An Roinn Oideachais agus Eolaíochta

Junior Certificate

MATHEMATICS SYLLABUS

(Higher, Ordinary and Foundation Level)

THE JUNIOR CERTIFICATE

Aims and Principles

1. The general aim of education is to contribute towards the development of all aspects of the individual, including aesthetic, creative, critical, cultural, emotional, intellectual, moral, physical, political, social and spiritual development, for personal and family life, for working life, for living in community and for leisure.

2. The Junior Certificate Programme is designed to meet the needs of all students in second-level education. Arising from this, every subject is offered at two levels, ordinary and higher. In the case of English, Irish and Mathematics a foundation level is also available.

3. The Junior Certificate Programme aims to

   - reinforce and further develop in the young person the knowledge, understanding, skills and competencies acquired at primary level;
   - extend and deepen the range and quality of the young person's educational experiences in terms of knowledge, understanding, skills and competencies;
   - develop the young person's personal and social confidence, initiative and competence through a broad, well-balanced general education;
   - prepare the young person for the requirements of further programmes of study, of employment or of life outside full-time education;
   - contribute to the moral and spiritual development of the young person and to develop a tolerance and respect for the values and beliefs of others;
   - prepare the young person for the responsibilities of citizenship in the national context and in the context of the wider European and global communities.

4. The Junior Certificate Programme is based on the following principles:

   Breadth and balance
   At this stage of their school careers, all students should have a wide range of educational experiences. Particular attention must be given to reinforcing and developing the skills of numeracy, literacy and oracy. Particular emphasis should be given to social and environmental education, science and technology and modern languages.

   Relevance
   Curriculum provision should address the immediate and prospective needs of the young person, in the context of the cultural, economic and social environment.

   Quality
   Every young person should be challenged to achieve the highest possible standards of excellence, with due regard to different aptitudes and abilities and to international comparisons.

5. Each Junior Certificate Syllabus is presented for implementation within the general curriculum context outlined above.

JUNIOR CERTIFICATE

MATHEMATICS

(HIGHER, ORDINARY AND FOUNDATION LEVEL)

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1. INTRODUCTION

1.1 Context

Mathematics is a wide-ranging subject with many aspects. On the one hand, in its manifestations in the form of counting, measurement, pattern and geometry, it permeates the natural and constructed world about us, and provides the basic language and techniques for handling many aspects of everyday and scientific life. On the other hand, it deals with abstractions, logical arguments, and fundamental ideas of truth and beauty, and so is an intellectual discipline and a source of aesthetic satisfaction. These features have caused it to be given names such as "the queen and the servant of the sciences". Its role in education reflects this dual nature: it is both practical and theoretical—geared to applications and of intrinsic interest—with the two elements firmly interlinked.

Mathematics has traditionally formed a substantial part of the education of young people in Ireland throughout their schooldays. Its value to all students as a component of general education, and as preparation for life after school, has been recognised by the community at large. Accordingly, it is of particular importance that the mathematical education offered to students should be appropriate to their abilities, needs and interests, and should fully and appositely reflect the broad nature of the subject and its potential for enhancing the students' development.

1.2 Aims

It is intended that mathematics education should:

A. Contribute to the personal development of the students:

- helping them to acquire the mathematical knowledge, skills and understanding necessary for personal fulfilment;
- developing their problem-solving skills and creative talents, and introducing them to ideas of modelling;
- developing their ability to handle abstractions and generalisations, and to recognise and present logical arguments;
- furthering their powers of communication, both oral and written, and thus their ability to share ideas with other people;
- fostering their appreciation of the creative and aesthetic aspects of mathematics, and their recognition and enjoyment of mathematics in the world around them;
- hence, enabling them to develop a positive attitude towards mathematics as an interesting and valuable subject of study;

B. Help to provide them with the mathematical knowledge, skills and understanding needed for continuing their education, and eventually for life and work:

- promoting their confidence and competence in using the mathematical knowledge and skills required for everyday life, work and leisure;
- equipping them for the study of other subjects in school;
- preparing a firm foundation for appropriate studies later on;
- in particular, providing a basis for further education in mathematics itself.

1.3 General objectives

The teaching and learning of mathematics has been described as involving *facts, skills, concepts* (or "conceptual structures"), *strategies,* and—stemming from these—*appreciation.*

In terms of student outcomes, this can be formulated as follows. The students should be able to *recall* relevant facts. They should be able to demonstrate *instrumental understanding* ("knowing how") and necessary *psychomotor* skills (skills of physical co-ordination). They should possess *relational understanding* ("knowing why"). They should be able to *apply* their knowledge in familiar and eventually in unfamiliar contexts; and they should develop *analytical* and *creative* powers in mathematics. Hence, they should develop *appreciative* attitudes to the subject and its uses. The aims listed in Section 1.2 can therefore be translated into the following general objectives.

A. Students should be able to *recall* basic facts; that is, they should be able to:

- display knowledge of conventions such as terminology and notation;
- recognise basic geometrical figures and graphical displays;
- state important derived facts resulting from their studies.

(Thus, they should have fundamental information readily available to enhance understanding and aid application.)

B. They should be able to demonstrate *instrumental understanding;* hence, they should know how (and when) to:

- carry out routine computational procedures and other such algorithms;
- perform measurements and constructions to an appropriate degree of accuracy;
- present information appropriately in tabular, graphical and pictorial form, and read information presented in these forms;
- use mathematical equipment such as calculators, rulers, set squares, protractors and compasses, as required for these procedures.

(Thus, they should be equipped with the basic competencies needed for mathematical activities.)

C. They should have acquired *relational understanding;* that is, understanding of concepts and conceptual structures, so that they can:

- interpret mathematical statements;
- interpret information presented in tabular, graphical and pictorial form;
- recognise patterns, relationships and structures;
- follow mathematical reasoning.

(Thus, they should be able to see mathematics as an integrated, meaningful and logical discipline.)

D. They should be able to *apply* their knowledge of facts and skills; that is, when working in familiar types of context, they should be able to:

- translate information presented verbally into mathematical form;
- select and use appropriate mathematical formulae or techniques in order to process the information;
- draw relevant conclusions.

(Thus, they should be able to use mathematics and recognise that it has many areas of applicability.)

E. They should be able to *analyse* information, including information presented in cross-curricular and unfamiliar contexts; hence, they should be able to:

- select appropriate strategies leading to the solution of problems;
- form simple mathematical models;
- justify conclusions.

F. They should be able to *create* mathematics for themselves; that is, they should be able to:

- explore patterns;
- formulate conjectures;
- support, communicate and explain findings.

G. They should have developed the *psychomotor* skills necessary for all the tasks described above.

H. They should be able to *communicate* mathematics, both verbally and in written form; that is, they should be able to:

- describe and explain the mathematical procedures they undertake;
- explain findings and justify conclusions (as indicated above).

