Cambridge Assessment International Education

Learner Guide

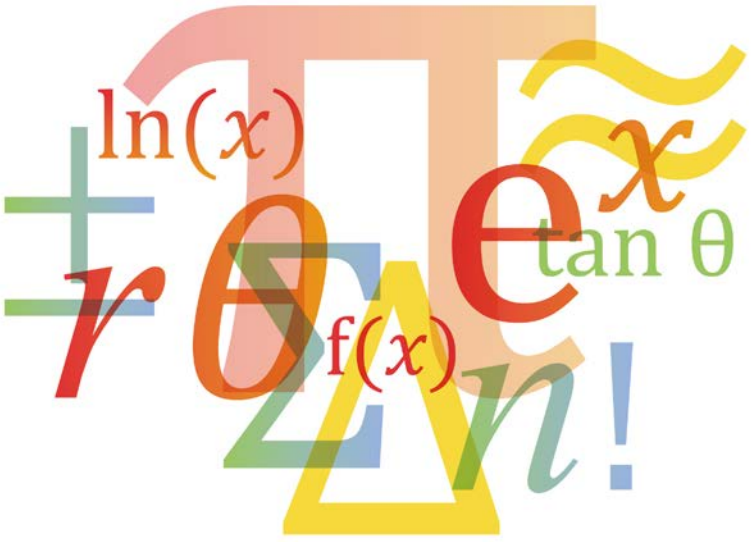
Cambridge IGCSE®

Additional Mathematics 0606

Cambridge O Level

Additional Mathematics 4037

For examination from 2020



Version 1

Cambridge Pathway

In order to help us develop the highest quality resources, we are undertaking a continuous programme of review; not only to measure the success of our resources but also to highlight areas for improvement and to identify new development needs.

We invite you to complete our survey by visiting the website below. Your comments on the quality and relevance of our resources are very important to us.

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www.cambridgeinternational.org/cambridge-for/teachers/teacherconsultants/

Contents

Section 1: About this guide

This guide explains what you need to know about your Cambridge IGCSE (or O Level) Additional Mathematics course and examinations.

It will help you to:

- understand what skills you should develop by taking the course
- understand how you will be assessed
- understand what we are looking for in the answers you write
- plan your revision programme
- revise, by providing revision tips and an interactive revision checklist (Section 7).

The Additional Mathematics course aims to build competency, confidence and fluency in your mathematical understanding and your use of mathematical techniques. You will develop a feel for quantity, patterns and relationships in mathematics. You will also develop your reasoning, problem-solving and analytical skills in a variety of mathematical contexts.

Section 2: Syllabus content – what you need to know about

This section gives you an outline of the syllabus content for this course. Your teacher can give you more detail if you want it.

- Functions
- Quadratic functions
- Equations, inequalities and graphs
- Indices and surds
- Factors of polynomials
- Simultaenous equations
- Logarithmic and expotential functions
- Straight line graphs
- Circular measure
- Trigonometry
- Permutations and combinations
- Series
- Vectors in two dimensions
- Differentiation and integration

When taking this course, it is assumed that you will have already studied IGCSE O Level Mathematics 0580 or a similar qualification.

The syllabus aims below, describe the purposes of this course. They are not listed in order of priority.

- consolidate and extend your mathematical skills and use these in more advanced techniques
- further develop your knowledge of mathematical concepts and principles, and use this knowledge for problem solving
- appreciate the interconnectedness of mathematical knowledge
- acquire a suitable foundation in mathematics for further study in the subject or in mathematics-related subjects
- devise mathematical arguments and use and present them precisely and logically
- integrate information technology (IT) to enhance the mathematical experience
- develop the confidence to apply your mathematical skills and knowledge in appropriate situations
- develop creativity and perseverance in the approach to problem solving
- derive enjoyment and satisfaction from engaging in mathematical pursuits, and gain an appreciation of the elegance and usefulness of mathematics
- provide foundation for AS Level/Higher study.

Make sure you always check the latest syllabus, which is available at www.cambridgeinternational.org

Section 3: How you will be assessed

You will assessed using two written examination papers:

- Paper 1
- Paper 2

You will be tested on any part of the syllabus content in both papers.

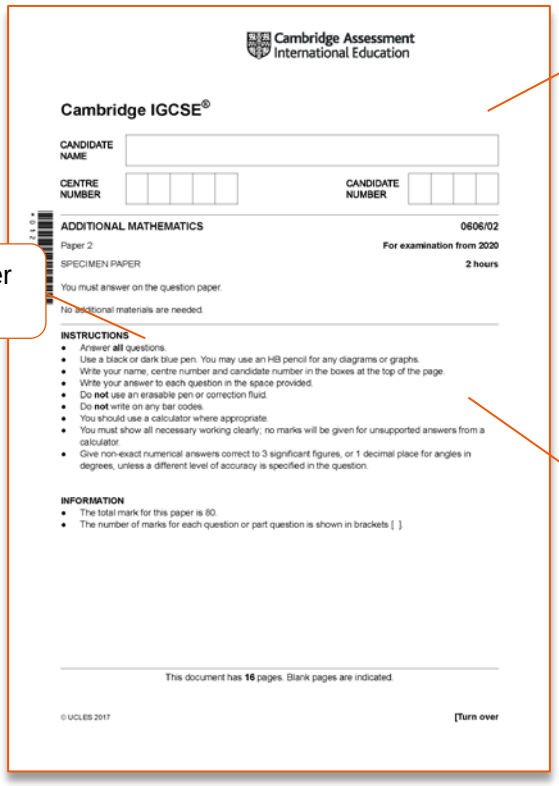
Papers at a glance

The table below gives you further information about the examination papers:

Component	Time and marks	Skills assessed	Details	Percentage of qualification
Paper 1	2 hours 80 marks	Knowledge and understanding of mathematical techniques Application of mathematical techniques	You answer all questions	50%
Paper 2	2 hours 80 marks	Knowledge and understanding of mathematical techniques Application of mathematical techniques	You answer all questions	50%

About each paper

The information below is true for both Paper 1 and Paper 2.



