



Guidelines for Reading Mathematics

The STEMReader Project has created guidance for reading mathematics aloud, either by human, or screenreader technology.

v0.2

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Table of Contents:

- [Guidelines for Reading Mathematics](#)
- [Consultation on Guidelines for reading aloud maths notation \(UK, Level 2 maths\)](#).
- [Background](#)
- [Introduction](#)
- [Numbers](#)
- [Expressions / Operations](#)
- [Formula sheet](#)
- [Sources](#)
- [Footnotes](#)

Consultation on Guidelines for reading aloud maths notation (UK, Level 2 maths).

This document is intended for the purpose of seeking views from stakeholders on the appropriateness and suitability of these guidelines for use with the UK educational community. We welcome comments, proposed amendments and additional rules and examples by email to info@stemreader.org.uk.

If you would prefer to read this document in Microsoft Word, it is available here: [Guidance \(docx\)](#).

September 2015:	Pilot consultation seeking feedback from experts who use technology to teach maths or to support print impaired learners. Comments compiled in Section 6.
October - November 2015:	Feedback sought from the wider educational, disability and assessment community.

January 2016	Intended publication of the final draft of guidelines.
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Background

These guidelines are being developed as part of the [STEMReader](#) project to develop technology to read aloud maths notation. The STEMReader project is led by [ECS Partners](#), a subsidiary of the [University of Southampton](#), and was made possible by funding from the [Department of Business Innovation and Skills](#) and [Innovate UK project](#) (administered by the [Higher Education Academy](#)).

The views expressed in this publication are those of the author(s) and not necessarily those of the University of Southampton, the Department of Business Innovation and Skills, Innovate UK or the Higher Education Academy.

1. Introduction

There is no definitive way to read aloud maths notation. Over time educators, mathematicians and students often develop their own shorthand approach to vocalising maths, particular as the maths they encounter becomes more complex. Also English-speaking countries have local variations in maths notation and name given to symbols.

These rules have been collated to follow the common usage within the UK education system and have been designed primarily as an aid for those supporting learners trying to achieve Level 2 Maths qualifications (or National 5 in Scotland). The guidelines have been developed with these assessment criteria in mind and have been selected to be the appropriate manner to read notation within assessment situations without impacting the questions being asked of the candidate.

The examples within these guidelines are based upon questions from maths papers published by English, Welsh and Scottish awarding organisations. It is intended that they can be used as a guide for individuals reading aloud materials to the learner as well as a guide for computer programmers and typesetters interested in creating accessible materials or assistive technologies.

In these guidelines the term "learner" is used to describe an individual who is wishing to listen to the maths notation. This is used as a generic term. It could refer to a candidate in an exam, a learner in the classroom, a student studying at college or someone outside education wishing to read materials containing maths notation.

1.1. Maths semantics and typesetting

Mathematical notation is a visual shorthand for concepts, operations and expressions that can take many words to vocalise. Furthermore, mathematics relies on spatial layout to convey meaning.

For example, $2^{\frac{1}{2}}$ is not the same as $2\frac{1}{2}$.

If the learner is using a computer to read aloud maths it is important that these semantics are communicated accurately to them as they cannot see or read the expression or have problems accurately understanding the notation. In order to do so the maths must be typeset correctly so that computer can "see" the mathematical semantics. The STEMReader website provides links to guidance on how to create accessible maths resources and publications [not yet published].

1.2. Concise verses Verbose options

Once you start to read maths aloud, you quickly discover that what seems like simple notation results in a long stream of text. For example,

$$\text{Solve the equation } \frac{3x+2}{x-1} + 3 = 4$$

must be read as "solve the equation Start Fraction 3 x plus 2 Over x minus 1 End Fraction plus 3 equals 4" to ensure that there is no ambiguity in what is contained in the numerator and denominator of the fraction.

Such an extended reading of the equation is necessary for someone who is unable to see the equation and needs clear guidance on where they are within the equation. However, processing the additional words (within the equation) adds to the cognitive load for the reader which, in turn, may impact their ability to undertake the mathematical operation ¹.

