



NSW Education Standards Authority

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Centre Number

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Student Number

2024 HIGHER SCHOOL CERTIFICATE EXAMINATION

Mathematics Standard 2

General Instructions

- Reading time – 10 minutes
- Working time – 2 hours and 30 minutes
- 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
- Write your Centre Number and Student Number at the top of this page

Total marks: 100

Section I – 15 marks (pages 2–8)

- Attempt Questions 1–15
- Allow about 25 minutes for this section

Section II – 85 marks (pages 9–39)

- Attempt Questions 16–41
- Allow about 2 hours and 5 minutes for this section

Section I

15 marks

Attempt Questions 1–15

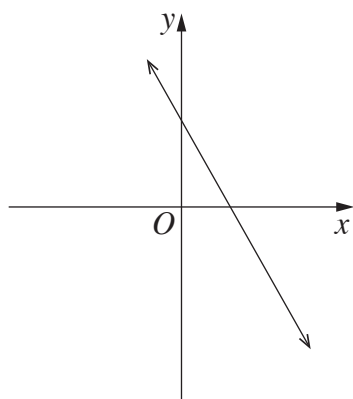
Allow about 25 minutes for this section

Use the multiple-choice answer sheet for Questions 1–15.

1 If $x = -2.531$, what is the value of x^2 rounded to 2 decimal places?

- A. -6.41
- B. -6.40
- C. 6.40
- D. 6.41

2 Consider the function shown.



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SCALE

Which of the following could be the equation of this function?

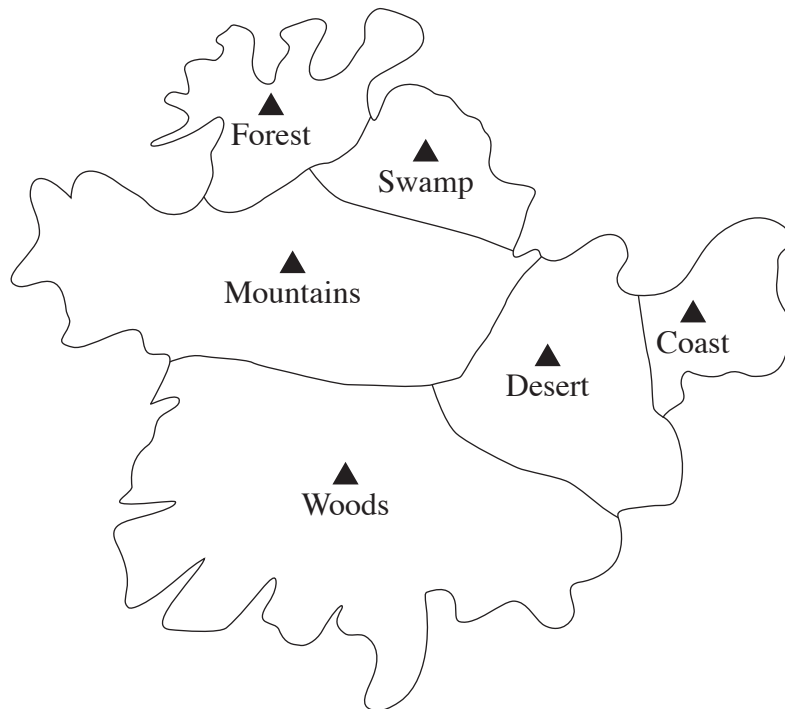
- A. $y = 2x + 3$
- B. $y = 2x - 3$
- C. $y = -2x + 3$
- D. $y = -2x - 3$

- 3 Shoppers are invited to complete an online survey.

What type of sampling is this?

- A. Self-selecting
- B. Simple random
- C. Stratified
- D. Systematic

- 4 The map shows regions within a country.



A network diagram is to be drawn to represent this map. Vertices will be used to indicate each region and edges will be used to represent a border shared between two regions.

How many edges will there be in the network diagram?

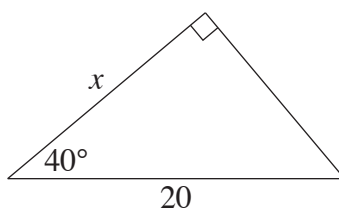
- A. 8
- B. 7
- C. 6
- D. 5

- 5 Pia's marks in Year 10 assessments are shown. The scores for each subject were normally distributed.

	<i>Pia's mark</i>	<i>Year 10 mean</i>	<i>Year 10 standard deviation</i>
English	78	66	6
Mathematics	80	71	10
Science	77	70	15
History	85	72	9

In which subject did Pia perform best in comparison with the rest of Year 10?

- A. English
 - B. Mathematics
 - C. Science
 - D. History
- 6 Consider the diagram shown.



Which of the following is the correct expression for the length of x ?

- A. $20 \cos 40^\circ$
- B. $20 \sin 40^\circ$
- C. $\frac{20}{\cos 40^\circ}$
- D. $\frac{20}{\sin 40^\circ}$

- 7** Three years ago, the price of a uniform was \$180.

Due to inflation, the price increased annually by 2.5%.

What is the price of this uniform now?

