# Blueprint for *MathLinks 9* Final Exam – Option 1

| **Number**<br>**General Outcome**: Develop number sense. | |
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| **Specific Outcome**: Demonstrate an understanding of powers with integral bases (excluding base 0) and whole number exponents by:<br>• representing repeated multiplication, using powers<br>• using patterns to show that a power with an exponent of zero is equal to one<br>• solving problems involving powers.<br>[C, CN, PS, R] | |
| Demonstrate the differences between the exponent and the base by building models of a given power, such as $2^3$ and $3^2$. | MC #35, Conceptual<br>MC #40, Conceptual |
| Explain, using repeated multiplication, the difference between two given powers in which the exponent and base are interchanged; e.g., $10^3$ and $3^{10}$. | |
| Express a given power as a repeated multiplication. | |
| Express a given repeated multiplication as a power. | MC #39, Procedural |
| Explain the role of parentheses in powers by evaluating a given set of powers; e.g., $(-2)^4$, $(-2^4)$ and $-2^4$. | |
| Demonstrate, using patterns, that $a^0$ is equal to 1 for a given value of $a$ (a ≠ 0). | |
| Evaluate powers with integral bases (excluding base 0) and whole number exponents. | |
| **Specific Outcome**: Demonstrate an understanding of operations on powers with integral bases (excluding base 0) and whole number exponents:<br>• $(a^m)(a^n) = a^{m+n}$<br>• $a^m \div a^n = a^{m-n}$, $m > n$<br>• $(a^m)^n = a^{mn}$<br>• $(ab)^m = a^m b^m$<br>• $\left(\dfrac{a}{b}\right)^n = \dfrac{a^n}{b^n}$, $b \neq 0$.<br>[C, CN, PS, R, T] | |
| Explain, using examples, the exponent laws of powers with integral bases (excluding base 0) and whole number exponents. | |
| Evaluate a given expression by applying the exponent laws. | MC #36, Conceptual<br>MC #39, Procedural<br>MC #41, Conceptual<br>NR #60, Procedural |
| Determine the sum of two given powers, e.g., $5^2 + 5^3$, and record the process. | |

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| Determine the difference of two given powers, e.g., $4^3 - 4^2$, and record the process. | WR #3e), Procedural |
| Identify the error(s) in a given simplification of an expression involving powers. | MC #34, Conceptual |
| **Specific Outcome**: Demonstrate an understanding of rational numbers by:<br>• comparing and ordering rational numbers<br>• solving problems that involve arithmetic operations on rational numbers.<br>[C, CN, PS, R, T, V] | |
| Order a given set of rational numbers in fraction and decimal form by placing them on a number line; e.g., $\frac{3}{5}$, $-0.666\ldots$ , $0.5$, $-\frac{5}{8}$, $\frac{3}{2}$. | NR #38, Problem Solving |
| Identify a rational number that is between two given rational numbers. | MC #42, Procedural |
| Solve a given problem involving operations on rational numbers in fraction or decimal form. | MC #7, Procedural<br>NR #8, Problem Solving |
| **Specific Outcome**: Explain and apply the order of operations, including exponents, with and without technology.<br>[PS, T] | |
| Solve a given problem by applying the order of operations without the use of technology. | MC #4, Procedural<br>WR #3a), b), Procedural |
| Solve a given problem by applying the order of operations with the use of technology. | |
| Identify the error in applying the order of operations in a given incorrect solution. | |
| **Specific Outcome**: Determine the square root of positive rational numbers that are perfect squares.<br>[C, CN, PS, R, T] | |
| (Students should be aware of the existence of positive and negative square roots; however, at this grade, they should only work with the principal, positive square root.)<br><br>Determine whether or not a given rational number is a square number, and explain the reasoning. | WR #1b), Procedural |
| Determine the square root of a given positive rational number that is a perfect square. | MC #37, Conceptual<br>MC #41, Conceptual |
| Identify the error made in a given calculation of a square root; e.g., is 3.2 the square root of 6.4? | |
| Determine a positive rational number, given the square root of that positive rational number. | |

| **Specific Outcome**: Determine an approximate square root of positive rational numbers that are non-perfect squares. [C, CN, PS, R, T] | |
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| Estimate the square root of a given rational number that is not a perfect square, using the roots of perfect squares as benchmarks. | |
| Determine an approximate square root of a given rational number that is not a perfect square, using technology; e.g., a calculator, a computer. | |
| Explain why the square root of a given rational number as shown on a calculator may be an approximation. | |
| Identify a number with a square root that is between two given numbers. | |

