NSW Education Standards Authority

2021 HIGHER SCHOOL CERTIFICATE EXAMINATION

Mathematics Standard 1

General Instructions
- Reading time – 10 minutes
- Working time – 2 hours
- Write using black pen
- Calculators approved by NESA may be used
- A reference sheet is provided at the back of this paper
- For questions in Section II, show relevant mathematical reasoning and/or calculations

Total marks: 80

Section I – 10 marks (pages 2–6)
- Attempt Questions 1–10
- Allow about 15 minutes for this section

Section II – 70 marks (pages 9–32)
- Attempt Questions 11–30
- Allow about 1 hour and 45 minutes for this section

Section I

10 marks
Attempt Questions 1–10
Allow about 15 minutes for this section

Use the multiple-choice answer sheet for Questions 1–10.

1 A network diagram is shown.
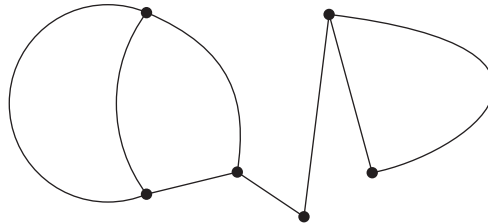
How many vertices are in this network?

A. 5

B. 6

C. 7

D. 8

2 A survey of which of the following would provide data that are both categorical and nominal?

A. Hair colour

B. Height in centimetres

C. Number of people present at a concert

D. Size of coffee cup classified as small, medium or large

3 Consider the network diagram.
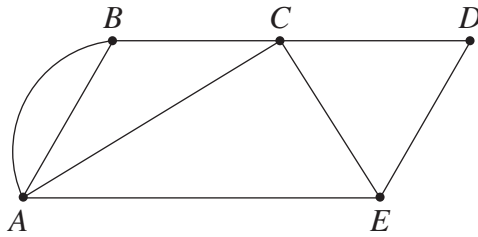
What is the sum of the degrees of all the vertices in this network?

A. 5

B. 8

C. 14

D. 16

4 Three years ago an appliance was valued at $2467. Its value has depreciated by 15% each year, based on the declining-balance method.

What is its salvage value today, to the nearest dollar?

A. $952

B. $1110

C. $1357

D. $1515

5   Which of the following best represents the graph of $y = -3x + 4$?

A.
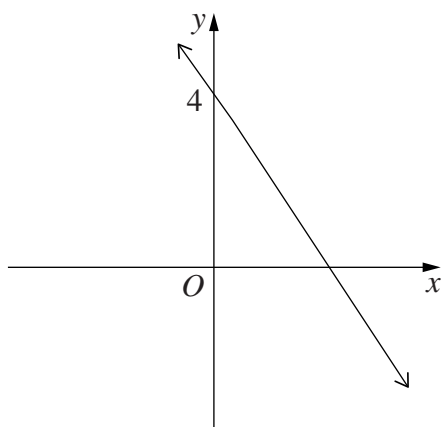
B.
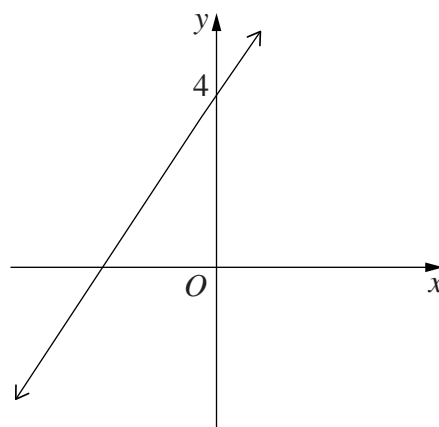
C.
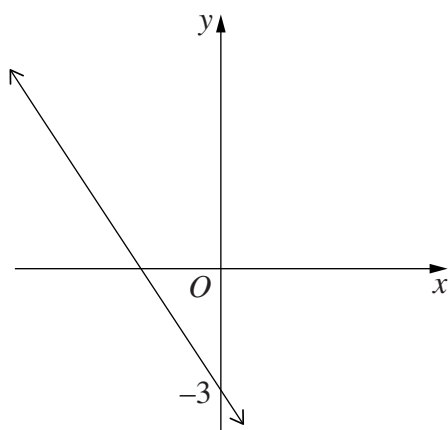
D.
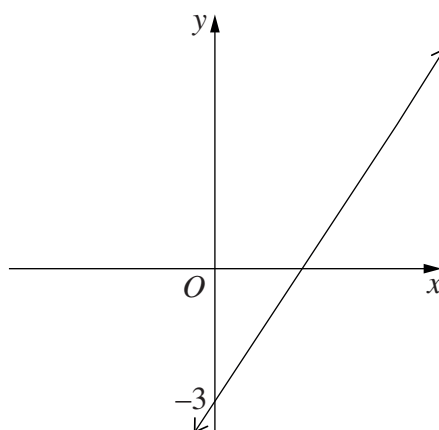
6   Blood pressure is recorded as systolic pressure/diastolic pressure and measured in mmHg.