- A. \$180.14
- B. \$181.35
- C. \$193.50
- D. \$193.84

- 8** A bill for servicing a car is made up of:

- \$242 for parts, which includes 10% GST
- \$100 for labour, excluding GST.

The mechanic needs to add 10% GST onto the labour charge.

How much GST does the customer pay in total?

- A. \$22.00
- B. \$24.20
- C. \$32.00
- D. \$34.20

- 9** The time taken to paint a school varies inversely with the number of painters completing the task.

It takes 6 painters a total of 20 days to paint a school.

How many days would it take 15 painters to paint the same school?

- A. 4.5
- B. 8
- C. 15.5
- D. 50

- 10** Consider the formula $s = wt + \frac{p}{2}$.

Which of the following correctly shows p as the subject of the formula?

- A. $p = 2wt - s$
- B. $p = 2wt - 2s$
- C. $p = 2s - wt$
- D. $p = 2s - 2wt$

- 11** A train left Richmond at 6:42 am and arrived at Central Station at 8:04 am. The distance travelled by the train from Richmond to Central was 61 km.

What was the average speed of this train, correct to the nearest km/h?

- A. 38
- B. 45
- C. 50
- D. 74

- 12** A survey of 370 people was conducted to investigate the association between watching *Anime* and the age of the person.

The two-way table shows the responses collected.

Age \ Watching	Watches <i>Anime</i>	Does not watch <i>Anime</i>	TOTAL
30 years old and under	152	61	213
Over 30 years old	34	123	157
TOTAL	186	184	370

Approximately what percentage of the over 30-year-olds watch *Anime*?

- A. 9%
 - B. 18%
 - C. 22%
 - D. 42%
- 13** José takes out a loan of \$9000. Simple interest is charged on the loan.

The loan and the interest charged will be repaid by making monthly repayments of \$300 over 4 years.

What simple interest rate per annum, to the nearest percent, is charged on the loan?

- A. 15%
- B. 38%
- C. 40%
- D. 60%

- 14 Year 11 is making pizzas to raise money for a charity.

The cost (C) and revenue (R) in dollars, when x pizzas are sold are represented by the equations

$$C = 2.5x + 6$$

$$R = 8x.$$

Enough pizzas are sold so that a profit is made.

By how much does the profit increase for each additional pizza sold?

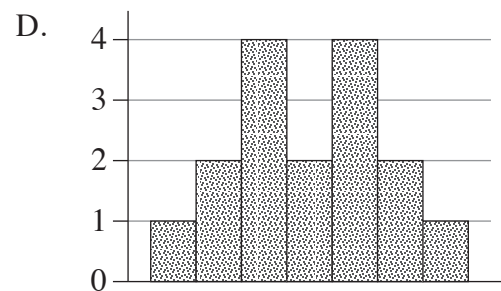
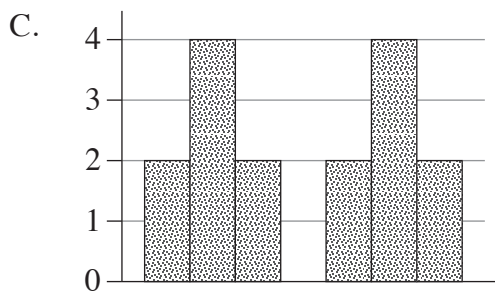
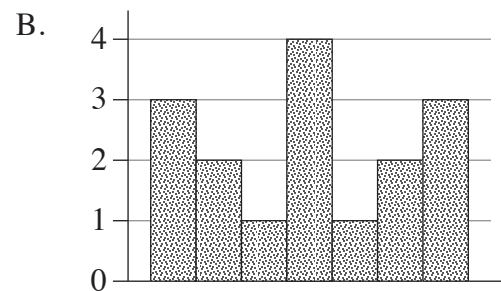
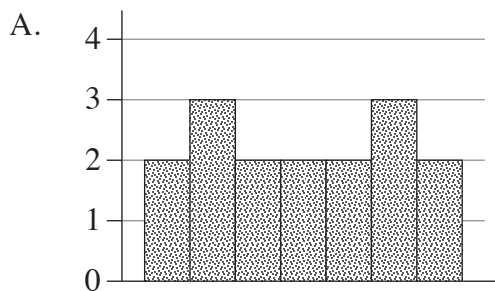
- A. \$2.50
- B. \$5.50
- C. \$6.00
- D. \$8.00

- 15 Some data are used to create a box plot shown.



A histogram is created from the same set of data.

Which of these histograms is NOT possible for the given box plot?