Cambridge Assessment International Education

Cambridge IGCSE®

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

ADDITIONAL MATHEMATICS 0606/02

Paper 2 For examination from 2020

SPECIMEN PAPER 2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Blank pages are indicated.

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There are 80 marks available. Each question will vary in the total number of marks available.

You must answer **all** questions.

Always check the instructions on the front of your exam paper.

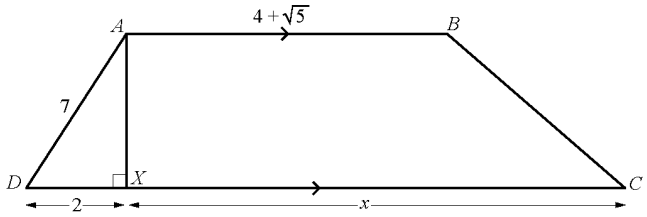
These include important details such as:

- if no accuracy is specified in the question then give your answers correct to 3 significant figures
- if you are dealing with angles in degrees, and an accuracy is not specified in the question, then your answer must be to 1 decimal place.

You will need a scientific calculator.

For some questions you will not be allowed to use it, but the question will always make this clear.

4 DO NOT USE A CALCULATOR IN THIS QUESTION.



The diagram shows a trapezium $ABCD$ in which $AD = 7$ cm and $AB = (4 + \sqrt{5})$ cm. AX is perpendicular to DC with $DX = 2$ cm and $XC = x$ cm.

Given that the area of trapezium $ABCD$ is $15(\sqrt{5} + 2)\text{cm}^2$, obtain an expression for x in the form $a + b\sqrt{5}$, where a and b are integers. [6]

The maximum marks available for a question is given in square brackets.

3 Find the inverse of the matrix $\begin{pmatrix} 4 & 2 \\ 5 & 3 \end{pmatrix}$ and hence solve the simultaneous equations

$4x + 2y - 8 = 0,$
$5x + 3y - 9 = 0.$ [5]

$\frac{1}{(4\times3)-(2\times5)}\begin{pmatrix} 3 & -2 \\ -5 & 4 \end{pmatrix}$

$= \frac{1}{2}\begin{pmatrix} 3 & -2 \\ -5 & 4 \end{pmatrix} = \begin{pmatrix} 3/2 & -1 \\ -5/2 & 2 \end{pmatrix}$

$\begin{pmatrix} 4 & 2 \\ 5 & 3 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 8 \\ 9 \end{pmatrix}$

$\therefore \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 3/2 & -1 \\ -5/2 & 2 \end{pmatrix}\begin{pmatrix} 8 \\ 9 \end{pmatrix}$

$= \begin{pmatrix} 3 \\ -2 \end{pmatrix}$

$\therefore x = 3$ (Ans)
$y = -2$

Answer on the question paper using a black or dark blue pen. You can use a HB pencil for any diagrams or graphs.

You must show **all** necessary working clearly; no marks will be given for answers provided without evidence of how you reached them. Your working allows you to demonstrate that you know the required mathematical methods to get the answer, and shows that you haven't just used a calculator to get the final result.

8 **(a)** Giving your answer in its simplest form, find the exact value of

(i) $\int_{0.2}^{1} e^{5x-1}\,dx,$

Make sure that you are working to the required level of accuracy and give your final answers in the form required. For example, if the answer has to be in 3 significant figures, then intermediate values within your working should show at least 4 significant figures, and only your **final answer** should be rounded to 3 significant figures.

If an exact form is required, you must give the exact answer – often you will not need your calculator when finding an exact form.

Some questions will be structured. This means that the question is split into parts. Often the answers to later parts will depend on the answers to earlier parts, like the eample shown here.

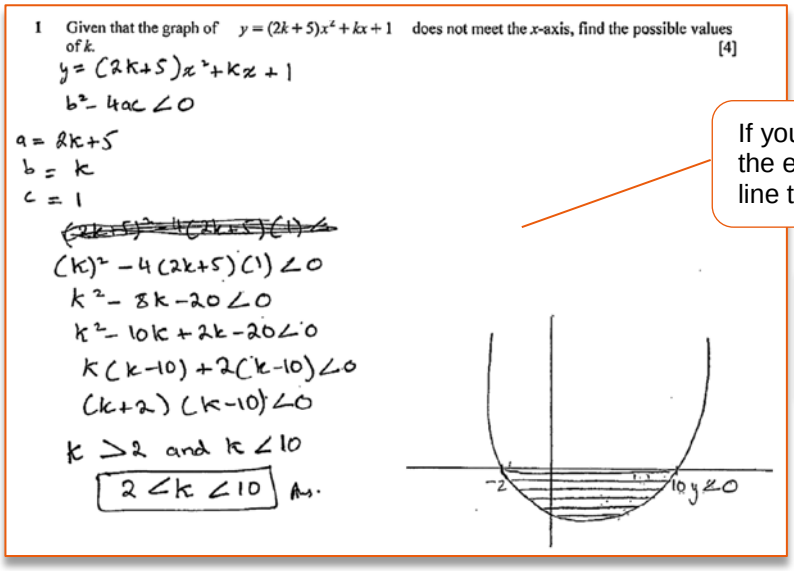
3 **(a)** Express $12x^2 - 6x + 5$ in the form $p(x - q)^2 + r$, where p, q and r are constants to be found. [3]

(b) Hence find the greatest value of $(12x^2 - 6x + 5)^{-1}$ and state the value of x at which this occurs. [2]

Some questions will be unstructured. You will have to use your problem solving skills to decide what steps you need to take in order to answer the question.

1 Solve $xy = 3$,

$x^4y^5 = 486$. [3]



1 Given that the graph of $y = (2k+5)x^2 + kx + 1$ does not meet the x-axis, find the possible values of k. [4]

$y = (2k+5)x^2 + kx + 1$

$b^2 - 4ac < 0$

$a = 2k+5$

$b = k$

$c = 1$

~~$(2k+5)^2 - 4(2k+5)(1) < 0$~~

$(k)^2 - 4(2k+5)(1) < 0$

$k^2 - 8k - 20 < 0$

$k^2 - 10k + 2k - 20 < 0$

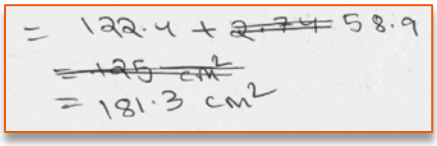
$k(k-10) + 2(k-10) < 0$

$(k+2)(k-10) < 0$

$k > 2$ and $k < 10$

$2 < k < 10$ Ans.

