2025/4683
Web version of 2024/74253

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

ATAR course examination, 2024

Question/Answer booklet

MATHEMATICS APPLICATIONS

Section One: Calculator-free

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

In words

Time allowed for this section

Reading time before commencing work: five minutes
Working time: fifty 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

To be provided by the candidate

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

Special items: nil

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	54	35
Section Two: Calculator-assumed	8	8	100	99	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 2024: 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.

See next page

Section One: Calculator-free **35% (54 Marks)**

This section has **five** 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: 50 minutes.

Question 1 **(11 marks)**

A school is hosting a sports carnival to raise funds for charity. The first event is a 400 metre running race between a Year 8 student and a Year 12 student. The Year 12 student will start at the starting line and is expected to run at a speed of 8 metres per second. The Year 8 student will start 100 metres ahead of the starting line and is expected to run at a speed of 6 metres per second. Let n represent the number of seconds after the start of the race.

(a) (i) Write a recursive rule to model the total distance (in metres) the Year 12 student is from the starting line during the race. (2 marks)

(ii) Deduce a rule for the n^{th} term to model the total distance (in metres) the Year 8 student is from the starting line during the race. (2 marks)

(b) Determine how many metres the Year 8 student is ahead of the Year 12 student after 5 seconds. (2 marks)

After 30 seconds, the Year 8 student trips over. This results in a 5-second delay for the Year 8 student.

(c) Determine how much of a lead the Year 8 student will have after the 5-second delay. (3 marks)

(d) Determine who wins the race. Justify your answer. (2 marks)

See next page

Question 2 **(9 marks)**

A computer repair shop recorded the number and types of complaints received from its customers regarding laptop computers with different purchase prices.

		Purchase price			
		Under $1000	**From $1000 to $1500**	**More than $1500**	**Total**
Complaints	**Battery failure**	50	50	16	
	Overheating	25			85
	Update failures		70	12	112
	Viruses	45		38	117
	Total	150	200	80	430

(a) Complete the two-way table above. (3 marks)

(b) The manager of the computer repair shop believes that the purchase price of the laptop computers is being explained by the number and type of complaints.

(i) State why this belief is incorrect. (1 mark)

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

See next page

(c) The incomplete two-way percentaged table is shown below.

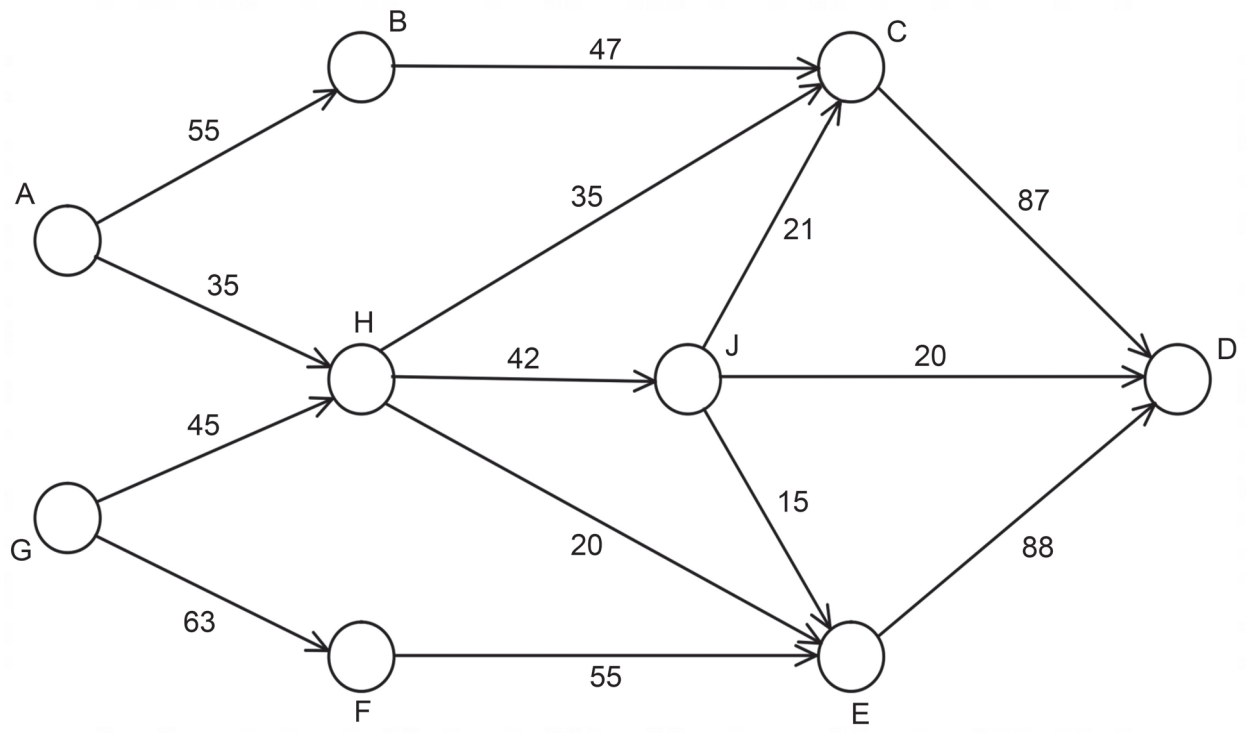
		Purchase price			
		Under $1000	**From $1000 to $1500**	**More than $1500**	**Total**
Complaints	**Battery failure**	33.3	25	20	
	Overheating	16.7		17.5	
	Update failures				
	Viruses				
	Total				

