Draft Specification for

Junior Cycle Mathematics

For approval for consultation

Contents

Introduction to junior cycle

Junior cycle education places students at the centre of the educational experience, enabling them to actively participate in their communities and in society and to be resourceful and confident learners in all aspects and stages of their lives. Junior cycle is inclusive of all students and contributes to equality of opportunity, participation and outcome for all.

The junior cycle allows students to make a greater connection with learning by focusing on the quality of learning that takes place and by offering experiences that are engaging and enjoyable for them, and relevant to their lives. These experiences are of a high quality, contribute directly to the physical, mental and social wellbeing of learners, and where possible, provide opportunities for them to develop their abilities and talents in the areas of creativity, innovation and enterprise. The learner's junior cycle programme builds on their learning to date and actively supports their progress in learning and in addition, supports them in developing the learning skills that will assist them in meeting the challenges of life beyond school.

Rationale

This mathematics specification provides students with access to important mathematical ideas to develop the mathematical knowledge and skills that they will draw on in their personal and working lives. It also provides students, as life-long learners, with the basis on which further study and research in mathematics and applications in many other fields are built.

Mathematical ideas have evolved across societies and cultures over thousands of years, and are constantly developing. Digital technologies are facilitating this expansion of ideas and provide new tools for mathematical exploration and invention. While the usefulness of mathematics for modelling and problem solving is well known, mathematics also has a fundamental role in both enabling and sustaining cultural, social, economic, and technological advances and empowering individuals to become critical citizens.

The specification is underpinned by the conception of mathematics as an interconnected body of ideas and reasoning processes that students negotiate collaboratively with teachers and their peers and as independent learners. Number, measurement and geometry, statistics and probability are common aspects of most people's mathematical experience in everyday personal, study and work situations. Equally important are the essential roles that algebra, functions and relations, logic, mathematical structure and working mathematically play in people's understanding of the natural and social worlds, and the interaction between them.

Junior Cycle Mathematics builds on students prior learning and focuses on developing increasingly sophisticated and refined mathematical understanding, fluency, reasoning, modelling and problem-solving. These capabilities enable students to respond to familiar and unfamiliar situations by employing mathematics to make informed decisions and solve problems efficiently.

The specification supports student learning across the whole educational system by ensuring that the links between the various components of mathematics, as well as the relationship between mathematics and other subjects, are emphasised. Mathematics is composed of multiple but interrelated and interdependent concepts and structures which students can apply beyond the mathematics classroom. For example, in science, understanding sources of error and their impact on the confidence of conclusions is vital; in geography, interpretation of data underpins the study of human populations and their physical environments; in history, students

need to be able to imagine timelines and time frames to reconcile related events; and in English, deriving quantitative, logical and spatial information is an important aspect of making meaning out of texts. Thus the understanding of mathematics developed through study at junior cycle can inform and support students' learning across the whole educational system.

Aim

The aim of Junior Cycle Mathematics is to provide relevant and challenging opportunities for all students to become mathematically proficient so that they can cope with the mathematical challenges of daily life and enable them to continue their study of mathematics in senior cycle and beyond. In this specification, mathematical proficiency is conceptualised not as a one-dimensional trait but as having five interconnected and interwoven components which are described below:

- conceptual understanding—comprehension of mathematical concepts, operations, and relations

- procedural fluency—skill in carrying out procedures flexibly, accurately, efficiently, and appropriately

- strategic competence—ability to formulate, represent, and solve mathematical problems in both familiar and unfamiliar contexts

- adaptive reasoning—capacity for logical thought, reflection, explanation, justification and communication

- productive disposition—habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence, perseverance and one's own efficacy.

Overview: Links

Mathematics supports a broad range of learning experiences at junior cycle. Table 1 shows how Junior Cycle Mathematics is linked to central features of learning and teaching in junior cycle.

Statements of Learning

Table 1: Links between Junior Cycle Mathematics and the Statements of Learning

The statement	Examples of possible relevant learning
SOL 1. The student communicates effectively using a variety of means in a range of contexts in L1.	Students organise, consolidate and communicate numerical and mathematical thinking clearly and coherently to peers, teachers and others verbally, and in written form using diagrams, graphs, tables and mathematical symbols.
SOL 14. The student makes informed financial decisions and develops good consumer skills.	Students learn to develop their critical thinking and reasoning skills by making value for money calculations and judgements which will enable them to make informed financial decisions.
SOL 15. The student recognises the potential uses of mathematical knowledge, skills and understanding in all areas of learning.	Students apply their mathematical knowledge and skills to a wide variety of problems across different subjects, including gathering, analysing, and presenting data, and using mathematics to model real-world situations.
SOL 16. The student describes, illustrates, interprets, predicts and explains patterns and relationships.	Students develop techniques to explore and understand patterns and relationships in both mathematical and non-mathematical contexts.
SOL 17. The student devises and evaluates strategies for investigating and solving problems using mathematical knowledge, reasoning and skills.	Students develop problem-solving strategies through engaging in tasks for which the solution is not immediately obvious. They reflect on their own solution strategies to such tasks and compare them to those of others as part of a collaborative learning cycle.