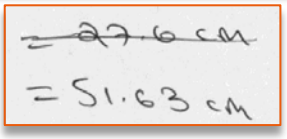
If you make an error and you do not want the examiner to mark it, just put a straight line through all the appropriate work.



$= 122.4 + ~~2.774~~ 58.9$

$= ~~125 \text{ cm}^2~~$

$= 181.3 \text{ cm}^2$



$= ~~27.6 \text{ cm}~~$

$= 51.63 \text{ cm}$

If you run out of room for working on a question, ask for an extra piece of paper which can then be attached to your exam booklet.

Section 4: What skills will be assessed

The areas of knowledge, understanding and skills that you will be assessed on are called **assessment objectives** (AO).

Assessment objectives (AO)		What does the AO mean?
AO1 **Demonstrate knowledge and understanding of mathematical techniques**	You should be able to:	
	• recall and use mathematical manipulative techniques	You need to show that you can remember and use mathematical manipulative techniques, e.g. algebraic simplification; solution of equations.
	• interpret and use mathematical data, symbols and terminology	You need to show that you can decide what given mathematical data means and use it in a correct manner. You need to recognise and understand mathematical symbols and mathematical terminology. For example, the symbols and terms used in the topic of functions; the symbols and terms used in the topic of differentiation and integration.
	• comprehend numerical, algebraic and spatial concepts and relationships	You need to understand the numerical, algebraic and spatial ideas, concepts and relationships, e.g. the relationships between degrees and radians; the different conditions which the value of the discriminant of a quadratic equation can represent.
AO2 **Apply mathematical techniques**	You should be able to:	
	• recognise the appropriate mathematical procedure for a given situation	You need to be able to recognise the appropriate mathematical procedure or method for a given situation or problem, e.g. when to differentiate or integrate when dealing with kinematics problems; dealing with either an arithmetic or geometric progression.
	• formulate problems into mathematical terms and select and apply appropriate techniques	You need to be able to recognise how to put problems into mathematical terms and then select and use appropriate methods to solve these problems, e.g. finding the points of intersection of a normal to a curve with the coordinate axes; obtaining straight-line form equations and finding unknown coefficients.

For this syllabus, AO1 and AO2, both have equal weightings of 50% in both Paper 1 and Paper 2. This means that both papers will test your AO1 and AO2 knowledge, understanding and skills.

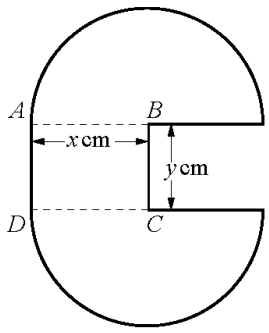
Section 5: Command words

The table below includes command words used in the assessment for this syllabus. The command words are key instruction words that help to indicate what is required of you. The use of the command word will relate to the subject context.

Command word	What it means
Calculate	work out from given facts, figures or information, generally using a calculator
Describe	state the points of a topic/give characteristics and main features
Determine	establish with certainty
Explain	set out purposes or reasons/ make the relationships between things evident/provide why and/or how and support with relevant evidence
Give	produce an answer from a given source or recall/memory
Plot	mark point(s) on a graph
Show (that)	provide structured evidence that leads to a given result
Sketch	make a simple freehand drawing showing the key features
State	express in clear terms
Verify	confirm a given statement/result is true
Work out	calculate from given facts, figures or information with or without the use of a calculator
Write	give an answer in a specific form
Write down	give an answer without significant working

The example below demonstrates one of the command words in context.

7



The diagram shows a badge, made of thin sheet metal, consisting of two semi-circular pieces, centres B and C, each of radius x cm. They are attached to each other by a rectangular piece of thin sheet metal, $ABCD$, such that AB and CD are the radii of the semicircular pieces and $AD = BC = y$ cm.

(a) Given that the area of the badge is $20\,\text{cm}^2$, show that the perimeter, P cm, of the badge is given by $P = 2x + \frac{40}{x}$. [4]

The command word used in part (a) is '**show that**'. The candidate has to show **structured** evidence that leads to the given result.

An examiner would expect to see **each step** in the working that leads to the given answer.

$20 = \pi x^2 + xy$

In this example, you should use the given area first (20 cm^2), and realise that the shape is made up of a circle and a rectangle. This would lead to the expression, $20 = \pi x^2 + xy$. This step gains the first mark.

Re-arranging $20 = \pi x^2 + xy$, $y = \dfrac{20 - \pi x^2}{x}$

Looking at the given answer, *y* does not appear in it so a substitution for *y* must be made somewhere. This step of working will gain a second mark.

Curved part of the perimeter is the circumference of a circle of radius *x*.
The curved length is therefore $2\pi x$
The rest of the perimeter is 2 straight lengths, each of length *y* and 2 straight lengths, each of length *x*.

An examiner would expect to see this sort of reasoning.

So the perimeter $P = 2\pi x + 2x + 2y$

Substituting for *y* gives $P = 2\pi x + 2x + 2\left(\dfrac{20}{x} - \pi x\right)$

This would earn the next mark.

