Scottish Certificate of Education

Standard Grade Amended Arrangements in Computing Studies

At Foundation, General and Credit Levels in and after 1994

1991

Contents

Introduction

Arrangements in Computing Studies on the Standard Grade of the Scottish Certificate of Education were issued to presenting authorities and centres in January 1986 and an examination based on these was introduced in 1988. In the light of the Report of the Standard Grade review of Assessment Group (SGROAG): "Assessment in Standard Grade Courses: Proposals for Simplification", a Short Life Working Group on Computing Studies subsequently was established and Revised Arrangements in Computing Studies were issued in September 1987. Examinations at Foundation, General, and Credit Levels based on the Revised Arrangements were offered from 1989. The Revised Arrangements (paragraph 3 1) recognised the pace of change in the field of computing and it was envisaged that "... (the) syllabus and content outline will be reviewed at regular intervals".

The introduction of Computing Studies on the Higher Grade, together with the need to take account of the expanding body of knowledge and of new computer hardware and software developments, led to the establishment early in 1990 of a Joint Working Group (JWG), the remit of which was to review the Standard Grade Revised Arrangements to take account of the expanding body of knowledge in computing, facilitate the incorporation of future developments in associated hardware and software, and to lead to articulation with the Higher Grade Computing Studies syllabus.

In March 1991 the JWG's proposals were issued to interested bodies for comment.

With the assistance of the JWG, the Board's Computing Studies Panel has modified the original proposals in the light of comments received and has agreed the finalised Arrangements detailed in this document.

Examinations in Computing Studies based on the amended Arrangements will be offered on the Standard Grade in and after 1999.

1 Rationale

A view widely held by parents, pupils and employers is that young people in particular should know about and be able to use computers since these and related technologies are playing an increasingly important part in economic, social and political life. A rationale for the study of computing includes the following perspectives:

- many young people have an interest in the ways in which computers operate, how hardware and software interact and the various ways in which machines can be programmed;

- young people should have an understanding of the nature and social purpose of computers, thus obviating the fear of technology admitted to by many adults;

- the study of computers and their uses can be a means of translating educational aims concerning the skills of problem solving into a practical reality to which young people can relate;

- the study of computing can contribute usefully to the general cognitive development of young people and enhance their self-esteem;

- knowledge of computers and their uses gives advantages for future employment, even for those who leave school at the earliest opportunity.

The Standard Grade Computing Studies course reflects all of these perspectives. It is considered that a general, broad-based approach to computing is appropriate to the S3 and S4 stages of education. The Computing Studies syllabus is seen as a vehicle for engaging candidates in problem-solving activities in a variety of contexts and providing them with practical experience in areas where computers are used. The syllabus is intended to capture and heighten interest and offer a stimulating and systematic study of computers and their uses. The syllabus also provides a suitable basis for further study of the subject and the opportunity to develop the attitudes necessary for responding to the challenges of a technological environment.

2 Aims, Objectives and Assessable Elements

2 1 Aims

The Standard Grade Computing Studies syllabus aims to develop:

knowledge and understanding of the uses of computers, how they operate, and their effect on the individual and society;

the ability to apply knowledge and understanding of computing facts in order to find solutions to problems;

practical abilities in the use of computers and computer software in order to solve practical problems.

In addition, it aims to provide a suitable basis for further study of the subject.

2 2 Objectives

As a result of pursuing the above aims in a computing environment, candidates should be able to demonstrate the ability to:

recall, describe and explain computing facts and concepts;

analyse, outline, refine and discuss approaches to finding solutions to problems;

obtain relevant information and use computer hardware and software in implementing practical solutions to problems;

identify and rectify errors in practical solutions to problems;

discuss progress, assess adequacy, consider implications and suggest improvements to the solutions of problems.

2 3 Assessable Elements

The abilities identified by the above objectives are grouped into three assessable elements, namely

Knowledge and Understanding;
Problems Solving;
Practical Abilities.

The elements form the basis for assessing and profiling performance. The level of performance expected of candidates with regard to the abilities within Knowledge and Understanding, Problem Solving and Practical Abilities is described by the Grade Related Criteria (Section 7).

3 Syllabus - Outline

3 1 Time Allocation

In devising the syllabus, a teaching time of 160 hours for the course has been presumed. Time allocations for each syllabus section are indicated below. These times are offered for guidance only and are not prescriptive. The suggested time allocation allows 10 hours for use by the teacher in any section of the syllabus requiring more attention.

3 2 Broad Areas of Content

The syllabus focuses on three broad areas:

Computer Applications;
Computer Systems;
Computer Programming.

The main aspects and detailed content associated with these are specified below. Learning and teaching approaches, and the particular resources to be used, are not prescribed. It is necessary, however, that candidates are provided with learning experiences which will enable them to develop their knowledge and understanding of computing, their problem-solving skills, and a variety of practical abilities. To this end, candidates should spend a significant amount of time undertaking practical work.

The broad areas of content are described in paragraphs 3 2 1 to 3 2 3 below. Certain items of the Detailed Content of these broad areas are expanded upon in paragraph 4 3. This expansion provides a means of keeping the syllabus abreast of advances in technology. The items covered in paragraph 4 3 will be the subject of regular review.

3 2 1 Computer Applications (60 hours)

Two areas will be studied:

General Purpose Packages (40 hours);
Industrial and Commercial Applications (20 hours).

Overviews for these areas will be studied and each area will include an associated case study.

The purpose of the case studies to enable candidates to develop further their knowledge and understanding of the main aspects identified in the overview, and to give them additional opportunities to apply problem-solving skills and acquire practical abilities. There is no restriction on the choice of case study or on its detailed content. Main aspects, detailed content and suggested case studies for the above areas are given in paragraph 4 1 3 and 4 1 4. **The detailed content, together with the expanded detailed content specified in paragraph 4 3, will be used as the source for questions set in external examination papers and candidates' work in this broad area may be used as evidence of attainment in Practical Abilities.**

3 2 2 Computer Systems (20 hours)

The main aspects associated with the content of this broad area are:

Systems software;
Operating and filing systems;
Low level machine;
Hardware.

Detailed specification of the content associated with each of these main aspects is provided in paragraph 4 2. **The detailed content, together with the expanded detailed content specified in paragraph 4 3, will be used as the source for questions set in external examination papers and candidates' work in this broad area may be used as evidence of attainment in Practical Abilities.**

3 2 3 Computer Programming (40 hours)

Programming is concerned with the development of the practical abilities of problem analysis and design of solutions, practical implementation (which includes coding) and evaluation. The main aspects and detailed content associated with Programming are given in the General Programming Specification in paragraph 4 4 3. Computer programming will be undertaken in an environment of the centre's choice. Because of the range of environments which may be used, programming will be entirely internally assessed. **Candidates' work in this broad area will be used as evidence of attainment in Practical Abilities.**

3 3 Project Work (30 hours)

Throughout their study of the broad areas of content, candidates are also required to undertake project work. Project work offers structured learning experiences in which candidates can work at their own pace, creating and following their individual work plans. All candidates will be required to carry out at least one project. **Candidates' project work will be used as evidence of attainment in Practical Abilities.** The detailed arrangements for undertaking project work are described in paragraph 5 1.

4 Syllabus - Detailed Content

4 1 Computer Applications (60 hours)

This section expands upon the information provided in paragraph 3 2 1 above and on the overviews and case studies associated with each of the areas within Computer Applications. The overviews and case studies are intended to give pupils a broad and balanced experience of applications of computer use in a wide variety of situations. The selection of hardware and software to support the areas of study will be at the discretion of the individual centres.

4 1 1 Overviews

The overviews for each of the areas within Computer Applications detail the content which candidates need to know and understand and be able to use in solving problems.

4 1 2 Case Studies

A case study is a topic intended to reinforce and expand on some or all of the main aspects described in the associated overview. The case study will normally involve the study of specific applications of computers and include at least some practical work. The case study may be concerned with a type of computer package, such as a desk top publishing system, or a specific context in which computers can be used, such as a travel agency.

The choice of case study for each of the two areas - General Purpose Packages and Industrial and Commercial Applications - is the responsibility of the presenting centre and therefore allows for teachers' specialisms or consideration of local interests. Some suggestions for case studies are given in paragraph 4 1 3 and 4 1 4.

