OFFICE OF TASMANIAN ASSESSMENT, STANDARDS & CERTIFICATION

GENERAL MATHEMATICS
(MTG315115)

PART 1 – Bivariate Data Analysis

Time: 36 minutes

Pages:	12
Questions:	3
Attachments:	Information Sheet

Candidate Instructions

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2. Answer **ALL** questions. Answers must be written in the spaces provided on the examination paper.

3. You should make sure you answer all parts within each question so that the criterion can be assessed.

4. This examination is 3 hours in length. It is recommended that you spend approximately 36 minutes in total answering the questions in this booklet.

5. The 2016 External Examination Information Sheet for General Mathematics can be used throughout the examination. No other written material is allowed into the examination.

6. All written responses must be in English.

On the basis of your performance in this examination, the examiners will provide results on each of the following criteria taken from the course statement:

Criterion 4   Demonstrate knowledge and understanding of bivariate data analysis.

Section Total:	/36

Additional Instructions for Candidates

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Spare diagrams have been provided in the back of the booklet for you to use if required.

If you use either of these spare diagrams you MUST indicate you have done so in your answer to that question.

(a) Using two of the terms shown below, describe the **trend** and the **secular** (long term) **trend** indicated in the two graphs below: (2 marks)

trend terms: seasonal, cyclic, or random,

secular trend terms: upwards, a downwards or no long-term trends.

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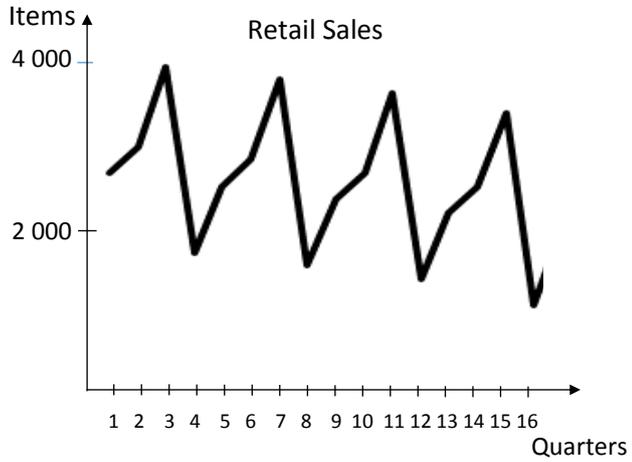
(b) The quarterly electricity usage of a household, in kilowatt hours (kWh), and some seasonal index and deseasonalised quarterly usage figures related to these are shown in the table below. (3 marks)

Quarter	1	2	3	4
Electricity usage (kWh)	220	421	400	147
Seasonal index	0.60		1.27	0.68
Deseasonalised Electricity Usage (kWh)	367		315	216

(i) Determine the seasonal index for **quarter 2**.

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(ii) Deseasonalise the electricity usage for quarter 2 and hence determine which quarter used the least amount of electricity in seasonally adjusted terms.

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Question 2 (approximately 14 minutes)

A new child care centre opened in January. The number of children attending on the **first day** of each month is shown in the table below.

(a) (i) Calculate the missing 3-point moving average figures and include these in the table below. (Give your numbers to one decimal place.) (2 marks)

Month	Month number	Children	3-pt moving average
January	1	52	■■■
February	2	46	**54.3**
March	3	65	**56.0**
April	4	57	**57.3**
May	5	50	**59.3**
June	6	71	
July	7	65	
August	8	75	
September	9	83	
October	10	54	■■■

(ii) Include the missing 3-point moving average figures on the graph below.
(2 marks)
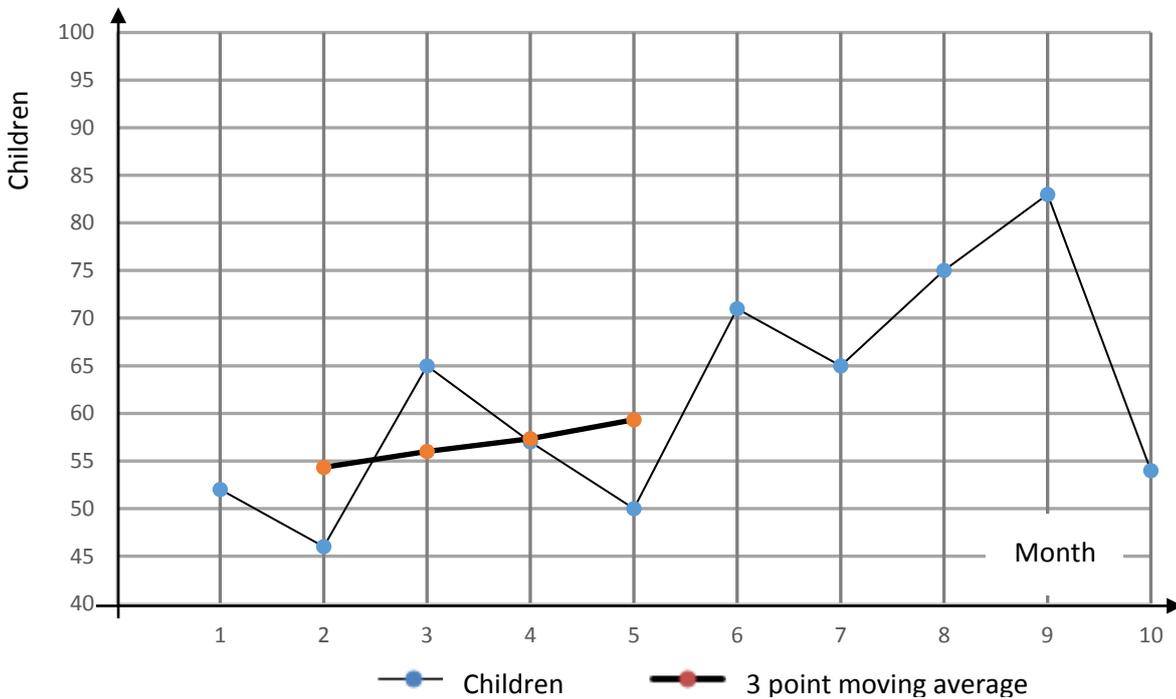
Question 2 continues.

Question 2 (continued)

(b)   Determine the equation of the **trend line** for the **3-point moving average** of the number of children attending the child care centre. (Give your numbers to one decimal place.)   (2 marks)

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(c)   Use your equation from part (b) to forecast the number of children that would be attending in October of the (same) year. (Give your answer to the nearest whole number.)   (2 marks)

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(d)   The child care centre manager finds that they cannot cater for more than 100 children on a regular basis. Showing algebraic workings, predict in which **month** this could occur for the first time.   (3 marks)

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(e)   Consider your answers to parts (c) and (d). Comment on the **reliability** of your answers.   (3 marks)

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Question 3 (approximately 17 minutes)

Sam runs a small seaside shop. He is interested to see if the number of cold drinks he sells is dependent on the temperature of the day.

