Appendices

List of Appendices

Appendix A List of all Participants

Name	**Department**	**University**
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Mrs Muriel Alexander	Widening Participation Service	University of Glasgow
Dr Iain Allison	Faculties of Science Support Unit	University of Glasgow
Ms Susan Andrews	Lifelong Learning	Scottish Engineering
Dr Chris Aust	School of Engineering	The Robert Gordon University
Dr Jim Balfour	Department of Civil Engineering	Heriot Watt University
Dr Donald Ballance	Department of Mechanical Engineering	University of Glasgow
Dr Ken Barclay	School of Computing	Napier University
Dr Nigel Barltrop	Department of Naval and Marine Engineering	University of Strathclyde
Dr Simon Bates	School of Physics	University of Edinburgh
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Dr Garry Brindley	School of Computing	The Robert Gordon University
Dr Collette Britton	Department of Veterinary Infection and Immunity	University of Glasgow
Professor Chris Brotherton	Department of Applied Psychology	Heriot Watt University
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Dr Ronal Brown	Department of Physics	University of Strathclyde
Dr Alan Bruce	Division of Health and Food Sciences	University of Abertay
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Mrs Liz Clark	School of Education	University of Aberdeen
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Dr Derek Cosens	School of Biological Sciences	University of Edinburgh
Professor Mary Cotter	School of Medical Sciences	University of Aberdeen
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Mr Martin Cullen	School of the Built and Natural Environment	Glasgow Caledonian University
Mr John Dakers	Department of Educational Studies	University of Glasgow
Dr Avril Davidson	Scottish Science Advisory Committee Secretariat	Royal Society of Edinburgh
Dr Susan Dewar	Department of Biology	Heriot Watt University
Dr Peter Dickman	Department of Computing Science	University of Glasgow
Dr Elizabeth Downes	Division of Health and Food Sciences	University of Abertay
Dr Roger Downie	Division of Environmental and Evolutionary Biology	University of Glasgow
Ms Wendy Dow	Department of Educational Studies	University of Glasgow
Mr Gerry Doyle	Department of Curriculum Studies	University of Glasgow
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Dr Neil Evans	Department of Veterinary Cell Sciences	University of Glasgow

Name	**Department**	**University**
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Dr Duncan Fortune	School of Engineering, Science and Design	Glasgow Caledonian University
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Dr Margaret Fraser	School of Engineering	The Robert Gordon University
Dr Andy Freer	Department of Chemistry	University of Glasgow
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Dr Paul Gardner	School of Psychology	University of St Andrews
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Dr Frances Goldman	Department of Mathematics	University of Glasgow
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Dr John Green	School of Life Sciences	Napier University
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Dr Simon Guild	Bute Medical School	University of St Andrews
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Dr Linda Harvey	Department of Bioscience	University of Strathclyde
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Name	**Department**	**University**
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Dr Philip Meaden	Department of Biology	Heriot Watt University
Professor Maureen Melvin	School of Life Sciences	The Robert Gordon University
Dr Martin Milner	School of Biology	University of St Andrews
Ms Alison Mitchell	Department of Computing Science	University of Glasgow
Dr Stuart Monro	Scientific Director	Dynamic Earth
Dr Geoffrey Moores	Division of Infection and Immunity	University of Glasgow
Dr Iain Morgan	Department of Veterinary Pathological Sciences	University of Glasgow
Dr Alex Mullen	Department of Pharmaceutical Sciences	University of Strathclyde
Mr Graham Murdoch	Department of Curricular Studies	University of Strathclyde
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Dr Lubna Nasir	Department of Veterinary Pathological Sciences	University of Glasgow
Dr Douglas Neil	Division of Environmental and Evolutionary Biology	University of Glasgow
Dr Desmond Nicholl	Biological Sciences	University of Paisley
Dr Ian Nimmo	College of Medicine and Veterinary Medicine	University of Edinburgh
Dr Robin Orchardson	Division of Neuroscience and Biomedical Systems	University of Glasgow
Professor John Palfreyman	Division of Health and Food Sciences	University of Abertay
Dr Graham Patrick	Chemistry	University of Paisley
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Dr Clare Peddie	School of Biology	University of St Andrews
Dr Robin Phillips	School of Environmental and Biological Sciences	University of Stirling
Dr Neil Pitcher	Mathematics & Statistics	University of Paisley
Professor Rob Pooley	Department of Computer Science	Heriot Watt University
Dr Michael Purton	Department of Veterinary Cell Sciences	University of Glasgow
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Dr Norman Reid	Department of Educational Studies	University of Glasgow
Professor Bob Reuben	Department of Mechanical Engineering	Heriot Watt University
Dr David Robertson	School of Health Sciences	The Robert Gordon University
Dr Sheila Rowan	Department of Physics and Astronomy	University of Glasgow
Professor Peter Rowlinson	Department of Computing Science and Mathematics	University of Stirling
Dr Scott Roy	Department of Electronics and Electrical Engineering	University of Glasgow
Dr Carol Salt	School of Environmental and Biological Sciences	University of Stirling
Dr Judith Setchell	Physics	University of Paisley
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Dr Patsy Sterpaio	Division of Health and Food Sciences	University of Abertay
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Dr Rob Strang	Division of Biochemistry and Molecular Biology	University of Glasgow
Professor Peter Strike	School of Life Sciences	Napier University
Dr Neil Taylor	Department of Education	University of Dundee
Dr David Thomas	Division of Mathematics	University of Dundee
Dr Tony Tooke	Division of Electronic Engineering & Physics	University of Dundee

Name	**Department**	**University**
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Mr Alan Venters	School of Nursing and Midwifery	University of Dundee
Dr John Wake	Division of Biotechnology and Forensic Sciences	University of Abertay
Dr John Walden	School of Geography and Geosciences	University of St Andrews
Dr Gordon Walkden	College of Physical Sciences	University of Aberdeen
Dr Annalu Waller	Division of Applied Computing	University of Dundee
Dr Harry Ward	Department of Physics and Astronomy	University of Glasgow
Professor Roger Watt	Department of Psychology	University of Stirling
Dr Graeme White	Department of Chemical Engineering	Heriot Watt University
Dr Thomas Whitelaw	Department of Mathematics	University of Glasgow
Dr Graham Wightman	Division of Biotechnology and Forensic Sciences	University of Abertay
Dr Hazel Wilkins	School of Life Sciences	The Robert Gordon University
Dr Martin Wilkinson	Department of Environmental and Marine Science and Technology	Heriot Watt University
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Professor Pat Willmer	School of Biology	University of St Andrews
Dr Andrew Wright	School of Life Sciences	Napier University
Dr Lesley Yellowlees	School of Chemistry	University of Edinburgh
Dr Hilary Kay Young	Division of Environmental and Applied Biology	University of Dundee

Appendix B STEM Project Advisory Group

Name	**Position/ Department**	**Establishment**
Professor John Coggins	Dean, Faculty of Biomedical and Life Sciences	University of Glasgow
Professor Alan Roach	School of Engineering & Science	University of Paisley
Mrs Moira Finlayson	Faculty of Biomedical and Life Sciences	University of Glasgow
Dr Nigel Akam	Executive Officer of SHTTSB	Scottish Optoelectronics Association
Dr Peter Ball	Representative in Scotland	Institute of Physics
Dr Stuart Bramley	Chair of Technology & Science Alliance (West of Scotland)	University of Strathclyde
Dr Alan Bruce	Division of Health and Food Sciences	University of Abertay
Mr John Dakers	Department of Educational Studies	University of Glasgow
Professor John Palfreyman	Chair, Deans of Science & Engineering in Scotland	University of Abertay
Dr Norman Reid	Director, Science Education Research Unit	University of Glasgow
Dr Willie Rennie	Representative in Scotland	Royal Society of Chemistry
Dr Susan Rodrigues	Director	ISES
Dr John Roulston	Chair of High Technology Talent Strategy Board for Scotland	BAE Systems
Dr Paul Skett	Biosciences Federation Education Committee	University of Glasgow
Professor Peter Strike	Dean, School of Life Sciences	Napier University

Appendix C Extended Subject Specific Comments

In this appendix we report comments we received about the current subject curricula. Given that it had very quickly become clear we were going to advocate a significant change and broadening of approach, it was evident that there would have to be a significant "decluttering" of subject content. The discussions therefore tended to involve a critical analysis of content, and it was in the nature of this process to be often quite critical. We should emphasise that, whilst we are, in our broader cause, reporting a critical view of the curriculum. We are not criticising teachers. Very many of our academic participants were at pains to comment how much they recognised and felt considerable empathy for the challenges faced by teachers. Many of us have been immensely impressed by the calibre, dedication and commitment of many individual teachers we have had the privilege to meet.

It is our hope that a redesigned curriculum could be liberating for teachers, through giving them a much improved context in which to deploy their undoubted professionalism, and hopefully also better to inspire the interest and enthusiasm of their pupils.

It is also worth emphasising that in discussing the relative merits of syllabus topics for inclusion or exclusion no particular effort was made to identify content of the "right" overall length. Lecturers were expressing their views of the relative merits of different topics as useful for students entering university courses. All of this detail has been relegated to an appendix to our report because we regard it as much less important in detail than the major conclusions and recommendations made in the body of the report.

Physics

The physics lecturers interviewed so far think that the Higher syllabus is overcrowded and that there is too much to get through in the time allocated. There is still a "two term dash" to the Highers, which has not changed in spite of the Howie Report. This means that for some students there is a lack of understanding of some of the topics covered. Lecturers would prefer students to develop an understanding of the broad principles of physics, rather than to have an incomplete grasp of a huge collection of facts.

The consensus of opinion is that, at school, Physics courses should include mechanics, properties of matter, heat, light, electricity, electronics and radiation. These are all covered in school either at Higher or in Standard Grade. Not all lecturers agree with the weighting given to each subject however. They suggest that there is an overemphasis on electronics and the content could be reduced in this area (e.g. n-channel enhancement MOSFET). Lecturers also think that dosimetry is a more specialist subject and need not be included in the Higher. The way that uncertainty is dealt with is considered to be too difficult at this stage and a more qualitative approach is recommended. Civil and mechanical engineers, who require a pass in Higher Physics for entry to their courses, think that the present Higher is unbalanced in favour of electronics and express the desire for more materials science in the course. At present the materials science section includes only the gas laws and density and pressure. Table 3 shows where it is thought that content should be altered.

There is a need for more experimental work to be done by the student rather than by demonstration. Practical work is considered essential as a way of explaining the theories involved and to encourage students in problem solving abilities.

The number of students studying Higher Physics in Scotland has not reduced as dramatically as in other European countries (Holland is also an exception) in recent years. The reason for this, according to research quoted earlier, is thought to be the popularity of the Standard Grade Physics syllabus that has taken an application led approach. It has been shown that students in the 10-20 year age range respond better to an applications led approach and perform well as they are more engaged by the content and see its relevance to their lives. It should be noted that the present Standard Grade is now in need of an update in some areas. It is of some concern to lecturers of physics that so very few students taking Higher Physics do choose to study physics at university. The numbers studying physics at university are falling and lecturers want to know how this situation could be reversed. Would it be appropriate to follow on from the successful Standard Grade course with an applications led Higher? It has been stressed that an applications led syllabus is not less demanding and that the actual content does not need to be altered too greatly - it is the way the topics are introduced that differs.

