Problem Analysis:

Cognitive Factors in Chemistry Problem Solving at Secondary School Level

submitted by

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in fulfillment of the regulations pertaining to
the degree of Doctor of Philosophy

University of Glasgow
Centre for Science Education

October, 1990

Acknowledgements

A project of this length requires the co-operation and help of a large number of people. While it is not possible to list all of them individually, it is my privilege to record my particular and grateful thanks to the following:

Professor A H Johnstone, Director, Centre for Science Education, University of Glasgow, who has encouraged and stimulated me throughout this project, and has given me much time, patience, and valuable advice.

Professor D M Titterington and Dr T R Prvan, Department of Statistics, University of Glasgow, who advised me on the statistical treatment of my results.

Dr J R T Cassells, Head Teacher, Bellahouston Academy, Glasgow, who suggested references on Language literature and whose own thesis was an excellent example to follow.

Dr P R P MacGuire, Centre for Science Education, University of Glasgow, who suggested many references in Problem Solving and Cognitive Psychology, and who gave me a great deal of support.

My wife, Mrs Linda M Watson, who has shown extraordinary patience and has given unswerving support during the seven years of this project.

My grateful thanks are due also to those colleagues in Chemistry who have wrestled with the electronic questionnaire, and whose professional opinion is the keystone of the project's validity:

Prof A H Johnstone[1,2]	University of Glasgow
Dr R A Hadden[1,2]	Centre for Science Education, Glasgow
Dr J McDowall[1,2]	Northern College of Education, Aberdeen
Dr S Friel[1]	Trinity High School, Renfrew
Mr D MacFarlane[1]	Jordanhill College of Education
Mr P Malcolm[1]	Kilmarnock College of Further Education
Mrs D Steele[1]	Hutchesons' Grammar School, Glasgow
Dr J R Murdoch[1]	Northern College of Education, Aberdeen
Mr D Eccles[1]	Inverurie High School, Aberdeenshire
Dr N R Coley[1]	California, USA
Dr J K Cassidy[2]	Strathclyde Regional Council, Lanark
Mr C Holroyd[2]	Educational Consultant & Servant, Glasgow
Mr T C Swinfen[2]	Head of Science, Uppingham School, Leics
Dr A G Smith[2]	California, USA
Dr R Silberman[2]	New York State University, USA

[1,2]: participated in both phases;

[1] : participated in Phase 1

[2] : participated in phase 2

Finally, my thanks are due to the Scottish Examination Board, Dalkeith, who co-operated in selecting random samples of marked scripts and allowed me to have access to them.

Robert J Watson, October 1990

Problem Analysis: Cognitive Factors in Chemistry Problem Solving at Secondary School Level

Summary

This project is about Problem Solving, but is unlike most existing Problem Solving research insofar as it concentrates on the nature of the problem itself, and not on the behaviour of the person solving the problem.

The project involved two distinct stages, which can be treated (and indeed performed) quite separately. The first stage was the analysis of the chosen problems themselves, by the method of employing a panel of experts to answer questions (propositions) based on each individual problem in turn. The responses from the experts were analysed, and only a high degree of agreement was accepted as evidence for the presence or absence of the chosen factors, which were identified in the propositions. Since, on the first exercise, there was not sufficient agreement on some propositions, the propositions were revised and the exercise was done again. It was not necessary to use exactly the same panel, although some individuals did both exercises. The experts' responses thus formed the basis of a classification of the problems by chosen factors. The second stage used sets of marks obtained by pupils, selected randomly by the Scottish Examination Board, to compare the classification of each problem with pupils' success or failure in that problem.

The initial intention, to try to emphasise particular factors by analysis of the patterns produced by linking individual pupils' marks with problem classification, yielded some interesting patterns, from which tentative suggestions could be made, but they could not be regarded as sufficiently reliable to be authoritative on their own account. The pupils were therefore treated as a group, and tables were produced of problems in order of merit, once more seeking patterns from the tables. Several different methods of displaying the data were tried, and again no useful pattern or conclusion emerged. The grouping of the classifications, within the proposition sets of Process, Concepts, Skills and Language, finally produced the long-sought patterns, and statistical analysis showed some trends towards differences in performances, which could be linked to problem characteristics. Even though these differences were not statistically significant, some useful comments could be made, and pointers recognised.

The method of analysis used was designed to be applied to any problem set of a type amenable to expert panel analysis, and the software written for the analysis, on the BBC microcomputer, was made "content free" for such use. The project was as concerned with the design of a research tool as with the specific analysis of Chemistry problems, and I would venture to suggest that it succeeded in both these aims.

Robert J Watson

Glasgow, October 1990.

Contents

Chapter 1

The Context of this Project

The Context of this Project

This thesis describes the development of a method of analysing a particular type of problem - the examination question - in a way that can be applied on a wider basis than the particular substrate (SCE Chemistry) which has been used. It also describes the ways in which the results generated can be applied to pupils' results, and reaches some conclusions about those factors which appear to be most relevant to difficulties in solving the problems.

Before embarking on a detailed description of the methods used and results obtained, it is useful to review other work in this field, so as to place the thesis in its proper context.

There are three sections which are pertinent to review: the development of the SCE examinations and their reasoning, the influence on educational assessment of process, concept, skills and language, and the general literature on problem solving and cognitive theory.

The SCE Examinations in Chemistry

The SCE examinations in Chemistry trace their roots back to the Alternative Syllabus in Chemistry (1) and its subsequent implementation by the SCE Examination Board (2, 3, 4). The

Chemical Education Materials Study (CHEM) Project and the Chemical Bond Approach (BOND) project in the USA (5), which followed on the launch of Sputnik in 1957 and the subsequent decision to promote Science Education in Western countries, paralleled early thoughts on the revision of Chemistry teaching in Scotland. In March 1960 an influential conference of two representatives from nearly all of the European countries, and the United States, was held at Greystones in Ireland. It is clear from the report of that conference (6) that new thinking was widespread in Europe and America. The American projects were headed by top level academics, and have been criticised as being very well designed in terms of chemical theory, but poor in terms of pedagogy. These events influenced A J Mee and J R M Brown of Her Majesty's Inspectorate (HMI), who involved Scottish teachers in the development of Circular 512 (1), which was published one year later. Teachers were involved from the earliest stages of the Scottish design, and good teaching practice was emphasised as well as chemical veracity. A H Johnstone (George Watson's College, later University of Glasgow), A W Jeffrey (Madras College, later HMI) and W J Milne (Kirkcaldy High School, later SCE Exam Board) were prominent among the teachers who suggested and trialled material (7).

Work in the field of objectives and curriculum design in education, particularly in North America, summarised in (8) and (9), and the *Taxonomy of Educational Objectives* (10) greatly influenced the syllabus design and the method of assessment, in particular with relation to "objective" or "multiple-choice" testing, and the departure from the universal system of structured grammatical answers which had been normal up to that point. Several official publications relating to SCE Science have included lists of objectives, stated in behavioural form, of which the lists in *Curriculum Papers: 7: Science for General Education* (11) provide a good example. It should be noted, in this context, that the fashion for specifying all educational processes in terms of behavioural objectives only was short-lived, and had been much modified by the mid-1970's. The main inadequacy of this traditional behaviourist approach to education was that the *specification of behavioural objectives by themselves did not say what the learner must learn or what the teacher must teach* (12, page 538). The interaction between learner, teacher and content was largely ignored by this approach, and the work of Jerome Bruner (13) provided a much-needed counterbalance. The various papers published by the Scottish Curriculum Development Service (SCDS), under the auspices of the Consultative Committee on the Curriculum (CCC) (14, 15, 16, 17, 18) are a good guide to the subsequent development of thinking on the Science curriculum in Scotland during the 1970's and early 1980's, and a number of Bulletins (later called Journals) were published (19), which were of considerable practical value to teachers, and were intended to amplify the syllabus publications. A number of Memoranda were also published, of which several are cited in this thesis.

The Certificate of Sixth Year Studies (CSYS) was developed later, as a response to pressure to produce a qualification which approached the academic standard of A level. Unlike the A level syllabuses, however, it was written to represent a maturing of the concepts developed in the Higher Grade course, rather than an addition to the content. It set out to develop the theory behind the facts which were accepted in Higher Grade, and also involved a good measure of independent study in its practical project. It was implemented through the co-operation of the SCE and SCDS (20).

Each level of the Chemistry syllabus, Ordinary, Higher and Sixth Year Studies, uses the same format in examination:

1. Multiple Choice ("Objective") Paper: scanning the syllabus in breadth, with a large number of questions, and answers chosen from the list of alternatives offered.
2. Written paper: contains some short answer questions, but also involves written and detailed reasoning.
3. In CSYS, there is also the requirement to produce an extended project report, written in cursive English and presented in a form which can be defended at oral examination.

Other researchers have investigated multiple-choice problems and their ramifications (21, 22): this thesis deals with the other type of problem, the written answer type, which is contained in a separate examination paper. There has been some effort to appreciate the difficulties of objective assessment in this type of exam (23), and some interesting examples of confusing cases have been generated in the search for reliability and validity in this type of paper (24). These considerations are, however, peripheral to this thesis, except insofar as it employs written answer type problems as the substrate on which to operate the analysis process.

Classes of Propositions

Process, Concept, Skills and Language are the classes into which the propositions - questions asked about the problems in the chosen set - are divided. It is not an accident that these divisions were chosen. These factors have been given increasing prominence in the theory of science education in the past 25 years. Processes, concepts and skills, in the context of language, were argued as separate terms by Marshall McLuhan in *Understanding Media* (25), and have been incorporated in part into the theories of Skinner (26), Ausubel (27) and Gagne (28). Processes are specifically included in Teachers' Guides relevant to SCE Chemistry (29), and there is some confusion as to the distinction between processes, concepts and skills (30), in which many activities generally reckoned to be "skills" or "concepts" are listed as "processes". References to "process skills" and "concept skills" do not help in this respect. The relationship between processes, concepts and skills is well defined by Stenhouse

(31). Some useful suggestions for propositions based on processes and skills are contained in the SCDS publication, *Mathematical Needs for Ordinary Grade Chemistry* (32).

The Bullock Report (33) brought the importance of language in education to widespread attention, and other commentators (34, 35) added insights to this field at about the same time. The importance of language in Chemistry in Scotland was demonstrated by research (36, 37) and by several educational publications (38, 39, 40, 41, 42, 43). It was therefore chosen as the fourth topic of propositions to be tested.

Problem Solving and Cognitive Psychology

Problem Solving is now included in the text of most general works on cognitive psychology, of which Sanford's is a good example (44). It is dealt with from the point of view of the person solving the problem, and various strategies and heuristics are examined. The work of Polya (45) in this field is generally reckoned to be the most useful starting point for such a study, and first introduces the concept of taking particular actions when trying to solve a problem, coining the term "heuristics". Kahney's book (46) is a good summary of current research into problem solving, presented in a very readable style, and Greene and Hicks (47) present, in the same series, an excellent overview of the whole field of cognitive processes.

The definition of the word "problem" is itself subject to a wide variety of answers, depending on the context of the definition and the speciality of the author. The most general definition is as follows:

A problem state exists when an organism has some goal which it wishes to achieve, but is unable to achieve it. (E Durkheim)

Put in a more colloquial, but very cogent and succinct, form by J D Herron (48), this general definition becomes:

Problem solving is what you do when you don't know what to do.

The analysis of problem solving in terms of the behaviour of people is very much involved with cognitive theory and general work on the nature of thinking. The differences among individuals are involved, and social and developmental psychological theories must be considered as part of a complex matrix of investigation. In short, problem solving is not a simple field of investigation, and there is a vast literature.

It is clear that an understanding of complex human behaviour involves more than just knowing the rules of logic. But, on the other hand, it is also true that human behaviour is considerably more rational than the early behaviourists thought. (Scandura, 12)

Any complete answer to this question (Why is it that some people can solve given problems, whereas others cannot?), as a minimum, will necessarily involve specification of specific problem-solving competencies (content), an understanding of underlying psychological mechanisms (cognition), and some way to deal with individual differences. (Scandura, ibid.)

The limits of working memory have a bearing on problem solving ability:

Most simulation programs directly reflect the limited capacity of human beings to process information. (Miller, 49)

This thesis takes as its substrate the sets of written problems administered to SCE Chemistry candidates, and should therefore refer to recent work which relates problems of this type to information processing theory (50, 51, 52, 53, 54, 55). The main import of this work is to show that there are distracting elements in problems (50, 54) and that problems may be analysed in terms of the number of steps taken in their solution, then the information processing capacity of the individual can be compared to that person's success in solving the problem. In many cases there is a high correspondence of facility value patterns and problem content capacity measurements (51, 52, 53, 55).

This theory of cognitive processes has been developed in a number of models. Ernst and Newell (56) provided a simplified description of the problem solving process which progressed from Input (description) through Translation, Internal Representation and Problem Solving Techniques (heuristics), to a Solution Representation. Greeno (57) and Feigenbaum (58) proposed a model in which Perception fed to Short Term Memory which interacted both ways with Working Memory, which in turn interacted with Semantic and Factual Memory (Long Term Memory). White (59) used many of these ideas in proposing an explicit model of cognitive processes.

In White's model, events are recorded by receptors and translators (the senses) and passed through a transient memory (TM) stage to short term memory (STM), whose function is the holding of information for a brief period. Working memory (WM) is seen as a part of STM, and takes up some of the space available for its operation, while the rest of STM is still holding some information. In the course of these transfers, filters operate to screen the incoming information for its relevance to the task on hand. From long term memory (LTM), episodes, verbal knowledge, images and intellectual skills are combined in processing, thinking and remembering, feeding the results into the working memory, from which the performance of the required task (knowledge stating, picture drawing or skill using) is elicited. The process is summarised in Figure 1 on the next page:

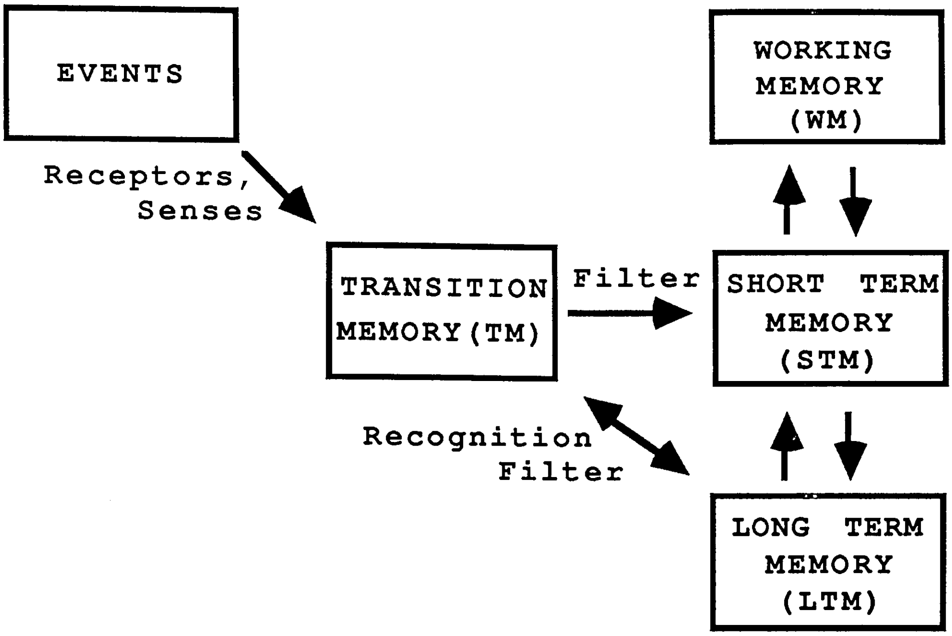


Figure 1 - Model of Cognitive memory interaction

The short term memory, in all these models, is the part of information processing referred to in Miller's classic paper (49), and in Dempster's more recent work (60). Information held in short term memory can be forgotten (consider the example of looking up a telephone number in the directory and remembering it only long enough to dial it) or can be passed on to the working memory, which has a greater capacity than the short term memory and can hold information for a longer time. To enter the long term memory, the information has to be processed. The processing, according to White, means linking the new information to the existing knowledge. This idea is the basis of Ausubel's theory of learning (61). Ausubel emphasises the use of "advance organisers" - Novak (62) calls them "cognitive bridges". A different interpretation of the evidence was offered by Crowder (63), in which an alternative structure was proposed, and another variation is offered by Schavaneveldt and Boruff (64).

The information in short term memory, while restricted (49) to seven plus or minus two items, may nevertheless be quite complex because of the phenomenon of **chunking**, in which each item can be complex, always provided that it can be absorbed by the person as a single unit of information. This effect is documented by Broadbent (65), Egan and Shwartz (66), Fletcher (67), MacGregor (68), Barsalou (69) and Long (70) among others.

An approach often used in research into problem solving is the relatively informal introspective method regarding the kinds of capabilities and processes that are felt to be necessary for solving particular types of problems. The work of Polya (71, 72) is an excellent example. His analyses of problem solving, and especially his insights into the processes involved, have resulted in the identification of a number of potentially useful problem-solving heuristics. This is, in my opinion, to be preferred to the more traditional approach to problem solving research, which confounds the often subtle effects of specific content, cognition and individual difference variables, and may be expected to yield only averaged information concerning general tendencies in problem-solving behaviour.

A more recent book by K J Gilhooly (73) summarises the various approaches to human reasoning, and emphasises the range of possible approaches, of which rational logic is only one part. Creativity, daydreaming and inductive and deductive reasoning are all involved in an overview of what goes on in the human brain.

In recent years there have been great advances in computer technology and software engineering, which have brought the creation of expert systems and artificial intelligence to a level which seemed, only a few years ago, to be science fiction. The link between problem solving and artificial intelligence is explored in books by Grogono and Nelson (74), Gaines and Shaw (75), Langley, Simon, Bradshaw and Zytkow (76) and by Rutkowska and Crook (77), and in journals by Adelson (78), Anderson, Boyle and Reiser (79), Barnard, Hammond, Morton, Long and Clark (80), Clancey (81), Hunt (82, 83), and Laird, Newell and Rosenbloom (84).

Within the field of Problem Solving there are many different approaches to investigations, and it is necessary to specify a given project more exactly than the general title itself. Under "Problem Solving" in the *Psychological Abstracts*, there are some hundreds of references for each year, and they cannot all be expected to be relevant to a particular project.

This thesis proposes a method of problem analysis, and the application of the results of that analysis to actual performances in solving the problems that were analysed. There are very few references to projects which have approached the subject from this direction, as opposed to the vast number which seek to describe or measure the behaviour or performance of people solving general problems. Rothkopf (85) indicated that the content of instruction was more important than its form. He investigated how to match the content of instruction closely to individual student needs, and how to communicate specific instructional goals to learners. Gladwin (86) compared the hierarchies of abstraction which are apparent in the classroom with the "gut reaction" methods of real life problem solvers. Heller and Reif (87) worked on problem descriptions in physics, in which a general theoretical model was used to generate descriptions of individual problems. These were used in the teaching of the problems to students, and markedly improved their subsequent performance in solving them. Hocevar, Strom, Zimmer and Zarnegar (88) analysed the effects of problem structure on two-step mathematics word problem performance. They found, working with 8-12 year-old children, that their results did not support the hypothesis that the locus of difficulty in two-step problems is the identification and sequencing of the first and second steps. In addition, their students had considerable difficulty with the first step in two-step problems even though this prerequisite step was relatively easy. These findings suggest that some students attempt to grasp the entire problem at once and fall prey to information overload.

Computer Databases on Literature

A computer search was made, on the DIALOG2 system, which accesses the ERIC database, on the search terms "PROBLEM SOLVING AND COGNITIVE PROCESSES AND FACTOR ANALYSIS". This search produced only two references (89, 90). These were examined and found not to reflect accurately on this project. Armour-Thomas and Haynes (89) dealt with the cognitive processes within general problem solving and their measurement, and Ashman and Das (90) were concerned with the processing of problems by advance planning. On the keywords "FACTOR ANALYSIS AND ASSOCIATIVE PROCESSES", Keller and Ho (91) dealt with the type of problem involving decisions and the options open to the solver, and Pierzchala (92) appeared, from the title of his work, to be concerned with the general process of problem solving, rather than with the analysis of a particular problem type. It did not seem necessary to obtain a translation of this paper from the original Polish.

A further computer search was made, on the widened terms of reference, "PROBLEM SOLVING AND PROBLEM STRUCTURE". This search yielded 26 references, whose titles were examined to see if they might be relevant to this project. Shalin's dissertation (93) appeared at first to be useful, but did not bear on the method of analysis or the linking with pupils' performance. The next search was made on the keywords, "PROBLEM ANALYSIS". All the references listed had to do with problems other than the examination type on which this thesis is based, and a final search on "FACTOR ANALYSIS" only, yielded 61 other references, all of which were examined and found not to be appropriate to the context of this work. They have not been listed in the Bibliography.

I am thus forced to conclude that this work has few parallels in existing literature, and that, apart from its relation to the general context of problem solving and cognitive psychology, it is a method of approach, to the analysis of a particular type of problem, that has not been attempted before.

Chapter 2

A New Approach to Problem Solving Research

A New Approach to Problem Solving Research

As has been shown in Chapter 1, previous work on Problem Solving has tended to concentrate on the Problem Solver, and the question of "what makes a good problem solver and how does this person behave in a different way from poor problem solvers?" The focus of this project has been on the nature of the problem itself, and the notion of whether there are patterns or types of problem that present special difficulties.

Initial Thinking

Much thought and research in Science Education in Scotland and elsewhere over the past twenty years has been given to the teaching and assessment of Process, Concepts and Skills as separate objects of mastery, instead of concentrating, as happened before, on the syllabus content - the knowledge and application of scientific facts and precepts as applied to a particular discipline. The evolution of new syllabuses in Physics, Chemistry and Biology in the 1960's, in parallel with developments all over the world in the wake of the Sputnik and the start of the Space Race, embraced new theories of learning and teaching which laid less emphasis on the absorption of facts, and introduced principles of hierarchical concepts on which a scientific education could be built. The work of Gagne (8, 28), Ausubel (27, 61), Bloom (10), Skinner (26), and Mager

(94) was important in establishing the ground rules of this new orthodoxy, and implicit in these developments was the assumption of a transfer of training within the concepts and principles acquired along the way. A generation has passed since these ideas were put into serious practice, and there has been time to reflect on their efficacy. First, there is no direct and incontrovertible evidence that the quality of Science Education in the Western countries has greatly improved since the introduction of the new syllabuses. That is to say, examination statistics on their own do not provide convincing evidence of improvement, despite the greater number of passes at particular grades, since the tests themselves reflect the view of the examiners that the recall of knowledge represents only a small part of the total to be assessed. Data books (95) were unknown in Science examinations (with the exception of log tables and Periodic Tables) before the new examinations.

A dissociating view, that processes cannot be taught by themselves and that a body of knowledge is essential as a foundation for these processes, and that transfer of training is not by any means as universal as the early researchers hoped, has gained much ground in recent years (14, 15, 16, 17, 18, 19, 20, 30, 31, 43). All Chemistry teachers who encounter difficulties with the mole concept, simply because problems associated with it invariably involve the arithmetic skill of proportion at some point, notice that for some pupils the idea of proportion has to be re-taught, even though it has been thoroughly taught in the Maths class. This is a basic example of the lack of that transfer of training which was assumed in the early theories. The difference between the various disciplines of Science is partly, but not wholly, the result of different bodies of factual knowledge. It is very rare, if not impossible, for an individual to become a competent scientist by learning skills and processes and concepts without absorbing a considerable amount of factual knowledge relating to at least one discipline. That being said, it is easier for someone who is trained in one scientific discipline to master another than for a layman to master a first scientific discipline. In that sense, therefore, the theories advanced in the 1960's have some substance. The point is that they do not represent the whole story.

The aim of this project, therefore, was to try to measure the importance of process, concept and skill in relation to other factors of content and perceived difficulty, and to relate the two sets of dissonant theories mentioned above.

A final part of the analysis exercise was related to language, taking into account the important advances made in the last decade in the realisation of the importance of language in scientific communication. Language difficulties could be measured in the same way as process, concept and skill, and provided a fourth dimension to the analysis of the problems used in this project. The emphasis was laid on the problem itself, rather than on the problem solver.

The Project - An Overview

The basic research was divided into two parts;

(a) establishment of problem characteristics.

(b) testing these characteristics on exam results.

(a) Establishment of Problem Characteristics

The problems chosen for this project are problems in Chemistry, presented by the Scottish Examination Board for the 1986 Examination at Ordinary Grade, Higher Grade and the Certificate of Sixth Year Studies. This is of course a very narrow selection, bearing in mind the vast range of problems that exist, but the point of the project is to propose a **method** of establishing problem patterns and characteristics, rather than to promulgate some general solution to the investigation of all types of problem at once. The method I have chosen has certain specific assumptions and preconditions, which are important because they set limits on the technique.

Assumptions and Preconditions

First, the problem must be capable of a recognisable solution or solution set. Not all problems are so constructed. If the solution set does not exist or is universal, then this method will not work. At the same time, however, the type of problem represented by a universal solution set is in a different category altogether, and the judgment of whether a given solution is valid or not is entirely personal and subjective. I would therefore claim that to exclude that type of problem from this project is reasonable. It is incapable of any objective measurement of validity.

Second, given that a solution or solution set exists, there ought to be a person, or set of persons, who are recognisable experts in the type of problem that is being investigated. How these people are to be recognised or defined depends obviously on the nature of the problem: for example, in Chemistry problems at SCE level, Scottish Chemistry Teachers can be regarded as experts in the field. The method depends on successful identification of experts in the problem field. The greater the number of experts, the more valid will be the results of their expertise but the greater also will be the possible complications arising from their use. It follows also that members of the panel of experts have to be willing to give their time and expertise to the project.

Third, the method uses a battery of simple questions, referred to as **propositions**, which can be answered by "Yes" or "No". (This word "proposition" is used throughout to distinguish the character-finding questions, the propositions, from the test questions, which are referred to as "problems".) The point of these propositions is that they will contribute to the overall pattern of results in the analysis of characteristics. The propositions must not be ambiguous, because unanimity, or at least a very substantial majority, among the panel of experts is essential to the reliability of the measurement. If the experts cannot agree, then the proposition must be rephrased to remove ambiguity or else removed altogether. It follows that the greatest of care must be taken in phrasing and setting out each proposition, because this is the first stage in the process, and all the subsequent stages depend on it being right.

Fourth, it must be possible to obtain results from problem solvers that can be analysed in terms of success or failure in solving the problem. If necessary, a test instrument must be devised and administered to these subjects, and that test instrument must incorporate some clear criterion of success or failure in the problem. In this context, it would be valid to split problems down into sub-problems or problem steps, and to analyse these independently. Such a decision must be made at the start, before the analysis takes place. The test to be given to the learners can be given at any time during the project: it is only the results which matter. If problems are to be split up, however, the marking scheme for the test must take account of this and success or failure must be recognised for each sub-part that is to be used.

Details of the Analysis Method

A panel of experts must first be selected, and agree to help with the analysis. A set of propositions must be decided, to reveal the characteristics of the problems under scrutiny. This is probably the most important of the early tasks. The propositions must be designed so as to be unambiguous, or else it is unlikely that the desired unanimity will be achieved. If, when the results of this first analysis are examined, they reveal that the panel of experts are at variance with each other, the propositions will have to be rephrased so as to remove the ambiguity in them, and then the whole first exercise will have to be repeated with the new propositions. This is clearly not desirable, because the goodwill and co-operation of the chosen experts must be retained, but it is not essential that exactly the same panel be used in each case, provided always that the experts are chosen according to the same criteria of expertise. The task of setting clear propositions is therefore vital to the success of the whole project.

There may be some factors which are overlooked in this first stage of proposition-setting, and which come to light later in the investigation. At first glance, it would seem difficult to incorporate such factors, but the fact that the original panel of experts does not necessarily have to be reassembled provides a practical solution. A supplementary set of propositions can be administered to a similarly qualified panel at any time, because the obtaining of exam or test results from candidates is quite separate from the process of establishing the characteristics of the problems. The second stage of the project can be repeated with relative ease, because it involves only the researcher.

A Practical Method of Running the Project

Even in a small project, the problem of handling large amounts of data has to be faced. In the case of this project, the number of propositions used to establish characteristics was 20, and the number of problems on which these propositions were to be asked was 57 (17 in the O grade paper, and 20 each in the H grade and CSYS papers). This makes a total of 20 times 57, i.e., 1140 yes/no propositions, that each expert must answer. There are obvious difficulties of administration, caused simply by the volume of information required. The amount of paper needed to record one such questionnaire is huge. A possible solution to this problem is to use a microcomputer to record both questionnaire and answers. This solution has the further merit that answers would be written straight on to a disc in a format suitable for immediate decimal numbers in the range 0 to 31 (00000 to 11111 binary). It is not essential that the groups should be all of the same size, i.e., 5 propositions: it is simply convenient that they were divided in this way. It happened that one set of propositions, the Language propositions, could be answered with complete objectivity - they were not subject to any expert opinion - and it was therefore unnecessary for the experts to answer them. This reduced the load on the experts to a total of 15 times 57, i.e., 855 propositions, still a very considerable task. The success or failure of candidates could then be compared with the patterns generated for problems in an attempt to discover which patterns of characteristics gave the most difficulty.

In the first stage of the project, it was necessary to construct software that would enable the experts (whose expertise was not required to include computing) to answer the propositions with a minimum of trouble and boredom. Since there was no suitable commercial software for this purpose, I developed the analysis program myself. This gave me the advantage that I could structure the answer files most appropriately for the project, in a way that would be directly useful to the programs for analysis, which I also developed. The programs were intended to work with the minimum of trouble to the users, and to be as transparent as possible in use, so that the experts would not be influenced by problems with machinery. I chose the BBC microcomputer for this purpose because it was the only one common to all schools and Higher

Education establishments in the local area, and because I am familiar with its use.

The first program, called PROBana, selected the appropriate propositions and asked them, one by one, of the expert. It was designed to start exactly where the user had left off previously, and to record the user's name on to the disc, for later identification. The answers were written on to the disc at appropriate times in the program, and at any time that the user elected to leave the program. It seemed to work efficiently, because I received no complaints from the users that the program was not working properly. The disc was designed to start automatically, and users did not have to remember any details of filenames or programs.

When the discs were returned, a second program gathered the namefiles and answerfiles together onto one disc for analysis. ANSana simply displayed a respondent's file to check whether the whole task had been completed or not. Unanswered propositions were represented by the letter "X", and answers were "Y" or "N", with the option of stating whether the respondent was sure of the answer or not. If the expert was not sure, that answer would be rendered as "y" or "n" respectively.

The third program, COMPana, compared the answers from the various respondents to check for a degree of unanimity. This was scaled in an arbitrary fashion to check for reasonable agreement rather than total unanimity, by assigning values of +2, +1, 0, -1 and -2 respectively to Y, y, X, n and N responses and summing the total. If that total was less than 0.5 times the number of respondents, in either direction, the proposition was considered to have failed to achieve a sufficient standard of unanimity, and was examined to reduce its ambiguity for the second trial. A number of changes was made in the propositions, and a second trial was started. This fresh start made it possible to change the problems under consideration to those in the 1986 examination, as mentioned above. The previous examples had been taken from a variety of SCE past papers, but there was considerable difficulty in arranging for sufficient numbers of candidates for each test, especially at CSYS level, and the problem of marking large numbers of scripts was now clear. The Scottish Examination Board supplied results from 100 candidates in each level, and it was hoped at the time that examination of the SEB statistics might be of value. This ultimately proved to be fruitless, because the statistics available did not correspond to the factors analysed in the project.

(b) Testing These Characteristics on Exam Results

At this point, it was intended that the model used for comparing the analysis of problems with the actual performance of candidates under examination would be that if there were two or more problems which differed in only one of the attributes of Process, Concepts (or chemical content), Skills and Language, then the performance of candidates in these problems would be compared. If some candidates passed in one and failed in the other, there might be *prima facie* evidence that one particular attribute, the one not common to both problems, was responsible for determining success or failure. This model was not successful, for two main reasons: first, that there were not sufficient cases of candidates who did perform in exactly this way, and second, more importantly, while there were some problems which isolated Language in this way, there were no corresponding pairs of problems which isolated Process, Concepts or Skills. In addition, the two examples of problems in O grade and H grade which had identical attributes were both "either/or" problems, in which no candidate attempted both, so that there was no opportunity for a "control" comparison.

A program called MARKENT was used to convert the data into coded raw scores, which were then stored on disc for later use. Great care was taken to avoid any errors of transcription at this stage. The reason for transferring raw scores was that they could be converted easily into Pass/Fail marks by applying a pass score and comparing, and by having raw scores available, a variety of pass grades could be tested. A special code was used to record the occasions where a problem was not attempted, and distinguish these from the ones which had been attempted and awarded a zero mark. The sex of each candidate was also recorded, but there was no evidence in the results of any difference in performance between the sexes. To ensure confidentiality, no attempt was made to record either names or schools of the candidates.

Similar Attributes Comparisons

The groupings of problems with similar attributes was shown by the program FAMILY, and several pairs of problems were grouped in this way, but when this data was transferred to the program PHASE4, which listed those candidates (by number) who had passed in one and failed in the other of the pairs of problems identified by similarity of attributes, the result showed that there were very few such cases in comparison to the total numbers, and that there was no pattern, coherent or otherwise, emerging from the data. A great deal of information could be extracted from the data available, but although there were some promising patterns, which are discussed in detail in Chapter 5, they were sufficiently small in size to deny any authoritative conclusions. A different approach was therefore attempted, using the same data, in the hope of achieving a useful result.

This new approach was to generate lists of problems in the order of merit of their successful solution, by calculating the number of passes divided by the total number of attempts; i.e., the number of passes divided by the total number of passes and fails, ignoring those problems that were not attempted at all. It was noted that similar patterns of attributes were grouped together at the same places in the tables thus produced, indicating the level of perceived difficulty of the problems and relating these levels to attributes of process, concept, skills and language. Where a problem did not correspond with the pattern, and was not listed close to its similar fellows, there might well be a reason to be found by re-examining that problem.

In the O grade results, there was just such a pattern, in which one particular problem, number 13 in the O grade paper, stood out from its fellows with the same characteristics. This particular set of analysis numbers had occurred in several problems, and the others were grouped around the top end of the order of merit list. Problem 13 was poorly answered in comparison, and examination of the problem revealed that it dealt in part with ion-electron half-reactions, which were well known to cause difficulty among O grade candidates. This result looked very promising. Unfortunately, it was the only one which appeared to occur within all the O grade, H grade and CSYS data. Accordingly, this line of enquiry was abandoned.

The next stage was to attempt to order the lists by particular Process values, then by Concept values, then Skills values and finally Language values. This was done for all three sets of data, but no significant pattern emerged. The average values of pass rates were calculated and displayed, but no particular pattern emerged of conclusions that might be drawn. The obvious conclusion, that a problem with the least complications in the factors under consideration, i.e., with no Process, Concept, Skills or Language difficulties, should prove easiest to solve in terms of pass rates, was generally supported. This at least was a partial vindication of the general method which I had employed. Further analyses which listed only those problems which had two factors in common, and then those which had three out of four factors in common, provided some interesting discussion in a few cases. There was no sensible conclusion to be drawn from close inspection of the tables, although some useful pointers were observed.

Grouping Analysis

At length, I decided to investigate the effect of **grouping** the propositions that I had used, into two parts for each class of proposition. The reasons for these groupings are discussed elsewhere. The data could then be re-worked for each of the classes of Process, Concept, Skills and Language, in terms of the presence or absence of a general factor. The mean of the pass rates, and the standard deviation for each set, were calculated and displayed. These pass rate numbers, however, are themselves calculated results which do not seem to conform to any common distribution, and on the advice of the Department of Statistics in the University, a non-parametric statistical test was used. This was the Mann/Whitney/Wilcoxon Rank Order test (96), and it showed no significance at the 5% level of confidence in any of the sets of results. The differences in means and standard deviations did seem to indicate that the chosen factors could lead to some conclusions, but without statistical significance, these conclusions could not be any more than tentative at most. Considerable differences in pass rate means were noted at all levels of paper, in many cases exceeding the standard deviations. This has often been used as a rule of thumb, in inspection of results, to ascertain whether significant differences are likely to occur. Some comments are made on this basis in Chapter 7.

The project therefore has indicated that there is a method of analysis that can be employed to generate difficulty factors for given problems, that these factors can be compared with mark analysis data, and that some conclusions, albeit tentative in this case, can be drawn from the marriage of these sets of data.

Chapter 3:

Phase 1 - Propositions

Phase 2 - Analysis

Phase 1 - Propositions (1983-84)

The first task was to set up a suitable collection of propositions which would be capable of being applied to the expert panel for analysis of the problem set, and to select the problem set itself. The problem set in Phase 1 consisted of a group of 20 questions in each of O grade, H grade and CSYS chosen from the 1982 to 1985 papers. The propositions were chosen from a list obtained by "brainstorming". It was noted at this time that they fell into categories of Process, Concept (or Content), Skills and Language. The wording of the propositions was arranged so as to lead to a "Yes" or "No" answer in each case. The propositions which were chosen are listed in Table 1. There were 20 propositions altogether, divided into 4 groups of 5, for Process, Concept, Skills and Language.

The total number of questions to be answered by the expert panel was therefore 20 propositions multiplied by 20 problems multiplied by 3 levels - a total of 1200 questions. It was clear from the start that it was quite impractical to address the problem of collecting and collating these answers by a traditional questionnaire process - the questionnaire would have had to be as thick as a telephone directory, and about as welcoming to the volunteer experts. In addition, the same propositions were to be addressed to each of the 60 problems in turn, and to do this using paper would have been very wasteful.

Table 1

List of selected propositions

Phase 1, 1983-84

A. PROCESS

1. Does the problem contain ARITHMETICAL CALCULATIONS?
2. Is the solution QUALITATIVE (explanation, comparison etc.) rather than QUANTITATIVE (involving figures)? Note: if the solution contains both qualitative and quantitative answers, respond YES.
3. Does the problem require the application of rules or formal relationships (e.g., Gas Laws)?
4. Does the problem require LOGICAL DECISIONS?
5. Is any VALUE JUDGMENT required?

B. CONCEPT (Chemical Content)

1. Does the problem involve FORMULAE?
2. Does the solution require EQUATIONS?
3. Does the problem refer to SPECIFIC SUBSTANCES?
4. Does the problem involve the MOLE CONCEPT?
5. Does the problem imply SAFETY REQUIREMENTS or PRECAUTIONS?

C. SKILLS

1. Does the problem PRESENT information as GRAPHS or TABLES?
2. Does the problem involve DRAWING or INTERPRETING DIAGRAMS or FLOW-CHARTS?
3. Does the problem involve SORTING of relevant data from irrelevant?
4. Does the problem require the use of PROPORTION?
5. Does the problem involve CONDITIONAL REASONING (IF...THEN...ELSE)?

D. LANGUAGE

In the statement of the problem (i.e., not including the actual questions),

1. Is the average sentence longer than 20 words?
2. Is there more than 1 subordinate clause?
3. Are there more than 5 words of 3 or more syllables (excluding technical terms and names of chemicals)?
4. Are there any words which have more than one meaning in different contexts?
5. Can the question be answered by a single word or series of words (as opposed to a grammatically structured answer)?

The solution to the problem was to use a microcomputer to manage the collection of data. This had several advantages:

1. There are no complicated forms to fill in, with a much smaller probability of error.
2. There is a very considerable saving in paper.
3. The data is written on to a magnetic disc, and the answers are written on to the same disc, for sending back to the experimenter. The disc can then be re-used with another respondent, since only the answerfile need be retained.
4. The information on the returned disc is already electronically encoded, so that no laborious transcription is required. It is only necessary to write suitable programs for the analysis of the answers in a variety of ways.
5. The main program has been written in such a way that the data representing the actual questions and propositions is read from the disc as the program proceeds - to change the data it is not necessary to change the main program. In other words, the main program is virtually CONTENT FREE. Other programs have been written to set up or to modify the data files in any desired way. Even the "yes/no" format is easy to change, say to a Likert-type or Osgood-type 5- or 7-point scale, and the same advantages of analysis apply.

The BBC microcomputer was selected for this project, because it was the only type that was common to all schools in Scotland at the start of the project in 1983-4.

The panel of experts was selected on the criterion that each should be a graduate specialist in Chemistry with teaching or academic experience in Education. A total of fifteen experts was invited to assist. Each member of the panel was provided with the following:

1. One disc prepared for use with the BBC microcomputer (model B), containing the program "PROBana" and text files for problems and propositions, and three blank answerfiles, one for each of O grade, H grade and CSYS. Also contained on the disc was an analysis program, "ANSana", which displayed any selected answerfile, so that the user could inspect progress. This disc was to be returned when the answerfiles were completed. A file on the disc also contained the expert's name, for use in the next stage of the analysis. Two utility programs were also supplied, "namewri" and "answri" for re-creating blank namefiles and answerfiles.

2. One set of papers, containing instructions for using the disc, the list of propositions and the full text of each of the test papers.

3. It was ascertained that each member of the panel had reasonable access to a BBC microcomputer on which to run the disc. If necessary, facilities were made available within the University.

The program "PROBana", which is listed in Appendix A, was designed to operate automatically, reading the required files without the user having to remember them, and writing information on to the disc whenever necessary. All instructions for the user were clearly displayed on the screen.

The program was so arranged that the user could leave the task at any time, saving the up-to-date position on the disc, and at the next attempt, it would start at the point where the user had left off. In this way, it was intended to be as "friendly" as possible. Choices of class of proposition (or all Process, Concept and Skills classes in sequence), and continuing task or the re-working of a particular problem again, were provided in the program. In addition, a routine was provided to skip over the on-screen instructions, which took several minutes to display, when the user felt that he had mastered the program and did not need to read the instructions again.

When a problem was selected, either by direct selection or by default in a continuing task, a summary of the problem was displayed at the top of the screen, and each of the propositions in turn was displayed below it. The user was then invited to enter "Y" or "N" to the proposition in relation to that problem, by pressing the "Y" or "N" key. All other keys on the keyboard (except ESCAPE and "Q" which had special functions, stated at the top of the screen, and "R", which is explained below) were disabled at this point. Immediately after that, the question "Are you sure?" was displayed. If the user answered "N" to that, the answer would be recorded as a *lower case* "y" or "n" to show uncertainty. The answer "Y" to the prompt, "Are you sure?" would record the response to the proposition as *upper case* "Y" or "N". The program took care of the filing of the response in the correct place for later retrieval and analysis. The letter "R" was reserved for that function of the program in which the user had elected to repeat a problem. In that case, the previous answer was displayed on the screen, and "R" was used to retain that answer and move immediately to the next proposition.

The program made full use of colour on the screen to stimulate and maintain interest, and to emphasise those instructions which were essential to the proper management of the files. Colours were chosen, however, to stand out reasonably well on a monochrome screen, for the benefit of any users who had not access to a colour monitor. Throughout the development of this program, the size of the task was kept in mind, and every effort was made to ensure that non-essential tasks of file handling and retrieval were accomplished automatically, without any effort required on the part of the user. The disc was set up to run "PROBana" automatically, by the standard method, common to all BBC/Acorn microcomputers, of holding down the SHIFT key while pressing the BREAK key.

The initial set of instructions on the screen invited users to select either "P", "C" or "S" (for Process, Concept or Skills respectively), or "A" (for Automatic, which ran all Process then Concept then Skills propositions in sequence). The Language propositions were all capable of completely objective answer, since they were concerned with calculations of numbers of words, or comparison with published lists, and so the program was written in such a way that members of the panel did not have to attempt these propositions. They could, however, elect to choose the Language propositions, by selecting "L" at the P,C,S or A choice, even though this was not mentioned in the screen instructions. This option was mentioned in the written instructions which accompanied the disc (see Table 2 on page 46 below). The intention of this strategy was to reduce the workload on the panel members by 25%, from 1200 questions to 900. None of the panel members elected to attempt the Language propositions, indicating that their workload was already quite high enough.

After each class of propositions was completed, the data was written automatically on to the disc, and the user was invited to run the program again for the remaining propositions.

The program checked at the beginning of each run for completion of all the answerfiles. If they were complete, it displayed a message of thanks to the user and instructions for returning the disc.

Attached to this thesis is a set of discs, prepared for the BBC micro model B or the Acorn Master microcomputer, containing the main programs written for this project.

Table 2

Instructions to Expert Panel members

1. The disc supplied, for the BBC micro, is set up for immediate use. Put the disc into the disc drive, then press "BREAK" while holding down the SHIFT key. The program will run automatically. Please do NOT, at any time, put a tab over the "write-enable" notch on the top right of the disc. This would prevent the program from working, as it has to read from and write to the disc.

2. You will require to have this set of papers with you when you run the program, as it will be necessary to refer to the question papers while you respond to the "propositions". The question papers have been slightly re-numbered to avoid A or B suffixes, but the program will give the original numbering as well as the new numbers. Yellow marks the start of the O grade, Green the H grade and Red the CSYS papers.

3. The full list of propositions is on the next page, for reference. You are not required to attempt the "Language" propositions, because these are matters of measurement rather than of judgment, although you may try them if you want to. If you want to try the Language propositions, this is what to do: when you are offered the menu of choices in the program, take the "C" option (to change previous answers), and then, when Process, Content or Skills is offered, choose "L" (for Language) *even though it is not on the menu* - the program will allow it.

4. You may use the utility program "ANSana" at any time, by the command: **CHAIN "ANSana"**. This will display your answers to date, for any desired grade. Do not use the other utilities, "answri" and "namewri", unless you wish to create new (blank) answerfiles or namefiles. Any previous entries in these files will be destroyed.

5. When you have completed the questionnaire, please return the disc to me for analysis. There is no need to return these papers as well.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION.

Technical Considerations

The BBC microcomputer has 32 kilobytes (32K) of Random Access Memory (RAM). This was considered reasonable at the time of its launch in 1981-82, but modern microcomputers have a great deal more RAM and can afford to use much more wasteful programming techniques than are possible with the BBC micro. The limit of 32K places restrictions on the type of display and the length of programs that can be used. In "PROBana" and all the other programs written for this project, MODE 7 (Teletext) graphics have been used throughout, because all other display modes use up more memory than is available in addition to the program. Integer variables have been employed extensively instead of floating point numerical variables, because these use less memory space to store (4 bytes each instead of 7). It proved possible to store all the required working files in the machine's memory for any one level of problem and any one class of proposition, but routines had to be written for reading from and writing to the disc at appropriate times during the running of the program, to exchange the lists of problem and proposition statements in the memory, as well as to update the answerfiles.

In addition, the Acorn DFS (Disc Filing System) employed in the BBC microcomputer has two important technical disadvantages over other systems: first, the limit of 31 files on a disc (even if the individual files are short and there is plenty of space left free on the disc), and second, the inability of the system to break a file into two or more parts on the disc, or to reorganise the files on the disc surface without specific commands (e.g., *COMPACT), which affect the contents of the memory, and cannot therefore be used within programs as they themselves may cause the programs to fail.

The first disadvantage, the limit in file numbers, meant that the number of separate files on the disc had to be carefully controlled so as not to exceed 31 at any time. Decisions therefore had to be made as to the grouping of information into files on the disc. These in turn limited the potential flexibility of the program design.

The second disadvantage, the inability to split files or to move files around the disc surface automatically, is more difficult to comprehend at first: when the system is told (commanded) to write a file, under a given filename, on to the disc, it attempts to write it into the space occupied by the original file of that name, in the case where a file of that name already existed. If that file happens to be the last one written on the disc, there is no problem, provided that there is sufficient space left on the disc. The problem arises where another file has been written on to the disc after the one specified in the command, so that the boundaries of that file on the disc are defined at both ends. If the new file is bigger than the old one, which is often the case when new information has been added to memory, the system fails in its task and issues the error message, "Can't Extend". This means effectively that the replacement file cannot be written on to the disc, even though there might well be sufficient disc space still available. An experienced user can usually find a way around the problem, by deleting the old file from the disc and then invoking the writing routine on its own, without disturbing the data in memory. This course of action is out of the question to a naive user, and in this project had to be avoided at all costs.

The solution to the "Can't Extend" problem was to create blank files for all the files to be used on the disc, designed so that each one had at least enough disc space to cover all its anticipated requirements. The "PROBana" program then altered individual items of information in the memory, without at any time increasing or decreasing the total amount required, so that the replacement file was always exactly the same size as the original or blank one. This was done by using "nonsense" characters (characters that would not normally be used in text) to build the blank files, and instructing the program to ignore these characters when it encountered them.

These technical problems are limited to the BBC model B and Acorn Master microcomputers, and are not encountered on other types of machines. The solutions employed are therefore specific to these machines, but they can be used without ill effect on any type of microcomputer.

Phase 2 - Analysis of Phase 1 Questionnaires

A total of ten completed discs was returned from the Phase 1 exercise. It was intended that there should be unanimity among the expert panel regarding the answers to the propositions related to the chosen problems.

A second major program, "COMPana", was written to analyse and display the variation among the experts' views. This had to be able to cope with incomplete responses, and to use every piece of data received from the panel. It did this by recognising, and then ignoring, any nonsense characters that had survived from the original blank files on the discs. The results of this program are reproduced in Appendix B.

As often happens among professional experts, complete unanimity was lacking, and there were two types of approach that could be adopted: from the researcher's viewpoint, and from the experts' viewpoint.

From the researcher's viewpoint, the variations in response were particularly associated with some specific propositions; it was clear that these were not sufficiently unambiguous in their wording to permit a unanimous response for a given problem. The prospect of altering their wording to create a less ambiguous proposition was attractive, but had to be approached with care, so as to avoid losing all meaning in the pursuit of a spurious clarity of view from the expert panel.

From the experts' viewpoint, there was the variation on how strongly held were the views expressed in yes/no terms. A fairly crude attempt was made to reconcile the experts' own judgment of confidence in assessment (the answer to the supplementary "Are you sure?" question in "PROBana") with the expressed desire for uniformity of opinion. For each expert, in each proposition/problem combination, the possible responses, Y, y, n, and N were graded +2, +1, -1 and -2 respectively. The total for each combination was worked out, and the average generated. If the absolute value of this average was less than 0.3, the combination was rejected and shown on the "COMPana" output as a "failed proposition". Between 0.3 and 1, the combination showed as "y", greater than 1 as "Y", between -0.3 and -1 as "n", and less than -1 as "N". There is no specific justification for these cut-off values, which were chosen as reasonable compromise figures. Another criticism of this method is that there is no way of telling the extent of uncertainty among the experts; but it was felt better to have some way of allowing for uncertainty, as recorded in the data, than to ignore it completely.

None of those experts who returned completed or partially completed discs had any complaint of any failure on the part of the software. This was a great encouragement to proceed to the next part of the analysis.

It was intended, at the beginning of Phase 1, that Chemistry classes within schools would be given the question papers under test conditions, as a practice run before their SCE examinations, and it was hoped that their teachers might be prepared to assist with the marking of these scripts. there were two factors which combined to make this impractical.

The first was a chance factor - the long-running teachers' dispute which started in 1984 and continued until 1986 - which meant that co-operation from colleagues in other schools was difficult to obtain in these peculiar circumstances. The second factor was essentially geographical. It happened that there were relatively few CSYS Chemistry candidates located in the West of Scotland, as a proportion of the total entry. It was impossible to obtain a sufficient number of CSYS students in schools reasonably close at hand. These factors indicated that the original problem set ought to be abandoned.

When this conclusion was combined with the difficulties that had emerged from the analysis of the "PROBana" results, the decision to treat the Phase 1 exercise as a pilot project was inevitable, and it was resolved to repeat the process with a new panel of experts and the improvements to the project whose desirability had become so apparent. This repeat exercise was designated as Phase 3 of the project.

Chapter 4

Phase 3 - Improvements and Repeats

Phase 3

Improvements and Repeats

There were two major differences between Phase 3 and the original Phase 1 exercise which it superseded. The first was that those propositions which had "failed" in the Phase 1 analysis - the output of the "COM3ana" program (a modification of COMPana which isolated those propositions which had failed) - were re-worded so as to reduce possible sources of ambiguity while attempting to retain as much of the original intent as possible. These revised propositions are in Table 3, page 56.

The second major difference was that the problem set was chosen as the set of SEB examinations in Chemistry in 1986, at Ordinary Grade, Higher Grade and the Certificate of Sixth Year Studies. There were two advantages of this decision. The first was that the papers were already well balanced as to content and type of question, as a matter of Examination Board policy. The second was that it would now be possible, with the co-operation of the Scottish Examination Board, to obtain results from pupils that had attempted the problems under the best possible conditions, those of the examination itself.

With some very minor changes, the same "PROBana" program was used again. So that there would be no chance of confusing answerfiles with the original set, the "nonsense" characters were changed.

Table 3

List of Revised Propositions

1985-86

A. PROCESS

(1) 1. Is the solution to this problem QUANTITATIVE (involving numbers) in any of its parts?

(2) 2. Does the solution to this problem require ARITHMETICAL CALCULATIONS (as opposed to simple reading or recall of figures, e.g., from graphs or tables)?

(3) 3. Does the solution involve PROPORTION in calculations? (If the answer to proposition 2 is NO, then the answer to this must be NO also)

(4) 4. Does the solution to this problem involve the application of a recalled or a given FORMULA (NOT a chemical formula): e.g., $m = vc$ or $PV = nRT$?

(5) 5. Does the solution require REASONING as opposed to simple RECALL? (If both are required, answer YES)

B. CONCEPTS

(6) 1. Does the solution require the recall or construction of CHEMICAL FORMULAE? (Do not count formulae which are supplied in the text)

(7) 2. Does the solution require the recall or construction of CHEMICAL EQUATIONS (including word equations)? (Do not count equations which are supplied in the text)

(8) 3. Does this problem refer to SPECIFIC SUBSTANCES (as opposed to classes or types of substance - e.g., "ethanal" as opposed to "aldehydes")? If both, answer YES.

(9) 4. Does the solution to this problem involve the MOLE concept?

(10) 5. Does this problem specifically imply SAFETY REQUIREMENTS or PRECAUTIONS?

C. SKILLS

(11) 1. Does this problem (or the solution to it) involve GRAPHS, TABLES or SELECTION GRIDS?

(12) 2. Does this problem involve DRAWING or INTERPRETING DIAGRAMS or FLOW-CHARTS (as opposed to graphs, tables or grids)?

(13) 3. Does this problem involve SORTING of information into categories or classes?

(14) 4. Is more data provided than is required for the solution (i.e., is any of the data IRRELEVANT to the answer)?

(15) 5. Does this problem involve any skills beyond simple recall or Data Book information retrieval?

D. LANGUAGE

(16) 1. In the statement of this problem, is the re any average sentence longer than 15 words? x

(17) 2. Are there any subordinate clauses?

(18) 3. Are there more than 3 words of 3 or more syllables (excluding technical terms and names of chemicals)?

(19) 4. Are there any words which have more than one meaning in different contexts? This refers to the list of words published in "Words That Matter in Science" (Cassels and Johnstone, RSC, 1985)

(20) 5. Can all parts of the problem be answered by a single word or series of words, as opposed to a grammatically structured answer?

The main differences between the revised propositions and the original ones were in the lengths of the statements, which were revised to make them less ambiguous, and in the definitions in the Language propositions, which were made more demanding in order to achieve greater discrimination among problems. Since the late 1970s, when the importance of language in Chemistry was researched and emphasised, SCE examinations in Chemistry have been written with much greater consideration of the language difficulties.

Some of the original panel of experts were no longer available, but a suitable panel was assembled, and 12 discs were prepared and distributed, with the same "PROBana" program and new proposition and problem files. When they were returned, the same "COMPana" analysis was carried out, and this time there were no failed propositions, by the definition of average responses being definitely on one side or the other. In other words, the COM3ana analysis showed blank, that is, with no failures. The data was ready for the next stage of the analysis.

The Next Stage

The answers given by the expert panel to the propositions were first of all classified into meaningful codes. This was done by taking the answers to each of the proposition sets in turn, and assigning the value 1 to a "Yes" and 0 to a "No".

The five answers in a proposition set were therefore represented by a binary number of five digits, which was converted into a decimal number for convenience.

Suppose that for a particular problem, the answers to a proposition set were:

1: Yes

2: No

3: Yes

4: Yes

5: No

The answers Yes, No, Yes, Yes, No became the binary number 10110, which becomes the decimal number 22 by the standard conversion: (S=sixteens, E=eights, F=fours, T=twos, U=units)

S	E	F	T	U
1	0	1	1	0

Thus binary 10110 = 16 + 4 + 2 = 22.

In this way, all the sets of answers were coded for ease of reference. The full set of explanations of the codes is given in Appendix E, and some examples are listed in Table 4 below.

Table 4

Characteristics of Selected Proposition Values

1. Process Values

Proc 0:	Binary: 00000 Is not quantitative Does not involve Arithmetic Does not involve Proportion Does not involve non-chemical Formulae Requires only simple Recall
Proc 1:	Binary: 00001 Is not quantitative Does not involve Arithmetic Does not involve Proportion Does not involve non-chemical Formulae Requires REASONING as opposed to RECALL
Proc 2:	Binary: 00010 Is not quantitative Does not involve Arithmetic Does not involve Proportion Involves a (non-chemical) FORMULA Requires only simple Recall
Proc 4:	Binary: 00100 Is not quantitative Does not involve Arithmetic Involves PROPORTION Does not involve non-chemical Formulae Requires only simple Recall
Proc 8:	Binary: 01000 Is not quantitative Involves ARITHMETICAL calculations Does not involve Proportion Does not involve non-chemical Formulae Requires only simple Recall
Proc 16:	Binary: 10000 Solution is QUANTITATIVE Does not involve Arithmetic Does not involve Proportion Does not involve non-chemical Formulae Requires only simple Recall
Proc 31:	Binary: 11111 Solution is QUANTITATIVE Involves ARITHMETICAL calculations Involves PROPORTION Involves a (non-chemical) FORMULA Requires REASONING as opposed to RECALL

Table 4 (continued)

2. Concept (Content) Values

Cont 0: Binary: 00000
No Chemical Formulae (unless supplied)
No Chemical Equations (unless supplied)
Does not refer to Specific Substances
Does not involve the MOLE concept
No Safety requirements inferred

Cont 1: Binary: 00001
No Chemical Formulae (unless supplied)
No Chemical Equations (unless supplied)
Does not refer to Specific Substances
Does not involve the MOLE concept
Infers SAFETY Requirements

Cont 2: Binary: 00010
No Chemical Formulae (unless supplied)
No Chemical Equations (unless supplied)
Does not refer to Specific Substances
Involves the MOLE concept
No Safety requirements inferred

Cont 4: Binary: 00100
No Chemical Formulae (unless supplied)
No Chemical Equations (unless supplied)
Refers to SPECIFIC SUBSTANCES
Does not involve the MOLE concept
No Safety requirements inferred

Cont 8: Binary: 01000
No Chemical Formulae (unless supplied)
Recall or construction of CHEMICAL EQUATIONS
Does not refer to Specific Substances
Does not involve the MOLE concept
No Safety requirements inferred

Cont 16: Binary: 10000
Recall or construction of CHEMICAL FORMULAE
No Chemical Equations (unless supplied)
Does not refer to Specific Substances
Does not involve the MOLE concept
No Safety requirements inferred

Cont 31: Binary: 11111
Recall or construction of CHEMICAL FORMULAE
Recall or construction of CHEMICAL EQUATIONS
Refers to SPECIFIC SUBSTANCES
Involves the MOLE concept
Implies SAFETY Requirements

Table 4 (continued)

3. Skills Values

Skil 0: Binary: 00000
Does not involve Graphs Tables or Grids
Does not involve Diagrams or Flow-Charts
Does not require sorting of information
Every part of problem necessary for solution
Simple recall only

Skil 1: Binary: 00001
Does not involve Graphs Tables or Grids
Does not involve Diagrams or Flow-Charts
Does not require sorting of information
Every part of problem necessary for solution
Skills beyond simple recall

Skil 2: Binary: 00010
Does not involve Graphs Tables or Grids
Does not involve Diagrams or Flow-Charts
Does not require sorting of information
Contains IRRELEVANT data
Simple recall only

Skil 4: Binary: 00100
Does not involve Graphs Tables or Grids
Does not involve Diagrams or Flow-Charts
Involves SORTING of information
Every part of problem necessary for solution
Simple recall only

Skil 8: Binary: 01000
Does not involve Graphs Tables or Grids
Involves DIAGRAMS or FLOW-CHARTS
Does not require sorting of information
Every part of problem necessary for solution
Simple recall only

Skil 16: Binary: 10000
Involves GRAPHS TABLES or SELECTION GRIDS
Does not involve Diagrams or Flow-Charts
Does not require sorting of information
Every part of problem necessary for solution
Simple recall only

Skil 31: Binary: 11111
Involves GRAPHS TABLES or SELECTION GRIDS
Involves DIAGRAMS or FLOW-CHARTS
Involves SORTING of information
Contains IRRELEVANT data
Skills beyond simple recall

Table 4 (continued)

4. Language Values

Lang 0:	Binary: 00000 Short sentences No subordinate clauses Short words No ambiguous words Grammatically structured answer required
Lang 1:	Binary: 00001 Short sentences No subordinate clauses Short words No ambiguous words Single word answers
Lang 2:	Binary: 00010 Short sentences No subordinate clauses Short words Words in unusual contexts Grammatically structured answer required
Lang 4:	Binary: 00100 Short sentences No subordinate clauses Long/Complex words No ambiguous words Grammatically structured answer required
Lang 8:	Binary: 01000 Short sentences Contains subordinate clauses Short words No ambiguous words Grammatically structured answer required
Lang 16:	Binary: 10000 Long sentences No subordinate clauses Short words No ambiguous words Grammatically structured answer required
Lang 31:	Binary: 11111 Long sentences Contains subordinate clauses Long/Complex words Words in unusual contexts Single word answers

Table 4 above shows the proposition characteristics generated for values of 0, 1, 2, 4, 8, 16 and 31, since these represent binary numbers 00000, 00001, 00010, 00100, 01000, 10000 and 11111 respectively, and thus show the range of possible characteristics.

The result of this coding was that the characteristics of particular problems would stand out in a comparison. If necessary, it would not be difficult to revert to the original binary and compare problems by the results of individual propositions. It should be noted that there was not any correspondence between the relative value of the number generated and the complexity of the problem, because the connection was, in general, between the number of 1's in the binary number (except for Lang proposition number 5), and the complexity of the problem: thus codes 15, 23, 27, 29, 30 and 31 (with 4 or 5 "Yes" answers out of 5) tended to represent the most complex problems in any proposition set, and codes 0, 1, 2, 4, 8 and 16 represented in general the simplest ones.

With a total of 57 problems, many of which had several features in common, and 32 codes in each proposition set, it was not surprising to find that many possible combinations of codes were not represented among the problem set. The system was clearly capable of considerable expansion.

Chapter 5

Phase 4

Phase 4

The Pupils' Results

While the data collection and analysis for Phase 3 was going on, the other set of data, the pupils' results, were collected with the co-operation of the Scottish Examination Board.

The size of sample was 100 scripts at each level of the 1986 examination in Chemistry: i.e., 100 O Grade, 100 H Grade and 100 CSYS scripts. These were selected at random by the Examination Board, and made available, at the Board's premises, on the strict understanding that confidentiality would be maintained, and that there would be no way of identifying any individual or school in the research project. The scripts were not removed from the Board's premises at any time.

The following data was therefore gathered from the scripts:

1. Sex of pupil
2. Examiner's actual mark for each question
3. Whether each question was attempted or not

The intention was to use the actual marks to compare with a pass grade for each problem attempted, and to distinguish between problems that had been attempted and awarded zero marks, and problems that had not been attempted at all. The success or failure rates could then be compared at a variety of standards.

The first stage in the treatment of this data was to convert it into a form suitable for processing alongside the problem codes that were established in the earlier parts of the project. In the whole project, there were only two parts which were not processed automatically. These were:

1. The transfer of calculated problem codes to a disc file
2. The transfer of pupils' marks to a disc file

Accordingly, it was important to ensure that these two stages, which involved keyboard entry of data, were accomplished without error. Two programs were written to enter data and display it on the screen in a form that was easily checked against written records: "QVALUE" for entry of problem codes and "MARKENT" for entry of pupil marks. The QVALUE program merely entered the calculated values from the keyboard and wrote them on to the disc as integer numbers, but MARKENT had to deal with the possibility of half marks in the pupils' results. This was done by multiplying all marks by 2, then writing them as integer numbers into the file. Integer numbers were used instead of floating point numbers whenever possible, in order to save disc space and internal memory, both of which commodities are rather limited in the BBC B microcomputer.

Three separate marks files were created in this way, one for each of the O grade, H grade and CSYS papers. They were written on to the disc in the style that was established for all such data files in this project: the O Grade files were in directory O, H Grade in directory H and CSYS in directory S. Thus the file containing pupils' marks for Higher Grade was called "H.marks". In addition to the set of marks for each pupil, the file also contained a single character, "M" or "F" for the sex of each candidate. Blank entries, those problems that were not attempted, were entered with the value 99, to distinguish them from problems that were attempted but gained zero marks. In each paper, there were choices of question, labelled A or B, in which more than one question of the same structure and type, but differing in specific content, was offered; only one question was to be attempted in each case. Thus, every candidate had some blank entries in his/her file.

Processing of Data

There were two ways of dealing with the raw scores - to multiply each possible mark by a pass-mark factor and compare the raw scores to it in turn, or to establish a pass mark for each question individually and compare the raw score with it.

In the first attempts at combining the two sets of data, the first method - of establishing individual passes by multiplying each possible score by a constant factor and then comparing the raw scores - was adopted. Because of memory limitations, it was necessary first to create a new file for each pass factor, in each of the grades.

The program "PASSMK" was written for this purpose. It enquired first for the factor (the factors chosen were 20% to 80% by 10% increments), then compared each raw score in turn with the calculated pass mark for that problem. If the individual passed in that question, a mark of -1 (read by the BBC system as "TRUE") was assigned: a failure received a mark of 0 (read as "FALSE"), and a blank (not attempted) retained the score of 99. The files which were created, called O.passes, H.passes and S.passes respectively, had the same structure as the raw score files, including the sex of each candidate, which was transferred directly, but recorded TRUE, FALSE or 99 for each question.

