LEVEL 2

WJEC Level 2 Additional Mathematics

Approved by Qualifications Wales

Specification

Teaching from 2026
For award from 2027

This Qualifications Wales regulated qualification is not available to centres in England.

Made for Wales.
Ready for the world.

WJEC would like to thank the students and teachers of Fitzalan High School, Cardiff and Llanwern High School, Newport for their participation in the creation of these covers.

This specification meets the requirements of the following regulatory documents published by Qualifications Wales:

- Standard Conditions of Recognition which contains the rules that all awarding bodies and their qualifications must meet when offering qualifications to learners in Wales.
- Approval Criteria for Level 2 Additional Mathematics which sets out the subject specific requirements for Additional Mathematics from September 2026 and beyond.

CONTENTS

Level 2 Additional Mathematics

SUMMARY OF ASSESSMENT

Mandatory units

Unit 1: Algebra **Written examination: 50 minutes** **33⅓% of qualification** **40 marks**
The paper will comprise a number of short and longer, both structured and unstructured, questions. A calculator will **not** be allowed in this paper.
Unit 2: Calculus **Written examination: 50 minutes** **33⅓% of qualification** **40 marks**
The paper will comprise a number of short and longer, both structured and unstructured, questions. A calculator will be allowed in this paper.

Optional units

Unit 3: Geometry and Trigonometry **Written examination: 50 minutes** **33⅓% of qualification** **40 marks**
The paper will comprise a number of short and longer, both structured and unstructured, questions. A calculator will be allowed in this paper.
Unit 4: Statistics **Written examination: 50 minutes** **33⅓% of qualification** **40 marks**
The paper will comprise a number of short and longer, both structured and unstructured, questions. A calculator will be allowed in this paper.

Unit 5: Mechanics **Written examination: 50 minutes** **33⅓% of qualification** **40 marks**
The paper will comprise a number of short and longer, both structured and unstructured, questions. A calculator will be allowed in this paper.
Unit 6: Discrete and Decision Mathematics **Written examination: 50 minutes** **33⅓% of qualification** **40 marks**
The paper will comprise a number of short and longer, both structured and unstructured, questions. A calculator will be allowed in this paper.

This is a unitised qualification.

It is not tiered.

To be awarded the qualification, learners must complete **three** units:
- **two** mandatory units
- **one** optional unit.

Learners who complete fewer than three units will receive unit certification for the successful completion of each unit.

There is no hierarchy implied by the order in which the units are presented. Therefore, the order does not imply a prescribed teaching order.

The assessment for Unit 1: Algebra will be made available for the first time in January 2027, with the assessments for the remaining five units being available in the 2027 summer series.

After the first January window, Unit 1: Algebra, and Unit 2: Calculus will be available in every January and summer series. The remaining four optional units will be available in every summer series.

The qualification will be awarded for the first time in summer 2027.

Qualification Approval Number: C00/5167/6

Level 2 Additional Mathematics

1 INTRODUCTION

1.1 Aims

Level 2 Additional Mathematics supports learners to:

- develop deeper thinking, reasoning, communication, application and metacognitive skills through a mathematical approach to problem solving
- formulate and reinforce key mathematical skills
- develop an understanding of new concepts and mathematical approaches and the ability to apply them
- be creative in applying mathematics to challenging problems and to novel and abstract situations
- reason mathematically, make deductions and inferences, draw conclusions and engage with formal mathematical proof
- develop an awareness of the holistic nature of mathematics
- connect ideas within mathematics and between mathematics and other subjects.

These aims are set out in Qualifications Wales' Approval Criteria.

1.2 Curriculum for Wales

This Level 2 Additional Mathematics qualification is underpinned by the Curriculum for Wales framework and has been designed to ensure that learners can continue to make progress towards the four purposes whilst studying for this qualification. Central to this design are the principles of progression, along with the statements of what matters and those subject specific skills and concepts outlined in the 'Designing your Curriculum' section of the Mathematics and Numeracy Area of Learning and Experience.

In developing this qualification, we have considered where there are opportunities to embed the cross-curricular themes and where there are opportunities for integral skills and cross-curricular skills to be developed. Appendix A provides a simple mapping, and information to support teachers will be provided in the Guidance for Teaching.

We have also considered where the qualification can generate opportunities for integrating the learning experiences noted on page 25; the Guidance for Teaching will include further information on integrating these learning experiences into delivery.

The Level 2 Additional Mathematics qualification builds on the conceptual understanding learners have developed through their learning from 3-14, as well as that from GCSE Mathematics and Numeracy. It supports the five interdependent proficiencies that make up the Curriculum for Wales' principles of progression for the Mathematics and Numeracy Area, which are:

- conceptual understanding
- communication using symbols
- fluency
- logical reasoning
- strategic competence.

1.3 Prior learning and progression

Although there is no specific requirement for prior learning, the qualification is designed primarily for learners between the ages of 14 and 16 and builds on the conceptual understanding learners have developed through their learning from ages 3–14 and by studying GCSE Mathematics and Numeracy.

The qualification allows learners to develop a strong foundation of knowledge, skills and understanding which supports progression to post-16 study and prepares learners for life, learning and work. The qualification provides a suitable foundation for the study of Mathematics and other related subjects at either AS or A level. In addition, the specification provides a coherent, satisfying and worthwhile course of study for learners who do not progress to further study in this subject.

1.4 Guided learning hours

Level 2 Additional Mathematics has been designed to be delivered within 60-90 guided learning hours. Each unit has been designed to delivered within 20-30 guided learning hours.

