



NSW Education Standards Authority

**2020** HIGHER SCHOOL CERTIFICATE EXAMINATION

# Mathematics Standard 1

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## 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

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## 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

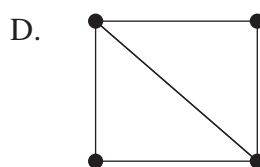
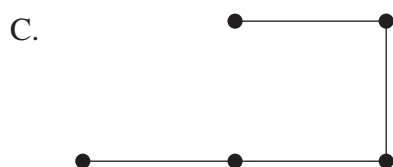
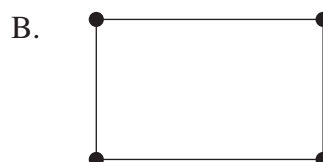
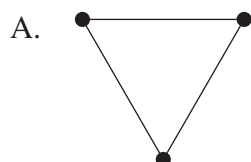
Attempt Questions 1–10

Allow about 15 minutes for this section

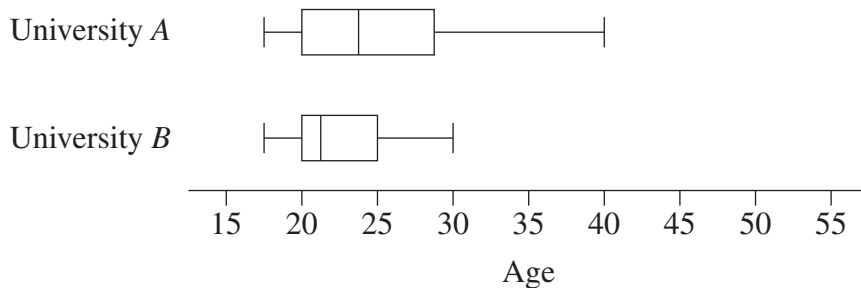
Use the multiple-choice answer sheet for Questions 1–10.

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- 1 Which of the following networks has more vertices than edges?



- 2 A random sample of students was taken from each of two universities, and their ages were recorded. The boxplots of their ages are shown.



For the given samples of students' ages, which of the following statements is FALSE?

- A. The range for University A is smaller than the range for University B.
- B. The median for University A is higher than the median for University B.
- C. The interquartile range (IQR) for University A is larger than the IQR for University B.
- D. The oldest student in the sample from University A is older than the oldest student in the sample from University B.

3 What is 0.002073 expressed in standard form with two significant figures?

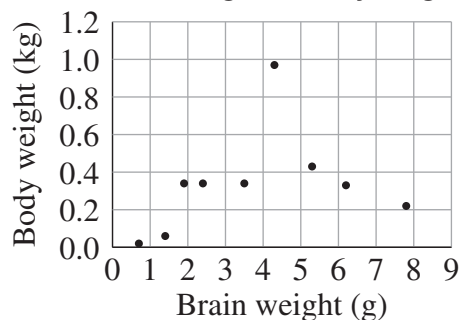
- A.  $2.07 \times 10^{-2}$
- B.  $2.1 \times 10^{-2}$
- C.  $2.07 \times 10^{-3}$
- D.  $2.1 \times 10^{-3}$

4 The table shows the average brain weight (in grams) and average body weight (in kilograms) of nine different mammals.

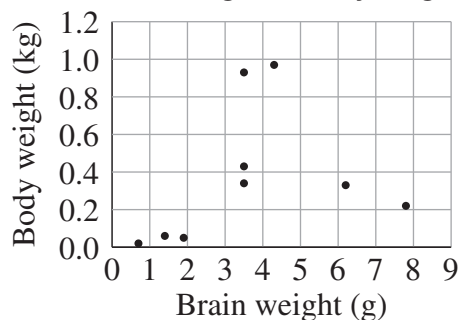
<i>Brain weight (g)</i>	0.7	1.4	1.9	2.4	3.5	4.3	5.3	6.2	7.8
<i>Body weight (kg)</i>	0.02	0.06	0.05	0.34	0.93	0.97	0.43	0.33	0.22

Which of the following is the correct scatterplot for this dataset?