Physics lecturers are not as unhappy with course content at Higher and SG as chemistry lecturers are with chemistry courses, but they are in agreement that content should be reduced in an effort to free up time to better teach the basic principles and to involve students in more extended practical activities. The idea of introducing a contemporary issue to enthuse students and to encourage debate in the classroom is also agreed across the sciences.

HE lecturers think that the links between the 5-14 curriculum and the Standard Grade are not good and the difference in level of difficulty of the Standard Grade and Higher Physics is too extreme.

The following recommendations are made as a result of discussions with lecturers in physics and engineering.

To summarise:

- The course is overcrowded and content needs to be reduced so that more time can be given to understanding the basic principles.
- Consideration should be given to the introduction of more practical work.
- The introduction of a contemporary issue should be considered.
- It is suggested that the electronics content could be reduced and that dosimetry should be removed from the syllabus.
- The section on uncertainty should be revised and a qualitative approach only taken.
- Whilst the Standard Grade in Physics has been very successful it is in need of updating.
- The possibility of following on from Standard Grade with an applications led Higher in Physics should be considered.
- The link between the 5-14 curriculum and Standard Grade should be improved, as the physics content of the 5-14 curriculum does not prepare pupils for Standard Grade in Physics.
- There should be some reinforcement of material covered at Standard Grade within the Higher.

Table 3: Present Physics Higher content.

Topic in Arrangements document	**Comments by lecturers**
Vectors	Relatively Important
Equations of motion	Relatively Important
Newton's Second Law, energy and power	Relatively Important
Momentum and impulse	Relatively Important
Density and pressure	Relatively Important
Gas Laws	Relatively Important
Electric fields and resistors in circuits	Relatively Important
Alternating current and voltage	Relatively Important
Capacitance	Relatively Important
Analogue electronics **	Not regarded as essential at this stage. Some lecturers thought that this section could be completely omitted, others that it could be reduced.
Waves	Relatively Important
Refraction of light	Relatively Important
Optoelectronics and semiconductors **	Could be substantially reduced in content. Wave-particle duality thought to be too difficult and not needed at this stage. Lasers could also be omitted. Conductors and semi-conductors should be kept in course but not MOSFET.
Nuclear reactions	Relatively Important
Dosimetry and safety **	Could be omitted, regarded as too specialist
Units, prefixes and scientific notation.	Relatively Important
Uncertainties **	It was agreed that a qualitative approach was sufficient at this stage.
What else do you think should be included?	A few requests were received for more on the properties of matter.

**Places where a reduction in content can be made in the syllabus.

Chemistry

Several lecturers consider Standard Grade Chemistry to be "dull, turgid and dire". It is not known what pupils think but this may help explain the drop in numbers over the years of those studying Higher Chemistry.

The overall impression of the Higher is that it consists of a lot of rather disparate facts and this is perhaps backed up by the Principal Assessor's comments on the 2003 paper: "Basic recall questions were relatively poorly done – more rote learning is required".

Lecturers think that there should be more concentration on basic principles in Higher Chemistry as students tend to be poor at formulae, equations and mole calculations. Again the SQA Assessor said that practice in writing formulae and equations would be helpful. He continued about calculations, in general, to say that pupils should learn the basic routine for the different types of calculations.

Lecturers would like more emphasis on practical work at school. Schools should not be prevented from carrying out practical work because of over-reaction to Health and Safety issues. While they want students to be able to write up laboratory reports, and would like more help given on this at school level, they are not keen that laboratory work be externally assessed as they feel that this reduces the variety of laboratory work carried out and the focus on its real instructive purpose. Practical skills are assessed in the Higher by submitting a written report on one experiment and this, in many cases, seems to have prevented further practical work being performed. Lecturers do not think that practical work should be formally assessed and favour more extended practicals which may be used to develop problem solving skills, illustrate theory and motivate pupils.

The overall impression is that the chemistry course is overcrowded, rather dated and assessment driven. When scientific issues hit the press there is generally a heated debate with not everyone agreeing on the correct way to go forward. There is at present no discussion of any topical issue at Higher level and pupils are left with the idea that everything in science is known or that the study of science is carried out in denial that there are such public issues. Research has shown that pupils are keen to debate issues in the sciences.

To teach the basics thoroughly and introduce topical items something must be removed from the syllabus. Areas where pruning could take place are fuels, the chemical industry and polymers. Opinion is divided about the importance of the sections on carbohydrates, proteins and fats and oils: some lecturers do not consider it vital while others see it as a way of making chemistry relevant by linking it to food, the human body and biology. The way forward with school chemistry courses is probably to try a themed approach to attract the pupil. Suggestions have been made for medicinal, forensic and sports chemistry. These approaches have been tried in some countries, notably in the state of New South Wales in Australia.[1]

Lecturers are not against having an element of choice in the syllabus to give scope for individual teacher initiative and interests, say up to 20%. This choice could be used so that teacher expertise could be utilised or that it could suit the need of schools in a particular area. It would also enable a subject to be treated in a bit more depth.

The section on industrial chemistry could perhaps be one of the choices. It is seen as in need of updating and also in need of having enlivening material produced for it.

Several lecturers also support the introduction of a contemporary issue. Students could look up references, gather information and write a report on their findings. This would help keep the course up-to-date and improve literacy skills.

School chemistry no longer attracts large numbers of pupils and, while some of this may be due to an increasing choice of subjects, part of it is due to the perceived difficulty of the Higher and also due to the prescribed nature of the curriculum which has become very assessment driven. Lecturers would like some of the wonder of the subject brought back into the classroom and this would require giving teachers more time for demonstrations and

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[1] http://www.boardofstudies.nsw.edu.au/syllabus_hsc/pdf_doc/science_support.pdf

discussion, as well as the reintroduction of more relevant and extended practical work. When compared to other chemistry courses, in other countries at the same level, there seems to be much less experimental work carried out by Scottish pupils.

On looking at the chemistry content of the 5-14 curriculum pupils do not seem to learn much about chemistry until Level F and this level may only be reached by a few at the end of S2. Again this is where the introduction of the Curriculum Review is welcome so that better bridges can be built between the different stages of school.

Assessment

Alternative forms of assessment should be considered along with the final examination. The current courses are thought to be over-assessed and assessment driven. The burden of assessment must be reduced and a more holistic approach taken. An assessment strategy should be chosen to focus on broad principles rather than on isolated facts and also to test and develop the core skills.

The current Higher paper does not require extended written explanations and often the problem solving questions do not test the ability to use chemical knowledge except within tightly defined, well-aired contexts. These skills could be tested in other ways. Literacy could be tested by production of a report or poster on a specific topic and problem solving skills could be assessed using more open-ended and extended exercises

Should the pupil's grade at Higher depend only on the final exam mark or should there be an element of continuous assessment involved? The latter would be more in line with the universities and would also give scope to test the basic skills in a chemical context.

Proposed reduction of syllabus

The current syllabus is overleaf; the shaded areas show where our contributors felt reductions can most appropriately be made.

To summarise:

1. The link between the 5-14 curriculum and Standard Grade should be improved, as the chemistry content of the 5-14 curriculum does not prepare pupils for Standard Grade in Chemistry.
2. There should be some reinforcement of material covered at Standard Grade within the Higher
3. Basic principles should be reinforced, especially formulae, equations and mole calculations.
4. Numeracy skills must be improved and pupils need more practice with calculations of all types.
5. Thought should be given to reinforcing the general skills throughout the course. In particular using more open ended activities should further develop problem solving skills. These skills should be developed both in the practical and the knowledge based areas.
6. Lecturers agree that the syllabus is overcrowded and they do not have a problem with a reduction in content (see Table 4 below).
7. The subject needs to be made more relevant and interesting. This could involve adopting a variety of teaching methods.
8. There should be more emphasis on relevant and extended practical work to aid understanding of principles, improve problem solving ability and generate curiosity in the subject.
9. Introduction of a contemporary issue for debate and the production of a report is suggested. This would help keep the syllabus up-to date and improve literacy skills.
10. Consideration should be given to developing an applications led or a themed approach to Standard Grade and perhaps the Higher.

Table 4: Course Content - Chemistry: Areas of importance and areas where cuts can be made.

Topics in the Higher and Standard Grade Chemistry Syllabus	**Lecturers Comments**
Chemical reactions	Important but does not need done both at SG and Higher
Reaction rate	Important but does not need done at both SG and Higher
Enthalpies **Hess's Law**	Opinion divided here, if done it should be done more thoroughly.
Electronic structure and the periodic table	Vital
Bonding	Vital
Physical properties	Important to have a broad overview, specific details may be able to be omitted.
The mole (calculations)	The whole area of formulae, equations and calculations needs to keep being reinforced.
Fuels	Most thought that there was an overemphasis on this topic and that it could be reduced, replaced or certainly at least updated
Hydrocarbons	Course concentrates on nomenclature and addition reactions. Seems OK though quite dull unless suitably applied
Alcohols, RCHO,RCOR, RCOOH, RCOOR	Concentrates on nomenclature and oxidation, hydrolysis of esters. Uses of compounds. Seems OK
Percentage yield	Unless practical work being done this was not regarded as being useful
Electrolysis/ Electrochemistry	This did not occupy a large part of the syllabus and some mention was felt to be reasonably important
Equilibrium	Important
The chemical industry	This was regarded as being dreadfully dull. Consensus of opinion was that it should be reduced in content and made more relevant.
Nuclear chemistry	On balance it was felt that this should be kept in.
Acids/bases/Redox	Important again need familiarity with half ion equations and balanced equations
Polymers	There is a lot on polymers in the current syllabus and it was felt that this could be reduced significantly.
Fertilisers (in SG only) includes Nitrogen cycle, requirement for N,K and P, Haber process, props ammonia, prep nitric acid	Title does not seem appropriate but content is OK Should probably be kept at SG (or whatever replaces it)
Carbohydrates (done at Standard Grade only)	Opinion divided here. Some see this as not essential. Others see this as the key to making chemistry more relevant to all and giving a link to biology. Those in favour of this wanted to link it in to the chemistry of food and also to mention DNA/RNA
Proteins	
Fats and oils	
What else would you like to see in school courses?	Syllabus kept up-to-date, image of scientist improved, course made more interesting. This was probably the most important opinion expressed.

Biology

Lecturers are, on the whole, impressed with the content of Higher Biology but they do consider the course too crowded and very assessment driven. They do not find that students retain much of the knowledge of the content of the Higher at university perhaps reflecting a lack of broader application of the knowledge. They are also particularly disappointed with regard to the problem solving and experimental outcomes.

Many lecturers at university believe that Higher Biology should provide a broad foundation of knowledge and skill across the whole subject and feel that the present course perhaps concentrates too heavily on molecular biology and genetics. There is agreement that a Biology course should contain elements of the following four topics:

1. Range of organisms
2. Anatomy and physiology of animals
3. Simple genetics
4. Basic biochemistry

The present Higher covers 3 and 4 but there is not much on the range of organisms (e.g. viruses are mentioned but not bacteria) or on the anatomy and physiology of animals. In the interests of producing a balanced course, the introduction of something on these topics would be welcomed. The only concern expressed about the detailed current content of the Biology course is that the third unit, Control of Growth and Development, needs to be updated.

One of the concerns expressed by biologists at university is that the subject has become so vast over the last few years that it is very difficult at school to give an idea of all the areas that biology encompasses. Many branches of the subject have become more mathematically based and this is not generally appreciated in schools, particularly when guidance is given on careers. Many pupils appear to be advised that it is not necessary to study mathematics if they wish to study biology further.

