC CBAC

GCE COMPUTING
CG2 TASK

CG2

Number of candidates entered for this unit

……

Nifer yr ymgeiswyr a gynigir yn y project hon

Name of Centre *Enw'r Ganolfan*	Centre Number *Rhif y Ganolfan*

Candidate's Examination No. *Rhif Arholiad yr ymgeisydd*	Candidate's Name (Surname first) *Enw'r Ymgeisydd (Cyfenw yn gyntaf)* BLOCK CAPITALS - *PRIFLYTHRENNAU*	Centre's Mark (100) Marc y Ganolfan (100)	Moderator's Mark *Marciau'r Safonwr*	Difference *Gwahaniaeth*	For office use only Swyddfa' n unig

DECLARATION	I certify that the work of the above candidates has been carried out under the conditions required by the WJEC.	***DATGANIAD***	*Tystiaf fod gwaith yr ymgeiswyr uchod wedi'i gyflawni dan yr amodau a bennwyd gan CBAC.*

Subject Teacher / *Athro'r Pwnc*	**Date / *Dyddiad***	**Moderator / *Safonwr***

WJEC CBAC

GCE COMPUTING
CG2 TASK

CG2a

Name of Candidate: ……..……. Candidate's Number: ……...……

Name of Centre: …… Centre Number: ……...

Title of Task: Board set scenario

CRITERIA	Max. Mark	Centre Mark	Mod. Mark	CENTRE COMMENTS
ANALYSIS AND DESIGN	**35**			
Problem definition	**3**			
Objectives	**4**			
Justification of proposed solution	**3**			
Data structures and methods of access	**5**			
User interface	**5**			
Hardware and software requirements	**2**			
Processing stages	**10**			
Evaluation criteria	**3**			
SOFTWARE DEVELOPMENT	**30**			
Software development	**30**			
PROGRAM DOCUMENTATION	**15**			
Data structure and variables	**3**			
User interface	**2**			
Annotated listings	**10**			
TESTING	**20**			
Testing strategy	**2**			
Test data	**3**			
Actual test runs	**10**			
Evaluation	**5**			
TOTAL	**100**			**Please transfer mark to the appropriate C Form**

Coursework Assessment Comments
To be completed by the supervisor during coursework assessment. Please indicate where help beyond normal supervisory guidance has been given and how this has affected the marks awarded.

List the sources of information used in developing the coursework.

NOTICE TO CANDIDATES
The work you submit for assessment must be your own. If you copy from someone else, allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified from at least the subject concerned.

DECLARATION BY TEACHER	**DECLARATION BY CANDIDATE**
I confirm that the candidate's work was conducted under the conditions laid out by the specification. I have authenticated the candidate's work and am satisfied that to the best of my knowledge the work produced is solely that of the candidate. **Teacher's signature**: …….. **Date**: ……2009	I have read and understood the **Notice to Candidate** (above). I have produced the attached work without assistance other than that which my teacher has explained is acceptable within the specification. **Candidate's signature:** …….. **Date**: ……2009

GCE COMPUTING
CG4 PROJECT

CG4

Number of candidates entered for this unit

……

Nifer yr ymgeiswyr a gynigir yn y project hon

Name of Centre *Enw'r Ganolfan*	Centre Number *Rhif y Ganolfan*

Candidate's Examination No. *Rhif Arholiad yr ymgeisydd*	Candidate's Name (Surname first) *Enw'r Ymgeisydd (Cyfenw yn gyntaf)* BLOCK CAPITALS - *PRIFLYTHRENNAU*	Centre's Mark (100) Marc y Ganolfan (100)	Moderator's Mark *Marciau'r Safonwr*	Difference *Gwahaniaeth*	For office use only Swyddfa' n unig

DECLARATION	I certify that the work of the above candidates has been carried out under the conditions required by the WJEC.	***DATGANIAD***	*Tystiaf fod gwaith yr ymgeiswyr uchod wedi'i gyflawni dan yr amodau a bennwyd gan CBAC.*

Subject Teacher / *Athro'r Pwnc*	**Date / *Dyddiad***	**Moderator / *Safonwr***

GCE COMPUTING
CG4 PROJECT

CG4a

Name of Candidate: ……..……. Candidate's Number: ……...……

Name of Centre: …… Centre Number: ……...