Often a person would use pauses, stresses and variations in tone (known as prosody) to communicate groupings and semantics within maths notation. For readers with some sight, it is possible to read this notation in a more concise fashion as they are able to track the notation on screen.

Research suggests that the reduced cognitive load of processing less text outweighs the potential ambiguity of not vocalising all structures. A concise reading of the example above would be as "solve the equation 3 x plus 2, Over, x minus 1, plus 3, equals, 4" where commas have been inserted to indicate places to pause.

Within this guide we will list the concise reading of notation as the default. More extended or "Verbose" approaches will be included as optional where appropriate. Currently, prosody of how to read the notation is not specified but we plan to include this in the future.

1.3. Text to speech voice variations

When using a computer to read aloud text or maths notation, it is up to the learner to select the voice they wish the computer to read with. This is often a personal choice based on the accent, gender and clarity of the voice. Each voice manufacturer uses different language models which can particularly affect how they read aloud numbers and symbols (for example recognising that numbers starting with 0 or + are likely to be a phone number and should be read as individual digits).

In this document we have focussed on how text, numbers and symbols are read aloud by the Cereproc voices Jack and Jess (English accents) and Heather and Stuart (Scottish accents) as these voices are made available free of charge to some educational organisations.

Where alternative ways of reading maths notation are available, footnotes are used to explain the option selected for this guidance.

2. Numbers

2.1. Whole Numbers

In most instances, numbers will be presented within text, and how they are read is defined by the language model of the TTS voice. Use of commas and spaces within numbers can affect how it will be read aloud. Therefore care should be taken with the spacing of numbers.

2.2. Negative/positive numbers

Where a plus or minus symbol is used to indicate the number is positive or negative, for the + symbol read "positive", for the – symbol read "negative"².

Unicode	Symbol	Read as	Definition
0002B	+	Positive	The plus sign before a number is used to show it is a positive number, that is, a number with a value greater than zero
0002D	-	Negative	The minus sign before a number is used to show it is a negative number, that is, a number with a value less than zero

Example

One day has a maximum temperature of $+4^{\circ}\text{C}$ and a minimum temperature of -3°C . Calculate the temperature range for the day.

positive 4 degrees C

negative 3 degrees C

2.3. Fractions

Fractions are presented graphically with a numerator above a denominator, separated by a horizontal (or occasionally sloping line). When reading aloud a fraction, it is important that the listener understands what is contained within the numerator and denominator. In semantic mathematical mark-up, the fraction object is captured through the defining the contents of the numerator and denominator. The separator between them is purely a graphical representation and how it is drawn does not alter the structure of the fraction.

2.3.1. Simple Fractions

For a simple fraction, where the numerator is a single variable or number, read as [numerator] over [denominator].

Example

Write $\frac{5}{25}$ as a decimal

5 over 25

Example

Write $\frac{25}{5}$ as a decimal

25 over 5

2.3.2. Common Fractions

$\frac{1}{2}$ should always be read as one half.

If the denominator is between 2 and 10 then it may be read in its colloquial form:

Fraction	Transcription
$\frac{1}{3}$ $\frac{2}{3}$	one third, two thirds

Fraction	Transcription
$\frac{1}{4}$ $\frac{2}{4}$ $\frac{3}{4}$	one quarter, two quarters, three quarters
$\frac{1}{5}$ $\frac{2}{5}$ $\frac{3}{5}$ $\frac{4}{5}$	one fifth, two fifths, three fifths, four fifths
$\frac{1}{6}$ $\frac{2}{6}$ $\frac{3}{6}$ $\frac{4}{6}$ $\frac{5}{6}$	one sixth, two sixths, three sixths, four sixths, five sixths
$\frac{1}{7}$ $\frac{2}{7}$ $\frac{3}{7}$ $\frac{4}{7}$ $\frac{5}{7}$ $\frac{6}{7}$	one seventh, two sevenths, three sevenths, four sevenths, five sevenths, six sevenths
$\frac{1}{8}$ $\frac{2}{8}$ $\frac{3}{8}$ $\frac{4}{8}$ $\frac{5}{8}$ $\frac{6}{8}$ $\frac{7}{8}$	one eighth, two eighths, three eighths, four eighths, five eighths, six eighths, seven eighths
$\frac{1}{9}$ $\frac{2}{9}$ $\frac{3}{9}$ $\frac{4}{9}$ $\frac{5}{9}$ $\frac{6}{9}$ $\frac{7}{9}$ $\frac{8}{9}$ $\frac{9}{9}$	one ninth, two ninths, three ninths, four ninths, five ninths, six ninths, seven ninths, eight ninths
$\frac{1}{10}$ $\frac{2}{10}$ $\frac{3}{10}$ $\frac{4}{10}$ $\frac{5}{10}$ $\frac{6}{10}$ $\frac{7}{10}$ $\frac{8}{10}$ $\frac{9}{10}$	one tenth, two tenths, three tenths, four tenths, five tenths, six tenths, seven tenths, eight tenths, nine tenths

