Alberta Provincial Achievement Testing

Assessment Highlights 2012–2013

GRADE 9

Mathematics

This document contains assessment highlights from the 2013 Grade 9 Mathematics Achievement Test. The examination statistics included in this document represent all writers, both French and English. To obtain English-only or French-only statistics that apply to your school, please refer to your detailed reports, which are available on the extranet.

Assessment highlights provides information about the overall test, test blueprints, and student performance on the achievement test that was administered in 2013. Also provided is commentary on student performance at the acceptable standard and the standard of excellence on selected items from the 2013 Mathematics Achievement Test. This information is intended for teachers and is best used in conjunction with multi-year and detailed school reports that are available in schools via the extranet. *Assessment highlights* reports for all achievement test subjects and grades will be posted on the Alberta Education website every year in the fall.

All released achievement tests, including test blueprints, answer keys with the item difficulty, reporting category, test section, and item description for each test item, are located at

education.alberta.ca/admin/testing/achievement/answerkeys.aspx

These materials, along with the program of studies and subject bulletins, provide information that can be used to inform instructional practice.

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The Alberta Education Internet address is education.alberta.ca.

This document was written primarily for:

Students	
Teachers	✓ of Grade 9 Mathematics
Administrators	✓
Parents	
General Audience	
Others	

Contents

The 2013 Grade 9 Mathematics Achievement Test

This report provides teachers, school administrators, and the public with an overview of the performance of those students who wrote the 2013 Grade 9 Mathematics Achievement Test. It complements the detailed school and jurisdiction reports.

How Many Students Wrote the Test?

A total of 24 881 students wrote the 2013 Grade 9 Mathematics Achievement Test. The English form of the test was written by 23 409 students, and the French form of the test was written by 1 472 students.

What Was the Test Like?

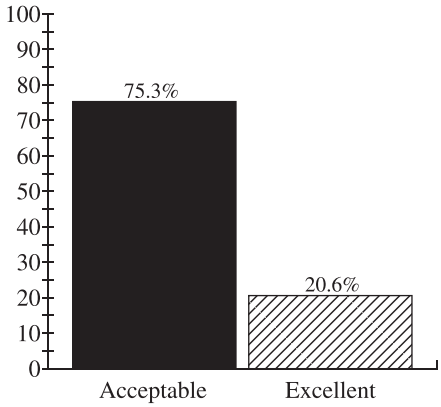
The 2013 Grade 9 Mathematics Achievement Test consisted of 40 multiple-choice and 10 numerical-response questions based on four strands: Number, Patterns and Relations, Shape and Space, and Statistics and Probability. In keeping with the intent of the 2007 Program of Studies, the questions on the test required students to apply their understanding of one or more mathematical concepts from within and/or across the four strands. As they solved the mathematical problems, students were expected to use the interrelated mathematical processes of Communication, Connections, Mental Mathematics and Estimation, Problem Solving, Reasoning, and Visualization. A detailed explanation of these mathematical processes is in the Alberta K–9 Mathematics Program of Studies.

How Well Did Students Do?

The percentages of students meeting the acceptable standard and the standard of excellence in 2013 are shown in the graph below. Out of a total score of 50 on the test, the provincial average was 30.1/50 (60.2%). The results presented in this report are based on scores achieved by all students who wrote the test, including those in French Immersion and Francophone programs. Detailed provincial assessment results are provided in school and jurisdiction reports.

Grade 9—2013 Mathematics Achievement Test		
	Acceptable (%)	Excellent (%)
2013	75.3	20.6

Percentage of Students Meeting the Acceptable Standard & Standard of Excellence (%)



2013 Achievement Standards: The percentage of students in the province who met the acceptable standard on the 2013 Grade 6 Mathematics Achievement Test (based on those who wrote)

2013 Achievement Standards: The percentage of students in the province who met the standard of excellence on the 2013 Grade 6 Mathematics Achievement Test (based on those who wrote)

2013 Test Blueprint and Student Achievement

In 2013, 75.3% of students who wrote the test achieved the acceptable standard on the Grade 9 Mathematics Achievement Test, and 20.6% of students who wrote achieved the standard of excellence.