Sam records the number of cold drinks (C) he sells against the temperature (T) of the day for a period of nine days. The data he collected is shown in the table and the graph below.

Temperature (°C) T	Cold drinks sold C
15	7
18	11
22	142
23	29
24	37
25	44
30	62
32	68
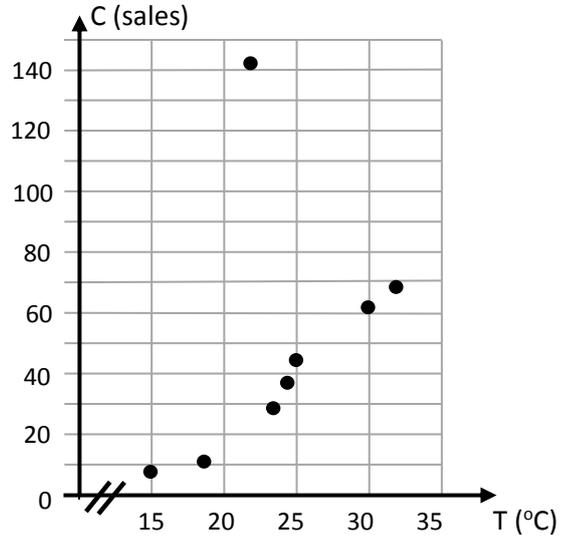
Sam found the equation of the **line of best fit** and the **correlation coefficient** for this data to be:

$$C = 3.01\,T - 21.13 \qquad r = 0.3941$$

(a) Explain the gradient and the y-intercept in context of the variables Sam investigated. Comment on their relevance. (3 marks)

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(b) Write a conclusion based on the correlation coefficient. (2 marks)

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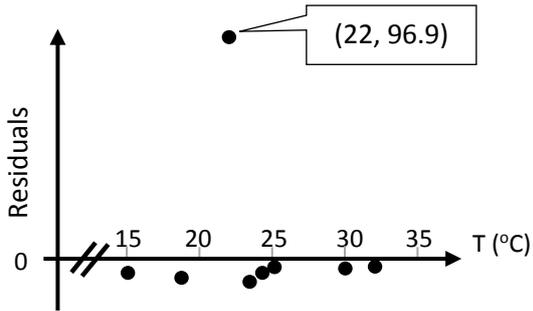
Question 3 continues.

Question 3 (continued)

(c)   The residuals plot for this linear model and the point (22, 96.9) are shown below.

(i)   Interpret the **residual point** (22, 96.9), in terms of the variables being
       investigated.   (2 marks)

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(ii)   Explain the effect that this point value (22, 142) has on the linear model Sam
       found.   (2 marks)

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(d)   **Remove** the point (22, 142) from the original data point opposite and determine the:
                                                                                    (2 marks)

       New linear equation: ....

       New correlation coefficient: ....

(e)   Prepare a scaled **residual plot** for the new linear model you have found in in part (d).
                                                                                    (3 marks)

Question 3 continues.

Question 3 (continued)

(f)   On the basis of your answers to parts (d) and (e), state whether or not the linear equation you have found in (d) models this data well or otherwise. Give reasons for your choice.   (3 marks)

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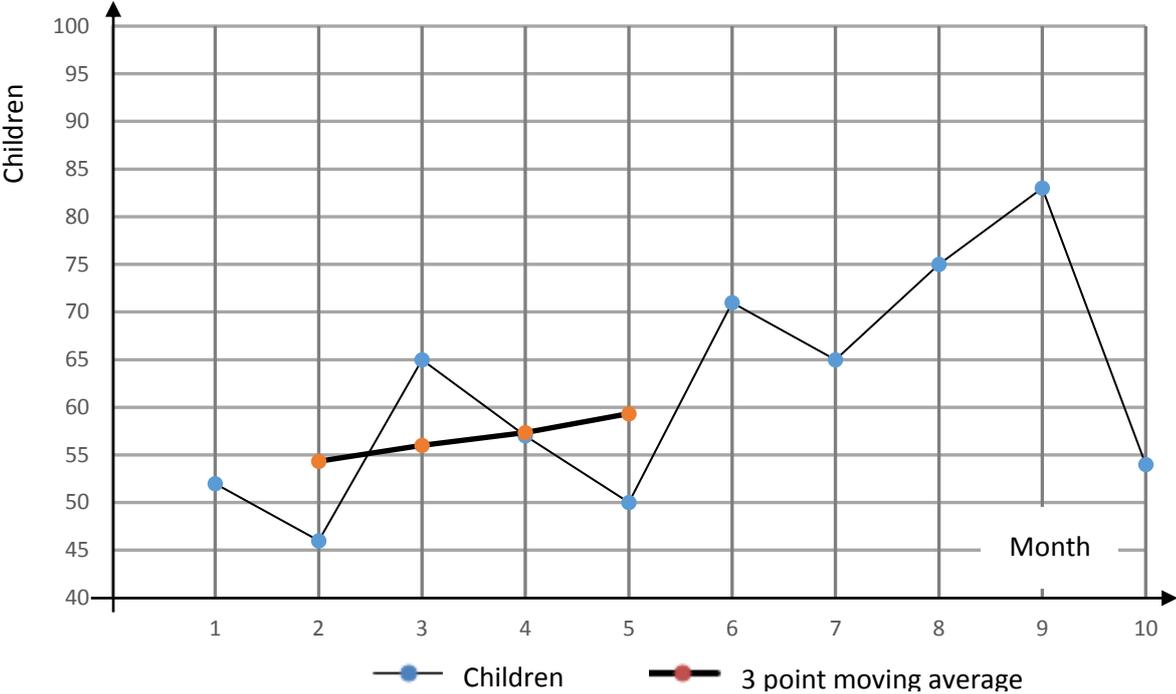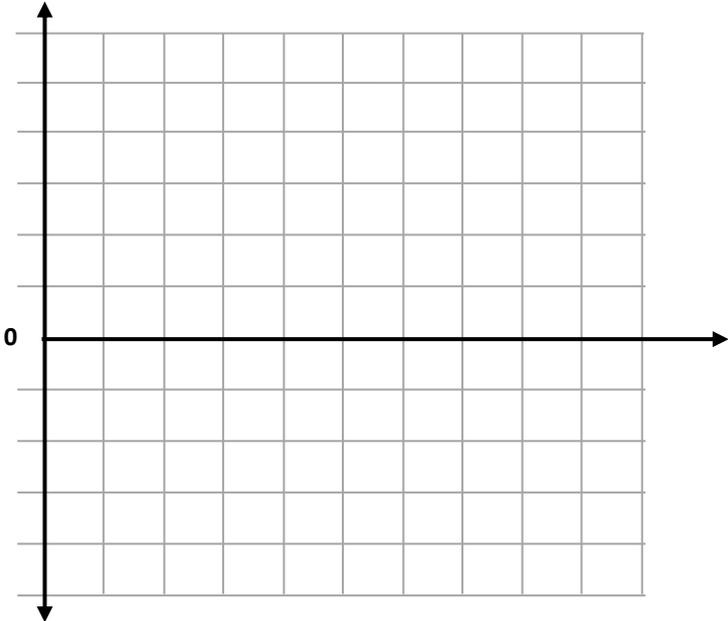
SPARE DIAGRAMS