1.5 Use of language

As our understanding of diversity, equity, and inclusion evolves, so must our language. Updated terminology better reflects individual identities and fosters respect and accuracy. Language used should be specific as possible. Staying informed and adaptable is crucial, as inclusive language promotes dignity and equity. Recognising that language will continue to evolve, we will remain open to further amendments to ensure it accurately represents and supports all individuals. WJEC will inform centres of any amendments and the most up to date version of the specification will always be on the website.

1.6 Equality and fair access

The specification may be followed by any learner, irrespective of gender, ethnic, religious or cultural background. It has been designed to avoid, where possible, features that could, without justification, make it more difficult for a learner to access and achieve because they have a particular protected characteristic.

The protected characteristics under the Equality Act 2010 are age, disability, gender reassignment, pregnancy and maternity, race, religion or belief, sex and sexual orientation.

Access arrangements and reasonable adjustments are made for eligible learners to enable them to access the assessments and demonstrate their knowledge and skills without changing the demands of the assessment.

Information on access arrangements and reasonable adjustments is found in the following document from the Joint Council for Qualifications (JCQ): Access Arrangements, Reasonable Adjustments: General and Vocational Qualifications. This document is available on the JCQ website (www.jcq.org.uk).

We will be following the principles set out in this document and, as a consequence of provision for reasonable adjustments, very few learners will encounter a complete barrier to any part of the assessment.

2 SUBJECT CONTENT

How to read the amplification

The amplification provided in the right-hand column uses the following four stems:

- ‘Learners should be aware of’ is used when learners need a general understanding of a topic in order to access the unit. Learners will **not** be directly assessed on this content.
- ‘Learners should know’ is used when learners are required to demonstrate factual knowledge.
- ‘Learners should understand’ is used when learners are required to demonstrate greater depth of knowledge and understanding.
- ‘Learners should be able to’ is used when learners need to apply their knowledge and understanding to a practical situation or demonstrate application of practical skills and techniques.

The use of the word ‘including’ indicates that the specified content must be taught and could be subject to assessment.

The use of the words ‘for example’ or ‘such as’ indicates that the specified content is for guidance only, and alternative examples could be chosen.

Unit 1

Algebra

Mandatory unit
Written examination
33⅓% of qualification
40 marks

The purpose of this unit is to:
- formulate and reinforce key mathematical techniques
- strengthen manipulative algebraic skills.

A calculator will **not** be allowed in this examination.

Areas of content

1.1 Algebraic manipulation	
In this section, learners will gain knowledge, understanding and skills in the following areas: 1.1.1: Surds 1.1.2: Laws of indices 1.1.3: Proofs	
Section	Amplification
1.1.1 Surds	Learners should be able to: • simplify numerical expressions involving surds, including rationalising the denominator of expressions. Numerators will be restricted to constants.
1.1.2 Laws of indices	Learners should be able to: • use the laws of indices to simplify numerical and algebraic expressions written in index form with positive, negative, zero and fractional indices For example: • Write expressions such as $\sqrt{\frac{x^{\frac{5}{2}} \times x^{\frac{7}{2}}}{x^2}}$ and $\frac{5x^{\frac{1}{2}}+6x^{\frac{5}{2}}}{2x^{\frac{1}{2}}}$ as a single power of x • Solve $8^x = \frac{2^{56}}{4^{10}}$
1.1.3 Proofs	Learners should be able to construct formal mathematical proofs: • using the correct notation, including use of the symbol ≡, and a clear structure involving a series of logical steps to reach conclusions • including using algebraic identities

1.2 Quadratic functions

In this section, learners will gain knowledge, understanding and skills in the following areas:

1.2.1 Solving quadratic equations
1.2.2 Applications of quadratic functions
1.2.3 Quadratic simultaneous equations
1.2.4 The discriminant
1.2.5 Quadratic graphs

Section	Amplification
1.2.1 Solving quadratic equations	Learners should be able to: • solve quadratic equations by factorising or completing the square • solve quadratic equations with higher powers such as: $x^4 - 2x^2 + 1 = (x^2 - 1)^2 = 0$ • use completing the square as a method to find maximum or minimum values of quadratic functions. When completing the square, the coefficient of x^2 will not be greater than 1.
1.2.2 Applications of quadratic functions	Learners should be able to: • form and manipulate quadratic expressions from a given context • form, manipulate and solve quadratic equations that arise from a given context.
1.2.3 Quadratic simultaneous equations	Learners should be able to: • solve two simultaneous equations in two unknowns algebraically, including one linear equation and one quadratic equation.
1.2.4 The discriminant	Learners should be able to: • find and interpret the discriminant of quadratic equations • understand the conditions for two distinct real roots, one repeated real root and no real roots.
1.2.5 Quadratic graphs	Learners should be able to: • sketch graphs of quadratic functions, clearly showing any points of intersection with the coordinate axes.

1.3 Sequences and series

In this section, learners will gain knowledge, understanding and skills in the following areas:

1.3.1 Arithmetic sequences and series
1.3.2 Geometric sequences and series

Section	Amplification
1.3.1 Arithmetic sequences and series	Learners should be able to: • find the nth term of arithmetic sequences using: $u_n = a + (n-1)d$ • find the sum to n terms of arithmetic series using: $S_n = \frac{1}{2}n[2a + (n-1)d]$ or $S_n = \frac{1}{2}n[a + l]$ • work with arithmetic series and sequences in a variety of ways – for example, to find the first term and the common difference using an algebraic method.
1.3.2 Geometric sequences and series	Learners should be able to: • find the nth term of geometric sequences using: $u_n = ar^{n-1}$ • find the sum to n terms of geometric series using: $S_n = \frac{a(1 - r^n)}{1 - r}$ • work with geometric series and sequences in a variety of ways – for example, to find the first term and the common ratio using an algebraic method. Learners are not expected to find the sum to infinity of a convergent geometric series.

