Cognitive Levels of Questions and Sample Questions

Primary–Grade 12

Prepared by the Department of Education and Early Childhood Development, February 2024.

NOVA SCOTIA

Contents

Acknowledgement

A special thank you is offered to the mathematics specialists from across the province—including the Regional Centres for Education, Conseil Scolaire Acadien Provincial (CSAP), and the Mi'kmaw Kina'matnewey organization—who participated in the development of this document.

Introduction

This document has been created to guide classroom assessment practice in mathematics. It presents the cognitive level definitions, outlines verbs often associated with each level, and provides sample questions for each of the cognitive levels. The aim is to provide clarity to teachers on the three types of cognitive levels of questioning. This knowledge will help guide both instruction (e.g., through the creation of purposeful tasks, questions, and activities) and assessment.

Why focus on cognitive levels?

- Knowledge of the cognitive levels of questioning increases the likelihood that students will have exposure to the various levels of questions. This experience will help develop concept familiarity, provide opportunities to push the boundaries of students' thinking, and ultimately lead to a deeper conceptual understanding of mathematics.
- It is important to challenge students at varying cognitive levels. The cognitive demand of mathematics tasks can, and should, vary as students develop into capable and confident mathematical learners.
- When weaved into a cohesive instruction and assessment plan, a variety of tasks that vary across the three cognitive levels of questions (knowledge, application, and analysis), are most impactful.

> "Using worthwhile tasks where students are able to use a variety of methods and strategies that make sense to them, are expected to explain and justify their approaches, and are encouraged to look for connections among strategies is precisely how students build procedural fluency from conceptual understanding."
>
> —*Elementary and Middle School Mathematics: Teaching Developmentally* (Van de Walle, Karp, Bay-Williams 2018)

Exposing students to a multitude of mathematical tasks and learning experiences that demand various levels of cognitive understanding is essential to support students' learning of mathematics. Knowledge questions are low cognitive demand tasks that are straightforward, routine procedures that require basic recall or recognition of information. Application and analysis questions are more cognitively demanding tasks that challenge students to make connections to known concepts, apply these understandings to new situations, and to analyze their conclusions.

Introduction

Knowledge, application, and analysis tasks are important in every grade, primary through 12. These tasks are created to reflect the age and experience of the learners. For example, a task that is cognitively demanding of a student in grade Primary is likely less demanding of an older student who has a more developed mathematical understanding. Consequently, there is a purposeful alignment of our curriculum outcomes with the various levels of questions and there are many examples of the three cognitive types of questioning found throughout our curriculum documents. These instructional and assessment tasks provide rich and powerful educational experiences for all students. Our goal is to offer the various cognitive levels of questioning throughout our instruction and assessment of each grade-level mathematics outcome.

Notes for practice:

Analysis questions can lose their novelty over time. If students encounter numerous similar questions then they will start to recognize patterns in the solutions and as such the problem-solving nature of the questions becomes less cognitively demanding.

Some knowledge, application, and analysis questions will use the same verb. So, using a "possible verb" provided in this document does not necessarily make the question a certain cognitive level of demand. Consider the context of the question and appropriate grade-level verbs to choose the verb best suited to the purpose of the question.

Cognitive Levels

Knowledge

Facility in using mathematics, or reasoning about mathematical situations, depends on mathematical knowledge and familiarity with mathematical concepts. Knowledge of a wide range of mathematical terminology, number properties, geometric properties, basic facts, and mathematical procedures opens the door to the development of a deeper mathematical understanding and purposeful mathematical thinking.

Knowledge questions require students to recall or recognize information, names, definitions, or steps in a procedure.

Knowledge questions, items, or tasks require learners to

- rely on recall and recognition of facts, terms, concepts, or properties
- carry out a learned procedure or algorithm without having to make a connection; for example, calculate a sum, difference, product, or quotient
- recognize an equivalent representation within the same form, for example, from symbolic to symbolic
- draw or measure simple geometric figures
- retrieve information directly from a graph, table, or figure (e.g., identify a coordinate point on a cartesian plane, identify the number of objects in an arithmetic sequence when the sequence is given, read a value from a bar graph such as the number of blue cars counted)

Possible verbs: *calculate, define, evaluate, find, identify, list, measure, name, recall, recognize, solve,* and *use*

Application

Application questions challenge students to go beyond basic knowledge of mathematics to apply skills or reasoning to solve a typical problem. Application questions focus students' attention on the use of procedures for the purpose of developing deeper levels of understanding of mathematical concepts and ideas. Prior or new knowledge is often used to complete a task when solving application questions. Students are expected to understand the problem, as well as identify and use an appropriate (personal) strategy to solve the problem.

Application questions require students to make connections, represent a situation in more than one way (translating between representations), or solve contextual problems.

Application questions, items, or tasks require learners to

- show deeper mathematical understanding
- choose and apply personal strategies and reasoning to solve a problem
- represent a situation mathematically, using or translating between appropriate representations, for a particular purpose or within a given context
- require flexibility of thinking

- interpret and solve a word or story problem
- consolidate skills and knowledge from multiple concepts or strands
- make connections between facts, terms, properties, or operations
- compare figures or statements
- explain and provide the steps in a solution process
- identify or extend a pattern
- interpret and use information from a graph, table, or figure to solve a problem (e.g., interpreting a pictograph where the image does not represent 1, determining slope from a linear graph)
- model a routine problem using an appropriate mathematical representation
- solve a routine problem requiring multiple steps
- interpret a simple argument
- apply a variety of skills and knowledge from prior learning to solve problems
- examine solutions to routine problems to identify the correct solution or identify errors in a given solution
- implement and execute a set of mathematical instructions (e.g., given a set of specifications, draw figures and shapes)
- make correct decisions about set membership

Possible verbs: *apply, classify, compare, correct, describe, estimate, explain, extend, interpret, model, organize, predict, represent, show, solve, sort, summarize, translate,* and *verify*

Analysis

Analysis questions provide the opportunity for students to engage with the conceptual ideas that underlie the procedures in order to successfully complete the task and develop further understanding. Extending their thinking and reasoning to solve analysis level questions challenges students to formulate a plan and monitor their own processes. With analysis type problems, there is not a predictable, well-rehearsed approach or pathway explicitly suggested. Students must draw on prior knowledge to solve these kinds of complex problems.

Analysis questions require students to go beyond comprehension and application to higher order thinking skills, such as generalizations and non-routine problem-solving.

Analysis questions, items, or tasks require learners to:

- use complex and non-algorithmic thinking
- problem solve, reason, plan, analyze, judge, explore, and employ creative thought
- think in abstract, creative, and sophisticated ways
- analyze a mathematical situation by determining or describing the relationships between mathematical arguments or objects

Cognitive Levels

- describe how different representations can be used for different purposes
- analyze similarities and differences between procedures and concepts
- generalize results or patterns, sometimes to make them more widely applicable
- solve a novel, a multi-step, or a multiple-decision-point problem
- solve a problem with more than one strategy (including personal strategies)
- justify a solution to a problem or an assumption made in a mathematical model
- make connections between related mathematical ideas and other content areas
- describe, compare, and contrast solution methods
- justify the truth or falsity of a statement by referencing mathematical results or properties through deductive reasoning
- create mathematical models for a complex situation
- interpret the significance of findings in relation to a given concept
- create a problem using given data and conditions
- solve open-ended problems and questions with more than one solution

Possible verbs: *analyze, compare, connect, contrast, create, describe, examine, explain, formulate, generalize, infer, investigate, justify, prove, reflect,* and *relate*

Distribution of cognitive levels

The approximate percentages of knowledge, application, and analysis questions in the Nova Scotia provincial assessments for mathematics in grades P–12 are:

Knowledge 20–30%

Application 50–60%

Analysis 10–20%

These percentages are also recommended for well-balanced summative classroom-based assessments.

Sample Questions

On the following pages, there are sample questions at each grade level to help illustrate each of the cognitive levels: knowledge, application, and analysis. There was a conscious attempt to use questions from across the mathematical strands.

Modifying Questions

When creating mathematics assessments or tasks, it is possible to modify existing questions so that they become more (or less) cognitively demanding. In many cases, changing a verb or other wording in a question will alter the cognitive demand required to answer the question.

See below examples for modifying questions.

Knowledge example

Circle the core of this pattern.

This question is a knowledge question because it relies on students to recall and recognize terms, concepts, and properties.

Application example

What is the missing element in the following pattern?

The question is now transformed into an application question because the student needs to identify the pattern and then extend it to find the missing element.

Analysis example

Represent this pattern as a number pattern.

__ __ __ __ __ __ __ __ __

This question is now an analysis question as we are now asking students to think in a creative and abstract way. We are asking them to take their knowledge of numbers and of patterns and come up with a solution to the problem. While this may seem trivial, for the grade 1 student who first encounters this type of problem, it will be a cognitively demanding task.

Grade Primary

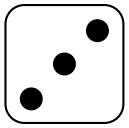
Grade Primary

#	Question	Reason	Outcome
1	Which number is between 8 and 10? ○ 8 ○ 9 ○ 10	The question relies on students to recall facts, terms, and concepts.	**Knowledge** **N01**
2	The teacher asked the class to count from 1 to 5. Which numbers would they say? ○ 1, 5 ○ 2, 3, 4 ○ 1, 2, 3, 4, 5	The question relies on students to recall facts, terms, and concepts.	**Knowledge** **N01**

Grade Primary

#	Question	Reason	Outcome
3	Leo is counting backwards from 9. Leo says: **9,8,7...** What number does Leo say next? ○ 8 ○ 6 ○ 5	The question relies on students to recall facts, terms, and concepts.	**Knowledge** **N01**
4	Which crayon is longer? ○  ○ 	The question relies on students to recall concepts related to measurement.	**Knowledge** **M01**

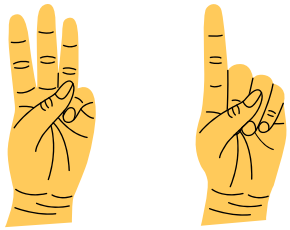
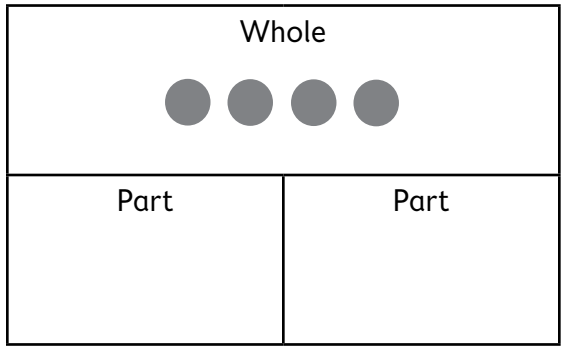
Grade Primary

#	Question	Reason	Outcome
5	Which number represents the dots shown?  ○ 2 ○ 3 ○ 4	The question relies on students to represent a situation mathematically, using or translating between appropriate representations, for a particular purpose (subitizing), or within a given context.	**Application N02**
6	Fill in the numbers that come before and after each of the numbers shown. ☐ 5 ☐ ☐ 3 ☐ ☐ 6 ☐	The question relies on students to choose and apply personal strategies and reasoning to solve a problem.	**Application N01**