Question 2 (a) (i)

Question 3 (e)

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PLACE YOUR CANDIDATE
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GENERAL MATHEMATICS
(MTG315115)

PART 2 – Growth and Decay in Sequences

Time: 36 minutes

Pages:	12
Questions:	4
Attachments:	Information Sheet

Candidate Instructions

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On the basis of your performance in this examination, the examiners will provide results on each of the following criteria taken from the course statement:

Criterion 5   Demonstrate knowledge and understanding of growth and decay in sequences.

Section Total:	/36

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Additional Instructions for Candidates

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A spare graph has been provided in the back of the booklet for you to use if required.

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Question 4 (approximately 9 minutes)

The amount of cherries produced in Tasmania, in tonnes, by the end of each year, from 2008 to 2011 are shown in the table below.

Year	2008	2009	2010	2011
Cherries (tonnes)	3 150	4 300	5 450	6 600

(a)   If this pattern was to continue, predict how many cherries were produced in 2013.

(1 mark)

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(b)   Write an **arithmetic sequence** rule that describes the amount of cherries produced.

(1 mark)

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(c)   Using the arithmetic sequence from part (b), **algebraically** determine at the end of which year the amount of cherries produced would first exceed 12 000 tonnes.

(3 marks)

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(d)   Defining the terms you use, write a **difference (recursive) equation** that could also be used to predict the amount of cherries produced each year.   (2 marks)

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(e)   Assuming this **arithmetic sequence** continues**,** for the years 2008 to 2017, inclusive, determine the total amount of cherries produced over that time period.   (2 marks)

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Question 5 (approximately 5 minutes)

Ahmed and Jasmin start working at the same time. They both start on salaries of $55 000.

Over a ten year period, Ahmed's salary increases by $4 000 each year, whilst Jasmin's salary increases by 6.0% each year.

(a) What are their salaries in the second year? (1 mark)

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(b) Using appropriate sequence formulae and other supporting evidences, compare Ahmed's and Jasmin's salaries over a **ten year period**. (4 marks)

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Question 6 (approximately 9 minutes)

Sue runs and cycles as part of her weekly exercise program.

The distance Sue runs each week can be modelled by the difference equation:

$$R_{n+1} = 0.75\, R_n + 5.0 \qquad\qquad \text{where } R_1 = 9.0 \text{ km}$$

(a)   Determine the distance that Sue will run in week 2. (Give your answer to one decimal place). (1 mark)

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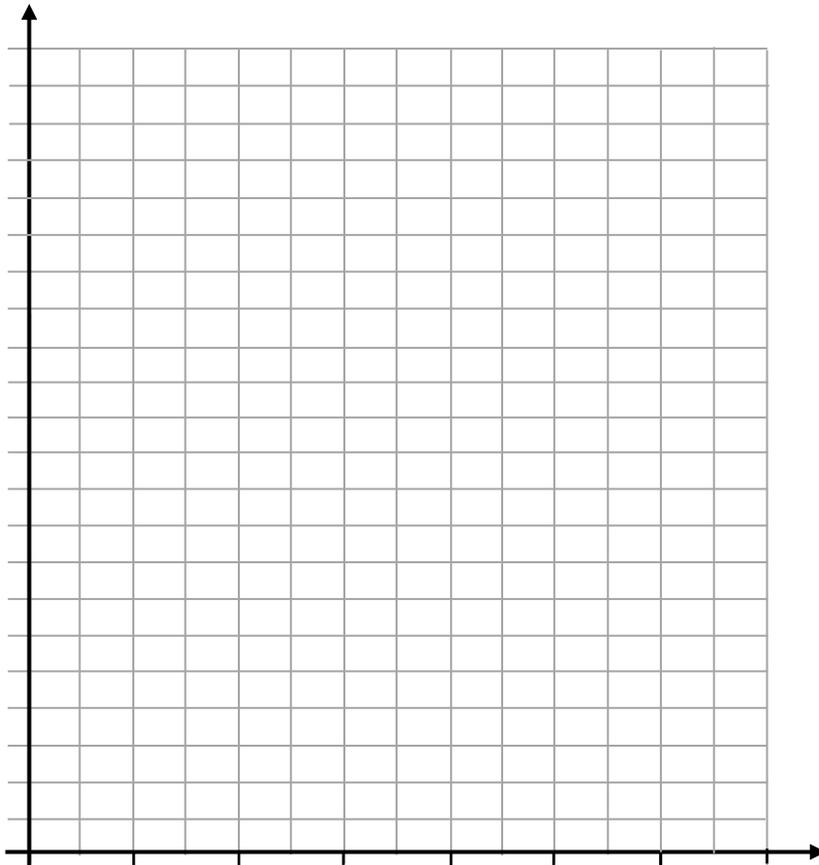
The distance Sue cycles each week can be modelled by the difference equation:

$$C_{n+1} = 0.90\, C_n + 4.0 \qquad \text{where } C_1 = 6.0 \text{ km}$$

(b)   **Graph** the distances that Sue runs and cycles for weeks 1 to 7 on the grid below.
(3 marks)

Question 6 continues.

(c)   Use the graph for weeks 1 to 7 and data from your calculator that **extends beyond week 7** to describe the **trend** in these two forms of exercise that Sue undertakes. What are the maximum distances she runs and cycles, and when approximately will these occur?   (3 marks)

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Sue decides to cycle a **constant** distance of 45 km each week.

A new difference equation (shown below), could be used to model this new scenario:

$$C_{n+1} = 0.90\, C_n + k \qquad \text{where } C_1 = 45 \text{ km}$$

(d)   Determine the value of 'k' and write the new difference equation.   (2 marks)

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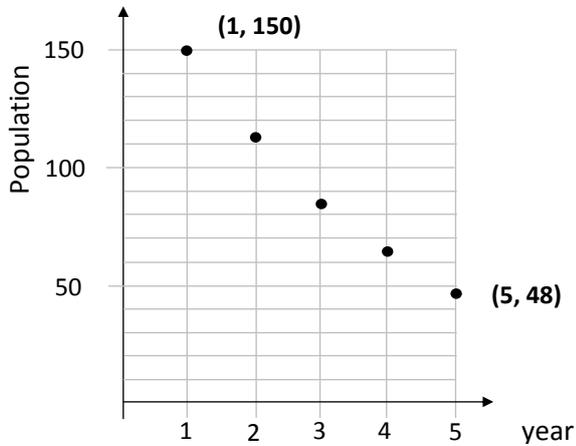
Question 7 (approximately 14 minutes)

At the beginning of the first year of a scientific study, the population of a parrot species was 150. At the beginning of the fifth year of this study, the population of parrots had decreased to 48.

