



South Australian
Certificate of Education

Essential Mathematics

2021

Question booklet

Topic 2: Measurement (Questions 1 to 3) 30 marks

Topic 4: Statistics (Questions 4 to 6) 30 marks

Topic 5: Investments and loans (Questions 7 to 9) 30 marks

- Answer **all** questions
- Write your answers in this question booklet
- You may write on pages 15 and 22 if you need more space
- Allow approximately 40 minutes for **each** topic

Examination information

Materials

- Question booklet
- SACE registration number label

Instructions

- Show appropriate working and steps of logic in this question booklet
- Use black or blue pen
- You may use a sharp dark pencil for diagrams and graphical representations
- Approved calculators may be used — complete the box below

Total time: 130 minutes

Total marks: 90

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Attach your SACE registration number label here	<p>Graphics calculator</p> <p>1. Brand _____</p> <p>Model _____</p> <p>2. Brand _____</p> <p>Model _____</p>
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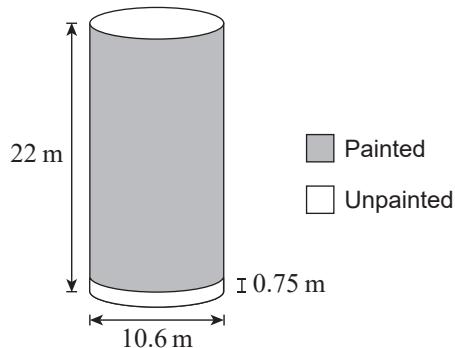
Government
of South Australia

Question 1 (8 marks)

A farming community is planning to have images painted on the *front half* of *four* silos. To purchase the correct amount of paint, the community needs to calculate the surface area to be painted.

All four silos are cylinders and identical in size.

- Each silo is 22 metres (m) high and has a diameter of 10.6 m.
 - The painted images will begin 0.75 m above ground level on each silo, as shown in the diagram below.



- (a) (i) Calculate the circumference of the *circular end* of one silo.

(1 mark)

- (ii) Show that the surface area to be painted on the *front half* of one silo is approximately 350 square metres (m^2).

(2 marks)

- (iii) Calculate the total surface area that will need to be painted on the *front half* of the four silos if two coats of paint will be applied.

(1 mark)

To ensure the paint does not run out, the community needs to purchase enough paint to cover a surface area of 3000 m^2 and finds that:

- 1 litre of this paint is expected to cover 12 m^2 of surface area
 - paint can be purchased in 15-litre (L) cans.

(b) Calculate how many 15 L cans of paint will need to be purchased to cover 3000 m^2 .

(2 marks)

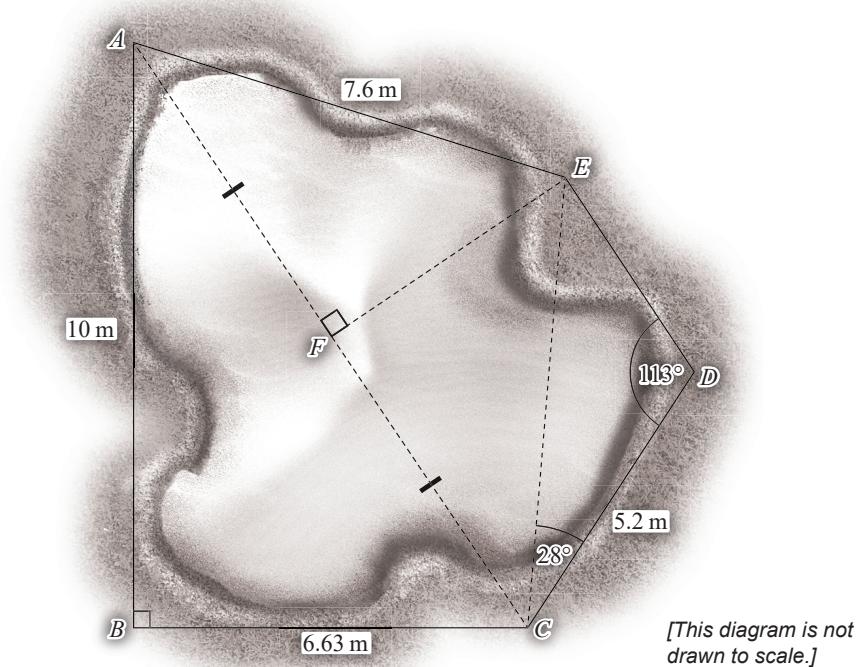
(c) The community purchases 16 cans of paint. Using your answer to part (a)(iii), show with a calculation whether this is reasonable.