| **Patterns and Relations (Patterns)** **General Outcome**: Use patterns to describe the world and solve problems. | |
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| **Specific Outcome**: Generalize a pattern arising from a problem-solving context, using a linear equation, and verify by substitution. [C, CN, PS, R, V] | |
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| Write an expression representing a given pictorial, oral or written pattern. | MC #15, Problem Solving |
| Write a linear equation to represent a given context. | MC #10, Problem Solving MC #19, Problem Solving |
| Describe a context for a given linear equation. | |
| Solve, using a linear equation, a given problem that involves pictorial, oral and written linear patterns. | NR #11, Procedural NR #12, Procedural MC #47, Procedural |
| Write a linear equation representing the pattern in a given table of values, and verify the equation by substituting values from the table. | MC #20, Procedural |

| **Specific Outcome**: Graph a linear relation, analyze the graph, and interpolate or extrapolate to solve problems. [C, CN, PS, R, T, V] | |
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| Describe the pattern found in a given graph. | |
| Graph a given linear relation, including horizontal and vertical lines. | |
| Match given equations of linear relations with their corresponding graphs. | MC #13, Conceptual NR #43, Problem Solving |
| Extend a given graph (extrapolate) to determine the value of an unknown element. | MC #16, Conceptual WR #2a), Conceptual |

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| Interpolate the approximate value of one variable on a given graph, given the value of the other variable. | |
| Extrapolate the approximate value of one variable from a given graph, given the value of the other variable. | |
| Solve a given problem by graphing a linear relation and analyzing the graph. | WR #2b), c), Procedural |

**Patterns and Relations (Variables and Equations)**
**General Outcome**: Represent algebraic expressions in multiple ways.

**Specific Outcome**: Model and solve problems, using linear equations of the form:
- $ax = b$
- $\frac{x}{a} = b, a \neq 0$
- $ax + b = c$
- $\frac{x}{a} + b = c, a \neq 0$
- $ax = b + cx$
- $a(x + b) = c$
- $ax + b = cx + d$
- $a(bx + c) = d(ex + f)$
- $\frac{a}{x} = b, x \neq 0$

where $a$, $b$, $c$, $d$, $e$ and $f$ are rational numbers.
[C, CN, PS, V]

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| Model the solution of a given linear equation, using concrete or pictorial representations, and record the process. | |
| Verify by substitution whether a given rational number is a solution to a given linear equation. | MC #55, Procedural |
| Solve a given linear equation symbolically. | MC #53, Problem Solving<br>MC #54, Procedural<br>WR #3d), Procedural |
| Identify and correct an error in a given incorrect solution of a linear equation. | |
| Represent a given problem, using a linear equation. | MC #17, Conceptual<br>MC #19, Problem Solving |
| Solve a given problem, using a linear equation, and record the process. | MC #20, Procedural<br>NR #21, Procedural<br>NR #56, Procedural<br>MC #57, Procedural<br>WR #2d), Problem Solving |

| **Specific Outcome**: Explain and illustrate strategies to solve single variable linear inequalities with rational coefficients within a problem-solving context. [C, CN, PS, R, V] | |
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| Translate a given problem into a single variable linear inequality, using the symbols ≥, >, < or ≤. | |
| Determine if a given rational number is a possible solution of a given linear inequality. | MC #58, Conceptual |
| Generalize and apply a rule for adding or subtracting a positive or negative number to determine the solution of a given inequality. | MC #44, Procedural |
| Generalize and apply a rule for multiplying or dividing by a positive or negative number to determine the solution of a given inequality. | |
| Solve a given linear inequality algebraically, and explain the process orally or in written form. | |
| Compare and explain the process for solving a given linear equation to the process for solving a given linear inequality. | |
| Graph the solution of a given linear inequality on a number line. | WR #3c), Procedural |
| Compare and explain the solution of a given linear equation to the solution of a given linear inequality. | |
| Verify the solution of a given linear inequality, using substitution for multiple elements in the solution. | |
| Solve a given problem involving a single variable linear inequality, and graph the solution. | MC #50, Procedural<br>WR #3c), Procedural |
| **Specific Outcome**: Demonstrate an understanding of polynomials (limited to polynomials of degree less than or equal to 2). [C, CN, R, V] | |
| Create a concrete model or a pictorial representation for a given polynomial expression. | |
| Write the expression for a given model of a polynomial. | |
| Identify the variables, degree, number of terms and coefficients, including the constant term, of a given simplified polynomial expression. | MC #51, Conceptual<br>MC #52, Conceptual |
| Describe a situation for a given first degree polynomial expression. | |
| Match equivalent polynomial expressions given in simplified form; e.g., $4x - 3x^2 + 2$ is equivalent to $-3x^2 + 4x + 2$. | |