SOL 18. The student observes and evaluates empirical events and processes and draws valid deductions and conclusions.	Students generate and summarise data, select appropriate graphical or numerical methods to describe it, and draw conclusions from graphical and numerical summaries of the data. As part of their understanding of mathematical proof they come to appreciate the distinction between contingent deductions from particular cases, and deductions which can be proved to be true universally.
SOL 24. The student uses technology and digital media tools to learn, communicate, work and think collaboratively and creatively in a responsible and ethical manner.	Students engage with digital technology to analyse and display data numerically and graphically; to display and explore algebraic functions and their graphs; to explore shapes and solids; to investigate geometric results in a dynamic way; and to communicate and collaborate with others.

Key skills

In addition to their specific content and knowledge, the subjects and short courses of junior cycle provide students with opportunities to develop a range of key skills. There are opportunities to support all key skills in this course but some are particularly significant.

The junior cycle curriculum focuses on eight key skills:

Figure 1: Key skills of junior cycle

Key skill elements relating to mathematics

The examples below identify some of the elements that are related to learning activities in mathematics. Teachers can also build many of the other elements of key skills into their classroom planning. The eight key skills are set out in detail in Key Skills of Junior Cycle.

Table 2: Links between junior cycle mathematics and key skills

| Key skill	Key skill element	Examples of possible student learning activities
Being creative	*Exploring options and alternatives*	As students engage in a task for which the solution is not immediately obvious, they ask questions, explore ideas and alternatives, evaluate ideas and actions and take more responsibility for their learning.
Being literate	*Expressing ideas clearly and accurately*	Students explain their thinking and justify their reasoning, using mathematical terminology appropriately and accurately.
Being numerate	*Using digital technology to develop numeracy skills and understanding*	Students use digital technology to analyse and display data numerically and graphically; to display and explore algebraic functions and their graphs; to explore shapes and solids; to investigate geometric results in a dynamic way; and to communicate and collaborate with others.
Communicating	*Using numbers*	Students use numbers to describe or summarise a situation; to support their reasoning and conclusions; and to convey and explain patterns and relationships.
Managing information and thinking	*Thinking creatively and critically*	Students engage in rich tasks which require them to use their mathematical knowledge and skills in novel ways

		They reflect on their own approaches to such tasks and compare them to those of others, evaluating the strengths and weaknesses of different possible approaches.
Managing myself	*Being able to reflect on my own learning*	Students reflect on which learning activities they find most effective, using this knowledge to help further their learning in mathematics.
Staying well	*Being confident*	Students enjoy frequent opportunities to experience success in Mathematics. They experience a positive approach to learning in which different approaches are valued and they are encouraged to learn from mistakes.
Working with others	*Learning with others*	Students work on collaborative tasks with peers in which they develop both their mathematical and their interpersonal skills, offering mutual support and feedback throughout the process.

Overview: Course

The specification for Junior Cycle Mathematics focuses on developing students' ability to think logically, strategically, critically, and creatively through the **Unifying Strand** and the four contextual strands: **Number**; **Geometry and Trigonometry**; **Algebra and Functions**; and **Statistics and Probability**.

The specification has been designed for a **minimum** of 240 hours timetabled student engagement across the three years of junior cycle.