A graph of the population of parrots over this time period is shown below.

(a)   Show that a **geometric sequence rule** that could be used to describe how the population changes is: (2 marks)

$$t_n = 150 \, (0.75)^{n-1}$$

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(b)   What is the annual percentage decrease in the population?   (1 mark)

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(c)   Use the geometric sequence rule from part (a) to predict at the beginning of which year the population would become extinct, i.e. when there are less than 1.0 birds.   (2 marks)

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Question 7 continues.

Question 7 (continued)

When the parrot population had decreased to 48, it was decided to add 30 extra parrots from a captive breeding program, at the beginning of each year. Scientists predicted that this would also result in an annual 18% population decrease.

(d)   Identify 'r' in the first order difference (recurrence) equation below that will predict the population of the parrots at the beginning of each year.   (1 mark)

$$P_{n+1} = r\,P_n + 30, \text{ where } P_1 = 48 \text{ parrots}$$

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(e)   Use this equation to describe the change in population in parrots over the next 25 years. Approximately at what number will the population of parrots stabilise?   (3 marks)

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When the scientists started adding 30 birds each year, they found that the population decrease was **more than 18%**, with the population stabilising at 140 parrots.

(f)   Based on this information, determine the actual **'r'** figure and the difference equation. Determine the actual annual percentage population decrease that occurred.   (4 marks)

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Difference equation: ....

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Actual annual percentage population decrease: ....
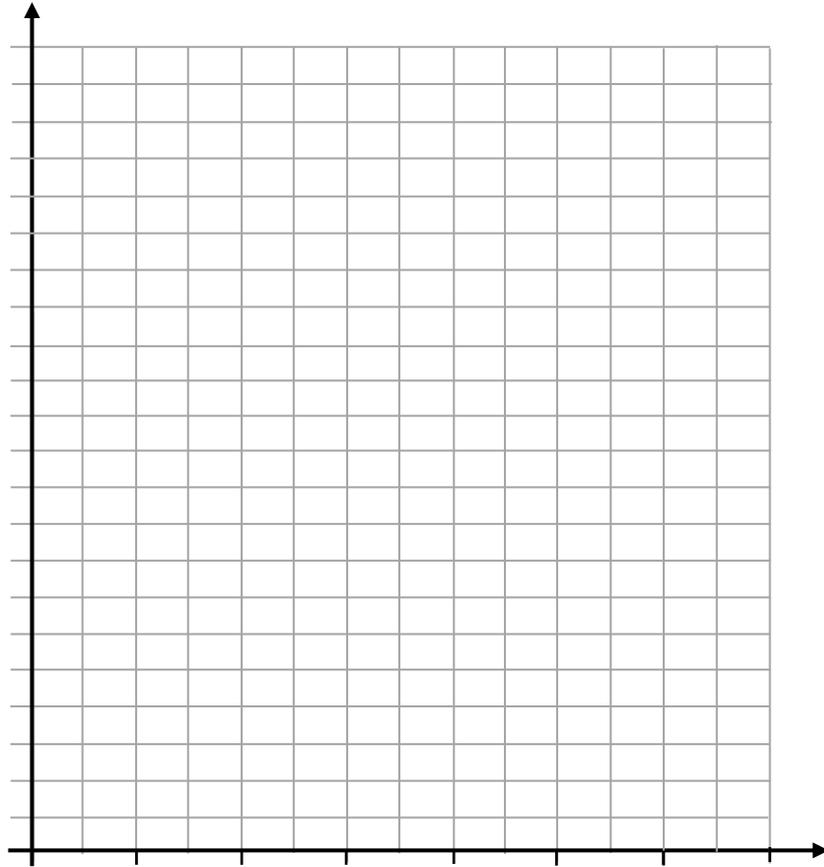
Question 6

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GENERAL MATHEMATICS
(MTG315115)

PART 3 – Finance

Time: 36 minutes

Pages:	12
Questions:	4
Attachments:	Information Sheet

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Criterion 6 Demonstrate knowledge and understanding of standard financial models.

Section Total:	/36

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Question 8 (approximately 8 minutes)

Ivana wants to invest $20 000 for three years. Two banks offered her the following investment options:

    Bank A   2.52% p.a. (nominal) compounded monthly

    Bank B   2.55% p.a. (nominal) compounded half yearly

(a)   Using **effective interest rates** to compare these rates, determine with which bank she should invest.   (3 marks)

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(b)   If Ivana bought shares with the $20 000 and sold them, 3 years later for $21 952 determine how much extra money she would have made as opposed to investing her money with *Bank B* for 3 years.   (3 marks)

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(c)   If instead, Ivana had invested her $20 000 at 4.40% p.a. compounded annually, generate a **recurrence (difference) equation** representing this situation.   (2 marks)

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Question 9 (approximately 7 minutes)

'Payday' loans are **simple interest** loans that are taken out over short periods of time. The simple interest rates on 'Payday' loans are **very high**.

Bill took out a 'Payday' loan for $1 000 on 1 March. He repaid the loan with $1 220 on 4 May.

(a)   Showing **algebraic workings**, determine the simple interest rate (p.a.) for this loan.

(4 marks)

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(b)   If, instead, Bill had borrowed $1 000 at a lower simple interest rate of 5.9% p.a. between 1 March and 4 May, determine how much interest he would have saved.

(3 marks)

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Question 10 (approximately 10 minutes)

Sophie wants to save up to buy a new car for $25 000 in five years time.

To do this Sophie makes regular deposits of $290 per month into an account that pays 3.20% p.a. interest compounded monthly.

(a) How much will Sophie have saved after five years? (3 marks)

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(b) Sophie currently owns a car valued at $ 9 000. If this car depreciates at 15% p.a. on a **reducing balance**, determine its value after five years. (3 marks)

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Question 10 continues.

Question 10 (continued)

(c)   After five years Sophie is able to sell her car for $ 3 500. Even with this money, she needed to have increased the amount she deposited every month from the $290 in part (a) in order to have $25 000 after five years.

Determine the **extra** amount that Sophie would need to deposit every month in order to have a total of $25 000 in five years.   (4 marks)

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Question 11 (approximately 11 minutes)

A person borrows $320 000 in order to buy a house. They repay this at an interest rate of 6.80% p.a. compounded monthly over 25 years.

(a)   Show that the **monthly repayment figure** over this 25 year period is $2 221 to the nearest dollar.   (2 marks)

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(b)   What are the total repayments over the first five years?   (2 marks)

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After five years the interest rate decreases to 5.20% p.a. compounded monthly.

