Grade 12
Applied Mathematics
Achievement Test

Student Booklet

January 2025

Manitoba

Grade 12 applied mathematics achievement test.
Student booklet. January 2025

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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: 67**
Additional Time Allowed: 30 minutes

Unit	Marks
Relations and Functions	17
Financial Mathematics	16
Probability	17
Design and Measurement	8
Logical Reasoning	9

Directions

- Show all your work and clearly indicate your final answer.
- 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	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

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

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

$$I = Prt$$

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

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

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

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

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

Design and Measurement

Prism: $\text{Surface area} = Ph + 2B$

$\text{Volume} = Bh$

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

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

Cube: $\text{Surface area} = 6l^2$

$\text{Volume} = l^3$

Rectangular prism: $\text{Surface area} = 2lw + 2lh + 2wh$

$\text{Volume} = lwh$

Triangular prism: $\text{Surface area} = bh + l(a + b + c)$

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

Square-based pyramid: $\text{Surface area} = b^2 + 2bs$

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

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

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

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

$\text{Volume} = \pi r^2 h$

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

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

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

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Relations and Functions

Question 1 — Total: 1 mark

101

The population of a town increases at a rate of 15% per year.

Select the "*b*" value in the exponential function $y = ab^x$, given this situation.

A) 0.15

B) 0.85

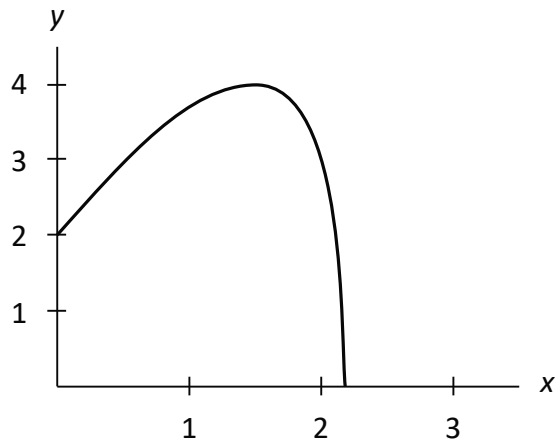
C) 1.15

D) 1.85

Question 2 — Total: 1 mark

102

The domain has been restricted on the following graph. Select the type of function represented.



A) cubic

B) logarithmic

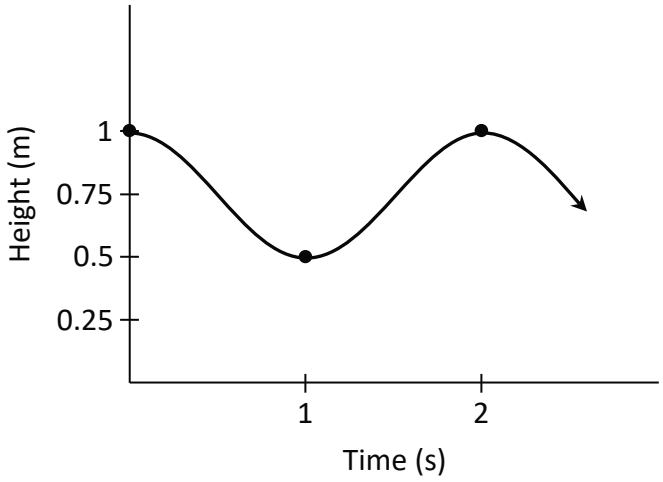
C) quadratic

D) sinusoidal

Question 3 — Total: 1 mark

103

A baby is in a swing. The following graph represents the height of the baby as a function of time.



State the amplitude of the graph.