Expanding gives $P = 2\pi x + 2x + \dfrac{40}{x} - 2\pi x$

Simplifying gives $P = 2x + \dfrac{40}{x}$

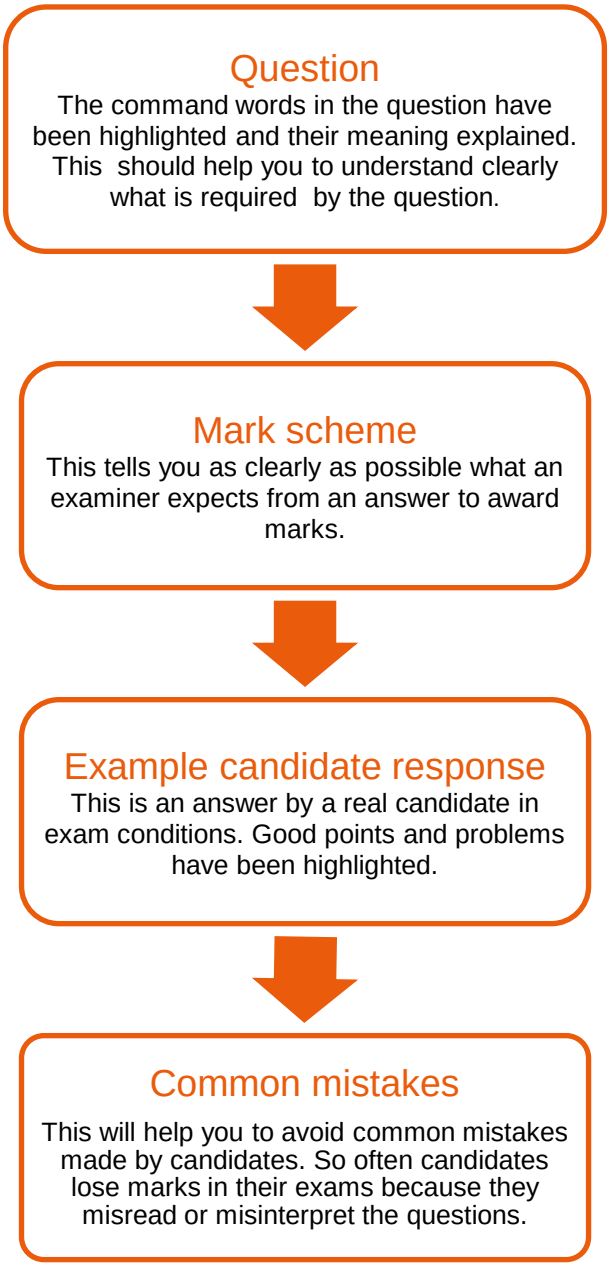
Seeing these final stages, will allow the examiner to award the final mark.

Section 6: Example candidate response

This section takes you through a question and real learner response from a Cambridge IGCSE Additional Mathematics past paper. It will help you to see how to identify command words within questions and to understand what is required in your response. A command word is the part of the question that tells you what you need to do with your knowledge. For example, you might need to describe something, explain something, argue a point of view or list what you know.

All information and advice in this section is specific to the example question and response being demonstrated. It should give you an idea of how your responses might be viewed by an examiner but it is not a list of what to do in all questions. In your own examination, you will need to pay careful attention to what each question is asking you to do.

This section is separated as follows.



Question

The question used in this example is from Paper 1 and is an example of a structured question.

Let's look at what the command words for this question mean for the answer.

8 **(i)** Find $\int (10e^{2x} + e^{-2x})dx$. [2]

Find… is a key instruction. You are expected to integrate each of the two terms with respect to *x* in order to find an indefinite integral.

(ii) Hence find $\int_{-k}^{k} (10e^{2x} + e^{-2x})dx$ in terms of the constant k. [2]

Hence find… is a key instruction. You are expected to make use of your answer to part (i) to make use of the limits given in order to find the value of the definite integral given.

(iii) Given that $\int_{-k}^{k} (10e^{2x} + e^{-2x})dx = -60$, show that $11e^{2k} - 11e^{-2k} + 120 = 0$. [2]

show (that) ... is a command word. You have to provide enough evidence in your work to show that you know how to obtain the given result.

(iv) Using a substitution of $y = e^{2k}$ or otherwise, find the value of k in the form $a \ln b$, where a and b are constants. [3]

Find… is a key instruction. The use of the instruction 'using a …' tells you that you have to use the substitution provided to obtain a quadratic equation, which you then solve. However, it also says 'or otherwise' so in this example you don't have to use the given substitution, you can form and solve a quadratic equation using a different method. You must give your answer in the form given in the question.

Mark scheme

The marks scheme for question 8 is shown below.

Q	Answer	Mark	Explanation
(i)	$5e^{2x} - \frac{1}{2}e^{-2x} \quad (+c)$	B1 B1	There is one mark for each correct term. The arbitrary constant has been put in brackets as it is not needed to obtain a mark. It is not necessary to simplify each term, but it is preferable to do so.
(ii)	$\left(5e^{2k} - \frac{1}{2}e^{-2k}\right) - \left(5e^{-2k} - \frac{1}{2}e^{2k}\right)$	M1 A1	There is a method mark (M1) for the correct use of the limits, provided that integration has taken place, and there are no sign errors. There is an accuracy mark (A1) for a correct statement as it appears in the answer column, or an equivalent correct statement without brackets.
(iii)	$\left(5e^{2k} - \frac{1}{2}e^{-2k}\right) - \left(5e^{-2k} - \frac{1}{2}e^{2k}\right) = -60$ or $\frac{11}{2}e^{2k} - \frac{11}{2}e^{-2k} = -60$ or equivalent leading to $11e^{2k} - 11e^{-2k} + 120 = 0$	B1 DB1	An accuracy mark (B1) is awarded for the correct expression from part (ii) equated to –60. The expression can be unsimplified as shown in the first line, or simplified, as showin in the second line. Any equivalent statements are acceptable. You need to show detailed working here; there has to be evidence of correct simplification leading to this result as the answer is given in the question. This mark cannot be obtained unless the previous B1 has been awarded.
(iv)	$11y^2 + 120y - 11 = 0$ $(11y - 1)(y + 11) = 0$ leading to $k = \frac{1}{2}\ln\frac{1}{11},\ \ln\frac{1}{\sqrt{11}},\ -\ln\sqrt{11},\ -\frac{1}{2}\ln 11$	M1 DM1 A1	There is a method mark for an attempt to use the given substitution, **or otherwise**, to obtain a quadratic equation in y or e^{2k}, and an attempt to solve this quadratic equation to obtain y or e^{2k}. You only need to consider the positive solution. To consider awarding the next 2 marks, the above method mark must have been obtained. There is a dependent method mark (DM1) for an attempt to deal correctly with e in order to get k = … There is an accuracy mark only for any of the 4 equivalent solutions shown here.