I. They should *appreciate* mathematics as a result of being able to:

- use mathematical methods successfully;
- recognise mathematics throughout the curriculum and in their environment;
- apply mathematics successfully to common experience;
- acknowledge the beauty of form, structure and pattern;
- share mathematical experiences with other people.

J. They should be *aware* of the history of mathematics and hence of its past, present and future role as part of our culture.

1.4 Note

The Higher, Ordinary and Foundation Mathematics syllabuses for the Junior Certificate were introduced (as Intermediate Certificate syllabuses, entitled "Syllabus A", "Syllabus B", and "Syllabus C", respectively) in 1987, for first examination in 1990. Some amendments have been made to the content, and the amended versions are presented in this booklet.

Junior Certificate Mathematics

HIGHER LEVEL
SYLLABUS

2. HIGHER LEVEL

2.1 Rationale

The Higher course is geared to the needs of students of above average mathematical ability. Among the students taking the course are those who will proceed with their study of advanced mathematics not only for the Leaving Certificate but also at third level; some are the mathematicians of the next generation. However, not all students taking the course are future specialists or even future users of academic mathematics. Moreover, when they start to study the material, some are only beginning to be able to deal with abstract concepts.

A balance must be struck, therefore, between challenging the most able students and encouraging those who are developing a little more slowly. Provision must be made not only for the academic student of the future, but also for the citizen of a society in which mathematics appears in, and is applied to, everyday life. The course therefore focuses on material that underlies academic mathematical studies, ensuring that students have a chance to develop their mathematical abilities and interests to a high level; but it also covers the more practical and obviously applicable topics that students are meeting in their lives outside school.

For the target group, particular emphasis can be placed on the development of powers of abstraction and generalisation and on an introduction to the idea of proof—hence giving students a feeling for the great mathematical concepts that span many centuries and cultures. Problem-solving can be addressed in both mathematical and applied contexts. Alongside this, adequate attention must be paid to the acquisition and consolidation of fundamental skills, in the absence of which the students' development and progress will be handicapped.

2.2 Aims

In the light of the general aims of mathematics education listed in section 1.2, the specific aims are that the Higher course will provide students with the following:

- a firm understanding of mathematical concepts and relationships;
- confidence and competence in basic skills;
- the ability to formulate and solve problems;
- an introduction to the idea of proof and to the role of logical argument in building up a mathematical system;
- a developing appreciation of the power and beauty of mathematics and of the manner in which it provides a useful and efficient system for the formulation and solution of problems.

2.3 Assessment objectives

The assessment objectives are objectives A, B, C, D (dealing with knowledge, understanding and application), G (dealing with psychomotor skills) and H (dealing with communication). These objectives should be interpreted in the context of the aims of the Higher course as formulated above.

2.4 Content

Knowledge of the content of the primary curriculum is assumed, but many concepts and skills are revisited for treatment at greater depth and at a greater level of difficulty or abstraction.

It is assumed that calculators and mathematical tables are available for appropriate use.

Sets

1. Listing of elements of a set. Membership of a set defined by a rule. Universe, subsets. Null set (empty set). Equality of sets.

2. Venn diagrams.

3. Set operations: intersection, union, difference, complement. Set operations extended to three sets.

4. Commutative property and associative property for intersection and union; failure of commutativity and associativity for difference; necessity of brackets for the non-associative operation of difference. Distributive property of union over intersection and of intersection over union; necessity of brackets.

Not envisaged as examination terminology.

Number systems

1. The set **N** of natural numbers. Order ($<, \leq, >, \geq$). Place value. Sets of divisors. Pairs of factors. Prime numbers. Sets of multiples. Lowest common multiple. Highest common factor. Cardinal number of a set.

The operations of addition, subtraction, multiplication and division in **N**. Meaning of a^n for $a, n \in \mathbf{N}$, $n \neq 0$. Estimation leading to approximate answers.

2. The set **Z** of integers. Order ($<, \leq, >, \geq$).

The operations of addition, subtraction, multiplication and division in **Z**. Use of the number line to illustrate addition, subtraction and multiplication. Meaning of a^n for $a \in \mathbf{Z}$, $n \in \mathbf{N}$, $n \neq 0$. Estimation leading to approximate answers.

3. The set **Q** of rational numbers. Decimals, fractions, percentages. Decimals and fractions plotted on the number line.

Rational numbers expressed as decimals. Terminating decimals expressed as fractions.

The operations of addition, subtraction, multiplication and division in **Q**. Rounding off. Significant figures for integer values only. Estimation leading to approximate answers.

Ratio and proportion.

4. Meaning a^p of where $a, p \in \mathbf{Q}$.

Rules for indices (where $a, b, p, q \in \mathbf{Q}$ and $a, b \neq 0$):

$$a^p a^q = a^{p+q}$$

$$\frac{a^p}{a^q} = a^{p-q}$$

$$a^0 = 1$$

$$(a^p)a^q = a^{pq}$$

$$a^{\frac{1}{n}} = \sqrt[n]{a}, \quad n \in \mathbf{Z},\ n \neq 0,\ a > 0$$

$$a^{\frac{m}{n}} = \sqrt[n]{a^m}, \quad m, n \in \mathbf{Z},\ n \neq 0,\ a > 0$$

$$a^{-p} = \frac{1}{a^p}$$

$$(ab)^p = a^p b^p$$

$$\left(\frac{a}{b}\right)^p = \frac{a^p}{b^p}$$

Square roots, reciprocals: understanding and computation.

Scientific notation: non-zero positive rationals expressed in the form $a \times 10^n$, where $n \in \mathbf{Z}$ and $1 \leq a < 10$.

5. The set **R** of real numbers: every point on the number line represents a real number. Order (<, ≤, >, ≥).

Addition, subtraction and multiplication applied to $a \pm \sqrt{b}$, where $a \in \mathbf{Q}$, $b \in \mathbf{Q}^+$.

The set of irrational numbers $\mathbf{R} \setminus \mathbf{Q}$.

6. Commutative and associative properties for addition and multiplication; failure of commutativity and associativity for subtraction and division; distributive property of multiplication over addition.

Not envisaged as examination terminology.

Priority of operations.

Applied arithmetic and measure

1. Bills. Profit and loss. Percentage profit. Percentage discount. Tax. Annual interest. Compound interest (interest added at regular intervals to a maximum of three; formula not required). Value added tax (VAT).

Percentage profit based on cost price or selling price (relevant one to be specified in examination questions).

2. SI units of length (m), area (m^2), volume (m^3), mass (kg), and time (s). Multiples and submultiples. Twenty-four hour clock, transport timetables. Relationship between average speed, distance and time.

Multiples and submultiples: mm, cm, km, cm2, hectare, km2, cm3, g, tonne, minute, hour. Use of "litre".