Example

Work out $\frac{1}{7} \times \frac{2}{3}$

one seventh times two thirds

Example

Circle the fractions in the list which are equivalent to $\frac{3}{4}$

- $\frac{33}{44}$
- $\frac{4}{7}$
- $\frac{9}{12}$
- $\frac{13}{14}$

33 over 44
 four sevenths
 9 over 12
 13 over 14

2.3.3. Fractions with Multiple Terms

Where a fraction is complex (for example when the numerator or denominator contains an operation, exponent or more than one number), it is important that a user with reduced or no sight is able to separate out the numerator from the denominator. Therefore both a concise and verbose option are provided.

Concise:

complex fractions should be read as [numerator] all over [denominator]

Verbose:

complex fractions should be read as start fraction [numerator] all over [denominator] end fraction

Example

Simplify $\frac{x^2+5}{x+2}$

Concise: x squared + 5 all over x + 2

Verbose: start fraction x squared + 5 all over x + 2 end fraction

2.3.4. Mixed numbers

Where a number is written as a whole number and a fraction, insert "and" between the number and the fraction and read the fraction according to the rules detailed above.

Example

Write $3\frac{2}{5}$ **as a decimal**

3 and two fifths

Example

Write $3\frac{2}{15}$ **as a decimal**

3 and two over fifteen

Example

Calculate $2\frac{1}{4} \div \frac{3}{5}$

two and one quarter divided by three fifths

2.4. Decimal points

A decimal point should be read as "point". Numbers following a decimal point should be read as individual digits. Ensure "0" is spoken as zero not "oh". Spaces may be used within long decimal numbers to group digits. These should be represented as a short pause when reading aloud the number, but it can also impact how it is spoken by the computer and should be used with caution. The language model of the TTS voice will impact how digits are read aloud so consider writing digits as words if you wish to ensure a number is spoken correctly.

Example

3.14

three point one four

Example

0.125

zero point one two five

Example

0.000 125

zero point zero zero zero, one two five

2.4.1. Recurring Decimal points

In the UK, a recurring or repeated decimal is usually denoted by a dot above the digit. It should be noted that different notation is used to denote a recurring/repeating decimal in different countries.

Example

Write $0.\dot{2}\dot{4}$ as a fraction in its lowest terms

zero point two with dot over, four with dot over

3. Expressions / Operations

3.1. Equal Sign

Unicode	Symbol	Read as	Definition
0003D	=	Equals	The number or expression to the left has the same value as the number or expression to the right.

Example

$$a = 2$$

a equals 2

3.2. Addition

When the + symbol appears as an operator between two variables or numbers then it should be read as "plus" .³

Unicode	Symbol	Read as	Definition
0002B	+	Plus	The plus sign denotes addition. Addition of two whole numbers is the total amount of those quantities combined.

Example

Work out $436 + 217$

436 plus 217

3.3. Subtraction

When the - symbol appears as an operator between two variables or numbers then it should be read as "minus".⁴

Unicode	Symbol	Read as	Definition
0002D	-	Minus	The minus sign denotes subtraction. Subtraction represents removing object from a collection. The result of a subtraction is the remainder of the first operand once the value of the second operand is removed.

Example

Calculate $15 - 23$

15 minus 23

3.4. Plus or Minus

When a plus sign on top of a minus sign appears between two variables or numbers then it should be read as "plus or minus".