The numbers taking Higher Biology have been decreasing slowly for at least nine years, while the numbers taking Higher Human Biology are increasing. If the two are considered together there has still been an overall decrease in numbers (13%) in the last nine years. It is strange that numbers taking biology at school are decreasing as numbers entering biology at university are increasing and the subject as a whole is expanding in many interesting and diverse ways. There is a need for school biology to reflect this and to bring some of the excitement of the new developments into the classroom.

Lecturers comment on students' lack of skills in framing extended writing. This is something that is tested in the Higher Biology exam (contributing ca 15% weight to the total mark) and has been seen as a problem area for many years. A SQA contact however has commented that for the first time there has been an improvement in this section of the 2004 exam and thinks that perseverance in this area is at last beginning to pay off.

It is agreed that biology at school should try to keep up with current issues and should address social and ethical questions but there is some concern that this should not be done at the expense of communicating the core principles of the discipline. There is thought to be a lot of detail in the Higher course, and that this could be thinned. There is no consensus agreement on what specific topics are most important and this is seen as an area where teachers and lecturers could get together to attempt to devise a syllabus that would suit the needs of both those progressing to study biology and those who are not.

If the time allocated to the Higher remains the same the content will need to be reduced to allow the desired changes to be made. At present there is no clear consensus recommendation on how this might be done and it is suggested that when reviewing the subject it would be useful if a group of biologists from both schools and universities could get together to devise a curriculum which will be relevant and be capable of adapting to changes without the need for regular major rewrites.

To summarise:

- Some parts of curriculum need updating and it is important to frame the curriculum so that it can be updated more regularly as the discipline moves forward.
- Applications of current public relevance should be included.
- The course is perhaps a little unbalanced, needing more on organisms and less on cell biology.
- Universities regard Human Biology as an alternative rather than as a supplementary Higher in judging entry.

Mathematics

Most lecturers interviewed have made comments on the Mathematics Higher. Universities have to, increasingly, provide additional mathematical tutorials covering both basic skills and ground that is covered in the Highers as they find that many students who have Higher Mathematics do not seem to have retained much of what they had learned. Also many say that they no longer set problems involving more complex calculations as they have had to simplify their own use of mathematics so that students could cope. Thus, simpler examples involving calculations are given in kinetics, both in chemistry and in biology, and subjects such as thermodynamics tend to be developed in a more descriptive way than previously. Many recognise that these compromises have some impact on the skills of graduates.

Even well qualified students appear to have problems with basic algebra, especially the manipulation and simplification of equations. Without a good grounding in fractions, ratio and percentages understanding algebra when it is introduced must be exceedingly difficult. The foundations of mathematics are laid in primary school and thereafter must be steadily developed and, we would hope, continually reinforced.

The content of the Mathematics 5-14 National Guidelines and the attainment levels set have been raised as a matter of concern. Pupils are introduced to fractions in the 5-14 curriculum in primary school, but it is not until level D, which most pupils achieve by primary 7 that pupils are expected to convert simple fractions into percentages. In Level E, which most pupils should reach by S2, pupils should be able to find a fraction or percentage of a quantity, find ratios between quantities and use simple unitary ratio. It is not until Level F, which should be attainable, in part, by some pupils and completed by a few in the course of P7-S2, that a pupil will be expected to use direct and indirect proportion in context and to be able to add, subtract, multiply or divide fractions[2]. This means that many pupils will meet these concepts for the first time in Standard Grade. Lecturers would like more emphasis on arithmetic, and fractions in particular, in the primary school so that mathematics as such can be introduced closer to the start of secondary school. Pupils who then wish to progress to study Standard Grade at Credit Level can then be better prepared and will gain a better mastery of manipulation skills with fractions which can then be transferred to algebra. It is suggested that primary school teachers should perhaps receive additional training in the teaching of ratio, percentages and fractions, either as part of their degree programme, or as professional development. If pupils have practised application of the concept of ratios, science teachers could easily find suitable opportunities to assist in introducing the idea and application of proportion.

The suggestion is that perhaps secondary teachers could help with teaching arithmetic in primary schools as they know what is important for progression in mathematics. There is an impression that there is quite a lot of time wasted in S1/S2 trying to bring everyone up to the same level, with the result that pupils lose interest. This time could be put to better use improving mathematical skills. This could perhaps lead to an earlier and more successful introduction of algebra. When interviewing students this was also their impression of these years. The 5-14 curriculum does not appear to challenge many children, either at the P1-P7 stage or in S1/S2. There is the impression that more time could be spent in primary school building up a basic competency with numbers and that perhaps

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[2] These comments have been derived ***from the National Guidelines Mathematics 5-14***

fractions could be introduced earlier in primary school, with algebra being started for some in S1 or S2.

Generally logarithms, indices, exponentials and vectors are not well understood. It is felt that there is not enough time at school to give as much practice as is required for mastery of the required skills. Pupils need more practice using examples of gradually increasing complexity. There is also an indication that the contents of the third unit of Higher Mathematics may be rushed as pupils approach the end of the course and the final examination. In the Mathematics Department at Glasgow University the Higher syllabus has been studied and tutorial sheets are being produced for the problem areas. The tutorial sheets are to be used as a means of improving the mathematical skills of students who have started at university. This will be trialled next session. A student questionnaire was sent about these tutorial sheets and students were in favour of this idea, but, interestingly, when asked in what area they had problems very few felt that they had a problem with basic algebra. From a lecturer's perspective the reason they have a problems in other areas, for example in calculus, is that they cannot manipulate the equations after they have performed a differentiation or an integration.

The actual Higher syllabus mostly matches well what university staff would desire. What is unpopular is the element of choice for the third unit where students can choose from a further mathematics (Mathematics 3) unit or a statistics unit. Most regard statistics as an integral part of mathematics but at the same time feel that the other third unit contains essential material, namely further trigonometry, further calculus, vectors, logarithms and exponential functions. Now that statistics has been introduced at Standard Grade it should be possible to include a continuation of this at Higher.

There are also queries about why there is so little geometry in the Higher, as it is important to a number of professions. It may also give a better understanding of what a proof means and help with trigonometry.

The 3-18 Curriculum Review hopefully will give a more seamless transition between the different stages of school (e.g. the 5-14 curriculum and Standard Grade) and this may make more time available in 1st and 2nd years at High School. We also see scope for cross-curricular support in helping consolidate mathematical skills.

Several lecturers mention a previous comment by a Chemistry assessor in a Higher paper. He stated that: "Students should be shown how to lay out calculations in a systematic manner, following on one stage after the other." We believe this is a skill which deserves explicit attention: presentation of the solution to a problem in a clear logical sequence can help encourage pupils to learn to address new problems in a strategic and stepwise fashion. This is where "presentational literacy" and "problem solving" skills overlap.

Learning advisers at university say that biology and chemistry students come for help complainingly with "mathematical" problems, as many do not think that they should be doing mathematics in these subjects as they came to university to study science and not mathematics! Mathematics was famously and accurately described as the hand-maiden of science.

Whilst entry to degree courses in biology, and to a lesser extent chemistry, can be obtained without Higher Mathematics, 88% of those entering the science faculty at Glasgow have this qualification. In the biological sciences, where an actual Higher in Mathematics is not required, there is still a need for students to have basic mathematical skills over and above those developed at Standard Grade. A review of the Standard Grade should be considered. However on discussing the merits of Standard Grade Mathematics against the Intermediate 2 Mathematics course, Standard Grade was preferred to Intermediate 2 as it is regarded as a better gateway to Higher and has more problem solving questions in the examination. The current Foundation course is also thought to be good. This is one subject where the Standard Grade is preferred over the Intermediate qualifications.

With more students going to university the pool of students taking mathematics has perhaps widened and it *may* be that different teaching and assessment methods should be made available for some. There is evidence that a more applied approach to mathematics motivates and stimulates the interest of some students. When students see the relevance of mathematics to a particular situation they are more prepared to become engaged with the problem and to find the solution.

At Paisley University a more applied approach to mathematics is adopted and students appreciate and thrive on this method of teaching. There have been suggestions that a more applied approach may improve mathematics teaching in schools. Universities have expressed surprise that computers are not used more in the teaching of mathematics at school. In recent years the role of information technology has been expanded in schools and they have been equipped with computers, local networks and internet connections. What difference has this technology initiative made? Has it changed the way teachers teach and learners learn? According to a recent report[3] in the short answer is "No". Computers in classrooms seem to be used in areas peripheral to the learning process, such as word processing of projects. One purpose of the huge investment in technology was that it would be used as an aid to understanding and visualization. This investment in hardware was not followed up by investment in suitable software or investment of teacher time to think up imaginative new ways of teaching using technology. The idea appeared to be that once the investment had been made the rest would follow automatically. In 1998 the Scottish Office said that "the NGfl (National Grid for Learning) will change the face of education in Scotland by integrating the new information and communications technologies into the process of teaching and learning". With the present day heavy demands on a teacher's time, lack of motivating examples of classroom uses and curricular materials and perhaps a lack of skills in the use of ICT it is probably not surprising that more use has not been made of computers in teaching. Investment is needed in suitable teaching packages, training and most importantly teacher training and freeing up of teacher time to become involved with development of material. Computers can be also be used as a teacher aid in marking thus freeing up teacher time.

Learning pathways, teaching resources and pedagogy (including ICT) need to be considered.

The Smith Report[4] which applies mainly to England, Wales and Northern Ireland, recommends that more time should be allocated within the school timetable for acquiring greater mastery of core mathematical concepts and operations. It recommends re-designating GCSE Mathematics as a double award. This recommendation might also be relevant for Scotland where it appears that not enough time is allocated for the mastery of basic skills. There is a section in the report dealing with Scottish matters where it states that there is a lack of congruence between levels A-F within the 5-14 curriculum and Standard Grade. Two development officers were appointed in 2002 to look at methods of improving progression routes and ways of cutting down the assessment load. The Smith Report has also debated the positioning of statistics and data handling within the Mathematics syllabus where (in England and Wales) it occupies 25% of timetable allocation and has made the suggestion that it could be incorporated within the sciences.

A suggestion from one lecturer was that students be asked to sit a "driving test" exam in mathematical manipulation. The idea is that students would be tested in the basic mathematical skills in a test in which they had to achieve at least 75%. Without a pass in this proficiency test the pupil would not get a pass in Higher Mathematics. This would mean that the student had shown mastery in the required skills.

To summarise:

- The time available to teach mathematics should certainly not be reduced
- The syllabus content is important in this subject and it is felt that the current syllabus matches the needs of the universities. The Unit 3 option at Higher is not welcome as it pits very important mathematics topics against an introduction to statistics. Ideally there should be some statistics in the mainline course.
- There should be more practice and reinforcement of the basic principles.

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[3] British Journal of Educational Technology (Vol. 34 No2 2003 pp 137-150)

[4] The Post-14 Mathematics Inquiry , Report of Professor Adrian Smith's Inquiry into Post-14 Mathematics Education at http://eee.mathsinquiry.org.uk/report/toc.html

- There is a need to improve mathematical skills, especially in basic algebra, logarithms and exponentials.
- Alternative teaching and assessment methods should be investigated (including computer use).
- The introduction of some additional geometry to the course should be considered along with the idea of proof.
- There should be improved congruence between 5-14 and Standard Grade curricula.
- Mathematics should be reinforced in other areas of the curriculum.
- Topics are presented in isolation from their applications. A more applied approach to the teaching of mathematics would be welcomed.

Computing/ Information Studies

Higher Mathematics is regarded as a better predictor of ability to cope with a computing science course than a Higher in Computing or Information Studies.

