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### Semester One Examination, 2020

### Question/Answer booklet

# MATHEMATICS

If required by your examination administrator, please place your student identification label in this box

**APPLICATIONS**

**UNIT 3**

## Section Two:

## Calculator-assumed

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| WA student number: In figures |  |  |  |  |  |  |  |  |  |  |

In words

Your name

|  |  |
| --- | --- |
| Number of additional answer booklets used (if applicable): |  |

## Time allowed for this section

Reading time before commencing work: ten minutes

Working time: one hundred minutes

## 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 approved for use in this 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 | 8 | 8 | 50 | 52 | 35 |
| Section Two: Calculator-assumed | 13 | 13 | 100 | 98 | 65 |
|  | | |  | **Total** | 100 |

|  |  |  |
| --- | --- | --- |
| Markers use only | | |
| Question | Maximum | Mark |
| 9 | 6 |  |
| 10 | 10 |  |
| 11 | 7 |  |
| 12 | 8 |  |
| 13 | 7 |  |
| 14 | 7 |  |
| 15 | 8 |  |
| 16 | 7 |  |
| 17 | 8 |  |
| 18 | 8 |  |
| 19 | 7 |  |
| 20 | 7 |  |
| 21 | 8 |  |
| S2 Total | 98 |  |
| S2 Wt (×0.6633) | 65% |  |

## Instructions to candidates

1. The rules for the conduct of examinations are detailed in the school handbook. 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 specific 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% (98 Marks)

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

Working time: 100 minutes.

Question 9 (6 marks)

The recursive rule can be used to model the repayment of a loan, where is the amount owing in dollars after monthly repayments of .

(a) Determine

(i) the initial amount of the loan. (1 mark)

(ii) the amount owing after repayments to the nearest cent. (1 mark)

(iii) the minimum number of repayments required to reduce the amount owing to no more than . (1 mark)

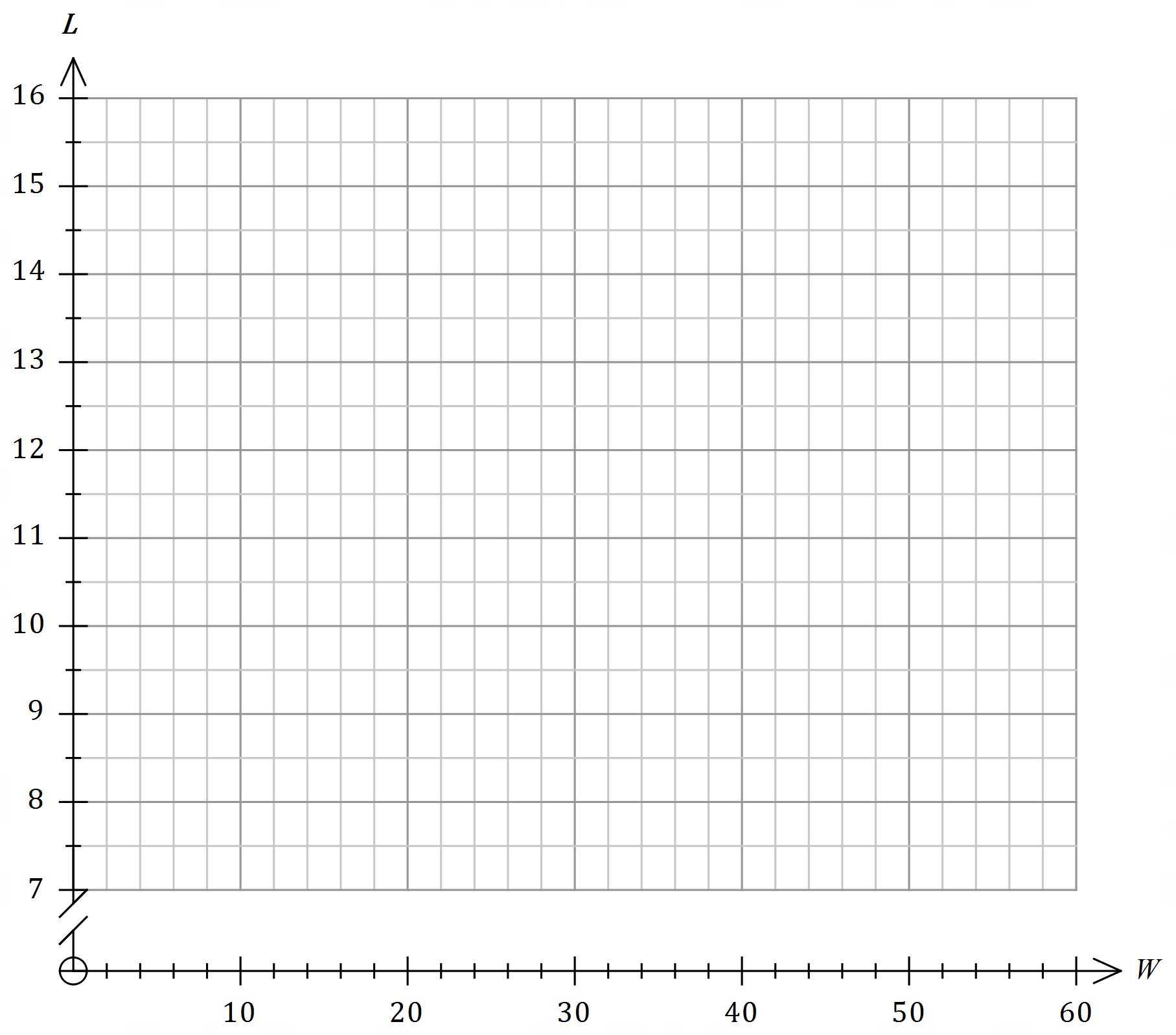
(b) After repayments, changes to the financial circumstances of the borrower meant that the monthly repayment was halved. Determine the change in the minimum number of repayments required to reduce the amount owing to no more than . (3 marks)