Unicode	Symbol	Read as	Definition
000B1	±	Plus or minus	The number or expression to the right of the symbol has both a positive and negative value. These two values are equal in absolute value.

Example

Calculate 3 ± 5

Three plus or minus five

3.5. Multiplication

3.5.1. Explicit multiplication sign

Where the multiplication sign \times appears as an operator between two variables or numbers then it should be read aloud as "times"⁵.

Example

Calculate 26×19

26 times 19

Example

If the area of the rectangle equals $l \times w$

l times w

3.5.2. Implicit multiplication

Where two variables or a variable and operator are displayed consecutively as an implicit multiplication, the multiplication should not be read aloud.

Example

Find the value of $3a + 2b$

Three a plus two b

Example

If $3y + 5x = 10$

Three y plus five x equals ten

3.6. Division

Where the division sign \div appears as an operator between two variables or numbers then it should be read aloud as "divided by". It should be noted that division should not be typeset with a slash (e.g. $7/3$). As this will be read aloud as slash, it is not possible to semantically determine if this is being used as a division operator.

Example

Work out $110 \div 4$ exactly

110 divided by 4

3.7. Brackets representing a multiplier or grouping an expression

Brackets can take different forms. The most common are round brackets or parentheses ($()$). It is usual within the UK education system to refer to these as brackets. Brackets can be used to denote a number of mathematical functions. If the maths elements are typeset correctly in MathML or a similar semantic notation, it may be possible for a computer reader to detect which type of function the bracket is representing.

When a bracket is used to group an expression or to represent an implicit multiplication then the brackets should be read aloud as "open bracket"..."close bracket". Where there is a sequence of brackets, it can be useful to pause between the "close bracket" and following "open bracket" to signify they are separate expressions.⁶

Example

Work out $3 - (5 - 2)$

3 minus open bracket 5 minus 2 close bracket

Example

Simplify $3(x + 2) + 5x$

3 open bracket $x + 2$ close bracket + 5 x

Example

Expand and simplify $(y - 2)(y - 5)$

open bracket y minus 2 close bracket, open bracket y minus 5 close bracket

3.7.1. Other forms of brackets

If other forms of brackets are used, they should be read as above but substituting the correct form of bracket:

Unicode left	Unicode right	Symbol	Read as	Notes
0005B	0005D	[...]	Left square bracket, Right square bracket	If used to denote a matrix then read as per guidance on matrices.
0007B	0007D	{...}	Left curly bracket, Right curly bracket	While "brace" is mathematical correct, it is easily confused with bracket by the listener. If used to denote a set of numbers or system of equation then read as per the guidance for this notation.
27E8 or 3008	27E9 or 3009	⟨...⟩	Left angle bracket, Right angle bracket	These should not be read as less than and greater signs, although their Unicode/entities are often used to typeset angle brackets. Due to this confusion they should be avoided unless absolutely necessary.

3.8. Mathematical Exponents

When a mathematical exponent is written as a superscript number or variable then this should be read as "to the power of". If possible pause at the end of the superscript variable, operator or expression to indicate it has finished ⁷.

Where the exponent is of value 2 this may be read as "squared" ⁸ followed by a pause.

Verbose transcription: where the reader may be unable to distinguish when an exponent has finished, then read aloud "end power" after the exponent, unless the exponent is of the value of 2 when a pause should be used to indicate the end of the root.

Example

Calculate $(5 \times 10^3) \div (2 \times 10^{-2})$

Concise: open bracket 5 times 10 to the power of 3 close bracket, divided by, open bracket 2 times 10 to the power of negative 2 close bracket

Verbose: open bracket 5 times 10 to the power of 3 end power close bracket divided by, open bracket 2 times 10 to the power of negative 2 end power close bracket

Example

Evaluate $\left(\frac{7^3 \times 7^3}{7^{10}}\right)^{-1}$

Concise: Open bracket 7 to the power of 3, times 7 to the power of 5, all over 7 to the power of 10, close bracket to the power of negative 1.

Verbose: Open bracket start fraction 7 to the power of 3 end power, times 7 to the power of 5 end power, all over 7 to the power of 10 end power, end fraction, close bracket to the power of negative 1 end power.