A Higher in Computing or Information Studies is not necessarily required for entry to a computing course at university. Better guidance needs to be given in schools so that students know that to gain entry to computing science courses at university a requirement, at most universities, is that they have Higher Mathematics. The two Highers in the computing area have a quite different content, although in general they do will not be counted as two separate contributing Highers to meet a university entry threshold.

Students who have Higher Computing are a little more aware of the programming aspect of computing whereas those with Higher Information Studies are better with databases and information management. Very few students come to university with Advanced Higher Computing qualifications (Numbers from the SQA website for 2003 are 478 for the Computing course and 85 for the Information Studies). The impression is that many teachers feel very insecure with the content of the Advanced Highers and that there is a need to attract more graduates in Computer Science into schools, as well as offering more training and updating for teachers currently in post.

There is a large gender imbalance in computer sciences at all universities and this needs to be addressed. More females take post-graduate degrees in computing after a first degree in Mathematics or other subject and here they perform as well as their male counterparts.

A National Qualifications Review in Computing and Information Studies was carried out by SQA in 2001. The consultation was carried out in two stages. In Phase 1 consultation involved, amongst others, lecturers from 9 universities. In the Computing Higher the programming content was an issue concerning higher education institutions. In Phase 2 of the consultation, higher education representatives were invited to provide further comment. The programming unit has been removed from the current Higher course (pre-2004), but the rest of the course structure remains the same with some minor changes being made to individual units.

The relevant conclusions of the review were that there should remain separate courses in Computing and Information Studies and that units should have a balance between knowledge and understanding and practical problem solving skills.

Draft units were placed on the web between December 2003 and January 2004. In our exercise lecturers were shown, and had experience of, the existing arrangement documents for the two Highers and the comments made here relate to those documents.

Concerns have been expressed about the programming unit, as it is optional and not up-to-date and not seen as effective. The networking and multimedia unit is seen as relevant and useful. The two mandatory units of computer systems and software development are thought to be too knowledge based and not practical enough. There needs to be more emphasis on what a computer can do, rather than how it works. There should also be more emphasis on modelling.

Lecturers feel that it is not generally acknowledged that computing science is a science and an academic subject: it is *not* ICT (Information and Communication Technology). Universities would welcome a school course that will develop in the student the necessary academic skills to study computing science at university. At present it feels that Higher Mathematics is a better preparation than Higher Computing.

What skills do computer scientists require?

They need:

- analytical skills;
- an ability to think abstractly;
- the ability to take an everyday problem and break it down into smaller parts;
- speed and accuracy;
- the ability to look at different ways of solving a problem and
- the ability to fault-find.

Is it possible or realistic to try to develop these skills in a school Higher in Computing and does the revised Higher help towards the development of these skills? It has been suggested that the British Computer Society (BCS) should provide benchmarking and that perhaps this could be used to suggest a suitable design for a course at the Higher level. The SQA, however, indicates that the BCS was indeed consulted in the Review.

The new Higher Computing is available from August 2004 and has two compulsory units: Computer Systems and Software Development. Each unit has two main outcomes, one detailing the required knowledge and understanding, the other the necessary practical skills. When the proposed new Higher was shown to lecturers the units were written as a series of content statements it seemed difficult to judge how much programming students will be required to do as part of the new course. At both Paisley and Glasgow Universities lecturers would like the students to have an understanding of the basics of programming if they take computing courses before they come to university. The programming language used is not too important but the experience is important. In the SQA Review it states that some of the content from the programming unit in the existing Higher should be transferred to the Advanced Higher and that the content of the Software Development (Adv. Higher) unit should be increased to provide a better bridge to Computer Science degree courses. At present the arrangement documents for the Advanced Higher are not available for comment. It seems an anomaly that the school qualification that has been designed to provide a bridge to computer science degree courses is the Advanced Higher and not the Higher. In all other subjects the relevant bridging qualification is the Higher and in fact at some universities the Advanced Higher in some subjects may give access to second year level. Universities would prefer if the content of the Higher in Computing provided the bridge rather than the Advanced Higher. As the first group of school students will sit the new Higher in 2005 it will not be known until 2007 how well these students will cope with university computing science.

To summarise:

- The existing Higher Computing (offered up until 2004) does not adequately prepare students for entry to a computing science degree course
- A review of the current computing courses in schools has been carried out and the new Highers in Computing and information Systems are available. It is unclear at present if the new Higher in Computing adequately addresses the concerns expressed by universities.
- Higher Mathematics is a better indicator of student suitability at present.
- There is a large gender imbalance in computing science courses at universities. This is more marked than the gender imbalance at school.
- There appear to be problems getting qualified staff in schools to teach computing and to keep their skills up-to-date.

- It appears that the Advanced Higher is perceived as the link to university computing science courses.

Recommendations:

- Basic programming skills should form part of the Higher in Computing
- The suitability of the new Higher Computing as a bridge to computer science degree courses should be monitored. The bridge should be the Higher and not the Advanced Higher.
- There appears to be a need for more teachers of computing subjects who have up-to-date skills.
- Ways of making computing courses more attractive to females should be researched and tested.

Technological Studies

Recognition of the Higher seems to be the major problem here. The Higher is quite academic but it is not regarded highly in schools and pupils are urged to take Higher Physics in preference. The numbers taking the Higher have dropped by 23% in the last nine years and the drop at SG is even larger at almost 40%. Only 2244 pupils sat the SG in 2004 and 886 took the Higher examination. This course is the only one in schools designed to give pupils an idea of what engineering is about.

As can be seen from the above Technological Studies is not a popular Higher or SG. Not all schools offer this subject and in the Greater Glasgow district it is on offer in only three schools. There appear to be areas of the country where it is more popular than others: it is more popular in the North East of the country where it is encouraged in schools by the universities and by the oil industry who have put money into funding the courses. Industry has provided money for equipment and the universities have offered the use of laboratories and workshops.

Most divisions in engineering faculties will accept Higher Technological Studies in place of Higher Physics for university entry and a few civil engineering departments may actually prefer it, as it is less biased towards electronics than Higher Physics. On looking to see how acceptable a qualification it was for entry to science/engineering degrees, it was found from an analysis of University of Glasgow Science (surely Engineering?) Faculty that of 60 students who had Higher Technological Studies in their entry qualifications, only one did not possess Higher Physics. This made it impossible to compare the progress of students with Higher Technological Studies against those with Higher Physics. On looking at degree statistics in sciences and engineering at Paisley University it was again found that only one student in the sample who had Higher TS did not also have a Higher in Physics and so again no comparison could be made.

A research paper[5] shows that since 1993, 86% of entrants to the engineering faculty of a Scottish university had Higher Physics as opposed to 14% with Higher Technological Studies. The paper aimed to analyse student progress with respect to their entry qualifications. They also found that there were no students entering the department of Electronics and Electrical Engineering who had Higher Technological Studies who did not have a Higher in Physics. It appears that Higher Technological Studies is regarded as supplementary to a Higher in Physics.

Higher Physics and Technological Studies are both accepted for university entry. It appears that most students wanting to go to university take Higher Physics in S5 and then in S6 a few will take Higher TS as a "crash" Higher.

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[5] Technological Studies, physics and university entrance to engineering courses- Brian Canavan and Gordon Doughty IDATER 98 Loughborough University

The reasons why the subject is not popular in schools appear to be many and complex. Parents, who seem to exert an influence on pupil choice at SG, do not encourage their children to study non-academic subjects and seem to have a prejudice against engineering subjects in general. Engineering seems to be still associated with the heavy manufacturing industries and therefore redundancy. Engineering subjects require space, equipment and materials and so are expensive to finance, so school managers may prefer to offer less expensive options. Technical rooms may have remained unchanged for many years and pupils are not encouraged to take up the subject as the environment is not seen as attractive when compared to, for instance, a new computing room. There may also be a shortage of trained TS teachers[6] and this may help to further reduce the numbers taking the subject. An article in TES stated that not every pupil had access to technological education in the North East of Scotland due to a shortage of teachers and that this could be a disaster for the economy of the local area as there was a need for engineers of all types. A solution to the problem is being developed with a local FE college and Aberdeen University. Links have been formed between the two institutions and students with HNDs in Engineering could progress to the BSc Technology with Education course. The North East of Scotland is also the place where more pupils take Technological Studies than anywhere else in Scotland and where funding from local industry has been obtained. The schools also enjoy good links with the local universities and colleges. Indications are that there is even more cause for concern in most other regions of Scotland.

There also appears to be a lack of knowledge among course options counsellors in schools and so they do not give appropriately supportive advice. It is rumoured that some guidance staff still think that the course involves woodwork. The technological teachers themselves may contribute to the problem, as they perhaps could do more to promote the subject. Isolation may play its part. In many cases only one teacher in the technology department will teach Technological Studies and if he moves on there may be no-one confident enough to take on the course.

Perhaps this subject has never adequately been promoted to pupils and has never been given the resources it requires if it is to be taught in an imaginative way. The subject was retitled over ten years ago but the replacement of the word "engineering" by "technological" has not increased the popularity of the subject and some want it to be again renamed. With the introduction of faculties in schools some think that if the subject were to be placed within the science faculty this may attract pupils. Some fear however that this could prove counterproductive and any increase in numbers in TS could be at the expense of further decrease in the other sciences.

How can Technological Studies be made more attractive to pupils at school?

The current format of the course is not attractive to many pupils and particularly girls. A questionnaire, issued to school pupils a number of years ago, was designed to see what were the perceptions of boys and girls of the word "technology". The boys responded in the expected way naming computers, tanks, planes, robots and space age stuff etc. Girls, on the other hand, responded mainly in contexts of society, the environment, health and welfare and making lives better and safer etc. The current content and the approaches to learning and teaching are not really appropriate if we wish to attract girls to the subject.

it appears that content is not the root cause of the failure to attract more pupils to the subject, for all of the reasons mentioned above. The present course is regarded as not academic enough for some pupils, whilst not practical enough for others. It seems to be a course where the aims are not clearly enough identified and it is not known for whom it is actually designed. One suggestion received is that the existing course is delivered using a thematic approach. This has already been done in at least one school with great success where the course has been delivered using self-assembly robots. These packs are bought and the course is delivered using this as the vehicle for the course. The pupil can learn about materials, movement, and control systems using this robot and at the end of the day they get to purchase the robot they have constructed.

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[6] "Dark Hole for Technology" in the TES October 2004

Another suggestion, which may be worthy of consideration, is that aspects of technology be incorporated within the sciences. There is very little overlap in the Higher Physics and TS courses. Both contain an electronics component but the emphasis in Physics is on knowledge, understanding and problem solving while in TS it is on designing and constructing. It would perhaps be possible to have a combined course incorporating the two different strands. It would seem sensible to have one person who could appreciate the five different elements mentioned above. This could also be implemented in other areas of physics such as mechanics and optics.

Engineering courses equivalent to the Scottish Highers are popular in Eire, with large numbers participating in schools. It may be worthwhile looking at the syllabus which seems to be practical and traditional in nature. This appears not to offer a total solution however, as universities in Eire seem to have the same problems as elsewhere in recruiting students to engineering.

