Grade 12 Mathematics
Achievement Tests

Information Bulletin

2024/2025

Manitoba

Grade 12 Mathematics Achievement Tests: Information Bulletin, 2024/2025

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Manitoba Education and Early Childhood Learning
Winnipeg, Manitoba, Canada

Any websites referenced in this resource are subject to change without notice.

This resource is available on the Manitoba Education and Early Childhood Learning website at www.edu.gov.mb.ca/k12/assess/gr12/infobulls/index.html.

Disponible en français.

While the department is committed to making its publications as accessible as possible, some parts of this document are not fully accessible at this time.

Available in alternate formats upon request.

The *Grade 12 Mathematics Achievement Tests: Information Bulletin* provides an overview of testing procedures, dates, and features of the Grade 12 Applied Mathematics, Essential Mathematics, and Pre-Calculus Mathematics Achievement Tests. This information is helpful for school personnel as they prepare themselves and students for upcoming provincial testing, and as they communicate this information to parents.

The *Information Bulletin* is one of a series of documents:

- *Policies and Procedures for Provincial Tests*
- ***Grade 12 Mathematics Achievement Tests: Information Bulletin***
- *Grade 12 Mathematics Achievement Tests: Administration Manual*
- *Information for Local Marking*

These documents prepare teachers and administrators for the administration of the Grade 12 mathematics achievement tests. Please use this document in conjunction with the other documents in the series to gain a full understanding of the procedures associated with the testing program at Manitoba Education and Early Childhood Learning ("the department").

The *Information Bulletin*, the other documents in the series, as well as archived achievement tests are available on the Manitoba Education and Early Childhood Learning website at www.edu.gov.mb.ca/k12/assess/gr12/index.html.

INQUIRIES

For all inquiries, please contact the Provincial Assessment Program at 204-945-6156 or email assesseval@gov.mb.ca.

LOOK FOR CHANGES

Changes from previous year's documents will be highlighted using the symbol

NEW

Contents

Introduction

As outlined in *Policies and Procedures for Provincial Tests*, students enrolled in the following Grade 12 mathematics courses are required to write the corresponding Grade 12 mathematics achievement test as part of the provincial requirements for completing the course:

Percentage of Student's Final Grade	
Course	Percentage (%)
Applied Mathematics (40S)	20
Essential Mathematics (40S)	20
Pre-Calculus Mathematics (40S)	20

All Grade 12 mathematics achievement tests are to be marked locally. The department will support schools and school divisions in preparing for local marking.

The department will centrally mark a sample of the locally marked test booklets to provide feedback to schools and school divisions on their local marking.

Schedule for Achievement Tests Administration

Semester	**Applied Mathematics**	**Essential Mathematics**	**Pre-Calculus Mathematics**
1	January 21, 2025	January 22, 2025	January 23, 2025
2	June 12, 2025	June 11, 2025	June 10, 2025

Students must begin writing the Grade 12 mathematics achievement tests between 8:30 a.m. and 10:00 a.m. Please refer to the test-specific sections for the duration of each test.

Procedures for Achievement Tests Administration

Approximately one month prior to the test administration dates, the administration manual will be available on the department website so that teachers and administrators can familiarize themselves with specific administration procedures and the requirements of each test. Copies of the administration manual will also be mailed with the test materials.

Test materials will be mailed two weeks prior to the test dates. Once test materials are in the school, the school principal is responsible for ensuring that they are kept secure until test administration and are only accessed by authorized personnel. All shrink-wrapped student booklets are not to be opened until the day of the test and all marking guides are not to be opened until the test administration has been completed.

In order to ensure that the test results are reliable and valid, tests must be administered strictly according to the procedures prescribed in the administration manual. Detailed instructions regarding the marking and reporting of achievement test results for students who miss the achievement test are also provided in the administration manual.

Policies on student absenteeism during the test, late arrivals, and other circumstances for missing an achievement test are provided in the document *Policies and Procedures for Provincial Tests* which is available online at www.edu.gov.mb.ca/k12/assess/gr12/pol_proc/index.html (see sections 4.1 and 4.2). This document also describes the policies and procedures regarding cheating and plagiarism (see section 7.0).

Adaptations are available for students with diverse learning needs, including, for example, Braille versions of tests and the use of a scribe. More detailed information about adaptations is provided in the document *Policies and Procedures for Provincial Tests* (see section 3.3). In the event that an adaptation affects how a test is scored, detailed instructions are provided in adaptation-related correspondence and with marking materials sent to schools for local marking.

General Description of Grade 12 Mathematics Achievement Tests

The Grade 12 mathematics achievement tests are developed provincially and based on the document: *Grades 9 to 12 Mathematics: Manitoba Curriculum Framework of Outcomes* (2014). The achievement tests are administered in school jurisdictions toward the end of the school year or semester to students registered in any of the following Grade 12 courses: Applied Mathematics (40S), Essential Mathematics (40S), and Pre-Calculus Mathematics (40S).

Design and development

Achievement tests are developed by a committee. Each test development committee consists of an assessment consultant and a number of classroom teachers. The selection of teachers having varied experience in teaching is made in order to form a committee representative of the province: teachers from urban and rural regions, teaching in the English, French Immersion, and Français programs.

The role of the test development committee is to ensure that the achievement test is as congruent as possible with the curriculum within the parameters of large-scale testing. Using the curriculum, committee members design questions to assess as many outcomes as possible, and develop marking keys to go along with the test. Curriculum consultants from the department are then invited to comment on the test content.

Piloting process

The newly created achievement test is then pilot tested. This process allows for an examination of the test itself and a verification of the marking keys.

The pilot test is designed to simulate the real testing situation. Schools from a balance of programs (English, French Immersion, and Français) are invited to participate in the pilot testing process. To ensure precise feedback, pilot tests are administered following common procedures across the province.

Once the pilot test has been administered, the students' responses are analyzed to determine the strengths and weaknesses of the test. Additionally, feedback is solicited from classroom teachers, departmental test supervisors, markers, and students to determine what worked and what did not. After this information has been reviewed, changes are made to the test in an attempt to make it as strong as possible in terms of reliability, validity, and fairness to students.

Features of Achievement Tests

The achievement tests may include selected response and constructed response questions.

	Permitted use	
Course	Formula Sheet	Study Sheet
Applied Mathematics (40S)	Yes	Yes
Essential Mathematics (40S)	Yes	Yes
Pre-Calculus Mathematics (40S)	Yes	**No**

A formula sheet for each test is included in the students' test booklets. Samples are included in this document on pages 19, 35, and 51.

When permitted, students may bring one 8½" by 11" sheet of paper (study sheet) that includes any information that the student has deemed important. The student may write on both sides of the paper and the information may be handwritten or typed (in any size font). If a large print format of the test is requested, a study sheet of the equivalent size is permitted.