Question 4 — Total: 2 marks

The following equation models the relationship between time and the number of apples on a tree:

$$T = -76.94 + 27.64\ln(a)$$

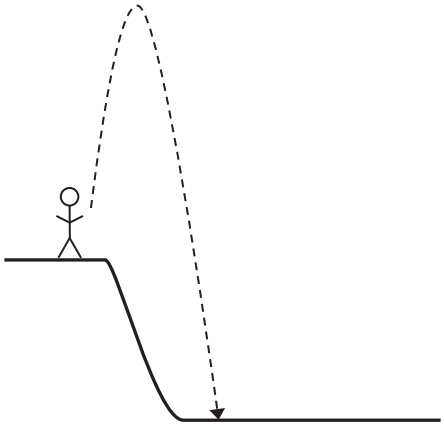
where T represents the time (in days)
and a represents the number of apples.

a) Determine on which day the tree will have 80 apples. (*1 mark*) 104

b) Determine the number of apples on day 18. (*1 mark*) 105

Question 5 — Total: 3 marks

Avery is on top of a hill. From 15 m above the ground, he throws a stone in the air. The stone reaches its maximum height of 31.53 m after 1.84 s. The stone hits the ground after 4.37 s.



106

a) State the quadratic regression equation that models this situation. You may use the table below. (*1 mark*)

Time (s)	Height (m)

Regression equation: _____

107

b) Determine how much time the stone is above 25 m. (*2 marks*)

Question 6 — Total: 3 marks

The pitch of a siren changes over time. Ryan collects the following data:

Time (s)	0.295	0.687	1.080	1.473	1.865
Pitch (Hz)	962	865	770	865	962

a) State a possible sinusoidal regression equation that models the pitch of the siren as a function of time. (*1 mark*) 108

b) Determine the pitch of the siren at 12 seconds. (*1 mark*) 109

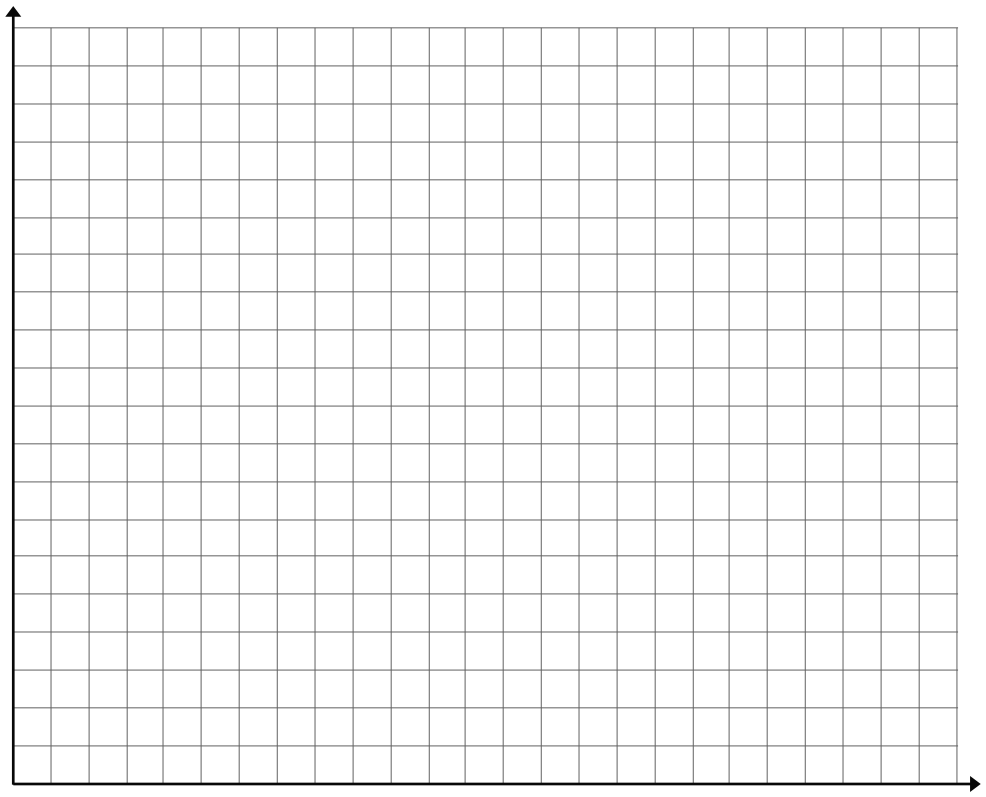
c) State the range of this situation. (*1 mark*) 110

Question 7 — Total: 7 marks

Joel made an investment that increased in value.

Time (years)	3	8	13	19	25
Value of Investment ($)	4764	6375	8531	12 102	17 167

a) Create a clearly labelled graph by plotting the given data. Draw a curve of best fit. (*3 marks*) 111



b) State the exponential regression equation that models this situation. (*1 mark*) 112

c) State the initial amount of Joel's investment. (*1 mark*) 113

d) Determine the value of Joel's investment at 20 years. (*1 mark*) 114

Financial Mathematics

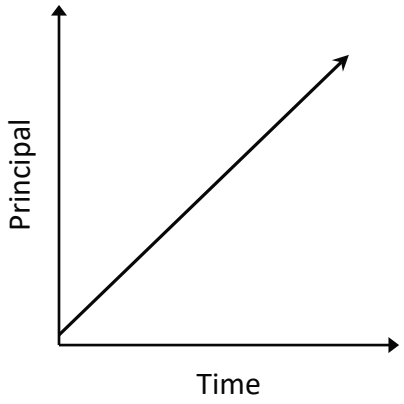
e) Calculate the rate of return at 20 years. (*1 mark*) 115

Question 8 — Total: 1 mark

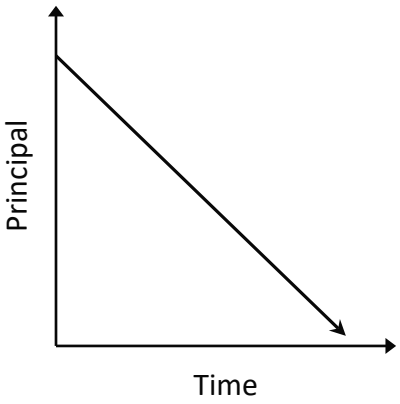
116

Select the graph that best demonstrates the amount of principal paid on a mortgage, compounded semi-annually, over an amortization period of 25 years.

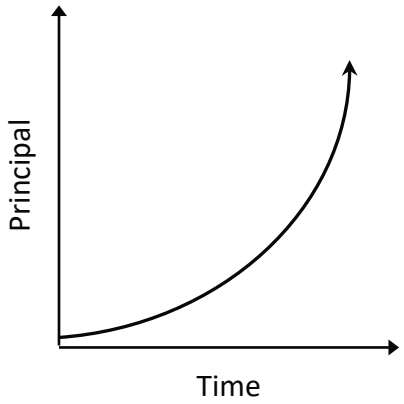
A)



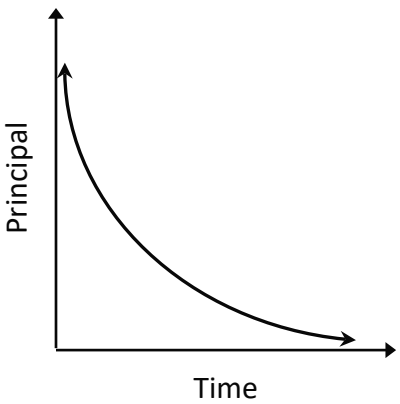
C)



B)



D)



Question 9 — Total: 1 mark

117

Jason bought a house for $325 000.00 five years ago.

- He made a down payment of $25 000.00.
- He has paid $45 000.00 of the principal.
- The value of the house has appreciated to $360 000.00.

Select Jason's current equity in the house.

A) $70 000.00

B) $105 000.00

C) $360 000.00

D) $385 000.00

Question 10 — Total: 2 marks

118

Omar has $65 000.00 to invest. His bank provides two options.

Option 1: Guaranteed investment certificates (GICs)

Option 2: Stocks

State one advantage for each option.

GICs

Stocks

Question 11 — Total: 4 marks

Callie wants to buy a house in a new neighbourhood.

- The average property taxes in the neighbourhood are $4500.00 per year.
- The average heating costs are $200.00 per month.
- Her gross family income is $78 000.00 per year.

a) Determine the maximum monthly mortgage payment for which Callie would qualify when using the gross debt service ratio. (*2 marks*) 119

b) The bank offers Callie a mortgage at an interest rate of 3.09%, compounded semi-annually and amortized over 25 years. Based on your answer in (a), determine the maximum mortgage she could afford. (*2 marks*) 120

Question 12 — Total: 1 mark

121

Suchitra invests $13 000.00 at an interest rate of 6.00%.

Using the Rule of 72, estimate the number of years it will take for her investment to reach a value of $52 000.00.

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Question 13 — Total: 6 marks

Geoff and Jamie are 38 years old and plan to retire at age 60.

Geoff started to invest when he turned 18 years old.

- He made an initial investment of $1000.00.
- He invested $250.00 per month at an interest rate of 5.00%, compounded monthly, until he turned 38 years old.

a) Determine the value of Geoff's investment at age 38. (*2 marks*) 122

b) Geoff stops monthly investments at 38 years old and lets the investment earn interest until he turns 60 years old. The interest rate will remain at 5.00%, compounded monthly. Determine the value of Geoff's investment when he turns 60. (*2 marks*) 123

Jamie starts to invest at 38 years old.

- She makes an initial investment of $1000.00.
- She makes monthly deposits at an interest rate of 5.00%, compounded monthly, until she turns 60 years old.

c) Determine the monthly deposit amount Jamie should make to match Geoff's total investment in (b). (*2 marks*) 124

Probability

Question 14 — Total: 1 mark

125

The probability of the sidewalk being shovelled by the time Shipra gets home from work is 0.71.

Select the odds against the sidewalk being shovelled by the time Shipra gets home from work.

A) 71 : 100

B) 71 : 29

C) 29 : 71

D) 29 : 100

Question 15 — Total: 1 mark

126

Select the best answer, given that $P(A) = \frac{7}{15}$, $P(B) = \frac{4}{15}$, and $P(A \cup B) = \frac{8}{15}$.

A) Events *A* and *B* are dependent events.

B) Events *A* and *B* are mutually exclusive events.

C) Events *A* and *B* are complementary events.

D) Events *A* and *B* are non-mutually exclusive events.

Question 16 — Total: 1 mark

127

The Cree expression NIKISKINOHAMAKAN translates as “I am teaching” in English.

State the expression to represent the total number of ways the letters can be arranged. Leave the answer in factorial form.

Question 17 — Total: 2 marks

There are 12 people enrolled in a fitness class. They must be divided into three equal groups and rotate through three stations.

a) State the number of possible ways the people in one group can be seated on a rowing machine if there are 4 rowing machines. (*1 mark*) 128

b) State the odds in favour of a group beginning their workout on the rowing machines if there are three workout stations. (*1 mark*) 129

Question 18 — Total: 4 marks

There are 8 students in a drama class going on a field trip to see a play. At the theatre, they must sit in a row of seats.

a) State the number of ways the students can be seated. (*1 mark*) 130

b) Determine the number of ways the students can be seated if Payton and Alex, 2 of the students, sit together. (*2 marks*) 131

c) Payton and Alex are no longer allowed to sit together. 132

State the number of ways the students can be seated. (*1 mark*)

Question 19 — Total: 3 marks

The probability that the temperature will be above -15°C on Saturday is 0.93. If the temperature is above -15°C, the probability that Tera will participate in a cross-country ski race on Saturday is 0.80. If the temperature is not above -15°C, the probability that Tera will participate in a cross-country ski race is 0.37.

a) Use a graphic organizer to show all possible outcomes for this situation. (*1 mark*) 133

b) Determine the probability that Tera will participate in the cross-country ski race on Saturday. (*2 marks*) 134

Question 20 — Total: 3 marks

There are 13 students in Class A and 16 students in Class B that would like to volunteer at a dog shelter. Only 3 students will be randomly selected to volunteer.

a) Determine the number of ways at least 1 student in Class A can be chosen to volunteer. (*2 marks*) 135

b) Determine the probability that all 3 students chosen are from Class B. (*1 mark*) 136

Question 21 — Total: 2 marks

137

Danielle received a bag of chocolates for her birthday. There are 5 milk chocolates, 4 white chocolates, and 3 dark chocolates in the bag.

She randomly picks 2 chocolates from the bag, without replacement. Determine the probability that both chocolates are the same kind.

Design and Measurement

Question 22 — Total: 4 marks

Mandy makes 7 hats for a birthday party.

- The slant height of each hat is 5.996 in.
- The radius of each hat is 2.5 in.

a) State the surface area of one hat. (*1 mark*)

138

b) Mandy adds 5% more paper per hat for gluing purposes. Determine the total amount of paper needed to make all 7 hats. (*1 mark*)

139

c) Mandy adds a ribbon around the base of each hat.

- The ribbon is sold by the foot.
- The cost of ribbon is $0.14 per foot, taxes included.

Determine the total cost to add a ribbon around the base of all 7 hats. (*2 marks*)

Question 23 — Total: 4 marks

Zoey bought honey contained in a cylindrical pail.

- The pail has a diameter of 20 cm.
- The pail has a height of 25 cm.

a) Calculate the amount of honey in the pail, assuming the pail is filled to the top. (*1 mark*) 141

b) Zoey wants to empty the honey from the pail into jars. Each jar can contain 350 mL (1 mL = 1 cm^3) of honey. State the number of jars Zoey will need. (*1 mark*) 142

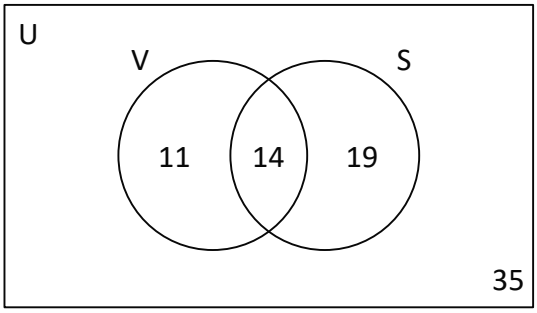
c) Determine the minimum cost if a case of 6 jars costs $5.40 and a single jar costs $0.95, taxes included. (*2 marks*) 143

Logical Reasoning

Question 24 — Total: 1 mark

144

The Venn diagram given below illustrates the relationship between athletes who play volleyball (V) and athletes who swim (S) at a high school.



Select which of the following statements is true.

A) There are 11 athletes who play volleyball.

B) There are 30 athletes who play volleyball or swim.

C) There are 46 athletes who do not swim.

D) There are 60 athletes at the high school.

Question 25 — Total: 3 marks

Logically equivalent statements have the same truth tables.

145

a) Complete the truth table to show that $p \rightarrow q$ and $\sim q \rightarrow \sim p$ are logically equivalent. (*2 marks*)

p	q	$p \rightarrow q$	$\sim q$	$\sim p$	$\sim q \rightarrow \sim p$
True	True				
True	False				
False	True				
False	False				

146

b) Select the statement that $p \rightarrow q$ and $\sim q \rightarrow \sim p$ represent. (*1 mark*)

A) conditional statement and contrapositive statement

B) conditional statement and converse statement

C) inverse statement and contrapositive statement

D) inverse statement and converse statement

Question 26 — Total: 2 marks

Given the following sets:

$A = \{\text{whole numbers}\}$

$B = \{\text{positive odd numbers}\}$

$C = \{\text{prime numbers}\}$

$D = \{\text{positive multiples of two}\}$

147

a) State an example of one set that is the subset of another using two of the sets above. (*1 mark*)

148

b) State the two given sets that are disjoint. (*1 mark*)

Question 27 — Total: 1 mark

149

A printer is used to number the pages of a 60-page book.

State how many times the digit 5 appears in the page numbers.

Question 28 — Total: 2 marks

Vern conducted an experiment and stated:

"If the water is frozen, then the temperature of the water is below 0°C."

a) Write the converse of the statement. (*1 mark*) 150

b) Write the contrapositive of Vern's original statement. (*1 mark*) 151

END OF TEST

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