When standing upright, Mary's blood pressure was 139/85. Three minutes after sitting down, her blood pressure was 118/74.

What was the change in Mary's diastolic blood pressure?

A.   There was an increase of 11 mmHg.

B.   There was an increase of 21 mmHg.

C.   There was a decrease of 11 mmHg.

D.   There was a decrease of 21 mmHg.

7   Suppose $a = \dfrac{b}{7}$, where $b = 22$.

What is the value of a, correct to three significant figures?

A.   3.14

B.   3.15

C.   3.142

D.   3.143

8   A student is thinking of a number. Let the number be x.

When the student subtracts 8 from this number and multiplies the result by 3, the answer is 2 more than x.

Which equation can be used to find x?

A. $3(x - 8) = 2x$

B. $3x - 8 = 2x$

C. $3(x - 8) = x + 2$

D. $3x - 8 = x + 2$

9   James invests \$5000 at 3% per annum simple interest for 2 years, while Sally invests \$5000 at 3% per annum compounded annually for 2 years.

For the given investments, which of the following statements is TRUE?

A.   James earns more interest than Sally.

B.   Sally earns more interest than James.

C.   James and Sally earn the same amount of interest.

D.   There is not enough information to compare the interest earned by James and Sally.

10   The compass bearing of *B* from *A* is N38°E.

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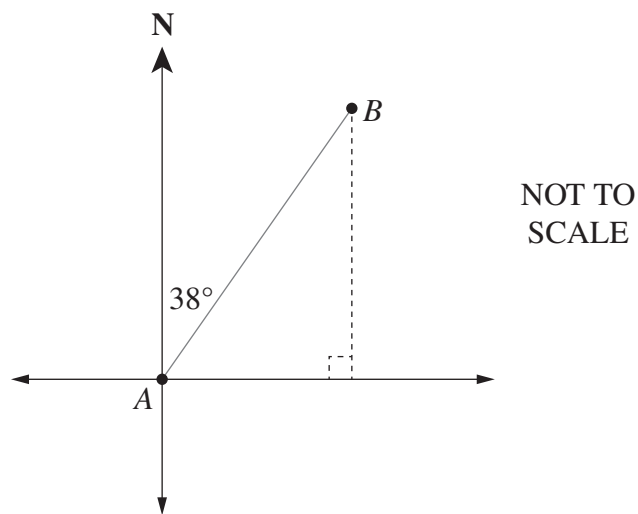
What is the true bearing of *A* from *B*?

A.   128°

B.   218°

C.   232°

D.   322°

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Centre Number

Student Number

Mathematics Standard 1

Section II Answer Booklet

70 marks
Attempt Questions 11–30
Allow about 1 hour and 45 minutes for this section

Instructions
- Write your Centre Number and Student Number at the top of this page.

- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

- Your responses should include relevant mathematical reasoning and/or calculations.

- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.

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Question 11 (2 marks)

Chocolate of a particular brand can be bought in three different sizes.   **2**

Option 1: 100 grams for $1.50
Option 2: 300 grams for $4.20
Option 3: 500 grams for $7.25

Which option gives the lowest price per 100 grams? Justify your answer with calculations.

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Question 12 (3 marks)

A dance school runs a holiday program and charges $150 per student.   **3**

The costs of running the program are:

Dance teacher: $110 per hour

Room hire: $52 per hour plus 10% GST.

The program goes for two hours a day for five days.

What profit does the dance school make if 20 students pay for the program?

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Question 13 (2 marks)

The fuel consumption for a car is 6.7 litres/100 km. On a road trip, the car travels a distance of 1560 km and the fuel cost is $1.45 per litre.

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What is the total fuel cost for this trip?

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Question 14 (2 marks)

It costs $2.45 for a car to travel on a toll road. Due to inflation, the cost is to increase by 3% each year.

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How much will it cost for a car to travel on the toll road in 5 years time?

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Question 15 (3 marks)

City A is in Sweden and is located at (58°N, 16°E). Sydney, in Australia, is located at (33°S, 151°E). **3**

Robert lives in Sydney and needs to give an online presentation to his colleagues in City A starting at 5:00 pm Thursday, local time in Sweden.

What time and day, in Sydney, should Robert start his presentation?

It is given that 15° = 1 hour time difference. Ignore daylight saving.