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Centre Number

Mathematics Standard 2

Section II Answer Booklet

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Student Number

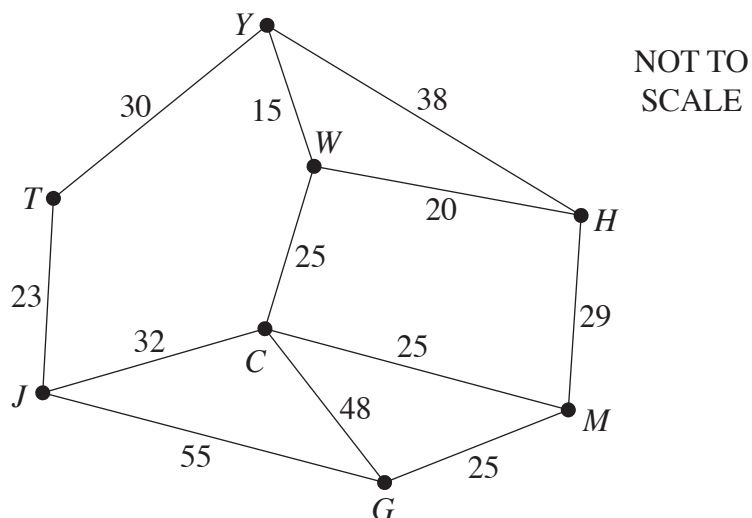
85 marks**Attempt Questions 16–41****Allow about 2 hours and 5 minutes for this section****Instructions**

- 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 16 (4 marks)

A network of towns and the distances between them in kilometres is shown.



- (a) What is the shortest path from T to H ?

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- (b) A truck driver needs to travel from Y to G but knows that the road from C to G is closed.

2

What is the length of the shortest path the truck driver can take from Y to G after the road closure?

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Question 17 (2 marks)

The cost of electricity is 30.13 cents per kWh.

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Calculate the cost of using a 650 W air conditioner for 6 hours.

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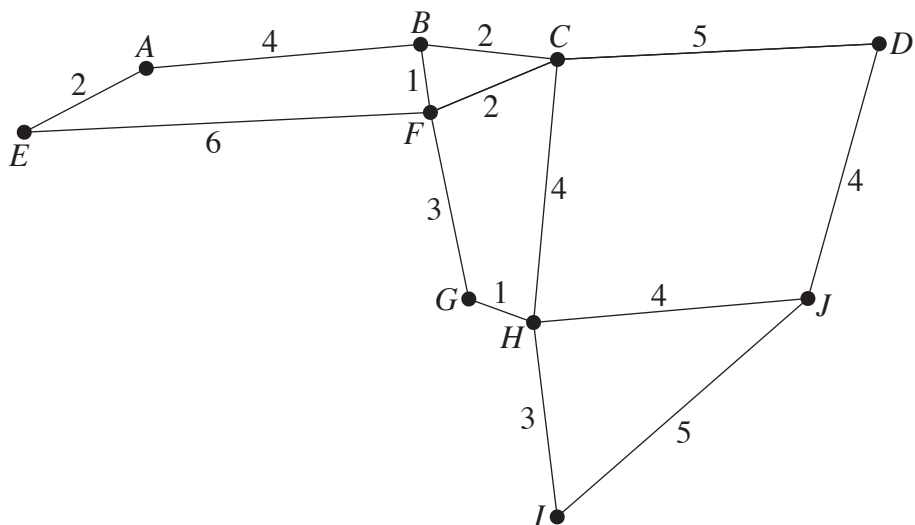
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Question 18 (3 marks)

The diagram shows a network with weighted edges.



- (a) Draw a minimum spanning tree for this network and determine its weight.

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Weight =

- (b) Is it possible to find another spanning tree with the same weight? Give a reason for your answer.

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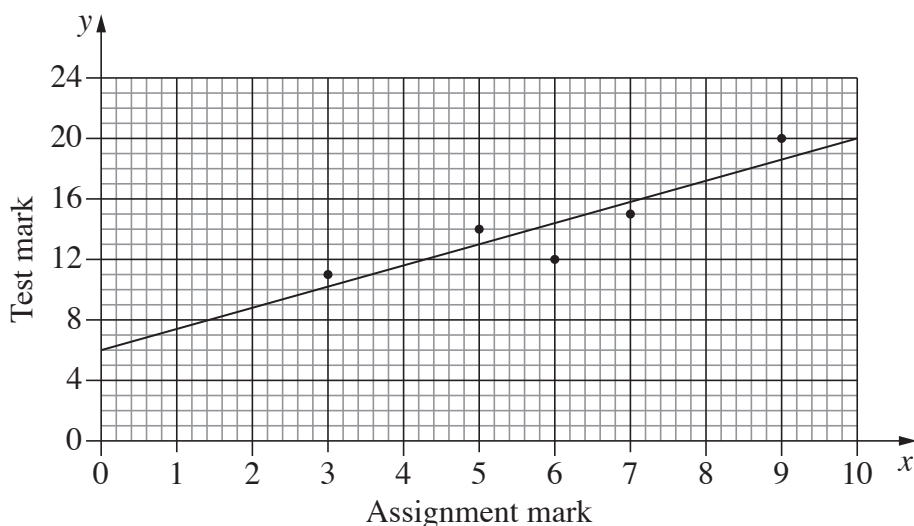
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Question 19 (3 marks)

A teacher was exploring the relationship between students' marks for an assignment and their marks for a test. The data for five different students are shown on the graph.

The least-squares regression line is also shown.



- (a) What is the equation of the least-squares regression line for this dataset?

2

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- (b) Another student, whose marks are not on the graph, scored 5 for the assignment and 12 on the test.

1

Did this student do better or worse on the test than the regression line predicts?
Provide a reason for your answer.

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Question 20 (3 marks)

The table shows the future value for an annuity of \$1 for varying interest rates and time periods.

