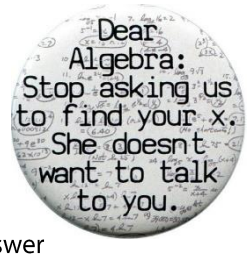
Exam/Study Tip # 4: Preparing a Mark Boosting Set of Reference Materials for the Mathematics Exams

Students studying **Mathematical Methods** or **Specialist Mathematics** are required to sit two examinations at the end of the year. Between them they cover the whole year's work.



Examination 1 is a one hour technology free paper (no calculators or notes allowed) and consists of a series of short answer and some shorter extended answer questions. This examination is worth 22% of the marks used to determine each mathematics Study Score. A formula sheet will be provided to students in this examination.

Examination 1 is reasonably straight forward, but requires that students possess strong algebraic and arithmetic skills (including fractions and surds), as well as excellent graphing skills. The new Study Design for 2016-2020 has changed the nature of Exam 1 so that some shorter multi step extended answer questions could be included to be done tech free in Exam 1.

Examination 2 is a two hour "open book" examination (calculators and notes allowed) and consists of a series of multiple choice and extended answer questions. This examination is worth 44% of the marks used to determine each mathematics Study Score. Students are allowed to bring into this examination, unlimited pages of pre-prepared notes or a text book. These materials are referred to as **"Reference Materials"**. The same formula sheet that was provided in Exam 1 will also be provided to students in this examination. You will find that the formula sheet for Mathematical Methods is much briefer than that for Specialist Mathematics.

The multiple-choice questions in Examination 2 are **usually** written so that the use of a CAS calculator is not particularly of great benefit, although a strong familiarity with the calculator provides an enormous benefit to short cutting a solution.

The answers to questions in both examinations must be given in exact values (unless otherwise specified). This means that once an exact value is found **DO NOT** continue on to decimalise it. When more than 1 mark is allocated to a question, appropriate working must be shown. This means that students will be often be required to show working steps in order to obtain full marks.

The extended answer questions incorporate applications that are not usually detailed in text books, and will require students to apply their knowledge of taught mathematical principles to applications they have not previously been exposed to.

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Further Mathematics

Both exams in Further Mathematics are technology active and cover the whole year's work. Technology active means that you may bring into the exam a CAS calculator and a book of **"Reference Materials"**. Examination 1 is a "Facts and Skills" assessment and has 40 multiple choice questions (24 from the core and 16 from two of four modules). Examination 2 is an Extended Answer assessment, consisting of 60 marks of extended answer questions requiring written answers. Each exam contributes 33% to your Study Score with the other 34% being provided by your School Assessed Coursework.

Further Maths exams include a range of questions from the very routine through to quite complex analytical questions. Many students will find the first questions in each section very simple, followed by some more challenging questions. Questions at the end of each section will often be very challenging and require that students apply their knowledge in quite novel situations.

It is unlikely that a student who needs to look at their notes for every question would do very well in the exams, partly because they would not have the time to complete all questions, but also because the more challenging questions are unlikely to have simple solutions that are detailed in standard notes.

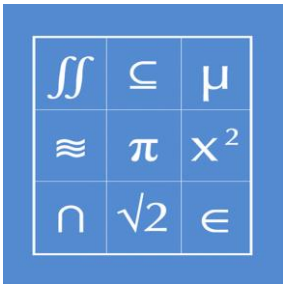
The new Study Design for 2016-2020 states that the reference materials ***may be a textbook (which can be annotated), a securely bound lecture pad, a permanently bound student-constructed set of notes without fold-outs or an exercise book.***

When Can I Use Reference Materials?

The table below summarises the materials that will be allowed in the end-of-year mathematics examinations.

Study	Examination 1	Examination 2
Further Mathematics	Reference material allowed	Reference material allowed
Mathematical Methods	NO Reference material allowed	Reference material allowed
Specialist Mathematics	NO Reference material allowed	Reference material allowed

Criteria for Acceptable Reference Materials



(a) Materials must be in book format of A4 size or smaller when closed.

(b) There is no page limit for the Reference Materials. As long as the materials are contained in one book or bound item – they will be accepted.

(c) **ONLY ONE** bound set of notes is allowed into the open-book examinations. A single textbook is allowed as the reference material, although not advised.

