

VCAA Bulletin Supplement 2

Consultation paper for VCE Mathematics examinations: 2006 and beyond

At the 22 October meeting of the VCAA, the Board approved the Mathematics Expert Studies Committee recommendation that the current VCE Mathematics study structure and relationship between VCE mathematics studies continue for the next accreditation period, with the inclusion of Mathematical Methods (CAS) as a parallel and alternative study to Mathematical Methods, available for all schools from 2006.

It also approved, *in principle*, the recommendation from the Mathematics Expert Studies Committee that each of Mathematical Methods, Mathematical Methods (CAS) and Specialist Mathematics have a technology free examination and a technology assumed access examination (approved graphics calculator or CAS as applicable), that the technology free examination for Mathematical Methods and Mathematical Methods (CAS) be common to both studies, and that Further Mathematics examinations assume student access to an approved graphics calculator or CAS for both examinations, *subject to consultation* on models for these examinations with key stakeholders. Details of the Board's decisions were published in the November 2003 VCAA Bulletin No. 8.

The following provides background, an overview of key issues and considerations, examination models for consultation, and a pro forma for response. The VCAA invites and encourages teachers and other interested parties to respond to this consultation on these issues and models.

Historical overview

Computation, proof, modelling and problem solving are key mathematical activities both with respect to investigation of the structure and theory of mathematics itself and also in its application to practical contexts. Throughout history, various technologies have been used to support these investigations and applications, including drawing and construction tools and devices in geometry; abacuses, counting boards, pen and paper algorithms, diagrams and schema, slide rules for arithmetic and algebra; and mechanical calculators and devices for arithmetic, algebra, probability and calculus. Up until about the twentieth century, each of these technologies required human involvement at input, operation and output/interpretation stages of the process. From the late 1930s, electro-mechanical and electronic calculators and computers which automatically carry out computations were constructed, and, from the 1950s, were developed into the modern digital calculators and computers which we are familiar with today. These can carry out various numerical, graphical and symbolic computations and manipulations, depending on the range and combination of functionalities, programs and mathematically able software they support.



These technologies have now been used in academia, industry, research, business and commerce for several decades as tools for investigation, problem solving, modelling and communication, and increasingly, from the 1990s, in education to support teaching and learning of the mathematics curriculum. The use of technology in the senior mathematics curriculum, and end of secondary schooling mathematics examinations in Victoria, has evolved over the last several decades as different technologies have become more widely available, affordable, and integrated into mainstream teaching and learning practice:

- 1970 – slide rule and four figure mathematical tables;
- 1978 – scientific calculators
- 1997/8 – approved graphics calculators permitted (examinations graphics calculator ‘neutral’)
- 1999 – ‘assumed access’ for graphics calculators in Mathematical Methods and Specialist Mathematics examinations, permitted for Further Mathematics examinations
- 2000 – ‘assumed access’ for graphics calculators in all mathematics examinations, examinations for revised Victorian Certificate of Education (VCE) Mathematics study 2000 – 5 incorporating some graphics calculator ‘active’ questions
- November 2002 – Mathematical Methods (CAS) pilot study, ‘assumed access’ for approved CAS in pilot examinations.

From 2000, VCE Mathematics examiners have assumed student access to an approved graphics calculator for Further Mathematics, Mathematical Methods and Specialist Mathematics examinations, and, from 2002, an approved CAS for the Mathematical Methods (CAS) pilot examinations. Where approved calculators can be used, their memories are not required to be cleared for these examinations. Thus, students are able to store various programs, notes, diagrams, graphs, and the like, in the memories of their calculators, and these may be used by students as they find them of assistance.

While earlier considerations on the use of technology in mathematics education, in particular the use of computer algebra systems (CAS), focused on pedagogical and curriculum issues, these issues do not arise in isolation from assessment. *Congruence* between pedagogy, curriculum and assessment is a central part of the discussion about the use of such technology, where this refers to the alignment between curriculum structure and aims, approaches to working mathematically, and the nature, scope and purpose of assessments, in particular examinations.

International use of CAS

CAS have now been used in examinations, or parts of examinations, for several years, in systems such as the French and Danish *Baccalaureat*, the US College Board *Advanced Placement Calculus*, from the mid to late 1990s and, more recently, the VCAA Mathematical Methods (CAS) pilot study in 2002 and 2003 (see Table 1).