(2 marks)

Question 2 (16 marks)

A bunker is a sand-filled obstacle in a golf course.

A golf course needs the sand replaced in one of the bunkers. An image of the bunker with some measurements has been found and is shown below. The groundskeeper needs to determine a good estimate of the area of the bunker by using these measurements.



- (a) Calculate the area of triangle ABC .

(1 mark)

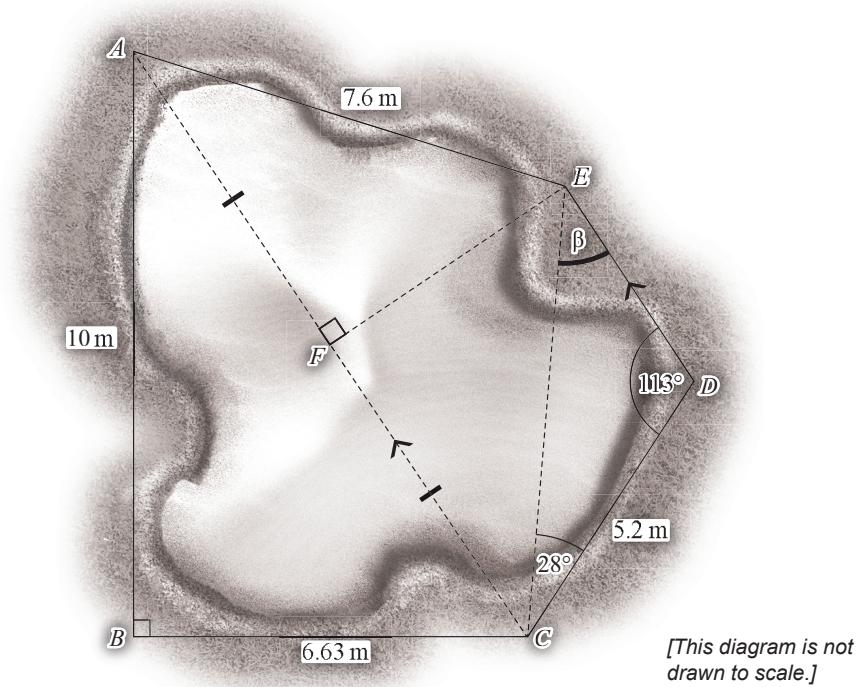
- (b) (i) Show that the length of AC is 12 m.

(2 marks)

- (ii) Show that the length of EF is approximately 4.7 m.

(2 marks)

It is known that lines CA and DE are parallel and that the shape $ACDE$ is a trapezium. The length of DE is needed to find the area of the trapezium.



- (c) (i) Calculate angle β ($\angle CED$).

(1 mark)

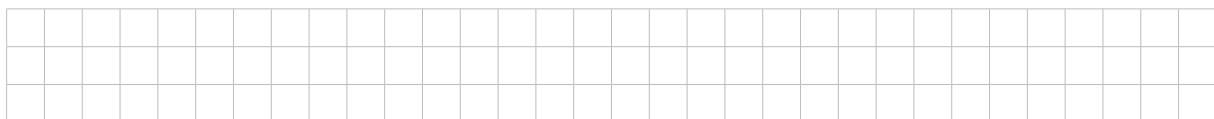
- (ii) Using your answer to part (c)(i) and information in the diagram above, show that the length of DE is approximately 3.9 m.