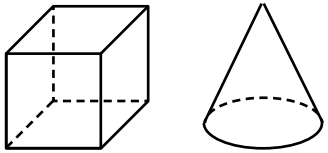
Grade Primary

#	Question	Reason	Outcome
7	Circle the mistake in the pattern. 	The question relies on students to identify or extend a pattern and examine solutions to routine problems to identify the correct solution or identify errors in a given solution.	**Application PR01**
8	Hold your pencil in one hand. Hold your glue in the other hand. Circle the lighter object: 	The question relies on students to show a mathematical understanding of measurement. It allows the student to choose and apply personal strategies.	**Application M01**

Grade Primary

#	Question	Reason	Outcome
9	Which sentence matches the fingers shown?  ○ 3 and 0 ○ 3 and 1 ○ 4 and 0	The question relies on students to solve a problem with more than one strategy (including personal strategies).	**Analysis** **N04**
10	Represent the counters shown in two parts.  	The question relies on students to use complex and non-algorithmic thinking.	**Analysis** **N04**

Grade Primary

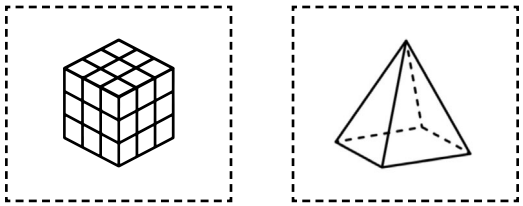
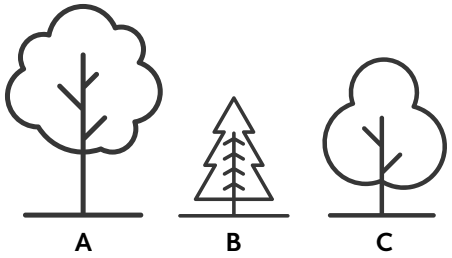
#	Question	Reason	Outcome
11	Here are two objects. How are these objects the same and how are they different? 	The question relies on students to describe, compare, and contrast.	Analysis G02
12	Sam said, “A bathtub holds less than a cup.” Is that possible? Explain your thinking. 	The question relies on students to problem solve, reason, plan, analyze, judge, explore, and employ creative thought.	Analysis M01

Grade One

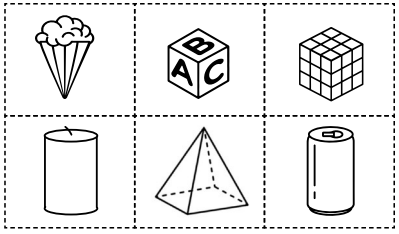
Grade One

#	Question	Reason	Outcome
1	What is the sum of these expressions? 6 + 4 8 + 2	The question relies on students to recall facts, terms, and concepts.	**Knowledge** **N10**
2	Which number is 2 less than 11? ○ 2 ○ 7 ○ 9 ○ 11	The question relies on students to perform a specified procedure or a learned method; for example, calculate a sum, difference, product, or quotient.	**Knowledge** **N08**

Grade One

#	Question	Reason	Outcome
3	What 2-D shapes are in the faces of these 3-D objects? 	The question relies on students to recall and recognize the properties and attributes of 2-D shapes and 3-D objects.	Knowledge G03
4	Look at the 3 trees A, B, and C.  A B C Put the trees, A, B, and C, in order from the shortest to the tallest tree.	The question relies on students to order given objects as well as demonstrate an understanding of measurement by identifying attributes that can be compared. It also requires students to choose and apply personal strategies and reasoning to solve a problem.	Application M01

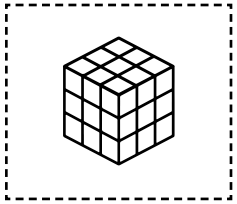
Grade One

#	Question	Reason	Outcome
5	Solve these expressions in 2 different ways? 8 + 9 8 – 2	The question relies on students to select and use different representations, depending on situation and purpose. Students must involve more flexibility of thinking to represent a situation mathematically in more than one way and can make use of personal strategies and reasoning to solve the problem.	**Application** **N10**
6	Circle the objects with rectangular or triangular faces. 	The question relies on students to make connections between facts, terms, properties, or operations as well as compare objects.	**Application** **G01**

Grade One

#	Question	Reason	Outcome
7	Which expressions have the same value? ○ 8 + 1 ○ 8 – 2 ○ 8 + 9 ○ 7 – 1 ○ 6 + 4	The question relies on students to analyze the problem and judge the answers.	**Analysis** **N10**
8	Which of these two sets of objects is heavier?  	The question relies on students to demonstrate an understanding of measurement as a process of comparing by determining which set of objects has more mass; do not suggest a method and ask them to come up with a method to solve on their own and explain their solution to you.	**Analysis** **M01**

Grade One

#	Question	Reason	Outcome
9	Name and compare these two 3-D objects. What attributes did you use to compare them?  	The question relies on students to examine 3-D objects to see how they are constructed and to become aware of their attributes, among those the 2-D shapes that make up the faces of 3-D objects.	**Analysis** **G03**

Grade Two

Grade Two

#	Question	Reason	Outcome
1	Using base ten blocks, find the difference of 73 – 45.	The question relies on students to perform a specified procedure using base-ten blocks.	**Knowledge N09**
2	Circle the core of the pattern. 	The question relies on students to recall and recognize terms, concepts, and properties.	**Knowledge PR01**

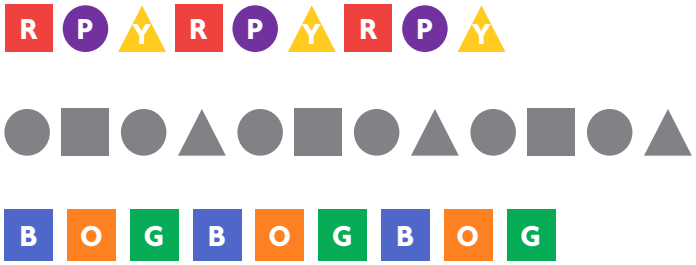
Grade Two

#	Question	Reason	Outcome
3	How many months are in a year? 	The question relies on students to recall information.	Knowledge M01
4	Find the difference of 73 and 45 using as many different strategies as you can.	The question relies on students to recall and recognize terms, concepts, and properties.	Application N09

Grade Two

#	Question	Reason	Outcome
5	Look at the repeating pattern.  Continue the pattern in two different ways.	The question relies on students to represent a situation mathematically in more than one way and to be flexible in their thinking.	Application PR01
6	It is April 16th. In two weeks, Bethany is going to the dentist. On what date will Bethany go to the dentist? **April** Sunday Monday Tuesday Wednesday Thursday Friday Saturday 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	The question relies on students to make connections between facts while solving a word problem.	Application M01

Grade Two

#	Question	Reason	Outcome
7	Add the numbers 28 and 65 in two different ways. Explain how you know why the sum is the same.	The question relies on students to analyze, investigate, and explain their solution.	Analysis N09
8	Look at these repeating patterns. Which of the patterns are alike? Explain how you know. 	The question relies on students to analyze the problem and explain their solution.	Analysis PR01

Grade Two

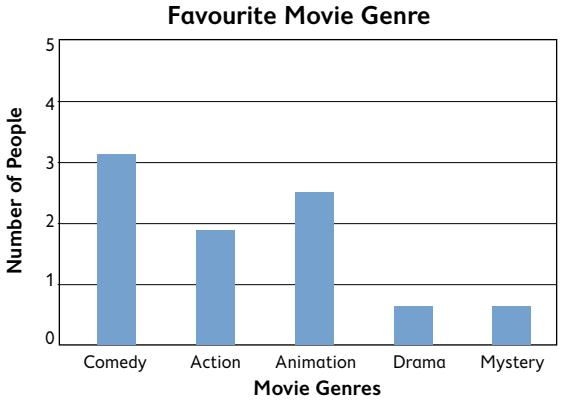
#	Question	Reason	Outcome
9	Explain how you might use a calendar to help subtract 14 from a number. Sunday Monday Tuesday Wednesday Thursday Friday Saturday 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	The question relies on students to come up with a creative solution to a novel problem.	**Analysis** **M01**

Grade Three

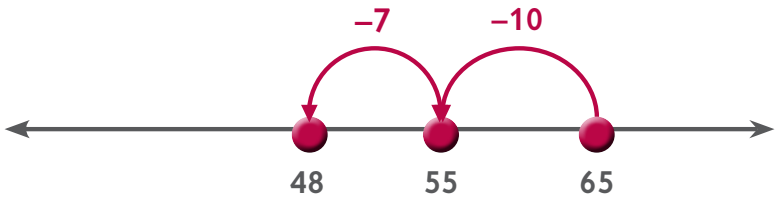
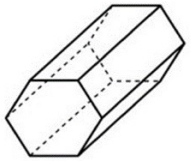
Grade Three

#	Question	Reason	Outcome
1	Which number represents the difference between 19 and 28? ○ 8 ○ 9 ○ 19 ○ 28	The question relies on students to perform a specified procedure, in this case calculate a difference.	**Knowledge** **N09**
2	Justin needs a referent with a mass closest to 1 g. Which object should Justin choose? ○ book bag ○ paper clip ○ stapler	The question relies on students to recall and recognize facts, terms, concepts, or properties.	**Knowledge** **M04**

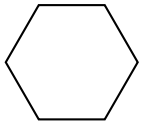
Grade Three

#	Question	Reason	Outcome
3	Lucas recorded data in the bar graph as shown:  What is the title of the bar graph?	The question relies on students to read information from a graph.	Knowledge SP02
4	It took Julie 120 minutes to drive to Nana's house for a visit. How many hours did it take? Show how you know using pictures, numbers, or words.	The question relies on students to interpret and solve a word problem.	Application M02

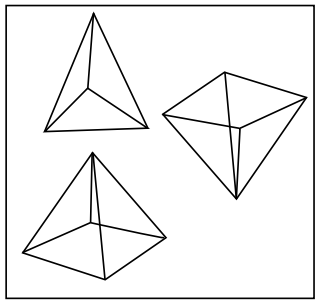
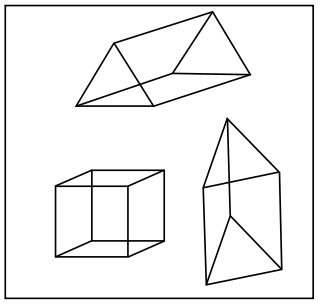
Grade Three

#	Question	Reason	Outcome
5	Which equation is represented on the number line shown?  ○ 17 + 48 = 65 ○ 48 + 17 = 65 ○ 65 – 17 = 48	The question relies on students to translate between representations.	Application N09
6	Which statement is true about the prism?  ○ The prism has rectangular and octagonal faces. ○ The prism has square and hexagonal faces. ○ The prism has rectangular and hexagonal faces. ○ The prism has square and octagonal faces.	The question relies on students to make connections between properties of 3-D objects.	Application G01

Grade Three

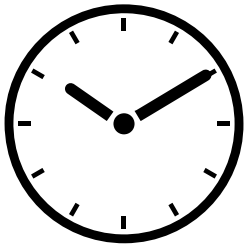
#	Question	Reason	Outcome
7	The grade 3 class has a goal to fundraise $900 for a community centre. A donor just gave them $363 and now they have $598. How much more money do they need to reach their goal? 	The question relies on students to solve a multi-step novel problem.	**Analysis** **N09**
8	A garden is the shape of a regular hexagon. One side of the hexagon is 2 m long.  What is the perimeter of the garden? ○ 2 m ○ 8 m ○ 12 m ○ 16 m	The question relies on students to solve a novel, a multi-step, or a multiple decision point problem.	**Analysis** **M05**