(d) Materials must be held together via a single horizontal or vertical spine.

(e) Pages must be permanently bound and securely attached to the spine. They **must not** be able to be detached from the Reference Materials during the exam. This means that you cannot use Reference Materials that are presented in a form that will enable you to modify the content by adding or removing pages or tabs. Be careful particularly of the A-4 lecture pad that has a fine perforated line near the spine. These are NOT allowed.

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Forms of collation/binding that are not acceptable include:

- Ring-binder folders.
- Plastic A4 slips (permanent or removable) into which pages may be inserted or removed.
- Manila folders and similar folders with clip, clamp, slide and metal prong style binding of loose-leaf material.
- Glued lecture pads.
- Bound books that have perforations designed so as to allow pages to be detached. If one or more pages can be or are detached from the Reference Materials, the entire Reference Materials will be confiscated by the examination supervisor, and the incident will be reported to the VCAA as a breach of rules.

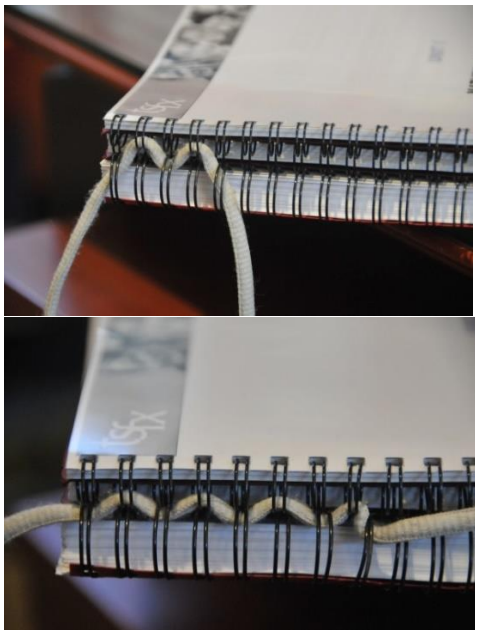
Acceptable "Reference Materials" include:

Text books or your own prepared permanently bound notes. For example:

- A securely bound lecture pad.
- A permanently bound student-constructed set of notes without fold-outs or sticky tabs.
- An exercise book with cloth, glue or staple binding.
- An A4 (or smaller) sized spiral bound exercise books (without perforations).
- Lecture pads that have been permanently bound by stapling or some other means.
- A4 sheets of paper that have been appropriately bound (plastic comb binding is acceptable). Materials can be bound at "Officeworks"

Note:

Students **MAY** securely bind individual units together to make an acceptable set of Reference Materials. For example, a series of exercise books may be permanently glued together and then secured/joined with a single spine such as wide industrial tape that is **PERMANENTLY** glued to the spines of each book. Multiple coil bound books can be transformed into acceptable Reference Materials by **PERMANENTLY** gluing the covers together, and then "sewing" the spines of the books together with thick string or wire, as illustrated below.



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Further Notes:

Different schools have different interpretations as to what constitutes an “acceptable set of Reference Materials". Therefore, it is important that students confirm what is “acceptable” before the exams.

(a) No fold-outs, maps or brochure style components are permitted.

(b) You cannot attach removable tabs, post-it notes or other non-securely bound items to the Reference Materials.

(c) You are allowed to firmly attach (e.g. by glue, adhesive tape or staples) additional materials to the pages in the bound reference. Be careful to glue every side and corner. No curling pages allowed.

(d) Reference Materials can be annotated (have your handwritten comments/additional notes written in). They can also include photocopied pages of notes from your teacher.

(e) You are allowed to draw attention to sections of the Reference Materials by folding or cutting page corners, or by colour coding pages.

(f) Students are allowed to insert coloured dividers into their prepared materials.

The rules relating to acceptable “Reference Materials” continue to be refined and clarified by the VCAA. We therefore recommend that students read the advice provided by VCAA at the beginning of each school term.
Many schools check and ‘sign off’ the notes in the week of the exams. This makes entering into the exam room much easier.

Preparing an Effective Set of Reference Materials

The “open book” style of testing in the mathematics subjects has resulted in more difficult questions and applications in the technology active examinations.

