



Government of **Western Australia**
School Curriculum and Standards Authority



ATAR course examination, 2025

Question/Answer booklet

MATHEMATICS APPLICATIONS

Section Two: Calculator-assumed

Place one of your candidate identification labels in this box.
Ensure the label is straight and within the lines of this box.

WA student number: In figures

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In words

Time allowed for this section

Reading time before commencing work: ten minutes
Working time: one hundred minutes

Number of additional
answer booklets used
(if applicable):

Materials required/recommended for this section

To be provided by the supervisor

This Question/Answer booklet
Formula sheet (retained from Section One)

To be provided by the candidate

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: drawing instruments, templates, notes on two unfolded sheets of A4 paper, and up to three calculators, which can include scientific, graphic and Computer Algebra System (CAS) calculators, are permitted in this ATAR course examination

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.



Structure of this paper

Section	Number of questions available	Number of questions to be answered	Working time (minutes)	Marks available	Percentage of examination
Section One: Calculator-free	5	5	50	51	35
Section Two: Calculator-assumed	8	8	100	100	65
Total					100

Instructions to candidates

1. The rules for the conduct of the Western Australian external examinations are detailed in the *Year 12 Information Handbook 2025: Part II Examinations*. Sitting this examination implies that you agree to abide by these rules.
2. Write your answers in this Question/Answer booklet preferably using a blue/black pen. Do not use erasable or gel pens.
3. You must be careful to confine your answers to the specific question asked and to follow any instructions that are specified to a particular question.
4. Show all your working clearly. Your working should be in sufficient detail to allow your answers to be checked readily and for marks to be awarded for reasoning. Incorrect answers given without supporting reasoning cannot be allocated any marks. For any question or part question worth more than two marks, valid working or justification is required to receive full marks. If you repeat any question, ensure that you cancel the answer you do not wish to have marked.
5. It is recommended that you do not use pencil, except in diagrams.
6. Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.
7. The Formula sheet is not to be handed in with your Question/Answer booklet.

Section Two: Calculator-assumed**65% (100 Marks)**

This section has **eight** questions. Answer **all** questions. Write your answers in the spaces provided.

Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Working time: 100 minutes.

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Question 6**(13 marks)**

Josh lives in Sydney and Simon lives in Perth. They each decide to drive to Alice Springs to meet before driving together to Darwin. Simon and Josh will both leave for Alice Springs on Saturday, 2 January.

Due to traffic in Sydney, Josh can only drive 250 km on the first day. After this he plans to drive 3 km more each day than the previous day.

Let n represent the number of days spent driving.

(a) Write a recursive rule to model the distance Josh drives each day. (2 marks)

(b) Calculate how far Josh is away from Sydney by the end of day four. (1 mark)

The distance Simon drives each day can be represented by the rule $T_n = 220(1.06)^{n-1}$.

(c) Interpret what the numbers 220 and 1.06 represent in the context of the question. (2 marks)

(d) Determine the day and date when Simon drove 330.8 km. (3 marks)

The approximate distance from Sydney to Alice Springs is 2770 km and from Perth to Alice Springs is 2550 km.

- (e) Determine who is the first to arrive in Alice Springs. Justify your answer. (3 marks)

After Josh and Simon meet in Alice Springs, they drive together to Darwin. The distance they travel each day can be represented by the rule $T_{n+1} = aT_n + b$.

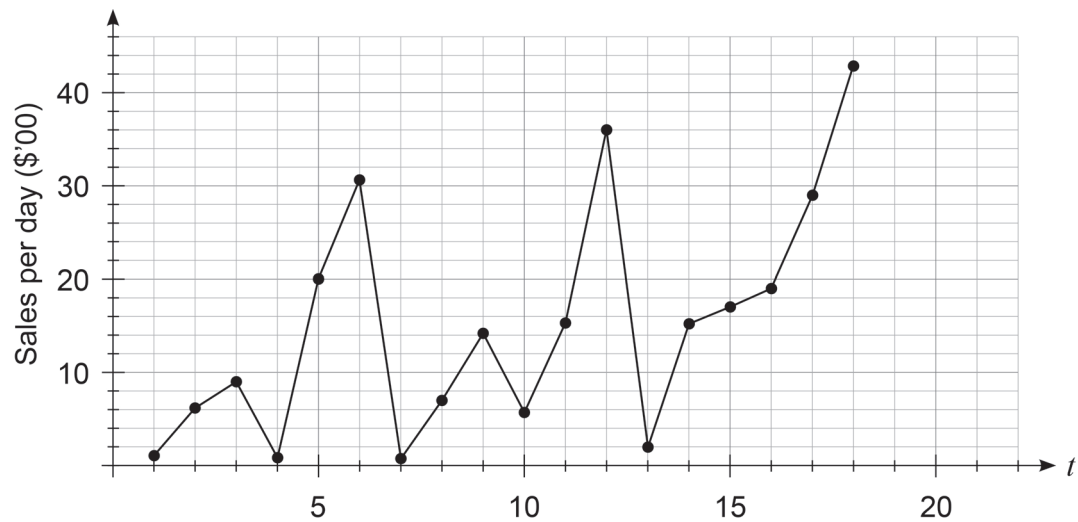
- (f) Given they travel 380 km on day one, 309 km on day two and 269.95 km on day three, determine the value of a and b . (2 marks)

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Question 7

(13 marks)

A trial pop-up Christmas gift wrapping store has opened in a shopping centre. To determine whether the shopping centre will continue the pop-up store in future years, data on the sales per day, in hundreds of dollars, have been recorded. The graph below shows the time series data of the sales for the Christmas gift wrapping store since the beginning of December.