(2 marks)

- (d) Using the answers from parts (b) and (c) and information in the diagram above, calculate the area of the trapezium $ACDE$.

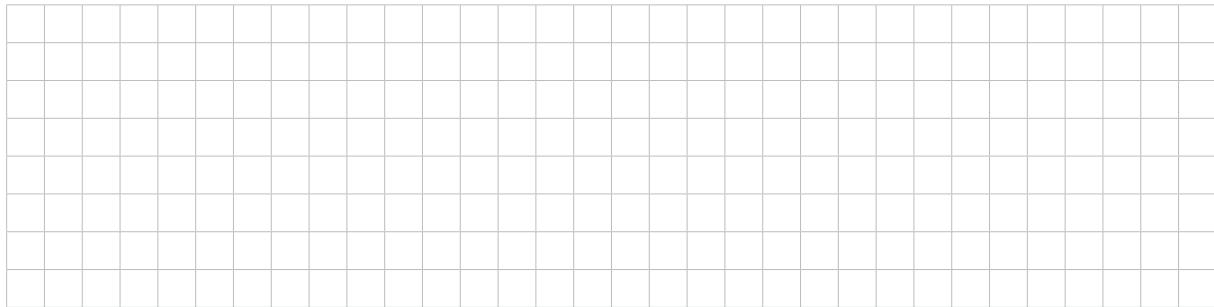
(2 marks)

- (e) (i) Show that the total area of the bunker is approximately 70 m^2 .



(1 mark)

- (ii) Explain if the mathematical processes used would give a reasonable estimate of the area of the bunker.



(2 marks)

The dry sand in the bunker needs to be dug out to a depth of 0.20 m and removed by a truck. The following information is also known:

- the density of dry sand is 1442 kilograms per metre cubed (kg/m^3)
- the truck hired to remove the dry sand from the bunker can carry 2700 kg per trip.

- (f) Using this information, calculate the number of trips that the truck will need to make to remove the sand dug out of the bunker.



(3 marks)

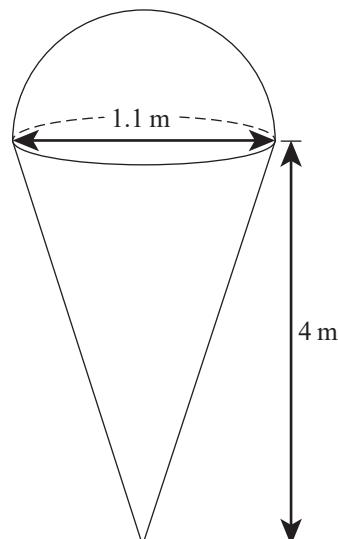
Question 3 (6 marks)

A famous chef made an ice cream with a mass of over 1 tonne. A dairy farmer, Charlie, wishes to make an ice cream that is even larger.

Charlie plans to make an ice cream which will have a cone that will be 4 m tall and filled with ice cream. A hemisphere of ice cream with a 1.1 m diameter will sit on top of the cone.

Note: Volume of a cone $V = \frac{1}{3}\pi r^2 h$

$$\text{Volume of a sphere } V = \frac{4}{3}\pi r^3$$



- (a) Show that the total volume, V , of ice cream required to make Charlie's ice cream is approximately 1.62 m^3 .

(4 marks)

The ice cream Charlie will use has a density of 540 kg/m^3 .

- (b) State if the ice cream Charlie uses will have a mass of more than 1 tonne. Justify your answer with calculations.

(2 marks)

Question 4 (11 marks)

Table 1 below displays the life expectancy (in years) of females and males from some regions of the world in 2018. The regions surveyed had similar population sizes.

Table 1

Regions	Life expectancy (years)	
	Females	Males
A	83.8	78.6
B	78.6	72.3
C	77.8	72.9
D	77.5	70.8
E	73.8	70.2
F	71.1	68.5
G	62.9	59.4

- (a) Complete Table 2 below (correct to one decimal place).

