Grade 9 Assessment Highlights Mathematics

Alberta Provincial Achievement Testing **2021–2022**

Alberta

This document was written primarily for:

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

Alberta Education, Government of Alberta

2021–2022

Mathematics 9 Assessment Highlights

Distribution: This document is posted on the Alberta Education website.

Contents

You can find provincial achievement test-related materials on the Alberta Education website.

Additional topics of interest are found in the *General Information Bulletin*.

This document contains assessment highlights from the *2022 Grade 9 Mathematics Provincial Achievement Test*.

Assessment Highlights provides information about the overall test, the test blueprint, and student performance on the provincial achievement test that was administered in 2022. Also provided is information on student performance at the acceptable standard and the standard of excellence on selected items from the *2022 Grade 9 Mathematics Provincial Achievement Test*. This information is intended for teachers and is best used in conjunction with multi-year and detailed school reports that are available to schools via the Stakeholder File Exchange (SFX). *Assessment Highlights* for all provincial achievement test subjects and grades are posted on the Alberta Education website every year in the fall.

The examination statistics that are included in this document represent both French and English writers. If you would like to obtain English-only statistics or French-only statistics that apply to your school, please refer to your detailed reports, which are available on the Stakeholder File Exchange (SFX).

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The *2022 Grade 9 Mathematics Provincial Achievement Test*

This report provides teachers, school administrators, and the public with an overview of the performance of those students who wrote the *2022 Grade 9 Mathematics Provincial Achievement Test*. It complements the detailed school and jurisdiction reports.

How many students wrote the test?

A total of 27 331 students in Alberta had results reported provincially for the *2022 Grade 9 Mathematics Provincial Achievement Test*. Security breaches occurred over the last few days of the 2021-22 PAT administration window. To maintain the validity and comparability of provincial results, students most likely impacted by these security breaches have been excluded from the provincial cohort.

What was the test like?

The *2022 Grade 9 Mathematics Provincial Achievement Test* consisted of two parts: *Part A* and *Part B*.

Part A consisted of 16 numerical-response questions and represented 20% of the final overall test score. The test assessed students' foundational skills and fluency in mental math, estimation, algebra, square roots, exponent laws, and arithmetic operations on rational numbers without the use of calculators.

Part B consisted of 29 multiple-choice questions and 8 numerical-response questions and represented 80% of the final overall test score. The test assessed students' ability to recall concepts and principles and to apply reasoning skills to solve problems. The test required students to apply their understanding of one or more mathematical concepts from within and/or across the four strands: *Number*, *Patterns and Relations*, *Shape and Space*, and *Statistics and Probability*.

How well did students do?

The percentages of students meeting the acceptable standard and the standard of excellence in 2022 are shown in the graph below. The examination statistics that are included in this document represent both French and English writers. If you would like to obtain English-only or French-only statistics that apply to your school, please refer to the detailed reports that are available on the Stakeholder File Exchange (SFX).

Percentage of Students Meeting the Acceptable Standard (%)

Percentage of Students Meeting the Standard of Excellence (%)
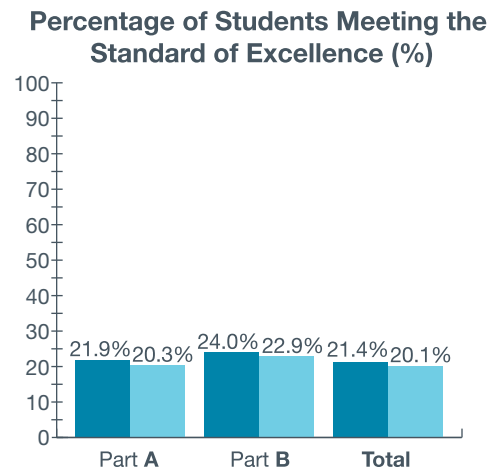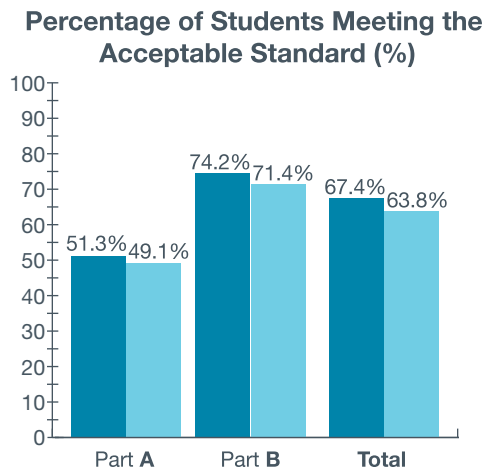
2019 Achievement Standards: The percentage of students in the province that met the acceptable standard and the standard of excellence on the 2019 *Grade 9 Mathematics Provincial Achievement Test* (based on those who wrote)

