# Alberta Provincial Achievement Testing

## Assessment Highlights 2010-2011

GRADE 9

# Mathematics

Government of Alberta

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Freedom To Create. Spirit To Achieve.

This document contains assessment highlights from the 2010 Grade 9 Mathematics Achievement Test (*1997 Program of Studies*) as well as some observations about the 2010 Pilot 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 2010. Also provided is commentary on student performance at the *acceptable standard* and the *standard of excellence* on selected items from the 2010 Mathematics Achievement Test (*1997 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.

For further information, contact
Kelly Rota, Grade 6 and 9 Mathematics Assessment Standards Team Leader, at Kelly.Rota@gov.ab.ca;
Delcy Rolheiser, Grade 6 and 9 Mathematics Examiner, at Delcy.Rolheiser@gov.ab.ca; or
Ken Marcellus, Director, Achievement Testing, at Ken.Marcellus@gov.ab.ca
in the Assessment Sector, or call (780) 427-0010. To call toll-free within Alberta, dial 310-0000.

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 2011 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 2011 Grade 9 Mathematics Achievement Test. It complements the detailed school and jurisdiction reports.

## *How Many Students Wrote the Test?*

A total of 38 083 students wrote the 2011 Grade 9 Mathematics Achievement Test. The English form of the test was written by 35 660 students and the French form of the test was written by 2 423 students.

## *What Was the Test Like?*

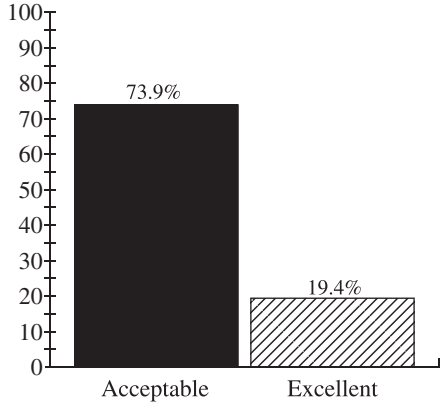
The 2011 Grade 9 Mathematics Achievement Test consisted of 40 multiple-choice and 10 numerical-response questions based on four strands: Number, Patterns and Relations, Shape and Space, Statistics and Probability. In keeping with the intent of the 2007 Program of Studies, the questions on the test required 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 2011 are shown in the graph below. Out of a total score of 50 on the test, the provincial average was 33.4/50 (66.8%). 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—2011 Mathematics Achievement Test** | | |
|---|---|---|
| | Acceptable (%) | Excellence (%) |
| 2011 | 73.9 | 19.4 |

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




2011 Achievement Standards: The percentage of students in the province who met the *acceptable standard* on the 2011 Grade 9 Mathematics Achievement Test (based on those who wrote)

2011 Achievement Standards: The percentage of students in the province who met the *standard of excellence* on the 2011 Grade 9 Mathematics Achievement Test (based on those who wrote).

# *2011 Test Blueprint and Student Achievement*

In 2011, 73.9% of students who wrote the test achieved the *acceptable standard* on the Grade 9 Mathematics Achievement Test, and 19.4% of students who wrote achieved the *standard of excellence*.

Out of a total score of 50 on the test, the provincial average was 33.4/50 (66.8%). 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 (Raw Score and Percentage) |
|---|---|---|---|---|
| | Low | Moderate | High | |
| **Number** | **5** | **8** | **3** | **10.9/16 (67.9%)** |
| **Patterns and Relations** | **7** | **6** | **4** | **11.4/17 (67.4%)** |
| **Shape and Space** | **6** | **4** | **2** | **7.3/12 (61.2%)** |
| **Statistics and Probability** | **0** | **3** | **2** | **3.8/5 (75.6%)** |
| **Provincial Student Achievement (Average Raw Score and Percentage)** | **12.6/18 (69.8%)** | **14.1/21 (67.4%)** | **6.7/11 (60.5%)** | **Total Test Raw Score 33.4/50 (66.8%)** |

*Each question is categorized according to its level of complexity (Low, Moderate, or High). Descriptions of the levels of complexity are in the 2011-2012 Mathematics 9 Subject Bulletin.

# *2011 Grade 9 Mathematics Achievement Test Design Commentary*

The 2011 Mathematics Provincial Achievement Test for Grade 9 was based on the 2007 Alberta K–9 Mathematics Program of Studies that was implemented in the 2010–2011 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 *2011–2012 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 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 (e.g., items that are of high complexity tend to be more challenging), there are instances in which this is not the case. For example, item #1 and item #29 both assess Specific Outcome #1 from the Patterns and Relations strand; however, student performance on these two items was significantly different; i.e., students actually did better on item #1, which was classified as a moderate complexity item, than on item #29, which was classified as a low-complexity item.

The following 8 items have been released to help illustrate areas of student strength and areas for improvement from each of the four strands. The reporting categories for each item, as well as the statistics in terms of the percentage of students who answered the item correctly and the percentages for the incorrect options chosen, have also been provided.