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Question 16 (2 marks)

Make r the subject of the formula $P = 2r + 10$. **2**

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Question 17 (4 marks)

The network diagram shows the travel times in minutes along roads connecting a number of different towns.
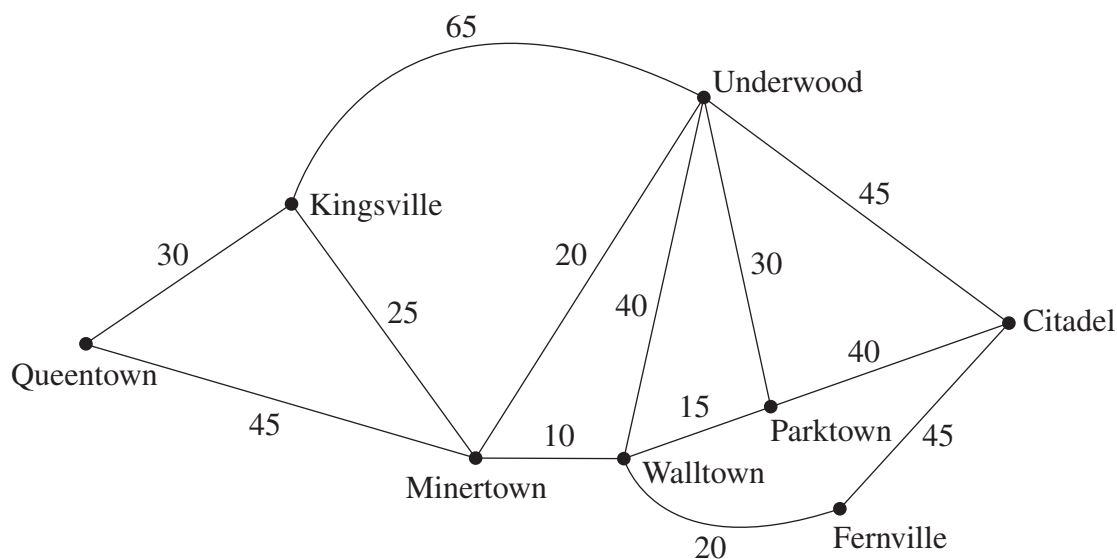
(a) Draw a minimum spanning tree for this network and determine its length.   **3**

Length of minimum spanning tree = ...

(b) How long does it take to travel from Queentown to Underwood using the fastest route?   **1**

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Question 18 (7 marks)

People are placed into groups to complete a puzzle. There are 9 different groups.

The table shows the number of people in each group and the amount of time, in minutes, for each group to complete the puzzle.

Number of people	2	2	3	5	5	7	7	7	8
Time taken (minutes)	28	30	26	19	21	12	13	11	8

(a)   Complete the scatterplot by adding the last four points from the table.   **2**
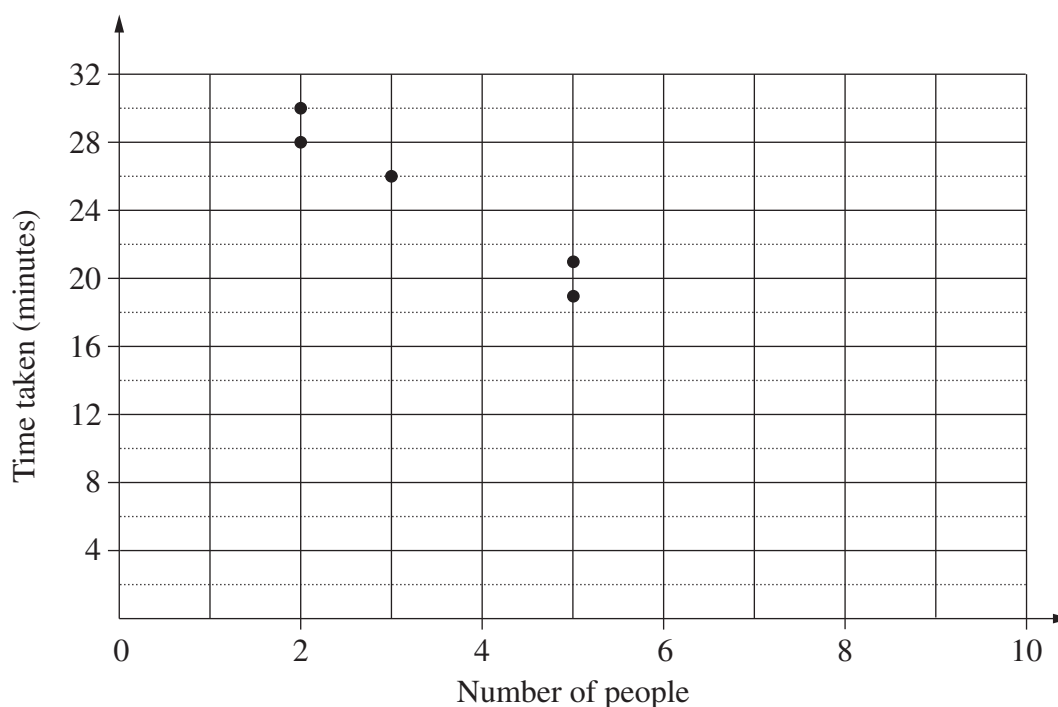
Number of people

(b)   Add a line of best fit by eye to the graph in part (a).   **1**

Question 18 continues on page 17

Question 18 (continued)

(c)   The graph in part (a) shows the association between the time to complete the   **3**
         puzzle and the number of people in the group.