<i>Period \ Rate</i>	<i>1%</i>	<i>2%</i>	<i>3%</i>	<i>4%</i>	<i>5%</i>
1	1.0100	1.0200	1.0300	1.0400	1.0500
2	2.0301	2.0604	2.0909	2.1216	2.1525
3	3.0604	3.1216	3.1836	3.2465	3.3101
4	4.1010	4.2040	4.3091	4.4163	4.5256
5	5.1520	5.3081	5.4684	5.6330	5.8019
6	6.2135	6.4343	6.6625	6.8983	7.1420
7	7.2857	7.5830	7.8923	8.2142	8.5491
8	8.3685	8.7546	9.1591	9.5828	10.0266

- (a) Ken invests \$200 at the start of each year for eight years, at an interest rate of 5% per annum. 1

Calculate the future value of Ken's investment.

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- (b) Shay is planning to take a holiday in three years. She needs \$4500 for this holiday and will make regular six-monthly payments into an account that earns interest at the rate of 4% per annum, compounded 6 monthly. 2

What is the minimum amount Shay needs to pay into this account every 6 months? Give your answer to the nearest \$10. Support your answer with calculations.

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Question 21 (3 marks)

William has a reducing balance loan on which he owes \$5590. He makes monthly repayments of \$110.

The loan company charges interest at 24% per annum, compounded monthly.

The spreadsheet shows some of the information for the next two months of the loan.

- (a) Complete the entries in the spreadsheet to show the balance owing on the loan at the end of two months. 2

	A	B	C	D	E
1	Month	Principal	Interest charged	Amount repaid	Balance owing
2	1	\$5590.00	\$111.80	\$110.00	
3	2			\$110.00	

- (b) Explain why the loan will never be repaid if William continues to make repayments of \$110 per month. 1

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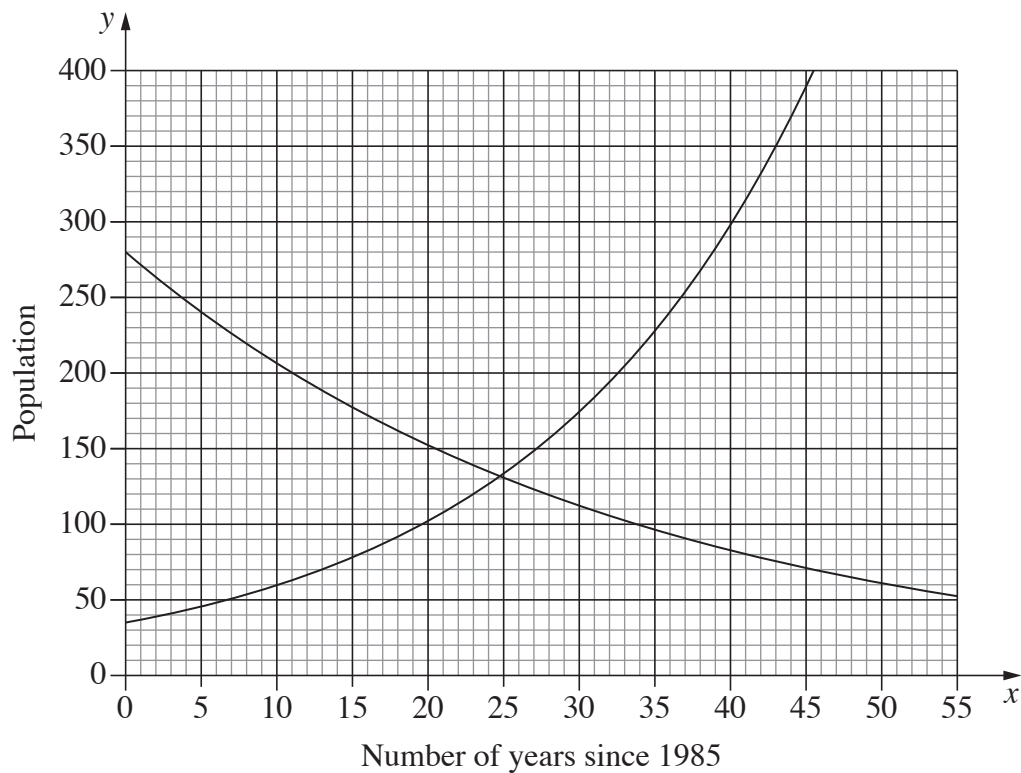
Question 22 (3 marks)

The graph shows the populations of two different animals, W and K , in a conservation park over time. The y -axis is the size of the population and the x -axis is the number of years since 1985.

3

Population W is modelled by the equation $y = A \times (1.055)^x$.

Population K is modelled by the equation $y = B \times (0.97)^x$.



Complete the table using the information provided.

	Population W	Population K
Population in 1985	$A = 34$	$B =$
Percentage yearly change in the population		
Predicted population when $x = 50$		61

Question 23 (3 marks)

Zazu works a 38-hour week and is paid at an hourly rate of \$45. Any overtime hours worked are paid at time-and-a-half.

3

In a particular week, Zazu worked the regular 38 hours and some overtime hours. In that week Zazu earned \$2790.