- (a) Identify the moving average that would be the most suitable for the data displayed in the graph above. (2 marks)

A more detailed view of the data (correct to two decimal places) is given in the table below.

Week	Day	Time (t)	Seasonal mean	Sales per day as a percentage of the seasonal mean	Deseasonalised data (d)
1	Tuesday	1	11.30	9.73	12.99
	Wednesday	2		54.87	10.27
	Thursday	3		79.65	10.02
	Friday	4		7.96	1.90
	Saturday	5		177.00	13.87
	Sunday	6		270.80	12.25
2	Tuesday	7	13.13	6.09	9.45
	Wednesday	8		53.30	11.59
	Thursday	9		108.12	15.81
	Friday	10		42.64	11.85
	Saturday	11		116.50	A
	Sunday	12		273.35	14.37
3	Tuesday	13	20.83	9.60	23.61
	Wednesday	14		72.96	25.17
	Thursday	15		81.60	18.93
	Friday	16		91.20	40.19
	Saturday	17		139.20	20.11
	Sunday	18		205.44	17.13

- (b) Complete the seasonal index table below. (2 marks)

Day	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Daily index			89.79%	47.27%	144.23%	249.86%

- (c) Using the table from part (b), complete the following sentence: (2 marks)

On average, Thursday's sales are _____ % _____ the trend value.

- (d) Given the sales for Saturday in week 2 were \$1530, determine the value of **A** in the table on page 6. (2 marks)

The equation of the least-squares line using the deseasonalised data is $\hat{d} = 1.03t + 5.79$.

- (e) Use the equation of the least-squares line to predict the sales that will be made on Thursday of week 4. (3 marks)

- (f) Comment on this prediction. (2 marks)

Question 8

(13 marks)

Peter works at a hairdressing salon. He hopes to purchase his own hairdressing salon in three years' time. He has already saved \$12 500 and is going to open an investment account with this money.

Peter considers the following investment options.

Option	Annual interest rate (%)	Number of compounding periods each year	Balance after three years (\$)
A	2.75	12	
B		365	13 595.32

- (a) Complete the table above. (2 marks)

Peter selects a different investment option which pays an annual interest rate of 3.2%, compounded quarterly. He also decides to deposit \$350 into his account at the end of each quarter.

- (b) State a recurrence relation that will model the balance of his investment at the end of each quarter. (2 marks)

- (c) Determine the value of Peter's investment after three years. (2 marks)

Peter's goal was to have at least \$20 000 in his account after three years.

- (d) Determine the equal quarterly deposits he should have made to reach his goal. (2 marks)

After saving for three years, Peter finds a hairdressing salon he wants to buy. Even though he has been saving, he still needs to borrow \$45 000 to purchase the salon.

He has secured a loan for this amount, with the balance owing at the end of each month modelled by the recurrence relation $T_{n+1} = 1.004T_n - 500$, $T_0 = 45\,000$.

(e) Calculate the annual interest rate being charged. (1 mark)

(f) Assuming the conditions of the loan remain the same, determine

(i) how many months it will take Peter to pay off the loan. (1 mark)

(ii) the total amount paid by Peter over the duration of the loan. (3 marks)

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Question 9

(15 marks)

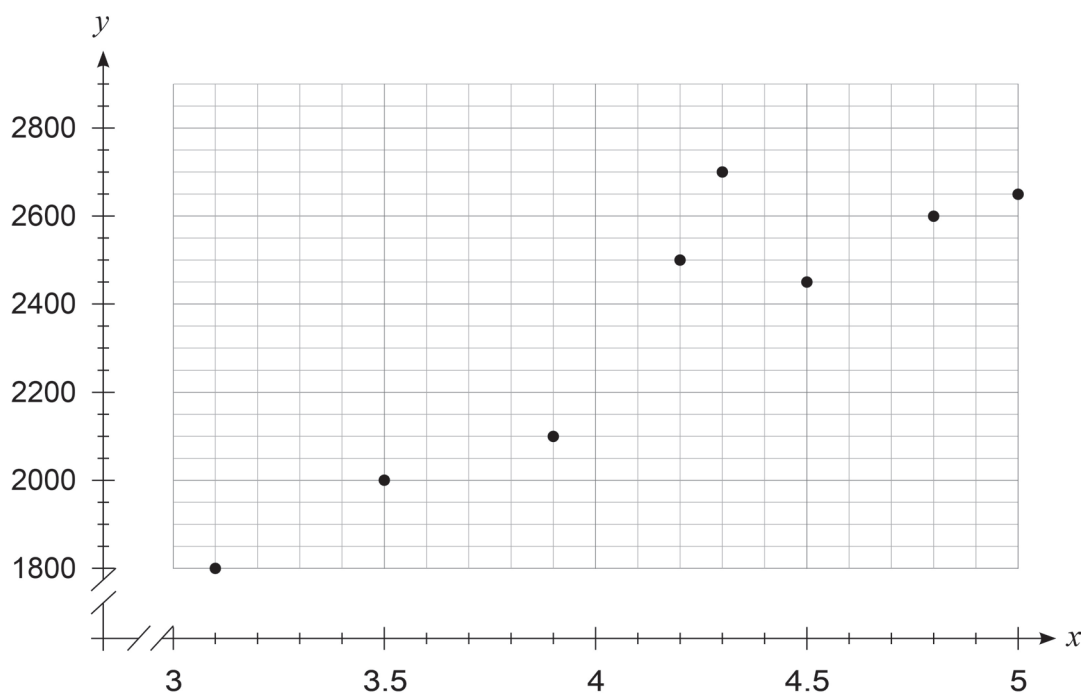
A statistician is analysing whether chess players perform better when they stay in a hotel with a higher rating. Hotels are rated by online reviews on a scale from 3 to 5, with 3 being the worst and 5 being the best rating that can be achieved. Chess players are rated by an Elo score ranging from 1000 to 2800. The higher the Elo score the better the performance by the chess player.