         Identify the form (linear or non-linear), the direction and the strength of the
         association.

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(d)   Calculate the mean of the time taken to complete the puzzle for the three groups   **1**
         of size 7 observed in the dataset.

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End of Question 18

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Question 19 (3 marks)

Yin purchased a car for $20 000. The value of the car decreases according to a linear model. The graph shows the value of the car, $V, against the time, t months, since it was purchased.
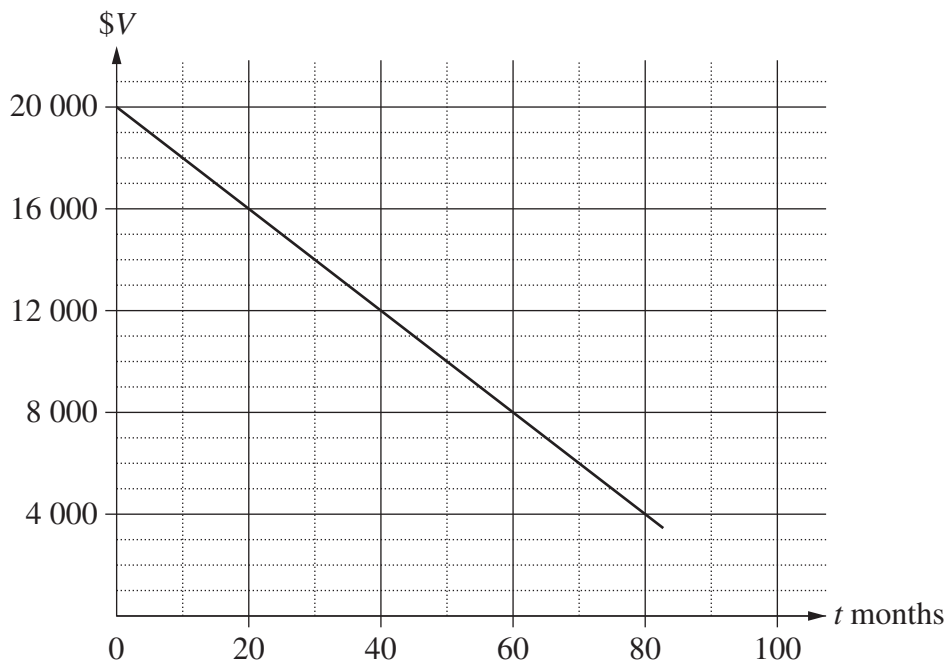
(a) By how much does the value of the car decrease every 10 months? **1**

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(b) Find the value of the car after 5 years. **1**

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(c) Identify ONE problem with using this model to determine the value of Yin's car over time. **1**

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Question 20 (2 marks)

In a bag, there are six playing cards, 2, 4, 6, 8, Queen and King. The Queen and King are known as picture cards.

Two of these cards are chosen randomly. All the possible outcomes are shown.

2 and 4	2 and 6	2 and 8	2 and Queen	2 and King
4 and 6	4 and 8	4 and Queen	4 and King	6 and 8
6 and Queen	6 and King	8 and Queen	8 and King	Queen and King

(a) What is the probability that the two cards chosen include one or both picture cards?　　**1**

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(b) What is the probability that the two cards chosen do NOT include any picture cards?　　**1**

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A rectangular sportsground has been drawn to scale on a 1-cm grid as shown. The scale used is 1 : 3000.

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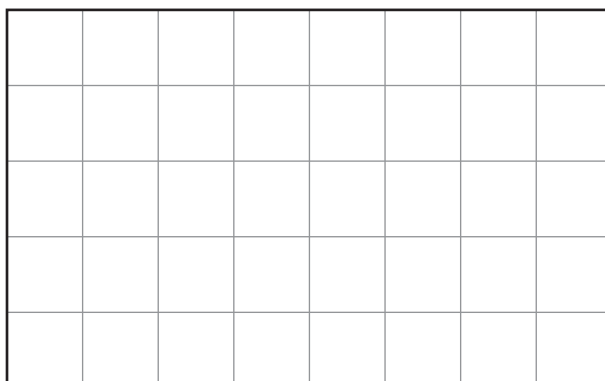
Kerry took 12 minutes to walk around the perimeter of this sportsground.

What was Kerry's average speed in kilometres per hour?

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Question 22 (4 marks)

A tap is leaking water. It leaks 1 drop every 4 seconds, and 15 of these drops make up 1 mL.