How many hours of overtime did Zazu work in that week?

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Question 24 (4 marks)

Sarah, a 60 kg female, consumes 3 glasses of wine at a family dinner over 2.5 hours.

Note: there are 1.2 standard drinks in one glass of wine.

The blood alcohol content (BAC) for females can be estimated by

$$BAC_{\text{female}} = \frac{10N - 7.5H}{5.5M},$$

where N = number of standard drinks

H = number of hours drinking

M = mass in kilograms.

- (a) Calculate Sarah's BAC at the end of the dinner, correct to 3 decimal places. 2

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- (b) The time it takes a person's BAC to reach zero is given by 2

$$\text{Time} = \frac{BAC}{0.015}.$$

Calculate the time it takes for Sarah's BAC to return to zero, assuming she stopped drinking after 2.5 hours. Give your answer to the nearest minute.

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Question 25 (3 marks)

Alex and Jun each invest \$1800 for 5 years.

3

- Alex's investment earns simple interest at a rate of 7.5% per annum.
- Jun's investment earns interest at a rate of 6.0% per annum, compounding quarterly.

By calculating the interest earned over the 5 years, determine who will have the greater amount.

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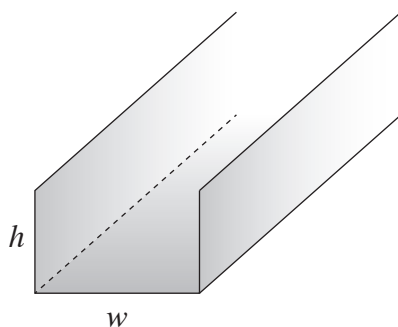
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Question 26 (3 marks)

A sheet of metal is folded to make a gutter, as shown. The cross-section of the gutter is a rectangle of width w cm and height h cm.

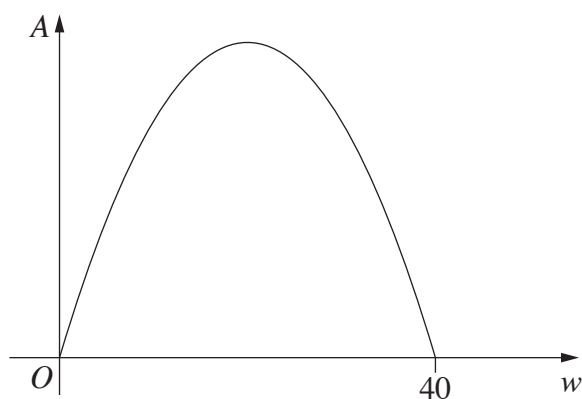
3



The area, $A \text{ cm}^2$, of the cross-section can be modelled by the quadratic formula

$$A = -0.5w^2 + 20w.$$

A graph of this model is shown.



Find the width and height of the rectangle which will give the greatest possible area of the cross-section.

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Question 27 (3 marks)

A couple borrows \$30 000 to be repaid in equal monthly repayments of \$280 over 10 years.

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After following this repayment plan for 5 years, they decide to decrease their monthly repayment to \$250. As a result, it will take them an additional two years to pay off their loan.

How much more will they repay in total by making this change?

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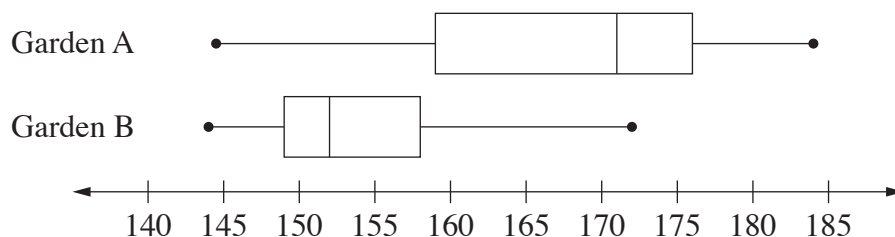
Question 28 (3 marks)

Flowers were planted in two gardens (Garden A and Garden B).

3

On a particular day, 25 flowers were randomly selected from each garden and their heights measured in millimetres.

The data are represented in parallel box-plots.



Compare the two datasets by examining the skewness of the distributions, and the measures of central tendency and spread.

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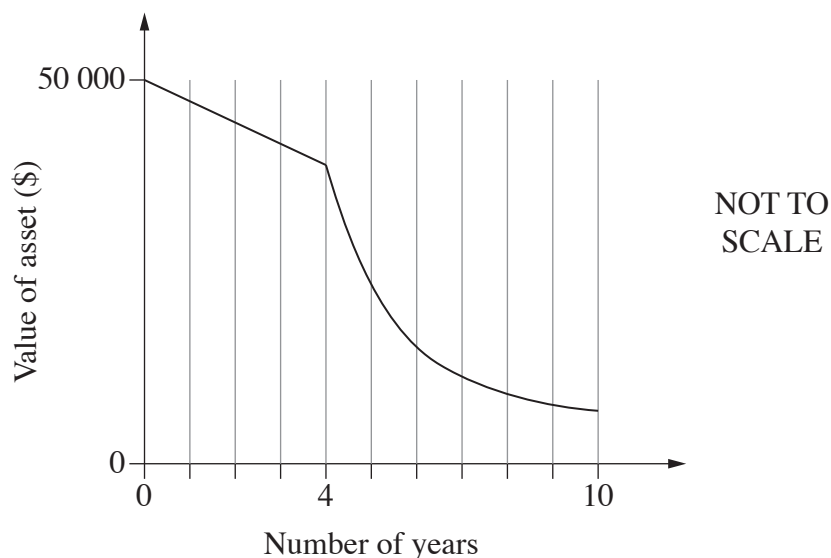
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Question 29 (4 marks)

The graph shows the decreasing value of an asset.