(i) Complete the table above by using either row percentages **or** column percentages, as appropriate. (3 marks)

(ii) State an association that can be observed from the completed two-way percentaged table above. (1 mark)

Question 3 **(11 marks)**

An oil and gas company has two wells that produce natural gas. The gas is transported under pressure, through a network of pipes, to a refinery. Compressor stations are placed at intervals to ensure the gas remains pressurised for maximum flow through the pipes. The network below shows the capacity of the flow through each pipe in cubic metres per hour.



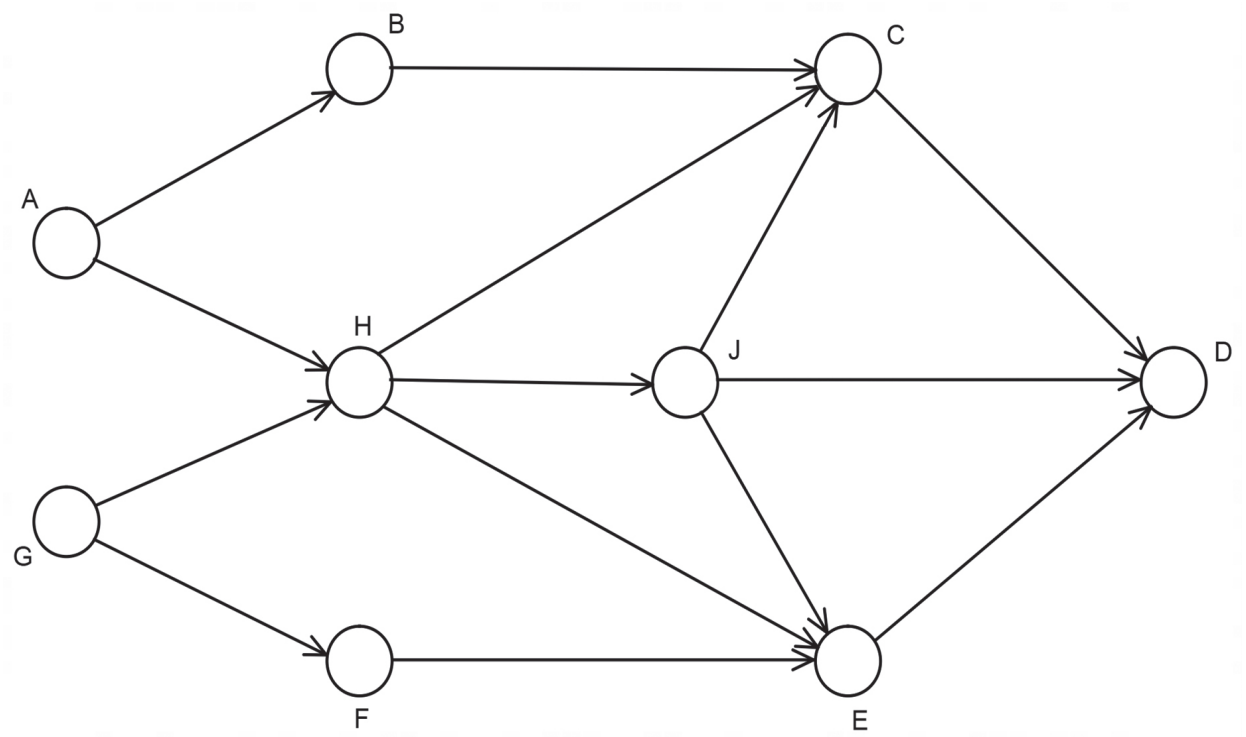
(a) Identify the source(s) and the sink(s). (2 marks)