Figure 2: The structure of the specification for junior cycle mathematics
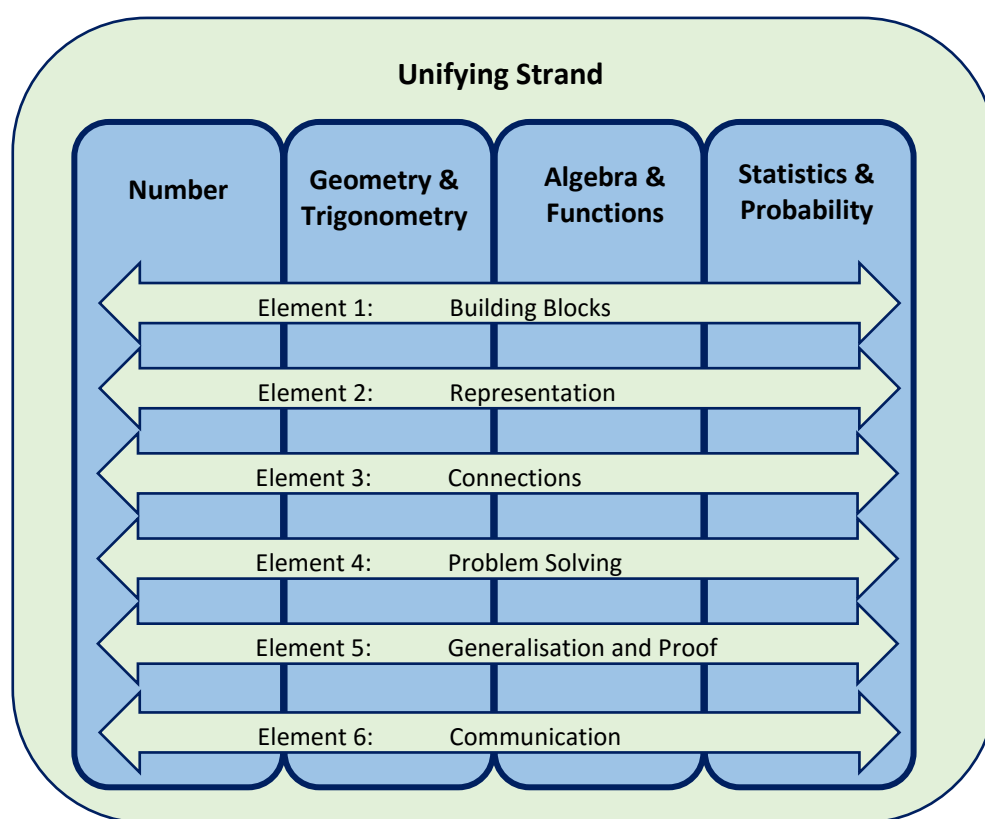
The Unifying Strand

This strand permeates all of the contextual strands and is composed of the six elements of the specification, which are shown below.

There is no specific content linked to this strand; rather, its learning outcomes underpin the rest of the specification. Each learning outcome in this strand is applicable to all of the activities and content of the other four strands – for example, students should be able to draw on all of their mathematical knowledge and skills to solve a problem or to communicate mathematics.

Furthermore, the elements of this strand are interdependent, so that students should develop the different skills associated with each element in tandem rather than in isolation – for example, engaging in problem-solving can help students improve their understanding of building blocks and their ability to make connections within mathematics.

Elements

Building blocks	Students should understand and recall the concepts that underpin each strand, and be able to carry out the resulting procedures accurately, effectively, and appropriately.
Representation	Students should be able to represent a mathematical situation in a variety of different ways and flexibly translate between each representation.
Connections	Students should be able to make connections within strands and between strands, as well as connections between mathematics and the real world.
Problem solving	Students should be able to investigate patterns, formulate conjectures, and solve problems in familiar and unfamiliar contexts.
Generalisation and proof	Students should be able to move from specific instances to general mathematical statements, and to present and evaluate mathematical arguments and proofs.
Communication	Students should be able to communicate mathematics effectively in verbal and written form.

Number

This strand focuses on different aspects of number, laying the groundwork for the transition from arithmetic to algebra. Students explore different representations of numbers and the connections between them, as well as the properties and relationships of binary operations. They investigate number patterns, and use ratio and proportionality to solve a variety of

problems in numerous contexts. Students are expected to be able to use calculators appropriately and accurately, as well as carrying out calculations by hand and mentally. They appreciate when it is appropriate to use estimation and approximation, including to check the reasonableness of results.

Geometry and trigonometry

This strand focuses on analysing characteristics and properties of two- and three-dimensional geometric shapes. Students use geometry and trigonometry to model and solve problems involving area, length, volume, and angle measure. They develop mathematical arguments about geometric relationships and explore the concept of formal proof, using deduction to establish the validity of certain geometric conjectures and critiquing the arguments of others.

Algebra and functions

This strand focuses on representing and analysing patterns and relationships found in numbers. Building on their work in the Number strand, students generalise their observations, expressing, interpreting, and justifying general mathematical statements in words and in symbolic notation. They use the idea of equality to form and interpret equations, and the syntactic rules of algebra to transform expressions and solve equations. Students explore and analyse the relationships between tables, diagrams, graphs, words, and algebraic expressions as representations of functions.

