CURRICULUM, PEDAGOGY AND BEYOND

THE MATHEMATICAL ASSOCIATION OF VICTORIA

MAV24 CONFERENCE

THE MATHEMATICAL ASSOCIATION OF VICTORIA

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Exploring approaches: replenishing VCE resources and enhancing exam preparation

4th December 2024

Peideng Nie
Austin Education Pty Ltd

Acknowledgement of the Country

“I would like to begin my presentation by acknowledging the traditional custodians of the land on which we stand today, the Wurundjeri people of the Kulin Nation, and pay my respects to their Elders past, present and emerging.”

A bit about myself

- M.Teach UniMelb, B.Sci Monash; VIT registered teacher
- Delved many years in teaching/lecturing/tutoring VCE subjects, in particular, Specialist Maths and Maths Methods
- Know a bit of TI, a bit of Casio, and a bit of Mathematica
- VCAA assessor in Specialist Mathematics for several years
- Worked for Jacaranda Wiley – online video project and other various materials in the VCE textbook series
- And most importantly, daddy of Aubrey (she is 1yr 4m now)

Agenda of our workshop

- 11:05-11:15 (10 minutes) Group Discussion

  Refer to the handout provided, choose one or two items, make quick notes and share your experience, thoughts and ideas with others
- 11:15-11:30

  Report on the SM related questions/material; further elaboration
- 11:30-11:40

  Report on the MM related questions/materials; further elaboration
- 11:40-11:55

  Summarising, reporting + elaborating
- 11:55

  Wrap up

Part One – compare/contrast/discuss

Over next page, there are some guiding questions/activities for you to write notes and to discuss.

Bear in mind, you don’t have to include all of them…that’s not the aim of game today.

You may find this annotation approach useful throughout the year, when you plan to write your questions/tests/SACs.

Part One – compare/contrast/discuss

- Browse the pairs (or triples) of materials (exam question collections)
- Use “O1” “O2” “O3” to categorise the question parts.
- Use “H”, “M”, “E” to rank the relative difficulty of each question part.
- Mark allocations? (we will talk about this later)
- In the Questions, do you find any similarities? Differences? Patterns? What would be suitable within the current study design? What not? If not…
- Any possibilities to remaster/modify these questions?
- Exam or SAC ideas for further expansion/modifications?
- How would you write the assessments within your team? Independently or collaboratively? OR mixture?

Part Two – reporting

We welcome different voices from each table.

Feel free to share your finding.

This is a good opportunity to exchange ideas.

SM – Sample 1

Question 2

An oil tanker hits a reef and spills oil into the sea. Initially the oil spills at an increasing rate, but action by the crew and coastal authorities enables the spill to be brought under control some time later. Assume that the oil spills from the tanker at the rate of $\frac{kt}{12+t^4}$ litres/day, where $k = 10^6$ and t is the time in days from when the oil tanker hit the reef.

a. Find the rate, in litres/day, at which the oil spills into the sea after 4 days, correct to three significant figures.

1 mark

b. i. If the rate at which oil spills into the sea has a maximum value when $t = a$, find the exact value of a.

3 marks

ii. Hence or otherwise find the maximum rate at which oil spills into the sea, in litres/day, correct to

Question 3 (10 marks)

A pollutant, at time $t = 0$ days, begins to enter a pond of still, unpolluted water at a rate of $\frac{dV}{dt} = \frac{8t}{240+5t^4}$, where V is the volume of pollutant, in cubic metres, in the pond after t days.

The pollutant does not dissolve or mix, and spreads across the pond, maintaining the shape of a thin circular disc of radius $r(t)$ metres and constant depth of 1 millimetre.

a. What is the maximum rate, in cubic metres per day, at which the pollutant will enter the pond, and for what value of t will this rate occur? 1 mark

b. At what rate is the radius of the disc increasing after $t = 4$ days, where it may be assumed that the radius of the disc is 6.54 m?

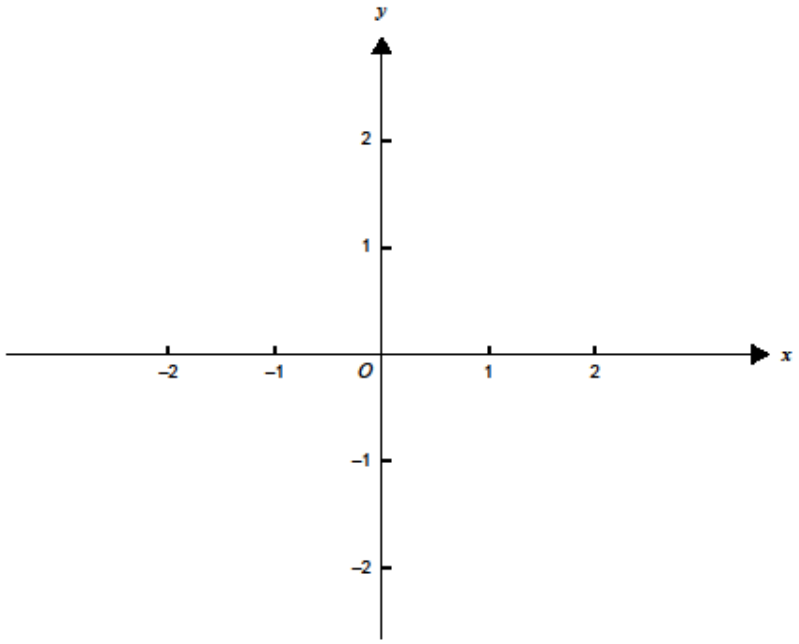
Give your answer in metres per day correct to two decimal places. 3 marks

Do not write in this area.

SM – Sample 2

Question 3

a. On the axes provided, sketch the curve given by the rule $x^2 - 4y^2 = 1$.