These examinations usually emphasise applications that are **NOT** typically covered in text books, and hence, we strongly recommend that students prepare their own Reference Materials rather than taking their text book into the open-book exams.

The fact that the Reference Materials have no page limit and there are no restrictions regarding the type of materials that can be included suggests that VCAA is confident that no amount of notes or resources will be of significant benefit to those students who do not know their course materials.

But is this really the case?

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Each year, the majority of students derive only a small benefit from their Reference Materials in the actual exams. However, a carefully and cleverly constructed set of Reference Materials can make a huge impact on examination scores.

So what should students include in the mathematics Reference Materials in order to make these notes powerful resources in the final exams?

Your materials should include the following:

- Summaries of vital concepts and rules.
- Guidelines as to when each rule can be applied.
- Step-by-step instructions and clear methodologies with sample calculations that you can fall back on if you develop "mind blanks" in the examination.
- Limitations of rules and methodologies.
- Exceptions to rules and methodologies.
- Flow charts that describe how to tackle complex analytical style questions.
- Summaries of every examinable technique (including skills and concepts from prerequisite Units) as well as clear explanations as to what each technique is used for. This summary will serve as a valuable prompt that may help determine which approach to take when asked to solve questions that students have not been previously exposed to.
- Details of the common errors made by students, reminders as to how exam writers try to trick/trap students, as well as lists of watch-outs by topic. Students may then peruse the appropriate "Tricks and Watch-out List" before attempting questions on the examination. This will ensure that valuable marks are not lost during the course of the exam(s).

For example:

The Logarithmic Functions section of the Mathematical Methods materials should include a reminder to "check the validity of answers" before leaving logarithmic equation questions. Many students lose marks in this topic as they forget to substitute the calculated values of x into the given equation so as to determine whether the answers are defined (the log of zero or a negative number is undefined). In fact – students should check the validity of all answers, as anomalies may arise with every function type.

For example:

In Further Mathematics when using Trigonometry, the ambiguous case of the Sine Rule should be emphasised. It would be necessary to detail that when you are using the Sine Rule to find an angle; also consider the ambiguous case where the angle could be obtuse. The answer could either be the solution given by the calculator or the remainder when subtracted from 180^0.

- Difficult/challenging sample extended answer examination questions that have been used in recent year's CAS-active examinations.
- CAS calculator methodologies and usual syntax, particularly syntax that has given you trouble in the past. This may be, for Maths Methods, how to use inverse Binomial CDF to find a probability of success or how to use factor or rfactor to find a root of a graph. Or in Specialist Maths, how to use your CAS to find partial fractions, use propfrac to long divide, or to solve a DE in one step.

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Detailed Instructions Regarding the Preparation of Reference Materials

For ease of use, Reference Materials should consist of separate "Theory Sections" as well as "Question Banks".

The Theory Section(s)

The Theory Section(s) should incorporate the relevant theory, carefully selected worked examples (to protect you from mind blanks and stress moments), methodologies/step-by-step instructions, prompts (to help you determine a solution process), watchouts and common errors lists (to protect you from losing valuable marks in the exam), as well as a clear and detailed index that will enable you to quickly and easily locate information. Notes that have been prepared throughout the year and not at the last moment are much easier to use because of familiarity.

Suggestion:

As you are studying/revising each topic in mathematics this year, write, type, or scan summary notes, methods (in a step-by-step fashion), as well as worked examples into a WORD document. This will allow you to edit and update your notes without having to re-write large slabs of materials before the end of the year examinations.

It is also advisable to take notes as the year progresses, rather than writing them all at the end, because if you are familiar with your own notebook it will be easy in the exam to quickly know where to look. A teacher's greatest disappointment is to see a student 'borrow' a friend's notes the day of the exam because theirs haven't been well prepared!

The Question Bank(s)

The Question Bank(s) should include the challenging questions that you came across throughout the year (including past extended answer exam questions) and a variety of worked examples that will assist in addressing questions that you are not confident with. This includes guidelines and examples relating to solving the difficult and strange applications that are not detailed in your text books but that can appear in the exams (this will require a bit of research of past exams, both VCAA and other publishing companies).