Statistics and probability

This strand focuses on determining probability from random events and generating and investigating data. Students explore the relationship between experimental and theoretical probability as well as completing a data investigation; from formulating a question and designing the investigation through to interpreting their results in context and communicating their findings. Students use graphical and numerical tools, including summary statistics and the concepts and processes of probability, to explore and analyse patterns in data. Through these activities, they gain an understanding of data anaysis as a tool for learning about the world.

Progression from early childhood to senior cycle

Early Childhood

Aistear, the early childhood curriculum framework, celebrates early childhood as a time of wellbeing and enjoyment where children learn from experiences as they unfold. Children's interests and play should be the source of their first mathematical experiences. These experiences can become mathematical as they are represented and explored. Young children represent their ideas by talking, but also through models and graphics. From the motoric and sing-song beginnings of rhymes and geometric patterns built from unit blocks stem the gradual generalisation and abstraction of patterns throughout the child's day.

Primary school

The Primary Mathematics Curriculum aims to provide children with a language and a system through which to analyse, describe, illustrate and explain a wide range of experiences, make predictions, and solve problems. Mathematics education seeks to enable learners to think and communicate quantitatively and spatially, solve problems, recognise situations where mathematics can be applied, and use appropriate technology to support such applications. The Junior Cycle Mathematics specification consolidates and develops students' learning from primary school and as such, exploration of the learning in the Primary Mathematics Curriculum is assumed.

Senior cycle

The Junior Cycle Mathematics specification is developed to align with Leaving Certificate Mathematics to allow for the effective transfer of knowledge, understanding, and skills from junior to senior cycle. While certain aspects of the strands have been adapted to specifically suit junior cycle – for example, having four rather than five strands – it is nonetheless clear from the structure of this specification how students' learning in Junior Cycle Mathematics should be developed in senior cycle. A good understanding of the knowledge and skills outlined in the specification will lay the foundations for successful engagement with Senior Cycle Mathematics.

Expectations for students

Expectations for students is an umbrella term that links learning outcomes with annotated examples of student work in the subject specification. When teachers, students or parents looking at the online specification scroll over the learning outcomes, a link will sometimes be available to examples of work associated with a specific learning outcome or with a group of learning outcomes. The examples of student work will have been selected to illustrate expectations, will have been annotated by teachers and will be made available alongside this specification. The examples will include work that is:

- exceptional

- above expectations

- in line with expectations.

The purpose of the examples of student work is to show the extent to which the learning outcomes are being realised in actual cases.

Learning outcomes

Learning outcomes are statements that describe what knowledge, understanding, skills and values students should be able to demonstrate having studied mathematics in junior cycle. Junior Cycle Mathematics is offered at Ordinary and Higher level. The majority of the learning outcomes set out in the following tables apply to all students. Additional learning outcomes for those students who take Higher level mathematics are emboldened. As set out here, the learning outcomes represent outcomes for students at the end of their three years of study. The specification stresses that the learning outcomes are for three years and therefore the learning outcomes focused on at a point in time will not have been 'completed', but will continue to support students' learning of mathematics up to the end of junior cycle.

The outcomes are numbered within each strand. The numbering is intended to support teacher planning in the first instance and does not imply any hierarchy of importance across the outcomes themselves. The examples of student work linked to learning outcomes will offer commentary and insights that support different standards of student work.

Unifying Strand

Element: Building blocks

Students should be able to:

U.1 recall and demonstrate understanding of the fundamental concepts and procedures that underpin each strand

U.2 apply the procedures associated with each strand accurately, effectively, and appropriately

U.3. recognise that equality is a relationship in which two mathematical expressions have the same value

Element: Representation

Students should be able to:

U.4 represent a mathematical situation in a variety of different ways, including: numerically, algebraically, graphically, physically, in words – and to interpret, analyse, and compare such representations

Element: Connections

Students should be able to:

U.5 make connections within and between strands

U.6 make connections between mathematics and the real world

Element: Problem solving

Students should be able to:

U.7 make sense of a given problem, and if necessary mathematise a situation

U.8 apply their knowledge and skills to solve a problem, including decomposing it into manageable parts and/or simplifying it using appropriate assumptions

U.9 interpret their solution to a problem in terms of the original question

U.10 evaluate different possible solutions to a problem, including assessing the reasonableness of the solutions, identifying possible improvements and/or limitations of the solutions (if any)

Element: Generalisation and proof

Students should be able to:

U.11 formulate general mathematical statements or conjectures based on specific instances

U.12 present and evaluate mathematical arguments and proofs

Element: Communication

Students should be able to:

U.13 communicate mathematics effectively: justify their reasoning, interpret their results, explain their conclusions, and use the language and notation of mathematics to express mathematical ideas precisely

Number Strand

Students should be able to:

N.1 investigate the representation of numbers and arithmetic operations so that they can

a) represent the operations of addition, subtraction, multiplication, and division in $\mathbb{N}$, $\mathbb{Z}$, and $\mathbb{Q}$ using models including the number line, decomposition, and accumulating groups of equal size

b) perform the operations of addition, subtraction, multiplication, and division and understand the relationship between these operations and the properties: (commutative, associative and distributive) in $\mathbb{N}$, $\mathbb{Z}$, and $\mathbb{Q}$ (**and in $\mathbb{R} \setminus \mathbb{Q}$ at HL, including operating on surds**)

c) explore numbers written as exponents (in index form) so that they can

   I. flexibly translate between whole number and index representation of numbers

   II. use and apply the rules $a^p\, a^q = a^{p+q}$; $(a^p)/(a^q) = a^{p-q}$; $(a^p)^q = a^{pq}$; and $n^{1/2} = \sqrt{n}$, for $a \in \mathbb{Z}$, and $p, q, p{-}q, \sqrt{n} \in \mathbb{N}$ (**and for $a, a^p, a^q, \sqrt{n} \in \mathbb{R}$, and $p, q \in \mathbb{Q}$ at HL**)

   III. use and apply the rules $a^0 = 1$; $a^{p/q} = \sqrt[q]{a^p} = (\sqrt[q]{a})^p$; $a^{-r} = 1/(a^r)$; $(ab)^r = a^r\, b^r$; and $(a/b)^r = (a^r)/(b^r)$, for $a, a^p, a^q \in \mathbb{R}$; $p, q \in \mathbb{Z}$; and $r \in \mathbb{Q}$

   IV. generalise numerical relationships involving numbers written in index form

   V. correctly use the order of arithmetic and index operations including the use of brackets

d) calculate and interpret factors (including the highest common factor), multiples (including the lowest common multiple), and prime numbers

e) present numerical answers to the degree of accuracy specified, for example, correct to the nearest hundred, to two decimal places, or to three significant figures

f) convert the number p in decimal form to the form $a \times 10^n$, where $1 \le a < 10$, $n \in \mathbb{Z}$, $p \in \mathbb{Q}$, and $p \ge 1$ (**and $0 < p < 1$**)

N.2 investigate equivalent representations of rational numbers so that they can

a) flexibly convert between fractions, decimals, and percentages

b) use and understand ratio and proportion

c) solve money-related problems including those involving bills, VAT, profit or loss, % profit or loss (on the cost price), cost price, selling price, compound interest for not more than 3 years, income tax (standard rate only), net pay (including other deductions of specified amounts), value for money calculations and judgements, **mark up (profit as a % of cost price), margin (profit as a % of selling price), compound interest, income tax and net pay (including other deductions)**

N.3 investigate situations involving proportionality so that they can:

a) use absolute and relative comparison where appropriate

b) model situations involving proportionality, including those involving currency conversion and those involving average speed, distance, and time.

N.4 analyse numerical patterns in different ways, including making out tables and graphs, and continue such patterns

N.5 explore the concept of a set so that they can

a) understand the concept of a set as a well-defined collection of elements, and that set equality is a relationship where two sets have the same elements

b) define sets by listing their elements, if finite (including in a 2-set or **3-set** Venn diagram**)**, or by describing rules that define them

c) use and understand suitable set notation and terminology, including null set, $\varnothing$, subset, $\subset$, cardinal number, #, intersection, $\cap$, union, $\cup$, set difference, \, $\mathbb{N}$, $\mathbb{Z}$, $\mathbb{Q}$, $\mathbb{R}$, and $\mathbb{R}\backslash\mathbb{Q}$

d) perform the operations of intersection and union on 2 sets **(and on 3 sets)**, set difference, and complement, including the use of brackets to define the order of operations

e) **investigate whether the set operations of intersection, union, and difference are commutative and/or associative**.

Geometry and Trigonometry Strand

Students should be able to:

GT.1   calculate, interpret, and apply units of measure and time

GT.2   investigate 2D shapes and 3D solids so that they can

a) draw and interpret scaled diagrams

b) draw and interpret nets of rectangular solids, **prisms (polygonal bases), cylinders**

c) find the perimeter and area of plane figures made from combinations of discs, triangles, and rectangles

d) find the volume of rectangular solids, cylinders, **triangular based prisms, spheres**, and combinations of these

e) find the surface area and curved surface area (as appropriate) of rectangular solids, **cylinders, triangular based prisms, spheres,** and combinations of these

GT.3 investigate the concept of proof through their engagment with geometry so that they can

a) recall and use the concepts, axioms, theorems, corollaries and converses, specified in *Geometry for Post-Primary School Mathematics* (section 9 for OL **and section 10 for HL**)