Grade Three

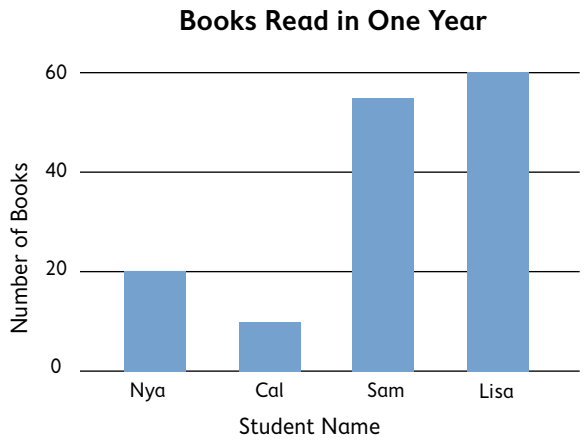
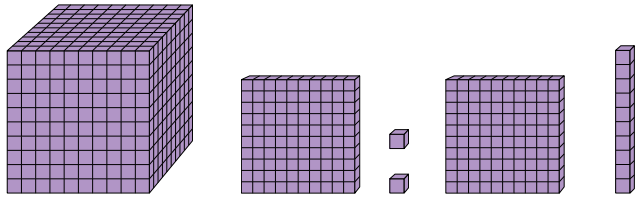
#	Question	Reason	Outcome
9	Objects were sorted into two groups as shown: GROUP A  GROUP B  Which of the following statements best describes the sorting rule used to sort the objects? ○ triangles and squares ○ polygons and non-polygons ○ pyramids and prisms ○ objects with 3 sides and objects with 4 sides	The question relies on students to compare and contrast their understanding of 3-D objects.	**Analysis** **G01**

Grade Four

Grade Four

#	Question	Reason	Outcome
1	What value does the digit 8 represent in the number 5801? ○ 8 ○ 80 ○ 800 ○ 8000	The question relies on students to recall concepts, in this case place value.	**Knowledge** **N01**
2	What time is displayed on this clock? 	The question relies on students to recall how to read an analog clock.	**Knowledge** **M01**

Grade Four

#	Question	Reason	Outcome
3	Who read the least number of books? 	The question relies on students to read information from a graph.	Knowledge SP02
4	What number is represented by these base-ten blocks? 	The question relies on students to perform a translation between the pictorial representation and a symbolic representation.	Application N01

Grade Four

#	Question	Reason	Outcome
5	Fill in the missing numerals in the following multiplication chart. **Multiplication Chart** X | 1 | 2 | 3 | 4 | 5 1 | 1 | 2 | 3 | 4 | ? 2 | 2 | ? | 6 | 8 | 10 3 | ? | 6 | 9 | 12 | 15 4 | 4 | 8 | 12 | ? | 20 5 | 5 | 10 | ? | 20 | 25	The question relies on students to identify or extend a pattern.	**Application PR01**
6	Cyril has collected 40 coins. He wants to place 4 coins on each page of his scrapbook. How many pages will Cyril fill? 	The question relies on students to apply operation or pattern knowledge to solve the problem as well as choose and apply personal strategies and reasoning to solve a problem.	**Application N07**

Grade Four

<table>
<tr><th>#</th><th>Question</th><th>Reason</th><th>Outcome</th></tr>
<tr>
<td>7</td>
<td>Fill in the missing blanks of the place value chart so that the values equal the numeral 1824.

<table>
<tr><td>thousands</td><td>hundreds</td><td>tens</td><td>ones</td></tr>
<tr><td>1</td><td>7</td><td>?</td><td>?</td></tr>
</table>

How many different ways can you represent 1824?</td>
<td>The question relies on students to generalize a pattern of equivalency (i.e., that 120 is equal to 12 tens or 120 ones) to solve a novel open-ended problem. It also requires students to solve a problem with more than one strategy (including personal strategies).</td>
<td> 
Analysis
N01</td>
</tr>
<tr>
<td>8</td>
<td>In a class of 22 students, 10 students play hockey, and 15 students play basketball.

Is it possible that there are some students who play neither sport?

Explain your thinking using a Venn diagram.</td>
<td>The question relies on students to solve a novel problem.</td>
<td> 
Analysis
PR04</td>
</tr>
</table>

Grade Four

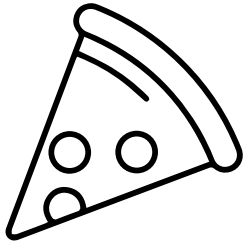
#	Question	Reason	Outcome
9	Which representation is **not** equivalent to the number represented in the place value chart below? thousands: 2 | hundreds: 1 | tens: 0 | ones: 6 ○ 2 thousands, 1 hundred, 6 ones ○ 21 hundreds, 6 ones ○ 216 tens ○ 210 tens, 6 ones	The question relies on students to generalize a pattern of equivalency as well as analyze a mathematical situation by determining or describing the relationships between mathematical arguments to solve a novel problem.	**Analysis** **PR04**

Grade Five

Grade Five

#	Question	Reason	Outcome
1	What number is 10 000 more than 209 300?	The question relies on students to recall facts and perform a specific procedure.	**Knowledge N01**
2	What is the quotient of 198 and 9?	The question relies on students to calculate a specified quotient.	**Knowledge N06**

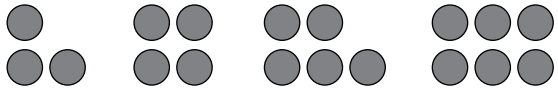
Grade Five

#	Question	Reason	Outcome
3	Solve the following equation: $12 = 12n$	The question relies on students to solve a simple equation.	**Knowledge** **PR02**
4	A family ordered pizza for supper. Elisha ate $\frac{1}{4}$ of the pizza and Jade ate $\frac{3}{8}$ of the pizza. Who ate more of the pizza? 	The question relies on students to demonstrate an understanding of fractions and solve a story problem requiring them to compare fractions. The students need to make use of flexible thinking to solve this type of problem.	**Application** **N07**

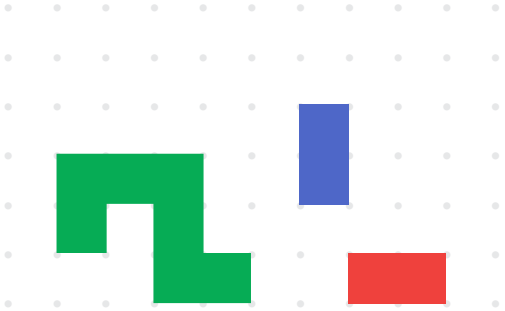
Grade Five

#	Question	Reason	Outcome
5	Write an equation with an unknown that matches the story problem. Lena baked 24 muffins. Her friends came over and ate some of the muffins. There are now 15 muffins left. How many muffins did her friends eat?	The question relies on students to interpret a story problem and represent a situation mathematically.	**Application PR02**
6	The following rectangles all have a perimeter of 18 cm: 1 cm by 8 cm, 2 cm by 7 cm, 3 cm by 6 cm, 4 cm by 5 cm Which of these rectangles has the largest area? Which has the smallest area? Explain your thinking.	The question relies on students to make generalizations when given a perimeter or an area, or both, in a problem-solving context. It requires them to compare figures or statements and show deeper mathematical understanding to solve a problem.	**Application M01**

Grade Five

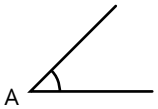
#	Question	Reason	Outcome
7	Examine the following pattern.  Figure 1 Figure 2 Figure 3 Figure 4 How many circles will be in the 50th figure? ○ 51 ○ 52 ○ 53 ○ 54	The question relies on students to generalize a pattern.	Analysis PR01
8	The perimeter of a rectangular wall is 12 m. The width of the wall is 2 m. What is the area of the wall? ○ 6 m^2 ○ 8 m^2 ○ 10 m^2 ○ 28 m^2	The question relies on students to consolidate skills and knowledge from multiple concepts as well as show a deeper mathematical understanding by choosing and applying personal strategies to solve a problem.	Analysis M01

Grade Five

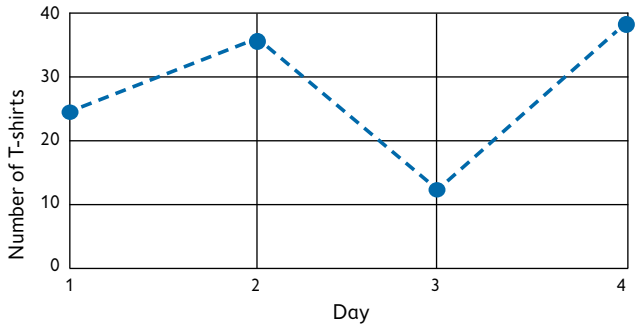
#	Question	Reason	Outcome
9	The pieces below can be fitted together to make shapes with at least one line of symmetry. Perform a single transformation on one or two of the shapes to create a new symmetrical shape.  Find all possible solutions. Justify your answer.	The question relies on students to analyze a mathematical situation by determining a transformation that can be performed on one shape that will move it beside another shape to create a new symmetrical shape.	Analysis G03

Grade Six

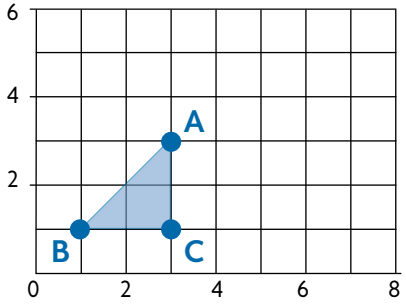
Grade Six

#	Question	Reason	Outcome
1	Calculate 6.48 ×3 ○ 194.4 ○ 19.44 ○ 18.44 ○ 18.144	The question relies on students to calculate a product.	**Knowledge** **N08**
2	Which measurement would most closely describe angle A?  ○ 45° ○ 75° ○ 90° ○ 180°	The question relies on students to recall measurements of common angles.	**Knowledge** **M01**

Grade Six

#	Question	Reason	Outcome
3	Using the information in the graph below, on which day did the school sell the most t-shirts? **T-Shirts Sold Each day at Pine Valley Middle School**  ○ Day 1 ○ Day 2 ○ Day 3 ○ Day 4	The question relies on students to read and interpret information from a graph.	**Knowledge** **SP01**
4	Why can only one factor tree be drawn for the number 17? Explain your thinking.	The question relies on students to choose and apply personal strategies to solve a problem.	**Application** **N03**

Grade Six

#	Question	Reason	Outcome
5	Sun and Fun Splash Park sells entrance passes for $5 and this gives you access to the pool and playground area. If you want to ride the waterslides, you have to pay $4/trip down the slide. How much would it cost for 8 trips down the waterslides? **# of trips down waterslides:** 0, 1, 2, 3 **Cost:** 5, 9, 13, 17	The question relies on students to extend a pattern using information from a table to solve a problem.	**Application PR01**
6	If figure ABC was rotated 90° counter clockwise around point A, what are the coordinates of C'?  ○ (1, 3) ○ (3, 5) ○ (4, 1) ○ (5, 3)	The question relies on students to implement and execute a set of mathematical instructions.	**Application G06**