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For the first 4 years, the value of the asset depreciated by \$1500 per year, using a straight-line method of depreciation.

After the end of the 4th year, the method of depreciation changed to the declining-balance method at the rate of 35% per annum.

What is the total depreciation at the end of 10 years?

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Questions 16–29 are worth 44 marks in total

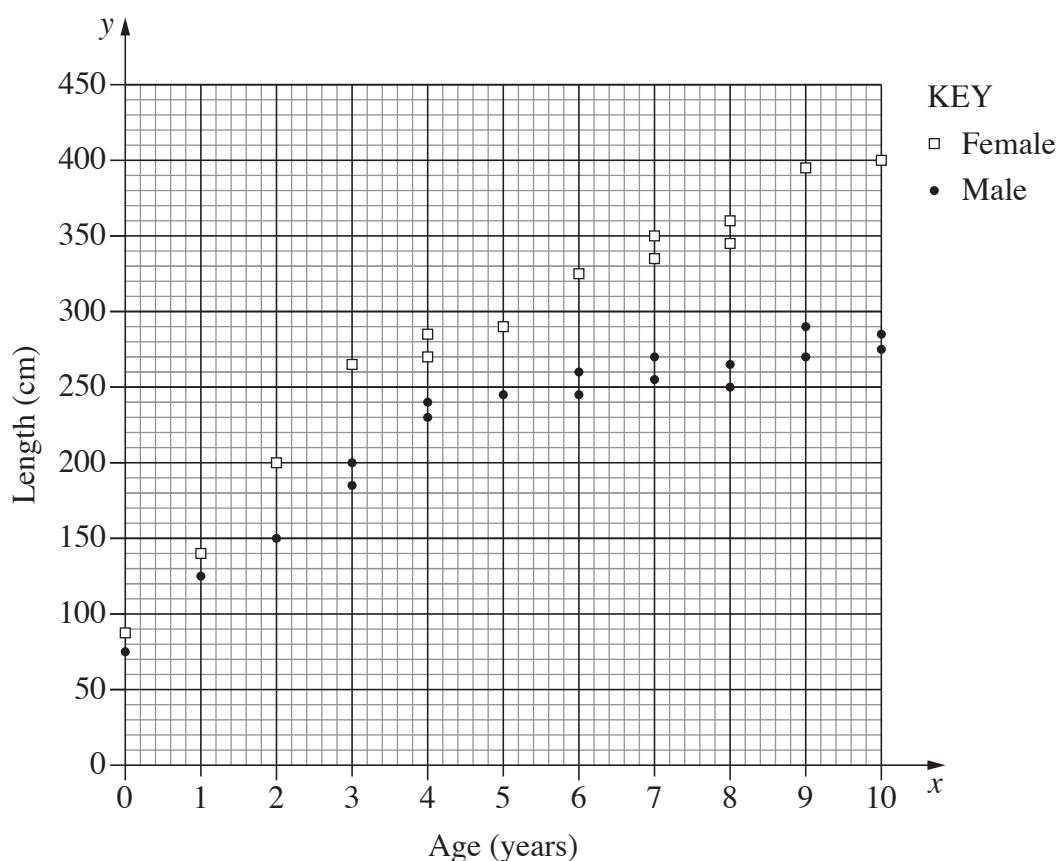
Question 30 (3 marks)

A researcher is studying anacondas (a type of snake).

3

A dataset recording the age (in years) and length (in cm) of female and male anacondas is displayed on the graph.

Anacondas reach maturity at about 4 years of age.



Write THREE observations about anacondas that may be made from the scatterplot. (Note: No calculations are required.)

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Question 31 (3 marks)

A coin is biased so that it is twice as likely to show a head than a tail.

- (a) What is the probability of obtaining a head with one throw of this coin? **1**

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- (b) In two throws of this coin, what is the probability of obtaining at least one head? **2**

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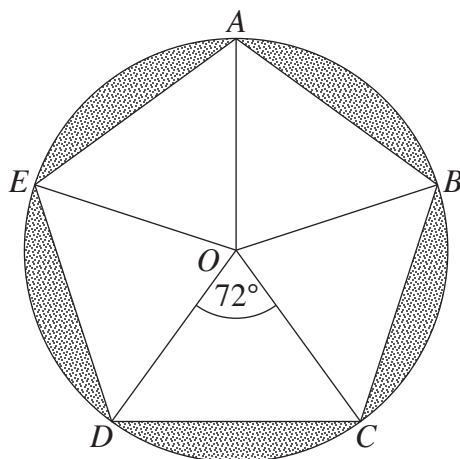
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Question 32 (4 marks)

A regular pentagon $ABCDE$ is drawn inside a circle with a radius of 30 cm.