The table below shows the hotel rating and the Elo score for ten chess players.

Hotel rating (x)	5	4.3	3.9	3.5	4.2	4.8	3.1	4.5	4.7	3
Elo rating (y)	2650	2700	2100	2000	2500	2600	1800	2450	2750	1900

(a) Identify the response variable for these data. (1 mark)

(b) On the graph below, plot the last two data points from the table. (1 mark)



A spare graph is provided at the end of this Question/Answer booklet. If you need to use it, cross out this attempt and indicate that you have redrawn it on the spare graph.

(c) Determine the equation of the least-squares line and correlation coefficient for these data. (2 marks)

- (d) Draw the least-squares line on the graph shown in part (b) on page 10. (1 mark)

A spare graph is provided at the end of this Question/Answer booklet. If you need to use it, cross out this attempt and indicate that you have redrawn it on the spare graph.

- (e) Interpret the gradient of the least-squares line in the context of the question. (2 marks)

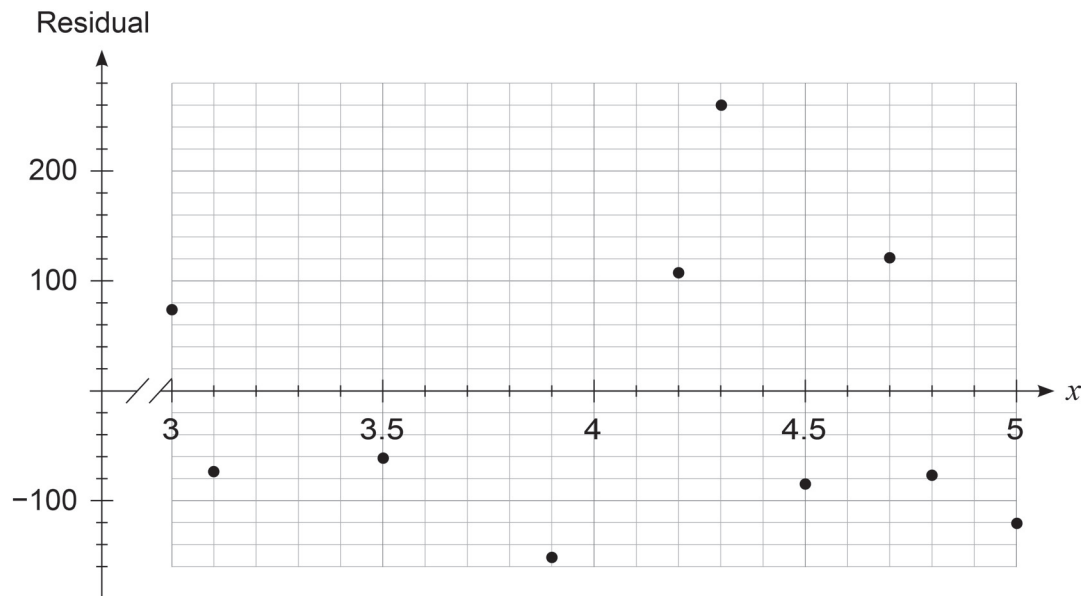
- (f) (i) Use your equation, from part (c) on page 10, to predict a professional chess player's Elo rating if they stay in a hotel with a rating of 4.5. (1 mark)

- (ii) Explain why your prediction is different from the value given in the table on page 10. (1 mark)

- (iii) Outline **one** reason as to why extrapolation in the context of this question would make no sense. (1 mark)

Question 9 (continued)

The residual plot for these data is shown below.



(g) Assess whether a linear model is appropriate for these data. Justify your answer. (2 marks)

(h) State **one** reason that might contribute to a chess player's Elo rating, other than the hotel rating. (1 mark)

If a chess player has an Elo rating above 2400, they are classified as an International Master.

(i) For those chess players who are classified as an International Master, determine what percentage of the variation in Elo rating can be explained by the variation in hotel rating for these data. (2 marks)

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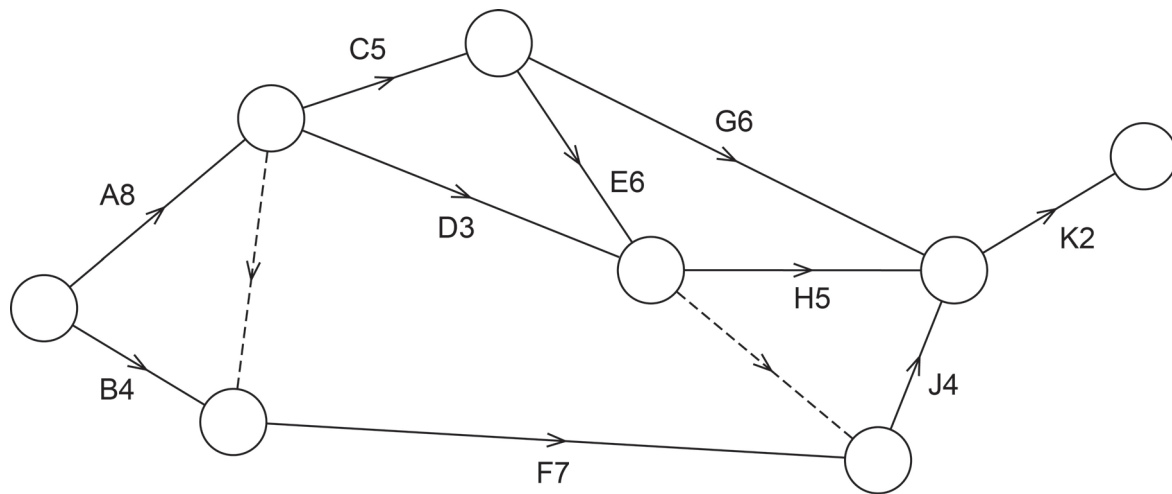
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Question 10