| **Specific Outcome**: Model, record and explain the operations of addition and subtraction of polynomial expressions, concretely, pictorially and symbolically (limited to polynomials of degree less than or equal to 2).<br>[C, CN, PS, R, V] | |
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| Model addition of two given polynomial expressions concretely or pictorially, and record the process symbolically. | MC #49, Procedural |
| Model subtraction of two given polynomial expressions concretely or pictorially, and record the process symbolically. | |
| Identify like terms in a given polynomial expression. | |
| Apply a personal strategy for addition or subtraction of two given polynomial expressions, and record the process symbolically. | MC #32, Procedural<br>MC #45, Problem Solving<br>MC #48, Procedural |
| Refine personal strategies to increase their efficiency. | |
| Identify equivalent polynomial expressions from a given set of polynomial expressions, including pictorial and symbolic representations. | |
| Identify the error(s) in a given simplification of a given polynomial expression. | |
| **Specific Outcome**: Model, record and explain the operations of multiplication and division of polynomial expressions (limited to polynomials of degree less than or equal to 2) by monomials, concretely, pictorially and symbolically.<br>[C, CN, R, V] | |
| Model multiplication of a given polynomial expression by a given monomial concretely or pictorially, and record the process symbolically. | WR #1a), Procedural |
| Model division of a given polynomial expression by a given monomial concretely or pictorially, and record the process symbolically. | |
| Apply a personal strategy for multiplication and division of a given polynomial expression by a given monomial. | MC #46, Procedural<br>MC #48, Procedural |
| Refine personal strategies to increase their efficiency. | |
| Provide examples of equivalent polynomial expressions. | WR #1a), Procedural |
| Identify the error(s) in a given simplification of a given polynomial expression. | |

| Shape and Space (Measurement) |
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| **General Outcome**: Use direct or indirect measurement to solve problems. |

| **Specific Outcome**: Solve problems and justify the solution strategy, using the following circle properties: <br> • the perpendicular from the centre of a circle to a chord bisects the chord <br> • the measure of the central angle is equal to twice the measure of the inscribed angle subtended by the same arc <br> • the inscribed angles subtended by the same arc are congruent <br> • a tangent to a circle is perpendicular to the radius at the point of tangency. <br> [C, CN, PS, R, T, V] | |
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| Provide an example that illustrates: <br> • the perpendicular from the centre of a circle to a chord bisects the chord <br> • the measure of the central angle is equal to twice the measure of the inscribed angle subtended by the same arc <br> • the inscribed angles subtended by the same arc are congruent <br> • a tangent to a circle is perpendicular to the radius at the point of tangency. | |
| Solve a given problem involving application of one or more of the circle properties. | MC #22, Procedural <br> MC #26, Conceptual/Procedural <br> MC #30, Conceptual <br> MC #31, Procedural |
| Determine the measure of a given angle inscribed in a semicircle, using the circle properties. | MC #29, Conceptual |
| Explain the relationship among the centre of a circle, a chord and the perpendicular bisector of the chord. | |

| Shape and Space (3-D Objects and 2-Shapes) |
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| **General Outcome**: Describe the characteristics of 3-D objects and 2-D shapes, and analyze the relationships among them. |

| **Specific Outcome**: Determine the surface area of composite 3-D objects to solve problems. <br> [C, CN, PS, R, V] | |
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| Determine the area of overlap in a given composite 3-D object, and explain the effect on determining the surface area (limited to right cylinders, right rectangular prisms and right triangular prisms). | |
| Determine the surface area of a given composite 3-D object (limited to right cylinders, right rectangular prisms and right triangular prisms). | MC #5, Problem Solving <br> WR #1c), Problem Solving |
| Solve a given problem involving surface area. | MC #18, Problem Solving |

| Specific Outcome: Demonstrate an understanding of similarity of polygons. [C, CN, PS, R, V] | |
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| Determine if the polygons in a given pre-sorted set are similar, and explain the reasoning. | |
| Draw a polygon similar to a given polygon, and explain why the two are similar. | |
| Solve a given problem, using the properties of similar polygons. | MC #14, Procedural |

**Shape and Space (Transformations)**
**General Outcome**: Describe and analyze position and motion of objects and shapes.