The mark scheme provides the final answers for each sub-part of a question and, when appropriate, the required lines of working to reach that answer.

Final answer: This value is what the examiner expects to see. The answer has to be exactly as given in the mark scheme, unless there are acceptable alternatives. In both cases, it will be clearly stated in the mark scheme. Deviations from the final answer might occur, for example, in cases where the question involves making use of a graph such the answer sits within an acceptable 'range', or there might be acceptable deviations in accuracy when measuring or rounding.

Method marks: In some questions, method marks can be awarded for certain parts or lines of the working, as well as for the final answer. This means that you could can get the final answer incorrect but still get some marks for the question if you include the correct working. The mark scheme will often give more than one method and working to reach an answer, but it will not include all possible methods. So, if you use a method not included in the mark scheme but it is accurate and relevant, then the examiner will still award marks for the appropriate parts of the working – unless the questions asks you to use a specific method or implies it by the use of the key term 'hence'.

Example candidate response

Below is a real candidate response from an examination taken one summer. The rounded orange boxes provide an examiner's comments on the candidate's answer, explaining where marks have been awarded and how the answer might have been improved. The candidate was awarded **5 out of 9** marks.

8 (i) Find $\int(10e^{2x}+e^{-2x})dx$. [2]

$= \frac{5\cancel{0}e^{2x}}{\cancel{2}} + \frac{e^{-2x}}{-2}$

$= 5e^{2x} - \frac{e^{-2x}}{2}$

Mark: 2 out of 2

Examiner comment:
The candidate has integrated each term correctly and they are awarded 2 out of 2 marks.

They have used the general result for integration of an exponential term and simplified the fractions and signs later. This approach helped them to avoid making errors with signs and arithmetic.

Note that they did not include an arbitrary constant (+ *c*) to their final answer. Here, this omission has not been penalised because it is not needed in the next part of the question. However, do **not** assume that this will always be the case. It is **good practice** to add '+*c*' to any indefinite integration (i.e. an integration that does not involve limits).

(ii) Hence find $\int_{-k}^{k}(10e^{2x}+e^{-2x})dx$ in terms of the constant k. [2]

$= \left[5e^{2x} - \frac{e^{-2x}}{2}\right]_{-k}^{k}$

$= \left\{5e^{2k} - \frac{e^{-2k}}{2}\right\} - \left(5e^{-2k} + \frac{e^{2k}}{2}\right)$

$= \frac{10e^{2k} - e^{-2k}}{2} - \left\{\frac{10e^{-2k} + e^{2k}}{2}\right.$

Mark: 0 out of 2

Examiner comment:
The candidate has attempted to make use of their answer to part (i). However, there is a sign error in the second bracket – it should read $\left(5e^{-2k} - \frac{e^{2k}}{2}\right)$.

This implies that an incorrect method has been used when substituting in the given limits. So, the candidate scores M0 as the method is not correct and A0 as they do not have the correct final answer.

(iii) Given that $\int_{-k}^{k}(10e^{2x}+e^{-2x})dx = -60$, show that $11e^{2k} - 11e^{-2k} + 120 = 0$. [2]

$= \frac{10e^{2k} - e^{-2k} - 10e^{-2k} + e^{2k}}{2} = -60$

$10e^{\left(\frac{2k}{-2k}\right)} + e^{\left(\frac{2k}{-2k}\right)} = -120$

$11e^{2k} - 11^{-2k} = 2(-60)$

$11e^{2k} - 11^{-2k} + 120 = 0$

$\therefore$ Shown

Mark: 0 out of 2

Examiner comment:
The candidate did not obtain a correct answer for part (ii), so would not have been able to obtain the given result in part (iii) using correct working. The first B1 is for correctly equating the correct expression from (ii) to –60, so this mark cannot be awarded. Incorrect manipulation of the signs of the terms leads to an answer that appears to be correct but does not come from completely correct working, so the candidate cannot score the method mark either. In a 'show that' type question, your working must be detailed and **accurately** show how you reached the given answer.

(iv) Using a substitution of $y = e^{2k}$ or otherwise, find the value of k in the form $a \ln b$, where a and b are constants. [3]

if $y = e^{2k}$,

$11y - \frac{11}{y} + 120 = 0$

$11y + 120 = \frac{11}{y}$

$11y^2 + 120y - 11 = 0$

$11y^2 + 121y - y - 11 = 0$

$11y(y + 11) - 1(y + 11) = 0$

$(y + 11)(11y - 1)$

$y = -11$ or $y = \frac{1}{11}$

$e^{2k} = -11$

∴ not possible

$e^{2k} = \frac{1}{11}$

$\ln e^{2k} = \ln\left(\frac{1}{11}\right)$

$2k = \ln\left(\frac{1}{11}\right)$

$k = \frac{1}{2}\ln\left(\frac{1}{11}\right)$

$a = \frac{1}{2}$, $b = \frac{1}{11}$

Mark: 3 out of 3

Examiner comment:

The candidate makes use of the suggested substitution and with correct algebraic manipulation obtains a 3 term quadratic equation $11y^2 + 120y - 11 = 0$. A correct method of solution is shown in full, with the candidate correctly factorising to obtain the correct solutions $y = -11$ and $y = \frac{1}{11}$. The question requests that the final answer is in a given form ($a \ln b$), so the candidate eliminates the solution $e^{2x} = -11$ then goes on to make use of logarithms and the power law of logarithms to obtain the correct answer.

The candidate scores full marks for this part of the question.

Common mistakes

Common mistakes in questions of this type made by candidates in past examinations include:

- Incorrect integration of the exponential terms, usually errors with signs and also with coefficients of the terms. Omission of the arbitrary constant (+ *c*), although this is not always penalised.
- Sign errors when working out the square bracket notation.
- Substituting the limits in the wrong way round, with the lower limit being substituted in first.
- Not checking previous work to make sure that it is correct before manipulating the signs in the work to arrive at the given answer. Fully correct working throughout, showing each step in the working clearly, is needed to show how you have obtained a given answer.
- Not using the given substitution – sometimes this will cost marks (if you are told to use it specifically), other times it might lead to errors because using the given substitution is generally considered to be the easier option and errors are less likely to occur.
- Not showing sufficient working for the solution of the quadratic equation.
- Leaving the answer in terms of *y* rather than completing the solution for *x*.
- Assuming that an exponential function can be negative.
- Giving the answer as a decimal rather than in the form specified in the question.
- Not using the given answer in a previous part, in this example part (iii) and using an incorrect answer instead. This will not gain any marks. The answer is given in part (iii) so that if a candidate cannot get this answer, they can check their work for errors. If they cannot identify where the errors are, they can still carry on and attempt part (iv).

