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ASSESSMENT, STANDARDS
& CERTIFICATION

Tasmanian Certificate of Education
External Assessment 2020

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GENERAL MATHEMATICS

(MTG315120)

PART 1 Bivariate Data Analysis

Time recommended for this part: 36 minutes

Pages:	12
Questions:	3
Attachment:	Information sheet

Candidate Instructions

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On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the course document:

Criterion 4 Interpret concepts, explore and apply methods of bivariate data analysis and time series analysis using the statistical investigation process.

Section Total:	/30
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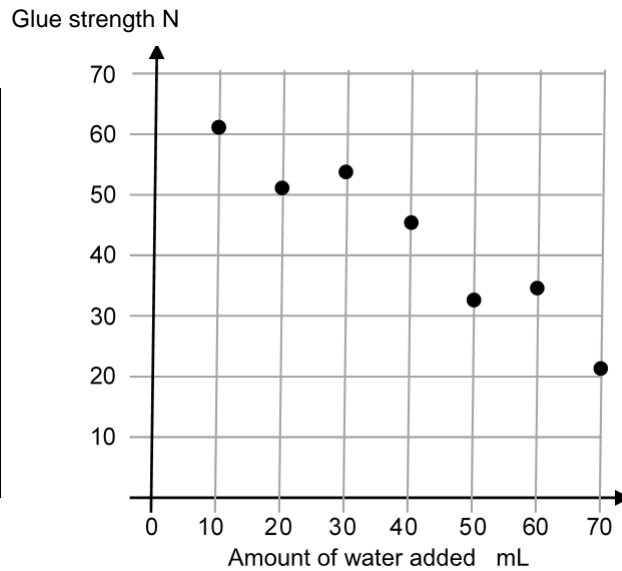
EXAM STARTS OVER THE PAGE

Question 1 (approximately 17 minutes)

A manufacturer of glue finds that adding water to it makes it much easier to apply, but it also affects its strength.

Different amounts of water are added to a standard sample of glue and its strength, (measured in Newtons - N), is found by applying force to joined timber blocks until breakage occurs. The data below shows how adding the water affects the strength of the glue.

Amount of water added (mL)	Glue strength (N)
10	61
20	51
30	53
40	45
50	32
60	33
70	21



- (a) Use your calculator to find the linear regression relationship between the glue's strength (S) and the amount of water added (w). Use 2 decimal places in your equation. (2 marks)

.....

- (b) Find two points that are on the trend line and mark the trend line on the graph. (2 marks)

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- (c) Find the correlation coefficient and interpret it in words. (2 marks)

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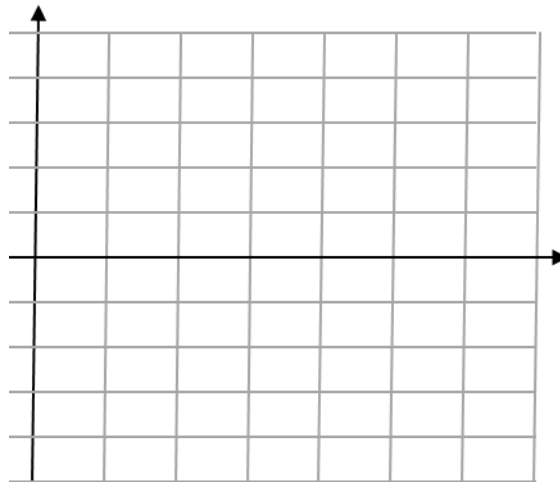
Question 1 continues.

Question 1 (continued).

(d) Prepare a graph of residuals.

(3 marks)

Amount of water added (mL)	Glue strength (N)	Residual
10	61	
20	51	-3.93
30	53	
40	45	
50	32	
60	33	
70	21	



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Only

(e) State two features of the residuals graph which show that the data is well modelled by its equation. (1 mark)

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(f) The point (20, -3.93) is on the residuals graph. Explain what this point means. (1 mark)

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(g) What is the strength of the glue without any water added? (1 mark)

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(h) The manufacturer believes that it would be acceptable for the glue's strength to be up to 20 N less than it currently is. How much water can be added to the sample of glue? (2 marks)

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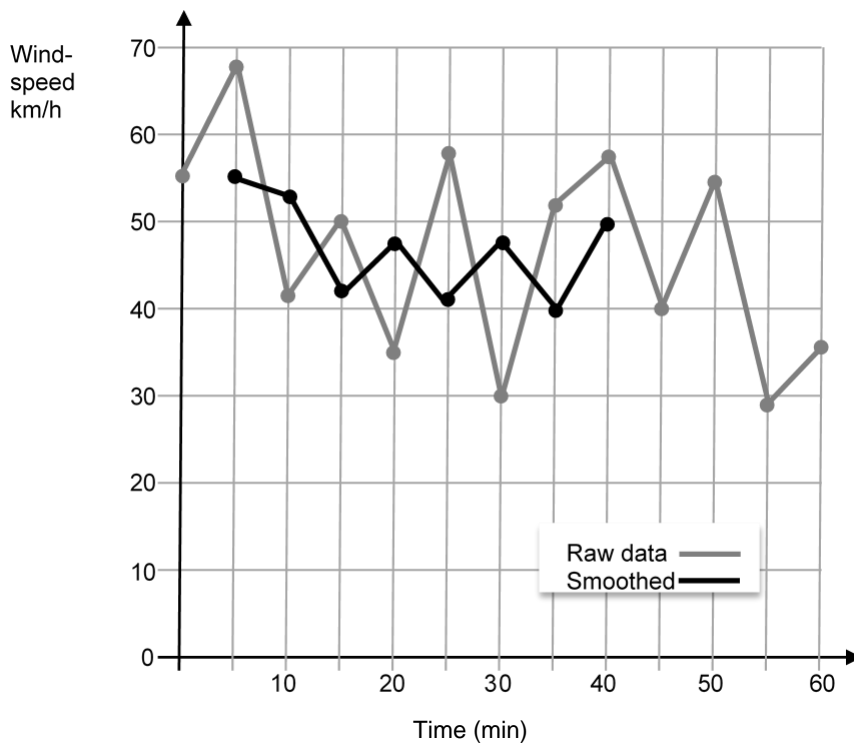
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Question 2 (approximately 12 minutes)

A weather station records the wind-speed (in km/h) at 5 minute intervals starting at 12:00 noon. The data is presented below. Some of the data has been smoothed using a three point moving average.