Table 1: comparison of systems structure for the use of CAS in senior secondary mathematics examinations

System	Examination structure and CAS types
France: <i>Baccalaureate Générale</i> 1999 –	CAS neutral questions, unrestricted access to approved CAS for all parts of examinations, pure mathematical emphasis. CAS calculators, not including <i>TI-92/Voyage 200</i> .
US, College Board: <i>Advanced Placement Calculus</i> 1995 –	CAS ‘not an advantage’ questions, access to a broad range of approved graphics calculators or CAS calculators permitted in the same examination (questions not differentiated), other parts technology free. Graphics calculators and CAS calculators, CASIO ALGEBRA FX 2.0, TI-89 (not including <i>TI 92/Voyage 200</i>), HP 28S, 40G, 48G and 49G.
Denmark: <i>Baccalaureat</i> Pilot 1996–1999 Generally available 2000 –	Pencil and paper (PAP) technology free examination and a graphics calculator or CAS (calculator or computer) assumed access examination, with common questions and some distinctive questions with CAS and non-CAS versions. Open book technology assumed access examination, including electronic files for computers. A broad range of hand-held and computer based (e.g. <i>Derive, Maple, Mathematica, MathCAD</i>) CAS can be used.
Austria: <i>individual teacher set examinations, subject to inspectorate audit</i> 1999 –	Teacher constructed examinations, include technology free and CAS permitted components. School authorities for federal states have inspectors check examinations with respect to curriculum appropriateness. CAS calculators or computer based CAS permitted at the teacher’s discretion. School implementing Informatics curriculum have compulsory laptop requirement and use computer based CAS.

System	Examination structure and CAS types
Switzerland: <i>individual teacher set examinations, subsequently published publicly</i> 1998 –	Teacher constructed examinations, published publicly on an annual basis for quality assurance. Include technology free and CAS permitted components. CAS calculators or computer based CAS at the teacher's discretion, examinations can be open book and permit electronic file access at the teacher's discretion.
Australia, Victoria: <i>Mathematical Methods (CAS)</i> Three stage phased pilot 2001–2005	Assumed access to an approved CAS (calculator or computer) for all parts of examinations (multiple choice, short answer and extended response), application emphasis in extended response questions. Common questions on corresponding examination papers for CAS and non-CAS versions of the same course, with common and distinctive content. 2001–2002: CAS calculators (CASIO ALGEBRA FX 2.0, HP –40G, TI-89) 2002–2005: CAS calculators (CASIO ALGEBRA FX 2.0, HP –40G, and TI-89) and computer based CAS (<i>Derive</i> and <i>Mathematica</i>). Access to stored programs and files permitted for hand-held CAS, but not for computer based CAS.
International Baccalaureate: <i>Higher Level Mathematics</i> Initial two year pilot from September 2004	Assumed access to approved CAS calculator, examinations to have a technology assumed access part and technology free part. TI-89.

Issues

- For high stakes tertiary entrance studies such as Mathematical Methods, Mathematical Methods (CAS) and Specialist Mathematics, the role of formal assessment (examinations and coursework) as a mechanism for demonstration of important mathematical knowledge and understanding, as well as facility with important mental, by hand and technology skills and processes, is critical. So too is the issue of demonstration of some of this knowledge and some of these understandings and skills *independently* of technology. In this context, the notion of *how* congruence between pedagogy, curriculum and assessment is developed, at a pragmatic level, depends critically on the *structure, conditions* and *design* of examinations and school based assessment. In particular, the nature, scope and purpose of examinations impacts significantly on possible directions and models for implementation.
- Electronic computers and calculating devices run algorithms, and combinations of algorithms, based on the principles and theory of computability theory, and implemented through *programs*. Some of these programs are built in to software packages and calculators, while other programs can be created, stored, modified, used and deleted by the operator, both on computers and calculators such as graphics calculators. CAS software runs sophisticated and integrated collections of programs that provide a comprehensive and coherent model of mathematics and mathematical structure. Their development is resource intensive and requires substantial amounts of testing to ensure they are robust and stable, hence there are only a few general CAS or symbolic manipulators available.
A range of relatively simple user constructed programs that can be implemented on graphics calculators provide

them with what are effectively specific symbolic manipulation capabilities. For example, it is relatively straightforward to write programs that perform single function differentiations similar to some of the formulas provided on the formula sheets for mathematics examinations, such as finding the derivative of $f(x) = \sin(kx)$. Indeed, the development of such programs for computers and early programmable calculators was sometimes used in the early 1980s as an illustrative application of programming.