Commercially Produced Material

It is quite common for students to copy sections of important work from their textbook or from the shared One-Note that the class may use throughout the year. This is quite reasonable as long as these sections are selected purposefully and with careful decision. There is no point in hurrying to copy slabs of material just before the exams.

An example of books that can be added as part of your bound notes are the Nelson A+ exam 1 and 2 books that you have worked on throughout the year, annotated personally to give you hints for questions you have found particularly challenging. You may include comments about questions that you know the examiners remarked on in the previous year that this topic was done badly. These A+ books are of A4 size purposefully so they can be 'stuck' to a book or lecture pad and bound together. The Essential series of Cambridge Mathematics have well developed and detailed explanations at the beginning of each section and these could be copied and stuck into your book. The new Nelson VCE series for 2016, in contrast, have more succinct explanations but include all past exam questions and their solutions included that are relevant to each topic, all graded for difficulty and the data of student success in the years these questions appeared in the exams.

It used to be in long ago years that the bound book had to be all hand written. Now that any form of type, handwritten, photocopied or stuck in pages are all allowed, it is suggested that you use all forms available to you to produce the most useful notes FOR YOU.

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Organising the Reference Materials

Students can choose to construct their Reference Materials in one of two ways:

- By grouping questions and theory by topic.
- By creating one "Theory Section" and one "Question Bank".

Option 1: Grouping Questions and Theory by Topic

Separate the notes for each topic using plastic or paper dividers, as illustrated on side.

For Example:

Section 1 could be dedicated to Algebra.

Section 2 could be dedicated to Trigonometric Functions etc.

Then collate questions by topic, and add them to the back of each individual set of theory notes.

Suggestion:

Dedicate one section for analysis questions (as these integrate multiple topics) as well as a separate section for additional questions. Insert any questions that cannot fit into the appropriate topic bank as well as last minute question into the "Additional Questions" section.

Option 2: Generic Format

Pool all the theory notes at the front of the Reference Materials and create one generic Question Bank behind the Theory Section.

The Question Bank(s)

Throughout the year, as you are working through your various resources, identify those questions you would like to take into the exams, and incorporate these in your Question Bank(s).

The questions in the Question Bank(s) do not need to be organised in any particular fashion. As you come across a new question, just add it to the relevant Question Bank (i.e. Topic Question Bank or Generic Question Bank) and annotate the corresponding Theory Section with the relevant question number. This will help you easily locate worked examples when necessary, as well as save on valuable time!

In other words – Collate questions in the order you paste them into your Reference Materials.

If you have decided to adopt the "Generic Format" (Option 2), then Questions 1 – 10 could relate to Trigonometry, Questions 11 – 50 could relate to Differentiation, Question 51, 59, 77 could relate to Trigonometry again.

If you have decided to adopt Option 1 (Grouping questions and theory by topic), then using the Algebra Section as an example, Questions 1, 2 and 3 could relate to factorising quadratic expressions, Questions 4 – 29 could relate to factorising linear expressions, Questions 30, 102, 5467 could relate to factorising cubic expressions.

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Creating a Referenced Question Bank

As you add each question to your Bank(s), reference these questions in the appropriate section of the given notes.
For example: The Theory Section could include the following materials:

Evaluating Limits Algebraically

The manner in which we evaluate limits algebraically depends on whether the **denominator** of the function carries terms involving x.

Given $\lim_{x\to a} f(x)$**:**

(a) If the equation does not carry a denominator or if the denominator has **NO** terms involving x, simply substitute the value of a into the given equation and simplify.

For example: $\lim_{x\to 1}(5-2x-x^3) = 5-2(1)-(1)^3 = 2$

(b) If the denominator carries terms involving x, we need to first determine whether the value of x (or a) in question causes the function to be undefined. Substitute the value of a into the denominator of the equation.

If the answer is equal to zero, we need to eliminate the term(s) that is/are causing the function to become undefined. Factorise the given equation and eliminate these terms by cancellation. Before evaluating the limit, substitute the value of a into the new denominator to ensure there are no other terms present that will make the function undefined.

For example: $\lim_{x\to 3}\left[\frac{(x^2-5x+6)}{(x-3)}\right] = \lim_{x\to 3}\left[\frac{(x-3)(x-2)}{(x-3)}\right] = \lim_{x\to 3}(x-2) = 3-2 = 1$ ***(See Question 4)***

The Question Bank would include the **additional examples** you wish to take into the exams (in this case, Question 4):

QUESTION 4

Evaluate $\lim_{x\to 1}\left(\frac{x-1}{x^2+x-2}\right)$.