Grade Six

#	Question	Reason	Outcome
7	Place operation symbols (+/–/x/÷), and possibly parentheses, in each space between the numbers to create the indicated solutions. 3___6___3___4 = 11 3___6___3___4 = 108 3___6___3___4 = 6	The question relies on students to solve a problem in more than one way. It requires creative thought and some planning on the part of the student to solve.	Analysis N09
8	Nicole uses a road map that has a scale of 1:200 000, where 1 cm on the map represents an actual distance of 200 000 cm. What is the actual distance in kilometres between two cities that are 5 cm apart on the map? ○ 10 km ○ 100 km ○ 200 km ○ 1000 km	The question relies on students to calculate and use relationships between values to solve a novel multi-step problem.	Analysis N05

Grade Six

#	Question	Reason	Outcome
9	Juan bought some $10 video games. Dharma bought some $15 video games. They each spent less than $200 dollars. Which of the amounts below would be possible if they both spent the same amount?	The question relies on students to use a pattern to determine the solution to a novel problem.	 **Analysis** **N03**

Grade Seven

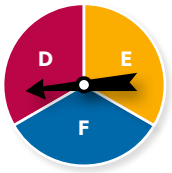
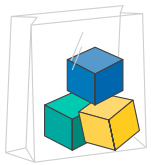
Grade Seven

#	Question	Reason	Outcome
1	Evaluate 2.876 – 0.975	The question relies on students to compute the difference between two decimal numbers.	**Knowledge N02**
2	Evaluate (–10) + (17) using a number line.	The question relies on students to perform a single addition using a number line.	**Knowledge N06**

Grade Seven

#	Question	Reason	Outcome
3	Solve each equation: $18 + n = 31$ $m \div 6 = 7$	The question relies on students to solve a straightforward algebraic equation and recall facts.	**Knowledge** **PR07**
4	The temperature at 6 am is –10°C. During the day, the temperature rises 17°C. What is the new temperature? 	The question relies on students to identify and use an appropriate strategy to solve a one step real-world problem when no method is suggested.	**Application** **N06**

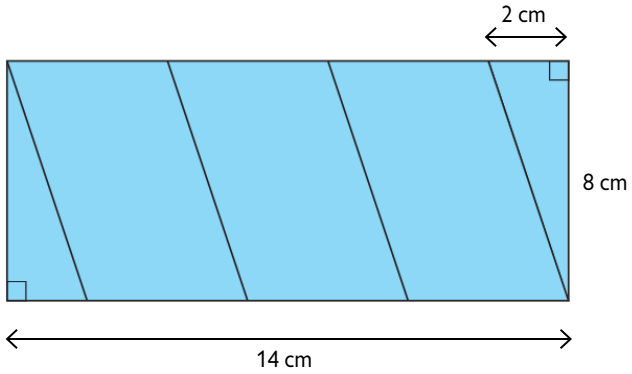
Grade Seven

#	Question	Reason	Outcome
5	A spinner has 3 equal sectors labelled D, E, and F. A bag contains 3 congruent cubes: 1 green, 1 yellow, and 1 blue. The pointer is spun, and a cube is picked at random. Use a tree diagram to calculate the probability of spinning E and picking a green cube.  	The question relies on students to use an alternate representation (tree diagram) to calculate the probability of two independent events making use of the image representation of the problem.	Application SP06
6	Use tiles to solve the following equation. Draw pictures to represent each step. $4x = 16$	The question relies on students to use an alternate representation to solve a routine multi-step problem.	Application PR07

Grade Seven

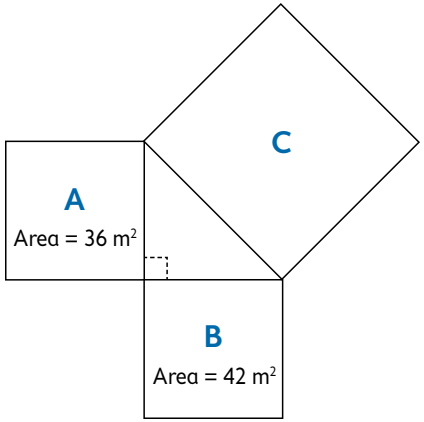
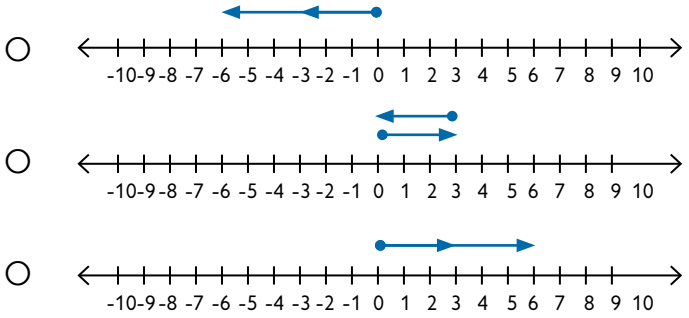
#	Question	Reason	Outcome
7	A glass has a circular base with a radius of 3.5 cm. A rectangular tray has dimensions of 40 cm by 25 cm. How many glasses will fit on the tray? What assumptions did you make?	The question relies on students to use a personal strategy to solve a non-routine problem. The problem incorporates solving by reflection and requires explanation of assumptions made in arriving at a final answer.	Analysis M01
8	Jude was asked to solve the equation $5d + 7 = 22$ for d. Using inspection she found that $d = 15$. Explain Jude's mistake and how she could have solved the equation correctly.	The question relies on students to justify the truth or falsity of a statement by referencing mathematical results or properties and justifying their position.	Analysis PR07

Grade Seven

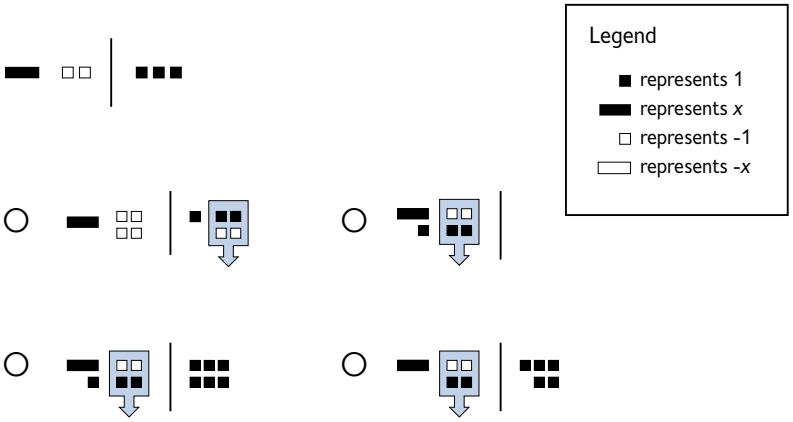
#	Question	Reason	Outcome
9	Solve for the area of one parallelogram. The base of each triangle is 2 cm.  	The question relies on students to use geometric properties to solve a non routine problem as well as draw on knowledge and understanding from previous learning.	**Analysis** **M02**

Grade Eight

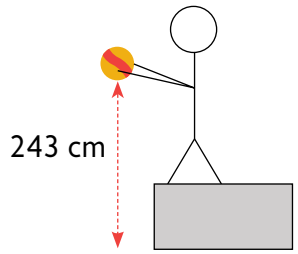
Grade Eight

#	Question	Reason	Outcome
1	What is the area of square C?  	The question relies on students to recall previously learned material to solve a routine problem.	Knowledge M01
2	Which model represents the multiplication of two integers that equal (–6)?  	The question relies on students to identify the representation of a simple product.	Knowledge N07

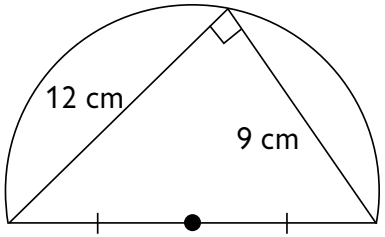
Grade Eight

#	Question	Reason	Outcome
3	Given the following equation, expressed using algebra tiles, which option represents the use of the zero model, used for solving such an equation. 	The question relies on the student's ability to recognize and recall the pictorial representation of the zero model used to solve linear equations using algebra tiles.	Knowledge PR02
4	Pythagoras High School had 158 students absent on Friday. 12.5% of the student population was absent on Friday. What is the total population of students that go to Pythagoras High School?	The question relies on students to read and understand the context of the question in to apply previously learned knowledge. They must select and use an appropriate strategy where the solving method is not suggested.	Application N03

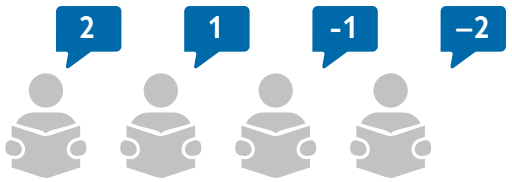
Grade Eight

#	Question	Reason	Outcome
5	The grade 8 students at Hip Hop High entered a team in the provincial dance competition. The competition charged a $136 entrance fee and an additional $4 per student who attended the dance competition. If the total cost was $188, how many students attended the competition?	The question relies on students to read and understand the context of the question in order to apply previously learned knowledge. They must select and use an appropriate strategy where the solving method is not suggested.	Application PR02
6	Muneeb is standing on a platform and drops a ball from a height of 243 cm. If the ball bounced $\frac{2}{3}$ of the distance through which it fell, then how high did the ball bounce? ○ 162 cm ○ 364 cm ○ 486 cm ○ 729 cm  	The question relies on students to read and understand the context of the question in order to apply previously learned knowledge. They must select and use an appropriate strategy where the solving method is not suggested.	Application N06

Grade Eight

#	Question	Reason	Outcome
7	An airplane is flying at an altitude of 5000 m. The airport is 3 kilometres away from a point directly below the airplane on the ground. What is the distance, to the nearest tenth of a kilometre, of the flight path of the airplane to the airport? Justify your reasoning.	The question relies on students to read and understand the context and build a concept of what is being asked. The student needs to integrate a variety of concepts such as Pythagorean theorem and conversion of units to solve this novel problem.	Analysis M01
8	A semicircle with a right triangle inscribed in it is shown:  What is the radius of the semicircle?	The question relies on students to use geometric properties to solve a novel problem as well as draw on knowledge and understanding from previous learning and from different areas of mathematics to solve more complex problems.	Analysis M01

Grade Eight

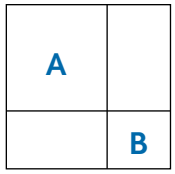
#	Question	Reason	Outcome
9	Four students simplified the expression $\frac{[18-(-6)](-4)}{(-8)(-6)}$. Their answers are shown:  a) Which student correctly simplified the expression? Explain your reasoning. b) Determine the mistakes made by the other three students and justify your reasoning.	The question relies on students to describe, compare, and contrast solution methods while going beyond comprehension and application to higher order thinking skills to generalize other possible mistakes.	Analysis N07

Grade Nine

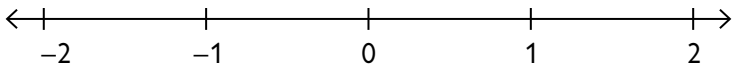
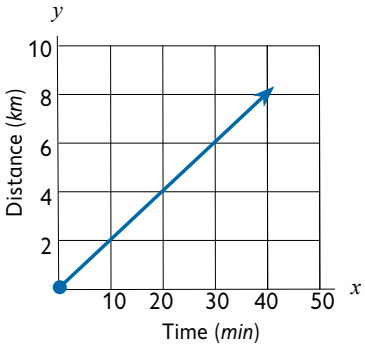
Grade Nine