Work undertaken in case studies will not be assessed externally. Such work, however, may be used to provide evidence of a candidate's level of competence in Knowledge and Understanding, Problem Solving and Practical Abilities.

4 1 3 General Purpose Packages (40 hours)

This area considers how computers can be used to input, process, store and transfer information and how applications packages can be seen as tools with problem solving applications. The overview deals in general terms with the main aspects of General Purpose Packages, which should be studied with reference to a broad range of applications, eg electronic mail, on-line library systems, expert systems. In addition, the overview specifies the main aspects, wordprocessing, database, spreadsheet and graphics. Study of the main aspects of General Purpose Packages, together with the associated practical work with the four classes of package, is expected to require around 32 hours teaching time.

Candidates should study at least **one** package within each of the four classes of package, ie wordprocessing, database, spreadsheet and graphics. The use of such packages affords opportunities for the development of practical abilities. It is recognised, however, that the level of difficulty involved in the practical implementation of an application package is related to the particular hardware and software which is used. It will be for presenting centres to decide which packages will be used and what features of the selected package are appropriate to the development of practical abilities at Foundation, General and Credit Levels. It should be noted that the practical learning experiences of a candidate working at a particular Level need not match those items of detailed content about which they may be examined in the external question papers.

Approximate time allocations and suggestions for a case study appropriate to General Purpose Packages are as follows.

Overview (32 hours)

Case Study (8 hours)

Examples:

Viewdata/Teletext
An Expert System
Electronic Mail
Graphics
Spreadsheet
Wordprocessing
Database

GENERAL PURPOSE PACKAGES - OVERVIEW

The following detailed content will be used as the source of questions set in the external examination papers. It does not represent compulsory practical activity.

MAIN ASPECT	F/G/C	G/C	C
NEED	storage, retrieval and communicating of large quantities of information.	accurate, complete and up-to-date information.	flow of information between and within organisation.
HARDWARE AND SOFTWARE	applications packages; integrated package; basic hardware for general.	printer quality.	knowledge systems.
STORAGE	manual, electronic; types of data-numbers, text, graphics, need for backup.		order of magnitude of storage capacity.
HUMAN COMPUTER INTERFACE (HCI)	menu driven; user friendliness; WIMP environment - Windows, Icon, Mouse/Menu, Pull-down Menu/Pointer.	command driven; on-line help, on-line tutorial; Graphical user Interface.	
SOFTWARE INTEGRATION	links between tasks; common HCI.	ease of transfer.	static/dynamic data linkage.
SELECTION OF PACKAGES	main purpose of each package (eg wordprocessing for production of texts).	potential of packages to fulfil more than one function (eg drawing graphs using spread.	selection of most appropriate package or packages on the basis of hardware and software availability and the nature of the task.
COMMUNICATION	electronic communication; networks; modem; teletext, viewdata, facsimile; on-line, off-line.	local area network; wide area network; reliability of data link.	multi-access.
IMPLICATIONS - SOCIAL	 job types and careers; retraining; mail shots.	 effects on employment and working conditions; increased paper.	
- SECURITY AND PRIVACY	right of access to personal data; need to check accuracy; precautions against data loss.	exceptions to right of access; control of access (eg passwords); unauthorised access to data (eg "hacking").	data protection principles; data subject, data user; Computer Misuse Act and other legislation.
- ECONOMIC	 initial costs.	replacement costs; running costs.	staff costs.

GENERAL PURPOSE PACKAGES - OVERVIEW (continued)			
MAIN ASPECT	**F/G/C**	**G/C**	**C**
ADVANTAGES	speed and accuracy of processing; ease of amendments.	increased productivity; layout flexibility.	availability of information.
COMMON FEATURES OF MOST GENERAL PURPOSE PACKAGES	run/open application; new; open/load file; package; save file; print file; insert/amend/delete; change text appearance.	print part of file/document; copy/move.	alter HCI parameters; header, footer, printer drivers.
WORDPROCESSING	enter text; wordwrap; alter line length; centre text.	standard paragraph; search and replace; spelling check; justify text; tabulation; alter page length.	standard letters.
SPREADSHEET	rows/columns/cells; values; text; simple formulae, eg (+ - * /, SUM (..)); calculation - automatic and manual; charting.	insert row; insert column; complex formulae; alter column width; replicate; alter cell attributes (eg number of decimal places).	formulae involving conditions (IF (...)). relative reference; absolute reference; cell protection.
DATABASE	add record; create fields; search on one field; sort on one field.	alter record format; search on more than one field.	computed field; alter screen input format; alter output format; use of key words; sort on more than one field.
GRAPHICS	draw graphic; enter text; select tool.	alter tool attributes (eg line width); scale graphic; rotate graphic.	

4 1 4 Industrial and Commercial Applications (20 hours)

The study of this area includes an overview of Automated Systems and an overview of Commercial Data Processing. Approximate time allocations and suggestions for a case study linked to Industrial and Commercial Applications are as follows:

Overview:	Automated Systems (6 hours)
Overview:	Commercial Data Processing (6 hours)
Case study	(8 hours)

Examples:

Robotics
CAD/CAM
Banking
Stock Control
Airline Reservations
Industrial Process Control
Stock Exchange
Accounting Applications
Simulations

4 1 5 Automated Systems

The study of Automated Systems provides an overview of the use of computers in control, design and simulation. In control applications, computers send information to, and receive information from, other devices in the form of electrical signals. The response speed of the system is often a critical factor in the development of such applications. The combination of flexible design and machine control lies at the heart of Computer Aided Design (CAD) and Computer Aided Manufacture (CAM). The whole field of simulation allows representation of situations which would otherwise be too hazardous or lengthy.

The main aspects of Automated Systems should be illustrated by references to a range of application such as robotics, control, CAD/CAM and simulations.

INDUSTRIAL AND COMMERCIAL APPLICATIONS
AUTOMATED SYSTEMS - OVERVIEW

The following detailed content will be used as the course of questions set in the external examination papers. It does not represent compulsory practical activity.

MAIN ASPECT	F/G/C	G/C	C
NEED	speed; hazardous environment; repetitive tasks.	efficiency; accuracy.	adaptability.
HARDWARE AND SOFTWARE	interface; sensors; feedback; robots: - anatomy - motor - programmable - stationary/mobile; CAD/CAM; CNC; simulation.	analogue I/O; guides - magnetic and light; open and closed loops; high level instructions; real-time.	A to D and D to A converters; end effector; control language; degrees of freedom; digitiser; ROM software.
HUMAN COMPUTER INTERFACE	interaction.		
IMPLICATIONS - SOCIAL	retraining.	employment - changes in nature of job; - increased leisure time.	
- TECHNICAL		industrial automation; safety precautions.	design of workplace; factory of the future; need for systems analysis.
- ECONOMIC		high initial cost; long term savings; replacement costs.	capital, labour intensive; effects on productivity.

4 1 6 Commercial Data Processing

A study of Commercial Data Processing gives an overview of large scale data processing and the main stages of the data processing cycle involving both batch and interactive processing. The main aspects indicated below should be illustrated by appropriate references to a range of applications, eg banking, mail order, payroll and stock control.

INDUSTRIAL AND COMMERCIAL APPLICATIONS
COMMERCIAL DATA PROCESSING - OVERVIEW

The following detailed content will be used as the source of questions set in the external examination papers. It does not represent compulsory practical activity.