In the first run of Phase 4, it was hoped that there would be sets of problems with similar characteristics, whose pass rates could then be compared directly. Unfortunately, the relatively small number of problems made this impossible to establish. There was only one set of problems, (H Grade paper, questions 1 and 2), which could represent the required control set, with exactly the same characteristics. In the H Grade paper, this pair was a choice set, in which only one was to be completed; thus no candidate attempted both questions, and there could not be a direct comparison. There was no such pair in either the O grade or the CSYS paper.

A series of programs was now developed to establish which problems had similar characteristics. For convenience, they were named the "FAMILY" series, because their purpose was to seek family resemblances among problem types.

The original hypothesis was that if two questions were identified as differing in only one respect (out of Process, Content, Skills or Language), and that if a significant number of candidates did not perform similarly in each of these questions, then there would be evidence to suppose that the aspect in which the questions differed might be responsible for the difference in performance. The next stage in the treatment of the data, therefore, was to establish which questions were nearly similar to each other in classification. A program called "FAMILY" was written to seek and list out all questions in which the classifications for P, C, S or L were identical. As has been explained already, there was only one such instance, in a question which was in two optional parts.

The program was therefore modified into "FAMILY2", which searched for all equalities of question values and displayed them in order, counting through the problem numbers, so that pairs of problems with similar characteristics were listed together, and the pairs could easily be seen. This process was taken further in "FAMILY3", which ignored pairs of problems that were alike in only one respect, but listed those pairs of problems that had 2, 3 or 4 proposition values in common. This program identified the four-value pairs mentioned above, and listed all possible sets of contingencies.

With the groups of problems thus established, the data on groups was transferred to a program called "PHASE4", which listed all those candidates who passed in one and failed in the other of each of the paired problems that had been identified in the "FAMILY" series. Candidates who passed in both or failed in both problems, or who had left either of the questions blank, were ignored by this program.

The output from this program, which amounted to several pages of lists, looked promising at first. In the O grade analysis, 139 such cases were identified, with two, three or even four cases of a candidate performing differently in questions which differed only in one aspect of their proposition characteristics, while 227 such cases appeared in the H grade data, and 46 in the CSYS. The intention was to highlight the remaining characteristic as the possible cause of success or failure in that case. This strategy did not work as well as had been hoped, for the following reasons:

1. All of the identified three-class pairs included Process characteristics in common. As a consequence, there was no opportunity to isolate Process.
2. Nearly all similarities in characteristic in the O Grade data were of the "PCS" type - they had the same Process, Concept and Skill ratings, and thus isolated Language. Interestingly, most of the relevant H Grade examples were "PCL", thus isolating Skills, and two of the CSYS examples were "PSL", isolating Concepts. The exact distribution of

paired question properties is shown in Table 5 below.

3. The pattern of passes and failures was not always a one-way correspondence, as might be expected if the isolated factor had been to blame for the result. A modification of the "PHASE4" program showed specific deviations from this expected pattern. The results of this analysis are contained in Table 5.

Table 5

Analysis of Phase 4 Results - O Grade

Problems		Type		Pass Ratio		Total	Blanks	Identical
2	15	PCL	*	0	10	10	74	16
4	17	PCS	*	30	7	37	0	63
6	7	PCS		0	0	0	100	0
6	9	PCS		5	5	10	50	40
6	10	PCS		1	2	3	81	16
6	13	PCS	*	29	0	29	31	40
7	9	PCS		0	0	0	88	12
7	10	PCS		2	5	7	82	11
7	13	PCS		3	2	5	71	24
9	10	PCS		0	0	0	100	0
9	13	PCS	*	25	0	25	39	36
10	13	PCS	*	11	2	13	63	24
14	15	PCS		0	0	0	100	0

Total Possible Discrepancies = 1300: Total attempted = 282

Total Actual Discrepancies = 139: One Choice Blank = 879

Analysis of Phase 4 Results - H Grade

Problems		Type		Pass	Ratio	Total	Blanks	Identical
1	2	PCSL		0	0	0	100	0
6	15	PCL	*	25	1	26	37	37
10	15	PCS	*	32	8	40	1	59
11	16	PCS		20	11	31	0	69
13	16	PCL	*	8	40	48	3	49
14	17	PCL		10	17	27	3	70
14	20	PCL		5	6	11	63	26
16	17	PCL		17	13	30	1	69
17	20	PCL		9	5	14	62	24

Total Possible Discrepancies = 900: Total attempted = 403

Total Actual Discrepancies = 227: One Choice Blank = 270

Analysis of Phase 4 Results - CSYS

Problems		Type		Pass	Ratio	Total	Blanks	Identical
6	7	PCS		0	0	0	100	0
6	20	PSL		2	0	2	94	4
10	12	PCS		25	3	28	0	72
10	19	PCS	*	11	0	11	78	11
12	19	PCS		5	0	5	78	17
18	20	PSL		0	0	0	100	0

Total Possible Discrepancies = 600: Total attempted = 104

Total Actual Discrepancies = 46: One Choice Blank = 450

In most cases of pairs of problems which differ in one characteristic only, there is a clear majority for one problem or the other - an indication that one of the pair was found more difficult than the other. Of the totals listed at the foot of each set of results, the important ones are the "Total attempted" and "Total Actual Discrepancies". Blanks were usually left because of a choice of question to attempt in the paper. Thus in the O grade data, 139 out of 282 means that 49.2% of the pairs met with difference in success from individual candidates. In H grade, 227 out of 403, or 56.3%, fared differently, and in CSYS the proportion was 46 out of 104, or 44.2%. In each table, the "Total attempted" + "Total Actual Discrepancies" + "One Choice Blank" amounts equal the "Total Possible Discrepancies" amount, and the "Total" + "Blanks" + "Identical" figures for each pair of problems always equals 100, the number of candidates. Those pairs of problems which show 100 blanks are always pairs which were offered as alternatives in the paper, and therefore were never both attempted.

It appears, therefore, that these results might not be entirely without value, but that their significance and validity are very uncertain. They can be used only to indicate possible trends and future lines of enquiry. The following discussion must be read in that context throughout.

Tentative Discussion of Phase 4 Results

The most fruitful line of discussion is to take those pairs of problems which had clear majorities to one side, and which had a reasonable number of candidates performing differently in them. If a substantial majority of candidates who attempted both questions performed identically in them, it follows that the differences will be less significant in terms of the hypothesis that the isolated characteristic has anything to do with these differences. Pairs of problems were selected for detailed discussion in accordance with the following criteria:

1. Number of differences = at least 10.
2. Ratio of differences to identicals = at least 1:2.
3. Majority among differences = at least 70% on one side.

The following pairs of problems were therefore selected, and are marked with asterisks in Table 5 above (pages 72-73):

1. O Grade paper, problems 2 and 15 (PCL)
   4 and 17 (PCS)
   6 and 13 (PCS)
   9 and 13 (PCS)
   10 and 13 (PCS)
2. H Grade paper, problems 6 and 15 (PCL)
   10 and 15 (PCS)
   13 and 16 (PCL)
3. CSYS paper, problems 10 and 19 (PSL)

Discussion of Pairs of Problems

O Grade paper, problems 2 and 15 (Type: PCL)

Process = 1: Concept = 20: Language = 29

Skills (problem 2) = 16: (problem 15) = 23

Process 1 : (Binary 00001) implies that the problems are: not quantitative, do not involve arithmetic, do not involve proportion, do not involve non-chemical formulae, but require reasoning as opposed to simple recall.

Concept 20 : (Binary 10100) means that the problems contain the recall or construction of chemical formulae, no chemical equations (unless supplied), reference to specific substances, do not involve the mole concept, and do not infer safety requirements or precautions.

Language 29 : (Binary 11101) implies long sentences, subordinate clauses, and long or complex words; but no words that have different meanings in everyday contexts, and require only single word answers.

Skills 16 (Binary 10000) means the involvement of graphs, tables or selection grids, but does not involve diagrams or flow-charts, sorting of information, irrelevant material, or skills beyond those of simple recall.

Skills 23 (Binary 10111) differs in the last three attributes, requiring sorting of information, containing some irrelevant data and requiring skills beyond simple recall.

10 candidates failed problem 2 and passed problem 15.

This result is somewhat unexpected. It would be supposed that the problem which showed the less complex characteristics would have the greater success. To try to find out why the pass ratio went this way, it is necessary to examine he problems themselves.

Problem 2 (O Grade paper, question 2)

2
2. (*a*) Write the name of an ion, X, containing sulphur, which combines with **one** ammonium ion to give a compound, NH_4X (Data Booklet, page 8). **1**

(*b*) The following reaction is an example of precipitation:

$$MgCl_2 + 2AgNO_3 \rightarrow Mg(NO_3)_2 + 2AgCl$$

Which substance is the precipitate? (Data Booklet, page 11.) **1**

(2)

2 marks given, related tasks: pass mark = 2/2.

Problem 15 (O Grade paper, question 12B)

15
B. X and Y refer to 0·1 M solutions of two acids.

X is a much better conductor of electricity than Y. X reacts quickly with magnesium, Y reacts much more slowly.

The grid contains various statements which may apply to an acid solution.

It reacts with copper. A	It is neutralised by an alkali. B	It reacts with a carbonate. C
It is a solution of a strong acid. D	It contains $H^+(aq)$ ions. E	It is a solution of a weak acid. F

(*a*) Write down the letters of **two** boxes which say something correct for **both** X and Y. **2**

(*b*) Write down the letter of **one** box which says something correct for Y but **not** for X. **1**

(*c*) Write the formula of an acid which might have been used to prepare solution Y. **1**

(4)

4 marks given, pass mark = 2/4.

The different reasoning (see Appendix G) which led to a pass mark of 2/2 in problem 2 and a pass mark of 2/4 in problem 15 is the most likely explanation of the discrepancy between the problem characteristics and the pass results. If the pass mark in problem 2 had been set at 1/2, it is likely that the opposite situation would have obtained. It is necessary also to note that the answer to problem 2 (a) is not a common ion - there are very few sulphur-containing ions which have a single negative charge. The use of the Data Book is essential to solve this problem.

O Grade paper, problems 4 and 17 (Type: PCS)

Process = 1: Concept = 28: Skill = 9:

Language (problem 4) = 20: Language (problem 17) = 29

Process 1 : (Binary 00001) implies that the problems are: not quantitative, do not involve arithmetic, do not involve proportion, do not involve non-chemical formulae, but require reasoning as opposed to simple recall.

Concept 28 : (Binary 11100) means that the problems contain the recall or construction of chemical formulae, the recall or construction of chemical equations, reference to specific substances, do not involve the mole concept, and do not infer safety requirements or precautions.

Skills 9: (Binary 01001) indicates that the problems do not involve graphs, tables or grids, but do involve diagrams or flow-charts; they do not require sorting of information, every part of the problem is necessary to the solution, and skills beyond simple recall are required.

Language 20 (problem 4, Binary 10100) states that this contains long sentences, no subordinate clauses, long or complex words, no words that have other meanings in everyday life, and requires a grammatically structured answer.

Language 29 (problem 17, Binary 11101) means that long sentences are involved; there are subordinate clauses and long or complex words. There are no words that have other meanings in everyday life, and a single word answer is sufficient.

30 candidates passed problem 4 and failed problem 17, while 7 candidates failed problem 4 and passed problem 17.

In this case, a clear majority (30 to 7) succeeded in problem 4 and failed problem 17. This could indicate that the presence of subordinate clauses was a cause of failure. Another possible cause can be found on examination of the problems themselves. They differ in basic complexity.

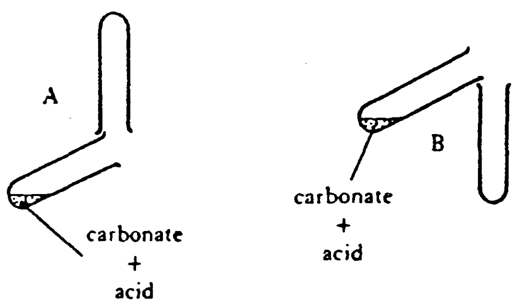
Problem 4 (O Grade paper, question 4)

4

4. Potassium carbonate reacts with sulphuric acid to give potassium sulphate, water and carbon dioxide.

(*a*) Write an equation for this reaction. **1**

(*b*) Explain which of the following methods, A or B, would be more suitable for collecting the carbon dioxide. **1**

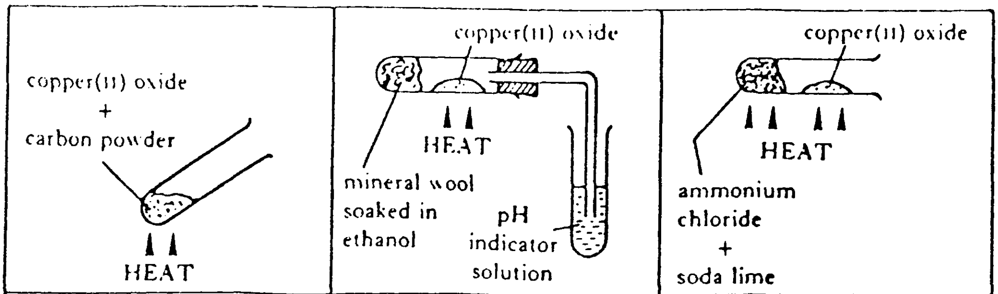


(2)

2 marks given, separate tasks, pass mark 1/2.

Problem 17 (O grade paper, question 14)

17 14. The diagrams illustrate some reactions of copper(II) oxide. *Marks*



Experiment X	Experiment Y	Experiment Z

(*a*) The same colour change is observed in the copper(II) oxide in all three experiments. What is this colour change? **1**

(*b*) Which gas is produced in Experiment X? **1**

(*c*) (i) What would happen to the pH of the solution in Experiment Y?

(ii) Name the substance causing this change. **2**

(*d*) In Experiment Z, the ammonia, produced from the ammonium chloride and soda lime, reacts with the copper(II) oxide. The copper(II) oxide is reduced to copper metal. Nitrogen and water are also formed.

Write an equation for the reaction between the ammonia and the copper(II) oxide. (The equation need not be balanced.) **1**

(5)

5 marks given, pass mark 3/5.

The most likely explanation for the difference in performance between the two problems is the relative complexity of problem 17, rather than the greater difficulty of its language.

The remaining pairs of problems all contain the same Process, Concept and Skills characteristics. In addition, they all contain problem 13, and in every case the majority was clearly in favour of the problem other than number 13. They are therefore best considered as a group of problems compared with the one problem.

Process 1 : (Binary 00001) implies that the problems are: not quantitative, do not involve arithmetic, do not involve proportion, do not involve non-chemical formulae, but require reasoning as opposed to simple recall.

Concept 4 : (Binary 00100) means that there are no chemical formulae and no chemical equations, unless supplied, that specific substances are involved, rather than classes or types of substances, there is no mention of the mole concept, and there are no safety requirements or precautions involved.

Skills 9: (Binary 01001) indicates that the problems do not involve graphs, tables or grids, but do involve diagrams or flow-charts; they do not require sorting of information, every part of the problem is necessary to the solution, and skills beyond simple recall are required.

Language 28 (problem 6, Binary 11100) indicates long sentences, subordinate clauses, long or complex words, no words which have different everyday meanings, and a grammatically structured answer.

Language 0 (problem 9, Binary 00000) means short sentences, no subordinate clauses, short words, no ambiguous words, and a grammatically structured answer.

Language 4 (problem 10, Binary 00100) has short sentences, no subordinate clauses, long or complex words, no ambiguous words and a grammatically structured answer.

Language 24 (problem 13, Binary 11000) means long sentences, subordinate clauses, no long or complex words, no ambiguous words and a grammatically structured answer.

There is no immediate reason, on this analysis, why problem 13 should be perceived by candidates as more difficult than any of the others in this group of 4: but the results clearly point to this inference:

29 candidates passed problem 6 and failed problem 13; none failed problem 6 and passed problem 13.

25 candidates passed problem 9 and failed problem 13; none failed problem 9 and passed problem 13.

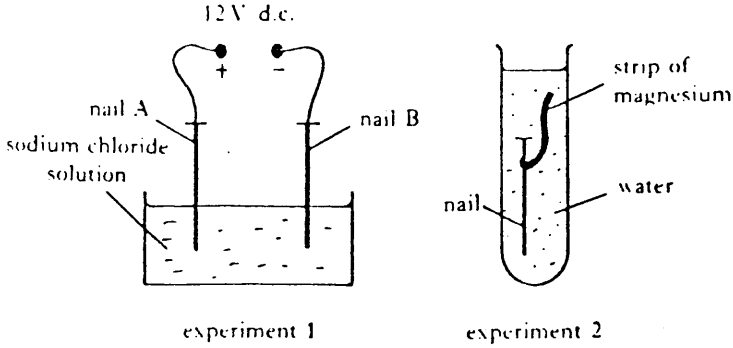
11 candidates passed problem 10 and failed problem 13; only 2 failed problem 10 and passed problem 13.

Again, insight into the results can be obtained from an examination of the problems themselves, reproduced on the following pages:

Problem 6 (O Grade paper, question 6A)

6 6. Answer EITHER A OR B.

A. Two corrosion experiments with iron nails are shown below:



(a) In experiment 1, which nail, A or B, will be protected against rusting? **1**

(b) In experiment 2, how does the magnesium protect the nail from rusting? **1**

(c) Choose one of these experiments and describe briefly one example of how this method is actually used to protect iron or steel on a large scale. (Indicate clearly which experiment you are referring to.) **1**

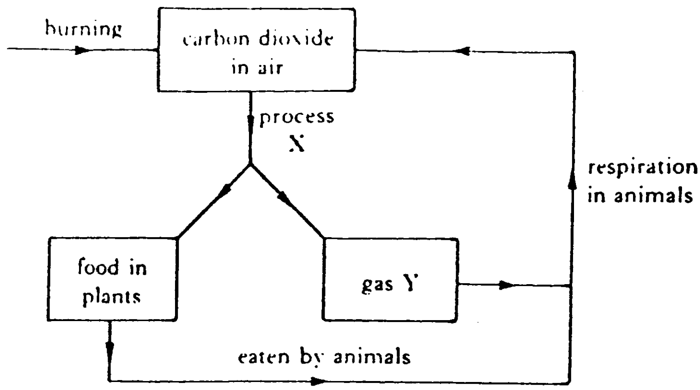
(3)

3 marks given, pass mark 2/3.

Problem 9 (O Grade paper, question 8A)

9 8. Answer EITHER A OR B.

A. The flow chart shows part of the carbon dioxide cycle.



(a) Name process X. **1**

(b) Name gas Y. **1**

(c) The amount of carbon dioxide entering the air has increased considerably in the last 50 years. Give a reason for this increase. **1**

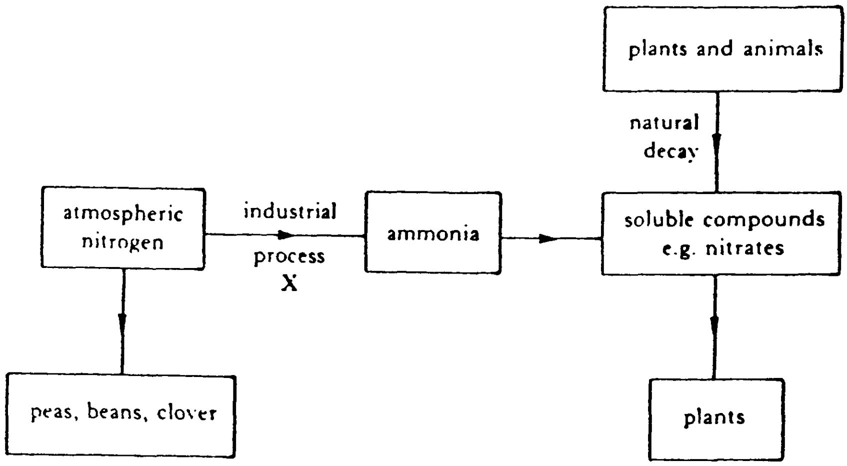
(3)

3 marks given, pass mark 2/3.

Problem 10 (Ordinary Grade paper, question 8B)

10

B. The flow chart shows part of the nitrogen cycle.



(*a*) What enables peas, beans and clover to use nitrogen directly from the air? 1

(*b*) Name the industrial process X. 1

(*c*) Crop yields have increased considerably in the last 50 years. Give a reason for this increase. 1

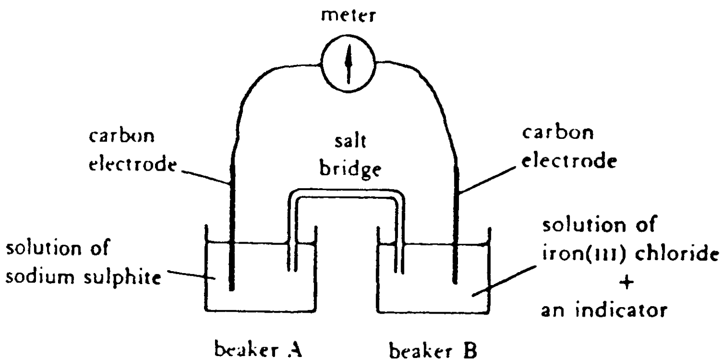
(3)

3 marks given, pass mark 2/3.

Problems 9 and 10 were given as an "either/or" choice. 61 candidates attempted problem 9 and 37 candidates attempted problem 10. 2 candidates did not attempt either problem.

Problem 13 (Ordinary Grade paper, question 11)

13 **11.**



The half-reactions which take place in the above apparatus are:

$$SO_3^{2-}(aq) + H_2O(l) \longrightarrow SO_4^{2-}(aq) + 2H^+(aq) + 2e^-$$
$$2Fe^{3+}(aq) + 2e^- \longrightarrow 2Fe^{2+}(aq)$$

As the reaction proceeds, (i) a reading is obtained on the meter;

(ii) the indicator in beaker B gradually turns blue.

(*a*) In which direction do electrons flow through the meter? **1**

(*b*) Which ion causes the indicator to turn blue? **1**

(*c*) Describe a test to show that a reaction has taken place in beaker A. You must include in your answer the names of any reagents you would use and the results you would expect to obtain. **2**

(4)

4 marks given, pass mark 2/4.

The reason for the poor performance in problem 13, in comparison with the other problems of similar type, is unlikely to be due to any vagaries of language, as indicated above. Instead, there is good reason to suppose that there are two factors involved in this result. The first is that problem 13 is more complex in its structure than the other problems. The diagram is more complicated, and complicated equations are supplied, which must be interpreted. The mastery of ion-electron half-reactions has long been recognised as one of the most difficult parts of the Ordinary grade course, and success in this problem depends on just such mastery. The original propositions did not distinguish between a complex diagram, as in problem 13, and a relatively simple diagram or flow chart, as is found in problems 6, 9 and 10. There is reason to believe, also, that the number of separate pieces of information contained in problem 13 is greater than those in the other problems, and there is a high probability of information overload in this problem. This phenomenon has been investigated at length by El-Banna, Johnstone and others (51, 52, 53, 55), and their work has indicated that the normal maximum that most people can contain in their working memory is 7 items, plus or minus 2 (49). Problem 13 appears to contain a number of working steps and could well involve more than 7 items to be held in memory, which would overload many candidates.

Discussion of Higher Grade pairs

Two selected pairs involve the same problem, number 15, and can thus be considered together. There is, however, a difference in the type of comparison.

Higher grade paper, problems 6 and 15: (Type: PCL)
Process = 1: Concept = 4: Language = 0
Skills (problem 6) = 21: (problem 15) = 17

Process 1 (Binary 00001) means that the problems are not quantitative; they do not involve arithmetic, proportion or non-chemical formulae, and they require reasoning as opposed to recall.

Concept 4 (Binary 00100) means that specific substances are involved, but there are no chemical formulae or equations (unless supplied), and neither the mole concept nor safety requirements are invoked.

Language 0 (Binary 00000) has short sentences, no subordinate clauses, short words, no ambiguous words, and requires a grammatically structured answer.

Skills 21 (problem 6, Binary 10101) involves graphs, tables or selection grids, does not involve diagrams or flow-charts, involves sorting of information, needs all the supplied data for solution, and requires skills beyond simple recall.
Skills 17 (problem 15, Binary 10001) differs from Skills 21 only in the respect that it does not require the sorting of information.

On analysis of the problem characteristics, it would appear that problem 6 is more difficult than problem 15: however, the pass/fail numbers (25:1) indicate that problem 6 was found to be easier by the candidates. The actual problems therefore have to be examined.

Problem 6 (Higher Grade paper, question 5A)

6

5. Answer EITHER A OR B.

A. (*a*) Which type of bonding exists in (i) sulphur;

(ii) aluminium? 1

(*b*) Use the Data Booklet (page 2) to find the melting points of these elements. 1

(*c*) Explain why the melting point of aluminium is high. 1

(3)

3 marks given, partial knowledge possible; pass mark 1.5/3

Problem 15 (Higher Grade paper, question 13)

Marks

15

13.

Acid	*pH of 2M aqueous solution*
A CCl_3COOH	0·50
B $CHCl_2COOH$	0·90

(*a*) Which is the stronger acid? Explain your choice. 2

(*b*) Acid A dissociates in water as follows:

$$CCl_3COOH(aq) \leftrightharpoons CCl_3COO^-(aq) + H^+(aq).$$

How would the equilibrium be affected by the addition of

(i) solid NaOH;

(ii) solid NaCl;

(iii) solid CH_3COONa? 3

(*c*) Explain your answer in the case of solid CH_3COONa. 1

(6)

6 marks given: pass mark = 3/6.

It is clear that problem 15 is more complex than problem 6, and involves more complicated formulae (albeit supplied). Problem 15 also involves equilibrium and the factors which determine it. This is known as a problem area of the Higher grade syllabus. In addition, sufficient information to achieve a pass in problem 6 is supplied by the Data Booklet, and no further skill or reasoning (to achieve half marks) is required beyond the skill of obtaining information from tables. In problem 15, however, considerable reasoning skill is required in all parts of the problem.

Higher Grade paper, problems 10 and 15 (Type: PCS)

Process = 1: Concept = 4: Skill = 17

Language (problem 10) = 12: (problem 15) = 0

Language 12 (problem 10, Binary 01100) means short sentences but subordinate clauses, long or complex words but no ambiguous words, and a grammatically structured answer.

Problem 10 appears to be the more difficult in terms of these criteria, but, as in the previous pair, the results indicate the opposite, as 32 candidates passed problem 10 but failed problem 15, and only 8 failed 10 and passed 15. Once again it is necessary to examine the problems themselves.

Problem 10 (Higher Grade paper, question 8)

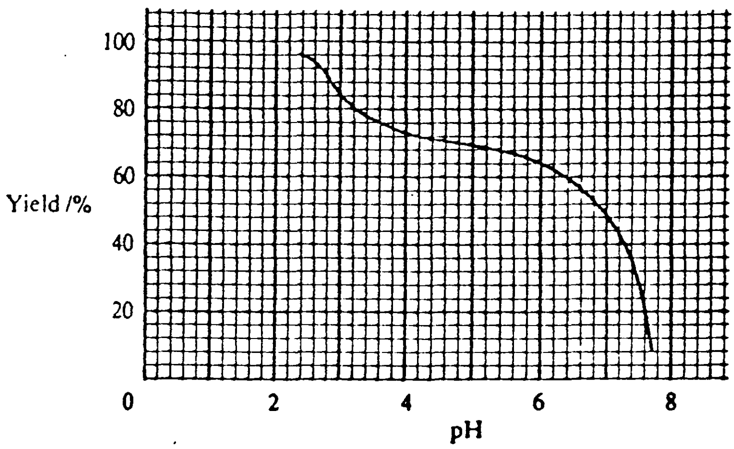
(10)

8. The following equation shows how bromine can be extracted from sea water.

$$Cl_2(g) + 2Br^-(aq) \longrightarrow Br_2(aq) + 2Cl^-(aq)$$

(a) Which type of chemical reaction is represented by this equation? 1

(b) The graph shows the effect of pH on the yield of bromine obtained.



What happens to the yield of bromine as the sea water becomes more acidic? 1

(c) Would chlorine be a suitable reagent for obtaining fluorine from fluoride ions? Explain your answer. 2

(4)

4 marks given, pass mark = 2/4.

In this case it is not so easy to see why there is a distinct majority of passes in favour of problem 10. Certainly this problem is slightly less complicated than 15, and there is less probability of overload. The overall level of skill seems to be about the same in both cases. Problem 15 is the only one which addresses equilibria, essential to all parts of its solution and therefore to a pass mark, whereas it is possible to obtain half marks in problem 10 by two simple parts of the question, which require less skill in themselves.

Higher Grade paper, problems 13 and 16 (Type: PCL)

Process = 1: Concept = 4: Language = 28

Skills (problem 13) = 1: (problem 16) = 23

Process 1 and Concept 4 are as described above.

Language 28 (Binary 11100) has long sentences, subordinate clauses, long or complex words and a grammatically structure answer, but no ambiguous words.

Skills 1 (problem 13, Binary 00001) does not involve graphs, tables, grids, diagrams or flow-charts, sorting of information or any material irrelevant to the solution. It does involve skills beyond simple recall.

Skills 23 (problem 16, Binary 10111) involves graphs, tables or selection grids, but not diagrams or flow-charts. It requires sorting of information, contains irrelevant data and involves skills beyond simple recall.

Problem 13 was the less successful one, with 8 candidates passing it and failing problem 16, while 40 candidates failed 13 and passed 16. Once again the expected pattern, as predicted by the characteristics, was reversed in practice.

Problem 13 (Higher Grade paper, question 11)

13

11. (a) (i) What shape are the crystals of both sodium chloride and caesium chloride? **1**

(ii) In these crystals, each sodium ion is surrounded by six chloride ions whereas each caesium ion is surrounded by eight chloride ions.

Describe the lattice arrangement in each of these compounds and explain why they are different. **2**

(b) $NaOH(s) \longrightarrow NaOH(aq) \quad \Delta H = a$

$NaOH(s) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(\ell) \quad \Delta H = b$

$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(\ell) \quad \Delta H = c$

From the above data, write an equation to show the relationship between **a**, **b**, and **c**. **2**

(5)

5 marks given, half marks unlikely; pass mark = 3/5.

Problem 16 (Higher Grade paper)

Marks

16

14. The following are variables which can affect the progress of a chemical reaction.

temperature	light	catalyst	concentration
particle size	stirring	pressure	inhibitor

(a) (i) In the chain reaction between hydrogen and chlorine, which of the above is commonly used to initiate (start) the reaction? **1**

(ii) Explain how this causes the reaction to begin. **1**

(iii) Name the two other stages in a chain reaction. **1**

(b) Which of the above variables will alter the position of equilibrium in the following reaction?

$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g) \quad \Delta H = +90 \text{kJ mol}^{-1}$$ **2**

(c) Explain why reactions involving solids tend to go faster when the solids are finely divided. **2**

(d) A mixture of hydrogen and oxygen does not react at room temperature. When a piece of clean platinum is placed in the mixture, the hydrogen and oxygen react explosively.

(i) Explain why hydrogen and oxygen do not react at room temperature. **1**

(ii) What is the purpose of the platinum? **1**

(iii) Discuss and explain how the platinum functions. **3**

(12)

12 marks given; pass mark = 6/12.

Problem 16 dealt with a part of the syllabus, the effect of various factors on rates of reaction, that is generally found to be easy. This syllabus segment has now been incorporated into the Standard Grade syllabus for Chemistry, which is a clear indication that its facility is recognised. Problem 13, on the other hand, is related to Hess's Law and to ionic arrangements, which appear to cause more problems to students. The marking scheme in problem 16, moreover, is split up into many single-mark short questions, while that of problem 13 requires only 3 relatively complex answers. It should therefore be easier to obtain a pass mark in problem 16 than in problem 13.

Discussion of CSYS pairs

There was only one CSYS pair which fitted the criteria for consideration in this discussion. There were considerably fewer pairs of related problems in the CSYS group, thus illustrating the greater diversity of problem to be expected at this higher level of achievement.

CSYS paper, problems 10 and 19 (Type: PCS)

Process = 1: Concept = 4: Skills = 1

Language (problem 10) = 12: (problem 19) = 20

11 candidates passed problem 10 and failed problem 19, while no candidate performed in the opposite way.

Process 1, Concept 4 and Skills 1 have been described above.

Language 12 (problem 10, Binary 01100) has short sentences, but contains subordinate clauses, long or complex words, and requires a grammatically structured answer. It does not involve ambiguous words.

Language 20 (problem 19, Binary 10100) implies long sentences, long or complex words, and a grammatically structured answer. It does not contain subordinate clauses or ambiguous words.

Problem 10 (CSYS paper, question 8)

10 **8.** The following equations are for two hydrolyses:

$$SiCl_4(\ell) + 2H_2O(\ell) \rightarrow SiO_2(s) + 4HCl(g) \qquad \Delta G^\circ_{298} = -139 \text{ kJ}$$

$$CCl_4(\ell) + 2H_2O(\ell) \rightarrow CO_2(g) + 4HCl(g) \qquad \Delta G^\circ_{298} = -234 \text{ kJ}$$

(*a*) From this information alone what predictions can be made about their

(i) feasibility,

(ii) position of equilibrium,

(iii) rate? **3**

(*b*) In practice, the addition of water to tetrachlorosilane ($SiCl_4$) results in an immediate vigorous hydrolysis. The addition of water to tetrachloromethane has no effect even with prolonged boiling.

Suggest an explanation for this difference. **1**

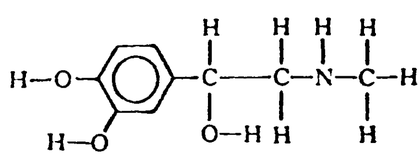
(4)

4 marks given: pass mark = 2/4

Problem 19 (CSYS paper, question 15B)

B. "The structural formula of the hormone adrenaline is shown below.

19



This formula does not indicate the true shape of the molecule. For example, in the terminal methyl group the bonds are arranged tetrahedrally around the carbon atom."

Discuss other parts of the molecule in this way. **(4)**

4 marks given: pass mark = 2/4

11 candidates passed problem 10 and failed problem 19, while no candidates performed in the opposite way.

The most likely cause of the discrepancy of performance between these two problems is that problem 19 requires an essay type of answer, with no structure being presented to the candidate. Although problem 10 requires a high degree of skill, the answers nevertheless are structured in single mark groups, and it is easier to acquire a pass mark in those circumstances than in a single long answer for 4 marks, which presents a different type of challenge. In addition, while the hydrolysis of carbon and silicon compounds is exhaustively covered in the syllabus, less attention is paid to the 3-dimensional structure of organic molecules.

Discussion of Phase 4 Results

In a high number of cases, the observed pattern of pass/fail pairs differs from the pattern to be expected if the isolated characteristic was indeed the cause of the difficulty. In addition, the fact that Process was never isolated, and that the great majority of cases isolated Language, made it impossible to compare the four factors evenly.

It is necessary, in every case of clear preference for one problem from a pair, to examine the problems themselves and adduce explanations for the observed results. These explanations reflect mainly on the content, in terms of the syllabus, rather than concept, of the problems. This is evidence for the view that ideas of process, concept or skills cannot be taught in isolation, separated from the actual content of the syllabus, at least when the course is assessed by an examination which depends on a thorough knowledge of syllabus content for success.

There are also preconceptions of difficulty associated with particular content areas. In the example of the SCE Chemistry syllabuses at Ordinary Grade, Higher Grade and CSYS, there are several examples of topics that are commonly perceived as being of extraordinary difficulty for students. This is especially so at Ordinary Grade, because at the more advanced grades, most students who lack the aptitude for the subject have been weeded out already. A higher degree of expertise is expected at Higher Grade and CSYS, simply because possession of an Ordinary Grade pass is generally taken to be the necessary entry qualification for the Higher Grade course, and a Higher Grade pass as the necessary entry qualification for the Sixth Year Studies course, whether designed that way in the exam regulations or not. There are, therefore, more areas of perceived difficulty in the Ordinary Grade syllabus than in Higher Grade, and more perceived difficulty in Higher Grade than in CSYS. A useful source of information on these topics is the Annual Report of the SCE Examiners in Chemistry for the 1986 examination (96).

In the Ordinary Grade syllabus, topics of perceived difficulty include calculations of atomic weights and chemical formulae by analysis, the use of the mole concept in calculations from equations, complex organic chemistry, especially in the chemistry of foods, the preferential discharge of ions and ion-electron half-reactions in oxidation/reduction problems. The chemistry of polymers often causes difficulties. The Higher Grade syllabus (4) includes the topics of large number calculations (e.g., Avogadro's number), bond energies and Hess's Law, reaction mechanisms and equilibria. Some attempt has been made to include these specific ideas in the formulation of propositions (see page 56 or Appendix C).

It could be argued that all parts of the CSYS syllabus are difficult; but the notion of perceived difficulty is less easy to sustain in that context, because all candidates will have a pass at Higher Grade before attempting CSYS. This is because of the status of CSYS as a University entry qualification, being counted as an extra Higher Grade pass. Thus any candidate who had failed to achieve at least a "B" pass at Higher Grade would be most unlikely to attempt CSYS, preferring to re-sit Higher Grade to achieve a University entrance pass. In this way the quality of candidates at entry to the Sixth Year Studies course is assured to a degree much less probable in either Ordinary Grade or Higher Grade, and the notion that particular topics have greater preconceptions of difficulty is less useful in discussion.

The research method of this project can be used to investigate areas of content which invite special attention in the ways discussed above, by using content-specified propositions in the first stage of the problem analysis. The factors thus identified may then be used in the writing of materials and the formulation of strategies for improving the teaching of Chemistry in schools.

Chapter 6

Phase 5

Order of Merit Calculations

Phase 5 - Order of Merit Calculations

With the failure of the paired comparison method to produce results that were sufficiently comprehensive to test all the types of characteristics, and indeed with the paired comparisons giving results which seemed to run counter to expectation and which required explanation in terms of factors which were not identified in the original analysis, it became necessary to examine the data by an alternative method.

The method chosen was to group the performances of the exam candidates in order of merit by problem, with the proposition values shown, so as to see whether particular patterns of proposition values emerged among the most successful problems. This grouping was not, however, a simple comparison of the number of passes in each problem, because some problems were presented as either/or choices to the candidates, and would therefore have a much lower number of passes than those problems for which there was no choice in attempting. Indeed, a first run of the program MERIT, which presented a list of the problems in the order of their pass numbers, revealed no pattern in the presentation. A sample page, from the O grade results, is shown in Table 6a below. Table 6b shows the same data, but this time ordered by pass rate, i.e., the rate generated by calculating the number of passes divided by the total of passes + fails (ignoring blanks) in the program MERIT2, which was developed from MERIT.

Table 6a

MERIT results - O grade data

Pass grade for this run = 50%

Ordered by Pass Rate only

Qn	Proc	Conc	Skil	Lang	Pass	Blnk
1	17	4	4	7	78	0
12	17	28	21	31	74	0
2	1	20	16	29	73	0
8	0	4	0	1	70	3
3	29	14	1	25	69	0
4	1	28	9	20	66	0
16	1	0	13	28	65	2
6	1	4	9	28	59	31
5	31	6	1	25	59	9
14	1	20	23	13	54	26
11	1	20	1	5	51	6
9	1	4	9	0	51	38
13	1	4	9	24	47	1
17	1	28	9	29	45	0
10	1	4	9	4	32	63
7	1	4	9	12	24	70
15	1	20	23	29	19	74

Table 6b

Pass grade for this run = 50%

Ordered by (Pass/Pass+Fail) Rate

Qn	Proc	Conc	Skil	Lang	Pass	Blnk	Rate
6	1	4	9	28	59	31	86
10	1	4	9	4	32	63	86
9	1	4	9	0	51	38	82
7	1	4	9	12	24	70	80
1	17	4	4	7	78	0	78
12	17	28	21	31	74	0	74
2	1	20	16	29	73	0	73
14	1	20	23	13	54	26	73
15	1	20	23	29	19	74	73
8	0	4	0	1	70	3	72
3	29	14	1	25	69	0	69
4	1	28	9	20	66	0	66
16	1	0	13	28	65	2	66
5	31	6	1	25	59	9	65
11	1	20	1	5	51	6	54
13	1	4	9	24	47	1	47
17	1	28	9	29	45	0	45

At this stage, the pass/fail criterion was a 50% pass mark applied to all questions.

The program MERIT2 was designed not only to calculate the merit order for problems at each grade, but also to write the calculated data on to a file on a disc in the other drive (for reasons of space on a single disc). It also read data from different runs of the PASSMK program. These different runs calculated passes at different pass marks, from 20% to 80%, at 10% intervals. Thus between the two programs, a series of files was created on this second disc, containing data for each level at a series of pass marks. The program called DISPLAY was written to show the patterns, if patterns there were, of merit orders at various pass rates. For this purpose, the proposition values for each problem were shown in Binary form, so that any patterns of bits, representing single proposition answers, would show up if they were present. The ideal result would have been to show, in any proposition value column, a pattern of zeros followed by ones, or the reverse. If there had been groupings of all zeros or all ones in any such column, some evidence would have been obtained for the primacy of the characteristics identified in the propositions.

The method of operation in this process was largely dictated by the shortcomings of the BBC micro (Acorn DFS) disc operating system, which allowed only 31 files on each disc, and a maximum of 100 Kilobytes altogether. The order was:

(1) Run PASSMK, saving data on to the MERIT disc.

(2) Run MERIT2, saving data on to a (blank) data disc.

(3) When all runs of PASSMK and MERIT2 are completed, run DISPLAY, using the data disc thus created.

Table 7a (Ordinary Grade)

Display of Merit Orders

Pass grade for this run = 50%

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
6	00001	00100	01001	11100	40	19	59	7	3	10	13	18	31
10	00001	00100	01001	00100	15	17	32	3	2	5	42	21	63
9	00001	00100	01001	00000	34	17	51	8	3	11	18	20	38
7	00001	00100	01001	01100	12	12	24	1	5	6	47	23	70
1	10001	00100	00100	00111	47	31	78	13	9	22	0	0	0
12	10001	11100	10101	11111	41	33	74	19	7	26	0	0	0
2	00001	10100	10000	11101	42	31	73	18	9	27	0	0	0
14	00001	10100	10111	01101	26	28	54	15	5	20	19	7	26
15	00001	10100	10111	11101	14	5	19	5	2	7	41	33	74
8	00000	00100	00000	00001	41	29	70	17	10	27	2	1	3
3	11101	01110	00001	11001	37	32	69	23	8	31	0	0	0
4	00001	11100	01001	10100	42	24	66	18	16	34	0	0	0
16	00001	00000	01101	11100	37	28	65	21	12	33	2	0	2
5	11111	00110	00001	11001	34	25	59	18	14	32	8	1	9
11	00001	10100	00001	00101	26	25	51	28	15	43	6	0	6
13	00001	00100	01001	11000	25	22	47	34	18	52	1	0	1
17	00001	11100	01001	11101	24	21	45	36	19	55	0	0	0

Mpass = 537 (57.4%); Fpass = 399 (42.6%)

Mfail = 284 (64.4%); Ffail = 157 (35.6%)

Inspection of Table 7a reveals that there is no column in any of the individual propositions that has a pattern of all zeros together and all ones together (of those propositions which gave rise to both zeros and ones). There is of course no point in examining those propositions whose answer did not change within the level of examination. The full output of this part of the project is in Appendix H, and shows that the same lack of pattern occurs at all three levels. Table 7a can be compared directly with Table 6b, in that the totals of passes, failures and blanks correspond throughout, as does the order of the problems in the table. The total number of failures in each problem in Table 6b can be worked out by subtracting the number of passes and the number of blanks from 100, the total number of candidates.

For the sake of completeness, Table 7b and Table 7c show the results of the DISPLAY program output for 50% runs on Higher Grade (Table 7b) and CSYS (Table 7c). It will readily be seen that the same lack of bit pattern occurs in the H Grade and CSYS tables as in the O Grade. "Mpass" represents the number of Male candidates who registered passes in total, and "Fpass" the number of female candidates, while "Mfail" and "Ffail" represent the respective failure numbers. The percentages are calculated on the total passes and fails, ignoring blanks. (The number of male O grade candidates was 60, with 40 females; in H grade there were 65 males and 35 females, and in CSYS there were 60 males and 40 females.) There is not a great variance between the actual numbers and the calculated rates.

Table 7b (Higher Grade)

Display of Merit Orders

Pass grade for this run = 50%

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
2	00000	10100	00000	00001	56	28	84	0	0	0	9	7	16
6	00001	00100	10101	00000	36	22	58	4	1	5	25	12	37
3	00001	00101	01001	11001	52	29	81	6	2	8	7	4	11
7	00001	10100	10011	00000	22	11	33	3	1	4	40	23	63
10	00001	00100	10001	00010	53	32	85	12	3	15	0	0	0
19	11101	01100	10001	11110	30	17	47	12	3	15	23	15	38
11	00001	00100	10111	00101	45	30	75	20	5	25	0	0	0
5	11101	00110	00001	00001	44	24	68	14	10	24	7	1	8
9	00001	00101	11111	00001	49	23	72	16	12	28	0	0	0
4	11111	11110	00001	00001	42	27	69	22	8	30	1	0	1
18	11111	10110	00001	11110	41	26	67	24	9	33	0	0	0
12	11111	01110	00001	11001	46	21	67	19	14	33	0	0	0
16	00001	00100	10111	11100	46	20	66	19	15	34	0	0	0
15	00001	00100	10001	00000	39	22	61	25	13	38	1	0	1
17	00001	10100	10111	10110	41	20	61	24	14	38	0	1	1
20	00001	10100	10001	11100	14	9	23	9	6	15	42	20	62
8	11011	11100	11011	11111	42	16	58	21	19	40	2	0	2
1	00000	10100	00000	00001	7	2	9	2	5	7	56	28	84
14	00001	10100	00100	11110	38	17	55	25	18	43	2	0	2
13	00001	00100	00001	11000	29	7	36	33	28	61	3	0	3

Mpass = 772 (65.7%); Fpass = 403 (34.3%)

Mfail = 310 (62.5%); Ffail = 186 (37.5%)

Table 7c (CSYS)

Display of Merit Orders

Pass grade for this run = 50%

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
10	00001	00100	00001	01100	55	37	92	5	3	8	0	0	0
14	11011	10110	00001	11101	24	26	50	4	1	5	32	13	45
11	00001	10101	01011	11100	54	32	86	6	8	14	0	0	0
12	00001	00100	00001	00000	52	27	79	8	13	21	0	0	0
7	00001	00000	00001	01000	28	18	46	8	4	12	24	18	42
15	00001	10110	10111	11101	47	30	77	12	10	22	1	0	1
8	00011	00100	00001	11100	45	30	75	14	10	24	1	0	1
13	11011	11110	10001	11101	25	9	34	7	4	11	28	27	55
16	00001	00100	01001	00101	45	31	76	15	9	24	0	0	0
17	00001	11101	10001	11101	45	29	74	14	11	25	1	0	1
9	11011	01100	01001	11100	42	29	71	18	11	29	0	0	0
5	00000	00100	01001	00100	35	33	68	25	7	32	0	0	0
2	11001	10110	00001	01100	40	24	64	19	16	35	1	0	1
18	00001	00001	00101	11100	25	14	39	18	12	30	17	14	31
4	11111	11110	00001	11101	28	14	42	18	20	38	14	6	20
6	00001	00000	00001	11100	12	8	20	12	10	22	36	22	58
19	00001	00100	00001	10100	7	3	10	5	7	12	48	30	78
20	00001	00000	00101	11100	1	2	3	3	2	5	56	36	92
3	11111	01110	10001	11100	6	0	6	6	6	12	48	34	82
1	00000	00100	00000	11100	15	16	31	44	24	68	1	0	1

Mpass = 631 (60.5%); Fpass = 412 (39.5%)

Mfail = 261 (58.1%); Ffail = 188 (41.9%)

There is no evidence, from these figures, to suppose that at any level there was any difference between the performance of male candidates and the performance of female candidates.

Because the binary (single column or bit analysis) method showed no pattern of bits at any grade, there was no point in continuing with this form of display, and the patterns of decimal proposition values were examined further to see if there were any combinations of proposition values that consistently showed greater success than others, and whether there were problems which were anomalous in this respect.

The program DECDISP repeated the DISPLAY program, with the proposition values in decimal form. The results of this program, for the 50% runs on the three levels, are shown in Tables 8a, 8b and 8c below. The O grade results (Table 8a) immediately draw attention because they seem to indicate a pattern in the first few sets of proposition values. Apart from problem 13, which has been discussed earlier (Page 85), the pattern of Process 1, Concept 4 and Skills 9 appears to be a reasonable predictor of success. (Problem 13 is anomalous because of its chemical content and its above average complexity at O grade.) This hopeful sign, however, was sadly not repeated in the H grade and CSYS tables, which show a great diversity of proposition values in the rank order. There was not as much to be gained from this analysis as had at first appeared.

Table 8a

Display of All Merit Files

O Grade Questions

Pass grade for this run = 50%

Ordered by (Pass/Pass+Fail) Rate

Qu	Pro	Con	Ski	Lan	Passes			Failures			Blanks			Rate%
					Ma	Fe	To	Ma	Fe	To	Ma	Fe	To	
6	1	4	9	24	40	19	59	7	3	10	13	18	31	86
10	1	4	9	0	15	17	32	3	2	5	42	21	63	86
9	1	4	9	0	34	17	51	8	3	11	18	20	38	82
7	1	4	9	4	12	12	24	1	5	6	47	23	70	80
1	17	4	4	7	47	31	78	13	9	22	0	0	0	78
12	17	28	21	22	41	33	74	19	7	26	0	0	0	74
2	1	20	16	31	42	31	73	18	9	27	0	0	0	73
14	1	20	23	7	26	28	54	15	5	20	19	7	26	73
15	1	20	23	5	14	5	19	5	2	7	41	33	74	73
8	0	4	0	1	41	29	70	17	10	27	2	1	3	72
3	29	14	1	17	37	32	69	23	8	31	0	0	0	69
4	1	28	9	20	42	24	66	18	16	34	0	0	0	66
16	1	0	13	28	37	28	65	21	12	33	2	0	2	66
5	31	6	1	17	34	25	59	18	14	32	8	1	9	65
11	1	20	1	5	26	25	51	28	15	43	6	0	6	54
13	1	4	9	16	25	22	47	34	18	52	1	0	1	47
17	1	28	9	16	24	21	45	36	19	55	0	0	0	45

Table 8b

Display of All Merit Files

H Grade Questions

Pass grade for this run = 50%

Ordered by (Pass/Pass+Fail) Rate

Qu	Pro	Con	Ski	Lan	Passes			Failures			Blanks			Rate%
					Ma	Fe	To	Ma	Fe	To	Ma	Fe	To	
2	0	20	0	1	56	28	84	0	0	0	9	7	16	100
6	1	4	21	0	36	22	58	4	1	5	25	12	37	92
3	1	5	9	25	52	29	81	6	2	8	7	4	11	91
7	1	20	19	0	22	11	33	3	1	4	40	23	63	89
10	1	4	17	2	53	32	85	12	3	15	0	0	0	85
19	29	12	17	30	30	17	47	12	3	15	23	15	38	76
11	1	4	23	5	45	30	75	20	5	25	0	0	0	75
5	29	6	1	1	44	24	68	14	10	24	7	1	8	74
9	1	5	31	1	49	23	72	16	12	28	0	0	0	72
4	31	30	1	1	42	27	69	22	8	30	1	0	1	70
18	31	22	1	30	41	26	67	24	9	33	0	0	0	67
12	31	14	1	25	46	21	67	19	14	33	0	0	0	67
16	1	4	23	28	46	20	66	19	15	34	0	0	0	66
15	1	4	17	0	39	22	61	25	13	38	1	0	1	62
17	1	20	23	22	41	20	61	24	14	38	0	1	1	62
20	1	20	17	28	14	9	23	9	6	15	42	20	62	61
8	27	28	27	31	42	16	58	21	19	40	2	0	2	59
1	0	20	0	1	7	2	9	2	5	7	56	28	84	56
14	1	20	4	30	38	17	55	25	18	43	2	0	2	56
13	1	4	1	24	29	7	36	33	28	61	3	0	3	37

Table 8c

Display of All Merit Files

CSYS Questions

Pass grade for this run = 50%

Ordered by (Pass/Pass+Fail) Rate

Qu	Pro	Con	Ski	Lan	Passes			Failures			Blanks			Rate%
					Ma	Fe	To	Ma	Fe	To	Ma	Fe	To	
10	1	4	1	12	55	37	92	5	3	8	0	0	0	92
14	27	22	1	29	24	26	50	4	1	5	32	13	45	91
11	1	21	11	28	54	32	86	6	8	14	0	0	0	86
12	1	4	1	0	52	27	79	8	13	21	0	0	0	79
7	1	0	1	8	28	18	46	8	4	12	24	18	42	79
15	1	22	23	29	47	30	77	12	10	22	1	0	1	78
8	3	4	1	28	45	30	75	14	10	24	1	0	1	76
13	27	30	17	29	25	9	34	7	4	11	28	27	55	76
16	1	4	9	5	45	31	76	15	9	24	0	0	0	76
17	1	29	17	29	45	29	74	14	11	25	1	0	1	75
9	27	12	9	28	42	29	71	18	11	29	0	0	0	71
5	0	4	9	4	35	33	68	25	7	32	0	0	0	68
2	25	22	1	12	40	24	64	19	16	35	1	0	1	65
18	1	1	5	28	25	14	39	18	12	30	17	14	31	57
4	31	30	1	29	28	14	42	18	20	38	14	6	20	52
6	1	0	1	28	12	8	20	12	10	22	36	22	58	48
19	1	4	1	20	7	3	10	5	7	12	48	30	78	45
20	1	0	5	28	1	2	3	3	2	5	56	36	92	38
3	31	14	17	28	6	0	6	6	6	12	48	34	82	33
1	0	4	0	28	15	16	31	44	24	68	1	0	1	31

The DECana Series

The computer has two specific strengths, which were used to the full in this project: first, it can perform complex calculations quickly and accurately, with any number of repetitions as desired; second, it is very good at manipulating data, again, quickly and accurately. The fact that the data was already coded and present on a disc led to the next series of analysis programs, the DECana series. This analysis was based on the computer's ability to sort the data into any desired order. The sorting was done on each of the proposition values present in turn, placing sets of problems with the same proposition values together, with their pass rates as before, and calculating the average value of the pass rates. The output was sent to the printer for visual examination. Table 9 shows some of the output of this series.

Table 9a

Average Pass Rates By Pairs
O Grade Questions
Rate = (Pass/Pass+Fail) * 100
Selected on Process + Content Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Rate%	Ave
9	1	4	9	0	34	17	51	8	3	11	18	20	38	82	
7	1	4	9	4	12	12	24	1	5	6	47	23	70	80	
13	1	4	9	16	25	22	47	34	18	52	1	0	1	47	
6	1	4	9	24	40	19	59	7	3	10	13	18	31	86	
10	1	4	9	0	15	17	32	3	2	5	42	21	63	86	76.20
15	1	20	23	5	14	5	19	5	2	7	41	33	74	73	
2	1	20	16	31	42	31	73	18	9	27	0	0	0	73	
11	1	20	1	5	26	25	51	28	15	43	6	0	6	54	
14	1	20	23	7	26	28	54	15	5	20	19	7	26	73	68.25
4	1	28	9	20	42	24	66	18	16	34	0	0	0	66	
17	1	28	9	16	24	21	45	36	19	55	0	0	0	45	55.50

Selected on Process + Skills Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Rate%	Ave
7	1	4	9	4	12	12	24	1	5	6	47	23	70	80	
13	1	4	9	16	25	22	47	34	18	52	1	0	1	47	
6	1	4	9	24	40	19	59	7	3	10	13	18	31	86	
10	1	4	9	0	15	17	32	3	2	5	42	21	63	86	
9	1	4	9	0	34	17	51	8	3	11	18	20	38	82	
4	1	28	9	20	42	24	66	18	16	34	0	0	0	66	
17	1	28	9	16	24	21	45	36	19	55	0	0	0	45	70.29
15	1	20	23	5	14	5	19	5	2	7	41	33	74	73	
14	1	20	23	7	26	28	54	15	5	20	19	7	26	73	73.00

Selected on Process + Language Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Rate%	Ave
10	1	4	9	0	15	17	32	3	2	5	42	21	63	86	
9	1	4	9	0	34	17	51	8	3	11	18	20	38	82	84.00
11	1	20	1	5	26	25	51	28	15	43	6	0	6	54	
15	1	20	23	5	14	5	19	5	2	7	41	33	74	73	63.50
13	1	4	9	16	25	22	47	34	18	52	1	0	1	47	
17	1	28	9	16	24	21	45	36	19	55	0	0	0	45	46.00

Selected on Content + Skills Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Rate%	Ave
7	1	4	9	4	12	12	24	1	5	6	47	23	70	80	
10	1	4	9	0	15	17	32	3	2	5	42	21	63	86	
9	1	4	9	0	34	17	51	8	3	11	18	20	38	82	
6	1	4	9	24	40	19	59	7	3	10	13	18	31	86	
13	1	4	9	16	25	22	47	34	18	52	1	0	1	47	76.20
15	1	20	23	5	14	5	19	5	2	7	41	33	74	73	
14	1	20	23	7	26	28	54	15	5	20	19	7	26	73	73.00
4	1	28	9	20	42	24	66	18	16	34	0	0	0	66	
17	1	28	9	16	24	21	45	36	19	55	0	0	0	45	55.50

Selected on Content + Language Values

10	1	4	9	0	15	17	32	3	2	5	42	21	63	86	
9	1	4	9	0	34	17	51	8	3	11	18	20	38	82	84.00
11	1	20	1	5	26	25	51	28	15	43	6	0	6	54	
15	1	20	23	5	14	5	19	5	2	7	41	33	74	73	63.50

Selected on Skills + Language Values

5	31	6	1	17	34	25	59	18	14	32	8	1	9	65	
3	29	14	1	17	37	32	69	23	8	31	0	0	0	69	67.00
9	1	4	9	0	34	17	51	8	3	11	18	20	38	82	
10	1	4	9	0	15	17	32	3	2	5	42	21	63	86	84.00
13	1	4	9	16	25	22	47	34	18	52	1	0	1	47	
17	1	28	9	16	24	21	45	36	19	55	0	0	0	45	46.00

Table 9b
Average Pass Rates By Pairs
H Grade Questions
Rate = (Pass/Pass+Fail) * 100
Selected on Process + Concept Values

Qu	Pro	Con	Ski	Lan	Passes			Failures			Blanks			Rate%	Ave
					Ma	Fe	To	Ma	Fe	To	Ma	Fe	To		
1	0	20	0	1	7	2	9	2	5	7	56	28	84	56	
2	0	20	0	1	55	26	81	1	2	3	9	7	16	96	76.00
13	1	4	1	28	27	6	33	35	29	64	3	0	3	34	
10	1	4	17	12	53	32	85	12	3	15	0	0	0	85	
6	1	4	21	0	39	23	62	1	0	1	25	12	37	98	
11	1	4	23	5	45	30	75	20	5	25	0	0	0	75	
16	1	4	23	28	46	20	66	19	15	34	0	0	0	66	
15	1	4	17	0	39	22	61	25	13	38	1	0	1	62	70.00
3	1	5	9	29	52	29	81	6	2	8	7	4	11	91	
9	1	5	31	8	49	23	72	16	12	28	0	0	0	72	81.50
20	1	20	17	28	14	9	23	9	6	15	42	20	62	61	
17	1	20	23	28	41	20	61	24	14	38	0	1	1	62	
14	1	20	4	28	37	16	53	26	19	45	2	0	2	54	
7	1	20	19	0	24	12	36	1	0	1	40	23	63	97	68.50

Selected on Process + Skills Values

Qu	Pro	Con	Ski	Lan	Passes			Failures			Blanks			Rate%	Ave
					Ma	Fe	To	Ma	Fe	To	Ma	Fe	To		
1	0	20	0	1	7	2	9	2	5	7	56	28	84	56	
2	0	20	0	1	55	26	81	1	2	3	9	7	16	96	76.00
10	1	4	17	12	53	32	85	12	3	15	0	0	0	85	
20	1	20	17	28	14	9	23	9	6	15	42	20	62	61	
15	1	4	17	0	39	22	61	25	13	38	1	0	1	62	69.33
17	1	20	23	28	41	20	61	24	14	38	0	1	1	62	
16	1	4	23	28	46	20	66	19	15	34	0	0	0	66	
11	1	4	23	5	45	30	75	20	5	25	0	0	0	75	67.67
12	31	14	1	25	46	21	67	19	14	33	0	0	0	67	
18	31	22	1	30	41	26	67	24	9	33	0	0	0	67	
4	31	30	1	1	53	30	83	11	5	16	1	0	1	84	72.67

Selected on Process + Language Values

1	0	20	0	1	7	2	9	2	5	7	56	28	84	56	
2	0	20	0	1	55	26	81	1	2	3	9	7	16	96	76.00
15	1	4	17	0	39	22	61	25	13	38	1	0	1	62	
7	1	20	19	0	24	12	36	1	0	1	40	23	63	97	
6	1	4	21	0	39	23	62	1	0	1	25	12	37	98	85.67

Selected on Process + Language Values (cont)

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Rate%	Ave
20	1	20	17	28	14	9	23	9	6	15	42	20	62	61	
17	1	20	23	28	41	20	61	24	14	38	0	1	1	62	
16	1	4	23	28	46	20	66	19	15	34	0	0	0	66	
14	1	20	4	28	37	16	53	26	19	45	2	0	2	54	
13	1	4	1	28	27	6	33	35	29	64	3	0	3	34	55.40
Selected on Concept + Skills Values															
15	1	4	17	0	39	22	61	25	13	38	1	0	1	62	
10	1	4	17	12	53	32	85	12	3	15	0	0	0	85	73.50
16	1	4	23	28	46	20	66	19	15	34	0	0	0	66	
11	1	4	23	5	45	30	75	20	5	25	0	0	0	75	70.50
1	0	20	0	1	7	2	9	2	5	7	56	28	84	56	
2	0	20	0	1	55	26	81	1	2	3	9	7	16	96	76.00
Selected on Concept + Language Values															
15	1	4	17	0	39	22	61	25	13	38	1	0	1	62	
6	1	4	21	0	39	23	62	1	0	1	25	12	37	98	80.00
16	1	4	23	28	46	20	66	19	15	34	0	0	0	66	
13	1	4	1	28	27	6	33	35	29	64	3	0	3	34	50.00
2	0	20	0	1	55	26	81	1	2	3	9	7	16	96	
1	0	20	0	1	7	2	9	2	5	7	56	28	84	56	76.00
20	1	20	17	28	14	9	23	9	6	15	42	20	62	61	
14	1	20	4	28	37	16	53	26	19	45	2	0	2	54	
17	1	20	23	28	41	20	61	24	14	38	0	1	1	62	59.00
Selected on Skills + Language Values															
1	0	20	0	1	7	2	9	2	5	7	56	28	84	56	
2	0	20	0	1	55	26	81	1	2	3	9	7	16	96	76.00
4	31	30	1	1	53	30	83	11	5	16	1	0	1	84	
5	29	6	1	1	52	29	81	6	5	11	7	1	8	88	86.00
17	1	20	23	28	41	20	61	24	14	38	0	1	1	62	
16	1	4	23	28	46	20	66	19	15	34	0	0	0	66	64.00

Table 9c

Average Pass Rates By Pairs

CSYS Questions

Rate = (Pass/Pass+Fail) * 100

Selected on Process + Concept Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Fe	To	Failures Ma	Fe	To	Blanks Ma	Fe	To	Rate%	Ave
1	0	4	0	28	15	16	31	44	24	68	1	0	1	31	
5	0	4	9	4	35	32	67	25	8	33	0	0	0	67	49.00
20	1	0	5	28	1	2	3	3	2	5	56	36	92	38	
7	1	0	1	8	28	18	46	8	4	12	24	18	42	79	
6	1	0	1	28	12	8	20	12	10	22	36	22	58	48	55.00
16	1	4	9	5	45	31	76	15	9	24	0	0	0	76	
12	1	4	1	0	46	24	70	14	16	30	0	0	0	70	
10	1	4	1	12	55	37	92	5	3	8	0	0	0	92	
19	1	4	1	20	7	3	10	5	7	12	48	30	78	45	70.75

Selected on Process + Skills Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Fe	To	Failures Ma	Fe	To	Blanks Ma	Fe	To	Rate%	Ave
7	1	0	1	8	28	18	46	8	4	12	24	18	42	79	
6	1	0	1	28	12	8	20	12	10	22	36	22	58	48	
12	1	4	1	0	46	24	70	14	16	30	0	0	0	70	
10	1	4	1	12	55	37	92	5	3	8	0	0	0	92	
19	1	4	1	20	7	3	10	5	7	12	48	30	78	45	66.80
18	1	1	5	28	25	14	39	18	12	30	17	14	31	57	
20	1	0	5	28	1	2	3	3	2	5	56	36	92	38	47.50

Selected on Process + Language Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Fe	To	Failures Ma	Fe	To	Blanks Ma	Fe	To	Rate%	Ave
18	1	1	5	28	25	14	39	18	12	30	17	14	31	57	
20	1	0	5	28	1	2	3	3	2	5	56	36	92	38	
6	1	0	1	28	12	8	20	12	10	22	36	22	58	48	
11	1	21	11	28	54	32	86	6	8	14	0	0	0	86	57.25
17	1	29	17	29	41	25	66	18	15	33	1	0	1	67	
15	1	22	23	29	44	29	73	15	11	26	1	0	1	74	70.50
14	27	22	1	29	24	26	50	4	1	5	32	13	45	91	
13	27	30	17	29	25	9	34	7	4	11	28	27	55	76	83.50

Selected on Concept + Skills Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Fe	To	Failures Ma	Fe	To	Blanks Ma	Fe	To	Rate%	Ave
6	1	0	1	28	12	8	20	12	10	22	36	22	58	48	
7	1	0	1	8	28	18	46	8	4	12	24	18	42	79	63.50
19	1	4	1	20	7	3	10	5	7	12	48	30	78	45	
12	1	4	1	0	46	24	70	14	16	30	0	0	0	70	
10	1	4	1	12	55	37	92	5	3	8	0	0	0	92	
8	3	4	1	28	45	30	75	14	10	24	1	0	1	76	70.75

Selected on Concept + Skills Values (cont)

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Rate%	Ave
5	0	4	9	4	35	32	67	25	8	33	0	0	0	67	
16	1	4	9	5	45	31	76	15	9	24	0	0	0	76	71.50
2	25	22	1	12	39	24	63	20	16	36	1	0	1	64	
14	27	22	1	29	24	26	50	4	1	5	32	13	45	91	77.50

Selected on Concept + Language Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Rate%	Ave
6	1	0	1	28	12	8	20	12	10	22	36	22	58	48	
20	1	0	5	28	1	2	3	3	2	5	56	36	92	38	43.00
1	0	4	0	28	15	16	31	44	24	68	1	0	1	31	
8	3	4	1	28	45	30	75	14	10	24	1	0	1	76	53.50
14	27	22	1	29	24	26	50	4	1	5	32	13	45	91	
15	1	22	23	29	44	29	73	15	11	26	1	0	1	74	82.50
4	31	30	1	29	28	14	42	18	20	38	14	6	20	52	
13	27	30	17	29	25	9	34	7	4	11	28	27	55	76	64.00

Selected on Skills + Language Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Rate%	Ave
10	1	4	1	12	55	37	92	5	3	8	0	0	0	92	
2	25	22	1	12	39	24	63	20	16	36	1	0	1	64	78.00
8	3	4	1	28	45	30	75	14	10	24	1	0	1	76	
6	1	0	1	28	12	8	20	12	10	22	36	22	58	48	62.00
4	31	30	1	29	28	14	42	18	20	38	14	6	20	52	
14	27	22	1	29	24	26	50	4	1	5	32	13	45	91	71.50
18	1	1	5	28	25	14	39	18	12	30	17	14	31	57	
20	1	0	5	28	1	2	3	3	2	5	56	36	92	38	47.50
17	1	29	17	29	41	25	66	18	15	33	1	0	1	67	
13	27	30	17	29	25	9	34	7	4	11	28	27	55	76	71.50

In comparing and contrasting the sets of problems identified by matched pairs of propositions, it seems best to choose only those sets whose pass rates not only differ substantially in average value, but also do not overlap between sets. These sets are listed below for fuller consideration.