#	Question	Reason	Outcome
1	Which represents the value of -2^4? ○ −16 ○ −8 ○ 8 ○ 16	The question relies on students to recall previously learned material to solve a basic computation problem involving a single computation.	**Knowledge** **N01**
2	Which of the following expressions is a monomial with degree 2? ○ $2x^2 + 2x$ ○ $2x$ ○ $2x^2$ ○ 2	The question relies on students to recall mathematical definitions.	**Knowledge** **PR05**

Grade Nine

#	Question	Reason	Outcome
3	Between which two integers would the value of $\sqrt{12}$ be found? ○ 11 and 13 ○ 5 and 6 ○ 3 and 4 ○ is exactly 6	The question relies on students to recall the perfect square benchmarks used to approximate non perfect square roots.	**Knowledge** **N06**
4	A square auditorium is divided into 4 sections. Sections A and B are squares. Section A has an area of 16 m^2 and Section B has an area of 9 m^2. Determine the combined area of the remaining space in the auditorium. 	The question relies on students to apply knowledge of square roots to solve an area problem involving squares.	**Application** **N05**

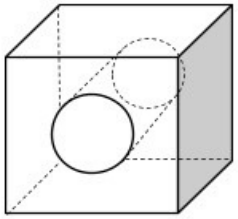
Grade Nine

#	Question	Reason	Outcome
5	Write the following rational numbers on the number line shown: $0.\overline{6}, -0.9, -\frac{4}{5}, 1.7, -1\frac{3}{4}, -\frac{2}{3}$  	The question relies on students to compare values and translate between representations.	Application N03
6	Cameron is training for a 10 km race. The graph shown represents his time and distances at 10-minute intervals.  a) How long will it take Cameron to run 3 km? b) How far can he run in 45 minutes? c) How fast is Cameron running? d) Using the graph, predict how far he will run in 50 minutes.	The question relies on students to extract information from a graph and to identify and extend a pattern.	Application PR02

Grade Nine

#	Question	Reason	Outcome
7	Given that a and b are integers and $a^b = 64$, what are all the possible paired values for a and b? How do you know you have identified all possible pairs?	The question relies on students to go beyond comprehension and application to higher order thinking to solve a non-routine problem and justify their solution.	**Analysis** **N01**
8	A radio tower at the airport detects an incoming plane at an altitude (A) of 2000 metres. Two minutes (t) later the plane descends to an altitude of 1600 meters. Given this information: a) Determine a linear equation for the descending plane. b) At what point in its descent will the plane be at 5 minutes after it is observed at 1600 metres?	The question relies on students to solve a non-routine problem by integrating different elements of what they have learned about linear relationships.	**Analysis** **PR01**

Grade Nine

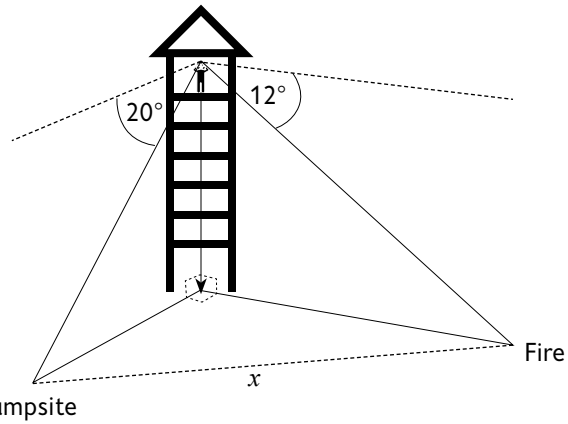
#	Question	Reason	Outcome
9	The wooden block shown is in the shape of a cube with a side length of 60 cm. A hole, in the shape of a circle with a circumference of 69 cm, is cut through the block. What is the total surface area of the block? 	The question relies on students to use geometric properties and draw on knowledge from different areas of mathematics to solve a novel problem.	Analysis G01

Mathematics Ten

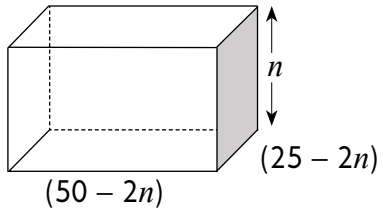
Mathematics Ten

#	Question	Reason	Outcome
1	Write $y = -\frac{2}{3}x + 3$ in general form.	The question relies on students to carry out a learned procedure or algorithm without having to make a connection.	**Knowledge RF06**
2	Convert 55 yards to metres.	The question relies on students to carry out a learned procedure or algorithm without having to make a connection.	**Knowledge M02**

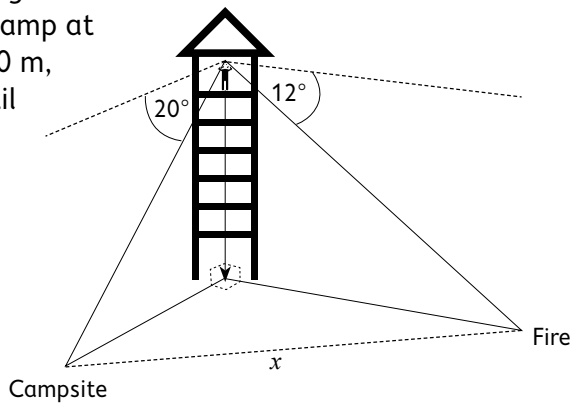
Mathematics Ten

#	Question	Reason	Outcome
3	Which represents $5\sqrt[3]{6}$? ○ $\sqrt[3]{750}$ ○ $\sqrt[3]{150}$ ○ $\sqrt[3]{90}$ ○ $\sqrt[3]{30}$	The question relies on students to apply basic computations to solve a routine problem without context.	Knowledge AN02
4	A forest ranger in a fire tower that is 100 m high sees a campsite at an angle of depression of 20°. He then turns 90° and sees a fire at an angle of depression of 12°. How far is the fire from the campsite?  	The question relies on students to identify and select an appropriate strategy to solve a routine problem requiring multiple steps.	Application M04

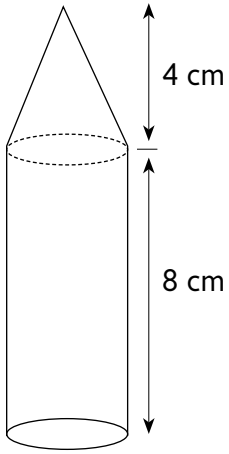
Mathematics Ten

#	Question	Reason	Outcome
5	What is the simplified algebraic expression for the volume of the cardboard box shown? Show your work.  	The question relies on students to identify and select an appropriate strategy to solve a routine problem requiring multiple steps. This problem also requires the student to draw on previous knowledge about volume.	Application AN04
6	A line passes through the points C (2,2) and D (6,10). Determine the equation of the line in slope-intercept form that passes through C and is perpendicular to CD.	The question relies on students to identify and select an appropriate strategy to solve a routine problem requiring multiple steps.	Application RF07

Mathematics Ten

#	Question	Reason	Outcome
7	A forest ranger in a fire tower that is 100 m high sees a campsite at an angle of depression of 20°. He then turns 90° and sees a fire at an angle of depression of 12°. If the fire is burning in the direction of that camp at a rate of 0.3 h/100 m, then how long until the fire reaches the campsite?  	The question relies on students to go beyond basic comprehension and application to higher order thinking skills to solve a novel problem set in a mathematical context where students are unlikely to have encountered closely similar items.	**Analysis** **M04**
8	Give an example of a context where the domain could be $-2 \leq x \leq 6$, and the range $0 \leq y \leq 4$. Justify your answer by using words and/or a diagram.	The question relies on students to go beyond basic comprehension and application to higher order thinking skills to solve a novel problem set in a mathematical context where students are unlikely to have encountered closely similar items.	**Analysis** **RF01**

Mathematics Ten

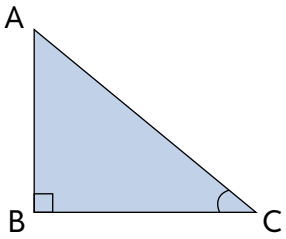
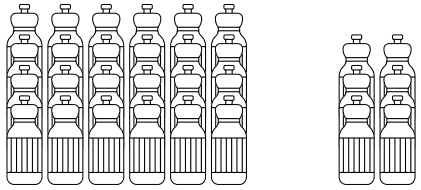
#	Question	Reason	Outcome
9	The object shown is made up of a cone on top of a cylinder. If the cylinder has a volume of 96 cm^3, what is the volume of the object, rounded to the nearest whole number?  	The question relies on students to combine knowledge of geometric properties and measurement to solve a novel problem where students are unlikely to have encountered closely similar items.	**Analysis** **M03**

Mathematics At Work Ten

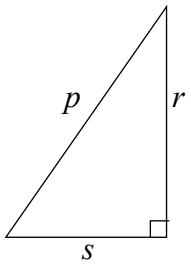
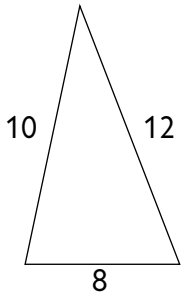
Mathematics At Work Ten

#	Question	Reason	Outcome
1	How many centimetres are approximately equivalent to 100 inches? ○ 40 cm ○ 250 cm ○ 97.5 cm ○ 102.5 cm	The question relies on students to compute a simple product to solve a routine conversion problem.	**Knowledge M01**
2	What is the circumference of a tire with a radius of 13 inches? 	The question relies on students to solve a routine problem with a known formula.	**Knowledge M03**

Mathematics At Work Ten

#	Question	Reason	Outcome
3	Given the right triangle with reference angle C, label the sides as opposite, adjacent, and hypotenuse.  	The question relies on students to recall definitions of terms and identify them on a diagram.	Knowledge G04
4	A case of 24 sports drinks costs $40.99. A 6-pack costs $12.39. What is the most economical size if you need to buy 100 drinks for a bikeathon? Show your work. 	The question relies on students to solve a routine problem requiring multiple steps.	Application N01

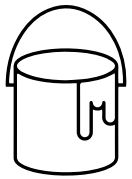
Mathematics At Work Ten

#	Question	Reason	Outcome
5	Two restaurants have offered Jamir a job: a) Mario's pays $8/h, and tips average $24 daily. b) Teppan's pays $5.50/h, and tips average $35 daily. If Jamir works 30 hours weekly, spread over four days, how much would Jamir earn at each restaurant?	The question relies on students to use an appropriate strategy to solve a problem requiring multiple steps.	**Application N02**
6	Determine whether each student's work is correct and explain your thinking. • Ferren wrote the Pythagorean relationship of Triangle A as $r^2 = p^2 + s^2$. • Mia wrote the Pythagorean relationship of Triangle B as $10^2 + 8^2 = 12^2$.  Triangle A  Triangle B	The question relies on students to examine solutions and identify errors.	**Application G02**