MAIN ASPECT	F/G/C	G/C	C
NEED	volume of documents; speed of processing; speed of access; repetitive tasks.		management information.
DATA PROCESSING CYCLE	data collection; data preparation, input, processing and storage; output.	difference between data and information.	
DATA COLLECTION, PREPARATION AND INPUT	Kimball tags; bar codes; magnetic stripes; character recognition.	key to disc; direct data entry; turnaround document. magnetic ink character recognition (MICR); check digit; types of check (eg length range, reliability).	remote data entry; mark sense cards; optical character recognition (OCR); validation; verification.
PROCESSING AND STORAGE	data, field, record, file; update; backup.	batch processing; interactive processing; master file; transaction file.	sequential access; random/direct access; file ancestry.
OUTPUT	paper, screen, pre-printed stationery.	microfiche.	file.
HARDWARE AND SOFTWARE	basic hardware: - mainframe computer system - terminals.		remote terminals.
IMPLICATIONS			
- SOCIAL	effects on business.	job types and careers - programmer - systems analyst - engineer - computer operator - data preparation operator.	computer crime, fraud.
- TECHNICAL		electronic funds transfer (EFT); point of sale (POS).	
- ECONOMIC	initial costs; mass market.	running costs.	
- SECURITY AND PRIVACY	accuracy of information; privacy.	security; sale of customer lists.	current legislation.
ADVANTAGES	comparison with manual systems.	maintaining contact with and information about large number of customers.	single entry multiple use.

4 2 Computer Systems (20 hours)

This broad area deals with the main aspects of systems software, operating and filing systems, low level machine and hardware set out below. Content may be delivered in the context of particular computer applications or treated as a distinct topic. The separate identification of content in the Arrangements is merely for convenience of definition and does not imply a preference for a particular teaching approach.

COMPUTER SYSTEMS - OVERVIEW

The following detailed content will be used as the source of questions set in the external examination papers. It does not represent compulsory practical activity.

MAIN ASPECT	F/G/C	G/C	C
SYSTEM SOFTWARE	purpose of high level languages; need for translation.	common features of high level languages.	special purpose languages; types of translator: - compiler - interpreter - assembler - relative advantages; portability of software.
OPERATING AND FILING SYSTEMS	operating system as a program; directory/catalogue.	standard functions of operating systems; batch system; interactive system; real-time systems; types of file - data - program.	specialised functions of operating systems; multi-programming; multi-access; resource allocation; interactive systems with background job capability; types of filing system - flat - hierarchical; sequential and random/ direct access to data.
LOW LEVEL MACHINE	stored program; bit, byte, kilobyte (K), megabyte; main memory size; Input, Process, Output (IPO); Central Processing Unit (CPU).	concept of machine code; representation of number, text, graphics; concept of character set.	 word; concept of addressability; representation of non-negative integers; floating point representation of large numbers; control characters; control unit; Arithmetic/Logic Unit (ALU).
HARDWARE	microprocessor; chip; main store/memory; ROM and RAM; backing store; input devices; output devices.	 storage location;	effect of changes in technology; capacity of backing store; concept of non-magnetic storage; sequential and random/direct access devices.

4 3 Expanded Detail Content

The table below gives an expansion of some items of content which will be the subject of regular review. The table allows for an updating of what candidates are expected to know, understand and use in solving problems. The content specified in the table together with the Detailed Content given for Computer Applications and Computer Systems will be the source for questions set in the external examination papers.

ITEM OF DETAILED CONTENT	F/G/C	G/C	C
backing store (Computer Systems)	magnetic tape; floppy disc; hard disc; CDROM.		use of a combination of backing storage devices for multimedia. re-writeable optical disc.
input devices (Computer Systems)	mouse; trackball/tracker ball; light pen; graphics tablet; touch sensitive screen; keyboard.	scanner; voice recognition; handwriting recognition.	specialised input devices for eg - disabled users - virtual reality. use of a combination of input devices for multimedia.
output devices (Computer Systems)	printer: - dot matrix; - laser; - inkjet; plotter; VDU.	Liquid Crystal Display (LCD); voice output.	specialised output devices for eg - disabled users - virtual reality. use of a combination of output devices for multimedia.
basic hardware for general purpose packages (General Purpose Packages)	types of computer: - desktop computer; - laptop computer; - palmtop computer.		

4 4 Computer Programming (40 hours)

4 4 1 Introduction

The practical abilities which are to be developed through programming activity are problem analysis and design of solutions, practical implementation and evaluation. The level of performance required in these abilities is described by the Extended Grade Related Criteria in paragraph 7 10. The main aspects and detailed content associated with programming are specified in paragraph 4 4 3.

4 4 2 Programming Environment

There is no restriction on the software environment to be used for programming activity. However, the chosen environment must enable broad coverage of the main aspects and content given in the general programming specification in paragraph 4 4 3. Programming environments may involve imperative languages (such as COMAL), declarative languages (such as COMAL), declarative languages (such as PROLO) and the use of application packages with high functional capability (such as certain spreadsheet packages), and centres may choose to use a variety of programming environments throughout the course. Centres will decide which features of their chosen environment will be used by candidates aiming at presentation at particular Levels. Exemplar specifications for a number of different languages based on the general programming specification are given in Appendices I(a) to I(e). Centres are free to use these exemplars, to amend them, or to devise their own programming specification. It is to be noted that in these exemplars, some details of the content do not match precisely the general programming specification. This is inevitable, given differences between programming environments and is acceptable for the purposes of assessment for certification as long as there is broad compatibility.

4 4 3 Programming a Solution

The following general programming specification identifies the main aspects which should be covered in programming and indicates the detailed content which should normally be covered at Foundation, General and Credit Levels. This detailed content is exemplified in Appendices I(a) to I(e).

GENERAL PROGRAMMING SPECIFICATION			
MAIN ASPECT	**F/G/C**	**G/C**	**C**
REPRESENTATION OF SOLUTION TO PROBLEM	one simple representation (eg structure diagram).		use of a variety of representations (eg pseudo code, proto-type versions, diagram).
TEXT ENTRY	enter; edit; list/print out current version.		
SEQUENCE	significance (if any) of the order of program instructions.		
MODULARITY (ie construction and use of blocks of code)	sensible arrangement of blocks of code.	flow of data between sections of code.	use of code which requires passing of parameters.
SIMPLE DATA TYPES	numeric; text.		
STRUCTURED DATA TYPES			one-dimensional arrays.
DATA TRANSFER (ie mechanisms for getting data into and out of a program)	single item.	multiple items.	
STATEMENTS	assignment of constants; assignment of expressions.	assignment of incremental expressions.	
EXPRESSIONS	simple, commonly used keywords and operators (eg arithmetic operators).	commonly used predefined functions; comparison operators.	logical operators.
REPETITION (where relevant to language)	fixed loop.	control variable used in loop; nested loops.	conditional loops
CONDITION		simple condition.	complex condition.
IDENTIFY AND RECTIFY ERRORS	syntax, system and logical errors.		
TEST SOFTWARE	use supplied test data.	use own test data.	supply full set of test data.
READABILITY	use meaningful variable names; provide internal commentary.		
USER INTERFACE	screen layout.	prompts to user.	input validation.

5 Project Work and Coursework

5 1 Project Work (30 hours)

5 1 1 Candidates respond well to the challenge of solving a problem of appropriate difficulty or carrying out a suitable investigation and thereafter preparing a report. Project work offers the satisfaction of completing a task using a specification which has been accepted, interpreted and developed by the individual. Project work also offers structured learning experiences in which candidates can work at their own pace, create and follow their individual work plans and have the opportunity to decide on priorities as well as outcomes.

5 1 2 Project Work provides an appropriate vehicle for the internal assessment of practical work in computing and therefore makes a major contribution to the assessment of Practical Abilities. The project specifications and marking schemes issued and the moderation arrangements operated by the Board provide a framework within which comparability and standards can be assured. Projects will be specified by the Board for all Levels.

5 1 3 For each candidate, **one** project will be used to determine the grade for Project Work.

5 1 4 The Board will issue a range of project specifications from which a choice is to be made. Each project specification will be accompanied by a confidential marking scheme detailing how the project is to be assessed. The marking scheme will be drawn up with reference to the Extended Grade Related Criteria (EGRC) for Practical Abilities set out in paragraph 7 10, will indicate the Level or Levels to which the Project applies, and hence which grades can be achieved. The marking scheme will indicate the cut-off scores associated with the grades available for a particular project. The project specifications and marking schemes should not be seen as inviolable: if necessary, they can be amended by the teacher to suit local circumstances with assessable tasks being added or deleted and corresponding changes made to the marking scheme.

5 1 5 Projects will be designed to test performance at one, or more than one, level. For projects assessing performance at Credit and General Levels, it will be possible for candidates to achieve a "near-miss" grade. Thus candidates may achieve a grade 3 award from a Credit Level project and a grade 5 award from a General Level project.