The Ordinary Grade problem set selected by this rule is:

14, 15 (Con 20, Ski 23): 73%

4, 17 (Con 28, Ski 9): 54.5%

Concept values differ in only one respect, the requirement of chemical equations in the latter: Skill value 9 implies sorting of information and skills beyond simple recall, while value 23 includes graphs, tables or selection grids and data which is irrelevant to the solution as well as these attributes. It could be argued that the presence of a selection grid (which is the case in this pair of problems) actually **reduces** the memory load on the candidate by organising the problem, and therefore contributes to the greater pass rate. The irrelevant data can be seen as a natural consequence of the presence of a selection grid, rather than as a separate obstacle to success.

There are no other sets of problems identified in the DECana output on the Ordinary Grade problems which are different in average and whose members' pass rates do not overlap. The criterion is a strict one, but is the only one which ensures that the two sets are significantly different.

In the Higher Grade paper, the following sets of problems were chosen:

6, 15 (Con 4, Lan 0): 80%

14, 17, 20 (Con 20, Lan 28): 59%

Concept values differ only inasmuch as the latter set require the construction or recall of chemical formulae; but Language difficulties are very different, because the second, less successful, set contains long sentences, subordinate clauses and long words, which are not found in the first set. It is possible that language difficulties contribute to this result. Problem 6 is uncomplicated, with a success rate of 98%, (a pass mark can be obtained simply from choosing information from the Data Book), while problem 15 is a multi-part problem, which is broken up into single mark parts. It does involve equilibria, which helps to account for the lower success rate of 62%. The other set of problems had similar pass rates, from 54% to 62%, and were more complex in their statements. It is noted that problem 17 contained a selection grid, which could have helped the pass rate to be as high as it was, and that problem 20 had graphical information. The reading of the graphs, however, did not provide the whole solution to the problem.

The CSYS results yielded the following sets of problems:

15, 17 (Pro 1, Lan 29): 70.5%

13, 14 (Pro 27, Lan 29): 83.5%

Since the Language attributes are identical, differences must be sought from the Process characteristics, which share the requirement for reasoning as opposed to simple recall, an attribute which is common to all but two CSYS problems, all but two Higher Grade problems, and all but one Ordinary Grade problem. The characteristics which are evident in the second set are quantitative arithmetical calculations and the application of a non-chemical formula to the solution. Interestingly, they were the more successfully solved. At the CSYS level, it is possible to speculate that calculations, especially of a routine and formula-application type, cause less difficulty than the reasoning with unfamiliar substances that appears in both problems 15 and 17.

6, 20 (Con 0, Lan 28): 43%

14, 15 (Con 22, Lan 29): 82.5%

The main difference between these two sets seems to be in Concept, as the Language difference concerns a structured answer in the first set but single word answers in the second. The presence of chemical formulae and specific substances in problems 14 and 15, absent in the first set, seem to have been helpful, despite the presence of the mole concept as well. That small difference in Language, however, is an important one, since the answers to problems 6 and 20 have no structure supplied, and are complex ones. It would seem that this factor is more important than the Concept ones, or that specific substances are more comforting than general cases.

6, 20 (Con 0, Lan 28): 43%

4, 13 (Con 30, Lan 29): 64%

Once again the complexity of the answers in the first set is significant, while the Concept characteristics of problems 4 and 13 are the same as in the previous set of 14 and 15, with the addition of chemical equations to the problem. It would seem that Language is the important factor in the explanation of these sets of results.

2, 10 (Ski 1, Lan 12): 78%

18, 20 (Ski 5, Lan 28): 47.5%

In the second set of problems there is some irrelevant data, while the statement of the problems uses long sentences. It should be noted also that problems 2 and 10 are structured into one-mark replies, while 18 and 20 require complex answers to which no structure is given in the statement of the problem. The Language aspects are the more important.

13, 17 (Ski 17, Lan 29): 71.5%

18, 20 (Ski 5, Lan 28): 47.5%

A similar argument regarding the structuring of answers applies to these sets of problems and their success rates. The answers to problems 13 and 17 can be stated in single words or equations or calculations. The skills of interpreting tables and sorting information, present in those problems, caused less difficulty than the structuring of the answer.

Continuing the DECana series, sets of problems were listed which had three characteristics in common. This naturally contained fewer sets of problems, but some interesting results were obtained, which are listed in Table 10 below:

Table 10a
Average Pass Rates By Threes
O Grade Questions
Rate = (Pass/Pass+Fail) * 100
Selected on Process + Concept + Skills Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Rate%	Ave
6	1	4	9	28	37	18	55	10	4	14	13	18	31	80	
7	1	4	9	12	12	11	23	1	6	7	47	23	70	77	
10	1	4	9	4	15	16	31	3	3	6	42	21	63	84	
9	1	4	9	0	34	17	51	8	3	11	18	20	38	82	
13	1	4	9	24	25	22	47	34	18	52	1	0	1	47	74.00
15	1	20	23	29	14	5	19	5	2	7	41	33	74	73	
14	1	20	23	13	26	28	54	15	5	20	19	7	26	73	73.00
4	1	28	9	20	42	24	66	18	16	34	0	0	0	66	
17	1	28	9	29	22	21	43	38	19	57	0	0	0	43	54.50

Selected on Process + Concept + Language Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Rate%	Ave
15	1	20	23	29	14	5	19	5	2	7	41	33	74	73	
2	1	20	16	29	19	20	39	41	20	61	0	0	0	39	56.00

Table 10b
Average Pass Rates By Threes
H Grade Questions
Rate = (Pass/Pass+Fail) * 100
Selected on Process + Concept + Skills Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Rate%	Ave
1	0	20	0	1	7	2	9	2	5	7	56	28	84	56	
2	0	20	0	1	55	26	81	1	2	3	9	7	16	96	76.00
10	1	4	17	12	53	32	85	12	3	15	0	0	0	85	
15	1	4	17	0	39	22	61	25	13	38	1	0	1	62	73.50
16	1	4	23	28	46	20	66	19	15	34	0	0	0	66	
11	1	4	23	5	45	30	75	20	5	25	0	0	0	75	70.50

Selected on Process + Concept + Language Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Rate%	Ave
1	0	20	0	1	7	2	9	2	5	7	56	28	84	56	
2	0	20	0	1	55	26	81	1	2	3	9	7	16	96	76.00
15	1	4	17	0	39	22	61	25	13	38	1	0	1	62	
6	1	4	21	0	39	23	62	1	0	1	25	12	37	98	80.00
16	1	4	23	28	46	20	66	19	15	34	0	0	0	66	
13	1	4	1	28	27	6	33	35	29	64	3	0	3	34	50.00
20	1	20	17	28	14	9	23	9	6	15	42	20	62	61	
14	1	20	4	28	37	16	53	26	19	45	2	0	2	54	
17	1	20	23	28	41	20	61	24	14	38	0	1	1	62	59.00

Selected on Process + Skills + Language Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Fe	To	Failures Ma	Fe	To	Blanks Ma	Fe	To	Rate%	Ave
1	0	20	0	1	7	2	9	2	5	7	56	28	84	56	
2	0	20	0	1	55	26	81	1	2	3	9	7	16	96	76.00
16	1	4	23	28	46	20	66	19	15	34	0	0	0	66	
17	1	20	23	28	41	20	61	24	14	38	0	1	1	62	64.00

Selected on Concept + Skills + Language Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Fe	To	Failures Ma	Fe	To	Blanks Ma	Fe	To	Rate%	Ave
1	0	20	0	1	7	2	9	2	5	7	56	28	84	56	
2	0	20	0	1	55	26	81	1	2	3	9	7	16	96	76.00

Table 10c

Average Pass Rates By Threes
CSYS Questions
Rate = (Pass/Pass+Fail) * 100
Selected on Process + Concept + Skills Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Fe	To	Failures Ma	Fe	To	Blanks Ma	Fe	To	Rate%	Ave
7	1	0	1	8	28	18	46	8	4	12	24	18	42	79	
6	1	0	1	28	12	8	20	12	10	22	36	22	58	48	63.50
12	1	4	1	0	46	24	70	14	16	30	0	0	0	70	
10	1	4	1	12	55	37	92	5	3	8	0	0	0	92	
19	1	4	1	20	7	3	10	5	7	12	48	30	78	45	69.00

Selected on Process + Concept + Language Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Fe	To	Failures Ma	Fe	To	Blanks Ma	Fe	To	Rate%	Ave
6	1	0	1	28	12	8	20	12	10	22	36	22	58	48	
20	1	0	5	28	1	2	3	3	2	5	56	36	92	38	43.00

Selected on Process + Skills + Language Values

Qu	Pro	Con	Ski	Lan	Passes Ma	Fe	To	Failures Ma	Fe	To	Blanks Ma	Fe	To	Rate%	Ave
18	1	1	5	28	25	14	39	18	12	30	17	14	31	57	
20	1	0	5	28	1	2	3	3	2	5	56	36	92	38	47.50

A detailed discussion of Table 10 is largely redundant, because comparisons of the unmatched characteristics in the individual problems have already been made in Table 6 (see page 101) above, and following the rules established (see page 118) for comparing groups of problems in the DEC2ana discussion, there are no sets of problems whose pass rate ranges do not overlap.

DEC3ana was therefore a natural extension of the pattern of trial research in the DECana series, but did not itself lead to any further revelations or conclusions. It is included in this report because it could not reasonably be left out, not because it contributes anything extra to the work.

Chapter 7

Combining Propositions

Combining Propositions

Although some useful discussions had been generated from the results of the analyses from Phase 4 onwards, and a great deal of useful conclusion and speculation was made, the analyses still lacked any definite pattern of inference which could be drawn from the figures, and no statistical calculations could be made on the tables generated. There was one final technique which had not been tried, that of seeking overarching comparisons in the propositions and grouping them and their results into sets which could themselves be compared and contrasted. Table 11 shows how this grouping of propositions was achieved.

Table 11

Combination of Revised Propositions

A1 Numerical Processes

(1) 1. Is the solution to this problem QUANTITATIVE (involving numbers) in any of its parts?

(2) 2. Does the solution to this problem require ARITHMETICAL CALCULATIONS (as opposed to simple reading or recall of figures, e.g., from graphs or tables)?

(3) 3. Does the solution involve PROPORTION in calculations? (If the answer to proposition 2 is NO, then the answer to this must be NO also)

A2 Non-Numerical Processes

(4) 4. Does the solution to this problem involve the application of a recalled or a given FORMULA (NOT a chemical formula): e.g., $m = vc$ or $PV = nRT$?

(5) 5. Does the solution require REASONING as opposed to simple RECALL? (If both are required, answer YES)

B1 Concepts of Formulae and Equations

(6) 1. Does the solution require the recall or construction of CHEMICAL FORMULAE? (Do not count formulae which are supplied in the text)

(7) 2. Does the solution require the recall or construction of CHEMICAL EQUATIONS (including word equations)? (Do not count equations which are supplied in the text)

B2 Concepts Other Than Formulae or Equations

(8) 3. Does this problem refer to SPECIFIC SUBSTANCES (as opposed to classes or types of substance - e.g., "ethanal" as opposed to "aldehydes")? If both, answer YES.

(9) 4. Does the solution to this problem involve the MOLE concept?

(10) 5. Does this problem specifically imply SAFETY REQUIREMENTS or PRECAUTIONS?

C1 Data Processing Skills

(11) 1. Does this problem (or the solution to it) involve GRAPHS, TABLES or SELECTION GRIDS?

(12) 2. Does this problem involve DRAWING or INTERPRETING DIAGRAMS or FLOW-CHARTS (as opposed to graphs, tables or grids)?

(14) 4. Is more data provided than is required for the solution (i.e., is any of the data IRRELEVANT to the answer)?

C2 Sorting and Retrieving (other than Processing)

(13) 3. Does this problem involve SORTING of information into categories or classes?

(15) 5. Does this problem involve any skills beyond simple recall or Data Book information retrieval?

D1 Interpretation of Language in the Problem

(16) 1. In the statement of this problem, is the average sentence longer than 15 words?

(17) 2. Are there any subordinate clauses?

(18) 3. Are there more than 3 words of 3 or more syllables (excluding technical terms and names of chemicals)?

(19) 4. Are there any words which have more than one meaning in different contexts? This refers to the list of words published in "Words That Matter in Science" (Cassels and Johnstone, RSC, 1985)

D2 Structure of Answer (as opposed to Problem)

(20) 5. Can all parts of the problem be answered by a single word or series of words, as opposed to a grammatically structured answer?

The bases on which sets of propositions can be combined are, by the nature of things, subjective. The exercise is similar to that of asking which is the odd-one-out of a set of objects - the answer could be any of the set, provided that a sufficient reason was given for the choice. The rationale for these particular combinations was that they were the most obvious ones to choose, in each of the sets of propositions. Other possible bases of combinations were felt to be less appropriate, because they were either more contrived and less obvious, or because they split the sets of propositions less evenly, giving less opportunity for comparison of rates in any meaningful way. The DECana series of programs was therefore further revised, so as to collect together each subset of propositions and display the subset as a group, for direct comparison with the other subset in that type of proposition. In addition, the mean and standard deviation (used here simply as a rule of thumb measure of variance) was calculated and displayed for each subset. A set of programs, for total rates, then for Male and Female rates, was written, and finally combined into the program ALLana, the results of which program are shown in Table 12 on page 130:

Table 12a

Mean/SD of All Rates in Categories
Ordinary Grade Questions

Categorised by Process Values

Numerical Processes TRUE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
3	29	14	1	25	28	25	53	32	15	47	0	0	0	47	63	53
12	17	28	21	31	26	25	51	34	15	49	0	0	0	43	63	51
5	31	6	1	25	23	20	43	29	19	48	8	1	9	44	51	47
1	17	4	4	7	24	17	41	36	23	59	0	0	0	40	43	41

MAv=43.50; MSD= 2.50: FAv=55.00; FSD= 8.49: TAv=48.00; TSD= 4.58

Numerical Processes FALSE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
10	1	4	9	4	15	16	31	3	3	6	42	21	63	83	84	84
9	1	4	9	0	34	17	51	8	3	11	18	20	38	81	85	82
6	1	4	9	28	37	18	55	10	4	14	13	18	31	79	82	80
7	1	4	9	12	12	11	23	1	6	7	47	23	70	92	65	77
14	1	20	23	13	26	28	54	15	5	20	19	7	26	63	85	73
15	1	20	23	29	14	5	19	5	2	7	41	33	74	74	71	73
4	1	28	9	20	42	24	66	18	16	34	0	0	0	70	60	66
8	0	4	0	1	32	25	57	26	14	40	2	1	3	55	64	59
16	1	0	13	28	28	21	49	30	19	49	2	0	2	48	52	50
13	1	4	9	24	25	22	47	34	18	52	1	0	1	42	55	47
17	1	28	9	29	22	21	43	38	19	57	0	0	0	37	52	43
2	1	20	16	29	19	20	39	41	20	61	0	0	0	32	50	39
11	1	20	1	5	11	15	26	43	25	68	6	0	6	20	38	28

MAv=59.69; MSD=21.60: FAv=64.85; FSD=14.95: TAv=61.62; TSD=17.79

Categorised by Content Values

Formulae/Equations TRUE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
14	1	20	23	13	26	28	54	15	5	20	19	7	26	63	85	73
15	1	20	23	29	14	5	19	5	2	7	41	33	74	74	71	73
4	1	28	9	20	42	24	66	18	16	34	0	0	0	70	60	66
3	29	14	1	25	28	25	53	32	15	47	0	0	0	47	63	53
12	17	28	21	31	26	25	51	34	15	49	0	0	0	43	63	51
17	1	28	9	29	22	21	43	38	19	57	0	0	0	37	52	43
2	1	20	16	29	19	20	39	41	20	61	0	0	0	32	50	39
11	1	20	1	5	11	15	26	43	25	68	6	0	6	20	38	28

MAv=48.25; MSD=17.93: FAv=60.25; FSD=13.28: TAv=53.25; TSD=15.38

Formulae/Equations FALSE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
10	1	4	9	4	15	16	31	3	3	6	42	21	63	83	84	84
9	1	4	9	0	34	17	51	8	3	11	18	20	38	81	85	82
6	1	4	9	28	37	18	55	10	4	14	13	18	31	79	82	80
7	1	4	9	12	12	11	23	1	6	7	47	23	70	92	65	77
8	0	4	0	1	32	25	57	26	14	40	2	1	3	55	64	59
16	1	0	13	28	28	21	49	30	19	49	2	0	2	48	52	50
13	1	4	9	24	25	22	47	34	18	52	1	0	1	42	55	47
5	31	6	1	25	23	20	43	29	19	48	8	1	9	44	51	47
1	17	4	4	7	24	17	41	36	23	59	0	0	0	40	43	41

MAv=62.67; MSD=19.55: FAv=64.56; FSD=14.90: TAv=63.00; TSD=16.56

Mean/SD of All Rates in Categories
Ordinary Grade Questions

Categorised by Skills Values

Processing Data TRUE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
10	1	4	9	4	15	16	31	3	3	6	42	21	63	83	84	84
9	1	4	9	0	34	17	51	8	3	11	18	20	38	81	85	82
6	1	4	9	28	37	18	55	10	4	14	13	18	31	79	82	80
7	1	4	9	12	12	11	23	1	6	7	47	23	70	92	65	77
14	1	20	23	13	26	28	54	15	5	20	19	7	26	63	85	73
15	1	20	23	29	14	5	19	5	2	7	41	33	74	74	71	73
4	1	28	9	20	42	24	66	18	16	34	0	0	0	70	60	66
12	17	28	21	31	26	25	51	34	15	49	0	0	0	43	63	51
16	1	0	13	28	28	21	49	30	19	49	2	0	2	48	52	50
13	1	4	9	24	25	22	47	34	18	52	1	0	1	42	55	47
17	1	28	9	29	22	21	43	38	19	57	0	0	0	37	52	43
2	1	20	16	29	19	20	39	41	20	61	0	0	0	32	50	39

MAv=62.00; MSD=19.75: FAv=67.00; FSD=13.32: TAv=63.75; TSD=15.90

Processing Data FALSE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
8	0	4	0	1	32	25	57	26	14	40	2	1	3	55	64	59
3	29	14	1	25	28	25	53	32	15	47	0	0	0	47	63	53
5	31	6	1	25	23	20	43	29	19	48	8	1	9	44	51	47
1	17	4	4	7	24	17	41	36	23	59	0	0	0	40	43	41
11	1	20	1	5	11	15	26	43	25	68	6	0	6	20	38	28

MAv=41.20; MSD=11.69: FAv=51.80; FSD=10.42: TAv=45.60; TSD=10.65

Categorised by Language Values

Interpretation of Language TRUE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
10	1	4	9	4	15	16	31	3	3	6	42	21	63	83	84	84
6	1	4	9	28	37	18	55	10	4	14	13	18	31	79	82	80
7	1	4	9	12	12	11	23	1	6	7	47	23	70	92	65	77
14	1	20	23	13	26	28	54	15	5	20	19	7	26	63	85	73
15	1	20	23	29	14	5	19	5	2	7	41	33	74	74	71	73
4	1	28	9	20	42	24	66	18	16	34	0	0	0	70	60	66
3	29	14	1	25	28	25	53	32	15	47	0	0	0	47	63	53
12	17	28	21	31	26	25	51	34	15	49	0	0	0	43	63	51
16	1	0	13	28	28	21	49	30	19	49	2	0	2	48	52	50
13	1	4	9	24	25	22	47	34	18	52	1	0	1	42	55	47
5	31	6	1	25	23	20	43	29	19	48	8	1	9	44	51	47
17	1	28	9	29	22	21	43	38	19	57	0	0	0	37	52	43
1	17	4	4	7	24	17	41	36	23	59	0	0	0	40	43	41
2	1	20	16	29	19	20	39	41	20	61	0	0	0	32	50	39
11	1	20	1	5	11	15	26	43	25	68	6	0	6	20	38	28

MAv=54.27; MSD=20.36: **FAv=60.93; FSD=14.01**: TAv=56.80; TSD=16.67

Interpretation of Language FALSE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
9	1	4	9	0	34	17	51	8	3	11	18	20	38	81	85	82
8	0	4	0	1	32	25	57	26	14	40	2	1	3	55	64	59

MAv=68.00; MSD=13.00: **FAv=74.50; FSD=10.50**: TAv=70.50; TSD=11.50

Table 12b
Higher Grade Questions

Categorised by Process Values

Numerical Processes TRUE

Qu	Pro	Con	Ski	Lan	Passes			Failures			Blanks			Mrat%	Frat%	Rate%
					Ma	Fe	To	Ma	Fe	To	Ma	Fe	To			
5	29	6	1	1	52	29	81	6	5	11	7	1	8	90	85	88
4	31	30	1	1	53	30	83	11	5	16	1	0	1	83	86	84
19	29	12	17	30	30	17	47	12	3	15	23	15	38	71	85	76
18	31	22	1	30	41	26	67	24	9	33	0	0	0	63	74	67
12	31	14	1	25	46	21	67	19	14	33	0	0	0	71	60	67
8	27	28	27	29	41	16	57	22	19	41	2	0	2	65	46	58

MAv=73.83; MSD= 9.63: FAv=72.67; FSD=15.03: TAv=73.33; TSD=10.42

Numerical Processes FALSE

Qu	Pro	Con	Ski	Lan	Passes			Failures			Blanks			Mrat%	Frat%	Rate%
					Ma	Fe	To	Ma	Fe	To	Ma	Fe	To			
6	1	4	21	0	39	23	62	1	0	1	25	12	37	98	100	98
7	1	20	19	0	24	12	36	1	0	1	40	23	63	96	100	97
2	0	20	0	1	55	26	81	1	2	3	9	7	16	98	93	96
3	1	5	9	29	52	29	81	6	2	8	7	4	11	90	94	91
10	1	4	17	12	53	32	85	12	3	15	0	0	0	82	91	85
11	1	4	23	5	45	30	75	20	5	25	0	0	0	69	86	75
9	1	5	31	8	49	23	72	16	12	28	0	0	0	75	66	72
16	1	4	23	28	46	20	66	19	15	34	0	0	0	71	57	66
15	1	4	17	0	39	22	61	25	13	38	1	0	1	61	63	62
17	1	20	23	28	41	20	61	24	14	38	0	1	1	63	59	62
20	1	20	17	28	14	9	23	9	6	15	42	20	62	61	60	61
1	0	20	0	1	7	2	9	2	5	7	56	28	84	78	29	56
14	1	20	4	28	37	16	53	26	19	45	2	0	2	59	46	54
13	1	4	1	28	27	6	33	35	29	64	3	0	3	44	17	34

MAv=74.64; MSD=16.00: FAv=68.64; FSD=25.49: TAv=72.07; TSD=18.51

Categorised by Content Values

Formulae/Equations TRUE

Qu	Pro	Con	Ski	Lan	Passes			Failures			Blanks			Mrat%	Frat%	Rate%
					Ma	Fe	To	Ma	Fe	To	Ma	Fe	To			
7	1	20	19	0	24	12	36	1	0	1	40	23	63	96	100	97
2	0	20	0	1	55	26	81	1	2	3	9	7	16	98	93	96
4	31	30	1	1	53	30	83	11	5	16	1	0	1	83	86	84
19	29	12	17	30	30	17	47	12	3	15	23	15	38	71	85	76
18	31	22	1	30	41	26	67	24	9	33	0	0	0	63	74	67
12	31	14	1	25	46	21	67	19	14	33	0	0	0	71	60	67
17	1	20	23	28	41	20	61	24	14	38	0	1	1	63	59	62
20	1	20	17	28	14	9	23	9	6	15	42	20	62	61	60	61
8	27	28	27	29	41	16	57	22	19	41	2	0	2	65	46	58
1	0	20	0	1	7	2	9	2	5	7	56	28	84	78	29	56
14	1	20	4	28	37	16	53	26	19	45	2	0	2	59	46	54

MAv=73.45; MSD=13.10: FAv=67.09; FSD=21.29: TAv=70.73; TSD=14.74

Formulae/Equations FALSE

Qu	Pro	Con	Ski	Lan	Passes			Failures			Blanks			Mrat%	Frat%	Rate%
					Ma	Fe	To	Ma	Fe	To	Ma	Fe	To			
6	1	4	21	0	39	23	62	1	0	1	25	12	37	98	100	98
3	1	5	9	29	52	29	81	6	2	8	7	4	11	90	94	91
5	29	6	1	1	52	29	81	6	5	11	7	1	8	90	85	88
10	1	4	17	12	53	32	85	12	3	15	0	0	0	82	91	85
11	1	4	23	5	45	30	75	20	5	25	0	0	0	69	86	75
9	1	5	31	8	49	23	72	16	12	28	0	0	0	75	66	72
16	1	4	23	28	46	20	66	19	15	34	0	0	0	71	57	66
15	1	4	17	0	39	22	61	25	13	38	1	0	1	61	63	62
13	1	4	1	28	27	6	33	35	29	64	3	0	3	44	17	34

MAv=75.56; MSD=15.76: FAv=73.22; FSD=24.38: TAv=74.56; TSD=18.23

Categorised by Skills Values

Processing Data TRUE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
6	1	4	21	0	39	23	62	1	0	1	25	12	37	98	100	98
7	1	20	19	0	24	12	36	1	0	1	40	23	63	96	100	97
3	1	5	9	29	52	29	81	6	2	8	7	4	11	90	94	91
10	1	4	17	12	53	32	85	12	3	15	0	0	0	82	91	85
19	29	12	17	30	30	17	47	12	3	15	23	15	38	71	85	76
11	1	4	23	5	45	30	75	20	5	25	0	0	0	69	86	75
9	1	5	31	8	49	23	72	16	12	28	0	0	0	75	66	72
16	1	4	23	28	46	20	66	19	15	34	0	0	0	71	57	66
15	1	4	17	0	39	22	61	25	13	38	1	0	1	61	63	62
17	1	20	23	28	41	20	61	24	14	38	0	1	1	63	59	62
20	1	20	17	28	14	9	23	9	6	15	42	20	62	61	60	61
8	27	28	27	29	41	16	57	22	19	41	2	0	2	65	46	58

MAv=75.17; MSD=12.74: FAv=75.58; FSD=18.15: TAv=75.25; TSD=13.79

Processing Data FALSE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
2	0	20	0	1	55	26	81	1	2	3	9	7	16	98	93	96
5	29	6	1	1	52	29	81	6	5	11	7	1	8	90	85	88
4	31	30	1	1	53	30	83	11	5	16	1	0	1	83	86	84
18	31	22	1	30	41	26	67	24	9	33	0	0	0	63	74	67
12	31	14	1	25	46	21	67	19	14	33	0	0	0	71	60	67
1	0	20	0	1	7	2	9	2	5	7	56	28	84	78	29	56
14	1	20	4	28	37	16	53	26	19	45	2	0	2	59	46	54
13	1	4	1	28	27	6	33	35	29	64	3	0	3	44	17	34

MAv=73.25; MSD=16.51: FAv=61.25; FSD=26.41: TAv=68.25; TSD=19.16

Categorised by Language Values

Interpretation of Language TRUE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
3	1	5	9	29	52	29	81	6	2	8	7	4	11	90	94	91
10	1	4	17	12	53	32	85	12	3	15	0	0	0	82	91	85
19	29	12	17	30	30	17	47	12	3	15	23	15	38	71	85	76
11	1	4	23	5	45	30	75	20	5	25	0	0	0	69	86	75
9	1	5	31	8	49	23	72	16	12	28	0	0	0	75	66	72
18	31	22	1	30	41	26	67	24	9	33	0	0	0	63	74	67
12	31	14	1	25	46	21	67	19	14	33	0	0	0	71	60	67
16	1	4	23	28	46	20	66	19	15	34	0	0	0	71	57	66
17	1	20	23	28	41	20	61	24	14	38	0	1	1	63	59	62
20	1	20	17	28	14	9	23	9	6	15	42	20	62	61	60	61
8	27	28	27	29	41	16	57	22	19	41	2	0	2	65	46	58
14	1	20	4	28	37	16	53	26	19	45	2	0	2	59	46	54
13	1	4	1	28	27	6	33	35	29	64	3	0	3	44	17	34

MAv=68.00; MSD=10.82: FAv=64.69; FSD=20.78: **TAv=66.77; TSD=13.78**

Interpretation of Language FALSE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
6	1	4	21	0	39	23	62	1	0	1	25	12	37	98	100	98
7	1	20	19	0	24	12	36	1	0	1	40	23	63	96	100	97
2	0	20	0	1	55	26	81	1	2	3	9	7	16	98	93	96
5	29	6	1	1	52	29	81	6	5	11	7	1	8	90	85	88
4	31	30	1	1	53	30	83	11	5	16	1	0	1	83	86	84
15	1	4	17	0	39	22	61	25	13	38	1	0	1	61	63	62
1	0	20	0	1	7	2	9	2	5	7	56	28	84	78	29	56

MAv=86.29; MSD=12.54: FAv=79.43; FSD=23.66: **TAv=83.00; TSD=15.97**

Table 12c
CSYS Questions

Categorised by Process Values

Numerical Processes TRUE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
14	27	22	1	29	24	26	50	4	1	5	32	13	45	86	96	91
9	27	12	9	28	49	32	81	11	8	19	0	0	0	82	80	81
13	27	30	17	29	25	9	34	7	4	11	28	27	55	78	69	76
2	25	22	1	12	39	24	63	20	16	36	1	0	1	66	60	64
4	31	30	1	29	28	14	42	18	20	38	14	6	20	61	41	52
3	31	14	17	28	6	1	7	6	5	11	48	34	82	50	17	39

MAv=70.50; MSD=12.65: FAv=60.50: FSD=25.77: TAv=67.17; TSD=17.66

Numerical Processes FALSE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
10	1	4	1	12	55	37	92	5	3	8	0	0	0	92	93	92
11	1	21	11	28	54	32	86	6	8	14	0	0	0	90	80	86
7	1	0	1	8	28	18	46	8	4	12	24	18	42	78	82	79
8	3	4	1	28	45	30	75	14	10	24	1	0	1	76	75	76
16	1	4	9	5	45	31	76	15	9	24	0	0	0	75	78	76
15	1	22	23	29	44	29	73	15	11	26	1	0	1	75	73	74
12	1	4	1	0	46	24	70	14	16	30	0	0	0	77	60	70
5	0	4	9	4	35	32	67	25	8	33	0	0	0	58	80	67
17	1	29	17	29	41	25	66	18	15	33	1	0	1	69	63	67
18	1	1	5	28	25	14	39	18	12	30	17	14	31	58	54	57
6	1	0	1	28	12	8	20	12	10	22	36	22	58	50	44	48
19	1	4	1	20	7	3	10	5	7	12	48	30	78	58	30	45
20	1	0	5	28	1	2	3	3	2	5	56	36	92	25	50	38
1	0	4	0	28	15	16	31	44	24	68	1	0	1	25	40	31

MAv=64.71: MSD=19.96: FAv=64.43; FSD=17.96: TAv=64.71; TSD=17.65

Categorised by Content Values

Formulae/Equations TRUE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
14	27	22	1	29	24	26	50	4	1	5	32	13	45	86	96	91
11	1	21	11	28	54	32	86	6	8	14	0	0	0	90	80	86
9	27	12	9	28	49	32	81	11	8	19	0	0	0	82	80	81
13	27	30	17	29	25	9	34	7	4	11	28	27	55	78	69	76
15	1	22	23	29	44	29	73	15	11	26	1	0	1	75	73	74
17	1	29	17	29	41	25	66	18	15	33	1	0	1	69	63	67
2	25	22	1	12	39	24	63	20	16	36	1	0	1	66	60	64
4	31	30	1	29	28	14	42	18	20	38	14	6	20	61	41	52
3	31	14	17	28	6	1	7	6	5	11	48	34	82	50	17	39

MAv=73.00; MSD=12.05: FAv=64.33; FSD=22.10: TAv=70.00; TSD=15.63

Formulae/Equations FALSE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
10	1	4	1	12	55	37	92	5	3	8	0	0	0	92	93	92
7	1	0	1	8	28	18	46	8	4	12	24	18	42	78	82	79
8	3	4	1	28	45	30	75	14	10	24	1	0	1	76	75	76
16	1	4	9	5	45	31	76	15	9	24	0	0	0	75	78	76
12	1	4	1	0	46	24	70	14	16	30	0	0	0	77	60	70
5	0	4	9	4	35	32	67	25	8	33	0	0	0	58	80	67
18	1	1	5	28	25	14	39	18	12	30	17	14	31	58	54	57
6	1	0	1	28	12	8	20	12	10	22	36	22	58	50	44	48
19	1	4	1	20	7	3	10	5	7	12	48	30	78	58	30	45
20	1	0	5	28	1	2	3	3	2	5	56	36	92	25	50	38
1	0	4	0	28	15	16	31	44	24	68	1	0	1	25	40	31

MAv=61.09; MSD=20.60: FAv=62.36; FSD=19.43: TAv=61.73; TSD=18.38

CSYS Questions

Categorised by Skills Values

Processing Data TRUE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
11	1	21	11	28	54	32	86	6	8	14	0	0	0	90	80	86
9	27	12	9	28	49	32	81	11	8	19	0	0	0	82	80	81
13	27	30	17	29	25	9	34	7	4	11	28	27	55	78	69	76
16	1	4	9	5	45	31	76	15	9	24	0	0	0	75	78	76
15	1	22	23	29	44	29	73	15	11	26	1	0	1	75	73	74
5	0	4	9	4	35	32	67	25	8	33	0	0	0	58	80	67
17	1	29	17	29	41	25	66	18	15	33	1	0	1	69	63	67
3	31	14	17	28	6	1	7	6	5	11	48	34	82	50	17	39

MAv=72.12; MSD=12.08: FAv=67.50; FSD=19.94: TAv=70.75; TSD=13.41

Processing Data FALSE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
10	1	4	1	12	55	37	92	5	3	8	0	0	0	92	93	92
14	27	22	1	29	24	26	50	4	1	5	32	13	45	86	96	91
7	1	0	1	8	28	18	46	8	4	12	24	18	42	78	82	79
8	3	4	1	28	45	30	75	14	10	24	1	0	1	76	75	76
12	1	4	1	0	46	24	70	14	16	30	0	0	0	77	60	70
2	25	22	1	12	39	24	63	20	16	36	1	0	1	66	60	64
18	1	1	5	28	25	14	39	18	12	30	17	14	31	58	54	57
4	31	30	1	29	28	14	42	18	20	38	14	6	20	61	41	52
6	1	0	1	28	12	8	20	12	10	22	36	22	58	50	44	48
19	1	4	1	20	7	3	10	5	7	12	48	30	78	58	30	45
20	1	0	5	28	1	2	3	3	2	5	56	36	92	25	50	38
1	0	4	0	28	15	16	31	44	24	68	1	0	1	25	40	31

MAv=62.67; MSD=20.57: FAv=60.42; FSD=20.71: TAv=61.92; TSD=19.24

Categorised by Language Values

Interpretation of Language TRUE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
10	1	4	1	12	55	37	92	5	3	8	0	0	0	92	93	92
14	27	22	1	29	24	26	50	4	1	5	32	13	45	86	96	91
11	1	21	11	28	54	32	86	6	8	14	0	0	0	90	80	86
9	27	12	9	28	49	32	81	11	8	19	0	0	0	82	80	81
7	1	0	1	8	28	18	46	8	4	12	24	18	42	78	82	79
13	27	30	17	29	25	9	34	7	4	11	28	27	55	78	69	76
8	3	4	1	28	45	30	75	14	10	24	1	0	1	76	75	76
16	1	4	9	5	45	31	76	15	9	24	0	0	0	75	78	76
15	1	22	23	29	44	29	73	15	11	26	1	0	1	75	73	74
5	0	4	9	4	35	32	67	25	8	33	0	0	0	58	80	67
17	1	29	17	29	41	25	66	18	15	33	1	0	1	69	63	67
2	25	22	1	12	39	24	63	20	16	36	1	0	1	66	60	64
18	1	1	5	28	25	14	39	18	12	30	17	14	31	58	54	57
4	31	30	1	29	28	14	42	18	20	38	14	6	20	61	41	52
6	1	0	1	28	12	8	20	12	10	22	36	22	58	50	44	48
19	1	4	1	20	7	3	10	5	7	12	48	30	78	58	30	45
3	31	14	17	28	6	1	7	6	5	11	48	34	82	50	17	39
20	1	0	5	28	1	2	3	3	2	5	56	36	92	25	50	38
1	0	4	0	28	15	16	31	44	24	68	1	0	1	25	40	31

MAv=65.89; MSD=18.58: FAv=63.42; FSD=21.22: TAv=65.21; TSD=18.11

Interpretation of Language FALSE

Qu	Pro	Con	Ski	Lan	Passes Ma	Passes Fe	Passes To	Failures Ma	Failures Fe	Failures To	Blanks Ma	Blanks Fe	Blanks To	Mrat%	Frat%	Rate%
12	1	4	1	0	46	24	70	14	16	30	0	0	0	77	60	70

MAv=77.00; MSD= 0.00: FAv=60.00; FSD= 0.00: TAv=70.00; TSD= 0.00

As a rule of thumb, if the Standard Deviation of **each** of the sets of pass rates in a group of problems is less than the difference between the means, then there is a comment to be made, although that difference may not be statistically significant when a non-parametric test is applied. The point is that in such a case there is a trend to be noted, even though it is not possible to confirm whether it would become significant if the sample size was increased, because it is not now possible to obtain more data from the 1986 examination. Sets of pass rates which pass this criterion are highlit in **Bold type** in Table 12 above.

Ordinary Grade Problems

The sets of problems comparing numerical process propositions with non-numerical ones, and those sets of content propositions which involve formulae or equations, compared with those that do not, do not meet the criterion specified, that the standard deviation of both sets should be less than the difference between the means of the sets. Although the mean pass rate for numerical processes is higher than that for non-numerical ones, there is a very large variance in difficulty among non-numerical problems. The Concept sets show a greater mean pass rate when formulae or equations are not to be constructed, but the variances are large in both sets, indicating a wide range of problem difficulties.

Interestingly, in the Skills sets, the problems which involve processing data are better done than those which do not. All sets (male, female and total) pass the criterion for consideration. There is a large difference between the means, which is partly offset by the fairly large standard deviations. It could be that graphs, tables, selection grids, diagrams and flow charts help the candidate to solve the problem, while the presence of irrelevant data (often directly associated with these devices) is not an important determinant of failure, at least at this level.

The Language sets show a difference in the female averages which obeys the rule, and indicates that girls might in this instance have found that the interpretation of the language of the problem statement was an obstacle to success. There is a large difference in the male averages, which is offset by the large variance in their pass rates, and so does not pass the criterion.

Higher Grade Problems

The only sets to show differences which pass the test are those for male students in Language sets, which seem to indicate that greater difficulty is experienced in interpreting the problem than in answering it.

It is worth mention that, in this relatively small sample of students, the females show considerably greater standard deviations throughout the sets, indicating that there was a greater divergence of ability among the female students than among the males. This pattern appears to be repeated in the CSYS data, but is not found at Ordinary Grade.

CSYS Problems

There are no differences in the CSYS data which satisfy the criterion for particular comment. The standard deviations are of the same order of magnitude throughout, which might indicate that, at this level, the combined propositions are less important than other factors in determining success.

Statistical Analysis

The analysis above reveals only the possibility of statistical significance, not the actuality. The data being compared in the twinned sets of results is of pass rates which are calculated according to criteria which were decided on the grounds of considering the structure and content of each problem in turn. There is no underlying distribution, whether normal or not, and a non-parametric test must be employed. The Mann/Whitney/Wilcoxon Rank Order test was used to examine the paired set data. The results of this examination are shown in Appendix I. Appendix J shows the calculations which were made to compare the performances of Male and Female candidates.

These calculations were done by two further programs, called TOTstat (listed in Appendix A) and MFstat, and the algorithms were tested against several manual calculations to ensure that they were correct.

In each case, the U statistic is calculated by summing the rank orders of the appropriate side, and subtracting n(n+1)/2, where n is the number of entries on that side. It happens that there are two such values, depending on which end is chosen as the top rank, and each of these always corresponds to the value generated by the opposite ranked order for the other side. It is necessary therefore to calculate both possible values, either by taking both sides in turn, or by re-calculating the rank orders in the opposite direction, but it is not necessary to perform both alternative calculations, because the same pair of numbers will result. The lower value of the U statistic is compared with the table value, and should be less than or equal to the table value to achieve statistical significance.

The appropriate table values (97) are shown in brackets in the Appendix I and J tables, and show that there are no results which are significant at the 5% level of confidence, using this method. Two results, for Ordinary Grade Skills comparisons and for Higher Grade Language comparisons, are however very close to the table values, and although they are not significant at 5%, may well be significant at the 10% level. Unfortunately, tables of values for the 10% level of confidence are not available. These are the same sets which are discussed above, (page 112), under the rule of thumb generated by examination of means and standard deviations of sets, and there is no point in discussing them again. The more rigorous U statistic merely confirms that they are of interest.

The program MFstat compared Male and Female pass rates within each of the two sets defined in each category of propositions. In this case, the number of entries was the same for each run, but the statistic was calculated in the same way as before. The results of this final analysis, to seek differences between Male and Female performance, are shown in Appendix J. There are no differences arising from the Mann/Whitney/Wilcoxon Rank Order Test which are significant at the 5% level of confidence. It is therefore not possible, from this test, to determine that there is any difference between Male and Female performance at any level.

Chapter 8

Conclusions

Conclusions

This research project had two major parts: the gathering of information from the panel of experts on whether the problems matched particular propositions, and the search for patterns when the proposition values were linked with the pupils' success rates in these problems. Each part achieved partial success in its objective, and each depended on the same thing - the composition and wording of the propositions - for its success.

Gathering of information involved several distinct steps. These started with the decision to set up an electronic questionnaire, which was not essential, but greatly simplified the process for all concerned. Next came the setting up of the various propositions, and the selection of individuals to join the panel of experts. When the data was collected from the panel, it then had to be checked to see that there was reasonable consensus. A lack of consensus led to the rewriting of the propositions which had displayed the ambiguity. It follows that the problem set had to be defined completely at this stage also, because it was the interaction of problem with proposition which gave the process values on which the analysis depended. The rewriting of the propositions gave the opportunity for the problem set to be changed, as the whole exercise of selecting, briefing, and administering the electronic questionnaire to, the expert panel had to be repeated. It must be emphasised, however, that the rewriting or revision of the propositions is the only external circumstance in which the problem set can be changed, because the initial exercise has to be repeated. Changing the problem set, whether or not the propositions are altered, requires that the whole process be repeated from the beginning. Suitable arrangements had to be made for a representative sample of candidates to attempt the problems, preferably under defined conditions. It was not essential that this was done at the same time as the expert analysis of the problems, and it was not essential, but it was very convenient, to use the SCE examinations themselves.

It is a major strength of this project method, that it can be used for current, future or retrospective analyses of problem sets. The two processes of obtaining data from the expert panel, and the setting of the problems to candidates, are entirely separate, and have nothing in common except the problem set itself. There is no requirement that these events be linked in time. It is possible to repeat the expert panel analysis at any time, with a different set of propositions, and apply the results of this analysis to the same set of candidates' results. It is equally possible to obtain results from a different set of candidates and apply them to the same set of propositions, but this would be of value only in confirming the validity of the sample of candidates. The number of propositions used does not matter. It just so happened, in this project, that the propositions fell neatly into four sets of five, but it is quite unnecessary for any such pattern to be incorporated in the design of the experiment. Any number of propositions can be used, and any method of coding the results is suitable. The best methods are those which can readily be translated from code numbers to the expert panel response. In many cases of this method, coding of the results might be inappropriate; the choice depends on whether the results can be expressed economically without coding.

The preceding paragraphs make it clear that the whole project, and success or failure in the linking with candidates' results, depends squarely on the choice of propositions. It seemed at first that the only problem with the propositions was how to express them in such a way that they would have unambiguous meaning in relation to all the problems in the chosen set. That is essential, but is by no means the only significant part of the proposition choice.

The project depends on the propositions themselves for success or failure in establishing the cognitive factors in problem design. At first sight, that would seem to require the gift of prophecy, or at least a very strong hunch on the part of the experimenter. How can a project succeed, when it depends on prediction of the very factors that it seeks to identify?

There is a parallel between the characteristics of this project and those of the method commonly used to find the square root of a number. This method involves making a guess and then trying it against the number (by dividing it): then using the same process over again, this time with the average of the result of that calculation and the guess, in place of the guess. Each repeat of the process yields a more accurate result, and when the required degree of accuracy is obtained, the process stops. This is known as a recursive method, and is a useful technique in computer programming.

This project may be used recursively, because it may be repeated, with revised propositions, on the original problem set, and be applied to the same set of candidates' results. It is not necessary to use the same expert panel each time (just as well, if an electronic questionnaire can have 1,140 questions in it!), and it is not necessary to use the same number of propositions. The propositions can be made more specific, to test particular properties of the problem set, and can identify cognitive factors to considerable accuracy; but just as it is never possible to define a square root completely, so it is not possible to make any more than an accurate guess at the cognitive factors inherent in a problem set. As in the case of the square root example, it is possible to know how accurate the current guess is, by narrowing the proposition field with each recursion.

It is important, to avoid "panel fatigue", to remember that the number of propositions must be multiplied by the number of problems in the set to obtain the total number of responses required from panel members. If there is a large proposition field to choose from, it is better to start with the bigger task and to use it to narrow down the field, then subsequent recursions should be easier, with a smaller number of propositions (the problem set must be the same), so as to retain the goodwill of the expert panel.

The administration of the whole project has been arranged on a microcomputer, and all the appropriate software for analysis and display of results has been created in the course of the project. It follows therefore, that any repeat of the project, or any recursion on the same problem and candidate set with revised propositions, would be easy to administer and would take a great deal less time than the current project has taken. The time that has been spent has been in testing methods of analysis, most of which did not yield useful results for this particular set of data, and in operating on a trial and error basis. The fact that most methods of analysis did not yield useful results should not be blamed on the methods themselves, rather on the propositions on which the whole project hinged. It is very likely that a set of propositions can be written, testing much more detailed points about the problem set, which would yield patterns of results much more readily.

A variety of approaches has been adopted and tried. In that sense, it is probably better that the propositions used did not yield useful results, because the lack of results acted as a stimulus to develop different ways of analysing and displaying the data, and the fact that there were very few results approaching statistical significance should be blamed on the propositions, not on the methods that were used. Most, but not all, of the methods of analysis should be used again. The grouping of problems into sets by pairs, or even threes, of proposition characteristics shared, (the DECana series), is the method that I would prefer least, because it has an inherent ambiguity - is the pattern of results the consequence of the shared features, or of the features that are different? The remaining methods are worthy of retaining and using. If the propositions can be expressed as two parts, then the Rank Sum Two-Sample test, which is a very reliable and powerful test, can be employed. A simple variant of the method, using only two propositions based on very specific items of information about the problems, would be very quick and easy to set up and run, and should give significant results provided that the propositions are constructed on the basis of the results, and their comments, shown in this report.

Throughout this project, the research effort has been to establish the best way to combine the proposition values established by the first part of the project with the results obtained by a randomly selected sample of candidates' results, in such a way as to emphasise those cognitive factors which appear in the problems. In the field of Chemistry at SCE level, there are factors which are known to teachers, without having been proved, as potential causes of difficulty among students. These vary from one level to another, as the results and discussions in previous chapters have demonstrated. This project has established a way to show whether the beliefs of teachers about perceived difficulties are true, or whether some beliefs are personal difficulties projected on to the students.

It was part of the original idea that one or more of the fields of Process, Concept, Skills or Language might be emphasised as the root of students' difficulties. This has not been shown in the project, but neither has it been disproved. There is no evidence to support the view that transfer of training automatically follows when Processes are taught in isolation from the other factors. Because the chosen problem set happened to have many similarities, and not all the factors could be isolated from the others, the original hypothesis could not be upheld or rejected. It may be that no individual factor can be held up to be the prime cause of difficulty. All factors can be argued for their difficulties.

There is a case for the construction of a problem set specifically to test the factors of Process, Concept, Skills and Language, by choosing problems on the grounds of their dissimilarity, but the researcher would be placed in the dubious role of prophet, trying to foresee the reactions of the expert panel. There is also the administrative task to be considered, of marking a large number of scripts from a large sample of students. This is not impossible, but would involve a considerable amount of effort, which was not directly helping the main task along, and the researcher would have to be very careful not to be influenced by the factors that were thought to be present in the problems, when marking the scripts. The results of a preliminary exercise might well be taken into account, before embarking on a new problem compilation.

This has been a project about development, rather than about research. It has sought to establish a method of investigating the cognitive factors inherent within a chosen set of problems, and the way in which these cognitive factors influence success in solving the problem. It should be judged on the quality of its method, not on the significance of its results. In other words, this is a development which could lead to a great deal of further research, as the methods which have been established are used to investigate other problem sets, in as much or as little detail as the researcher requires. It is a research tool, open-ended and content-free, ready to be used in any field of problem solving.

List of Appendices

Page references indicated contain detailed content references.

Appendix A

Listings of Significant Programs, with Appropriate Comments

Appendix A

Listings of Selected Programs, with Appropriate Comments

```
 10 REM *****************************
 20 REM *                           *
 30 REM *   Program Name "WELCOME"  *
 40 REM *                           *
 50 REM * Introduces program PROBana *
 60 REM *                           *
 70 REM *       Robert J Watson     *
 80 REM *                           *
 90 REM *        April 1985         *
100 REM *                           *
110 REM *****************************
120 REM
130 MODE7
140 X=OPENIN("N.name")
150 INPUT#X,X$
160 CLOSE#X
170 IF LEFT$(X$,1)=" " THEN 190
180 CHAIN"PROBana"
190 PROClogo
200 PROCdelay(150)
210 CLS
220 PRINT'''"This project is designed to render old-"''
    "fashioned questionnaires obsolete, by"'' "replacing
    mounds of paper with this "''"single floppy disc."
230 PRINT''"The idea is simple enough: if you will"''"answer
    questions on the screen, your"''"answers will then be
    written back on"''"to the disc for you to send back to
    me."
240 PROCturnpage(100)
250 PRINT'''"One last thing:"''"If the unthinkable happens and
    you "''"damage the answerfile by trying to"''"ESCAPE or
    BREAK or switch off while the"
260 PRINT''"program is actually recording or "''""WRITING""
    your answers on to the disc,"''"you can recover and start
    again by "''"using the utility program ""answri""
    on"''"the disc. Just type CHAIN ""answri""."
270 PROCturnpage(150)
280 PRINT''"Two other utilities:"''""ANSana"" will display
    your answerfile"''"on the screen, and ""namewri""
    creates"''"a blank namefile (in case of accidents)"
290 PRINT''"To use these, type the command CHAIN,"''"followed
    by the program name in quotes."
300 PROCturnpage(150)
310 PRINTTAB(0,10)CHR$141" Thank you very much for your
    help."
320 PRINTTAB(0,11)CHR$141" Thank you very much for your
    help."
330 PROCdelay(100)
340 CHAIN"PROBana"
350 END
360 DEF PROCdelay(x)
370 time=TIME+x
380 REPEAT
390   UNTIL TIME>time
```

```
400 ENDPROC
410 DEF PROCturnpage(z)
420 PROCdelay(z)
430 PRINTTAB(5,23)"Press COPY to continue"
440 REPEAT
450   *FX15,1
460   UNTIL INKEY(-106)
470 CLS
480 ENDPROC
490 DEFPROCoff:VDU23;11;0;0;0;:ENDPROC
500 DEFPROCon:VDU23;11,255;0;0;0;:ENDPROC
510 DEF PROClogo
520 CLS
530 PROCoff:PRINTTAB(5,6);
540 PRINTCHR$(157);"                                        ";CHR$(156)
550 PRINTTAB(5);
560 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131);
    "Glasgow University"CHR$(135);"  ";CHR$(157);" ";
    CHR$(156)
570 PRINTTAB(5);
580 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131);
    "Glasgow University"CHR$(135);"  ";CHR$(157);" ";
    CHR$(156)
590 PRINTTAB(5);
600 PRINTCHR$(157);"                                        ";CHR$(156)
610 PRINTTAB(5);
620 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131);
    "Science Education "CHR$(135);"  ";CHR$(157);" ";
    CHR$(156)
630 PRINTTAB(5);
640 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131);
    "Science Education "CHR$(135);"  ";CHR$(157);" ";
    CHR$(156)
650 PRINTTAB(5);
660 PRINTCHR$(157);"                                        ";CHR$(156)
670 PRINTTAB(5);
680 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131); "
     Research Group  "CHR$(135);"  ";CHR$(157);" "; CHR$(156)
690 PRINTTAB(5);
700 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131); "
     Research Group  "CHR$(135);"  ";CHR$(157);" "; CHR$(156)
710 PRINTTAB(5);
720 PRINTCHR$(157);"                                        ";CHR$(156)
730 ENDPROC
```