3. Perimeter.

Area: square, rectangle, triangle.

Surface area and volume of rectangular solids (i.e. solids with uniform rectangular cross-section).

Derivation and use of the relevant formulae for perimeter, area and volume.

$$\frac{\text{Length of circumference of circle}}{\text{Length of diameter}} = \pi.$$

Use of formulae for length of circumference of circle ($2\pi r$) and for area of disc (i.e. area of region enclosed by circle, πr^2). Use of formulae for curved surface area and volume of cylinder ($2\pi rh$, $\pi r^2 h$), right circular cone $(\pi rl, \frac{1}{3}\pi r^2 h)$ and sphere $(4\pi r^2, \frac{4}{3}\pi r^3)$.

Application to problems, including use of the Theorem of Pythagoras.

Problems may include compound figures made out of those specified above.

Algebra

1. Meaning of variable, constant, term, expression, coefficient.

Evaluation of expressions.

2. Addition and subtraction of simple algebraic expressions of forms such as:

$(ax + by + c) \pm \cdots \pm (dx + ey + f)$

$(ax^2 + bx + c) \pm \cdots \pm (dx^2 + ex + f)$

where $a, b, c, d, e, f \in \mathbf{Z}$.

Examples:
$(2x + 3) + (4x - 2)$
$(3x + 2y) - (x + 3y - 4)$
$(5x^2 + 7x - 2) + (2x^2 - x - 7)$

Use of the associative and distributive property to simplify such expressions as:

$a(bx + cy + d) + \cdots + e(fx + gy + h)$

$a(bx^2 + cx + d)$

$ax(bx^2 + c)$

where $a, b, c, d, e, f, g, h \in \mathbf{Z}$.

Examples:
$3(x + 4) - 5(2x + 3) + 2(5x - 6)$
$5(3x^2 - 4x + 8)$

Multiplication of expressions of forms such as:

$(ax + b)(cx + d)$

$(ax + b)(cx^2 + dx + e)$

where $a, b, c, d, e \in \mathbf{Z}$.

Examples:
$(2x - 3)(5x + 4)$
$(x - 4)(x^2 - 5x - 11)$

Division of expressions of forms such as:

$(ax^2 + bx + c) \div (ex + f)$

$(ax^3 + bx^2 + cx + d) \div (ex + f)$

where $a, b, c, d, e, f \in \mathbf{Z}$.

Examples:
$(2x^2 + 11x + 15) \div (x + 3)$
$(6x^2 + x - 12) \div (3x - 4)$
$(6x^3 - x^2 - 33x - 28) \div (3x + 4)$

Rearrangement of formulae.

Addition and subtraction of expressions of the form:

$$\frac{ax + b}{c} \pm \ldots \pm \frac{dx + e}{f}$$

where $a, b, c, d, e, f \in \mathbf{Z}$,

$$\frac{a}{bx + c} \pm \frac{p}{qx + r}$$

where $a, b, c, p, q, r \in \mathbf{Z}$.

3. Use of the distributive property in the factorising of expressions such as:

$abxy + ay$

where $a, b \in \mathbf{Z}$,

$sx - ty + tx - sy$

where s, t, x, y are variable.

Example: $8xy - 4y$

Factorisation of quadratic expressions of the form:

$ax^2 + bx$

$ax^2 + bx + c$

where $a, b, c \in \mathbf{Z}$.

Difference of two squares of the form $a^2x^2 - b^2y^2$, where $a, b \in \mathbf{N}$.

4. Formation and interpretation of number sentences leading to the solution of first degree equations in one variable.

First degree equations in two variables. Problems and their solutions.

Quadratic equations of the form $ax^2 + bx + c = 0$. Solution using factors and/or the formula for real roots only. Problems and their solutions.

5. Equations of the form:

$$\frac{ax + b}{c} \pm \ldots \pm \frac{dx + e}{f} = \frac{g}{h}$$

where $a, b, c, d, e, f, g, h \in \mathbf{Z}$.

$$\frac{a}{bx + c} \pm \ldots \pm \frac{p}{qx + r} = \frac{d}{e}$$

where $a, b, c, p, q, r, d, e \in \mathbf{Z}$. Problems and their solutions.

6. Solution of linear inequalities in one variable, of forms such as:

$ax + b \leq c$

$a \leq bx + c < d$

where $a, b, c, d \in \mathbf{Z}$.

Examples:
$2x - 1 \leq 9$
$1 \leq 2x - 1 < 11$
$3 > 2x - 7 > -5$

Statistics

1. Collecting and recording data. Tabulating data. Drawing and interpreting bar-charts, pie-charts, and trend graphs.

2. Discrete array expressed as a frequency table. Drawing and interpreting histograms.

Mean and mode. Mean of a grouped frequency distribution.

Cumulative frequency. Ogive, median, interquartile range.

Geometry

1. Synthetic geometry:

Preliminary concepts:
The plane.
Subsets of the plane: line *ab*, line segment [*ab*], half line [*ab*; collinear points.
|*ab*| as the length of the line segment [*ab*].
Half-planes.
Angle; naming an angle with three letters. Straight angle.
Angle measure; $|\angle abc|$ as the measure of $\angle abc$.
Acute, right, obtuse, and reflex angles.
Parallel lines; perpendicular lines.
Vertically opposite, alternate and corresponding angles.
Triangle (scalene, isosceles, equilateral), quadrilateral (convex), rhombus, parallelogram, rectangle, square, circle.
Concept of area in relation to these figures.

"*Fact*": A straight angle measures 180°.

****Theorem***: Vertically opposite angles are equal in measure.

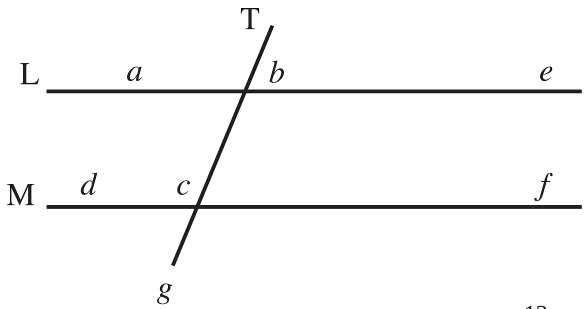
"*Fact*": Alternate angles are equal in measure when formed by two parallel lines intersecting a third line.

"*Fact*": Corresponding angles are equal in measure when formed by two parallel lines intersecting a third line.

"*Fact*": In the diagram below:

(a) If $|\angle abc| = |\angle bcf|$ then line L || line M
(b) If $|\angle abc| = |\angle dcg|$ then line L || line M

(i.e. the converses of the two previous "facts" are true).



In the case of the theorems marked with an asterisk (*), formal proofs may be examined; in the case of other results stated, proofs will not be examined.

For constructions, the use of compasses, set squares, protractor, and straight-edge are allowed unless otherwise specified.