| Specific Outcome: Draw and interpret scale diagrams of 2-D shapes. [CN, R, T, V] | |
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| Identify an example of a scale diagram in print and electronic media, e.g., newspapers, the Internet, and interpret the scale factor. | |
| Draw a diagram to scale that represents an enlargement or a reduction of a given 2-D shape. | |
| Determine the scale factor for a given diagram drawn to scale. | MC #9, Problem Solving NR #33, Procedural |
| Determine if a given diagram is proportional to the original 2-D shape, and, if it is, state the scale factor. | |
| Solve a given problem that involves the properties of similar triangles. | |

| Specific Outcome: Demonstrate an understanding of line and rotation symmetry. [C, CN, PS, V] | |
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| Classify a given set of 2-D shapes or designs according to the number of lines of symmetry. | NR #3, Conceptual |
| Complete a 2-D shape or design, given one half of the shape or design and a line of symmetry. | |
| Determine if a given 2-D shape or design has rotation symmetry about the point at its centre, and, if it does, state the order and angle of rotation. | MC #1, Conceptual MC #2, Conceptual |
| Rotate a given 2-D shape about a vertex, and draw the resulting image. | |
| Identify a line of symmetry or the order and angle of rotation symmetry in a given tessellation. | |
| Identify the type of symmetry that arises from a given transformation on a Cartesian plane. | |

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| Complete, concretely or pictorially, a given transformation of a 2-D shape on a Cartesian plane; record the coordinates; and describe the type of symmetry that results. | |
| Identify and describe the types of symmetry created in a given piece of artwork. | |
| Determine whether or not two given 2-D shapes on a Cartesian plane are related by either rotation or line symmetry. | |
| Draw, on a Cartesian plane, the translation image of a given shape, using a given translation rule such as R2, U3 or →→, ↑↑; label each vertex and its corresponding ordered pair; and describe why the translation does not result in line or rotation symmetry. | |
| Create or provide a piece of artwork that demonstrates line and rotation symmetry, and identify the line(s) of symmetry and the order and angle of rotation. | |
| **Statistics and Probability (Data Analysis)** <br> **General Outcome**: Collect, display and analyze data to solve problems. | |
| **Specific Outcome**: Describe the effect of: <br> • bias <br> • use of language <br> • ethics <br> • cost <br> • time and timing <br> • privacy <br> • cultural sensitivity <br> on the collection of data. <br> [C, CN, R, T] | |
| Analyze a given case study of data collection; and identify potential problems related to bias, use of language, ethics, cost, time and timing, privacy or cultural sensitivity. | MC #24, Conceptual |
| Provide examples to illustrate how bias, use of language, ethics, cost, time and timing, privacy or cultural sensitivity may influence data. | |
| **Specific Outcome**: Select and defend the choice of using either a population or a sample of a population to answer a question. <br> [C, CN, PS, R] | |
| Identify whether a given situation represents the use of a sample or a population. | MC #6, Conceptual <br> MC #25, Conceptual <br> MC #59, Conceptual |

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| Provide an example of a situation in which a population may be used to answer a question, and justify the choice. | |
| Provide an example of a question where a limitation precludes the use of a population; and describe the limitation, e.g., too costly, not enough time, limited resources. | |
| Identify and critique a given example in which a generalization from a sample of a population may or may not be valid for the population. | MC #23, Problem Solving |
| Provide an example to demonstrate the significance of sample size in interpreting data. | |

**Specific Outcome**: Develop and implement a project plan for the collection, display and analysis of data by:
• formulating a question for investigation
• choosing a data collection method that includes social considerations
• selecting a population or a sample
• collecting the data
• displaying the collected data in an appropriate manner
• drawing conclusions to answer the question.
[C, PS, R, T, V]

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| Create a rubric to assess a project that includes the assessment of:<br>• a question for investigation<br>• the choice of a data collection method that includes social considerations<br>• the selection of a population or a sample and the justification for the selection<br>• the display of collected data<br>• the conclusions to answer the question. | |
| Develop a project plan that describes:<br>• a question for investigation<br>• the method of data collection that includes social considerations<br>• the method for selecting a population or a sample<br>• the methods for display and analysis of data. | WR #4b), Problem Solving |
| Complete the project according to the plan, draw conclusions, and communicate findings to an audience. | |
| Self-assess the completed project by applying the rubric. | |

| Statistics and Probability (Chance and Uncertainty) | |
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| **General Outcome**: Use experimental or theoretical probabilities to represent and solve problems involving uncertainty. | |
| **Specific Outcome**: Demonstrate an understanding of the role of probability in society. [C, CN, R, T] | |
| Provide an example from print and electronic media, e.g., newspapers, the Internet, where probability is used. | |
| Identify the assumptions associated with a given probability, and explain the limitations of each assumption. | |
| Explain how a single probability can be used to support opposing positions. | WR #4a), Problem Solving |
| Explain, using examples, how decisions may be based on a combination of theoretical probability, experimental probability and subjective judgement. | MC #27, Problem Solving<br>MC #28, Procedural |