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O is the centre of the circle.



What is the area of the shaded region of the circle? Answer correct to 2 significant figures.

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Question 33 (3 marks)

Wombats can run at a speed of 40 km/h over short distances.

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At this speed, how many seconds would it take a wombat to run 150 metres?

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Question 34 (4 marks)

A container for soccer balls is made using two half spheres joined to each end of a cylindrical body.

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Three soccer balls fit exactly inside the container. Each ball has a diameter of 23 cm.

The hemispherical ends of the container just touch the surface of the soccer balls.

What is the total surface area of the container? Give your answer in square metres correct to 1 decimal place.

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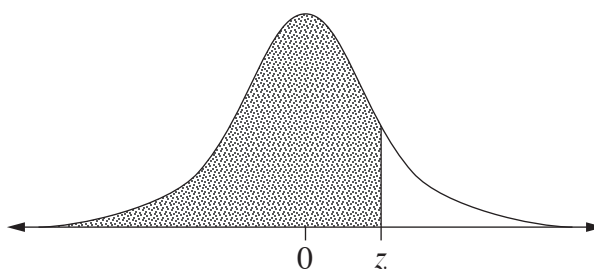
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Question 35 (5 marks)

A random variable is normally distributed with mean 0 and standard deviation 1. The table gives the probability that this random variable is less than z .

z	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4
<i>Probability</i>	0.7257	0.7580	0.7881	0.8159	0.8413	0.8643	0.8849	0.9032	0.9192

The probability values given in the table for different values of z are represented by the shaded area in the following diagram.



The scores in a university examination with a large number of candidates are normally distributed with mean 58 and standard deviation 15.

- (a) By calculating a z -score, find the percentage of scores that are between 58 and 70. 2

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- (b) Explain why the percentage of scores between 46 and 70 is twice your answer to part (a). 1

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- (c) By using the values in the table above, find an approximate minimum score that a candidate would need to be placed in the top 10% of the candidates. 2

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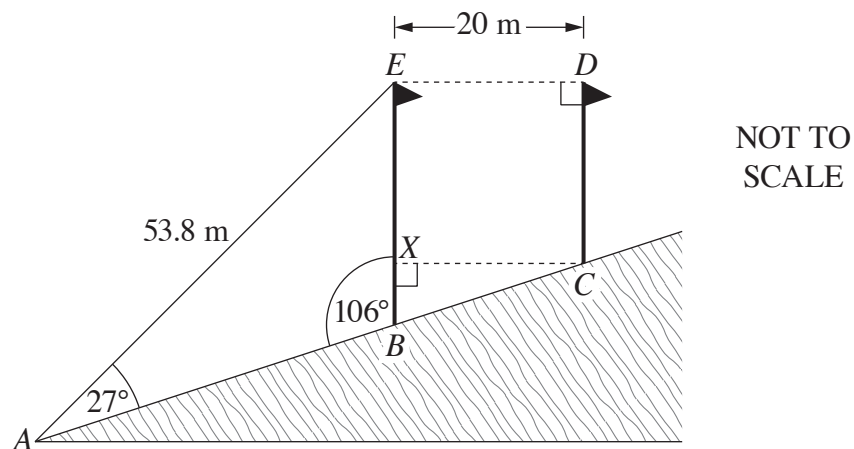
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Question 36 (4 marks)

The diagram shows two vertical flagpoles, BE and CD , set on sloping ground.



- (a) What is the height of the flagpole BE , correct to 1 decimal place?

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- (b) What is the height of the flagpole CD , correct to 1 decimal place?

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Question 37 (2 marks)

Sakura will travel from Sydney (UTC +10) to Rio de Janeiro (UTC –3).

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The flight from Sydney to Rio de Janeiro will take 20 hours.

The flight will arrive in Rio de Janeiro at 3 pm on Wednesday 20 July.

On what day and at what time will Sakura leave Sydney?

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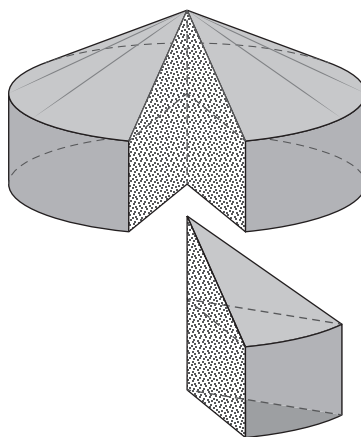
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Question 38 (3 marks)

A cake is constructed using a cylinder and a cone-shaped top. The cylinder has diameter 30 cm and height 6 cm.

3



The ratio of the volume of the cylinder to the volume of the cone-shaped top is 5 : 1.

The cake is to be cut into equal slices with volume 212 cm^3 .

How many equal slices can be cut from the cake?