# *Sample Questions from the 2011 Grade 9 Mathematics Achievement Test*

**Items 1–4 Illustrate Student Strengths**

| Item | Question # on PAT | Strand | Primary Outcome Number | Item Complexity | % of Student Responses | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | A | B* | C | D |
| 1 | 1 | PR | 1 | Moderate | 8.2 | 84.2 | 5.2 | 2.1 |

*** Correct response**

*Use the following information to answer question 1.*

Line segment $QT$ is 48 units.


**1.** Which of the following linear equations represents the length of line segment $QT$?

**A.** $5t + 15 = 48$

**B.** $11t + 15 = 48$

**C.** $5t - 15 = 48$

**D.** $11t - 15 = 48$

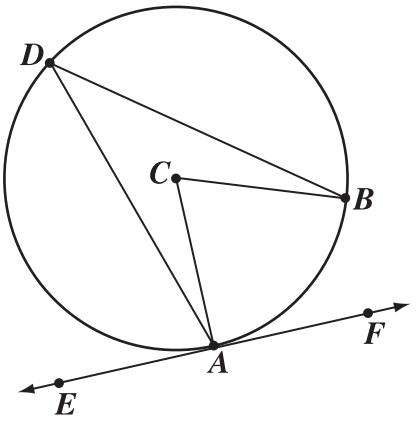
To answer this item correctly, students had to correctly identify and combine like terms in a given polynomial representation.

The most common incorrect response (A) suggests that students were able to set up the equation and identify the like terms; however, they subtracted the like terms instead of combining them.

| Item | Question # on PAT | Strand | Primary Outcome Number | Item Complexity | % of Student Responses | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | A | B* | C | D |
| 2 | 12 | SS | 1 | Low | 8.6 | 80.1 | 4.1 | 7.2 |

*** Correct response**

*Use the following information to answer question 12.*




In this diagram, point *C* represents the centre of the circle.

**12.** Which of the following rows of terms correctly labels the parts of the diagram above?

| Row | $\angle ADB$ | $\overline{AD}$ | $\angle ACB$ | $\overleftrightarrow{EF}$ |
|---|---|---|---|---|
| **A.** | Inscribed angle | Tangent line | Central angle | Chord |
| **B.** | Inscribed angle | Chord | Central angle | Tangent line |
| **C.** | Central angle | Tangent line | Inscribed angle | Chord |
| **D.** | Central angle | Chord | Inscribed angle | Tangent line |

To answer this item correctly, students had to correctly identify parts of a circle-geometry diagram. This is the first step in being able to understand and apply circle properties to solve problems.

The most common incorrect response (A) suggests that some students confused the concepts of chords and tangent lines.

| Item | Question # on PAT | Strand | Primary Outcome Number | Item Complexity | % of Student Responses | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | A* | B | C | D |
| 3 | 18 | PR | 5 | Low | 86.9 | 6.5 | 4.9 | 1.5 |

*** Correct response**

*Use the following information to answer question 18.*

$3x^2 - 4$

**18.** Which row correctly shows the degree, the coefficient, and the constant term in the expression shown above?

| Row | Degree | Coefficient of $x^2$ | Constant Term |
|---|---|---|---|
| **A.** | 2 | 3 | $-4$ |
| **B.** | 3 | 2 | 4 |
| **C.** | 2 | $-4$ | 3 |
| **D.** | 3 | 4 | 2 |

To answer this item correctly, students had to correctly identify the degree, the coefficient, and constant of a given polynomial expression.

The most common incorrect response (B) suggests that some students confused the degree with the coefficient on the $x^2$ term.

| Item | Question # on PAT | Strand | Primary Outcome Number | Item Complexity | % of Student Responses | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | A | B | C | D* |
| 4 | 32 | N | 3 | Moderate | 7.0 | 5.2 | 12.9 | 74.7 |

*** Correct response**

*Use the following information to answer question 32.*

The following list shows Rick's yearly vehicle expenses.

- Insurance: $1 200
- Gasoline: $1 300
- Repairs: $850

**32.** If Rick works 8 hours/day, 5 days/week, and takes home $10/hour, then what is the **least** number of complete weeks he must work in order to pay for all his yearly vehicle expenses?

**A.** 6 weeks
**B.** 7 weeks
**C.** 8 weeks
**D.** 9 weeks

To answer this item correctly, students had to correctly solve a contextual problem involving money by applying arithmetic operations on rational numbers.

The most common incorrect response (C) suggests that some students completed the required arithmetic operations correctly but simply applied rounding rules instead of applying mathematical reasoning to make sense of their solution.

**Items 5–8 Illustrate Areas for Improvement**

| Item | Question # on PAT | Strand | Primary Outcome Number | Item Complexity | % of Student Responses | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | A* | B | C | D |
| 5 | 6 | PR | 5 | Low | 60.1 | 24.3 | 8.7 | 6.8 |

*** Correct response**

**6.** Which of the following expressions is equivalent to $-(3x - 2)$?

**A.** $-3x + 2$
**B.** $-3x - 2$
**C.** $3x + 2$
**D.** $3x - 2$

To answer this item correctly, students had to correctly multiply a monomial and a polynomial expression. Not being able to perform this relatively simple operation would hinder a student's ability to solve more complex equations.