For
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Only

Time (min)	Wind-speed (km/h)	Smoothed data
0	55	
5	68	55
10	42	53.3
15	50	42.3
20	35	47.7
25	58	41
30	30	46.7
35	52	39.7
40	57	49.7
45	40	
50	54	
55	29	
60	36	



Question 2 continues.

Question 2 (continued).

For
Marker
Use
Only

- (a) Complete the smoothed data column by finding three more data points. (3 marks)

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.....
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- (b) Complete the graph of the smoothed data. (1 mark)

- (c) Why is smoothed data useful in this situation? (1 mark)

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.....

The equation of the linear trend line through the smoothed data is:

$$W = - 0.18t + 51.4 \quad \text{where } \mathbf{W} \text{ is the wind-speed in km/h}$$

and \mathbf{t} is time in minutes since 12:00 noon.

- (d) What is the gradient and what does it imply? (2 marks)

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- (e) Use the equation to predict the wind-speed at 1:30 pm (2 marks)

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- (f) Can your prediction be considered reliable? Explain your answer. (1 mark)

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/ 10

Question 3 (approximately 7 minutes)

The sales totals for last year for a ski and snow gear shop are shown below. The seasonal indices shown were calculated over a longer period of time.

	Quarter			
	Summer	Autumn	Winter	Spring
Sales Total	\$ 10 320	\$ 22 540	\$ 33 250	\$ 5 450
Index	0.54	1.28	1.86	

For
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Use
Only

- (a) Show that the index for Spring is 0.32. (1 mark)

.....

- (b) Which season has the highest index? Explain what this means. (1 mark)

.....

- (c) De-seasonalise the sales totals data. (2 marks)

.....

- (d) Which season had greatest sales in de-seasonalised terms? Explain what this means. (2 marks)

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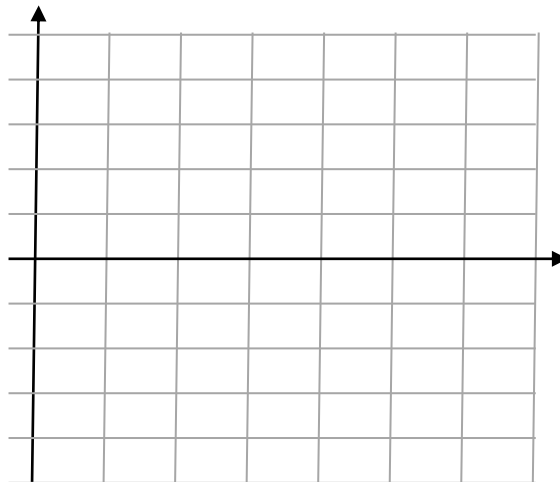
/ 6

/ 30

Spare Diagrams

Question 1 (d)

Amount of water added (mL)	Glue strength (N)	Residual
10	61	
20	51	-3.93
30	53	
40	45	
50	32	
60	33	
70	21	



Question 2

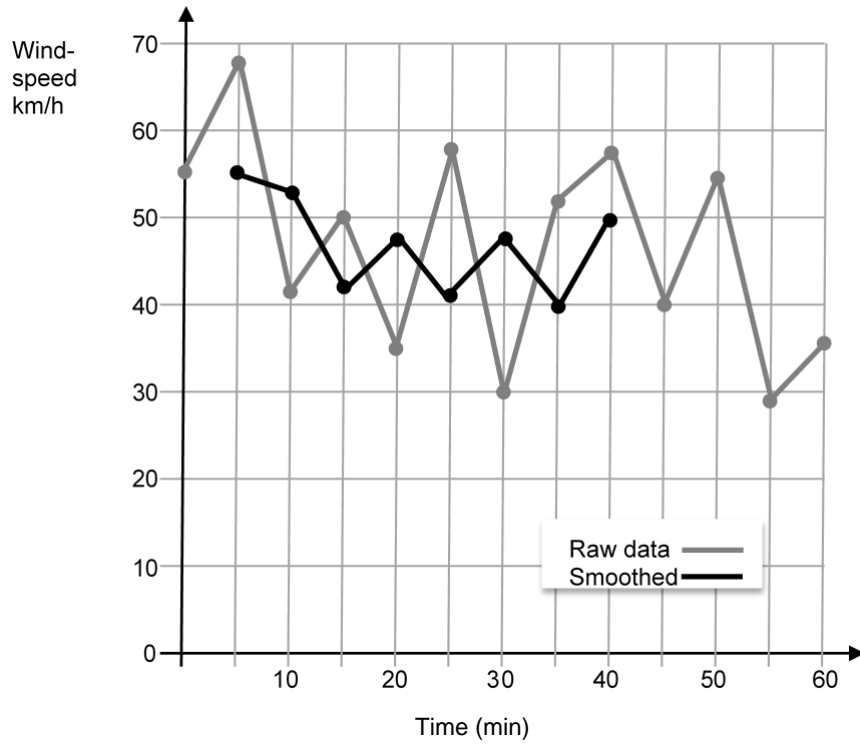
Time (min)	Wind-speed (km/h)	Smoothed data
0	55	
5	68	55
10	42	53.3
15	50	42.3
20	35	47.7
25	58	41
30	30	46.7
35	52	39.7
40	57	49.7
45	40	
50	54	
55	29	
60	36	

Spare diagrams continue.

Spare Diagrams

Spare diagrams (continued).

Question 2



Question 3

	Quarter			
	Summer	Autumn	Winter	Spring
Sales Total	\$ 10 320	\$ 22 540	\$ 33 250	\$ 5 450
Index	0.54	1.28	1.86	

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GENERAL MATHEMATICS

(MTG315120)

PART 2

Growth and Decay in Sequences

Time recommended for this part: 36 minutes

Pages: 12

Questions: 3

Attachment: Information sheet

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Criterion 5 Interpret concepts and perform calculations to model and investigate patterns of growth and decay in discrete situations.