This program was placed on each of the discs sent to expert panel members, and was selected automatically each time the disc was started with the SHIFT/BREAK sequence. It checked the file in which the name was written, and if it was not blank, it then (line 180) loaded and ran the main program, "PROBana". The final procedure, PROClogo, (lines 510 to 730 above) is common to all the programs in the series. and displays a title, "Glasgow University Science Education Research Group", on the MODE 7 screen. The program "PROBana" was called up after the screens of information had been read. Because PROBana writes a name file, this program would not be seen to operate again after the first time, when the blank name file was over-written.

```
10 REM ***************************
20 REM **                       **
30 REM ** Program Name "PROBana" **
40 REM **                       **
50 REM ** Robert J Watson Jan 85 **
60 REM **   Phase 2: July 1986   **
70 REM **                       **
80 REM **  Glasgow  University  **
90 REM **   Science  Education  **
100 REM **    Research   Group    **
110 REM **                       **
120 REM ***************************
130 MODE 7
140 VDU15
150 PROClogo
160 PROCsetup
170 PROCdelay(200)
180 CLS
190 FORi%=1 TO 2
200   PRINTTAB(7,i%);CHR$(130);CHR$(141);title$
210   NEXT
220 PRINT'''"Hello, ";firstname$;"."
230 PRINT''"I very much appreciate your help."
240 PROCskipinstructions
250 IF skip THEN 270
260 PROCinstructions
270 PROCmenu
280 REM: files loaded at this point
290 PROCmenuPCS
300 REM: decisions taken at this point
310 PROCwrite_answer
320 PROCcheckanswers
330 IF NOT finalflag THEN 290
340 *DIR $
350 PROCend
360 END
380 DEF PROCsetup
390 ON ERROR PROCerror
400 title$="Problem Analysis"
410 vcorr=0
420 question=1
430 quit=FALSE
440 finalflag=FALSE
450 answerend=FALSE
460 endfile=FALSE
470 automatic=FALSE
480 *KEY0 RUN|M
490 *KEY10 *.|L|M
500 *DIR N
510 X=OPENIN("name")
520 INPUT#X,name$
530 CLOSE#X
540 IF LEFT$(name$,1)="|" THEN name=FALSE ELSE name=TRUE
550 PROCentername
560 *ACCESS name L
570 *DIR $
580 DIM proposition$(5)
590 ENDPROC
```

```
 610 DEF PROCerror
 620 CLOSE#0
 630 *DRIVE 0
 640 *ACCESS *.* L
 650 IF ERR=17 THEN PROCescape ELSE REPORT:PRINT" at line
     ";ERL:PROCon:END
 660 ENDPROC
 680 DEF PROCescape
 690 VDU28,0,24,39,0
 700 CLS
 710 PRINT'''"Do you wish to start again?"
 720 PRINT''"If you press the RETURN key,"'''"you will start
     again at the beginning."'''"Pressing any other key will
     stop the "'''"program."''''"Thank you again for your help!"
 730 PRINTTAB(0,23)"Key f0 has been set to RUN this program"
 740 IF GET=13 THEN RUN ELSE VDU12,15
 750 PROCon
 760 *DIR $
 770 end$="End of Program"
 780 FOR i%=0 TO 1
 790 PRINTTAB((35-LEN(end$))/2,10+i%);CHR$(131);CHR$(141);
     end$
 800   NEXT
 810 PRINT''''''''''
 820 END
 830 ENDPROC
 850 DEF PROCskipinstructions
 860 PRINT'''"You can skip the instructions if you "'''"want
     to: just press ""s"" (for skip)"'''"to move on rapidly."
     '''"Pressing any other key will set up "'''"the
     instructions for you."
 870 *FX15,1
 880 a$=GET$
 890 IF INSTR("Ss",a$)=0 THEN skip=FALSE ELSE skip=TRUE
 900 ENDPROC
 920 DEF PROCdelay(x)
 930 time=TIME+x
 940 REPEAT
 950   UNTIL TIME>time
 960 ENDPROC
 980 DEF PROCinstructions
 990 CLS
1000 FOR i%=1 TO 2
1010   PRINTTAB(7,i%);CHR$(131);CHR$(141);title$
1020   NEXT
1030 PRINT''"You will be given a number of problems"'''"from
     SCE papers, which you should have"'''"in front of
     you."'''"If you don't have them there at the "'''"moment,
     press ESCAPE to get out of the "'''"program without
     causing any problems"
1040 PRINT''"to the disc files."'''"Pressing ESCAPE at any time
     will get"'''"you out of the program safely."
1050 PROCturnpage(300)
1060 PRINT''''"You will be given two menu choices."'''"At the
     first one, you will be asked to"'''"choose O grade, H
     grade, or CSYS "'''"questions.  The problem sheets are
     "'''"coloured yellow, green and red "
1070 PRINT''"respectively."
```

```
1080 PROCturnpage(300)
1090 PRINT'''''"When you have chosen O, H or S. "'''"the
     appropriate set of problems and"'''"problem codes will be
     loaded from the "'''"disc and you will be offered the
     choice"
1100 PRINT''"of PROCESS, CONTENT or SKILLS. "'''"A set of
     propositions will then be"'''"selected, to which the
     answer will "'''"always be ""YES"" or ""NO""."
1110 PROCturnpage(300)
1120 PRINT''"Sometimes you may not be absolutely "'''"sure; in
     that case you will be given"'''"the opportunity to say so,
     and that"''''""unsure"" answer will be recorded."
1130 PRINT''"At the end, the whole set of your "'''"answers will
     be recorded on to the disc"'''"so that you can send the
     whole lot back"'''"to me for analysis."
1140 PRINT''''"    MANY THANKS FOR YOUR HELP!!"
1150 PROCturnpage(300)
1160 ENDPROC
1180 DEF PROCturnpage(z)
1190 PROCoff
1200 PROCdelay(z)
1210 PRINTTAB(7,23-vcorr)"Press COPY to continue"
1220 REPEAT
1230   *FX15,1
1240   UNTIL INKEY(-106)
1250 CLS
1260 ENDPROC
1280 DEF PROCmenu
1290 CLS
1300 PRINT'''"Please select one of the sets of SCE"'''"problems,
     either O or H or S for "'''"analysis."'''"You should do
     this by pressing either"''''""O"" or ""H"" or ""S"" now."
1310 *FX15,1
1320 a$=GET$
1330 a=INSTR("OoHhSs",a$):grade=(a+1) DIV 2
1340 IF a=0 THEN 1310
1350 ON grade GOTO 1360,1400,1440
1360 REM O grade problems chosen
1370 *DIR O
1380 PROCloadfiles
1390 ENDPROC
1400 REM H grade problems chosen
1410 *DIR H
1420 PROCloadfiles
1430 ENDPROC
1440 REM SYS problems chosen
1450 *DIR S
1460 PROCloadfiles
1470 ENDPROC
1490 DEF PROCloadfiles
1500 course$=" ORDINARY GRADE     HIGHER GRADE       SIXTH
     YEAR STUDIES "
1510 grade$=MID$(course$,(1+(19*(grade-1))),19)
1520 PRINTTAB(5,18)" LOADING";grade$
1530 Q=OPENIN("quest")
1540 INPUT#Q,numberQ
1550 PRINTTAB(0,20)"questionfile";TAB(15);STRING$(numberQ,".")
1560 DIM question$(numberQ)
```

```
1570 FOR I%=1 TO numberQ
1580   PRINTTAB(14+I%,20)" "
1590   INPUT#Q,question$(I%)
1600   NEXT
1610 CLOSE#Q
1620 C=OPENIN("code")
1630 INPUT#C,numberC
1640 PRINTTAB(0,21)"codefile";TAB(15);STRING$(numberC,".")
1650 DIM code$(numberC)
1660 FOR I%=1 TO numberC
1670   PRINTTAB(14+I%,21)" "
1680   INPUT#C,code$(I%)
1690   NEXT
1700 CLOSE#C
1710 A=OPENIN("answer")
1720 REM: different file structure in Phase 2
1730 PRINTTAB(0,22)"answerfile";TAB(15);STRING$(numberQ,".")
1740 DIM answer$(20,20)
1750 FOR I%=1 TO 20
1760   PRINTTAB(14+I%,22)" "
1770   FOR J%=1 TO 20
1780     INPUT#A,answer$(I%,J%)
1790     NEXT
1800   NEXT
1810 CLOSE#A
1820 ENDPROC
1840 DEFPROCoff:VDU23;11;0;0;0;:ENDPROC
1860 DEFPROCon:VDU23;11,255;0;0;0;:ENDPROC
1880 DEF PROClogo
1890 CLS
1900 PROCoff:PRINTTAB(5,6);
1910 PRINTCHR$(157);"                                ";CHR$(156)
1920 PRINTTAB(5);
1930 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131);
     "Glasgow University"CHR$(135);"  ";CHR$(157);" ";
     CHR$(156)
1940 PRINTTAB(5);
1950 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131);
     "Glasgow University"CHR$(135);"  ";CHR$(157);" ";
     CHR$(156)
1960 PRINTTAB(5);
1970 PRINTCHR$(157);"                                ";CHR$(156)
1980 PRINTTAB(5);
1990 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131);
     "Science Education "CHR$(135);"  ";CHR$(157);" ";
     CHR$(156)
2000 PRINTTAB(5);
2010 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131);
     "Science Education "CHR$(135);"  ";CHR$(157);" ";
     CHR$(156)
2020 PRINTTAB(5);
2030 PRINTCHR$(157);"                                ";CHR$(156)
2040 PRINTTAB(5);
2050 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131); "
      Research Group  "CHR$(135);"  ";CHR$(157);" "; CHR$(156)
2060 PRINTTAB(5);
2070 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131); "
      Research Group  "CHR$(135);"  ";CHR$(157);" "; CHR$(156)
```

```
2080 PRINTTAB(5);
2090 PRINTCHR$(157);"                                    ":CHR$(156)
2100 ENDPROC
2120 DEF PROCmenuPCS
2130 PROCoff
2140 CLS
2150 IF endfile THEN 2330
2160 PRINT''TAB(5)CHR$141"Choice of propositions"
2170 PRINTTAB(5)CHR$141"Choice of propositions"
2180 PROCskipinstructions
2190 IF skip THEN 2330
2200 CLS
2210 PRINT''TAB(5)CHR$141"Choice of propositions"
2220 PRINTTAB(5)CHR$141"Choice of propositions"
2230 PRINT'''"There are 3 groups of questions that I"''"would
     like you to answer, concerning "''"the SCE problems that
     you have chosen."
2240 PRINT'''"These are as follows:"''
2250 PRINT" 1. Questions on PROCESS ."''" 2. Questions on
     CONTENT ."''" 3. Questions on SKILLS ."
2260 PROCturnpage(300)
2270 PRINT'''"Each set of propositions (questions)"''"will be
     presented in turn for each SCE"''"problem.  To remind you
     where you are,"''"the code number and the first line
     of"''"each question will be displayed on the"
2280 PRINT''"screen at the top, and the proposition"''"at the
     bottom."
2290 PROCturnpage(250)
2300 PRINT'''"You will be asked to indicate YES "''"or NO to
     each proposition by pressing"''"""Y"" or ""N""
     respectively,"''"and you will then get a chance to"
2310 PRINT''"state whether or not you are sure of"''"your
     answer.  Finally, you will have a"''"chance to change
     your mind if you want."
2320 PROCturnpage(300)
2330 CLS
2340 PRINTTAB(8,1)CHR$141"IMPORTANT "
2350 PRINTTAB(8,2)CHR$141"IMPORTANT "
2360 VDU28,0,24,39,3:vcorr=3
2370 CLS
2380 PRINT''"The program will start where you left"''"off last
     time.  If you want to re-do"''"any of the decisions that
     you have "''"made, you can do this by entering the"
2390 PRINT''"code number of the problem that you "''"want to
     re-do, and then following "''"through all the set of SCE
     problems for"''"that particular set of propositions."
2400 PROCturnpage(10)
2410 PRINT'''"(You will always, of course, have the "''"option
     of quitting the program and"''"saving all your answers to
     date on the"''"disc. Remember NOT to use ESCAPE.)"
2420 PRINT''"If you do this, you will be told"''"what your
     previous answer was, and"''"you will have the extra
     option of"''"retaining it as it is."
2430 PROCturnpage(10)
2440 PRINT'''"To change any of your previous answers,"''"you
     can choose to press ""C"" for Change."''"Pressing any
     other key (except ESCAPE)"''"will allow the program to
     start where"''"you left off."
```

```
2450 PRINT''"Note that if you press ESCAPE during"''"the run,
     you will NOT save your answers"''"on to the disc."
2460 PROCturnpage(10)
2470 PRINT''"To save everything up to that point, "''"you can
     press ""Q"" (for ""quit"")."''"The answers will then be
     saved as the "''"program stops."
2480 PRINT''"Press ""C"" to choose your start point"''"in the
     run, or any other key to start"''"where you left off."
2490 VDU28,0,24,39,0:vcorr=0
2500 *FX15,1
2510 a$=GET$:IF INSTR("Cc",a$)<>0 THEN PROCexchange ELSE
     exchange=FALSE
2520 CLS:PROCoff
2530 PRINT''"Choose one of the following:"
2540 PRINT'TAB(6)"P. PROCESS "
2550 PRINT'TAB(6)"C. CONTENT "
2560 PRINT'TAB(6)"S. SKILLS "
2570 PRINT'TAB(6)"A. AUTOMATIC "
2580 PRINT''"""Automatic"" will start with Process, "'"then go
     on to Skills and Content."'"It will check where you left
     off."'" You cannot use this option if you "' "selected
     ""C""."
2590 PRINT'"If you choose one of the others, the"'"program
     will work through that set"'"of propositions only for
     each of your"'"chosen set of problems."
2600 *FX15,1
2610 a$=GET$
2620 a=INSTR("PpCcSsLlAa",a$):propset=(a+1) DIV 2:IF a=0 THEN
     2600
2630 IF exchange AND propset=5 THEN PRINT'"Sorry! You can't do
     that!":PROCdelay(200):GOTO 2520
2640 *DIR P
2650 ON propset GOTO 2660,2700,2740,2780,2820
2660 propfile$="Process"
2670 PRINTTAB(0,24)" Now checking previous ";propfile$;"
     answers";
2680 PROCdecision
2690 ENDPROC
2700 propfile$="Content"
2710 PRINTTAB(0,24)" Now checking previous ";propfile$;"
     answers";
2720 PROCdecision
2730 ENDPROC
2740 propfile$="Skills"
2750 PRINTTAB(0,24)" Now checking previous ";propfile$;"
     answers";
2760 PROCdecision
2770 ENDPROC
2780 propfile$="Lang"
2790 PRINTTAB(0,24)" Now checking previous ";propfile$;"
     answers";
2800 PROCdecision
2810 ENDPROC
2820 PROCauto
2830 ENDPROC
2850 DEF PROCauto
2860 exchange=FALSE
2870 automatic=TRUE
```

```
2880 propfile$="Process"
2890 PRINTTAB(0.24)" Now checking previous ";propfile$;"
     answers":
2900 PROCdecision
2910 propfile$="Content"
2920 PRINTTAB(0.10)" Now checking previous ";propfile$;"
     answers"
2930 PROCdecision
2940 propfile$="Skills"
2950 PRINTTAB(0,10)" Now checking previous ";propfile$;"
     answers"
2960 PROCdecision
2970 automatic=FALSE
2980 PROCend
2990 ENDPROC
3010 DEF PROCdecision
3020 PROCloadpropfile
3030 IF exchange THEN question=question-1 ELSE question=0
3040 REPEAT
3050   question=question+1
3060   PROCcheckanswers
3070   IF finalflag THEN PROCend
3080   IF answerend AND question<numberQ THEN 3050
3090   IF endfile THEN 3120
3100   PROCdisplay
3110   REM: answers taken here
3120   UNTIL question=numberQ
3130 CLS
3140 PRINTTAB(0,4)CHR$141;propfile$;" is now finished for
     ";MID$("OHS",grade,1);" grade."
3150 PRINTTAB(0,5)CHR$141;propfile$;" is now finished for
     ";MID$("OHS",grade.1);" grade."
3160 PRINTTAB(10,8)CHR$141" Thank You "
3170 PRINTTAB(10,9)CHR$141" Thank You "
3180 PRINT'''"You can of course opt to re-do any part"'''"by
     choosing the ""change"" option in the"'''"menu when it is
     offered again."
3190 PROCwrite_answer
3200 PROCturnpage(100)
3210 IF NOT automatic THEN PROCmenuPCS  ELSE *DIR P
3220 ENDPROC
3240 DEF PROCloadpropfile
3250 REM: loading propositionfiles
3260 P=OPENIN propfile$
3270 INPUT#P,numberofprops
3280 FOR I%=1 TO numberofprops
3290   INPUT#P,proposition$(I%)
3300   NEXT
3310 CLOSE#P
3320 ENDPROC
3340 DEF PROCcheckanswers
3350 answerend=FALSE:endfile=FALSE
3360 IF exchange THEN
     start=((INSTR("PCSL",LEFT$(propfile$,1))-1)*5)+1:finalflag
     =FALSE:ENDPROC
3370 firstprop=((INSTR("PCSL",LEFT$(propfile$,1))-1)*5)+1
3380 lastprop=firstprop+4
3390 startflag=FALSE
```

```
3400 FOR I%=firstprop TO lastprop
3410   IF startflag THEN 3430
3420   IF answer$(question,I%)="X" THEN
     start=I%:startflag=TRUE
3430   NEXT
3440 IF startflag THEN finalflag=FALSE:ENDPROC
3450 answerend=TRUE:IF question>=numberQ THEN endfile=TRUE
3460 REM: check for finalflag
3470 finalflag=TRUE
3480 FOR I%=1 TO numberQ
3490   FOR J%=1 TO 20
3500     IF answer$(I%,J%)="X" THEN finalflag=FALSE
3510     NEXT
3520   NEXT
3530 ENDPROC
3550 DEF PROCend
3560 VDU28,0,24,39,0
3570 CLOSE#0
3580 *DRIVE 0
3590 *DIR $
3600 *ACCESS *.* L
3610 CLS:PROCoff
3620 PRINTTAB(7,5)CHR$141"Thank you very much."
3630 PRINTTAB(7,6)CHR$141"Thank you very much."
3640 PRINT''"You have finished all the ";MID$("OHS",grade,1);"
     grade"''"questions.  Please RUN the program "''"again, by
     pressing key f0, to do the"''"other grades."
3650 PROCturnpage(200)
3660 PRINT''"If you have completed all three sets"''"of
     problems, please return the disc to:"
3670 PRINT''TAB(10)"Robert J Watson,"
3680 PRINTTAB(10)"c/o Dr A H Johnstone,"
3690 PRINTTAB(10)"Dept of Chemistry,"
3700 PRINTTAB(10)"The University,"
3710 PRINTTAB(10)"Glasgow G12 8QQ"
3720 PRINT''''"  using the reply envelope supplied."
3730 PRINT''CHR$141"Thank you again for your assistance."
3740 PRINTCHR$141"Thank you again for your assistance."''
3750 PROCturnpage(100)
3760 PROCon
3770 *KEY10 *CAT|M
3780 *DIR $
3790 end$="End of Program"
3800 FOR i%=0 TO 1
3810   PRINTTAB((35-LEN(end$))/2,10+i%);CHR$(131);CHR$(141);
     end$
3820   NEXT
3830 PRINT''''''''''
3840 END
3850 ENDPROC
3870 DEF PROCentername
3880 LOCAL X$,A,name2$,capital
3890 IF name THEN 3960
3900 PROCon
3910 CLS
3920 PRINTTAB(0,10)"Will you please type in your name?"''
3930 name2$=""
3940 INPUT" NAME: "name$
```

```
3950 IF LEN(name$)<3 THEN 3910
3960 capital=1
3970 FOR I%=1 TO LEN(name$)
3980   X$=MID$(name$,I%,1)
3990   IF X$=" " THEN capital=I%+1
4000   A=ASC(X$)
4010   IF I%=capital THEN A=A+(32*(A>96 AND A<123)):GOTO 4030
4020   A=A-(32*(A<91 AND A>64))
4030   name2$=name2$+CHR$(A)
4040   NEXT
4050 name$=name2$
4060 FOR I%=1 TO LEN(name$)
4070   IF MID$(name$,I%,1)=" " THEN
     firstname$=LEFT$(name$,I%-1):GOTO 4100
4080   firstname$=name$
4090   NEXT
4100 IF firstname$=name$ OR LEN(firstname$)<3 THEN
     PRINT'''"Your full name, please.":PROCdelay(100):GOTO 3910
4110 IF name THEN ENDPROC
4120 PRINT'''"Thank you. Let's go on."
4130 PROCoff
4140 PROCdelay(100)
4150 *ACCESS name
4160 X=OPENOUT("name")
4170 PRINT#X,name$
4180 CLOSE#X
4190 ENDPROC
4210 DEF PROCdisplay
4220 CLS
4230 PRINTTAB(0,1)"REMEMBER: Press ""Q"" to quit, not ESC"
4240 IF grade=3 THEN PRINTTAB(0,3)CHR$(129);"CSYS,
     19";MID$(code$(question),2,2);", paper
     ";MID$(code$(question),4,1);", question
     ";MID$(code$(question),5,3);".":GOTO4260
4250 PRINTTAB(0,3)CHR$(132-grade);LEFT$(code$(question),1);"
     grade, 19";MID$(code$(question),2,2);", paper
     ";MID$(code$(question),4,1);", question
     ";MID$(code$(question),5,3);"."
4260 PRINTTAB(0,5)"Problem number ";question;":"
4270 PRINTTAB(0,6);question$(question)
4280 VDU28,0,24,39,VPOS+2: REM sets text window
4290 PROCgetanswers
4300 VDU28,0,24,39,0: REM sets normal text window
4310 CLS
4320 PRINTTAB(0,10)" Now checking previous ";propfile$;"
     answers"
4330 ENDPROC
4350 DEF PROCgetanswers
4360 prop=((start-1) MOD 5)
4370 actualprop=start-1
4380 REPEAT
4390   CLS
4400   prop=prop+1:PRINTTAB(0,0)propfile$" proposition number
     ";prop;":"
4410   actualprop=actualprop+1
4420   PRINTTAB(0,1)proposition$(prop)
4430   IF answer$(question,actualprop)="X" THEN
     previousans=FALSE ELSE previousans=TRUE
```

```
4440   IF previousans THEN PRINT"Your previous answer was
     "::PROCprintanswer
4450   IF previousans THEN PRINT" (To retain this answer press
     ""R"")."
4460   PROCcheckyesno
4470   IF retainflag THEN 4530
4480   ans$=LEFT$(response$,1)
4485   IF propfile$="Lang" THEN 4520
4490   PRINT''"Are you sure? ";
4500   PROCcheckyesno
4510   IF response$="No" THEN ans$=CHR$(ASC(ans$)+32)
4520   answer$(question,actualprop)=ans$
4530   UNTIL prop=5
4540 start=(INSTR("pcsl",LEFT$(propfile$,1))-1)*5
4550 ENDPROC
4570 DEF PROCcheckyesno
4580 LOCAL Z,Z$
4590 PRINT''"Please press either ""Y"" or ""N"": ";
4600 *FX15,1
4610 Z$=GET$
4620 IF INSTR("Qq",Z$)<>0 THEN quit=TRUE:PROCwrite_answer
4630 Z=INSTR("YyNnRr",Z$):IF Z=0 OR (Z>4 AND NOT previousans)
     THEN 4610
4640 IF Z>2 THEN response$="No":previousans=FALSE
4650 IF Z<3 THEN response$="Yes":previousans=FALSE
4660 IF Z>4 THEN retainflag=TRUE ELSE retainflag=FALSE
4670 IF retainflag THEN response$="retained"
4680 PRINT response$
4690 PROCdelay(1)
4700 ENDPROC
4720 DEF PROCprintanswer
4730 LOCAL Z
4740 Z=INSTR("YyNn¦",answer$(question,actualprop))
4750 ON Z GOTO 4760,4770,4780,4790,4800
4760 PRINT"Yes: sure.":ENDPROC
4770 PRINT"Yes: unsure.":ENDPROC
4780 PRINT"No: sure.":ENDPROC
4790 PRINT"No: unsure.":ENDPROC
4800 PRINT"a blank.":ENDPROC
4820 DEF PROCwrite_answer
4830 IF grade=1 THEN *DIR O
4840 IF grade=2 THEN *DIR H
4850 IF grade=3 THEN *DIR S
4860 *ACCESS answer
4870 A=OPENOUT("answer")
4880 FOR question=1 TO 20
4890   FOR prop=1 TO 20
4900     PRINT#A,answer$(question,prop)
4910     NEXT
4920   NEXT
4930 CLOSE#A
4940 *ACCESS answer L
4950 IF quit THEN PROCescape
4960 ENDPROC
4980 DEF PROCexchange
4990 LOCAL number%
5000 exchange=TRUE
5010 endfile=FALSE
```

```
5020 CLS
5030 PROCon
5040 PRINTTAB(0,8)"Please enter the NUMBER of the
     question"''"that you want to repeat: Number ";
5050 number$=""
5060 REPEAT:a=GET:IF a>47 AND a<58 PRINTCHR$a: ELSE IF a<>13
     PRINT''"Please enter numbers only, or ESCAPE"''"to leave
     the program":PROCdelay(100):GOTO5020
5070   IF a<>13 number$=number$+CHR$a
5080   UNTIL a=13
5090 number%=VAL(number$):IF number%=0 OR number%>numberQ THEN
     5020
5100 question=number%
5110 IF grade=3 THEN PRINTTAB(0,12)CHR$(129);"CSYS,
     19";MID$(code$(question),2,2);", paper
     ";MID$(code$(question),4,1);", question
     ";MID$(code$(question),5,3);".":GOTO5130
5120 PRINTTAB(0,12)CHR$(132-grade);LEFT$(code$(question),1);"
     grade, 19";MID$(code$(question),2,2);", paper
     ";MID$(code$(question),4,1);", question
     ";MID$(code$(question),5,3);"."
5130 PROCoff
5140 PROCturnpage(50)
5150 ENDPROC
```

After the logo which is the common first screen, PROCsetup is used (line 380 onwards) to define the various flags and set them to FALSE. Full instructions are then offered, but can be missed out (PROCskipinstructions, PROCinstructions). The instructions confirm that the ESCAPE key is used throughout the program to close all files and exit safely from the program, in the event of any problem. PROCescape (line 680) does not write any new information on to the disc, as it is intended to stop the program safely, and not corrupt any data already present on the disc.

The program uses five sets of external files which must be present on the disc. These are the name file (N.name) which contains nonsense characters at first but is rewritten on the first run of the program; the problem files, called "quest" in each of the O, H and S directories, a set of code files, called "code" in the same three directories, and containing information about the source of each problem: the proposition files, in directory P, called "process", "content", "skills" and "lang" respectively; and the answer files, placed in O, H and S directories under the name "ans##" where ## represents a two digit number unique to each expert respondent.

PROCmenu (line 1280) asks the user to select the grade (O, H or S) on which he/she wishes to work, and loads the appropriate set of files by selecting the appropriate directory. PROCloadfiles is called up from this procedure once the directory has been selected. PROCmenuPCS (line 2120) then offers the choice of propositions. It should be noted that Language propositions may be selected (see line 2620, in which "L" and "l" are included in the check string) although the screen information does not include this choice. This procedure calls up PROCdisplay, after checking whether the selected problem has been attempted before, or whether to start at the place where the user left off last time. The menu procedures also check the answer file to see that it is not yet complete, and set the "finalflag" TRUE if it is. This flag then calls up the final screens of the program (lines 3550 to 3850).

PROCdisplay (line 4210) reserves the top part of the screen for permanent instructions to the user, and shows, on the lower part, the currently selected problem and each of the selected propositions in turn. The user is invited to press "Y" or "N" in response. If this combination of problem and proposition has been attempted before, the procedure detects that fact and sets the "previousans" flag. This then displays the previous answer and allows for it to be retained by pressing "R" (see lines 4430 to 4450 and 4630). The answers are stored in memory while the procedure is running. The letter "Q" is reserved throughout this procedure for the purpose of quitting the program and writing all new information on to the disc. In addition, when the last problem and proposition in the selected sets are reached, the writing of the answer file on to the disc is automatic. The program has to be run separately for each grade of problems. The end sequence contains instructions to the user on what to do with the completed disc.

Throughout the program, every effort was made to ensure that as little difficulty as possible was caused to naive users. This was done by automatic reading and writing of files, full screen displays (never at any time was the user left with an empty screen) and by disabling all keys which were not relevant to requirements on every occasion. The screen displays were made as attractive as possible, with liberal use of colour and double height characters where appropriate. During relatively long operations (e.g., reading of lengthy files) a screen display of dots being "eaten up" was introduced to give the user an indication of the speed of the process (lines 1550, 1640 and 1730 and the short routines following these).

At the end of each procedure, one line seems to be missing. The missing lines were blank lines, inserted so as to break up the program listing on screen for easy reference and alteration. To save space, they have been deleted from the listing in this appendix.

```
 10 REM ****************************
 15 REM **    Program Name ANSana   **
 20 REM **  Answer Analysis Mk 2    **
 30 REM ** R J Watson 12 May 1985 **
 40 REM **  GU Science Education   **
 50 REM **      Research Group      **
 60 REM ****************************
 70 MODE7
 80 ON ERROR PROCerror:END
 90 PROCoff
100 PRINTTAB(5,2)CHR$141"Answer Analysis"
110 PRINTTAB(5,3)CHR$141"Answer Analysis"
120 PROCdelay(100)
130 CLS
140 INPUTTAB(3)"Enter number of respondent: "number%
150 IF number%>9 THEN extra$=STR$(number%) ELSE extra$="0"
    +STR$(number%)
160 swap=FALSE
170 namefile$="N.name"+extra$
180 X=OPENUP namefile$
190 IF X=0 AND NOT swap THEN *SWAP
200 IF X=0 AND NOT swap THEN swap=TRUE:GOTO 180
210 IF X=0 THEN PRINT'''"This filenumber is not present":
    PROCdelay(100):GOTO 130
220 INPUT#X,name$
230 CLOSE#X
240 PRINT''''"Do you want a printer dump of the table"'''"at
    the end? (Y or N)"
250 A$=GET$
260 A=INSTR("YyNn",A$)
270 IF A=0 THEN 250
280 dump_required=((A+1) DIV 2)-2
290 PRINT'''"Which problem set? (O,H,S)"
300 A$=GET$
310 A=INSTR("OoHhSs",A$)
320 IF A=0 THEN 300
330 grade=(A+1) DIV 2
340 grade$=MID$(" Ordinary Grade       Higher Grade
    Sixth Year Studies  ",(grade-1)*22,21)
350 finished=FALSE
360 FOR I=LEN(grade$) TO 1 STEP-1
370   IF finished THEN 400
380   IF MID$(grade$,I,1)<>" " THEN finished=TRUE
390   lastcharacter=I
400   NEXT
410 grade$=LEFT$(grade$,lastcharacter)
420 PRINT''''"Loading";grade$;"answers"
430 PRINTTAB(10,18)"Question Number:"
440 PRINTTAB(0,20)"  1  2  3  4  5  6  7  8  9 10 11 12 13 14
    15 16 17 18 19 20"
450 ON grade GOTO 460,480,500
460 *DIR O
470 GOTO510
480 *DIR H
490 GOTO510
500 *DIR S
510 answerfile$="ans"+extra$
520 X=OPENIN answerfile$
```

```
530 DIM answer$(20,20)
540 PRINTTAB(0,20);
550 FOR I%=1 TO 20
560   FOR J%=1 TO 20
570     INPUT#X,answer$(I%,J%)
580     NEXT
590   PRINT"   ";
600   NEXT
610 CLOSE#X
620 CLS
630 IF dump_required THEN VDU2,1,27,1,33,1,40 ELSE VDU3
640 IF dump_required THEN *FX6
650 PRINTTAB(12);grade$
660 IF dump_required THEN PRINT
670 PRINTTAB(6);"Respondent: ";name$
680 IF dump_required THEN PRINT'
690 PRINTTAB(10)"PROC  CONC  SKILL LANG "
700 PRINTTAB(10)"12345 12345 12345 12345"
710 FORI=1TO20
720   PRINTTAB(8+(I>9));I;
730   FOR J=1 TO 20
740     PRINTTAB(9+J+((J-1) DIV 5))answer$(I,J);
750     NEXT
760   IF dump_required THEN PRINT
770   PRINT
780   NEXT
790 *DIR $
800 PROCon
810 VDU1,12,1,27,1,64,1,27,1,69,3
820 END
830 **********************************
840 DEFPROCoff
850 VDU23;11;0;0;0;
860 ENDPROC
870 **********************************
880 DEFPROCon
890 VDU23;11,255;0;0;0;
900 ENDPROC
910 **********************************
920 DEF PROCdelay(x)
930 time=TIME+x
940 REPEAT
950   UNTIL TIME>time
960 ENDPROC
970 **********************************
980 DEF PROCerror
990 CLOSE#0
1000 *DIR $
1010 REPORT
1020 PRINT" in line ";ERL
1030 ENDPROC
```

This program asks for the number of the respondent, then creates the filenames of name and answer files in order to read them. It displays the answer file at the chosen grade. A sample output is shown on the following page, with the name of the respondent overwritten to maintain confidentiality.

Sample Output fron "ANSana"

Ordinary Grade

Respondent: Xxxxxxx Xxxxxxx

	PROC	CONC	SKILL	LANG
	12345	12345	12345	12345
1	NNNNN	NNYNN	NNyNN	
2	NNNnY	YNYNN	NNNYn	
3	NYyYY	NYYyN	NNNNY	
4	NNnNY	YYYNN	NNNNY	
5	YYYNY	NNYYN	NNNNY	
6	NNNNY	NNYNN	NNNNY	
7	NNNNY	NNYNN	NNNNY	
8	NNNNN	NNYNN	yYNyY	
9	NNNNY	NNYNN	yYNyY	
10	NNNNY	NNYNN	yYNyY	
11	NNNyY	nnYNN	NNNNY	
12	NNNNY	NYYNN	YNYNY	
13	NNNNY	NNYNN	NYNNY	
14	NNNNY	YNYNN	YNYNY	
15	NNNNY	YNYNN	YNYNY	
16	NNNNY	NNYNN	NYNNY	
17	NNNNY	NNYNN	YNNNY	
18				
19				
20				

This sample shows a typical mixture of "sure" and "unsure" responses: at Ordinary Grade, most experts were fairly sure of their responses. Problems 18-20 do not exist in O grade, and thus are marked "blank".

Sixth Year Studies

Respondent: Xxxxxx Xxxxxx

	PROC	CONC	SKILL	LANG
	12345	12345	12345	12345
1	NNNNN	NNYyN	XXXXX	
2	YYYNY	YNYYN	XXXXX	
3	YYynY	YNYYn	XXXXX	
4	YYYNY	YnYYn	XXXXX	
5	NNNNN	NNNNN	XXXXX	
6	NNNNy	NNnNN	XXXXX	
7	NNNNy	NNNNN	XXXXX	
8	NNNNy	NNYNN	XXXXX	
9	yYnYY	XXXXX	XXXXX	
10	NNNNY	XXXXX	XXXXX	
11	NNNNY	XXXXX	XXXXX	
12	NNNNn	XXXXX	XXXXX	
13	YYnYY	XXXXX	XXXXX	
14	YYNYy	XXXXX	XXXXX	
15	NNNNY	XXXXX	XXXXX	
16	NNNNY	XXXXX	XXXXX	
17	NNNNY	XXXXX	XXXXX	
18	NNNNn	XXXXX	XXXXX	
19	NNNNy	XXXXX	XXXXX	
20	NNNNy	XXXXX	XXXXX	

The "blanks" are placed in the Language section because it was not intended that all the experts answer this section. The "X" responses indicate problem/proposition combinations that this respondent did not complete.

```
 10 REM ************************
 20 REM *                      *
 30 REM *        COM2ana       *
 40 REM * equivalent to COMPana *
 50 REM *  Comparison of files  *
 60 REM * from PROBana exercise *
 70 REM *  using Double Discs   *
 80 REM *    Robert J Watson    *
 90 REM *     4 March, 1986     *
100 REM *                      *
110 REM ************************
120 REM
130 ON ERROR CLOSE#0:PROCon:REPORT:PRINT" in line ";ERL:END
140 drive=0
150 MODE 7
160 PROCtitle
170 PROCchoose_level
180 PROCgetdata
190 PROCprinter
200 PROCcompare
210 END
220 **********************************
230 DEF PROCoff
240 VDU23,1,0;0;0;0;
250 ENDPROC
260 **********************************
270 DEF PROCon
280 VDU23,1,1;0;0;0;
290 ENDPROC
300 **********************************
310 DEF PROCtitle
320 PROCoff
330 title$="PROBana Comparisons"
340 tab=INT((36-LEN(title$))/2)
350 PRINTTAB(tab,11)CHR$141;CHR$129;title$
360 PRINTTAB(tab,12)CHR$141;CHR$129;title$
370 PROCdelay(200)
380 CLS
390 ENDPROC
400 **********************************
410 DEF PROCdelay(x)
420 time=TIME+x
430 REPEAT
440   UNTIL TIME>time
450 ENDPROC
460 **********************************
470 DEF PROCchoose_level
480 CLS
490 PRINTTAB(0,2)"There are 3 levels to choose for
    this''"comparison.  Please choose from"
500 PRINTTAB(4,8);CHR$131;"O grade"
510 PRINTTAB(4,10);CHR$130;"H grade"
520 PRINTTAB(4,12);CHR$129;"CSYS"
530 PRINTTAB(0,15);CHR$136;"Press O, H or S now; all other
    keys"'';CHR$136;"have been disabled."
540 g$=GET$
550 g%=INSTR("OoHhSs",g$)
560 IF g%=0 THEN 540
```

```
570 k%=INT((g%+1)/2)
580 grade$=MID$("O grade H grade CSYS    ",(k%-1)*8+1,8)
590 gr$=LEFT$(grade$,4)
600 FOR h%=5 TO LEN(grade$)
610   IF MID$(grade$,h%,1)<>" "THEN gr$=gr$+MID$(grade$,h%,1)
620   NEXT
630 grade$=gr$
640 PRINT''"You have chosen";CHR$(132-k%);grade$;"."
650 PRINT'"Please wait while data files are loaded."
660 PROCdelay(150)
670 CLS
680 ENDPROC
690 ********************************
700 DEF PROCgetdata
710 files=15
720 IF k%=1 THEN questions=17 ELSE questions=20
730 props=20
740 filenumber$=""
750 DIM ans$(files,questions)
760 k$=MID$("OHS",k%,1)
770 FOR i%=0 TO files
780   PRINTTAB(5,1);CHR$134;CHR$141;"Loading Data Files"
790   PRINTTAB(5,2);CHR$134;CHR$141;"Loading Data Files"
800   PRINTTAB(2,9);CHR$(132-k%);CHR$141;"Category: ";k$;"
    Grade"
810   PRINTTAB(2,10);CHR$(132-k%);CHR$141;"Category: ";k$;"
    Grade"
820   filename$=k$+".ans"
830   IF i%<10 THEN filename$=filename$+"0"
840   filename$=filename$+STR$(i%)
850   a%=OPENUP filename$
860   IF a%=0 THEN PROCswap
870   PROCcountdown
880   IF a%=0 THEN 970
890   FOR q%=1 TO questions
900     FOR p%=1 TO props
910       INPUT#a%,temp$
920       IF i%<>0 AND p%>15 THEN temp$="X"
930       ans$(i%,q%)=ans$(i%,q%)+temp$
940       NEXT
950     NEXT
960   CLOSE#a%
970   NEXT i%
980 PROCdelay(100)
990 ENDPROC
1000 ********************************
1010 DEF PROCcountdown
1020 PRINTTAB(5,1);CHR$134;CHR$141;"Loading Data Files"
1030 PRINTTAB(5,2);CHR$134;CHR$141;"Loading Data Files"
1040 PRINTTAB(2,9);CHR$(132-k%);CHR$141;"Category: ";k$;"
    Grade"
1050 PRINTTAB(2,10);CHR$(132-k%);CHR$141;"Category: ";k$;"
    Grade"
1060 PRINTTAB(2,15);CHR$134;CHR$141;"File number ";~i%;" ";:IF
    a%=0 THEN PRINT CHR$132;"Empty   " ELSE PRINT
    CHR$133;"Loading "
1070 PRINTTAB(2,16);CHR$134;CHR$141;"File number ";~i%;" ";:IF
    a%=0 THEN PRINT CHR$132;"Empty   " ELSE PRINT
```

```
     CHR$133;"Loading "
1080 IF i%<10 THEN i$=STR$(i%) ELSE i$=CHR$(i%+55)
1090 IF a%<>0 THEN filenumber$=filenumber$+i$+" "
1100 ENDPROC
1110 **********************************
1120 DEF PROCcompare
1130 CLS
1140 IF NOT printflag THEN VDU14 ELSE
     VDU2,1,27,1,69,1,27.1.87,1,1
1150 FOR question=1 TO questions
1160   report$=""
1170   PRINT grade$;": Question number ";question'
1180   PRINT "File:";TAB(7);filenumber$;TAB(36);"Ave":IF
     printflag THEN PRINT
1190   FOR prop=1 TO props
1200     answertest$=""
1210     IF prop<10 THEN p$="0" +STR$(prop) ELSE p$=STR$(prop)
1220     PRINT"No ";p$;". ";
1230     FOR file=0 TO files
1240       answer$=MID$(ans$(file,question),prop,1)
1250       IF answer$="X" THEN answer$=" "
1260       IF answer$<>"" THEN PRINT answer$;" ";
1270       answertest$=answertest$+answer$
1280       NEXT
1290     PROCaverage
1300     PRINT TAB(37);average$:IF printflag THEN PRINT
1310     NEXT
1320   PROCresult
1330   PRINT result$
1340   IF NOT printflag THEN PRINT CHR$136;"    Press SHIFT to
     continue"
1350   CLS
1360   NEXT
1370 IF printflag THEN VDU1,27,1,64,3 ELSE VDU15
1380 ENDPROC
1390 **********************************
1400 DEF PROCswap
1410 IF drive=0 THEN drive=1 ELSE drive=0
1420 IF drive=1 THEN *DRIVE 1
1430 IF drive=0 THEN *DRIVE 0
1440 a%=OPENUP filename$
1450 ENDPROC
1460 **********************************
1470 DEF PROCprinter
1480 CLS
1490 PROCoff
1500 PRINT'''"Do you wish a hard copy? ";
1510 a$=GET$
1520 a=INSTR("YyNn",a$)
1530 IF a=0 THEN 1510
1540 IF a>2 THEN PRINT "No": printflag=FALSE ELSE PRINT "Yes":
     printflag=TRUE
1550 PROCdelay(100)
1560 ENDPROC
1570 **********************************
1580 DEF PROCaverage
1590 LOCAL j%,k,q$,w$,e$
1600 q$=answertest$
```

```
1610 FOR j%=1 TO LEN(q$)
1620   IF MID$(q$,j%,1)=" " THEN 1640
1630   w$=w$+MID$(q$,j%,1)
1640   NEXT
1650 FOR j%=1 TO LEN(w$)
1660   e$=MID$(w$,j%,1)
1670   IF e$="Y" THEN k=k+2
1680   IF e$="y" THEN k=k+1
1690   IF e$="n" THEN k=k-1
1700   IF e$="N" THEN k=k-2
1710   NEXT
1720 k=k/j%
1730 average$="Q"
1740 IF k>0.4 THEN average$="y"
1750 IF k>0.99 THEN average$="Y"
1760 IF k<-0.4 THEN average$="n"
1770 IF k<-0.99 THEN average$="N"
1780 report$=report$+average$
1790 ENDPROC
1800 ***********************************
1810 DEF PROCresult
1820 LOCAL j%,p%,c%,s%,l%,r$,p$,c$,s$,l$
1830 pfail=FALSE:cfail=FALSE:sfail=FALSE:lfail=FALSE
1840 FOR j%=1 TO 5
1850   r$=MID$(report$,j%,1)
1860   IF r$="Q" THEN pfail=TRUE
1870   IF r$="Y" OR r$="y" THEN p%=p%+2^(5-j%)
1880   NEXT
1890 IF pfail THEN p$="Proc:FAIL;" ELSE p$="Proc: "+STR$(p%)+"
     ;"
1900 FOR j%=6 TO 10
1910   r$=MID$(report$,j%,1)
1920   IF r$="Q" THEN cfail=TRUE
1930   IF r$="Y" OR r$="y" THEN c%=c%+2^(10-j%)
1940   NEXT
1950 IF cfail THEN c$="Conc:FAIL;" ELSE c$="Conc: "+STR$(c%)+"
     ;"
1960 FOR j%=11 TO 15
1970   r$=MID$(report$,j%,1)
1980   IF r$="Q" THEN sfail=TRUE
1990   IF r$="Y" OR r$="y" THEN s%=s%+2^(15-j%)
2000   NEXT
2010 IF sfail THEN s$="Skil:FAIL;" ELSE s$="Skil: "+STR$(s%)+
     " ;"
2020 FOR j%=16 TO 20
2030   r$=MID$(report$,j%,1)
2040   IF r$="Q" THEN lfail=TRUE
2050   IF r$="Y" OR r$="y" THEN l%=l%+2^(20-j%)
2060   NEXT
2070 IF lfail THEN l$="Lang:FAIL"  ELSE l$="Lang: "+STR$(l%)
2080 result$=p$+c$+s$+l$
2090 ENDPROC
```

"COM2ana" is identical to "COMPana" except that it employs a double disc drive, whereas COMPana used a specially formatted disc, obtained by using the "Disc Doctor" ROM program, and not usable on BBC machines without this ROM present. "COMPana" is designed to gather together the sets of answers for each of the expert panel, and to compare the answers received for each problem/proposition combination. The memory capacity of the BBC micro does not permit all the data to be present in memory at the same time, so it is necessary first to select the level at which to operate (see PROCchoose_level, line 470). This sets the appropriate directories for the next stage, PROCgetdata (line 700). The apparent repetition of some lines of print (e.g., lines 780 to 810) is because of the method of obtaining double height characters on the BBC micro, using CHR$(141). The line must be printed twice to obtain the full characters.

PROCgetdata searches the current disc for the files required, looking for O.ans## (where O grade has been selected and ## is the number of respondent being sought). All possible respondents are sought in turn, from 00 to 15 (lines 710 and 770). If the files are not present on the currently selected disc, (line 860), then PROCswap (line 1400) changes the selected drive to the other one, and continues the search. Only when both drives have been searched without result does the program continue to the next respondent, giving the message "Empty" at that entry (line 1060). If a file is located, the message "Loading" appears, and the data is read into memory. PROCcountdown (line 1010) is included so as to maintain an informative screen display while the lengthy task of searching for and reading from files is under way. The reason for this involved method of storage and recovery of files is not that the files are very large, but because the Acorn DFS system permits only 31 files on a disc, and there are 16 possible respondents, each with 3 possible answer files, one in each grade, i.e., 48 files. In addition, although this program does not require the name file, it is desirable, for other programs, to have it present on the disc. The answer files were copied from the users' discs on to a master disc. The theoretical total of 64 files exceeds the number permitted on two discs, but in practice this total was not reached, because not all the possible respondents succeeded in completing the task. There was no point in copying unanswered files on to the master disc.

PROCcompare (line 1120) calls two other procedures, PROCaverage and PROCresult, which together collect and identify all the responses for each problem/proposition combination in turn, then assign scores to them and calculate the average score. Lines 1740 to 1770 assign a symbol ("Y", "y", "n" or "N") to each combination, according to the average, and the whole set of responses, including the calculated average, is printed out as a report. Finally, PROCresult (line 1810) is called up. This either detects the failure of the respondents to agree (indicated by an average close to zero) or reads the symbol, assigning 1 to "Y" or "y" and 0 to "N" or "n". It then increments the appropriate proposition value by whichever power of 2 is indicated by its position (lines 1870, 1930, 1990 and 2050), so that the proposition value will be calculated and displayed. Thus there is no part of the process which is not automated, and depends on a human operator not making any mistake.

The results are displayed as a series of tables, which are reproduced below in Appendix B, on pages A62 to A90.

```
10 REM ****************************
20 REM *                          *
30 REM *    Program name QVALUE   *
40 REM *   Creating and Updating  *
50 REM *         QVAL files       *
60 REM *                          *
70 REM *      Robert J Watson     *
80 REM *       29 March 1988      *
90 REM *                          *
100 REM ****************************
110 MODE7
120 ON ERROR PROCerr
130 PROClogo
140 PROCdelay(150)
150 CLS
160 PROCtitle
170 PROCchoice
180 PROCgetfiles
190 PROCprinter
200 PROClist
210 PROCadjust
220 PROCenter
230 IF change THEN PROCsave
240 PROCend
250 END
260 DEF PROCchoice
270 LOCAL a%,a$
280 DIM grade$(3)
290 change=FALSE
300 CLS
310 PRINT''"There are data files for:"
320 gr$="OHS"
330 FOR i%=1 TO 3
340   g$=MID$(gr$,i%,1)
350   grade$(i%)=CHR$(132-i%)+g$+" Grade"
360   grade$(3)=CHR$(129)+"  CSYS"
370   FOR j%=0 TO 1
380     PRINTTAB(10,4+i%*2+j%);CHR$(141);grade$(i%);"."
390     NEXT
400   NEXT
410 PRINT'''Please choose";CHR$(131);"O";CHR$(135);",";
    CHR$(130);"H"; CHR$(135);", or";CHR$(129);"S";CHR$(135);
    "now."
420 a=GET AND 223
430 a$=CHR$(a)
440 ans%=INSTR(gr$,a$)
450 IF ans%=0 THEN 420
460 file$=a$+".QVAL"
470 qfile$=a$+".QORDER"
480 PRINT''"File chosen is";CHR$(132-ans%);file$
490 PROCdelay(75)
500 IF ans%=1 THEN q%=17 ELSE q%=20
510 DIM proc%(q%),cont%(q%),skil%(q%),lang%(q%)
520 FOR i%=1 TO q%
530   proc%(i%)=-1
540   cont%(i%)=-1
550   skil%(i%)=-1
560   lang%(i%)=-1
```

```
570   NEXT
580 ENDPROC
590 DEF PROCgetfiles
600 LOCAL z%
610 z%=OPENUP file$
620 IF z%=0 THEN PRINT'file$;" does not exist on the
    disc"'"at present.  The program will create"'"a new
    file.":PROCdelay(200):ENDPROC
630 CLOSE#z%
640 z%=OPENIN file$
650 FOR i%=1 TO q%
660   INPUT#z%,proc%(i%),cont%(i%),skil%(i%),lang%(i%)
670   NEXT
680 CLOSE#z%
690 ENDPROC
700 DEF PROClist
710 CLS
720 @%=6
730 start%=0
740 IF print THEN VDU2
750 PRINTTAB(10);grade$(ans%);" Values"
760 IF print THEN PRINT
770 PRINTTAB(15);"Proc";TAB(21);"Cont";TAB(27);"Skil";
    TAB(33);"Lang"
780 IF print THEN PRINT
790 FOR i%=1 TO q%
800   PRINT"Question ";
810   IF i%<10 THEN PRINT" ";
820   PRINT;i%;":";
830   PRINT,proc%(i%),cont%(i%),skil%(i%),lang%(i%)
840   IF start%<>0 THEN 870
850   IF proc%(i%)=-1 THEN start%=i%
860   IF print THEN PRINT STRING$(39,"-")
870   NEXT
880 VDU1,12,1,27,1,64,3
890 PROCcontinue(100)
900 @%=10
910 ENDPROC
920 DEF PROCerr
930 CLOSE#0
940 IF ERR=17 THEN 230
950 REPORT
960 PRINT" while in line ";ERL
970 PROCon
980 END
990 ENDPROC
1000 DEF PROCenter
1010 IF start%=0 THEN ENDPROC
1020 change=TRUE
1030 FORi%=start% TO q%
1040   CLS
1050   PRINTCHR$(133);TAB(7);"Press";CHR$(131);"ESCAPE";
    CHR$(133);"to finish"
1060   FOR k%=0 TO 1
1070     PRINTTAB(0,2+k%);CHR$(141);grade$(ans%);CHR$(131);
    "Question No";CHR$(129)i%;CHR$(131);"."
1080     NEXT
1090   PROCon
```

```
1100   PRINTTAB(0,6);"Enter";CHR$(130);"Process "; CHR$(135);
    "value:";CHR$(130);
1110   INPUT""proc%(i%)
1120   PRINT''"Enter";CHR$(131);"Content "; CHR$(135);"value:";
    CHR$(131);
1130   INPUT""cont%(i%)
1140   PRINT''"Enter";CHR$(132);"Skills  "; CHR$(135);"value:";
    CHR$(132);
1150   INPUT""skil%(i%)
1160   PRINT''"Enter";CHR$(134);"Language";CHR$(135);"value:";
    CHR$(134);
1170   INPUT""lang%(i%)
1180   PROCdelay(150)
1190   NEXT
1200 ENDPROC
1210 DEF PROCsave
1220 LOCAL z%
1230 CLS
1240 PRINT'''"Saving ";file$;"."''
1250 *ACCESS *.*
1260 z%=OPENOUT file$
1270 FOR i%=1 TO q%
1280   PRINT#z%,proc%(i%),cont%(i%),skil%(i%),lang%(i%)
1290   NEXT
1300 CLOSE#z%
1310 PRINT"Saving ";qfile$;"."
1320 z%=OPENOUT qfile$
1330 FOR i%=1 TO q%
1340   PRINT#z%,proc%(i%)
1350   NEXT
1360 FOR i%=1 TO q%
1370   PRINT#z%,cont%(i%)
1380   NEXT
1390 FOR i%=1 TO q%
1400   PRINT#z%,skil%(i%)
1410   NEXT
1420 FOR i%=1 TO q%
1430   PRINT#z%,lang%(i%)
1440   NEXT
1450 CLOSE#z%
1460 *ACCESS *.* L
1470 CLS
1480 ENDPROC
1490 DEF PROCadjust
1500 IF change THEN x$=" more" ELSE x$=""
1510 LOCAL c%
1520 CLS
1530 PRINT''"Do you wish to make any";x$;" changes?";
1540 PROCyesorno
1550 IF NOT yes THEN ENDPROC
1560 change=TRUE
1570 PRINT'''"Enter question number: ";
1580 INPUT""qno%
1590 IF qno%>q% THEN 1520
1600 CLS
1610 PRINT''"Question number ";qno%''
1620 PRINT"Process  value = ";proc%(qno%)
1630 PRINT"Is this correct?";
```

```
1640 PROCyesorno
1650 IF yes THEN 1680
1660 INPUT"Enter correct value: "c%
1670 proc%(qno%)=c%
1680 PRINT''"Content  value = ";cont%(qno%)
1690 PRINT"Is this correct?";
1700 PROCyesorno
1710 IF yes THEN 1740
1720 INPUT"Enter correct value: "c%
1730 cont%(qno%)=c%
1740 PRINT''"Skills   value = ";skil%(qno%)
1750 PRINT"Is this correct?";
1760 PROCyesorno
1770 IF yes THEN 1800
1780 INPUT"Enter correct value: "c%
1790 skil%(qno%)=c%
1800 PRINT''"Language value = ";lang%(qno%)
1810 PRINT"Is this correct?";
1820 PROCyesorno
1830 IF yes THEN 1860
1840 INPUT"Enter correct value: "c%
1850 lang%(qno%)=c%
1860 PROCcontinue(50)
1870 PROCadjust
1880 ENDPROC
1890 DEF PROCtitle
1900 REM in MODE 7
1910 PROCoff
1920 title$="Creating and Listing QVAL files"
1930 date$="29 Mar 1988"
1940 titletab%=INT((34-LEN(title$))/2)
1950 datetab%=INT((34-LEN(date$))/2)
1960 FOR i%=0 TO 1
1970   PRINT TAB(titletab%,11+i%);CHR$141;CHR$(130+i%);title$
1980   PRINT TAB(datetab%.14+i%);CHR$141;CHR$(130+i%);date$
1990   NEXT
2000 PROCdelay(200)
2010 ENDPROC
2020 DEF PROCoff
2030 VDU23,1,0;0;0;0;
2040 ENDPROC
2050 DEF PROCon
2060 VDU23,1,1;0;0;0;
2070 ENDPROC
2080 DEF PROCdelay(x%)
2090 LOCAL time%
2100 time%=TIME+x%
2110 REPEAT
2120   UNTIL TIME>time%
2130 ENDPROC
2140 DEF PROCcontinue(y%)
2150 PROCdelay(y%)
2160 PRINTTAB(5,23);CHR$134;"Press";CHR$136;"COPY";CHR$137;"to
     continue";
2170 *FX15,1
2180 REPEAT
2190   UNTIL INKEY(-106)
2200 CLS
```

```
2210 ENDPROC
2220 DEF PROCprinter
2230 CLS
2240 PRINT'''Do you wish a printed copy? ";
2250 PROCyesorno
2260 IF yes THEN print=TRUE ELSE print=FALSE
2270 IF print THEN VDU2,1,27,1,69,1,27,1,82,1,3,1,27,1,87,
     1,1,3:#$="#" ELSE #$="#"
2280 IF print THEN *FX6
2290 IF print THEN PRINT''CHR$136;"Please ensure that the
     printer is "''CHR$136;"connected and switched ON LINE."
     ELSE PRINT'''The printer is not required."
2300 PROCcontinue(50)
2310 ENDPROC
2320 DEF PROCyesorno
2330 LOCAL a$,a
2340 *FX15,1
2350 a$=GET$
2360 a=INSTR("YyNn",a$)
2370 IF a=0 THEN 2350
2380 yes=INT((a+1)/2)-2
2390 IF yes THEN PRINTCHR$130;"Yes" ELSE PRINTCHR$129;"No"
2400 PROCdelay(50)
2410 ENDPROC
2420 DEF PROCend
2430 CLS
2440 FOR i%=11 TO 12
2450   PRINTTAB(11,i%);CHR$(141);CHR$(134);"End of Program"
2460   NEXT
2470 @%=10
2480 PROCon
2490 PRINTTAB(0,23);
2500 END
2510 ENDPROC
2520 ENDPROC
2530 DEF PROClogo
2540 CLS
2550 PROCoff:PRINTTAB(5,6);
2560 PRINTCHR$(157);"                                ";CHR$(156)
2570 PRINTTAB(5);
2580 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131);
     "Glasgow University"CHR$(135);"  ";CHR$(157);" ";
     CHR$(156)
2590 PRINTTAB(5);
2600 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131);
     "Glasgow University"CHR$(135);"  ";CHR$(157);" ";
     CHR$(156)
2610 PRINTTAB(5);
2620 PRINTCHR$(157);"                                ";CHR$(156)
2630 PRINTTAB(5);
2640 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131);
     "Science Education "CHR$(135);"  ";CHR$(157);" ";
     CHR$(156)
2650 PRINTTAB(5);
2660 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131);
     "Science Education "CHR$(135);"  ";CHR$(157);" ";
     CHR$(156)
2670 PRINTTAB(5);
```

```
2680 PRINTCHR$(157);"                              ";CHR$(156)
2690 PRINTTAB(5);
2700 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131);"
     Research Group  "CHR$(135);"  ";CHR$(157);" ";CHR$(156)
2710 PRINTTAB(5);
2720 PRINTCHR$(157);CHR$(132);CHR$(157);CHR$(141);CHR$(131);"
     Research Group  "CHR$(135);"  ";CHR$(157);" ";CHR$(156)
2730 PRINTTAB(5);
2740 PRINTCHR$(157);"                              ";CHR$(156)
2750 ENDPROC
```

The purpose of this program is to create and list out the files containing the proposition values generated by the COMPana program. (The full output of this program is shown in Appendix B, and demonstrates how the values are calculated.) This program permits entry of those values by the keyboard.

Because there is a possibility of error in transcription at any stage which involves keyboard entry, this program can also be used to correct such errors. This is done in two stages: first, at the creation stage of the files, when values are typed in (lines 1100 to 1170), in which a check is given at each entry, and second, when the whole file is printed out on paper, when the whole table can be checked, item by item, against the COMPana printed output. Both checks were made to ensure that there were no errors at this vital stage of the project. It was not possible to automate the creation of the proposition value files, because the limited memory of the BBC micro did not allow the COMPana program to be extended sufficiently to contain the QVALUE entry. Any errors in transcription can be corrected using PROCadjust (line 1490).

This is an example of a program developed in the later stage of the project, updated from an earlier attempt. It contains a number of stock procedures, which can be used as desired. In the later stages, programs could be created easily from those standard routines, with the new parts generally appearing in the processing and display routines. A library of standard routines had been developed by this time.

Writing the values on to the disc was automatic (lines 230 and 1210) if any change had been made to the values.

```
 10 REM ****************************
 20 REM *                          *
 30 REM *    Program name FAMILY3  *
 40 REM *   Grouping of Questions  *
 50 REM *    by similarities in    *
 60 REM *    proposition results   *
 70 REM *                          *
 80 REM *      Robert J Watson     *
 90 REM *        2 April 1988      *
100 REM *                          *
110 REM ****************************
120 MODE7
130 PROClogo
140 PROCdelay(150)
150 CLS
160 PROCtitle
170 PROCchoice
180 PROCload
190 PROCprinter
200 MODE3
210 PROCsort
220 MODE7
230 PROCend
240 END
250 DEF PROCload
260 LOCAL z%
270 z%=OPENUP file$
280 IF z%=0 THEN PRINT'''This file is not present on the
    disc!"'''Run the program QVALUE if necessary"''':
    PROCcontinue(50):PROCend
290 CLOSE#z%
300 z%=OPENIN file$
310 FOR i%=1 TO q%
320   INPUT#z%,proc%(i%),cont%(i%),skil%(i%),lang%(i%)
330   NEXT
340 CLOSE#z%
350 ENDPROC
360 DEF PROCsort
370 REM MODE3
380 IF print THEN VDU2 ELSE VDU14
390 t%=20
400 @%=2
410 PRINTTAB(t%+titletab%);title$'
420 PRINTTAB(t%+datetab%);date$'
430 PRINTTAB(t%+2);grade$(ans%);"Multiple Proposition
    Questions"''
440 FOR quest%=1 TO q%
450   FOR props%=quest% TO q%
460     IF props%=quest% THEN 550
470     PROCsetflags
480     IF noprint% THEN 550
490     PROCprintflags
500     IF proc%(quest%)=proc%(props%) THEN
    PRINTTAB(t%);"Process  Value ",proc%(quest%);" is in
    question",quest%;" & ",props%
510     IF cont%(quest%)=cont%(props%) THEN
    PRINTTAB(t%);"Content  Value ",cont%(quest%);" is in
    question",quest%;" & ",props%
```

```
520     IF skil%(quest%)=skil%(props%) THEN
    PRINTTAB(t%);"Skills   Value ",skil%(quest%);" is in
    question",quest%;" & ",props%
530     IF lang%(quest%)=lang%(props%) THEN
    PRINTTAB(t%);"Language Value ",lang%(quest%);" is in
    question",quest%;" & ",props%
540     PROCprintflags
550     NEXT
560   NEXT
570 IF print THEN CLS ELSE PRINT':PROCcontinue(50)
580 VDU3,15
590 @%=10
600 ENDPROC
610 DEF PROCchoice
620 LOCAL a%,a$
630 DIM grade$(3)
640 change=FALSE
650 CLS
660 PRINT''"There are data files for:"
670 gr$="OHS"
680 FOR i%=1 TO 3
690   g$=MID$(gr$,i%,1)
700   grade$(i%)=CHR$(132-i%)+g$+" Grade"
710   grade$(3)=CHR$(129)+"  CSYS"
720   FOR j%=0 TO 1
730     PRINTTAB(10,4+i%*2+j%);CHR$(141);grade$(i%);"."
740     NEXT
750   NEXT
760 PRINT'''"Please choose";CHR$(131);"O";CHR$(135);",";
    CHR$(130);"H";CHR$(135);", or";CHR$(129);"S";CHR$(135);
    "now."
770 a=GET AND 223
780 a$=CHR$(a)
790 ans%=INSTR(gr$,a$)
800 IF ans%=0 THEN 770
810 file$=a$+".QVAL"
820 qfile$=a$+".QORDER"
830 PRINT''"File chosen is";CHR$(132-ans%);file$
840 PROCdelay(75)
850 IF ans%=1 THEN q%=17 ELSE q%=20
860 DIM proc%(q%),cont%(q%),skil%(q%),lang%(q%)
870 ENDPROC
880 DEF PROCtitle
890 REM in MODE 7
900 PROCoff
910 title$="FAMILY3"
920 date$="13 May 1990"
930 titletab%=INT((34-LEN(title$))/2)
940 datetab%=INT((34-LEN(date$))/2)
950 FOR i%=0 TO 1
960   PRINT TAB(titletab%,11+i%);CHR$141;CHR$(130+i%);title$
970   PRINT TAB(datetab%,14+i%);CHR$141;CHR$(130+i%);date$
980   NEXT
990 PROCdelay(200)
1000 ENDPROC
1010 DEF PROCoff
1020 VDU23,1,0;0;0;0;
1030 ENDPROC
```

```
1040 DEF PROCon
1050 VDU23,1,1;0;0;0;
1060 ENDPROC
1070 DEF PROCdelay(x%)
1080 LOCAL time%
1090 time%=TIME+x%
1100 REPEAT
1110   UNTIL TIME>time%
1120 ENDPROC
1130 DEF PROCcontinue(y%)
1140 PROCdelay(y%)
1150 PRINTTAB(5,23);CHR$134;"Press";CHR$136;"COPY";CHR$137;"to
     continue";
1160 *FX15,1
1170 REPEAT
1180   UNTIL INKEY(-106)
1190 CLS
1200 ENDPROC
1210 DEF PROCprinter
1220 CLS
1230 PRINT'''Do you wish a printed copy? ";
1240 PROCyesorno
1250 IF yes THEN print=TRUE ELSE print=FALSE
1260 IF print THEN VDU2,1,27,1,69,1,27,1,82,1,3,3:#$="#" ELSE
     #$="#"
1270 IF print THEN *FX6
1280 IF print THEN PRINT''CHR$136;"Please ensure that the
     printer is "''CHR$136;"connected and switched ON LINE."
     ELSE PRINT'''The printer is not required."
1290 PROCcontinue(50)
1300 ENDPROC
1310 DEF PROCyesorno
1320 LOCAL a$,a
1330 *FX15,1
1340 a$=GET$
1350 a=INSTR("YyNn",a$)
1360 IF a=0 THEN 1340
1370 yes=INT((a+1)/2)-2
1380 IF yes THEN PRINTCHR$130;"Yes" ELSE PRINTCHR$129;"No"
1390 PROCdelay(50)
1400 ENDPROC
1410 DEF PROCend
1420 CLS
1430 FOR i%=11 TO 12
1440   PRINTTAB(11,i%);CHR$(141);CHR$(134);"End of Program"
1450   NEXT
1460 @%=10
1470 PROCon
1480 PRINTTAB(0,23);
1490 END
1500 ENDPROC
1510 DEF PROClogo
Note: lines 1520 to 1730 deleted (see other programs)
1740 DEF PROCsetflags
1750 twoflag%=FALSE
1760 threeflag%=FALSE
1770 fourflag%=FALSE
1780 IF proc%(quest%)=proc%(props%) AND
```

```
     cont%(quest%)=cont%(props%) THEN twoflag%=TRUE
1790 IF proc%(quest%)=proc%(props%) AND
     skil%(quest%)=skil%(props%) THEN twoflag%=TRUE
1800 IF proc%(quest%)=proc%(props%) AND
     lang%(quest%)=lang%(props%) THEN twoflag%=TRUE
1810 IF cont%(quest%)=cont%(props%) AND
     skil%(quest%)=skil%(props%) THEN twoflag%=TRUE
1820 IF cont%(quest%)=cont%(props%) AND
     lang%(quest%)=lang%(props%) THEN twoflag%=TRUE
1830 IF skil%(quest%)=skil%(props%) AND
     lang%(quest%)=lang%(props%) THEN twoflag%=TRUE
1840 IF proc%(quest%)=proc%(props%) AND
     cont%(quest%)=cont%(props%) AND
     skil%(quest%)=skil%(props%) THEN threeflag%=TRUE
1850 IF proc%(quest%)=proc%(props%) AND
     cont%(quest%)=cont%(props%) AND
     lang%(quest%)=lang%(props%) THEN threeflag%=TRUE
1860 IF proc%(quest%)=proc%(props%) AND
     skil%(quest%)=skil%(props%) AND
     lang%(quest%)=lang%(props%) THEN threeflag%=TRUE
1870 IF cont%(quest%)=cont%(props%) AND
     skil%(quest%)=skil%(props%) AND
     lang%(quest%)=lang%(props%) THEN threeflag%=TRUE
1880 IF proc%(quest%)=proc%(props%) AND
     cont%(quest%)=cont%(props%) AND
     skil%(quest%)=skil%(props%) AND
     lang%(quest%)=lang%(props%) THEN fourflag%=TRUE
1890 IF twoflag% THEN noprint%=FALSE ELSE noprint%=TRUE
1900 ENDPROC
1910 DEF PROCprintflags
1920 IF twoflag% THEN flag$=STRING$(42,"-")
1930 IF threeflag% THEN flag$=STRING$(42,"+")
1940 IF fourflag% THEN flag$=STRING$(42,"*")
1950 PRINTTAB(t%);flag$
1960 ENDPROC
```

This program shows the sets of problems which have two, three or four proposition values in common. From it, the data in PHASE4 was collected. These results are found in Table 5 of the main text (Page 72).

```
 10 REM ******************************
 20 REM *                            *
 30 REM *    Program name PHASE4     *
 40 REM *                            *
 50 REM * Analysis of passes files   *
 60 REM *  with data from FAMILY3    *
 70 REM *                            *
 80 REM *       Robert J Watson      *
 90 REM *        2 April 1988        *
100 REM *                            *
110 REM ******************************
120 MODE7
130 ON ERROR PROCerr
140 PROClogo
150 PROCdelay(150)
160 CLS
```

```
170 PROCtitle
180 CLS
190 PROCchoice
200 PROCprinter
210 PROCdata
220 PROCanalyse
230 PROCend
240 END
250 DEF PROCdata
260 DIM quest$(q%),cand%(100,q%),sex$(100)
270 FOR i%=0 TO 1
280   PRINTTAB(0,10+i%);CHR$(134);CHR$(141);"Reading data
    from";CHR$(132-ans%);file$;CHR$(134);"now";CHR$(133);:h%=P
    OS:PRINT
290   NEXT
300 @%=3
310 z%=OPENIN file$
320 IF z%=0 THEN PRINT'':file$;" is not present on the
    disc."'''"Please RUN the program again with "''file$;" on
    the disc."'''':END
330 INPUT#z%,factor
340 pass%=INT(factor*50+0.5)
350 FOR i%=1 TO 100
360   INPUT#z%,sex$(i%)
370   FORk%=0 TO 1
380     PRINTTAB(1,4+k%);CHR$(141);CHR$(130);"Pass grade for
    this run =";CHR$(129);pass%;"%"
390     PRINTTAB(h%,10+k%),i%
400     NEXT
410   FOR j%=1 TO q%
420     INPUT#z%,cand%(i%,j%)
430     NEXT
440   NEXT
450 CLOSE#z%
460 FOR i%=0 TO 1
470   PRINTTAB(10,14+i%);CHR$(133);CHR$(141);CHR$(136);
    "Reading Data"
480   NEXT
490 IF ans%=1 THEN RESTORE 620
500 IF ans%=2 THEN RESTORE 780
510 IF ans%=3 THEN RESTORE 900
520 READ n%
530 DIM type$(n%),q1%(n%),q2%(n%)
540 FOR i%=1 TO n%
550   READ type$(i%),q1%(i%),q2%(i%)
560   NEXT
570 FOR i%=0 TO 1
580   PRINTTAB(10,14+i%);CHR$(130);CHR$(141);CHR$(137);" Data
    Read in "
590   NEXT
600 PROCcontinue(50)
610 ENDPROC
620 REM O grade data
630 DATA 13
640 REM type,question numbers
650 DATA PCL,2,15
660 DATA PCS,4,17
670 DATA PCS,6,7
```

```
 680 DATA PCS,6,9
 690 DATA PCS,6,10
 700 DATA PCS,6,13
 710 DATA PCS,7,9
 720 DATA PCS,7,10
 730 DATA PCS,7,13
 740 DATA PCS,9,10
 750 DATA PSL,9,13
 760 DATA PCS,10,13
 770 DATA PCS,14,15
 780 REM H grade data
 790 DATA 9
 800 REM type,question numbers
 810 DATA PCSL,1,2
 820 DATA PCL,6,15
 830 DATA PCS,10,15
 840 DATA PCS,11,16
 850 DATA PCL,13,16
 860 DATA PCL,14,17
 870 DATA PCL,14,20
 880 DATA PCL,16,17
 890 DATA PCL,17,20
 900 REM CSYS data
 910 DATA 6
 920 REM type,question numbers
 930 DATA PCS,6,7
 940 DATA PSL,6,20
 950 DATA PCS,10,12
 960 DATA PCS,10,19
 970 DATA PCS,12,19
 980 DATA PSL,18,20
 990 DEF PROCanalyse
1000 @%=3
1010 IF print THEN VDU2,15 ELSE VDU14
1020 IF print THEN t%=5:m%=18 ELSE t%=0:m%=0
1030 PRINTTAB(m%+titletab%);title$'
1040 PRINTTAB(m%+10);grade$(ans%);" Data"'
1050 PRINTTAB(m%+5);"Pass grade for this run = ";pass%;"%"''
1060 k%=0:l%=0:boy%=0:girl%=0:blank%=0
1070 pcsl%=0:pcsl2%=0:pcs%=0:pcs2%=0:pcl%=0:pcl2%=0:psl%=0:
     psl2%=0
1080 FOR i%=1 TO 100
1090   FOR j%=1 TO n%
1100     IF type$(j%)="PCSL" THEN pcsl2%=pcsl2%+1
1110     IF type$(j%)="PCS" THEN pcs2%=pcs2%+1
1120     IF type$(j%)="PCL" THEN pcl2%=pcl2%+1
1130     IF type$(j%)="PSL" THEN psl2%=psl2%+1
1140     IF cand%(i%,q1%(j%))=99 OR cand%(i%,q2%(j%))=99 THEN
     blank%=blank%+1:GOTO 1250
1150     IF cand%(i%,q1%(j%))=cand%(i%,q2%(j%)) THEN 1250
1160     l%=l%+1
1170     IF k%=i% THEN 1200
1180     IF sex$(i%)="M" THEN boy%=boy%+1 ELSE girl%=girl%+1
1190     k%=i%
1200     PRINTTAB(t%);"Type:";type$(j%);": ";"Candidate
     no.",i%;" (";sex$(i%);")";FNpass1;"in qu.",q1%(j%);"
     and";FNpass2;"in qu.",q2%(j%);"."
1210     IF type$(j%)="PCSL" THEN pcsl%=pcsl%+1
```

```
1220      IF type$(j%)="PCS" THEN pcs%=pcs%+1
1230      IF type$(j%)="PCL" THEN pcl%=pcl%+1
1240      IF type$(j%)="PSL" THEN psl%=psl%+1
1250      NEXT
1260   NEXT
1270 PRINT''TAB(m%+3);"Pass grade   =",pass%;"%"''
1280 PRINTTAB(m%+3);"Total number =",l%
1290 PRINTTAB(m%+3);"Total Boys   =",boy%
1300 PRINTTAB(m%+3);"Total Girls  =",girl%
1310 PRINTTAB(m%+3);"Total Blanks =",blank%
1320 PRINTTAB(m%+3);"No of PCSL prs",pcsl2%/100
1330 PRINTTAB(m%+3);"No of PCS  prs",pcs2%/100
1340 PRINTTAB(m%+3);"No of PCL  prs",pcl2%/100
1350 PRINTTAB(m%+3);"No of PSL  prs",psl2%/100
1360 PRINTTAB(m%+3);"PCSL different",pcsl%
1370 PRINTTAB(m%+3);"PCS  different",pcs%
1380 PRINTTAB(m%+3);"PCL  different",pcl%
1390 PRINTTAB(m%+3);"PSL  different",psl%
1400 IF NOT print THEN PRINT'':PROCcontinue(50)
1410 VDU1,12,15,3
1420 ENDPROC
1430 DEF FNpass1
1440 REM for q1% data
1450 IF cand%(i%,q1%(j%)) THEN p$=" passed "ELSE p$=" failed "
1460 =p$
1470 DEF FNpass2
1480 REM for q2% data
1490 IF cand%(i%,q2%(j%)) THEN p$=" passed "ELSE p$=" failed "
1500 =p$
1510 DEF PROCchoice
1520 LOCAL a%,a$
1530 DIM grade$(3)
1540 change=FALSE
1550 CLS
1560 PRINT''"There are data files for:"
1570 gr$="OHS"
1580 FOR i%=1 TO 3
1590   g$=MID$(gr$,i%,1)
1600   grade$(i%)=CHR$(132-i%)+g$+" Grade"
1610   grade$(3)=CHR$(129)+"  CSYS"
1620   FOR j%=0 TO 1
1630     PRINTTAB(10,4+i%*2+j%);CHR$(141);grade$(i%);"."
1640     NEXT
1650   NEXT
1660 PRINT''"Please choose";CHR$(131);"O";CHR$(135);",";
     CHR$(130);"H"; CHR$(135);",or";CHR$(129);"S";
     CHR$(135);"now."
1670 a=GET AND 223
1680 a$=CHR$(a)
1690 ans%=INSTR(gr$,a$)
1700 IF ans%=0 THEN 1670
1710 file$=a$+".passes"
1720 PRINT''"File chosen is";CHR$(132-ans%);file$
1730 PROCdelay(75)
1740 IF ans%=1 THEN q%=17 ELSE q%=20
1750 ENDPROC
1760 DEF PROCtitle
1770 REM in MODE 7
```

```
1780 PROCoff
1790 title$="Phase 4 Analysis"
1800 date$="2 April 1988"
1810 titletab%=INT((34-LEN(title$))/2)
1820 datetab%=INT((34-LEN(date$))/2)
1830 FOR i%=0 TO 1
1840   PRINT TAB(titletab%,11+i%);CHR$141;CHR$(130+i%);title$
1850   PRINT TAB(datetab%,14+i%);CHR$141;CHR$(130+i%);date$
1860   NEXT
1870 PROCdelay(200)
1880 ENDPROC
1890 DEF PROCoff
1900 VDU23,1,0;0;0;0;
1910 ENDPROC
1920 DEF PROCon
1930 VDU23,1,1;0;0;0;
1940 ENDPROC
1950 DEF PROCdelay(x%)
1960 LOCAL time%
1970 time%=TIME+x%
1980 REPEAT
1990   UNTIL TIME>time%
2000 ENDPROC
2010 DEF PROCcontinue(y%)
2020 PROCdelay(y%)
2030 mode%=?&8F
2040 IF mode%=3 THEN h%=25:v%=23
2050 IF mode%=0 THEN h%=25:v%=30
2060 IF mode%=7 THEN h%=5:v%=23
2070 PRINTTAB(h%,v%);CHR$134;"Press";CHR$136;"COPY";CHR$137;
     "to continue";
2080 *FX15,1
2090 REPEAT
2100   UNTIL INKEY(-106)
2110 CLS
2120 ENDPROC
2130 DEF PROCprinter
2140 CLS
2150 PRINT''"Do you wish a printed copy? ";
2160 PROCyesorno
2170 IF yes THEN print=TRUE ELSE print=FALSE
2180 IF print THEN VDU2,1,27,1,69,1,27,1,78,1,3
2190 IF print THEN *FX6
2200 IF print THEN PRINT''CHR$136;"Please ensure that the
     printer is "''CHR$136;"connected and switched ON LINE."
     ELSE PRINT'''The printer is not required."
2210 PROCcontinue(50)
2220 ENDPROC
2230 DEF PROCyesorno
2240 LOCAL a$,a
2250 *FX15,1
2260 a$=GET$
2270 a=INSTR("YyNn",a$)
2280 IF a=0 THEN 2260
2290 yes=INT((a+1)/2)-2
2300 IF yes THEN PRINTCHR$130;"Yes" ELSE PRINTCHR$129;"No"
2310 PROCdelay(50)
2320 ENDPROC
```

```
2330 DEF PROCend
2340 CLS
2350 FOR i%=11 TO 12
2360   PRINTTAB(11,i%);CHR$(141);CHR$(134);"End of Program"
2370   NEXT
2380 @%=10
2390 PROCon
2400 PRINTTAB(0,23);
2410 END
2420 ENDPROC
2430 DEF PROClogo
 - to line 2650, PROClogo as in other programs
2660 DEF PROCerr
2670 CLOSE#0
2680 IF ERR<>17 THEN 2700
2690 PROCend
2700 CLS
2710 REPORT
2720 PRINT" while in line ";ERL
2730 END
2740 ENDPROC
```

The RESTORE commands (lines 490 to 510) set the program pointers to the appropriate places to receive O grade, H grade or CSYS data when required. The first DATA statement in each set is the number of items to be read into memory. It is used to set the counting loop (line 540) to the appropriate value, which is different for each level, and cannot be set in advance, because the correspondence of proposition values depends on the results of the electronic questionnaire which established these values in the first place.