Over the past several years, as the memory capacity of graphics calculators has increased substantially, so too has the potential for the development and use of more sophisticated programs such as the recent programs for the differentiation of expressions such as $f(x) = e^{-2x}\sin(3x)$. Such programs are typically 'stand alone' programs that do not have the integrated functionality, or robustness, of CAS, and will not necessarily have been subject to the extensive product testing applied to CAS developed by major technology companies. During the next few years, there is likely to be progressive 'CASification' of graphics calculators by supplementary program, even if not to the level of complexity of purpose designed general CAS. This trend is evident both in the US and in Australia, where programs such as *Factor 9* (which can factorise polynomials with integer coefficients and carry out simple operations like completing the square for quadratic trinomials) are in common use by students, as well as increasing use of the latest version of the program *Symbolic*, which can carry out differentiation of combined functions.

The use of such programs is likely to become even more widespread as existing ones continue to be refined and enhanced and new ones become available and are shared. These programs clearly have the potential to impact on the capacity for assessment of valued and important mental and by hand skills that are part of mathematics

studies with the current examination framework. At the same time, the process of clearing calculator memory has become increasingly complex if it is to effectively neutralise the use of various so called 'cheating programs' that have now become available. Thus, selective clearing of 'non-approved' programs, or even all programs and files stored in calculator memory will become an increasingly arduous task. Ongoing attention to the need to clear calculator memory would not only be technically demanding, but also problematic from the pedagogical perspective, as many (if not most) teachers of Mathematical Methods and Specialist Mathematics have integrated the application of various programs (such as those for ready evaluation of hypergeometric probabilities, or implementation of Euler's method for numerical solution of differential equations) into their teaching and learning activities. For some older models of calculators programs provide necessary functionality such as numerical integration in Specialist Mathematics. Given that around 18 000 students enrol in Mathematical Methods Units 3 and 4 each year; and around 6000 students enrol in Specialist Mathematics Units 3 and 4 each year; these developments mean that the issue of use of graphics calculator and CAS technology converges with respect to some aspects of examination structure and question design. Thus, while the existence of supplementary *symbolic* programs does not impact on current Further Mathematics examinations (which require *numerical* functionality) or current CAS pilot examinations (for which CAS functionality is *richer* and *more efficient*), it will impact increasingly on Mathematical Methods and Specialist Mathematics examinations with respect to various assumptions and values underpinning the current study design. While examiners can design and set question that take into account likely access by some students to the functionality provided by such supplementary programs, the ongoing development of even more sophisticated programs for graphics calculators that provide *quasi-CAS* symbolic manipulation capabilities will make it increasingly difficult for examiners of Mathematical Methods and Specialist Mathematics to continue to directly assess important skills with respect to the current VCE mathematics study design and its related values and rationale. While this 'graphics calculator plus program' combination is *not* the same as a comprehensive and integrated CAS designed to interchangeably handle numerical, graphical and symbolic constructs, it does raise the issue of balance with respect to equity and design intent for the existing Mathematical Methods and Specialist Mathematics studies.

3. Current models of graphics calculator such as the TI-83+ already have the capacity to store substantial amounts of text, graphs, mathematical data and 'study cards' in their memory. The TI-83+ (silver edition) – which is *not* currently approved for VCAA examinations - has one megabyte of archive memory, and text can be entered into this using a conventional computer keyboard, which can also be used in conjunction with the standard TI-83+ and the TI-89 CAS calculator, each which have several hundred kilobytes of archive memory. The *TI Keyboard* enables files to be imported and exported, opened, edited and saved, in and between these calculators and *Microsoft Word*. Simple word searches can then be carried out on the content of these files. The TI-83+ calculator also incorporates a version of *Geometer's SketchPad* and/or

Cabri-Geometry, as well a basic spreadsheet application *CellSheet*.