(13 marks)

A restaurant is due to be renovated. The owner has identified 10 activities that need to be carried out to complete the renovation project. The network below shows these activities, labelled with capital letters, and the time to complete them in days.



(a) Identify the immediate predecessor/s for activity J. (2 marks)

(b) Determine the critical path and minimum completion time for the project. Show working on the network. (3 marks)

A spare network is provided at the end of this Question/Answer booklet. If you need to use it, cross out this attempt and indicate that you have redrawn it on the spare network.

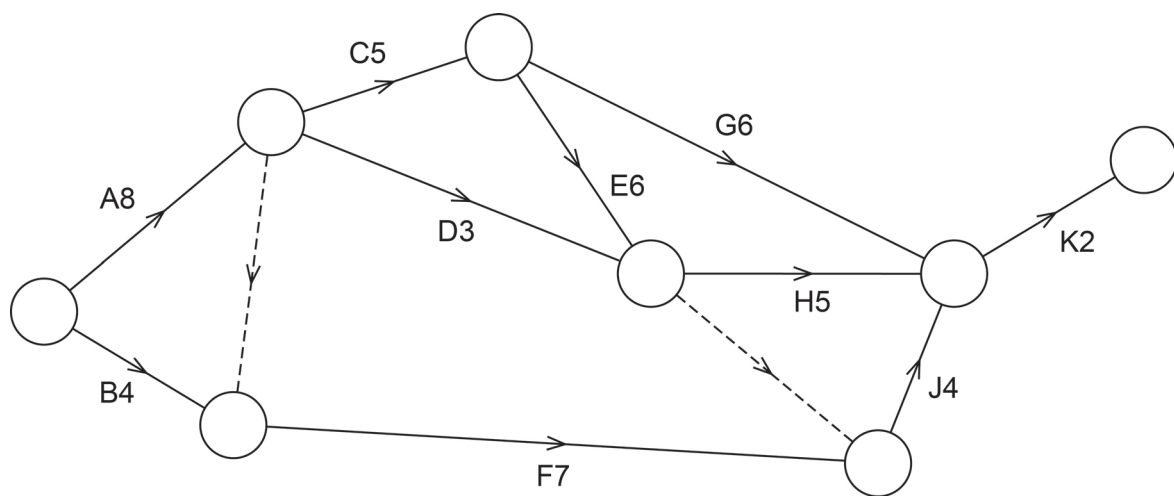
(c) Calculate the latest starting time (LST) for activity G. (1 mark)

(d) (i) Determine the float time for activity F. (1 mark)

- (ii) Explain why some activities have a float time of zero days. (2 marks)

The restaurant owner has decided to employ additional workers, allowing activities A, E and H to be reduced by two days each. He claims that the minimum completion time will therefore be reduced by six days.

- (e) (i) Determine if the restaurant owner's claim is correct. Justify your answer. A copy of the network is provided here. (2 marks)



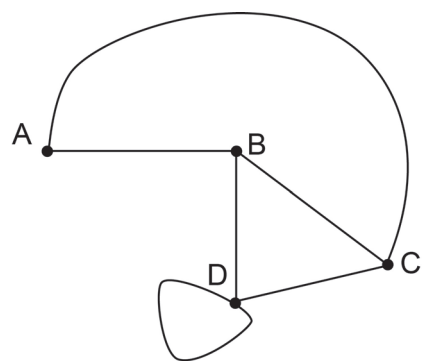
A spare network is provided at the end of this Question/Answer booklet. If you need to use it, cross out this attempt and indicate that you have redrawn it on the spare network.

- (ii) On the basis of your answer to part (e)(i), did the critical path change? If so, state the new critical path. If not, explain why. (2 marks)

Question 11

(8 marks)

The connected graph below shows a rural area where the vertices represent towns, and each edge represents the roads joining each town.



The council plan to install bicycle paths alongside some of the existing roads, to connect the towns to each other.

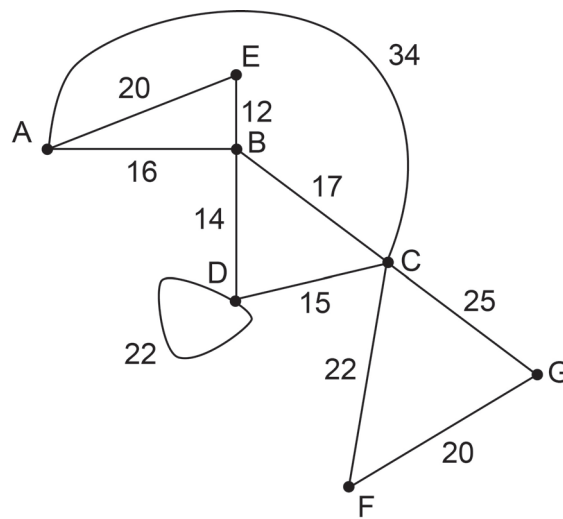
- (a) Draw **four** spanning trees, in the table below, to show how the council could do this. (2 marks)

A B D C	A B D C
A B D C	A B D C

The council would like to include two more towns in their plan to install bicycle paths that will connect the towns to each other.