(c)   They have decided to keep paying $2 221 a month after the introduction of this new interest rate. How long from this point will it take to fully repay the loan?   (3 marks)

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Question 11 continues.

Question 11 (continued)

(d) Compared to the original loan conditions, how much money is saved by using the lower interest rate after five years in part (c). (4 marks)

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GENERAL MATHEMATICS
(MTG315115)

PART 4 – Trigonometry

Time: 36 minutes

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Criterion 7   Demonstrate knowledge and understanding of applications of trigonometry.

Section Total:	/36

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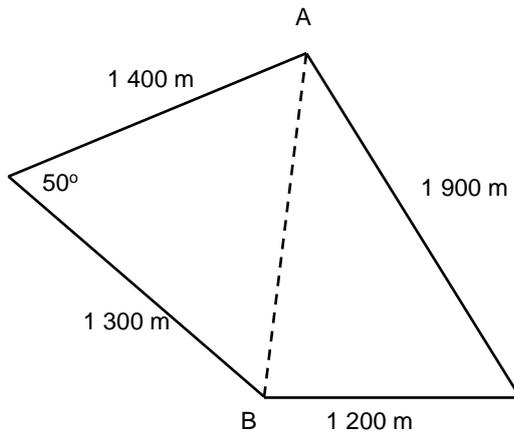
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Question 12 (approximately 6 minutes)

The dimensions of a block of land are shown below.

(a)   Show that the length of AB is 1 145 m.   (2 marks)

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(b)   Determine the area of the block of land.   (4 marks)

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Question 13 (approximately 6 minutes)

Two bird watchers observe an eagle that is flying **due east** of them at the same time.

Person A observes the eagle at an angle of elevation of 27°. Person B, who is 200 m due east of person A, observes the eagle an angle of elevation of 48°.

(a)   Complete the diagram illustrating this in the space below.   (2 marks)

Eagle

East

(b)   Use trigonometry to determine the height of the eagle above the ground.   (4 marks)

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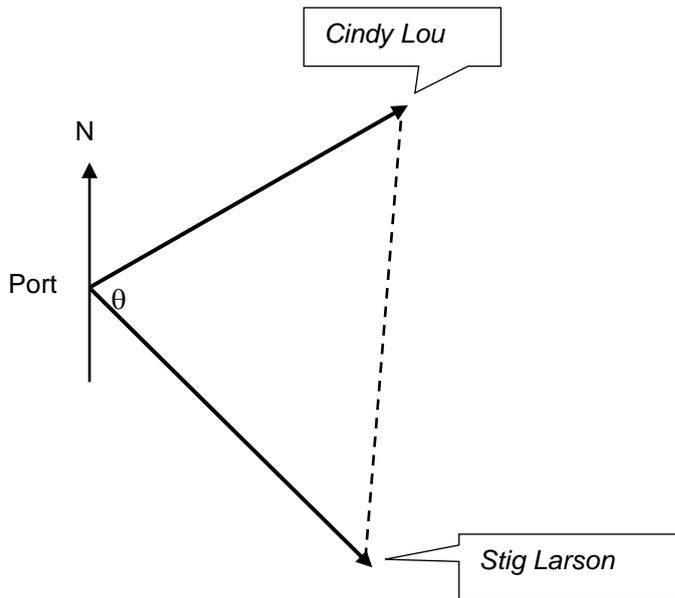
Question 14 (approximately 9 minutes)

Two fishing boats leave port at the same time. The *Cindy Lou* travels on a bearing of
N 50° E for 26 km. The *Stig Larson* travels 23 km on a different bearing, as shown in the
diagram below. After two hours, the boats stop and are 33 km apart.

(a)   Use the above information to complete the diagram below illustrating this situation after
   two hours.   (2 marks)

(b)   Use trigonometry to show that the angle (θ) formed between the two boats is 84.4°.
                                                                                   (3 marks)

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Question 14 continues.

Question 14 (continued)

(c) The *Cindy Lou* then travels **another 12 km** on the same bearing (N 50° E) before stopping, as shown below. (The *Stig Larson* remains where it was.)

Determine the distance between the two boats and the bearing that the *Cindy Lou* is now from the *Stig Larson*. (4 marks)

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Question 15 (approximately 15 minutes)

A cargo ship sailed from Fremantle, Western Australia (32ºS, 116ºE) at 10:00 pm on 14 October, taking the **shortest possible route** to Colombo, Sri Lanka (7ºN, 80ºE).

(a)   What is the standard time difference between Fremantle and Colombo?   (2 marks)

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(b)   In Fremantle, a person makes a phone call to their friend in Colombo. If they want to contact their friend in Colombo, between 8:00 am and 6:00 pm, Sri Lankan time, between what Western Australian times should they make this phone call?   (2 marks)

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(c)   Determine the shortest **distance** between Fremantle and Colombo. Give your answer to the nearest nautical mile.   (4 marks)

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Question 15 continues.

(d)   If the cargo ship sailed at an average speed of 21 knots determine its **arrival date** and **time** in Colombo, Sri Lanka.   (4 marks)

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Colombo, Sri Lanka (7°N, 80°E) is on the **same line of latitude** as Georgetown, Guyana.

(e)   Georgetown, Guyana is 15 230 km **due west** of Colombo. Determine the **longitude** and hence the **position coordinates** of Georgetown. Give the position coordinates to the nearest degree.   (3 marks)