Solution

Substitute $x=1$ into the denominator to determine whether the function will become undefined. As the denominator is equal to zero, factorise the given expression and simplify.

Remember to state any restrictions on the values of x (*remember to define the restrictions using the ORIGINAL (given) equation):*

$$\lim_{x\to 1}\left(\frac{x-1}{x^2+x-2}\right) = \lim_{x\to 1}\frac{(x-1)}{(x-1)(x+2)} = \lim_{x\to 1}\left(\frac{1}{x+2}\right) = \frac{1}{1+2} = \frac{1}{3}, \quad x\neq 1, -2$$

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Additional Suggestions

- Regularly review and update your materials to incorporate changes and additional worked examples that you have encountered throughout the year.
- If your school teacher suggests you use an exercise book to produce your Reference Materials, only write on one side of each sheet. You will then be able to cut out the sections you wish to retain and paste these materials into your final/official Reference Materials.
- Students may choose to highlight each section of their notes using different coloured text.

  For example: Theory could be typeset using black text, general methodologies in blue text and common errors and watchouts in red text, so that appropriate materials can be located quickly and with ease.

  Alternatively, use frames, images and icons to highlight the different sections of your Reference Materials.
- Students adopting the "Generic Format" may choose to print each topic on different coloured paper so that relevant materials can be quickly located. **Note:** Choose pale pastel coloured paper so that the notes are easy to read.
- We recommend that students print two pages of notes onto one side of a sheet of paper (in landscape format) so that materials are not bulky, and so that sections of interest can be located with speed.
- Do not bind the Reference Materials until a week or two before the exams. This will enable you to add newly discovered materials to your Reference Materials whilst you are preparing for the exams.
- Once you have completed your Reference Materials, add a few sheets of blank paper to the back of each "Theory Section" and "Question Bank" if you have opted to group questions and theory by topic (Option 1), and at least 20 sheets of blank A4 paper to the back of the generic Theory Section and Question Bank (if you opted for the generic Format). This way, if you do come across additional questions/notes between the time of binding and the exam, you will have the opportunity to incorporate these resources into your Reference Materials.
- Add a **detailed index** to the front of your Reference Materials. Use this index as prompts/suggestions when you come across a question that you do not know how to solve.
- Very importantly, refer to your Reference Materials regularly in the weeks leading up to the examinations so that you can learn to locate relevant sections quickly (you will not have time to search for materials during the exam).

Regards,
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Free Reference Materials for Mathematics Examination 2

Students attending our mathematics **"Unit 3 and/or Unit 4 Exam Revision Lectures"** in July and September will receive a comprehensive set Reference Materials at **NO ADDITIONAL CHARGE**.

In addition, students will receive a detailed list of the common errors made by students, prompts, exam tricks and watch-outs to ensure that valuable marks are not lost during the course of the examination.

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Reference Materials – Samples

These samples have been provided as an example to illustrate how students should structure their Reference Materials, irrespective of which mathematics stream they are studying. Similarly structured materials will be issued to students attending our Unit 4 mathematics programs.

Sample Index – Special Relations (Maths Methods)

The Algebra of Functions **Page 163**

Addition and Subtraction of Ordinates	Page 164
Multiplication of Ordinates	Page 165

Composite Functions **Page 166**

Common Operations	Page 167
Sketching Composite Functions	Page 168
Existence of Composite Functions	Page 169
Domains and Ranges of Composite Functions	Page 169

Inverse Relations **Page 170**

Inverse Functions	Page 170
Identifying Inverse Pairs	Page 171
Sketching Inverse Functions	Page 172
Writing Equations Describing Inverse Functions	Page 172

Derivatives of Trigonometric Functions
(Maths Methods and Specialist Maths)

If $y = a\sin|\cos|\tan[f(x)]$ then $\frac{dy}{dx} = af'(x)\cos|-\sin|\sec^2 x[f(x)]$

That is, $\frac{dy}{dx}$ = coefficient of trig × derivative of the angle × derived trig function with the original angle