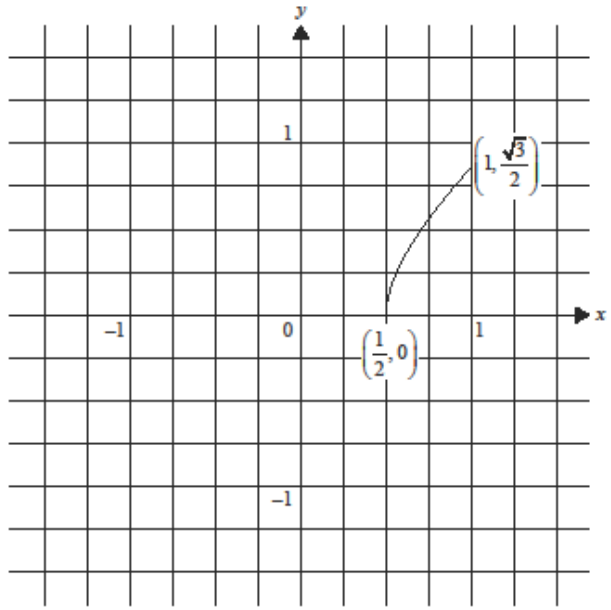
2 marks

The part of the curve for $x \geq 1$ and $0 \leq y \leq 1$ is rotated about the y-axis to form a volume of revolution which is to model an ornamental fountain.

b. When the depth of the water in the fountain is h metres, show that the volume of water in the fountain is V cubic metres, where $V = \pi\left(\frac{4h^3}{3} + h\right)$.

Question 3 (13 marks)

Part of the graph of $y = \frac{1}{2}\sqrt{4x^2 - 1}$ is shown below.



The curve shown is rotated about the y-axis to form a volume of revolution that is to model a fountain, where length units are in metres.

a. Show that the volume, V cubic metres, of water in the fountain when it is filled to a depth of h metres is given by $V = \frac{\pi}{4}\left(\frac{4}{3}h^3 + h\right)$. 2 marks

SM – Sample 3

Question 15 (15 marks) Use the Question 15 Writing Booklet.

(a) (i) Show that $\int_{-a}^{a} \frac{f(x)}{f(x)+f(-x)}dx = \int_{-a}^{a} \frac{f(-x)}{f(x)+f(-x)}dx$. 2

(ii) Hence, or otherwise, evaluate $\int_{-1}^{1} \frac{e^x}{e^x+e^{-x}}dx$. 2

(b) An urn contains w white marbles and y yellow marbles. Two players, A and B, play a game in which they take turns to randomly draw a marble from the urn.

If player A draws a white marble then player A wins. If player B draws a yellow marble then player B wins.

Each player replaces the marble if their draw is unsuccessful. The game stops as soon as one player wins.

Player A draws first.

(i) Explain why, in the case where $w = y$, player A has a greater chance of winning than player B. 1

(ii) Show that for player B to have a greater chance of winning than player A, 3

$$\frac{y}{w} > \frac{1+\sqrt{5}}{2}.$$

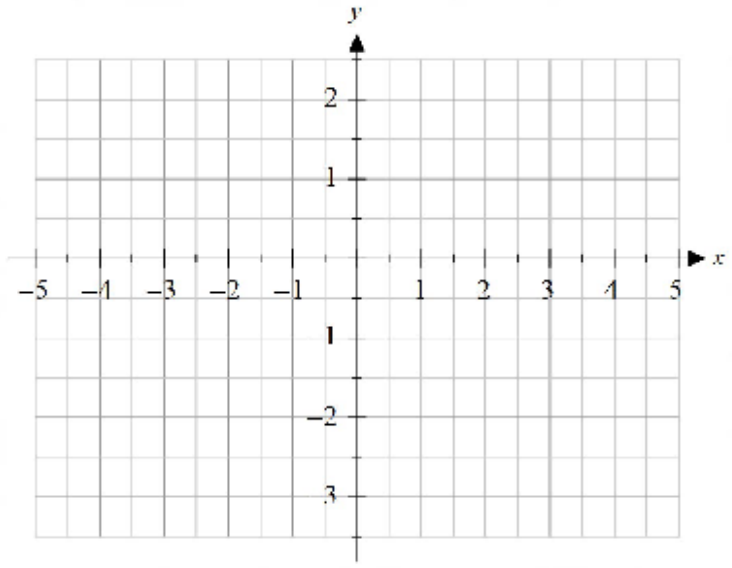
(c) (i) Show that $\int_{0}^{1} \frac{x}{(x+1)^2}dx = \ln 2 - \frac{1}{2}$. 2

(ii) Let $I_n = \int_{0}^{1} \frac{x^n}{(x+1)^2}dx$. 3

Question 3 (10 marks)

Consider the function $f : R\setminus\{-1\} \to R, f(x) = \frac{x}{(x+1)^2}$.

a. On the set of axes below, sketch the graph of $y = f(x)$, labelling all asymptotes with their equations, any axial intercepts, the stationary point, and the point of inflection, including their exact coordinates. 2 marks



b. Use integration to show that $\int_{0}^{1} f(x)dx = \log_e(2) - \frac{1}{2}$. 2 marks

MM Sample 1

Question 3

The Bouncy Ball Company (BBC) makes tennis balls whose diameters are normally distributed
67 mm and standard deviation 1 mm. The tennis balls are packed and sold in cylindrical tins that each
balls. A tennis ball fits into such a tin if the diameter of the ball is less than 68.5 mm.

a. What is the probability, correct to four decimal places, that a randomly selected tennis ball pr
BBC fits into a tin?

BBC management would like each ball produced to have diameter between 65.6 and 68.4 mm.

b. What is the probability, correct to four decimal places, that the diameter of a randomly selected
made by BBC is in this range?