Section Total: /30

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Question 4 (approximately 7 minutes)

Model each of the following situations using a difference equation.

- (a) A piece of paper is ripped in half. The pieces are stacked on top of each other and ripped again. The number of pieces is counted before each rip. (Use first term T_1 .) (1 mark)

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- (b) A flight of stairs has steps that are 18 cm in height. The height of each step above ground floor level is measured. (Use ground floor level as initial term T_0 .) (1 mark)

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- (c) \$ 120 is deposited into an account which earns 2% p.a. interest added annually. Every year a \$ 5 administration fee is charged to the account. (Use initial term T_0 .) (1 mark)

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- (d) For each of the sequences represented in parts (a) (b) and (c), state if the sequence is an example of an arithmetic sequence, geometric sequence or neither. Give a reason for your choice in each case. (3 marks)

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Question 5 (approximately 13 minutes)

Aisha starts a coffee cart business.

On the first day she sells 40 cups of coffee.

On the second day she sells 44 cups of coffee.

Aisha thinks that this could be the start of either an arithmetic or geometric sequence in coffee sales.

- (a) Find the expected number of coffees sold on each of the next 3 days in each case.

(2 marks)

ARITHMETIC SEQUENCE					
Day	1	2	3	4	5
Number of cups coffee sold	40	44			

GEOMETRIC SEQUENCE (round number to nearest integer)					
Day	1	2	3	4	5
Number of cups coffee sold	40	44			

- (b) Find, in each case, a general expression for the number of cups of coffee sold on the n^{th} day, i.e. the sequence rule. (2 marks)

ARITHMETIC SEQUENCE

.....

GEOMETRIC SEQUENCE

.....

Question 5 continues.

Question 5 (continued).

For
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- (c) Use your expressions to find, in each case, the number of cups that will be sold on the 20th day. (2 marks)

ARITHMETIC SEQUENCE

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GEOMETRIC SEQUENCE

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- (d) Use a formula to find, in each case, the total number of cups that Aisha would sell over 20 days. (3 marks)

ARITHMETIC SEQUENCE

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GEOMETRIC SEQUENCE

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- (e) Each day Aisha loads her cart with enough supplies for 210 cups. Given that the pattern of increase is shown to be an ARITHMETIC SEQUENCE, find the day on which Aisha finds that she is unable to meet the demand for coffee. (2 marks)

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Question 6 (approximately 16 minutes)

A car hire company begins business with 180 cars. It plans to build the car fleet and keep it looking fresh by selling 30% of its cars each year and buying 45 new cars each year.

The situation could be modelled by using the difference equation:

$$T_{n+1} = 0.7 (T_n) + 45 \quad T_0 = 180$$

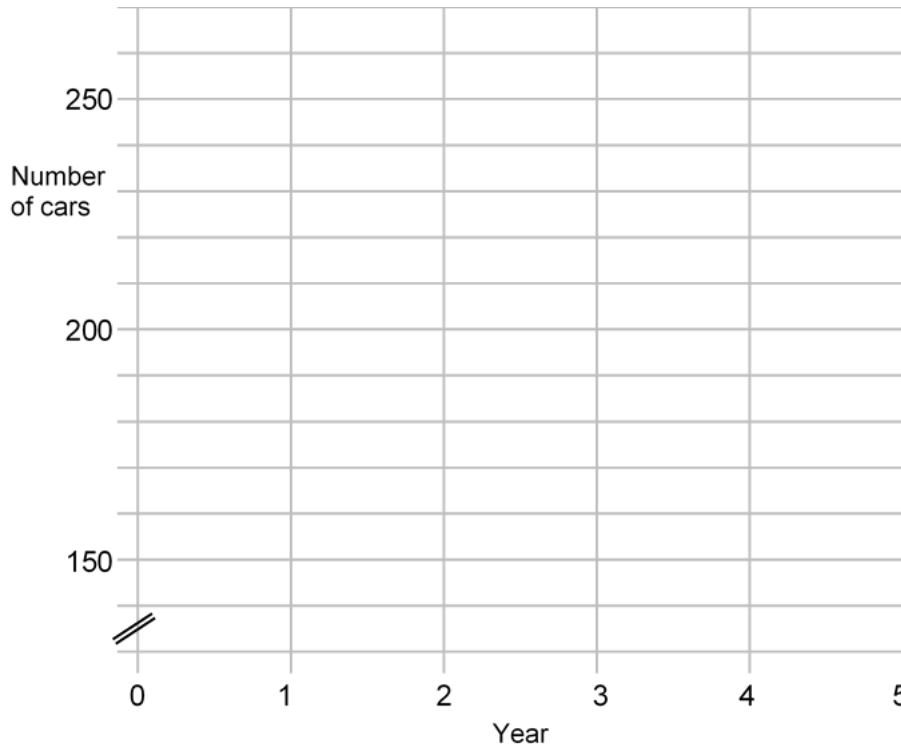
- (a) Explain the significance of the number 0.7 in this equation. (1 mark)

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- (b) Model the sequence on your calculator and generate the first 6 terms of the sequence. (1 mark)

Year	0	1	2	3	4	5
Number of cars	180					

- (c) Plot a graph which shows how car numbers change over time. (1 mark)



- (d) How many cars will the company own in the long term? (1 mark)

.....

Question 6 continues.

Question 6 (continued).

Instead of buying 45 new cars each year the company buys 75 new cars each year.

- (e) Model the situation with a difference equation. (1 mark)

.....