(b) Determine the maximum flow of gas through the network. Show systematic workings. (4 marks)

(c) Draw the minimum cut that corresponds to the maximum flow on the network above. (1 mark)

See next page

(d) Indicate on the network below the flow through each pipe corresponding to the maximum flow determined in part (b). (2 marks)



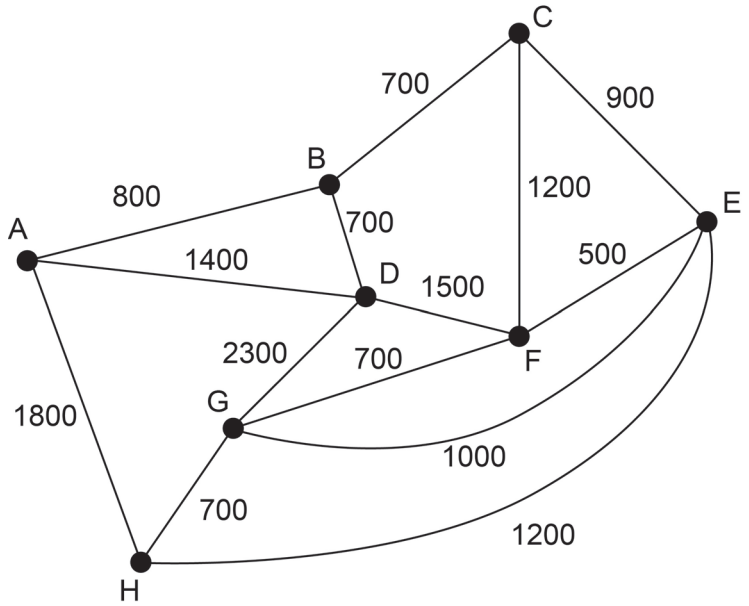
(e) As the refinery is not working at full capacity, the company plans to increase the capacity of the flow through **one** section of pipe (AB or FE) from 55 to 65 cubic metres per hour. Which section should they choose for the best improvement in total gas flow and how will this change the maximum flow? (2 marks)

Question 4 **(13 marks)**

A council in the South West region of Western Australia has erected a number of water stations for hikers travelling through the forest on a walking trail. Over the years, the council has increased the number of water stations, with direct connecting paths to some other water stations, where the ground makes this feasible.

The table and graph below show the direct distances (in metres), between water stations of the paths that have been constructed.

	A	B	C	D	E	F	G	H
A		800		1400				1800
B	800		700	700				
C		700			900	1200		
D	1400	700				1500	2300	
E			900			500	1000	1200
F			1200	1500	500		700	
G				2300	1000	700		700
H	1800				1200		700	

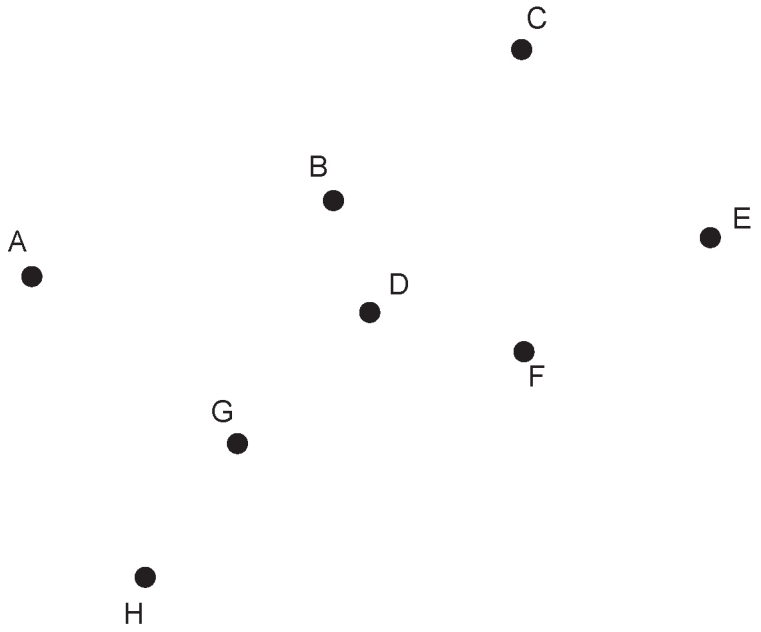


(a) The council has decided to upgrade some of the paths between water stations. It aims to create the shortest distance connecting all water stations, using the upgraded path(s) for travel. Using Prim's algorithm, determine which paths should be upgraded to ensure the distance is minimised. (3 marks)