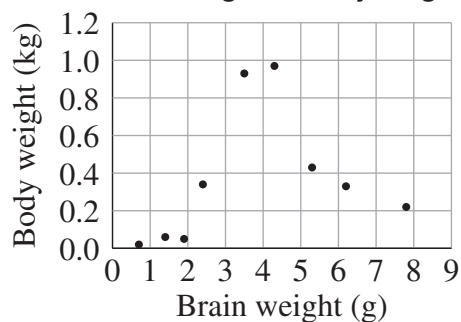
A. **Brain weight vs body weight**



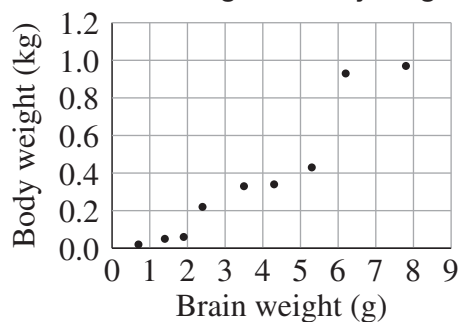
B. **Brain weight vs body weight**



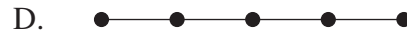
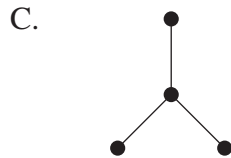
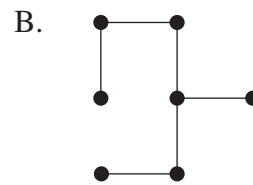
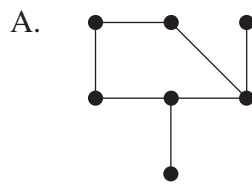
C. **Brain weight vs body weight**



D. **Brain weight vs body weight**

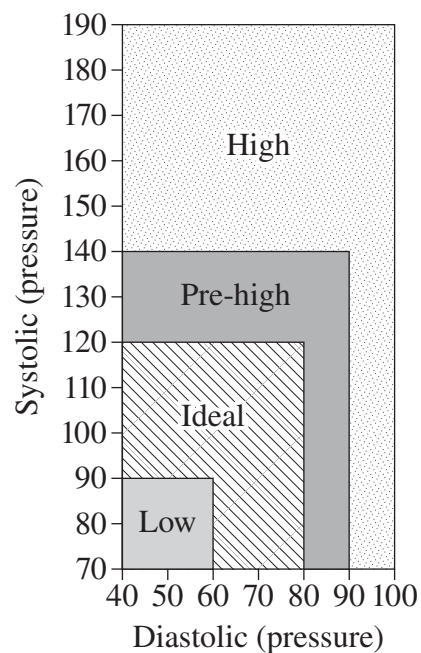


5 Which of the following network diagrams is NOT a tree?



6 When blood pressure is measured, two numbers are recorded: systolic pressure and diastolic pressure. If the measurements recorded are 140 systolic and 90 diastolic, then the blood pressure is written as 140/90 mmHg.

Blood pressure measurements are categorised as shown in the diagram.



Amy has a blood pressure of 97/76 mmHg and Betty has a blood pressure of 125/75 mmHg.

Which row of the table describes the blood pressure for Amy and Betty?

	<i>Amy's blood pressure</i>	<i>Betty's blood pressure</i>
A.	High	Ideal
B.	Ideal	Ideal
C.	High	Pre-high
D.	Ideal	Pre-high

- 7 The distance between Bricktown and Koala Creek is 75 km. A person travels from Bricktown to Koala Creek at an average speed of 50 km/h.

How long does it take the person to complete the journey?

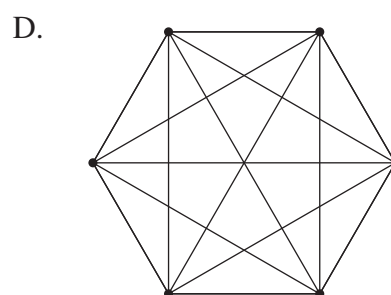
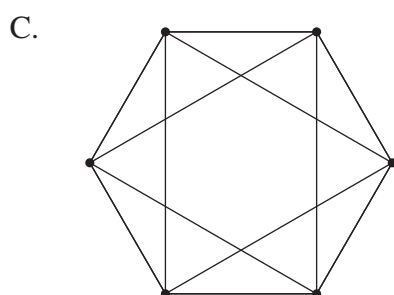
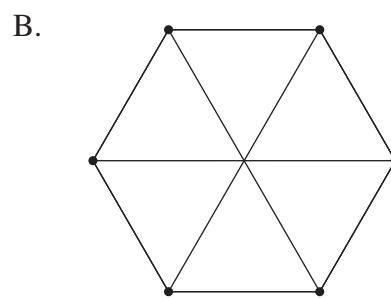
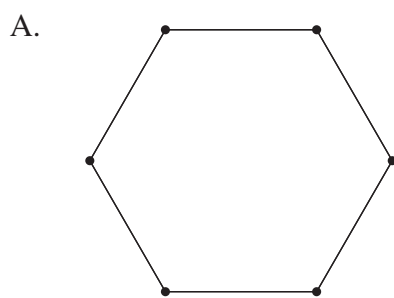
- A. 40 minutes
  - B. 1 hour 25 minutes
  - C. 1 hour 30 minutes
  - D. 1 hour 50 minutes
- 8 Joan invests \$200. She earns interest at 3% per annum, compounded monthly.