General advice

- You should always **read the instructions** on the front of the examination paper carefully. In particular, pay attention to the accuracy required when dealing with angles in degrees and angles in radians.
- You should also check that you have actually completed the question by answering in full and in the required form. An incorrect form will not score accuracy marks.
- You should only use calculators to **check** your answers when solving quadratic equations; solution by either factorisation or use of the quadratic formula is expected to be seen as part of the solution of a question. A similar approach may be used for questions involving surds.
- You should be aware of the implication of the word ‘Hence’ in a mathematical context. It is often there to help you with the next step in a question, but is also often there if a particular method of solution is required.
- If you run out of space and need to write your response to a question elsewhere in the question paper or on additional paper, you must make an appropriate comment by the original question to indicate where the solution can be found.
- You need to show full and clear methods to increase your chances of being awarded full marks.
- Sometimes drawing or marking information on a diagram is helpful, and you are encouraged to do this.

- In questions where the answer is given, you are required to show that it is correct and provide fully explained solutions with all method steps shown.
- In questions that require a solution of several steps, clearly structured and logical solutions are more likely to gain credit as they are easier to read and follow.
- Omitting method steps through using a calculator often results missing out on marks for a solution.
- You are encouraged to write down any general formulae you are using as this reduces errors and is likely to improve the accuracy of your solutions.

Section 7: Revision

This advice will help you revise and prepare for the examinations. It is divided into general advice for examinations as a whole, and more specific advice for Paper 1 and Paper 2.

Use the tick boxes ☐ to keep a record of what you have done, what you plan to do or what you understand.

For more advice on revision, see the Cambridge Learner Revision Guide on our website.

General advice

Before the examination

- ☐ Find out when the examinations are and plan your revision so you have time to revise. Create a revision timetable and divide it into sections to cover each topic.
- ☐ Find out how long each paper is, how many questions you have to answer, how many marks there are for each question, and work out how long you have for each question.
- ☐ Know the meaning of the command words used in questions and how to apply them to the information given. Look at past examination papers and highlight the command words and check what they mean.
- ☐ Make revision notes. Try different styles of notes.
- ☐ Make your own dictionary or draw up a glossary of key terms for each section of the syllabus.
- ☐ Practise drawing clear, simple, neat, fully-labelled mathematical diagrams.
- ☐ Work for short periods then have a break. Revise small sections of the syllabus at a time.
- ☐ Test yourself by writing out key points, working through revision exercises from your text books, working through past papers and marking them using the mark schemes.
- ☐ Make sure that you show all the necessary working when practising questions
- ☐ Make sure that your answers are in the correct form when practising questions.
- ☐ Have a look at past questions so that you are clear of what to expect in an examination.
- ☐ Look at mark schemes to help you to understand how the marks are awarded for each question.

In the examination

- Read the instructions carefully and attempt to answer all questions.
- Plan your time according to the marks for each question. For example, a question one mark requires less time and a shorter answer than one worth 5 marks.
- Do not leave out questions or parts of questions. Remember, **no answer means no mark**.
- Read each question very carefully.
  - Identify the command words – you could underline or highlight them.
  - Identify the other key words and perhaps underline them too.
  - Try to put the question into your own words to understand what it is really asking.
- Read all parts of a question before starting your answer. Think carefully about what is needed for each part. You will not need to repeat material.
- Look very carefully at the resource material you are given.
  - Read the title, key, axes of graphs, etc. to find out exactly what it is showing you.
  - Look for dates, scale, and location.
  - Try using coloured pencils or pens to pick out anything that the question asks you about.
- **Answer the question** that is being asked**.** This is very important!
- Use your knowledge and understanding.
- Do not just write all you know, only write what is needed to answer the question.
- Plan your answers. Clear, concise, well-ordered, well-argued, well-supported answers are necessary.
- Annotated diagrams can help you, and be used to support your answer. Use them whenever possible to help you visualise the information given if a diagram is not provided in the question.
- Make sure your writing is clear and easy to read. It is no good writing a brilliant answer if the examiner cannot read it!

Advice for Paper 1 and Paper 2

- Ensure that you have actually answered the question.
- Do not spend too long on a question if you are having problems with it. Go on to answer another question and come back to it later if you have time.
- Make sure that you have given the answer in the required form or to the required level of accuracy.
- Make sure that in ‘show that’ questions you have shown **all** the stages of your working. Do not miss anything out.
- If a question part starts with the word ‘Hence’ it means that you must use your work from the previous part to help answer the question part you are now on.

Advice for Paper 1 and Paper 2

- If a question part starts with the phrase ‘Hence or otherwise’ it means that you can either use your work from the previous part to help answer the question part you are now on (this is usually the easiest option) or use another method.
- If your answer is in degrees make sure you give your answer correct to one decimal place, unless a different degree of accuracy is requested.
- If your answer is in radians make sure you give your answer correct to 3 significant figures, unless a different degree of accuracy is requsted.
- Draw a diagram if necessary to help you visualise a geometric or trigonometric problem.
- Make sure you cross out clearly any work that you do not want marked.
- If you run out of room when answering a question, always ask for extra paper. This will then be attached to your exam paper and marked. Do not try to fit in solutions if you do not have enough space as they are sometimes difficult to read.
- Do not write your answers in pencil first and then go over them in pen as it makes it difficult for examiners to see what you have written.
- If you find you have finished with time to spare, go back through your paper and carefully **check** your answers.

Revision checklists

The revision checklists on the following pages provide the list of content as given in the syllabus. You can use them when you revise to rate your confidence in different areas of the course. The checklists don't contain all the detailed knowledge you need to know, just an overview. For more detail, talk to your teacher.