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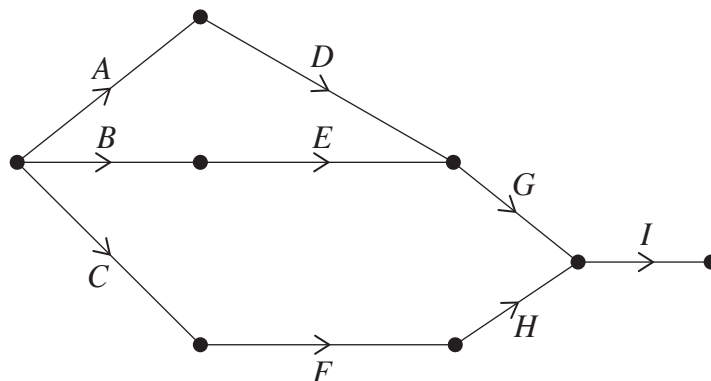
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Question 39 (3 marks)

A project involving nine activities is shown in the network diagram.

The duration of each activity is not yet known.



The following table gives the earliest start time (EST) and latest start time (LST) for three of the activities. All times are in hours.

Activity	EST	LST
A	0	2
C	0	1
I	12	12

- (a) What is the critical path?

1

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- (b) The minimum time required for this project to be completed is 19 hours.

1

What is the duration of activity *I*?

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- (c) The duration of activity *C* is 3 hours.

1

What is the maximum amount of time that could occur between the start of activity *F* and the end of activity *H*?

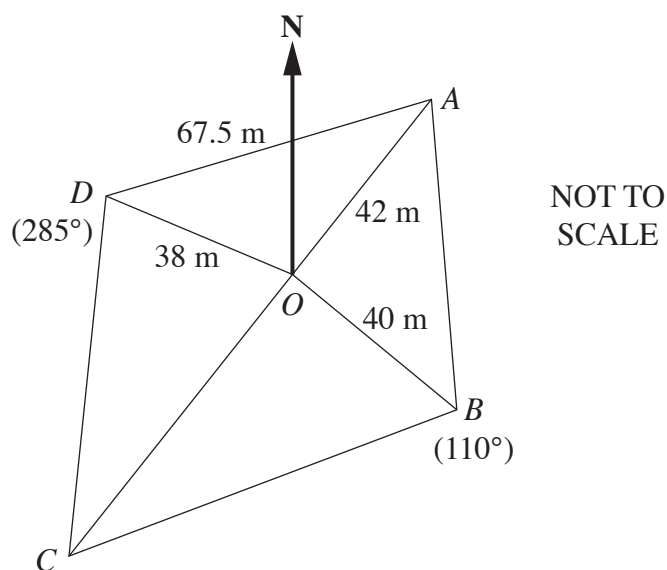
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Question 40 (3 marks)

A compass radial survey is shown.

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Given that AC is a straight line, find the bearing of C from O , correct to the nearest degree.

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Question 41 (4 marks)

Twenty-five years ago, Phoenix deposited a single sum of money into a new bank account, earning 2.4% interest per annum compounding monthly.

4

Present value interest factors for an annuity of \$1 for various interest rates (r) and numbers of periods (n) are given in the table.

<i>Rate (r)</i> <i>Period (n)</i>	<i>0.001</i>	<i>0.002</i>	<i>0.003</i>	<i>0.004</i>
60	58.207	56.487	54.835	53.249
120	113.026	106.592	100.649	95.156
180	164.655	151.036	138.927	128.137
240	213.278	190.460	170.908	154.093
300	259.071	225.430	197.627	174.521

Phoenix made the following withdrawals from this account.

- \$2000 at the end of each month for the first 15 years, starting at the end of the first month.
- \$1200 at the end of each month for the next 10 years, starting at the end of the 181st month after the account was opened.

Calculate the minimum sum that Phoenix could have deposited in order to make these withdrawals.

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Section II extra writing space

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Handwriting practice lines for Section II extra writing space.

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Mathematics Standard 1

Mathematics Standard 2

REFERENCE SHEET

Measurement

Limits of accuracy

$$\text{Absolute error} = \frac{1}{2} \times \text{precision}$$

$$\text{Upper bound} = \text{measurement} + \text{absolute error}$$

$$\text{Lower bound} = \text{measurement} - \text{absolute error}$$

Length

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

Area

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

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

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

Surface area

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

$$A = 4\pi r^2$$

Volume

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

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

Trigonometry

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

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

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

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

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

Financial Mathematics

$$FV = PV(1 + r)^n$$

Straight-line method of depreciation

$$S = V_0 - Dn$$

Declining-balance method of depreciation

$$S = V_0(1 - r)^n$$

Statistical Analysis

An outlier is a score

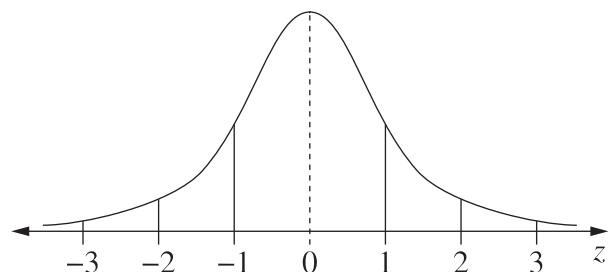
less than $Q_1 - 1.5 \times IQR$

or

more than $Q_3 + 1.5 \times IQR$

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

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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