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SPARE DIAGRAMS

Question 13

Eagle
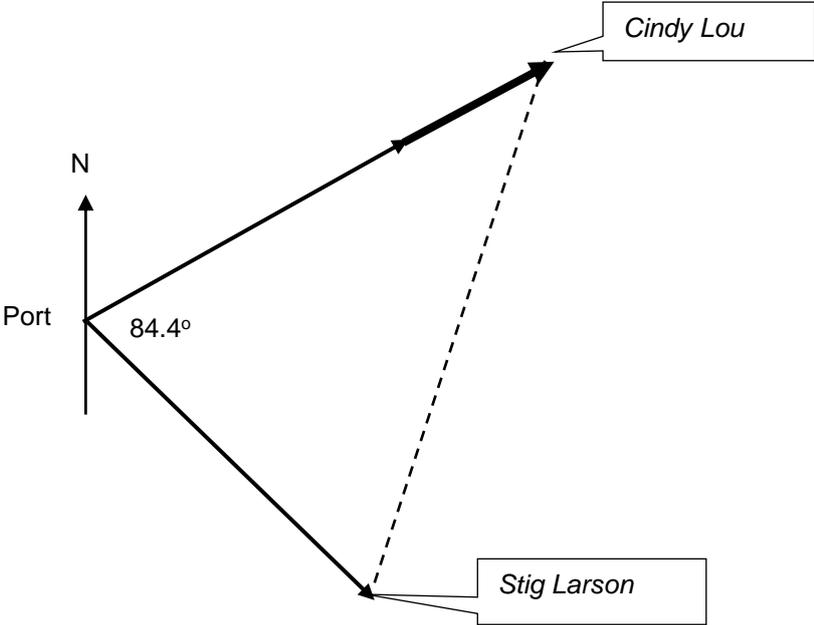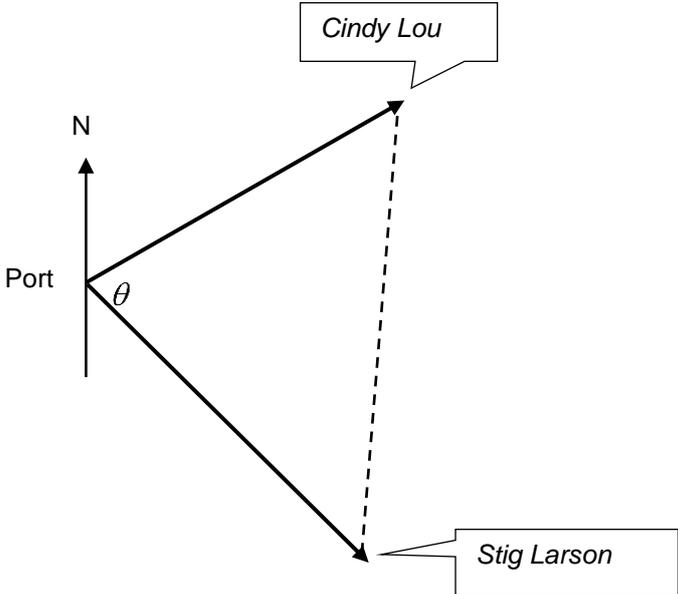
East

Question 14

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GENERAL MATHEMATICS
(MTG315115)

PART 5 – Graphs and Networks

Time: 36 minutes

Pages:	12
Questions:	4
Attachments:	Information Sheet

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3. You should make sure you answer all parts within each question so that the criterion can be assessed.

4. This examination is 3 hours in length. It is recommended that you spend approximately 36 minutes in total answering the questions in this booklet.

5. The 2016 External Examination Information Sheet for General Mathematics can be used throughout the examination. No other written material is allowed into the examination.

6. All written responses must be in English.

On the basis of your performance in this examination, the examiners will provide results on each of the following criteria taken from the course statement:

Criterion 8   Demonstrate knowledge and understanding of graphs and networks.

Section Total:	/36

Additional Instructions for Candidates

Logical and mathematical presentation of answers and the statement of the arguments leading to your answer will be considered when assessing this part.

You are expected to provide a calculator approved by the Office of Tasmanian Assessment, Standards and Certification.

For questions worth 1 mark, whilst no workings are required, markers may consider appropriate step(s) taken to come to an answer.

For questions worth 2 or more marks, markers will look at the presentation of answer(s) and at the argument(s) leading to the answer(s).

For questions worth 3 or more marks, you are **required to show** relevant working.

Spare diagrams have been provided in the back of the booklet for you to use if required.

If you use either of these spare diagrams you MUST indicate you have done so in your answer to that question.

Question 16 (approximately 8 minutes)

The network diagram below shows the flow capacity, in kilolitres (kL) per minute, in water pipes connecting points A to G.
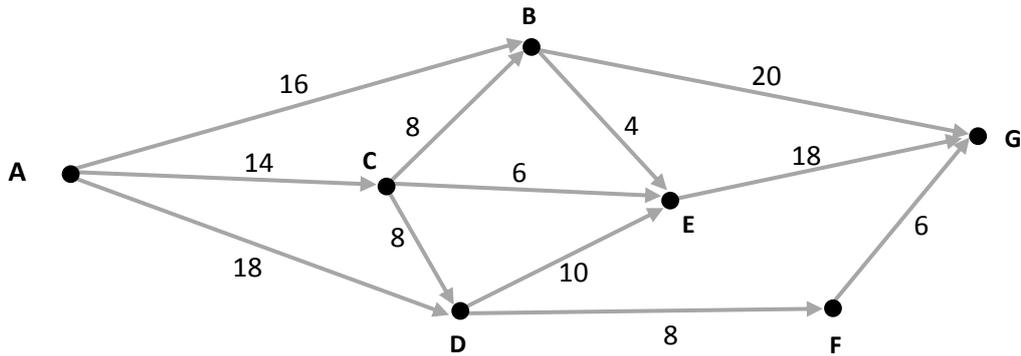
(a)   Identify the **source** and the **sink** of this network.   (1 mark)

Source: ....

Sink: ....

(b)   Without calculating the maximum flow, briefly explain why some of the 48 kL per minute of water that could flow from the source is not able to be carried by the irrigation system to the sink.   (2 marks)

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(c)   Use the 'minimum cut = maximum flow' method to determine the **maximum flow** in this network. Show your workings on the network diagram above.   (2 marks)

Maximum flow: ....

(d)   If **only one of the pipes** could be modified to improve the water flow, which pipe could this be, and by how much could this pipe be increased? Give **two possible** solutions.
                                    (3 marks)

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A market gardener has an irrigation system consisting of a series of pipes with a water inlet at vertex A and outlets at vertices B to I.
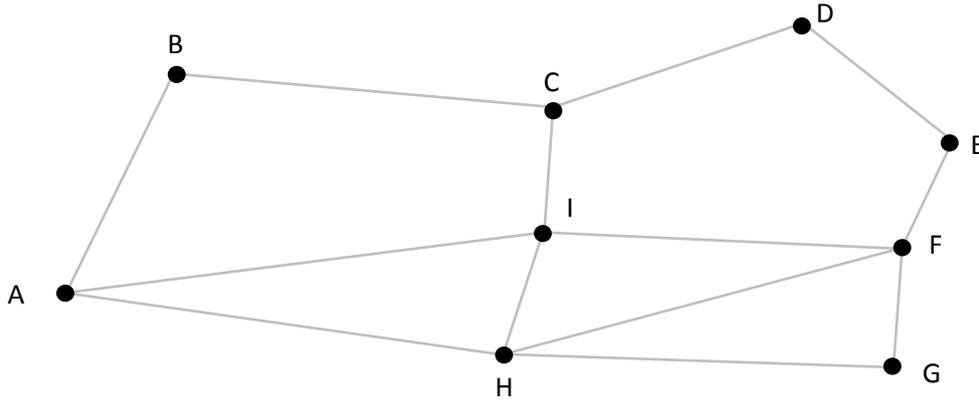
(a) Starting at vertex A, and then walking to vertex B and then onto vertex C a person walks along all of the pipe sections once and once only. (2 marks)

(i) What is the name given to such a path?

....

(ii) Detail a possible path that the person could take.

....