Unit 2

Calculus

Mandatory unit
Written examination
33⅓% of qualification
40 marks

The purpose of this unit is to introduce and develop an understanding of new concepts relating to calculus, supporting progression to the further study of mathematics or a related discipline.

A calculator will be allowed in this examination.

Areas of content

2.1 Differentiation	
In this section learners will gain knowledge, understanding and skills in the following areas: 2.1.1 Differentiating terms and expressions 2.1.2 Second derivatives 2.1.3 Stationary points on a curve 2.1.4 Equations of tangents	
Section	Amplification
2.1.1 Differentiating terms and expressions	Learners should be aware of: • differentiation from first principles, in order to gain a better understanding of the gradient function. Learners should be able to: • differentiate x^n and related expressions, including polynomials, for integer values of n only, that is, use of $\frac{\mathrm{d}}{\mathrm{d}x}(x^n) = nx^{n-1}$
2.1.2 Second derivatives	Learners should be able to: • find second derivatives in simple cases, for example, given $y = x^3 + 3x^2 + 1$ find $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$
2.1.3 Stationary points on a curve	Learners should be able to: • find the maximum and minimum points on a curve and determine their nature. Learners are not expected to consider points of inflection.
2.1.4 Equations of tangents	Learners should be able to: • find the equation of a tangent to a curve at a given point.

2.2 Integration	
In this section learners will gain knowledge, understanding and skills in the following areas: 2.2.1 Integrating terms and expressions 2.2.2 Evaluating definite integrals 2.2.3 Calculating the area between a curve and the x-axis	
Section	Amplification
2.2.1 Integrating terms and expressions	Learners should be aware of: • integration being the reverse process of differentiation. Learners should be able to: • integrate x^n and related expressions for integer values of n only, that is, given $\frac{\mathrm{d}y}{\mathrm{d}x} = x^n$ then $y = \frac{x^{n+1}}{n+1} + c \ (n \neq -1)$
2.2.2 Evaluating definite integrals	Learners should be able to: • evaluate definite integrals, including integrands that are polynomials.
2.2.3 Calculating the area between a curve and the x-axis	Learners should be able to: • apply integration to simple areas where the curve is entirely above or below the x-axis in the given interval, where the interval could be defined by vertical lines or inequalities.

Unit 3

Geometry and Trigonometry

Optional unit
Written examination
33⅓% of qualification
40 marks

The purpose of this unit is to develop and strengthen the knowledge, skills and understanding of topics relating to geometry and trigonometry and be able to apply them in different contexts.

A calculator will be allowed in this examination.

Areas of content

3.1 Coordinate geometry in the (x, y) plane	
In this section learners will gain knowledge, understanding and skills in the following areas: 3.1.1 Properties of a straight line 3.1.2 Application of Pythagoras' theorem	
Section	Amplification
3.1.1 Properties of a straight line	Learners should understand: • the conditions for two line segments to be parallel or perpendicular. Learners should be able to: • find the equation of a straight line • find the midpoint of a line segment • identify 2-D geometrical shapes from the properties of the line segments forming the shape.
3.1.2 Application of Pythagoras' theorem	Learners should be able to apply Pythagoras' theorem to: • find the length of a line segment • form the equation of the circle using $(x-a)^2+(y-b)^2=r^2$, where (a, b) is the centre of the circle and r is the radius of the circle. Learners should be able to use the positions of the centres of two circles to: • determine whether two circles touch internally or externally • find the shortest distance between two circles.

3.2 Trigonometry

In this section learners will gain knowledge, understanding and skills in the following areas:

3.2.1 Trigonometric graphs
3.2.2 Trigonometric identities
3.2.3 Solving simple trigonometric equations
3.2.4 Use of the sine rule, the cosine rule, and the formula for the area of a triangle in the form $\frac{1}{2}ab\sin C$

Section	Amplification
3.2.1 Trigonometric graphs	Learners should understand: • The sine, cosine and tangent functions • The symmetries and periodicity of the trigonometric graphs $y = \sin\theta$, $y = \cos\theta$ and $y = \tan\theta$
3.2.2 Trigonometric identities	Learners should be able to use the identities: • $\tan\theta \equiv \frac{\sin\theta}{\cos\theta}$ • $\sin^2\theta + \cos^2\theta \equiv 1$

3.2.3
Solving simple trigonometric equations
	Learners should be able to:
	• solve simple trigonometric equations in a given interval, including the solution to equations such as:
	  • $\sin\theta = \frac{\sqrt{3}}{2}$
	  • $2\cos\theta = -0.8$
	  • $4\tan\theta\cos\theta + 1 = 0$
	  • $2\cos^2\theta + \sin\theta = 2$

3.2.4 Use of the sine rule, the cosine rule, and the formula for the area of a triangle in the form $\frac{1}{2}ab\sin C$.	Learners should be able to: • apply the sine rule, the cosine rule, and the formula for the area of a triangle in the form $\frac{1}{2}ab\sin C$ to solve problems in 2D • consider the ambiguous case of sine.

Unit 4

Statistics

Optional unit
Written examination
33⅓% of qualification
40 marks

The purpose of this unit is to develop and strengthen the understanding of topics and concepts relating to statistics and probability and be able to use the associated mathematical language and terminology effectively.

A calculator will be allowed in this examination.