- (f) Generate the first 6 terms of the sequence. (1 mark)

Year	0	1	2	3	4	5
Number of cars	180					

- (g) Plot a graph of this sequence using the same axes as Question 6 (c). (2 marks)

- (h) How many cars will the company own in the long term? (1 mark)

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- (i) How would changing the **initial number** of cars purchased affect the **long term number** in this case? (2 marks)

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- (j) How many cars would the company need to purchase each year if it wished to maintain the fleet number at the initial level of 180 cars? (2 marks)

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Spare Diagrams

Question 5 (a)

ARITHMETIC SEQUENCE					
Day	1	2	3	4	5
Number of cups coffee sold	40	44			

GEOMETRIC SEQUENCE (round number to nearest integer)					
Day	1	2	3	4	5
Number of cups coffee sold	40	44			

Question 6 (b)

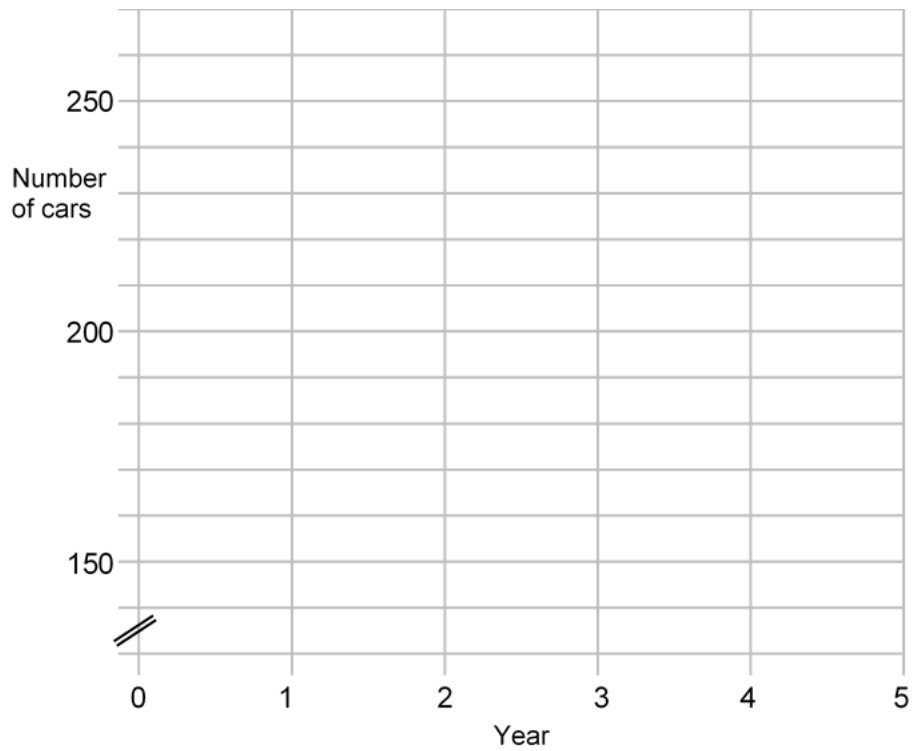
Year	0	1	2	3	4	5
Number of cars	180					

Spare diagrams continue.

Spare Diagrams

Spare diagrams (continued).

Question 6 (c)



Question 6 (f)

Year	0	1	2	3	4	5
Number of cars	180					

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GENERAL MATHEMATICS

(MTG315120)

PART 3

Finance

Time recommended for this part: 36 minutes

Pages:	12
Questions:	4
Attachment:	Information sheet

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Criterion 6 Interpret concepts and perform calculations to solve problems involving standard financial models.

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Question 7 (approximately 7 minutes)

\$ 2 500 is invested at 4% p.a. compounded monthly for a period of 3 years.

- (a) Calculate the amount of interest earned. (2 marks)

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- (b) How much would have to be invested to amount to a total of \$ 3 000 over 3 years? (2 marks)

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- (c) Find (to 2 decimal places) the effective interest rate offered by this investment. (2 marks)

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Question 8 (approximately 6 minutes)

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- (a) Explain the difference between straight line depreciation and reducing balance depreciation. (1 mark)

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Photographic equipment worth \$ 4 000 is depreciated by 25% per year based on the reducing balance.

- (b) Use the depreciation table below to show how the value of the equipment changes over 5 years. (3 marks)

Year	Value at start of year	Depreciation	Value at end of year
1	\$ 4 000		
2			
3			
4			
5			

- (c) Confirm the final value of your table by using a formula. (1 mark)

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EXAM CONTINUES OVER THE PAGE

Question 9 (approximately 10 minutes)

Troy is starting a plumbing business and has decided to invest in a superannuation plan. Each fortnight Troy will make a \$ 350 payment into a superannuation account which guarantees him 3% p.a. interest compounding fortnightly.

For
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Use
Only

- (a) How much will Troy have in the account if he intends to make regular contributions until he retires after 40 years of business? (3 marks)

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- (b) Find the size of the fortnightly deposit if Troy wishes to have \$ 750 000 in the account when he retires. (1 mark)

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- (c) Troy has some spare savings and decides to 'kick-start' the superannuation fund by making his first deposit \$ 8 000 followed by regular deposits of \$ 375. How much will be in the account when he retires? (2 marks)

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Question 9 continues.

Question 9 (continued).

(d) How much interest would Troy have earned over 40 years in the case of the 'kick-started' fund detailed in part (c)? (2 marks)

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/ 8

Question 10 (approximately 13 minutes)

Luke and Hannah take out a housing loan of \$ 300 000 at 4% p.a. compounding fortnightly calculated on the reducing balance. They arrange to make fortnightly repayments over 25 years.

For
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Use
Only

(a) Use an algebraic formula to show that their fortnightly repayment will be \$730.47.

(3 marks)

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(b) Find the total they repay over 25 years.

(1 mark)

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(c) How much will they owe after 6 years?

(2 marks)

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Question 10 continues.

Question 10 (continued).

For
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After making 6 years of payments, they inherit some money and decide to make a lump sum payment of \$ 100 000 to reduce the size of their loan. They also decide to increase their fortnightly repayments to \$ 900.