The DATA statements in lines 620 to 980 (which are separate from the program and do not form a procedure in their own right) should be compared with Table 5 in the text (page 72). They show where the pairs that are to be compared are entered into the program. Great care was taken to ensure that these DATA statements were entirely accurate, by comparing with the output from the FAMILY3 program.

PROCanalyse (lines 990 to 1500) is the main calculation of the program, which is essentially counting data and displaying the totals. These figures were collected into a slightly different form in Table 5, but are the same totals as are calculated by this program.

```
 10 REM *****************************
 20 REM *                           *
 30 REM *    Program name PASSMK    *
 40 REM *                           *
 50 REM *    Assigns Pass Marks     *
 60 REM *  to O. H, S.marks files   *
 70 REM *                           *
 80 REM *       Robert J Watson     *
 90 REM *        1 April  1988      *
100 REM *                           *
110 REM *****************************
120 MODE7
130 PROClogo
140 PROCdelay(150)
150 CLS
160 PROCtitle
170 PROCfactor
180 PROCchoice
190 CLS
200 PROCreaddata
210 PROCdelay(150)
220 CLS
230 PROCsave
240 REM *****************************
250 REM * Structure of new file is  *
260 REM * factor, each cand's sex,  *
270 REM * p/f per question as TRUE  *
280 REM * (pass) or FALSE (fail) or *
290 REM * 99 for no attempt         *
300 REM *****************************
310 PROCend
320 END
330 DEF PROCfactor
340 CLS
350 PROCon
360 PRINT'''Enter factor for setting passmarks: ";
370 INPUT""factor
380 IF factor>1.8 OR factor <0.2 THEN PRINT'''Factor must lie
    between 0.2 and 1.8!":PROCcontinue(50):GOTO 340
390 pass%=INT(factor*50+0.5)
400 PROCoff
410 FOR i%=0 TO 1
420   PRINTTAB(2,10+i%);CHR$(131);CHR$(141);"Pass grade
    chosen as";CHR$(129);pass%;CHR$(131);"%"
430   NEXT
440 PROCcontinue(50)
450 ENDPROC
460 DEF PROCchoice
470 LOCAL a%,a$
480 DIM grade$(3)
490 change=FALSE
500 CLS
510 PRINT''There are data files for:"
520 gr$="OHS"
530 FOR i%=1 TO 3
540   g$=MID$(gr$,i%,1)
550   grade$(i%)=CHR$(132-i%)+g$+" Grade"
560   grade$(3)=CHR$(129)+"  CSYS"
```

```
570   FOR j%=0 TO 1
580     PRINTTAB(10,4+i%*2+j%);CHR$(141);grade$(i%);"."
590     NEXT
600   NEXT
610 PRINT''"Please choose";CHR$(131);"O";CHR$(135);",";
    CHR$(130);"H";CHR$(135);", or";CHR$(129);"S";CHR$(135);
    "now."
620 a=GET AND 223
630 a$=CHR$(a)
640 ans%=INSTR(gr$.a$)
650 IF ans%=0 THEN 620
660 file$=a$+".marks"
670 savefile$=a$+".passes"
680 PRINT''"File chosen is";CHR$(132-ans%):file$
690 PROCdelay(100)
700 IF ans%=1 THEN q%=17 ELSE q%=20
710 ENDPROC
720 DEF PROCtitle
730 REM in MODE 7
740 PROCoff
750 title$="Setting Pass Marks"
760 date$="1 April 1988"
770 titletab%=INT((34-LEN(title$))/2)
780 datetab%=INT((34-LEN(date$))/2)
790 FOR i%=0 TO 1
800   PRINT TAB(titletab%,11+i%);CHR$141;CHR$(130+i%);title$
810   PRINT TAB(datetab%.14+i%);CHR$141;CHR$(130+i%);date$
820   NEXT
830 PROCdelay(200)
840 ENDPROC
850 DEF PROCoff
860 VDU23,1,0;0;0;0;
870 ENDPROC
880 DEF PROCon
890 VDU23,1,1;0:0;0;
900 ENDPROC
910 DEF PROCdelay(x%)
920 LOCAL time%
930 time%=TIME+x%
940 REPEAT
950   UNTIL TIME>time%
960 ENDPROC
970 DEF PROCcontinue(y%)
980 PROCdelay(y%)
990 PRINTTAB(5,23);CHR$134;"Press";CHR$136;"COPY";CHR$137;"to
    continue";
1000 *FX15,1
1010 REPEAT
1020   UNTIL INKEY(-106)
1030 CLS
1040 ENDPROC
1050 DEF PROCprinter
1060 CLS
1070 PRINT''"Do you wish a printed copy? ";
1080 PROCyesorno
1090 IF yes THEN print=TRUE ELSE print=FALSE
1100 IF print THEN VDU2.1,27,1,69,1,27,1,82,1,3,3
1110 IF print THEN *FX6
```

```
1120 IF print THEN PRINT''CHR$136;"Please ensure that the
     printer is "''CHR$136:"connected and switched ON LINE."
     ELSE PRINT'''The printer is not required."
1130 PROCcontinue(50)
1140 ENDPROC
1150 DEF PROCyesorno
1160 LOCAL a$,a
1170 *FX15,1
1180 a$=GET$
1190 a=INSTR("YyNn",a$)
1200 IF a=0 THEN 1180
1210 yes=INT((a+1)/2)-2
1220 IF yes THEN PRINTCHR$130;"Yes" ELSE PRINTCHR$129;"No"
1230 PROCdelay(50)
1240 ENDPROC
1250 DEF PROCend
     PROCend as in other programs
1340 ENDPROC
1350 DEF PROClogo
     PROClogo as in other programs
1570 ENDPROC
1580 DEF PROCreaddata
1590 DIM quest$(q%),cand%(100,q%),fullmk%(q%),
     passmk%(q%),sex$(100)
1600 IF ans%=1 THEN RESTORE 2030
1610 IF ans%=2 THEN RESTORE 2220
1620 IF ans%=3 THEN RESTORE 2440
1630 FOR i%=1 TO q%
1640   READ quest$(i%),fullmk%(i%)
1650   passmk%(i%)=fullmk%(i%)*factor
1660   REM ***************************
1670   REM * marks saved as double   *
1680   REM * to allow for half marks *
1690   REM ***************************
1700   NEXT
1710 @%=3
1720 FOR i%=10 TO 11
1730   PRINTTAB(0,i%);CHR$(134);CHR$(141);"Reading data
     from";CHR$(132-ans%);file$;CHR$(134);"now";CHR$(133);:h%=P
     OS:PRINT
1740   NEXT
1750 z%=OPENIN file$
1760 IF z%=0 THEN PRINT'';file$;" is not present on the
     disc."'''Please RUN the program again with "''file$;" on
     the disc."''':END
1770 FOR i%=1 TO 100
1780   FOR k%=10 TO 11
1790     PRINTTAB(h%,k%),i%
1800     NEXT
1810   INPUT#z%,sex$(i%)
1820   FOR j%=1 TO q%
1830     INPUT#z%,cand%(i%,j%)
1840     NEXT
1850   NEXT
1860 CLOSE#z%
1870 FOR i%=0 TO 1
1880   PRINTTAB(7,14+i%);CHR$(133);CHR$(141);CHR$(136);
     "Processing Data"
```

```
1890   NEXT
1900 FOR i%=1 TO 100
1910   FOR j%=1 TO q%
1920     IF cand%(i%.j%)=99 THEN notflag%=TRUE ELSE
     notflag%=FALSE
1930     IF cand%(i%.j%)>=passmk%(j%) THEN cand%(i%.j%)=TRUE
     ELSE cand%(i%,j%)=FALSE
1940     IF notflag% THEN cand%(i%,j%)=99
1950     NEXT
1960   NEXT
1970 FOR i%=0 TO 1
1980   PRINTTAB(7.14+i%);CHR$(130);CHR$(141);" Data converted"
1990   NEXT
2000 ENDPROC
2010 REM Data for O grade questions
2020 REM question no., possible mark
2030 DATA 1,3
2040 DATA 2,2
2050 DATA 3,3
2060 DATA 4,2
2070 DATA 5,2
2080 DATA 6(A),3
2090 DATA 6(B),3
2100 DATA 7,3
2110 DATA 8(A),3
2120 DATA 8(B),3
2130 DATA 9,2
2140 DATA 10,4
2150 DATA 11,4
2160 DATA 12(A),4
2170 DATA 12(B),4
2180 DATA 13,6
2190 DATA 14,5
2200 REM Data for H grade questions
2210 REM question no., possible
2220 DATA 1(A),2
2230 DATA 1(B),2
2240 DATA 2,2
2250 DATA 3,3
2260 DATA 4,3
2270 DATA 5(A),3
2280 DATA 5(B),3
2290 DATA 6,3
2300 DATA 7,4
2310 DATA 8,4
2320 DATA 9,4
2330 DATA 10,4
2340 DATA 11,5
2350 DATA 12,5
2360 DATA 13,6
2370 DATA 14,12
2380 DATA 15,12
2390 DATA 16,12
2400 DATA 17(A),12
2410 DATA 17(B),12
2420 REM Data for CSYS questions
2430 REM question no., possible
2440 DATA 1,3
```

```
2450 DATA 2,5
2460 DATA 3(A),7
2470 DATA 3(B),7
2480 DATA 4,5
2490 DATA 5(A),2
2500 DATA 5(B),2
2510 DATA 6,4
2520 DATA 7,9
2530 DATA 8,4
2540 DATA 9,4
2550 DATA 10,2
2560 DATA 11(A),8
2570 DATA 11(B),8
2580 DATA 12,7
2590 DATA 13,6
2600 DATA 14,7
2610 DATA 15(A),4
2620 DATA 15(B),4
2630 DATA 15(C),4
2640 REM End of Data
2650 DEF PROCsave
2660 z%=OPENUP savefile$
2670 IF z%<>0 THEN PRINT''savefile$;" already exists."''"Do
     you wish to overwrite it?";ELSE GOTO 2700
2680 PROCyesorno
2690 IF NOT yes THEN ENDPROC
2700 CLOSE#z%
2710 CLS
2720 FOR i%=0 TO 1
2730   PRINTTAB(1,4+i%);CHR$(141);CHR$(130);"Pass grade for
     this run =";CHR$(129);pass%;"%"
2740   PRINTTAB(0,10+i%);CHR$(133);CHR$(141);"Writing data
     to";CHR$(132-ans%);savefile$;CHR$(133);"now";CHR$(134);:
     h%=POS:PRINT
2750   NEXT
2760 *ACCESS *.passes
2770 z%=OPENOUT savefile$
2780 PRINT#z%,factor
2790 FOR i%=1 TO 100
2800   FOR k%=10 TO 11
2810     PRINTTAB(h%,k%),i%
2820     NEXT
2830   PRINT#z%,sex$(i%)
2840   FOR j%=1 TO q%
2850     PRINT#z%,cand%(i%,j%)
2860     NEXT
2870   NEXT
2880 CLOSE#z%
2890 *ACCESS *.passes L
2900 FOR i%=0 TO 1
2910   PRINTTAB(4,14+i%);CHR$(130);CHR$(141);"Finished writing
     ";savefile$
2920   NEXT
2930 PROCdelay(100)
2940 ENDPROC
```

This is the original PASSMK program, which requests a pass factor (between 0 and 2) and multiplies this by the actual mark recorded in the "marks" file. The reason for the value of the factor is that original marks are recorded as double the actual mark, so as to allow for half marks but to permit the saving of memory and disc space which is consequent on the use of integer variables which take only four bytes each, as opposed to seven in the case of a floating point variable.

The factor is requested in PROCfactor (line 330) and is carried forward to be multiplied by the actual mark (line 1650) to give a pass mark which can then be compared with the actual mark (lines 1900 to 1950). This results in a code for each candidate and each problem, which can be one of three things - TRUE, meaning a pass at the selected factor, FALSE, meaning a fail at that factor, or -99, meaning that that problem was not attempted (as opposed to a zero mark).

When the analysis and conversion is complete, a new file, the "passes" file is written to disc, containing the same candidate and problem entries, but with pass codes instead of actual marks. The program may be summarised, therefore, as a conversion from "marks" files to the corresponding "passes" files, at selected pass grades.

The "passes" files are used in the following MERIT program.

```
 10 REM ****************************
 20 REM *                          *
 30 REM *    Program name MERIT    *
 40 REM *                          *
 50 REM *    Places questions in   *
 60 REM *  merit order by passrate *
 70 REM *                          *
 80 REM *      Robert J Watson     *
 90 REM *        10 May 1988       *
100 REM *      Rev 8 July 1988     *
110 REM *                          *
120 REM ****************************
130 ON ERROR MODE7:PROCerror
140 MODE7
150 PROClogo
160 PROCdelay(150)
170 CLS
180 PROCtitle
190 PROCchoice
200 CLS
210 PROCreaddata
220 PROCanalyse
230 PROCsort
250 pass$=STR$(passmk%)
260 MODE7
270 PROCsave
280 PROCend
290 END
300 DEF PROCchoice
310 LOCAL a%,a$
320 DIM grade$(3)
```

```
330 change=FALSE
340 CLS
350 PRINT''"There are data files for:"
360 gr$="OHS"
370 FOR i%=1 TO 3
380   g$=MID$(gr$,i%,1)
390   grade$(i%)=CHR$(132-i%)+g$+" Grade"
400   grade$(3)=CHR$(129)+"  CSYS"
410   FOR j%=0 TO 1
420     PRINTTAB(10,4+i%*2+j%);CHR$(141);grade$(i%);"."
430     NEXT
440   NEXT
450 PRINT''"Please choose";CHR$(131);"O";CHR$(135);",";CHR$
    (130); "H";CHR$(135);",or";CHR$(129);"S";CHR$(135);"now."
460 a=GET AND 223
470 a$=CHR$(a)
480 ans%=INSTR(gr$,a$)
490 IF ans%=0 THEN 460
500 file$=a$+".passes"
510 qfile$=a$+".QVAL"
520 savefile$=a$+".P/PF@"
530 PRINT''"File chosen is";CHR$(132-ans%);file$
540 PROCdelay(100)
550 IF ans%=1 THEN q%=17 ELSE q%=20
560 ENDPROC
570 DEF PROCtitle
580 REM in MODE 7
590 PROCoff
600 title$="Merit Order in Questions"
610 date$="8 October 1989"
620 titletab%=INT((34-LEN(title$))/2)
630 datetab%=INT((34-LEN(date$))/2)
640 FOR i%=0 TO 1
650   PRINT TAB(titletab%,11+i%);CHR$141;CHR$(130+i%);title$
660   PRINT TAB(datetab%,14+i%);CHR$141;CHR$(130+i%);date$
670   NEXT
680 PROCdelay(200)
690 ENDPROC
700 DEF PROCoff
710 VDU23,1,0;0;0;0;
720 ENDPROC
730 DEF PROCon
740 VDU23,1,1;0;0;0;
750 ENDPROC
760 DEF PROCdelay(x%)
770 LOCAL time%
780 time%=TIME+x%
790 REPEAT
800   UNTIL TIME>time%
810 ENDPROC
820 DEF PROCcontinue(y%)
830 PROCdelay(y%)
840 PRINTTAB(5,23);CHR$134;"Press";CHR$136;"COPY";CHR$137;"to
    continue";
850 *FX15,1
860 REPEAT
870   UNTIL INKEY(-106)
880 CLS
```

```
 890 ENDPROC
 900 DEF PROCprinter
 910 CLS
 920 PRINT'''Do you wish a printed copy? ";
 930 PROCyesorno
 940 IF yes THEN print=TRUE ELSE print=FALSE
 950 IF print THEN VDU2,1,27,1,69,1,27,1,82,1,3,3
 960 IF print THEN *FX6
 970 IF print THEN PRINT''CHR$136;"Please ensure that the
     printer is "''CHR$136;"connected and switched ON LINE."
     ELSE PRINT'''The printer is not required."
 980 PROCcontinue(50)
 990 ENDPROC
1000 DEF PROCyesorno
1010 LOCAL a$,a
1020 *FX15,1
1030 a$=GET$
1040 a=INSTR("YyNn",a$)
1050 IF a=0 THEN 1030
1060 yes=INT((a+1)/2)-2
1070 IF yes THEN PRINTCHR$130;"Yes" ELSE PRINTCHR$129;"No"
1080 PROCdelay(50)
1090 ENDPROC
1100 DEF PROCend
1110 CLS
1120 FOR i%=11 TO 12
1130   PRINTTAB(11,i%);CHR$(141);CHR$(134);"End of Program"
1140   NEXT
1150 @%=10
1160 PROCon
1170 PRINTTAB(0,23);
1180 END
1190 ENDPROC
1200 DEF PROClogo
     PROClogo as in other programs
1420 ENDPROC
1430 DEF PROCreaddata
1440 DIM quest%(q%),cand%(100,q%),sex$(100),rate%(q%),
     Mpass%(q%),Fpass%(q%),Mfail%(q%),Ffail%(q%),Mblank%(q%),
     Fblank%(q%),qval%(q%,4)
1450 y%=OPENIN qfile$
1460 FOR i%=1 TO q%
1470   quest%(i%)=i%
1480   FOR j%=1 TO 4
1490     INPUT#y%,qval%(i%,j%)
1500     NEXT
1510   NEXT
1520 CLOSE#y%
1530 @%=3
1540 FOR i%=10 TO 11
1550   PRINTTAB(0,i%);CHR$(134);CHR$(141);"Reading data
     from";CHR$(132-ans%);file$;CHR$(134);"now";CHR$(133);:
     h%=POS:PRINT
1560   NEXT
1570 z%=OPENIN file$
1580 IF z%=0 THEN PRINT'';file$;" is not present on the disc."
     '''Please RUN the program again with "''file$;" on the
     disc."''':END
```

```
1590 INPUT#z%,passmk%
1600 FOR i%=4 TO 5
1610   PRINTTAB(8,i%);CHR$(130);CHR$(141);"Pass grade =";
CHR$(129);passmk%;"%"
1620   NEXT
1630 FOR i%=1 TO 100
1640   FOR k%=10 TO 11
1650     PRINTTAB(h%,k%),i%
1660     NEXT
1670   INPUT#z%,sex$(i%)
1680   FOR j%=1 TO q%
1690     INPUT#z%,cand%(i%,j%)
1700     NEXT
1710   NEXT
1720 CLOSE#z%
1730 ENDPROC
1740 DEF PROCanalyse
1750 CLS
1760 FOR i%=0 TO 1
1770   PRINTTAB(7,10+i%);CHR$(130);CHR$(141);CHR$(136);
"Analysing data"
1780   PRINTTAB(11,13+i%);CHR$(131);CHR$(141);"Counting"
1790   NEXT
1800 @%=3
1810 FOR j%=1 TO 100
1820   FOR k%=4 TO 5
1830     PRINTTAB(6,k%);CHR$(130);CHR$(141);"Candidate no.";
CHR$(131),j%
1840     NEXT
1850   FOR i%=1 TO q%
1860     IF cand%(j%,i%)=99 AND sex$(j%)="M" THEN
Mblank%(i%)=Mblank%(i%)+1:GOTO 1920
1870     IF cand%(j%,i%)=99 AND sex$(j%)="F" THEN
Fblank%(i%)=Fblank%(i%)+1:GOTO 1920
1880     IF cand%(j%,i%) AND sex$(j%)="M" THEN
Mpass%(i%)=Mpass%(i%)+1
1890     IF cand%(j%,i%) AND sex$(j%)="F" THEN
Fpass%(i%)=Fpass%(i%)+1
1900     IF NOT cand%(j%,i%) AND sex$(j%)="M" THEN
Mfail%(i%)=Mfail%(i%)+1
1910     IF NOT cand%(j%,i%) AND sex$(j%)="F" THEN
Ffail%(i%)=Ffail%(i%)+1
1920     NEXT
1930   NEXT
1940 ENDPROC
1950 DEF PROCsort
1960 FOR i%=0 TO 1
1970   PRINTTAB(11,13+i%);CHR$(133);CHR$(141);"Sorting "
1980   NEXT
1990 FOR i%=1 TO q%
2000   rate%(i%)=INT(100*(Mpass%(i%)+Fpass%(i%))/(Mpass%(i%)
+Fpass%(i%)+Mfail%(i%)+Ffail%(i%))+0.5)
2010   NEXT
2020 FOR i%=1 TO q%-1
2030   FOR j%=i%+1 TO q%
2040     IF rate%(i%)<rate%(j%) THEN PROCswap
2050     NEXT
2060   NEXT
```

```
2070 CLS
2080 FOR i%=0 TO 1
2090   PRINTTAB(5,10+i%);CHR$(129);CHR$(141);"Finished with
     data"
2100   NEXT
2110 PROCdelay(75)
2120 ENDPROC
2130 DEF PROCswap
2140 temp%=quest%(i%)
2150 quest%(i%)=quest%(j%)
2160 quest%(j%)=temp%
2170 temp%=rate%(i%)
2180 rate%(i%)=rate%(j%)
2190 rate%(j%)=temp%
2200 temp%=Mpass%(i%)
2210 Mpass%(i%)=Mpass%(j%)
2220 Mpass%(j%)=temp%
2230 temp%=Fpass%(i%)
2240 Fpass%(i%)=Fpass%(j%)
2250 Fpass%(j%)=temp%
2260 temp%=Mfail%(i%)
2270 Mfail%(i%)=Mfail%(j%)
2280 Mfail%(j%)=temp%
2290 temp%=Ffail%(i%)
2300 Ffail%(i%)=Ffail%(j%)
2310 Ffail%(j%)=temp%
2320 temp%=Mblank%(i%)
2330 Mblank%(i%)=Mblank%(j%)
2340 Mblank%(j%)=temp%
2350 temp%=Fblank%(i%)
2360 Fblank%(i%)=Fblank%(j%)
2370 Fblank%(j%)=temp%
2380 FOR k%=1 TO 4
2390   temp%=qval%(i%,k%)
2400   qval%(i%,k%)=qval%(j%,k%)
2410   qval%(j%,k%)=temp%
2420   NEXT
2430 ENDPROC
2440 DEF PROCerror
2450 CLOSE#0
2460 PROCon
2470 PROCend
2480 ENDPROC
2490 DEF PROCdisplay
2500 @%=2
2510 IF print THEN VDU2,1,27,1,69 ELSE VDU14
2520 IF print THEN t%=20 ELSE t%=0
2530 PRINTTAB(t%+titletab%);title$'
2540 PRINTTAB(t%+10);grade$(ans%);CHR$(135);" Questions"''
2550 pass$=STR$(passmk%)
2560 PRINTTAB(t%+3);"Pass grade for this run = ";pass$;"%"''
2562 PRINTTAB(t%+1);"Ordered by (Pass/Pass+Fail) Rate"''
2570 IF print THEN PRINTTAB(20);STRING$(40,"-")
2580 PRINTTAB(t%);"Qn";TAB(t%+4);"Proc";TAB(t%+10);"Cont";
     TAB(t%+16);"Skil";TAB(t%+22);"Lang";TAB(t%+27);"Pass";
     TAB(t%+31);"Blnk";TAB(t%+35);"Rate"
2590 IF print THEN PRINTTAB(20);STRING$(40,"-")
2600 FOR i%=1 TO q%
```

```
2610    PRINT TAB(t%),quest%(i%);
2620    FOR j%=1 TO 4
2630      PRINTTAB(t%-2+6*j%),qval%(i%,j%);
2640      NEXT
2650    PRINTTAB(t%+28),Mpass%(i%)+Fpass%(i%);
2660    PRINTTAB(t%+32),Mblank%(i%)+Fblank%(i%);
2662    PRINTTAB(t%+36),rate%(i%);
2670    IF print THEN PRINT'TAB(20);STRING$(40,"-")
2680    NEXT
2690 IF print THEN VDU1,12,3 ELSE VDU15
2700 PRINT''
2710 IF NOT print THEN PROCcontinue(10)
2720 ENDPROC
2730 DEF PROCsave
2740 CLS
2780 *DRIVE 1
2790 savefile$=savefile$+pass$
2800 z%=OPENUP savefile$
2810 IF z%=0 THEN 2870
2820 CLOSE#z%
2830 PRINT'''File";CHR$(130);savefile$;CHR$(135);"already
     exists.  Overwrite?";
2840 PROCyesorno
2850 IF NOT yes THEN *DRIVE 0
2860 IF NOT yes THEN CLOSE#z%:ENDPROC
2870 PRINT'''Writing";CHR$(131);savefile$;CHR$(135);"now."
2880 z%=OPENOUT savefile$
2890 FOR i%=1 TO q%
2900    PRINT#z%,quest%(i%)
2910    FOR j%=1 TO 4
2920      PRINT#z%,qval%(i%,j%)
2930      NEXT
2940    PRINT#z%,Mpass%(i%)
2950    PRINT#z%,Fpass%(i%)
2960    PRINT#z%,Mfail%(i%)
2970    PRINT#z%,Ffail%(i%)
2980    PRINT#z%,Mblank%(i%)
2990    PRINT#z%,Fblank%(i%)
3000    NEXT
3010 CLOSE#z%
3020 *DRIVE 0
3030 PRINT'''Finished."
3040 PROCdelay(100)
3050 ENDPROC
```

The main task of this program is in PROCanalyse (line 1740), and PROCsort (line 1950). PROCanalyse does all the counting of passes for the various questions, and calculates the pass rate (line 2000) for each problem. PROCsort then employs PROCswap (line 2130), which uses a substitution algorithm, to place the problems into the order of merit. PROCdisplay (line 2490) builds a table of results which can be printed out, and PROCsave (line 2730) creates a file of the male and female passes, failures and blank totals for each problem, placing the problems in the order of merit. PASSMK and MERIT were run several times, with different pass marks, and the PROCsave files were read and printed by the program DISPLAY, which thus gave a series of tables.

```
  10 REM ****************************
  20 REM *                          *
  30 REM *   Program name DISPLAY   *
  40 REM *                          *
  50 REM * Displays files generated *
  60 REM *     by program MERIT     *
  70 REM *                          *
  80 REM *      Robert J Watson     *
  90 REM *       30 May 1988        *
 100 REM *                          *
 110 REM ****************************
 120 ON ERROR MODE7:PROCerror
 130 MODE7
 140 PROClogo
 150 PROCdelay(150)
 160 CLS
 170 PROCtitle
 180 PROCchoice
 190 CLS
 200 PROCreaddata
 210 PROCprinter
 220 MODE3
 230 PROCdisplay
 240 MODE7
 250 PROCend
 260 END
     PROCchoice, PROCon, PROCoff, PROClogo, PROCprinter,
     PROCdelay, PROCcontinue, PROCend and PROCtitle as before.
1400 DEF PROCreaddata
1410 DIM quest%(q%),Mpass%(q%),Fpass%(q%),Mfail%(q%),
     Ffail%(q%),Mblank%(q%),Fblank%(q%),qval%(q%,4)
1420 FOR i%=10 TO 11
1430   PRINTTAB(0,i%);CHR$(134);CHR$(141);"Reading data
     from";CHR$(132-ans%);file$;CHR$(134);"now";CHR$(133)
1440   NEXT
1450 *DRIVE 1
1460 z%=OPENIN file$
1470 IF z%=0 THEN PRINT'';file$;" is not present on the
     disc."''''Please RUN the program again with "''file$;" on
     the disc."''':END
1480 FOR i%=1 TO q%
1490   INPUT#z%,quest%(i%)
1500   FOR j%=1 TO 4
1510     INPUT#z%,qval%(i%,j%)
1520     NEXT
1530   INPUT#z%,Mpass%(i%)
1540   INPUT#z%,Fpass%(i%)
1550   INPUT#z%,Mfail%(i%)
1560   INPUT#z%,Ffail%(i%)
1570   INPUT#z%,Mblank%(i%)
1580   INPUT#z%,Fblank%(i%)
1590   NEXT
1600 CLOSE#z%
1610 *DRIVE 0
1620 ENDPROC
1630 DEF PROCerror
1640 CLOSE#0
1650 PROCon
```

```
1660 PROCend
1670 ENDPROC
1680 DEF PROCdisplay
1690 IF print THEN VDU2.1.27.1.69 ELSE VDU14
1700 t%=22
1710 PRINTTAB(t%+titletab%);title$'
1720 PRINTTAB(30):grade$(ans%);CHR$(135):" Questions"'
1730 PRINTTAB(25);"Pass grade for this run = ";passmk%:"%"'
1740 IF print THEN PRINT STRING$(79."-")
1750 PRINT" Qu   P r o c   C o n t   S k i l   L a n g
      Passes  Failures  Blanks"
1760 PRINTTAB(6):"1 2 3 4 5  1 2 3 4 5  1 2 3 4 5  1 2 3 4 5
      Ma Fe To Ma Fe To Ma Fe To"
1770 IF print THEN PRINT STRING$(79."-")
1780 @%=3
1790 Mp%=0:Fp%=0:Mf%=0:Ff%=0
1800 FOR i%=1 TO q%
1810   PRINTquest%(i%):TAB(5);
1820   FOR j%=1 TO 4
1830     PRINTFNbinary(qval%(i%,j%));" ";
1840     NEXT
1850   PRINT.Mpass%(i%).Fpass%(i%),Mpass%(i%)+Fpass%(i%).
     Mfail%(i%),Ffail%(i%),Mfail%(i%)+Ffail%(i%),Mblank%(i%),
     Fblank%(i%),Mblank%(i%)+Fblank%(i%)
1860   Mp%=Mp%+Mpass%(i%)
1870   Fp%=Fp%+Fpass%(i%)
1880   Mf%=Mf%+Mfail%(i%)
1890   Ff%=Ff%+Ffail%(i%)
1900   IF print THEN PRINT STRING$(79,"-")
1910   NEXT
1920 PRINTTAB(6):"Mpass = ";Mp%;"
     (":INT(1000*Mp%/(Mp%+Fp%)+.5)/10:"%): Fpass = ";Fp%:"
     (";INT(1000*Fp%/(Mp%+Fp%)+.5)/10:"%): Mfail = ";Mf%:"
     (":INT(1000*Mf%/(Mf%+Ff%)+.5)/10:"%); Ffail = ";Ff%:"
     (":INT(1000*Ff%/(Mf%+Ff%)+.5)/10:"%)."
1930 IF print THEN PRINT STRING$(79."-")
1940 IF print THEN VDU1,12,3 ELSE VDU15
1950 PRINT''
1960 IF NOT print THEN PROCcontinue(10)
1970 ENDPROC
1980 DEF FNbinary(x%)
1990 LOCAL v%,w%.x$
2000 x$=""
2010 FOR v%=1 TO 5
2020   w%=x% MOD 2
2030   x%=x% DIV 2
2040   x$=x$+STR$(w%)+" "
2050   NEXT
2060 y$=""
2070 FOR v%=LEN(x$) TO 1 STEP-1
2080   y$=y$+MID$(x$.v%,1)
2090   NEXT
2100 =y$
```

This program is designed to take information already partially processed by PASSMK and MERIT, and display it in a form from which patterns might be expected to emerge. It uses a number of stock routines which have been omitted for clarity from the listing. The important parts of the process are

PROCreaddata (line 1400), which reads information from the files written by MERIT, and PROCdisplay, (line 1680), which does the main work of the program. Most of this procedure is taken up with print and format instructions, but there are two parts which use the power of the computer to calculate quickly and accurately. In lines 1860 to 1920, the components of the figures are added and then converted into percentages, and in line 1830, the function FNbinary (lines 1980 to 2100) is called up. This converts the decimal proposition values back to binary form and displays them in the table, so that patterns of bits can be examined, in relation to each single proposition. The use of a function in this context speeds up the processing and permits the display to be created faster than the printer can cope with the input, so that a continuous stream of tables is created. These tables are reproduced in full in Appendix H, page A153.

```
 10 REM ***************************
 20 REM *                         *
 30 REM *   Program name DECana4  *
 40 REM *                         *
 50 REM * Analyses files generated *
 60 REM *     by program MERIT4   *
 70 REM *   QVALs in decimal form *
 80 REM *                         *
 90 REM *      Robert J Watson    *
100 REM *        11 July 1988     *
110 REM *  Revised 18 February 1990 *
120 REM *                         *
130 REM ***************************
140 ON ERROR MODE7:PROCerror
150 MODE7
160 PROClogo
170 PROCdelay(150)
180 CLS
190 DIM grade$(3)
200 q%=20
210 DIM quest%(q%),Mpass%(q%),Fpass%(q%),Mfail%(q%),
    Ffail%(q%),Mblank%(q%),Fblank%(q%),qval%(q%,4),
    rate%(q%),cat%(q%)
220 PROCtitle
230 PROCprinter
240 FOR run%=1 TO 3
250   PROCchoice
260   CLS
270   PROCreaddata
280   IF skip% THEN 350
290   FOR type%=1 TO 4
300     PROCreorder(type%)
310     MODE3
320     PROCdisplay
330     MODE7
340     NEXT
350   NEXT
360 PROCend
370 END
    PROCchoice, PROCdelay, PROCoff, PROCon, PROCprinter,
    PROCyesorno, PROCcontinue, PROClogo, PROCend as before.
```

```
 600 DEF PROCtitle
 610 REM in MODE 7
 620 PROCoff
 630 title$="Mean/SD of Rates in Categories"
 640 date$="18 February 1990"
 650 titletab%=INT((34-LEN(title$))/2)
 660 datetab%=INT((34-LEN(date$))/2)
 670 FOR i%=0 TO 1
 680   PRINT TAB(titletab%,11+i%);CHR$141;CHR$(130+i%);title$
 690   PRINT TAB(datetab%,14+i%);CHR$141;CHR$(130+i%);date$
 700   NEXT
 710 PROCdelay(200)
 720 ENDPROC
1460 DEF PROCreaddata
1470 FOR i%=10 TO 11
1480   PRINTTAB(0,i%);CHR$(134);CHR$(141);"Reading data
     from";CHR$(132-ans%);file$;CHR$(134);"now";CHR$(133)
1490   NEXT
1500 z%=OPENIN file$
1510 IF z%=0 THEN skip%=TRUE ELSE skip%=FALSE
1520 IF skip% THEN ENDPROC
1530 FOR i%=1 TO q%
1540   INPUT#z%,quest%(i%)
1550   FOR j%=1 TO 4
1560     INPUT#z%,qval%(i%,j%)
1570     NEXT
1580   INPUT#z%,Mpass%(i%)
1590   INPUT#z%,Fpass%(i%)
1600   INPUT#z%,Mfail%(i%)
1610   INPUT#z%,Ffail%(i%)
1620   INPUT#z%,Mblank%(i%)
1630   INPUT#z%,Fblank%(i%)
1640   NEXT
1650 CLOSE#z%
1660 ENDPROC
1670 DEF PROCerror
1680 CLOSE#0
1690 @%=10
1700 PROCon
1710 IF ERR<>17 THEN REPORT:PRINT" while in line ";ERL:END
1720 PROCend
1730 ENDPROC
1740 DEF PROCdisplay
1750 IF print THEN VDU2 ELSE VDU14
1760 t%=21
1770 @%=10
1780 PRINTTAB(t%+titletab%);title$'
1790 PRINTTAB(29);grade$(ans%);" Questions"'
1800 PRINTTAB(t%+datetab%);date$'
1810 PRINTTAB(24);"Rate = (Pass/Pass+Fail) * 100"'
1820 PRINTTAB(24);"Categorised by ";
1830 IF type%=1 THEN PRINT "Process";
1840 IF type%=2 THEN PRINT "Content";
1850 IF type%=3 THEN PRINT "Skills";
1860 IF type%=4 THEN PRINT "Language";
1870 PRINT " Values"'
1880 FOR  c%=-1 TO 0
1890   IF print THEN PRINT STRING$(79,"-")
```

```
1900   IF type%=1 THEN PRINT"Numerical Processes ";
1910   IF type%=2 THEN PRINT"Formulae/Equations ";
1920   IF type%=3 THEN PRINT"Processing Data ";
1930   IF type%=4 THEN PRINT"Interpretation of Language ";
1940   IF c% THEN PRINT "TRUE" ELSE PRINT "FALSE"
1950   PRINT" Qu     Pro  Con  Ski  Lan   Passes   Failures   Blanks Rate%  Mean   SD"
1960   PRINT"                                      Ma Fe To Ma Fe To Ma Fe To"
1970   IF print THEN PRINT STRING$(79,"-")
1980   IF print THEN PRINT STRING$(79,"-")
1990   nextflag%=TRUE
2000   FOR i%=1 TO q%
2010     IF cat%(i%)<>c% THEN 2160
2020     @%=3
2030     PRINTquest%(i%);
2040     @%=5
2050     FOR j%=1 TO 4
2060       PRINT,qval%(i%,j%);
2070       NEXT
2080     @%=3
2090     PRINT,Mpass%(i%),Fpass%(i%),Mpass%(i%)+Fpass%(i%),Mfail%(i%),Ffail%(i%),Mfail%(i%)+Ffail%(i%),Mblank%(i%),Fblank%(i%),Mblank%(i%)+Fblank%(i%);" ";
2100     PRINTrate%(i%);
2110     IF nextflag% THEN tot%=0:div%=1:dev=0
2120     PRINT"  ";
2130     @%=&20206
2140     PRINTFNaverage,FNstandard_deviation
2150     IF print THEN PRINT STRING$(79,"-")
2160     NEXT
2170   NEXT
2180 IF print THEN VDU1,12,3 ELSE VDU15
2190 PRINT''
2200 IF NOT print THEN PROCcontinue(10)
2210 ENDPROC
2220 DEF PROCreorder(x%)
2230 FOR i%=1 TO q%
2240   rate%(i%)=INT(100*((Mpass%(i%)+Fpass%(i%))/(Mpass%(i%)+Fpass%(i%)+Mfail%(i%)+Ffail%(i%)))+0.5)
2250   IF x%=1 AND qval%(i%,x%)>3 THEN cat%(i%)=TRUE ELSE cat%(i%)=FALSE
2260   IF x%=1 THEN 2320
2270   IF x%=2 AND qval%(i%,x%)>7 THEN cat%(i%)=TRUE ELSE cat%(i%)=FALSE
2280   IF x%=2 THEN 2320
2290   IF x%=3 AND qval%(i%,x%)>5 OR qval%(i%,x%)=2 OR qval%(i%,x%)=3 THEN cat%(i%)=TRUE ELSE cat%(i%)=FALSE
2300   IF x%=3 THEN 2320
2310   IF x%=4 AND qval%(i%,x%)>1 THEN cat%(i%)=TRUE ELSE cat%(i%)=FALSE
2320   NEXT
2330 FOR i%=1 TO q%-1
2340   FOR j%=i%+1 TO q%
2350     IF rate%(i%)<rate%(j%) THEN PROCswap
2360     NEXT
2370   NEXT
2380 ENDPROC
```

```
2390 DEF PROCswap
2400 temp%=quest%(i%)
2410 quest%(i%)=quest%(j%)
2420 quest%(j%)=temp%
2430 temp%=rate%(i%)
2440 rate%(i%)=rate%(j%)
2450 rate%(j%)=temp%
2460 temp%=Mpass%(i%)
2470 Mpass%(i%)=Mpass%(j%)
2480 Mpass%(j%)=temp%
2490 temp%=Fpass%(i%)
2500 Fpass%(i%)=Fpass%(j%)
2510 Fpass%(j%)=temp%
2520 temp%=Mfail%(i%)
2530 Mfail%(i%)=Mfail%(j%)
2540 Mfail%(j%)=temp%
2550 temp%=Ffail%(i%)
2560 Ffail%(i%)=Ffail%(j%)
2570 Ffail%(j%)=temp%
2580 temp%=Mblank%(i%)
2590 Mblank%(i%)=Mblank%(j%)
2600 Mblank%(j%)=temp%
2610 temp%=Fblank%(i%)
2620 Fblank%(i%)=Fblank%(j%)
2630 Fblank%(j%)=temp%
2640 FOR k%=1 TO 4
2650   temp%=qval%(i%,k%)
2660   qval%(i%,k%)=qval%(j%,k%)
2670   qval%(j%,k%)=temp%
2680   NEXT
2690 ENDPROC
2700 DEF FNaverage
2710 tot%=tot%+rate%(i%)
2720 now%=cat%(i%)
2730 another%=FALSE
2740 nextflag%=TRUE
2750 IF i%=q% THEN 2800
2760 FOR k%=i% TO q%-1
2770   IF now%=cat%(k%+1) THEN another%=TRUE
2780   NEXT
2790 IF another% THEN nextflag%=FALSE:div%=div%+1:=" "
2800 =tot%/div%
2810 DEF FNstandard_deviation
2820 IF NOT nextflag% THEN =" "
2830 FOR k%=1 TO q%
2840   IF cat%(k%)<>c% THEN 2870
2850   factor=(rate%(k%)-tot%/div%)^2
2860   dev=dev+factor
2870   NEXT
2880 =SQR(dev/div%)
```

The main difference between this program and DISPLAY is that PROCdisplay is called up four times in the counting loop in line 280, and a new procedure, PROCreorder, is introduced to process the data in terms of the grouping of propositions.

PROCreorder (line 2220) first separates the propositions into two groups, for each type of proposition, by setting a flag. cat%, either TRUE or FALSE for each proposition. At the same time, the whole set of problems is placed in merit order by employing PROCswap, which substitutes sets of data when required in line 2350. The result is a reordered set of data with a flag set for each problem.

PROCdisplay (line 1740) uses the ordered data and goes through it twice (see counting loop in line 1880), selecting first the TRUE flag problems and then the FALSE flag problems, by means of line 2010. The display masses together the problems within each category in turn, and calculates the average and standard deviation of the pass rates by calling up the functions FNaverage (line 2700) and FNstandard_deviation (line 2810). The algorithms for these functions were checked with sets of figures which had been calculated previously.

```
 10 REM ****************************
 20 REM *                          *
 30 REM *   Program name TOTstat   *
 40 REM *                          *
 50 REM *   Mann-Whitney/Wilcoxon  *
 60 REM * Rank Sum Two-Sample Test *
 70 REM *                          *
 80 REM *   for Total Pass Rates   *
 90 REM *                          *
100 REM *      Robert J Watson     *
110 REM *      26 February 1990    *
120 REM *                          *
130 REM ****************************
140 ON ERROR MODE7:PROCerror
150 *SHADOW
160 MODE7
170 PROClogo
180 PROCdelay(150)
190 CLS
200 DIM grade$(3)
210 q%=20
220 DIM quest%(q%),Mpass%(q%),Fpass%(q%),Mfail%(q%),
    Ffail%(q%),Mblank%(q%),Fblank%(q%),qval%(q%,4),
    rate%(q%),cat%(q%),mrate%(q%),frate%(q%),rank(q%)
230 PROCtitle
240 PROCprinter
250 FOR run%=1 TO 3
260   IF run%=1 THEN q%=17
270   PROCchoice
280   CLS
290   PROCreaddata
300   IF skip% THEN 370
310   FOR type%=1 TO 4
320     PROCreorder(type%)
330     MODE0
340     PROCdisplay
350     MODE7
360     NEXT
370   NEXT
380 PROCend
390 END
    PROCchoice as before
```

```
 620 DEF PROCtitle
 630 REM in MODE 7
 640 PROCoff
 650 title$="Statistical Comparison Total Rates"
 660 date$="26 February 1990"
 670 titletab%=INT((34-LEN(title$))/2)
 680 datetab%=INT((34-LEN(date$))/2)
 690 FOR i%=0 TO 1
 700   PRINT TAB(titletab%,11+i%);CHR$141;CHR$(130+i%);title$
 710   PRINT TAB(datetab%,14+i%);CHR$141;CHR$(130+i%);date$
 720   NEXT
 730 PROCdelay(200)
 740 ENDPROC
     PROCon, PROCoff, PROCprinter, PROCdelay, PROCcontinue,
     PROClogo, PROCend as before. PROCreaddata as before.
1750 DEF PROCdisplay
1760 IF print THEN VDU2 ELSE VDU14
1770 t%=21
1780 PRINTTAB(t%+titletab%);title$'
1790 PRINTTAB(17);"Mann-Whitney/Wilcoxon Rank Sum Two-Sample
     Test"'
1800 PRINTTAB(29);grade$(ans%);" Questions"'
1810 PRINTTAB(t%+datetab%);date$'
1820 PRINTTAB(24);"Rate = (Pass/Pass+Fail) * 100"'
1830 PRINTTAB(24);"Categorised by ";
1840 IF type%=1 THEN PRINT "Process";
1850 IF type%=2 THEN PRINT "Content";
1860 IF type%=3 THEN PRINT "Skills";
1870 IF type%=4 THEN PRINT "Language";
1880 PRINT " Values"'
1890 FOR  c%=-1 TO 0
1900   IF print THEN PRINT STRING$(79,"-")
1910   IF type%=1 THEN a$="Numerical Processes "
1920   IF type%=2 THEN a$="Formulae/Equations "
1930   IF type%=3 THEN a$="Processing Data "
1940   IF type%=4 THEN a$="Interpretation of Language "
1950   PRINTTAB(28-LEN(a$));
1960   IF c% THEN PRINT a$;"TRUE compared with ";a$;"FALSE"
1970   IF c% THEN PRINTTAB(27);"(TRUE items marked with *)"
1980   IF NOT c% THEN PRINT a$;"FALSE compared with
     ";a$;"TRUE"
1990   IF print THEN PRINTSTRING$(79,"-")
2000   FOR i%=1 TO q%
2010     rank(i%)=q%-i%+1
2020     NEXT
2030   FOR i%=1 TO q%-1
2040     IF rate%(i%)=rate%(i%-1) AND rate%(i%)=rate%(i%+1)
     THEN rank(i%)=q%-i%+1:rank(i%-1)=rank(i%):rank(i%+1)=
     rank(i%):GOTO 2060
2050     IF rate%(i%)=rate%(i%+1) AND rate%(i%)<>rate%(i%-1)
     THEN rank(i%)=(2*rank(i%+1)+1)/2:rank(i%+1)=rank(i%)
2060     NEXT
2070   IF NOT c% THEN 2160
2080   PRINTTAB(30);"Rate";TAB(41);"Rank"'
2090   FOR i%=1 TO q%
2100     @%=11
2110     PRINTTAB(20),rate%(i%);
2120     IF c%=cat%(i%) THEN PRINT "*";
```

```
2130      @%=&20109
2140      PRINT,rank(i%)
2150      NEXT
2160    cos=0:n%=0
2170    FOR i%=1 TO q%
2180      IF cat%(i%)<>c% THEN 2210
2190      cos=cos+rank(i%)
2200      n%=n%+1
2210      NEXT
2220    U=cos-(n%*(n%+1))/2
2230    PRINT
2240    IF print THEN PRINTSTRING$(79,"-")
2250    PRINTTAB(26);"U Statistic Value = ";U
2260    IF print THEN PRINTSTRING$(79,"-")
2270    PRINT'
2280    NEXT
2290 IF print THEN VDU1.12.3 ELSE VDU15
2300 PRINT''
2310 IF NOT print THEN PROCcontinue(10)
2320 ENDPROC
2330 DEF PROCreorder(x%)
2340 FOR i%=1 TO q%
2350   rate%(i%)=INT(100*((Mpass%(i%)+Fpass%(i%))/(Mpass%(i%)
     +Fpass%(i%)+Mfail%(i%)+Ffail%(i%)))+0.5)
2360   mrate%(i%)=INT(100*((Mpass%(i%))/(Mpass%(i%)+
     Mfail%(i%)))+0.5)
2370   frate%(i%)=INT(100*((Fpass%(i%))/(Fpass%(i%)+
     Ffail%(i%)))+0.5)
2380   IF x%=1 AND qval%(i%,x%)>3 THEN cat%(i%)=TRUE ELSE
     cat%(i%)=FALSE
2390   IF x%=1 THEN 2450
2400   IF x%=2 AND qval%(i%,x%)>7 THEN cat%(i%)=TRUE ELSE
     cat%(i%)=FALSE
2410   IF x%=2 THEN 2450
2420   IF x%=3 AND qval%(i%,x%)>5 OR qval%(i%,x%)=2 OR
     qval%(i%,x%)=3 THEN cat%(i%)=TRUE ELSE cat%(i%)=FALSE
2430   IF x%=3 THEN 2450
2440   IF x%=4 AND qval%(i%,x%)>1 THEN cat%(i%)=TRUE ELSE
     cat%(i%)=FALSE
2450   NEXT
2460 FOR i%=1 TO q%-1
2470   FOR j%=i%+1 TO q%
2480     IF rate%(i%)<rate%(j%) THEN PROCswap
2490     NEXT
2500   NEXT
2510 ENDPROC
     PROCswap as before.
```

TOTstat was written to work out the Mann/Whitney/Wilcoxon rank order test statistics. This is a simple and repetitive procedure, and is just the sort of task that a computer does well. The main elements of the program are similar to the other programs, and it is only in PROCdisplay that it differs substantially from the others. This program was developed directly from DECana4, and uses the same method, of assigning flags then selecting the appropriate flags within each run of PROCdisplay, of collecting together the combined proposition value sets. The full output is in Appendix I (page A166).

PROCreorder (line 2330) is essential, as the pass rates have to be placed in rank order and assigned a rank value. It calls up PROCswap as in DECana4. PROCdisplay (lines 1750 to 2320) contains the main task of the program. It first selects the set to be used by the counting loop in line 1890, affected further by line 2180, then assigns rank values in lines 2000 to 2060. The only complication was in assigning half values of ranks to equal pass rates when they occurred. Lines 2030 to 2060 deal with that problem, by counting through the pass rates and detecting equal values, then altering the rate values appropriately. The assumption was made, and later confirmed by inspection, that there was no occasion in any of that data in which more than three equal pass rates were encountered, so there was no need to write a further algorithm or a general algorithm for the case.

When rank values have been assigned, the procedure prints out a list of all pass rates in order, with one group marked by asterisks to distinguish them from the other in the table. In this way, a visual pattern is produced which supplements the calculated statistic. With the rate values in place, the calculation of the statistic is trivial, and is accomplished in lines 2160 to 2220.

As in DECana4, PROCdisplay is done twice, in accordance with the counting loop in line 1890. Unlike DECana4, however, the selection of the single group does not take place until much later in the procedure, so that the only part of the procedure that is not common to both runs of the counting loop is the calculation of the statistic. The table is repeated, with the asterisks in the opposite places on the second run. That is the significance of line 2180, which only then separates one run of the loop from the other.

Further modifications of this program calculated statistics for Male and Female pass rates, the results of which are shown in Appendix J (page A173)

Appendix B

Output from COMPana Program

Ordinary Grade: Question number 1

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	Y	y	y	Y	Y	Y	Y	Y	Y	Y
Pr 2.	N	N	N	Y	N	Y	N	Y	N	n
Pr 3.	N	N	N	n	N	N	N	N	n	N
Pr 4.	N	N	N	n	N	N	N	N	n	N
Pr 5.	Y	Y	N	Y	Y	Y	Y	Y	N	Y
Pr 6.	N	N	N	n	N	Y	N	N	Y	n
Pr 7.	N	N	N	n	N	N	N	N	n	N
Pr 8.	Y	Y	Y	Y	Y	n	Y	Y	Y	Y
Pr 9.	N	N	N	n	N	N	N	N	N	N
Pr 10.	N	N	N	n	N	N	N	N	N	N
Pr 11.	N	N	N	n	y	N	N	Y	N	N
Pr 12.	N	N	N	n	N	N	N	N	Y	N
Pr 13.	Y	Y	y	y	Y	Y	Y	Y	N	Y
Pr 14.	Y	N	N	Y	N	N	N	Y	N	n
Pr 15.	N	N	N	n	N	N	N	n	n	N
Pr 16.	N									N
Pr 17.	N									N
Pr 18.	Y									Y
Pr 19.	Y									Y
Pr 20.	Y									Y

Proc: 17 ;
Cont: 4 ;
Skil: 4 ;
Lang: 7

Ordinary Grade; Question number 2

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	N	N	N	Y	N	N	N	Y	N	N
Pr 2.	N	N	N	n	N	N	y	N	Y	N
Pr 3.	N	N	N	n	N	N	N	N	Y	N
Pr 4.	N	N	n	n	N	N	N	N	Y	N
Pr 5.	Y	N	Y	Y	y	y	N	Y	Y	y
Pr 6.	N	N	Y	Y	Y	Y	Y	N	y	y
Pr 7.	N	N	N	n	N	N	N	N	N	N
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	N	N	N	n	N	N	N	N	N	N
Pr 10.	N	N	N	n	N	N	N	N	y	N
Pr 11.	Y	Y	Y	Y	Y	y	y	Y	N	Y
Pr 12.	N	N	N	n	N	N	N	N	Y	N
Pr 13.	N	N	N	n	N	N	N	Y	Y	n
Pr 14.	N	N	Y	n	y	N	N	N	N	N
Pr 15.	N	N	n	y	n	N	N	N	Y	n
Pr 16.	Y									Y
Pr 17.	Y									Y
Pr 18.	Y									Y
Pr 19.	N									N
Pr 20.	Y									Y

Proc: 1 ;
Cont: 20 ;
Skil: 16 ;
Lang: 29

Ordinary Grade; Question number 3

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
Pr 2.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 3.	Y	Y	y	Y	Y	Y	Y	Y	Y	Y
Pr 4.	Y	N	Y	n	N	N	N	N	Y	n
Pr 5.	Y	Y	Y	Y	Y	Y	Y	Y	y	Y
Pr 6.	N	N	N	n	N	N	Y	N	Y	n
Pr 7.	Y	Y	Y	Y	Y	n	Y	N	Y	Y
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	Y	Y	y	Y	N	Y	Y	Y	Y	Y
Pr 10.	N	N	N	n	N	N	N	Y	N	N
Pr 11.	N	N	N	n	N	N	N	Y	N	N
Pr 12.	N	N	N	n	N	N	N	N	N	N
Pr 13.	N	N	N	n	N	N	N	y	N	N
Pr 14.	N	N	N	n	N	N	N	N	Y	N
Pr 15.	Y	n	Y	Y	Y	N	Y	Y	Y	Y
Pr 16.	Y									Y
Pr 17.	Y									Y
Pr 18.	N									N
Pr 19.	N									N
Pr 20.	Y									Y

Proc: 29 ;
Cont: 14 ;
Skil: 1 ;
Lang: 25

Ordinary Grade; Question number 4

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	Y	N	N	Y	N	N	N	N	Y	n
Pr 2.	N	N	N	Y	N	N	N	N	Y	N
Pr 3.	N	N	n	n	N	N	N	N	y	N
Pr 4.	N	N	N	n	N	N	N	N	y	N
Pr 5.	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
Pr 6.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 7.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	N	N	N	n	N	N	N	N	Y	N
Pr 10.	N	N	N	n	N	N	N	N	N	N
Pr 11.	N	N	N	n	N	N	N	N	N	N
Pr 12.	Y	Y	y	y	Y	n	Y	y	Y	Y
Pr 13.	N	N	N	n	N	N	Y	y	N	N
Pr 14.	N	N	N	n	N	N	N	N	Y	N
Pr 15.	Y	Y	Y	Y	Y	N	Y	Y	y	Y
Pr 16.	Y									Y
Pr 17.	N									N
Pr 18.	Y									Y
Pr 19.	N									N
Pr 20.	N									N

Proc: 1 ;
Cont: 28 ;
Skil: 9 ;
Lang: 20

Ordinary Grade; Question number 5

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 2.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 3.	Y	Y	Y	Y	Y	Y	Y	Y	y	Y
Pr 4.	Y	N	N	Y	y	Y	N	Y	Y	y
Pr 5.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 6.	N	N	N	n	N	N	Y	N	Y	n
Pr 7.	N	N	N	n	N	N	Y	N	Y	n
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 10.	N	N	N	n	N	N	N	N	N	N
Pr 11.	N	N	N	n	N	N	N	Y	N	N
Pr 12.	N	N	N	n	N	N	N	N	N	N
Pr 13.	N	N	N	n	N	N	N	Y	n	N
Pr 14.	N	N	N	n	N	N	N	N	Y	N
Pr 15.	Y	Y	Y	Y	Y	y	Y	Y	Y	Y
Pr 16.	Y									Y
Pr 17.	Y									Y
Pr 18.	N									N
Pr 19.	N									N
Pr 20.	Y									Y

Proc: 31 ;
Cont: 6 ;
Skil: 1 ;
Lang: 25

Ordinary Grade; Question number 6

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	N	N	N	n	N	N	N	N	N	N
Pr 2.	N	N	N	n	N	N	N	N	Y	N
Pr 3.	N	N	N	n	N	N	N	N	n	N
Pr 4.	N	N	N	n	N	N	N	N	Y	N
Pr 5.	Y	N	Y	Y	Y	Y	Y	Y	y	Y
Pr 6.	N	N	N	n	N	N	N	y	N	N
Pr 7.	N	N	N	n	N	N	N	Y	N	N
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	N	N	N	n	N	N	N	N	N	N
Pr 10.	N	N	N	Y	N	N	N	N	N	N
Pr 11.	N	N	N	n	N	N	n	N	N	N
Pr 12.	Y	Y	N	N	Y	Y	Y	Y	y	y
Pr 13.	N	N	N	n	N	N	N	Y	Y	n
Pr 14.	Y	N	N	n	Y	N	N	N	N	n
Pr 15.	N	Y	Y	Y	Y	y	Y	Y	Y	Y
Pr 16.	Y									Y
Pr 17.	Y									Y
Pr 18.	Y									Y
Pr 19.	N									N
Pr 20.	N									N

Proc: 1 ;
Cont: 4 ;
Skil: 9 ;
Lang: 28

Ordinary Grade: Question number 7

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	N	N	N	n	N	N	N	N	N	N
Pr 2.	N	N	N	n	N	N	N	N	Y	N
Pr 3.	N	N	N	n	N	N	N	N	y	N
Pr 4.	N	N	N	n	N	N	N	N	Y	N
Pr 5.	Y	N	Y	Y	Y	Y	Y	Y	n	Y
Pr 6.	N	N	N	n	N	N	Y	Y	Y	n
Pr 7.	N	N	N	n	N	N	Y	Y	Y	n
Pr 8.	Y	Y	Y	Y	Y	y	Y	Y	Y	Y
Pr 9.	N	N	N	n	N	N	N	N	N	N
Pr 10.	N	N	N	n	N	N	N	N	y	N
Pr 11.	N	N	N	n	N	N	N	N	N	N
Pr 12.	Y	Y	N	Y	Y	Y	Y	Y	y	Y
Pr 13.	N	N	N	n	N	N	N	Y	Y	n
Pr 14.	Y	N	N	n	Y	N	N	N	N	n
Pr 15.	Y	Y	Y	Y	Y	y	Y	Y	Y	Y
Pr 16.	N									N
Pr 17.	Y									Y
Pr 18.	Y									Y
Pr 19.	N									N
Pr 20.	N									N

Proc: 1 ;
Cont: 4 ;
Skil: 9 ;
Lang: 12

Ordinary Grade; Question number 8

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	N	N	N	n	N	N	N	N	Y	N
Pr 2.	N	N	N	n	N	N	N	N	N	N
Pr 3.	N	N	N	n	N	N	N	N	Y	N
Pr 4.	N	N	N	n	N	N	N	N	Y	N
Pr 5.	N	N	N	n	N	N	N	N	N	N
Pr 6.	N	N	N	n	N	N	Y	Y	Y	n
Pr 7.	N	N	N	n	N	N	N	y	Y	N
Pr 8.	Y	Y	Y	Y	Y	y	Y	Y	Y	Y
Pr 9.	N	N	N	n	N	N	N	N	Y	N
Pr 10.	N	N	N	n	N	N	N	N	N	N
Pr 11.	N	N	y	n	N	N	N	N	N	N
Pr 12.	N	N	Y	n	N	N	N	N	N	N
Pr 13.	N	N	N	n	N	N	N	n	N	N
Pr 14.	N	N	y	n	N	N	N	N	Y	N
Pr 15.	N	N	Y	n	N	N	N	N	Y	n
Pr 16.	N									N
Pr 17.	N									N
Pr 18.	N									N
Pr 19.	N									N
Pr 20.	Y									Y

Proc: 0 ;
Cont: 4 ;
Skil: 0 ;
Lang: 1

Ordinary Grade; Question number 9

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	N	N	N	n	N	N	N	N	Y	N
Pr 2.	N	N	N	n	N	N	N	N	y	N
Pr 3.	N	N	N	n	N	N	N	N	Y	N
Pr 4.	N	N	N	n	N	N	N	N	Y	N
Pr 5.	Y	Y	Y	Y	y	y	N	Y	y	Y
Pr 6.	N	N	N	n	N	N	Y	Y	Y	n
Pr 7.	N	N	N	n	N	N	N	y	Y	N
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	N	N	N	n	N	N	N	N	Y	N
Pr 10.	N	N	N	n	N	N	N	N	N	N
Pr 11.	N	N	y	n	N	N	Y	N	n	n
Pr 12.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 13.	N	N	N	n	N	N	N	Y	Y	n
Pr 14.	N	N	y	n	n	N	Y	N	Y	n
Pr 15.	Y	N	Y	Y	Y	Y	N	n	Y	y
Pr 16.	N									N
Pr 17.	N									N
Pr 18.	N									N
Pr 19.	N									N
Pr 20.	N									N