- (b) Determine the minimum number of bicycle paths (edges) they would need to install, if there was a total of six connected towns. (1 mark)

The council decides to include seven towns in their plan. The distances, in kilometres, between the towns are shown on the edges of the network below. The council wants to install the minimum total length of bicycle paths alongside the existing roads between towns.



- (c) (i) Highlight, on the network above, the bicycle paths that should be installed. (2 marks)

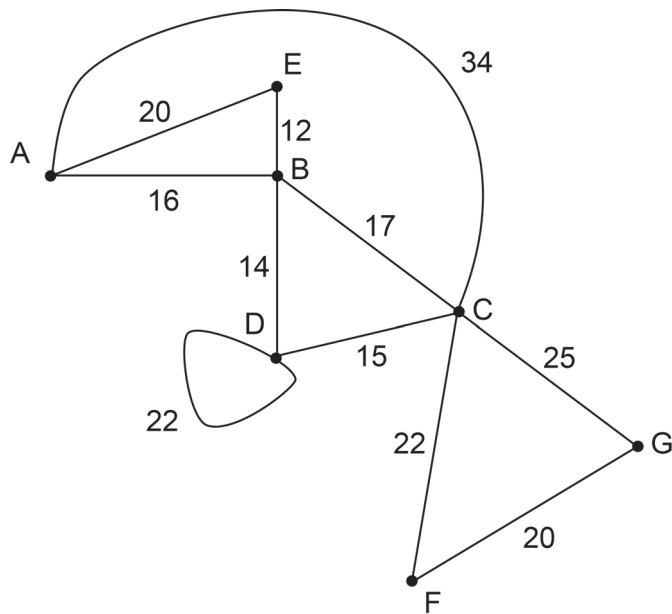
A spare network is provided at the end of this Question/Answer booklet. If you need to use it, cross out this attempt and indicate that you have redrawn it on the spare network.

- (ii) Calculate the minimum length of bicycle paths required. (1 mark)

Question 11 (continued)

The contractors employed to install the bicycle paths will charge a base rate (\$/km). However, due to differences in terrain, path BD will cost 1.5 times the base rate per km, paths CF and FG will cost double the base rate per km, and paths AB and CD will cost three times the base rate per km. The council wants to keep the total cost to a minimum.

- (d) Highlight, on the network below, the bicycle paths that should be installed and determine the total length of bicycle paths required. (2 marks)



A spare network is provided at the end of this Question/Answer booklet. If you need to use it, cross out this attempt and indicate that you have redrawn it on the spare network.

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Question 12**(13 marks)**

A retiring mathematics teacher donates \$4000 to the school where she has worked for many years to pay for a prize to be awarded to a student at the school's annual prize-giving ceremony.

The school principal sets up an annuity with this money, receiving an interest rate of 0.3% compounded monthly and using \$250 at the end of each year to purchase the prize.

(a) (i) Calculate the nominal annual interest rate. (1 mark)

(ii) Determine a recursive rule to model the balance of the annuity at the end of each year. (2 marks)

(b) Determine

(i) how much money will be left in the annuity after five years. (1 mark)

(ii) the number of years the school will be able to award this prize using this annuity. (2 marks)

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The school principal is considering changing this investment to a perpetuity after ten years so there will always be money available to award this prize. The financial institution at that time will offer them an annual interest rate of 4.2% compounded monthly.

The school principal states that the new minimum value of the annual prize should be \$130.

- (c) Show that the yearly perpetuity amount received by the school will be insufficient to purchase the annual prize. (4 marks)