See *Guidelines for Teachers.*

For interpretation of the use of the word "fact", see *Guidelines for Teachers.*

****Theorem***: The measures of the three angles of a triangle sum to 180°.

****Theorem***: An exterior angle of a triangle equals the sum of the two interior opposite angles in measure.

Construction: To construct a triangle, given sufficient data.

Ruler allowed.

Meaning of congruent triangles.

"*Fact*": Two triangles are congruent if they satisfy any one of the following four conditions:

- three sides in one equal in measure to three sides in the other (SSS);
- two sides and the included angle in one equal in measure, respectively, to two sides and the included angle in the other (SAS);
- two angles and a side in one equal in measure, respectively, to two angles and a corresponding side in the other (ASA);
- a right angle, hypotenuse and a side equal in measure, respectively, in each (RHS).

Construction: To bisect an angle without using a protractor.

****Theorem***: If two sides of a triangle are equal in measure, then the angles opposite these sides are equal in measure.

Converse: If a triangle has two angles equal in measure, then the sides opposite these angles are equal in measure (i.e. the triangle is isosceles).

"*Fact*": If in a triangle two sides are of unequal length, then the angles opposite these sides are unequal in measure and the larger angle is opposite the longer side.

"*Fact*": Any two sides of a triangle are together greater in measure than the third side.

"*Fact*": The area of any rectilinear figure is equal to the sum of the areas of any two non-overlapping rectilinear figures of which it is composed.

****Theorem***: Opposite sides and opposite angles of a parallelogram are respectively equal in measure.

****Theorem***: A diagonal bisects the area of a parallelogram.

Theorem: The diagonals of a parallelogram bisect each other.

Meaning of distance from a point to a line.

Meaning of base and corresponding perpendicular height of a triangle and a parallelogram.

"*Fact*": The area of a rectangle = length × breadth.

Theorem: The area of a triangle = $\frac{1}{2}$ |base| × (corresponding) perpendicular height.

Theorem: The area of a parallelogram = |base| × (corresponding) perpendicular height.

Construction: To construct the perpendicular bisector of a line segment without using a protractor or set square.

Theorem: Any point on the perpendicular bisector of a line segment [*ab*] is equidistant from *a* and *b*.

Converse: Any point equidistant from two points *a* and *b* lies on the perpendicular bisector of the line segment [*ab*].

Circle: centre, arc, chord, tangent, segment, sector, radius, diameter, semicircle. Cyclic quadrilateral.

Construction: To construct the circumcircle of a triangle.

Theorem: Any point on the bisector of an angle is equidistant from the half lines forming the angle.

Construction: To construct the incircle of a triangle.

****Theorem***: The measure of the angle at the centre of the circle is twice the measure of the angle at the circumference, standing on the same arc.

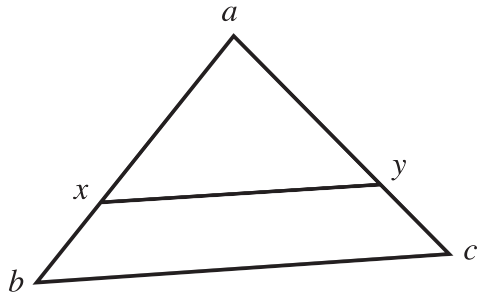
Deduction: All angles at the circumference on the same arc are equal in measure.
Deduction: An angle subtended by a diameter at the circumference is a right angle.
Deduction: The sum of opposite angles of a cyclic quadrilateral is 180°.

Theorem: If a line passes through a point *t* on a circle and is perpendicular to the diameter at *t*, then the line is a tangent to the circle at *t*.

Converse: The tangent at any point of a circle is perpendicular to the diameter drawn to the point of contact.

****Theorem***: A line through the centre of a circle perpendicular to a chord bisects the chord.

Theorem: A line drawn parallel to one side of a triangle divides the other two sides in the same ratio.



Deduction: In the diagram above:

$$\frac{|ab|}{|ax|} = \frac{|ac|}{|ay|}$$

Construction: To divide a line segment into a given number of equal parts.

Theorem: If two triangles are equiangular, the lengths of corresponding sides are in proportion.

Theorem (Theorem of Pythagoras): In a right-angled triangle, the square of the length of the side opposite to the right angle is equal to the sum of the squares of the lengths of the other two sides.

Converse of the Theorem of Pythagoras: If the square of the length of one side of a triangle is equal to the sum of the squares of the lengths of the other two sides, then the triangle has a right angle and this is opposite the longest side.

2. Transformation geometry:

Translation, central symmetry, axial symmetry. Translation and central symmetry map a line onto a parallel line. Axis and centre of symmetry. Rotation.

Intuitive approach using drawings.

3. Coordinate geometry:

Coordinating the plane.

Coordinates of images of points under translation, axial symmetry and central symmetry.

Distance. Midpoint.

Slope of a line. Parallel and perpendicular lines.

Equation of a line in the forms:

$$ax + by + c = 0$$
$$y = mx + c$$
$$y - y_1 = m(x - x_1)$$

where $a, b, c, m, x_1, y_1 \in \mathbf{Q}$.

Intersection of lines.

Trigonometry

1. Cosine, sine and tangent of angles between 0° and 360° (inclusive). Functions of 30°, 45° and 60° in surd form, derived from suitable triangles.

2. Solution of right-angled triangles and triangles requiring applications of the sine rule. Relevant problems.

Proof of sine rule not required.

Use of formulae $\frac{1}{2}ab \sin C$, $\frac{1}{2}bc \sin A$, $\frac{1}{2}ca \sin B$ for finding area.

Proof of formulae not required.

Functions and graphs

1. Concept of a function. Couples, domain, codomain, range.

2. Use of function notation:

$f(x) =$

$f : x \rightarrow$

$y =$

Drawing graphs of functions $f : x \rightarrow f(x)$, where $f(x)$ is of the form $ax + b$ or $ax^2 + bx + c$, where $a, b, c \in \mathbf{Z}$, $x \in \mathbf{R}$.

Using the graphs to estimate the (range of) value(s) of x for which $f(x) = k$, where $k \in \mathbf{R}$.

3. Maximum and minimum values of quadratic functions estimated from graphs.

4. Graphing solution sets on the number line for linear inequalities in one variable.

Solution of quadratic inequalities is excluded, but students may be asked to read off a range of values for which a function is (say) negative.

5. Graphical treatment of solution of first degree simultaneous equations in two variables.

Junior Certificate Mathematics

ORDINARY LEVEL SYLLABUS

3. ORDINARY LEVEL

3.1 Rationale

The Ordinary course is geared to the needs of students of average mathematical ability. Typically, when such students come in to second level schools, some are only beginning to be able to deal with abstract ideas and some are not yet ready to do so. However, many of them may eventually go on to use and apply mathematics—perhaps even quite advanced mathematics—in their future careers, and all of them will meet the subject to a greater or lesser degree in their daily lives.

