Alberta Provincial Achievement Testing

Assessment Highlights 2011–2012

GRADE 9

Mathematics

This document contains assessment highlights from the 2012 Grade 9 Mathematics Achievement Test (*2007 Program of Studies*). The examination statistics that are included in this document represent all writers: both French and English. If you would like 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 provide information about the overall test, test blueprints, and student performance on the achievement test that was administered in 2012. Also provided is commentary on student performance at the *acceptable standard* and the *standard of excellence* on selected items from the 2012 Mathematics Achievement Test (*2007 Program of Studies*). 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 2012 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 2012 Grade 9 Mathematics Achievement Test. It complements the detailed school and jurisdiction reports.

How Many Students Wrote the Test?

A total of 37 626 students wrote the 2012 Grade 9 Mathematics Achievement Test. The English form of the test was written by 35 181 students and the French form of the test was written by 2 445 students.

What Was the Test Like?

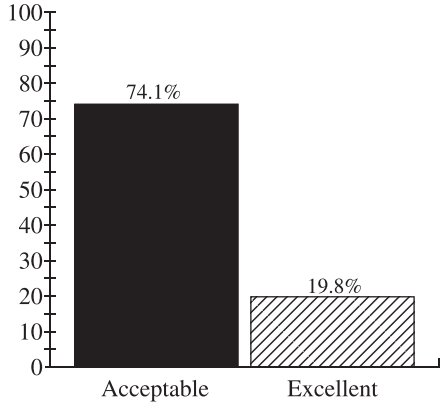
The 2012 Grade 9 Mathematics Achievement Test consisted of 40 multiple-choice and 10 numerical-response questions based on four strands: Number, Patterns and Relations, Shape and Space, and Statistics and Probability. In keeping with the intent of the 2007 Program of Studies, the questions on the test 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 2012 are shown in the graph below. Out of a total score of 50 on the test, the provincial average was 28.9/50 (57.8%). 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—2012 Mathematics Achievement Test		
	Acceptable (%)	Excellence (%)
2012	74.1	19.8

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



2012 Achievement Standards: The percentage of students in the province who met the *acceptable standard* on the 2012 Grade 9 Mathematics Achievement Test (based on those who wrote)

2012 Achievement Standards: The percentage of students in the province who met the *standard of excellence* on the 2012 Grade 9 Mathematics Achievement Test (based on those who wrote)

2012 Test Blueprint and Student Achievement

In 2012, 74.1% of students who wrote the test achieved the *acceptable standard* on the Grade 9 Mathematics Achievement Test, and 19.8% of students who wrote achieved the *standard of excellence*.

Out of a total score of 50 on the test, the provincial average was 28.9/50 (57.8%). The blueprint below shows how the questions on the test were classified and includes the average raw score in each category for all grade nine students who wrote this test.

Strand	Level of Complexity*			Provincial Student Achievement (Average Raw Score and Percentage)
	Low	Moderate	High	
Number	**5**	**10**	**2**	**8.8/14 (62.9%)**
Patterns and Relations	**2**	**9**	**3**	**10.9/18 (60.6%)**
Shape and Space	**8**	**4**	**2**	**7.3/14 (52.1%)**
Statistics and Probability	**3**	**2**	**0**	**2.0/5 (40.0%)**
Provincial Student Achievement (Average Raw Score and Percentage)	**9.7/16 (60.6%)**	**15.3/27 (56.7%)**	**3.8/7 (54.3%)**	**Total Test Raw Score 28.9/50 (57.8%)**

*Each question is categorized according to its level of complexity (Low, Moderate, or High). Descriptions of the levels of complexity are in the 2012-2013 Mathematics 9 Subject Bulletin.

2012 Grade 9 Mathematics Achievement Test Design Commentary

The 2012 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 (e.g., complexity) and modified test design features (e.g., 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 regard 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 *2012–2013 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 chosen by more than 70 percent of the students are generally considered easy. Items for which the correct answer is chosen by 50–70 percent of the students are about average in difficulty. Items for which the correct answer is chosen by less than 50 percent 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 an item makes of a student (i.e., what an item requires the student to recall, understand, analyze, and do) are premised on 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 exceptions.

The following 8 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 2012 Grade 9 Mathematics Achievement Test

The following 4 items, from all 4 strands, illustrate significant performance differences between students who achieved the *standard of excellence* and those who achieved the *acceptable standard*.