Example

For $x = 5$, **solve** $x^2 + 3$

For x equals 5, solve x squared, plus 3

Example

Find the value of $2x^2$ **when** $x = 3$

Find the value of 2 x squared, when x equals 3

3.9. Variables/Letters

When an expression includes a variable represented by a symbol other than a number, read aloud the name of the letter or character as defined within the notation dictionary. Read lowercase variables in a math item without referring to case. If uppercase variables are used in a math item, then read "Capital" before the variable.

Example

Where $y + Y = 1$ show that

Where y plus capital y equals 1

Example

Factorise fully $3a^3b + 12a^2b^2 + 9a^5b^3$

3 a to the power of 3 b + 12 a squared b squared + 9 a to the power of 5 b to the power of 3

Example

when $\theta = 30^\circ$

when theta equals 30 degrees.

3.10. Subscripts

Where a variable, operator or expression is displayed as a subscript, then precede this with "subscript". If possible pause at the end of the subscript variable, operator or expression to indicate it has finished. It may be possible to shorten "subscript" to "sub" if the reader is aware of this contraction.

Verbose transcription: where the reader may be unable to distinguish when the subscript has finished, then read aloud "end subscript" after the exponent.

Example

Given that $u_n = 5u_{n-1} + 1$

Concise: u subscript n equals 5 u subscript n minus 1, plus 1

Verbose: u subscript n end subscript equals 5 u subscript n minus 1 end subscript, plus 1

3.11. Square roots, Radicals and Surds

Where a root is not preceded by an index, it is assumed to have an implied index of 2 and notate a square root. This should be read aloud as "square root of" followed by the expression shown within the radical symbol.

Where a root is preceded by an index of 3 this should be read aloud as "cubed root of" followed by the expression shown within the radical symbol.

For a root with an index with a number greater than 3, the expressions should be read starting with the index as "xth root of". If the radical index is a variable then it should be read as "x root of y".

Verbose transcription: where the reader may be unable to distinguish when the index and root has finished, then read aloud "Index" prior to the root index and end root after the variable.

Example

Work out the value of $(\sqrt{2} + \sqrt{8})^2$

Concise: open bracket square root of 2 plus square root of 8 close bracket, squared.

Verbose: open bracket square root of 2 end root, plus square root of 8 end root, close bracket, squared.

Example

Without using a calculator, show that $\sqrt{20} = 2\sqrt{5}$

Concise: Square root of 20 equals 2 square root of 5

Verbose: Square root of 20 end root, equals 2, square root of 5 end root.

Example

$\sqrt[4]{144} = \sqrt[x]{288}$

Concise: 4th root of 144 equals xth root of 288

Verbose: Index 4th root of 144 end root, equals, Index xth root of 288 end root.

3.12. Factorial

When an exclamation mark is written after a number to indicate a factorial, this should be read as "factorial"

Example

Write $\frac{3!}{5!}$ exactly in standard form

Three factorial over five factorial

3.13. Absolute Values

Where vertical lines are displayed either side of a variable or expression to denote absolute value, also known as the modulus This should be read aloud as "modulus of ..." ⁹. When included in an equation or longer expression, pause at the end of the subscript variable or expression to indicate where the absolute value notation has finished.

Example

Find $|u|$

Modulus of u

3.14. Functions

Where brackets are used to differentiate between the input of a function, it should be read aloud as "[function name] of [input]". Common functions, such as those used in trigonometry can be read differently as outlined in other parts of this document.

Example

$$f(x) = \frac{2}{x^2} - 3x$$

Concise: f of x equals, 2 over x squared, minus 3 x .

Verbose: f of x equals, start fraction 2 over x squared, end fraction minus 3 x .

Example

$$y = \frac{1}{f(x)}$$

Concise: y equals 1 over f of x

Verbose: y equals start fraction 1 over f of x end fraction.

3.15. Equalities/ Inequalities

Where the $<$ symbol is used between two or variables or expressions it should be read as "less than".

Where the \leq symbol is used between two or variables or expressions it should be read as "less than or equal to".

Where the $>$ symbol is used between two or variables or expressions it should be read as "greater than".