The Ordinary course, therefore, must start where these students are, offering mathematics that is meaningful and accessible to them at their present stage of development. It should also provide for the gradual introduction of more abstract ideas, leading the students towards the use of academic mathematics in the context of further study. The course therefore pays considerable attention to consolidating the foundation laid at primary level and to addressing practical topics; but it also covers aspects of the traditional mathematical areas of algebra, geometry, trigonometry and functions.

For the target group, particular emphasis can be placed on the development of mathematics as a body of knowledge and skills that makes sense and that can be used in many different ways—hence, as an efficient system for the solution of problems and provision of answers. Alongside this, adequate attention must be paid to the acquisition and consolidation of fundamental skills, in the absence of which the students' development and progress will be handicapped.

3.2 Aims

In the light of the general aims of mathematics education listed in section 1.2, the specific aims are that the Ordinary course will provide students with the following:

- an understanding of mathematical concepts and of their relationships;
- confidence and competence in basic skills;
- the ability to solve problems;
- an introduction to the idea of logical argument;
- appreciation both of the intrinsic interest of mathematics and of its usefulness and efficiency for formulating and solving problems.

3.3 Assessment objectives

The assessment objectives are objectives A, B, C, D (dealing with knowledge, understanding and application), G (dealing with psychomotor skills) and H (dealing with communication). These objectives should be interpreted in the context of the aims of the Ordinary course as formulated above.

3.4 Content

The content of the primary curriculum is taken as a prerequisite, but many concepts and skills are revisited for treatment at greater depth and at a greater level of difficulty or, ultimately, of abstraction.

It is assumed that calculators and mathematical tables are available for appropriate use.

Sets

1. Listing of elements of a set. Membership of a set defined by a rule. Universe, subsets. Null set (empty set). Equality of sets.

2. Venn diagrams.

3. Set operations: intersection, union, difference, complement. Set operations extended to three sets.

4. Commutative property and associative property for intersection and union; failure of commutativity and associativity for difference; necessity of brackets for the non-associative operation of difference.

Not envisaged as examination terminology.

Number systems

1. The set **N** of natural numbers. Order ($<, \leq, >, \geq$). Place value. Sets of divisors. Pairs of factors. Prime numbers. Sets of multiples. Lowest common multiple. Highest common factor. Cardinal number of a set.

The operations of addition, subtraction, multiplication and division in **N**. Meaning of a^n for $a, n \in \mathbf{N}$, $n \neq 0$. Estimation leading to approximate answers.

2. The set **Z** of integers. Order ($<, \leq, >, \geq$).

The operations of addition, subtraction, multiplication and division in **Z**. Use of the number line to illustrate addition, subtraction and multiplication. Meaning of a^n for $a \in \mathbf{Z}$, $n \in \mathbf{N}$, $n \neq 0$. Estimation leading to approximate answers.

3. The set **Q** of rational numbers. Decimals, fractions, percentages. Decimals and fractions plotted on the number line.

The operations of addition, subtraction, multiplication and division in **Q**. Rounding off. Estimation leading to approximate answers.

Ratio and proportion.

4. Rules for indices (where $a \in \mathbf{Q}$, $m, n \in \mathbf{N}$, $m \neq 0$, $n \neq 0$):

$$a^m a^n = a^{m+n}$$

$$\frac{a^m}{a^n} = a^{m-n}, \; m > n$$

$$(a^m)^n = a^{mn}$$

Meaning of $a^{\frac{1}{2}}$, $a \geq 0$.

Square roots, reciprocals: understanding and computation.

Scientific notation: non-zero positive rationals expressed in the form $a \times 10^n$, where $n \in \mathbf{N}$ and $1 \leq a < 10$.

5. The set **R** of real numbers: the idea that every point on the number line represents a real number. Order ($<, \leq, >, \geq$).

6. Commutative and associative properties for addition and multiplication; failure of commutativity and associativity for subtraction and division; distributive property of multiplication over addition.

Priority of operations.

Not envisaged as examination terminology.

Applied arithmetic and measure

1. Bills. Profit and loss. Percentage profit. Percentage discount. Tax. Annual interest. Compound interest (interest added at regular intervals to a maximum of three; formula not required). Value added tax (VAT).

Percentage profit based on cost price or selling price (relevant one to be specified in examination questions).

2. SI units of length (m), area (m^2), volume (m^3), mass (kg), and time(s). Multiples and submultiples. Twenty-four hour clock, transport timetables. Relationship between average speed, distance and time.

Multiples and submultiples: mm, cm, km, cm^2, hectare, km^2, cm^3, g, tonne, minute, hour. Use of "litre".

3. Perimeter.

Area: square, rectangle, triangle.

Surface area and volume of rectangular solids (i.e. solids with uniform rectangular cross-section).

$$\frac{\text{Length of circumference of circle}}{\text{Length of diameter}} = \pi.$$

Use of formulae for length of circumference of circle ($2\pi r$) and for area of disc (i.e. area of region enclosed by circle, πr^2).

Use of formulae for curved surface area and volume of cylinder ($2\pi rh$, $\pi r^2 h$) and sphere ($4\pi r^2, \frac{4}{3}\pi r^3$).

Application to problems.

Problems may include compound figures made out of those specified above.

Algebra

1. Meaning of variable, constant, term, expression, coefficient.

Evaluation of expressions.

2. Addition and subtraction of simple algebraic expressions of forms such as:

$(ax + by + c) \pm \ldots \pm (dx + ey + f)$

$(ax^2 + bx + c) \pm \ldots \pm (dx^2 + ex + f)$

where $a, b, c, d, e, f \in \mathbf{Z}$.

Examples:
$(2x + 3) + (4x - 2)$
$(3x + 2y) - (x + 3y - 4)$
$(5x^2 + 7x - 2) + (2x^2 - x - 7)$

Use of the associative and distributive property to simplify such expressions as:

$a(bx + cy + d) + \ldots + e(fx + gy + h)$

$a(bx^2 + cx + d)$

$ax(bx^2 + c)$

where $a, b, c, d, e, f, g, h \in \mathbf{Z}$.

Examples:
$3(x + 4) - 5(2x + 3) + 2(x + 3) + 2(5x - 6)$
$y(2x + 1)$

Multiplication of expressions of the form:

$(ax + b)(cx + d)$

$(ax + b)(cx^2 + dx + e)$

where $a, b, c, d, e \in \mathbf{Z}$.

Examples:
$(2x - 3)(5x + 4)$
$(x - 4)(x^2 - 5x - 11)$

Addition and subtraction of expressions of the form

$$\frac{ax + b}{c} \pm \ldots \pm \frac{dx + e}{f}$$

where $a, b, c, d, e, f \in \mathbf{Z}$.