Out of a total score of 50 on the test, the provincial average was 30.1/50 (60.2%). The blueprint below shows how the questions on the test were classified and includes the average raw score in each category for all Grade 9 students who wrote this test.

Strand	Level of Complexity*			Provincial Student Achievement (Raw Score and Percentage)
	Low	Moderate	High	
Number	**5**	**10**	**1**	**9.8/16 (61.3%)**
Patterns and Relations	**8**	**10**	**0**	**10.7/18 (59.4%)**
Shape and Space	**4**	**6**	**2**	**6.7/12 (55.8%)**
Statistics and Probability	**0**	**1**	**3**	**3.1/4 (77.5%)**
Provincial Student Achievement (Average Raw Score and Percentage)	**11.2/17 (65.9%)**	**15.3/27 (57.7%)**	**3.8/6 (63.3%)**	**Total Test Raw Score 30.1/50 (60.2%)**

*Each question is categorized according to its level of complexity (low, moderate, or high). Descriptions of the levels of complexity are in the *2013–2014 Mathematics 6 Subject Bulletin*.

2013 Grade 9 Mathematics Achievement Test Design Commentary

The 2013 Mathematics Provincial Achievement Test for Grade 9 was based on the 2007 Alberta K–9 Mathematics Program of Studies that was implemented in the 2011–2012 school year. The test blueprint provides information about new test design features (i.e., complexity) and modified test design features (i.e., item format and strand). Items now are selected not only in terms of the knowledge and skills that they assess, but also in terms of their complexity with regards to content and cognition. The introduction of item complexity will provide more information about the depth to which students have mastered particular learning outcomes, as well as provide one more control in the selection of test items to better ensure that tests are equivalent from year to year. Please refer to the *2013–2014 Mathematics 9 Subject Bulletin* for more detailed information about item complexity.

The selection of test items within each of the four strands is now based on two primary factors: item difficulty and item complexity.

> **Item difficulty** refers to the percentage of students who actually chose the correct answer. Items for which the correct answer is selected by more than 70% of the students are generally considered easy. Items for which the correct answer is selected by 50–70% of the students are about average in difficulty. Items for which the correct answer is selected by less than 50% of the students are regarded as challenging.
>
> **Item complexity** refers to the cognitive and content demands associated with an item. The rationale for classifying items by their level of complexity is to focus on the expectations of the item and not the ability of the student. The cognitive demands that an item requires of a student (i.e., what an item requires the student to recall, understand, analyze, and do) are made with the assumption that the student is familiar with the basic concepts of the task.

The categories—low complexity, moderate complexity, and high complexity—form an ordered description of the demands an item may make on a student. For example, low-complexity items may require a student to solve a one-step problem. Moderate-complexity items may require multiple steps. High-complexity items go even further and require a student to analyze and synthesize information. It is therefore important to consider both the content being assessed by an item and the item complexity when making inferences about student performance on any one outcome. Although there is a logical and predictable relationship between item difficulty and item complexity (i.e., items that are of high complexity tend to be more challenging), there are instances in which this is not the case.

The following eight items have been released to illustrate significant performance differences between two groups of students: (1) those students who achieved the standard of excellence as opposed to those who achieved the acceptable standard, and (2) those students who achieved the acceptable standard as opposed to those who were below the acceptable standard. The purpose of these comparisons is to provide additional information that may be used for instructional purposes.

Sample Questions from the 2013 Grade 9 Mathematics Achievement Test

The following four items, from all four strands, illustrate significant performance differences between students who achieved the standard of excellence versus those who achieved the acceptable standard.

Item #	Strand	Specific Outcome	Item Complexity	Item Description
15	N	5	Low	Identify a rational number with a square root that is between two numbers on a number line (Gr.8, N.1).

	% of Student Responses (*Correct)			
	A	**B**	**C**	**D***
Students Achieving the Standard of Excellence	1.5	1.9	1.1	95.5
Students Achieving the Acceptable Standard	7.1	7.6	6.0	79.3

Use the following information to answer question 15.

The square roots of two rational numbers are represented on the number line shown below.

15. If Q is located between points P and R on the number line above, then which of the following square roots could not represent Q?