4. It is likely that CAS will converge rapidly between hand-held and computer based platforms over the next few years, while the capacities of 'hand-held' devices for dealing with large quantities of text, graphical, symbolic and other data continue to increase. The *TI-Voyage 200* (see <http://education.ti.com/us/product/tech/89/features/voyagebid.html>) and *CASIO ClassPad 300* (see <http://classpad.net/product/>) are examples of current convergent hand-held technologies, which have incorporated several mathematically able software, including CAS and dynamic geometry, and can readily handle text, notes and conventional symbolic mathematical symbols and type. An important consideration for the forthcoming accreditation period will be to ensure as much as possible, that the processes put in place for the use of technology in examinations at the beginning of the accreditation period (2006 until 2009*) are sufficiently robust to enable a sound response to such convergent developments in the calculator/information and communications technology (ICT) field as may occur during the accreditation period.

While computer based CAS have now been used in academia, research, industry and commerce for several decades, their use in senior secondary mathematics examinations is likely to be limited when they may only be used without access to stored files or programs, as is currently the case in the examinations for the Mathematical Methods (CAS) pilot study. Such a condition effectively precludes the use of CAS on laptop computers (unless schools have sufficient laptops which are not used by students), and most schools are only likely be able to support a single class for examinations in a computer centre, if at all. School based site licences for CAS software, with complementary individual student licences, can enable a cost effective provision of various mathematically able software in schools. For example a school site license for the *CAS Derive* currently costs A\$700, and additional individual student copies can be purchased for A\$70 each.

*The duration of the accreditation period will be confirmed during the review.

VCE mathematics examination models

In light of these issues, and following on from the work of the VCE Mathematics Expert Studies Committee in 2002 and 2003, the VCAA has developed the following three preliminary mathematics examination models for consultation. They are together intended to provide a range of possible structures based on consideration of:

- fidelity to the nature, purpose and design of the various mathematics studies and their assessments
- equity and balance with respect to demonstration of mental, by hand and technology skills
- examination models from various systems and jurisdictions around the world
- the increasing convergence in some aspects of graphics calculator and CAS functionality, and the functionality of hand-held and computer based CAS platforms
- current VCE mathematics examination structures, including the Mathematical Methods CAS pilot

- the principle that students should, as much as is practicable, be able to undertake a pathway of VCE Mathematics study using a single approved technology.

Each model is characterised by a different combination of:

- assumed student access to an approved technology for an examination or restriction of student access to such technology
- approved graphics calculator or CAS technology, platforms and conditions of use
- supplementary materials, provided and permitted, for examinations such as formulas sheets, notes and other text materials, and access to programs and electronic files.

Each model describes the examination structure and conditions for VCE Unit 3 and 4 level mathematics studies, including Mathematical Methods (CAS), for the accreditation period from 2006. Almost all students enrolled in Specialist Mathematics would be concurrently enrolled in either Mathematical Methods or Mathematical Methods (CAS).

The development of these models has been informed by investigation of examinations in various systems and jurisdictions around the world as well as advice, suggestions and commentary from a range of national and international mathematics educators, examiners and system managers with interest, expertise and experience in the field. In particular, Model A draws on the current VCE mathematics examination structure and conditions, while Model B and Model C draw on the College Board Advanced Placement Calculus and Danish Baccalaureat examination structure and conditions respectively.

In each model, there would continue to be a range of common Mathematical Methods and Mathematical Methods (CAS) questions for which neither graphics calculator nor CAS technology would be of assistance, as well as common questions (graphical, numerical) where graphics calculator or CAS technology is of assistance, but uses the same, or similar, functionality.

The term ‘assumed access’ is taken to mean, as it currently does, that students will need to have access to an approved technology (graphics calculator or CAS as applicable) and may also use a scientific calculator in their mathematics examinations. The term ‘technology free’ could be taken to mean no access to any digital technology (including a scientific calculator), tables and the like, *or* it could be taken to mean no access to graphics calculator or CAS technology, but permit use of scientific calculator and tables, as may be appropriate and applicable. The following models do not prescribe or preclude either of these interpretations of ‘technology free’. Variations on whether formula sheets and tables are provided or not, are possible for each model, for example general formula sheets or tables may not be provided but specific questions could incorporate formulas, excerpts from tables and exact values for certain expressions as applicable.

It should also be noted that the structure for the Further Mathematics examinations, within any given model, can, for all practical purposes, be regarded as essentially independent from that of Mathematical Methods, Mathematical Methods (CAS) and Specialist Mathematics. However, the structures for examinations in each model for Mathematical Methods, Mathematical Methods (CAS) and Specialist Mathematics will be closely linked given the relationships between these studies. The use of electronic or other communication devices, or access to the internet would **not** be permitted for any of these examination models (as is currently the case).