Mathematics At Work Ten

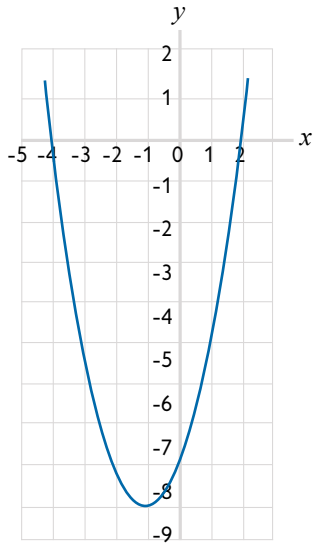
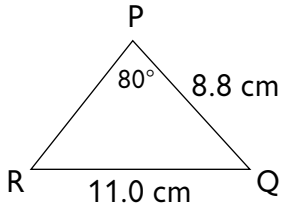
#	Question	Reason	Outcome
7	Liahna works as a truck driver for a shipping company from Canada that transports goods to and from the United States. As Liahna is nearing the border, she notices that the 450 L gas tank is nearing empty. a) Given the following information, how much money would Liahna save if she chooses to fill the tank at the gas station with the lowest price? Gas in Edmunston, NB: CAD$1.10/L Gas in Madawaska, ME: USD$2.80/gal. CAD$1 = USD$0.786842 b) For what reason(s) might Liahna decide to fill the tank at the other gas station?	The question relies on students to solve a non-routine problem where students need to make multiple conversions (units and currency) to compare prices.	Analysis N01
8	Priya needs to determine the surface area of a cylindrical light pole in the parking lot of her business so that it can be painted. She stands 4.5 metres from the base of the pole and measures the angle of elevation to the top of the pole to be 43°. If the radius of the light pole is 30 centimetres, what is the surface area to be painted?	The question relies on students to combine knowledge from different areas of mathematics to solve a novel problem.	Analysis G04/M04

Mathematics At Work Ten

#	Question	Reason	Outcome
9	You want to paint the four walls of your room. The four walls are all 7.0 m long and 2.4 m high. It takes a 1-gallon can of paint to cover approximately 400 square feet and the paint sells for $35 a can. What would it cost to purchase the paint? What do you need to consider? 	The question relies on students to reflect on a given context to identify important elements to consider when solving a novel problem. Students will also need to make connection between different areas of mathematics.	**Analysis** **M04/N01**

Mathematics Eleven

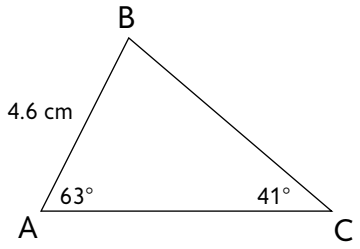
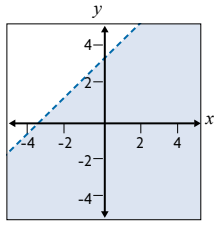
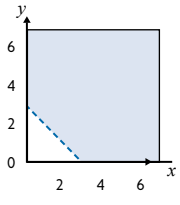
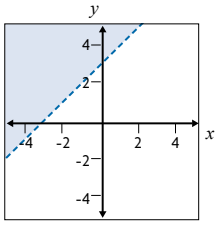
Mathematics Eleven

#	Question	Reason	Outcome
1	State the vertex, equation of axis of symmetry, x-intercepts and y-intercept of the quadratic graphed on the right: 	The question relies on students to recall definitions and terminology relating to quadratic functions.	Knowledge RF02
2	Use the sine law to determine the measure of angle R to the nearest degree? 	The question relies on students to carry out a learned procedure or algorithm without having to make a connection.	Knowledge G03

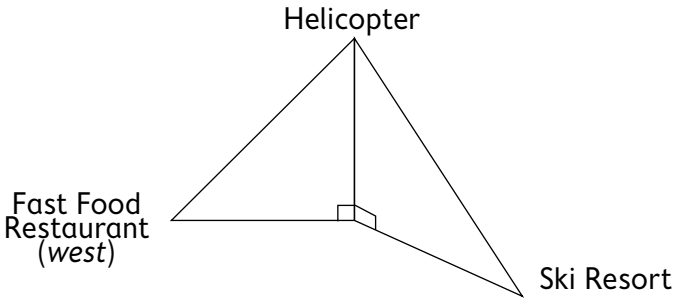
Mathematics Eleven

#	Question	Reason	Outcome
3	Determine if the point (3,4) is part of the solution set for the inequality given. $3x^2 - 2y \leq 4$	The problem requires students to demonstrate their fundamental understanding that solutions to an inequality are points that make the inequality true. A simple substitution and computation suffice to solve.	Knowledge RF01
4	The daily revenue (y) of a ski resort can be modelled by the equation $y = -16x^2 - 480x + 6400$, where x represents the temperature in degrees Celsius. At what temperature does the daily revenue reach its maximum value and what is the maximum value?	The question relies on students to make connections and identify the appropriate strategies to solve a problem.	Application RF02

Mathematics Eleven

#	Question	Reason	Outcome
5	Determine the length of *AC* in the following diagram. 	The question relies on students to identify the appropriate strategies to solve a problem and determine if sufficient information is provided to use the identified strategy. This is a routine multi-step problem.	Application G03
6	Identify the linear inequality in each of the following graphs. a)  b)  c) 	The question relies on students to analyze a graph to retrieve information and provide a symbolic representation of a given function.	Application RF01

Mathematics Eleven

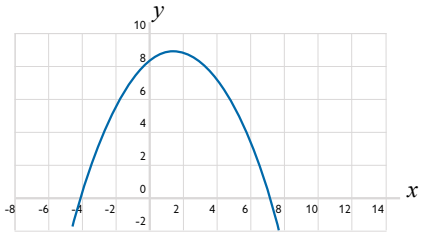
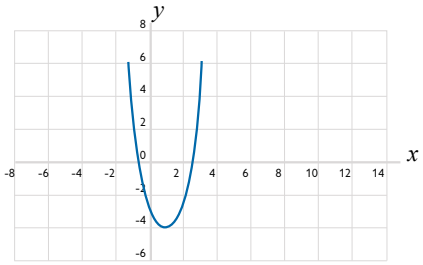
#	Question	Reason	Outcome
7	Prove that the difference between an odd integer and an even integer is an odd integer.	The question relies on students to justify the truth or falsity of a statement by referencing mathematical results or properties. Students will need to generalize results or patterns to make them widely applicable.	**Analysis LR01**
8	You are in a helicopter, 0.85 km directly over a school. When you look west, the angle of depression to a fast-food restaurant is 55°. When you look S82°E the angle of depression to the ski resort is 10°. What is the distance between the fast-food restaurant and the ski resort? Use the diagram below to help with your solution. Round your answer to the nearest tenth of a km. 	The question relies on students to recall and apply previously learned information to solve a multi-step novel problem of greater complexity. Students will need to carefully analyze the context to correctly interpret and solve the problem.	**Analysis G03**

Mathematics Eleven

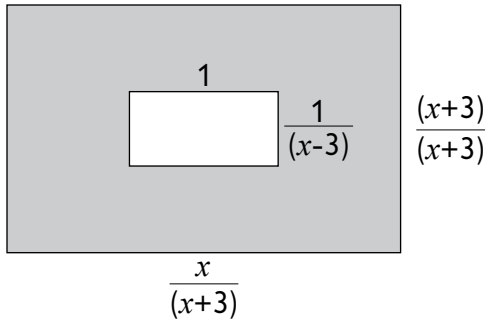
#	Question	Reason	Outcome
9	Bill kicks a football in Tom's direction. The football follows a parabolic path. Tom, who does not know it has been kicked, may be standing in the football's path. After having travelled a horizontal distance of 10 metres, the football reaches a maximum height of 18 metres. Will Tom, who is 1.8 metres tall, get hit by the football if he is standing 19.8 metres from where the football was kicked? Justify your answer algebraically.	The question relies on students to carefully analyze a context to solve a non-routine problem. The student will need to draw on various knowledge and likely use multiple representations to successfully solve the problem.	 **Analysis** **RF02**

Pre-Calculus Eleven

Pre-Calculus Eleven

#	Question	Reason	Outcome
1	Write each of the following in an alternate form. If whole, write in simplest radical form, if mixed, write as whole. a) $\sqrt{90x^3}$ b) $5m^3\sqrt{2}$	The question relies on students to carry out routine mathematical procedures converting between different forms of expressions.	**Knowledge** **AN02**
2	Describe each of the following graphs in terms of transformation of the graph of $y = x^2$.   	The question relies on students to retrieve information from a graph.	**Knowledge** **RF03**

Pre-Calculus Eleven

#	Question	Reason	Outcome
3	Determine the non-permissible values for $\frac{2}{(x-2)(x+3)} - \frac{5}{x+3}$.	The question relies on students to recall the properties of mathematical functions.	**Knowledge** **AN05**
4	Find the area of the shaded region.  	The question relies on students to solve a multi-step problem to a problem that may not be identical to, but is closely similar to, those already encountered in the course.	**Application** **AN05**

Pre-Calculus Eleven

#	Question	Reason	Outcome
5	A student attempted to rationalize the denominator in an expression, as shown below. Identify, explain, and correct any errors. $\frac{9}{6-2\sqrt{3}}$ $= \left(\frac{9}{6-2\sqrt{3}}\right)\left(\frac{6+2\sqrt{3}}{6+2\sqrt{3}}\right)$ $= \frac{54+18\sqrt{9-3}}{36-12}$ $= \frac{54+54\sqrt{3}}{24}$ $= \frac{9+9\sqrt{3}}{4}$	The question relies on students to examine solutions to routine problems to identify and correct any errors.	Application AN04
6	Determine the value(s) of m for which the graph of the parabola $y = x^2 + mx + 16$ is always above the x-axis.	The question relies on students to apply and adapt an appropriate strategy (make use of a personal strategy).	Application RF03

Pre-Calculus Eleven

#	Question	Reason	Outcome
7	Mikhala and Jocelyn are examining some effects of absolute value on the sum of the squares of the set of values {–4.1, 6, –8, 2.3}. Mikhala takes the absolute value of each number and then squares it. Jocelyn squares each value and then takes the absolute value. a) What result does each student get? b) Explain the results. c) Is this always true? Explain.	The question relies on students to create data and then make a generalization about the results.	Analysis AN01
8	Liban stated that the permissible values for the quotient and the product of the expressions $\frac{x^2+4x+3}{x^2-16}$ and $\frac{x^2-2x+8}{x^2-7x+12}$ are the same. Do you agree or disagree with this statement? Justify your answer.	The question relies on students to use reasoning to carry out appropriate procedures in order to justify the truth or falsity of a statement.	Analysis AN05

Pre-Calculus Eleven

#	Question	Reason	Outcome
9	Determine the equations for the linear-quadratic system with the following properties: ○ vertex of the parabola is located at (2, 18) ○ the line intersects the parabola on the y-axis at (0, 4) ○ the line intersects the parabola on the x-axis	The question relies on students to apply knowledge and skills to solve a novel problem by using personal strategies. Students must make connections between the graph, the equations, and the properties of the functions in the system.	**Analysis** **RF06**

Mathematics At Work Eleven

Mathematics At Work Eleven

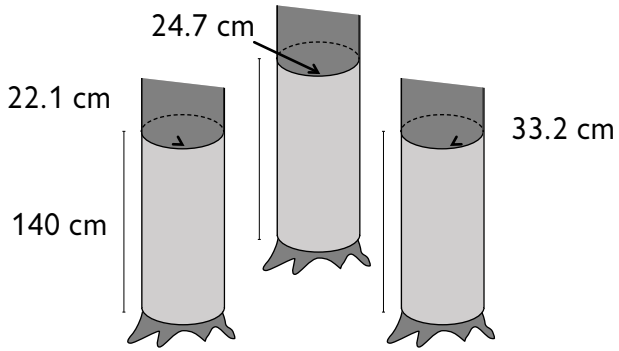
<table>
<tr><th>#</th><th>Question</th><th>Reason</th><th>Outcome</th></tr>
<tr>
<td>1</td>
<td>Michelle is a high school student living at home. She has a part-time job. Michelle's budget for a month is in the following table.

a) Calculate her total expenses.
b) What is the difference between her expenses and her income?