2022 Achievement Standards: The percentage of students in the province that met the acceptable standard and the standard of excellence on the 2022 *Grade 9 Mathematics Provincial Achievement Test* (based on those who wrote)

2022 Test Blueprint and Student Achievement

In 2022, 63.8% of students who wrote the *Grade 9 Mathematics Provincial Achievement Test* achieved the acceptable standard, and 20.1% of students who wrote achieved the standard of excellence. There was a strong positive correlation between student performance on *Part A* and performance on *Part B*. This suggests a strong relationship between routine algebraic operations and problem solving. Generally speaking, students who performed well on *Part A* also performed well on *Part B*, and vice versa.

The blueprints below show the reporting categories by which 2022 summary data are reported to schools and school authorities. The blueprints also show the provincial average of student achievement by both raw score and percentage.

Part A Test Blueprint

Content Reporting Category	Number (Percentage) of Questions	Provincial Student Achievement (Average Raw Score and Percentage)
Rational Numbers	3 (18.75%)	1.4/3 (46.7%)
Powers and Exponent Laws	3 (18.75%)	1.7/3 (56.7%)
Square Roots of Perfect and Non-perfect Squares	5 (31.25%)	2.9/5 (58.0%)
Algebraic Expressions, Equations, and Inequalities	5 (31.25%)	2.7/5 (54.0%)
Number (Percentage) of Questions	(100%)	8.8/16 (55.0%)

Part B Test Blueprint

Program of Study Strand	Level of Complexity*			Provincial Student Achievement (Average Raw Score and Percentage)
	Low	Moderate	High	
Number	5	4	1	5.4/10 (54.0%)
Patterns and Relations	3	10	1	8.2/14 (58.6%)
Shape and Space	3	5	2	5.7/10 (57.0%)
Statistics and Probability	3	0	0	2/3 (66.7%)
Provincial Student Achievement (Average Raw Score and Percentage)	8.3/14 (59.3%)	10.9/19 (57.4%)	2.1/4 (52.5%)	21.1/37 (57.0%)

*Each question is categorized according to its level of complexity (low, moderate, or high). Descriptions of the levels of complexity can be found in the *2022-2023 Mathematics 9 Subject Bulletin.*

Sample Questions from the *2022 Grade 9 Mathematics Provincial Achievement Test—Part A*

The following five items illustrate substantial performance differences between students who performed at the standard of excellence, those at the acceptable standard, and those below the acceptable standard.

Reporting Categories: Rational Numbers (RN); Powers and Exponent Laws (PE); Square Roots of Perfect and Non-perfect Squares (SR); Algebraic Expressions, Equations, and Inequalities (AE)

Item	Key	% of Students with Correct Solution	Number of Unique Errors	Content Reporting Category	Item Description
4	−18	35.8	1 275	RN	Divide a whole number by a negative fraction (Gr.9, N.3; Gr.8, N.6)

Standard Achieved by Students on *Part A*	% of Students with Correct Solution	Number of Unique Errors	Three Most Common Errors (Number of Students)		
Students Achieving Standard of Excellence (*n* = 5 540)	80.2	98	18 (391)	−8 (158)	−20 (54)
Students Achieving Acceptable Standard* (*n* = 13 402)	39.3	433	18 (1 524)	−8 (612)	−2 (405)
Students Below Acceptable Standard (*n* = 13 566)	9.1	713	18 (556)	2 (418)	6 (371)

*Includes those students who achieved the acceptable standard but not the standard of excellence