Areas of content

4.1 Probability	
In this section learners will gain knowledge, understanding and skills in the following areas: 4.1.1 Mutually exclusive and independent events 4.1.2 Venn diagrams	
Section	Amplification
4.1.1 Mutually exclusive and independent events	Learners should be able to: • understand and use the addition law for mutually exclusive events, A and B, that is, $\mathrm{P}(A \cup B) = \mathrm{P}(A) + \mathrm{P}(B)$ • understand and use the multiplication law for independent events, A and B, that is, $\mathrm{P}(A \cap B) = \mathrm{P}(A) \times \mathrm{P}(B)$
4.1.2 Venn diagrams	Learners should be able to: • use Venn diagrams to calculate probabilities • use set notation and associated language, including the use of the generalised addition law, that is, $\mathrm{P}(A \cup B) = \mathrm{P}(A) + \mathrm{P}(B) - \mathrm{P}(A \cap B)$

4.2 Data representation and interpretation

In this section learners will gain knowledge, understanding and skills in the following areas:

4.2.1 Measures of central tendency and variation
4.2.2 Statistical diagrams
4.2.3 Scatter diagrams

Section	Amplification
4.2.1 Measures of central tendency and variation	Learners should be able to: • interpret measures of central tendency • calculate standard deviation, including from listed data, frequency tables and grouped frequency tables • interpret measures of variation, including range, interquartile range, variance and standard deviation • compare data distributions using one measure of central tendency and/or one measure of variation.
4.2.2 Statistical diagrams	Learners should be able to: • interpret diagrams for single variable data sets, including box and whisker diagrams, cumulative frequency diagrams and histograms • use diagrams to compare sets of data • understand skewness to describe the distribution of data, including use of the terms symmetrical, positive skew and negative skew • identify and interpret possible outliers in statistical diagrams, such as box and whisker diagrams.
4.2.3 Scatter diagrams	Learners should be able to: • interpret scatter diagrams for bivariate data, including understanding of correlation and that correlation does not imply causation • understand and interpret regression lines for bivariate data • use the equation of a regression line to make predictions, including interpolation and consideration of the dangers of extrapolation. Learners are not expected to calculate the coefficients of regression lines.

4.3 Statistical Distributions

In this section learners will gain knowledge, understanding and skills in the following areas:

4.3.1 Discrete probability distributions

Section	Amplification
4.3.1 Discrete probability distributions	Learners should be able to: • calculate probabilities from a simple discrete probability distribution • interpret a probability function for a discrete random variable • calculate the mean and variance of a discrete random variable • interpret the mean and variance of a discrete random variable.

Unit 5

Mechanics

Optional unit
Written examination
33⅓% of qualification
40 marks

The purpose of this unit is to introduce and develop an understanding of topics and concepts relating to mechanics and be able to apply them in different contexts.

A calculator will be allowed in this examination.

Areas of content

5.1 Vector and Scalar Quantities	
In this section learners will gain knowledge, understanding and skills in the following areas: 5.1.1 Distinguish between scalar and vector quantities	
Section	Amplification
5.1.1 Distinguish between scalar and vector quantities	Learners should know: • the fundamental difference between vectors quantities and scalar quantities. Learners should be able to: • provide physical examples of scalar quantities and vector quantities. The use of the unit vectors $\mathbf{i}$ and $\mathbf{j}$ is not included.

5.2 Forces

In this section learners will gain knowledge, understanding and skills in the following areas:

5.2.1 Different types of forces and their characteristics
5.2.2 The nature of forces and their effects on objects
5.2.3 Analysing situations involving balanced and unbalanced forces
5.2.4 The principles of Newton's three laws of motion
5.2.5 Applying Newton's laws to analyse and solve problems involving forces and motion

Section	Amplification
5.2.1 Different types of forces and their characteristics	Learners should be able to identify: • contact forces, such as a normal reaction • non-contact forces, such as weight, where weight is the force of gravity acting on an object. Learners should be able to: • indicate one or more relevant forces on a diagram, including weight. Learners should know: • how these forces affect the motion of an object, either in a static state or whilst in motion.
5.2.2 The nature of forces and their effects on objects	Learners should be able to: • explain how forces can affect the motion of an object.
5.2.3 Analysing situations involving balanced and unbalanced forces	Learners should be able to: • calculate resultant forces of unbalanced systems in one dimension only • calculate the force needed to bring a system into equilibrium, either in a static state or whilst in motion.
5.2.4 The principles of Newton's three laws of motion	Learners should know that • balanced forces result in no change in motion • objects require an unbalanced force to change their velocity • acceleration depends on the magnitude of force and the mass of the object • the direction of the net force determines the direction of acceleration • action and reaction forces are equal in magnitude and opposite in direction. Learners should be able to: • use free-body diagrams to represent forces • apply Newton's second law ($F = ma$) to calculate force, mass or acceleration.
5.2.5 Applying Newton's laws to analyse and solve problems involving forces and motion.	Learners should be able to: • solve problems using $F = ma$

5.3 Rectilinear Motion

In this section learners will gain knowledge, understanding and skills in the following areas:

5.3.1 Quantities and units
5.3.2 Uniform and non-uniform motion
5.3.3 Problems involving displacement, velocity, acceleration and time
5.3.4 Motion graphs (displacement-time, velocity-time)

Section	Amplification
5.3.1 Quantities and units	Learners should know: • key quantities: displacement, distance, velocity, speed, acceleration and time, and associated units.
5.3.2 Uniform and non-uniform motion	Learners should know that: • rectilinear motion is motion along a straight line • uniform motion is motion with constant velocity • non-uniform motion is motion involving acceleration.

5.3.3
Problems involving displacement, velocity, acceleration, and time
	Learners should be able to:
	• apply the following equations to motion under constant acceleration (a)
	  • $v = u + at$
	  • $s = ut + \frac{1}{2}at^2$
	  • $v^2 = u^2 + 2as$
	  • $s = \frac{1}{2}(u+v)t$
	
	Learners should also be able to apply these equations to vertical motion under gravity, where acceleration due to gravity is g=9.8ms^{-2} (to one decimal place).