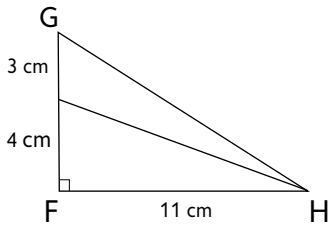
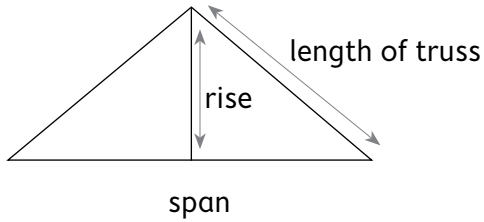
<table>
<tr><th>Monthly Net Income</th><th>Budget</th></tr>
<tr><td>Job</td><td>$475</td></tr>
<tr><th>Monthly Expenses</th><th>Fixed Expenses</th></tr>
<tr><td>Savings</td><td>$45</td></tr>
<tr><td>Cell phone</td><td></td></tr>
<tr><td>Transportation (bus fare)</td><td>$40</td></tr>
<tr><td>Variable Expenses</td><td></td></tr>
<tr><td>Clothing</td><td>$250</td></tr>
<tr><td>Entertainment</td><td>$50</td></tr>
<tr><td>Personal items</td><td>$55</td></tr>
<tr><td>School expenses</td><td>$35</td></tr>
<tr><td>Other (gifts)</td><td>$50</td></tr>
</table>
</td>
<td>The question relies on students to recall definitions and carry out basic computations.</td>
<td> 
Knowledge
N02</td>
</tr>
<tr>
<td>2</td>
<td>What are 8 yd.^{3} expressed in ft.^{3}?

○ 24 ft.^{3}
○ 72 ft.^{3}
○ 216 ft.^{3}
○ 13 824 ft.^{3}</td>
<td>The question relies on students to carry out a straightforward calculation without making connections.</td>
<td> 
Knowledge
M01</td>
</tr>
</table>

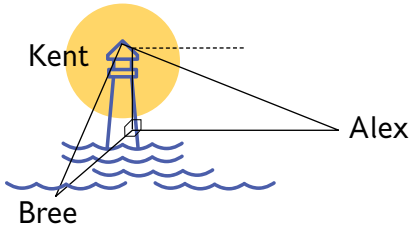
Mathematics At Work Eleven

#	Question	Reason	Outcome
3	The distance on a map from location A to location B is 1200 km. If the distance shown on a map is 6 cm, then what is the scale factor? Express your answer in fractional form.	The question relies on students to recall previously learned concepts and carry out basic computations.	Knowledge G02
4	Brad is purchasing burlap to protect his three apple trees against the cold winter weather. He will wrap the burlap around the bottom 140 cm of each tree trunk. The trees are 22.1 cm, 24.7 cm, and 33.2 cm in circumference. How much burlap will he need? 	The question relies on students to solve a problem that is typical of problems already seen but in a different context. Students must modify a formula to fit the context when solving this multi-step problem.	Application M01

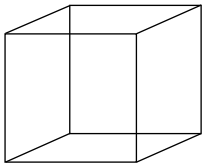
Mathematics At Work Eleven

#	Question	Reason	Outcome
5	Which represents the measure of ∠GHF in the triangle shown, to the nearest tenth of a degree?  ○ 32.5° ○ 20.0° ○ 14.4° ○ 12.5°	The question relies on students to select an appropriate strategy to solve a routine multi-step problem.	**Application G01**
6	The span of a roof is 30 feet and the pitch is $\frac{1}{3}$. What is the length of the truss?  	The question relies on students to select an appropriate strategy to solve a routine multi-step problem. The student must retrieve contextual information from the diagram and use knowledge from different fields in order to solve the problem.	**Application A02**

Mathematics At Work Eleven

#	Question	Reason	Outcome
7	A 19 m lighthouse overlooks a body of water. Bree uses a clinometer to view the top of the lighthouse from across the river at an angle of elevation of 20°. Kent, the lighthouse attendant, can see Alex at an angle of depression of 15°.  How far apart are Bree and Alex?	The question relies on students to select an appropriate strategy to solve a novel multi-step problem. The student must analyze and retrieve contextual information from the diagram in order to solve the problem.	Analysis G01
8	The values A (3, 9) and B (12, 24) were substituted into the slope formula by Students A, B, and C, as shown: Student A: $m = \frac{24 - 9}{12 - 3}$ Student B: $m = \frac{9 - 24}{3 - 12}$ Student C: $m = \frac{12 - 3}{24 - 9}$ Which of these proposed solutions are correct? Explain.	The question relies on students to apply higher order reasoning to describe, compare, and contrast solution methods.	Analysis A01

Mathematics At Work Eleven

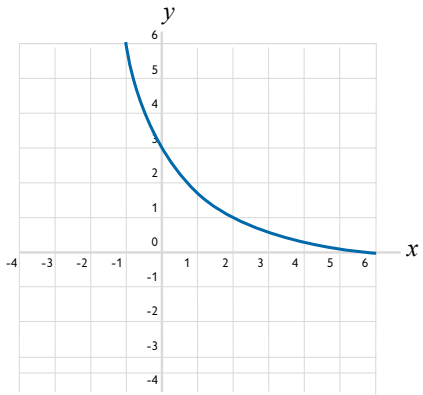
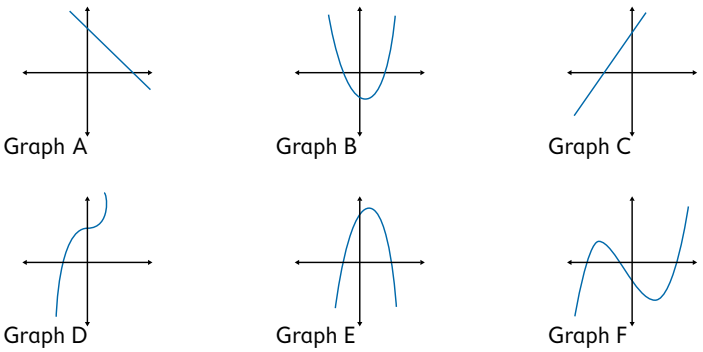
#	Question	Reason	Outcome
9	A cube has a volume of 27 cm^3. If the side length of the cube is doubled, will the volume of the cube also be doubled? Explain. 	The question relies on students to analyze a mathematical situation by determining the relationship between attributes. Students will have to push beyond comprehension and application to higher order thinking skills in order to solve this non-routine problem.	**Analysis** **M02**

Mathematics Twelve

Mathematics Twelve

#	Question	Reason	Outcome
1	Oleg took out a $16 000 loan from the bank to pay for school. The bank offered him an interest rate of 5.6%, compounded quarterly. The loan is to be repaid in 3 years. How much interest will Oleg need to pay?	The question relies on students to substitute values into a formula in order to solve a routine problem.	Knowledge FM01
2	Using graphing technology, sketch the function $f(x) = x^3 + 2x^2 - x - 2$ and determine the following characteristics: x-intercepts, y-intercepts, domain, range, number of turning points, end behaviour	The question relies on students to recall definitions in order to determine function characteristics.	Knowledge RF01

Mathematics Twelve

#	Question	Reason	Outcome
3	Match the corresponding function to the graph.  ○ $y = 3(0.5)^x$ ○ $y = 2(1.25)^x$ ○ $y = 0.5(3)^x$ ○ $y = 2(0.75)^x$	The question relies on students to recall the properties of exponential functions.	Knowledge RF02
4	State a possible equation for each of the following graphs.  Graph A Graph B Graph C Graph D Graph E Graph F	The question relies on students to identify key characteristics of functions to come up with a plausible equation for each of the graphs. This is likely similar to questions done in class.	Application RF01

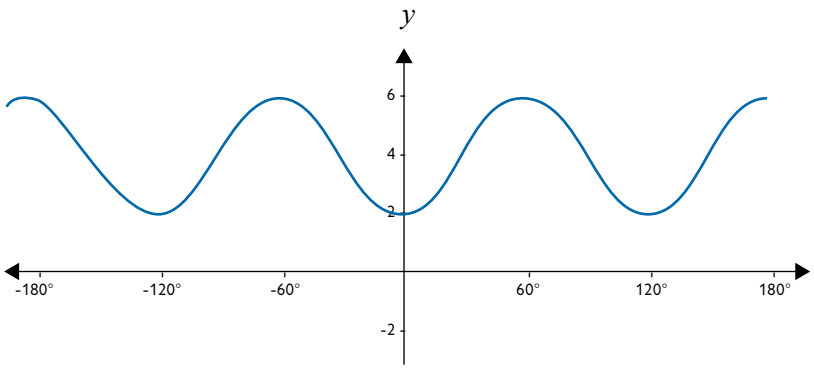
Mathematics Twelve

#	Question	Reason	Outcome
5	Amanda, Jahzara, Luk, and Sarah each have different coloured cars. One car is red, one is blue, one is white, and the other is black. *Clue 1*: Amanda's car is not red or white. *Clue 2*: Jahzara's car is not blue or white. *Clue 3*: Luk's car is not black or blue. *Clue 4*: Sarah's car is red. Determine which person has which car. Show your thinking below.	The question relies on students to apply a personal strategy in order to solve a logic problem.	Application LR01
6	Graph the function $f(x) = (x-2)(x+3)(x-1)$, clearly indicating x-intercepts, y-intercept, and the end behaviour.	The question relies on students to identify key components of a function and graph the function.	Application RF01

Mathematics Twelve

#	Question	Reason	Outcome
7	Write an equation or draw a sketch for a polynomial function that satisfies each set of characteristics: a) degree 2, y-intercept of 4 b) having three x-intercepts and end behaviour in quadrants 2 and 4 c) having a range of $y \geq 2$, y-intercept 2	The question relies on students to generalize their understanding of functions.	**Analysis** **RF01**
8	Explain the difference between an angle measuring 5° and an angle measuring 5 radians.	The question relies on students to analyze the relationship between the two types of measurement and explain their differences.	**Analysis** **RF03**