To summarise:

- Recognition of the Higher seems to be the major problem here. The Higher curriculum *appears* both academically rigorous and relevant but it is not highly regarded in schools and pupils are urged to take Higher Physics in preference. There are concerns about very low uptake, and teacher availability.
- The subject appears to be not well promoted and class areas where courses are taught may not be attractive. Courses may also not get the resources required.
- A thematic approach could be used to improve the attractiveness of the existing course, e.g. constructing robots.
- Engineering courses are popular in Eire so it may be useful to look at the syllabus.
- Integrating Engineering within the sciences is a possibility – especially physics.
- Most, but not all, divisions in engineering faculties will accept Higher Technological Studies in place of Higher Physics for university entry.
- This is the only subject which introduces pupils to engineering: perhaps industry, schools and universities should work together to review the aims, objectives and content of the course, and how it is promoted.

Geology

Higher Geology has a very small annual uptake and is not required for entry to an undergraduate course in Geology. We have not discussed it in any detail. The two geologists interviewed during our project are happy with its content. One would like students to show better observational skills and to be able better to estimate heights and distances.

It is interesting to note that in the Assessor’s feedback to centres on the Higher paper for 2002/3 three main weaknesses were identified: essay writing, performing calculations and drawing and interpreting graphs. Again the importance of the transferable skills is stressed.

Appendix D 5-14 Mathematics Curriculum

In Mathematics 5-14 the mathematical toolkit consists of three outcomes involving:

- Information handling
- Number, money and measurement
- Shape, position and movement

The pupil progresses through five or six broad levels (A to E or F) from 5-14.

Level A should be attainable in the course of P1 – P3 by almost all pupils.

Level B should be attainable by some pupils in P3 or even earlier, but certainly by most in P4.

Level C should be attainable by some pupils in P4 – P6 by most pupils.

Level D should be attainable by some pupils in P5 – P6 or even earlier, but certainly by most in P7.

Level E should be attainable by some pupils in P7- S1 or even earlier, but certainly by most in S2.

Level F should be attainable in part by some pupils, and completed by *a few pupils*, in the course of P7-S2.

In primary school pupils are encouraged to work at their own pace and there is less whole class teaching, so by the time pupils progress to secondary school they will not all be at the same stage. Most pupils are expected to have attained Level E by the end of S2 when they will then progress to Standard Grade. Let us look at the content of Level E in the number, money and measurement strand, to see what is expected of the pupil at this stage in fractions, percentages and ratio.

At Level E:

Work with fractions and percentages:

Mentally find widely used fractions and percentages of whole number quantities:

With a calculator find a fraction or percentage of a quantity;

Without a calculator as previously defined.

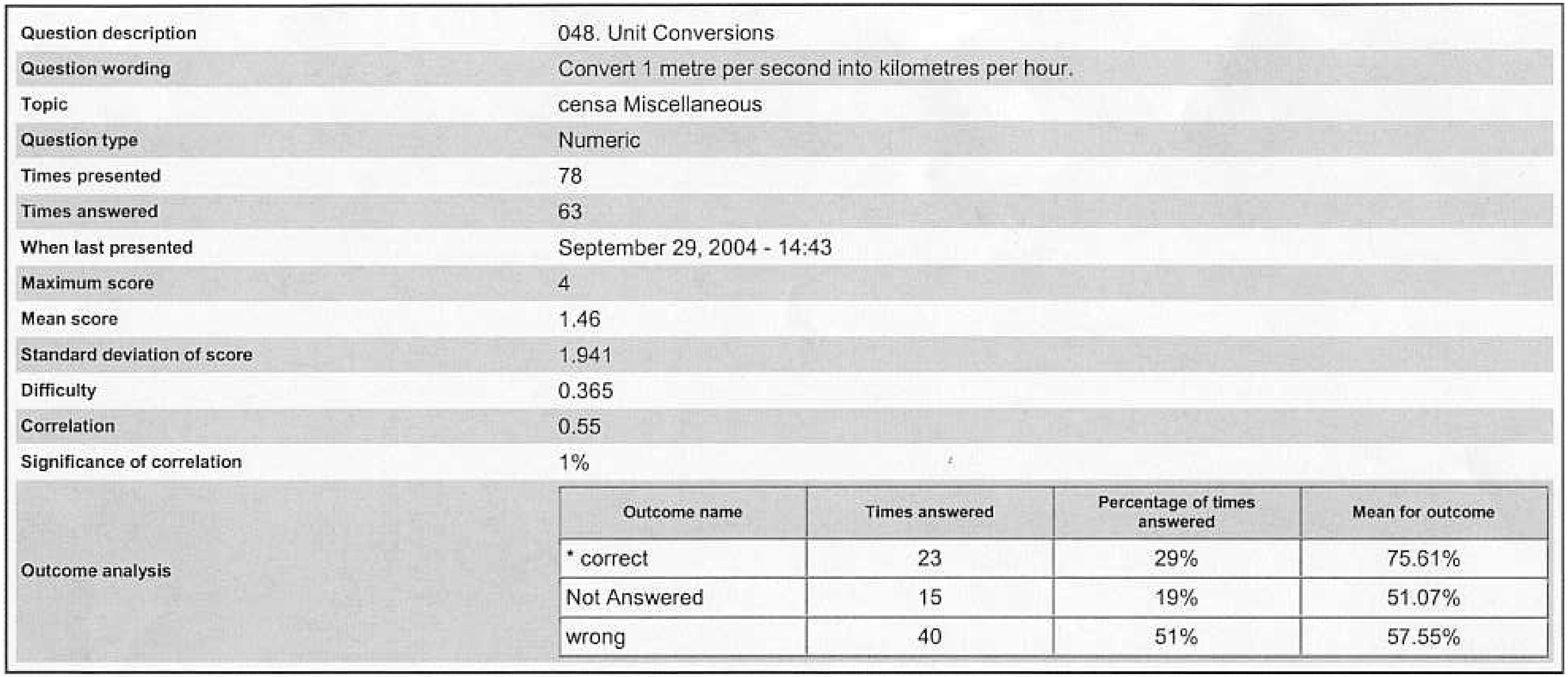
Find ratios between quantities;

Use simple ***unitary*** *ratio.*

Appendix E Mathematics Test Questions from the Robert Gordon University

As can be seen, one question involves conversion of 1 metre per second into kilometres per hour; out of 78 responses only 23 were answered correctly. The second question involves calculating the perimeter of a third of a circle, given the radius. Here only 13 students out of 77 got the answer correct. The third question is on adding an algebraic fraction. 28 students out of 78 got this correct. Other universities offer similar courses.

1



<table>
<tr><td>Question description</td><td>048. Unit Conversions</td></tr>
<tr><td>Question wording</td><td>Convert 1 metre per second into kilometres per hour.</td></tr>
<tr><td>Topic</td><td>censa Miscellaneous</td></tr>
<tr><td>Question type</td><td>Numeric</td></tr>
<tr><td>Times presented</td><td>78</td></tr>
<tr><td>Times answered</td><td>63</td></tr>
<tr><td>When last presented</td><td>September 29, 2004 - 14:43</td></tr>
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<tr><td>Mean score</td><td>1.46</td></tr>
<tr><td>Standard deviation of score</td><td>1.941</td></tr>
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<tr><td>Correlation</td><td>0.55</td></tr>
<tr><td>Significance of correlation</td><td>1%</td></tr>
<tr><td>Outcome analysis</td><td>
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<tr><td>wrong</td><td>40</td><td>51%</td><td>57.55%</td></tr>
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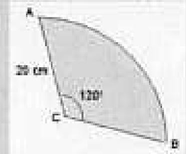
2

<table>
<tr><td>Question description</td><td>070. Properties of a Circle</td></tr>
<tr><td>Question wording</td><td>An open fan is similar to the shape of a sector of a cirlce.
The angle of ACB = 120° and the radius of the circle is 20 cm.
Calculate the length of the arc AB.

(use the letter 'p' to represent π)</td></tr>
<tr><td>Topic</td><td>censa Perimeter, Area & Volume</td></tr>
<tr><td>Question type</td><td>Text Match</td></tr>
<tr><td>Times presented</td><td>77</td></tr>
<tr><td>Times answered</td><td>55</td></tr>
<tr><td>When last presented</td><td>September 29, 2004 - 14:30</td></tr>
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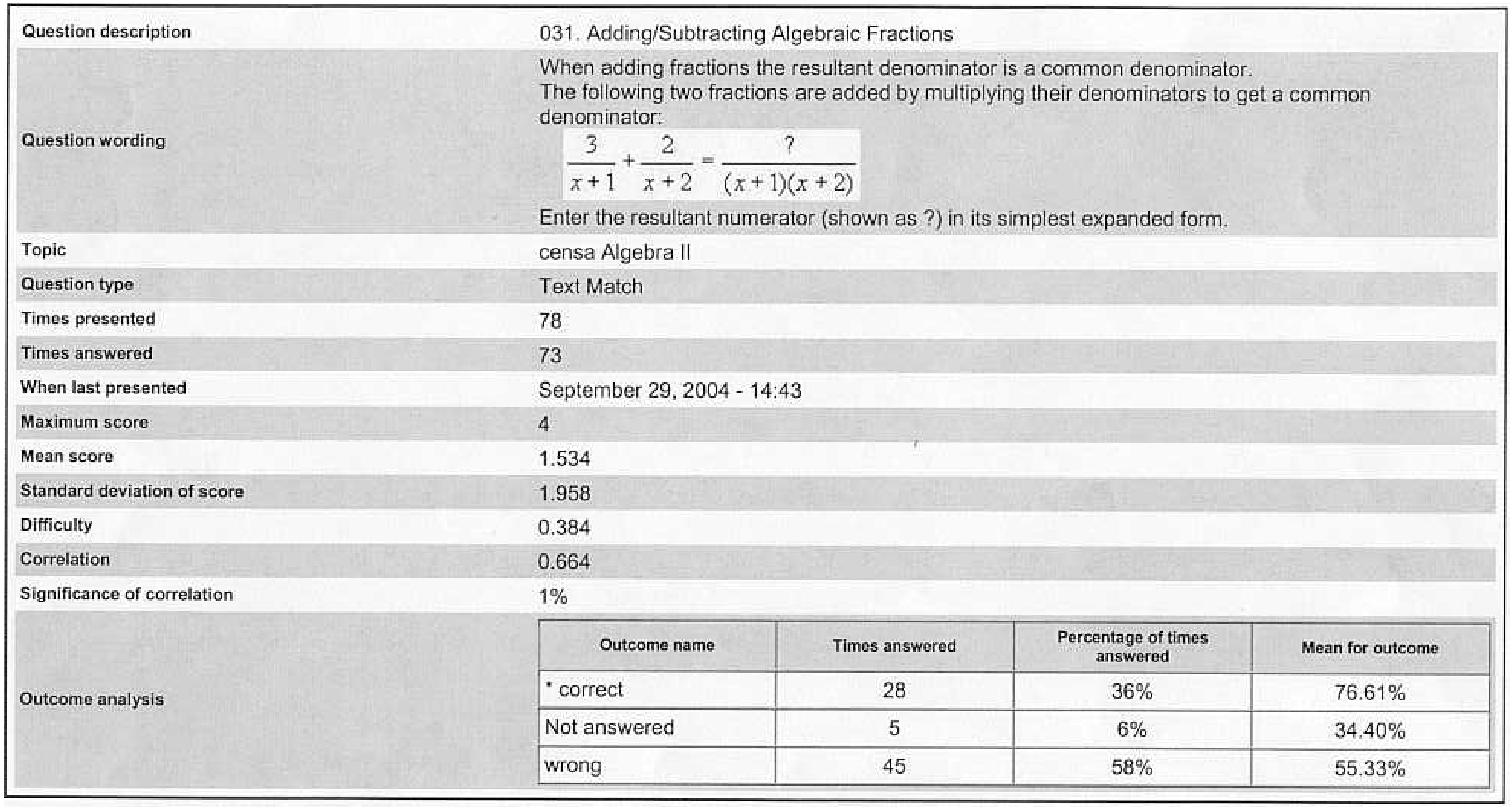