What is the future value of Joan's investment after 1.5 years?

- A. \$209.07
  - B. \$209.19
  - C. \$279.51
  - D. \$311.93
- 9 Team A and Team B have entered a chess competition.

Team A and Team B have three members each. Each member of Team A must play each member of Team B once.

Which of the following network diagrams could represent the chess games to be played?



- 10** A plumber charges a call-out fee of \$90 as well as \$2 per minute while working.

Suppose the plumber works for  $t$  hours.

Which equation expresses the amount the plumber charges (\$ $C$ ) as a function of time ( $t$  hours)?

- A.  $C = 2 + 90t$
- B.  $C = 90 + 2t$
- C.  $C = 120 + 90t$
- D.  $C = 90 + 120t$

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Centre Number

# Mathematics Standard 1

## Section II Answer Booklet

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Student Number

70 marks

Attempt Questions 11–30

Allow about 1 hour and 45 minutes for this section

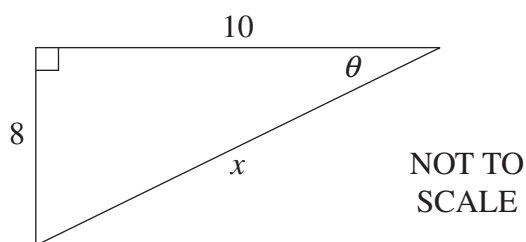
### Instructions

- 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.

Please turn over

**Question 11** (4 marks)

Consider the triangle shown.



- (a) Find the value of  $\theta$ , correct to the nearest degree.

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- (b) Find the value of  $x$ , correct to one decimal place.

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Do NOT write in this area.

**Question 12** (3 marks)

Two painters each provide a quote for painting an area of 1500 square metres. Painter *A* charges \$100 per 30 square metres. Painter *B* charges \$80 per hour and bases their quote on painting 25 square metres per hour.

**3**

Calculate how much will be saved by choosing the cheaper quote.

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**Question 13** (3 marks)

Taro needs \$1000 in 5 years time. He is going to invest some money today in an account earning 3% per annum compounded annually. He will make no further deposits or withdrawals.

**3**

How much money does he need to invest today?

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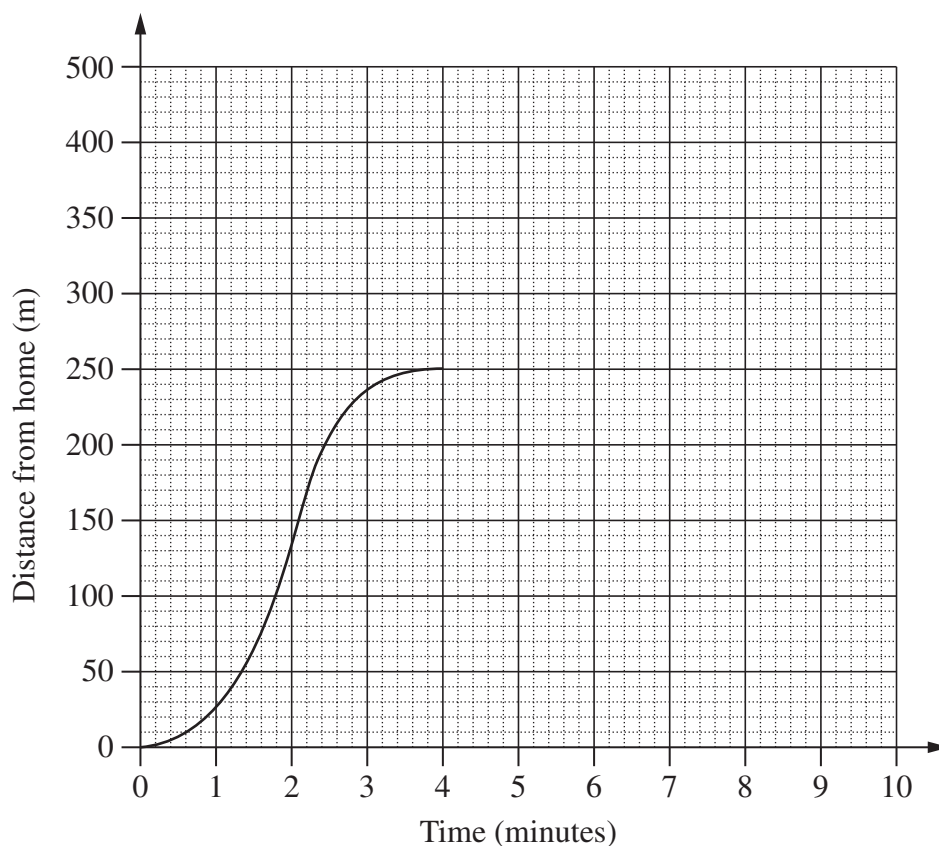
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**Question 14** (4 marks)

Adam travels on a straight road away from his home. His journey is shown in the distance–time graph.