I.   axioms 1,2,3,4 and 5

II.   theorems 1,2,3,4,5,6,9,10,13,14,15 **and 11,12,19,** and appropriate converses

III.   corollaries 3,4 **and 1,2,5** and approprite converses

b) **use and explain the terms: theorem, proof, axiom, corollary, converse, and implies**

c) apply the concept of proof to develop geometrical understanding

d) display understanding of the proofs of theorems 1, 2, 3, 4, 5, 6, 9,10,14,15, **and 13**, **19;** and of corollaries 3, 4, **and 1,2,5** (formal proofs are not examinable)

e) perform constructions 1 to 15 in *Geometry for Post-Primary School Mathematics* **(constructions 3 and 7 at HL only)**

GT.4 evaluate and use trigonometric ratios (sin, cos, and tan, defined in terms of right-angled triangles) and their inverses, involving angles between 0° and 90° in decimal form

GT.5 investigate properties of points, lines and line segments in the co-ordinate plane so that they can

    a) find and interpret: distance, midpoint, slope, point of intersection, and slopes of parallel **and perpendicular** lines

    b) draw graphs of line segments and interpret such graphs in context, including discussing the rate of change (slope) and the y intercept

    c) find and interpret the equation of a line in the form $y = mx + c$; $y - y_1 = m(x - x_1)$; and **$ax + by + c = 0$** (for a, b, c, m, x_1, $y_1 \in \mathbb{Q}$); including finding the slope, the y intercept, and other points on the line

GT.6 investigate transformations of simple objects so that they can

    a) recognise and draw the image of points and objects under translation, central symmetry, axial symmetry, and rotation

    b) locate the axes of symmetry in shapes.

Algebra and Functions Strand

Students should be able to:

AF.1 investigate patterns and relationships (linear, quadratic, doubling and tripling) in number, spatial patterns and real-world phenomena involving change so that they can

a) represent these patterns and relationships in tables and graphs

b) write a generalised expression for linear (and quadratic) patterns in words and algebraic expressions and fluently translate between each representation

c) categorise patterns as linear, non-linear, quadratic, and exponential (doubling and tripling) using their defining characteristics as they appear in the different representations

AF.2 investigate situations in which letters stand for quantities that are variable so that they can

a) generate and interpret expressions in which letters stand for numbers

b) evaluate expressions given the value of the variables

c) use the concept of equality to form and interpret equations

AF.3 apply the properties of arithmetic operations and factorisation to generate equivalent expressions so that they can develop and use appropriate strategies to

a) add, subtract and simplify

   i. linear expressions in one or more variables with coefficients in $\mathbb{Q}$

   ii. quadratic expressions in one variable with coefficients in $\mathbb{Z}$

   iii. **expressions of the form $a / (bx + c)$, where $a, b, c \in \mathbb{Z}$**

b) multiply expressions of the form

   - i. $a (bx + cy + d)$; $a (bx2 + cx + d)$; and $ax (bx2 + cx + d)$, where $a, b, c, d \in \mathbb{Z}$

   ii. $(ax + b) (cx + d)$ (and $(ax + b) (cx2 + dx + e)$), where $a, b, c, d, e \in \mathbb{Z}$

iii. divide quadratic and cubic expressions by linear expressions, where all coefficients are integers and there is no remainder

c) flexibly translate between the factorised and expanded forms of algebraic expressions of the form:

   I. axy, where a $\in \mathbb{Z}$

   II. $axy + byz$, where a, b $\in \mathbb{Z}$

   III. $sx - ty + tx - sy$, where $s, t \in \mathbb{Z}$

   IV. $dx^2 + bx$; $x^2 + bx + c$; **(and $ax^2 + bx + c$)**, where $b, c, d \in \mathbb{Z}$ **and $a \in \mathbb{N}$**

   V. $x^2 - a^2$ **(and $a^2 x^2 - b^2 y^2$)**, where $a, b \in \mathbb{N}$

AF.4 select and use suitable strategies (graphic, numeric, algebraic, trial and improvement, working backwards) for finding solutions to

a) linear equations in one variable with coefficients in $\mathbb{Q}$ and solutions in $\mathbb{Z}$ **or in $\mathbb{Q}$**

b) quadratic equations in one variable with coefficients and solutions in $\mathbb{Z}$ (**coefficients in $\mathbb{Q}$ and solutions in $\mathbb{R}$)**

c) simultaneous linear equations in two variables with coefficients and solutions in $\mathbb{Z}$ (**or in $\mathbb{Q}$)**

d) linear inequalities in one variable of the form $g(x) < k$, and graph the solution sets on the number line for $x \in \mathbb{N}, \mathbb{Z}$, and $\mathbb{R}$