<table>
<tr><td>Question description</td><td>031. Adding/Subtracting Algebraic Fractions</td></tr>
<tr><td>Question wording</td><td>When adding fractions the resultant denominator is a common denominator.
The following two fractions are added by multiplying their denominators to get a common denominator:
$\frac{3}{x+1} + \frac{2}{x+2} = \frac{?}{(x+1)(x+2)}$
Enter the resultant numerator (shown as ?) in its simplest expanded form.</td></tr>
<tr><td>Topic</td><td>censa Algebra II</td></tr>
<tr><td>Question type</td><td>Text Match</td></tr>
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<tr><td>Difficulty</td><td>0.384</td></tr>
<tr><td>Correlation</td><td>0.664</td></tr>
<tr><td>Significance of correlation</td><td>1%</td></tr>
<tr><td>Outcome analysis</td><td>
<table>
<tr><th>Outcome name</th><th>Times answered</th><th>Percentage of times answered</th><th>Mean for outcome</th></tr>
<tr><td>* correct</td><td>28</td><td>36%</td><td>76.61%</td></tr>
<tr><td>Not answered</td><td>5</td><td>6%</td><td>34.40%</td></tr>
<tr><td>wrong</td><td>45</td><td>58%</td><td>55.33%</td></tr>
</table>
</td></tr>
</table>

Appendix F Higher Biology Problem Solving Outcomes

Outcome 2

Solve problems related to cell biology.

Performance criteria

(a) Relevant information is selected and presented in an appropriate format.

(b) Information is accurately processed, using calculations where appropriate.

(c) Conclusions drawn are valid and explanations given are supported by evidence.

(d) Experimental procedures are planned, designed and evaluated appropriately.

(e) Predictions and generalisations made are based on available evidence.

All units have the same performance criteria, although not all may be tested in each outcome. The problem solving covers experimental work, collecting information from graphs, solving numerical problems and solving problems on specific topics.

Appendix G Higher Mathematics Grade Descriptions

Higher Mathematics courses should enable candidates to solve problems that integrate mathematical knowledge across performance criteria, outcomes and units, and which require extended thinking and decision-making. The award of Grades A, B and C is determined by the candidate's demonstration of the ability to apply knowledge and understanding to problem solving. To achieve Grades A and B in particular, this demonstration will involve more complex contexts including the depth of treatment indicated in the detailed content tables.

In solving problems, candidates should be able to:

a) Interpret the problem and consider what might be relevant;

b) Decide how to proceed by selecting an appropriate strategy;

c) implement the strategy through applying mathematical knowledge and understanding and come to a conclusion;

d) decide on the most appropriate way of communicating the solution to the problem in an intelligible form.

Familiarity and complexity affect the level of difficulty of problems. It is generally easier to interpret and communicate information in contexts where the relevant variables are obvious and where their inter relationships are known. It is usually more straightforward to apply a known strategy than to modify one or devise a new one. Some concepts are harder to grasp and some techniques more difficult to apply, particularly if they have to be used in combination. Here the student has to interpret the problem, select an appropriate strategy, implement the strategy and then communicate the answer.

(There is however one vital piece missing from these four statements: this is the checking of the result to assess if the answer is reasonable).

Appendix H 5-14 Curriculum for Science Levels C-F

Knowledge and Understanding – Earth in Space

Strand	Level C	Level D	Level E	Level F
Earth in space Developing an understanding of the position of the Earth in the Solar System and the Universe, and the effects of its movement and that of the Moon.	• describe the Solar System in terms of the Earth, Sun and planets • link the temperature of the planets to their relative positions and atmospheres	🟩 • describe the movement of planets around the Sun 🟩 • give some examples of the approaches taken to space	🟩 • relate the movement of planets around the Sun to gravitational forces 🟥 • explain day, month and year in terms of the relative motion of the Sun, the Earth and the Moon 🟩 • describe the universe in terms of stars, galaxies and black holes	🟥 • describe some of the ideas used to explain the origin and evolution of the Universe
Materials from Earth Developing an understanding of the materials available on our planet, and the links between properties and uses.	🟩 • describe the differences between solids, liquids and gases 🟩 • give some everyday uses of solids, liquids and gases	🟩 • describe the internal structure of the Earth 🟩 • describe the processes that led to the formation of the three main types of rock 🟩 • give examples of useful materials that we obtain from the Earth's crust 🟩 • describe how soils are formed 🟦 • name the gases of the atmosphere and describe some of their uses	🟦 • describe the particulate nature of solids, liquids and gases and use this to explain their known properties 🟦 • describe what is meant by an element 🟦 • describe how physical properties of elements are used to classify them as metals or non-metals	🟥 • describe some features of the structure of the atom 🟦 • describe some of the characteristic features of the periodic table 🟦 • explain the water cycle using the particulate model
Changing materials Developing an understanding of the ways in which materials can be changed.	🟩 • describe changes when materials are mixed 🟩 • describe how solids of different sizes can be separated 🟩 • distinguish between soluble and insoluble materials 🟩 • describe in simple terms the changes that occur when water is heated or cooled.	🟦 • describe what happens when materials are burned 🟩 • explain how evaporation and filtration can be used in the separation of solids from liquids 🟦 • describe the effect of burning fossil fuels.	🟦 • give examples of simple chemical reactions, explaining them in terms of elements and compounds 🟦 • describe the effect of temperature on solubility 🟦 • describe the use of pH to measure acidity 🟦 • describe the process of neutralisation and give some everyday applications 🟦 • describe what happens when metals react with oxygen, water and acids 🟥 • describe how metal elements can be extracted from compounds in the Earth's crust.	🟥 • give examples of the ways in which the rates of chemical reactions can be changed 🟦 • distinguish between chemical and physical changes 🟦 • give examples of chemical reactions using word equations.

🟩	P6/7
🟦	S1/S2
🟥	S1/S2 – to be developed

Source: Lasswade High School Centre
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Knowledge and Understanding – Living Things and the Processes of Life

Strand	Level C	Level D	Level E	Level F
Variety and characteristic features Developing an understanding of the characteristic features of the main groups of plants and animals, including humans and microorganisms. The principles of genetics are also considered.	• give some of the more obvious distinguishing features of the five vertebrate groups • name some common members of the vertebrate groups • name some common animals and plants using simple keys	• give the main distinguishing features of the major groups of flowering and non-flowering plants	• create and use keys to identify living things. *This could recapitulate on work done in primary, and expand to cover the main 'Kingdoms'. This then progresses logically to the two items shown below.* • give the main distinguishing features of microorganisms • give examples of inherited and environmental causes of variation	• describe the harmful and beneficial effect of microorganisms • outline the principles of modern biotechnology and explain its significance now and for the future • explain the role of chromosomes and genes in inheritance
The processes of life Developing an understanding of growth and development and life cycles, including cells and cell processes. The main organs of the human body and their functions are also considered.	• name the life processes common to humans and other animals • identify the main organs of the human body • describe the broad functions of the organs of the human body • describe the broad functions of the main parts of flowering plants	• describe the role of lungs in breathing *The mechanics of breathing, e.g. movement of ribs, diaphragm, lung expansion should be dealt with in primary school. Detailed description of the inner structure of the lungs, and the process of gaseous exchange would be covered in secondary.* • outline the process of digestion *The structure, function, and care of teeth should be dealt with in primary school. The chemical process of digestion, and the detailed function of the digestive organs, should be part of the secondary course.* • describe the main changes that occur during puberty	• identify and give the functions of the main structures found in plant and animal cells • identify, name and give the functions of the main organs of the human reproductive system	• describe how different cells are adapted to their functions • describe the process of respiration • describe the function of enzymes in the control of cellular reactions • describe the effect of pH and temperature on enzyme activity

Source: Lasswade High School Centre
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School Material

Knowledge and Understanding –
Living Things and the Processes of Life (Continued)

Strand	Level C	Level D	Level E	Level F
		• describe the main stages in human reproduction • describe the main stages in flowering-plant reproduction	• identify the raw materials, conditions and products of photosynthesis	
Interaction of living things with their environment Developing an understanding of the interdependence of living things with the environment. The conservation and care of living things are also considered.	• give examples of living things that are rare or extinct; explain how living things and the environment can be protected and give examples.	• describe examples of human impact on the environment that have brought about beneficial changes, and examples that have detrimental effects	• construct and interpret simple food webs and make predictions of the consequences of change	• construct and explain food pyramids
		• give examples of how plants and animals are suited to their environment	• describe examples of competition between plants and between animals	• give a simple description of the theory of evolution and explain how species survive or become extinct
		• explain how responses to changes in the environment might increase the chances of survival.	• give examples of physical factors that affect the distribution of living things.	• describe what is meant by an abiotic factor and give some examples of how these can be measured.

🟩 P6/7

🟦 S1/S2

🟥 S1/S2 –
to be developed

Source: Lasswade High School Centre

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School Material

Knowledge and Understanding – Energy and Forces

Strand	Level C	Level D	Level E	Level F
Properties and uses of energy Developing an understanding of energy through the study of the properties and uses of heat, light, sound and electricity.		• distinguish between heat and temperature	• describe the differences between the flow of heat by conduction and convection • give examples of everyday uses of good and poor conductors of heat	• describe how energy is transferred by radiation
	• link light to shadow formation • give examples of light being reflected from surfaces	• describe in simple terms how lenses work • give examples of simple applications of lenses	• describe working of lenses in terms of focal length (Addition) • explain the effect of a prism on white light • describe what happens when light passes through different materials	• explain the effect of colour filters on white light
	• link sound to sources of vibration	• use the terms 'pitch' and 'volume' to describe sound	• explain what happens when sound passes through different materials	• describe the relationship between pitch and frequency and loudness and amplitude
	• construct simple battery operated circuits, identifying the main components • classify materials as electrical conductors or insulators and describe how these are related to the safe use of electricity	• construct a series circuit • construct a series circuit following diagrams using conventional symbols • describe the effect of changing the number of components in a series circuit	• construct a series circuit following diagrams (Addition) • construct a parallel circuit following diagrams • use the terms 'voltage', 'current' and 'resistance' in the context of simple circuits • static electricity and history of electricity (Addition)	• describe the structure and function of an electromagnet • analyse the functions of everyday electronic systems in terms of input and output conditions • using prefabricated subsystems, construct simple electronic systems to solve given problems
Conversion and transfer of energy Developing an understanding of energy conversion in practical everyday contexts.	• give examples of energy being converted from one form to another	• give some examples of energy conversions involved in the generation of electricity • describe how electrical energy is distributed to our homes	• describe some examples of the interconversion of potential and kinetic energy • give some examples of chemical energy changes	• distinguish between gravitational potential and chemical potential energy
	• describe the energy conversions in the components of an electrical circuit	• name some energy resources	• explain the difference between renewable and non-renewable energy resources	

🟩	P6/7
🟦	S1/S2
🟥	S1/S2 – to be developed

Source: Lasswade High School Centre

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School Material

Knowledge and Understanding – Energy and Forces (Continued)

Strand	Level C	Level D	Level E	Level F
Forces and their effects Developing an understanding of forces and how they can explain familiar phenomena and practices.	• give some examples of friction • explain friction in simple terms • describe air resistance in terms of friction	• give examples of streamlining and explain how this lowers resistance	• describe the effects of balanced and unbalanced forces	• distinguish between mass and weight • name the newton as the unit of force and explain its relationship to mass • describe the relationship between force, area and pressure
		• describe the relationship between the Earth's gravity and the weight of an object	• explain how gravity on other planets and the Moon affects the weight of an object	
		The above will need some clarification as to the level of treatment appropriate at primary and secondary levels.		