- (a) Describe the journey in the first 4 minutes by referring to change in speed and distance travelled.

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- (b) After the 4 minutes shown on the graph, Adam rests for 2 minutes and then returns home by travelling on the same road at a constant speed. Adam is away from home for a total of 10 minutes.

2

On the grid above, complete the distance–time graph using the information provided.

**Question 15** (2 marks)

The time in Melbourne is 11 hours ahead of Coordinated Universal Time (UTC). The time in Honolulu is 10 hours behind UTC. A plane departs from Melbourne at 7 pm on Tuesday and lands in Honolulu 9 hours later.

**2**

What is the time and day in Honolulu when the plane lands?

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**Question 16** (2 marks)

Consider the equation  $m = 6 - \frac{3R}{2R - 5}$ .

**2**

Find the value of  $m$  when  $R = 10$ .

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**Question 17** (3 marks)

Matilda has a weekly net income of \$510. She has created a budget where she allocates this income to rent, car expenses, personal expenses, phone, and the rest to savings.

3

Her budget is shown below, with some details missing.

	A	B	C	D
1	<b>Matilda's weekly budget</b>			
2				
3	Rent	\$115		
4	Car expenses	\$210		
5	Personal expenses			
6	Phone	\$25		
7	Savings			
8				
9	<b>Total</b>	<b>\$510</b>		
10				

Matilda allocates 20% of her weekly net income to personal expenses.

How many weeks will it take Matilda to save \$4930?

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**Question 18** (2 marks)

The distance,  $d$  metres, travelled by a car while slowing down from  $u$  km/h to  $v$  km/h can be obtained using the formula

**2**

$$v^2 = u^2 - 100d.$$

What distance does a car travel while slowing down from 70 km/h to 40 km/h?

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**Please turn over**

**Question 19** (6 marks)

Each year the number of fish in a pond is three times that of the year before.

- (a) The table shows the number of fish in the pond for four years.

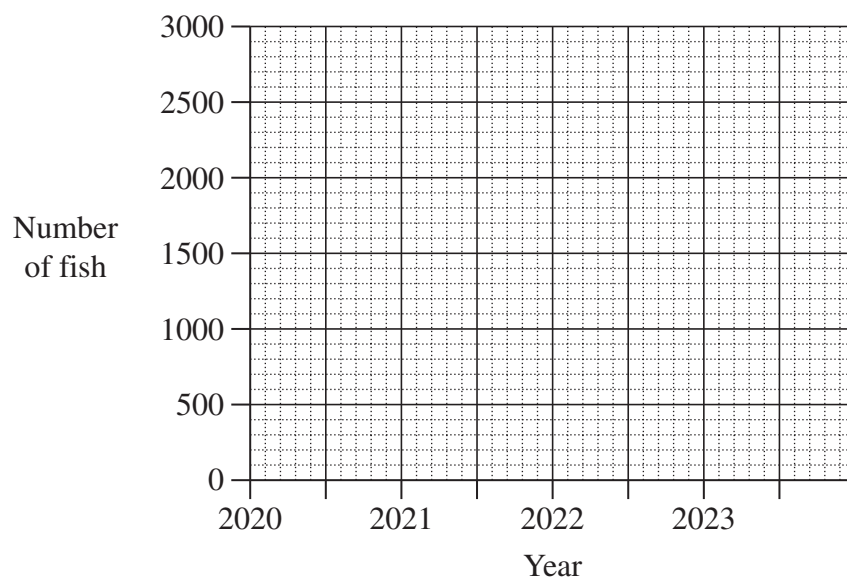
2

<i>Year</i>	2020	2021	2022	2023
<i>Number of fish</i>	100			2700

Complete the table above showing the number of fish in 2021 and 2022.

- (b) Plot the points from the table in part (a) on the grid.

2



- (c) Which model is more suitable for this dataset: linear or exponential? Briefly explain your answer.

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**Question 20** (3 marks)

The weight of a bundle of A4 paper ( $W$  kg) varies directly with the number of sheets ( $N$ ) of A4 paper that the bundle contains.

This relationship is modelled by the formula  $W = kN$ , where  $k$  is a constant.

The weight of a bundle containing 500 sheets of A4 paper is 2.5 kilograms.