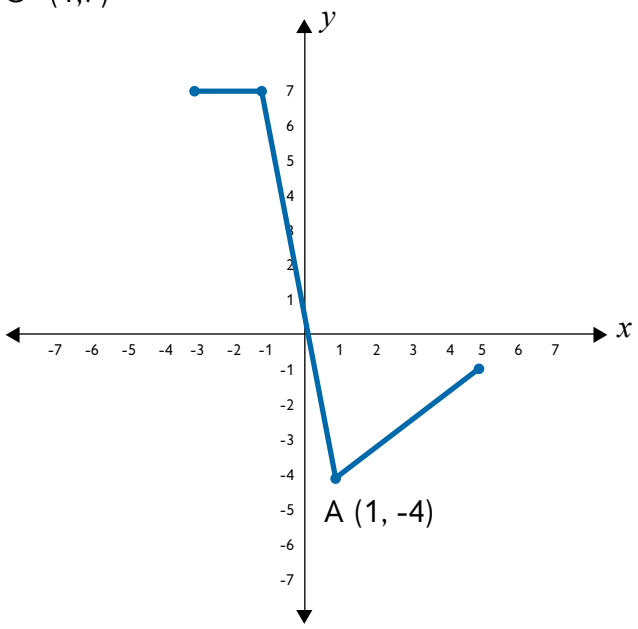
Mathematics Twelve

#	Question	Reason	Outcome
9	The equation of the graph below is $y = 2 \sin 3(x - 30°) + 4$.  a) If you were not given this equation, explain how you would find the values of the parameters a, b, c, and d for the equation $y = a \sin b(x - c) + d$. b) Which value(s) did you find first? Why? c) Which value was the most difficult to determine? d) Which values would change if this is a transformed cosine curve?	The question relies on students to make connections and generalizations about the equation and the graph of a sinusoidal function as well as analyze the relationship between sine and cosine curves.	Analysis RF03

Pre-Calculus Twelve

Pre-Calculus Twelve

#	Question	Reason	Outcome
1	Use the function $f(x) = 5 \cos 3(x-30°) + 2$ to answer the following: a) What is the period of this function? b) What is the amplitude of this function? c) What is the range of this function?	The question relies on students to identify key characteristics of a function from its equation.	**Knowledge** **T04**
2	Show that $x+1$ is a factor of $P(x) = x^3+2x^2+3x+2$.	The question relies on students to recall the factor theorem and thus solve $P(-1) = 0$.	**Knowledge** **RF11**

#	Question	Reason	Outcome
3	Given the graph of $f(x)$ shown below, what are the coordinates of point A if the transformed graph is represented by $g(x) = f(x + 2)$? ○ (–1,7) ○ (–1,–4) ○ (1,–2) ○ (1,7)  	The question relies on students to recall and carry out basic procedures to a graphed function.	Knowledge RF02

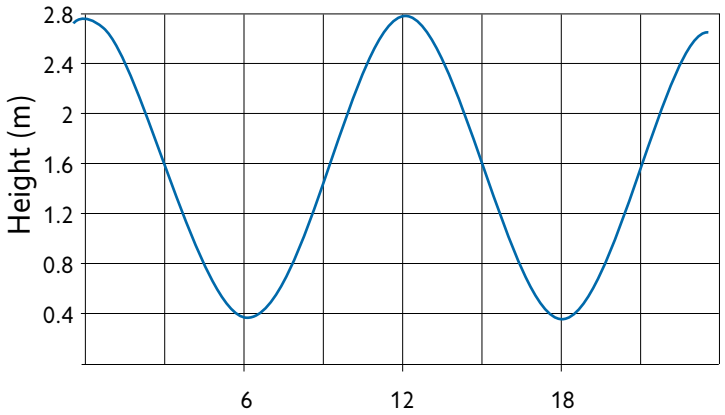
Pre-Calculus Twelve

#	Question	Reason	Outcome
4	A selection of the steps needed to complete the proof of $\frac{2(\tan x - \cot x)}{\tan^2 x - \cot^2 x} = \sin 2x$ have been randomly sorted. **Randomly Sorted Steps** 1: $\frac{2}{\frac{\sin^2 x}{\sin x \cos x} + \frac{\cos^2 x}{\sin x \cos x}}$ 2: $2\sin x \cos x$ 3: $\frac{2}{\frac{\sin x}{\cos x} + \frac{\cos x}{\sin x}}$ 4: $\frac{2}{\frac{1}{\sin x \cos x}}$ Sort the steps of the proof into the correct order.	The question relies on students to solve a multi-step problem to a problem that may not be identical to, but is closely similar to, those already encountered in the course.	Application T06

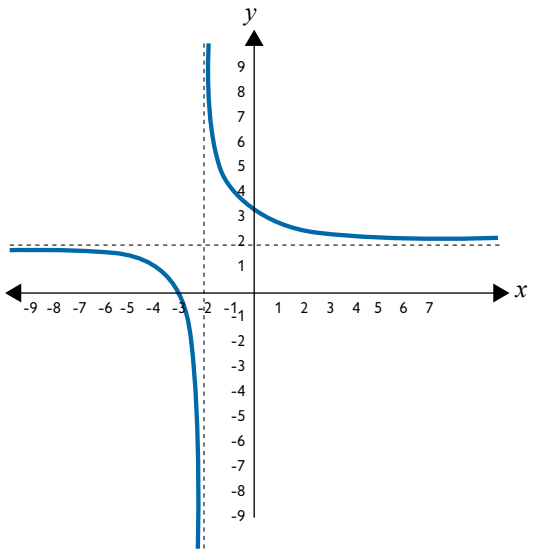
Pre-Calculus Twelve

#	Question	Reason	Outcome
5	If $f(x) = 5x - 1$ and $f(g(x)) = 5x^2+10x+4$, find $g(x)$.	The question relies on students to solve problems similar but not identical to those seen in the classroom.	Application RF01
6	Graph the following polynomial function, clearly indicating x-intercepts, y-intercept, and the end behaviour. $y = (x - 2)(x \div 3)(x - 1)$	This question requires students to take a polynomial equation in factored form, identify the key components of the graph and then graph the function. This should be a routine problem for students to complete, requiring multiple steps.	Application RF12

Pre-Calculus Twelve

#	Question	Reason	Outcome
7	Create three questions that could be answered using the graph below. Height of Tides Since Noon  	The question relies on students to use their knowledge of mathematics to create a context around a graph and develop questions based on the context.	**Analysis** **T04**

Pre-Calculus Twelve

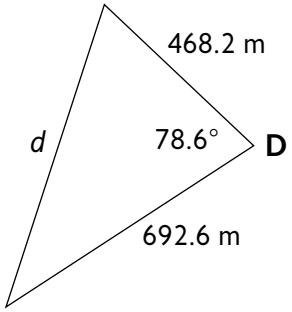
#	Question	Reason	Outcome
8	The graph of a function, $f(x) = \frac{ax+b}{cx+d}$ is shown.  Determine a possible equation for the function and justify your reasoning.	The question relies on students to use their knowledge of mathematics to carefully analyze the graph and identify multiple characteristics in order to justify a suitable equation for the function.	Analysis RF14

Pre-Calculus Twelve

#	Question	Reason	Outcome
9	When a colony of wasps was studied, its population was found to be approximated by the model $P(t) = 50e^{0.1t}$, $t \geq 0$, where P is the population of wasps and t days is the time from the start of the study. Over the same period of time a second wasp colony was also studied. Its population, Q, was found to be approximated by the model $Q(t) = 500 - 450e^{-0.1t}$, $t \geq 0$. When will these two wasp colonies have the same population?	The question relies on students to use knowledge from different areas of mathematics to solve a novel problem.	**Analysis** **RF10**

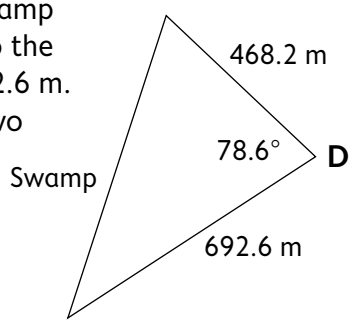
Mathematics At Work Twelve

Mathematics At Work Twelve

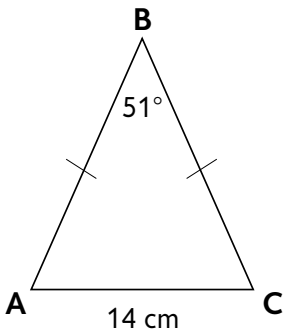
#	Question	Reason	Outcome
1	Using the law of cosines, solve for the length of side *d*.  	The question relies on students to recall and use a formula to solve a routine problem.	Knowledge G01
2	Mr. Trig recently marked a set of class assignments. The scores were as follows: 45 58 78 69 0 25 14 74 85 96 96 85 100 12 46 78 65 70 41 55 What is the mean score of this assignment?	The question relies on students to use basic computation to solve a routine problem.	Knowledge S01

Mathematics At Work Twelve

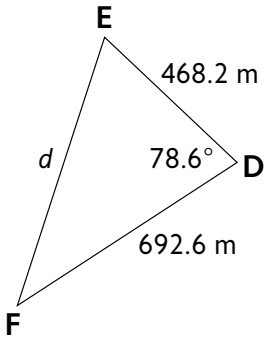
<table>
<tr><th>#</th><th>Question</th><th>Reason</th><th>Outcome</th></tr>
<tr>
<td>3</td>
<td>What is the rate of change for the relation represented in the table shown?
<table>
<tr><th>Number of Movies Streamed</th><th>Cost</th></tr>
<tr><td>0</td><td>$8.00</td></tr>
<tr><td>1</td><td>$10.00</td></tr>
<tr><td>2</td><td>$12.00</td></tr>
<tr><td>3</td><td>$14.00</td></tr>
<tr><td>4</td><td>$16.00</td></tr>
</table>
</td>
<td>The question relies on students to read information from a table and use basic computation to solve a routine problem.</td>
<td>Knowledge
A01</td>
</tr>
<tr>
<td>4</td>
<td>A surveyor needs to find the length of a swampy area near a lake. The surveyor sets up her transit at point D. She measures the distance to one end of the swamp to be 468.2 m and the distance to the other end of the swamp to be 692.6 m. The angle of sight between the two ends of the swamp is 78.6°.

Find the length of the swamp.
 
</td>
<td>The question relies on students to identify an appropriate strategy to solve a contextual problem like those seen in class.</td>
<td>Application
G01</td>
</tr>
</table>

Mathematics At Work Twelve

#	Question	Reason	Outcome
5	What are the missing side lengths in the isosceles triangle?  	The question relies on students to identify an appropriate strategy to solve a problem like those seen in class.	Application G01
6	Quadrilateral *ABCD* has coordinates *A*(1, 2), *B*(1, 6), *C*(4, 7) and *D*(3, 1). Reflect the quadrilateral about the *x*-axis and then translate the quadrilateral *A'B'C'D'* to the left 8 units and up 3 units. What are the coordinates of quadrilateral *A"B"C"D"*?	The question relies on students to visualize or represent the problem on a grid and then implement a set of mathematical instructions to solve the problem.	Application G03

Mathematics At Work Twelve

#	Question	Reason	Outcome
7	Samar and Marinna were asked to solve for the length of side *d* in the diagram shown:  Samar says the length of side *d* is 99.8 m and Marinna says side *d* has a length of 755.5 m. Who is correct and what possible errors were made? Justify your reasoning.	The question relies on students to describe and compare solution methods as well as provide a mathematical justification and deductive argument.	Analysis G02
8	A man wishes to cross the river with a wolf, a goat, and some hay. He has a small boat, but unfortunately, he can only take one thing across at a time. What is worse, if he leaves the wolf and the goat alone together, the wolf will eat the goat, and if he leaves the goat with the hay, the goat will eat the hay. How does he do it?	The question relies on students to solve a non-routine mathematical problem.	Analysis N01

Mathematics At Work Twelve

#	Question	Reason	Outcome
9	The mean of a set of eight test scores is 89. One of the grades was erased, but the other seven are 72, 88, 89, 85, 95, 90, and 100. Is it possible to calculate the median of the eight scores? Explain your reasoning.	The question relies on students to analyze the problem and provide justification for steps in a solution process.	 **Analysis** **S01**