Where the \geq symbol is used between two or variables or expressions it should be read as "greater than or equal to".

Example

$$3 < 5$$

three less than five

Example

When $x > y$

x greater than y

Example

For $16 \leq f < 20$

16 less than or equal to f less than 20

Example

When $x \geq 16$

x greater than or equal to 16

3.16. Approximately equal to

Unicode	Symbol	Read as	Definition
2248	\approx	approximately equal to...	Used when an exact answer is not possible.

Example

$$x \approx y$$

x approximately equal to y

3.17. Not equal to

Unicode	Symbol	Read as	Definition
2260	\neq	not equal to...	The expressions either side of the symbol do not have the same value

Example

True or false, $3 + 7 \neq 13$

3 plus 7 not equal to 13

3.18. Trigonometry

Use the Greek alphabet when reading trigonometric functions and items.

3.18.1. Sine

Although usually abbreviated to "sin" the trigonometric function sine is usually read as "sine" as a homophone of the word sign.

Example

$\sin \theta$

Sine theta

3.18.2. Cosine

The trigonometric function cosine is usually abbreviated to "cos" and read in its abbreviated form unless written out in full.

Example

 $\cos \theta$

Cos theta

Example

 $\cos(\theta + x) \neq \cos(\theta) + x$

cos open bracket theta plus x close bracket, does not equal, cos open bracket theta close bracket plus x.

3.18.3. Tangent

The trigonometric function tangent is usually abbreviated to "tan" and read in its abbreviated form unless written out in full.

Example

 $\tan \theta$

Tan theta

3.18.4. Angle

Unicode	Symbol	Read as	Definition
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Unicode	Symbol	Read as	Definition
2200	∠	Angle	This symbol generally denotes an angle, described by the named points that follows the symbol

Example

Given that O is the centre of the circle and that $\angle AOB = 75^\circ$

Angle, capital A, capital O, capital B = 75 degrees

3.19. Vectors

A vector can be represented using a range of notation.

Where variables representing a vector are represented in bold, they should be read as "bold [variable]".

Where a vector is represented with a an arrow or a thick line above two variables this should be read as "vector [variable 1] [variable 2]" ¹⁰

When a vector is written as a column vector surrounded by brackets this should be read aloud as "vector" followed by the top value and then the second value.

Example

$$\mathbf{a} = \begin{pmatrix} 3 \\ -7 \end{pmatrix}$$

bold a = vector 3 negative 7

Example

$$\overrightarrow{EF} = \begin{pmatrix} 3 \\ -7 \end{pmatrix}$$

Vector capital E capital F equals vector 3 negative 7

3.19.1. Unit Vector

Where a unit vector is shown by an accent ^ above the vector, this should be read as [variable] hat.

Example

$$\mathbf{a} = 2\hat{x} + 1.3\hat{y}$$

bold a equals 2 x hat plus 1.3 y hat

3.19.2. Scalar Product

When $\mathbf{a} \cdot \mathbf{b}$ is used to represent the scalar or dot product of two vectors this should be read aloud as "dot".

Example

$$\mathbf{a} \cdot \mathbf{b} = |\mathbf{a}| \times |\mathbf{b}| \times \cos \theta$$

bold a dot bold b equals modulus of a times modulus of b times cos theta

3.19.3. Cross Product

When $\mathbf{a} \times \mathbf{b}$ is used to represent the cross or vector product of two vectors this should be read aloud as "cross".

Example

$$\mathbf{a} \times \mathbf{b} = |\mathbf{a}| |\mathbf{b}| \sin |\theta|$$

bold a cross bold b equals modulus of bold a modulus of bold b sine open bracket theta close bracket

3.20. Ratios

When a colon is used between two numbers or variables to represent a ratio it should be read aloud as "colon". Note, if a ratio is written within text without mathematical mark-up, text to speech voices can confuse the colons used with a ratio with punctuation or time. Inserting a space either side of the colon will ensure that the notation is recognised correctly¹¹.

Example

Write $25 : 55 : 15$ in its simplest form.