Note: $\sin\theta \to \cos\theta$ and $\cos\theta \to -\sin\theta$ and $\tan\theta \to \sec^2\theta$

For example: If $y = 4\sin\left(x^2\right)$ then $\frac{dy}{dx} = 4\times 2x\times\cos\left(x^2\right) = 8x\cos\left(x^2\right)$

If $y = -\cos(1-3x^4)$ then $\frac{dy}{dx} = -1\times -12x^3\times -\sin(1-3x^4) = -12x^3\sin(1-3x^4)$

If $y = \cos\left(\log_e(x)\right)$ then $\frac{dy}{dx} = \frac{1}{x}\times -\sin\left(\log_e(x)\right) = -\frac{1}{x}\sin\left(\log_e(x)\right)$

WATCHOUTS

- **Do not** lower powers on trigonometric terms.
- Always re-write expressions in terms of one trigonometric function before differentiating.

  For example: $y = -\frac{\sin(4x)}{2\cos(4x)} = -\frac{1}{2}\times\frac{\sin(4x)}{\cos(4x)} = -\frac{1}{2}\tan(4x) \quad \therefore \frac{dy}{dx} = -\frac{1}{2}\times 4\times\sec^2(4x) = -2\sec^2(4x)$

- **Watchout:** $y = \cos^4 x \neq \cos\left(x^4\right)$

  $y = \cos^4 x = (\cos x)^4$ which needs to be resolved using the bracket/power chain rule.

  For example: $\frac{dy}{dx} = 4\times -\sin x\times(\cos x)^3 = -4\sin x(\cos x)^3$

  $y = \cos x^4 = \cos(x^4)$ which needs to be resolved using trigonometric chain rule.

  For example: $\frac{dy}{dx} = 1\times 4x^3\times -\sin(x^4) = -4x^3\sin(x^4)$

WATCHOUTS

- Logarithmic Laws can only be applied if logarithmic terms are being added or subtracted.
- Remember to remove **any** constant that is present in front of the logarithmic expression before applying logarithmic laws (write these constants as powers).
- Logarithms separated by **multiplication** or **division** cannot be solved by applying logarithmic laws directly.

  For example: $x = \dfrac{\log_{10} 5}{\log_{10} 3} \neq \log_{10}(5-3) \neq \log_{10}\left(\dfrac{5}{3}\right) \neq \log_{10}(5) - \log_{10}(3)$

- The logarithm of a zero or negative number is undefined. Therefore, after solving logarithmic equations, substitute solutions into the **original** equation to ensure that none of the calculated values render the logarithm undefined.
- Logarithmic functions of the form $y = \log_a(x-b)$ are only defined when $(x-b) > 0$.
- To write an equation as one term, change constants to logs using $\log_a a = 1$.
- The square root of an expression produces an answer that is $\pm$.

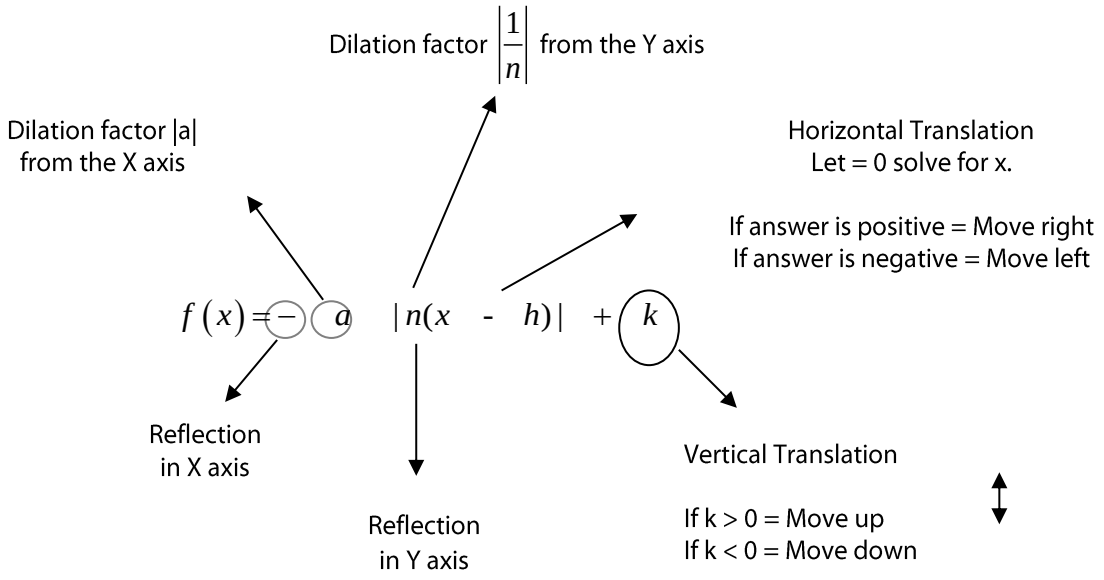
  For example: $(\log_5 x)^2 = 16 \quad \therefore \log_5 x = \pm 4 \quad \therefore x = 5^4$ or $\therefore x = 5^{-4}$