A. $\sqrt{\frac{324}{81}}$

B. $\sqrt{\frac{256}{9}}$

C. $\sqrt{\frac{225}{64}}$

D. $\sqrt{\frac{169}{4}}$

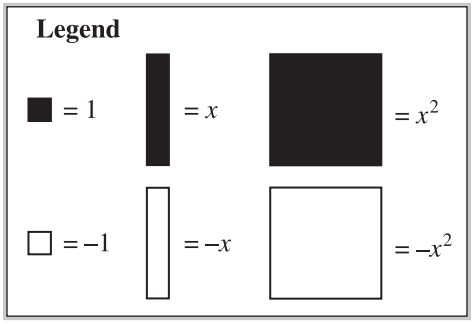
Commentary:

Of the students who achieved the standard of excellence but answered the item incorrectly, approximately 42.2% chose option B as their response. This suggests that these students may have incorrectly calculated the value of each square root by finding the square root of only the numerator instead of both the numerator and denominator. Likewise, of the students who achieved the acceptable standard but answered the item incorrectly, 36.7% made the same error and also selected option B. It is also interesting to observe that an additional 34.3% selected option A, which implies that these students may have misunderstood the question and selected the first square root that would be located between points P and R instead of selecting a square root that would be located to the left of point P or to the right of point R.

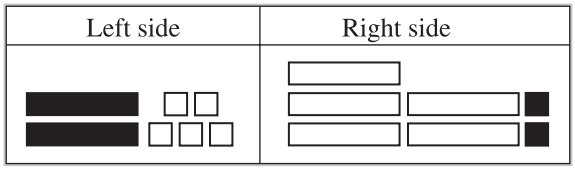
Item #	Strand	Specific Outcome	Item Complexity	Item Description
9	PR	3	Moderate	Model the solution of a given linear equation using a pictorial representation of the equation (Gr.8, PR.2).

	% of Student Responses (*Correct)			
	A*	**B**	**C**	**D**
Students Achieving the Standard of Excellence	84.4	3.4	6	6.1
Students Achieving the Acceptable Standard	40.3	16.4	16.5	26.4

Use the following information to answer question 9.



The left and right sides of an equation are represented below.



9. The left and right sides of an equation are represented below.

A. ▬ = ■

B. ▬ = ■ ■

C. ▬ = □

D. ▬ = □ □

Commentary:

Of the students who achieved the standard of excellence but answered the item incorrectly, approximately 39.4% chose option D as their response. This suggests that these students may have difficulties solving equations represented in pictorial form and/or in symbolic form. Likewise, of the students who achieved the acceptable standard but answered the item incorrectly, 44.5% also selected option D.

Item #	Strand	Specific Outcome	Item Complexity	Item Description
21	PR	1	Moderate	Write a linear equation that represents the pattern described in a given context (Gr.8, PR.2; Gr.7, PR.7).

	% of Student Responses (*Correct)			
	A	**B**	**C**	**D***
Students Achieving the Standard of Excellence	12.1	1.7	3.4	82.7
Students Achieving the Acceptable Standard	41.6	11.3	7	39.9

Use the following information to answer question 21.

Nathan completed a 5 km run on his first day of training for a cross-country race. He increased the length of his next training runs by 1.5 km each time.

21. Which of the following equations could be used to determine the distance (d) that Nathan ran on each training run (r)?

A. $d = 1.5r$

B. $d = 5r$

C. $d = 1.5 + 3.5r$

D. $d = 3.5 + 1.5r$

Commentary:

Of the students who achieved the standard of excellence but answered the item incorrectly, approximately 70.3% chose option A as their response. This response indicates an incomplete representation of the context, (i.e., only the additional distance being run on training days following the first day of training). Likewise, of the students who achieved the acceptable standard but answered the item incorrectly, 69.4% also selected option A. An additional 18.9% of the students achieving the acceptable standard selected option B, which suggests that they incorrectly focused on the length of the first training run and did not account for the increase of 1.5 km in subsequent training runs.