5.3.4
Motion graphs (displacement-time, velocity-time)
	Learners should know that:
	• for displacement-time graphs:
	  • gradient represents velocity
	  • straight line segments mean uniform velocity
	  • curved segments mean acceleration or deceleration
	• for velocity-time graphs:
	  • gradient represents acceleration
	  • area under the graph represents displacement.
	
	Learners should be able to:
	• interpret motion graphs
	• sketch motion graphs based on given information.

Unit 6

Discrete and Decision Mathematics

Optional unit
Written examination
33⅓% of qualification
40 marks

The purpose of this unit is to introduce and develop an understanding of new concepts and mathematical approaches relating to discrete and decision mathematics and be able to apply them to novel and abstract situations.

A calculator will be allowed in this examination.

Areas of content
A glossary of terms for this unit can be found in Appendix B of this specification.

6.1 Graphs and Networks	
In this section learners will gain knowledge, understanding and skills in the following areas: 6.1.1 Graphs and networks terminology 6.1.2 Eulerian and semi-Eulerian graphs	
Section	Amplification
6.1.1 Graphs and networks terminology	Learners should know the meaning of the following terms and phrases in the context of graphs and networks: • edge • directed edge/arc • vertex/node • vertex degree • loop • graph/network • weighted graph/network • subgraph • simple graph • walk • connected graph • complete graph • open walk • closed walk • trail • path • cycle • tree • spanning tree • minimum spanning tree (MST). **See definitions in Appendix B of this specification.**
6.1.2 Eulerian and semi-Eulerian graphs	Learners should be able to: • state the degree of each of the vertices for a given graph • construct a graph with a given set of vertices, each with a specified degree.

	Learners should be able to justify whether a given graph is: • Eulerian • semi-Eulerian • neither. Learners should be aware of how adding appropriate edges can transform a non-Eulerian graph into an Eulerian graph, or a semi-Eulerian graph.

6.2 Algorithms & algorithms on networks

In this section learners will gain knowledge, understanding and skills in the following areas:

6.2.1 Algorithms and flow charts
6.2.2 Sorting algorithms
6.2.3 Minimum spanning tree algorithms
6.2.4 Dijkstra's algorithm

Section	Amplification
6.2.1 Algorithms and flow charts	Learners should know some of the properties of an algorithm, and why they are necessary, such as: • finiteness • definiteness • correctness. Learners should know the meaning of common flow chart symbols in the context of an algorithm. This should include: • start/end • arrow • input/output • process • decision. Learners should be able to interpret and apply simple algorithms represented as: • a list of instructions • a flow chart.
6.2.2 Sorting algorithms	Learners should be able to apply sorting algorithms to lists of distinct letters or distinct numbers, in either ascending or descending order. This includes using: • Bubble sort • Quick sort (pivot = middle, or middle right if two middle values are possible).
6.2.3 Minimum spanning tree algorithms	Learners should be able to apply Kruskal's algorithm **or** Prim's algorithm to a given weighted network to find a minimum spanning tree (MST). Learners should know that the algorithm does not always lead to a unique solution.
6.2.4 Dijkstra's algorithm	Learners should be able to apply Dijkstra's algorithm to a given weighted network, to find a path of minimum weight.

6.3 Critical path analysis

In this section learners will gain knowledge, understanding and skills in the following areas:
6.3.1 Activity on arc networks, precedence tables and dummies
6.3.2 Critical paths
6.3.3 Gantt (cascade) charts

Section	Amplification
6.3.1 Activity on arc networks, precedence tables and dummies	Learners should be able to form a precedence table for a given list of precedence statements. Learners should be able to model a project by constructing an activity on arc network from a precedence table. The use of a dummy activity is not included. Learners should know that dummy activities are placeholders and do not represent actual tasks, and, as such, do not take up time or resources. Learners should know that a dummy activity may be used for a given activity on arc network to: • ensure unique start and end nodes • show a required precedence. Learners are not expected to justify the use of a dummy, but they are expected to be able to solve problems on networks that make use of dummies.
6.3.2 Critical paths	Learners should be able to calculate: • early event times • late event times for a given activity on arc network, by performing a forward/backward pass. Dummies may be used to ensure unique start and end nodes, and/or to show precedencies. Learners should be able to calculate the total float for activities and identify critical activities and critical paths from an activity on arc network, by considering the early and late event times.
6.3.3 Gantt (cascade) charts	Learners should be able to interpret Gantt (cascade) charts. This includes: • identifying critical activities • critical paths • the earliest start time for an activity • the latest end time for an activity • the total float for an activity • identifying which activities must/may be happening at a given time. Note: time scales will indicate elapsed time.

6.4 Linear programming

In this section learners will gain knowledge, understanding and skills in the following areas:

6.4.1 Linear programming terminology
6.4.2 Setting up linear programming problems in two variables
6.4.3 Solving linear programming problems in two variables

Section	Amplification
6.4.1 Linear programming terminology	Learners should know the meaning of the following terms: • decision variable • constraints • objective function • feasible solution • feasible region • optimal solution.
6.4.2 Setting up linear programming problems in two variables	Learners should be able to formulate simple constrained optimisation problems as linear programs, for two decision variables, for a given context. This could include identifying the appropriate objective function and stating whether it is to be maximised or minimised, and formulating appropriate inequalities for a given constraint. All decision variables will be subject to non-negativity constraints. Therefore, the feasibility region will be restricted to the first quadrant. Learners should be aware of the modelling cycle and how this applies to linear programming problems in terms of moving from the 'real life problem' to the associated 'mathematical problem' and the implication this has on the validity of the solutions.
6.4.3 Solving linear programming problems in two variables	Learners should be able to represent constraints and an objective line graphically. Learners should be able to use shading (to eliminate) and identify the feasibility region for a set of given or derived constraints. Learners should be able to solve linear programming problems involving two decision variables. Learners should use either the objective line method **or** the vertex testing method, to find a unique solution, including cases where integer solutions are required. In such cases, the optimal solution will be found at a point with integer coordinates. Learners are not expected to have any knowledge of the simplex algorithm for solving linear programming problems.