3. Use of the distributive law in the factorising of expressions such as:

$abxy + ay$

where $a, b \in \mathbf{Z}$,

$sx - ty + tx - sy$

where s, t, x, y are variable.

Example: $8xy - 4y$

Factorisation of quadratic expressions of the form:

$ax^2 + bx$

$x^2 + bx + c$

where $a, b, c \in \mathbf{Z}$.

Difference of two squares. Simple examples.

Examples:
$x^2 - y^2$
$x^2 - 16$
$9 - y^2$

4. Formation and interpretation of number sentences leading to the solution of first degree equations in one variable.

First degree equations in two variables, with coefficients elements of **Z** and solutions also elements of **Z**. Problems and their solutions.

Quadratic equations of the form $x^2 + bx + c = 0$ where $b, c \in \mathbf{Z}$ and $x^2 + bx + c$ is factorisable. Solution of simple problems leading to quadratic equations.

5. Solution of equations of the form

$$\frac{ax+b}{c} \pm \ldots \pm \frac{dx+e}{f} = \frac{g}{h}$$

where $a, b, c, d, e, f, g, h \in \mathbf{Z}$.

6. Solution of linear inequalities in one variable, of forms such as $ax + b \leq c$, where $a, b, c \in \mathbf{Z}$, $x \in \mathbf{Z}$.

Examples:
$2x - 1 \leq 9$
$10 - 2x > 2$

Statistics

1. Collecting and recording data. Tabulating data. Drawing and interpreting bar-charts, pie-charts and trend graphs.

Harder examples than those expected at primary level.

2. Discrete array expressed as a frequency table.

Mean and mode.

Geometry

1. Synthetic geometry:

Practical approach, for example using drawings.

For constructions, the use of compasses, set squares, protractor, and straight-edge are allowed unless otherwise specified.

Preliminary concepts:
The plane.
Subsets of the plane: line *ab*, line segment [*ab*], half line [*ab*; collinear points.
|*ab*| as the length of the line segment [*ab*].
Half-planes.
Angle; naming an angle with three letters. Straight angle.
Angle measure; $|\angle abc|$ as the measure of $\angle abc$.
Acute, right, obtuse, and reflex angles.
Parallel lines; perpendicular lines.
Vertically opposite, alternate and corresponding angles.
Triangle (scalene, isosceles, equilateral), quadrilateral (convex), rhombus, parallelogram, rectangle, square, circle.
Concept of area in relation to these figures.

See *Guidelines for Teachers.*

"*Fact*": A straight angle measures 180°.

For interpretation of the use of the word "fact", see *Guidelines for Teachers.*

Theorem: Vertically opposite angles are equal in measure.

"*Fact*": Alternate angles are equal in measure when formed by two parallel lines intersecting a third line.

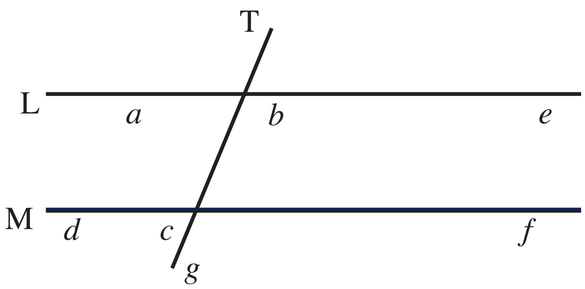
"*Fact*": Corresponding angles are equal in measure when formed by two parallel lines intersecting a third line.

"Fact": In the diagram below:

(a) If $|\angle abc| = |\angle bcf|$ then line L || line M

(b) If $|\angle abc| = |\angle dcg|$ then line L || line M

(i.e. the converses of the two previous "facts" are true).



Theorem: The measures of the three angles of a triangle sum to 180°.

Theorem: An exterior angle of a triangle equals the sum of the two interior opposite angles in measure.

Construction: To construct a triangle, given sufficient data.

Ruler allowed.

Meaning of congruent triangles.

"Fact": Two triangles are congruent if they satisfy any one of the following four conditions:

- three sides in one equal in measure to three sides in the other (SSS);
- two sides and the included angle in one equal in measure, respectively, to two sides and the included angle in the other (SAS);
- two angles and a side in one equal in measure, respectively, to two angles and a corresponding side in the other (ASA);
- a right angle, hypotenuse and a side equal in measure, respectively, in each (RHS).

Construction: To bisect an angle without using a protractor.

Theorem: If two sides of a triangle are equal in measure, then the angles opposite these sides are equal in measure.

Converse: If a triangle has two angles equal in measure, then the sides opposite these angles are equal in measure (i.e. the triangle is isosceles).

"Fact": If in a triangle two sides are of unequal length, then the angles opposite these sides are unequal in measure and the larger angle is opposite the longer side.

"Fact": Any two sides of a triangle are together greater in measure than the third side.

"Fact": The area of any rectilinear figure is equal to the sum of the areas of any two non-overlapping rectilinear figures of which it is composed.

Theorem: Opposite sides and opposite angles of a parallelogram are respectively equal in measure.

Theorem: A diagonal bisects the area of a parallelogram.

Theorem: The diagonals of a parallelogram bisect each other.

Meaning of distance from a point to a line.

Meaning of base and corresponding perpendicular height of a triangle and a parallelogram.

"Fact": The area of a rectangle = length × breadth.

Theorem: The area of a triangle = $\frac{1}{2}$ |base| × (corresponding) perpendicular height.

Theorem: The area of a parallelogram = |base| × (corresponding) perpendicular height.

Construction: To construct the perpendicular bisector of a line segment without using a protractor or set square.

Construction: To divide a line segment into three equal parts.

Circle: centre, arc, chord, tangent, segment, sector, radius, diameter, semicircle. Cyclic quadrilateral.

Theorem: An angle subtended by a diameter at the circumference is a right angle.

Theorem: The sum of opposite angles of a cyclic quadrilateral is 180°.

Theorem (Theorem of Pythagoras): In a right-angled triangle, the square of the length of the side opposite to the right angle is equal to the sum of the squares of the lengths of the other two sides.

Converse of the Theorem of Pythagoras: If the square of the length of one side of a triangle is equal to the sum of the squares of the lengths of the other two sides, then the triangle has a right angle and this is opposite the longest side.

2. Transformation geometry:

Intuitive approach using drawings.

Translation, central symmetry, axial symmetry.

Translation and central symmetry map a line onto a parallel line. Axis and centre of symmetry.

3. Coordinate geometry:

Coordinating the plane.

Coordinates of images of points under translation, axial symmetry in the x or y axis and central symmetry in the origin.

Using two points to get the midpoint, distance, slope.

Equation of a line in the form $y - y_1 = m(x - x_1)$.

Intersection of a line with x and y axes (using algebraic methods).