(d) How long will it take to pay off the loan? Answer in years and fortnights. (2 marks)

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(e) How much will the couple have paid in total by the time that the loan is repaid? (2 marks)

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(f) How much will Luke and Hannah have saved by making the lump sum payment and raising the size of their repayments? (1 mark)

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Spare Diagrams

Question 8 (b)

Year	Value at start of year	Depreciation	Value at end of year
1	\$ 4 000		
2			
3			
4			
5			

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GENERAL MATHEMATICS

(MTG315120)

PART 4

Trigonometry

Time recommended for this part: 36 minutes

Pages:	12
Questions:	3
Attachment:	Information sheet

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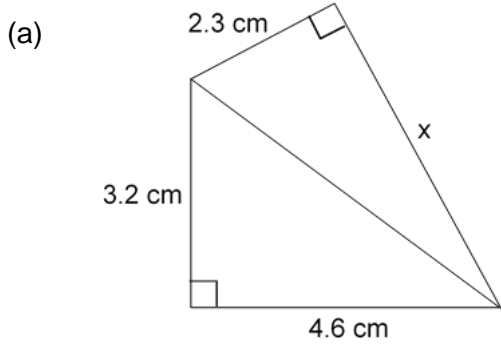
Criterion 7 Demonstrate knowledge and understanding of applications of trigonometry.

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Question 11 (approximately 8 minutes)

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Find the length of x .

(2 marks)

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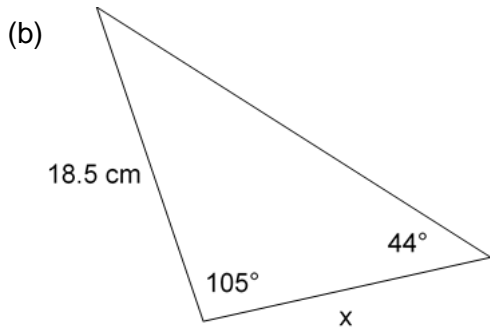
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Find the length of x .

(2 marks)

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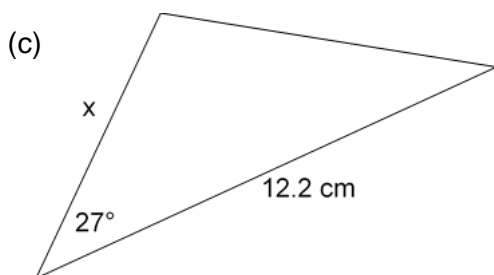
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Find the length of x , given that the area of the triangle is 21.62 cm^2 .

(3 marks)

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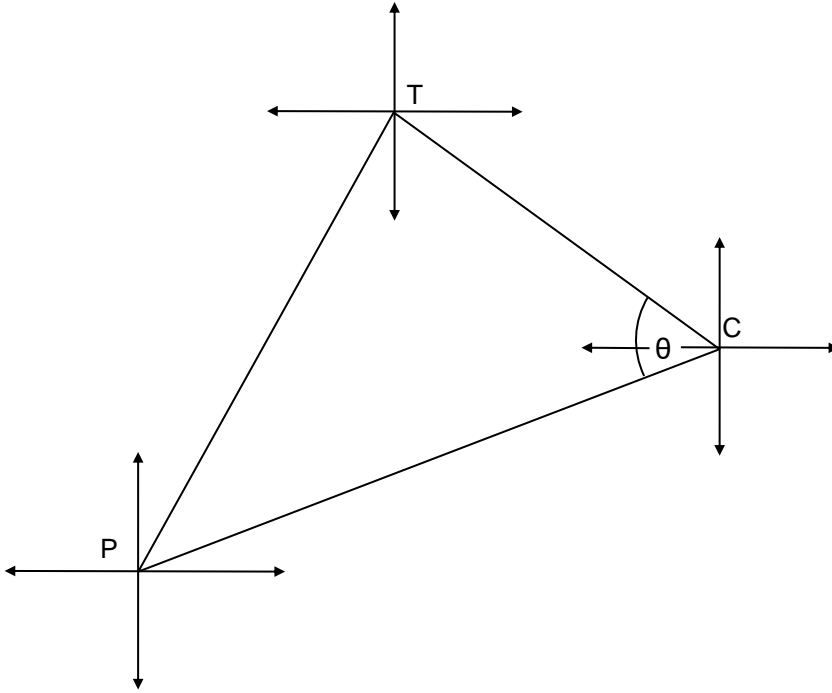
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Question 12 (approximately 12 minutes)

In a cross-country race, competitors leave a starting point P and follow a straight track for 5.4 km on a bearing of N67°E to an old church C. From the church, the runners must follow another path for 3.3 km on a bearing of N52°W to a tower T.

- (a) Represent the bearings as angles on the diagram below. (2 marks)



- (b) Show that angle θ equals 61° . (2 marks)

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- (c) Find the distance from the tower directly back to the starting point. (2 marks)

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Question 12 continues.

Question 12 (continued).

(d) Find (in degrees and minutes) the bearing of the starting point from the tower. (4 marks)

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Question 13 (approximately 16 minutes)

Cape Town (in South Africa) and Sydney are on the same latitude.

Cape Town is located at 34°S , 18°E .

Sydney is located at 34°S , 151°E .

- (a) Find the distance travelled in kilometres if a jet flies **due west** from Sydney to Cape Town.

(2 marks)

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- (b) Find the distance travelled in kilometres if, instead, the jet follows a **great circle route**.

(4 marks)

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- (c) Find the time saved (in minutes) by taking the great circle route if the jet flies at 820 km/h.

(2 marks)

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- (d) Explain why the great circle route results in a shorter distance even though the radius of the circle involved is larger.

(1 mark)

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.....

Question 13 continues.

Question 13 (continued).

A jet leaves Sydney at 9:30 am and flies at 820 km/h to Cape Town by the **shortest** possible route.