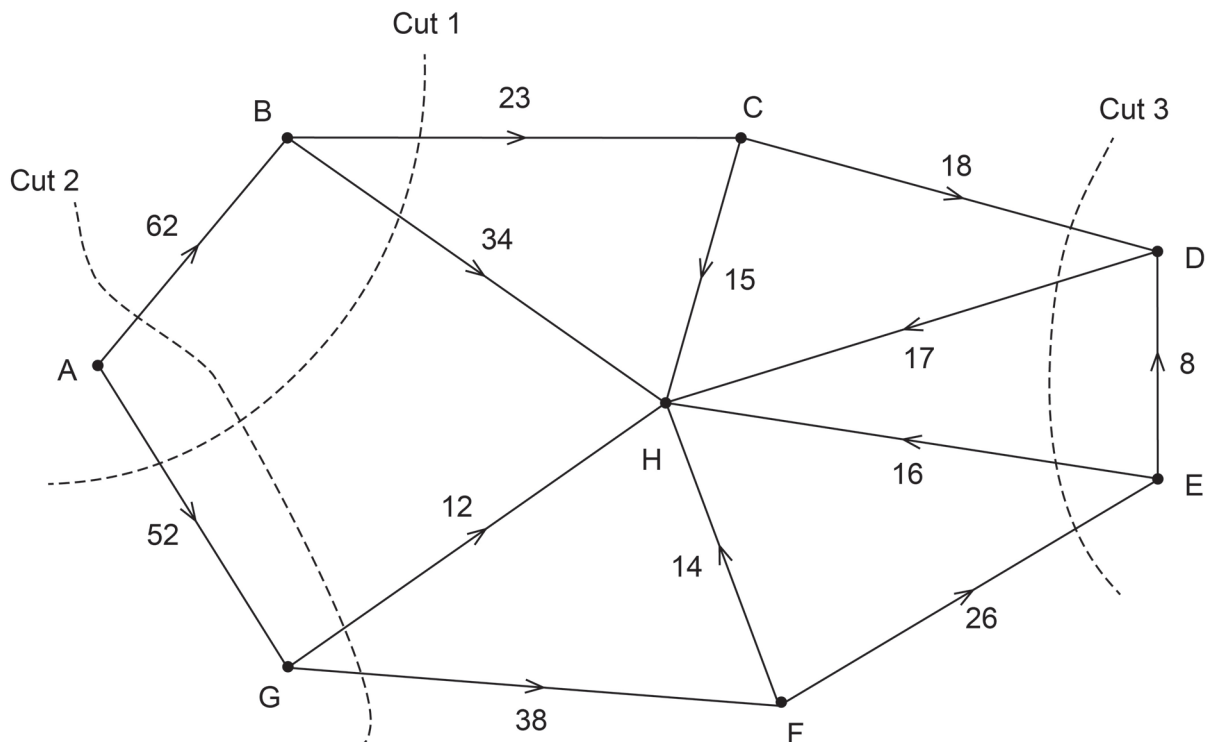
- (d) Determine the largest number of years the school principal can maintain the annuity before changing to a perpetuity and receive enough to cover the annual prize of \$130. (3 marks)

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Question 13

(12 marks)

In a factory, water is pumped from a holding tank and circulated through machines for cooling purposes. It is then collected at a cooling tank. This is shown in the network below with the numbers indicating how many litres per minute can travel along the connecting pipes.



(a) Identify the source and the sink. (2 marks)

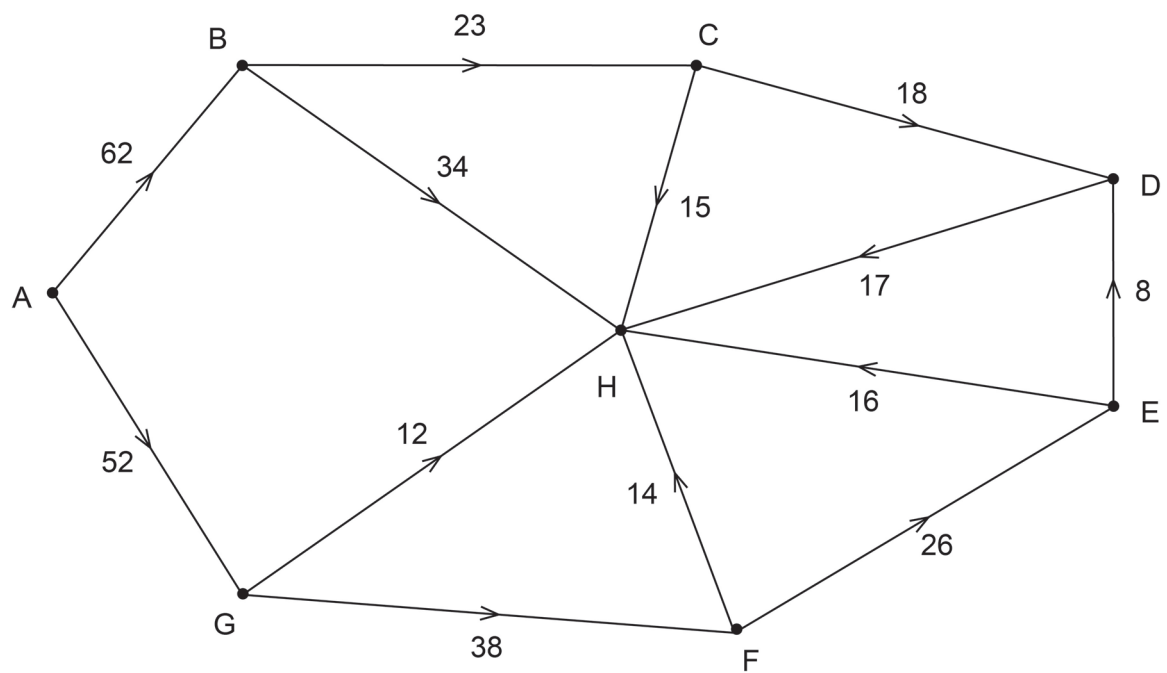
(b) Determine how many machines are in this cooling circuit. (1 mark)

(c) (i) Determine the value of Cut 1 and Cut 2. (2 marks)

(ii) On the basis of your answer to part (c)(i), determine what can be interpreted about the maximum flow through the network. (1 mark)

- (d) By listing each path used, determine the maximum flow through the network each hour. (4 marks)

- (e) Draw the minimum cut that corresponds to the maximum flow on the network below. (1 mark)



- (f) Explain why Cut 3 is an invalid cut. (1 mark)