4. Evaluate $12 \div \left(-\dfrac{2}{3}\right)$.

   Answer: _____

Common correct responses:

$$12 \div \left(\frac{-2}{3}\right)$$

$$= \overset{6}{\cancel{12}} \times \left(\frac{-3}{\cancel{2}}\right)$$

$$= 6 \times -3$$

$$= -18$$

$$\frac{12}{1} \div \left(-\frac{2}{3}\right)$$

$$\frac{12}{1} \times \left(\frac{-3}{2}\right)$$

$$-\frac{36}{2} = -18$$

Common incorrect responses:

$$2 \times \left(\frac{2}{-3}\right) = -\frac{24}{3} = -8$$

$$12 \div \left(\frac{2}{3}\right) = 12 \times \frac{3}{2}$$

$$= \frac{12 \times 3}{2}$$

$$= 18$$

Item	Key	% of Students with Correct Solution	Number of Unique Errors	Content Reporting Category	Item Description
6	0.5	40.4	673	PE	Apply order of operations with exponents to evaluate an expression (Gr.9, N.4)

Standard Achieved by Students on *Part A*	% of Students with Correct Solution	Number of Unique Errors	Three Most Common Errors (Number of Students)		
Students Achieving Standard of Excellence (*n* = 5 540)	78.6	65	2.5 (395)	−0.5 (373)	−1.5 (74)
Students Achieving Acceptable Standard* (*n* = 13 402)	45.6	283	−0.5 (1 382)	2.5 (814)	2 (535)
Students Below Acceptable Standard (*n* = 13 566)	13.7	617	2 (882)	−2 (683)	−0.5 (356)

*Includes those students who achieved the acceptable standard but not the standard of excellence

6. What is the value of $[2 + (-4)]^2 \div 8$ to the nearest tenth?

   Answer: _____

Common correct responses:

$$[2 + (-4)]^2 \div 8$$
$$(-2)^2 \div 8$$
$$4 \div 8$$
$$\boxed{= 0.5}$$

$$2 + (-4) = -2$$
$$(-2)^2 = 4$$
$$4 \div 8 = \frac{1}{2}$$
$$= 0.5$$

Common incorrect responses:

$$[4 + 16] \div 8$$
$$20 \div 8 = \boxed{2.5}$$

$$[2 \times 4]^2 \div 8$$

$$(-2)^2 \div 8$$

$$-4 \div 8$$

$$\boxed{-0.5}$$

$$[2 + (-4)]^2 \div 8$$

$$(-2)^2 \div 8$$

$$4 \div 8 = 2$$

Item	Key	% of Students with Correct Solution	Number of Unique Errors	Content Reporting Category	Item Description
9	8	63.2	471	SR	Solve a problem involving order of operations and square roots of perfect squares (Gr.9, N.5; Gr.8, N.1)

Standard Achieved by Students on *Part A*	% of Students with Correct Solution	Number of Unique Errors	Three Most Common Errors (Number of Students)		
Students Achieving Standard of Excellence (*n* = 5 540)	94.8	30	64 (176)	16 (15)	32 (14)
Students Achieving Acceptable Standard* (*n* = 13 402)	77.1	197	64 (1 420)	6 (166)	2 (111)
Students Below Acceptable Standard (*n* = 13 566)	31.1	411	64 (2 161)	12 (866)	6 (530)

*Includes those students who achieved the acceptable standard but not the standard of excellence

9. Evaluate $\sqrt{2 \times 2 \times 2 \times 2 \times 2 \times 2}$.

   Answer: $x =$ _____

Common correct responses:

$$= \sqrt{(2 \times 2) \times (2 \times 2) \times (2 \times 2)}$$
$$= \sqrt{2^2 \times 2^2 \times 2^2}$$
$$= 2 \times 2 \times 2$$
$$= 8$$

$$\sqrt{2^6} = 2^3 = 8$$

$$\sqrt{2 \times 2 \times 2 \times 2 \times 2 \times 2}$$
$$= \sqrt{64}$$
$$= 8$$

Common incorrect responses:

$$\sqrt{(2 \times 2) \times (2 \times 2) \times (2 \times 2)}$$
$$= \sqrt{2^2 \times 2^2 \times 2^2}$$
$$= 2 \times 2 \times 2 = 6$$

$$\sqrt{2 \times 2 \times 2 \times 2 \times 2} = 64$$

Item	Key	% of Students with Correct Solution	Number of Unique Errors	Content Reporting Category	Item Description
12	0.25	42.9	559	RN	Interpret two points on a number line that are rational numbers and calculate the difference (Gr.9, N.3)