Question 4 (14 marks)

A teacher coaches their school's table tennis team.

The teacher has an adjustable ball machine that they use to help the players practise.

The speed, measured in metres per second, of the balls shot by the ball machine is a normally distributed random variable W.

The teacher sets the ball machine with a mean speed of 10 metres per second and a standard deviation of 0.8 metres per second.

a. Determine $\Pr(W \geq 11)$, correct to three decimal places. 1 r

b. Find the value of k, in metres per second, which 80% of ball speeds are below. Give your answer in metres per second, correct to one decimal place. 1 r

The teacher adjusts the height setting for the ball machine. The machine now shoots balls high above the table tennis table.

Unfortunately, with the new height setting, 8% of balls do not land on the table.

Let $\hat{P}$ be the random variable representing the sample proportion of balls that do not land on the table in random samples of 25 balls.

c. Find the mean and the standard deviation of $\hat{P}$. 2 m

d. Use the binomial distribution to find $\Pr(\hat{P} > 0.1)$, correct to three decimal places. 2 m

Question 4 (15 marks)

A manufacturer produces tennis balls.

The diameter of the tennis balls is a normally distributed random variable D, which has a mean of 6.7 cm and a standard deviation of 0.1 cm.

a. Find $\Pr(D > 6.8)$, correct to four decimal places. 1 mark

b. Find the minimum diameter of a tennis ball that is larger than 90% of all tennis balls produced.
Give your answer in centimetres, correct to two decimal places. 1 mark

Tennis balls are packed and sold in cylindrical containers. A tennis ball can fit through the opening at the top of the container if its diameter is smaller than 6.95 cm.

c. Find the probability that a randomly selected tennis ball can fit through the opening at the top of the container.
Give your answer correct to four decimal places. 1 mark

d. In a random selection of 4 tennis balls, find the probability that at least 3 balls can fit through the opening at the top of the container.
Give your answer correct to four decimal places. 2 marks

DO NOT WRITE IN THIS AREA

MM Sample 2

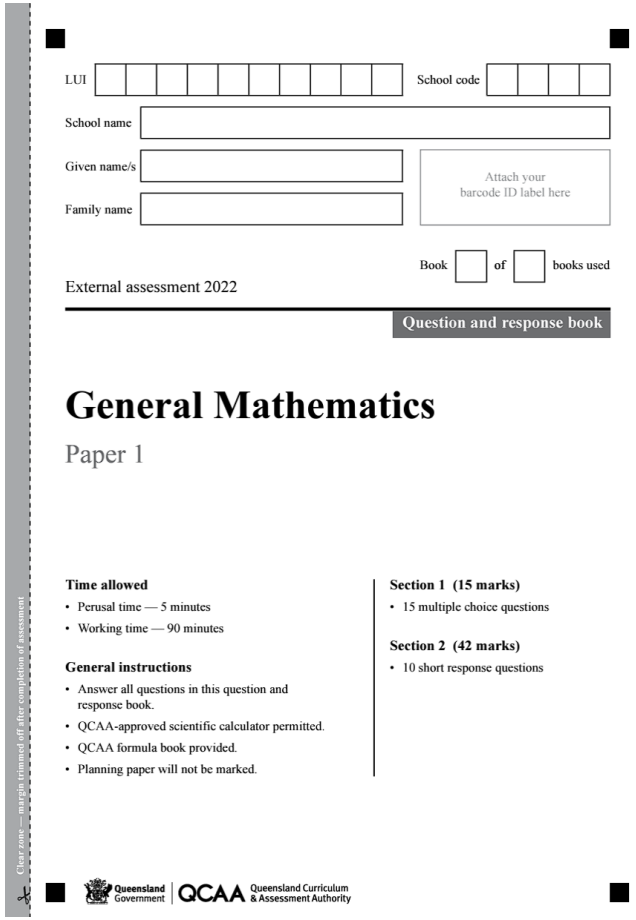
- https://senior-secondary.scsa.wa.edu.au/__data/assets/pdf_file/0004/1091560/2023-MAM-Examination-Calculator-Assumed.PDF

- Look at their probability questions…

https://www.sace.sa.edu.au/documents/652891/12a2b604-0727-4649-ae8c-8d485d8b6570

Look at Q8, Q9…

Sample 5 – GM (optional)



LUI ☐☐☐☐☐☐☐☐☐☐ School code ☐☐☐☐

School name ☐

Given name/s ☐ Attach your barcode ID label here

Family name ☐

Book ☐ of ☐ books used

External assessment 2022

Question and response book

General Mathematics

Paper 1

Time allowed
- Perusal time — 5 minutes
- Working time — 90 minutes

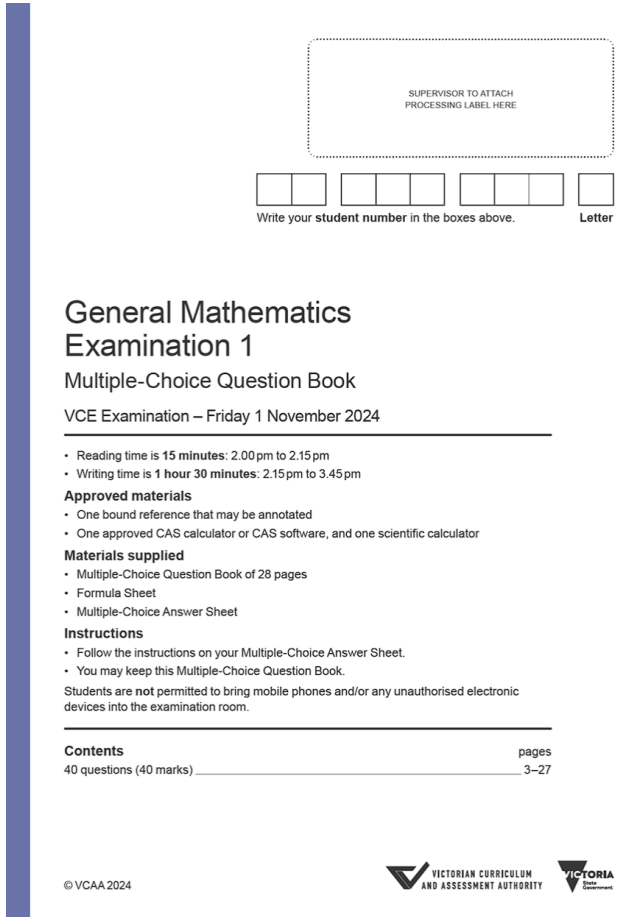
General instructions
- Answer all questions in this question and response book.
- QCAA-approved scientific calculator permitted.
- QCAA formula book provided.
- Planning paper will not be marked.