(a) Find the amount of water leaked in a 24-hour period. Give the answer in litres.   **3**

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(b) A bucket can hold 9 litres of water.   **1**

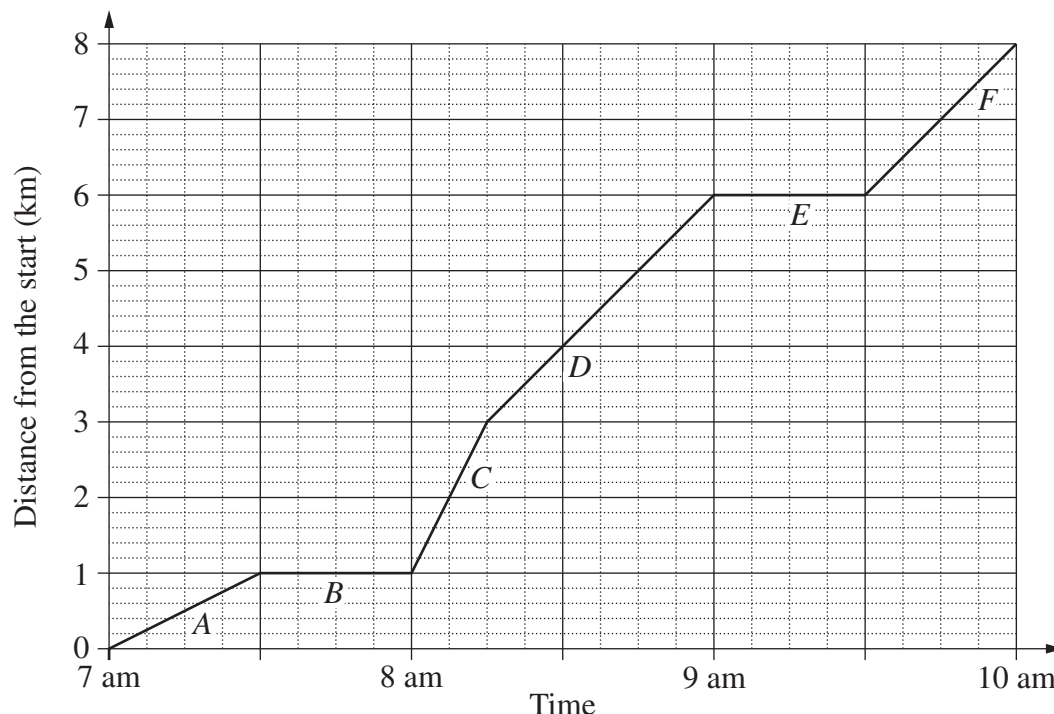How long will it take for the leaking tap to completely fill this empty bucket?

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Questions 11–22 are worth 38 marks in total

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Question 23 (6 marks)

Sue walks along a trail, starting at 7 am and finishing at 10 am. The travel graph shows Sue's journey from the start to the finish. The journey has been broken into six sections, *A*, *B*, *C*, *D*, *E* and *F*.

(a) On two occasions Sue stopped to rest. In which sections of the journey did Sue rest? **1**

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(b) In which section of the journey did Sue travel fastest? Justify your answer. **2**

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(c) Kim walked along the same trail, also starting at 7 am and finishing at 10 am. Kim walked at a constant speed for the entire journey. **3**

By showing Kim's journey on the grid above, determine between what times Sue was ahead of Kim.

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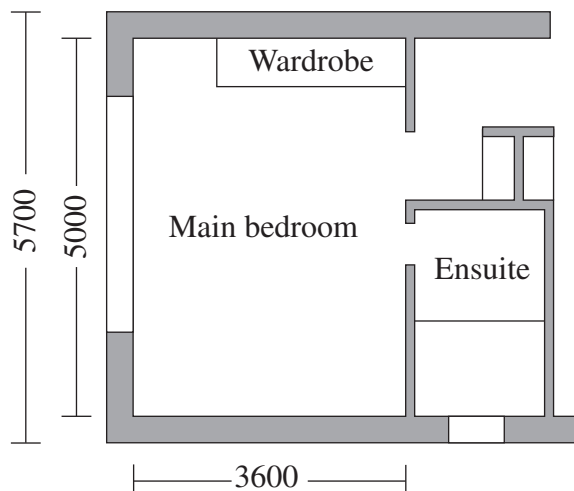
Question 24 (4 marks)

A building plan of part of a house is shown.

All measurements are in millimetres.