For
Marker
Use
Only

- (e) Find the time zones for Cape Town and Sydney. (1 mark)

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- (f) Find the estimated time of arrival of the jet in Cape Town. (3 marks)

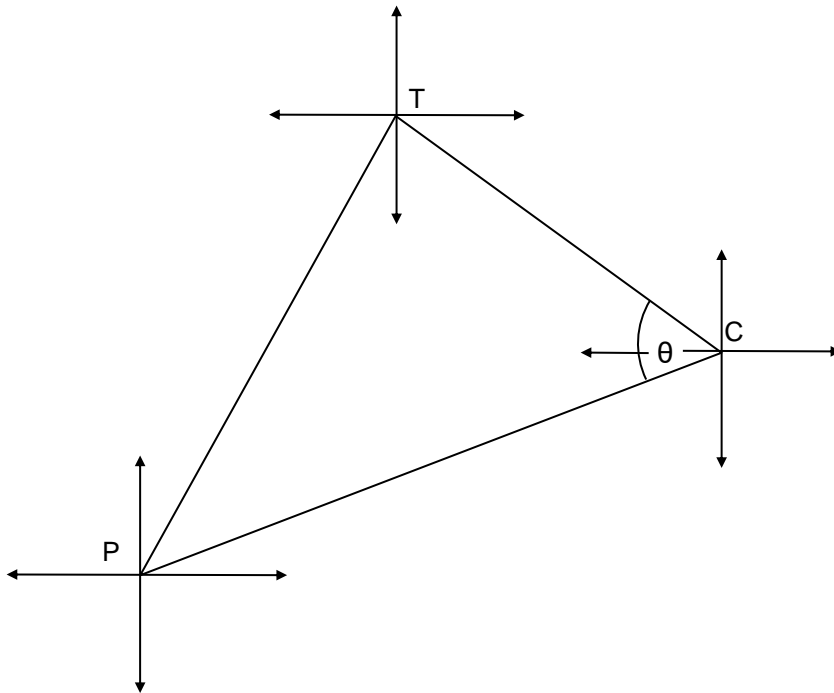
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Spare Diagrams

Question 12 (a)



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GENERAL MATHEMATICS

(MTG315120)

PART 5

Graphs and Networks

Time recommended for this part: 36 minutes

Pages:	12
Questions:	4
Attachment:	Information sheet

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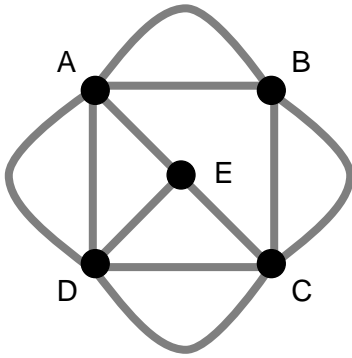
Criterion 8 Interpret language and concepts of graphs and networks in order to model and analyse practical situations aiding mathematical decision making.

Section Total:	/ 30
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Question 14 (approximately 5 minutes)

For
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Only



(a) Show that Euler's Formula holds true for this network. (2 marks)

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(b) What is an 'Eulerian circuit'? (1 mark)

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(c) Is it possible to make an Eulerian circuit through this network? How could you tell even without trying to trace the network? (1 mark)

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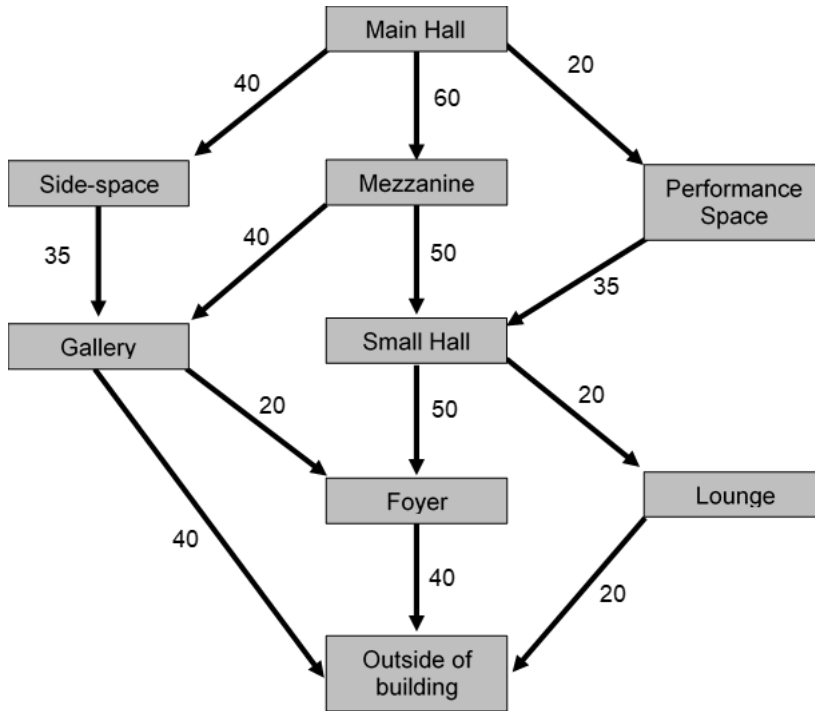
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Question 15 (approximately 10 minutes)

The graph below gives information about the flow of people from the Main Hall of a modern art gallery to its outside in the event of a fire emergency.

The weights on each edge of the graph show the number of people per minute that can move through a doorway, stairway or constriction.



(a) Make at least 6 'cuts' through the flow graph above and show the capacity of each. (3 marks)

(b) What is the maximum flow of people from the Main Hall to the outside of the building in the event of a fire? (1 mark)

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Question 15 continues.

Question 15 (continued).

Fire authorities have proposed two different suggestions for upgrading the building so that there is a greater capacity to move people from the Main Hall to outside the building.

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- (c) Proposal 1: The doors connecting the Small Hall to the Lounge could be widened to increase their capacity by an extra 20 people per minute.

How much would this change affect the overall flow from the Main Hall to outside? Explain your answer.

(2 marks)

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- (d) Proposal 2: Build a set of emergency stairs that could cope with 30 people per minute, directly connecting the Side-space to the outside of the building.

How much would this change affect the overall flow from the Main Hall to outside? Explain your answer.