Section 1 (15 marks)
- 15 multiple choice questions

Section 2 (42 marks)
- 10 short response questions

Clear zone — margin trimmed off after completion of assessment

Queensland Government | QCAA Queensland Curriculum & Assessment Authority



SUPERVISOR TO ATTACH PROCESSING LABEL HERE

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Write your **student number** in the boxes above. **Letter**

General Mathematics Examination 1

Multiple-Choice Question Book

VCE Examination – Friday 1 November 2024

- Reading time is **15 minutes**: 2.00 pm to 2.15 pm
- Writing time is **1 hour 30 minutes**: 2.15 pm to 3.45 pm

Approved materials
- One bound reference that may be annotated
- One approved CAS calculator or CAS software, and one scientific calculator

Materials supplied
- Multiple-Choice Question Book of 28 pages
- Formula Sheet
- Multiple-Choice Answer Sheet

Instructions
- Follow the instructions on your Multiple-Choice Answer Sheet.
- You may keep this Multiple-Choice Question Book.

Students are **not** permitted to bring mobile phones and/or any unauthorised electronic devices into the examination room.

Contents pages

40 questions (40 marks) ____ 3–27

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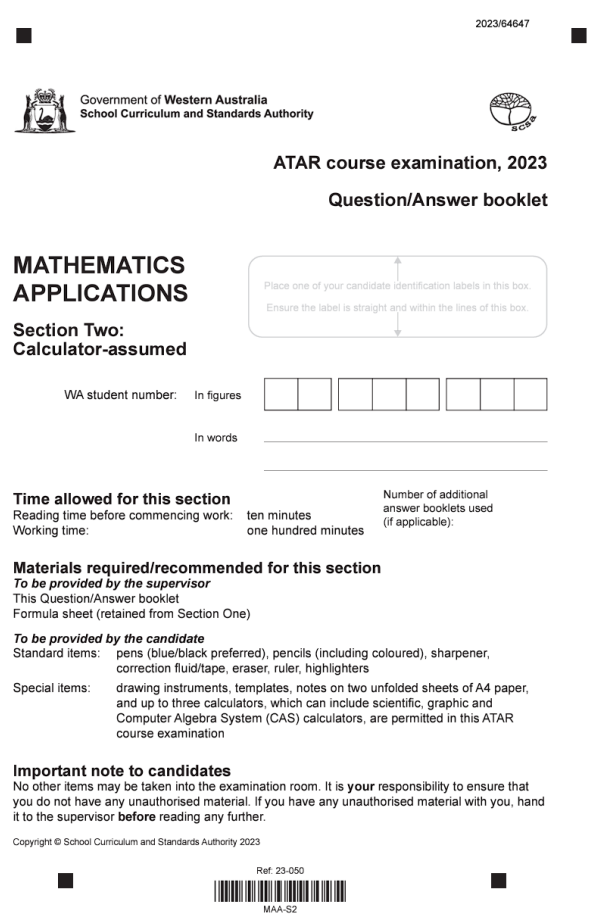

2023/64647

Government of **Western Australia**
School Curriculum and Standards Authority

ATAR course examination, 2023

Question/Answer booklet

MATHEMATICS APPLICATIONS

Section Two: Calculator-assumed

Place one of your candidate identification labels in this box.
Ensure the label is straight and within the lines of this box.

WA student number: In figures ☐☐☐☐☐☐

In words ____

Time allowed for this section
Reading time before commencing work: ten minutes
Working time: one hundred minutes

Number of additional answer booklets used (if applicable):

Materials required/recommended for this section
To be provided by the supervisor
This Question/Answer booklet
Formula sheet (retained from Section One)

To be provided by the candidate
Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters
Special items: drawing instruments, templates, notes on two unfolded sheets of A4 paper, and up to three calculators, which can include scientific, graphic and Computer Algebra System (CAS) calculators, are permitted in this ATAR course examination

Important note to candidates
No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

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Ref. 23-050

MAA-S2

Sample 5 – GM comments

	VCE	QCE	WACE	NSW*	SA
Tech-free exam?	No	No	Yes	No	No
Tech-active exam?	Yes, E1 + E2 CAS allowed	Yes, E1+E2, only graphics	Yes, CAS allowed	Yes, but not CAS	Yes, only one long exam
Does it have MCQ components?	Yes, in E1, 40 MCQs	Yes, in E1, 15 MCQs	No MCQs	Yes, 15 MCQs	No MCQs
Number of Marks?	40 + 60 = 100 marks	15+42+38 = 100 marks (in 2023)	35+65=100 marks (in 2023)	15+85=100 marks (in 2024)	90 marks
Time permitted?	15+90 mins each	5+90 mins	5+50 mins E1 10+100 mins E2	10+150 mins	130 mins

- Note that NSW has Maths Standard 1 and Maths Standard 2, sort of 'equivalent' to our General Maths.