(a) What is the internal length and the internal width of the main bedroom? Give your answer in metres. **1**

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(b) Rod wants to lay carpet in the main bedroom. The main bedroom has a wardrobe with a base area of 1.6 m^2. The area under the wardrobe does NOT need to be carpeted. **3**

Carpet costs \$40 per square metre. Rod buys the smallest whole number of square metres of carpet necessary. Find the cost of the carpet purchased for the bedroom.
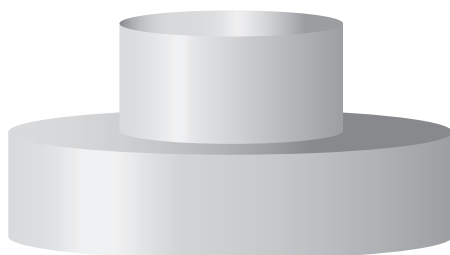
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Question 25 (2 marks)

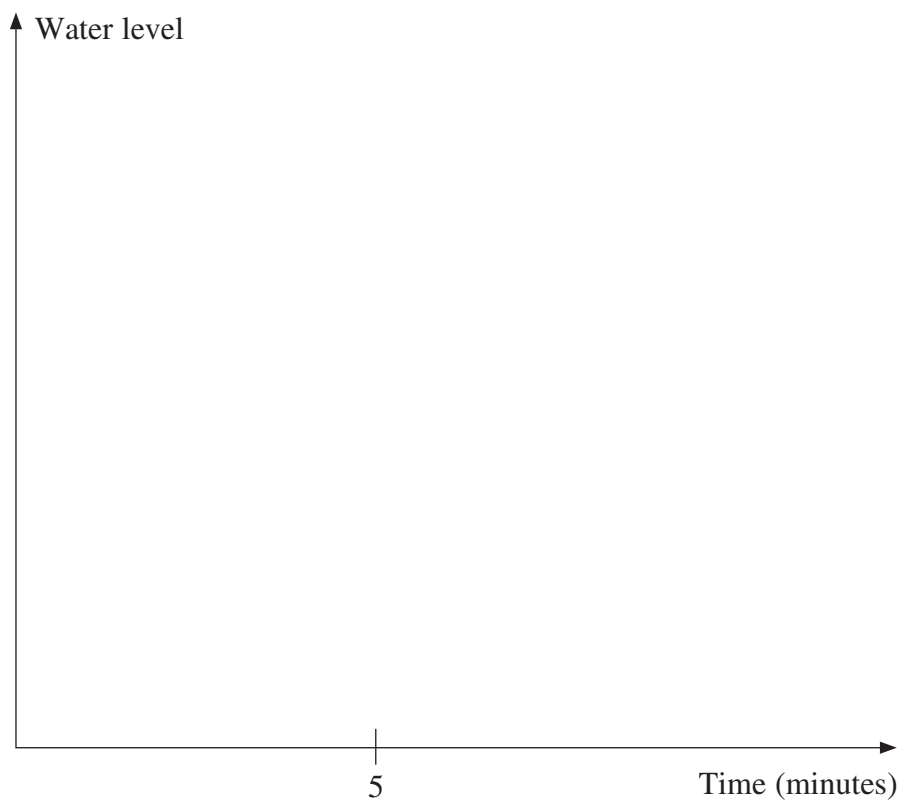The diagram shows a container which consists of a small cylinder on top of a larger cylinder.

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The container is filled with water at a constant rate to the top of the smaller cylinder. It takes 5 minutes to fill the larger cylinder.

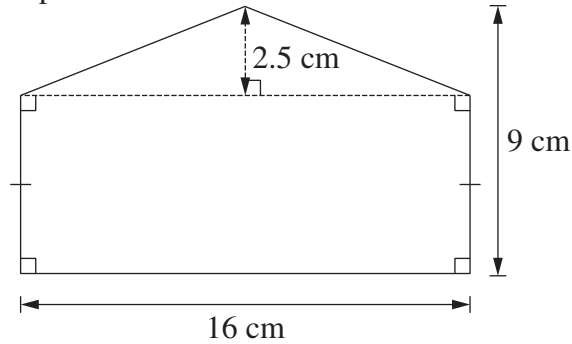Draw a possible graph of the water level in the container against time.

Water level

5

Time (minutes)

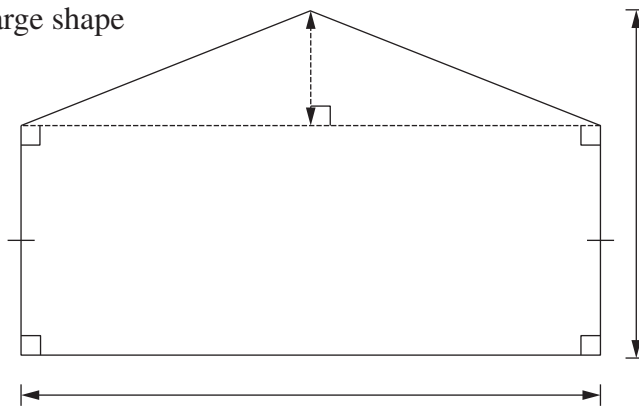3638310374

Question 26 (3 marks)

The diagrams show two similar shapes. The dimensions of the small shape are enlarged by a scale factor of 1.5 to produce the large shape.