AF.5 **form quadratic equations given integer roots**

AF.6 **apply the relationship between operations and an understanding of the order of operations including brackets and exponents to change the subject of a formula**

AF.7 investigate the concept of a function so that they can

a) demonstrate understanding of a function

b) represent and interpret functions in different ways – graphically (for x $\in \mathbb{N}, \mathbb{Z}$, and $\mathbb{R}$, (continuous functions only), as appropriate), diagrammatically, in words, and

algebraically - using the language and notation of functions (domain, range, co-domain, $f(x) =$, $f : x \mapsto$, and $y =$) (limited to linear and quadratic at OL)

c)   use graphical methods to find and interpret approximate solutions of equations such as $f(x) = g(x)$ **(and approximate solution sets of inequalities such as f(x) < g(x))**

d)   make connections between the shape of a graph and the story of a phenomenon, including identifying and interpreting maximum and minimum points.

Statistics and Probability Strand

Students should be able to:

SP.1 investigate the outcomes of experiments so that they can

a) create a sample space for an experiment in a systematic way, including tree diagrams for successive events and two-way tables for independent events

b) use the fundamental principle of counting to solve authentic problems

SP.2 investigate random events so that they can

a) demonstrate understanding that probability is a measure on a scale of 0-1 of how likely an event (including an everyday event) is to occur

b) use the principle that, in the case of equally likely outcomes, the probability of an event is given by the number of outcomes of interest divided by the total number of outcomes

c) use relative frequency as an estimate of the probability of an event, given experimental data, and recognise that increasing the number of times an experiment is repeated generally leads to progressively better estimates of its theoretical probability

SP.3 carry out a statistical investigation so that they can

a) generate a statistical question

b) plan and implement a method to gather and source unbiased, representative data

c) categorise data (categorical, numerical)

d) select, draw and interpret appropriate graphical displays of univariate data, including pie charts, bar charts, line plots, histograms (equal intervals), ordered stem and leaf plots, **and ordered back-to-back stem and leaf plots**

e) select, calculate and interpret a variety of summary statistics to describe aspects of data- Central tendency: mean **(including of a grouped frequency distribution)**, median, mode. Variability: range,

f) evaluate the effectiveness of different graphical displays in representing data

g) recognise misconceptions and misuses of statistics

h) discuss the assumptions and limitations of conclusions drawn from sample data or graphical/numerical summaries of data

Assessment and reporting

Assessment in education involves gathering, interpreting and using information about the processes and outcomes of learning. It takes different forms and can be used in a variety of ways, such as to record and report achievement, to determine appropriate routes for learners to take through a differentiated curriculum, or to identify specific areas of difficulty or strength for a given learner. While different techniques may be employed for formative, diagnostic and summative purposes, the focus of the assessment and reporting is on the improvement of student learning. To do this it must fully reflect the aim of the curriculum.

The junior cycle places a strong emphasis on assessment as part of the learning process. This approach requires a more varied approach to assessment in ensuring that the assessment method or methods chosen are fit for purpose, timely and relevant to students. Assessment in junior cycle mathematics will optimise the opportunity for students to become reflective and active participants in their learning and for teachers to support this. This rests upon the provision for learners of opportunities to negotiate success criteria against which the quality of their work can be judged by peer, self, and teacher assessment; and upon the quality of the focused feedback they get in support of their learning.

Providing focused feedback to students on their learning is a critical component of high-quality assessment and a key factor in building students' capacity to manage their own learning and their motivation to stick with a complex task or problem. Assessment is most effective when it moves beyond marks and grades, and reporting focuses not just on how the student has done in the past but on the next steps for further learning. This approach will ensure that assessment takes place as close as possible to the point of learning. Summative assessment still has a role to play, but is only one element of a broader approach to assessment.

Essentially, the purpose of assessment and reporting at this stage of education is to support learning. Parents/guardians should receive a comprehensive picture of student learning. Linking classroom assessment and other assessment with a new system of reporting that culminates in the awarding of the Junior Cycle Profile of Achievement (JCPA) will offer parents/guardians a clear and broad picture of their child's learning journey over the three years of junior cycle.

To support this, teachers and schools will have access to an Assessment Toolkit. Along with the guide to the Subject Learning and Assessment Review (SLAR) process, the Assessment Toolkit will include learning, teaching and assessment support material, including:

- formative assessment

- planning for and designing assessment

- ongoing assessments for classroom use

- judging student work – looking at expectations for students and features of quality

- reporting to parents and students

- thinking about assessment: ideas, research and reflections

- a glossary.