Title of Project:				
CRITERIA	**Max. Mark**	**Centre Mark**	**Mod. Mark**	**CENTRE COMMENTS**
ANALYSIS	**10**			
Background	**1**			
Investigation and analysis	**5**			
Problem definition	**2**			
Objectives	**2**			
DESIGN	**20**			
Output content and format	**2**			
Input content, capture and format	**2**			
Files and/or data structures, methods of access	**4**			
Validation	**2**			
Processing stages	**8**			
Evaluation criteria	**2**			
SOFTWARE DEVELOPMENT	**25**			
Software development	**25**			
MAINTENANCE DOC.	**10**			
Annotated listing	**5**			
Procedure / subroutine details	**3**			
List of variables	**2**			
TESTING	**20**			
Testing strategy	**2**			
Test plan / data	**4**			
Actual test results	**14**			
EVALUATION	**10**			
Evaluation of test results	**2**			
Solution satisfies the objectives	**3**			
Solution satisfies the evaluation criteria	**3**			
Future improvements	**2**			

USER DOCUMENTATION	**5**			
Installation	**1**			
Use	**4**			

TOTAL	**100**			**Please transfer mark to the appropriate C Form**

Coursework Assessment Comments
To be completed by the supervisor during coursework assessment. Please indicate where help beyond normal supervisory guidance has been given and how this has affected the marks awarded.

List the sources of information used in developing the coursework.

NOTICE TO CANDIDATES
The work you submit for assessment must be your own. If you copy from someone else, allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified from at least the subject concerned.

DECLARATION BY TEACHER	**DECLARATION BY CANDIDATE**
I confirm that the candidate's work was conducted under the conditions laid out by the specification. I have authenticated the candidate's work and am satisfied that to the best of my knowledge the work produced is solely that of the candidate. **Teacher's signature**: …….. **Date**: ……2010	I have read and understood the **Notice to Candidates** (above). I have produced the attached work without assistance other than that which my teacher has explained is acceptable within the specification. **Candidate's signature:** …….. **Date**: ……2010

APPENDIX C

'Cover Sheets' to be used with electronic submission of CG2

When work is submitted electronically, candidates should make use of the electronic front sheet (Form CG2e or Form CG4e) saved in html format. Each heading on the sheet should be hyperlinked to a pdf version of the write up for that particular requirement of the specification. For a full explanation, please see Section 8.3

WJEC CBAC

GCE COMPUTING
CG2 TASK

CG2e

Name of Candidate: ……..……. Candidate's Number: ……...……

Name of Centre: …… Centre Number: ……...

Title of task: Board set scenario	
Analysis and Design	Problem definition
	Objectives
	Justification of the proposed solution
	Data structures and methods of access
	User interface
	Hardware and software requirements
	Processing stage
	Evaluation criteria
Software development	Software development
Program Documentation	Data structures and variables
	User interface
	Annotated listings
Testing and Evaluation	Testing strategy
	Test data
	Actual test runs
	Evaluation

GCE COMPUTING
CG4 PROJECT

CG4e

Name of Candidate: ……..……. Candidate's Number: ……...……

Name of Centre: …… Centre Number: ……...

Title of project:	
Analysis	Background
	Investigation and Analysis
	Problem definition
	Objectives
Design	Output content and format
	Input content, capture and format
	Files and/or data structures, methods of access
	Validation
	Processing stages
	Evaluation criteria
Software development	Software development
Maintenance documentation	Annotated listings
	Procedure/subroutine details
	List of variables
Testing	Testing strategy
	Test plan/data
	Actual test results
Evaluation	Evaluation of test results
	Solution satisfies the objectives
	Solution satisfies the evaluation criteria
	Future improvements
User documentation	Installation
	Use