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Small shape

2.5 cm

9 cm

16 cm

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Large shape

Calculate the area of the large shape.

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Question 27 (4 marks)

Tracy takes out a 30-year reducing balance loan of $680 000 to buy a house. Interest is charged at 0.25% per month. The loan is to be repaid in equal monthly instalments of $2866.91 over a term of 30 years.

Part of a spreadsheet used to model the reducing balance loan is shown.

Month	Amount owing at the start of the month	Interest charged for that month	Repayment	Amount owing at the end of the month
1	680 000.00	1700.00	2866.91	678 833.09
2	678 833.09			

(a) Find the amount owing at the end of the second month. **2**

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(b) Suppose that the interest rate reduces to 0.15% per month and the monthly instalments remain as $2866.91. **2**

What will happen to the term of the loan? Explain your answer without using calculations.

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Question 28 (5 marks)

A right-angled triangle *XYZ* is shown. The length of *XZ* is 16 cm and ∠*YXZ* = 30°.

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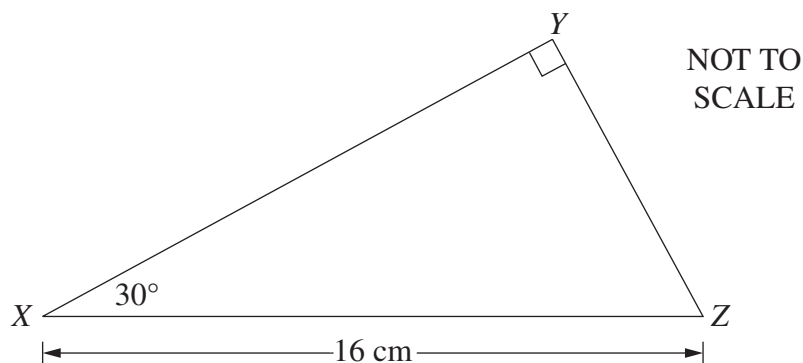
(a) Find the side length, *XY*, of the triangle in centimetres, correct to two decimal places.   **2**

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(b) Hence, find the area of triangle *XYZ* in square centimetres, correct to one decimal place.   **3**

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Question 29 (4 marks)

In a park the only animals are goannas and emus. Let x be the number of goannas and let y be the number of emus. **4**

The number of goannas plus the number of emus in the park is 31. Hence $x + y = 31$.

Each goanna has four legs and each emu has two legs. In total the emus and goannas have 76 legs.

By writing another relevant equation and graphing both equations on the grid on the following page, find the number of goannas and the number of emus in the park.

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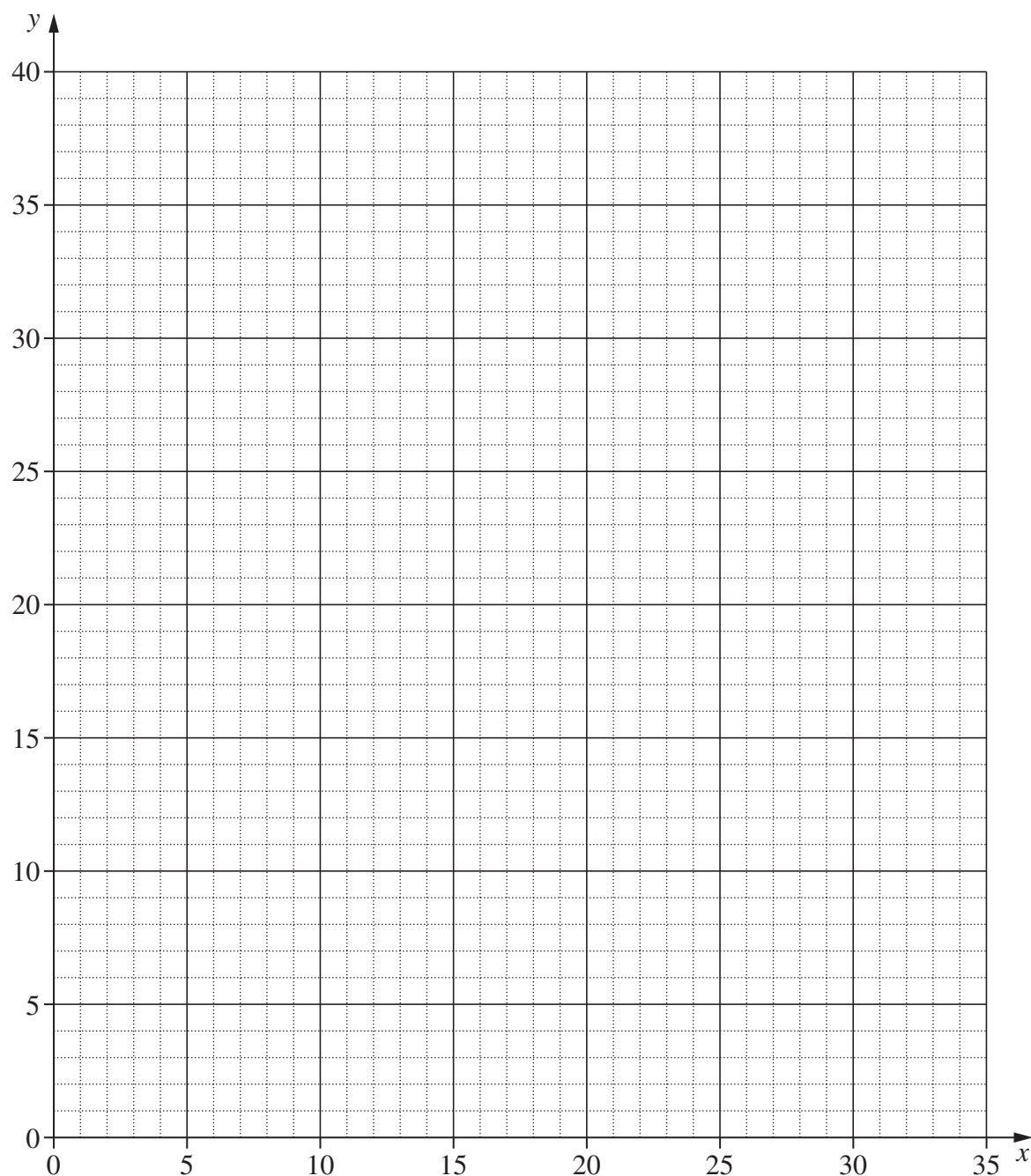
Number of goannas = ...