The contents of the Assessment Toolkit will include a range of assessment supports, advice and guidelines that will enable schools and teachers to engage with the new assessment system and reporting arrangements in an informed way, with confidence and clarity.

Assessment for the Junior Cycle Profile of Achievement

The assessment of Junior Cycle Mathematics for the purposes of the Junior Cycle Profile of Achievement (JCPA) will comprise two Classroom-Based Assessments: CBA 1; and CBA 2 and a written Assessment Task. The Assessment task is assocaited with CBA 2 and will be marked, along with a final examination, by the State Examinations Commission.

Rationale for the Classroom-Based Assessments in Mathematics

Over the three years of junior cycle, students will be provided with many opportunities to enjoy and learn mathematics. The Classroom-Based Assessments, outlined on the following pages, link to the priorities for learning and teaching in mathematics, with a particular emphasis on

problem solving and communicating. Through the Classroom-Based Assessments students will develop and demonstrate their mathematical proficiency by actively engaging in practical and authentic learning experiences.

The Classroom-Based Assessments will be carried out by all students, and will be marked at a common level. The teacher's judgement of their mathematical attainment will be recorded for subject learning and assessment review, as well as for the school's reporting to parents and students.

Classroom-Based Assessment 1:

CBA	Format	Student preparation	Completion of assessment	SLAR meeting
Mathematical investigation	Report which may be presented in a wide range of formats	Students will over a three- week period follow *the statistical enquiry cycle* **or** *the problem-solving cycle* to investigate a mathematical problem. **Statistical enquiry cycle:** formulate a question; plan and collect unbiased, representative data; organise and manage the data; explore and analyse the data using appropriate displays and numerical summaries and answer the original question giving reasons based on the analysis section. **Problem-solving cycle:** define a problem; decompose it into manageable parts and/or simplify it using appropriate assumptions; translate the problem to mathematics; model the problem with appropriate mathematics; solve the problem; interpret the solution in the context of the original problem.	End of second year	One review meeting

Classroom-Based Assessment 2:

CBA	Format	Student preparation	Completion of assessment	SLAR meeting
Mathematical investigation	Report which may be presented in a wide range of formats	Students will over a three-week period; follow *the statistical enquiry cycle* **or** *the problem-solving cycle* to investigate an entirely different mathematical problem involving mathematics from a different contextual strand to the investigation completed for CBA1.	End of first term, third year	One review meeting

Assessing the Classroom-Based Assessments

Further material setting out details of the practical arrangements related to assessment of the Classroom-Based Assessments, will be available in separate Assessment Guidelines for Mathematics. This will include, for example, the suggested length and formats for student pieces of work, and support in using 'on balance' judgement in relation to the features of quality.

The NCCA's Assessment Toolkit will also include substantial resource material for use and reference in the ongoing classroom assessment of junior cycle mathematics, as well as providing a detailed account of the Subject Learning and Assessment Review process.

Features of quality

The features of quality support student and teacher judgement of the Classroom-Based Assessments and are the criteria that will be used by teachers to assess the pieces of student work. All students will complete both CBAs. The features of quality will be available in the Assessment Guidelines for Mathematics.

Assessment Task

On completion of the second Classroom-Based Assessment, students will undertake an Assessment Task which will be marked by the State Examinations Commission.

The Assessment Task will assess students in aspects of their learning which may include:

- their ability to reflect on the development of their mathematical thinking

- their ability to evaluate new knowledge or understanding that has emerged through their experience of the Classroom-Based Assessment

- their ability to reflect on the skills they have developed, and their capacity to apply them to unfamiliar situations in the future

- their ability to reflect on how their appreciation of mathematics has been influenced through the experience of the Classroom-Based Assessment.

Final examination

There will be two examination papers, one at Ordinary and one at Higher level, set and marked by the State Examinations Commission (SEC). The examination will be two hours in duration and will take place in June of third year. The number of questions on the examination papers may vary from year to year. In any year, the learning outcomes to be assessed will constitute a sample of the relevant outcomes from the tables of learning outcomes.

Inclusive assessment practices

This specification allows for inclusive assessment practices whether as part of ongoing assessment or Classroom-Based Assessments. Where a school judges that a student has a specific physical or learning difficulty, reasonable accommodations may be put in place to remove, as far as possible, the impact of the disability on the student's performance in Classroom-Based Assessments. The accommodations, e.g. the support provided by a Special Needs assistant or the support of assistive technologies, should be in line with the arrangements the school has put in place to support the student's learning throughout the year.

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