Sample 5 – GM comments (ctd)

- QCE GM questions are excellent sources to replenish our VCE teaching and learning. Their analysis questions can be some decent starting points for your SAC writing.
- WACE Math Application questions have more in-depth skills assessed, so they allocate more marks to certain parts than they should be.
- Note that they have a calculator free exam, whereas we don’t in VCE (luxury of us!).

Part Three: my findings and observations in the recent years

Features of VCAA SM Past Exams

- Exam 1 total 40 marks
- 9-10 questions,
- Mostly assessing O1, occasionally O2
- A list of common topics can be accessed from the 2023-2027 Study Design document
- Big focus on by-hand arithmetic and acute observation to algebra/number patterns

- LOTS OF INTEGRATION

- Exam 2 total 80 marks
- 20 Multiple Choice Questions, can assess O1, O2, O3 or their combinations
- Most likely 6 ERQs
- Function+Graphs+Calculus
- Complex Number+Algebra
- Differential Equation
- VectorCalculus/Kinematics/ Calculus Modelling+Application
- Vector, lines and Planes
- Probability and Statistics

Features of VCAA MM Past Exams

- Exam 1 40 marks
- 8-9 questions, focusing mainly on O1, only a few O2
- A list of common topics can be accessed from the 2023-2027 Study Design document
- Focus on accurate representation of mathematics. Notations, calculations, exact values, algebra, equation solving…
- Bigger emphasis on features of functions, differentiation, transformations etc.

- Exam 2 80 marks
- 20 MCQs, can be anything from O1, O2 to O3
- Most likely 5 ERQs
- Polynomial Functions, Graphs, Transformation + Calculus
- Circular Functions (w or w/o other functions) and Modelling
- Further Functions (sum,difference, product etc.)
- Probability and Statistics
- Investigative Questions (Inverse, composite, …)

Legend of marks

- In VCE (previously the Board of Studies), the “M1-H1-A1” (or “1M-1H-1A”) system has been there for many years (since the late 80s or early 90s)
  - M1 – method mark, awarded if a student can apply a valid method (that will lead to the answer) with reasonable attempt.
  - H1 – consequential (His/Her) mark, awarded if a student applied a **correct** procedure using **their correct/incorrect previous result**. Very rare on each paper. The exam panels are trying to minimize consequential marks, but on special occasions, this mark may be allocated somewhere.
  - Interestingly, consequential marks are (slightly) more frequent in Chemistry and Physics.
  - A1 – answer mark, non-negotiable must be correct (value and/or form).

Allocating the marks

The following are the general ways to allocate marks.

- 1 mark question: only needs the correct answer/all answers required, unless it is a “show that”/“explain” type question.
  - Mostly A1.
  - Occasionally H1, if this part is reliant on some previous result.
- 2 marks question:
  - Case 1: ‘Given A, find B’
    - M1, A1; a valid method leading to an answer
  - Case 2: ‘Find A **and** find B’
    - A1, A1; an obvious method implied (often in E2),
      - two aspects need to be addressed

Allocating the marks (ctd.)

- 3 marks question:
  - Case 1: a method needs to be applied. Then, it just produces one possible answer. Another possible answer needs to be considered using a similar approach.
  - OR a method is being applied to produce one answer. Then, another required item needs to be produced, such as ‘find the value of x and find the maximum value…’
    - M1, A1, A1
  - Case 2: an important result needs to be produced first. Based on this initial result/equation/relation etc., a method needs to be implemented to produce the final answer intended.
    - A1, M1, A1
  - Case 3: two stages of working are required to derive the final answer.
    - M1, M1, A1

Allocating the marks (ctd.)

- 4 marks question (sometimes in E1, very rare in E2)
  - A possible case: M1, A1, M1, A1
  - The four marks may be split into two stages, with greater complexity
- 5 marks question (occasionally in E1, extremely rare in E2)
- Use the above 2 or 3 marks allocations to determine the most appropriate combinations/permutations.
- For example, break it into 1 + 2 + 2 marks, or 2 + 3 marks.
- It is rare, but it is a good tool to assess Outcome 2 (and Outcome 3)

Summary of my favourite tools of trade

In my daily work, the following teaching tools are very helpful:

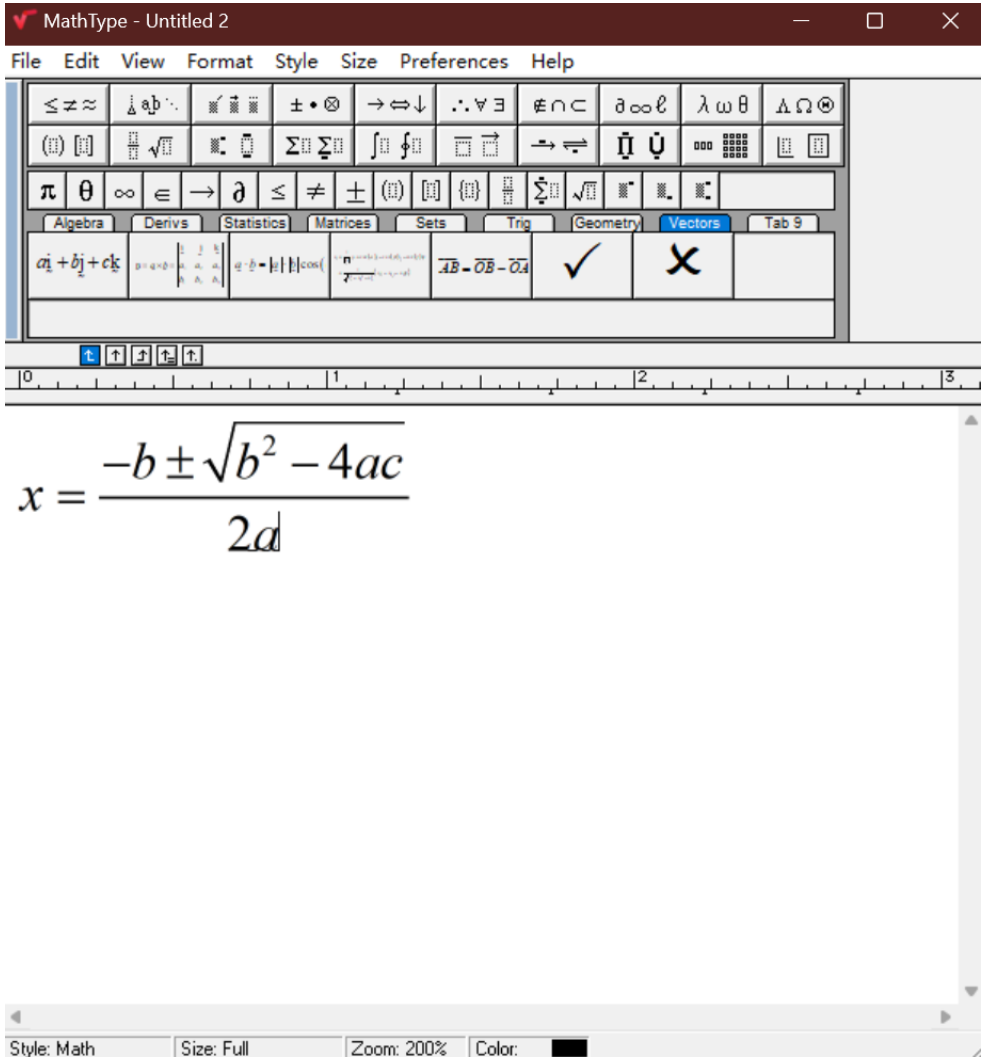
- MathType (an annual cost applies)
- eFofex Draw Tools (a cost applies)
- Mathcha.io/editor (free)
- TI Nspire CX II Teacher Software; CASIO CLASSPAD 400 emulator (free if your school booklists them)
- Goodnotes (a cost applies)

MathType 7.0+

This is the desired tool VCAA and many publishers/commercial exam writers use to compose the questions.

It goes very well with MS Words and easy to edit/format. Needs 1-2 months regular practice to be a proficient user.

Of course…if you are good at LaTeX, then it will be a totally different story. ;)

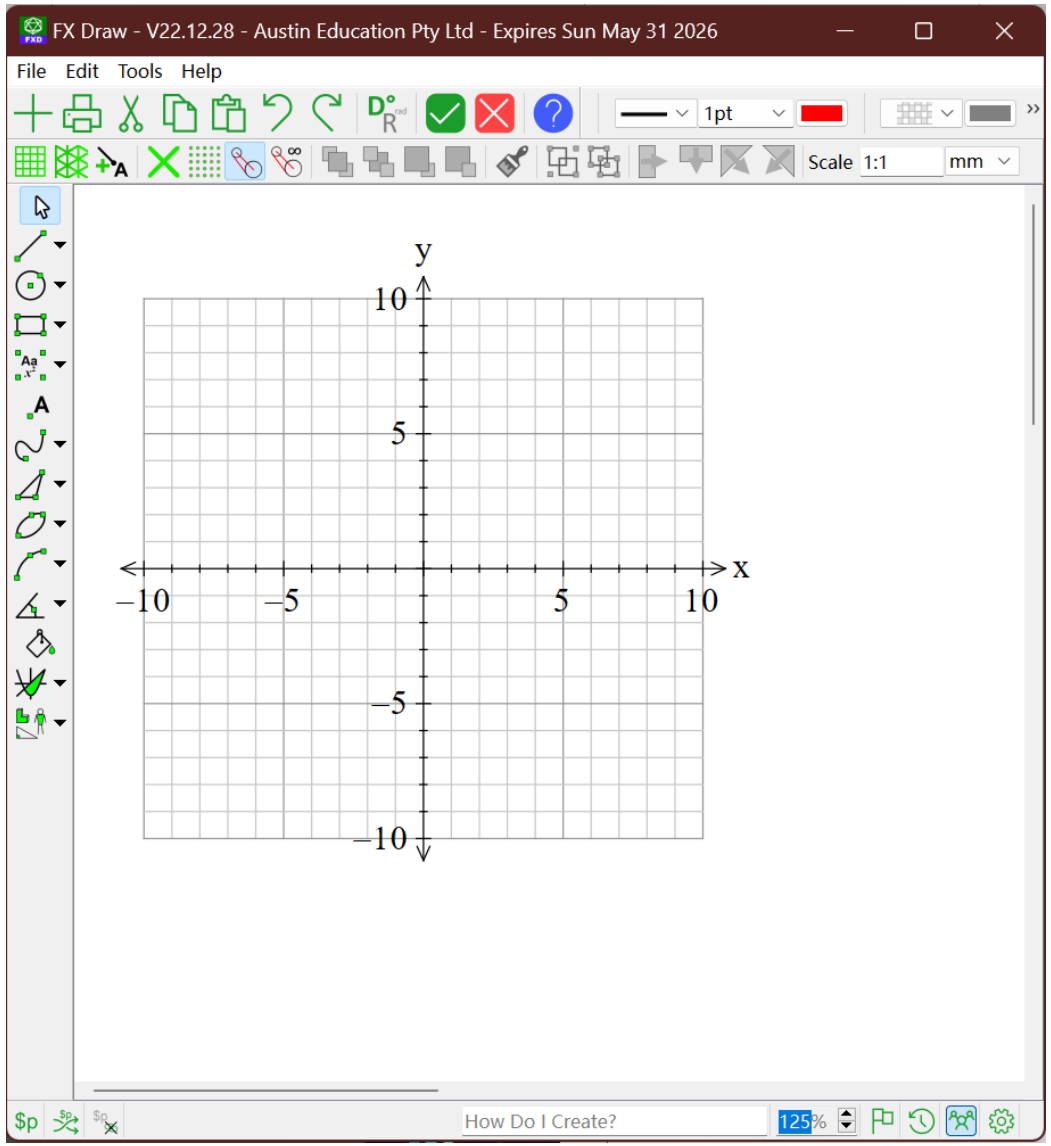


eFoFex Draw Tools

This is another graphing package to create diagrams, graphs, functions. Very easy to get the hang of. Straightforward interface.