Question 10 (10 marks)

The table below shows the average lifespan years and the average adult weight kg of male dogs for a variety of breeds.

|  |  |  |
| --- | --- | --- |
| Breed | Weight (kg) | Lifespan (years) |
| English Setter |  |  |
| Jack Russell |  |  |
| Saint Bernard |  |  |
| Chihuahua |  |  |
| Beagle |  |  |
| Bullmastiff |  |  |
| Golden Retriever |  |  |
| Border Collie |  |  |
| German Shepherd |  |  |
| Spaniel |  |  |

(a) Complete the scatterplot below. (2 marks)



(b) Determine

(i) the correlation coefficient between and . (1 mark)

(ii) the equation of the least-squares line that can be used to predict from .

(2 marks)

(c) Add the least-squares line to the scatterplot.

(2 marks)

(d) A breed of dog has an average male weight of kg.

(i) Predict the average lifespan of males of this breed. (1 mark)

(ii) Briefly discuss two factors that support the validity of your prediction. (2 marks)

Question 11 (7 marks)

Six students were asked to create a short presentation to explain the meaning of some graph theory terms. The following table shows which terms each student offered to present.

|  |  |
| --- | --- |
| Student | Terms |
| Fred | Circuit, Walk |
| Grace | Loop, Trail |
| Hazel | Loop, Trail, Edge |
| Joe | Trail |
| Kavan | Walk, Vertex |
| Mia | Edge, Vertex |

(a) Draw a bipartite graph to represent this information. (3 marks)

(b) Determine how many more edges must be added to the bipartite graph in (a) so that it would be a complete bipartite graph. (2 marks)

(c) Draw another bipartite graph to show how it is possible to assign each student to present just one term, so that all six terms are explained. (2 marks)

Question 12 (8 marks)

A random sample of drivers was taken at a test centre. Each pair of letters shown below represents one driver. The first letter shows the driving test outcome (Pass, P or Fail, F) for the person and the second letter shows if they were taking the test for the first time (Yes, Y or N, No).