- (a) Show that the value of  $k$  is 0.005. **1**

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- (b) A bundle of A4 paper has a weight of 1.2 kilograms. Calculate the number of sheets of A4 paper in the bundle. **2**

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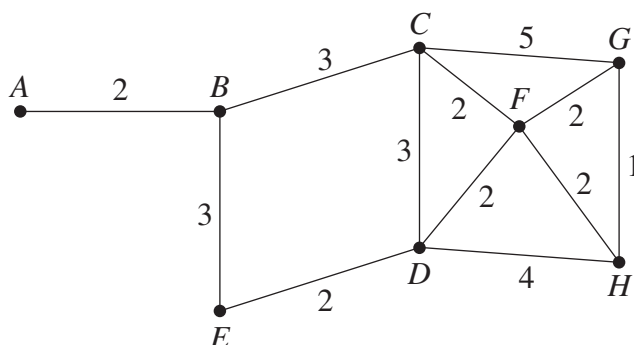
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**Question 21** (4 marks)

The diagram represents a network with weighted edges.



- (a) Draw a minimum spanning tree for this network in the space below and determine its length.

**3**

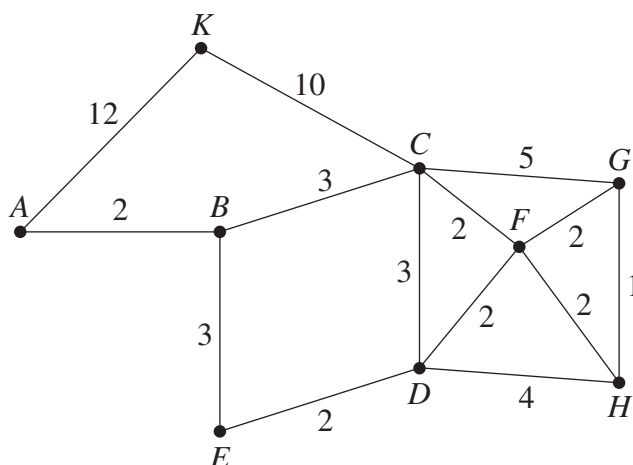
Minimum length of spanning tree = .....

**Question 21 continues on page 19**

Question 21 (continued)

- (b) The network is revised by adding another vertex,  $K$ . Edges  $AK$  and  $CK$  have weights of 12 and 10 respectively, as shown.

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What is the length of the minimum spanning tree for this revised network?

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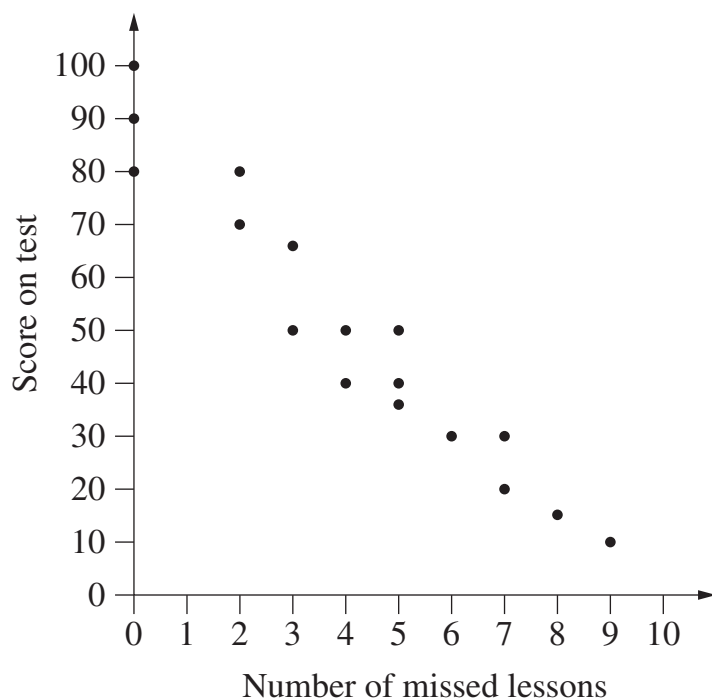
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End of Question 21

Questions 11–21 are worth 36 marks in total

**Question 22** (6 marks)

A group of students sat a test at the end of term. The number of lessons each student missed during the term and their score on the test are shown on the scatterplot.



- (a) Describe the strength and direction of the linear association observed in this dataset.

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- (b) Calculate the range of the test scores for the students who missed no lessons.

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**Question 22 continues on page 21**

Question 22 (continued)

(c) Draw a line of best fit on the scatterplot on the previous page. 1

(d) Meg did not sit the test. She missed five lessons. 1

Use the line of best fit drawn in part (c) to estimate Meg's score on this test.

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(e) John also did not sit the test and he missed 16 lessons. 1

Is it appropriate to use the line of best fit to estimate his score on the test? Briefly explain your answer.