- $(\log_2 3)(\log_2 4) \neq \log_2(3\times 4) \neq \log_2(3+4) \neq \log_2\left(\dfrac{3}{4}\right)$
- $\dfrac{\log_5 27}{\log_5 81} \neq \log_5(27-81) \neq \log_5\left(\dfrac{27}{81}\right)$
- If asked to solve an inequality – proceed using an equality sign. Once solutions have been obtained, sketch a graph and use logic to determine the appropriate answer.
- **Note:**

  When an inequality is multiplied or divided by a negative number, the direction of the inequality must be changed. Remember that the logarithm of a number that lies between 0 and 1 is a negative.

- $\dfrac{\log_a b}{\log_a c} = \dfrac{\log_{10} b}{\log_{10} c} = \dfrac{\log_e b}{\log_e c}$

Transformations Involving the Modulus Function
(from 2016 no longer in Maths Methods but in Specialist Maths)



WATCHOUTS

- The value of k in the equation above **does not** represent the y intercept.
- The graph of $y = \left|(-x)^n\right|$ where n represents an odd positive integer value is the graph of $y = \left|x^n\right|$ that has undergone a reflection in the Y axis.
- If n represents an even positive integer value then the graph of $y = \left|x^n\right|$ has not undergone any reflections to produce the graph of $y = \left|(-x)^n\right|$.

For example:

State the transformations required to produce the graph of $f(x) = 3|5 - 2x| - 1$ from $y = |x|$.

- Dilation of factor $\frac{1}{2}$ from the Y axis and a dilation of factor 3 from the X axis.
- Reflection over the Y axis
- Translation of $\frac{5}{2}$ units in the positive direction along the X axis. Translation of 1 unit in the negative direction along the Y axis.

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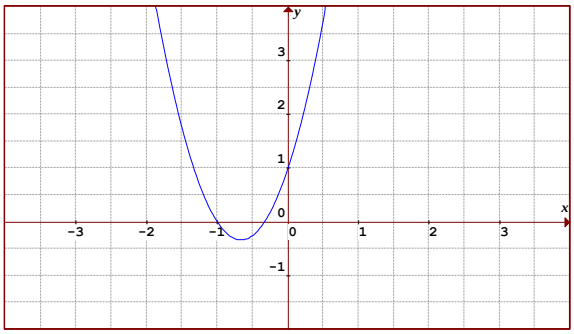
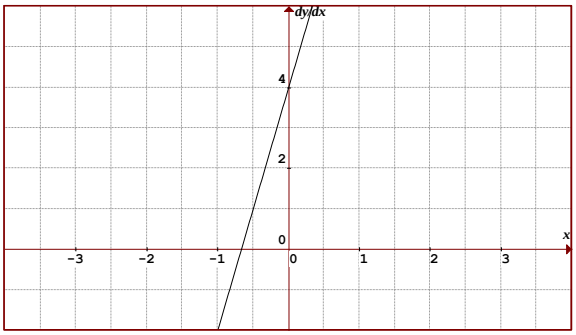
Graphs of the Derivative Function (Maths Methods)

Consider the curve $y = 3x^2 + 4x + 1$ and its derivative function $\frac{dy}{dx} = 6x + 4$.