FN PN FN FY PY PN PY FY FN PY PN PY PY PN FY PY PN PN FN PN PN

FN FN PY FY PY FN FN FN FY PY FN FN PY FN PN PY PY PN FY FY FN

(a) Two categorical variables have been recorded for each driver. Name one of the variables and explain why it is categorical. (2 marks)

(b) Summarise the data by completing the two-way frequency table below. (2 marks)

|  |  |  |
| --- | --- | --- |
|  | Yes | No |
| Pass |  |  |
| Fail |  |  |

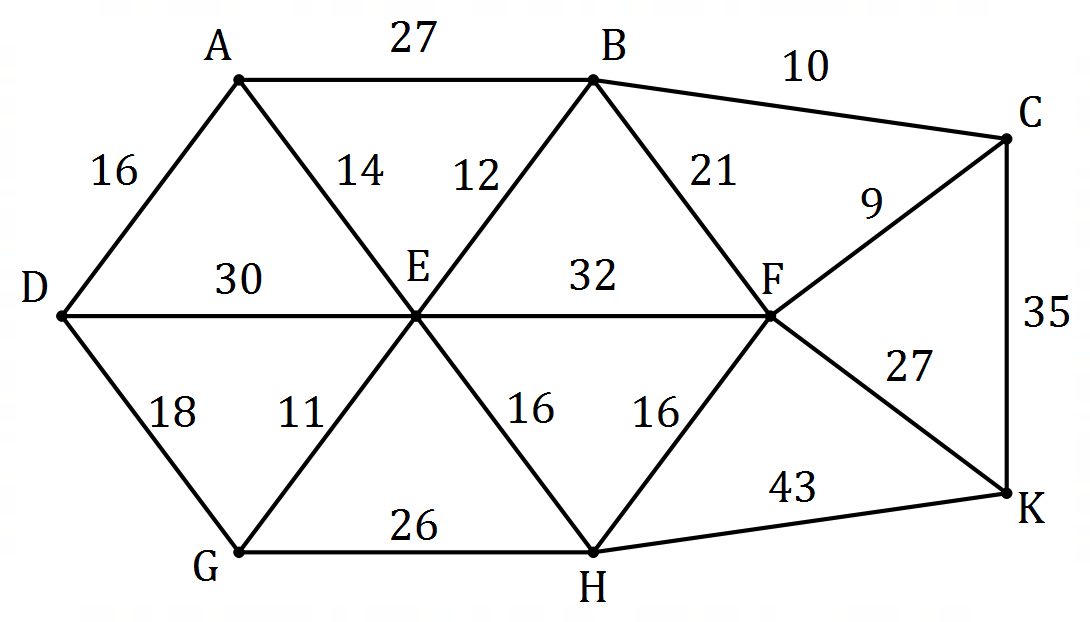
(c) Convert the two-way frequency table to show column percentages. (2 marks)

|  |  |  |
| --- | --- | --- |
|  | Yes | No |
| Pass |  |  |
| Fail |  |  |

(d) Discuss whether this sample data suggests the presence of an association between passing the driving test and taking the test for the first time. (2 marks)

Question 13 (7 marks)

In the graph below, the vertices represent towns and the weights on each edge represent the distance, in kilometres, between pairs of towns. A parcel delivery service is based at town D.



(a) Complete the table below to show the shortest distance km from town D to each of the other towns. (4 marks)