Proc: 1 ;
Cont: 4 ;
Skil: 9 ;
Lang: 0

Ordinary Grade; Question number 10

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	N	N	N	n	N	N	n	N	N	N
Pr 2.	N	N	N	n	N	N	N	N	Y	N
Pr 3.	N	N	N	n	N	N	N	N	n	N
Pr 4.	N	N	N	n	N	N	N	N	y	N
Pr 5.	Y	Y	Y	Y	y	Y	Y	Y	y	Y
Pr 6.	N	N	N	n	N	N	Y	Y	N	n
Pr 7.	N	N	N	n	N	N	N	N	N	N
Pr 8.	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Pr 9.	N	N	N	n	N	N	N	N	N	N
Pr 10.	N	N	N	n	N	N	N	N	N	N
Pr 11.	N	N	y	n	N	N	Y	N	N	N
Pr 12.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 13.	N	N	N	n	N	N	N	Y	n	N
Pr 14.	N	N	y	n	n	N	Y	N	N	n
Pr 15.	Y	N	Y	Y	Y	Y	Y	n	Y	Y
Pr 16.	N									N
Pr 17.	N									N
Pr 18.	Y									Y
Pr 19.	N									N
Pr 20.	N									N

Proc: 1 ;
Cont: 4 ;
Skil: 9 ;
Lang: 4

Ordinary Grade; Question number 11

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	N	N	N	n	N	Y	N	N	N	N
Pr 2.	N	N	N	n	N	N	N	N	Y	N
Pr 3.	N	N	N	n	N	N	N	N	Y	N
Pr 4.	N	N	y	n	N	N	N	N	Y	N
Pr 5.	Y	N	Y	Y	y	Y	Y	Y	Y	Y
Pr 6.	Y	n	n	Y	Y	Y	Y	Y	N	y
Pr 7.	N	N	n	n	N	N	N	Y	N	N
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y	n	Y
Pr 9.	N	N	N	n	N	N	N	N	N	N
Pr 10.	N	N	N	n	N	N	N	N	N	N
Pr 11.	N	N	N	n	N	N	N	N	Y	N
Pr 12.	N	N	N	n	N	Y	Y	N	N	n
Pr 13.	N	N	N	n	N	N	N	Y	Y	n
Pr 14.	N	N	N	n	n	N	N	N	N	N
Pr 15.	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Pr 16.	N									N
Pr 17.	N									N
Pr 18.	Y									Y
Pr 19.	N									N
Pr 20.	Y									Y

Proc: 1 ;
Cont: 20 ;
Skil: 1 ;
Lang: 5

Ordinary Grade; Question number 12

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 2.	N	N	N	Y	N	N	N	N	Y	N
Pr 3.	N	N	N	n	N	N	N	N	n	N
Pr 4.	N	N	N	n	N	N	N	N	Y	N
Pr 5.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 6.	Y	Y	y	Y	y	y	Y	Y	N	Y
Pr 7.	Y	N	Y	Y	Y	N	Y	Y	N	y
Pr 8.	Y	Y	Y	Y	Y	Y	Y	y	Y	Y
Pr 9.	N	N	N	n	N	N	N	N	N	N
Pr 10.	N	N	N	n	N	N	N	N	y	N
Pr 11.	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 12.	N	N	N	y	N	N	Y	N	N	N
Pr 13.	Y	Y	Y	n	N	Y	Y	Y	Y	Y
Pr 14.	N	N	N	N	N	N	n	N	N	N
Pr 15.	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Pr 16.	Y									Y
Pr 17.	Y									Y
Pr 18.	Y									Y
Pr 19.	Y									Y
Pr 20.	Y									Y

Proc: 17 ;
Cont: 28 ;
Skil: 21 ;
Lang: 31

Ordinary Grade; Question number 13

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	N	N	N	n	N	N	N	N	Y	N
Pr 2.	N	N	N	n	N	N	N	N	Y	N
Pr 3.	N	N	N	n	N	N	y	N	Y	N
Pr 4.	N	N	N	n	N	N	N	N	Y	N
Pr 5.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 6.	N	N	N	n	N	N	Y	N	Y	n
Pr 7.	N	N	N	n	N	N	N	N	N	N
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	N	N	N	n	N	N	N	N	Y	N
Pr 10.	N	N	N	n	N	N	N	N	N	N
Pr 11.	N	N	N	n	N	N	N	N	N	N
Pr 12.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 13.	N	N	N	n	N	N	N	Y	Y	n
Pr 14.	N	N	N	n	N	N	Y	N	Y	n
Pr 15.	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Pr 16.	Y									Y
Pr 17.	Y									Y
Pr 18.	N									N
Pr 19.	N									N
Pr 20.	N									N

Proc: 1 ;
Cont: 4 ;
Skil: 9 ;
Lang: 24

Ordinary Grade; Question number 14

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	N	N	N	n	N	N	N	N	N	N
Pr 2.	N	N	N	n	N	N	N	N	Y	N
Pr 3.	N	N	N	n	N	N	N	N	N	N
Pr 4.	N	N	N	n	N	N	N	N	N	N
Pr 5.	Y	N	Y	Y	Y	Y	Y	Y	N	Y
Pr 6.	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
Pr 7.	N	N	N	n	N	N	N	N	N	N
Pr 8.	Y	Y	Y	Y	n	Y	Y	Y	Y	Y
Pr 9.	N	N	N	n	N	N	N	N	N	N
Pr 10.	N	N	N	n	N	N	N	N	N	N
Pr 11.	Y	Y	Y	Y	Y	Y	Y	Y	y	Y
Pr 12.	N	N	N	n	N	N	Y	N	N	N
Pr 13.	Y	Y	Y	n	N	Y	Y	Y	Y	Y
Pr 14.	Y	Y	y	y	Y	Y	y	Y	Y	Y
Pr 15.	Y	Y	Y	Y	Y	N	Y	Y	y	Y
Pr 16.	N									N
Pr 17.	Y									Y
Pr 18.	Y									Y
Pr 19.	N									N
Pr 20.	Y									Y

Proc: 1 ;
Cont: 20 ;
Skil: 23 ;
Lang: 13

Ordinary Grade; Question number 15

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	N	N	N	n	N	Y	N	N	N	N
Pr 2.	N	N	N	n	N	N	N	N	N	N
Pr 3.	N	N	N	n	N	N	N	N	Y	N
Pr 4.	N	N	N	n	N	N	N	N	Y	N
Pr 5.	Y	n	Y	Y	Y	Y	N	Y	y	Y
Pr 6.	Y	N	Y	Y	Y	y	Y	Y	y	Y
Pr 7.	N	N	N	n	N	N	N	N	Y	N
Pr 8.	Y	y	Y	Y	n	N	N	Y	Y	y
Pr 9.	N	N	N	n	N	N	N	N	Y	N
Pr 10.	N	N	N	n	N	N	n	N	N	N
Pr 11.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 12.	N	N	N	n	N	N	Y	N	N	N
Pr 13.	Y	Y	Y	n	N	Y	Y	Y	Y	Y
Pr 14.	Y	Y	y	y	Y	Y	y	Y	Y	Y
Pr 15.	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Pr 16.	Y									Y
Pr 17.	Y									Y
Pr 18.	Y									Y
Pr 19.	N									N
Pr 20.	Y									Y

Proc: 1 ;
Cont: 20 ;
Skil: 23 ;
Lang: 29

Ordinary Grade; Question number 16

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	N	N	N	n	N	N	N	N	Y	N
Pr 2.	N	N	N	n	N	N	N	N	Y	N
Pr 3.	N	N	N	n	N	N	N	N	Y	N
Pr 4.	N	N	N	n	N	N	N	N	Y	N
Pr 5.	N	Y	Y	Y	Y	y	Y	Y	Y	Y
Pr 6.	N	n	N	n	N	N	Y	N	Y	n
Pr 7.	N	N	N	n	N	N	N	n	N	N
Pr 8.	N	N	n	n	n	N	n	N	Y	N
Pr 9.	N	N	N	n	N	N	N	N	N	N
Pr 10.	N	N	N	n	N	N	N	n	N	N
Pr 11.	N	N	N	n	n	N	Y	N	Y	n
Pr 12.	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Pr 13.	Y	Y	n	y	y	Y	Y	Y	y	Y
Pr 14.	N	N	N	n	n	N	Y	N	N	N
Pr 15.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 16.	Y									Y
Pr 17.	Y									Y
Pr 18.	Y									Y
Pr 19.	N									N
Pr 20.	N									N

Proc: 1 ;
Cont: 0 ;
Skil: 13 ;
Lang: 28

Ordinary Grade; Question number 17

File:	0	1	3	4	9	B	C	D	E	Ave
Pr 1.	N	N	N	n	N	N	N	N	y	N
Pr 2.	N	N	N	n	N	N	N	N	Y	N
Pr 3.	N	N	N	n	N	N	N	N	Y	N
Pr 4.	N	N	N	n	N	N	N	N	Y	N
Pr 5.	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Pr 6.	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
Pr 7.	Y	Y	N	Y	Y	n	N	Y	Y	y
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y	y	Y
Pr 9.	N	N	N	n	N	N	Y	N	N	N
Pr 10.	N	N	N	n	N	N	Y	N	N	N
Pr 11.	N	N	Y	n	n	N	N	N	N	N
Pr 12.	Y	Y	N	Y	Y	N	Y	Y	Y	Y
Pr 13.	N	N	N	n	N	N	N	Y	Y	n
Pr 14.	N	N	N	n	y	N	n	N	N	N
Pr 15.	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Pr 16.	Y									Y
Pr 17.	Y									Y
Pr 18.	Y									Y
Pr 19.	N									N
Pr 20.	Y									Y

Proc: 1 ;
Cont: 28 ;
Skil: 9 ;
Lang: 29

Higher Grade; Question number 1

File:	0	1	4	B	C	D	E	Ave
Pr 1.	N	N	n	Y	N	N	Y	n
Pr 2.	N	N	n	N	N	N	N	N
Pr 3.	N	N	n	N	N	N	Y	N
Pr 4.	N	N	Y	N	n	N	Y	n
Pr 5.	N	N	N	N	N	N	N	N
Pr 6.	Y	Y	Y	N	Y	Y	Y	Y
Pr 7.	N	N	n	N	N	N	Y	N
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	N	N	n	N	N	N	Y	N
Pr 10.	N	N	n	N	N	N	n	N
Pr 11.	N	N	n	N	N	N	N	N
Pr 12.	N	N	n	N	N	N	N	N
Pr 13.	N	N	n	N	n	y	n	N
Pr 14.	N	N	n	N	N	N	y	N
Pr 15.	N	N	N	N	N	N	Y	N
Pr 16.	N							N
Pr 17.	N							N
Pr 18.	N							N
Pr 19.	N							N
Pr 20.	Y							Y

Proc: 0 ;
Cont: 20 ;
Skil: 0 ;
Lang: 1

Higher Grade; Question number 2

File:	0	1	4	B	C	D	E	Ave
Pr 1.	N	N	n	Y	N	N	N	N
Pr 2.	N	N	n	N	N	N	Y	N
Pr 3.	N	N	n	N	N	N	y	N
Pr 4.	N	N	n	N	y	N	Y	n
Pr 5.	N	N	N	N	n	N	Y	N
Pr 6.	Y	Y	Y	Y	Y	Y	N	Y
Pr 7.	N	N	n	N	N	N	Y	N
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	N	N	n	N	N	N	N	N
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	N	N	n	N	N	N	Y	N
Pr 12.	N	N	n	N	y	Y	N	n
Pr 13.	N	N	n	N	N	Y	y	n
Pr 14.	N	N	n	N	N	N	N	N
Pr 15.	N	N	N	N	n	Y	Y	n
Pr 16.	N							N
Pr 17.	N							N
Pr 18.	N							N
Pr 19.	N							N
Pr 20.	Y							Y

Proc: 0 :
Cont: 20 :
Skil: 0 :
Lang: 1

Higher Grade; Question number 3

File:	0	1	4	B	C	D	E	Ave
Pr 1.	N	N	n	N	N	N	Y	N
Pr 2.	N	N	n	N	N	N	N	N
Pr 3.	N	N	n	N	N	N	Y	N
Pr 4.	N	N	n	N	N	N	Y	N
Pr 5.	N	Y	Y	Y	y	Y	N	y
Pr 6.	N	N	n	N	N	n	Y	N
Pr 7.	N	N	n	N	N	n	Y	N
Pr 8.	Y	Y	Y	Y	y	Y	Y	Y
Pr 9.	N	N	n	N	N	N	Y	N
Pr 10.	Y	Y	y	Y	Y	Y	N	Y
Pr 11.	N	N	n	N	N	N	N	N
Pr 12.	Y	Y	Y	Y	Y	N	Y	Y
Pr 13.	N	N	n	N	n	n	Y	n
Pr 14.	N	N	Y	N	N	N	Y	n
Pr 15.	Y	Y	Y	N	Y	Y	Y	Y
Pr 16.	Y							Y
Pr 17.	Y							Y
Pr 18.	Y							Y
Pr 19.	N							N
Pr 20.	Y							Y

Proc: 1 ;
Cont: 5 ;
Skil: 9 ;
Lang: 29

Higher Grade; Question number 4

File:	0	1	4	B	C	D	E	Ave
Pr 1.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 2.	Y	Y	Y	Y	Y	Y	N	Y
Pr 3.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 4.	Y	Y	y	Y	Y	Y	Y	Y
Pr 5.	Y	Y	Y	Y	Y	Y	N	Y
Pr 6.	Y	Y	Y	Y	N	Y	Y	Y
Pr 7.	Y	Y	Y	Y	N	Y	Y	Y
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	N	N	n	N	N	Y	N	N
Pr 12.	N	N	n	N	N	N	N	N
Pr 13.	N	N	n	N	N	n	n	N
Pr 14.	N	N	n	N	N	N	Y	N
Pr 15.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 16.	N							N
Pr 17.	N							N
Pr 18.	N							N
Pr 19.	N							N
Pr 20.	Y							Y

Proc: 31 ;
Cont: 30 ;
Skil: 1 ;
Lang: 1

Higher Grade; Question number 5

File:	0	1	4	B	C	D	E	Ave
Pr 1.	Y	Y	Y	Y	Y	Y	N	Y
Pr 2.	Y	Y	Y	Y	Y	Y	N	Y
Pr 3.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 4.	n	N	n	N	Y	Y	N	n
Pr 5.	Y	Y	Y	Y	Y	Y	N	Y
Pr 6.	N	N	n	Y	N	N	Y	n
Pr 7.	N	N	n	Y	N	N	Y	n
Pr 8.	Y	Y	Y	Y	y	Y	Y	Y
Pr 9.	Y	Y	Y	Y	Y	Y	N	Y
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	N	N	n	N	N	Y	N	N
Pr 12.	N	N	n	N	N	N	n	N
Pr 13.	N	N	n	N	N	n	Y	N
Pr 14.	N	N	n	N	N	N	y	N
Pr 15.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 16.	N							N
Pr 17.	N							N
Pr 18.	N							N
Pr 19.	N							N
Pr 20.	Y							Y

Proc: 29 ;
Cont: 6 ;
Skil: 1 ;
Lang: 1

Higher Grade; Question number 6

File:	0	1	4	B	C	D	E	Ave
Pr 1.	N	N	n	N	N	N	Y	N
Pr 2.	N	N	n	N	N	N	Y	N
Pr 3.	N	N	n	N	N	N	y	N
Pr 4.	N	N	n	N	N	N	Y	N
Pr 5.	Y	N	Y	N	y	Y	y	y
Pr 6.	N	N	n	N	N	N	Y	N
Pr 7.	N	N	n	N	N	N	Y	N
Pr 8.	Y	Y	Y	N	Y	Y	Y	Y
Pr 9.	N	N	n	N	N	N	Y	N
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 12.	N	N	n	N	N	N	N	N
Pr 13.	Y	Y	Y	Y	y	Y	Y	Y
Pr 14.	Y	N	n	N	N	N	Y	n
Pr 15.	N	N	Y	Y	y	Y	Y	y
Pr 16.	N							N
Pr 17.	N							N
Pr 18.	N							N
Pr 19.	N							N
Pr 20.	N							N

Proc: 1 ;
Cont: 4 ;
Skil: 21 ;
Lang: 0

Higher Grade: Question number 7

File:	0	1	4	B	C	D	E	Ave
Pr 1.	N	N	n	N	N	N	Y	N
Pr 2.	N	N	n	N	N	N	N	N
Pr 3.	N	N	n	N	N	N	Y	N
Pr 4.	N	N	n	N	N	N	Y	N
Pr 5.	Y	N	Y	N	y	Y	Y	y
Pr 6.	N	N	Y	Y	y	Y	Y	y
Pr 7.	N	N	n	N	N	N	Y	N
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	N	N	n	N	N	N	Y	N
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	Y	Y	Y	Y	Y	Y	N	Y
Pr 12.	N	N	n	N	y	N	Y	n
Pr 13.	N	N	n	N	N	Y	Y	n
Pr 14.	Y	Y	y	Y	Y	Y	n	Y
Pr 15.	N	N	Y	Y	y	Y	Y	y
Pr 16.	N							N
Pr 17.	N							N
Pr 18.	N							N
Pr 19.	N							N
Pr 20.	N							N

Proc: 1 ;
Cont: 20 ;
Skil: 19 ;
Lang: 0

Higher Grade; Question number 8

File:	0	1	4	B	C	D	E	Ave
Pr 1.	Y	N	Y	N	Y	Y	Y	y
Pr 2.	Y	N	Y	Y	Y	Y	N	y
Pr 3.	N	N	n	N	N	N	Y	N
Pr 4.	Y	Y	Y	Y	Y	y	Y	Y
Pr 5.	N	Y	Y	Y	Y	Y	N	y
Pr 6.	Y	Y	n	Y	y	n	Y	y
Pr 7.	Y	Y	Y	Y	y	Y	N	Y
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	N	N	n	N	N	N	Y	N
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	Y	Y	Y	Y	Y	Y	N	Y
Pr 12.	Y	Y	Y	n	Y	Y	N	y
Pr 13.	N	N	n	N	N	Y	N	N
Pr 14.	Y	Y	y	Y	Y	y	Y	Y
Pr 15.	Y	Y	Y	N	Y	Y	Y	Y
Pr 16.	Y							Y
Pr 17.	Y							Y
Pr 18.	Y							Y
Pr 19.	N							N
Pr 20.	Y							Y

Proc: 27 ;
Cont: 28 ;
Skil: 27 ;
Lang: 29

Higher Grade; Question number 9

File:	0	1	4	B	C	D	E	Ave
Pr 1.	N	N	n	N	N	N	Y	N
Pr 2.	N	N	n	N	N	N	N	N
Pr 3.	N	N	n	N	N	N	Y	N
Pr 4.	N	N	n	N	N	N	Y	N
Pr 5.	Y	Y	Y	Y	y	Y	N	Y
Pr 6.	N	N	n	N	N	n	y	N
Pr 7.	N	N	n	N	N	N	y	N
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	N	N	n	N	N	N	Y	N
Pr 10.	Y	y	y	Y	y	y	N	y
Pr 11.	Y	Y	Y	Y	Y	Y	N	Y
Pr 12.	Y	Y	Y	N	Y	Y	Y	Y
Pr 13.	Y	Y	y	Y	y	Y	Y	Y
Pr 14.	Y	N	Y	N	Y	Y	Y	y
Pr 15.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 16.	N							N
Pr 17.	Y							Y
Pr 18.	N							N
Pr 19.	N							N
Pr 20.	N							N

Proc: 1 ;
Cont: 5 ;
Skil: 31 ;
Lang: 8

Higher Grade; Question number 10

File:	0	1	4	B	C	D	E	Ave
Pr 1.	N	N	n	n	N	N	Y	N
Pr 2.	N	N	n	N	N	N	Y	N
Pr 3.	N	N	n	N	N	N	Y	N
Pr 4.	N	N	n	N	N	N	Y	N
Pr 5.	Y	Y	Y	Y	Y	Y	y	Y
Pr 6.	N	N	n	N	N	N	N	N
Pr 7.	N	N	n	N	N	N	N	N
Pr 8.	Y	Y	Y	Y	Y	Y	N	Y
Pr 9.	N	N	n	N	N	N	y	N
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 12.	N	N	n	N	N	N	N	N
Pr 13.	N	N	n	N	N	Y	Y	n
Pr 14.	N	N	n	N	y	N	n	N
Pr 15.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 16.	N							N
Pr 17.	Y							Y
Pr 18.	Y							Y
Pr 19.	N							N
Pr 20.	N							N

Proc: 1 ;
Cont: 4 ;
Skil: 17 :
Lang: 12

Higher Grade: Question number 11

File:	0	1	4	B	C	D	E	Ave
Pr 1.	N	N	n	N	N	N	Y	N
Pr 2.	N	N	n	N	N	N	Y	N
Pr 3.	N	N	n	N	N	N	Y	N
Pr 4.	N	N	n	N	N	N	Y	N
Pr 5.	Y	Y	Y	N	Y	Y	N	y
Pr 6.	N	N	n	N	N	N	Y	N
Pr 7.	N	N	Y	N	N	N	Y	n
Pr 8.	Y	Y	Y	y	Y	Y	Y	Y
Pr 9.	n	N	n	N	N	N	Y	N
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	Y	Y	Y	Y	Y	Y	N	Y
Pr 12.	N	N	n	N	N	N	N	N
Pr 13.	Y	Y	y	Y	Y	Y	Y	Y
Pr 14.	Y	Y	Y	N	Y	Y	y	Y
Pr 15.	N	Y	Y	N	Y	Y	Y	y
Pr 16.	N							N
Pr 17.	N							N
Pr 18.	Y							Y
Pr 19.	N							N
Pr 20.	Y							Y

Proc: 1 ;
Cont: 4 ;
Skil: 23 ;
Lang: 5

Higher Grade; Question number 12

File:	0	1	4	B	C	D	E	Ave
Pr 1.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 2.	Y	Y	Y	Y	Y	Y	N	Y
Pr 3.	Y	Y	Y	Y	Y	y	Y	Y
Pr 4.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 5.	Y	Y	Y	Y	Y	Y	N	Y
Pr 6.	N	N	n	N	N	N	y	N
Pr 7.	Y	Y	Y	Y	y	y	Y	Y
Pr 8.	Y	Y	Y	Y	Y	Y	n	Y
Pr 9.	Y	Y	Y	Y	y	Y	Y	Y
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	N	N	Y	N	N	Y	N	n
Pr 12.	N	N	n	N	N	N	Y	N
Pr 13.	N	N	n	N	N	Y	Y	n
Pr 14.	N	N	n	N	N	N	Y	N
Pr 15.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 16.	Y							Y
Pr 17.	Y							Y
Pr 18.	N							N
Pr 19.	N							N
Pr 20.	Y							Y

Proc: 31 ;
Cont: 14 ;
Skil: 1 ;
Lang: 25

Higher Grade; Question number 13

File:	0	1	4	B	C	D	E	Ave
Pr 1.	N	N	n	Y	N	N	n	N
Pr 2.	N	N	n	N	y	N	N	N
Pr 3.	N	N	n	N	N	N	Y	N
Pr 4.	N	N	n	N	y	y	N	n
Pr 5.	n	Y	Y	Y	Y	Y	N	y
Pr 6.	N	N	n	N	N	N	Y	N
Pr 7.	N	N	n	N	N	Y	Y	n
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	N	N	n	N	N	N	Y	N
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	N	N	n	N	N	N	y	N
Pr 12.	N	N	n	n	Y	N	N	N
Pr 13.	N	N	n	N	N	Y	Y	n
Pr 14.	N	N	n	N	N	N	Y	N
Pr 15.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 16.	Y							Y
Pr 17.	Y							Y
Pr 18.	Y							Y
Pr 19.	N							N
Pr 20.	N							N

Proc: 1 ;
Cont: 4 ;
Skil: 1 ;
Lang: 28

Higher Grade; Question number 14

File:	0	1	4	B	C	D	E	Ave
Pr 1.	N	N	n	N	N	N	Y	N
Pr 2.	N	N	n	N	N	N	n	N
Pr 3.	N	N	n	N	N	N	n	N
Pr 4.	N	N	n	N	N	N	Y	N
Pr 5.	Y	Y	Y	Y	y	Y	Y	Y
Pr 6.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 7.	N	N	n	N	n	N	Y	N
Pr 8.	Y	Y	y	Y	Y	Y	Y	Y
Pr 9.	N	N	n	N	N	N	Y	N
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	N	N	n	N	N	N	Y	N
Pr 12.	N	N	n	N	Y	N	N	N
Pr 13.	Y	Y	y	Y	Y	Y	Y	Y
Pr 14.	N	N	n	N	N	N	Y	N
Pr 15.	n	N	n	N	n	n	Y	n
Pr 16.	Y							Y
Pr 17.	Y							Y
Pr 18.	Y							Y
Pr 19.	N							N
Pr 20.	N							N

Proc: 1 ;
Cont: 20 ;
Skil: 4 ;
Lang: 28

Higher Grade: Question number 15

File:	0	1	4	B	C	D	E	Ave
Pr 1.	N	N	n	Y	N	N	n	N
Pr 2.	N	N	n	N	N	N	n	N
Pr 3.	N	N	n	N	N	N	Y	N
Pr 4.	N	N	Y	N	N	N	Y	n
Pr 5.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 6.	N	N	n	N	N	N	Y	N
Pr 7.	N	N	n	N	N	N	Y	N
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	N	N	n	N	N	N	Y	N
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	Y	Y	Y	Y	Y	Y	y	Y
Pr 12.	N	N	n	N	N	N	N	N
Pr 13.	N	N	n	N	N	Y	Y	n
Pr 14.	N	N	n	N	N	N	n	N
Pr 15.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 16.	N							N
Pr 17.	N							N
Pr 18.	N							N
Pr 19.	N							N
Pr 20.	N							N

Proc: 1 ;
Cont: 4 ;
Skil: 17 ;
Lang: 0

Higher Grade; Question number 16

File:	0	1	4	B	C	D	E	Ave
Pr 1.	N	N	n	N	N	N	Y	N
Pr 2.	N	N	n	N	N	N	N	N
Pr 3.	N	N	n	N	N	N	Y	N
Pr 4.	N	N	n	N	N	N	Y	N
Pr 5.	Y	Y	n	y	Y	Y	N	y
Pr 6.	N	N	n	N	N	N	N	N
Pr 7.	N	N	n	N	N	N	N	N
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	N	N	n	N	N	N	Y	N
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	Y	Y	Y	Y	Y	Y	N	Y
Pr 12.	N	N	n	N	N	N	N	N
Pr 13.	Y	y	y	Y	y	Y	Y	Y
Pr 14.	Y	Y	Y	Y	Y	y	Y	Y
Pr 15.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 16.	Y							Y
Pr 17.	Y							Y
Pr 18.	Y							Y
Pr 19.	N							N
Pr 20.	N							N

Proc: 1 ;
Cont: 4 ;
Skil: 23 ;
Lang: 28

Higher Grade: Question number 17

File:	0	1	4	B	C	D	E	Ave
Pr 1.	N	N	n	N	N	N	Y	N
Pr 2.	N	N	n	N	N	N	N	N
Pr 3.	N	N	n	N	N	N	Y	N
Pr 4.	N	N	n	N	N	N	Y	N
Pr 5.	Y	Y	Y	Y	Y	Y	N	Y
Pr 6.	Y	N	Y	Y	Y	Y	Y	Y
Pr 7.	N	N	n	N	N	N	Y	N
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	N	N	n	N	N	N	Y	N
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	Y	Y	Y	Y	Y	Y	N	Y
Pr 12.	N	N	n	N	N	N	N	N
Pr 13.	Y	Y	Y	Y	y	Y	n	Y
Pr 14.	Y	Y	Y	N	Y	Y	Y	Y
Pr 15.	Y	Y	Y	N	Y	Y	Y	Y
Pr 16.	Y							Y
Pr 17.	Y							Y
Pr 18.	Y							Y
Pr 19.	N							N
Pr 20.	N							N

Proc: 1 ;
Cont: 20 ;
Skil: 23 ;
Lang: 28

Higher Grade; Question number 18

File:	0	1	4	B	C	D	E	Ave
Pr 1.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 2.	Y	Y	Y	Y	Y	Y	N	Y
Pr 3.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 4.	Y	y	Y	Y	Y	Y	Y	Y
Pr 5.	Y	Y	Y	Y	Y	Y	N	Y
Pr 6.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 7.	N	N	n	N	Y	N	Y	n
Pr 8.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 9.	Y	Y	Y	Y	Y	N	N	y
Pr 10.	y	N	n	N	N	N	N	N
Pr 11.	N	N	n	n	N	Y	N	N
Pr 12.	N	N	n	Y	N	N	N	N
Pr 13.	N	N	n	N	N	Y	Y	n
Pr 14.	N	N	N	N	n	n	n	N
Pr 15.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 16.	Y							Y
Pr 17.	Y							Y
Pr 18.	Y							Y
Pr 19.	Y							Y
Pr 20.	N							N

Proc: 31 ;
Cont: 22 ;
Skil: 1 ;
Lang: 30

Higher Grade: Question number 19

File:	0	1	4	B	C	D	E	Ave
Pr 1.	Y	Y	Y	Y	Y	Y	y	Y
Pr 2.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 3.	N	Y	n	Y	Y	Y	y	y
Pr 4.	N	N	N	N	N	N	Y	N
Pr 5.	N	Y	Y	Y	Y	Y	Y	Y
Pr 6.	N	N	n	N	N	N	N	N
Pr 7.	Y	Y	Y	Y	Y	Y	N	Y
Pr 8.	Y	Y	Y	Y	n	Y	N	y
Pr 9.	N	N	n	N	N	N	N	N
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 12.	N	N	n	N	N	N	N	N
Pr 13.	N	N	n	N	N	Y	Y	n
Pr 14.	N	N	n	N	N	N	N	N
Pr 15.	Y	Y	Y	Y	Y	Y	y	Y
Pr 16.	Y							Y
Pr 17.	Y							Y
Pr 18.	Y							Y
Pr 19.	Y							Y
Pr 20.	N							N

Proc: 29 ;
Cont: 12 ;
Skil: 17 ;
Lang: 30

Higher Grade; Question number 20

File:	0	1	4	B	C	D	E	Ave
Pr 1.	N	N	n	Y	N	N	Y	n
Pr 2.	N	N	n	Y	N	N	N	N
Pr 3.	N	N	n	N	N	N	Y	N
Pr 4.	N	N	n	N	N	N	Y	N
Pr 5.	Y	Y	Y	Y	Y	Y	N	Y
Pr 6.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 7.	N	N	n	N	N	N	Y	N
Pr 8.	Y	Y	Y	Y	y	Y	Y	Y
Pr 9.	N	N	n	N	N	N	Y	N
Pr 10.	N	N	n	N	N	N	N	N
Pr 11.	Y	Y	Y	Y	Y	Y	N	Y
Pr 12.	N	N	n	N	N	N	N	N
Pr 13.	N	N	n	N	n	Y	Y	n
Pr 14.	N	N	n	N	n	N	Y	N
Pr 15.	Y	Y	Y	Y	Y	Y	Y	Y
Pr 16.	Y							Y
Pr 17.	Y							Y
Pr 18.	Y							Y
Pr 19.	N							N
Pr 20.	N							N

Proc: 1 ;
Cont: 20 ;
Skil: 17 ;
Lang: 28

Cert Sixth Yr Studies: Question number 1

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	N	N	N	n	N	N	N	Y	N
Pr 02.	N	N	N	n	N	N	N	Y	N
Pr 03.	N	N	N	n	N	N	N	Y	N
Pr 04.	N	N	N	n	N	N	N	Y	N
Pr 05.	N	Y	N	n	N	N	N	N	N
Pr 06.	N	N	N	n	N	N	N	Y	N
Pr 07.	N	N	N	n	N	N	N	Y	N
Pr 08.	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 09.	N	N	y	n	N	N	N	Y	n
Pr 10.	N	N	N	n	N	N	N	N	N
Pr 11.	N	N		n	N	N	N		N
Pr 12.	N	N		n	N	N	N		N
Pr 13.	N	N		n	N	N	n		N
Pr 14.	N	N		N	N	N	n		N
Pr 15.	N	Y		Y	N	N	N		n
Pr 16.	Y								Y
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	N								N

Proc: 0 ;
Cont: 4 ;
Skil: 0 ;
Lang: 28

Cert Sixth Yr Studies: Question number 2

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	Y	N	Y	Y	Y	Y	Y	Y	Y
Pr 02.	Y	N	Y	Y	Y	y	y	Y	Y
Pr 03.	N	N	N	n	N	n	N	Y	N
Pr 04.	N	N	N	n	N	N	N	N	N
Pr 05.	Y	Y	Y	Y	n	N	Y	N	y
Pr 06.	Y	Y	Y	Y	N	N	Y	Y	y
Pr 07.	N	N	N	n	Y	n	N	Y	n
Pr 08.	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 09.	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 10.	N	Y	N	n	N	N	N	N	N
Pr 11.	N	N		n	N	N	N		N
Pr 12.	N	N		n	Y	N	N		N
Pr 13.	N	N		n	N	N	Y		N
Pr 14.	N	N		n	N	Y	N		N
Pr 15.	Y	Y		Y	y	n	Y		Y
Pr 16.	N								N
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	N								N

Proc: 25 ;
Cont: 22 ;
Skil: 1 ;
Lang: 12

Cert Sixth Yr Studies: Question number 3

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	Y	Y	Y	Y	N	Y	Y	Y	Y
Pr 02.	Y	Y	Y	Y	Y	Y	Y	n	Y
Pr 03.	Y	Y	y	Y	Y	Y	Y	Y	Y
Pr 04.	Y	Y	y	Y	Y	Y	Y	N	Y
Pr 05.	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 06.	N	N	N	N	N	N	N	N	N
Pr 07.	Y	N	N	Y	Y	Y	Y	N	y
Pr 08.	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 09.	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 10.	N	N	n	n	N	N	N	N	N
Pr 11.	Y	N		Y	Y	Y	Y		Y
Pr 12.	N	N		n	N	n	N		N
Pr 13.	N	N		n	N	N	Y		N
Pr 14.	Y	N		n	N	N	N		N
Pr 15.	Y	Y		Y	Y	Y	Y		Y
Pr 16.	Y								Y
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	N								N

Proc: 31 ;
Cont: 14 ;
Skil: 17 ;
Lang: 28

Cert Sixth Yr Studies; Question number 4

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 02.	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 03.	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 04.	Y	Y	Y	Y	Y	Y	Y	y	Y
Pr 05.	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 06.	Y	N	Y	Y	Y	Y	Y	Y	Y
Pr 07.	Y	N	n	Y	Y	Y	Y	N	y
Pr 08.	Y	Y	Y	Y	Y	y	Y	Y	Y
Pr 09.	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 10.	N	N	n	n	N	N	N	N	N
Pr 11.	N	N		n	N	N	N		N
Pr 12.	N	N		n	N	N	N		N
Pr 13.	N	N		n	N	N	Y		N
Pr 14.	N	N		n	N	N	N		N
Pr 15.	Y	Y		Y	Y	Y	Y		Y
Pr 16.	Y								Y
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	Y								Y

Proc: 31 ;
Cont: 30 ;
Skil: 1 ;
Lang: 29

Cert Sixth Yr Studies; Question number 5

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	N	N	N	n	N	N	N	N	N
Pr 02.	N	N	N	n	N	n	N	y	N
Pr 03.	N	N	N	n	N	n	N	N	N
Pr 04.	N	N	N	n	N	n	n	N	N
Pr 05.	N	N	N	Y	N	Y	Y	N	n
Pr 06.	N	N	N	n	N	N	N	Y	N
Pr 07.	N	N	N	n	N	N	N	N	N
Pr 08.	Y	Y	N	Y	Y	Y	N	Y	y
Pr 09.	N	N	N	n	N	N	N	N	N
Pr 10.	N	N	N	n	N	N	N	N	N
Pr 11.	N	N		n	N	N	Y		N
Pr 12.	Y	Y		Y	Y	Y	N		Y
Pr 13.	N	N		n	N	N	Y		N
Pr 14.	N	N		n	N	N	N		N
Pr 15.	Y	Y		Y	Y	y	Y		Y
Pr 16.	N								N
Pr 17.	N								N
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	N								N

Proc: 0 ;
Cont: 4 ;
Skil: 9 ;
Lang: 4

Cert Sixth Yr Studies; Question number 6

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	N	N	N	n	N	N	N	Y	N
Pr 02.	N	N	N	n	N	N	N	Y	N
Pr 03.	N	N	N	n	N	N	N	N	N
Pr 04.	N	N	N	n	N	N	N	Y	N
Pr 05.	Y	Y	y	Y	y	Y	y	N	Y
Pr 06.	N	N	N	n	N	N	N	Y	N
Pr 07.	N	N	N	n	N	N	N	Y	N
Pr 08.	N	N	n	n	N	N	N	Y	N
Pr 09.	N	N	N	n	N	N	N	Y	N
Pr 10.	N	N	N	n	N	N	N	N	N
Pr 11.	N	N		n	N	y	N		N
Pr 12.	N	N		n	N	y	N		N
Pr 13.	N	N		n	N	N	n		N
Pr 14.	N	N		n	N	N	N		N
Pr 15.	N	Y		Y	Y	Y	n		y
Pr 16.	Y								Y
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	N								N

Proc: 1 ;
Cont: 0 ;
Skil: 1 ;
Lang: 28

Cert Sixth Yr Studies: Question number 7

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	N	N	N	n	N	N	N	N	N
Pr 02.	N	N	N	n	N	n	N	Y	N
Pr 03.	N	N	N	n	N	N	N	N	N
Pr 04.	N	N	N	n	N	N	N	Y	N
Pr 05.	Y	Y	y	Y	y	Y	Y	N	Y
Pr 06.	N	N	N	n	N	N	N	N	N
Pr 07.	N	N	N	n	N	N	N	N	N
Pr 08.	N	N	N	n	N	N	N	Y	N
Pr 09.	N	N	N	n	N	N	N	N	N
Pr 10.	N	N	N	n	N	N	N	N	N
Pr 11.	N	N		n	N	N	N		N
Pr 12.	N	N		n	N	N	N		N
Pr 13.	N	N		n	N	N	Y		N
Pr 14.	N	N		n	N	N	N		N
Pr 15.	N	Y		Y	y	Y	Y		Y
Pr 16.	N								N
Pr 17.	Y								Y
Pr 18.	N								N
Pr 19.	N								N
Pr 20.	N								N

Proc: 1 ;
Cont: 0 ;
Skil: 1 ;
Lang: 8

Cert Sixth Yr Studies: Question number 8

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	N	N	N	n	N	n	Y	N	N
Pr 02.	N	N	N	n	N	N	N	Y	N
Pr 03.	N	N	N	n	N	N	N	y	N
Pr 04.	Y	Y	Y	Y	Y	Y	y	N	Y
Pr 05.	Y	Y	y	Y	y	Y	Y	N	Y
Pr 06.	N	N	N	n	N	N	N	Y	N
Pr 07.	N	N	N	n	N	N	N	N	N
Pr 08.	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 09.	N	N	N	n	N	N	N	N	N
Pr 10.	N	N	N	n	N	N	N	N	N
Pr 11.	N	N		n	N	n	N		N
Pr 12.	N	N		n	N	N	N		N
Pr 13.	N	N		n	N	N	Y		N
Pr 14.	N	N		n	N	N	N		N
Pr 15.	Y	Y		Y	Y	Y	Y		Y
Pr 16.	Y								Y
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	N								N

Proc: 3 ;
Cont: 4 ;
Skil: 1 ;
Lang: 28

Cert Sixth Yr Studies: Question number 9

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	Y	Y	y	Y	Y	Y	Y	N	Y
Pr 02.	Y	Y	Y	Y	N	Y	Y	Y	Y
Pr 03.	N	N	n	n	N	n	n	n	N
Pr 04.	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 05.	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 06.	N	N		Y	N	N	N	Y	n
Pr 07.	Y	Y		Y	Y	N	Y	N	y
Pr 08.	Y	Y		Y	Y	Y	Y	Y	Y
Pr 09.	Y	N		Y	N	N	N	N	n
Pr 10.	Y	N		n	N	N	N	N	N
Pr 11.	N	N		Y	N	N	N		N
Pr 12.	Y	Y		Y	Y	Y	Y		Y
Pr 13.	N	N		n	N	N	Y		N
Pr 14.	N	N		n	N	Y	N		N
Pr 15.	Y	Y		Y	y	Y	Y		Y
Pr 16.	Y								Y
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	N								N

Proc: 27 ;
Cont: 12 ;
Skil: 9 ;
Lang: 28

Cert Sixth Yr Studies; Question number 10

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	Y	N	N	Y	Y	N	N	N	n
Pr 02.	N	N	N	n	N	N	N	Y	N
Pr 03.	N	N	N	n	N	N	N	N	N
Pr 04.	N	y	N	n	N	Y	N	y	n
Pr 05.	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 06.	N	N		n	Y	N	N	N	N
Pr 07.	N	N		n	N	N	N	N	N
Pr 08.	Y	Y		Y	Y	Y	Y	N	Y
Pr 09.	N	N		n	N	N	N	N	N
Pr 10.	N	N		n	N	N	N	N	N
Pr 11.	N	N		n	N	N	n		N
Pr 12.	N	N		n	N	N	N		N
Pr 13.	N	N		n	N	N	Y		N
Pr 14.	N	N		n	N	N	N		N
Pr 15.	y	Y		Y	Y	Y	Y		Y
Pr 16.	N								N
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	N								N

Proc: 1 ;
Cont: 4 ;
Skil: 1 :
Lang: 12

Cert Sixth Yr Studies: Question number 11

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	N	N	N	n	N	N	N	N	N
Pr 02.	N	N	N	n	N	N	N	Y	N
Pr 03.	N	N	N	n	N	N	N	N	N
Pr 04.	N	N	N	n	N	N	N	N	N
Pr 05.	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 06.	Y	Y		Y	Y	Y	Y	N	Y
Pr 07.	N	N		n	Y	N	N	N	N
Pr 08.	Y	Y		Y	Y	Y	Y	Y	Y
Pr 09.	N	N		n	N	N	N	N	N
Pr 10.	Y	Y		y	Y	y	y	N	y
Pr 11.	N	N		n	N	N	Y		N
Pr 12.	Y	Y		Y	Y	Y	N		Y
Pr 13.	Y	N		n	N	N	Y		n
Pr 14.	Y	Y		Y	Y	Y	n		Y
Pr 15.	Y	Y		Y	Y	Y	Y		Y
Pr 16.	Y								Y
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	N								N

Proc: 1 ;
Cont: 21 ;
Skil: 11 ;
Lang: 28

Cert Sixth Yr Studies; Question number 12

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	N	N	N	n	N	N	N	Y	N
Pr 02.	N	N	N	n	N	N	N	Y	N
Pr 03.	N	N	N	n	N	N	N	N	N
Pr 04.	N	N	N	n	N	n	N	N	N
Pr 05.	Y	Y	n	Y	y	Y	Y	N	y
Pr 06.	N	N		n	N	n	N	Y	N
Pr 07.	N	N		n	N	N	N	Y	N
Pr 08.	Y	Y		Y	Y	Y	Y	Y	Y
Pr 09.	N	N		n	N	N	N	Y	N
Pr 10.	N	N		n	n	N	N	N	N
Pr 11.	N	N		n	N	N	N		N
Pr 12.	N	N		n	N	Y	N		N
Pr 13.	N	N		n	N	N	Y		N
Pr 14.	N	N		n	N	N	N		N
Pr 15.	N	Y		Y	Y	Y	Y		Y
Pr 16.	N								N
Pr 17.	N								N
Pr 18.	N								N
Pr 19.	N								N
Pr 20.	N								N

Proc: 1 ;
Cont: 4 ;
Skil: 1 ;
Lang: 0

Cert Sixth Yr Studies: Question number 13

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 02.	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 03.	N	N	n	n	N	n	n	N	N
Pr 04.	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 05.	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pr 06.	Y	N		Y	Y	Y	Y	Y	Y
Pr 07.	Y	Y		Y	n	N	Y	Y	y
Pr 08.	Y	Y		Y	Y	Y	Y	Y	Y
Pr 09.	Y	Y		Y	Y	Y	Y	Y	Y
Pr 10.	N	N		n	N	N	N	N	N
Pr 11.	Y	Y		Y	Y	Y	Y		Y
Pr 12.	N	N		n	N	N	N		N
Pr 13.	N	N		n	N	N	Y		N
Pr 14.	Y	N		n	N	Y	N		n
Pr 15.	Y	Y		Y	N	Y	Y		Y
Pr 16.	Y								Y
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	Y								Y

Proc: 27 ;
Cont: 30 ;
Skil: 17 ;
Lang: 29

Cert Sixth Yr Studies; Question number 14

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	Y	Y	Y	Y	Y	Y	Y	n	Y
Pr 02.	Y	Y	Y	N	Y	Y	Y	Y	Y
Pr 03.	N	Y	N	n	N	n	n	Y	n
Pr 04.	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 05.	N	Y	y	Y	N	Y	Y	Y	y
Pr 06.	Y	Y		Y	N	Y	Y	Y	Y
Pr 07.	N	N		n	N	N	N	Y	N
Pr 08.	Y	Y		Y	Y	Y	Y	Y	Y
Pr 09.	Y	Y		Y	n	Y	Y	Y	Y
Pr 10.	N	N		n	N	N	N	N	N
Pr 11.	N	N		n	N	N	N		N
Pr 12.	N	N		n	N	y	N		N
Pr 13.	N	N		n	N	N	Y		N
Pr 14.	N	N		Y	N	Y	N		n
Pr 15.	Y	Y		Y	y	Y	Y		Y
Pr 16.	Y								Y
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	Y								Y

Proc: 27 ;
Cont: 22 ;
Skil: 1 ;
Lang: 29

Cert Sixth Yr Studies: Question number 15

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	Y	N	N	Y	N	N	N	N	n
Pr 02.	N	N	N	n	N	N	N	Y	N
Pr 03.	N	N	N	n	N	N	N	N	N
Pr 04.	N	N	N	n	N	N	N	Y	N
Pr 05.	Y	Y	Y	Y	Y	Y	Y	y	Y
Pr 06.	Y	N		Y	Y	Y	Y	Y	Y
Pr 07.	N	N		Y	N	N	N	N	N
Pr 08.	Y	Y		Y	Y	y	Y	Y	Y
Pr 09.	Y	N		Y	Y	Y	y	N	y
Pr 10.	N	N		n	N	N	N	N	N
Pr 11.	Y	Y		Y	Y	Y	Y		Y
Pr 12.	N	Y		n	N	n	N		n
Pr 13.	Y	Y		y	Y	Y	Y		Y
Pr 14.	Y	Y		Y	N	Y	Y		Y
Pr 15.	Y	Y		Y	Y	Y	Y		Y
Pr 16.	Y								Y
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	Y								Y

Proc: 1 ;
Cont: 22 ;
Skil: 23 ;
Lang: 29

Cert Sixth Yr Studies; Question number 16

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	N	N	N	n	N	N	N	Y	N
Pr 02.	N	N	N	n	N	N	N	Y	N
Pr 03.	N	N	N	n	N	N	N	Y	N
Pr 04.	N	N	N	n	N	N	N	Y	N
Pr 05.	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 06.	N	N		n	N	N	N		N
Pr 07.	N	N		n	N	Y	N		N
Pr 08.	Y	Y		Y	Y	Y	Y		Y
Pr 09.	N	N		n	N	N	N		N
Pr 10.	n	N		n	N	N	N		N
Pr 11.	N	N		n	N	N	N		N
Pr 12.	Y	Y		n	Y	Y	Y		Y
Pr 13.	N	N		n	N	n	n		N
Pr 14.	N	n		n	N	N	n		N
Pr 15.	Y	Y		Y	N	Y	Y		Y
Pr 16.	N								N
Pr 17.	N								N
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	Y								Y

Proc: 1 ;
Cont: 4 ;
Skil: 9 ;
Lang: 5

Cert Sixth Yr Studies; Question number 17

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	Y	N	N	n	N	N	N	N	N
Pr 02.	N	N	N	n	N	N	N	Y	N
Pr 03.	N	N	N	n	N	N	N	N	N
Pr 04.	N	N	N	n	N	Y	N	Y	n
Pr 05.	Y	Y	Y	Y	Y	Y	Y	N	Y
Pr 06.	Y	Y		Y	Y	Y	y		Y
Pr 07.	Y	Y		Y	Y	Y	Y		Y
Pr 08.	Y	Y		Y	Y	Y	Y		Y
Pr 09.	N	N		n	N	N	N		N
Pr 10.	Y	Y		y	Y	Y	Y		Y
Pr 11.	Y	Y		Y	Y	Y	Y		Y
Pr 12.	N	N		n	N	N	N		N
Pr 13.	N	N		n	N	N	Y		N
Pr 14.	N	N		N	N	Y	N		N
Pr 15.	Y	Y		Y	y	Y	Y		Y
Pr 16.	Y								Y
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	Y								Y

Proc: 1 ;
Cont: 29 ;
Skil: 17 ;
Lang: 29

Cert Sixth Yr Studies; Question number 18

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	N	N	N	n	N	N	N	Y	N
Pr 02.	N	N	N	n	N	N	N	N	N
Pr 03.	N	N	N	n	N	N	N	N	N
Pr 04.	N	N	N	n	N	N	N	Y	N
Pr 05.	Y	Y	n	Y	Y	Y	N	N	y
Pr 06.	n	N		n	N	N	N		N
Pr 07.	n	N		Y	N	N	N		N
Pr 08.	N	N		Y	N	N	N		N
Pr 09.	N	N		n	N	N	N		N
Pr 10.	Y	Y		Y	N	y	N		y
Pr 11.	N	N		n	N	N	N		N
Pr 12.	N	N		n	N	N	N		N
Pr 13.	Y	Y		y	Y	Y	Y		Y
Pr 14.	N	N		n	N	N	N		N
Pr 15.	Y	Y		Y	Y	y	N		Y
Pr 16.	Y								Y
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	N								N

Proc: 1 ;
Cont: 1 ;
Skil: 5 ;
Lang: 28

Cert Sixth Yr Studies: Question number 19

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	N	N	N	Y	N	N	N	N	N
Pr 02.	N	N	N	n	N	N	N	Y	N
Pr 03.	N	N	N	n	N	N	N	Y	N
Pr 04.	N	N	N	n	N	N	N	N	N
Pr 05.	N	Y	y	Y	Y	y	Y	N	y
Pr 06.	N	N		n	N	Y	N		N
Pr 07.	N	N		n	N	n	N		N
Pr 08.	Y	Y		Y	N	Y	Y		Y
Pr 09.	N	N		n	N	N	N		N
Pr 10.	N	N		n	N	N	N		N
Pr 11.	N	N		n	N	N	N		N
Pr 12.	N	N		n	N	Y	N		N
Pr 13.	N	N		n	N	N	N		N
Pr 14.	N	N		n	N	N	N		N
Pr 15.	Y	Y		Y	y	y	Y		Y
Pr 16.	Y								Y
Pr 17.	N								N
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	N								N

Proc: 1 ;
Cont: 4 ;
Skil: 1 ;
Lang: 20

Cert Sixth Yr Studies; Question number 20

File:	0	1	3	4	B	C	D	E	Ave
Pr 01.	N	N	N	n	N	N	N	Y	N
Pr 02.	N	N	N	n	y	N	N	Y	n
Pr 03.	N	N	N	n	N	N	N	Y	N
Pr 04.	N	N	N	n	N	N	N	Y	N
Pr 05.	Y	Y	y	Y	y	Y	N	N	y
Pr 06.	N	N		n	Y	n	N		n
Pr 07.	N	N		n	N	n	N		N
Pr 08.	N	N		n	N	N	N		N
Pr 09.	N	N		n	N	N	N		N
Pr 10.	N	N		Y	N	N	N		N
Pr 11.	N	N		n	N	N	N		N
Pr 12.	N	N		n	N	N	N		N
Pr 13.	Y	Y		y	y	y	Y		Y
Pr 14.	N	N		n	N	n	N		N
Pr 15.	Y	Y		Y	Y	y	N		Y
Pr 16.	Y								Y
Pr 17.	Y								Y
Pr 18.	Y								Y
Pr 19.	N								N
Pr 20.	N								N

Proc: 1 ;
Cont: 0 ;
Skil: 5 ;
Lang: 28

Appendix C

Lists of Propositions

List of selected propositions

Phase 1, 1983-84

A. PROCESS

1. Does the problem contain ARITHMETICAL CALCULATIONS?
2. Is the solution QUALITATIVE (explanation, comparison etc.) rather than QUANTITATIVE (involving figures)? Note: if the solution contains both qualitative and quantitative answers, respond YES.
3. Does the problem require the application of rules or formal relationships (e.g., Gas Laws)?
4. Does the problem require LOGICAL DECISIONS?
5. Is any VALUE JUDGMENT required?

B. CONCEPT (Chemical Content)

1. Does the problem involve FORMULAE?
2. Does the solution require EQUATIONS?
3. Does the problem refer to SPECIFIC SUBSTANCES?
4. Does the problem involve the MOLE CONCEPT?
5. Does the problem imply SAFETY REQUIREMENTS or PRECAUTIONS?

C. SKILLS

1. Does the problem PRESENT information as GRAPHS or TABLES?
2. Does the problem involve DRAWING or INTERPRETING DIAGRAMS or FLOW-CHARTS?
3. Does the problem involve SORTING of relevant data from irrelevant?
4. Does the problem require the use of PROPORTION?
5. Does the problem involve CONDITIONAL REASONING (IF...THEN...ELSE)?

D. LANGUAGE

In the <u>statement</u> of the problem (i.e., not including the actual questions),

1. Is the average sentence longer than 20 words?
2. Is there more than 1 subordinate clause?
3. Are there more than 5 words of 3 or more syllables (excluding technical terms and names of chemicals)?
4. Are there any words which have more than one meaning in different contexts?
5. Can the question be answered by a single word or series of words (as opposed to a grammatically structured answer)?

List of Revised Propositions
Phase 3, 1985-86

A. PROCESS

(1) 1. Is the solution to this problem QUANTITATIVE (involving numbers) in any of its parts?

(2) 2. Does the solution to this problem require ARITHMETICAL CALCULATIONS (as opposed to simple reading or recall of figures, e.g., from graphs or tables)?

(3) 3. Does the solution involve PROPORTION in calculations? (If the answer to proposition 2 is NO, then the answer to this must be NO also)

(4) 4. Does the solution to this problem involve the application of a recalled or a given FORMULA (NOT a chemical formula): e.g., $m = vc$ or $PV = nRT$?

(5) 5. Does the solution require REASONING as opposed to simple RECALL? (If both are required, answer YES)

B. CONCEPTS

(6) 1. Does the solution require the recall or construction of CHEMICAL FORMULAE? (Do not count formulae which are supplied in the text)

(7) 2. Does the solution require the recall or construction of CHEMICAL EQUATIONS (including word equations)? (Do not count equations which are supplied in the text)

(8) 3. Does this problem refer to SPECIFIC SUBSTANCES (as opposed to classes or types of substance - e.g., "ethanal" as opposed to "aldehydes")? If both, answer YES.

(9) 4. Does the solution to this problem involve the MOLE concept?

(10) 5. Does this problem specifically imply SAFETY REQUIREMENTS or PRECAUTIONS?

C. SKILLS

(11) 1. Does this problem (or the solution to it) involve GRAPHS, TABLES or SELECTION GRIDS?

(12) 2. Does this problem involve DRAWING or INTERPRETING DIAGRAMS or FLOW-CHARTS (as opposed to graphs, tables or grids)?

(13) 3. Does this problem involve SORTING of information into categories or classes?

(14) 4. Is more data provided than is required for the solution (i.e., is any of the data IRRELEVANT to the answer)?

(15) 5. Does this problem involve any skills beyond simple recall or Data Book information retrieval?

D. LANGUAGE

(16) 1. In the statement of this problem, is the average sentence longer than 15 words?

(17) 2. Are there any subordinate clauses?

(18) 3. Are there more than 3 words of 3 or more syllables (excluding technical terms and names of chemicals)?

(19) 4. Are there any words which have more than one meaning in different contexts? This refers to the list of words published in "Words That Matter in Science" (Cassels and Johnstone, RSC, 1985)

(20) 5. Can all parts of the problem be answered by a single word or series of words, as opposed to a grammatically structured answer?

Appendix D

Proposition Values

Generated by COMPana program

Values generated by CONPana program

Ordinary Grade Values

	Proc	Cont	Skil	Lang
Question 1:	17	4	4	7
Question 2:	1	20	16	29
Question 3:	29	14	1	25
Question 4:	1	28	9	20
Question 5:	31	6	1	25
Question 6:	1	4	9	28
Question 7:	1	4	9	12
Question 8:	0	4	0	1
Question 9:	1	4	9	0
Question 10:	1	4	9	4
Question 11:	1	20	1	5
Question 12:	17	28	21	31
Question 13:	1	4	9	24
Question 14:	1	20	23	13
Question 15:	1	20	23	29
Question 16:	1	0	13	28
Question 17:	1	28	9	29

Higher Grade Values

	Proc	Cont	Skil	Lang
Question 1:	0	20	0	1
Question 2:	0	20	0	1
Question 3:	1	5	9	29
Question 4:	31	30	1	1
Question 5:	29	6	1	1
Question 6:	1	4	21	0
Question 7:	1	20	19	0
Question 8:	27	28	27	29
Question 9:	1	5	31	8
Question 10:	1	4	17	12
Question 11:	1	4	23	5
Question 12:	31	14	1	25
Question 13:	1	4	1	28
Question 14:	1	20	4	28
Question 15:	1	4	17	0
Question 16:	1	4	23	28
Question 17:	1	20	23	28
Question 18:	31	22	1	30
Question 19:	29	12	17	30
Question 20:	1	20	17	28

Sixth Year Studies Values

	Proc	Cont	Skil	Lang
Question 1:	0	4	0	28
Question 2:	25	22	1	12
Question 3:	31	14	17	28
Question 4:	31	30	1	29
Question 5:	0	4	9	4
Question 6:	1	0	1	28
Question 7:	1	0	1	8
Question 8:	3	4	1	28
Question 9:	27	12	9	28
Question 10:	1	4	1	12
Question 11:	1	21	11	28
Question 12:	1	4	1	0
Question 13:	27	30	17	29
Question 14:	27	22	1	29
Question 15:	1	22	23	29
Question 16:	1	4	9	5
Question 17:	1	29	17	29
Question 18:	1	1	5	28
Question 19:	1	4	1	20
Question 20:	1	0	5	28

Appendix E

Descriptions of Proposition Values

1. Process Values

Proc 0: Binary: 00000
Is not quantitative
Does not involve Arithmetic
Does not involve Proportion
Does not involve non-chemical Formulae
Requires only simple Recall

Proc 1: Binary: 00001
Is not quantitative
Does not involve Arithmetic
Does not involve Proportion
Does not involve non-chemical Formulae
Requires REASONING as opposed to RECALL

Proc 2: Binary: 00010
Is not quantitative
Does not involve Arithmetic
Does not involve Proportion
Involves a (non-chemical) FORMULA
Requires only simple Recall

Proc 3: Binary: 00011
Is not quantitative
Does not involve Arithmetic
Does not involve Proportion
Involves a (non-chemical) FORMULA
Requires REASONING as opposed to RECALL

Proc 4: Binary: 00100
Is not quantitative
Does not involve Arithmetic
Involves PROPORTION
Does not involve non-chemical Formulae
Requires only simple Recall

Proc 5: Binary: 00101
Is not quantitative
Does not involve Arithmetic
Involves PROPORTION
Does not involve non-chemical Formulae
Requires REASONING as opposed to RECALL

Proc 6: Binary: 00110
Is not quantitative
Does not involve Arithmetic
Involves PROPORTION
Involves a (non-chemical) FORMULA
Requires only simple Recall

Proc 7: Binary: 00111
Is not quantitative
Does not involve Arithmetic
Involves PROPORTION
Involves a (non-chemical) FORMULA
Requires REASONING as opposed to RECALL

Proc 8: Binary: 01000
Is not quantitative
Involves ARITHMETICAL calculations
Does not involve Proportion
Does not involve non-chemical Formulae
Requires only simple Recall

Proc 9: Binary: 01001
Is not quantitative
Involves ARITHMETICAL calculations
Does not involve Proportion
Does not involve non-chemical Formulae
Requires REASONING as opposed to RECALL

Proc 10: Binary: 01010
Is not quantitative
Involves ARITHMETICAL calculations
Does not involve Proportion
Involves a (non-chemical) FORMULA
Requires only simple Recall

Proc 11: Binary: 01011
Is not quantitative
Involves ARITHMETICAL calculations
Does not involve Proportion
Involves a (non-chemical) FORMULA
Requires REASONING as opposed to RECALL

Proc 12: Binary: 01100
Is not quantitative
Involves ARITHMETICAL calculations
Involves PROPORTION
Does not involve non-chemical Formulae
Requires only simple Recall

Proc 13: Binary: 01101
Is not quantitative
Involves ARITHMETICAL calculations
Involves PROPORTION
Does not involve non-chemical Formulae
Requires REASONING as opposed to RECALL

Proc 14: Binary: 01110
Is not quantitative
Involves ARITHMETICAL calculations
Involves PROPORTION
Involves a (non-chemical) FORMULA
Requires only simple Recall

Proc 15: Binary: 01111
Is not quantitative
Involves ARITHMETICAL calculations
Involves PROPORTION
Involves a (non-chemical) FORMULA
Requires REASONING as opposed to RECALL

Proc 16: Binary: 10000
Solution is QUANTITATIVE
Does not involve Arithmetic
Does not involve Proportion
Does not involve non-chemical Formulae
Requires only simple Recall

Proc 17: Binary: 10001
Solution is QUANTITATIVE
Does not involve Arithmetic
Does not involve Proportion
Does not involve non-chemical Formulae
Requires REASONING as opposed to RECALL

Proc 18: Binary: 10010
Solution is QUANTITATIVE
Does not involve Arithmetic
Does not involve Proportion
Involves a (non-chemical) FORMULA
Requires only simple Recall

Proc 19: Binary: 10011
Solution is QUANTITATIVE
Does not involve Arithmetic
Does not involve Proportion
Involves a (non-chemical) FORMULA
Requires REASONING as opposed to RECALL

Proc 20: Binary: 10100
Solution is QUANTITATIVE
Does not involve Arithmetic
Involves PROPORTION
Does not involve non-chemical Formulae
Requires only simple Recall

Proc 21: Binary: 10101
Solution is QUANTITATIVE
Does not involve Arithmetic
Involves PROPORTION
Does not involve non-chemical Formulae
Requires REASONING as opposed to RECALL

Proc 22: Binary: 10110
Solution is QUANTITATIVE
Does not involve Arithmetic
Involves PROPORTION
Involves a (non-chemical) FORMULA
Requires only simple Recall

Proc 23: Binary: 10111
Solution is QUANTITATIVE
Does not involve Arithmetic
Involves PROPORTION
Involves a (non-chemical) FORMULA
Requires REASONING as opposed to RECALL

Proc 24: Binary: 11000
Solution is QUANTITATIVE
Involves ARITHMETICAL calculations
Does not involve Proportion
Does not involve non-chemical Formulae
Requires only simple Recall

Proc 25: Binary: 11001
Solution is QUANTITATIVE
Involves ARITHMETICAL calculations
Does not involve Proportion
Does not involve non-chemical Formulae
Requires REASONING as opposed to RECALL

Proc 26: Binary: 11010
Solution is QUANTITATIVE
Involves ARITHMETICAL calculations
Does not involve Proportion
Involves a (non-chemical) FORMULA
Requires only simple Recall

Proc 27: Binary: 11011
Solution is QUANTITATIVE
Involves ARITHMETICAL calculations
Does not involve Proportion
Involves a (non-chemical) FORMULA
Requires REASONING as opposed to RECALL

Proc 28: Binary: 11100
Solution is QUANTITATIVE
Involves ARITHMETICAL calculations
Involves PROPORTION
Does not involve non-chemical Formulae
Requires only simple Recall

Proc 29: Binary: 11101
Solution is QUANTITATIVE
Involves ARITHMETICAL calculations
Involves PROPORTION
Does not involve non-chemical Formulae
Requires REASONING as opposed to RECALL

Proc 30: Binary: 11110
Solution is QUANTITATIVE
Involves ARITHMETICAL calculations
Involves PROPORTION
Involves a (non-chemical) FORMULA
Requires only simple Recall

Proc 31: Binary: 11111
Solution is QUANTITATIVE
Involves ARITHMETICAL calculations
Involves PROPORTION
Involves a (non-chemical) FORMULA
Requires REASONING as opposed to RECALL

2. Concept (Content) Values

Conc 0: Binary: 00000
No Chemical Formulae (unless supplied)
No Chemical Equations (unless supplied)
Does not refer to Specific Substances
Does not involve the MOLE concept
No Safety requirements inferred

Conc 1: Binary: 00001
No Chemical Formulae (unless supplied)
No Chemical Equations (unless supplied)
Does not refer to Specific Substances
Does not involve the MOLE concept
Infers SAFETY Requirements

Conc 2: Binary: 00010
No Chemical Formulae (unless supplied)
No Chemical Equations (unless supplied)
Does not refer to Specific Substances
Involves the MOLE concept
No Safety requirements inferred

Conc 3: Binary: 00011
No Chemical Formulae (unless supplied)
No Chemical Equations (unless supplied)
Does not refer to Specific Substances
Involves the MOLE concept
Infers SAFETY Requirements

Conc 4: Binary: 00100
No Chemical Formulae (unless supplied)
No Chemical Equations (unless supplied)
Refers to SPECIFIC SUBSTANCES
Does not involve the MOLE concept
No Safety requirements inferred

Conc 5: Binary: 00101
No Chemical Formulae (unless supplied)
No Chemical Equations (unless supplied)
Refers to SPECIFIC SUBSTANCES
Does not involve the MOLE concept
Infers SAFETY Requirements

Conc 6: Binary: 00110
No Chemical Formulae (unless supplied)
No Chemical Equations (unless supplied)
Refers to SPECIFIC SUBSTANCES
Involves the MOLE concept
No Safety requirements inferred

Conc 7: Binary: 00111
No Chemical Formulae (unless supplied)
No Chemical Equations (unless supplied)
Refers to SPECIFIC SUBSTANCES
Involves the MOLE concept
Infers SAFETY Requirements