🟩 P6/7

🟦 S1/S2

🟥 S1/S2 – to be developed

Source: Lasswade High School Centre
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Appendix I Scottish Qualifications Authority. National Ratings for 2003 and Numbers Sitting Examinations.

Standard Grade, Intermediate 1 and 2, Higher and Advanced Higher

National ratings are comparability indices which can be used as a guide to the relative awarding standards in the various subjects at Standard Grade, Intermediate 1 and 2, Higher and Advanced Higher. The assumption underlying these indices is that candidates who, on average, do well in all subjects will also do well in any particular subject. While this assumption may not be true for a single candidate it may reasonably be applied to groups of candidates. The difference between a candidate's result in a given subject and the mean of the candidate's results in the other subjects taken is therefore, when averaged over a group of candidates, an indication of the "difficulty" of the subject in question. There is however a tendency for candidates to take groups of relatively easy or relatively demanding subjects, and to allow for this an adjustment is made.

The national ratings have their limitations. There are a number of factors that are not taken into account, such as differences in the length of time for which candidates have studied a subject, differences in motivation between subjects and differences in the teaching situation between subjects. Ideally, national ratings of zero for all subjects might be considered desirable, but in practice this is qualified by the fact that the underlying assumption described above may be less valid for some subjects, and there may be less need for direct comparability between academic subjects and those which are largely practical or creative.

There are three comparisons of interest that can be made from the data in the tables. SQA is concerned with maintaining continuity from year to year in the standard of each qualification, and therefore the national rating for each subject should not show large fluctuations from year to year, with the possible exception of subjects with small entry numbers. Secondly, subjects in the same curricular mode with similar candidatures can reasonably be expected to have similar ratings. And finally, comparing ratings of a subject at adjacent levels, i.e. Intermediate 2 and Higher or Higher and Advanced Higher, can help in considering articulation between the levels: for example a subject which is easy at Standard Grade but rather difficult at Higher may cause problems for candidates.

The national ratings presented in these tables show how many grades higher or lower candidates obtained in this subject than they obtained on average in their other subjects, with a positive rating indicating a relatively easy subject, and a negative rating a relatively difficult subject. Ratings for the external assessments of the National Courses are calculated on the 9-point band scale, then divided by two. Thus for example an Intermediate 2 rating of +1.00 would imply a subject was on average two points on the band scale or approximately one grade, easier. Standard Grade ratings are expressed in terms of the seven-grade scale. Thus a Standard Grade rating of -0.50 would mean that candidates gained awards of on average half a grade lower in this subject than in the other subjects they attempted.

All national ratings are derived from the results of candidates who attempted two or more subjects at a particular level. National ratings are not printed if the number of comparisons on which the calculation is based is less than twenty.

Table 5 (a) Standard Grade subjects: numbers entered in 2001/2002

Subject	Numbers	Ranking	H Ranking
English	59900	1	1
Mathematics	59032	2	2
French	39190	3	11
Chemistry	22744	4	4
Biology	22734	5	5
Computing Studies	22109	6	12
Geography	21941	7	8
History	21414	8	6
Art and Design	21387	9	9
Physics	19678	10	3
Physical Education	18165	11	
Craft and Design	15218	12	
Technological Studies	2659		

Table 5 (b) Higher subjects (2002)

Subject	Numbers	Ranking	Ranking at SG	Conversion (%)
English	28910	1	1	48.3
Mathematics	19790	2	2	33.5
Physics	9580	3	10	48.7
Chemistry	9560	4	4	42.0
Biology	9274	5	5	40.8
History	7908	6	8	36.9
Modern Studies	7891	7		56.4
Geography	7733	8	7	35.2
Art and Design	7200	9	9	33.6
Business Management	5893	10	4947(numbers sitting)	119.0
French	4771	11	3	12.2
Computing	4480	12	6	20.3
Technological Studies	957		2659 (numbers sitting)	36

Conversion is the number of candidates at Higher divided by the number of candidates at Standard Grade x 100.

Table 5 (c) Numbers sitting sciences in Year Groups

Year	0ne science (%)	Two sciences (%)	Three sciences (%)
S4 (1999) Stand. Grade	64	28	3
S4 (2003) Stand. Grade	57.3	26.7	2.8
S5(1999) Higher	25	13	2
S5(2003) Higher	18	9	1

Table 6 (a) Table of National Ratings for Standard Grade

Subject	2000	2001	2002	2003	Average
English	0.20	0.22	0.23	0.26	0.23
Mathematics	-0.33	-0.36	-0.43	-0.45	-0.39
Biology	-0.13	-0.01	-0.11	-0.13	-0.10
Chemistry	-0.11	-0.17	-0.21	-0.19	-0.17
Physics	-0.03	-0.07	-0.11	-0.25	-0.10
Technological Studies	-0.09	-0.04	-0.08	-0.25	-0.12
Science	0.10	0.07	0.14	0.20	0.13
Computing	-0.11	-0.10	-0.06	-0.05	-0.08

Table 6 (b) Table of National Ratings for Highers

Subject	2000	2001	2002	2003	Average
English	-0.08	-0.04	-0.15	-0.26	-0.13
Mathematics	-0.28	-0.29	-0.37	-0.30	-0.31
Biology	-0.38	-0.39	-0.32	-0.22	-0.33
Chemistry	-0.46	-0.53	-0.44	-0.41	-0.46
Physics	-0.36	-0.16	-0.19	-0.11	-0.20
Technological Studies	0.32	0.02	0.02	0.01	0.09
Human Biology	-0.31	-0.37	-0.16	-0.15	-0.25
Computing	-0.15	-0.11	-0.03	0.01	-0.07

Table 6 (c) Table of National Ratings for Intermediate 2

Subject	2000	2001	2002	2003	2004	Average
English and Communication	-0.15	0.15	-0.04			-0.01
Mathematics	-0.31	-0.70	-0.47	-0.56	-0.23	-0.45
Biology	-0.33	-0.53	-0.44	-0.43	-0.29	-0.40
Chemistry	-0.70	-0.65	-0.92	-0.67	-0.65	-0.72
Physics	-0.81	-0.71	-0.81	-0.51	-0.76	-0.72
Technological Studies	-0.54	-0.40	-0.66			-0.53
Computing	-0.56	-0.42	-0.42			-0.47

Table 7 Higher Pass Percentage Rates

Subject	2000	2001	2002	2003	Average
English	75	75	68	62	70
Mathematics	71	70	66	67	69
Biology	66	67	66	69	67
Chemistry	73	73	72	73	73
Physics	71	75	73	74	73
Tech Studies	75	70	69	67	70
Human Biology	64	63	65	64	64
Computing	70	74	73	71	72

Table 8 (a) Numbers sitting Standard Grade

Subject	1999	2000	2001	2002	% Credit	2003	% Credit
English	58955	59577	60900	59901	43	60650	44
Mathematics	59689	60149	59597	59047	32	59441	32
Biology	22717	22612	23049	22735	52	23160	51
Chemistry	22945	23275	23237	22746	57	22621	58
Physics	19391	19284	19272	19678	60	19136	57
Tech Studies	3649	3211	2739	2659	49	2244	50
Science	15141	15390	15340	13913	5	11470	5
Computing	19002	20135	21067	22114	44	21723	45

Table 8 (b) Numbers sitting Highers

Subject	1995	2000	2001	2002	% A/B 2002	2003	% A/B 2003	95-03 % increase
English	33955		16123	28910	36	29624	34	-12
Mathematics	20262	20050	20730	19790	41	19966	44	
Biology	12140	9237	9309	9274	40	8920	43	-26
Chemistry	11651	7479	9903	9560	44	9292	49	-20
Physics	11952	9572	10015	9580	51	9489	53	-20
Tech Studies	1146	847	1024	957	47	993	47	-13
Human Biology	1913	2631	2837	3111	42	3296	40	+72
Computing	3858		4604	4480	44	4753	42	+23

Table 8 (c) Numbers sitting Intermediate 1 and 2 examinations in the sciences

Intermediate 1

Subject	**2000**	**2001**	**2002**	**2003**	**2004**
Chemistry	11	41	263	723(S4)	1408
Biology	38	270	629	1370(Sci SG)	2809
Physics	74	147	282	777(Sci SG)	1073
Mathematics	2971	3933	5070	5321	6233

Intermediate 2

Subject	**2000**	**2001**	**2002**	**2003**	**2004**
Chemistry	1218	1490	1433	1613	2170
Biology	2542	3424	3492	3920	4672
Physics	1603	1849	1882	2069	2240
Mathematics	8829	11748	12497	12927	13723

Appendix J Entry and Exit Qualifications Data

GU Chemistry 1st Year Exam results and Relationship with Chemistry Entrance Qualifications

Table 9 (a)

Class of chemistry qualification	**Average Mark**
Higher A	70
Higher B	57
Higher C	50
Adv Higher A	74
Adv Higher B	77
Adv Higher C	72
A Level A (only 9 students)	83
A Level B (10 students)	76
A Level C (22 students)	63
A Level D (9 Students)	55

Table 9 (b)

Higher Chemistry Result:	**A**	**B**	**C**	**D**
Number of students	50	148	71	7
Mean mark in exam	70.26	59.89	50.52	49.29
Median mark in exam	74	60.5	50	46
Minimum mark in exam	19	7	19	27
Maximum mark in exam	99	96	83	79
SD of mark in exam	20.64	18.24	17.29	19.84

Table 9 (c)

Advanced Higher Chemistry Result:	**A**	**B**	**C**	**D**
Number of students	17	19	51	9
Mean mark in exam	73.82	76.79	73.59	55.44
Median mark in exam	77	83	75	55
Minimum mark in exam	43	31	43	19
Maximum mark in exam	95	93	95	76
SD mark in exam	15.12	17.25	12.35	17.60

Table 9 (d)

A Level Chemistry Result	**A**	**B**	**C**	**D**
Number	9	10	22	9
Mean	83.33	75.70	62.68	55.44
Median	92	76.5	61.5	55
Minimum	42	57	11	19
Maximum	97	94	94	76
SD	17.56	12.84	19.37	17.60

Statistics from the Glasgow results 2003

850 students graduated from the science faculty in 2003.

The most popular Highers were:

Table 10 (a) Highers

Subject	**Percentage**
Chemistry	90
Mathematics	88
English	86
Biology	72
Human Biology	9
Physics	52
Geography	34
Computing	22
Technological Studies.	2
Craft and Design	2
Graphic communication	2

16 people have Higher Technological and 15 of them have Higher Physics as well.

There is only one person with Tech studies without Higher Physics.