5 1 6 It is recognised that candidates aiming at Foundation Level presentation are likely to respond better to short projects. Consequently, projects assessing achievement of the Foundation Level EGRC should b be able to be completed in 6-10 hours. Conversely, candidates at Credit Level are likely to derive considerable benefit from longer projects. Projects assessing the Credit Level EGRC should normally be completed in 14-20 hours. General Level projects should require 10-14 hours for completion.

5 1 7 It is envisaged that all candidates, whatever their level of ability, will spend approximately 30 hours of class time on project work, a significant proportion (almost 20%) of the time allocated to the course. The balance of the available 30 hours which is not used in connection with the project to be submitted for certification purposes may be used to undertake practice projects using the specifications issued by the Board, or for other practical work defined by the teacher. (Work done in this "balance time" can be used along with other coursework to determine the grade for Coursework.) The arrangements for the internal assessment of Practical Abilities are detailed in Section 6.

5 1 8 Projects should be chosen by the candidate, with teacher guidance, on the basis of interest and likely Level of performance. Where a candidate completes a project and the teacher considers, in retrospect, that the project was at an inappropriate Level, the candidate may undertake a further project at a different Level(s).

5 2 Coursework

Coursework includes both programming and non-programming work which is related to the content of the course and may take the form of project work undertaken in addition to the submitted project, case studies or other practical work undertaken during the course. Coursework contributes in part to the assessment of Practical Abilities and evidence of attainment will be required, as described in paragraph 6 5 4. A range of activities which offer candidates full opportunity to develop Practical Abilities and which meet the EGRC identified in paragraph 7 10 should be incorporated in the course.

6 Assessment For Certification

6 1 Certification

Candidates will be assessed by a system common to all Levels. The Certificate will record an overall award on a 7-point scale of grades, grade 1 being the highest. The Certificate will also record attainment in each element. The overall award will be the mean, rounded as necessary, of the element grades, weighted as descried in paragraph 6 3 2 below.

6 2 Assessable Elements

6 2 1 Knowledge and Understanding is concerned with the demonstration of the ability to:

recall;
describe;
explain computing facts and concepts.

6 2 2 Problem Solving is concerned with the demonstration, in a variety of theoretical contexts, of the ability to:

analyse problems and design solutions;
evaluate solutions.

6 2 3 Practical Abilities is concerned with the demonstration, in a variety of practical situations, of the ability to:

analyse problems and design solutions;
implement practical solutions;
evaluate practical solutions.

6 3 Internal and External Assessment

6 3 1 Knowledge and Understanding and Problem Solving will be assessed externally by written examination.

Practical Abilities will be assessed internally, with external moderation by the Board.

6 3 2 The weighting of the elements will be in the ratio of 1:2:2 respectively for Knowledge and Understanding, Problem Solving and Practical Abilities, reflecting the relative importance of problem solving in the syllabus and the emphasis on internally assessed practical abilities.

6 4 Grade 7 and No Overall Award

For any element, grade 7 will indicate that the candidate has, in the element concerned, completed the course but has not demonstrated achievement of any specified Grade Related Criteria level of performance. Grade 7 in an element will not be available to external candidates.

The Board will regard the submission of an estimate grade for an externally assessed element as evidence that the course has been completed in that element.

Candidates who have not complied with the assessment requirements in any element (eg due to unauthorised absence from the external examination or failure to submit project work) will be deemed not to have completed the course, in that element. Such candidates **will not receive a grade** for that element and hence **will not receive an overall award** for the subject. In such cases, however, grade(s) for the other element(s) will be recorded on the Certificate.

6 5 Internal Assessment of Practical Abilities

6 5 1 The three types of work to be assessed internally in connection with Practical Abilities are:

Project Work;
Non-programming Coursework;
Programming Coursework.

6 5 2 Candidates will require to keep a Folder of Work to be used in connection with the assessment of Practical Abilities. Internal assessments may be subject to moderation and Folders of Work must therefore be available for submission to the Board by 31 March prior to the external examination. The Folder of Work should be produced in A4 format or folded to A4 size in a folder other than a ring binder and should be labelled clearly with the candidate's name.

Where candidates work together on a practical task, any work produced in such circumstances will be the product of the efforts of the entire group. As such it cannot constitute acceptable evidence for summative assessment purposes.

6 5 3 Project Work

Project work, project specifications and the associated marking schemes are described in paragraph 5 1. Candidate's work should be assessed at stages throughout the development of each project. If judged necessary, assistance may be given by the teacher so that failure in one part of a project does not preclude achievement in a subsequent, related part. Any assistance given should be noted, since it is likely to have influenced the marks awarded by the teacher.

For the project which is to be submitted for certification purposes, candidates will be required to complete a Project Report which should be retained in their Folder of Work. The Project Report should not bear any marks or comments by the teacher.

Teachers must ensure that candidates attempt projects at a Level consistent with their abilities. The marking scheme for each project specification supplied by the Board will be applied by the teacher to each candidate's work, and the grade obtained by the candidate determined in relation to the cut-off scores detailed in the marking scheme. Where project work has been attempted but the score for the project is less than the lowest cut-off score for that project, grade 7 should be awarded. The grade for project work will be used as described in paragraph 6 6 when deciding on the grade for Practical Abilities.

6 5 4 Coursework

Evidence of the Level of attainment in Practical Abilities will also derive from the candidate's performance in programming and non-programming coursework related to the content of the course. This may take the form of project work undertaken in addition to the submitted project. Coursework tasks should be set in the context of the appropriate syllabus Level, paying due attention to the hardware and software available. The instructions given to candidates should be appropriate to their Level of study - with detailed instructions being given at Foundation Level, outline instructions at General Level, and opportunities given to candidates to decide on approaches at Credit Level. To provide evidence of performance in Practical Abilities, the range of activities included in coursework should give candidates appropriate opportunities to demonstrate the abilities identified in paragraph 6 2 3.

A total of **four** coursework tasks (as described in paragraph 6 5 5 and 6 5 6) which best represent the standard of work normally attained by the candidate will be used as evidence of performance in coursework. These tasks should be designed with reference to the EGRC to ensure that they are of the required standard and should be chosen so that, together with the project, they provide evidence for each of the practical abilities identified in paragraph 6 2 3.

6 5 5 Non-programming Coursework

Two items of evidence which represent the candidate's normal level of attainment and which are drawn from different (non-programming) sections of the course (eg two case studies) should be included in the Folder of Work. Non-programming coursework should involve problem analysis and design, implementation and evaluation of practical solutions. Candidates must provide written evidence relating to these abilities. This should consist of:

evidence of analysis;
details of the method of solution;
examples of implementation such as hard copy output where appropriate;
an evaluation of the solution.

To assist moderation procedures, teachers should submit copies of any relevant instruction sheets specifying the problem given to candidates and marking schemes based on the EGRC.

6 5 6 Programming Coursework

Two documented programs representative of the candidate's normal standard of attainment should be included in the Folder of Work.

Programming involves not simply coding and testing, but also problem analysis, program design and evaluation of solutions. Candidates must provide written evidence relating to these abilities. The evidence should consist of:

evidence of analysis;
an indication of the structure of the program;
a printed listing;
some sample runs (where appropriate);
an evaluation of the solution.

To assist moderation procedures, teachers should submit copies of any relevant instruction sheets specifying the problem given to candidates and marking schemes based on the EGRC.

6 6 Determining the Grade for Practical Abilities

6 6 1 The overall grade for Practical Abilities is that grade which, in the judgement of the teacher, best reflects the level of attainment of the candidate as defined by the EGRC for Practical Abilities and as supported by the evidence in the Folder of Work. the procedures for determining the overall grade are described in paragraph 6 6 2 to 6 6 5; procedures for cases where the required evidence is not available are described in paragraph 6 6 5.

6 6 2 Project Work

As indicated above (Paragraph 6 5 3), a grade for the project included in the Folder of Work is assigned in accordance with the detailed instructions issued by the Board.