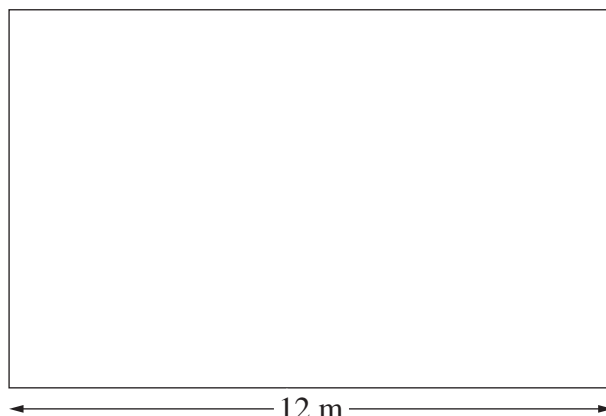
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**End of Question 22**

**Question 23** (3 marks)

The diagram shows a scale drawing of the floor of a room.

3



DRAWN  
TO SCALE

Carpet is to be laid to cover the entire floor. The cost of the carpet is \$100 per square metre.

Find the total cost of the carpet required.

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**Question 24** (4 marks)

- (a) The ages, in years, of ten people at the local cinema last Saturday afternoon are shown. 2

38 25 38 46 55 68 72 55 36 38

The mean of this dataset is 47.1 years.

How many of the ten people were aged between the mean age and the median age?

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- (b) On Wednesday, ten people all aged 70 went to this same cinema. 2

Would the standard deviation of the age dataset from Wednesday be larger than, smaller than or equal to the standard deviation of the age dataset given in part (a)? Briefly explain your answer without performing any calculations.

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**Question 25** (3 marks)

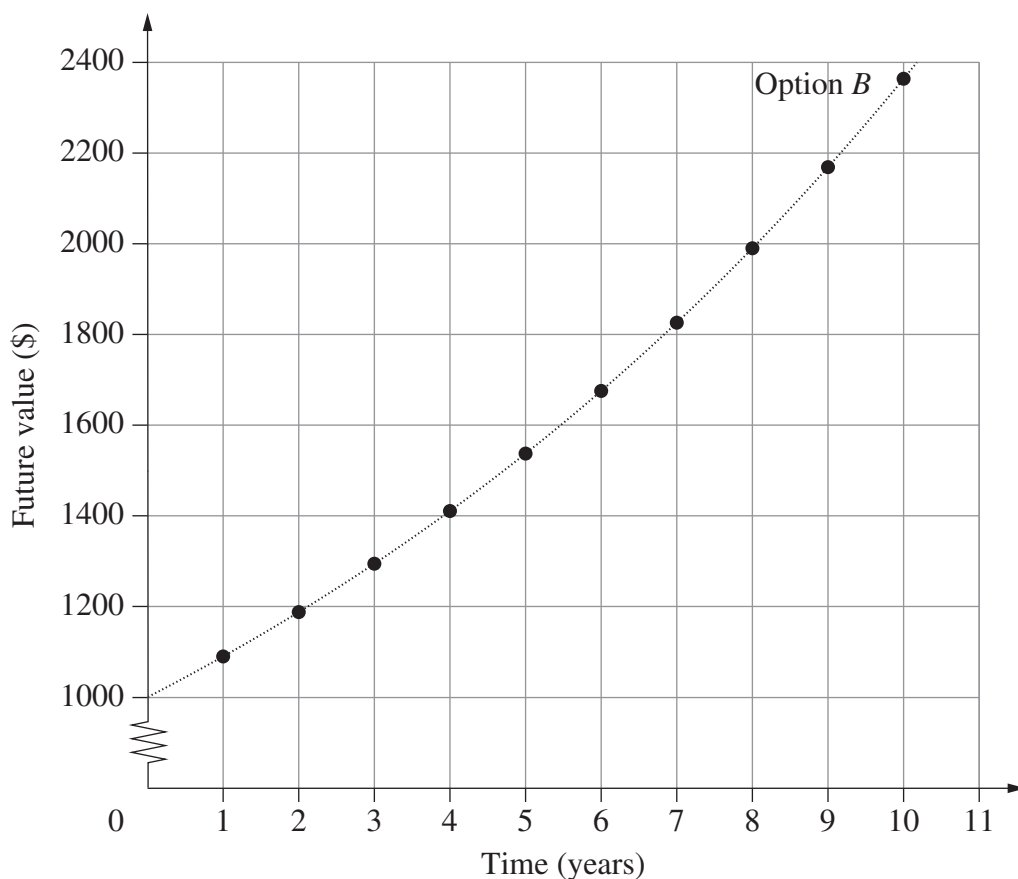
Tom is offered two different investment options.

3

Option A: 10% per annum simple interest.