Formulae provided in examinations. Same scale to be used on each axis in diagrams.

Trigonometry

1. Cosine, sine and tangent of angles less than 90°. Values of these ratios for integer values of angle. Value of angle (to nearest degree), given value of sin, cos, tan.

2. Solution of right-angled triangle problems of a simple nature involving heights and distances, including use of the Theorem of Pythagoras.

Functions and graphs

1. Concept of a function. Couples, domain, codomain, range.

2. Use of function notation:

$f(x) =$

$f : x \rightarrow$

$y =$

Drawing graphs of functions $f : x \rightarrow f(x)$, where $f(x)$ is of the form $ax + b$ or $ax^2 + bx + c$, where $a, b, c \in \mathbf{Z}$, $x \in \mathbf{R}$.

Using the graphs to estimate solutions of equations of the type $f(x) = 0$.

3. Graphing solution sets on the number line for linear inequalities in one variable.

Example: $2x + 1 < 5$, $x \in \mathbf{R}$

4. Graphical treatment of solution of first degree simultaneous equations in two variables.

Junior Certificate Mathematics

FOUNDATION LEVEL SYLLABUS

4. FOUNDATION LEVEL

4.1 Rationale

The Foundation course is geared to the needs of students who are unready for or unsuited by the mathematics of the Ordinary course. Some are not yet at a developmental stage at which they can deal with abstract concepts; some may have encountered difficulties in adjusting to post-primary school and may need a particularly gradual introduction to second level work; some have learning styles that essentially do not match the traditional approach of post-primary schools. Many of the students may still be uncomfortable with material presented in the later stages of the primary curriculum. Nonetheless, they need to learn to cope with mathematics in everyday life and perhaps in further study.

The Foundation course, therefore, must help the students to construct a clearer knowledge of, and to develop improved skills in, basic mathematics, and to develop an awareness of its usefulness. Appropriate new material should also be introduced, so that the students can feel that they are making a fresh start and are progressing. The course therefore pays great attention to consolidating the foundation laid at primary level and to addressing practical issues; but it also covers new topics and lays a foundation for progress to more traditional study in the areas of algebra, geometry and functions. An appeal is made to different interests and learning styles, for example by paying attention to visual and spatial as well as numerical aspects.

For the target group, particular emphasis can be placed on promoting students' confidence in themselves (confidence that they can do mathematics) and in the subject (confidence that mathematics makes sense). Thus, attention must be paid to the acquisition and consolidation of fundamental skills, as indicated above; and concepts should be embedded in meaningful contexts. Many opportunities can thus be presented for students to achieve success.

4.2 Aims

In the light of the general aims of mathematics education listed in section 1.2, the specific aims are that the Foundation course will provide students with the following:

- an understanding of basic mathematical concepts and relationships;
- confidence and competence in basic skills;
- the ability to solve simple problems;
- experience of following clear arguments and of citing evidence to support their own ideas;
- appreciation of mathematics both as an enjoyable activity through which they experience success and as a useful body of knowledge and skills.

4.3 Assessment objectives

The assessment objectives are objectives A, B, C, D (dealing with knowledge, understanding and application), G (dealing with psychomotor skills) and H (dealing with communication). These objectives should be interpreted in the context of the aims of the Foundation course as formulated above.

4.4 Content

The content of the primary curriculum is taken as a prerequisite, but many concepts and skills are revisited for revision and for treatment at a greater depth or level of difficulty.

It is assumed that calculators and mathematical tables are available for appropriate use.

Sets

1. Listing of elements of a set. Membership of a set defined by a rule. Universe, subsets. Null set (empty set). Equality of sets.

2. Venn diagrams.

3. Set operations: intersection and union (for two sets only), complement.

4. Commutative property for intersection and union.

Not envisaged as examination terminology.

Number systems

1. The set **N** of natural numbers. Order ($<, \leq, >, \geq$). Idea of place value. Sets of multiples. Lowest common multiple.

The operations of addition, subtraction, multiplication and division in **N** where the answer is in **N**. Meaning of a^n for a, $n \in$ **N**, $n \neq 0$. Evaluation of expressions containing at most one level of brackets. Estimation leading to approximate answers.

Examples:
$2 + 7\,(4 - 1)$
$6 + 10 \times 3$
$3(14 - 5) - (7 + 2)$

2. The set **Z** of integers. Positional order on the number line.

The operation of addition in **Z**.

3. The set $\mathbf{Q}^+$ of positive rational numbers.

Fractions: emphasis on fractions having 2, 3, 4, 7, 8, 16, 5, 10, 100 and 1000 as denominators. Equivalent fractions. The operations of addition, subtraction and multiplication in $\mathbf{Q}^+$. Estimation leading to approximate answers. Fractions expressed as decimals; for computations without a calculator, computation for fractions with the above denominators excluding 3, 7 and 16.

Decimals: place value. The operations of addition, subtraction, multiplication and division. Rounding off to not more than three decimal places. Estimation leading to approximate answers.

Percentage: fraction to percentage. Suitable fractions and decimals expressed as percentages.

Example: $\frac{32}{100}$; 32%

Equivalence of fractions, decimals and percentages.

Example: $\frac{42}{100}$; 0.42; 42%

4. Squares and square roots.

5. Commutative property.

Priority of operations.

Not envisaged as examination terminology.

Applied arithmetic and measure

1. Bills: shopping; electricity, telephone, gas, etc. Value added tax (VAT). Applications to meter readings and to fixed and variable charges. Percentage profit: to calculate selling price when given the cost price and the percentage profit or loss; to calculate the percentage profit or loss when given the cost and selling prices. Percentage discount. Compound interest for not more than three years. Calculating income tax.

Percentage profit based on cost price or selling price (relevant one to be specified in examination questions). Also: percentage increase, e.g. 5% increase in attendance at a match.

2. SI units of length (m), area (m^2), volume (m^3), mass (kg), and time (s). Multiples and submultiples. Twenty-four hour clock, transport timetables. Relationship between average speed, distance and time.

Multiples and submultiples: mm, cm, km, g, cm^2, km^2, cm^3, minute, hour. Use of "litre".
Students should be familiar with everyday use of "weight".

3. Calculating distance from a map. Use of scales on drawings.

4. Perimeter.

Area: square, rectangle, triangle.

Volume of rectangular solids (i.e. solids with uniform rectangular cross-section).

$$\frac{\text{Length of circumference of circle}}{\text{Length of diameter}} = \pi.$$

Use of formulae for length of circumference of circle ($2\pi r$), for area of disc (i.e. area of region enclosed by circle, πr^2). Use of formula for volume of cylinder ($\pi r^2 h$).

Statistics and data handling

1. Collecting and recording data. Tabulating data. Drawing and interpreting pictograms, bar-charts, pie-charts (angles to be multiples of 30° and 45°). Drawing and interpreting trend graphs. Relationships expressed by sketching such graphs and by tables of data; interpretation of such sketches and tables.