In both Model B and Model C, where a technology free Examination 1 and a technology assumed access Examination 2 are proposed, it should be noted that the corresponding time allocations are one and two hours respectively*, and that Examination 1 would comprise of short-answer questions, while Examination 2 would comprise of multiple-choice and extended-response questions. Examination 1 would substantially incorporate questions that directly test demonstration of important algebra and calculus knowledge, and the application of related mental and by hand skills *independently of technology*; however, it is not envisaged that it would be limited to assessing such knowledge and skills. For example, conceptual questions for which the use of technology would not be of assistance could also be assessed in this examination. Examination 2 would provide a context in which students would need to use analytical, graphical and numerical approaches as applicable and appropriate, and to tackle questions, or parts of questions where a suitable selection or combination of mental, by hand or technology assisted techniques could be used to answer these questions efficiently and effectively.

The weightings of marks allocated to short-answer, multiple-choice and extended-response questions would roughly reflect existing weightings with slight increase to short-answer items (or possibly some incorporation of an extended-response question) in the proposed Examination 1. For example, the one-hour short-answer Examination 1 could be allocated a total of 40 marks, and the two-hour multiple-choice and extended-response Examination 2 could have 30 and 50 marks allocated to each component respectively.

This formulation has been used in presenting Model B and Model C to minimise the risk of splitting the examinations into two ‘repeat’ assessments of each study, one with technology and one without it. It would also enable assessment of the appropriate selection and effective use of mental, by hand and technology assisted approaches across multiple-choice and written response questions in Examination 2, while ensuring that important mental and by hand skills were assessed in Examination 1. Mathematical knowledge and conceptual understanding would be assessed throughout both examinations.

The current VCE Mathematics examination structure and conditions is shown in Table 2, while that of Models A, B and C are shown in Tables 3, 4 and 5 respectively.

*The duration of the end-of-year examinations is yet to be confirmed.

Table 2: current VCE Mathematics examinations

<i>Further Mathematics</i>	
Examination 1 (1.5 hours)	Examination 2 (1.5 hours)
<ul style="list-style-type: none"> multiple-choice questions (core and modules) assumed access to an approved graphics calculator, stored programs and files permitted 4 ¥ A4 pages of notes from any source permitted formula sheet provided 	<ul style="list-style-type: none"> short-answer questions (core) and extended-response questions (modules) assumed access to an approved graphics calculator, stored programs and files permitted 4 ¥ A4 pages of notes from any source permitted formula sheet provided

<i>Mathematical Methods</i>	
Examination 1 (1.5 hours)	Examination 2 (1.5 hours)
<ul style="list-style-type: none"> multiple-choice and short-answer questions assumed access to an approved graphics calculator, stored programs and files permitted 4 ¥ A4 pages of notes from any source permitted formula sheet and normal distribution table provided 	<ul style="list-style-type: none"> extended-response questions assumed access to an approved graphics calculator stored programs and files permitted 4 ¥ A4 pages of notes from any source permitted formula sheet and normal distribution table provided

<i>Mathematical Methods (CAS)</i>	
Examination 1 (1.5 hours)	Examination 2 (1.5 hours)
<ul style="list-style-type: none"> multiple-choice and short-answer questions assumed access to an approved CAS, stored programs and files permitted for calculators, but not for TI-92/<i>Voyage</i> 200, <i>Derive</i> or <i>Mathematica</i> 4 ¥ A4 pages of notes from any source permitted substantial amount of common multiple-choice questions with Mathematical Methods (around 70–80%), limited amount of common short-answer questions (around 20%) formula sheet and normal distribution table provided 	<ul style="list-style-type: none"> extended-response questions assumed access to an approved CAS, stored programs and files permitted for calculators, but not for TI-92/<i>Voyage</i> 200, <i>Derive</i> or <i>Mathematica</i> 4 ¥ A4 pages of notes from any source permitted substantial amount of common questions, or parts of questions with Mathematical Methods (around 70–80%) formula sheet and normal distribution table provided

<i>Specialist Mathematics</i>	
Examination 1 (1.5 hours)	Examination 2 (1.5 hours)
<ul style="list-style-type: none"> multiple-choice and short-answer questions assumed access to an approved graphics calculator, stored programs and files permitted 4 ¥ A4 pages of notes from any source permitted formula sheet provided 	<ul style="list-style-type: none"> extended-response questions assumed access to an approved graphics calculator stored programs and files permitted 4 ¥ A4 pages of notes from any source permitted formula sheet provided