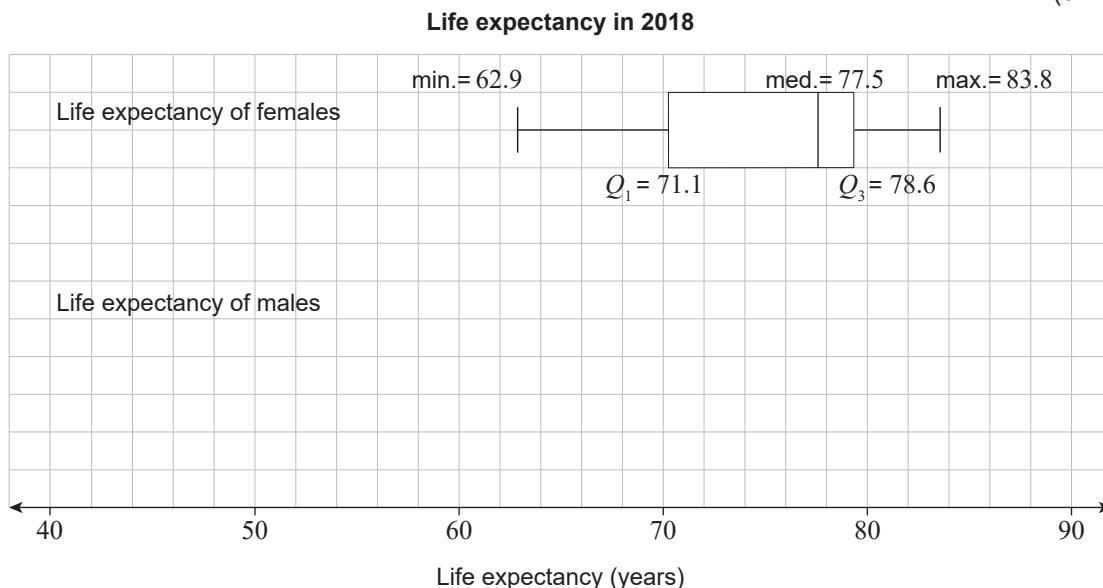
Table 2: Statistical measures for life expectancy in 2018

Statistical measure	Females	Males
Mean		70.4
Median		70.8
Standard deviation	6.7	
Interquartile range (IQR)	7.5	

(3 marks)

- (b) Using the scale below, complete and label a box-and-whisker diagram for the male data.

(3 marks)



- (c) (i) State one conclusion that can be made about the life expectancy of females in 2018 compared with males.

(1 mark)

- (ii) Using statistical measures to support your answer, explain whether females or males in 2018 have more variability in their life expectancy.

(2 marks)

In 2018, Australian females had a life expectancy of 85.3 years and Australian males had a life expectancy of 81.3 years.

- (d) Explain what conclusion can be made about the life expectancy of Australians in 2018 when compared with the regions of the world in Table 1.

(2 marks)

Question 5 (6 marks)

Oliver is researching the consumption of energy drinks by students at his school. One lunchtime, he stands near the canteen and asks students whether they have consumed energy drinks during the previous seven days.

Fifteen Year 9 students responded and shared that they had not consumed any energy drinks during the previous seven days.

Oliver submitted a report to the principal of his school, stating that none of the 725 students at his school consume energy drinks.

- (a) State two concerns with Oliver's sampling process.

(2 marks)

The number of students in each year level is given in the table below.

School Population	
Year level	Number of students
8	180
9	104
10	160
11	165
12	116
Total	725

- (b) (i) Calculate the percentage of Year 9 students in the school.

(1 mark)

- (ii) State the sampling method Oliver would be using if the percentages of students in each year level were reflected in his sample.

(1 mark)

- (iii) Give two reasons why the sampling method used in b(ii) may improve the reliability of Oliver's results.