(b) A student notes that the addition of **one more pipe** would make it possible to enable a **circuit** walk starting and finishing at vertex A. (3 marks)

(i) On the network diagram below, draw in an **additional pipe** (edge) that would enable this to occur.
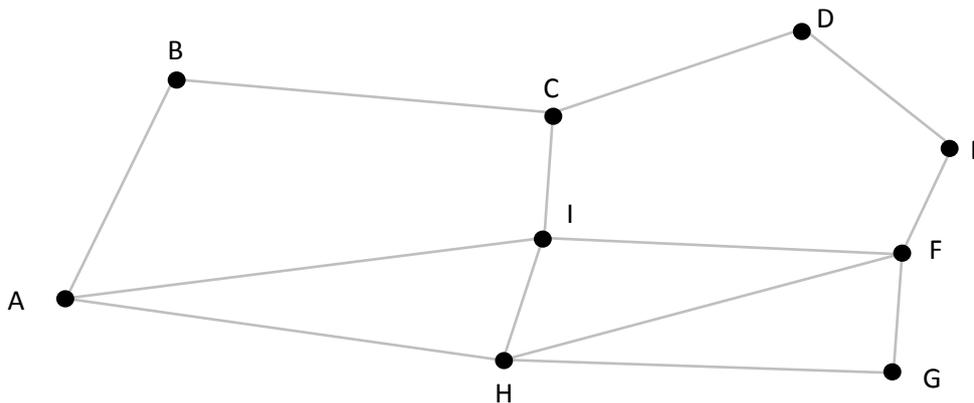
(ii) Starting and finishing at vertex A, detail such a circuit.

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The market gardener expands their watering system by installing aditional water outlets at J, K, L and M.

(c)   Using the diagram below, where the lengths of edges are in metres, determine the **minimum distance** between A and L. Describe this shortest path.   (3 marks)
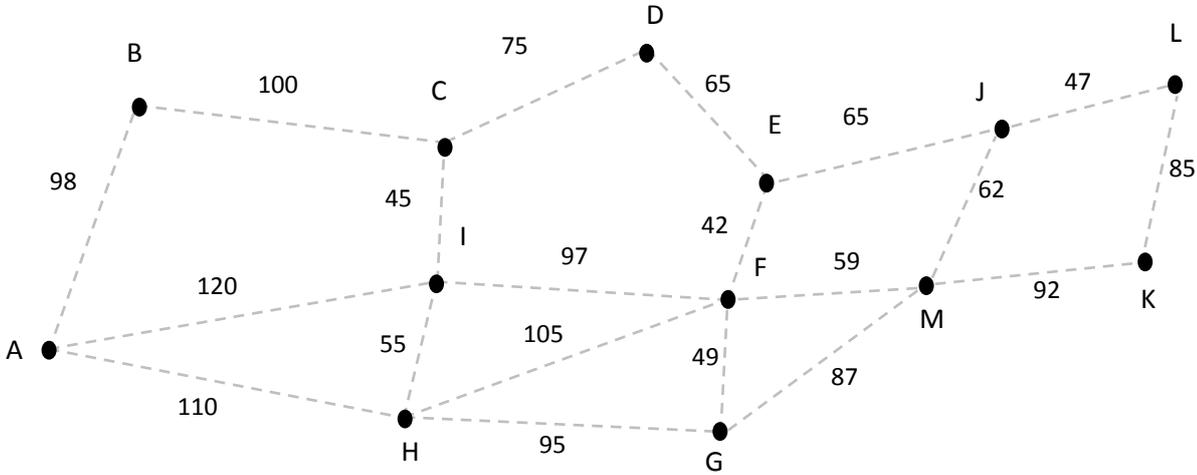
Shortest path taken from A to L: ....

Distance of path: ....

(d)   The market gardener decides to replace all these pipes with new pipe system. On the diagram below draw the **minimum spanning tree** required to do this and determine the **total length of pipe** needed.   (3 marks)
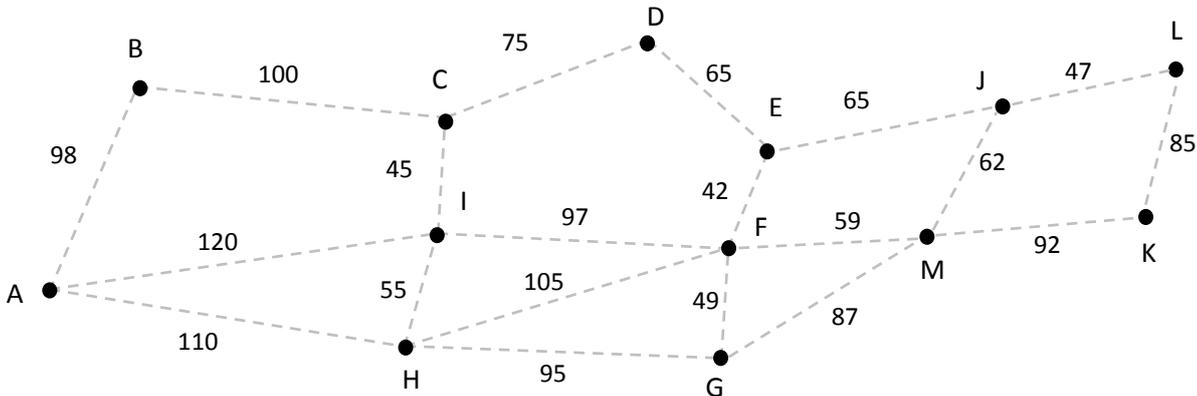
Total length of pipe needed: ....

....

Question 18 (approximately 11 minutes)

The activities table and the **partially** completed project network graph below show activities 'A' to 'J', their predecessor(s) and the time that each activity takes, in days.

Activity	Time (days)	Predecessor(s)
A	5	-
B	12	-
C	9	-
D	4	A, B
E	11	B
F	7	C
G	12	D, E
H	10	D, E
I	3	F
J	7	G

(a)   Use the activities table to **complete** the project network graph below, drawing and labelling all of the edges and vertices.   (3 marks)
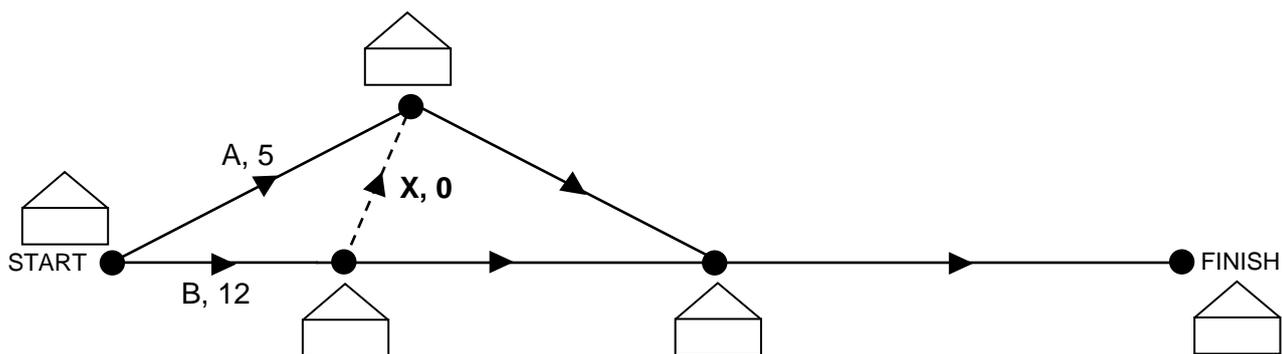
Question 18 continues.