Item #	Strand	Specific Outcome	Item Complexity	Item Description
39	N	3	Low	Solve a given problem involving operations on rational numbers and powers with integral bases and whole number exponents (Gr.8, N.6)

	% of Student Responses (*Correct)			
	A	**B**	**C**	**D***
Students Achieving the *Standard of Excellence*	1.9	9.8	9.9	78.2
Students Achieving the *Acceptable Standard*	10.0	23.5	23.8	41.6

Commentary:

Although the errors represented by option **B** and **C** were the most frequently chosen responses for both groups of students, the errors themselves suggest different misconceptions. The error represented by option **B** suggests that these students may have correctly applied the zero-exponent rule, but simply neglected to find the correct product. An alternative hypothesis is that students did correctly apply the zero exponent rule but did not understand that $-\frac{3}{2}$ was the product being asked for, e.g. $-\frac{2}{3}x-\frac{3}{2}=1$ which is equivalent to $\left(\frac{3}{2}\right)^0$. However, the error represented by option C suggests that these students did not correctly apply the order of operations with exponents.

39. Monica multiplies $-\frac{2}{3}$ by a number. If her answer is $-\frac{3}{2}$, then Monica multiplied $-\frac{2}{3}$ by

A. $-\left(\frac{3}{2}\right)^0$

B. $\left(\frac{3}{2}\right)^0$

C. $-\left(\frac{3}{2}\right)^2$

D. $\left(\frac{3}{2}\right)^2$

Item #	Strand	Specific Outcome	Item Complexity	Item Description
20	PR	4	Moderate	Translate a given problem into a single variable inequality with rational coefficients (Gr.8, PR.2; Gr.7, PR.6; Gr.6, PR.4)

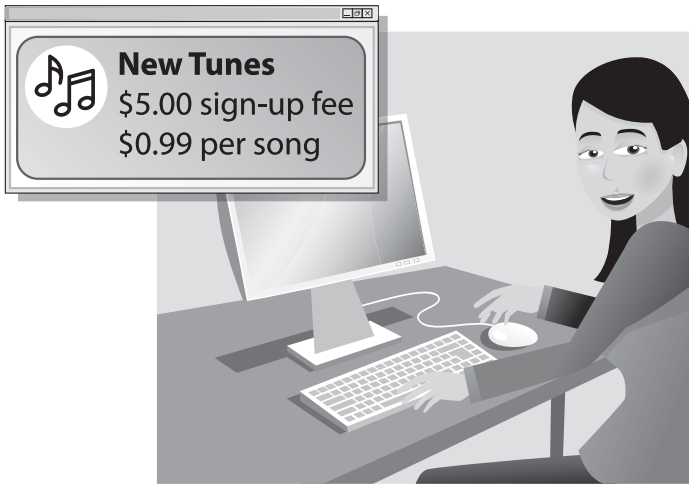
	% of Student Responses (*Correct)			
	A*	**B**	**C**	**D**
Students Achieving the *Standard of Excellence*	77.5	4.2	17.2	1.1
Students Achieving the *Acceptable Standard*	47.1	13.6	31.7	7.4

Commentary:

The most frequent error for both groups of students, represented by option **C**, suggests that these students did not understand how to represent the given context with an algebraic relation when the variable appears on the right side of the inequality. Conversely, the error represented by option **B** suggests that while these students did understand the order relationship of the information of the context, they failed to understand that the term "maximum" (in the stem of the question) implies "greater than or equal to," and not just "greater than."

Use the following information to answer question 20.

Chantal receives a $50 gift card to join the online music store shown below.



20. Which of the following inequalities can be used to determine the maximum number of songs that Chantal can purchase with her gift card?

A. $50 \geq 5 + 0.99x$

B. $50 > 5 + 0.99x$

C. $50 \leq 5 + 0.99x$

D. $50 < 5 + 0.99x$

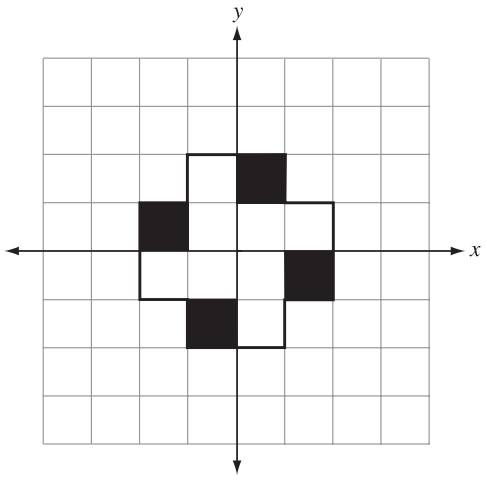
Item #	Strand	Specific Outcome	Item Complexity	Item Description
24	SS	5	Low	Determine the order of rotational symmetry of a given 2-D shape and the number of lines of symmetry it has (Gr.4, SS.6)