Supplementary page

Question number: _____

Supplementary page

Question number: _____

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Supplementary page

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Supplementary page

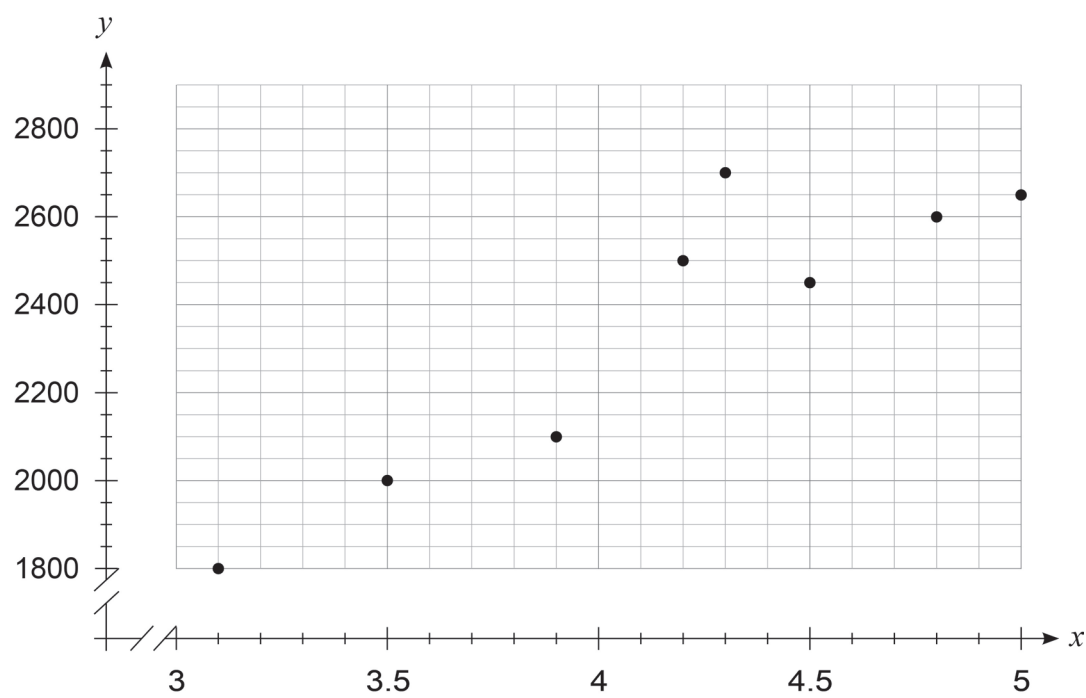
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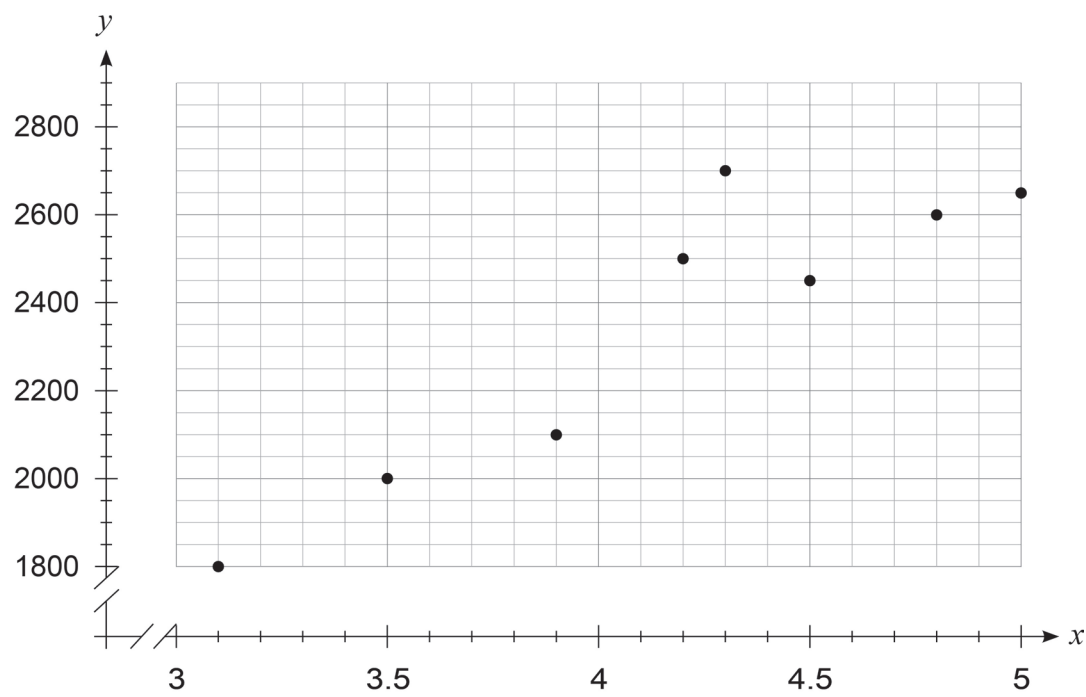
Supplementary page

Question number: _____

Spare graph for Question 9(b)