Marking Process

The Grade 12 mathematics achievement tests are marked locally. Teachers receive marking guides containing the marking keys, exemplars, and rationales to mark students' tests. In preparation for local marking, the department will provide local marking training sessions that focus on how to score tests using marking guides. Materials will be provided that contain sample student responses (i.e., exemplars) assessed according to the marking guide and accompanied by explanations justifying the score obtained. Local marking training sessions will take place as follows:

Semester	Applied Mathematics	Essential Mathematics	Pre-Calculus Mathematics
1	January 22, 2025	January 23, 2025	January 24, 2025
2	June 13, 2025	June 12, 2025	June 11, 2025

Note: Do not make any marks or comments in the test booklets.

The department will request a random sample of locally marked tests. Immediately upon completion of local marking, schools must send all scoring sheets and the randomly selected test booklets to the department. These tests are then marked centrally using a chain-marking system established by the department. To provide feedback on the local marking process, a report is made available for each individual school and school division based on test scores allocated in the schools and school divisions and those allocated centrally by the department.

Reporting Test Results

Schools will report achievement test results to students immediately after local marking. **Schools must report individual student results on provincial achievement tests separately from term marks when showing final grades on report cards and in school files.**

Applied Mathematics

Grade 12 Applied Mathematics Achievement Test

- Schedule for Test Administration
- Test Specifications
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- Terminology Sheet
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- Use of Classroom Resources
- Related Guides
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  - Terminology Sheet: Applied Mathematics

Grade 12 Applied Mathematics Achievement Test

The test is administered during one three-hour session. English and French versions of the test are available.

Schedule for Test Administration

Semester	Date	Time Required for Test	Additional Time Allowed[1]
1	January 21, 2025	3 hours	30 minutes
2	June 12, 2025	3 hours	30 minutes

[1] **Without providing an adaptation**

Students must begin writing the Grade 12 Applied Mathematics Achievement Test between 8:30 a.m. and 10:00 a.m.

Test Specifications

The following table provides an overview of the structure of the test.

Percentage of Marks by Unit	
Unit	Percentage (%)*
Relations and Functions	25
Probability	25
Financial Mathematics	25
Design and Measurement	13
Logical Reasoning	12

* Percentages are approximate.

The following table provides an overview of the structure of the test by question type.

Percentage of Marks by Question Type	
Question Type	Percentage (%)*
Selected response	10
Constructed response	90

Formula Sheet

The formula sheet as it appears in the Grade 12 Applied Mathematics Achievement Test can be found on page 19.

Terminology Sheet

The terminology sheet as it appears in the Grade 12 Applied Mathematics Achievement Test can be found on page 20.

* Percentages are approximate.

Marking Guidelines

A 0.5 mark deduction will apply each time a student makes one of the following errors: an arithmetic error; a procedural error (not a conceptual error); a lack of clarity in the explanation, the description, or the justification.

Communication Errors

The following communication errors, which are errors not conceptually related to the learning outcomes associated with the question, may result in a 0.5 mark deduction. Each communication error can only be deducted once per test.

E1 Final Answer

- does not include a percent sign
- does not identify the answer (e.g., TVM solver, Venn diagram)
- does not use the given contextual variables
- incorrectly states the final answer

E2 Notation

- does not include braces when using set notation
- does not include a box when using a Venn diagram
- does not include one of the following in the equation: "$y =$", "sin", "ln", or "x", or writes parameters separately from the equation
- does not change "$y \sim$" to "$y =$" when writing an equation

E3 Transcription/Transposition

- makes a transcription error (inaccurate transferring of information)
- makes a transposition error (changing order of digits)
- inaccurately plots one point on a scatter plot

E4 Whole Units

- does not use whole units for materials purchased in design and measurement questions
- does not use whole units in contextual questions involving discrete data (e.g., people)

E5 Units

- does not include the dollar sign for monetary values
- uses incorrect units of measure
- does not include the units in the final answer
- confuses square and cubic units (e.g., cm^2 instead of cm^3, or vice versa)
- does not include units with labels on a graph

E6 Rounding

- rounds incorrectly
- rounds too soon
- does not express the answer to the appropriate number of decimal places, including monetary values to two decimal places

Information for Teachers

In addition to curricular outcomes, please make note of the following:

General

- Students are expected to show their work. Partial marks may be awarded for all constructed-response questions.
- Students are expected to clearly indicate final answers (e.g., Venn diagram representations, pathway problems, financial programs).
- Students are expected to round all final answers to two decimal places unless otherwise indicated in the question, or if the answer terminates to a whole number or one decimal place. More than two decimal places are acceptable if rounded correctly, except for monetary values or if the context of the question implies whole units be used (e.g., people, cans of paint).
- Students are expected to include units in all final answers, where applicable.
- Students are expected to be familiar with graphic organizers. A graphic organizer is a visual representation of information. Examples include a tree diagram, a chart, a list, a Venn diagram, a truth table, Pascal’s triangle, etc.
- Students are expected to correctly apply taxes in Financial Mathematics, and Design and Measurement questions. When no tax calculation is necessary, the wording “taxes included” will be used. When students are required to add taxes, the wording “plus GST and/or PST” will be used and current GST and/or PST rates will be given (e.g., GST = 5%, PST = 7%).
- Students are expected to be familiar with general mathematical terms, such as circumference, isosceles, prime number, etc.
- Students are expected to be able to manipulate formulas given on the formula sheet.
- The research project will not be assessed as part of the achievement test.

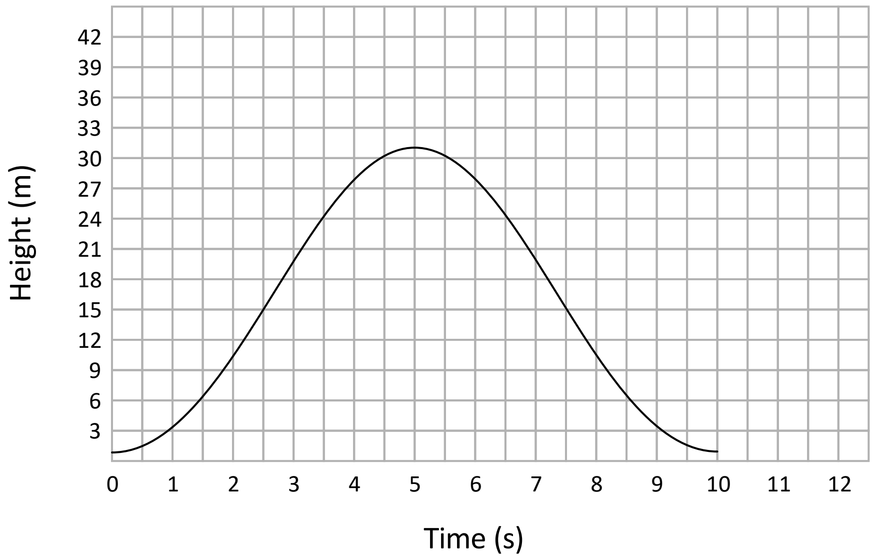
Relations and Functions

- A clearly labelled graph will include the following:
  - title and/or labels on both axes, including units, that communicate(s) the context
  - appropriate scales indicating the domain and range (window settings/grid range) for the context of the question
  - an appropriate shape that accurately represents the key characteristics of the function (e.g., maximum, minimum, asymptotes, intercepts) or plotted data points and corresponding curve of best fit.