Opportunities for integration of learning experiences

Level 2 Additional Mathematics generates opportunities for the following learning experiences to be developed (experiences will not be directly assessed):

- work both independently and collaboratively
- gain experience and appreciation of the role mathematics plays in other subjects and areas of the curriculum
- gain awareness and appreciation of some of the different careers and work-related areas that draw upon mathematics
- access rich tasks that invoke curiosity, build resilience and require Learners to be resourceful
- undertake practical work that allows Learners to apply their mathematical skills inside and outside of the classroom setting
- encounter familiar, unfamiliar and complex problems.

The Guidance for Teaching will include further information on the opportunities provided by the qualification for teachers/centres to integrate these learning experiences and skills into delivery.

For opportunities to develop cross-cutting themes, cross-curricular skills and integral skills please see Appendix A.

3 ASSESSMENT

3.1 Assessment Objectives and Weightings

Below are the assessment objectives for this specification. Learners must:

AO1
Recall and use their knowledge of the prescribed content.

AO2
Select and apply mathematical methods.

AO3
Interpret and analyse problems and use mathematical reasoning to solve them.

The table below shows the weighting of each assessment objective for each unit and for the qualification as a whole, within a tolerance of +/- 5 percentage points for the overall weightings.

<table>
<tr><th></th><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th></tr>
<tr><td>Unit 1</td><td>23⅓%</td><td>6⅔%</td><td>3⅓%</td><td>33⅓%</td></tr>
<tr><td>Unit 2</td><td>23⅓%</td><td>6⅔%</td><td>3⅓%</td><td>33⅓%</td></tr>
<tr><td>Unit 3</td><td rowspan="4">18⅓%</td><td rowspan="4">6⅔%</td><td rowspan="4">8⅓%</td><td rowspan="4">33⅓%</td></tr>
<tr><td>Unit 4</td></tr>
<tr><td>Unit 5</td></tr>
<tr><td>Unit 6</td></tr>
<tr><td>Overall weighting</td><td>65%
(60-70%)</td><td>20%
(15-25%)</td><td>15%
(10-20%)</td><td>100%</td></tr>
</table>

3.2 Organising, communicating and writing accurately

Two marks will be awarded on each examination paper for units 3, 4, 5 and 6 for the assessment of 'communicating, organising and writing accurately'. These marks will be in addition to the marks allocated to the mathematics. One mark will be awarded for communicating and organising. The other mark will be awarded for writing accurately. These questions will be clearly indicated on each examination paper.

For marks relating to organisation and communication, candidates will be expected to:

- present their response in a structured way
- explain to the reader what they are doing at each step of their response
- lay out their explanations and working in a clear and logical way
- write a conclusion that draws together their results and explains what their answer means.

For marks relating to writing accurately candidates will be expected to:

- show all their working
- use correct mathematical form in their working
- use appropriate terminology, units, etc.

3.3 Use of calculators

Calculators must meet the regulations set out below.

<table>
<tr>
<td>Calculators must be:
of a size suitable for use on the desk
either battery or solar powered
free of lids, cases and covers which have printed instructions or formulas.</td>
<td rowspan="2">During an examination, calculators must not
be able to offer any of these facilities:
language translators
symbolic algebra manipulation
symbolic differentiation or integration
communication with other machines or the internet.
give access to pre-stored information – this includes:
databanks
dictionaries
mathematical formulae
text.
Calculators must not be borrowed from another candidate during an examination for any reason.*</td>
</tr>
<tr>
<td>The candidate is responsible for the following:
the calculator's power supply
the calculator's working condition
clearing anything stored in the calculator.</td>
</tr>
</table>

* An invigilator may give a candidate a replacement calculator.

3.4 Formula and algorithm lists

Units 1, 3, 4 and 5 will have a formula list at the beginning of the examination paper, and Unit 6 will have an algorithm list. The lists provided are as follows.

Formula List – Unit 1 Algebra

Arithmetic Series

$$S_n = \frac{1}{2}n[a + l] = \frac{1}{2}n[2a + (n-1)d]$$

Geometric Series

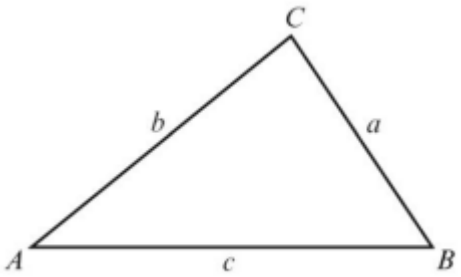
$$S_n = \frac{a(1 - r^n)}{1 - r}$$

Formula List – Unit 3 Geometry and Trigonometry

In any triangle *ABC*

Sine rule:

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$



Cosine rule:

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Area of triangle $= \frac{1}{2}ab\sin C$

Formula List – Unit 4 Statistics

Probability

Generalised addition formula:

$$\mathrm{P}(A \cup B) = \mathrm{P}(A) + \mathrm{P}(B) - \mathrm{P}(A \cap B)$$

Variance (Data)

$$\mathrm{Var}(X) = \frac{\sum x^2}{n} - \left(\frac{\sum x}{n}\right)^2$$

$$\mathrm{Var}(X) = \frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2$$

Discrete Distributions

Expectation (Mean): $\mathrm{E}(X) = \mu = \sum x\mathrm{P}(X = x)$

Variance: $\mathrm{Var}(X) = \sigma^2 = \sum x^2\mathrm{P}(X = x) - \mu^2$

Formula List – Unit 5 Mechanics

Newton's second law

$F = ma$ (resultant force = mass × acceleration)

Constant acceleration

$v = u + at$

$s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

$s = \frac{1}{2}(u + v)t$

Algorithm List – Unit 6 Discrete and Decision Mathematics

Bubble sort

Start at the beginning of the working list and move from left to right comparing adjacent items. If they are in order, leave them, if they are not, swap them.