6 6 3 Coursework

A single grade (ie one grade for both items) based on the EGRC for Practical Abilities should be assigned for the two items of non-programming coursework included in the Folder of Work (paragraph 6 5 5). The two items of programming coursework (paragraph 6 5 6) should be assigned a single grade in the same manner. In determining the grades for Coursework, teachers should decide by referring to the EGRC which Level of performance best describes the available evidence. Where the criteria for that Level are met satisfactorily, the lower of the two available grades should be awarded. Where the criteria for that level are met at a consistently high standard, the upper of the two available grades should be awarded. When assigning the Coursework grades, due account should be taken of the extent and regularity of help given to the candidate. In some cases, as evidence of achievement of a particular practical ability, the teacher will make a judgement on the basis of classroom observation; in others, the candidate will provide written material. A summary of the evidence which could be used for the assessment of Coursework is provided in Appendix II.

6 6 4 Overall grade for Practical Abilities

The overall grade for Practical Abilities is the mean of the grades assigned to each of the three components, Project Work, non-programming coursework and programming coursework, rounded if necessary to the nearest whole number. Where the teacher considers for any reason that the grade awarded for Practical Abilities does not fairly reflect the candidate's overall performance, the teacher may award a grade other than the mean, in which case an explanatory note should be submitted and any relevant, additional evidence included in the Folder of Work.

6 6 5 In exceptional circumstances the situation may arise where there is some evidence of the candidates' Practical Abilities but the evidence is insufficient to meet the requirements for certification. In such a situation a grade 7 should be assigned to each component for which the evidence is insufficient.

In the situation where the candidate fails to submit a project because of unavoidable circumstances, such as illness, then an additional **two** items of either non-programming or programming coursework may be graded in place of the missing Project Work.

The overall grade for Practical Abilities in each of the above exceptional situations is obtained from the rounded mean of the grades awarded as described in paragraph 6 6 4.

In any case where there is no evidence of performance in Practical Abilities, no award can be made for this element.

6 6 6 Summary

The teacher will:

select the project to be used in determining the grade (paragraphs 5 1 4 and 6 5 4);

assign a Project Work grade (paragraph 6 5 3);

select 2 items of non-programming coursework and 2 items of programming coursework for inclusion in the Folder of Work (paragraphs 6 5 5 and 6 5 6);

assign the two Coursework grades (paragraph 6 6 3);

assign the overall grade for Practical Abilities by calculating the mean of the Project Work and Coursework grades (with rounding as necessary) (paragraph 6 6 4);

in exceptional circumstances, adjust the overall grade for Practical Abilities before submission (paragraph 6 6 4);

decide on action to be taken in respect of candidates whose Folders of Work are incomplete (paragraph 6 6 5).

The Folder of Work should contain:

one project;
two items of non-programming coursework;
two items of programming coursework;
an explanation from the teacher if the grade assigned is other than the rounded mean of the Project Work and Coursework grades;
an additional two items of Coursework should be included where there is no project and a grade higher than 7 is being assigned.

Folders of Work submitted in connection with moderation procedures should be accompanied by a single copy of each relevant candidate instruction sheet.

6 7 Presentations and External Papers in Knowledge and Understanding and in Problem Solving

6 7 1 Grades for Knowledge and Understanding and for Problem Solving will be derived from the external examination papers which will be set and assessed by the Board. Three papers, designated Foundation (assessing grades 6 and 5), General (assessing grades 4 and 3) and Credit (assessing grades 2 and 1), will be offered.

At the time of presentation, centres will be required to indicate the Level(s) of the external papers which each candidate will attempt, as follows:

Foundation and/or General Level(s),
or General and/or Credit Level(s) only.

This presentation does not imply any restriction on grades available for Practical Abilities.

Candidates presented at two Levels are not obliged to attempt both papers but are strongly advised to do so, since, other than as a result of an appeal, candidates can only be awarded one of the grades assessed by the paper(s) attempted, or grade 7.

The following table may be helpful as a guide to presentation.

Expected External Grade	*Presentation Level(s)*	*Grades Assessed*
7, 6	Foundation	6, 5
5, 4	Foundation and General	6, 5, 4, 3
3, 2 1	General and Credit	4, 3, 2, 1

This arrangement allows in each case for a grade award higher or lower than expected (except at grades 1 and 7 respectively). A candidate expected to achieve grade 6 may choose to be presented for both the Foundation and the General papers. A candidate expected to achieve grade 3 may choose to be presented for the Foundation and General combination of papers, thereby accepting that grade 2 and grade 1 will not be possible.

For each of Knowledge and Understanding and Problem Solving, candidates will be allocated a grade on the basis of their performance in the external paper. Candidates who attempt two papers will be given the better of the two grades achieved for each element. Performance in one Level will not be taken into account in grading at the other Level.

6 7 2 The duration of the external papers is as follows:

Paper	*Grades Assessed*	*Duration*
Foundation	6, 5	1 hour
General	4, 3	1¼ hours
Credit	2, 1	1¾ hours

Within each paper, there will be no choice of questions.

6 7 3 In line with the Grade Related Criteria (GRC) defined in Section 7, the responses expected of candidates will increase in complexity from short phrases and sentences at Foundation Level to concise descriptions, explanations and reasoning or extended answers at Credit Level. As a consequence:

the Foundation Level Paper will consist mainly of short response questions;

the General Level Paper will consist of short and extended response questions;

the Credit Level Paper will consist of questions which demand extended, in-depth responses.

6 7 4 In each paper there will be approximately the same number of marks available for Knowledge and Understanding and for Problem Solving. The questions will assess candidates' achievement of the EGRC across the range of abilities specified for each of these elements.

6 7 5 Marks will be allocated to each question and a total mark obtained for each element. The two grades associated with each Level will be distinguished by setting two cut-off scores. The lower score (in the region of 40 - 50% of the available marks) will reflect a satisfactory overall standard of performance, the upper score (in the region of 70 - 80% of the available marks) a high overall standard of performance.

6 8 Estimate Grades for Knowledge and Understanding and for Problem Solving

Towards the end of the course the teacher should consider representative examples of each candidate's work, such as 'prelim' examinations, end-of-topic tests and completed worksheets, in terms of the EGRC. On the basis of this, the teacher will assign an estimate grade for each of Knowledge and Understanding and Problem Solving which must be submitted to the Board, by 31 March of the year of the examination.

Estimate grades may be used by the Board for its internal procedures, including such cases as absence from external examination, adverse circumstances and appeal. Evidence in support of these estimates should therefore be retained by centres for submission to the Board if required.

6 9 Moderation Procedures

Presenting centres will be informed by the Board of the procedures which will operate in connection with moderation of internal assessments of Practical Abilities.

6 10 Summary of Information to be available to the Board

6 10 1 Assessments

On the appropriate form and by the due date, the Board will require the following for each candidate:

Knowledge and Understanding

an estimate grade for Knowledge and Understanding.

Problem Solving

an estimate grade for Problem Solving.

Practical Abilities

the grade for Project Work;
the grade for Programming Coursework;
the grade for non-programming Coursework;
the overall grade for Practical Abilities.

6 10 2 Evidence to be retained by the Presenting Centre

The Folder of Work for each candidate, other than those submitted to the Board for moderation purposes, is to be retained by the presenting centre in case it should be required for re-grading following moderation.

In addition, centres should retain evidence to support the estimate grades for Knowledge and Understanding and for Problem Solving.

7 Grade Related Criteria

7 1 Definition

Grade Related Criteria are positive descriptions of the performance against which a candidate's achievement is measured. Comparisons are not made between the performance of one candidate and that of another.

7 2 Types of Grade related Criteria

7 2 1 Summary GRC

Summary GRC are broad descriptions of performance. They are published as an aid to the interpretation of the profile of attainment by candidates, parents, employers and other users of the Certificate. They also offer general guidance about the standards of the assessment instruments at the three Levels and about the determination of grades.

7 2 2 Extended Grade Related Criteria

Extended Grade Related Criteria are more detailed descriptions of performance. They are intended to assist teachers in directing the learning process, and in making assessments for each element. They are also used by examiners when conducting external assessment.

EGRC are intended to be used as the basis for all assessment, and hence should be applied in assessing Project Work, Coursework and performance in written examination papers.