25 colon 55 colon 15

4. Formula sheet

The following formulas are often used within GCSE/Level 2 maths assessments – whether provided within the paper or the candidate must recall the formula. Their maths transcription is provided here as further examples of how these guidelines can be applied.

Formula	Maths Transcription (concise)	Maths Transcription (verbose)
Area of a trapezium = $\frac{1}{2}(a + b)h$	one half open bracket a plus b close bracket, h	
Volume of sphere = $\frac{4}{3}\pi r^3$	4 over 3 pi r to power of 3	start fraction 4 over 3 end fraction, pi r to power of 3 end power.
Surface area of sphere = $4\pi r^2$	4 pi r squared	
Volume of cone = $\frac{1}{3}\pi r^2 h$	one third pi r squared, h	
Curved surface area of cone = $\pi r l$	pi r l	
In any triangle ABC Area of triangle = $\frac{1}{2}ab \sin C$	one half a b sine capital C	

Formula	Maths Transcription (concise)	Maths Transcription (verbose)
Sine rule $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$	a over sine capital A = b over sine capital B = c over sine capital C	Sine rule a/sinâ;A =b/sinâ;B =c/sinâ;C a over sine capital A = b over sine capital B = c over sine capital C start fraction, a over sine capital A, end fraction, = start fraction, b over sine capital B, end fraction, = start fraction, c over sine capital C, end fraction
Cosine rule $a^2 = b^2 + c^2 - 2bc \cos A$	a squared = b squared, plus c squared, minus 2 b c cos capital A	
The solutions of $ax^2 + bx + c = 0$, where $a \neq 0$, are given by $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$	x = negative b, plus or minus square root of b squared, minus 4 a c, over, 2 a	x = start fraction, negative b, plus or minus. Square root of b squared, minus 4 a c end root, over, 2 a end fraction
Annual Equivalent Rate (AER): $\left(1 + \frac{i}{n}\right)^n - 1$	Annual Equivalent Rate (AER): $\tilde{\epsilon}-(1+i/n)\tilde{\epsilon}-^n-1$ open bracket 1 plus, i over n, close bracket to the power of n, minus 1 open bracket 1 plus, start fraction i over n end fraction, close bracket to the power of n end power, minus 1	open bracket 1 plus, start fraction i over n end fraction, close bracket to the power of n end power, minus 1

5. Sources

The following sources were used as guides while developing these guidelines.

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Footnotes

¹Bates, E., & Fitzpatrick, D. (2010). Spoken mathematics using prosody, earcons and spearcons. In Computers Helping People with Special Needs (pp. 407-414). Springer Berlin Heidelberg. ↩

²Alternative reading of this symbol is "minus". As readers cannot differentiate between a negative number and the operator with this reading option it is not recommended. ↩

³Alternative reading of "add" could be used but is more common to early years of maths education. ↩

⁴Alternative readings are "take away" or "subtract". The first is more commonly used in the early years of maths education. Learners reported they preferred minus to subtract, possibly as when spoken it is a shorter word. ↩

⁵Alternative reading is "Multiplied by". Learners indicated preference for the shorter term "times" as clearer and quicker to process. ↩

⁶Alternative form is "parenthesis" instead of brackets. This is not commonly used in the UK for round brackets and learners found it confusing and long to listen to. ↩

⁷Alternative reading is "super" or "superscript". Learners and educators indicated these options were not mathematical language and found them confusing. ↩

⁸Alternative reading is "power of 2". Learners and educators indicated that "squared" was used from an early level of maths and is less confusing. It was also recommended that "cubed" be used instead of "power of 3" but this was not adopted as considered parts of the assessment

material at Level 2. ↩

⁹ Alternative reading is "absolute value of ..." which is longer to listen and process. ↩

¹⁰ Alternative reading is to describe the accent as "with right arrow about". This would be appropriate if this was not being used to represent a vector or if it was inappropriate to indicate the symbol represented a vector. This reading is more difficult for the listener to conceptualise so not recommended unless necessary ↩

¹¹ Alternative reading is "a to b" or "a is to b" for $a:b$. As it is difficult to establish that $:$ is always being used to represent a ratio and the common reading indicates how ratios work, it is suggested that "colon" is read instead. ↩