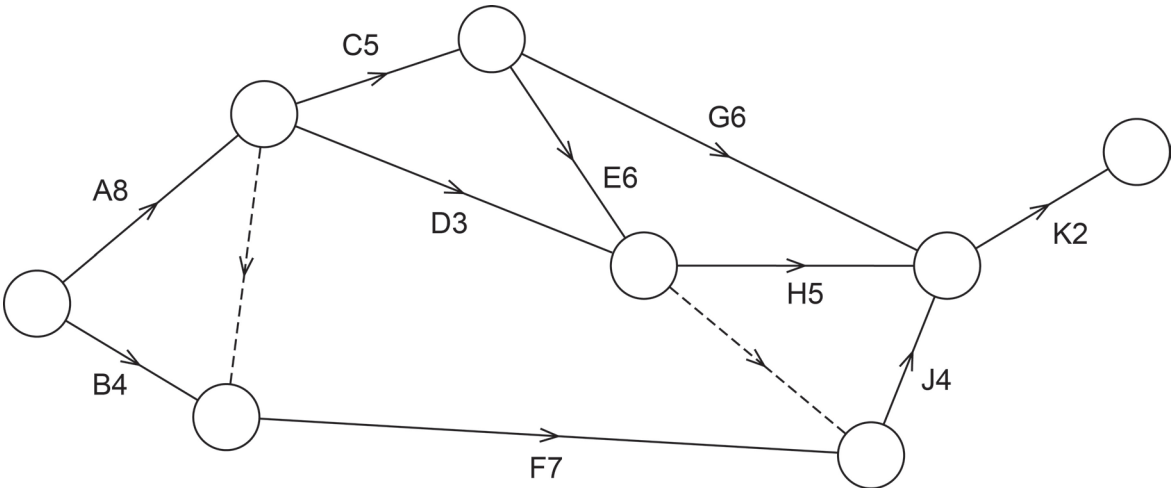


Spare graph for Question 9(d)

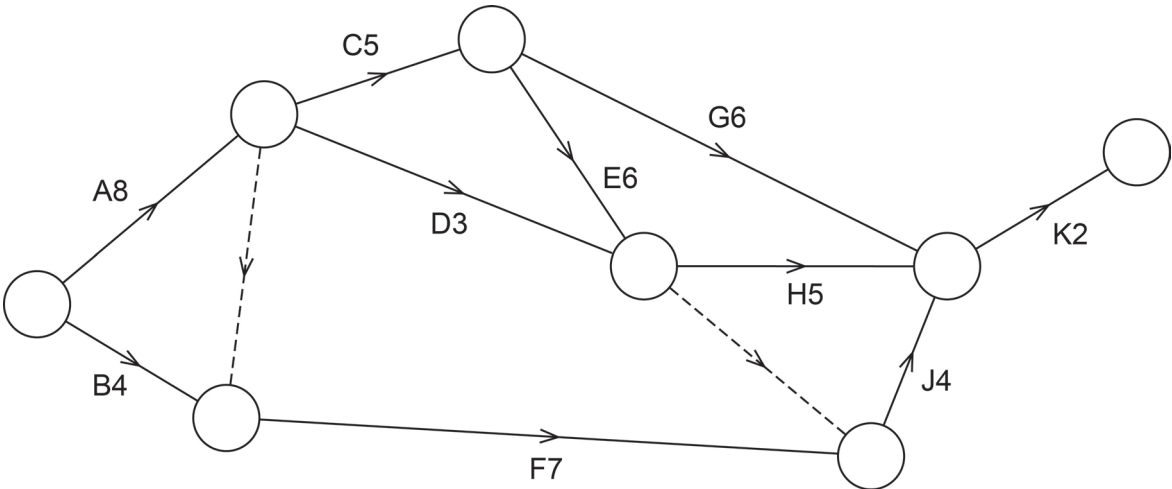


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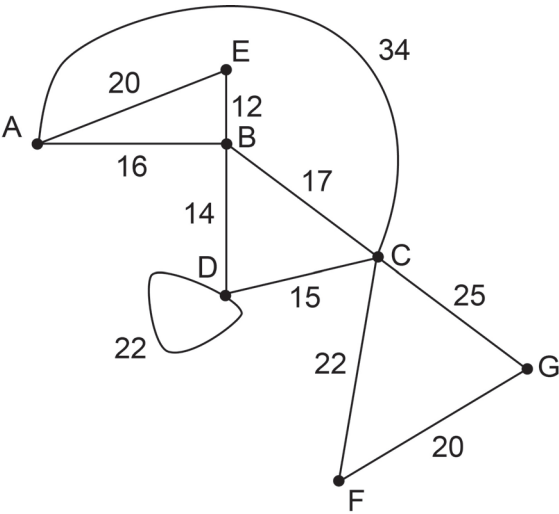
Spare network for Question 10(b)



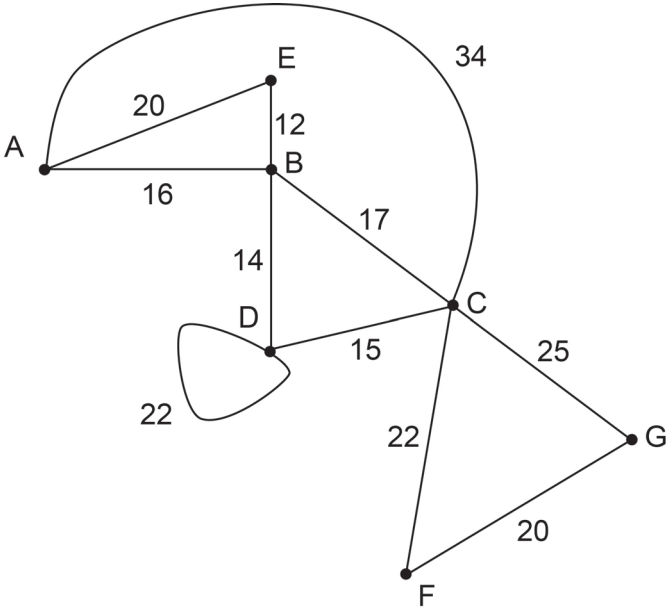
Spare network for Question 10(e)(i)



Spare network for Question 11(c)(i)



Spare network for Question 11(d)



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