In the graph of $\frac{dy}{dx}$ against x:

- The regions of the curve above the X axis correspond to the regions on $f(x)$ that display a **positive gradient**.
- The regions of the curve below the X axis correspond to the regions on $f(x)$ that display a **negative gradient**.
- The X intercepts correspond to the **stationary points** on the graph $f(x)$.

Therefore, when sketching the derivative function, it is important to remember the following points:

- Stationary points are plotted along the X axis.
- Regions of $f(x)$ that carry a **positive gradient** are drawn **above** the X axis.
- Regions of $f(x)$ that carry a **negative gradient** are drawn **below** the X axis.
- If the derivative does not exist at a point, use an open circle (o), or an asymptote on the graph of $f'(x)$.

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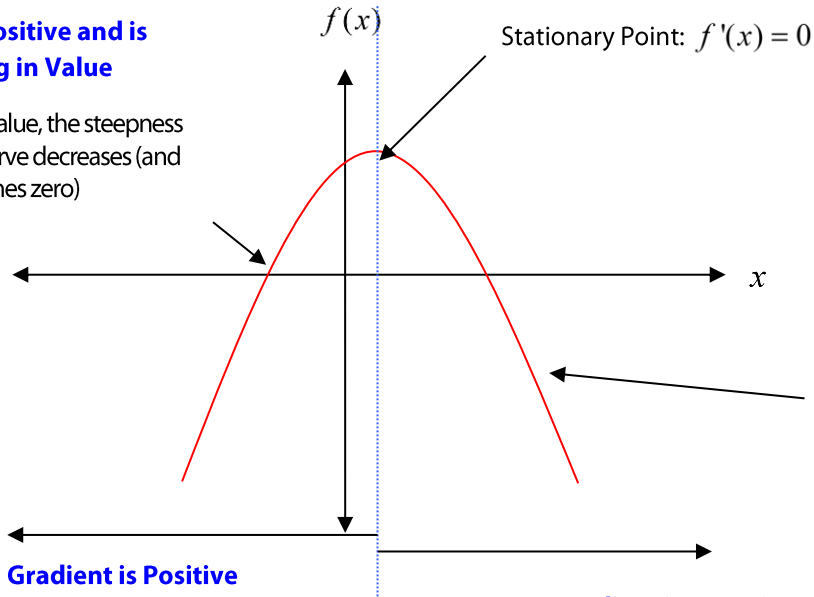
Gradient is Positive and is Decreasing in Value

As x increases in value, the steepness (gradient) of the curve decreases (and approaches zero)



Gradient is Negative and is Increasing in Value

As x increases in value, the steepness (gradient) of the curve increases

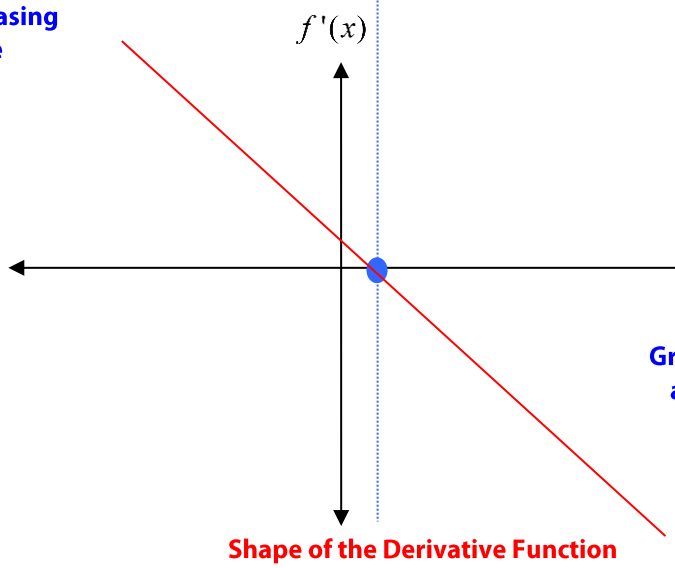
Gradient is Positive

Gradient is Negative

Sketch the corresponding region of $f'(x)$ above the X axis

Sketch the corresponding region of $f'(x)$ below the X axis

Gradient is Positive and is Decreasing in Value



Gradient is Negative and is Increasing in Value

Shape of the Derivative Function

As the graph of $f(x)$ is a negative quadratic function, the derived function is a line with a negative gradient.