(2 marks)

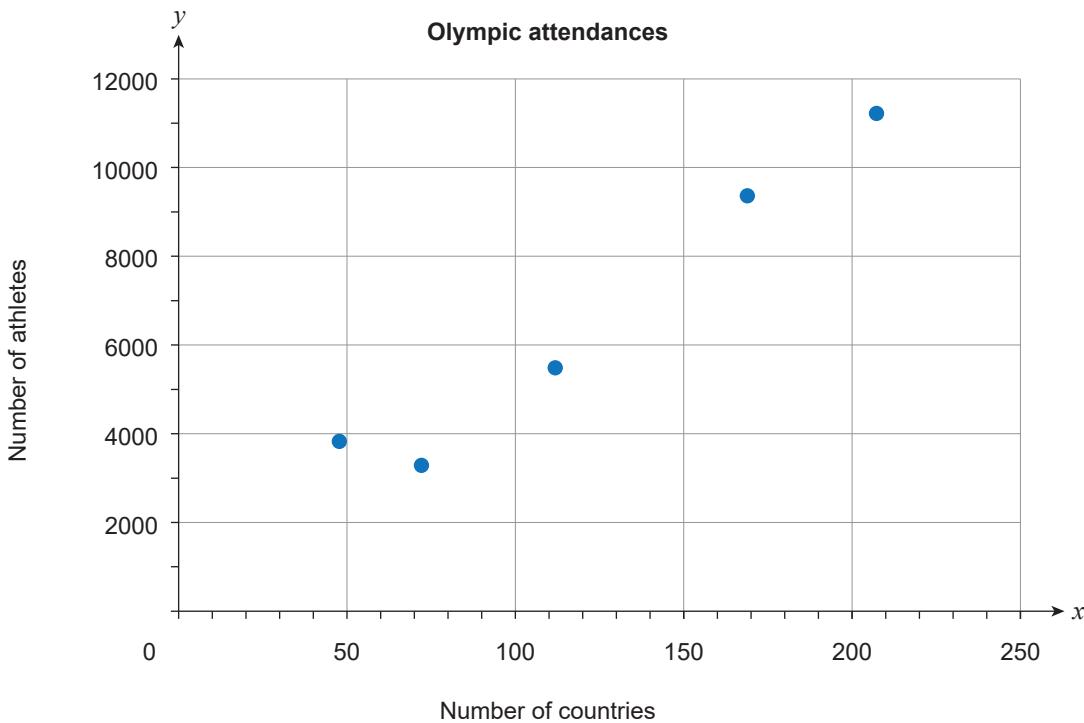
Question 6 (13 marks)

The table below shows the number of countries and the number of athletes that competed in selected Olympic Games between 1936 and 2016.

Year	Number of countries (x)	Number of athletes (y)
1936	49	3 963
1956	72	3 314
1968	112	5 516
1980	80	5 179
1992	169	9 356
2004	201	10 625
2016	207	11 238

Source: adapted from Statista n.d., 'Number of men and women athletes participating at the Summer Olympics from 1896 to 2020', Statista, viewed 24 August 2021, statista.com

- (a) The scatter plot below is missing the data points for 1980 and 2004. Plot these data points on the scatter plot.



(2 marks)

- (b) Calculate the coefficient of determination (r^2) and state the strength of the relationship between the number of countries and the number of athletes that competed at these Olympic Games.

(2 marks)

In 1980, a number of countries withdrew from the Olympic Games.

- (c) State why the set of data for the year 1980 does not appear to be an outlier.

(1 mark)

- (d) Calculate the equation of the least squares regression line (line of best fit). Write the equation in the space below.

(2 marks)

Question 6 continues on page 14.

In the 1900 Olympic Games:

- women were included in the competition for the first time
 - a total of 997 athletes from 29 countries competed.

- (e) State whether the least squares regression line (line of best fit) calculated in part (d) gives a reasonable prediction of the number of athletes who competed in the 1900 Olympic Games. Justify your answer using calculations.

(2 marks)

It is widely accepted that the modern Olympic Games began in 1896. A total of 241 men and no women competed that year.