	% of Student Responses (*Correct)			
	A	**B**	**C***	**D**
Students Achieving the *Standard of Excellence*	3.0	1.7	81.7	13.5
Students Achieving the *Acceptable Standard*	9.2	11.2	49.8	29.7

Commentary:

The most frequent error for both groups of students, represented by option **D**, suggests that while these students did understand the concept of rotational symmetry, they lacked knowledge in the area of line symmetry.

Use the following information to answer question 24.



24. *The shape shown above has rotational symmetry of order* ___***i***___ *, and* ___***ii***___ *lines of symmetry.*

The statement above is completed by the information in row

Row	*i*	*ii*
A.	2	0
B.	2	2
C.	4	0
D.	4	2

Item #	Strand	Specific Outcome	Item Complexity	Item Description
40	SP	3	Moderate	Identify how results from a given survey could be misinterpreted because of the way the results are graphed

	% of Student Responses (*Correct)			
	A	**B***	**C**	**D**
Students Achieving the *Standard of Excellence*	2.7	78.2	14.2	4.6
Students Achieving the *Acceptable Standard*	9.0	46.9	32.9	10.1

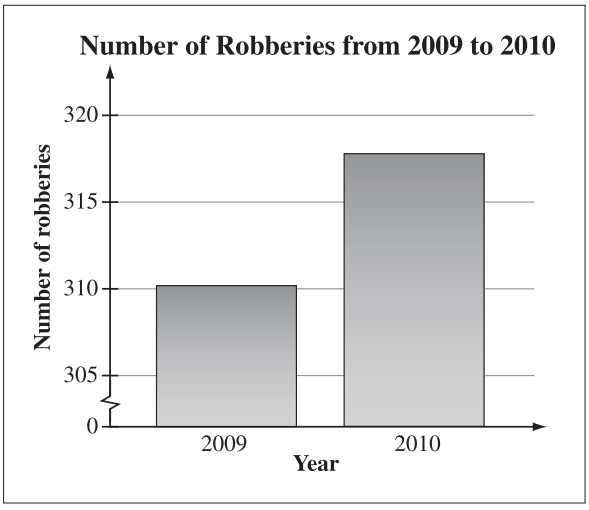
Commentary:

The most frequent errors for both groups of students, represented by option **C** and option **D**, suggest that these students simply did not read the question carefully; otherwise they would have known that the graph represents actual population data that was not generated from experimental or theoretical probability experiments.

Use the following information to answer question 40.

The local newspaper of a large city printed the following graph with the following headline:

"Robberies are Predicted to Double in 2011"



40. The newspaper headline is **not** a reasonable interpretation of the graph shown above because the

A. width of the bars is exaggerated

B. scale of the *y*-axis is misleading

C. probability is based on theoretical data

D. probability is based on experimental data

The following 4 items, from all 4 strands, illustrate significant performance differences between students who achieved the *acceptable standard* and those who were below the *acceptable standard*.

Item #	Strand	Specific Outcome	Item Complexity	Item Description
23	N	3	Moderate	Order a set of rational numbers given in fraction and decimal form (Gr.7, N.4; Gr.7, N.7; Gr.6, N.7)

	% of Student Responses (*Correct)			
	A*	**B**	**C**	**D**
Students Achieving the *Acceptable Standard*	63.5	22.5	10.0	3.9
Students Below the *Acceptable Standard*	28.4	30.3	22.9	18.0

Commentary:

The most frequent error for both groups of students, represented by option **B**, suggests that these students did understand how to order values involving positive fractions and decimals (as evident from the correct ordering of $\frac{2}{5}$ and 0.5); however, the error likely stems from a lack of understanding of how to order negative rational numbers.