Table 11 University of Glasgow Science Faculty Graduates 2004

	BSc First Class Honours	BSc Upper second class honours	BSc Lower second class honours	BSc Third class honours	MSci First Class Honours	MSci Upper second class honours	MSci Lower second class honours
Number	42	196	182	35	28	34	10
Mean	26.81	25.51	21.32	18.74	30.50	24.82	27.60
Median	28	26	22	20	31	24	28
Minimum	10	2	2	2	16	16	18
Maximum	40	42	38	34	42	42	36
SD	5.83	7.18	5.87	7.20	6.22	6.40	6.10

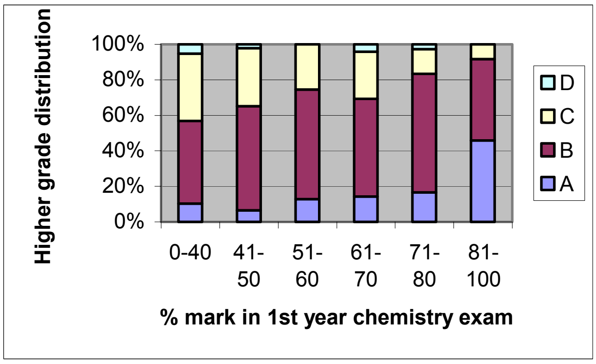
Table 12 University of Glasgow Engineering Faculty Graduates 2004

	BEng, BTechEd, BSc in Engineering	BEng, BTechEd, BSc in Engineering	BEng, BTechEd, BSc in Engineering	BEng, BTechEd, BSc in Engineering	MEng	MEng
	First Class	Upper Second Class	Lower Second Class	Third Class	First Class	Upper Second Class
Number	16	35	36	25	28	37
Mean	27.38	24.29	23.33	18.48	26.93	24.86
Median	28	24	21	18	26	24
Minimum	20	8	10	2	14	14
Maximum	36	36	40	32	42	42
SD	4.88	6.72	7.31	7.44	6.17	5.78

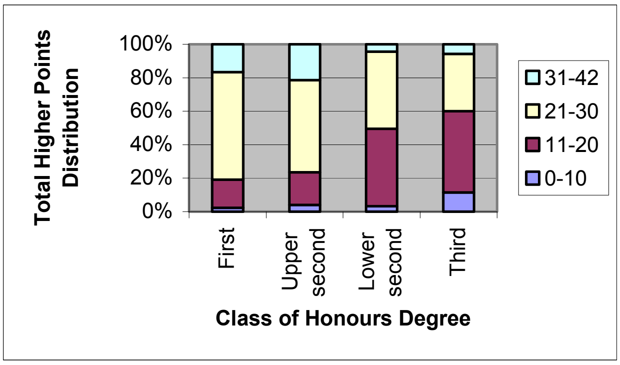
Table 13 University of Paisley Engineering Faculty Graduates 1992 - 2003

	BEng, BA	BEng, BA	BEng, BA	BEng, BA
	First Class	Upper Second Class	Lower Second Class	Third Class
Sum	1268	4528	4176	1208
Number	91	379	363	114
Mean	13.93	11.95	11.50	10.60
Median	14	12	12	10
Minimum	2	2	2	2
Maximum	32	36	30	26
SD	5.98	5.61	4.62	4.44

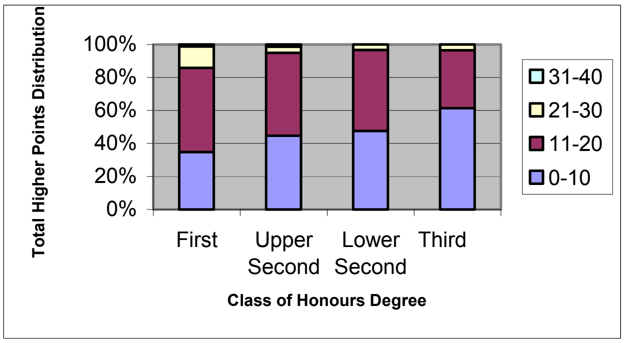
Breakdown of GU Students' 1st Year Chemistry Exam Marks by Higher Grade in Chemistry



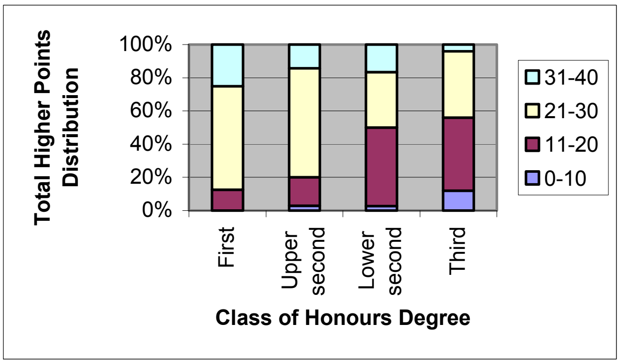
GU Science Bachelors Graduates. Breakdown of Degree Results by Total Higher Points.



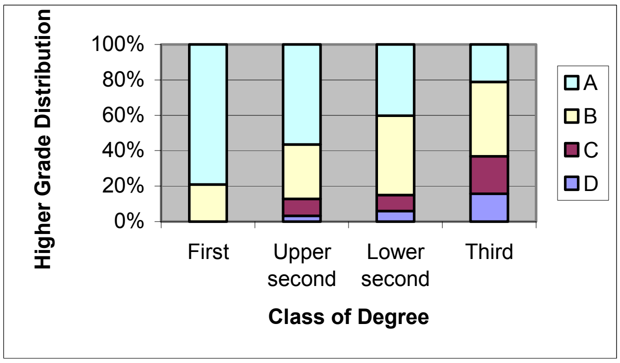
UoP Engineering Bachelors Graduates. Breakdown of Degree Results by Total Higher Points



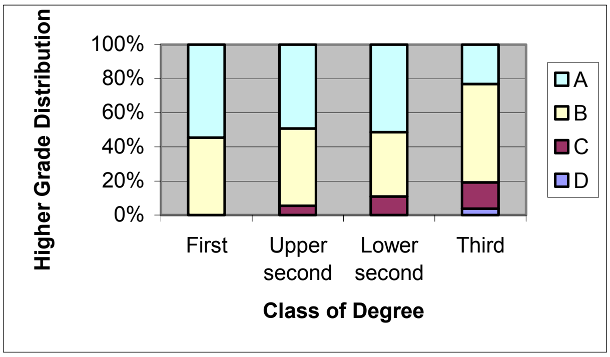
GU Engineering Bachelors Graduates. Breakdown of Degree Results by Total Higher Points.



GU Mathematics Based Science Graduates. Breakdown of Degree Results by Higher Grade in Mathematics



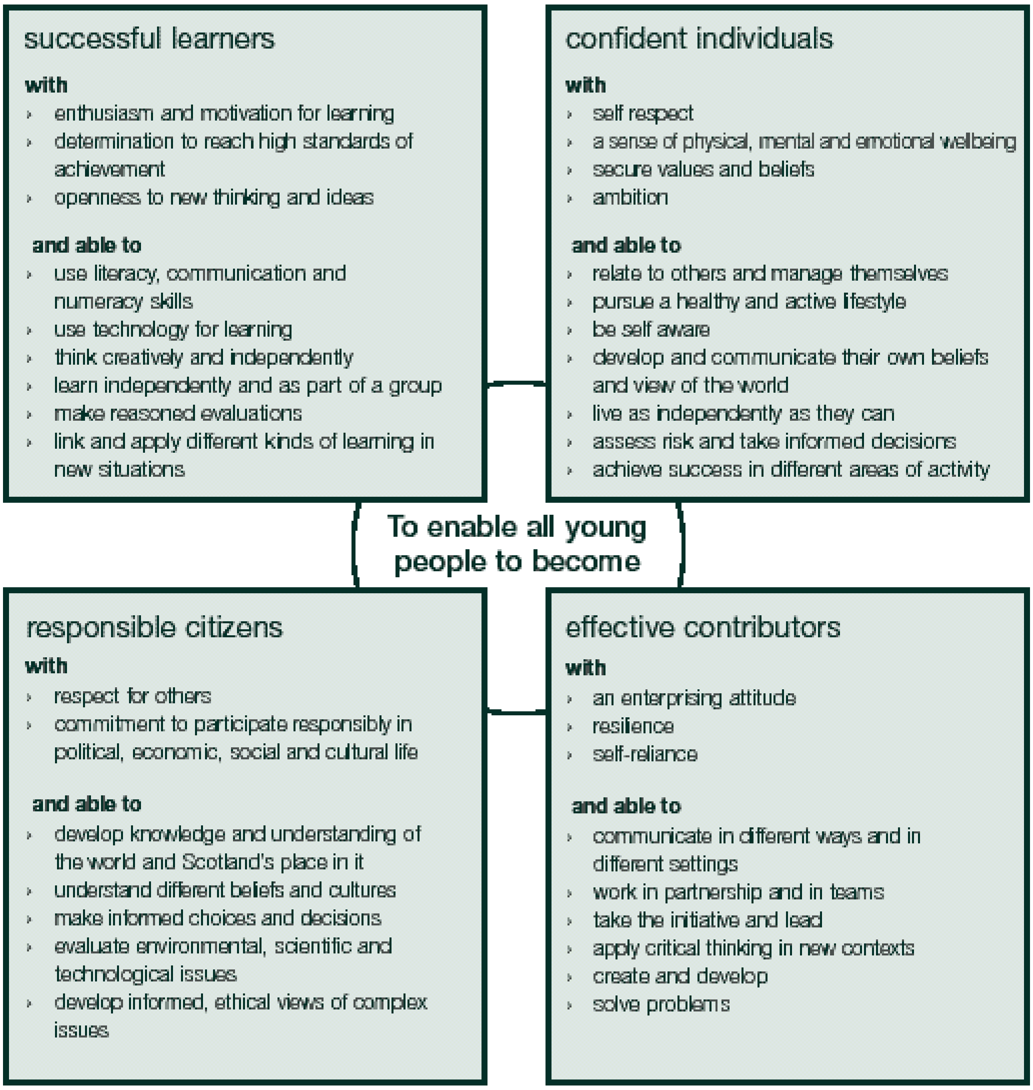
GU Engineering Graduates. Breakdown of Degree Results by Higher Grade in Mathematics



Appendix K The 3-18 Curriculum Review. Purposes of the Curriculum from 3-18

purposes of the curriculum from 3 -18

Our aspiration for all children and for every young person is that they should be **successful learners**, **confident individuals**, **responsible citizens** and **effective contributors** to society and at work. By providing structure, support and direction to young people's learning, the curriculum should enable them to develop these four capacities. The curriculum should complement the important contributions of families and communities.



successful learners

with

- enthusiasm and motivation for learning
- determination to reach high standards of achievement
- openness to new thinking and ideas

and able to

- use literacy, communication and numeracy skills
- use technology for learning
- think creatively and independently
- learn independently and as part of a group
- make reasoned evaluations
- link and apply different kinds of learning in new situations

confident individuals

with

- self respect
- a sense of physical, mental and emotional wellbeing
- secure values and beliefs
- ambition

and able to

- relate to others and manage themselves
- pursue a healthy and active lifestyle
- be self aware
- develop and communicate their own beliefs and view of the world
- live as independently as they can
- assess risk and take informed decisions
- achieve success in different areas of activity

To enable all young people to become

responsible citizens

with

- respect for others
- commitment to participate responsibly in political, economic, social and cultural life

and able to

- develop knowledge and understanding of the world and Scotland's place in it
- understand different beliefs and cultures
- make informed choices and decisions
- evaluate environmental, scientific and technological issues
- develop informed, ethical views of complex issues

effective contributors

with

- an enterprising attitude
- resilience
- self-reliance

and able to

- communicate in different ways and in different settings
- work in partnership and in teams
- take the initiative and lead
- apply critical thinking in new contexts
- create and develop
- solve problems