Standard Achieved by Students on *Part A*	% of Students with Correct Solution	Number of Unique Errors	Three Most Common Errors (Number of Students)		
Students Achieving Standard of Excellence (*n* = 5 540)	85.9	81	0.75 (163)	−0.75 (64)	0.2 (59)
Students Achieving Acceptable Standard* (*n* = 13 402)	47.5	225	0.75 (1 022)	−0.3 (372)	0.2 (350)
Students Below Acceptable Standard (*n* = 13 566)	14.8	499	0.75 (443)	0.2 (401)	0.1 (391)

*Includes those students who achieved the acceptable standard but not the standard of excellence

Use the following information to answer question 12.

Two rational numbers are represented by *A* and *B* on the number line shown below.

12. Evaluate *B* − *A*. Express your answer as a decimal to the nearest hundredth.

Answer: _____

Common correct response:

$$\left(-\tfrac{1}{4}\right) - \left(-\tfrac{1}{2}\right)$$

$$\left(-\tfrac{1}{4}\right) - \left(-\tfrac{2}{4}\right)$$

$$\frac{-1+2}{4} = \frac{1}{4} = 0.25$$

Common incorrect responses:

$$(-0.25) - (-0.5) = -0.75$$

$$A = -0.5 \quad B = -0.25$$

$$(-0.25) - (-0.5) = 0.25$$

$$= 0.3$$

Item	Key	% of Students with Correct Solution	Number of Unique Errors	Content Reporting Category	Item Description
17	−4	50.2	416	AE	Solve a linear equation involving brackets (Gr.9. PR.3)

Standard Achieved by Students on *Part A*	% of Students with Correct Solution	Number of Unique Errors	Three Most Common Errors (Number of Students)		
Students Achieving Standard of Excellence (n = 5 540)	93.4	54	−1 (136)	4 (60)	−2 (40)
Students Achieving Acceptable Standard* (n = 13 402)	59.8	215	4 (734)	−1 (692)	2 (426)
Students Below Acceptable Standard (n = 13 566)	16.1	353	2 (1 144)	4 (1 138)	1 (568)

*Includes those students who achieved the acceptable standard but not the standard of excellence

17. Solve for x in the equation $6x = 4(x - 2)$.

Answer: _____

Common correct response:

$$6x = 4(x - 2)$$

$$6x_{-4x} = 4x_{-4x} - 8$$

$$\frac{2x}{2} = \frac{-8}{2}$$

$$x = -4$$

Common incorrect responses:

$$6x = 4(x - 2)$$
$$-4 \qquad -4$$
$$2x = x - 2$$
$$x = \boxed{-2}$$

$$6x = 4x - 8$$
$$2x = -8$$
$$x = \boxed{4}$$

$$6x = 4x - 2$$
$$2x = -2$$
$$x = -1$$

Provincial Achievement Testing Program Support Documents

The Alberta Education website contains several documents that provide valuable information about various aspects of the provincial achievement testing program. To access these documents, go to the Alberta Education website. Click on one of the specific links to access the following documents.

Provincial 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 Provincial Achievement Test 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 Provincial Assessment Sector contacts.

Subject bulletins

At the beginning of each school year, subject bulletins are posted on the Alberta Education website for all provincial achievement test subjects for grades 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 provincial achievement tests in grades 6 and 9 English Language Arts and Français/French Language Arts, writing samples are designed for teachers and students to enhance students' writing and to assess this writing relative to the standards inherent in the scoring guides. The exemplars documents contain sample responses with scoring rationales that relate student work to the scoring categories and scoring criteria.

Previous provincial achievement tests and answer keys

All January provincial achievement tests (parts A and B) for Grade 9 semestered students are secured and must be returned to Alberta Education. All May/June provincial achievement tests are secured except *Part A* of grades 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 Alberta Provincial Achievement Testing Parent Guide for grades 6 and 9 are posted on the Alberta Education website. Each guide answers frequently asked questions about the Provincial Achievement Test Program and provides descriptions of and sample questions for each provincial achievement test subject.

Involvement of teachers

Teachers of grades 6 and 9 are encouraged to take part in activities related to the Provincial Achievement Test 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 provincial achievement test results to improve student learning.