23. Which of the following rows has the rational numbers ordered from **least** to **greatest**?

Row	Least			Greatest
A.	$-\frac{5}{7}$	$-0.\overline{6}$	$\frac{2}{5}$	0.5
B.	$-0.\overline{6}$	$-\frac{5}{7}$	$\frac{2}{5}$	0.5
C.	$-\frac{5}{7}$	$-0.\overline{6}$	0.5	$\frac{2}{5}$
D.	$-0.\overline{6}$	$-\frac{5}{7}$	0.5	$\frac{2}{5}$

Item #	Strand	Specific Outcome	Item Complexity	Item Description
11	PR	1	High	Identify the linear equation that could represent a given pattern that is presented in a table (Gr.8, PR.1)

	% of Student Responses (*Correct)			
	A	**B**	**C**	**D***
Students Achieving the *Acceptable Standard*	5.9	1.5	15.3	77.2
Students Below the *Acceptable Standard*	24.6	12.1	31.3	31.4

Commentary:

The most frequent errors for both groups of students, represented by options **A** and **C**, suggest that these students did understand how to solve the given equation to satisfy the relationship of the first row of the given table (i.e., between the weekly earnings of $10 and the corresponding weekly savings of $7); however, they did not verify whether the equation could represent all relationships in the table.

Use the following information to answer question 11.

Raj saves a part of his earnings each week. He uses the pattern below to decide how much of his weekly earnings he will save.

Weekly Earnings (e)	Weekly Savings (s)
$10	$7
$12	$8
$14	$9
$16	$10

11. Which of the following equations could represent the relationship between Raj's weekly savings, s, and his weekly earnings, e?

A. $s = e - 3$

B. $s = e - 6$

C. $s = 2.0(e - 5) - 3$

D. $s = 0.5(e + 10) - 3$

Item #	Strand	Specific Outcome	Item Complexity	Item Description
NR 2	SS	2	Moderate	Determine the difference in surface area of two 3-D objects that are similar (Gr.8, SS.3)

Performance of Students Achieving the *Acceptable Standard*				
Responses	1.25	15	1125*	1237
% of Student Responses (*Correct)	1.9	5.0	38.8	2.5

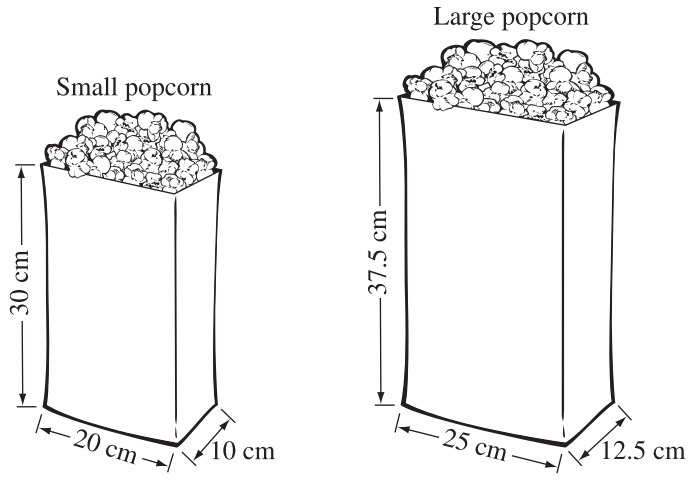
Performance of Students Below the *Acceptable Standard*				
Responses	1.25	7.5	15	1125*
% of Student Responses (*Correct)	6.3	6.0	15.9	4.0

Commentary:

The most frequent error for both groups of students, represented by the response of 15, indicates that these students do not fully understand the concept of surface area and simply found the difference of the sums of the three given edge lengths of each bag.

Use the following information to answer numerical-response question 2.

The local movie theatre sells two sizes of popcorn. The large bag of popcorn is a scale enlargement of the small bag.



Numerical Response

2. The difference between the exterior surface area of the large popcorn bag and the small popcorn bag is _____ cm^2.

(Record your answer in the numerical-response section on the answer sheet.)

Item #	Strand	Specific Outcome	Item Complexity	Item Description
14	SP	2	Moderate	Identify valid reasons for using a sample of a population instead of a population to answer a survey question (Gr.6, SP.2)

	% of Student Responses (*Correct)			
	A	**B***	**C**	**D**
Students Achieving the *Acceptable Standard*	21.4	48.8	18.6	11.1
Students Below the *Acceptable Standard*	27.6	27.1	22.3	22.6

Commentary:

The most frequent error for both groups of students, represented by option **A**, suggests that these students did not consider or understand the negation in the question, i.e., "Which of the following statements is **not** a valid reason…"Additionally, in the below the *acceptable standard* group, the number of students that selected each option is almost equal, which suggests that these students do not fully understand the reasons for selecting a sample over a population.

14. Which of the following statements is **not** a valid reason for using a representative sample to conduct a survey?

A. It is cheaper to use a sample.

B. There is too much error in a sample.

C. There is too much data in the complete population.

D. It is too time-consuming to use the complete population.

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.