The table headings are explained below:

Topic	You should be able to	R A G	Comments
These are the topics which are covered in both Paper 1 and Paper 2.	An overviee of the content in the syllabus you need to know.	You can use the tick boxes to show when you have revised an item and how confident you feel about it. R = **RED** means you are really unsure and lack confidence; you might want to focus your revision here and possibly talk to your teacher for help. A = **AMBER** means you are reasonably confident but need some extra practice. G = **GREEN** means you are very confident. As your revision progresses, you can concentrate on the **RED** and **AMBER** items in order to turn them into **GREEN** items. You might find it helpful to highlight each topic in red, orange or green to help you prioritise.	In this space, you can: • add further information of your own, for example topics from IGCSE Mathematics that you need to look at again as it is assumed knowledge for Additional Mathematics. • add learning aids, such as rhymes, poems or word play • pinpoint areas of difficulty you need to check further with your teacher or textbooks • include reference to a useful resource or revision website.

Note: the tables below cannot contain absolutely everything you need to know, but it does use examples wherever it can. You can tick boxes and write in the comments column directly on the PDF, or you can print the file first.

Topic	You should be able to	R	A	G	Comments
Functions	• understand the terms: function, domain, range (image set), one-one function, inverse function & composition of functions				
	• use the notation $\mathrm{f}(x)=\sin x,\ \mathrm{f}:x\to\lg x,\ (x>0),\mathrm{f}^{-1}(x)$ and $\mathrm{f}^2(x)\ \left[=\mathrm{f}(\mathrm{f}(x))\right]$				
	• understand the relationship between $y=\mathrm{f}(x)$ and $y=\lvert\mathrm{f}(x)\rvert$, where $\mathrm{f}(x)$ may be linear, quadratic or trigonometric				
	• explain in words why a given function is a function or why it does not have an inverse				
	• find the inverse of a one-one function and form composite functions				
	• use sketch graphs to show the relationship between a function and its inverse				
General notes					

Topic	You should be able to	R	A	G	Comments
Quadratic functions	• find the maximum or minimum value of the quadratic function $f: x \to ax^2 + bx + c$ by any method	☐	☐	☐	
	• use the maximum or minimum value of $f(x)$ to sketch the graph or determine the range for a given domain	☐	☐	☐	
	• know the conditions for $f(x) = 0$ to have: (i) two real roots, (ii) two equal roots, (iii) no real roots and the related conditions for a given line to (i) intersect a given curve, (ii) be a tangent to a given curve, (iii) not intersect a given curve	☐	☐	☐	
	• solve quadratic equations for real roots and find the solution set for quadratic inequalities	☐	☐	☐	
General notes:					

Topic	You should be able to	R	A	G	Comments
3 Equations, inequalities and graphs	• solve graphically or algebraically equations of the type $\lvert ax+b\rvert = c \quad (c \geq 0)$ and $\lvert ax+b\rvert = (cx+d)$	☐	☐	☐	
	• solve graphically or algebraically inequalities of the type $\lvert ax+b\rvert > c \quad (c \geq 0)$, $\lvert ax+b\rvert \leq c \quad (c > 0)$ and $\lvert ax+b\rvert \leq (cx+d)$	☐	☐	☐	
	• use substitution to form and solve a quadratic equation in order to solve a related equation	☐	☐	☐	
	• sketch the graphs of cubic polynomials and their moduli, when given in factorised form $y = k(x-a)(x-b)(x-c)$	☐	☐	☐	
	• solve cubic inequalities in the form $k(x-a)(x-b)(x-c) \leq d$ graphically	☐	☐	☐	
General notes:					

Topic	You should be able to	R	A	G	Comments
4 Indices and surds	• perform simple operations with indices and with surds, including rationalising the denominator	☐	☐	☐	
General notes:					
5 Factors of polynomials	• know and use the remainder and factor theorems	☐	☐	☐	
	• find factors of polynomials	☐	☐	☐	
	• solve cubic equations	☐	☐	☐	
General notes:					

Topic	You should be able to	R	A	G	Comments
6 Simultaneous equations	• solve simple simultaneous equations in two unknowns by elimination or substitution				
General notes:					
7 Logarithmic and exponential functions	• know simple properties and graphs of the logarithmic and exponential functions including $\ln x$ and e^x (series expansions are not required) and graphs of $k\mathrm{e}^{nx}+a$ and $k\ln(ax+b)$ where n, k, a and b are integers				
	• know and use the laws of logarithms (including change of base of logarithms)				
	• solve equations of the type $a^x=b$				
General notes:					

Topic	You should be able to	R	A	G	Comments
8 Straight line graphs	• interpret the equation of a straight line graph in the form $y = mx + c$	☐	☐	☐	
	• transform given relationships, including $y = ax^n$ and $y = Ab^x$, to straight line form and hence determine unknown constants by calculating the gradient or intercept of the transformed graph	☐	☐	☐	
	• solve questions involving mid-point and length of a line	☐	☐	☐	
	• know and use the condition for two lines to be parallel or perpendicular, including finding the equation of perpendicular bisectors	☐	☐	☐	
General notes:					
9 Circular measure	• solve problems involving the arc length and sector area of a circle, including knowledge and use of radian measure	☐	☐	☐	
General notes:					

Topic	You should be able to	R	A	G	Comments
10 Trigonometry	• know the six trigonometric functions of angles of any magnitude (sine, cosine, tangent, secant, cosecant, cotangent)	☐	☐	☐	
	• understand the amplitude and periodicity and the relationship between graphs of related trigonometric functions, e.g. $\sin x$ and $\sin 2x$	☐	☐	☐	
	• draw and use the graphs of $y = a\sin bx + c$; $y = a\cos bx + c$; $y = a\tan bx + c$ where a is a positive integer, b is a simple fraction or integer (fractions will have a denominator of 2, 3, 4, 6 or 8 only) and c is an integer	☐	☐	☐	
	• use the relationships $\sin^2 A + \cos^2 A = 1$; $\sec^2 A = 1 + \tan^2 A$; $\operatorname{cosec}^2 A = 1 + \cot^2 A$ $\frac{\sin A}{\cos A} = \tan A$; $\frac{\cos A}{\sin A} = \cot A$	☐	☐	☐	
	• solve simple trigonometric equations involving the six trigonometric functions and the above relationships (not including general solution of trigonometric equations)	☐	☐	☐	
	• prove simple trigonometric identities	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
General notes:					
11 Permutations and combinations	• recognise and distinguish between a permutation case and a combination case	☐	☐	☐	
	• know and use the notation $n!$ (with $0!=1$), and the expressions for permutations and combinations of *n* items taken *r* at a time	☐	☐	☐	
	• answer simple problems on arrangement and selection (cases with repetition of objects, or with objects arranged in a circle, or involving both permutations and combinations, are excluded)	☐	☐	☐	
General notes:					