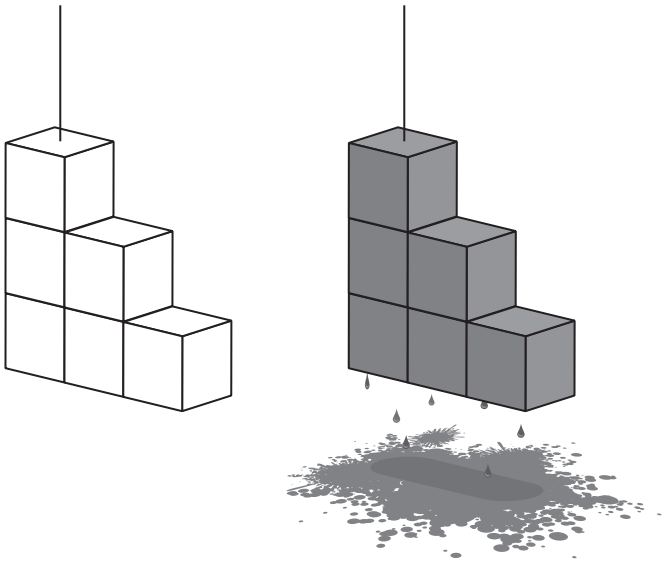
Item #	Strand	Specific Outcome	Item Complexity	Item Description
18	SS	2	Moderate	Determine the area of overlap in a given composite 3-D object (Gr.8, SS.3; Gr.8, SS.5; Gr.6, SS.3).

	% of Student Responses (*Correct)			
	A	**B**	**C**	**D***
Students Achieving the Standard of Excellence	7.5	25.6	2.9	64.0
Students Achieving the Acceptable Standard	23.6	32.2	9.8	34.3

Use the following information to answer question 18.

A 3-D object made of 2 cm × 2 cm × 2 cm cubes is dipped in paint.

Unpainted Object **Painted Object**



18. If the painted object is separated into individual cubes, then the total area of the **unpainted** surfaces will be

A. 12 cm^2

B. 24 cm^2

C. 32 cm^2

D. 48 cm^2

Commentary:

Of the students who achieved the standard of excellence but answered the item incorrectly, approximately 71.1% chose option B as their answer. This suggests that these students calculated the area of overlap for the composite 3-D figure instead of determining the unpainted surface area. Approximately 20.8% of the students in this group selected option A, which suggests that these students counted the number of unpainted sides instead of calculating the area of the unpainted sides. Likewise, of the students who achieved the acceptable standard but answered the item incorrectly, 49.1% selected option B and 36.0% selected option A, which suggests that the students who achieved the acceptable standard made errors similar to those made by the students who achieved the standard of excellence.

The following four items, from all four strands, illustrate significant performance differences between students who achieved the acceptable standard versus those who were below the acceptable standard.

Item #	Strand	Specific Outcome	Item Complexity	Item Description
22	PR	1	Low	Identify a written context that could be represented using a given linear equation (Gr.8, PR.2; Gr.7, PR.7; Gr.6, PR.4).

	% of Student Responses (*Correct)			
	A	**B**	**C**	**D***
Students Achieving the Acceptable Standard	25.5	6.2	5.1	63.2
Students Below the Acceptable Standard	35.1	25.0	17.5	22.0

Use the following information to answer question 22.

The relationship between two variables is given in the equation $35 + 15n = A$.

22. Which of the following situations could be represented using the equation above?

A. The price of a caterer for a party is $35 for each dinner ordered and $15 for each dessert ordered.

B. The bill for framing a painting is $35 for each square meter of glass required and $15 for the wooden frame.

C. The fee for a computer consultant is $15 for an administration charge and $35 for each hour worked.

D. The cost of silk screening a design on T-shirts is $15 for each shirt created and a $35 design fee.

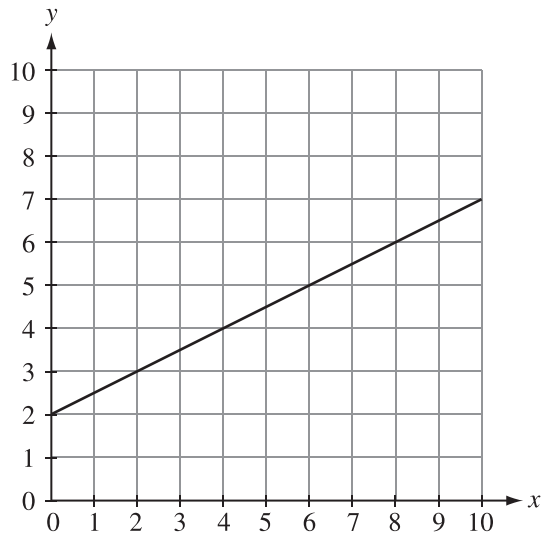
Commentary:

Of the students who achieved the acceptable standard but answered the item incorrectly, approximately 69.3% chose option A as their response. This suggests that these students may have difficulty understanding the role of the variable in an algebraic equation. Likewise, of the students who achieved below the acceptable standard but answered the item incorrectly, 45.2% selected option A and 32.2% selected option B, which further suggests that these students have additional difficulties in representing real-life contextual problems with linear equations.

Item #	Strand	Specific Outcome	Item Complexity	Item Description
38	PR	2	Low	Match the given graph of a linear relation with its corresponding linear equation (Gr.8, PR.1).

	% of Student Responses (*Correct)			
	A*	**B**	**C**	**D**
Students Achieving the Acceptable Standard	69.1	6.1	20.4	4.1
Students Below the Acceptable Standard	29.7	16.2	44.2	8.7

Use the following information to answer question 38.



38. The equation representing the linear relation on the graph shown above is

A. $y = 0.5x + 2$

B. $y = 0.5x - 2$

C. $y = 2x + 4$

D. $y = 2x - 4$

Commentary:

Of the students who achieved the acceptable standard but answered the item incorrectly, approximately 66.7% chose option C as their response. This suggests that these students may have difficulty relating a list of ordered pairs (given in the form of a linear graph) to an equation that can be used to create the list of ordered pairs. Likewise, of the students who achieved below the acceptable standard but answered the item incorrectly, 64.0% selected option C and 23.4% selected option B, which further implies that these students had additional difficulties with matching a graph of a linear relation with its corresponding linear equation.

Item #	Strand	Specific Outcome	Item Complexity	Item Description
27	N	4	Moderate	Solve a given problem by applying the order of operations on positive rational numbers (Gr.6, N.9).

	% of Student Responses (*Correct)			
	A	**B***	**C**	**D**
Students Achieving the Acceptable Standard	17.2	77.2	3.4	2.0
Students Below the Acceptable Standard	38.3	38.2	14.5	8.4

Use the following information to answer question 27.

Connie buys a horse for $750 (including GST). She considers the two payment plans shown below.

Plan 1 Pay $150 now and $25 each month
Plan 2 Pay $200 now and $55 each month

27. How many **fewer** monthly payments could Connie make if she selects Plan 2?

A. 10
B. 14
C. 20
D. 24

Commentary:

Of the students who achieved the acceptable standard but answered the item incorrectly, approximately 76.1% chose option A as their response. This suggests that these students may have misunderstood the question and determined the number of monthly payments that need to be made if Plan 2 was selected instead of comparing the two plans to determine how many fewer monthly payments would be made with Plan 2. Likewise, of the students who achieved below the acceptable standard but answered the item incorrectly, 62.6% selected option A for reasons likely similar to those students who achieved the acceptable standard.

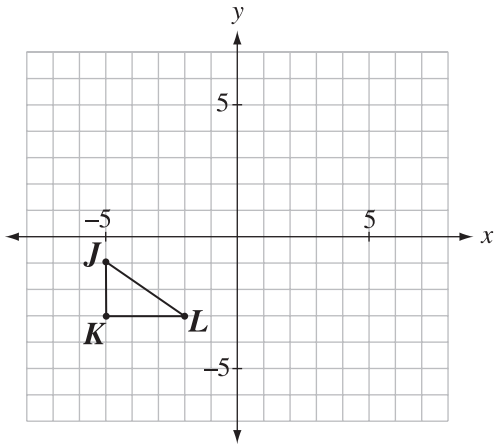
Item #	Strand	Specific Outcome	Item Complexity	Item Description
33	SS	5	High	Identify the location of the vertices of a 2-D shape after completing a combination of transformations on the Cartesian plane (Gr.7, SS.4; Gr.7, SS.5).