Table 3: Model A

<i>Further Mathematics</i>	
Examination 1 (1.5 hours)	Examination 2 (1.5 hours)
<ul style="list-style-type: none"> multiple-choice questions (core and modules) assumed access to an approved graphics calculator or CAS, stored programs and files permitted for calculators, but not for TI-92/<i>Voyage</i> 200, <i>Derive</i> or <i>Mathematica</i> 4 ¥ A4 pages of notes from any source permitted formula sheet and the like may be provided as appropriate and applicable 	<ul style="list-style-type: none"> short-answer questions (core) and extended-response questions (modules) assumed access to an approved graphics calculator or CAS, stored programs and files permitted for calculators, but not for TI-92/<i>Voyage</i> 200, <i>Derive</i> or <i>Mathematica</i> 4 ¥ A4 pages of notes from any source permitted formula sheet and the like may be provided as appropriate and applicable

<i>Mathematical Methods</i>	
Examination 1 (1.5 hours)	Examination 2 (1.5 hours)
<ul style="list-style-type: none"> multiple-choice and short-answer questions assumed access to an approved graphics calculator, stored programs and files permitted 4 ¥ A4 pages of notes from any source permitted formula sheet and normal distribution table provided 	<ul style="list-style-type: none"> extended-response questions assumed access to an approved graphics calculator stored programs and files permitted 4 ¥ A4 pages of notes from any source permitted formula sheet and normal distribution table provided

<i>Mathematical Methods (CAS)</i>	
Examination 1 (1.5 hours)	Examination 2 (1.5 hours)
<ul style="list-style-type: none"> multiple-choice and short-answer questions assumed access to an approved CAS, stored programs and files permitted for calculators, but not for TI-92/<i>Voyage</i> 200, <i>Derive</i> or <i>Mathematica</i> 4 ¥ A4 pages of notes from any source permitted substantial amount of common multiple-choice questions with Mathematical Methods (around 70–80%), limited amount of common short-answer questions (around 20%) formula sheet and normal distribution table provided 	<ul style="list-style-type: none"> extended-response questions assumed access to an approved CAS, stored programs and files permitted for calculators, but not for TI-92/<i>Voyage</i> 200, <i>Derive</i> or <i>Mathematica</i> 4 ¥ A4 pages of notes from any source permitted substantial amount of common questions, or parts of questions with Mathematical Methods (around 70–80%) formula sheet and normal distribution table provided

<i>Specialist Mathematics</i>	
Examination 1 (1 hour)	Examination 2 (2 hours)
<ul style="list-style-type: none"> short-answer questions technology free formula sheet and the like may be provided as appropriate and applicable 	<ul style="list-style-type: none"> multiple-choice questions and extended-response questions assumed access to an approved graphics calculator or CAS, stored programs and files permitted for calculators, but not for TI-92/<i>Voyage</i> 200, <i>Derive</i> or <i>Mathematica</i> common questions and some questions, or parts of questions with alternative CAS and non-CAS versions 4 ¥ A4 pages of notes from any source permitted formula sheet and the like may be provided as appropriate and applicable

Table 4: Model B

<i>Further Mathematics</i>	
Examination 1 (1.5 hours)	Examination 2 (1.5 hours)
<ul style="list-style-type: none"> multiple-choice questions (core and modules) assumed access to an approved graphics calculator or CAS, stored programs and files permitted for calculators, but not for TI-92/<i>Voyage 200</i>, <i>Derive</i> or <i>Mathematica</i> 4 ¥ A4 pages of notes from any source permitted formula sheet and the like may be provided as appropriate and applicable 	<ul style="list-style-type: none"> short-answer questions (core) and extended-response questions (modules) assumed access to an approved graphics calculator or CAS, stored programs and files permitted for calculators, but not for TI-92/<i>Voyage 200</i>, <i>Derive</i> or <i>Mathematica</i> 4 ¥ A4 pages of notes from any source permitted formula sheet and the like may be provided as appropriate and applicable

<i>Mathematical Methods</i>	
Examination 1 (1 hour)	Examination 2 (2 hours)
<ul style="list-style-type: none"> short-answer questions technology free common to Mathematical Methods and Mathematical Methods (CAS) formula sheet and the like may be provided as appropriate and applicable 	<ul style="list-style-type: none"> multiple-choice questions and extended-response questions assumed access to an approved graphics calculator stored programs and files permitted 4 ¥ A4 pages of notes from any source permitted formula sheet and the like may be provided as appropriate and applicable