Topic	You should be able to	R	A	G	Comments
12 Series	• use the Binomial Theorem for expansion of $(a+b)^n$ for positive integer n				
	• use the general term $\binom{n}{r}a^{n-r}b^r$, $0 \le r \le n$ (knowledge of the greatest term and properties of the coefficients is not required)				
	• recognise arithmetic and geometric progressions				
	• use the formulae for the *n*th term and for the sum of the first *n* terms to solve problems involving arithmetic and geometric progressions				
	• use the condition for the convergence of a geometric progression, and the formula for the sum to infinity of a convergent geometric progression				

General notes:

Topic	You should be able to	R	A	G	Comments
13 Vectors in two dimensions	• use vectors in any form, e.g. $\begin{pmatrix} a \\ b \end{pmatrix}$, $\overrightarrow{AB}$, $\mathbf{p}$, $a\mathbf{i} - b\mathbf{j}$	☐	☐	☐	
	• know and use position vectors and unit vectors	☐	☐	☐	
	• find the magnitude of a vector; add and subtract vectors and mulitply vectors by scalars	☐	☐	☐	
	• compose and resolve velocities	☐	☐	☐	
General notes:					

Topic	You should be able to	R	A	G	Comments
14 Differentiation and integration	• understand the idea of a derived function	☐	☐	☐	
	• use the notations $f'(x)$, $f''(x)$, $\frac{dy}{dx}$, $\frac{d^2y}{dx^2}$ $\left[=\frac{d}{dx}\left(\frac{dy}{dx}\right)\right]$	☐	☐	☐	
	• use the derivatives of the standard functions x^n (for any rational n), $\sin x$, $\cos x$, $\tan x$, e^x, $\ln x$, together with constant multiples, sums and composite functions of these	☐	☐	☐	
	• differentiate products and quotients of functions	☐	☐	☐	
	• apply differentiation to gradients, tangents and normals, stationary points, connetced rates of change, small increments and approximations and practical maxima and minima problems	☐	☐	☐	
	• use the first and second derivative tests to discriminate between maxima and minima	☐	☐	☐	
	• understand integration as the reverse process of differentiation	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
	• integrate sums of terms in powers of x including $\frac{1}{x}$ and $\frac{1}{ax+b}$	☐	☐	☐	
	• integrate functions of the form $(ax+b)^n$ for any rational n, $\sin(ax+b)$, $\cos(ax+b)$, e^{ax+b}	☐	☐	☐	
	• evaluate definite integrals and apply integration to the evaluation of plane areas	☐	☐	☐	
	• apply differentiation and integration to kinematics problems that involve displacement, velocity and acceleration of a particle moving in a straight line with variable or constant acceleration, and the use of $x-t$ and $v-t$ graphs	☐	☐	☐	
General notes:					

Section 8: Useful websites

The websites listed below are useful resources to help you study for your Cambridge IGCSE / O Level Additional Mathematics course.

https://undergroundmathematics.org/
This site is explicitly to support the UK A Level maths curriculum, but many of these topics are common to the Additional Mathematics syllabus.

www.bbc.co.uk/education/levels
You'll need to navigate to the 'Higher Level' Mathematics. You will be able to identify the areas that are common to the Additional Mathematics syllabus.

http://www.plus.maths.org/
A free on-line mathematics magazine for ages 15 and over. It includes articles from top mathematicians and science writers, mathematical news and careers information.

www.mathletics.co.uk
Online mathematics instruction for those topics you may have difficulty with.

www.mathsmadeeasy.co.uk
Lots of revision resources.

www.padowan.dk
This is a graph plotter that you could use to check out graphs of all types. You can revise your trigonometric graph sketching using this as a check.

http://betterexplained.com/
There's always a better way to understand an idea. This site includes explanations that helped the writer, hoping they'll help you too.

https://www.geogebra.org
Dynamic mathematics and science for learning at all levels. This is interactive geometry, algebra, statistics, and calculus software.

http://www.khanacademy.org/
A log in must be created. Khan Academy's materials and resources are available to you completely free of charge. Also available as an app. This will cover all aspects of the syllabus.

https://www.mathplanet.com/
Math planet is an online community where you can study mathematics for free. All material is focused on US high school mathematics but since mathematics is the same all over the world everybodyis welcome to study maths – it is all for free.

http://www.mathsisfun.com/
Maths Is Fun specialises in offering clear explanations of mathematical concepts. The language used is straightforward and is especially suited to those whose first language may not be English. The materials are organised by topic making the site easy to navigate. Each page is set out logically with clear explanations and examples. Questions are included that allow you to check your understanding. The site is free to use and also offers puzzles, games, quizzes, worksheets and a forum.

http://www.mrbartonmaths.com/
The aim of this website is to get everybody enjoying their maths a bit more. If you are a learner looking for a different way to understand a topic then hopefully mrbartonmaths.com will have something for you!

http://www.purplemath.com/
Purplemath's algebra lessons are written with the learner in mind. These lessons emphasize the practicalities rather than the technicalities, demonstrating dependable techniques, and pointing out common mistakes. The lessons are cross-referenced to help you find related material, and a 'search' box is on every page to help you find what you're looking for.

http://www.s-cool.co.uk/a-level/maths
A revision website, also available as an app. A log in must be created. A lot of the Additional Mathematics is covered in A Level Maths, so many of these topics will be useful.

http://www.sosmath.com/
S.O.S. MATHematics is a free resource for mathematics revision material

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