When you get to the end of the working list, the last item will be in its final position. This item is no longer in the working list.

If you made some swaps on the last pass, repeat the first instruction.

When a pass is completed without any swaps, every item is in its final position and the list is in order, stop.

Quick sort

Choose the item at the midpoint of the list to be the first pivot. If the list has an even number of items, the pivot should be to the right of the middle.

Write down all the items that are less than the pivot, keeping their order, in a sub list.
Write down the pivot.

Write down the remaining items (greater that the pivot, keeping their order) in a sub list.
Repeat for each sub list of size greater than one.

When all items have been chosen as pivots or any subgroups only contain one item, stop.

Dijkstra's algorithm

Label the start vertex with a **final** label, 0.

Record a working value at each vertex that is connected to the vertex that has just received its final label.

- Working value is final label plus the weight of the edge.
- If there is already a working value, it is only replaced if the new value is smaller.
- Once a vertex has a final value, it is no longer revisited, and its working values are no longer considered.

Look at the working values at all vertices without final labels. Select the smallest working value. This now becomes the final label at that vertex. If two vertices have the same working value, choose either of them first.

Repeat the second and third steps until the destination vertex receives its final label.

To find the shortest path, trace back from the destination to the start.

Kruskal's algorithm

Sort all the edges into ascending order of weight.

Select the edge of least weight to start the tree.

Consider the next edge of least weight. If it would form a cycle with those edges already selected, reject it. If it does not form a cycle, add it to the tree. If there is a choice of equal edges, choose one of them at random and consider each in turn.

Repeat the third step until all vertices are connected.

Prim's algorithm

Choose any vertex to start the tree.

Select an edge of least weight that joins a vertex already in the tree to a vertex not yet in the tree. If there is a choice of edges of equal weight, choose any of them.

Repeat the second step until all the vertices are connected.

4 MALPRACTICE

Before the course starts, the teacher is responsible for informing candidates of WJEC's regulations concerning malpractice. Candidates must not take part in any unfair practice in the preparation of work for Level 2 Additional Mathematics.

Information regarding malpractice is available in our Guide to preventing, reporting and investigating malpractice.

All cases of suspected or actual malpractice must be reported immediately to WJEC (malpractice@wjec.co.uk). If candidates commit malpractice, they may be penalised or disqualified from the examinations.

In all cases of malpractice, centres are advised to consult the JCQ booklet Suspected Malpractice: Policies and Procedures.

5 TECHNICAL INFORMATION

5.1 Entries and Awards

This is a unitised qualification. Learners are entered for each unit separately.

Unit 1: Algebra will be available for the first time in January 2027. All other units will be available for the first time in summer 2027. After the first January window, Unit 1: Algebra, and Unit 2: Calculus will be available in every January and summer series. The remaining four optional units will be available in every summer series. The qualification will be awarded for the first time in summer 2027 and every January and summer series thereafter.

Pre-16 Candidates (i.e. candidates who are 16 or under on 31st August in the academic year in which they were entered)

Candidates may resit an individual unit once only. The better uniform mark score from the two attempts will be used in calculating the final overall grade.

If any unit has been attempted twice and a candidate wishes to enter the unit for the third time, the candidate will have to re-enter all units and the appropriate cash-in(s). This is referred to as a 'fresh start'. When retaking a qualification (fresh start), a candidate may have up to two attempts at each unit. However, no results from examination units taken prior to the fresh start can be used in aggregating the new grade(s).

If a candidate has been entered for but is absent for a unit, the absence does not count as an attempt. The candidate would, however, qualify as a resit candidate in the final resit series.

Post-16 Candidates (i.e. candidates who are 16 or over on 1st September in the academic year in which they are entered)

There is no limit on the number of times a candidate can resit an individual unit; however, the better uniform mark score from the most two recent attempts will be used in calculating the final overall grade.

The ‘fresh start’ rule does not apply to post-16 candidates.

If a candidate has been entered for but is absent for a unit, the absence does not count as an attempt. The candidate would, however, qualify as a resit candidate in the final resit series.

The entry codes appear below.

		Entry codes	
		English medium	**Welsh medium**
Unit 1	Algebra	5322U1	5322N1
Unit 2	Calculus	5322U2	5322N2
Unit 3	Geometry and trigonometry	5322U3	5322N3
Unit 4	Statistics	5322U4	5322N4
Unit 5	Mechanics	5322U5	5322U5
Unit 6	Discrete and decision mathematics	5322U6	5322N6
Level 2 Additional Mathematics		5322QA	5322CA

The current edition of our Entry Procedures and Coding Information gives up-to-date entry procedures.

5.2 Grading, awarding and reporting

Level 2 Additional Mathematics is reported on a scale of Pass, Merit and Distinction. Learners who successfully complete a unit will receive a unit certificate with a Pass, Merit or Distinction grade. Results not attaining the minimum standard for the award will be reported as U (unclassified).