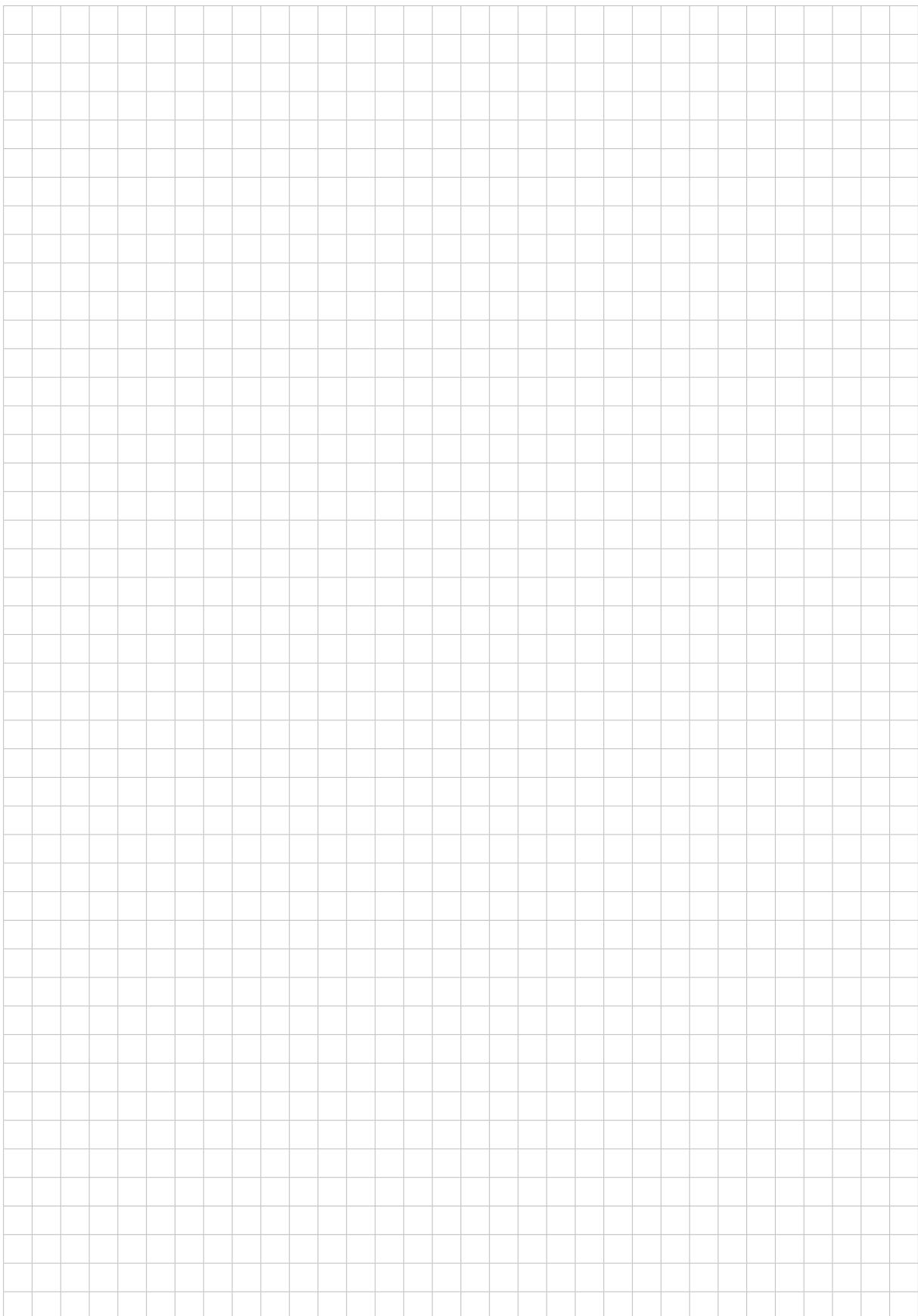
- (f) Using the equation of the least squares regression line (line of best fit) calculated in part (d), predict the number of countries that competed in the 1896 Olympic Games.