Number of emus = ...

End of Question 29

Please turn over

Question 30 (4 marks)

Blake opens a new credit card account on 1 May. He uses it, for the first time, on 4 May to buy concert tickets for $850.

He makes no further purchases or repayments during the month of May.

A statement for the credit card is issued on the last day of each month.

The statement for May shows that interest is charged at 19.75% per annum, compounding daily, from 20 May (included) until 31 May (included).

(a) What is the compound interest shown on the statement issued on 31 May? **3**

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(b) The minimum payment is calculated as 3% of the closing balance on 31 May. **1**

Calculate the minimum payment.

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Section II extra writing space

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Section II extra writing space

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Mathematics Standard 1
Mathematics Standard 2

REFERENCE SHEET

Measurement

Limits of accuracy

Absolute error $= \dfrac{1}{2} \times$ precision

Upper bound = measurement + absolute error

Lower bound = measurement − absolute error

Length

$l = \dfrac{\theta}{360} \times 2\pi r$

Area

$A = \dfrac{\theta}{360} \times \pi r^2$

$A = \dfrac{h}{2}(a + b)$

$A \approx \dfrac{h}{2}(d_f + d_l)$

Surface area

$A = 2\pi r^2 + 2\pi rh$

$A = 4\pi r^2$

Volume

$V = \dfrac{1}{3}Ah$

$V = \dfrac{4}{3}\pi r^3$

Trigonometry

$\sin A = \dfrac{\text{opp}}{\text{hyp}}, \quad \cos A = \dfrac{\text{adj}}{\text{hyp}}, \quad \tan A = \dfrac{\text{opp}}{\text{adj}}$

$A = \dfrac{1}{2}ab \sin C$

$\dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C}$

$c^2 = a^2 + b^2 - 2ab \cos C$

$\cos C = \dfrac{a^2 + b^2 - c^2}{2ab}$

Financial Mathematics

$FV = PV\left(1 + r\right)^n$

Straight-line method of depreciation

$S = V_0 - Dn$

Declining-balance method of depreciation

$S = V_0\left(1 - r\right)^n$

Statistical Analysis

An outlier is a score
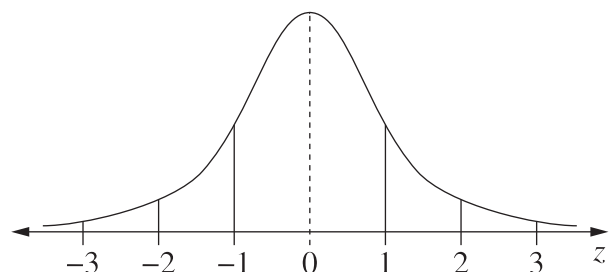
   less than $Q_1 - 1.5 \times IQR$
   or
   more than $Q_3 + 1.5 \times IQR$

$z = \dfrac{x - \mu}{\sigma}$

Normal distribution

- approximately 68% of scores have z-scores between –1 and 1
- approximately 95% of scores have z-scores between –2 and 2
- approximately 99.7% of scores have z-scores between –3 and 3

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