Individual unit results are reported on a uniform mark scale (UMS) with the following grade equivalences:

	Raw Max Marks	**UMS Max Marks**	**Distinction**	**Merit**	**Pass**
Unit 1	40	50	40	30	20
Unit 2	40	50	40	30	20
Unit 3	40	50	40	30	20
Unit 4	40	50	40	30	20
Unit 5	40	50	40	30	20
Unit 6	40	50	40	30	20

Qualification results are reported on a uniform mark scale (UMS) with the following grade equivalences:

	UMS Max Marks	**Distinction**	**Merit**	**Pass**
Subject Award	150	120	90	60

Appendix A: Opportunities for embedding elements of the Curriculum for Wales

Curriculum for Wales Strands	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
Cross-cutting Themes						
Local, National & International Contexts	✓			✓	✓	✓
Sustainability				✓	✓	✓
Relationships and Sexuality Education						
Human Rights Education						
Diversity				✓		
Careers and Work-Related Experiences	✓		✓	✓	✓	✓
Cross-curricular Skills - Literacy						
Listening	✓	✓	✓	✓	✓	✓
Reading	✓	✓	✓	✓	✓	✓
Speaking	✓	✓	✓	✓	✓	✓
Writing	✓	✓	✓	✓	✓	✓

Curriculum for Wales Strands	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
Cross-curricular Skills - Numeracy						
Developing Mathematical Proficiency	✓	✓	✓	✓	✓	✓
Understanding the number system helps us to represent and compare relationships between numbers and quantities	✓	✓	✓	✓	✓	✓
Learning about geometry helps us understand shape, space and position and learning about measurement helps us quantify in the real world	✓	✓	✓		✓	✓
Learning that statistics represent data, and that probability models chance, help us make informed inferences and decisions				✓		
Digital Competence						
Citizenship						
Interacting and Collaborating						
Producing	✓		✓	✓	✓	✓
Data and Computational Thinking	✓		✓	✓	✓	✓

Curriculum for Wales Strands	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
Integral Skills						
Creativity and Innovation	✓		✓	✓	✓	✓
Critical Thinking and Problem Solving	✓	✓	✓	✓	✓	✓
Planning and Organisation	✓	✓	✓	✓	✓	✓
Personal Effectiveness	✓	✓	✓	✓	✓	✓

Appendix B: Glossary of terms for Unit 6 Discrete and Decision Mathematics

6.1: Graphs and Networks	
Term	**Definition**
Edge	An edge is a line segment that connects two vertices in a graph.
Directed edge	An edge that has an orientation and can only be traversed in one direction. Also known as an arc.
Vertex/node	A vertex is a point on a graph that may or may not be connected to other vertices by edges. Note: Vertices are also known as points.
Vertex degree	The number of edges that are incident to the vertex. A vertex is even/odd if the degree is even/odd. Note: vertex degree is also known as valency, or the “order” of a vertex.
Loop	An edge that starts and finishes at the same vertex.
Graph/network	A graph G consists of vertices that are connected by edges. Note: Graphs are also known as networks in certain contexts.
Weighted graph/network	A graph/network where each edge has a numerical value (weight) assigned to it.
Subgraph	A graph G’ whose vertices and edges belong to G.
Simple graph	A graph in which there are no loops, no directions on the edges, and where there is at most one edge connecting any pair of vertices.
Walk	A route through a graph along edges from one vertex to the next.
Connected graph	A graph in which every vertex is connected by a walk.
Complete graph	A graph in which every vertex is connected to every other vertex by a unique edge.
Open walk	A walk where the start vertex is not the same as the end vertex.
Closed walk	A walk where the start vertex is the same as the end vertex.
Trail	A walk in which no edge is visited more than once.
Path	A walk in which no vertex is visited more than once.
Cycle	A walk in which the end vertex is the same as the start vertex and no other vertex is visited more than once.
Tree	A connected graph with no cycles.
Spanning tree	A subgraph of G that includes all vertices and is also a tree.
Minimum spanning tree (MST)	A spanning tree such that the total weight of its edges is as small as possible. Note: an MST is also known as a minimum connector.
Eulerian graph	A connected graph where every vertex has an even degree.

Semi-Eulerian graph	A connected graph where precisely two vertices have an odd degree.
6.2: Algorithms & algorithms on networks	
Term	**Definition**
Finiteness	The algorithm terminates after a finite number of steps.
Definiteness	Each step in the algorithm is precisely defined and unambiguous.
Correctness	The algorithm solves the given problem without errors or mistakes.
6.3: Critical path analysis	
Term	**Definition**
Precedence/ dependence table	A table that shows the activities that must be completed before others are started.
Activity on arc network	Activities are represented by arcs, and nodes represent the start and end of activities.
Duration	The length of time it takes to complete an activity.
Critical activity	Any activity in which an increase in its duration would result in a corresponding increase in the duration of the whole project.
Critical path	A path from the start/source vertex/node to the end/sink vertex/node that entirely follows critical activities.
Early event time	The earliest time of arrival at the event allowing for the completion of all preceding activities.
Late event time	The latest time that an event can be left without extending the time needed for the project.
Total float	The amount of time that its start may be delayed without affecting the duration of the project.
Gantt (cascade) chart	A graphical way to represent the range of possible start and finish times for all activities on a single diagram.
6.4: Linear programming	
Term	**Definition**
Decision variable	A variable associated with linear programming problems. A solution is formed by assigning appropriate values to all decision variables.
Constraint	A restriction on the values of the decision variables.
Objective function	The function that defines the criteria for evaluating the solution.
Feasible solution	Values for the decision variables that satisfy each of the constraints in the linear programming problem.
Feasible region	The region that contains all the feasible solutions.
Optimal solution	A feasible solution that has the optimum objective function value.