(2 marks)

- (g) Explain why it is unreasonable to assume that all of the data from the modern Olympic Games follow the same trend. Use parts (e) and (f) to justify your response.

(2 marks)

You may write on this page if you need more space to finish your answers to any questions.
Make sure to label each answer carefully (e.g. 3(a) continued).

A large grid of squares, approximately 20 columns by 30 rows, intended for students to write their answers on if they need more space than the page provides.

Question 7 (11 marks)

Lola has a job in which she earns \$125 000 per annum. Her employer makes a quarterly contribution of 9.5% into her superannuation fund.

- (a) Calculate the quarterly contribution that the employer makes into Lola's superannuation fund.

(2 marks)

Lola also makes voluntary quarterly contributions into her superannuation account. The total contribution Lola and her employer make each quarter is \$3000.

- (b) Show that Lola's average superannuation fund return rate is 6.74% per annum if she has \$500 000 in her fund after 20 years.

(2 marks)

- (c) Show that Lola's superannuation balance after 30 years will exceed \$1 000 000. Assume the superannuation fund conditions remain the same.

(1 mark)

In 2020, Australians were allowed to withdraw money from their superannuation fund if they were under financial pressure.

Lola chose to withdraw \$20 000 after 20 years, when she had \$500 000 in the fund.

- (d) Calculate Lola's new superannuation fund balance after 30 years. Assume the superannuation fund conditions remain the same.

(2 marks)

- (e) (i) Calculate the effect on Lola's balance after 30 years when \$20 000 is withdrawn after 20 years.

(1 mark)

- (ii) Explain why Lola's balance is reduced by more than \$20 000.

(2 marks)

- (f) State one strategy Lola could use to minimise the impact of the withdrawal of \$20 000.

(1 mark)

Question 8 (8 marks)

Three friends (Dakota, Stephen, and Yoko) each had a goal of earning \$275 interest. They each invested \$4000 in a savings account of their choice.

Dakota's and Stephen's savings accounts both took 18 months to earn \$275.

- (a) (i) Calculate the flat rate of return Dakota's account was earning.

(2 marks)

- (ii) Dakota pays tax at a rate of 32.5%. Calculate the tax she would pay on her investment at the end of 18 months.

(1 mark)

- (iii) Calculate Dakota's after-tax return.

(1 mark)

- (b) Show that Stephen's account earned 4.43% per annum if the interest was compounded weekly.

(2 marks)

Yoko invested her \$4000 in an account that earned the same rate of interest as Stephen (4.43% per annum, compounded weekly). Yoko also deposited \$1 every week into her account.

- (c) Calculate how many less weeks it took Yoko to accumulate the \$4275, compared to Stephen.

(2 marks)

Question 9 (11 marks)

A government-guaranteed home loan only requires a 5% deposit. News reports have suggested that the low deposit will allow first-home buyers to get into the property market.

Kaleb is a first-home buyer who wishes to purchase a home valued at \$600 000.

- (a) Show that Kaleb would need to borrow \$570 000 after paying a 5% deposit.

(1 mark)

- (b) If Kaleb repays the loan over 30 years, calculate his monthly repayments if the loan rate is 3.25% per annum, compounded monthly.

(2 marks)

Kaleb found another loan that required a 20% deposit. Using this loan, he would need to borrow \$480 000.

- (c) Calculate the time (in years) that it would take Kaleb to repay this \$480 000 loan if repayments are \$2480 each month. Assume the loan rate remains at 3.25% per annum, compounded monthly.