Conc 8: Binary: 01000
No Chemical Formulae (unless supplied)
Recall or construction of CHEMICAL EQUATIONS
Does not refer to Specific Substances
Does not involve the MOLE concept
No Safety requirements inferred

Conc 9: Binary: 01001
No Chemical Formulae (unless supplied)
Recall or construction of CHEMICAL EQUATIONS
Does not refer to Specific Substances
Does not involve the MOLE concept
Infers SAFETY Requirements

Conc 10: Binary: 01010
No Chemical Formulae (unless supplied)
Recall or construction of CHEMICAL EQUATIONS
Does not refer to Specific Substances
Involves the MOLE concept
No Safety requirements inferred

Conc 11: Binary: 01011
No Chemical Formulae (unless supplied)
Recall or construction of CHEMICAL EQUATIONS
Does not refer to Specific Substances
Involves the MOLE concept
Infers SAFETY Requirements

Conc 12: Binary: 01100
No Chemical Formulae (unless supplied)
Recall or construction of CHEMICAL EQUATIONS
Refers to SPECIFIC SUBSTANCES
Does not involve the MOLE concept
No Safety requirements inferred

Conc 13: Binary: 01101
No Chemical Formulae (unless supplied)
Recall or construction of CHEMICAL EQUATIONS
Refers to SPECIFIC SUBSTANCES
Does not involve the MOLE concept
Infers SAFETY Requirements

Conc 14: Binary: 01110
No Chemical Formulae (unless supplied)
Recall or construction of CHEMICAL EQUATIONS
Refers to SPECIFIC SUBSTANCES
Involves the MOLE concept
No Safety requirements inferred

Conc 15: Binary: 01111
No Chemical Formulae (unless supplied)
Recall or construction of CHEMICAL EQUATIONS
Refers to SPECIFIC SUBSTANCES
Involves the MOLE concept
Infers SAFETY Requirements

Conc 16: Binary: 10000
Recall or construction of CHEMICAL FORMULAE
No Chemical Equations (unless supplied)
Does not refer to Specific Substances
Does not involve the MOLE concept
No Safety requirements inferred

Conc 17: Binary: 10001
Recall or construction of CHEMICAL FORMULAE
No Chemical Equations (unless supplied)
Does not refer to Specific Substances
Does not involve the MOLE concept
Infers SAFETY Requirements

Conc 18: Binary: 10010
Recall or construction of CHEMICAL FORMULAE
No Chemical Equations (unless supplied)
Does not refer to Specific Substances
Involves the MOLE concept
No Safety requirements inferred

Conc 19: Binary: 10011
Recall or construction of CHEMICAL FORMULAE
No Chemical Equations (unless supplied)
Does not refer to Specific Substances
Involves the MOLE concept
Infers SAFETY Requirements

Conc 20: Binary: 10100
Recall or construction of CHEMICAL FORMULAE
No Chemical Equations (unless supplied)
Refers to SPECIFIC SUBSTANCES
Does not involve the MOLE concept
No Safety requirements inferred

Conc 21: Binary: 10101
Recall or construction of CHEMICAL FORMULAE
No Chemical Equations (unless supplied)
Refers to SPECIFIC SUBSTANCES
Does not involve the MOLE concept
Infers SAFETY Requirements

Conc 22: Binary: 10110
Recall or construction of CHEMICAL FORMULAE
No Chemical Equations (unless supplied)
Refers to SPECIFIC SUBSTANCES
Involves the MOLE concept
No Safety requirements inferred

Conc 23: Binary: 10111
Recall or construction of CHEMICAL FORMULAE
No Chemical Equations (unless supplied)
Refers to SPECIFIC SUBSTANCES
Involves the MOLE concept
Infers SAFETY Requirements

Conc 24: Binary: 11000
Recall or construction of CHEMICAL FORMULAE
Recall or construction of CHEMICAL EQUATIONS
Does not refer to Specific Substances
Does not involve the MOLE concept
No Safety requirements inferred

Conc 25: Binary: 11001
Recall or construction of CHEMICAL FORMULAE
Recall or construction of CHEMICAL EQUATIONS
Does not refer to Specific Substances
Does not involve the MOLE concept
Infers SAFETY Requirements

Conc 26: Binary: 11010
Recall or construction of CHEMICAL FORMULAE
Recall or construction of CHEMICAL EQUATIONS
Does not refer to Specific Substances
Involves the MOLE concept
No Safety requirements inferred

Conc 27: Binary: 11011
Recall or construction of CHEMICAL FORMULAE
Recall or construction of CHEMICAL EQUATIONS
Does not refer to Specific Substances
Involves the MOLE concept
Infers SAFETY Requirements

Conc 28: Binary: 11100
Recall or construction of CHEMICAL FORMULAE
Recall or construction of CHEMICAL EQUATIONS
Refers to SPECIFIC SUBSTANCES
Does not involve the MOLE concept
No Safety requirements inferred

Conc 29: Binary: 11101
Recall or construction of CHEMICAL FORMULAE
Recall or construction of CHEMICAL EQUATIONS
Refers to SPECIFIC SUBSTANCES
Does not involve the MOLE concept
Infers SAFETY Requirements

Conc 30: Binary: 11110
Recall or construction of CHEMICAL FORMULAE
Recall or construction of CHEMICAL EQUATIONS
Refers to SPECIFIC SUBSTANCES
Involves the MOLE concept
No Safety requirements inferred

Conc 31: Binary: 11111
Recall or construction of CHEMICAL FORMULAE
Recall or construction of CHEMICAL EQUATIONS
Refers to SPECIFIC SUBSTANCES
Involves the MOLE concept
Implies SAFETY Requirements

3. Skills Values

Skil 0: Binary: 00000
Does not involve Graphs Tables or Grids
Does not involve Diagrams or Flow-Charts
Does not require sorting of information
Every part of problem necessary for solution
Simple recall only

Skil 1: Binary: 00001
Does not involve Graphs Tables or Grids
Does not involve Diagrams or Flow-Charts
Does not require sorting of information
Every part of problem necessary for solution
Skills beyond simple recall

Skil 2: Binary: 00010
Does not involve Graphs Tables or Grids
Does not involve Diagrams or Flow-Charts
Does not require sorting of information
Contains IRRELEVANT data
Simple recall only

Skil 3: Binary: 00011
Does not involve Graphs Tables or Grids
Does not involve Diagrams or Flow-Charts
Does not require sorting of information
Contains IRRELEVANT data
Skills beyond simple recall

Skil 4: Binary: 00100
Does not involve Graphs Tables or Grids
Does not involve Diagrams or Flow-Charts
Involves SORTING of information
Every part of problem necessary for solution
Simple recall only

Skil 5: Binary: 00101
Does not involve Graphs Tables or Grids
Does not involve Diagrams or Flow-Charts
Involves SORTING of information
Every part of problem necessary for solution
Skills beyond simple recall

Skil 6: Binary: 00110
Does not involve Graphs Tables or Grids
Does not involve Diagrams or Flow-Charts
Involves SORTING of information
Contains IRRELEVANT data
Simple recall only

Skil 7: Binary: 00111
Does not involve Graphs Tables or Grids
Does not involve Diagrams or Flow-Charts
Involves SORTING of information
Contains IRRELEVANT data
Skills beyond simple recall

Skil 8: Binary: 01000
Does not involve Graphs Tables or Grids
Involves DIAGRAMS or FLOW-CHARTS
Does not require sorting of information
Every part of problem necessary for solution
Simple recall only

Skil 9: Binary: 01001
Does not involve Graphs Tables or Grids
Involves DIAGRAMS or FLOW-CHARTS
Does not require sorting of information
Every part of problem necessary for solution
Skills beyond simple recall

Skil 10: Binary: 01010
Does not involve Graphs Tables or Grids
Involves DIAGRAMS or FLOW-CHARTS
Does not require sorting of information
Contains IRRELEVANT data
Simple recall only

Skil 11: Binary: 01011
Does not involve Graphs Tables or Grids
Involves DIAGRAMS or FLOW-CHARTS
Does not require sorting of information
Contains IRRELEVANT data
Skills beyond simple recall

Skil 12: Binary: 01100
Does not involve Graphs Tables or Grids
Involves DIAGRAMS or FLOW-CHARTS
Involves SORTING of information
Every part of problem necessary for solution
Simple recall only

Skil 13: Binary: 01101
Does not involve Graphs Tables or Grids
Involves DIAGRAMS or FLOW-CHARTS
Involves SORTING of information
Every part of problem necessary for solution
Skills beyond simple recall

Skil 14: Binary: 01110
Does not involve Graphs Tables or Grids
Involves DIAGRAMS or FLOW-CHARTS
Involves SORTING of information
Contains IRRELEVANT data
Simple recall only

Skil 15: Binary: 01111
Does not involve Graphs Tables or Grids
Involves DIAGRAMS or FLOW-CHARTS
Involves SORTING of information
Contains IRRELEVANT data
Skills beyond simple recall

Skil 16: Binary: 10000
Involves GRAPHS TABLES or SELECTION GRIDS
Does not involve Diagrams or Flow-Charts
Does not require sorting of information
Every part of problem necessary for solution
Simple recall only

Skil 17: Binary: 10001
Involves GRAPHS TABLES or SELECTION GRIDS
Does not involve Diagrams or Flow-Charts
Does not require sorting of information
Every part of problem necessary for solution
Skills beyond simple recall

Skil 18: Binary: 10010
Involves GRAPHS TABLES or SELECTION GRIDS
Does not involve Diagrams or Flow-Charts
Does not require sorting of information
Contains IRRELEVANT data
Simple recall only

Skil 19: Binary: 10011
Involves GRAPHS TABLES or SELECTION GRIDS
Does not involve Diagrams or Flow-Charts
Does not require sorting of information
Contains IRRELEVANT data
Skills beyond simple recall

Skil 20: Binary: 10100
Involves GRAPHS TABLES or SELECTION GRIDS
Does not involve Diagrams or Flow-Charts
Involves SORTING of information
Every part of problem necessary for solution
Simple recall only

Skil 21: Binary: 10101
Involves GRAPHS TABLES or SELECTION GRIDS
Does not involve Diagrams or Flow-Charts
Involves SORTING of information
Every part of problem necessary for solution
Skills beyond simple recall

Skil 22: Binary: 10110
Involves GRAPHS TABLES or SELECTION GRIDS
Does not involve Diagrams or Flow-Charts
Involves SORTING of information
Contains IRRELEVANT data
Simple recall only

Skil 23: Binary: 10111
Involves GRAPHS TABLES or SELECTION GRIDS
Does not involve Diagrams or Flow-Charts
Involves SORTING of information
Contains IRRELEVANT data
Skills beyond simple recall

Skil 24: Binary: 11000
Involves GRAPHS TABLES or SELECTION GRIDS
Involves DIAGRAMS or FLOW-CHARTS
Does not require sorting of information
Every part of problem necessary for solution
Simple recall only

Skil 25: Binary: 11001
Involves GRAPHS TABLES or SELECTION GRIDS
Involves DIAGRAMS or FLOW-CHARTS
Does not require sorting of information
Every part of problem necessary for solution
Skills beyond simple recall

Skil 26: Binary: 11010
Involves GRAPHS TABLES or SELECTION GRIDS
Involves DIAGRAMS or FLOW-CHARTS
Does not require sorting of information
Contains IRRELEVANT data
Simple recall only

Skil 27: Binary: 11011
Involves GRAPHS TABLES or SELECTION GRIDS
Involves DIAGRAMS or FLOW-CHARTS
Does not require sorting of information
Contains IRRELEVANT data
Skills beyond simple recall

Skil 28: Binary: 11100
Involves GRAPHS TABLES or SELECTION GRIDS
Involves DIAGRAMS or FLOW-CHARTS
Involves SORTING of information
Every part of problem necessary for solution
Simple recall only

Skil 29: Binary: 11101
Involves GRAPHS TABLES or SELECTION GRIDS
Involves DIAGRAMS or FLOW-CHARTS
Involves SORTING of information
Every part of problem necessary for solution
Skills beyond simple recall

Skil 30: Binary: 11110
Involves GRAPHS TABLES or SELECTION GRIDS
Involves DIAGRAMS or FLOW-CHARTS
Involves SORTING of information
Contains IRRELEVANT data
Simple recall only

Skil 31: Binary: 11111
Involves GRAPHS TABLES or SELECTION GRIDS
Involves DIAGRAMS or FLOW-CHARTS
Involves SORTING of information
Contains IRRELEVANT data
Skills beyond simple recall

4. Language Values

Lang 0: Binary: 00000
Short sentences
No subordinate clauses
Short words
No ambiguous words
Grammatically structured answer required

Lang 1: Binary: 00001
Short sentences
No subordinate clauses
Short words
No ambiguous words
Single word answers

Lang 2: Binary: 00010
Short sentences
No subordinate clauses
Short words
Words in unusual contexts
Grammatically structured answer required

Lang 3: Binary: 00011
Short sentences
No subordinate clauses
Short words
Words in unusual contexts
Single word answers

Lang 4: Binary: 00100
Short sentences
No subordinate clauses
Long/Complex words
No ambiguous words
Grammatically structured answer required

Lang 5: Binary: 00101
Short sentences
No subordinate clauses
Long/Complex words
No ambiguous words
Single word answers

Lang 6: Binary: 00110
Short sentences
No subordinate clauses
Long/Complex words
Words in unusual contexts
Grammatically structured answer required

Lang 7: Binary: 00111
Short sentences
No subordinate clauses
Long/Complex words
Words in unusual contexts
Single word answers

Lang 8: Binary: 01000
Short sentences
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Grammatically structured answer required

Lang 9: Binary: 01001
Short sentences
Contains subordinate clauses
Short words
No ambiguous words
Single word answers

Lang 10: Binary: 01010
Short sentences
Contains subordinate clauses
Short words
Words in unusual contexts
Grammatically structured answer required

Lang 11: Binary: 01011
Short sentences
Contains subordinate clauses
Short words
Words in unusual contexts
Single word answers

Lang 12: Binary: 01100
Short sentences
Contains subordinate clauses
Long/Complex words
No ambiguous words
Grammatically structured answer required

Lang 13: Binary: 01101
Short sentences
Contains subordinate clauses
Long/Complex words
No ambiguous words
Single word answers

Lang 14: Binary: 01110
Short sentences
Contains subordinate clauses
Long/Complex words
Words in unusual contexts
Grammatically structured answer required

Lang 15: Binary: 01111
Short sentences
Contains subordinate clauses
Long/Complex words
Words in unusual contexts
Single word answers

Lang 16: Binary: 10000
Long sentences
No subordinate clauses
Short words
No ambiguous words
Grammatically structured answer required

Lang 17: Binary: 10001
Long sentences
No subordinate clauses
Short words
No ambiguous words
Single word answers

Lang 18: Binary: 10010
Long sentences
No subordinate clauses
Short words
Words in unusual contexts
Grammatically structured answer required

Lang 19: Binary: 10011
Long sentences
No subordinate clauses
Short words
Words in unusual contexts
Single word answers

Lang 20: Binary: 10100
Long sentences
No subordinate clauses
Long/Complex words
No ambiguous words
Grammatically structured answer required

Lang 21: Binary: 10101
Long sentences
No subordinate clauses
Long/Complex words
No ambiguous words
Single word answers

Lang 22: Binary: 10110
Long sentences
No subordinate clauses
Long/Complex words
Words in unusual contexts
Grammatically structured answer required

Lang 23: Binary: 10111
Long sentences
No subordinate clauses
Long/Complex words
Words in unusual contexts
Single word answers

Lang 24: Binary: 11000
Long sentences
Contains subordinate clauses
Short words
No ambiguous words
Grammatically structured answer required

Lang 25: Binary: 11001
Long sentences
Contains subordinate clauses
Short words
No ambiguous words
Single word answers

Lang 26: Binary: 11010
Long sentences
Contains subordinate clauses
Short words
Words in unusual contexts
Grammatically structured answer required

Lang 27: Binary: 11011
Long sentences
Contains subordinate clauses
Short words
Words in unusual contexts
Single word answers

Lang 28: Binary: 11100
Long sentences
Contains subordinate clauses
Long/Complex words
No ambiguous words
Grammatically structured answer required

Lang 29: Binary: 11101
Long sentences
Contains subordinate clauses
Long/Complex words
No ambiguous words
Single word answers

Lang 30: Binary: 11110
Long sentences
Contains subordinate clauses
Long/Complex words
Words in unusual contexts
Grammatically structured answer required

Lang 31: Binary: 11111
Long sentences
Contains subordinate clauses
Long/Complex words
Words in unusual contexts
Single word answers

Appendix F

The Problem Sets

Scottish Certificate of Education

Examinations in Chemistry

1986

[0500/10] 1986

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY

Ordinary Grade—PAPER I

Friday, 16th May—9.30 a.m. to 11.00 a.m.

All questions should be attempted. It should be noted, however, that some questions contain a choice.

Necessary data will be found in the booklets of Mathematical Tables and Science Data (1982 editions).

Candidates are reminded that 4 marks in this paper are allocated for communication skills.

TE&S 0500 10 6/6/3 36010

O grade 1986

PART A (23 marks)

Marks

All questions should be attempted. It should be noted, however, that questions 6 and 8 contain a choice.

1. Consider this list of elements:

sodium; magnesium; carbon; oxygen; sulphur; chlorine.

(*a*) Which element has 16 electrons in each of its atoms? 1

(*b*) Which element has a relative atomic mass of 12? 1

(*c*) Which element forms negative ions with the same electron arrangement as atoms of neon? 1

(3)

2. (*a*) Write the name of an ion, X, containing sulphur, which combines with one ammonium ion to give a compound, NH_4X (Data Booklet, page 8). 1

(*b*) The following reaction is an example of precipitation:

$$MgCl_2 + 2AgNO_3 \rightarrow Mg(NO_3)_2 + 2AgCl$$

Which substance is the precipitate? (Data Booklet, page 11.) 1

(2)

3. Propane burns in air according to the following equation:

$$C_3H_8 + O_2 \rightarrow CO_2 + H_2O$$

(*a*) Copy this equation and balance it. 1

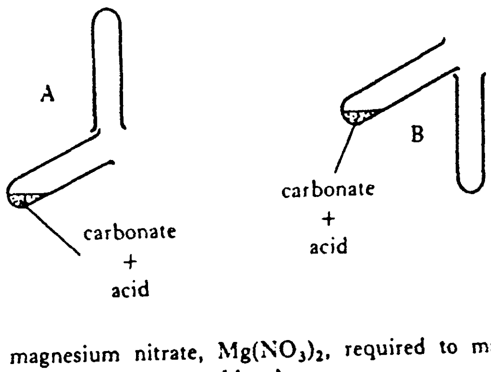
(*b*) Use your balanced equation to calculate the mass of carbon dioxide formed when 11 kg of propane are completely burned in air. **(Show your working.)** 2

(3)

4. Potassium carbonate reacts with sulphuric acid to give potassium sulphate, water and carbon dioxide.

(*a*) Write an equation for this reaction. 1

(*b*) **Explain** which of the following methods, A or B, would be more suitable for collecting the carbon dioxide. 1

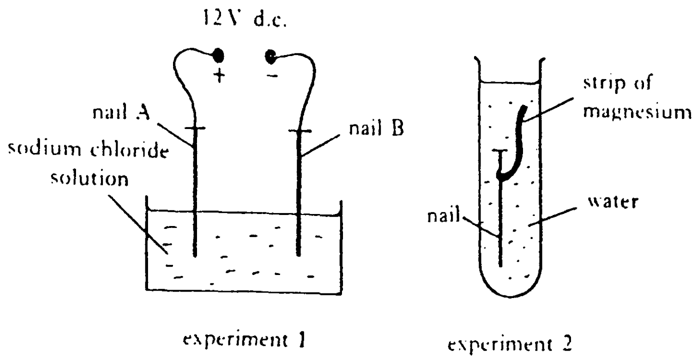


(2)

5. Calculate the mass of magnesium nitrate, $Mg(NO_3)_2$, required to make 250 cm^3 of 2 M magnesium nitrate solution. **(Show your working.)** (2)

(6) 6. Answer EITHER A OR B. *Marks*

A. Two corrosion experiments with iron nails are shown below:



(*a*) In experiment 1, which nail, A or B, will be protected against rusting? 1

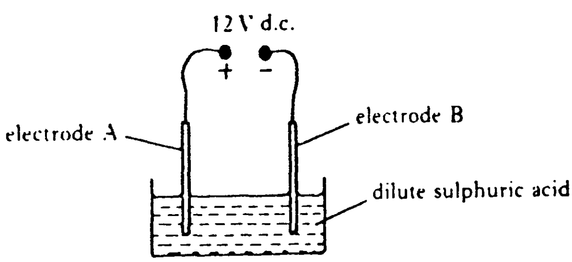
(*b*) In experiment 2, how does the magnesium protect the nail from rusting? 1

(*c*) Choose one of these experiments and describe briefly one example of how this method is actually used to protect iron or steel on a large scale. (Indicate clearly which experiment you are referring to.) 1

(3)

OR

(7) B. Aluminium can be anodised in the laboratory using the apparatus shown below:



(*a*) Which electrode, A or B, is the aluminium being anodised? 1

(*b*) Which gas is produced at the aluminium electrode as it is being anodised? 1

(*c*) Explain why anodised aluminium is resistant to corrosion. 1

(3)

(8) 7. Name the main product manufactured by:

(*a*) the Contact Process; 1

(*b*) the saponification of fats (hydrolysis with alkali); 1

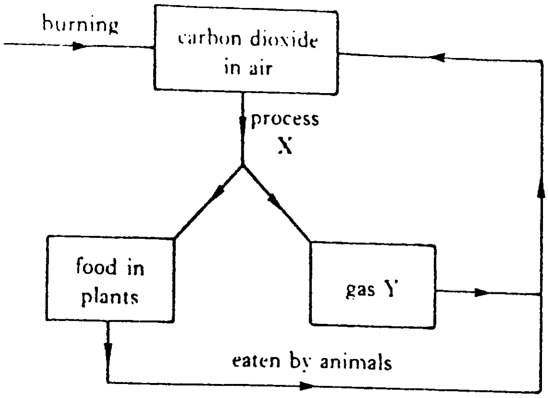
(*c*) the fermentation of glucose. 1

(3)

[Turn over

(9) 8. Answer EITHER A OR B. *Marks*

A. The flow chart shows part of the carbon dioxide cycle.



(*a*) Name process X. 1

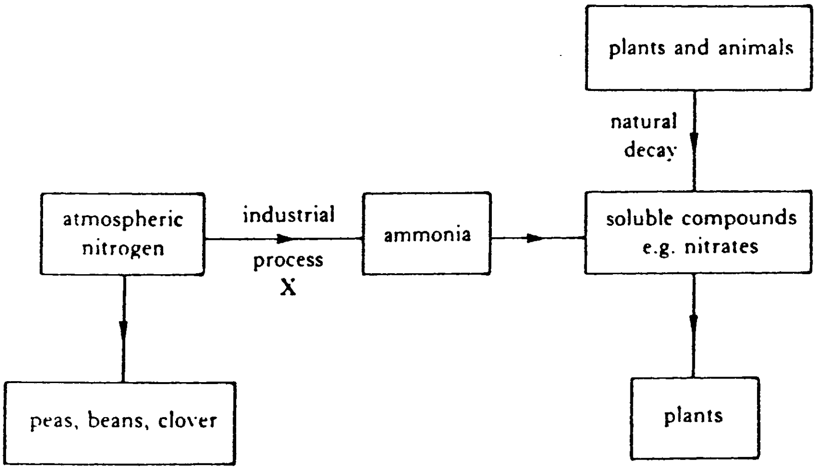
(*b*) Name gas Y. 1

(*c*) The amount of carbon dioxide entering the air has increased considerably in the last 50 years. Give a reason for this increase. 1

(3)

OR

(10) B. The flow chart shows part of the nitrogen cycle.



(*a*) What enables peas, beans and clover to use nitrogen directly from the air? 1

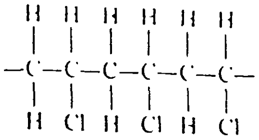
(*b*) Name the industrial process X. 1

(*c*) Crop yields have increased considerably in the last 50 years. Give a reason for this increase. 1

(3)

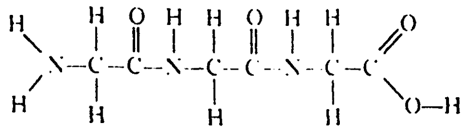
Marks

9. (*a*) Part of the structure of the polymer, poly(chloroethene) (PVC), is shown below.



Draw the full (extended) structural formula of the monomer used to make this polymer. **1**

(*b*) Consider the compound:



Hydrolysis of this compound gives 3 molecules of an amino acid. Draw the full structural formula of the amino acid obtained. **1**

(2)

[Turn over

PART B (23 marks)

Marks

All questions should be attempted. It should be noted, however, that question 12 contains a choice.

(12) 10. A pupil carried out a series of experiments involving the displacement of one metal by another. Four different metals were used and two of them, P and Q, were from unlabelled bottles. Each metal was placed, in turn, in various metal salt solutions.

The following table shows the results of the experiments. A tick (✓), indicates that a displacement reaction was seen to occur; a cross (×), that no reaction occurred.

	SOLUTIONS			
METAL	*zinc sulphate*	*iron(II) sulphate*	*copper(II) chloride*	*silver nitrate*
MAGNESIUM	✓	✓	✓	✓
COPPER	×	×	×	✓
P	×	✓	✓	✓
Q	✓	✓	✓	✓

(*a*) Suggest names for metals P and Q which would give the results shown in the table. **1**

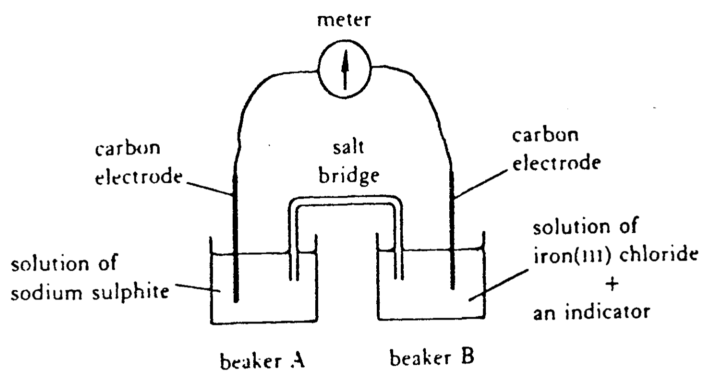
(*b*) Using your answer to (*a*), arrange the four metals in order of chemical reactivity, starting with the most reactive. **1**

(*c*) (i) What would have been the colour of the solution after the copper had reacted with the silver nitrate solution? **1**

(ii) For this reaction, write the ion-electron equation to show how the copper has changed. **1**

(4)

(13) 11.



The half-reactions which take place in the above apparatus are:

$$SO_3^{2-}(aq) + H_2O(l) \longrightarrow SO_4^{2-}(aq) + 2H^+(aq) + 2e^-$$
$$2Fe^{3+}(aq) + 2e^- \longrightarrow 2Fe^{2+}(aq)$$

As the reaction proceeds, (i) a reading is obtained on the meter;

(ii) the indicator in beaker B gradually turns blue.

(*a*) In which direction do electrons flow through the meter? **1**

(*b*) Which ion causes the indicator to turn blue? **1**

(*c*) Describe a test to show that a reaction has taken place in beaker A. You must include in your answer the names of any reagents you would use and the results you would expect to obtain. **2**

(4)

(14) 12. Answer EITHER A OR B. *Marks*

A. X and Y are different hydrocarbons having the same formula, C_6H_{12}.

Both X and Y react with bromine:

X reacts very slowly: $C_6H_{12} + Br_2 \longrightarrow C_6H_{11}Br + HBr$

Y reacts quickly: $C_6H_{12} + Br_2 \longrightarrow C_6H_{12}Br_2$

The grid contains various statements which may apply to a hydrocarbon.

It is an alkene. A	It is an unsaturated compound. B	The carbon atoms are joined by single bonds only. C
It is a saturated compound. D	It burns to produce carbon dioxide and water. E	It undergoes substitution reactions. F

(*a*) Write down the letter of **one** box which says something correct for **both** X and Y. **1**

(*b*) Write down the letters of **two** boxes which say something correct for X but **not** for Y. **2**

(*c*) Draw a full (extended) structural formula for Y. **1**

(4)

OR

(15) B. X and Y refer to 0·1 M solutions of two acids.

X is a much better conductor of electricity than Y. X reacts quickly with magnesium, Y reacts much more slowly.

The grid contains various statements which may apply to an acid solution.

It reacts with copper. A	It is neutralised by an alkali. B	It reacts with a carbonate. C
It is a solution of a strong acid. D	It contains $H^+(aq)$ ions. E	It is a solution of a weak acid. F

(*a*) Write down the letters of **two** boxes which say something correct for **both** X and Y. **2**

(*b*) Write down the letter of **one** box which says something correct for Y but **not** for X. **1**

(*c*) Write the formula of an acid which might have been used to prepare solution Y. **1**

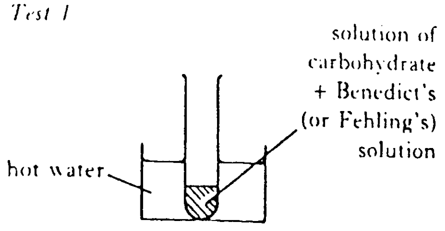
(4)

[Turn over

16

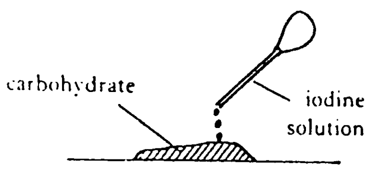
13. A carbohydrate was tested as shown in the diagram. *Marks*

Test 1



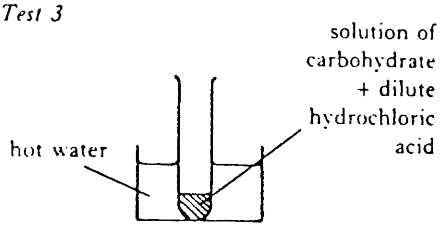
Result: no change in colour of Benedict's (or Fehling's) solution.

Test 2



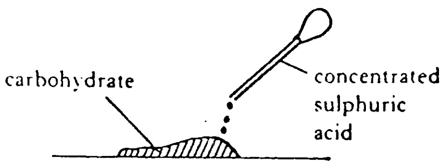
Result: iodine solution did not change colour.

Test 3



Result: after the solution was neutralised, Benedict's (Fehling's) solution gave an orange precipitate.

Test 4



Result:

?

(*a*) Complete the following sentences by writing the name of a carbohydrate each time.

(i) The carbohydrate cannot have been .... because it did not change the colour of the Benedict's (or Fehling's) solution in Test 1.

(ii) The carbohydrate cannot have been .... because it did not change the colour of the iodine solution in Test 2. **2**

(*b*) What name is given to the type of chemical reaction that occurred between the carbohydrate and the hydrochloric acid in Test 3? **1**

(*c*) Name a carbohydrate which would give the above results. **1**

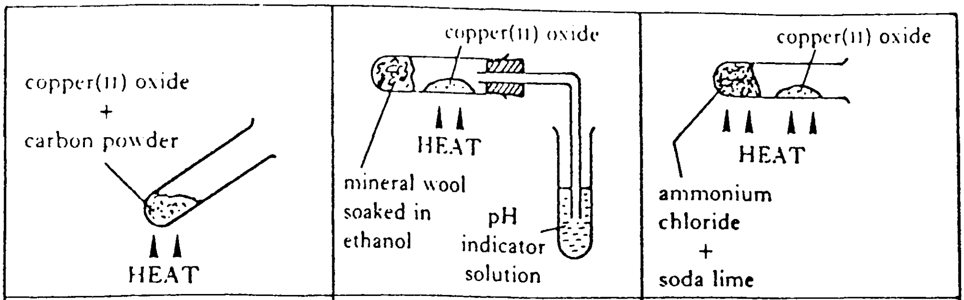
(*d*) Describe what you would see when concentrated sulphuric acid is added to the carbohydrate in Test 4 and explain why you get this result. **2**

(6)

17

Marks

14. The diagrams illustrate some reactions of copper(II) oxide.



Experiment X	Experiment Y	Experiment Z

(*a*) The same colour change is observed in the copper(II) oxide in all three experiments. What is this colour change? **1**

(*b*) Which gas is produced in Experiment X? **1**

(*c*) (i) What would happen to the pH of the solution in Experiment Y?

(ii) Name the substance causing this change. **2**

(*d*) In Experiment Z, the ammonia, produced from the ammonium chloride and soda lime, reacts with the copper(II) oxide. The copper(II) oxide is reduced to copper metal. Nitrogen and water are also formed.

Write an equation for the reaction between the ammonia and the copper(II) oxide. (The equation need not be balanced.) **1**

(5)

[END OF QUESTION PAPER]

[0500/170] 1986

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY

Higher Grade—PAPER II

Friday, 16th May—1.30 p.m. to 4.00 p.m.

Candidates are reminded that 4 marks in this paper are allocated for communication skills.

Working should be shown in all answers involving calculations.

Necessary tables and data will be found in the booklets of Mathematical Tables and Science Data (1982 editions).

TE&S 0500/170 6 6 3 22410

H grade 1986

PART A (48 marks)

All questions should be attempted. It should be noted, however, that questions 1 and 5 contain a choice.

It is suggested that about 1¼ hours be spent on this part of the paper.

Marks

1. Answer EITHER A OR B.

A. An organic compound has the formula $HCOOCH_3$.

(*a*) Name this compound. 1

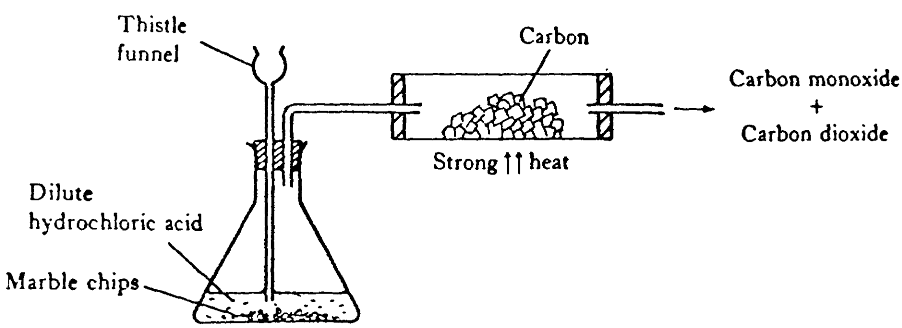
(*b*) Write its empirical formula. 1

(2)

OR

B. Draw the full structural formula of 2,2,4-trimethylpentane. (All bonds must be shown.) (2)

2. A sample of carbon monoxide, contaminated with carbon dioxide, may be obtained as shown below.



Sketch and label ADDITIONAL apparatus (and reagents) required to remove the carbon dioxide and collect the carbon monoxide over water. (2)

3. Calculate the volume (at s.t.p.) of oxygen required for the complete combustion of 1 g of ethene. (3)

4. Calculate the number of electrons in 6 g of magnesium (II) ions. (3)

Marks

6

5. Answer EITHER A OR B.

A. (*a*) Which type of bonding exists in (i) sulphur;

(ii) aluminium? **1**

(*b*) Use the Data Booklet (page 2) to find the melting points of these elements. **1**

(*c*) Explain why the melting point of aluminium is high. **1**

(3)

OR

7

B. (*a*) Which type of bonding exists in (i) sulphur dioxide;

(ii) silicon dioxide? **1**

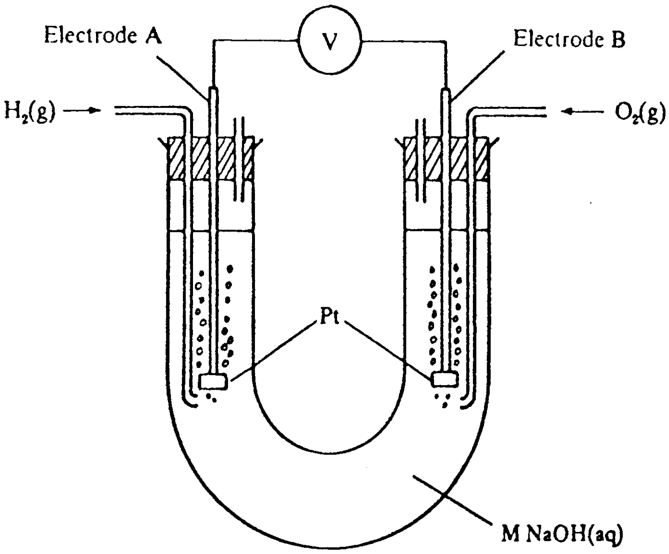
(*b*) Use the Data Booklet (page 9) to find the boiling points of these compounds. **1**

(*c*) Explain why the boiling point of sulphur dioxide is low. **1**

(3)

8

6. Some fuel cells are based on the fact that electricity can be produced by supplying oxygen and hydrogen to platinum electrodes immersed in sodium hydroxide solution.



(*a*) Using the Data Booklet (page 7), write an ion-electron equation for the reaction taking place at (i) electrode A,

(ii) electrode B. **2**

(*b*) Calculate the voltage that would be expected from this fuel cell. (Assume standard conditions.) **1**

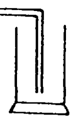
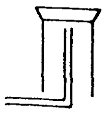
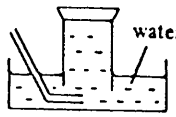
(3)

[Turn over

9

7. *Marks*

Drying agent	(A) CaO	(B) H_2SO_4

Method of collection	(C) 	(D) 	(E) 

For the preparation of a sample of dry ammonia,

(*a*) select a suitable drying agent and **explain** your choice; **2**

(*b*) select a suitable method of collection and **explain** your choice. **2**

(4)

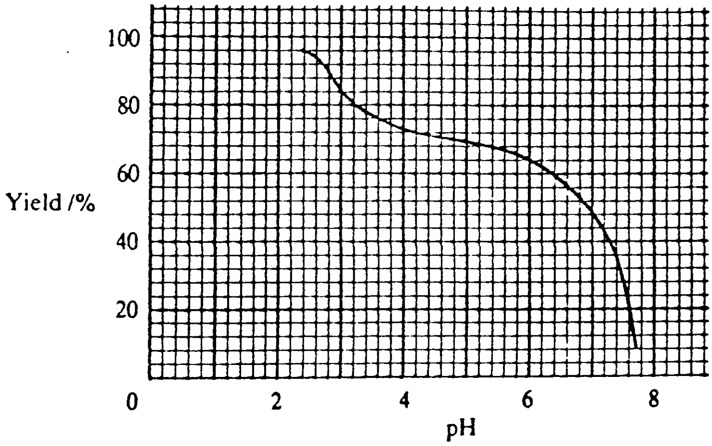
10

8. The following equation shows how bromine can be extracted from sea water.

$$Cl_2(g) + 2Br^-(aq) \longrightarrow Br_2(aq) + 2Cl^-(aq)$$

(*a*) Which type of chemical reaction is represented by this equation? **1**

(*b*) The graph shows the effect of pH on the yield of bromine obtained.



What happens to the yield of bromine as the sea water becomes more acidic? **1**

(*c*) Would chlorine be a suitable reagent for obtaining fluorine from fluoride ions? **Explain your answer.** **2**

(4)

Marks

11 **9.** The following terms are used in thermochemistry:

Ionisation energy (enthalpy)	Sublimation enthalpy	Electron affinity
Enthalpy of formation	Lattice enthalpy	Dissociation enthalpy

(*a*) Which term is associated with each of the following?

(i) $Cl(g) + e^- \longrightarrow Cl^-(g)$

(ii) $Na^+Cl^-(s) \longrightarrow Na^+(g) + Cl^-(g)$

(iii) $C(s) + 2Cl_2(g) \longrightarrow CCl_4(\ell)$ **3**

(*b*) Which of the above equations represents an endothermic process? **1**

(4)

12 **10.** A copper compound was known to contain either copper(I) or copper(II) ions.

The compound was dissolved in water and electrolysed. It was found that 0·32 g of copper was formed after the electrolysis cell had been operating for 16 minutes with a steady current of 1·0 A.

(*a*) At which electrode would copper have been formed? **1**

(*b*) Using the above information, determine which copper ion was present. **Working must be shown.** **3**

(4)

13 **11.** (*a*) (i) What shape are the crystals of both sodium chloride and caesium chloride? **1**

(ii) In these crystals, each sodium ion is surrounded by six chloride ions whereas each caesium ion is surrounded by eight chloride ions.

Describe the lattice arrangement in each of these compounds and explain why they are different. **2**

(*b*)

$$NaOH(s) \longrightarrow NaOH(aq) \quad \Delta H = a$$

$$NaOH(s) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(\ell) \quad \Delta H = b$$

$$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(\ell) \quad \Delta H = c$$

From the above data, write an equation to show the relationship between a, b, and c. **2**

(5)

14 **12.** Two isomeric straight-chain alkanols, having four carbon atoms, are known.

(*a*) Draw a structural formula for each of these alkanols. **2**

(*b*) Name a reagent which could be used to oxidise each of these alkanols to a carbonyl compound. **1**

(*c*) How could the carbonyl compounds be distinguished by a chemical test? State the results of the test. **2**

(5)

[Turn over

Marks

15

13.

Acid	pH of 2M aqueous solution
A CCl_3COOH	0·50
B $CHCl_2COOH$	0·90

(a) Which is the stronger acid? Explain your choice. 2

(b) Acid A dissociates in water as follows:

$$CCl_3COOH(aq) \rightleftharpoons CCl_3COO^-(aq) + H^+(aq).$$

How would the equilibrium be affected by the addition of

(i) solid $NaOH$;

(ii) solid $NaCl$;

(iii) solid CH_3COONa? 3

(c) Explain your answer in the case of solid CH_3COONa. 1

(6)

PART B (48 marks)

All four questions should be attempted. It should be noted however that question 17 contains a choice.

Candidates are advised to spend about 1¼ hours on this part.

Marks

16

14. The following are variables which can affect the progress of a chemical reaction.

temperature	light	catalyst	concentration
particle size	stirring	pressure	inhibitor

(*a*) (i) In the chain reaction between hydrogen and chlorine, which of the above is commonly used to initiate (start) the reaction? **1**

(ii) Explain how this causes the reaction to begin. **1**

(iii) Name the two other stages in a chain reaction. **1**

(*b*) Which of the above variables will alter the position of equilibrium in the following reaction?

$$N_2(g) + O_2(g) \leftrightharpoons 2NO(g) \quad \Delta H = +90\,kJ\,mol^{-1}$$ **2**

(*c*) Explain why reactions involving solids tend to go faster when the solids are finely divided. **2**

(*d*) A mixture of hydrogen and oxygen does not react at room temperature. When a piece of clean platinum is placed in the mixture, the hydrogen and oxygen react explosively.

(i) Explain why hydrogen and oxygen do not react at room temperature. **1**

(ii) What is the purpose of the platinum? **1**

(iii) Discuss and explain how the platinum functions. **3**

(12)

[Turn over

17

Marks

15. The names or formulae of some compounds are shown in the table below.
The questions which follow are based on the table.

propane	$C_2H_5NH_2$	ethyl propanoate	hex-1-ene
C_2H_5CHO	phenol	C_3H_6	propyne
phenylamine (aniline)	CH_3COCH_3	propan-1-ol	C_6H_6

(*a*) Name the compound with formula C_3H_4. **1**

(*b*) Which compound is an ester? **1**

(*c*) Which substances are basic in character? **2**

(*d*) Select **two** compounds which can be prepared directly (in one step) from propan-1-ol. **2**

(*e*) Which two compounds are isomers? **1**

(*f*) (i) Which chemical (**not** in the table) would be suitable for removing phenol from a sample of benzene contaminated with phenol? **1**

(ii) Describe briefly how this would be done in the laboratory. **1**

(*g*) Discuss any differences in structure or chemical behaviour between benzene (C_6H_6) and hex-1-ene (C_6H_{12}).

Mention three differences apart from the number of hydrogen atoms. **3**

(12)

Marks

(18)

16. (a) The extraction of phosphorus is similar to that of iron. Calcium phosphate is heated with sand and coke in an electric furnace at about 1500 °C. The sand (SiO_2) combines with the calcium phosphate forming slag and phosphorus(V) oxide. The phosphorus(V) oxide is reduced by the coke to phosphorus which is removed from the furnace and stored under water.

(i) What is the chemical name for the molten slag which forms during the reaction? 1

(ii) Why is it relatively easy to remove the phosphorus from the furnace? (You may wish to consult the Data Booklet.) 1

(iii) Why is the phosphorus stored under water? 1

(b) Phosphoric acid, (H_3PO_4), is triprotic (tribasic).

(i) Write correct formulae for two of the three calcium salts of this acid. 2

(ii) For one of the salts you have chosen, calculate the percentage by mass of phosphorus present. 2

(c) Phosphorus forms two hydrides PH_3 and P_2H_4.

(i) 0·152 g of a hydride of phosphorus has a volume of $100\,cm^3$ at s.t.p. Calculate the mass of one mole of the hydride and identify it. 3

(ii) Liquid ammonia boils at $-33\,°C$ but liquid phosphine (PH_3) boils at $-87{\cdot}5\,°C$. Explain this difference in terms of bonding. 1

(iii) Both ammonia and phosphine molecules have the same shape. Draw this shape. 1

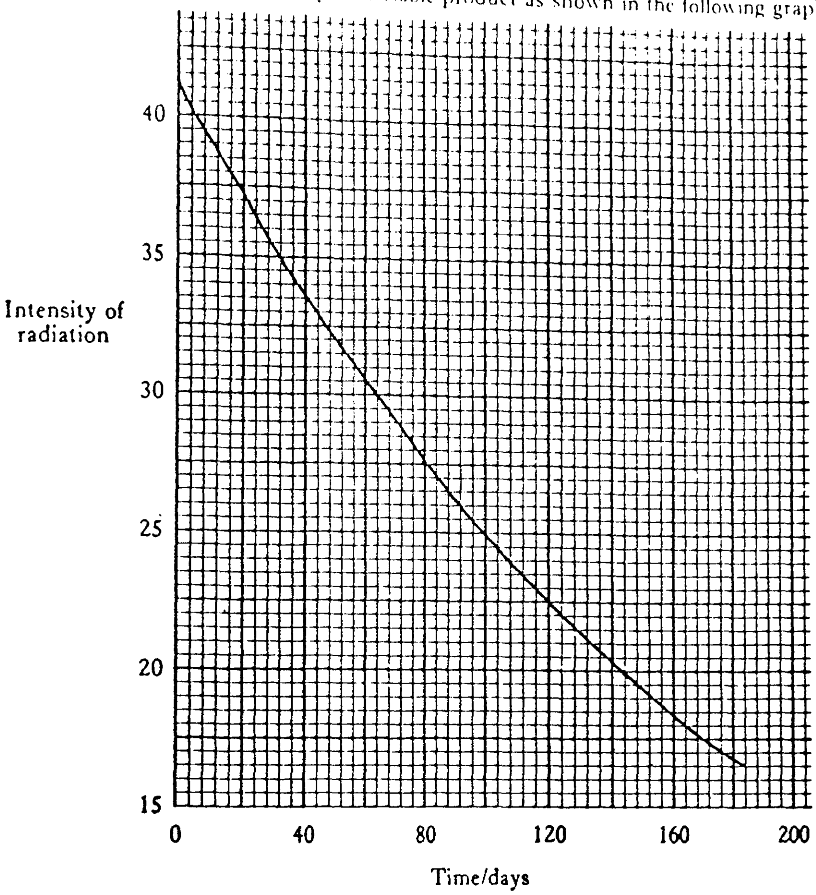
(12)

[Turn over

(19)

17. Answer EITHER A OR B. *Marks*

A. (*a*) A radioisotope X decays to a stable product as shown in the following graph.



(i) Determine the half-life of X. **1**

(ii) Identify X. (Use the Data Booklet, page 3.) **1**

(iii) Write a nuclear equation for the decay of X. **1**

(*b*) The mass spectrometer is used to determine mass numbers.

(i) Which type of particle moves through a mass spectrometer? **1**

(ii) Explain the significance of the word relative in the term "relative atomic mass". **1**

(iii) Neon has two isotopes ^{20}Ne and ^{x}Ne.

If the relative atomic mass of neon is 20·2 and the abundance of ^{20}Ne is 90%, calculate the mass number, x, of the second isotope. (**Working must be shown.**) **2**

(*c*) Many radioisotopes are made by bombarding stable atoms with alpha particles, neutrons or protons.

(i) Explain why neutrons are widely used for producing radioisotopes. **1**

(ii) Why are beta particles not used to produce radioisotopes? **1**

(iii) Explain how radioactivity can be used to estimate the age of organic remains. **3**

(12)

20

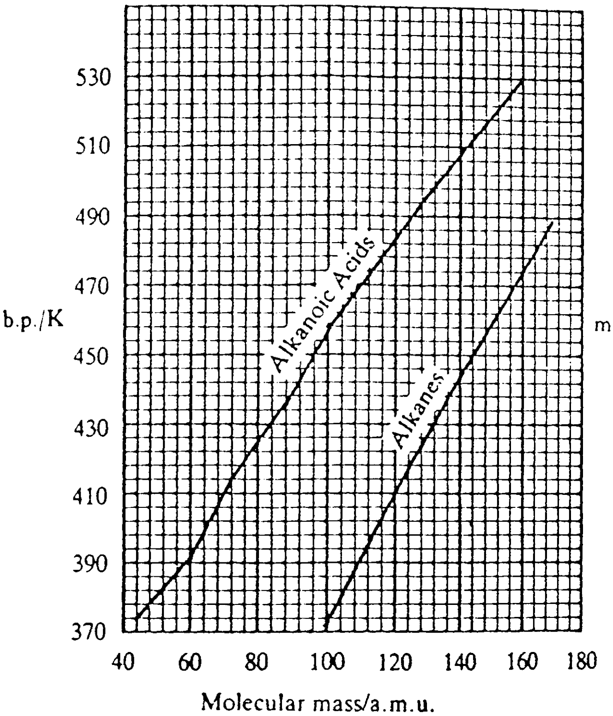
Marks

OR

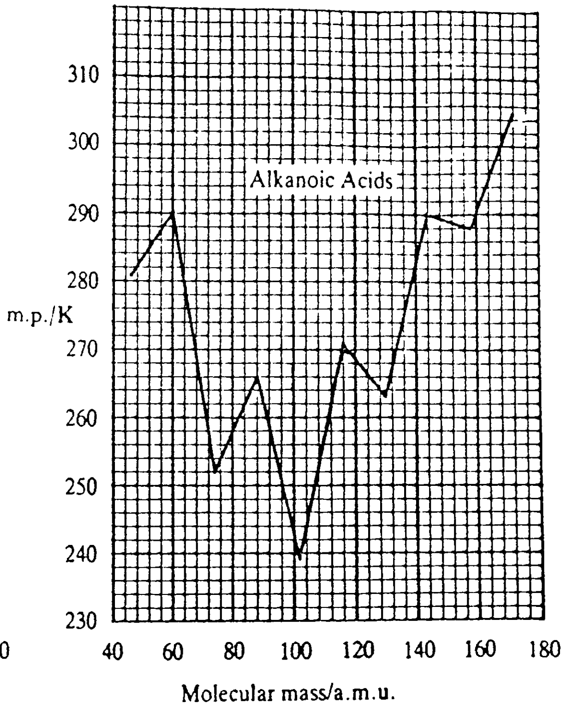
B. Graph 1 shows how the boiling points of the straight-chain alkanoic acids and the straight-chain alkanes vary with molecular mass.

Graph 2 shows how the melting points of the straight-chain alkanoic acids vary with molecular mass.

GRAPH 1 — BOILING POINTS



GRAPH 2 — MELTING POINTS



The following questions relate to Graph 1.

(*a*) What are the boiling points of the alkanes of molecular mass

(i) 100 a.m.u.;

(ii) 128 a.m.u.? **2**

(*b*) Why do the boiling points of the alkanes increase with increasing molecular mass? **1**

(*c*) An alkanoic acid contains 6 carbon atoms.

(i) Give its formula and molecular mass. **2**

(ii) Name the alkane of comparable mass. **1**

(iii) What accounts for the higher boiling point of the alkanoic acid? **1**

The following questions relate to Graph 2.

(*d*) The melting points of the alkanoic acids are anomalous. Explain what is meant by the word "anomalous". **1**

(*e*) How many carbon atoms are there in the alkanoic acid which is a solid at room temperature (assume 293K)? **2**

(*f*) Explain why propanoic acid is found in the laboratory as a liquid but ethanoic acid is found sometimes as a liquid and sometimes as a solid. **2**

(12)

[*END OF QUESTION PAPER*]

[0500/269] 1986

CERTIFICATE OF SIXTH YEAR STUDIES

CHEMISTRY

PAPER I

Friday, 16th May—9.30 a.m. to 12.00 noon

All questions should be attempted. It should be noted however that some questions contain a choice.

Three marks will be awarded for communication skills in this paper with one of these marks being allocated to question 15.

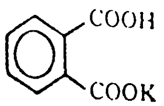
Necessary data will be found in the booklets of Mathematical Tables and Science Data (1982 editions).

TE&S 0500/269 6/6/3/5326

CSYS, 1986

Marks

1. Volumetric analysis procedures require the use of primary standards such as potassium hydrogen phthalate –



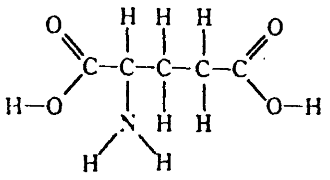
because they meet certain requirements.

(*a*) What is meant by a primary standard? **1**

(*b*) Give **two** necessary requirements of a primary standard. **2**

(3)

2. Glutamic acid has the structure



(*a*) How many moles of

(i) HCl,

(ii) NaOH,

would react with one mole of glutamic acid? **2**

(*b*) Monosodium glutamate is a common flavour enhancer added to tinned foods.

(i) Draw the full structural formula for monosodium glutamate. **1**

(ii) The use of such food additives is a matter of public concern.

Discuss briefly why this is so. **2**

(5)

Marks

3. Answer EITHER A OR B

3

A. The following reagents can be obtained as crystalline solids:

Reagent	*Formula*
X	$FeSO_4(NH_4)_2SO_4.6H_2O$
Y	$Ce(SO_4)_2\ 2(NH_4)_2SO_4.2H_2O$

Solutions of these reagents react as follows:

$Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e^-$
green brown

$Ce^{4+}(aq) + e^- \rightarrow Ce^{3+}(aq)$
yellow colourless

1·50 g of tablets containing iron (II) gluconate, used to treat iron deficiency in the body, were dissolved in dilute sulphuric acid. The solution was titrated against 0·12 M solution of reagent Y. The end point was reached when 25 cm^3 of the reagent were added.

(*a*) Calculate the percentage of iron (by mass) present in the iron (II) gluconate tablets. **4**

(*b*) Explain why reagent X is coloured both in aqueous solution and in the solid state. **2**

(*c*) The concentration of $Ce^{4+}(aq)$ could be measured by colorimetry.
What colour of filter would be used in this technique? **1**

(7)

OR

4

B. A metal chloride (6·05 g) was dissolved in water and the solution made up to a final volume of 100 cm^3. A solution of silver (I) nitrate containing 34 gl^{-1} was titrated against 20 cm^3 of the metal chloride solution. The end point was detected when 50 cm^3 of the silver (I) nitrate solution had been added.

(*a*) Calculate the molarity of the silver (I) nitrate solution. **1**

(*b*) What mass of metal is present in the metal chloride sample? **4**

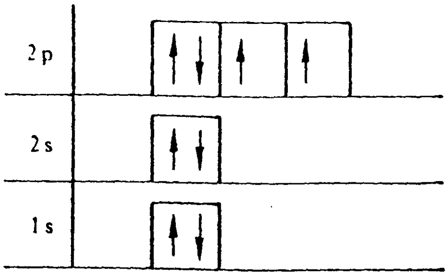
(*c*) Use the experimental results to establish that the metal chloride is rubidium chloride. **2**

(7)

[Turn over

Marks

5 **4.**



The electron configuration of an oxygen atom may be represented as shown above.

(*a*) Explain how this structural representation agrees with

(i) the Pauli exclusion principle,

(ii) Hund's Rule of maximum multiplicity. **2**

(*b*) The three 2p orbitals are degenerate.

(i) What does this mean? **1**

(ii) How do the three 2p orbitals differ from each other? **1**

(*c*) The electron configuration of oxygen may also be represented as

$$1s^2 2s^2 2p^4$$

Draw the electron configuration of the Mn^{2+} ion in this way. **1**

(5)

6 **5.** Answer **EITHER A OR B.**

A. As an ionic solute crystallises it forms a *more orderly* structure, yet there can sometimes be an *increase* in entropy during crystallisation of some ionic solutions.

Explain the apparent contradiction in these cases. **(2)**

OR

7 **B.** Endothermic reactions are those which involve an *increase* in enthalpy. Many pupils are surprised when they find that such reactions cause a *drop* in temperature.

Explain why there is no real contradiction in this case. **(2)**

8 **6.** The reaction between iron(III) ions and vanadium(III) ions is first order with respect to both species.

$$Fe^{3+}(aq) + V^{3+}(aq) \rightarrow Fe^{2+}(aq) + V^{4+}(aq)$$

In the presence of copper (II) ions the reaction proceeds much more rapidly and there is evidence to suggest the following mechanism:

(i) $Cu^{2+}(aq) + V^{3+}(aq) \xrightarrow{\text{slow}} Cu^{+}(aq) + V^{4+}(aq)$

(ii) $Cu^{+}(aq) + Fe^{3+}(aq) \xrightarrow{\text{fast}} Cu^{2+}(aq) + Fe^{2+}(aq)$

(*a*) Write the rate expression for the reaction between iron (III) ions and vanadium (III) ions. **1**

(*b*) What is the order of reaction with respect to iron (III) ions when copper (II) ions are present? Explain your answer. **2**

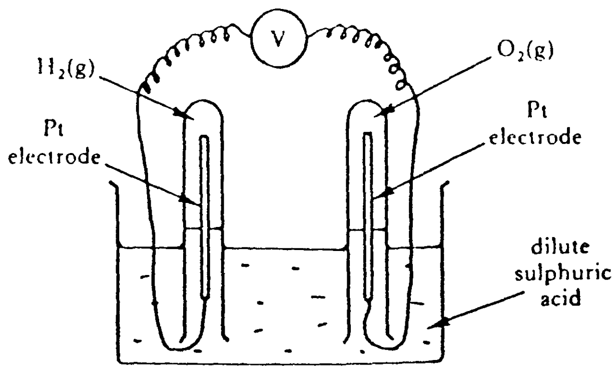
(*c*) In addition to the observation that copper (II) ions alter the rate, what indication is there that the copper (II) ions are acting as a catalyst for the reaction? **1**

(4)

Marks

9

7. A simple fuel cell can be constructed as follows:



The overall cell reaction can be represented by:

$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(\ell)$$

for which $\Delta G^\circ_{298} = -237\ \text{kJ mol}^{-1}$

$\Delta H^\circ_{298} = -286\ \text{kJ mol}^{-1}$

(*a*) Use the data book to write half-equations for the reactions occurring at each electrode during the operation of the cell. **2**

(*b*) Calculate the standard voltage of the fuel cell. **2**

(*c*) Calculate ΔS°_{298} for the cell reaction and explain why there is a significant entropy change. **3**

(*d*) In the 1980s research is likely to continue into the development of the electric car.

Discuss some of the advantages and disadvantages of such a vehicle. **2**

(9)

10

8. The following equations are for two hydrolyses:

$SiCl_4(\ell) + 2H_2O(\ell) \rightarrow SiO_2(s) + 4HCl(g)$ $\quad \Delta G^\circ_{298} = -139\ \text{kJ}$

$CCl_4(\ell) + 2H_2O(\ell) \rightarrow CO_2(g) + 4HCl(g)$ $\quad \Delta G^\circ_{298} = -234\ \text{kJ}$

(*a*) From this information alone what predictions can be made about their

(i) feasibility,

(ii) position of equilibrium,

(iii) rate? **3**

(*b*) In practice, the addition of water to tetrachlorosilane ($SiCl_4$) results in an immediate vigorous hydrolysis. The addition of water to tetrachloromethane has no effect even with prolonged boiling.

Suggest an explanation for this difference. **1**

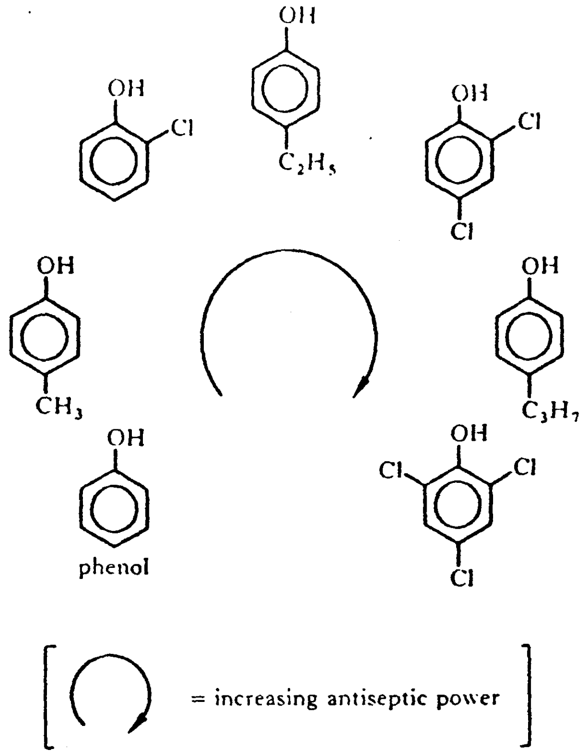
(4)

[Turn over

Marks

11

9. The effectiveness of phenol as an antiseptic was improved by structural modifications:



(a) Suggest why, apart from its lower antiseptic power, it was found necessary to discontinue the use of phenol as an antiseptic. **1**

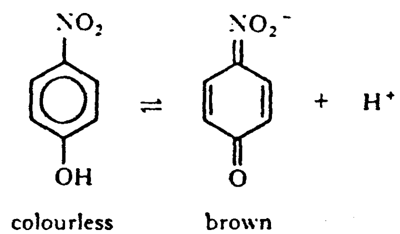
(b) Describe the trends which appear to have improved the antiseptic quality of phenol. **2**

(c) Sketch the structural formula of a molecule likely to exceed the antiseptic power of the final molecule in the sequence given. **1**

(4)

12

10. The compound $C_6H_4(NO_2)OH$ behaves as a simple acid/base indicator.
It exists in the equilibrium:

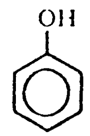
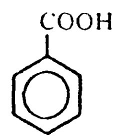
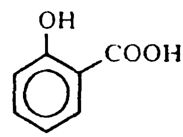


Explain how this system operates as an indicator. **(2)**

13

11. Answer EITHER A OR B.

A. Consider the data for three compounds:

	Compound X	*Compound Y*	*Compound Z*
			
K_a	$1{\cdot}0 \times 10^{-10}$	$6{\cdot}3 \times 10^{-5}$	—
pK_a	$10{\cdot}0$	—	$2{\cdot}99$

(*a*) Write an equation showing the ionisation for which the given pK_a value of compound Z applies. **1**

(*b*) Calculate (i) pK_a for compound Y,
(ii) K_a for compound Z. **2**

(*c*) Calculate the pH of a 0·0001 M solution of compound X. **2**

(*d*) Hydrogen bonding occurs between molecules in samples of compound Y.
(i) What effect does this produce in an infra-red spectrum of the compound? **1**
(ii) Suggest one other property of compound Y which is affected by hydrogen bonding. **1**

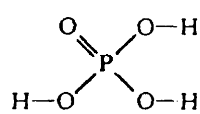
(*e*) It has been suggested that there is an *intramolecular* hydrogen bond in compound Z. Draw the full structural formula of compound Z and indicate this hydrogen bonding. **1**

(8)

14

OR

B. A hydrogen atom bonded to phosphorus is not as readily ionised as a hydrogen atom bonded to oxygen. This is important in the chemistry of acids of phosphorus, e.g., H_3PO_4 is a triprotic acid with the full structural formula:



(*a*) What is meant by the term "triprotic"? **1**

(*b*) Suggest full structural formulae for (i) H_3PO_2 a monoprotic acid,
(ii) H_3PO_3 a diprotic acid. **2**

(*c*) The following equilibria occur in aqueous hydrofluoric acid.

Equilibrium ①: $HF(aq) \rightleftharpoons H^+(aq) + F^-(aq)$

Equilibrium ②: $HF(aq) + F^-(aq) \rightleftharpoons HF_2^-(aq)$

(i) Write expressions for the equilibrium constants K_1 and K_2 for equilibria ① and ② respectively. **2**

(ii) Calculate the concentration of hydrogen ions in a solution of 1 M HF(aq) where $K_1 = 7{\cdot}0 \times 10^{-4}$ mol l^{-1}. **2**

(iii) State the units for K_2. **1**

(8)

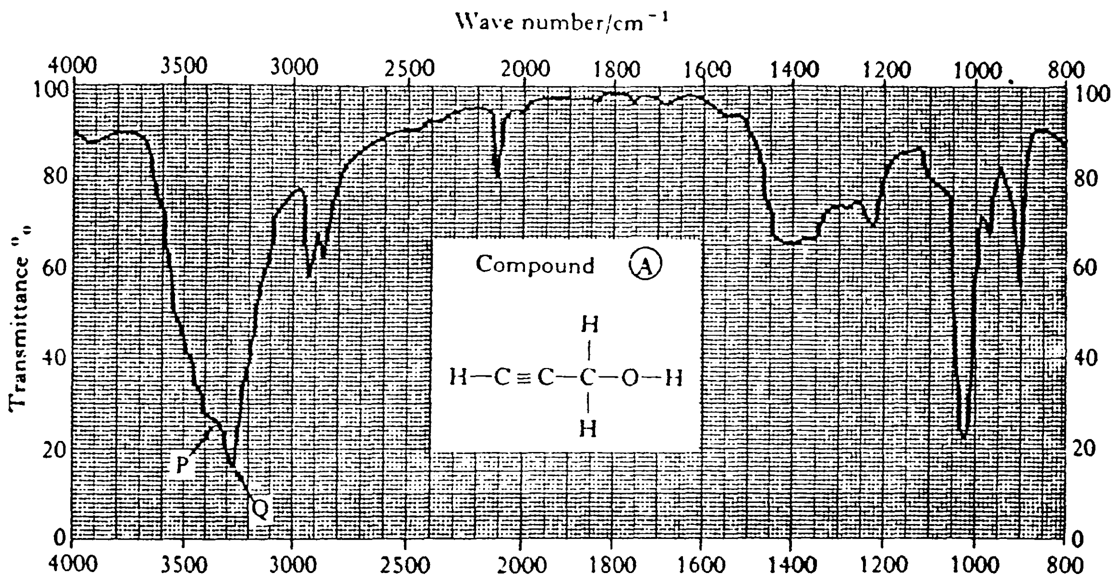
15

12. The bonds of functional groups on organic molecules absorb radiation of different wave number, making identification of functional groups possible.