Option B: 9% per annum interest, compounded annually.

Tom has \$1000 to invest. The graph shows the future values over time of \$1000 invested using Option B.



Tom wants to find the difference between the future values after 8 years using these two investment options.

By first drawing, on the grid above, the graph of the future values of \$1000 invested using Option A, estimate the difference between the future values after 8 years.

Estimate of difference = .....



**Question 26** (3 marks)

Barbara plays a game of chance, in which two unbiased six-sided dice are rolled. The score for the game is obtained by finding the difference between the two numbers rolled. For example, if Barbara rolls a 2 and a 5, the score is 3.

The table shows some of the scores.

		Die 1					
		<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
Die 2	<i>1</i>	0	1	2	3	4	5
	<i>2</i>		0	1	2	3	4
	<i>3</i>	2	1			2	
	<i>4</i>	3	2	1		1	2
	<i>5</i>		3	2	1	0	1
	<i>6</i>	5	4	3	2	1	0

- (a) Complete the six missing values in the table to show all possible scores for the game. 1
- (b) What is the probability that the score for a game is NOT 0? 2

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**Question 27** (3 marks)

The table shows the income tax rates for the 2019–2020 financial year.

3

<i>Taxable income</i>	<i>Tax on this income</i>
0 – \$18 200	Nil
\$18 201 – \$37 000	19c for each \$1 over \$18 200
\$37 001 – \$90 000	\$3572 plus 32.5c for each \$1 over \$37 000
\$90 001 – \$180 000	\$20 797 plus 37c for each \$1 over \$90 000
\$180 001 and over	\$54 097 plus 45c for each \$1 over \$180 000

For the 2019–2020 financial year, Wally had a taxable income of \$122 680. During the year, he paid \$3000 per month in Pay As You Go (PAYG) tax.

Calculate Wally's tax refund, ignoring the Medicare levy.

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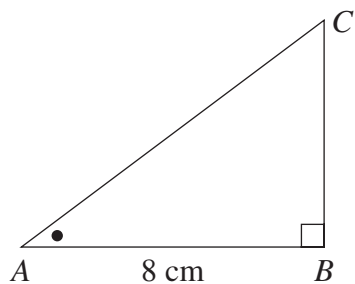
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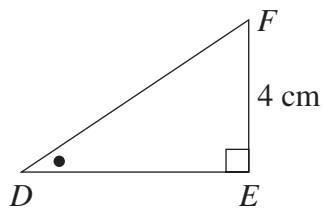
**Question 28** (4 marks)

Two similar right-angled triangles are shown.

4



Triangle I



Triangle II

NOT TO  
SCALE

The length of side  $AB$  is 8 cm and the length of side  $EF$  is 4 cm.

The area of triangle  $ABC$  is  $20 \text{ cm}^2$ .

Calculate the length in centimetres of side  $DF$  in Triangle II, correct to two decimal places.

