Grade 12
Applied Mathematics
Achievement Test

Student Booklet

June 2024

Manitoba

Grade 12 applied mathematics achievement test.
Student booklet. June 2024

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

Websites are subject to change without notice.

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.

GRADE 12 APPLIED MATHEMATICS
ACHIEVEMENT TEST

DESCRIPTION

Time Required to Complete the Test: 3 hours **Total Possible Marks: 66**
Additional Time Allowed: 30 minutes

Unit	Marks
Relations and Functions	14
Financial Mathematics	17
Probability	16
Design and Measurement	7
Logical Reasoning	12

DIRECTIONS

- Indicate your input values by writing them in your booklet or printing a copy if using a technology tool.
- State any assumptions you make.
- When rounding, express your answers in decimal or percentage form to at least the nearest hundredth (two decimal places), except for monetary values or when otherwise indicated.

  Example: $\frac{15}{29} = 0.52$ or 51.72%
- When no tax calculation is necessary, the wording "taxes included" will be used. When you are required to add taxes, the wording "plus GST and/or PST" will be used and current tax rates will be given (e.g., GST = 5%, PST = 7%).

Note: Rounding too soon in your solution may result in an inaccurate final answer for which full marks will not be awarded.

A clearly communicated answer

— is easily identified in the response space

— includes the parameters in the equation, and "y =", "sin", "ln", or "x", as applicable

— includes the units of measure, where applicable

— includes labels, units, scales for the axes on graphs, and key characteristics of functions (e.g., maximum, minimum, intercepts, and appropriate shape)

— is expressed as an exact value or is appropriately rounded

Marks may be deducted for errors relating to any of the above.

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

Terminology Sheet

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/Select	a stated or circled answer
Show your work/Justify	reasons or facts that support a position by using mathematical computations, words, or diagrams
State/Write	a word, sentence, or number, without an explanation

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

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

$$I = Prt$$

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

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

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

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

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

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

NO MARKS WILL BE AWARDED
FOR WORK DONE ON THIS PAGE.

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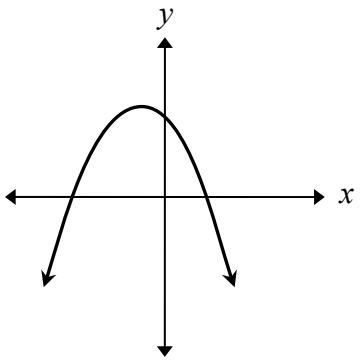
RELATIONS AND FUNCTIONS

Question 1 — Total: 1 mark

101

Select the equation represented by the graph.



A) $y = -4x^2 - 6x - 10$

B) $y = -4x^2 - 6x + 10$

C) $y = 4x^2 - 6x - 10$

D) $y = 4x^2 - 6x + 10$

Question 2 — Total: 1 mark

102

Select the end behaviour of the graph of the function $y = \ln x$.

A) from quadrant IV to quadrant I

B) from quadrant II to quadrant I

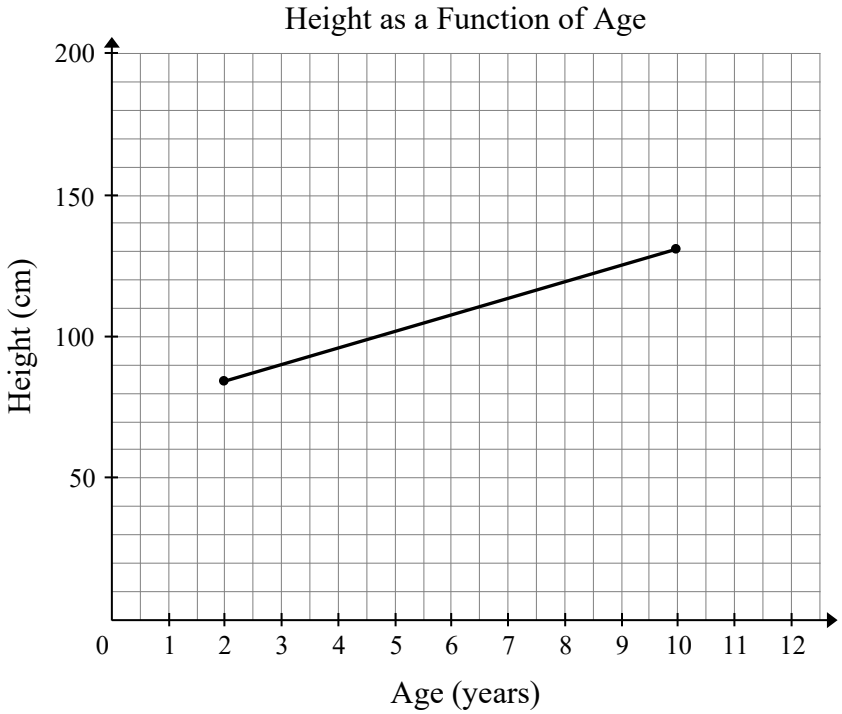
C) from quadrant III to quadrant I

D) from quadrant III to quadrant IV

Question 3 — Total: 1 mark

103

Given the following graph, state the domain.



Domain: _____

Question 4 — Total: 1 mark

104

The number of students enrolled in a business program at a Canadian university can be modelled by the following equation:

$$y = 7.05x^3 - 77.36x^2 + 1069.99x + 7208.23$$

where x represents the time in years
and y represents the number of students enrolled.

The university would like to achieve an enrolment of 19 000 students in this program. State how long it will take for the enrolment to reach 19 000 students. Round to the nearest whole year.

Question 5 — Total: 3 marks

Vern and Joanne are at an amusement park. They go on The Pirate Ship, a ride which acts like a giant pendulum swing.

- The starting position is 5 feet above the ground.
- The ride reaches a maximum height of 64 feet.
- The ride takes 4 seconds to go from the starting position to the maximum height.

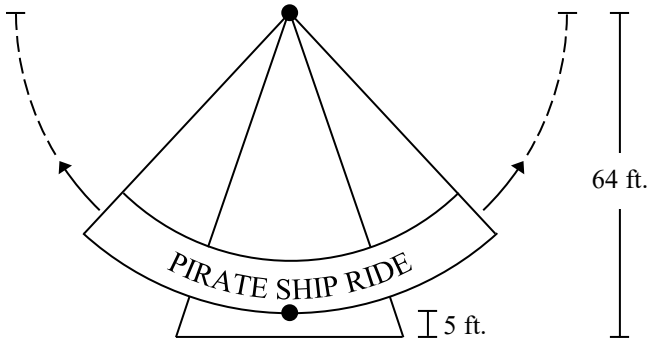


Diagram is not drawn to scale.

105

a) Determine a sinusoidal regression equation that models this situation. Show your work. You may use the table below.

(2 marks)

Time (s)	Height (ft.)

106

b) State how many times Vern and Joanne reach the maximum height during the first 65 seconds.

(1 mark)

Question 6 — Total: 3 marks

Google gives some pages on the web a score which is a rough measure of the importance of a website. The table below demonstrates how Google creates its scoring system.

Page Visits (per day)	100	1000	1 000 000	10 000 000
Google Score	1	2	4	5

107

a) State a logarithmic regression equation that models this situation.

(1 mark)

108

b) A certain website averages 870 visits per day. A shoe company is willing to advertise on this website if it can reach a Google score of 2.4 or greater. Determine how many more visits the website needs to get per day. Show your work.

(2 marks)

Question 7 — Total: 6 marks

A farmer starts a bison farm where the population can be predicted by the following exponential equation:

$$P = 25(1.047)^t$$

where P represents the bison population
and t represents the time (in years).

109

a) Create a clearly labelled graph of the predicted bison population over the next 40 years.

(3 marks)

110

b) State the predicted bison population at 30 years.

(1 mark)

c) The farmer operates the farm for 30 years and then retires.

- She sells the bison for $2000.00 each.
- She invests the money in an account with an interest rate of 4.00%, compounded monthly.
- She withdraws an equal amount monthly for 10 years until there is no money left.

Determine the amount of money that she withdraws monthly. Show your work.

(2 marks)

Question 8 — Total: 1 mark

112

Select the asset that is most likely to appreciate in value.

A) cellphone

B) car

C) house

D) boat

Question 9 — Total: 1 mark

113

John's investment had a value of $64 000 when he was 60 years old. Over the term of the investment, the interest rate was 4.00%.

Using the Rule of 72, select the amount of the initial investment made when John was 24 years old.

A) $16 000

B) $32 000

C) $128 000

D) $256 000

Question 10 — Total: 2 marks

114

Jin has a portfolio that contains three investments which were valued in 2019 and 2024.

Type of Investment	2019	2024	Gain/Loss
GIC	$5000.00	$5500.00	
TFSA	$30 000.00	$38 000.00	
Stocks	$80 000.00	$75 000.00	
Total			

Calculate the rate of return. Show your work. You may use the table above.

Question 11 — Total: 4 marks

Raphael needs a car. He is deciding between buying or leasing a car that costs $23 500.00 (taxes included), and has the following options:

Option 1: Bank financing at an interest rate of 5.00%, compounded monthly, over 5 years.

Option 2: Leasing at $316.00 per month over 60 months then buying the car for $8000.00 at the end of the lease.

115

a) Determine the monthly payment if Raphael chooses Option 1. Show your work.

(2 marks)

116

b) Determine the total cost of each option.

(1.5 marks)

117

c) Explain which option Raphael should choose.

(0.5 mark)

Question 12 — Total: 4 marks

Paul wants to purchase a new house valued at $265 000.00. He has $35 000.00 to use as a down payment. He gets approval for:

- monthly payments
- an interest rate, compounded semi-annually
- a 25-year amortization period

Bank 1: offers an interest rate of 3.34%

Bank 2: offers an interest rate of 3.09%

118

a) Determine the monthly mortgage payment at each bank. Show your work.

(3 marks)

119

b) Determine the difference between the total amounts paid to the banks after 25 years of payments.

(1 mark)

Question 13 — Total: 1 mark

120

Abdul wants to buy a house. He has the option of making biweekly or monthly payments.

Explain one advantage of making biweekly payments.

Question 14 — Total: 2 marks

121

Kamil bought a house for $300 000.00. Before moving in, he built an addition which increased the value of the house by $56 000.00.

If the house appreciates at an annual rate of 2.00%, determine the value of the house after 10 years. Show your work.

PROBABILITY

Question 15 — Total: 1 mark

122

There is a 17% probability of precipitation.

Select the odds in favour of precipitation.

A) $17:100$

B) $83:100$

C) $17:83$

D) $83:17$

Question 16 — Total: 1 mark

123

Maren has rented a karaoke machine for their birthday party. They selected 8 different songs that they want to sing but time only allows for them to sing 4 songs.

Select the expression that represents the number of ways that they can order these songs.

A) $4!$

B) $8!$

C) ${}_8C_4$

D) ${}_8P_4$

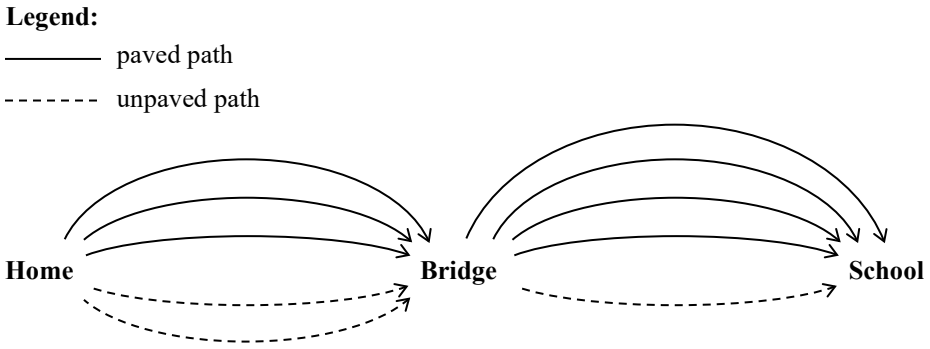
Question 17 — Total: 1 mark

124

Draw a Venn diagram showing mutually exclusive events.

Question 18 — Total: 2 marks

Silas is biking from home to school and must cross a bridge. On one side of the bridge, there are 3 paved paths and 2 unpaved paths. On the other side of the bridge, there are 4 paved paths and 1 unpaved path that lead to Silas' school.



125

a) Determine the total number of routes Silas could take from home to school.

(1 mark)

126

b) Determine the probability that Silas takes only paved paths from home to school.

(1 mark)

Question 19 — Total: 3 marks

Avra is knitting a blanket for her niece. She has 5 balls of yarn that are different shades of blue and 7 balls of yarn that are different shades of purple.

127

a) State the number of ways Avra could randomly choose 6 balls of yarn for the blanket.

(1 mark)

128

b) Determine the number of ways Avra could randomly choose 6 balls of yarn if she wants 2 shades of blue and 4 shades of purple. Show your work.

(2 marks)

Question 20 — Total: 2 marks

129

Determine the number of ways the letters in the name OPASKWAYAK can be arranged.
Show your work.

Question 21 — Total: 3 marks

On January 30, there is a 75% probability of blizzard conditions. If there is a blizzard, there is a 68% probability that schools will be closed. If there is not a blizzard, there is still a 28% probability schools will be closed (due to the cold).

130

a) Use a graphic organizer to show all possible outcomes for this situation.

(1 mark)

131

b) Determine the probability that schools will be closed January 30. Show your work.

(2 marks)

Question 22 — Total: 3 marks

A pre-school class has 12 children. The children stand in a row for their class picture.

132

a) State the number of different arrangements for the picture.

(1 mark)

133

b) Determine the number of arrangements in which two children, Acakos and Písim, stand beside each other. Show your work.

(2 marks)

DESIGN AND MEASUREMENT

Question 23 — Total: 1 mark

134

Select the measurement that is not equivalent to the other measurements.

A) $0.009\ km^2$

B) $9\ m^2$

C) $90\ 000\ cm^2$

D) $9\ 000\ 000\ mm^2$

Question 24 — Total: 3 marks

135

Arianna bought a new soccer ball. It is completely flat and she wants to inflate it.

- When the ball is inflated, it has a diameter of 22 cm.
- The pump she is using produces 0.000 3 m^3 of air per pump.

Determine the minimum number of pumps Arianna will need to inflate the ball to a diameter of 22 cm. Show your work.

Question 25 — Total: 3 marks

Mancole is a company that manufactures tents.
Fabric tents include four sides and a floor.
One particular tent has the following dimensions:

- a height of 8 ft.
- a slant height of 10 ft.
- a 12 ft. × 18 ft. floor

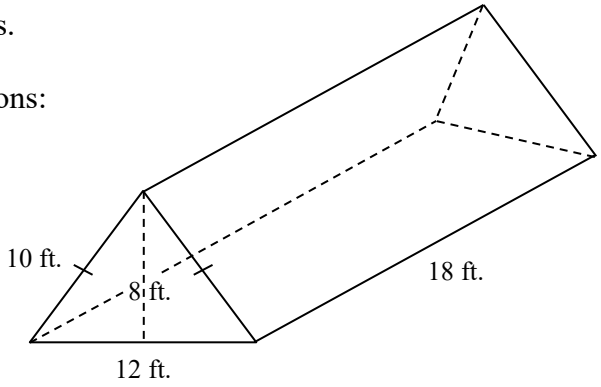


Diagram is not drawn to scale.

136

a) Determine the amount of fabric required to make one tent if an extra 30 ft^2 of fabric is needed for sewing.

(1 mark)

137

b) Each tent requires 18 poles. Each pole costs $24.00 and the fabric costs $3.00/$ft^2$.
Determine the total cost of the tent, plus GST and PST. Show your work.
(Note: GST = 5%, PST = 7%)

(2 marks)

LOGICAL REASONING

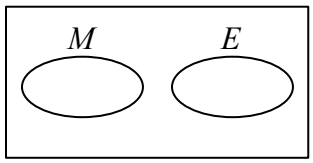
Question 26 — Total: 1 mark

138

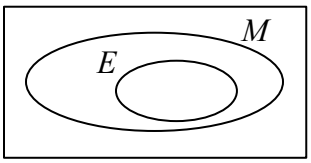
Cindy makes the following statement: "All the students in math class are also in the same English class."

If M represents the set of students in math class and E represents the set of students in English class, select the Venn diagram that best fits Cindy's statement.

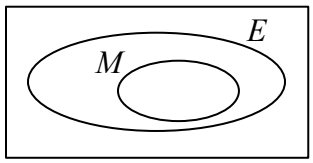
A)



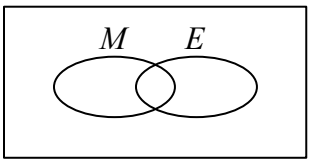
C)



B)



D)



Question 27 — Total: 1 mark

139

Given $A = \{2, 3, 5, 6, 8, 11, 12, 15\}$ and $B = \{3, 6, 12\}$, select the statement that is true.

A) B is the complement of A

B) A and B are disjoint sets

C) $A \subset B$

D) $B \subset A$

Question 28 — Total: 5 marks

There are 60 Grade 12 students at a high school.

- 40 students take biology (B)
- 30 students take chemistry (C)
- 24 students take physics (P)
- 8 students take only biology and chemistry
- 4 students take only biology and physics
- 6 students take only chemistry and physics
- 4 students take physics only

140

a) Draw a Venn diagram to represent this situation.

(3 marks)

141

b) State the number of students who take only one science course.

(1 mark)

142

c) Explain what $B \cap C \cap \overline{P}$ means in this situation.

(1 mark)

Question 29 — Total: 1 mark

143

Given the following statement:

"If a number is odd, then the number is prime."

State a counterexample to this statement.

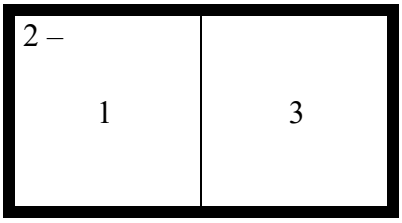
Question 30 — Total: 1 mark

144

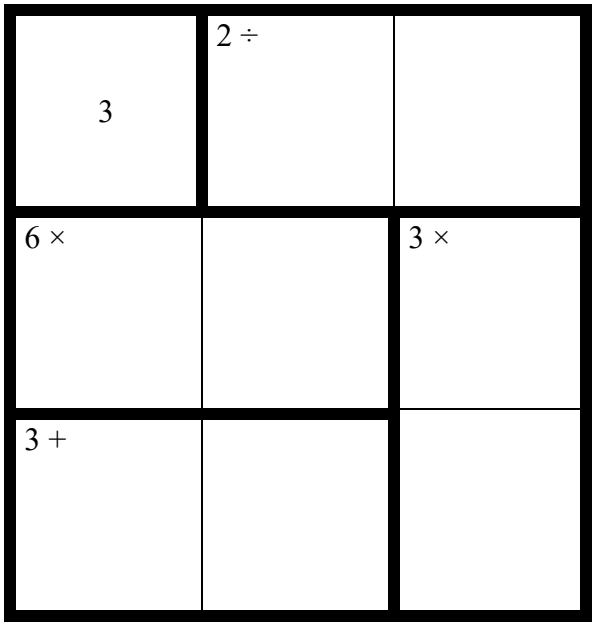
A 3 × 3 KenKen puzzle uses the digits 1, 2, and 3 in each row and column exactly once.

- Each bold rectangle in the puzzle is called a "cage".
- In each cage, the number in the top-left corner is the result of the given operation.
- The numbers may be written in any order in the cage.

Example:



Complete the KenKen puzzle below.



Question 31 — Total: 3 marks

Consider the following statement:

"Someone who plays drums is a musician."

145

a) Write a conditional statement using the statement above.

(1 mark)

146

b) Write the converse of the conditional statement in (a).

(1 mark)

147

c) Is the conditional statement in (a) biconditional? Explain.

(1 mark)

END OF TEST

NO MARKS WILL BE AWARDED
FOR WORK DONE ON THIS PAGE.

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