The table below shows the range of radiation absorbed by the bonds indicated with thicker lines.

Bond Type	*Wave number/cm^{-1}*
O—H	3600-3200
C≡C—H	3300–3260
C=C—H	3100–3000
C—C—H	2950–2850
C≡C	2250–2100
C=O	1850–1650
C=C	1650–1600
C—O	1250–1050

A typical infra-red spectrum is shown here:



Note that peak Q is due to the absorbance of infra-red radiation by the bond C—H in C≡C—H.

Marks

A series of reactions is performed with compound Ⓐ as the starting material:

$$Ⓐ \xrightarrow[\text{1 mole}]{H_2} Ⓑ \xrightarrow[\text{1 mole}]{H_2} Ⓒ \longrightarrow Ⓓ$$

(*a*) (i) How would the spectrum of compound Ⓑ differ from that of compound Ⓐ? **1**

(ii) How would the spectrum of compound Ⓒ differ from that of compound Ⓑ? **1**

(*b*) The spectrum of compound Ⓓ (C_3H_6O) shows no peaks P and Q but a new peak is present at wave number 1740 cm^{-1}.

(i) Draw the full structural formula for Ⓓ. **1**

(ii) Suggest a suitable reagent for converting Ⓒ to Ⓓ. **1**

(*c*) In practice, it is highly unlikely that one mole of compound Ⓓ could be obtained by carrying out this series of reactions on one mole of compound Ⓐ.

Suggest two possible reasons for this. **2**

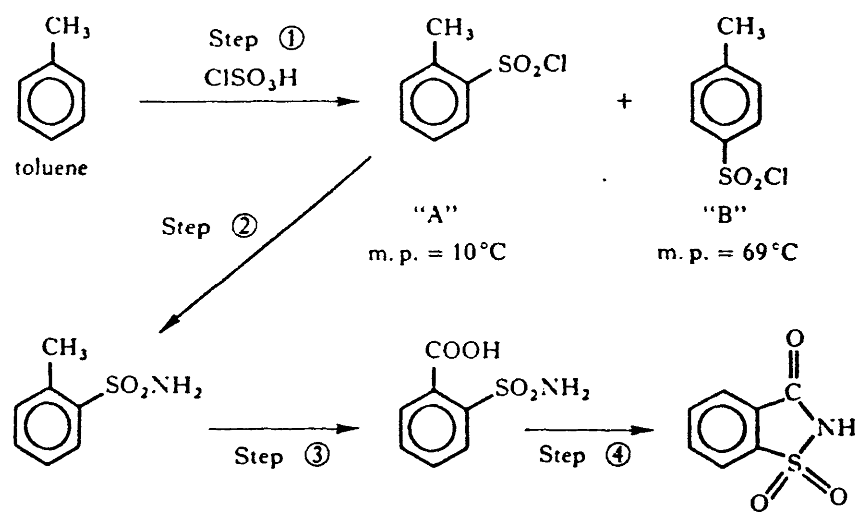
(*d*) Compounds Ⓑ and Ⓓ are isomers. A third isomer has a similar infra-red spectrum to that of compound Ⓓ.

Identify this isomer. **1**

(7)

16

13. A possible synthesis of saccharin is outlined below:



saccharin

(*a*) (i) What is the systematic name of toluene? **1**

(ii) What type of attack on toluene occurs in step ①? **1**

(iii) Throughout this series of reactions the aromatic ring remains intact.

Account for this stability. **1**

(*b*) Suggest a suitable method for separating the compound "A" from compound "B". **1**

(*c*) What type of reaction is involved in

(i) step ③,

(ii) step ④? **2**

(6)

[Turn over

Marks

(17)

14\. Titanium was first extracted in 1910. It occurs as titanium dioxide in the ore, rutile.

Large scale production of the metal was not carried out until the middle of the twentieth century but it is now expanding rapidly.

(*a*) Reduction of the oxide by heating with carbon is feasible but uneconomic.

(i) Suggest a reason for this. **1**

(ii) What undesirable property would be imparted to the titanium as a result of incompletely-removed carbon? **1**

(*b*) The first stage in the extraction involves roasting the oxide with carbon in a stream of chlorine. The equation for the reaction is

$$TiO_2 + 2C + 2Cl_2 \rightarrow TiCl_4 + 2CO$$

Compound	m.p./K	b.p./K
TiO_2	2098	very high
$TiCl_4$	248	401

Use the data to explain

(i) how the $TiCl_4$ can be separated from unused reactants;

(ii) why $TiCl_4$ cannot be electrolysed to produce the metal. **2**

(*c*) The metal can be produced by heating $TiCl_4$ with magnesium in an atmosphere of argon.

(i) Write the balanced equation for this reaction. **1**

(ii) Why is the argon atmosphere required? **1**

(iii) How could the magnesium be recovered? **1**

(7)

Marks

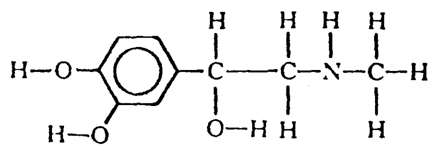
15. Answer EITHER A OR B OR C.

18 **A.** "In the chemical industry, the siting of a manufacturing plant and the conditions used to operate the chemical reactions within it are decided by social and economic factors. Other important considerations are energy requirements and environmental effects."

Discuss this statement with reference to any **one** common industrial process. **(4)**

OR

19 **B.** "The structural formula of the hormone adrenaline is shown below.



This formula does not indicate the true shape of the molecule. For example, in the terminal methyl group the bonds are arranged tetrahedrally around the carbon atom."

Discuss other parts of the molecule in this way. **(4)**

OR

20 **C.** "Wool and silk have been important fibres for many centuries. Nylon and chemically-related synthetic fibres now make a significant contribution to the textile industries."

Discuss the similarities and differences in structures and properties of the nylons and the natural fibres.

Comment on factors which may affect the relative proportion of the market gained by natural and synthetic fibres in the future. **(4)**

[END OF QUESTION PAPER]

Appendix G

Selection of Pass Marks in Problem Sets

Selection of Pass Marks in Problem Sets

In most of the problems selected, the pass mark has been selected as one-half of the marks available, rounded up to the nearest whole number in those cases where half marks would not normally be awarded. There are, however, some instances in which all parts of the question involve the same skills, and it is possible to have a pass mark equal to the available mark. The Problem number is followed by the Question number. In setting the pass marks, reference was made to the "Instructions to Markers" produced by the Scottish Examination Board, with respect to the probability of awarding half marks.

Ordinary Grade Problems

1.	1.	This has three parts, each with 1 mark. Only one word answers are expected, so half marks are not possible: furthermore, all parts involve the same skill. Thus the pass mark = 3/3.
2.	2.	One word answers, from the same page of the Data Book, each for 1 mark. Pass = 2/2.
3.	3.	Two parts, for 1 mark plus 2 marks. Since the second part depends on the first part for its answer, to gain a mark for it implies having gained 1 mark in the first part, so pass = 2/3.
4.	4.	Two parts, each one mark. Separate issues, therefore pass mark = 1/2.
5.	5.	This consists of one calculation which has several stages, and is worth 2 marks in total. Partial marks are unlikely in this case, so pass = 2/2.
6.	6A.	Three parts, each worth 1 mark. Part (c) involves selection of one of the other parts, so an acceptable pass = 2/3.
7.	6B.	Three parts, each 1 mark, which are all related. Partial understanding is possible, so pass = 2/3.
8.	7.	Three parts, each separate, worth 1 mark. Pass = 2/3.
9.	8A.	Three parts, each 1 mark. Two parts related to flowchart, and one general question. Pass = 2/3.
10.	8B.	Similar to question 8A. Pass = 2/3.
11.	9.	Two parts, each 1 mark, same skills involved, therefore pass = 2/2.
12.	10.	Three parts, with 1, 1 and 2 marks respectively. Parts (a) and (b) are similar, and (c) separate. Pass mark set at 3/4 because success in (a) leads to success in (b).

13. 11. Three parts, with 1, 1 and 2 marks. Pass mark set at 2/4 (correct answering of (a) and (b)).

14. 12A. Three parts, marked 1, 2 and 1. 3 marks for grid question, 1 for supplying a formula. Pass = 2/4.

15. 12B. Exactly similar to problem 14. Pass = 2/4.

16. 13. Four parts, with 2, 1, 1 and 2 marks respectively. All parts are related to a single compound, so pass mark is set at 4/6, on the grounds that if the candidate identifies the sugar involved, then total success is very probable, but failure to do this renders success very unlikely.

17. 14. Four parts, with 1, 1, 2 and 1 marks respectively. Refers to a specific part of the syllabus. Half marks are unlikely, except in part (d). Pass mark set at 3/5.

Higher Grade Problems

1. 1A. Two parts, each 1 mark. Separate problems, so pass mark set at 1/2.

2. 1B. One part, single problem. Pass = 2/2, because partial knowledge is misleading in structural formulae problems.

3. 2. Drawing of apparatus, 2 marks. Pass = 1/2.

4. 3. Calculation, 3 marks. Partial success is possible, so pass = 1.5/3.

5. 4. Similar to problem 4. Pass = 1.5/3.

6. 5A. Three parts, all separate. Short answers, but half marks are possible, so pass = 1.5/3.

7. 5B. Similar to problem 6. Pass = 1.5/3.

8. 6. Two parts, marked 2 and 1. Either the candidate succeeds completely in each part, or fails completely. Pass mark = 2/3.

9. 7. Two parts, 2 marks each. Selection from grid, then explanation in each case. Pass = 2/4.

10. 8. Three parts, 1, 1 and 2 marks. Half marks are quite feasible. Pass = 2/4.

11. 9. Two parts, 3 and 1 marks. Each sub-section is separate. Pass mark = 2/4.

12. 10. Two parts, marked 1 and 3. Second part is a multi-stage calculation which allows credit for partial knowledge. Pass mark = 2/4.

13. 11. Two parts, 3 and 2 marks. Half marks unlikely. Pass mark = 3/5.

14. 12. Three parts, with 2, 1 and 2 marks. Half marks are unlikely, so pass mark = 3/5.

15. 13. Three parts, 2, 3 and 1 marks respectively. Pass mark = 3/6.

16. 14. Four parts, with 3, 2, 2 and 5 marks. Half marks were possible. Pass mark = 6/12.

17. 15. Seven parts, 1, 1, 2, 2, 1, 2 and 3 marks respectively. Half marks unlikely, but since the total is even, the pass mark = 6/12.

18. 16. Three parts, 3, 4 and 5 marks. Some half marks are possible. Pass mark = 6/12.

19. 17A. Three parts, 3, 4 and 5 marks. Half marks possible. Pass mark = 6/12.

20. 17B. Six parts, 2, 1, 4, 1, 2 and 2 marks. Half marks are possible. Pass mark = 6/12.

Sixth Year Studies Problems

1. 1. Two parts, 1 and 2 marks. Half marks are not possible, so pass mark = 2/3.

2. 2. Two parts, 2 and 3 marks. Half marks are possible but unlikely, so pass mark = 3/5.

3. 3A. Three parts, 4, 2 and 1 marks respectively. Calculation and explanation, so half marks are possible. Pass mark = 3.5/7.

4. 3B. Three parts, 1, 4 and 2 marks. Half marks are possible, but even partial failure in the early part of the problem prevents final solution. Pass mark = 4/7.

5. 4. Three parts, 2, 2 and 1 marks. Half marks are not likely. Pass mark = 3/5.

6. 5A. 2 mark explanation. Half marks are possible. Pass mark = 1/2.

7. 5B. As problem 6, pass mark = 1/2.

8. 6. Three parts, 1, 2 and 1 marks respectively. Pass mark = 2/4.

9 7. Four parts, 2, 2, 3 and 2 marks. Half marks are possible. Pass mark = 4.5/9.

10. 8. Two parts. 3 and 1 marks respectively. Pass = 2/4.

11. 9. Four parts. 2. 2, 3 and 2 marks. Half marks are possible. Pass mark = 4.5/9.

12. 10. One part. 2 marks. Partial knowledge unlikely, so pass mark = 2/2.

13. 11A. Five parts. 1, 2, 2. 2 and 1 marks respectively. Pass mark = 4/8.

14. 11B. Three parts. 1, 2 and 5 marks. Pass mark = 4/8.

15. 12. Four parts, 2. 2. 2 and 1 marks respectively. Half marks not likely, so pass mark = 4/7.

16. 13. Three parts. 3. 1 and 2 marks. Pass mark = 3/6.

17. 14. Three parts, 2. 2 and 3 marks. Half marks unlikely. Pass mark = 4/7.

18. 15A. Structured answer, 4 marks. Pass = 2/4.

19. 15B. Structured answer, 4 marks. Pass = 2/4.

20. 15C. Structured answer, 4 marks. Pass = 2/4.

Appendix H

MERIT Tables

Display of All Merit Files
8 October 1989
Ordinary Grade Questions
Pass grade for this run = 20%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
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4	00001	11100	01001	10100	60	40	100	0	0	0	0	0	0
5	11111	00110	00001	11001	52	39	91	0	0	0	8	1	9
11	00001	10100	00001	00101	54	40	94	0	0	0	6	0	6
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7	00001	00100	01001	01100	12	17	29	1	0	1	47	23	70
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12	10001	11100	10101	11111	57	38	95	3	2	5	0	0	0
17	00001	11100	01001	11101	55	38	93	5	2	7	0	0	0
14	00001	10100	10111	01101	37	31	68	4	2	6	19	7	26
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15	00001	10100	10111	11101	18	5	23	1	2	3	41	33	74
16	00001	00000	01101	11100	48	37	85	10	3	13	2	0	2
13	00001	00100	01001	11000	47	34	81	12	6	18	1	0	1
3	11101	01110	00001	11001	43	37	80	17	3	20	0	0	0

Display of All Merit Files
8 October 1989
Ordinary Grade Questions
Pass grade for this run = 30%
Ordered by (Pass/Pass+Fail) Rate

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1	10001	00100	00100	00111	58	39	97	2	1	3	0	0	0
7	00001	00100	01001	01100	12	17	29	1	0	1	47	23	70
10	00001	00100	01001	00100	18	18	36	0	1	1	42	21	63
9	00001	00100	01001	00000	40	19	59	2	1	3	18	20	38
12	10001	11100	10101	11111	55	38	93	5	2	7	0	0	0
14	00001	10100	10111	01101	37	31	68	4	2	6	19	7	26
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8	00000	00100	00000	00001	51	36	87	7	3	10	2	1	3
15	00001	10100	10111	11101	18	5	23	1	2	3	41	33	74
13	00001	00100	01001	11000	47	34	81	12	6	18	1	0	1
3	11101	01110	00001	11001	43	37	80	17	3	20	0	0	0
17	00001	11100	01001	11101	44	34	78	16	6	22	0	0	0
16	00001	00000	01101	11100	42	33	75	16	7	23	2	0	2
5	11111	00110	00001	11001	40	28	68	12	11	23	8	1	9
2	00001	10100	10000	11101	42	31	73	18	9	27	0	0	0
11	00001	10100	00001	00101	26	25	51	28	15	43	6	0	6

Display of All Merit Files
8 October 1989
Ordinary Grade Questions
Pass grade for this run = 40%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
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9	00001	00100	01001	00000	40	19	59	2	1	3	18	20	38
7	00001	00100	01001	01100	12	16	28	1	1	2	47	23	70
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3	11101	01110	00001	11001	42	36	78	18	4	22	0	0	0
16	00001	00000	01101	11100	42	33	75	16	7	23	2	0	2
5	11111	00110	00001	11001	40	28	68	12	11	23	8	1	9
14	00001	10100	10111	01101	26	28	54	15	5	20	19	7	26
15	00001	10100	10111	11101	14	5	19	5	2	7	41	33	74
2	00001	10100	10000	11101	42	31	73	18	9	27	0	0	0
17	00001	11100	01001	11101	37	32	69	23	8	31	0	0	0
11	00001	10100	00001	00101	26	25	51	28	15	43	6	0	6
13	00001	00100	01001	11000	25	22	47	34	18	52	1	0	1

Display of All Merit Files
8 October 1989
Ordinary Grade Questions
Pass grade for this run = 50%
Ordered by (Pass/Pass+Fail) Rate

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7	00001	00100	01001	00100	12	12	24	1	5	6	47	23	70
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12	10001	11100	10101	10110	41	33	74	19	7	26	0	0	0
2	00001	10100	10000	11111	42	31	73	18	9	27	0	0	0
14	00001	10100	10111	00111	26	28	54	15	5	20	19	7	26
15	00001	10100	10111	00101	14	5	19	5	2	7	41	33	74
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3	11101	01110	00001	10001	37	32	69	23	8	31	0	0	0
4	00001	11100	01001	10100	42	24	66	18	16	34	0	0	0
16	00001	00000	01101	11100	37	28	65	21	12	33	2	0	2
5	11111	00110	00001	10001	34	25	59	18	14	32	8	1	9
11	00001	10100	00001	00101	26	25	51	28	15	43	6	0	6
13	00001	00100	01001	10000	25	22	47	34	18	52	1	0	1
17	00001	11100	01001	10000	24	21	45	36	19	55	0	0	0

Display of All Merit Files
8 October 1989
Ordinary Grade Questions
Pass grade for this run = 60%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
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10	00001	00100	01001	00100	15	17	32	3	2	5	42	21	63
9	00001	00100	01001	00000	34	17	51	8	3	11	18	20	38
7	00001	00100	01001	01100	12	12	24	1	5	6	47	23	70
1	10001	00100	00100	00111	47	31	78	13	9	22	0	0	0
12	10001	11100	10101	11111	41	33	74	19	7	26	0	0	0
2	00001	10100	10000	11101	42	31	73	18	9	27	0	0	0
14	00001	10100	10111	01101	26	28	54	15	5	20	19	7	26
15	00001	10100	10111	11101	14	5	19	5	2	7	41	33	74
8	00000	00100	00000	00001	41	29	70	17	10	27	2	1	3
3	11101	01110	00001	11001	37	32	69	23	8	31	0	0	0
4	00001	11100	01001	10100	42	24	66	18	16	34	0	0	0
5	11111	00110	00001	11001	34	25	59	18	14	32	8	1	9
11	00001	10100	00001	00101	26	25	51	28	15	43	6	0	6
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17	00001	11100	01001	11101	22	21	43	38	19	57	0	0	0

Display of All Merit Files
8 October 1989
Ordinary Grade Questions
Pass grade for this run = 70%
Ordered by (Pass/Pass+Fail) Rate

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9	00001	00100	01001	00000	34	17	51	8	3	11	18	20	38
6	00001	00100	01001	11100	37	18	55	10	4	14	13	18	31
1	10001	00100	00100	00111	47	31	78	13	9	22	0	0	0
7	00001	00100	01001	01100	12	11	23	1	6	7	47	23	70
2	00001	10100	10000	11101	42	31	73	18	9	27	0	0	0
4	00001	11100	01001	10100	42	24	66	18	16	34	0	0	0
5	11111	00110	00001	11001	34	25	59	18	14	32	8	1	9
12	10001	11100	10101	11111	36	27	63	24	13	37	0	0	0
8	00000	00100	00000	00001	32	25	57	26	14	40	2	1	3
14	00001	10100	10111	01101	21	22	43	20	11	31	19	7	26
15	00001	10100	10111	11101	10	5	15	9	2	11	41	33	74
11	00001	10100	00001	00101	26	25	51	28	15	43	6	0	6
3	11101	01110	00001	11001	28	25	53	32	15	47	0	0	0
16	00001	00000	01101	11100	28	21	49	30	19	49	2	0	2
13	00001	00100	01001	11000	21	19	40	38	21	59	1	0	1
17	00001	11100	01001	11101	15	13	28	45	27	72	0	0	0

Display of All Merit Files
8 October 1989
Ordinary Grade Questions
Pass grade for this run = 80%
Ordered by (Pass/Pass+Fail) Rate

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9	00001	00100	01001	00000	34	17	51	8	3	11	18	20	38
6	00001	00100	01001	11100	37	18	55	10	4	14	13	18	31
1	10001	00100	00100	00111	47	31	78	13	9	22	0	0	0
7	00001	00100	01001	01100	12	11	23	1	6	7	47	23	70
8	00000	00100	00000	00001	32	25	57	26	14	40	2	1	3
14	00001	10100	10111	01101	21	22	43	20	11	31	19	7	26
15	00001	10100	10111	11101	10	5	15	9	2	11	41	33	74
5	11111	00110	00001	11001	29	22	51	23	17	40	8	1	9
3	11101	01110	00001	11001	28	25	53	32	15	47	0	0	0
12	10001	11100	10101	11111	26	25	51	34	15	49	0	0	0
4	00001	11100	01001	10100	23	19	42	37	21	58	0	0	0
2	00001	10100	10000	11101	19	20	39	41	20	61	0	0	0
13	00001	00100	01001	11000	17	18	35	42	22	64	1	0	1
16	00001	00000	01101	11100	18	14	32	40	26	66	2	0	2
11	00001	10100	00001	00101	11	15	26	43	25	68	6	0	6
17	00001	11100	01001	11101	10	10	20	50	30	80	0	0	0

Display of All Merit Files
8 October 1989
Higher Grade Questions
Pass grade for this run = 20%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
1	00000	10100	00000	00001	9	7	16	0	0	0	56	28	84
2	00000	10100	00000	00001	56	28	84	0	0	0	9	7	16
3	00001	00101	01001	11101	58	31	89	0	0	0	7	4	11
6	00001	00100	10101	00000	40	23	63	0	0	0	25	12	37
7	00001	10100	10011	00000	25	12	37	0	0	0	40	23	63
19	11101	01100	10001	11110	42	20	62	0	0	0	23	15	38
20	00001	10100	10001	11100	23	15	38	0	0	0	42	20	62
16	00001	00100	10111	11100	64	34	98	1	1	2	0	0	0
17	00001	10100	10111	11100	64	33	97	1	1	2	0	1	1
11	00001	00100	10111	00101	63	35	98	2	0	2	0	0	0
12	11111	01110	00001	11001	64	34	98	1	1	2	0	0	0
15	00001	00100	10001	00000	63	33	96	1	2	3	1	0	1
10	00001	00100	10001	01100	61	35	96	4	0	4	0	0	0
4	11111	11110	00001	00001	61	33	94	3	2	5	1	0	1
18	11111	10110	00001	11110	62	32	94	3	3	6	0	0	0
5	11101	00110	00001	00001	53	29	82	5	5	10	7	1	8
8	11011	11100	11011	11101	57	28	85	6	7	13	2	0	2
14	00001	10100	00100	11100	56	29	85	7	6	13	2	0	2
13	00001	00100	00001	11100	53	28	81	9	7	16	3	0	3
9	00001	00101	11111	01000	51	29	80	14	6	20	0	0	0

Display of All Merit Files
8 October 1989
Higher Grade Questions
Pass grade for this run = 30%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
2	00000	10100	00000	00001	56	28	84	0	0	0	9	7	16
6	00001	00100	10101	00000	40	23	63	0	0	0	25	12	37
7	00001	10100	10011	00000	25	12	37	0	0	0	40	23	63
11	00001	00100	10111	00101	63	35	98	2	0	2	0	0	0
12	11111	01110	00001	11001	64	33	97	1	2	3	0	0	0
10	00001	00100	10001	01100	61	35	96	4	0	4	0	0	0
4	11111	11110	00001	00001	61	33	94	3	2	5	1	0	1
20	00001	10100	10001	11100	22	14	36	1	1	2	42	20	62
3	00001	00101	01001	11101	54	30	84	4	1	5	7	4	11
19	11101	01100	10001	11110	39	18	57	3	2	5	23	15	38
16	00001	00100	10111	11100	60	31	91	5	4	9	0	0	0
5	11101	00110	00001	00001	53	29	82	5	5	10	7	1	8
15	00001	00100	10001	00000	57	29	86	7	6	13	1	0	1
8	11011	11100	11011	11101	57	28	85	6	7	13	2	0	2
18	11111	10110	00001	11110	57	28	85	8	7	15	0	0	0
17	00001	10100	10111	11100	56	27	83	9	7	16	0	1	1
9	00001	00101	11111	01000	51	29	80	14	6	20	0	0	0
14	00001	10100	00100	11100	44	27	71	19	8	27	2	0	2
13	00001	00100	00001	11100	40	19	59	22	16	38	3	0	3
1	00000	10100	00000	00001	7	2	9	2	5	7	56	28	84

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8 October 1989
Higher Grade Questions
Pass grade for this run = 40%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
2	00000	10100	00000	00001	56	28	84	0	0	0	9	7	16
6	00001	00100	10101	00000	39	23	62	1	0	1	25	12	37
7	00001	10100	10011	00000	24	12	36	1	0	1	40	23	63
3	00001	00101	01001	11101	54	30	84	4	1	5	7	4	11
5	11101	00110	00001	00001	52	29	81	6	5	11	7	1	8
8	11011	11100	11011	11101	57	28	85	6	7	13	2	0	2
15	00001	00100	10001	00000	57	29	86	7	6	13	1	0	1
19	11101	01100	10001	11110	36	18	54	6	2	8	23	15	38
12	11111	01110	00001	11001	58	28	86	7	7	14	0	0	0
10	00001	00100	10001	01100	53	32	85	12	3	15	0	0	0
4	11111	11110	00001	00001	53	30	83	11	5	16	1	0	1
16	00001	00100	10111	11100	54	27	81	11	8	19	0	0	0
20	00001	10100	10001	11100	19	11	30	4	4	8	42	20	62
17	00001	10100	10111	11100	52	25	77	13	9	22	0	1	1
18	11111	10110	00001	11110	51	26	77	14	9	23	0	0	0
11	00001	00100	10111	00101	45	30	75	20	5	25	0	0	0
9	00001	00101	11111	01000	49	23	72	16	12	28	0	0	0
14	00001	10100	00100	11100	44	27	71	19	8	27	2	0	2
13	00001	00100	00001	11100	37	18	55	25	17	42	3	0	3
1	00000	10100	00000	00001	7	2	9	2	5	7	56	28	84

Display of All Merit Files
8 October 1989
Higher Grade Questions
Pass grade for this run = 50%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
2	00000	10100	00000	00001	56	28	84	0	0	0	9	7	16
6	00001	00100	10101	00000	36	22	58	4	1	5	25	12	37
3	00001	00101	01001	11001	52	29	81	6	2	8	7	4	11
7	00001	10100	10011	00000	22	11	33	3	1	4	40	23	63
10	00001	00100	10001	00010	53	32	85	12	3	15	0	0	0
19	11101	01100	10001	11110	30	17	47	12	3	15	23	15	38
11	00001	00100	10111	00101	45	30	75	20	5	25	0	0	0
5	11101	00110	00001	00001	44	24	68	14	10	24	7	1	8
9	00001	00101	11111	00001	49	23	72	16	12	28	0	0	0
4	11111	11110	00001	00001	42	27	69	22	8	30	1	0	1
18	11111	10110	00001	11110	41	26	67	24	9	33	0	0	0
12	11111	01110	00001	11001	46	21	67	19	14	33	0	0	0
16	00001	00100	10111	11100	46	20	66	19	15	34	0	0	0
15	00001	00100	10001	00000	39	22	61	25	13	38	1	0	1
17	00001	10100	10111	10110	41	20	61	24	14	38	0	1	1
20	00001	10100	10001	11100	14	9	23	9	6	15	42	20	62
8	11011	11100	11011	11111	42	16	58	21	19	40	2	0	2
1	00000	10100	00000	00001	7	2	9	2	5	7	56	28	84
14	00001	10100	00100	11110	38	17	55	25	18	43	2	0	2
13	00001	00100	00001	11000	29	7	36	33	28	61	3	0	3

Display of All Merit Files
8 October 1989
Higher Grade Questions
Pass grade for this run = 60%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
2	00000	10100	00000	00001	56	28	84	0	0	0	9	7	16
6	00001	00100	10101	00000	36	22	58	4	1	5	25	12	37
3	00001	00101	01001	11101	52	29	81	6	2	8	7	4	11
7	00001	10100	10011	00000	22	11	33	3	1	4	40	23	63
10	00001	00100	10001	01100	53	32	85	12	3	15	0	0	0
11	00001	00100	10111	00101	45	30	75	20	5	25	0	0	0
5	11101	00110	00001	00001	44	24	68	14	10	24	7	1	8
9	00001	00101	11111	01000	49	23	72	16	12	28	0	0	0
4	11111	11110	00001	00001	42	27	69	22	8	30	1	0	1
19	11101	01100	10001	11110	29	14	43	13	6	19	23	15	38
12	11111	01110	00001	11001	46	21	67	19	14	33	0	0	0
8	11011	11100	11011	11101	42	16	58	21	19	40	2	0	2
1	00000	10100	00000	00001	7	2	9	2	5	7	56	28	84
18	11111	10110	00001	11110	36	18	54	29	17	46	0	0	0
14	00001	10100	00100	11100	37	16	53	26	19	45	2	0	2
16	00001	00100	10111	11100	39	14	53	26	21	47	0	0	0
17	00001	10100	10111	11100	32	17	49	33	17	50	0	1	1
13	00001	00100	00001	11100	27	6	33	35	29	64	3	0	3
20	00001	10100	10001	11100	8	5	13	15	10	25	42	20	62
15	00001	00100	10001	00000	23	10	33	41	25	66	1	0	1

Display of All Merit Files
8 October 1989
Higher Grade Questions
Pass grade for this run = 70%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
2	00000	10100	00000	00001	56	28	84	0	0	0	9	7	16
3	00001	00101	01001	11101	52	29	81	6	2	8	7	4	11
6	00001	00100	10101	00000	32	20	52	8	3	11	25	12	37
10	00001	00100	10001	01100	45	26	71	20	9	29	0	0	0
5	11101	00110	00001	00001	42	22	64	16	12	28	7	1	8
7	00001	10100	10011	00000	14	9	23	11	3	14	40	23	63
4	11111	11110	00001	00001	37	22	59	27	13	40	1	0	1
8	11011	11100	11011	11101	41	16	57	22	19	41	2	0	2
12	11111	01110	00001	11001	39	18	57	26	17	43	0	0	0
1	00000	10100	00000	00001	7	2	9	2	5	7	56	28	84
19	11101	01100	10001	11110	22	13	35	20	7	27	23	15	38
9	00001	00101	11111	01000	30	12	42	35	23	58	0	0	0
17	00001	10100	10111	11100	29	13	42	36	21	57	0	1	1
11	00001	00100	10111	00101	25	17	42	40	18	58	0	0	0
16	00001	00100	10111	11100	29	11	40	36	24	60	0	0	0
18	11111	10110	00001	11110	27	12	39	38	23	61	0	0	0
14	00001	10100	00100	11100	26	12	38	37	23	60	2	0	2
15	00001	00100	10001	00000	23	10	33	41	25	66	1	0	1
20	00001	10100	10001	11100	5	5	10	18	10	28	42	20	62
13	00001	00100	00001	11100	14	3	17	48	32	80	3	0	3

Display of All Merit Files
8 October 1989
Higher Grade Questions
Pass grade for this run = 80%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
2	00000	10100	00000	00001	55	26	81	1	2	3	9	7	16
6	00001	00100	10101	00000	32	20	52	8	3	11	25	12	37
5	11101	00110	00001	00001	42	22	64	16	12	28	7	1	8
10	00001	00100	10001	01100	45	25	70	20	10	30	0	0	0
7	00001	10100	10011	00000	14	9	23	11	3	14	40	23	63
4	11111	11110	00001	00001	37	22	59	27	13	40	1	0	1
8	11011	11100	11011	11101	41	16	57	22	19	41	2	0	2
3	00001	00101	01001	11101	30	18	48	28	13	41	7	4	11
12	11111	01110	00001	11001	37	16	53	28	19	47	0	0	0
11	00001	00100	10111	00101	25	17	42	40	18	58	0	0	0
9	00001	00101	11111	01000	30	12	42	35	23	58	0	0	0
14	00001	10100	00100	11100	23	12	35	40	23	63	2	0	2
19	11101	01100	10001	11110	13	3	16	29	17	46	23	15	38
1	00000	10100	00000	00001	3	1	4	6	6	12	56	28	84
17	00001	10100	10111	11100	13	5	18	52	29	81	0	1	1
18	11111	10110	00001	11110	13	4	17	52	31	83	0	0	0
16	00001	00100	10111	11100	10	6	16	55	29	84	0	0	0
13	00001	00100	00001	11100	11	3	14	51	32	83	3	0	3
15	00001	00100	10001	00000	9	2	11	55	33	88	1	0	1
20	00001	10100	10001	11100	2	0	2	21	15	36	42	20	62

Display of All Merit Files
8 October 1989
Sixth Year Studies Questions
Pass grade for this run = 20%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
6	00001	00000	00001	11100	24	18	42	0	0	0	36	22	58
7	00001	00000	00001	01000	36	22	58	0	0	0	24	18	42
12	00001	00100	00001	00000	60	40	100	0	0	0	0	0	0
14	11011	10110	00001	11101	28	27	55	0	0	0	32	13	45
17	00001	11101	10001	11101	59	40	99	0	0	0	1	0	1
20	00001	00000	00101	11100	4	4	8	0	0	0	56	36	92
10	00001	00100	00001	01100	60	39	99	0	1	1	0	0	0
16	00001	00100	01001	00101	60	39	99	0	1	1	0	0	0
11	00001	10101	01011	11100	60	38	98	0	2	2	0	0	0
9	11011	01100	01001	11100	59	39	98	1	1	2	0	0	0
15	00001	10110	10111	11101	58	38	96	1	2	3	1	0	1
2	11001	10110	00001	01100	59	37	96	0	3	3	1	0	1
8	00011	00100	00001	11100	56	39	95	3	1	4	1	0	1
19	00001	00100	00001	10100	12	9	21	0	1	1	48	30	78
5	00000	00100	01001	00100	53	40	93	7	0	7	0	0	0
18	00001	00001	00101	11100	39	25	64	4	1	5	17	14	31
13	11011	11110	10001	11101	29	10	39	3	3	6	28	27	55
4	11111	11110	00001	11101	42	26	68	4	8	12	14	6	20
3	11111	01110	10001	11100	10	5	15	2	1	3	48	34	82
1	00000	00100	00000	11100	37	28	65	22	12	34	1	0	1

Display of All Merit Files
8 October 1989
Sixth Year Studies Questions
Pass grade for this run = 30%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
14	11011	10110	00001	11101	28	27	55	0	0	0	32	13	45
20	00001	00000	00101	11100	4	4	8	0	0	0	56	36	92
10	00001	00100	00001	01100	60	39	99	0	1	1	0	0	0
11	00001	10101	01011	11100	60	38	98	0	2	2	0	0	0
8	00011	00100	00001	11100	56	39	95	3	1	4	1	0	1
17	00001	11101	10001	11101	57	37	94	2	3	5	1	0	1
15	00001	10110	10111	11101	57	37	94	2	3	5	1	0	1
9	11011	01100	01001	11100	56	37	93	4	3	7	0	0	0
16	00001	00100	01001	00101	55	38	93	5	2	7	0	0	0
13	11011	11110	10001	11101	29	10	39	3	3	6	28	27	55
18	00001	00001	00101	11100	37	22	59	6	4	10	17	14	31
2	11001	10110	00001	01100	52	33	85	7	7	14	1	0	1
19	00001	00100	00001	10100	11	7	18	1	3	4	48	30	78
5	00000	00100	01001	00100	41	40	81	19	0	19	0	0	0
12	00001	00100	00001	00000	52	29	81	8	11	19	0	0	0
7	00001	00000	00001	01000	28	18	46	8	4	12	24	18	42
3	11111	01110	10001	11100	9	3	12	3	3	6	48	34	82
4	11111	11110	00001	11101	35	18	53	11	16	27	14	6	20
1	00000	00100	00000	11100	37	28	65	22	12	34	1	0	1
6	00001	00000	00001	11100	12	8	20	12	10	22	36	22	58

Display of All Merit Files
8 October 1989
Sixth Year Studies Questions
Pass grade for this run = 40%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
14	11011	10110	00001	11101	27	26	53	1	1	2	32	13	45
16	00001	00100	01001	00101	55	38	93	5	2	7	0	0	0
10	00001	00100	00001	01100	55	37	92	5	3	8	0	0	0
15	00001	10110	10111	11101	52	34	86	7	6	13	1	0	1
17	00001	11101	10001	11101	51	35	86	8	5	13	1	0	1
2	11001	10110	00001	01100	52	33	85	7	7	14	1	0	1
11	00001	10101	01011	11100	54	32	86	6	8	14	0	0	0
9	11011	01100	01001	11100	52	34	86	8	6	14	0	0	0
5	00000	00100	01001	00100	41	40	81	19	0	19	0	0	0
12	00001	00100	00001	00000	52	29	81	8	11	19	0	0	0
13	11011	11110	10001	11101	26	10	36	6	3	9	28	27	55
7	00001	00000	00001	01000	28	18	46	8	4	12	24	18	42
8	00011	00100	00001	11100	45	32	77	14	8	22	1	0	1
18	00001	00001	00101	11100	35	17	52	8	9	17	17	14	31
1	00000	00100	00000	11100	37	27	64	22	13	35	1	0	1
20	00001	00000	00101	11100	2	3	5	2	1	3	56	36	92
19	00001	00100	00001	10100	9	4	13	3	6	9	48	30	78
4	11111	11110	00001	11101	30	16	46	16	18	34	14	6	20
6	00001	00000	00001	11100	12	8	20	12	10	22	36	22	58
3	11111	01110	10001	11100	6	1	7	6	5	11	48	34	82

Display of All Merit Files
8 October 1989
Sixth Year Studies Questions
Pass grade for this run = 50%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
10	00001	00100	00001	01100	55	37	92	5	3	8	0	0	0
14	11011	10110	00001	11101	24	26	50	4	1	5	32	13	45
11	00001	10101	01011	11100	54	32	86	6	8	14	0	0	0
12	00001	00100	00001	00000	52	27	79	8	13	21	0	0	0
7	00001	00000	00001	01000	28	18	46	8	4	12	24	18	42
15	00001	10110	10111	11101	47	30	77	12	10	22	1	0	1
8	00011	00100	00001	11100	45	30	75	14	10	24	1	0	1
13	11011	11110	10001	11101	25	9	34	7	4	11	28	27	55
16	00001	00100	01001	00101	45	31	76	15	9	24	0	0	0
17	00001	11101	10001	11101	45	29	74	14	11	25	1	0	1
9	11011	01100	01001	11100	42	29	71	18	11	29	0	0	0
5	00000	00100	01001	00100	35	33	68	25	7	32	0	0	0
2	11001	10110	00001	01100	40	24	64	19	16	35	1	0	1
18	00001	00001	00101	11100	25	14	39	18	12	30	17	14	31
4	11111	11110	00001	11101	28	14	42	18	20	38	14	6	20
6	00001	00000	00001	11100	12	8	20	12	10	22	36	22	58
19	00001	00100	00001	10100	7	3	10	5	7	12	48	30	78
20	00001	00000	00101	11100	1	2	3	3	2	5	56	36	92
3	11111	01110	10001	11100	6	0	6	6	6	12	48	34	82
1	00000	00100	00000	11100	15	16	31	44	24	68	1	0	1

Display of All Merit Files
8 October 1989
Sixth Year Studies Questions
Pass grade for this run = 60%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
10	00001	00100	00001	01100	55	37	92	5	3	8	0	0	0
11	00001	10101	01011	11100	54	32	86	6	8	14	0	0	0
7	00001	00000	00001	01000	28	18	46	8	4	12	24	18	42
12	00001	00100	00001	00000	52	27	79	8	13	21	0	0	0
8	00011	00100	00001	11100	45	30	75	14	10	24	1	0	1
15	00001	10110	10111	11101	44	29	73	15	11	26	1	0	1
14	11011	10110	00001	11101	18	22	40	10	5	15	32	13	45
5	00000	00100	01001	00100	35	32	67	25	8	33	0	0	0
17	00001	11101	10001	11101	41	25	66	18	15	33	1	0	1
9	11011	01100	01001	11100	37	29	66	23	11	34	0	0	0
2	11001	10110	00001	01100	39	24	63	20	16	36	1	0	1
18	00001	00001	00101	11100	25	14	39	18	12	30	17	14	31
13	11011	11110	10001	11101	18	7	25	14	6	20	28	27	55
4	11111	11110	00001	11101	28	14	42	18	20	38	14	6	20
16	00001	00100	01001	00101	32	20	52	28	20	48	0	0	0
6	00001	00000	00001	11100	12	8	20	12	10	22	36	22	58
19	00001	00100	00001	10100	7	3	10	5	7	12	48	30	78
20	00001	00000	00101	11100	1	2	3	3	2	5	56	36	92
3	11111	01110	10001	11100	6	0	6	6	6	12	48	34	82
1	00000	00100	00000	11100	15	16	31	44	24	68	1	0	1

Display of All Merit Files
8 October 1989
Sixth Year Studies Questions
Pass grade for this run = 70%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
7	00001	00000	00001	01000	28	18	46	8	4	12	24	18	42
12	00001	00100	00001	00000	52	27	79	8	13	21	0	0	0
11	00001	10101	01011	11100	36	25	61	24	15	39	0	0	0
10	00001	00100	00001	01100	34	24	58	26	16	42	0	0	0
14	11011	10110	00001	11101	15	15	30	13	12	25	32	13	45
15	00001	10110	10111	11101	29	25	54	30	15	45	1	0	1
17	00001	11101	10001	11101	33	19	52	26	21	47	1	0	1
16	00001	00100	01001	00101	31	20	51	29	20	49	0	0	0
9	11011	01100	01001	11100	29	21	50	31	19	50	0	0	0
6	00001	00000	00001	11100	12	8	20	12	10	22	36	22	58
4	11111	11110	00001	11101	26	12	38	20	22	42	14	6	20
8	00011	00100	00001	11100	29	18	47	30	22	52	1	0	1
5	00000	00100	01001	00100	23	23	46	37	17	54	0	0	0
19	00001	00100	00001	10100	6	3	9	6	7	13	48	30	78
13	11011	11110	10001	11101	12	5	17	20	8	28	28	27	55
20	00001	00000	00101	11100	1	2	3	3	2	5	56	36	92
18	00001	00001	00101	11100	14	9	23	29	17	46	17	14	31
2	11001	10110	00001	01100	21	10	31	38	30	68	1	0	1
1	00000	00100	00000	11100	15	16	31	44	24	68	1	0	1
3	11111	01110	10001	11100	4	0	4	8	6	14	48	34	82

Display of All Merit Files
8 October 1989
Sixth Year Studies Questions
Pass grade for this run = 80%
Ordered by (Pass/Pass+Fail) Rate

Qu	Proc	Conc	Skil	Lang	Passes			Failures			Blanks		
	12345	12345	12345	12345	Ma	Fe	To	Ma	Fe	To	Ma	Fe	To
12	00001	00100	00001	00000	46	24	70	14	16	30	0	0	0
7	00001	00000	00001	01000	23	13	36	13	9	22	24	18	42
11	00001	10101	01011	11100	35	25	60	25	15	40	0	0	0
10	00001	00100	00001	01100	34	23	57	26	17	43	0	0	0
14	11011	10110	00001	11101	15	15	30	13	12	25	32	13	45
8	00011	00100	00001	11100	29	18	47	30	22	52	1	0	1
5	00000	00100	01001	00100	23	23	46	37	17	54	0	0	0
4	11111	11110	00001	11101	24	12	36	22	22	44	14	6	20
19	00001	00100	00001	10100	5	3	8	7	7	14	48	30	78
9	11011	01100	01001	11100	21	14	35	39	26	65	0	0	0
6	00001	00000	00001	11100	9	5	14	15	13	28	36	22	58
2	11001	10110	00001	01100	21	10	31	38	30	68	1	0	1
1	00000	00100	00000	11100	15	16	31	44	24	68	1	0	1
17	00001	11101	10001	11101	18	10	28	41	30	71	1	0	1
15	00001	10110	10111	11101	16	12	28	43	28	71	1	0	1
18	00001	00001	00101	11100	8	9	17	35	17	52	17	14	31
20	00001	00000	00101	11100	1	1	2	3	3	6	56	36	92
13	11011	11110	10001	11101	7	4	11	25	9	34	28	27	55
16	00001	00100	01001	00101	13	8	21	47	32	79	0	0	0
3	11111	01110	10001	11100	3	0	3	9	6	15	48	34	82

Appendix I

Mann/Whitney/Wilcoxon Rank Order Test

Combined Properties Tables

Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test

Ordinary Grade Questions

Categorised by Process Values
Numerical Processes TRUE compared with Numerical Processes FALSE
(TRUE items marked with *)

Rate	Rank
84	17
82	16
80	15
77	14
73	12.5
73	12.5
66	11
59	10
53*	9
51*	8
50	7
47	5.5
47*	5.5
43	4
41*	3
39	2
28	1

U Statistic Value = 15.5 (n=13,4: T=8)
Numerical Processes FALSE compared with Numerical Processes TRUE
U Statistic Value = 36.5

Categorised by Content Values
Formulae/Equations TRUE compared with Formulae/Equations FALSE
(TRUE items marked with *)

Rate	Rank
84	17
82	16
80	15
77	14
73*	12.5
73*	12.5
66*	11
59	10
53*	9
51*	8
50	7
47	5.5
47	5.5
43*	4
41	3
39*	2
28*	1

U Statistic Value = 24 (n=8,7: T=10)
Formulae/Equations FALSE compared with Formulae/Equations TRUE
U Statistic Value = 48

Categorised by Skills Values

Processing Data TRUE compared with Processing Data FALSE
(TRUE items marked with *)

Rate	Rank
84*	17
82*	16
80*	15
77*	14
73*	12.5
73*	12.5
66*	11
59	10
53	9
51*	8
50*	7
47*	5.5
47	5.5
43*	4
41	3
39*	2
28	1

U Statistic Value = 46.5

Processing Data FALSE compared with Processing Data TRUE
U Statistic Value = 13.5 (n=12,5: T=11)

Categorised by Language Values

Interpretation of Language TRUE / Interpretation of Language FALSE
(TRUE items marked with *)

Rate	Rank
84*	17
82	16
80*	15
77*	14
73*	12.5
73*	12.5
66*	11
59	10
53*	9
51*	8
50*	7
47*	5.5
47*	5.5
43*	4
41*	3
39*	2
28*	1

U Statistic Value = 7 (n=15,2: T=1)

Interpretation of Language FALSE / Interpretation of Language TRUE
U Statistic Value = 23

Higher Grade Questions
Categorised by Process Values
Numerical Processes TRUE compared with Numerical Processes FALSE
(TRUE items marked with *)

Rate	Rank
98	20
97	19
96	18
91	17
88*	16
85	15
84*	14
76*	13
75	12
72	11
67*	9.5
67*	9.5
66	8
62	6.5
62	6.5
61	5
58*	4
56	3
54	2
34	1

U Statistic Value = 45
Numerical Processes FALSE compared with Numerical Processes TRUE
U Statistic Value = 39 (n=14,6: T=17)

Categorised by Content Values
Formulae/Equations TRUE compared with Formulae/Equations FALSE
(TRUE items marked with *)

Rate	Rank
98	20
97*	19
96*	18
91	17
88	16
85	15
84*	14
76*	13
75	12
72	11
67*	9.5
67*	9.5
66	8
62	6.5
62*	6.5
61*	5
58*	4
56*	3
54*	2
34	1

U Statistic Value = 37.5 (n=11,9: T=23)
Formulae/Equations FALSE compared with Formulae/Equations TRUE
U Statistic Value = 61.5

Higher Grade Questions
Categorised by Skills Values
Processing Data TRUE compared with Processing Data FALSE
(TRUE items marked with *)

Rate	Rank
98*	20
97*	19
96	18
91*	17
88	16
85*	15
84	14
76*	13
75*	12
72*	11
67	9.5
67	9.5
66*	8
62*	6.5
62*	6.5
61*	5
58*	4
56	3
54	2
34	1

U Statistic Value = 59
Processing Data FALSE compared with Processing Data TRUE
U Statistic Value = 37 (n=12,8: T=22)

Categorised by Language Values
Interpretation of Language TRUE / Interpretation of Language FALSE
(TRUE items marked with *)

Rate	Rank
98	20
97	19
96	18
91*	17
88	16
85*	15
84	14
76*	13
75*	12
72*	11
67*	9.5
67*	9.5
66*	8
62	6.5
62*	6.5
61*	5
58*	4
56	3
54*	2
34*	1

U Statistic Value = 22.5 (n=13,7: T=20)
Interpretation of Language FALSE / Interpretation of Language TRUE
U Statistic Value = 68.5

CSYS Questions

Categorised by Process Values

Numerical Processes TRUE compared with Numerical Processes FALSE

(TRUE items marked with *)

Rate	Rank
92	20
91*	19
86	18
81*	17
79	16
76*	14
76	14
76	14
74	12
70	11
67	9.5
67	9.5
64*	8
57	7
52*	6
48	5
45	4
39*	3
38	2
31	1

U Statistic Value = 46

Numerical Processes FALSE compared with Numerical Processes TRUE

U Statistic Value = 38 (n=14,6: T=17)

Categorised by Content Values

Formulae/Equations TRUE compared with Formulae/Equations FALSE

(TRUE items marked with *)

Rate	Rank
92	20
91*	19
86*	18
81*	17
79	16
76*	14
76	14
76	14
74*	12
70	11
67	9.5
67*	9.5
64*	8
57	7
52*	6
48	5
45	4
39*	3
38	2
31	1

U Statistic Value = 61.5

Formulae/Equations FALSE compared with Formulae/Equations TRUE

U Statistic Value = 37.5 (n=11,9: T=23)

CSYS Values

Categorised by Skills Values

Processing Data TRUE compared with Processing Data FALSE

(TRUE items marked with *)

Rate	Rank
92	20
91	19
86*	18
81*	17
79	16
76*	14
76	14
76*	14
74*	12
70	11
67*	9.5
67*	9.5
64	8
57	7
52	6
48	5
45	4
39*	3
38	2
31	1

U Statistic Value = 61

Processing Data FALSE compared with Processing Data TRUE

U Statistic Value = 35 (n=12,8: T=22)

Categorised by Language Values

Interpretation of Language TRUE / Interpretation of Language FALSE

(TRUE items marked with *)

Rate	Rank
92*	20
91*	19
86*	18
81*	17
79*	16
76*	14
76*	14
76*	14
74*	12
70	11
67*	9.5
67*	9.5
64*	8
57*	7
52*	6
48*	5
45*	4
39*	3
38*	2
31*	1

U Statistic Value = 9 (n=19.1: T not quoted)

Interpretation of Language FALSE / Interpretation of Language TRUE

U Statistic Value = 10

Appendix J

Mann/Whitney/Wilcoxon Rank Order Test

Male/Female Comparison Tables

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
Ordinary Grade Questions
Categorised by Process Values
Male vs Female Pass Rate (Numerical Processes TRUE)
(Male Rates marked with *)

Rate	Rank
63	7.5
63	7.5
51	6
47*	5
44*	4
43*	2.5
43	2.5
40*	1

U Statistic Value = 2.5: n = 4: T=0

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
Ordinary Grade Questions
Categorised by Process Values
Male vs Female Pass Rate (Numerical Processes FALSE)
(Male Rates marked with *)

Rate	Rank
92*	26
85	24.5
85	24.5
84	23
83*	22
82	21
81*	20
79*	19
74*	18
71	17
70*	16
65	15
64	14
63*	13
60	12
55*	10.5
55	10.5
52	8.5
52	8.5
50	7
48*	6
42*	5
38	4
37*	3
32*	2
20*	1

U Statistic Value = 70.5: n = 13: T=45

Male/Female Rate Statistics
Mann Whitney/Wilcoxon Rank Sum Two-Sample Test
Ordinary Grade Questions
Categorised by Content Values
Male vs Female Pass Rate (Formulae/Equations TRUE)
(Male Rates marked with *)

Rate	Rank
85	16
74*	15
71	14
70*	13
63*	11
63	11
63	11
60	9
52	8
50	7
47*	6
43*	5
38	4
37*	3
32*	2
20*	1

U Statistic Value = 20: n = 8: T=13

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
Ordinary Grade Questions
Categorised by Content Values
Male vs Female Pass Rate (Formulae/Equations FALSE)
(Male Rates marked with *)

Rate	Rank
92*	18
85	17
84	16
83*	15
82	14
81*	13
79*	12
65	11
64	10
55*	8.5
55	8.5
52	7
51	6
48*	5
44*	4
43	3
42*	2
40*	1

U Statistic Value = 33.5: n = 9: T=17

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
Ordinary Grade Questions
Categorised by Skills Values
Male vs Female Pass Rate (Processing Data TRUE)
(Male Rates marked with *)

Rate	Rank
92*	24
85	22.5
85	22.5
84	21
83*	20
82	19
81*	18
79*	17
74*	16
71	15
70*	14
65	13
63*	11.5
63	11.5
60	10
55	9
52	7.5
52	7.5
50	6
48*	5
43*	4
42*	3
37*	2
32*	1

U Statistic Value = 57.5: n = 12: T=37

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
Ordinary Grade Questions
Categorised by Skills Values
Male vs Female Pass Rate (Processing Data FALSE)
(Male Rates marked with *)

Rate	Rank
64	10
63	9
55*	8
51	7
47*	6
44*	5
43	4
40*	3
38	2
20*	1

U Statistic Value = 8: n = 5: T=2

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
Ordinary Grade Questions
Categorised by Language Values
Male vs Female Pass Rate (Interpretation of Language TRUE)
(Male Rates marked with *)

Rate	Rank
92*	30
85	29
84	28
83*	27
82	26
79*	25
74*	24
71	23
70*	22
65	21
63*	19
63	19
63	19
60	17
55	16
52	14.5
52	14.5
51	13
50	12
48*	11
47*	10
44*	9
43	7.5
43*	7.5
42*	6
40*	5
38	4
37*	3
32*	2
20*	1

U Statistic Value = 81.5: n = 15: T=64

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
Ordinary Grade Questions
Categorised by Language Values
Male vs Female Pass Rate (Interpretation of Language FALSE)
(Male Rates marked with *)

Rate	Rank
85	4
81*	3
64	2
55*	1

U Statistic Value = 1: n = 2: T not quoted

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
Higher Grade Questions
Categorised by Process Values
Male vs Female Pass Rate (Numerical Processes TRUE)
(Male Rates marked with *)

Rate	Rank
90*	12
86	11
85	9.5
85	9.5
83*	8
74	7
71*	5.5
71*	5.5
65*	4
63*	3
60	2
46	1

U Statistic Value = 17: n = 6: T=5

Categorised by Process Values
Male vs Female Pass Rate (Numerical Processes FALSE)
(Female Rates marked with *)

Rate	Rank
100*	27.5
100*	27.5
98	25.5
98	25.5
96	24
94*	23
93*	22
91*	21
90	20
86*	19
82	18
78	17
75	16
71	15
69	14
66*	13
63	11.5
63*	11.5
61	9.5
61	9.5
60*	8
59*	6.5
59	6.5
57*	5
46*	4
44	3
29*	2
17*	1

U Statistic Value = 86: n = 14: T=55

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
Higher Grade Questions
Categorised by Content Values
Male vs Female Pass Rate (Formulae/Equations TRUE)
(Female Rates marked with *)

Rate	Rank
100*	22
98	21
96	20
93*	19
86*	18
85*	17
83	16
78	15
74*	14
71	12.5
71	12.5
65	11
63	9.5
63	9.5
61	8
60*	6.5
60*	6.5
59*	4.5
59	4.5
46*	2.5
46*	2.5
29*	1

U Statistic Value = 47.5: n = 11: T=30

Categorised by Content Values
Male vs Female Pass Rate (Formulae/Equations FALSE)
(Male Rates marked with *)

Rate	Rank
100	18
98*	17
94	16
91	15
90*	13.5
90*	13.5
86	12
85	11
82*	10
75*	9
71*	8
69*	7
66	6
63	5
61*	4
57	3
44*	2
17	1

U Statistic Value = 39: n = 9: T=17

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
Higher Grade Questions
Categorised by Skills Values
Male vs Female Pass Rate (Processing Data TRUE)
(Female Rates marked with *)

Rate	Rank
100*	23.5
100*	23.5
98	22
96	21
94*	20
91*	19
90	18
86*	17
85*	16
82	15
75	14
71	12.5
71	12.5
69	11
66*	10
65	9
63	7.5
63*	7.5
61	5.5
61	5.5
60*	4
59*	3
57*	2
46*	1

U Statistic Value = 68.5: n = 12: T=37

Categorised by Skills Values
Male vs Female Pass Rate (Processing Data FALSE)
(Female Rates marked with *)

Rate	Rank
98	16
93*	15
90	14
86*	13
85*	12
83	11
78	10
74*	9
71	8
63	7
60*	6
59	5
46*	4
44	3
29*	2
17*	1

U Statistic Value = 26: n = 8: T=13

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
Higher Grade Questions
Categorised by Language Values
Male vs Female Pass Rate (Interpretation of Language TRUE)
(Female Rates marked with *)

Rate	Rank
94*	26
91*	25
90	24
86*	23
85*	22
82	21
75	20
74*	19
71	17
71	17
71	17
69	15
66*	14
65	13
63	11.5
63	11.5
61	10
60*	8.5
60*	8.5
59*	6.5
59	6.5
57*	5
46*	3.5
46*	3.5
44	2
17*	1

U Statistic Value = 74.5: n = 13: T=45

Categorised by Language Values
Male vs Female Pass Rate (Interpretation of Language FALSE)
(Male Rates marked with *)

Rate	Rank
100	13.5
100	13.5
98*	11.5
98*	11.5
96*	10
93	9
90*	8
86	7
85	6
83*	5
78*	4
63	3
61*	2
29	1

U Statistic Value = 24: n = 7: T=8

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
CSYS Questions
Categorised by Process Values
Male vs Female Pass Rate (Numerical Processes TRUE)
(Female Rates marked with *)

Rate	Rank
96*	12
86	11
82	10
80*	9
78	8
69*	7
66	6
61	5
60*	4
50	3
41*	2
17*	1

U Statistic Value = 14: n = 6: T=5

Categorised by Process Values
Male vs Female Pass Rate (Numerical Processes FALSE)
(Male Rates marked with *)

Rate	Rank
93	28
92*	27
90*	26
82	25
80	23.5
80	23.5
78	21.5
78*	21.5
77*	20
76*	19
75*	17
75*	17
75	17
73	15
69*	14
63	13
60	12
58*	10
58*	10
58*	10
54	8
50*	6.5
50	6.5
44	5
40	4
30	3
25*	1.5
25*	1.5

U Statistic Value = 96: n = 14: T=55

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
CSYS Questions
Categorised by Content Values
Male vs Female Pass Rate (Formulae/Equations TRUE)
(Female Rates marked with *)

Rate	Rank
96*	18
90	17
86	16
82	15
80*	13.5
80*	13.5
78	12
75	11
73*	10
69*	8.5
69	8.5
66	7
63*	6
61	5
60*	4
50	3
41*	2
17*	1

U Statistic Value = 31.5: n = 9: T=17

Categorised by Content Values
Male vs Female Pass Rate (Formulae/Equations FALSE)
(Male Rates marked with *)

Rate	Rank
93	22
92*	21
82	20
80	19
78	17.5
78*	17.5
77*	16
76*	15
75*	13.5
75	13.5
60	12
58*	10
58*	10
58*	10
54	8
50*	6.5
50	6.5
44	5
40	4
30	3
25*	1.5
25*	1.5

U Statistic Value = 56.5: n = 11: T=30

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
CSYS Questions
Categorised by Skills Values
Male vs Female Pass Rate (Processing Data TRUE)
(Female Rates marked with *)

Rate	Rank
90	16
82	15
80*	13
80*	13
80*	13
78*	10.5
78	10.5
75	8.5
75	8.5
73*	7
69*	5.5
69	5.5
63*	4
58	3
50	2
17*	1

U Statistic Value = 31: n = 8: T=13

Categorised by Skills Values
Male vs Female Pass Rate (Processing Data FALSE)
(Female Rates marked with *)

Rate	Rank
96*	24
93*	23
92	22
86	21
82*	20
78	19
77	18
76	17
75*	16
66	15
61	14
60*	12.5
60*	12.5
58	10.5
58	10.5
54*	9
50	7.5
50*	7.5
44*	6
41*	5
40*	4
30*	3
25	1.5
25	1.5

U Statistic Value = 64.5: n = 12: T=37

Male/Female Rate Statistics
Mann-Whitney/Wilcoxon Rank Sum Two-Sample Test
CSYS Questions
Categorised by Language Values
Male vs Female Pass Rate (Interpretation of Language TRUE)
(Female Rates marked with *)

Rate	Rank
96*	38
93*	37
92	36
90	35
86	34
82	32.5
82*	32.5
80*	30
80*	30
80*	30
78	27
78*	27
78	27
76	25
75*	23
75	23
75	23
73*	21
69*	19.5
69	19.5
66	18
63*	17
61	16
60*	15
58	13
58	13
58	13
54*	11
50	9
50	9
50*	9
44*	7
41*	6
40*	5
30*	4
25	2.5
25	2.5
17*	1

U Statistic Value = 173: n = 19: T=113

Appendix K

Instructions for Attached BBC Discs

Instructions for BBC Model B Software

Each disc is set up for automatic booting, and runs a menu program called "SMENU". This lists the files in the default ($) directory, and CHAINs the file chosen by pressing the desired number. The files in the other directories, in both discs, are data files which are called up by the programs in the $ directory. Neither disc is copy-protected, and all files can be loaded, listed or dumped if desired.

The !BOOT file in each disc is the same, and sets up the red function keys for particular uses. Key f0 RUNs the program loaded into memory, and f1 LISTs it. f2 calls up a utility procedure, A.PROCED, which is a useful screen editor. f9 deletes the procedure after use. (See below for fuller details of PROCED.) Typing *TYPE !BOOT will list the settings.

Disc 1 contains the most important of the files relevant to the first part of the project, the electronic questionnaire. The appropriate service files, containing the required data, are all present on the disc, so that all programs may be run normally.

In all cases where there is some output from the program, there is the opportunity to send it either to the screen or also to a printer.

The programs on Disc 1 are as follows:

1. PROBana - the main electronic questionnaire program. This uses N.name and all the files in the O, H and S directories as it proceeds. The answerfiles have all been set to blanks, so that you can attempt the questionnaire if you wish.

2. ANSana is for checking the contents of answerfiles. It displays the contents of the chosen grade on the screen.

3. ADVAN lists the advantages of the electronic questionnaire in large type on the screen, suitable for a presentation.

4. PROPS also uses large type, and lists the propositions.

5. READER, UPDATE and WRIana are all utility programs to read, amend or create new text files for use with the PROBana questionnaire.

6. "answri" and "namewri" are utilities for creating new (blank) answerfiles and namefiles respectively.

Disc 2 contains a selection of the programs written for the other part of the project - the analysis of the data provided by the electronic questionnaire and the pupils' marks. The disc is set up with the main programs in the $ directory and the other directories containing appropriate service files, but some of the service files in this case are very large, particularly those ("marks" and "passes") relating to the candidates' performances. As with Disc 1, the programs can be RUN to test them.

The programs on Disc 3 are as follows:

1. FAMILY uses the QVAL files in the appropriate directories and creates lists of problems with similar characteristics as discussed in Chapter 5.

2. PASSMK operates on the "marks" files and converts them into "passes" files in accordance with the factor chosen at the beginning of the program. This factor should lie between 0.2 (10%) and 1.8 (90%). A factor of 1 gives a 50% pass mark for each problem. This program was superseded by a related one which used set pass marks for each problem. as discussed in Appendix G. The program will overwrite the existing "passes" files to new ones relating to whichever pass factor is chosen. The passes files on the disc are at 50% pass grades.

3. MERIT uses the passes files. and places the problems in order of merit. The program reads the chosen passes file. and then counts totals of male, female and blank in each problem, before re-ordering the problems through the PROCswap method. as discussed in Appendix A. Later versions also collected data into groups with similarities in proposition values.

4. ALLana divides the problems into two groups in relation to each of the proposition sets in turn. then displays the sets in order of merit and calculates means and standard deviations of male, female and total pass rates.

5. TOTstat is the program which carries out the Mann/Whitney/ Wilcoxon Rank Order calculations and displays the results in suitable tables for comparison with the U statistic critical values from the Statistical Tables.

A.PROCED is a useful screen editing procedure which was published in BEEBUG magazine. It is for editing BASIC programs and allows extra data to be inserted into lines as required, without the necessity of copying each line in total. The first lines of procedures and functions are listed first and chosen by the cursor keys. Pressing RETURN changes the editor into line mode, and the up/down cursor keys will then move one line at a time. After new characters have been added to a line. the RETURN key must be pressed to establish the change. Moving (by the up/down cursor) will restore the old line to the program. CTRL-D will delete the currently selected line. and CTRL-S starts a search for any character string which is entered on the prompt "Target: ". The editing finishes when ESCAPE is pressed, but can be re-started by pressing BREAK. The procedure is in lines 32000 onwards, and is deleted using f9. which is defined by the !BOOT file for that purpose. Note that this file is not present on Disc 2. because of lack of disc space. A program can nevertheless be loaded from Disc 2, then Disc 1 inserted and PROCED (present as an ASCII file) can be EXECuted using f2.

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