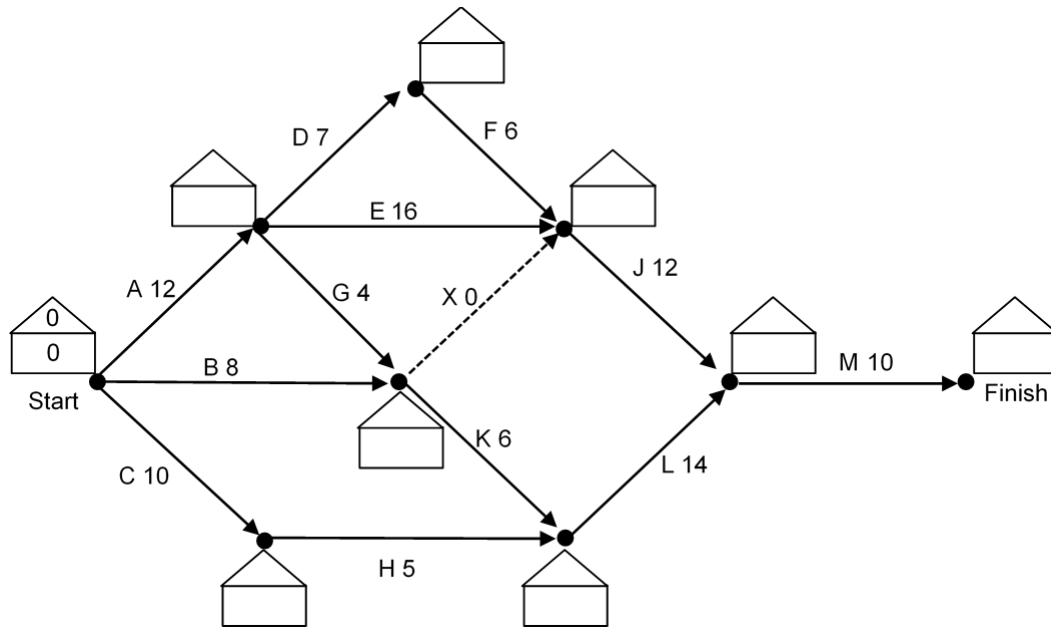
(2 marks)

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Question 16 (approximately 10 minutes)

The graph below was drawn to identify tasks which are critical to the overall completion time of a major project. Time is measured in days.

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(a) Complete the graph by showing the earliest starting time (EST) and latest finishing time (LFT) for each activity. Mark the **critical path** on the graph. (3 marks)

(b) What is the minimum completion time for the project? (1 mark)

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(c) What is the float involved in activity K? (1 mark)

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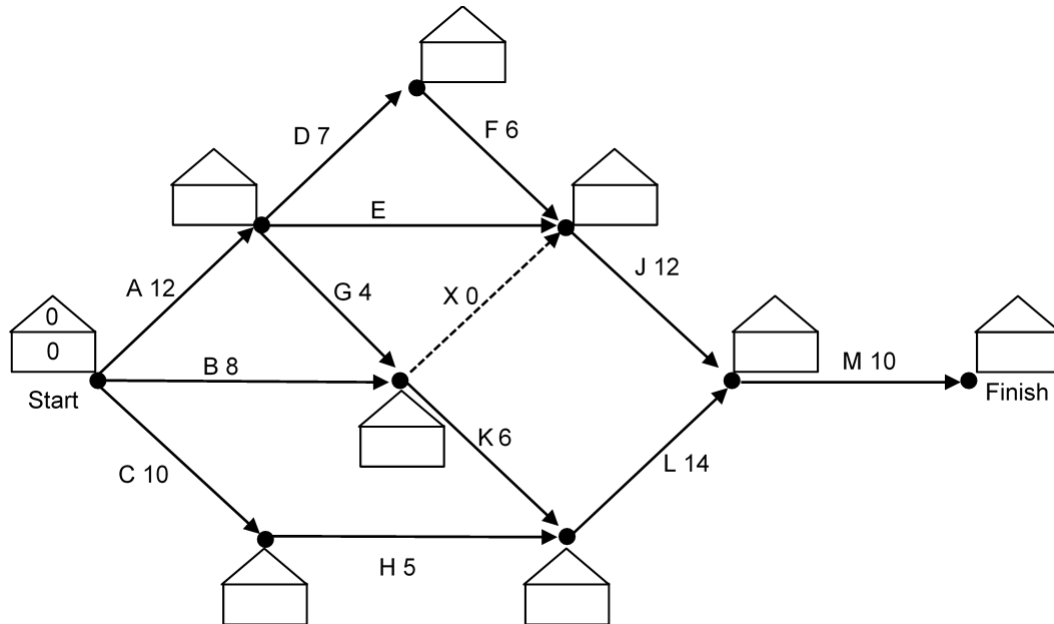
Question 16 continues.

Question 16 (continued).

A project manager finds that the time involved in activity E could be reduced by 4 days.

- (d) Rework the graph showing the duration of activity E, the EST and LFT for each activity and the critical path. (3 marks)

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- (e) What changes have occurred as the result of the project manager's findings? (1 mark)

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Question 17 (approximately 11 minutes)

There are four tasks involved in making a furniture item. Each task is to be assigned to one of four factory workers in such a way that the overall time for making the furniture is minimised. The table below shows the time in minutes that each of the four workers takes to complete the tasks.

	Time taken on tasks			
	Cut	Assemble	Sand	Varnish
Harriet	68	60	61	46
Izzy	85	82	79	70
Joel	62	58	70	45
Kevin	72	65	82	57

- (a) Represent the table as a matrix and use the Hungarian method to reduce it to a form where it is possible to allocate workers to tasks in a way that minimises the total time taken.

(3 marks)

Question 17 continues.

Question 17 (continued).