See example on following page.

Example:

Height of a Ferris wheel cabin over time



- Students are expected to interpret the domain and range of a function in all three of the following formats:

set notation	interval notation	words
$\{0 \le p < 50\}$ or $\{p \mid 0 \le p < 50, p \in \mathbb{R}\}$	[0, 50)	*p* is greater than or equal to zero but less than fifty

- When asked to state the domain and/or range of a function, students may choose any of the above formats.
- Logarithmic regressions will only include the use of natural logs.

  Example: $y = a + b\ \ln(x)$

- When provided with a given set of data points or a given context, students should be able to identify a type of regression.

Probability

- Students may express probabilities as fractions (e.g., $\frac{28}{52}$ or $\frac{7}{13}$), decimals (e.g., 0.54), or percentages to two decimal places (e.g., 53.85%).

Financial Mathematics

- Students are expected to assess a financial scenario including, but not limited to, debt-to-equity ratio, gross debt service ratio, and net worth.
- Students are expected to express debt-to-equity ratio, gross debt service ratio, and rate of return as percentages, reflected by the formulas on the formula sheet.
- As a general rule, when evaluating loan decisions, students should refer to 32% for gross debt service ratio and 50% for debt-to-equity ratio.

  Example: They cannot afford the house because their GDSR exceeds 32%.

- Unless otherwise stated, given interest rates are per annum.
- Units are needed when stating final answers from time value of money calculators/ financial apps.

Design and Measurement

- Students are expected to determine perimeter and area.
- Students are expected to convert within systems (metric to metric, imperial to imperial), with or without technology.

  Note: Unit conversions will not be provided on the test.

- In Design and Measurement problems, students must buy materials in whole units unless the question indicates that partial units are available.
- Students are expected to be able to plan the layout of component parts for a design project.

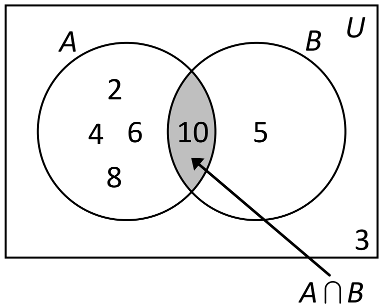
Logical Reasoning

- A conditional statement must include both the terms “if” and “then”.
- Students are expected to use truth tables based on simple statements that use logical connectives, including “and”, “or”, “not”, “if then” (conditional), and “if and only if” (biconditional).
- Students are expected to recognize the various formats of complements or negation (e.g., $\overline{P}$, P', $\sim p$, $\neg p$).
- When expressing answers to logic questions in set notation, students are expected to include braces.

  Example: $M = \{1, 2, 3, 4\}$

- When expressing answers to logic questions using a Venn diagram, students are expected to enclose the universal set and clearly indicate their answer.

  Example:



$U = \{2, 3, 4, 5, 6, 8, 10\}$
$A = \{2, 4, 6, 8, 10\}$
$B = \{5, 10\}$

- It is expected that a complete Venn diagram includes all elements of the universal set.
- Learning outcome 12.A.L.1 will be assessed. Questions will not require prior knowledge of any specific game or puzzle.

Use of Classroom Resources

During the test, students need a pencil, an eraser, a ruler, a study sheet, and a graphing calculator, tablets, or a computer. Students are allowed to use a bilingual dictionary containing only translations and no definitions.

Access to Internet tools used in the everyday Applied Mathematics class, such as applets or a mortgage payment calculator, is allowed during the test. The same measure applies to student-created templates such as spreadsheets and programs downloaded to the graphing calculator during the school year. **Additional technology such as mobile devices, tablets, or other personal devices are permitted within these guidelines and must be supervised during test administration.**

Use of the Internet to access course notes, find definitions, or search for conceptual information about the course is **strictly prohibited** during the test and must be monitored by the supervising teacher.

The following materials must **not** be used during the test:

- classroom notes, textbooks, and other such materials
- subject-related materials on display
- dictionaries (other than bilingual dictionaries)

Electronic communication between students through phones, email, or file sharing during the test is **strictly prohibited**.

These restrictions are necessary to ensure fair assessment practices and parallel testing conditions in all participating schools.

Related Guides

Formula Sheet: Applied Mathematics

Relations and Functions

$$y = ax + b$$

$$y = ax^2 + bx + c$$

$$y = ax^3 + bx^2 + cx + d$$

$$y = ab^x$$

$$y = a + b\ln(x)$$

$$y = a\sin(bx + c) + d$$

Probability

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$P(A \cap B) = P(A) \times P(B)$$

$$P(A \cap B) = P(A) \times P(B|A)$$

$$_nP_r = \frac{n!}{(n-r)!}$$

$$_nC_r = \frac{n!}{r!(n-r)!}$$

Financial Mathematics

$$t = \frac{72}{i}$$

$$I = Prt$$

$$A = P\left(1 + \frac{r}{n}\right)^{nt}$$

$$\text{Net worth} = \text{Total assets} - \text{Total liabilities}$$

$$\text{Debt-to-equity ratio (\%)} = \frac{(\text{Total liabilities} - \text{Mortgage})}{\text{Net worth}} \times 100$$

$$\text{Gross debt service ratio (\%)} = \frac{\begin{pmatrix}\text{Monthly} & & \text{Monthly} & & \text{Monthly} \\ \text{mortgage} & + & \text{property} & + & \text{heating} \\ \text{payment} & & \text{taxes} & & \text{costs}\end{pmatrix}}{\text{Gross monthly income}} \times 100$$

$$\text{Rate of return (\%)} = \frac{\begin{pmatrix}\text{Current value} & - & \text{Previous value} \\ \text{of portfolio} & & \text{of portfolio}\end{pmatrix}}{\text{Previous value of portfolio}} \times 100$$

Design and Measurement

Prism: Surface area $= Ph + 2B$

Volume $= Bh$

Pyramid: Surface area $= B + \frac{1}{2}Ps$

Volume $= \frac{1}{3}Bh$

Cube: Surface area $= 6l^2$

Volume $= l^3$

Rectangular prism: Surface area $= 2lw + 2lh + 2wh$

Volume $= lwh$

Triangular prism: Surface area $= bh + l(a + b + c)$

Volume $= \frac{1}{2}bhl$

Square-based pyramid: Surface area $= b^2 + 2bs$

Volume $= \frac{1}{3}b^2h$

Sphere: Surface area $= 4\pi r^2$

Volume $= \frac{4}{3}\pi r^3$

Cylinder: Surface area $= 2\pi r^2 + 2\pi rh$

Volume $= \pi r^2 h$

Cone: Surface area $= \pi r^2 + \pi rs$

Volume $= \frac{1}{3}\pi r^2 h$

Terminology Sheet: Applied Mathematics

Some questions may include directing words such as *calculate* and *determine*. These directing words are explained below.