<i>Mathematical Methods (CAS)</i>	
Examination 1 (1 hour)	Examination 2 (2 hours)
<ul style="list-style-type: none"> short-answer questions technology free common to Mathematical Methods and Mathematical Methods (CAS) formula sheet and the like may be provided as appropriate and applicable 	<ul style="list-style-type: none"> multiple-choice questions and extended-response questions assumed access to an approved CAS, stored programs and files permitted for calculators, but not for TI-92/<i>Voyage 200</i>, <i>Derive</i> or <i>Mathematica</i> 4 ¥ A4 pages of notes from any source permitted formula sheet and the like may be provided as appropriate and applicable

<i>Specialist Mathematics</i>	
Examination 1 (1 hour)	Examination 2 (2 hours)
<ul style="list-style-type: none"> short-answer questions technology free formula sheet and the like may be provided as appropriate and applicable multiple choice questions and extended response questions 	<ul style="list-style-type: none"> assumed access to an approved graphics calculator or CAS, stored programs and files permitted for calculators, but not for TI-92/<i>Voyage 200</i>, <i>Derive</i> or <i>Mathematica</i> common questions and some questions, or parts of questions with alternative CAS and non-CAS versions 4 ¥ A4 pages of notes from any source permitted formula sheet and the like may be provided as appropriate and applicable

Table 5: Model C

<i>Further Mathematics</i>	
Examination 1 (1.5 hours)	Examination 2 (1.5 hours)
<ul style="list-style-type: none"> multiple-choice questions (core and modules) assumed access to an approved graphics calculator or CAS open book format (access to notes and texts, stored programs and files permitted) 	<ul style="list-style-type: none"> short-answer questions (core) and extended-response questions (modules) assumed access to an approved graphics calculator or CAS open book format (access to notes and texts, stored programs and files permitted)

<i>Mathematical Methods</i>	
Examination 1 (1 hour)	Examination 2 (2 hours)
<ul style="list-style-type: none"> short-answer questions technology free common to Mathematical Methods and Mathematical Methods (CAS) formula sheet and the like may be provided as appropriate and applicable 	<ul style="list-style-type: none"> multiple-choice questions and extended-response questions assumed access to an approved graphics calculator open book format (access to notes and texts, stored programs and files permitted)

<i>Mathematical Methods (CAS)</i>	
Examination 1 (1 hour)	Examination 2 (2 hours)
<ul style="list-style-type: none"> short-answer questions technology free common to Mathematical Methods and Mathematical Methods (CAS) formula sheet and the like may be provided as appropriate and applicable 	<ul style="list-style-type: none"> multiple-choice questions and extended-response questions assumed access to an approved CAS open book format (access to notes and texts, stored programs and files permitted)

<i>Specialist Mathematics</i>	
Examination 1 (1 hour)	Examination 2 (2 hours)
<ul style="list-style-type: none"> short-answer questions technology free formula sheet and the like may be provided as appropriate and applicable 	<ul style="list-style-type: none"> multiple-choice questions and extended-response questions assumed access to an approved graphics calculator or CAS common questions and some questions, or parts of questions with alternative CAS and non-CAS versions open book format (access to notes and texts, stored programs and files permitted)

Consultation response

Responses to the consultation paper should be forwarded to the Mathematics Project Manager Mr Gary Motteram, Victorian Curriculum and Assessment Authority, 41 St Andrew's Place, East Melbourne, 3002, facsimile 9651 4324, by **Friday 27 February 2004**, using the enclosed proforma. Inquiries with respect to the consultation paper may be directed to either Mr Gary Motteram or the Mathematics Manager Mr David Leigh-Lancaster, telephone 9651 4537 or email: leigh-lancaster.david.d@edumail.vic.gov.au



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VCE Mathematics examination models

Response to consultation paper VCAA Bulletin December 2003

VCAA PRIVACY STATEMENT

The Victorian Curriculum and Assessment Authority (VCAA) is a statutory authority established under the *Victorian Curriculum and Assessment Authority Act 2000*. The VCAA is committed to protecting all personal information collected and handling this data in accordance with the *Information Privacy Act 2000*. All of the information we collect from you will be kept secure and confidential.