(b) Which worker should specialise in each task if the total production time is to be minimised? (1 mark)

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(c) How long will it take to manufacture the furniture using this assignment? (1 mark)

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(d) How much time is saved making four pieces of furniture using this specialisation of tasks when compared with each worker working alone to make one piece each? (3 marks)

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(e) Suggest a possible problem or disadvantage if specialisation of tasks is used. (1 mark)

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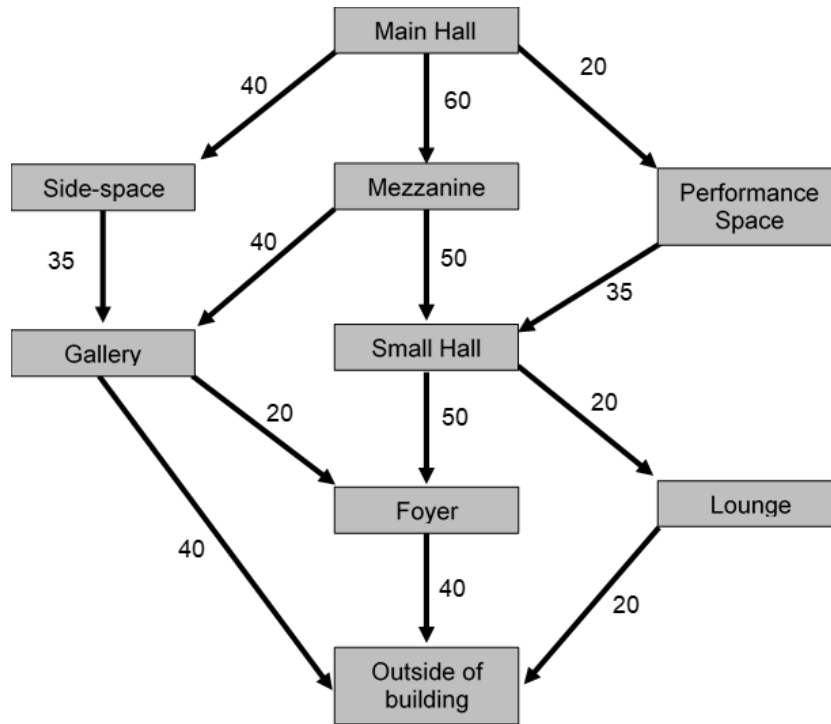
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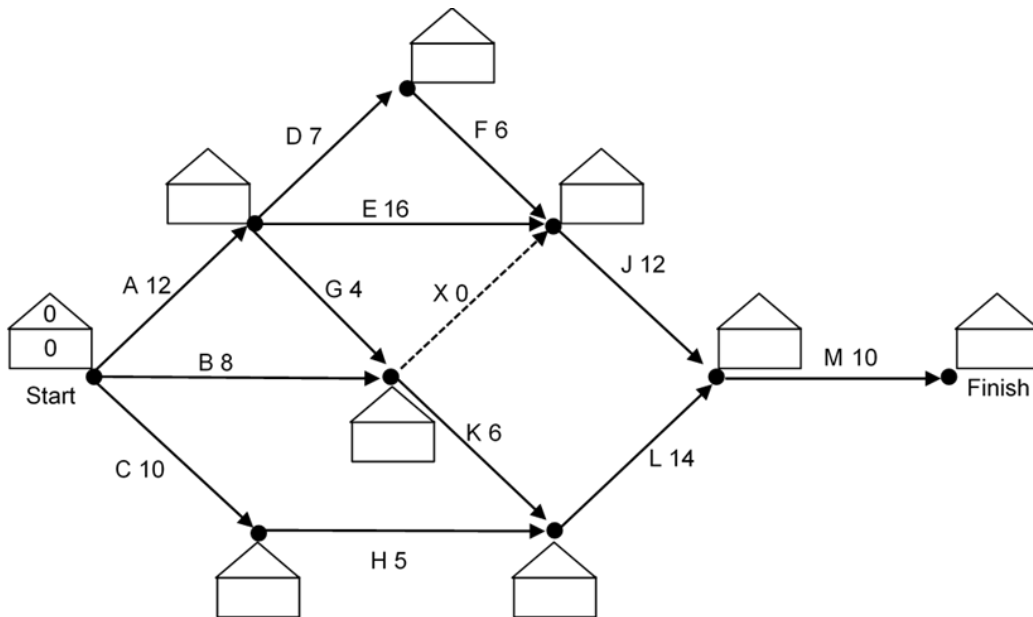
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Spare Diagrams

Question 15 (a)



Question 16 (a)

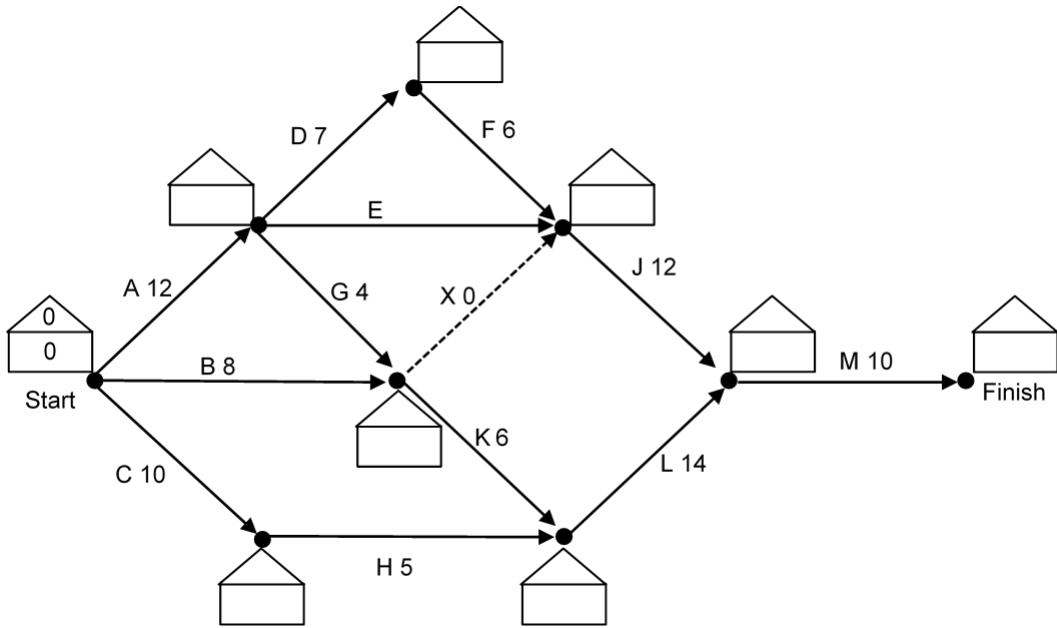


Spare diagrams continue.

Spare Diagrams

Spare diagrams (continued).

Question 16 (d)



Question 17 (a)



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