An tSraith Shóisearach do Mhúinteoirí

Junior CYCLE for teachers

Junior Cycle Mathematics Learning Outcomes

Unifying Strand

Elements / 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

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

Connections

Students should be able to:

U.5 make connections within and between strands

U.6 make connections between mathematics and the real world

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 evaluating the reasonableness of the solutions, and exploring possible improvements and/or limitations of the solutions (if any)

Generalisation and proof

Students should be able to:

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

U.12 generate and evaluate mathematical arguments and proofs

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 N, Z, and 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 N, Z, and Q **and in R\Q, including operating on surds**

c. explore numbers written as a^b (in index form) so that they can

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

II. use and apply generalisations such as $a^p a^q = a^{p+q}$; $(a^p)/(a^q) = a^{p-q}$; $(a^p)^q = a^{pq}$; and $n^{1/2} = \sqrt{n}$, for $a \in Z$, and p, q, $p-q$, $\sqrt{n} \in N$ **and for a, b, $\sqrt{n} \in R$, and p, $q \in Q$**

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

IV. generalise numerical relationships involving operations 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 $1 \le a < 10$, $n \in Z$, $p \in Q$, 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. solve problems 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 generating rules that define them

c. use and understand suitable set notation and terminology, including null set, Ø, subset, ⊂, complement, element, ∈, universal set, cardinal number, #, intersection, ∩, union, ∪, set difference, \ , N, Z, Q, R, and R\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, including relevant operations involving pi

d. find the volume of rectangular solids, cylinders, **triangular-based prisms, spheres,** and combinations of these, including relevant operations involving pi

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 engagement with geometry so that they can:

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

b. 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 including relevant operations involving square roots

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

c. use **and explain** the terms: theorem, proof, axiom, corollary, converse, and implies

d. create and evaluate proofs of geometrical propositions

e. 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** (full formal proofs are not examinable)

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° at integer values **and 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 $y_1 \in Q$); 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. draw 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. generate a generalised expression for linear **and quadratic** patterns in words and algebraic expressions and fluently convert 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. find the value of expressions given the value of the variables

c. use the concept of equality to generate 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 Q

II. quadratic expressions in one variable with coefficients in Z

III. expressions of the form a / (bx + c), where a, b, c $\in$ Z

b. multiply expressions of the form

I. a (bx + cy + d); a (bx^2 + cx + d); and ax (bx^2 + cx + d), where a, b, c, d $\in$ Z

II. (ax + b) (cx + d) **and $(ax + b)(cx^2 + dx + e)$,** where a, b, c, d, e $\in$ Z

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

d. flexibly convert between the factorised and expanded forms of algebraic expressions of the form:

I. axy, where a $\in$ Z

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

III. sx – ty + tx – sy, where s, t $\in$ Z

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

V. $x^2 - a^2$ **and $a^2x^2 - b^2y^2$,** where a, b $\in$ Z

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 Q and solutions in Z **or in Q**

b. quadratic equations in one variable with coefficients and solutions in Z **or coefficients in Q and solutions in R**

c. simultaneous linear equations in two variables with coefficients and solutions in Z **or in Q**

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

AF.5 generate 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 functions so that they can:

a. demonstrate understanding of the concept of a function

b. represent and interpret functions in different ways — graphically (for x $\in$ N, Z, and 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 → , and y =) (drawing the graph of a function given its algebraic expression is limited to linear and quadratic functions 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. generate 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 probabilty 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 which includes the ability to:

a. generate a statistical question

b. plan and implement a method to generate and/or source unbiased, representative data, and present this data in a frequency table

c. classify 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 appropriate summary statistics to describe aspects of univariate 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. discuss misconceptions and misuses of statistics

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