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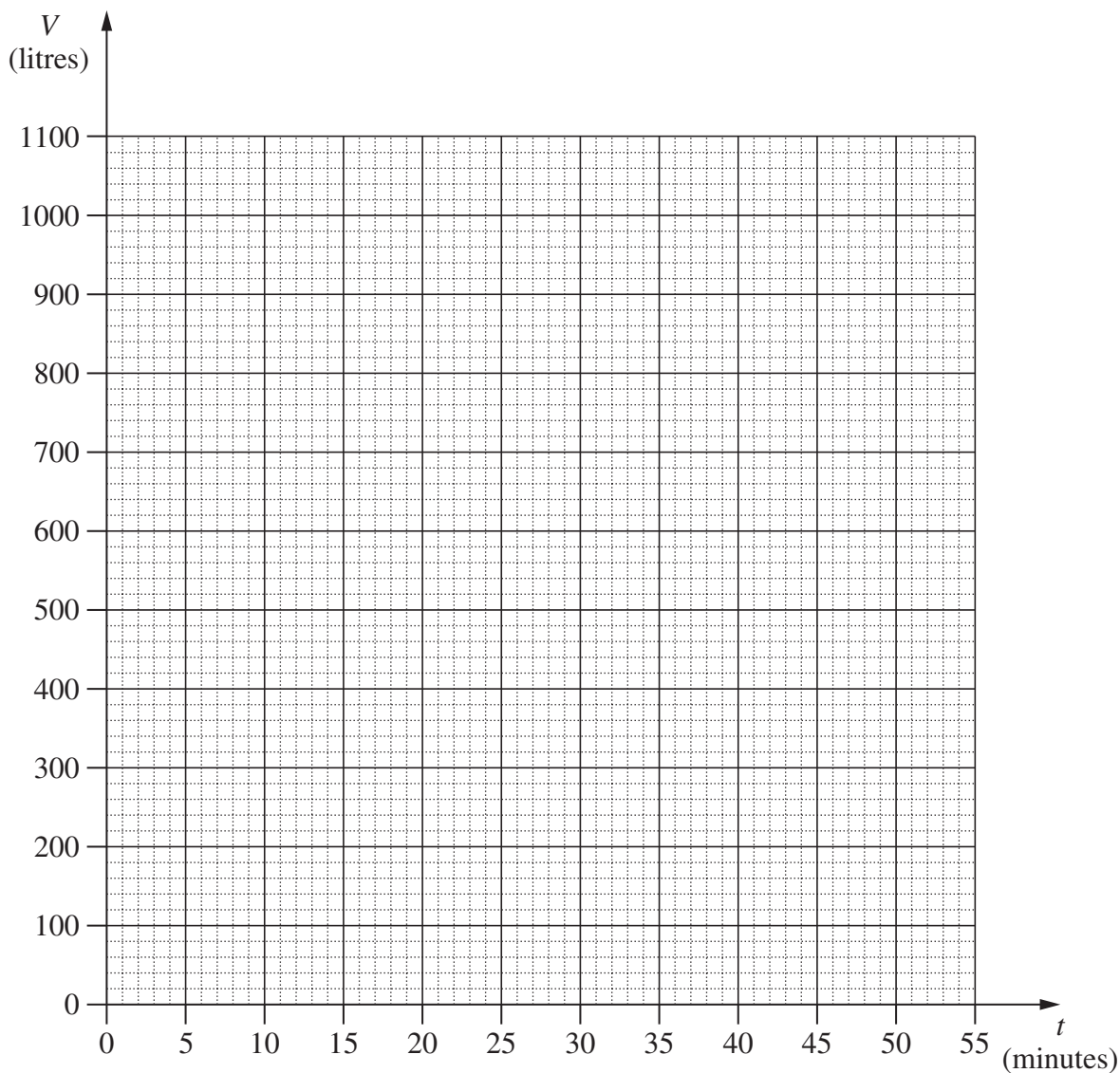
**Question 29** (4 marks)

There are two tanks on a property, Tank *A* and Tank *B*. Initially, Tank *A* holds 1000 litres of water and Tank *B* is empty.

- (a) Tank *A* begins to lose water at a constant rate of 20 litres per minute. The volume of water in Tank *A* is modelled by  $V = 1000 - 20t$  where  $V$  is the volume in litres and  $t$  is the time in minutes from when the tank begins to lose water.

1

On the grid below, draw the graph of this model and label it as Tank *A*.



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**Question 29 continues on page 29**

Question 29 (continued)

- (b) Tank *B* remains empty until  $t = 15$  when water is added to it at a constant rate of 30 litres per minute. 2

By drawing a line on the grid on the previous page, or otherwise, find the value of  $t$  when the two tanks contain the same volume of water.

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- (c) Using the graphs drawn, or otherwise, find the value of  $t$  (where  $t > 0$ ) when the total volume of water in the two tanks is 1000 litres. 1

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**End of Question 29**

**Please turn over**

**Question 30** (4 marks)

Colin takes out a 5-year reducing balance loan of \$19 000 with interest charged at 6% per annum. He uses this money to buy a car valued at \$19 000.

4

The table shows some of the output from a spreadsheet used to model the reducing balance loan.

<i>Year</i>	<i>Amount owing at the start of the year</i>	<i>Interest charged for that year</i>	<i>Repayment</i>	<i>Amount owing at the end of the year</i>
1	19 000.00	1 140.00	4510.53	15 629.47
2	15 629.47	937.77	4510.53	12 056.71
3	12 056.71		4510.53	

Colin's car is depreciated using the declining-balance method, with a depreciation rate of 20% per annum.

At the end of 3 years, after making the third repayment on the loan, Colin sells the car at its salvage value. He uses the money from the sale of the car to repay the amount owing on the loan at the end of the third year.

How much money will he have left over?

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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

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

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

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

#### 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

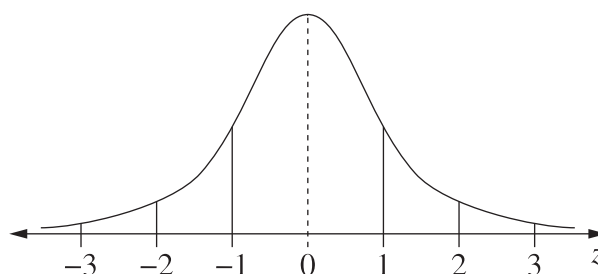
$$\text{less than } Q_1 - 1.5 \times IQR$$

or

$$\text{more than } Q_3 + 1.5 \times IQR$$

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

#### 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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