Name

School

Telephone

Fax

Email

For each model:

- comment on its suitability, including its strengths and limitations, and any important considerations or issues related to that model
- note possible variations to aspects of the model which may enhance its suitability with respect to particular considerations or issues for that model
- indicate a preference (first, second or third) with a brief rationale.

Please attach additional pages as required.

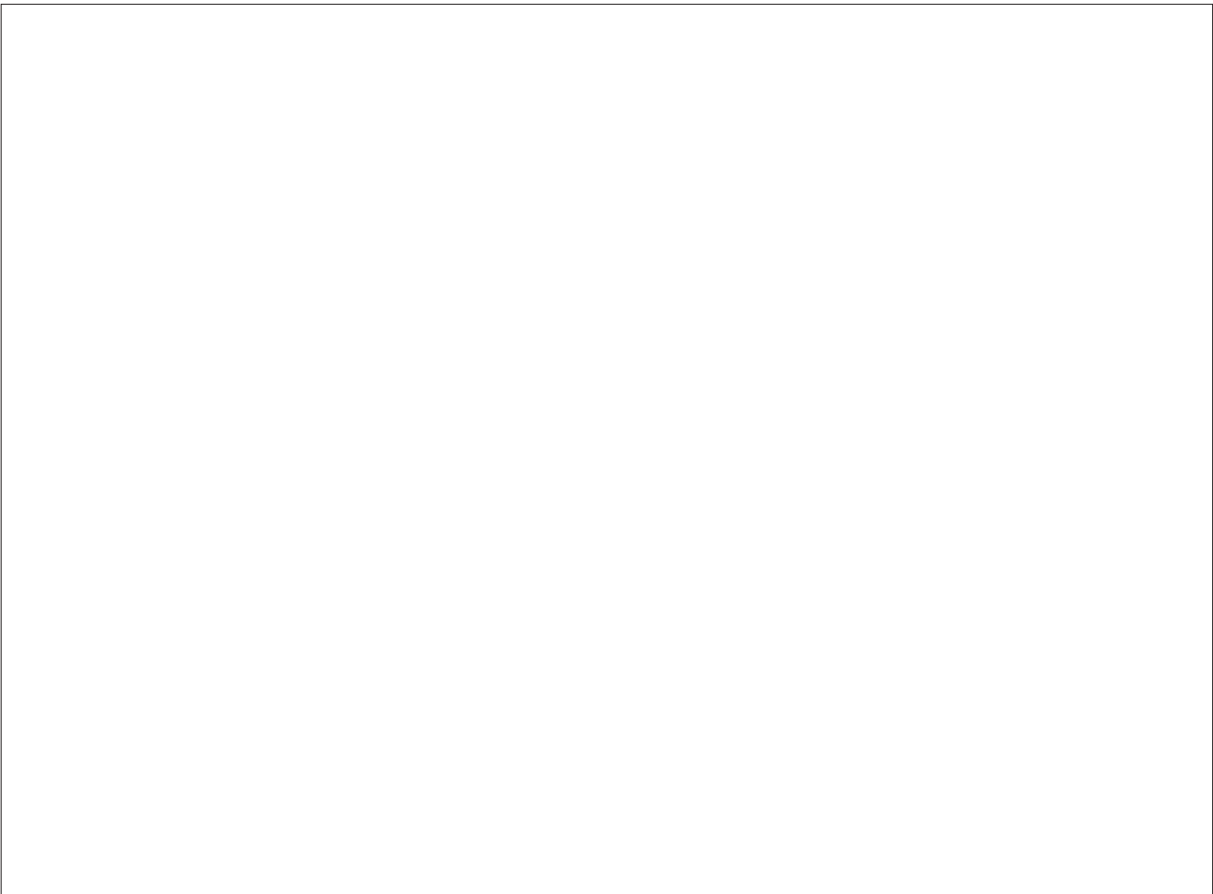
Please forward your consultation response, by **Friday 27 February 2004**, to:

Mr Gary Motteram, Mathematics Project Manager,
Victorian Curriculum and Assessment Authority,
41 St Andrews Place, East Melbourne 3002
or facsimile (03) 9651 4324.

Model A



Model B



Model C

A large, empty rectangular box with a thin black border, intended for a response to Model C.

Other feedback, comments, issues or considerations

A large, empty rectangular box with a thin black border, intended for providing other feedback, comments, issues, or considerations.



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