7 3 Application of Grade Related Criteria

7 3 1 GRC are defined at three Levels of performance: Foundation, General and Credit.

Awards will be reported on six grades, two grades being distinguished at each Level. The upper of the two grades at a given Level will be awarded to candidates who meet the stated criteria demonstrating a high standard of performance; the lower grade to those who demonstrate a lower, but still satisfactory standard of performance.

There will be a seventh grade for candidates who complete the course but fail to meet the stated criteria for any Level.

7 3 2 The assessment instruments will sample a sufficient range of abilities to ensure that the final grade for each element is, where appropriate, a fair reflection of attainment across the various criteria specified for that element.

7 3 3 EGRC take account of the content specified for a particular Level. Thus, a demonstration of achievement of Knowledge and Understanding criteria at, for example, Foundation Level will be in the context of the content associated with that Level. Similarly, a demonstration of Problem Solving EGRC at a particular Level will involve application of knowledge and understanding of the content associated with that Level.

In the detailed specification of content in paragraphs 4 1 3, 4 1 5, 4 1 6, 4 2 and 4 3, the column headed F/G/C specifies the content for Foundation Level; the two columns headed F/G/C and G/C specify the content associated with General Level; and the three columns headed F/G/C, G/C and C specify the content associated with Credit Level.

7 4 Knowledge and Understanding - Summary GRC

Foundation Level (grades 6, 5)

The candidate has demonstrated the ability to communicate knowledge and understanding of computing facts and concepts by recalling information, describing main features and giving explanations in response to straightforward questions, answers being in the form of short phrases and sentences.

General Level (grades 4, 3)

The candidate has demonstrated the ability to communicate knowledge and understanding of computing facts and concepts by recalling information, describing main features and giving explanations in response to questions, answers being in the form of short descriptions and explanations.

Credit Level (grades 2, 1)

The candidate has demonstrated the ability to communicate knowledge and understanding of computing facts and concepts by recalling information, describing main features and giving explanations in response to complex questions, answers being in the form of concise and of extended descriptions and explanations.

7 5 Problem Solving - Summary GRC

Foundation Level (grades 6, 5)

The candidate has demonstrated the ability to apply knowledge of computing facts and concepts to analyse straightforward problems, and to design and evaluate solutions, with answers to questions being in the form of short phrases and sentences.

General Level (grades 4, 3)

The candidate has demonstrated the ability to apply knowledge and understanding of computing facts and concepts to analyse problems, and to design and evaluate solutions, with answers to questions being in the form of phrases and sentences involving descriptions and explanations.

Credit Level (grades 2, 1)

The candidate has demonstrated the ability to apply knowledge and understanding of computing facts and concepts to analyse problems including novel aspects, with answers to questions being in the form of concise or extended descriptions and explanations.

7 6 Practical Abilities - Summary GRC

Foundation Level (grades 6, 5)

The candidate has demonstrated the ability in straightforward practical situations, given step-by-step instructions, to analyse problems and design solutions, and to use computers to implement and evaluate practical solutions.

General Level (grades 4, 3)

The candidate has demonstrated the ability in practical situations, given detailed instructions, to analyse problems and design solutions, and to use computers to implement and evaluate practical solutions.

Credit Level (grades 2, 1)

The candidate has demonstrated the ability in practical situations, given outline instructions, to analyse complex problems, and to use computers to implement and evaluate practical solutions.

7 7 Descriptions of Grades

These describe performance within Levels. They apply to each element.

Grade 6	The candidate has met the criteria for Foundation Level, demonstrating a satisfactory overall standard of performance.
Grade 5	The candidate has met the criteria for Foundation Level, demonstrating a high overall standard of performance.
Grade 4	The candidate has met the criteria for General Level, demonstrating a satisfactory overall standard of performance.
Grade 3	The candidate has met the criteria for General Level, demonstrating a high overall standard of performance.
Grade 2	The candidate has met the criteria for Credit Level, demonstrating a satisfactory overall standard of performance.
Grade 1	The candidate has met the criteria for Credit Level, demonstrating a high overall standard of performance.

7 8 Knowledge and Understanding - Extended GRC

7 8 1 In demonstrating Knowledge and Understanding of computing facts and concepts, the candidate:

RECALLS INFORMATION - by stating facts about items of detailed content;

DESCRIBES - by pointing out the main features of items of detailed content;

EXPLAINS - by giving reasons for the main features of items of detailed content.

7 8 2 At *Foundation Level* the candidate demonstrates these abilities by giving answers in the form of short phrases and sentences, to straightforward questions related to the detailed content for Foundation Level.

At *General Level* the candidate also demonstrates these abilities by giving answers to questions related to the detailed content for General Level.

At *Credit Level* the candidate also demonstrates these abilities by giving concise or extended answers to questions related to the detailed content for Credit Level.

7 9 Problem Solving - Extended GRC

7 9 1 In demonstrating Problem Solving abilities, the candidate:

analyses problems and designs solutions;
evaluates solutions.

7 9 2 Analysis of Problems and Design of Solutions

In demonstrating the ability to analyse problems and design solutions, the candidate:

ANALYSES PROBLEMS - by describing, from the information available, the fundamental nature of the problem and by identifying the main features of the problem which are relevant to its solution;

OUTLINES SOLUTIONS - by describing the constituent processes which are necessary to carry out the task and the sequence in which they should be performed, recognising as appropriate where the use of standard techniques or existing software would be relevant;

REFINES SOLUTIONS - by describing in an appropriate form how the main stages can be developed to a point where they can be implemented;

DISCUSSES STRATEGIES - by explaining why a particular approach is adopted.

7 9 3 Evaluation of Solutions

In demonstrating the ability to evaluate solutions, the candidate:

ASSESSES THE ADEQUACY OF SOLUTIONS - by comparing the solutions to problems with the original objectives or criteria by identifying any discrepancies and explaining these where appropriate;

CONSIDERS IMPLICATIONS - by identifying potential social, economic, technical and/or legal consequences of a particular problem and its solution;

SUGGESTS IMPROVEMENTS - by identifying possible enhancements to a proposed solution or changes to a strategy.

7 9 4 At *Foundation Level* a demonstration of these Problems Solving abilities involves the candidate in giving solutions to problems related to the detailed content for Foundation Level by providing answers in the form of short phrases and sentences. The problems will be concerned with simple applications of computing, and could involve, for example, choosing the correct steps from given options or putting steps into the correct order.

At *General Level* a demonstration of these Problem Solving abilities also involves the candidate in giving solutions to problems set in common situations related to the detailed content for General Level by giving answers in the form of phrases or sentences involving descriptions or explanations. The problems may require judgements to be made on contrasting views and formulation of balanced opinion and some justification of the adequacy of solutions.

At *Credit Level* a demonstration of these Problem Solving abilities also involves the candidate in giving solutions to problems set in a variety of situations related to the detailed content for Credit Level by giving concise or extended answers involving descriptions, explanations or reasoning. The problems may require the candidate to make inferences and provide reasoned arguments to justify choice of strategy and adequacy of solutions.

7 10 Practical Abilities - Extended GRC

7 10 1 The candidate, using a computer as appropriate and working in a practical context, can:

analyse problems and design solutions;
implement practical solutions;
evaluate practical solutions.

7 10 2 Analysis of Problems and Design of Solutions

In demonstrating the ability to analyse problems and design solutions through working in a practical context, the candidate:

ANALYSES PROBLEMS - by describing, from the information available, the fundamental nature of the problem and by identifying the main features of the problem which are relevant to its solutions. *(At Credit Level the problems are likely to require the candidate to make inferences from the information available.)*

OUTLINES SOLUTIONS - by describing in an appropriate form (eg pseudo-code, diagrammatic, written, structure diagram) the constituent processes which are necessary to carry out the task and the sequence in which they should be performed, recognising as appropriate where the use of standard techniques or existing software would be relevant. *At Foundation Level this might simply involve choosing the correct steps from given options or putting given steps into the correct order.)*

REFINES SOLUTIONS - by describing in an appropriate form how the main stages can be developed to a point where they can be implemented.