	% of Student Responses (*Correct)			
	A	**B**	**C**	**D***
Students Achieving the Acceptable Standard	15.0	7.5	13.6	63.8
Students Below the Acceptable Standard	21.5	20.6	28.9	28.1

Use the following information to answer question 33.

Triangle *JKL*, shown below, undergoes the following transformations:

- a 90° clockwise rotation about vertex *L*
- a translation of 3 units right and 4 units up



33. Which of the following rows represents the ordered pair for each vertex after **both** the transformations described above have been completed?

Row	*J″*	*K″*	*L″*
A.	(1, 1)	(1, 4)	(3, 4)
B.	(1, 1)	(1, –2)	(–1,–2)
C.	(4, 3)	(2, 3)	(2, 0)
D.	(3, 4)	(1, 4)	(1, 1)

Commentary:

Of the students who achieved the acceptable standard but answered the item incorrectly, approximately 41.6% chose option A as their response. This suggests that these students may have completed the two transformations correctly but had difficulties in maintaining the correct labels on each vertex in order to correctly identify the corresponding coordinates. Students who achieved below the acceptable standard but selected option A or C further suggest that these students had additional difficulties in completing successive transformations on the Cartesian plane. Students that selected option C likely completed the 90° clockwise rotation correctly but incorrectly translated the image 4 units to the right and 3 units up instead of translating it 3 units to the right and 4 units up.

Achievement Testing Program Support Documents

The Alberta Education website contains several documents that provide valuable information about various aspects of the achievement testing program. To access these documents, go to the Alberta Education website at education.alberta.ca. From the home page, follow this path: *Teachers* > *Provincial Testing* > *Achievement Tests*, and then click on one of the specific links under the *Achievement Tests* heading to access the following documents.

Achievement Testing Program General Information Bulletin

The *General Information Bulletin* is a compilation of several documents produced by Alberta Education and is intended to provide superintendents, principals, and teachers with easy access to information about all aspects of the achievement testing program. Sections in the bulletin contain information pertaining to schedules and significant dates; security and test rules; test administration directives, guidelines, and procedures; calculator and computer policies; test accommodations; test marking and results; field testing; resources and web documents; forms and samples; and Assessment Sector contacts.

Subject Bulletins

At the beginning of each school year, subject bulletins are posted on the Alberta Education website for all achievement test subjects for grades 3, 6, and 9. Each bulletin provides descriptions of assessment standards, test design and blueprinting, and scoring guides (where applicable) as well as suggestions for preparing students to write the tests and information about how teachers can participate in test development activities.

Examples of the Standards for Students' Writing

For achievement tests in grades 3, 6, and 9 English Language Arts and Français/French Language Arts, writing samples have been designed to be used by teachers and students to enhance students' writing and to assess this writing relative to the standards inherent in the scoring guides for the achievement tests. The exemplars documents contain sample responses with scoring rationales that relate student work to the scoring categories and scoring criteria.

Previous Achievement Tests and Answer Keys

All January achievement tests (parts A and B) for Grade 9 semestered students are secured and must be returned to Alberta Education. All May/June achievement tests are secured except Part A of grades 3, 6, and 9 English Language Arts and Français/French Language Arts. Unused or extra copies of only these Part A tests may be kept at the school after administration. Teachers may also use the released items and/or tests that are posted on the Alberta Education website.

Parent Guides

Each school year, versions of the *Parent Guide to Provincial Achievement Testing* for grades 3, 6, and 9 are posted on the Alberta Education website. Each guide presents answers to frequently asked questions about the achievement testing program as well as descriptions of and sample questions for each achievement test subject.

Involvement of Teachers

Teachers of grades 3, 6, and 9 are encouraged to take part in activities related to the achievement testing program. These activities include item development, test validation, field testing, and marking. In addition, arrangements can be made through the Alberta Regional Professional Development Consortia for teacher in-service workshops on topics such as Interpreting Achievement Test Results to Improve Student Learning.