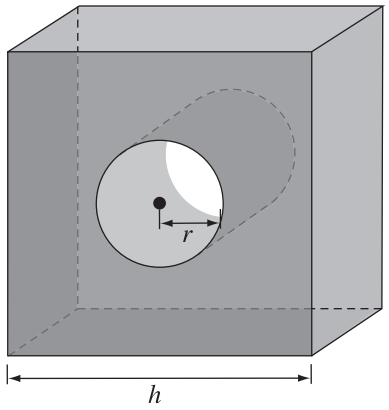
The most common incorrect response (B) suggests that some students applied the negative monomial only to the first term of the polynomial expression. The second most common incorrect response (C) suggests that some students applied the negative monomial only to the second term of the polynomial, or applied it to both terms but forgot to include the negative sign on the first term.

| Item | Question # on PAT | Strand | Primary Outcome Number | Item Complexity | % of Student Responses | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | A* | B | C | D |
| 6 | 13 | SS | 2 | High | 51.3 | 15.1 | 22.3 | 11.0 |

*** Correct response**

*Use the following information to answer question 13.*

The 3-D object below is a **cube** with a right cylinder cut out.




**13.** Which expression represents the surface area of the 3-D object?

**A.** $6h^2 - 2\pi r^2 + 2\pi rh$

**B.** $4h^2 - 2\pi r^2 + 2\pi rh$

**C.** $6h^2 + 2\pi r^2 - 2\pi rh$

**D.** $4h^2 + 2\pi r^2 - 2\pi rh$

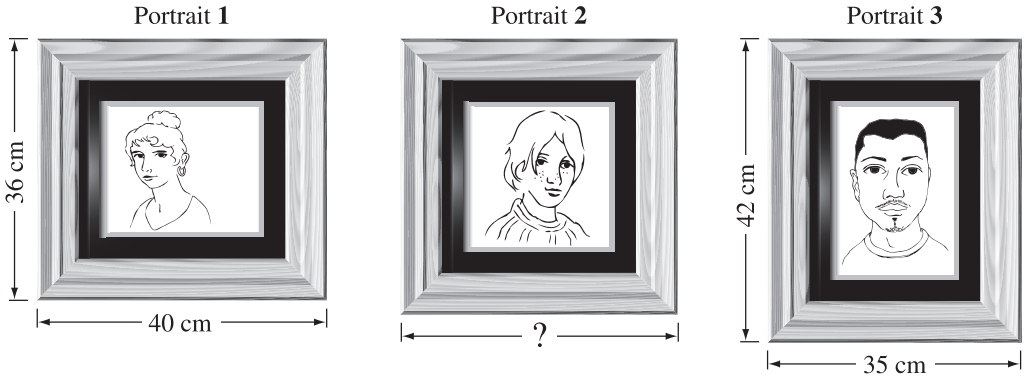
To answer this item correctly, students had to correctly develop a formula to calculate the surface area of a composite object.

The most common incorrect response (C) suggests that some students subtracted the area of the circles from the area of the curved surface instead of adding them together. These students were able, however, to correctly identify all the surface areas. The second most common incorrect response (B) suggests that some students did not include the required front and back areas; however, they did correctly subtract the circle areas and add this to the curved surface area.

| Item | Question # on PAT | Strand | Primary Outcome Number | Item Complexity | Percentage of Students Selecting Each Option | |
|---|---|---|---|---|---|---|
| | | | | | Correct | Incorrect |
| 7 | NR 6 | N | 6 | High | 53.7 | 46.3 |

*Use the following information to answer numerical-response question 6.*

Pat arranges three portraits from smallest to largest based on area. Portrait 2 is square, and its side length, measured in centimetres, is a whole number.




## Numerical Response

**6.** The side length of portrait 2 is _____ cm.

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

To answer this item correctly, students had to correctly find the perfect square between two non-perfect squares.

Of incorrect student responses, 73.8% provided answers between 35 and 40, suggesting that they did not understand that the portraits were arranged in order according to area.

| Item | Question # on PAT | Strand | Primary Outcome Number | Item Complexity | Percentage of Students Selecting Each Option | |
|---|---|---|---|---|---|---|
| | | | | | Correct | Incorrect |
| **8** | **NR 10** | **N** | **5** | **Low** | **53.0** | **47.0** |

## Numerical Response

**10.** The number of perfect squares that are whole numbers between 2 and 20 is _____.

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

To answer this item correctly, students had determine the total number of perfect squares between two non-perfect squares.

The most common set of incorrect responses (i.e., 4, 9, or 16), suggests that some students may have missed the fact that the question asked for the total number of perfect squares between 2 and 20, and not just one perfect square. Another common incorrect response of 4, suggests that some students may have inadvertently included the value of 1 in the range.

# *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.