See *Guidelines for Teachers.*

2. Discrete array expressed as a frequency table.

Mean and mode.

Algebra

1. Formulae, idea of an unknown, idea of a variable.

Informal treatment (see *Guidelines for Teachers*).

Evaluation of expressions of forms such as $ax + by$ and $a(x + y)$ where $a, b, x, y \in \mathbf{N}$; evaluation of quadratic expressions of the form $x^2 + ax + b$ where $a, b, x \in \mathbf{N}$.

Examples:
Find the value of $3x + 7y$ and of $6(x + y)$ for given values of x and y.
Find the value of $x^2 + 5x + 7$ when $x = 4$.

2. Use of associative and distributive properties to simplify expressions of forms such as:

$a(x \pm b) + c(x \pm d)$
$x(x \pm a) + b(x \pm c)$

where $a, b, c, d, x \in \mathbf{N}$.

Examples:
$3(x - 2) + 2(x + 1)$
$x(x + 1) + 2(x + 2)$
(see *Guidelines for Teachers*).

3. Solution of first degree equations in one variable where the solution is a natural number.

Examples:
Solve $3x + 4 = 19$.
Solve $4(x - 1) = 12$.

Relations, functions and graphs

1. Couples. Use of arrow diagrams to illustrate relations.

Example: “is greater than”

2. Plotting points. Joining points to form a line.

3. Drawing the graph of forms such as $y = ax + b$ for a specified range of values of x, where $a, b \in \mathbf{N}$. Simple interpretation of the graph.

Example:
Draw the graph of $y = 3x + 5$ from $x = 1$ to $x = 6$.

Geometry

1. Synthetic geometry:

Practical, intuitive approach, for example using drawings and paper-folding.

For constructions, the use of compasses, set squares, protractor, and straight-edge are allowed unless otherwise specified.

Preliminary concepts:
The plane.
Line ab, line segment $[ab]$, $|ab|$ as the length of the line segment $[ab]$.
Angle; naming an angle with three letters. Straight angle.
Angle measure; $|\angle abc|$ as the measure of $\angle abc$.
Acute, right and obtuse angles.
Parallel lines; perpendicular lines.
Vertically opposite angles.
Triangle (scalene, isosceles, equilateral), quadrilateral (convex), parallelogram, rectangle, square.

Use of geometrical instruments—ruler, compasses, set squares and protractor—to measure the length of a given line segment, the size of a given angle and the perimeter of a given square or rectangle.

Construction: To construct a line segment of given length.

Ruler allowed.

Construction: To construct a triangle when given:

Ruler allowed.

- the lengths of three sides;
- the lengths of two sides and the measure of the included angle;
- the length of a base and the measures of the base angles.

"*Fact*": A straight angle measures 180°.

"*Fact*": Vertically opposite angles are equal in measure.

"*Fact*": The measure of the three angles of a triangle sum to 180°.

For interpretation of the use of the word "fact", see *Guidelines for Teachers*.

Construction: To construct a right-angled triangle, given sufficient data.

Ruler allowed.

"*Fact*" *(Theorem of Pythagoras)*: In a right-angled triangle, the square of the length of the side opposite to the right angle is equal to the sum of the squares of the lengths of the other two sides.

Verification by finding the areas of the squares on the three sides or otherwise.

Construction: To construct a rectangle of given measurements.

Ruler allowed.

"*Fact*": A diagonal bisects the area of a rectangle.

Verification by paper-cutting or otherwise.

Construction: To draw a line through a point parallel to a given line.

Construction: To divide a line segment into two or three equal parts.

Construction: To bisect an angle without using a protractor.

Meaning of distance from a point to a line.

Meaning of base and corresponding perpendicular height of a parallelogram.

"*Fact*": The area of a parallelogram = |base| × (corresponding) perpendicular height.

2. Transformation geometry:

Intuitive approach using drawings.

Central symmetry, axial symmetry.

Use of instruments to construct the image (rectilinear figures only) under (i) axial symmetry and (ii) central symmetry.

5. ASSESSMENT IN JUNIOR CERTIFICATE MATHEMATICS

5.1 Introduction

Guidelines for assessment of the course are specified as follows.

- Assessment of the course for Junior Certificate is based on the following general principles:
  - candidates should be able to demonstrate what they know rather than what they do not know;
  - examinations should build candidates' confidence in their ability to do mathematics;
  - full coverage of both knowledge and skills should be encouraged.
- Written examination at the end of the Junior Cycle can test the following objectives (see section 1.3): objectives A to D, G and H, dealing respectively with recall, instrumental understanding, relational understanding and application, together with the appropriate psychomotor (physical) and communication skills. Other objectives are not currently assessed through the written examination.
- In interpreting the objectives suitably for students at each level, the aims of the relevant course should be borne in mind (see section 2.2, 3.2, or 4.2, as appropriate).

5.2 Design of examinations

These guidelines lead to the following points regarding the design of examinations.

- The choice of questions offered should be such as to encourage full coverage of the course and to promote equity in the tasks undertaken by different students.
- Each question in each paper should display a suitable gradient of difficulty.

  Typically, this is achieved by three-part questions with:
  - an easy first part;
  - a second part of moderate difficulty;
  - a final part of greater difficulty.

  With regard to the objectives, typically:
  - the first part tests recall or very simple manipulation;
  - the second part tests the choice and execution of routine procedures or constructions, or interpretation;
  - the third part tests application.

  Typically also, the three parts of the question should test cognate areas.
- Questions should be grouped by broad topic so that students encounter work in a familiar setting; but it is not intended that the same sub-topic should always appear in exactly the same place in the paper.
- In formulating questions:
  - the language used should be simple and direct;
  - the symbolism should be easily interpreted;
  - diagrams should be reasonably accurate, but in general no information should be communicated solely by a diagram.

5.3 Grade criteria

Knowledge and skills displayed by the students can be related to standards of achievement, as reflected in the different grades awarded for the Junior Certificate examinations. For details pertaining to grade criteria, see *Guidelines for Teachers.*

Procedures for drawing up National Syllabuses

The NCCA's Course Committees for the Junior Certificate have the following membership:

- Association of Secondary Teachers, Ireland
- Teachers' Union of Ireland
- Joint Managerial Body
- Association of Community and Comprehensive Schools
- Irish Vocational Education Association
- Subject Association
- Department of Education and Science (Inspectorate)

On the basis of the brief provided by Council, the NCCA's Course Committees prepare the syllabuses.

Recommendations of Course Committees are submitted to the Council of NCCA for approval. The NCCA, having considered such recommendations, advises the Minister for Education and Science accordingly.

Further information may be obtained by contacting the NCCA at 24 Merrion Square, Dublin 2.

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