Question 18 (continued)

(b) A **dummy activity, (X, 0),** starts at the end of activity B. Explain why this dummy activity is used on the this project network. (2 marks)

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(c) Identify the **critical path** of the project network and hence the **minimum time** to complete the project. To obtain full marks, numbers must be added to the project network opposite. (3 marks)

Critical path: ....

....

Minimum time: ....

(d) The duration of activity F is delayed by 'x' days. For what value of 'x' does the critical path determined in part (c) remain critical and the minimum time remain the same? (3 marks)

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Question 19 (approximately 6 minutes)

Four people, Alain, Beth, Christine and Dion are asked to give a quote (in $ per hour) to do four jobs, J1, J2, J3 and J4. The hourly rates that they quote are shown in table below.

	J1 ($)	J2 ($)	J3 ($)	J4 ($)
Alain	44	49	48	53
Beth	45	51	50	46
Christine	43	52	47	52
Dion	46	48	46	55

(a) Use the **Hungarian algorithm** method in order to make an assignment that will result in these jobs being completed using the cheapest possible hourly rates. (4 marks)

Spare grid - use only if required

(b) Use your answer from part (a) to allocate Alain, Beth, Christine and Dion to the jobs. (1 mark)

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(c) If the four people all worked for 8 hours, what would be the **minimum total cost**? (1 mark)

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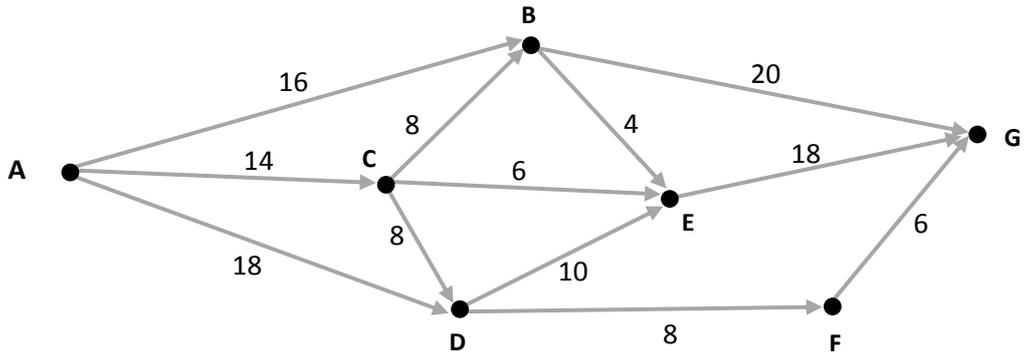
Question 16

Question 17 (c) and (d)
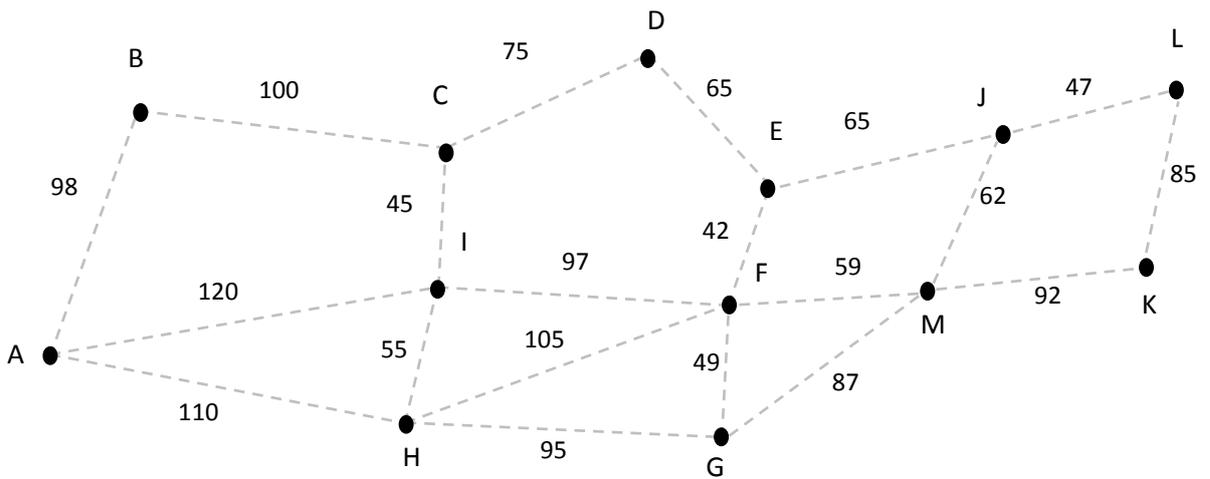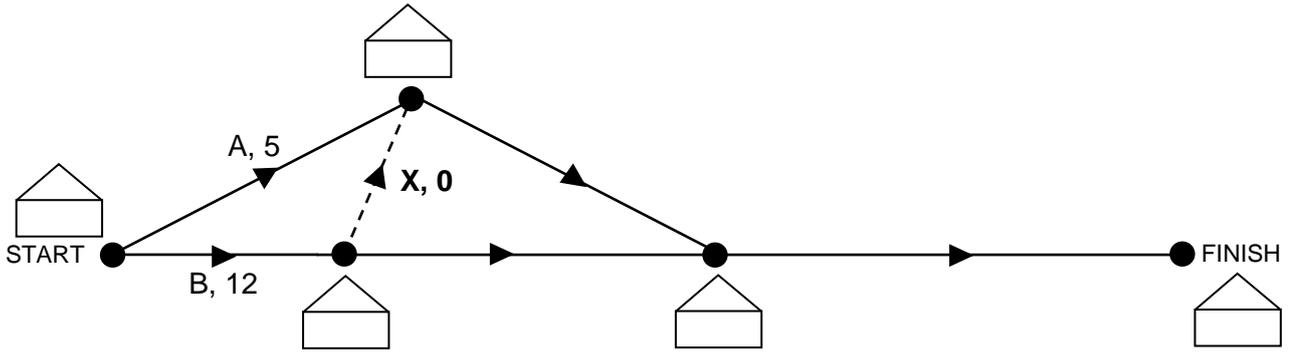
Question 18

Question 19

Spare grid - use only if required

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