DISCUSSES STRATEGIES - by communicating orally with peers, teachers and other adults in an appropriate manner. *(At Credit Level this includes producing a reasoned argument to justify the selection of a particular strategy.)*

7 10 3 Implementation of Practical Solutions

In demonstrating the ability to implement practical solutions, the candidate:

OBTAINS INFORMATION - by making use of system or software documentation as appropriate to the type and level of tasks involved in implementing a solution. *(At Foundation Level documentation might consist of teacher-prepared notes, at General Level proprietary documentation supplemented by teachers' notes, and at Credit Level proprietary documentation alone, making use of the index or contents list; and, at Credit Level, by abstracting and collating relevant information from a number of source materials selected by the candidate, eg experts, books, periodicals, videos, information systems.)*

USES HARDWARE EFFECTIVELY - by successfully completing tasks based on well-organised management of hardware, good planning of sessions at the computer and good housekeeping. *(At Foundation Level detailed instructions would be provided, at General Level outline instructions, and at Credit Level candidates might be expected to decide on the procedure to be followed and, where appropriate, on the hardware to be used.)*

USES APPROPRIATE SOFTWARE TOOLS EFFECTIVELY AND EFFICIENTLY - by implementing the design, through the appropriate use of operating system facilities and of a software package or programming language to achieve the planned outcome, and producing a computer solution which makes best use of available facilities. *(At Foundation Level detailed instructions would be provided, at General Level outline instructions, and at Credit Level candidates might be expected to decide on the procedure to be followed and, where appropriate, on the software to be used.)*

IDENTIFIES AND RECTIFIES ERRORS - by testing the implementation of a solution at appropriate stages during its development and, by recognising an error and its type, diagnosing the associated fault and taking appropriate action. (Error types include system errors, syntax errors and logical errors.)

WRITES DOCUMENTATION - by producing two broad categories of documentation: internal commentary as part of the software developed; and both user and technical notes. *(At Foundation Level candidates would be given a detailed format for these notes, at General Level a loose structure, and at Credit Level candidates would be expected to make decisions about structure and extent of these notes.)*

REPORTS ON / DISCUSSES PROGRESS - at any stage, by comparing the current state of the implementation with the design and original requirements of the problem and, on conclusion of the task, by producing a commentary of the means by which the final outcome was achieved; this may involve a diary of events, a note of any difficulties encountered and how they were handled, or a description of the way a particular task was carried out, indicating the roles of others involved in the task, if appropriate. *(At Credit Level candidates would provide clear, concise and complete descriptions which focused on relevant issues.)*

7 10 4 Evaluation of Practical Solutions

In demonstrating the ability to evaluate personally designed and given solutions, the candidate

ASSESSES THE ADEQUACY OF SOLUTIONS - by using test data and reporting on the results *(At Foundation Level test data are supplied, at General and Credit Levels candidates supply their own suitable test data; at Credit Level candidates produce a complete test specification, indicating the reasons for choice of test data sets, and report on its use to assess the adequacy of the solution.)*

- by comparing the final outcome with the original brief, identifying any discrepancies and explaining these where appropriate. *(At General Level with some justification; at Credit Level with more rigorous justification.)*

CONSIDERS IMPLICATIONS - by identifying potential social, economic, technical and/or legal consequences of a particular problem and its solution. *(At General and Credit Levels by judging contrasting views and formulating a balanced opinion.)*

SUGGESTS IMPROVEMENTS - by identifying possible enhancements to be solution, changes to the strategy adopted or changes to the original brief which would provide a more effective solution. *(At General and Credit Levels, reference might for example be made to user-friendliness, robustness, efficiency or screen layout; at Credit Level, possible changes might be identified by applying the final outcome to wider contexts or by suggesting, with hindsight, an alternative strategy to achieve the final outcome.)*

7 10 5 In demonstrating these abilities, the candidate

at Foundation Level

plans and carries out practical activities of a straightforward nature with the aid of step-by-step instructions.

at General Level

plans and carries out practical activities of limited complexity with the aid of detailed instructions.

at Credit Level

plans and carries out practical activities of a complex nature with the aid of outline instructions.

Appendix I(a)

EXEMPLAR PROGRAMMING SPECIFICATION: COMAL

The detailed content specified in this table illustrates how the General Programming Specification **might** be interpreted for a particular programming language (see paragraph 4 4 2).

In this exemplar a few items of content have been added or moved to other columns (see General Programming Specification in 4 4 3) because the author of this particular exemplar regarded these amendments as necessary to the carrying out of worthwhile tasks. Also, several items have been omitted because they are not relevant or feasible at the Level concerned. Individual teachers will make other detailed changes.

MAIN ASPECT	F/G/C	G/C	C
REPRESENTATION OF SOLUTION TO PROBLEM	one simple representation (eg structure diagram).		use of a variety of representations (eg pseudo-code, proto-type versions, diagram).
TEXT ENTRY	enter; edit; list/print out current version.		
SEQUENCE	simple instructions.		
MODULARITY	sensible arrangement of blocks of code.	flow of data between sections of code (eg construction of simple procedures (PROC... ENDPROC).	
SIMPLE DATA TYPES	numeric; character; string.		integer; real; boolean.
STRUCTURED DATA TYPES			set aside array variable space (DIM); use of one dimensional arrays.
DATA TRANSFER	keyboard input of numeric and text data (INPUT); output of numbers and text (PRINT)	pre-supplied data (eg READ, DATA); formatting of output (eg use of ,;TAB/AT).	
STATEMENTS	assignment of constants (eg boxes := 6); assignment of expressions (eg total := price + tax).	assignment of incremental expressions (eg counter := counter + 1).	
EXPRESSIONS	simple, commonly used key words and operators (eg arithmetic operators).	commonly used pre-defined functions; comparison operators.	logical operators (eg AND, OR, NOT).
REPETITION	fixed loop (FOR... DO... NEXT/ENDFOR).	control variable used in loop; nested loops.	conditional loop (WHILE... DO... ENDWHILE; REPEAT... UNTILEXEMPLAR).

EXEMPLAR PROGRAMMING SPECIFICATION: COMAL (continued)			
MAIN ASPECT	**F/G/C**	**G/C**	**C**
CONDITION		(IF...THEN...END IF).	IF ... THEN ... ELSE ... ENDIF; CASE ... OF ... WHEN ... OTHERWISE … ENDCASE).
IDENTIFY AND RECTIFY ERRORS	syntax, system and logical errors.		
TEST SOFTWARE	use supplied test data.	use own test data.	supply full set of test data.
READABILITY	use meaningful variable names; provide internal commentary.		
USER INTERFACE	screen layout.	prompts to user.	input validation.

Appendix I(b)

EXEMPLAR PROGRAMMING SPECIFICATION: PASCAL

The detailed content specified in this table illustrates how the General Programming Specification **might** be interpreted for a particular programming language (see paragraph 4 4 2).

In this exemplar a few items of content have been added or moved to other columns (see General Programming Specification in 4 4 3) because the author of this particular exemplar regarded these amendments as necessary to the carrying out of worthwhile tasks. Also, several items have been omitted because they are not relevant or feasible at the Level concerned. Individual teachers will make other detailed changes.

MAIN ASPECT	F/G/C	G/C	C
REPRESENTATION OF SOLUTION TO PROBLEM	one simple representation (eg structure diagram).		use of a variety of representations (eg pseudo-code, proto-type versions, diagram).
TEXT ENTRY	enter; edit; list/print out current version.		
SEQUENCE	simple instructions (BEGIN ... END).		
MODULARITY	use of pre-defined procedures; construction of simple procedures (PROCEDURE).	flow of data between sections of code.	
SIMPLE DATA TYPES	constant, type and var declarations (integer, real, string).		boolean; subrange.
STRUCTURED DATA TYPES	set aside string space; use of strings.		set aside array variable space (ARRAY); use of one dimensional arrays.
DATA TRANSFER	keyboard input of numeric and text data (READLN); output of numbers and text (WRITELN).	pre-supplied data (READ, WRITE); formatting of output.	file input/output.
STATEMENTS	assignment of constants (eg boxes := 6); assignment of expressions (eg total := price + tax).	assignment of incremental expressions (eg counter := counter + 1).	
EXPRESSIONS	simple, commonly used key words and operators (eg arithmetic operators).	commonly used pre-defined functions; comparison operators.	logical operators (eg AND, OR, NOT).
REPETITION	fixed loop (FOR... DO).	control variable used in loop; nested loops.	conditional loop (WHILE... DO ... ENDWHILE; REPEAT ... UNTIL).
CONDITION		(IF ... THEN ... ELSE).	(CASE ... OF ... END).