(3 marks)

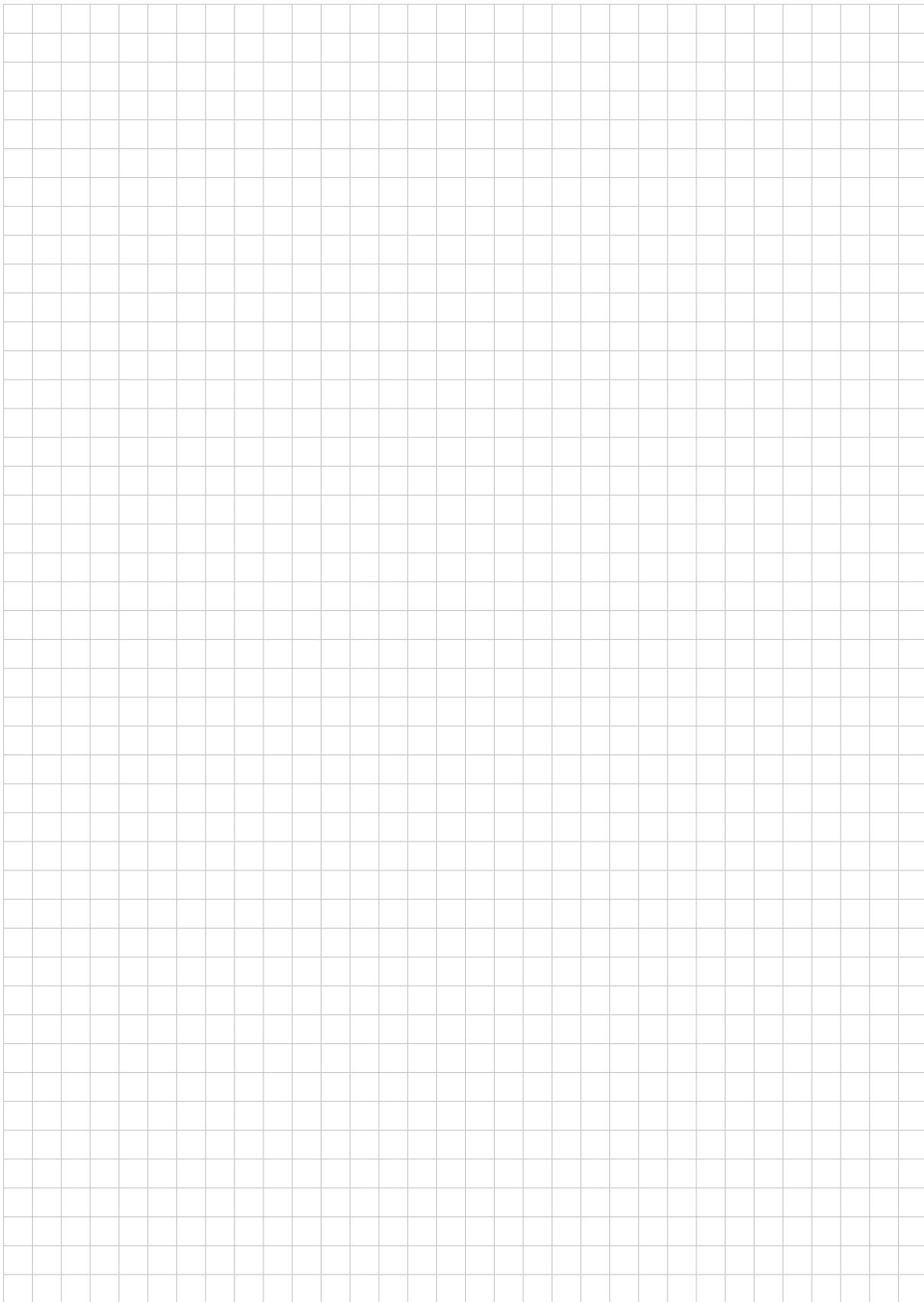
- (d) Calculate the interest Kaleb would save by paying a 20% deposit rather than the 5% deposit.

(3 marks)

- (e) Discuss the reasonableness of Kaleb choosing the option of paying a 20% deposit instead of choosing the government-guaranteed home loan.

(2 marks)

*You may write on this page if you need more space to finish your answers to any questions in Topic 5.
Make sure to label each answer carefully (e.g. 8(a)(iii) continued).*

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