We can use it to imitate the VCAA exam axes/grids, so that students can get more practices on graph sketching!

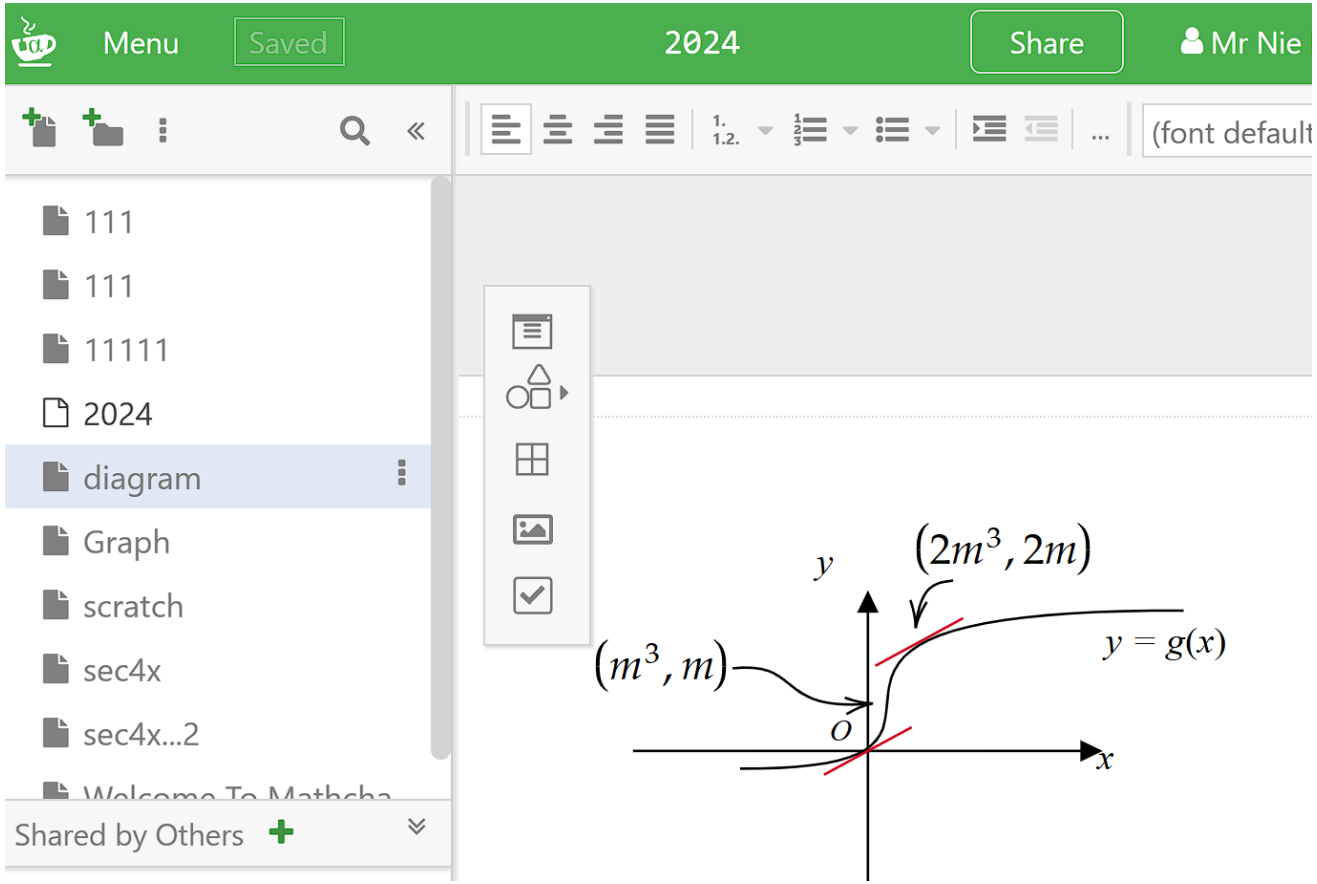
Recommended to use together with your CAS and/or Desmos/Geogebra etc.