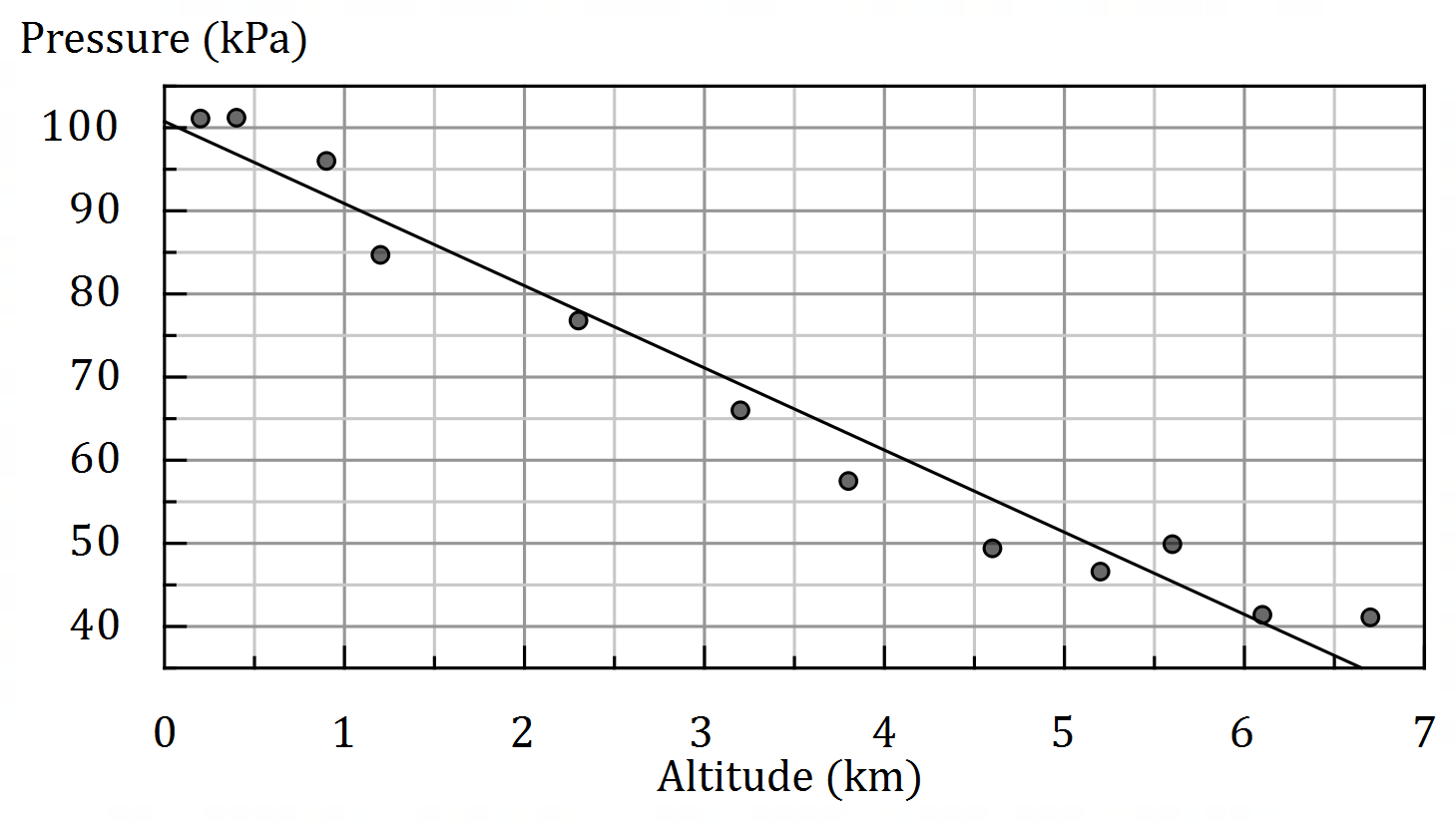
|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Town | A | B | C | E | F | G | H | K |
| , km |  |  |  |  |  |  |  |  |

(b) State the route that gives the minimum distance between towns D and K. (1 mark)

(c) One day the delivery service has two parcels to deliver, one at A and the other at K. Determine the shortest path from D to K that passes through A and state the length of this path. (2 marks)

Question 14 (7 marks)

The graph below shows pressure and altitude readings collected from a variety of sites in a country, together with the least-squares line for the linear association between the variables.



(a) The correlation coefficient for the linear association is one of the values shown in the list below. Circle this value and justify your choice. (3 marks)

(b) