Grade 12
Applied Mathematics
Achievement Test

# Student Booklet

January 2026

Manitoba

Grade 12 Applied Mathematics Achievement Test:
Student Booklet (January 2026)

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Winnipeg, Manitoba, Canada



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: 71**
**Additional Time Allowed: 30 minutes**

| Unit | Marks |
|---|---|
| Relations and Functions | 15.5 |
| Probability | 17.5 |
| Financial Mathematics | 18 |
| Design and Measurement | 10.5 |
| Logical Reasoning | 9.5 |

## Directions

- Show all your work and clearly indicate your final answer.
- Indicate your input values by writing them in your booklet.
- 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 units of measure, where applicable

— is expressed as an exact value or is appropriately rounded

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

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

— includes number of payments, interest rate, present value, payments, future value, payments per year, and compounds per year in all financial calculations using a TVM solver

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 to clearly express what you are thinking (symbols, diagrams, charts, or graphs can be used to support your explanation) |
| **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

Select the function that could have a domain of $(-\infty, \infty)$ and a range of $(-\infty, 2]$.

A) cubic

B) quadratic

C) sinusoidal

D) logarithmic

## Question 2 — Total: 1 mark

102

During an experiment, 1.5 L of water is boiled and the remaining volume, in litres, is measured over time, in minutes.

Select the equation that could model this situation.

A) $V = 1.5t^2$

B) $V = 1.5\sin t$

C) $V = 1.5(0.85)^t$

D) $V = 1.5(1.05)^t$

## Question 3 — Total: 3 marks

A dog's lung volume at rest can be modelled by the following sinusoidal function:

$$V = 0.37\sin 1.57t + 0.45$$

where $V$ represents the lung volume (in litres)
and $t$ represents the time (in seconds).

a) State the dog's lung volume at 1.35 seconds. 103

(*1 mark*)

b) Determine the period of the function. 104

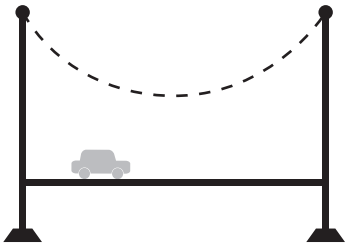
(*1 mark*)

c) Explain what the period represents in this situation. 105

(*1 mark*)

## Question 4 — Total: 4 marks

A car drives across a suspension bridge that has a support cable attached between two towers as shown in the diagram.



- The two towers are 480 m apart and have a height of 92 m above the road.
- When the car is 11 m from the left tower, the height of the cable is 85 m above the road.

106

a) Complete the table below.

(*1 mark*)

| Horizontal Distance (m) | Height (m) |
|---|---|
| | |
| | |
| | |

107

b) Determine the quadratic equation that models the shape of the cable, expressed to the nearest ten thousandth (four decimal places).

(*1 mark*)

Quadratic equation: _____

108

c) Determine the height of the cable when the car is halfway between the two towers.

(*1 mark*)

109

d) State the range of the function in this situation.

(*1 mark*)

## Question 5 — Total: 2.5 marks

The following equation models the relationship between a tree's height and its age:

$$h = 6.01 + 6.30 \ln A$$

where $h$ represents the height of the tree (in feet)
and $A$ represents the age of the tree (in years).

a) State the height of the tree when it is 6 years old. 110

(*1 mark*)

b) The tree was planted in the year 2020. Determine in which year the tree will reach a height of 20 feet. 111

(*1.5 marks*)

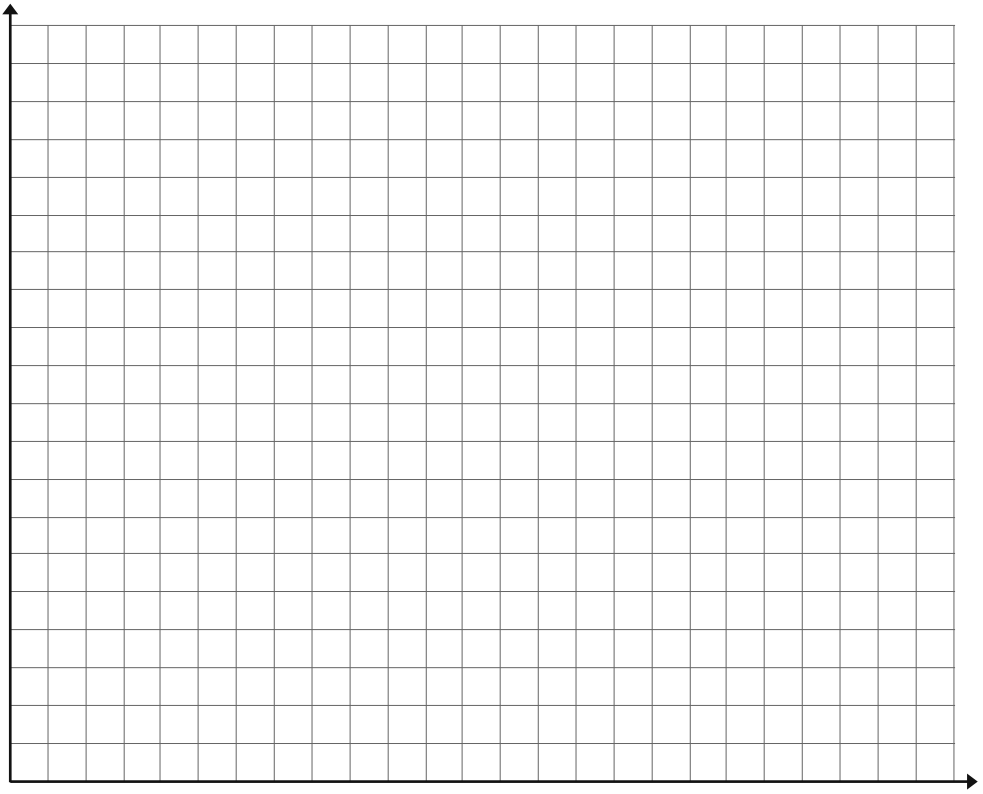
## Question 6 — Total: 4 marks

For a science fair project, Jaelyn flies a model helicopter and records the following data.

| **Time (s)** | 0 | 7 | 13 | 18 | 22 |
|---|---|---|---|---|---|
| **Height (m)** | 8 | 38 | 27 | 22 | 36 |

a) Create a clearly labelled graph by plotting the given data. Draw a curve of best fit. 112

(*2 marks*)



b) State the cubic regression equation that models this situation. 113

(*1 mark*)

c) Determine the time when the model helicopter was at a height of 18 m, using the regression equation.

(*1 mark*)

# Probability

## Question 7 — Total: 1 mark

115

Select the situation that represents mutually exclusive events.

A) Selecting a number that is prime and less than 10.

B) Rolling a multiple of 3 and an even number on a 6-sided die.

C) Drawing a 4-sided shape that is a rectangle and a parallelogram.

D) Selecting a number that is an 8 and an odd number.

## Question 8 — Total: 2 marks

There are 4 green marbles, 3 red marbles, and 1 blue marble in a bag.

a) State the odds in favour of drawing a green marble from the bag. 116

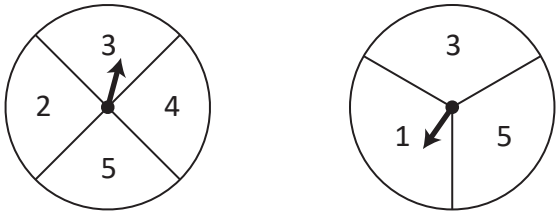
(*1 mark*)

b) State the odds against drawing a blue marble from the bag. 117

(*1 mark*)

## Question 9 — Total: 3 marks

A student is playing a game using the two spinners shown below. The student spins each spinner once and adds the results.




a) Use a graphic organizer to show the sums of all possible outcomes for this situation. 118

(*2 marks*)

b) State the probability that the sum is 8. 119

(*1 mark*)

## Question 10 — Total: 4.5 marks

In a group of 15 randomly selected students:

- 10 students are only signed up for the Applied math course
- 5 students are only signed up for the Essential math course

a) Determine the number of 6-person committees that can be made with exactly 2 Applied math students. 120

(*1.5 marks*)

b) Determine the number of 6-person committees that can be made with no more than 3 Essential math students. 121

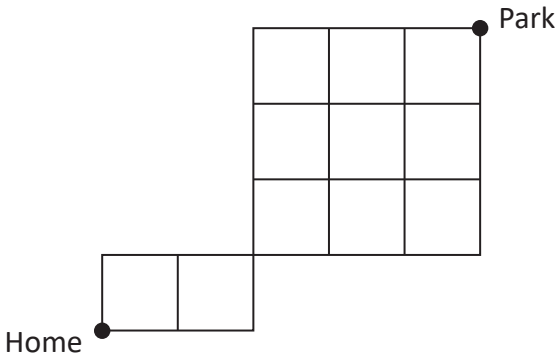
(*3 marks*)

## Question 11 — Total: 2 marks

122

Brent is walking to the park to meet some friends.

Determine the number of different paths Brent can take from his home to the park if he can only travel North and East.




## Question 12 — Total: 3 marks

Using the digits 2, 3, 5, 6, 7:

a) State how many different 3-digit numbers can be made if repetition is allowed. 123

(*1 mark*)

b) Determine how many different 3-digit numbers are greater than 650 if repetition is allowed. 124

(*1.5 marks*)

c) State the probability that a 3-digit number will be greater than 650 if repetition is allowed. 125

(*0.5 mark*)

## Question 13 — Total: 2 marks

126

There are 10 people in an office. They are split into three committees.

- One committee has 4 people.
- Two committees have 3 people each.
- A person can only be on one committee.

Determine the total number of ways these three committees can be formed.

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# Financial Mathematics

## Question 14 — Total: 1 mark

127

The table below shows the value of a speedboat over a two-year period.

| Year | Value |
|---|---|
| 0 | $53 000.00 |
| 1 | $40 810.00 |
| 2 | $31 423.70 |

Select the annual rate of depreciation.

A) 23%

B) 41%

C) 59%

D) 77%

## Question 15 — Total: 1.5 marks

128

Blaire's parents invest $10 000.00 when Blaire is born to use towards college. The investment has an annual interest rate of 8.00%.

Using the rule of 72, determine approximately how much money Blaire will have when they are 18 years old.

## Question 16 — Total: 5.5 marks

Cody will retire in 40 years. He starts to build a financial portfolio. The portfolio consists of the following investments:

**Investment 1:** He invests $12 000.00 in a bond earning simple interest at an annual interest rate of 6.00%.

**Investment 2:** He makes regular monthly deposits of $500.00 in a tax-free savings account (TFSA) with an annual interest rate of 3.45% compounded monthly.

a) Determine the value of Investment 1 when Cody retires. 129

(*1 mark*)

b) Determine the value of Investment 2 when Cody retires. 130

(*2 marks*)

c) Determine the total amount Cody invested into his portfolio when he retires. 131

(*1 mark*)

d) State the value of Cody's portfolio when he retires. 132

(*0.5 mark*)

e) Determine the average rate of return on Cody's portfolio when he retires. 133

(*1 mark*)

## Question 17 — Total: 4 marks

Kultaj is hoping to buy a house valued at $340 000.00. She has saved $50 000.00 to use on a down payment. The bank offers a 25-year mortgage at an annual interest rate of 5.25% compounded semi-annually.

a) Determine Kultaj's monthly mortgage payment. 134

(*2 marks*)

b) Kultaj has a gross annual income of $90 000.00. The monthly property taxes for the house would be $390.00 and the monthly heating cost would be approximately $240.00. Determine the gross debt service ratio (GDSR). 135

(*1 mark*)

c) Explain if the bank would lend her money based on the GDSR. 136

(*1 mark*)

## Question 18 — Total: 4 marks

Janelle wants to buy a new laptop for $1275.00, taxes included.

- The store is offering a 0% interest rate promotion with no payments for 6 months.
- If the full amount is not paid within 6 months, interest will be charged from the date of purchase at an annual interest rate of 21.99% compounded monthly.

a) Janelle makes no payments during the first 6 months and is now charged interest. Determine the total amount Janelle will owe 6 months after the date of purchase. 137

(*2 marks*)

b) After 6 months, Janelle starts making monthly payments of $200.00 at an annual interest rate of 21.99% compounded monthly. Determine how many months Janelle will take to pay off the loan. 138

(*2 marks*)

## Question 19 — Total: 2 marks

139

Explain one advantage and one disadvantage of leasing a new vehicle compared to purchasing the same vehicle.

**Advantage:**

**Disadvantage:**

# Design and Measurement

## Question 20 — Total: 1 mark

140

The town of Kirksel has a water tower in the shape of a sphere.
It holds 26 740 $ft^3$ of drinking water.

Select the radius of the water tower.

A) 18.55 ft.

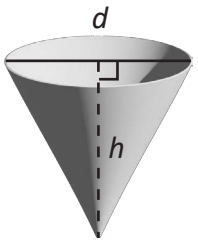
B) 39.79 ft.

C) 46.13 ft.

D) 79.90 ft.

## Question 21 — Total: 3 marks

Michelle has an ice cream cone.




- The diameter is 7 cm wide.
- The height is 12 cm high.

a) Calculate the surface area of the outside of the cone. 141

(*2 marks*)

b) State the cost of coating 30% of the outside of the cone with chocolate if the chocolate costs \$0.04 per $cm^2$. 142

(*1 mark*)

## Question 22 — Total: 1.5 marks

Corinne incorrectly calculated the surface area of a cylinder.

a) Indicate her mistake. 143

(*0.5 mark*)

$$\text{Surface area} = 2\pi\left(3.06\right) + 2\pi\left(3.06\right)\left(9\right)$$

$$= 19.2265\ldots + 173.0389\ldots$$

$$= 192.27\ \text{cm}^2$$

b) State the correct surface area. 144

(*1 mark*)

## Question 23 — Total: 5 marks

Corbin wants to build a rectangular outdoor curling rink.

His backyard allows him to build a rink with a length from 48 ft. to 60 ft., and a width from 10 ft. to 20 ft.

a) State a possible set of dimensions for his rink. 145

(*0.5 mark*)

☐ ft. by ☐ ft.

b) His rink has a perimeter made of wood, one board high. A 12 ft. board costs $51.20, taxes included. Calculate the total cost of wood needed, using the dimensions you stated in (a). 146

(*1.5 marks*)

c) Corbin needs to fill the rectangular rink with water in order to make ice. He wants a depth of 8 in. Determine the volume of water he needs. 147

(*1 mark*)

d) Water costs \$2.00 per 35 $ft^3$. Determine the cost of water used in (c). 148

(*1 mark*)

e) Corbin has a budget of \$800.00 for the rink. State how much money he has left over to purchase lights, after purchasing boards and water. 149

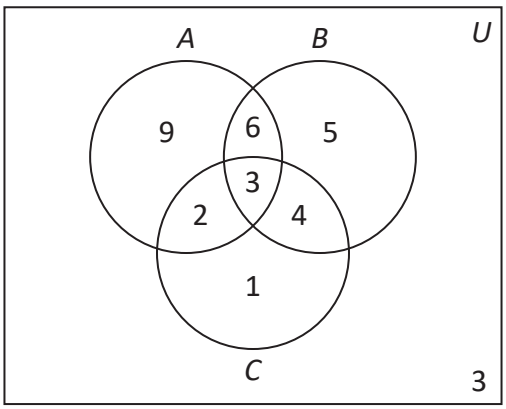
(*1 mark*)

# Logical Reasoning

## Question 24 — Total: 1 mark

150

Given the Venn diagram below,




select the number of elements in $(A \cup B) \setminus C$.

A) 4

B) 10

C) 13

D) 20

## Question 25 — Total: 2 marks

Consider the following true conditional statement:

"If I live in the capital city of Manitoba, then I live in Winnipeg."

a) Write the converse of the conditional statement above. 151

(*1 mark*)

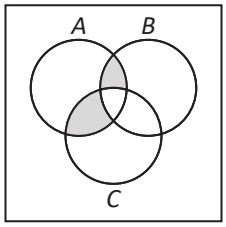
b) State the biconditional statement if possible. Otherwise, state a counterexample. 152

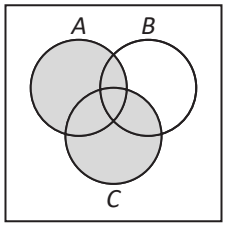
(*1 mark*)

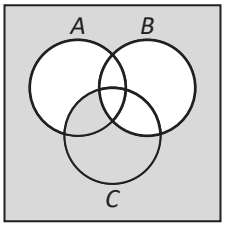
## Question 26 — Total: 1.5 marks

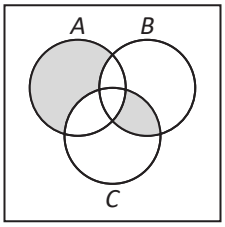
153

Match each set notation to its Venn diagram.




_____ _____ _____ _____

i: $(A \cup C)$

ii: $((A \cap B) \setminus C) \cup ((A \cap C) \setminus B)$

iii: $(A \setminus B \setminus C) \cup ((B \cap C) \setminus A)$

iv: $(A \cup B \cup C)' \cup ((A \cap C) \setminus B) \cup (C \setminus A \setminus B)$

## Question 27 — Total: 3 marks

Given the following statements:

- I have a fruit.
- I am learning biology.
- I am learning systems.
- I am learning math.
- I can make a snack.
- I have a strawberry.
- I am studying plants.
- I am studying inequalities.

a) Using two of the above statements, write a conditional statement. 154

(*1 mark*)

b) Write the inverse of your statement in (a). 155

(*1 mark*)

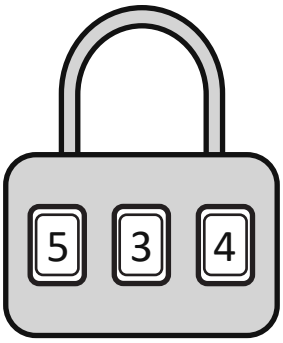
c) State a counterexample for either statement in (a) or (b). 156

(*1 mark*)

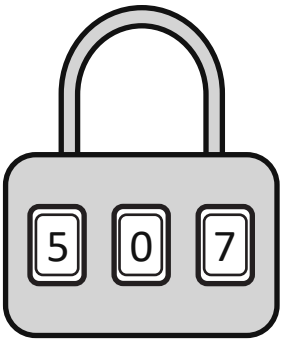
## Question 28 — Total: 2 marks

157

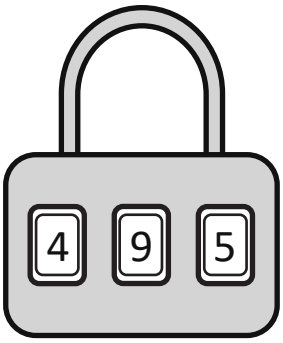
The following are clues to open a three-digit lock:



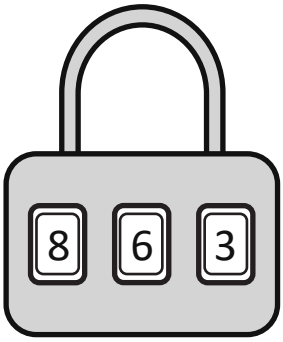

only one digit is correct and perfectly placed



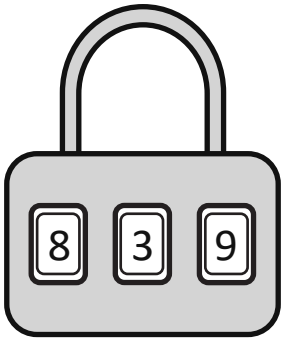

only one digit is correct but wrongly placed




two digits are correct but wrongly placed

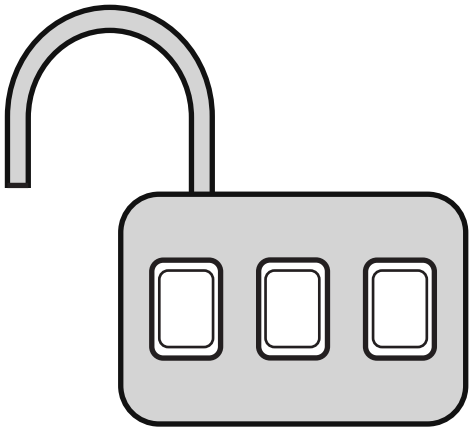



nothing is correct




only one digit is correct but wrongly placed

Determine the three-digit code.



**END OF TEST**

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