EXEMPLAR PROGRAMMING SPECIFICATION: PASCAL (continued)

MAIN ASPECT	F/G/C	G/C	C
IDENTIFY AND RECTIFY ERRORS	syntax, system and logical errors.		
TEST SOFTWARE	use supplied test data.	use own test data.	supply full set of test data.
READABILITY	use meaningful variable names; provide internal commentary.		
USER INTERFACE	screen layout.	prompts to user.	input validation.

Appendix I(c)

EXEMPLAR PROGRAMMING SPECIFICATION: SPREADSHEET

The detailed content specified in this table illustrates how the General Programming Specification **might** be interpreted for a particular programming language (see paragraph 4 4 2).

In this exemplar a few items of content have been added or moved to other columns (see General Programming Specification in 4 4 3) because the author of this particular exemplar regarded these amendments as necessary to the carrying out of worthwhile tasks. Also, one or two items have been omitted because they are not relevant or feasible at the Level concerned. Individual teachers will make other detailed changes.

MAIN ASPECT	F/G/C	G/C	C
REPRESENTATION OF SOLUTION TO PROBLEM	block diagram of spreadsheet structure.		description of block diagram structure; show functions.
TEXT ENTRY	enter; edit cells, print.	print range	
SEQUENCE			effect of location of cells on recalculation.
MODULARITY (ie construction and use of blocks of code)	sensible arrangement of blocks of code; use of pre-defined macros.	flow of data between sections of code; production of sequential macros.	production of macros involving selection and repetition.
SIMPLE DATA TYPES	values, labels, formulae.		
STRUCTURED DATA TYPES	one dimensional range eg @SUM(A1..A5).		two dimensional range eg @SUM(A1..D5).
DATA TRANSFER (ie mechanisms for getting data into and out of a program)	[covered under TEXT ENTRY].	multiple items (ie use of COPY, MOVE).	
STATEMENTS	[covered under TEXT ENTRY].	use of FILL DATA	
EXPRESSIONS	use of cell references, constants, arithmetic operators and pre-defined functions to generate simple expression.	comparison operators.	logical operators.
REPETITION (not covered)			
CONDITION		simple construct eg @IF(A2>2,1,0).	complex case eg @AND (list).
IDENTIFY AND RECTIFY ERRORS	syntax, system and logical errors.		
TEST SOFTWARE	use supplied test data.	use own test data.	supply full set of test data.
READABILITY	titles, row and column headings.		
USER INTERFACE	screen layout.	prompts to user.	autoexec macros.

Appendix I(d)

EXEMPLAR PROGRAMMING SPECIFICATION: PROLOG

The detailed content specified in this table illustrates how the General Programming Specification **might** be interpreted for a particular programming language (see paragraph 4 4 2).

In this exemplar a few items of content have been added or moved to other columns (see General Programming Specification in 4 4 3) because the author of this particular exemplar regarded these amendments as necessary to the carrying out of worthwhile tasks. Also, several items have been omitted because they are not relevant or feasible at the Level concerned. Individual teachers will make other detailed changes.

MAIN ASPECT	F/G/C	G/C	C
REPRESENTATION OF SOLUTION TO PROBLEM	use one design representation, eg data flow diagram.		use several abstract representations, eg data flow diagram, and or tree, several generations of logic program.
TEXT ENTRY	enter; edit, print.		
SEQUENCE	anticipate effect of clause and conditions sequencing upon execution.	improve performance through clause and condition re-sequencing.	optimise performance through rule and condition re-sequencing.
MODULARITY	group similar clauses together; deploy shallow goal chaining.	use clauses with parameters; write multi-clause procedures.	deploy deep goal chaining, use extensive parameter passing.
SIMPLE DATA TYPES	use numbers; words.		
STRUCTURED DATA TYPES		use lists or structures.	use lists and structures.
DATA TRANSFER	construct simple queries; interpret output.	construct queries with several goals.	
STATEMENTS	write facts; write rules which call facts.	write rules with basic primitives (eg 'is', 'write'); write rules which call other rules.	write rules with recursion.
REPETITION	negation, unification, goal reduction for variable-free goals.	negation, unification, goal reduction for goals with variables.	
EXPRESSIONS	simple arithmetic.	term unification.	
IDENTIFY AND RECTIFY ERRORS	diagnose syntax, system and logic errors; take appropriate action.		
TEST SOFTWARE	use supplied test queries.	supply own test queries.	supply full set of test queries.
READABILITY	meaningful variable names; internal commentary.		
USER INTERFACE	query I/O only.	programmed I/O (eg 'read', 'write').	if supported: system primitives for WIMP I/O.

Appendix I(e)

EXEMPLAR PROGRAMMING SPECIFICATION: EXPERT SYSTEM SHELL

The detailed content specified in this table illustrates how the General Programming Specification **might** be interpreted for a particular programming language (see paragraph 4 4 2).

In this exemplar a few items of content have been added or moved to other columns (see General Programming Specification in 4 4 3) because the author of this particular exemplar regarded these amendments as necessary to the carrying out of worthwhile tasks. Also, several items have been omitted because they are not relevant or feasible at the Level concerned. Individual teachers will make other detailed changes.

MAIN ASPECT	F/G/C	G/C	C
REPRESENTATION OF SOLUTION TO PROBLEM	use one design representation, eg decision table.		use several design formats, eg decision table, rule tree, several generations of rule representation of source knowledge.
TEXT ENTRY	enter, edit, print.		
SEQUENCE	anticipate effect of rule and condition sequencing upon inferencing.	improve performance through rule and condition re-sequencing.	optimise performance through rule and condition re-sequencing.
MODULARITY	group similar rules together; deploy shallow rule chaining.	use rules with parameters.	deploy deep rule chaining, use extensive parameter passing, write 'context' conditions.
SIMPLE DATA TYPES	numbers; words.		
STRUCTURED DATA TYPES		if supported: lists.	
DATA TRANSFER	initiate a consultation; interpret output.	if supported: use answer changing facilities.	
STATEMENTS	write sentences: facts, rules (as available in the knowledge representation language).	if supported: write question definitions.	if supported: create stored text for advice/explanation.
REPETITION	use the chaining mechanism.	if supported: specify consultation termination.	if supported: write control procedures.
EXPRESSIONS	write rules with AND, NOT; simple arithmetic.	write rules with OR; term comparison.	if supported: write list membership conditions.
IDENTIFY AND RECTIFY ERRORS	diagnose syntax, system and logic errors; take appropriate action.		
TEST SOFTWARE	use supplied test data.	supply own test data.	supply full set of test data.
READABILITY	meaningful variable names, internal commentary.		
USER INTERFACE	if supported: interpret how - and why - explanations.	provide meaningful and clear questions, explanations, and advice.	if supported: write user-defined menu questions, file-based advice.

Appendix II

Summary of Coursework Evidence

There is no prescribed format for the evidence to be used to support Coursework grades. The following summary, however, illustrates the types of evidence which could be used to assess achievement of the EGRC.

(**P** signifies that pupil-produced written evidence is provided; **T** that the teacher makes judgements based on classroom observation.)

Coursework Evidence		**EGRC**
A description of the problem	P	(Analyses problems)
Identification of the main steps	P	(Outlines solutions)
A refinement of the initial solution	P	(Refines solutions)
Discuss exercise with teacher	T	(Discusses strategies)
Use reference texts and/or ask for information	T	(Obtains information)
Select and use appropriate hardware	P, T	(Uses hardware)
Use an appropriate range of software features	P, T	Uses appropriate software)
Recognise and rectify errors - syntax, system, logical	P, T	(Identifies and rectifies errors)
Produce relevant documentation	P	(Writes documentation)
Statement of whether the solution meets requirements	P	Assesses adequacy of solutions)
A summary of the implications	P	(Considers implications)
A summary of recommended improvements	P	(Suggests improvements)