(b) Upgrading the paths is costed at $30 per metre. If the budget is $180 000, will this be sufficient to upgrade the appropriate paths? Justify your answer. (2 marks)

See next page

(c) (i) Draw the network identified by Prim's algorithm. (1 mark)



(ii) Show this network is bipartite by drawing a diagram. (2 marks)

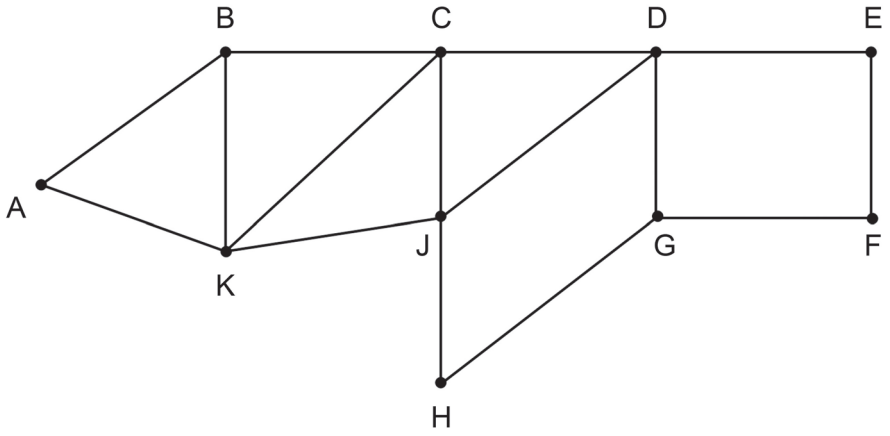
(d) Each day, a park ranger must check every path to ensure there are no obstacles interfering with a hiker's track. Can this be done using a semi-Eulerian or Eulerian trail? Justify your answer. (2 marks)

(e) A park ranger is stopped at watering station G and receives a message to travel to watering station B to assist an injured hiker. Calculate the shortest distance the ranger must travel, and the pathway, to get from G to B. Working must be shown. (3 marks)

See next page

Question 5 **(10 marks)**

A volunteer tour guide has identified several historical places of interest around the Perth central business district. The network shown below has a place of interest at each vertex and the best possible connections between them.



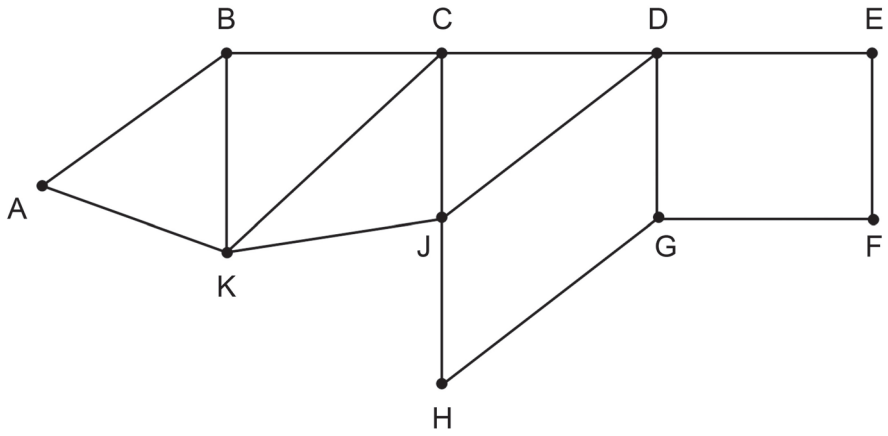
(a) (i) Verify Euler's formula holds true for the above graph. (2 marks)

(ii) Given that part (a)(i) shows the above graph is planar, state what else this means about the graph. (1 mark)

The tour guide wants to offer two types of tours: one that just focuses on visiting each place of interest and the other that visits each place of interest and travels along every connection in order to show more of what Perth has to offer.

(b) Determine whether the tour is able to visit each place of interest and travel along every connection with an Eulerian or semi-Eulerian trail. Justify your response. (2 marks)

(c) Show that the graph below is Hamiltonian by highlighting a possible tour that visits every place of interest. (2 marks)



(d) Determine the number of subgraphs with at most three edges, that contain all of the vertices A, B and C. Each subgraph must be a continuous path. Show a neat sketch of each subgraph. (3 marks)

End of section

Supplementary page

Question number: _____

Supplementary page

Question number: _____

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Question number: _____

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