Directing words	The question is asking for…
Calculate/Determine	a mathematical formula, an algebraic equation, or a numerical calculation to solve a problem
Complete	a table, diagram, or graph to be filled in
Create/Draw/Use a graphic organizer	a visual representation of information such as a graph, tree diagram, chart, list, Venn diagram, truth table, or Pascal's triangle
Describe/Explain	words or symbols, diagrams, charts or graphs, or other methods that clearly show what you are thinking
Indicate	a stated or shown answer
Justify	reasons or facts that support a position by using mathematical computations, words, or diagrams
Select	a circled answer
State/Write	a word, sentence, or number, without an explanation

Essential Mathematics

Grade 12 Essential Mathematics Achievement Test

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- Related Guides
  - Formula Sheet: Essential Mathematics
  - Terminology Sheet: Essential Mathematics
  - Manitoba Homeowner’s Insurance Rates

Grade 12 Essential Mathematics Achievement Test

The test is administered during one two-hour session. English and French versions of the test are available.

Schedule for Test Administration

Semester	Date	Time Required for Test	Additional Time Allowed[1]
1	January 22, 2025	2 hours	30 minutes
2	June 11, 2025	2 hours	30 minutes

[1] **Without providing an adaptation**

Students must begin writing the Grade 12 Essential Mathematics Achievement Test between 8:30 a.m. and 10:00 a.m.

Test Specifications

The following table provides an overview of the structure of the test.

Percentage of Marks by Unit	
Unit	Percentage (%)
Vehicle Finance	20–25
Statistics	10–15
Precision Measurement	10–15
Home Finance	15–20
Geometry and Trigonometry	15–20
Probability	10–15

Formula Sheet

The formula sheet as it appears in the Grade 12 Essential Mathematics Achievement Test can be found on pages 35 and 36.

Marking Guidelines

NEW

Errors that are conceptually related to the learning outcomes associated with the question will result in a 1 mark deduction.

Each time a student makes one of the following errors, a 0.5 mark deduction will apply:

- arithmetic error
- procedural error
- terminology error in explanation
- lack of clarity in written responses

Communication Errors

The following errors, which are not conceptually related to the learning outcomes associated with the question, may result in a 0.5 mark deduction. Each error can only be deducted once per test and is tracked in a separate section on the *Scoring Sheet*.

The total mark deduction for communication errors for any student response is not to exceed the marks awarded for that response. For example, there would be no communication error deductions if no marks were awarded for a given response.

E1 (Final answer)

- final answer not stated
- final answer not clearly indicated
- answer presented in another part of question

E2 (Notation)

- notation error
- NEW inappropriate use of equal sign

E3 (Transcription/Transposition)

- makes a transcription error (inaccurate transferring of information from one part of the page to another)
- makes a transposition error (changing order of digits)

E4 (Whole Units)

- does not use whole units in contextual questions involving discrete data (e.g., people, cans of paints)

E5 (Units)

- uses incorrect units of measure
- does not include units in final answer (e.g., missing dollar sign for monetary values, missing degrees for angles)
- answer stated in gradians or radians instead of degrees

E6 (Rounding)

- rounds incorrectly
- rounds too soon
- does not express the answer to the appropriate number of decimal places (e.g., monetary values are not expressed to two decimals)

Terminology Sheet

The terminology sheet, as it appears in the Grade 12 Essential Mathematics Achievement Test can be found on page 37.

Information for Teachers

General

It is expected that students know how many days, weeks, and months there are in one year.

Students are also expected to be able to manipulate formulas given on the formula sheet.

Show Your Work

When marks are awarded for process, students will be directed to show their work. If only a correct answer is provided, partial marks will be awarded.

Unit Errors

Final answers must include units even if units are implied in the question. The term "units" refers to units of measurement, such as kilometres, degrees Celcius, grams, and so on. Number of people or number of diagonals, for example, are not considered to be units of measurement and, therefore, do not need to be included in final answers to be awarded full marks.

Rounding Errors

Students are expected to round all final answers to two decimal places unless otherwise indicated in the question, or if the answer terminates to a whole number or one decimal place. More than two decimal places are acceptable if rounded correctly, except for monetary values or if the context of the question implies whole units be used (e.g., people, percentile rank).

Example 1: $\begin{aligned} 43 \div 8 &= 5.375 \\ &= 5.38 \end{aligned}$

Example 2: $\begin{aligned} 39 \div 200 &= 0.195 \\ &= 0.20 \end{aligned}$

Students are not to round answers in the Precision Measurement unit.

Monetary Value Errors

Final answers must be rounded to the nearest cent.

Example: $\begin{aligned} \$24.49 \times 1.12 &= \$27.4288 \\ &= \$27.43 \end{aligned}$

Whole number monetary values do not need to include cents.

Example: $\begin{aligned} \$2.35 + \$1.65 &= \$4.00 \\ &= \$4 \end{aligned}$

Monetary values that include cents must include two decimal places.

Example: $\begin{aligned} \$96.30 \div 3 \text{ people} &= \$32.1 \\ &= \$32.10 \end{aligned}$

Home Finance

Students may be asked to calculate what portion of the first month's mortgage payment is interest. This can be calculated using the simple interest formula ($I = Prt$).

Gross Debt Service Ratio (GDSR)

Students are expected to know how to convert any given annual values into monthly values. Students may be asked to express the GDSR as a percent or in decimal form. When discussing mortgage affordability and the GDSR, students must refer to the maximum of 32% (or 0.32) when making decisions.

Land Transfer Tax

The graduated tax rates will always be provided for each range of property values.

Property Tax Adjustment

Homeowners are responsible for property taxes on the portion of the calendar year that they own the property.

Example: If 4 months remain in the calendar year, the new owner is responsible for $\frac{4}{12}$ of the annual property tax amount.

Home Insurance

If applicable, a *Manitoba Homeowner's Insurance Rates* table will be provided (see page 38). Students are expected to know how to use the information presented in this table.

Students may be asked to calculate annual premiums and/or apply a discount to the annual insurance premium.

Manitoba no longer charges sales tax on home insurance premiums.

Probability

Expected Value

NEW

A formula for expected value is no longer provided on the formula sheet because there are alternate methods.

When justifying decisions regarding expected value, students must refer to the positive or negative expected value calculation.

Students may be asked to calculate the expected value for situations in which there is more than one gain or loss.

Vehicle Finance

All tax calculations for purchases and labour are to be based on Manitoba rates. Students are expected to refer to the tax table on the back of the formula sheet to ensure that the appropriate tax rates are used for given scenarios.

NEW When no tax calculation is necessary, the wording "taxes included" will be used. When you are required to add taxes, the wording "plus taxes" will be used.

Trade-in Values

Trade-in values are deducted before calculating tax(es) on a vehicle purchase.

Down Payments

Down payments are deducted after calculating tax(es) on a vehicle purchase.

Depreciation

Students may be asked to calculate the depreciation amount per year or the value of the vehicle after a specified number of years. Students should not apply taxes to this value.

Lease Calculations

Students are expected to know how to calculate the total amount paid for a lease. This may include a down payment, the monthly payment, and any other fees associated with the terms of the lease.

Residual Value

Students are expected to understand that residual value is the value of a vehicle at the end of the lease. It is often calculated as a percentage of the vehicle's initial value. Taxes are not to be considered when calculating the residual value.

Buyout

The term 'buyout' refers to the amount a person would have to pay for a vehicle after the lease period is over. To calculate the total cost of the buyout, taxes must be applied to the residual value.

Geometry and Trigonometry

Sine and Cosine Laws

Given two angles in a triangle, students may be asked to calculate the third angle in order to solve sine and cosine law problems.

Students are expected to know how to solve for angle measures using the inverse trig functions on their calculators.

Students will receive communication error E6 (rounding) if they do not use the most precise interim values in their calculators when solving sine and cosine law problems. Students need to round once, at the very end of their work, in order to keep values as accurate as possible.

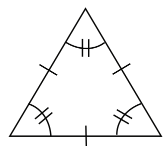
The following information is provided as a resource and should not be considered an exhaustive list.

Students are expected to know or be able to do the following:

Triangles

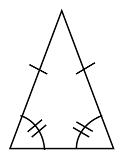
- Sum of the interior angles is 180°
- Solve for a third angle if two angles are given
- Equilateral: all sides equal; all angles equal 60°

  Example:



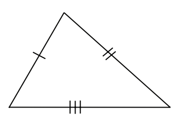
- Isosceles: two equal sides; base angles across from equal sides are equal

  Example:



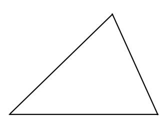
- Scalene: no equal sides or angles

  Example:



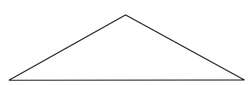
- Acute: all angles are less than 90°

  Example:



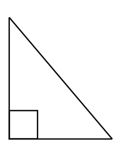
- Obtuse: one angle is greater than 90°

  Example:



- Right: one angle is 90°

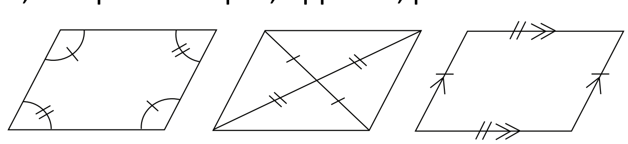
  Example:



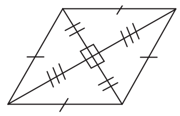
Quadrilaterals

- Sum of the interior angles is 360°
- Parallelogram: opposite angles are equal; diagonals bisect each other, but are not equal in length; two pairs of equal, opposite, parallel sides

  Example:

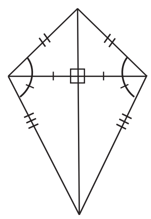


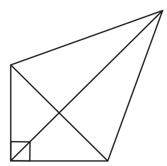
- Special Parallelograms
  - Rhombus: all sides equal; opposite angles are equal; diagonals are perpendicular bisectors, but are not equal in length

    Example: 

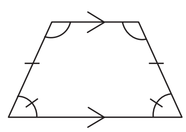
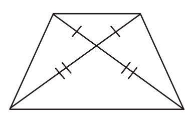
  - Square: all sides equal; all 90° angles; diagonals are equal length; perpendicular bisectors
  - Rectangle: two pairs of equal, opposite, parallel sides; all 90° angles; diagonals are equal length; diagonals bisect each other

- Kite: two pairs of equal sides; one pair of equal angles; perpendicular diagonals, one of which is bisected by the other

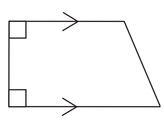
  Example: 

  Note: a right-angle kite exists. 

- Trapezoid: one pair of opposite parallel sides
  - Isosceles: one pair of opposite parallel sides; other pair of opposite sides are of equal length; base angles are equal; top angles are equal; diagonals are of equal length

    Examples:  

  - Right: one pair of opposite parallel sides; one right angle

    Example: 

Regular Polygons (pentagon, hexagon,...)

- Central angles: identify angles; calculate their measure
- Interior angles: identify angles; calculate their measure and their sum
- Diagonals: calculate the number of diagonals given the formula; understand the definition of a diagonal
- Exterior angles: identify angles; calculate their measure
- Supplementary angles: add to 180°
- Complementary angles: add to 90°
- Identify/sketch equal sides, parallel sides, and equal angles using notations

Possible Resources

- Borgen, Katherine. *MathWorks 12 Workbook* (Chapter 5). Vancouver, Canada: Pacific Educational Press, 2012.
- Hunter, Chris. *Mathematics for Apprenticeship and Workplace 12 Workbook* (Chapter 7). Toronto, ON: Nelson, 2012.

Precision and Measurement

Students are not to round their answers in this unit.

The following information is provided as a resource and should not be considered an exhaustive list.

Accuracy

Accuracy refers to how close a measurement is to its true value. Accuracy of a measurement can be affected by improper or careless use of a measuring device or by improper manufacturing of the device.

Precision

Precision refers to the smallest increment on a measuring device. It is expected that students can determine the precision from a picture of a device and/or from a given measured value. Examples of devices include odometers, thermometers, analog clocks, scales, etc.

When explaining which given device is more precise, students are expected to provide an adequate explanation. For example, “Device A is more precise because it goes up by 1 unit, whereas Device B goes up by 2 units.” Examples of insufficient explanations are “The ticks are closer together on Device A” and “Device A has more ticks.”

Uncertainty

Uncertainty is half of the precision.

Example: Given the measure 28.3 g, the precision is 0.1 g and the uncertainty is $0.1 \text{ g} \div 2 = 0.05 \text{ g}$.

It is expected that students be able to calculate the total uncertainty of measurements when using a device repeatedly.

Example:

$$\begin{array}{r} 5.4\,\text{cm} \pm 0.05\,\text{cm} \\ 60.3\,\text{cm} \pm 0.05\,\text{cm} \\ +\ 30.1\,\text{cm} \pm 0.05\,\text{cm} \\ \hline 95.8\,\text{cm} \pm 0.15\,\text{cm} \end{array}$$

Tolerance

The tolerance of a measurement is a range of acceptable measurements and can be found by subtracting the minimum value from the maximum value.

The tolerance of a measurement can be expressed in several ways. Each example below expresses the same tolerance but has a different nominal value.

The nominal value is the target measurement.

- $\begin{array}{l}\text{Maximum value}\\ \text{Minimum value}\end{array}$

  Example: $\begin{array}{l}20\,\text{cm}\\ 15\,\text{cm}\end{array}$ (The nominal value is not critical when tolerance is expressed in this form.)

- Nominal value $\pm \frac{1}{2}$ tolerance

  Example: $17.5\,\text{cm} \pm 2.5\,\text{cm}$

- Minimum ${}^{+\text{tolerance}}_{-0}$

  Example: $15\,\text{cm}\,{}^{+5\,\text{cm}}_{-0}$ (where the nominal value is 15 cm)

- Maximum ${}^{+0}_{-\text{tolerance}}$

  Example: $20\,\text{cm}\,{}^{+0}_{-5\,\text{cm}}$ (where the nominal value is 20 cm)

The nominal value can also be a target measurement between the minimum and maximum values.

Example 1: $16\,\text{cm}\,{}^{+4\,\text{cm}}_{-1\,\text{cm}}$ (where the nominal value is 16 cm)

Example 2: $17\,\text{cm}\,{}^{+3\,\text{cm}}_{-2\,\text{cm}}$ (where the nominal value is 17 cm)

Possible Resources

- Borgen, Katherine. *MathWorks 12 Workbook* (Chapter 2). Vancouver, Canada: Pacific Educational Press, 2012.
- Hunter, Chris. *Mathematics for Apprenticeship and Workplace 12 Workbook* (Chapter 2). Toronto, ON: Nelson, 2012.

Statistics

Mean

Students are expected to calculate the arithmetic, weighted, and trimmed means of a given data set. Students may be required to work backwards to find a missing data point when given the mean.

For trimmed mean questions, the number of data points to be trimmed will be given.

Median

Students are expected to determine the median of a given data set, which may contain an odd number or an even number of data points.

Example 1:	1, 2, 3, 4, 5, 6, 7 Median: 4	Example 2:	1, 2, 3, 4, 5, 6, 7, 8 Median: 4.5

Mode

Students are expected to identify the mode from a given data set. In some cases, there could be no mode or more than one mode.

Example 1:	1, 2, 3, 4 Mode: No mode	Example 2:	1, 1, 2, 3, 3, 4 Mode: 1 and 3

Percentile Rank

Percentile rank must be expressed as a whole number. Partial marks may be awarded for process, but final answers with a percent sign are incorrect and no final answer mark will be awarded. Percent means “per 100”; it is not a unit of measure. Therefore, communication error E5 (units) does not apply.

Use of Classroom Resources

During the test, students need a pencil, an eraser, a ruler, a study sheet, and a calculator. Students are allowed to use a bilingual dictionary containing only translations and no definitions.

The following materials must **not** be used during the test:

- classroom notes, textbooks, and other such materials
- subject-related materials on display
- dictionaries (other than bilingual dictionaries)
- computers (including any graphing software)

Electronic communication between students through phones, email, or file sharing during the test is **strictly prohibited**. Students must turn off their cell phones and all other prohibited electronic devices (e.g., headphones, smart watches) for the duration of the test.

> These restrictions are necessary to ensure fair assessment practices and parallel testing conditions in all participating schools.

Related Guides

Formula Sheet: Essential Mathematics

Name of Formula	Formula	Details
Percentile Rank (PR)	$PR = \frac{b}{n} \times 100$	b = number of raw scores below the given score n = total number of raw scores
Simple Interest (I)	$I = Prt$	P = principal r = annual interest rate t = time in years
Education Tax or Municipal Tax	$\text{Tax} = \text{Portioned assessment} \times \frac{\text{mill rate}}{1000}$	
Gross Debt Service Ratio ($GDSR$)	$GDSR = \frac{\left(\begin{array}{c}\text{Monthly}\\\text{mortgage}\\\text{payment}\end{array} + \begin{array}{c}\text{Monthly}\\\text{property}\\\text{taxes}\end{array} + \begin{array}{c}\text{Monthly}\\\text{heating}\\\text{costs}\end{array}\right)}{\text{Gross monthly income}}$	
Fuel Economy in L / 100 km (FE)	$\frac{FE}{100} = \frac{\text{Fuel used in litres}}{\text{Distance travelled in km}}$	
Sum of Interior Angles of Polygons (S)	$S = 180° (n - 2)$	n = number of sides
Measure of One Interior Angle of a Regular Polygon	$\text{Interior angle} = \frac{180°(n-2)}{n}$	n = number of sides
Measure of One Exterior Angle of a Regular Polygon	$\text{Exterior angle} = \frac{360°}{n}$	n = number of sides
Central Angle of Regular Polygons (C)	$C = \frac{360°}{n}$	n = number of sides
Number of Diagonals in a Polygon (D)	$D = \frac{n(n-3)}{2}$	n = number of sides

Additional formulas on next page.

Formula Sheet: Essential Mathematics (continued)

Trigonometric Laws			
Sine Law	$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$ $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$	Cosine Law	$a^2 = b^2 + c^2 - (2bc\cos A)$ $\cos A = \frac{b^2 + c^2 - a^2}{2bc}$

Tax Rates	
Provincial Retail Sales Tax (RST) 7%	Federal Goods and Services Tax (GST) 5%

Taxes on Vehicle Purchases

	RST	GST
Buying New	Yes	Yes
Buying Used from a Dealership	Yes	Yes
Buying Used Privately	Yes, calculated on greater of book value or purchase price	No
Safety	No	Yes
Materials and Labour	Yes	Yes
Lien Search	No	No

Note: Provincial sales tax (PST) is now called retail sales tax (RST).

Note: Since July 1, 2020, RST is no longer added to home insurance.

Terminology Sheet: Essential Mathematics

Some questions may include directing words such as *explain*, *state*, and *calculate*.
These words are explained below.

The word	**The question is asking for…**
identify	the appropriate answer(s) from a given list of choices
state	a word, sentence, or number, without an explanation
describe/explain	words or symbols, diagrams, charts or graphs, or other methods that clearly show what you are thinking
justify	an explanation, information, or evidence that shows why your method, idea, or answer is correct
sketch/illustrate	a reasonably neat picture or diagram (not necessarily to scale) that clearly shows or explains an idea, concept, or method
calculate	a mathematical formula, an algebraic equation, or a numerical calculation to solve a problem
determine	a verification or confirmation by count, observation, formula, pattern, use of a table, etc.

Manitoba Homeowner’s Insurance Rates

Manitoba Homeowner’s Insurance Rates ($500 deductible)								
	Winnipeg		Area 2		Area 3		Area 4	
Amount	**Standard**	**Comprehensive**	**Standard**	**Comprehensive**	**Standard**	**Comprehensive**	**Standard**	**Comprehensive**
$ 50 000	195	214	147	161	196	216	261	287
$ 55 000	216	238	160	176	217	239	289	318
$ 60 000	237	260	173	190	237	261	315	347
$ 65 000	252	277	187	205	255	281	339	373
$ 70 000	266	303	200	220	270	297	359	395
$ 75 000	294	314	210	231	285	314	379	417
$ 80 000	310	323	221	243	302	332	402	438
$ 85 000	318	333	226	249	313	344	416	462
$ 90 000	324	349	231	254	324	356	431	474
$ 95 000	348	370	244	268	345	380	459	505
$100 000	364	393	260	286	361	397	480	528
$105 000	390	417	278	306	378	416	503	553
$110 000	402	441	293	322	393	432	523	575
$115 000	418	464	299	329	409	450	544	598
$120 000	436	487	309	340	424	466	564	620
$125 000	451	510	319	351	444	488	591	650
$130 000	472	543	339	373	466	513	620	682
$135 000	498	557	345	380	477	525	634	697
$140 000	523	580	358	394	496	546	660	726
$145 000	538	596	375	413	508	559	676	744
$150 000	550	604	385	424	520	572	692	761
$155 000	557	613	398	438	551	606	733	806
$160 000	565	622	413	454	569	626	757	833
$165 000	572	629	425	468	589	648	783	861
$170 000	590	647	441	485	609	670	810	891
$175 000	607	668	451	496	624	686	830	913
$180 000	620	686	466	513	648	713	862	948
$185 000	636	702	478	526	667	734	887	976
$190 000	652	717	492	541	705	776	938	1032
$195 000	678	742	504	554	720	792	958	1054
$200 000	692	771	519	571	726	799	966	1063
Additional Amounts per $1000 coverage	Add: $3.15	Add: $3.50	Add: $2.75	Add: $3.03	Add: $3.55	Add: $3.91	Add: $4.72	Add: $5.19

$200 deductible—Increase premium by 10%

Pre-Calculus Mathematics

Grade 12 Pre-Calculus Mathematics Achievement Test

- General Directions
- Schedule for Test Administration
- Test Specifications
- Formula Sheet
- Terminology Sheet
- Graphing
  - Key Features of Graphs
- Information for Teachers
- Use of Classroom Resources
- Calculator Use on Grade 12 Pre-Calculus Mathematics Achievement Test
- Related Guides
  - Formula Sheet: Pre-Calculus Mathematics
  - Terminology Sheet: Pre-Calculus Mathematics
  - Marking Guidelines: Pre-Calculus Mathematics

Grade 12 Pre-Calculus Mathematics Achievement Test

The test consists of *Booklet 1* and *Booklet 2* and is administered during one three-hour session. English and French versions of the test are available.

General Directions

Booklet 1 begins with questions that require a calculator (approximately five questions). The remaining questions in *Booklet 1* are questions for which a calculator may be used, but is not required.

The students will be given 45 minutes with their calculators. After 45 minutes, the calculators are to be put away. It is **not** expected that students will have answered all questions in *Booklet 1* at this time.

Booklet 2 is to be distributed once the calculators have been put away.

The students will have the remaining time (2 hours 15 minutes) to work on questions in *Booklet 1* and *Booklet 2*, and will no longer have access to a calculator.

Schedule for Test Administration

Semester	Date	Time Required for Test	Additional Time Allowed[1]
1	January 23, 2025	3 hours	30 minutes
2	June 10, 2025	3 hours	30 minutes

[1] **Without providing an adaptation**

Students must begin writing the Grade 12 Pre-Calculus Mathematics Achievement Test between 8:30 a.m. and 10:00 a.m.

Test Specifications

The following table indicates the approximate number of marks by unit.

Number of Marks by Unit	
Unit	Marks*
Transformations of Functions	14
Trigonometric Functions	14
Binomial Theorem	11
Polynomial Functions	9
Trigonometric Equations and Identities	14
Exponents and Logarithms	15
Radicals and Rationals	13
Total Marks	90

The following table indicates the percentage of marks by question type.

Percentage of Marks by Question Type	
Question Type	Percentage (%)**
Selected response	10
Constructed response***	90

* Marks are approximate.
** Percentages are approximate.
*** 10% of questions require that students explain, describe, or justify their answers.

Formula Sheet

The formula sheet as it appears in the Grade 12 Pre-Calculus Mathematics Achievement Test can be found on page 51.

Terminology Sheet

The terminology sheet as it appears in the Grade 12 Pre-Calculus Mathematics Achievement Test can be found on page 52.

Graphing

This course requires the ability to analyze and sketch many different functions and relations.

Teachers should be aware that in all functions, unless otherwise stated, the domain is the largest subset of the real numbers for which the function is meaningful.

A clearly labelled graph will include the following:

- labels on both axes
- indication of scales on both axes (This is not meant to be more than one or two numbers on each axis; values that are important to the function are ideal places to show scale.)
- arrowheads or endpoints that indicate whether the graph continues or stops (restrictions on domain or range)
- accurate shape (whether it is straight or curved and whether the curve opens up, down, left, or right)
- asymptotes (if applicable) drawn as non-solid lines, with the graph approaching the asymptote, including asymptotes on the x and y axes
- intercepts (see Key Features of Graphs on page 44)

Key Features of Graphs

When asked to sketch a graph, students are required to provide a detailed drawing **with key features** of the graph that includes a minimum of two coordinate points.

Key features of the shape of different graphs studied in this course are listed below.

Sinusoidal Function

- period
- amplitude

Polynomial Function

- *x*-intercept(s)
- *y*-intercept
- behaviour at *x*-intercept(s) according to multiplicity
- end behaviour
- relative maxima or minima are not required

Radical Function*

- correct domain

Rational Function**

- asymptotic behaviour approaching vertical asymptote
- asymptotic behaviour approaching horizontal asymptote
- point of discontinuity
- minimum of one point in each section

Exponential Function

- *y*-intercept
- asymptotic behaviour approaching horizontal asymptote

Logarithmic Function

- *x*-intercept
- asymptotic behaviour approaching vertical asymptote

Transformations and Operations

- correct domain

---

* When asked to graph $y = \sqrt{f(x)}$, students are required to provide a minimum of three points which must include the invariant points.

** When asked to graph $y = \frac{1}{f(x)}$, students are required to include the invariant points.

Information for Teachers

- Decimal precision: When an answer is required to be "**correct to 3 decimal places**" students should know that rounding to 3 or fewer places in the earlier stages of the problem will probably result in an inaccurate answer. In fact, rounding should be avoided until the final answer. Full marks will be given for answers that are rounded or truncated to 3 decimal places or that give 3 or more decimal places.

  Example: The following are acceptable answers to $7 \div 9$ correct to 3 decimal places:

  $\frac{7}{9}$ $\quad 0.\overline{7} \quad 0.\overline{77} \quad 0.777 \quad 0.778 \quad 0.777\,777$

  The following are not acceptable answers:

  $0.78 \quad 0.77$

- Students are expected to show all possible solutions before rejecting any extraneous root(s).

  Example:
  $$\begin{aligned} \log_6(x-1)+\log_6(x) &= 1 \\ \log_6(x^2-x) &= 1 \\ x^2-x &= 6 \\ x^2-x-6 &= 0 \\ (x-3)(x+2) &= 0 \\ x &= 3 \quad \cancel{x=-2} \end{aligned}$$

  "$x = -2$" must be shown and then rejected if extraneous.

- Identities: A common student error is to equate the left-hand side with the right-hand side of an identity throughout the work. In an effort to avoid this error, a T-structure will be provided in the test booklet.

  Example:

Left-Hand Side	Right-Hand Side

- Fractions as final answers do not need to be reduced or rationalized.

  Examples of acceptable answers are $\frac{148}{185}$ and $\frac{\sqrt{3}}{\sqrt{2-1}}$.

- Domain and range may be accepted in either set notation or interval notation.
- A maximum of one mark will be awarded for "guess and check" solutions.

- Students will receive an E1 communication error if they do not reject impossible solutions that are introduced because of an error (only when marks are not allocated for rejecting).

  Example: $\sin\alpha = \frac{3}{5}$

  $$5^2 + 3^2 = x^2$$
  $$34 = x^2$$
  $$\sqrt{34} = x$$
  $$\cancel{\therefore \cos\alpha = \frac{\sqrt{34}}{5}}$$

  The solution $\cos\alpha = \frac{\sqrt{34}}{5}$ must be rejected since $\frac{\sqrt{34}}{5} > 1$.

  Some other examples include

  - when solving for permutations or combinations, n cannot be a fraction or negative
  - for binomial expansion, n cannot be a fraction or negative
  - for word problems, the solution must be logical (e.g., time cannot be negative)

- When stating the equation of a composite function, students are expected to include restrictions on the domain.

  Example: If $f(x) = x^2$ and $g(x) = \sqrt{x-3}$

  $$f(g(x)) = \left(\sqrt{x-3}\right)^2$$
  $$f(g(x)) = x - 3,\ x \geq 3$$

Use of Classroom Resources

During the test, students must have a pencil to shade in the answer sheet. They may also use a ruler, an eraser, and a bilingual dictionary containing only translations and no definitions. Students may use a scientific calculator on the test.

The following materials are **not allowed** during the test:

- graphing calculator
- study sheet
- classroom notes, textbooks, and other such materials
- subject-related materials on display
- dictionaries (other than bilingual dictionaries)
- computers (including any graphing software)
- extra paper (scrap paper for student use is provided on perforated pages at the beginning of *Booklet 1*; additional blank pages for student use are included at the end of each test booklet)

Electronic communication between students through phones, email, or file sharing during the test is **strictly prohibited**. Students must turn off their cell phones and all other prohibited electronic devices (e.g., headphones, smart watches) for the duration of the test.

> These restrictions are necessary to ensure fair assessment practices and parallel testing conditions in all participating schools.

Calculator Use on Grade 12 Pre-Calculus Mathematics Achievement Test

For the purposes of the Grade 12 Pre-Calculus Mathematics Achievement Test, a scientific calculator is defined as a hand-held electronic device designed for computation. With the advent of more sophisticated calculators, it is important to identify calculator characteristics that will not be acceptable for student use on the test. These characteristics are outlined below.

Calculators that have symbolic manipulation abilities (i.e., a CAS—computer algebra system) will not be acceptable for use on the test. More specifically, calculators with the capability to simplify algebraic expressions, multiply polynomials, or factor polynomials are not permitted.

Calculators must not be shared between students during the test.

Related Guides

Formula Sheet: Pre-Calculus Mathematics

$$s = \theta r$$

$$\sin^2\theta + \cos^2\theta = 1$$

$$\tan^2\theta + 1 = \sec^2\theta$$

$$1 + \cot^2\theta = \csc^2\theta$$

$$\sin(\alpha - \beta) = \sin\alpha\cos\beta - \cos\alpha\sin\beta$$

$$\cos(\alpha - \beta) = \cos\alpha\cos\beta + \sin\alpha\sin\beta$$

$$\tan(\alpha - \beta) = \frac{\tan\alpha - \tan\beta}{1 + \tan\alpha\tan\beta}$$

$$\sin(\alpha + \beta) = \sin\alpha\cos\beta + \cos\alpha\sin\beta$$

$$\cos(\alpha + \beta) = \cos\alpha\cos\beta - \sin\alpha\sin\beta$$

$$\tan(\alpha + \beta) = \frac{\tan\alpha + \tan\beta}{1 - \tan\alpha\tan\beta}$$

$$\sin 2\alpha = 2\sin\alpha\cos\alpha$$

$$\cos 2\alpha = \cos^2\alpha - \sin^2\alpha$$

$$\cos 2\alpha = 1 - 2\sin^2\alpha$$

$$\cos 2\alpha = 2\cos^2\alpha - 1$$

$$\tan 2\alpha = \frac{2\tan\alpha}{1 - \tan^2\alpha}$$

$$\log_a(MN) = \log_a M + \log_a N$$

$$\log_a\left(\frac{M}{N}\right) = \log_a M - \log_a N$$

$$\log_a\left(M^n\right) = n\log_a M$$

$$P(n,r) \text{ or } {}_nP_r = \frac{n!}{(n-r)!}$$

$$C(n,r) \text{ or } {}_nC_r = \frac{n!}{r!(n-r)!}$$

$$t_{k+1} = {}_nC_k a^{n-k} b^k$$

Given $ax^2 + bx + c = 0$,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Terminology Sheet: Pre-Calculus Mathematics

Some questions may contain directing words such as *explain*, *identify*, and *justify*.
These words are defined below.

Describe: Use words to provide the process or to report details of the response.

Determine: Use a mathematical formula, an algebraic equation, or a numerical calculation to solve a problem.

Evaluate: Find the numerical value.

Explain: Use words to provide the cause of or reason for the response, or to render the response more clear and understandable.

Identify: Recognize and select the answer by stating or circling it.

Justify: Show reasons for or give facts that support a position by using mathematical computations, words, and/or diagrams.

Sketch the graph: Provide a detailed drawing with key features of the graph that includes a minimum of 2 coordinate points.

Solve: Give a solution for a problem or determine the value(s) of a variable.

State: Give an answer without an explanation or justification.

Verify: Establish the truth of a statement by substitution or comparison.

Marking Guidelines: Pre-Calculus Mathematics

Errors that are conceptually related to the learning outcomes associated with the question will result in a 1 mark deduction.

Each time a student makes one of the following errors, a ½ mark deduction will apply:

- arithmetic error
- procedural error
- terminology error in explanation
- lack of clarity in explanation, description, or justification
- incorrect shape of graph (only when marks are not allocated for shape)

Communication Errors

The following errors, which are not conceptually related to the learning outcomes associated with the question, may result in a ½ mark deduction and will be tracked on the *Answer/Scoring Sheet.*

E1 **final answer**	▪ answer given as a complex fraction ▪ final answer not stated ▪ impossible solution(s) not rejected in final answer and/or in step leading to final answer
E2 **equation/expression**	▪ changing an equation to an expression or vice versa ▪ equating the two sides when proving an identity
E3 **variables**	▪ variable omitted in an equation or identity ▪ variables introduced without being defined
E4 **brackets**	▪ "sin x^2" written instead of "$\sin^2 x$" ▪ missing brackets but still implied
E5 **units**	▪ units of measure omitted in final answer ▪ incorrect units of measure ▪ answer stated in degrees instead of radians or vice versa
E6 **rounding**	▪ rounding error ▪ rounding too early
E7 **notation/transcription**	▪ notation error ▪ transcription error
E8 **domain/range**	▪ answer outside the given domain ▪ bracket error made when stating domain or range ▪ domain or range written in incorrect order
E9 **graphing**	▪ endpoints or arrowheads omitted or incorrect ▪ scale values on axes not indicated or inconsistently spaced ▪ coordinate points labelled incorrectly
E10 **asymptotes**	▪ asymptotes drawn as solid lines ▪ asymptotes omitted but still implied ▪ graph crosses or curls away form asymptotes