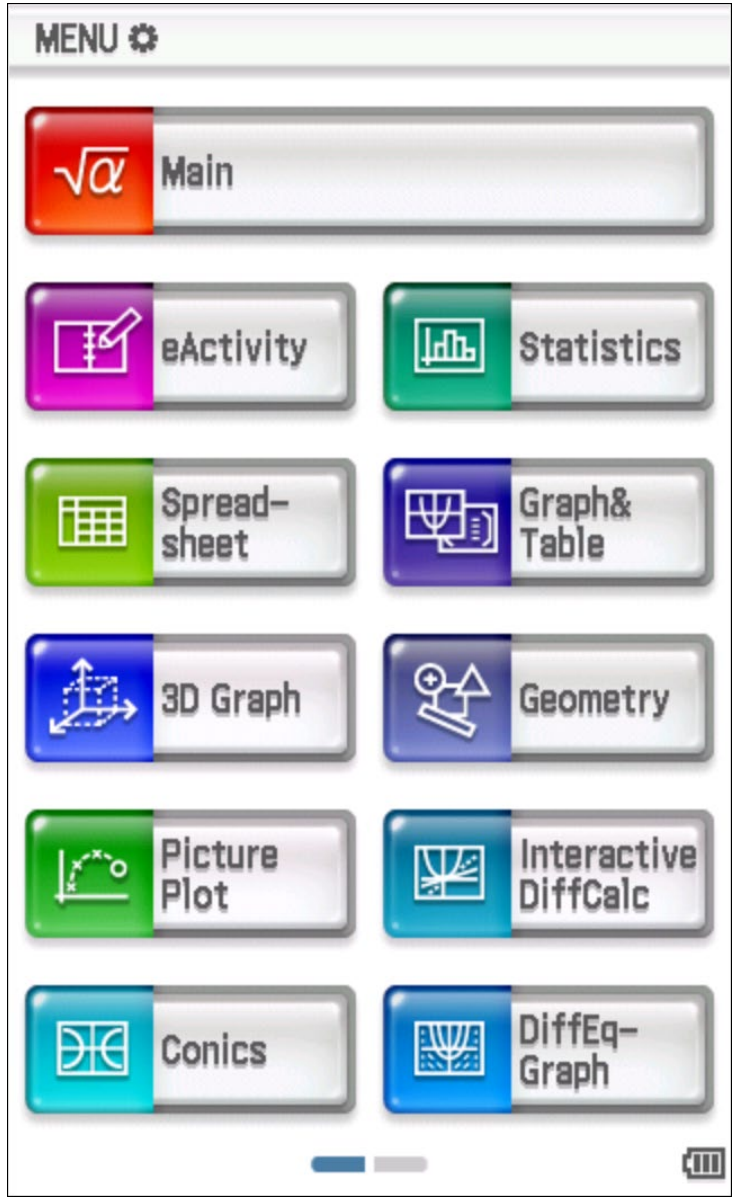
Mathcha.io/editor

Very fancy and handy.

What you see is what you create.



TI Nspire CX CAS II & CASIO CP400



GOODNOTES

- Great teaching tool. Farewell to the traditional chalk-talk,whiteboard and markers, only need a projector in a classroom
- Create video contents easily and do recordings; many teachers, tutors or YouTubers use it on their iPad, including myself.
- Easy to manage the annotated PDF files.

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Event App

App Download Instructions

Step 1: Download the App 'Arinex One' from the App Store or Google Play

App Store

Google Play

Step 2: Enter Event Code: **mav**

Step 3: Enter the email you registered with

Step 4: Enter the Passcode you receive via email and click 'Verify'. Please be sure to check your Junk Mail for the email, or see the Registration Desk if you require further assistance.

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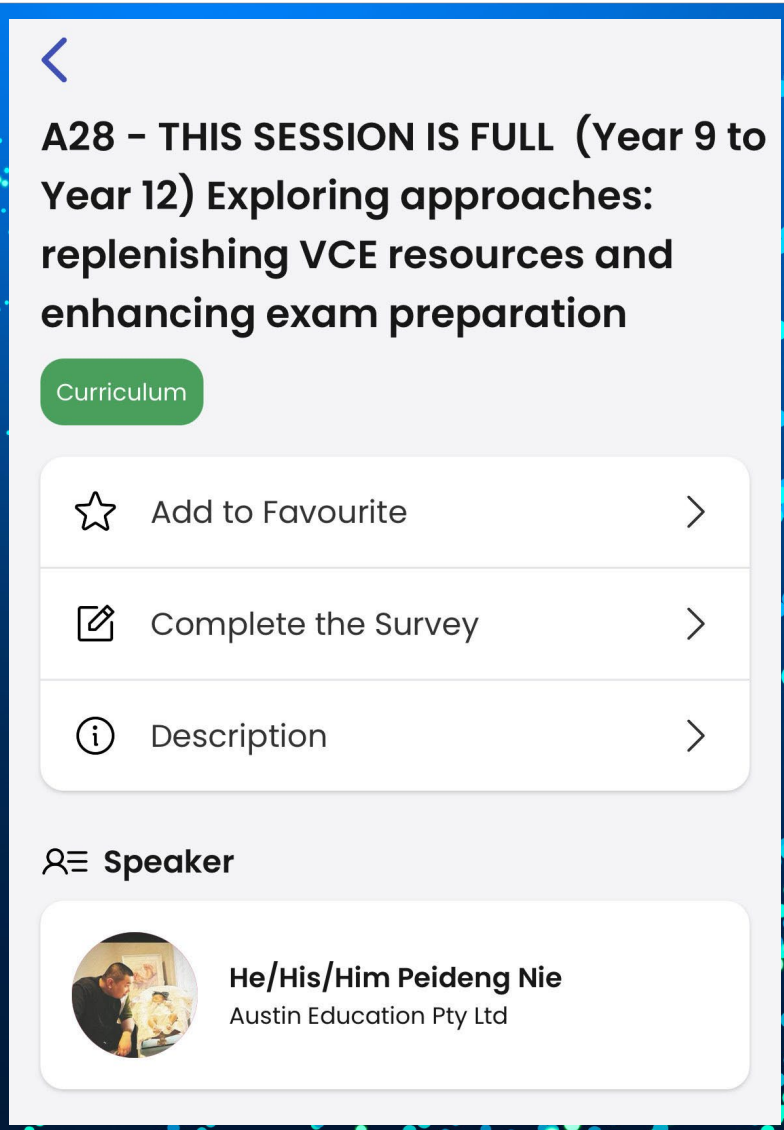
Your feedback will be invaluable to myself. Be in it to WIN!



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Thank you so much for your attendance today. We will see you next year!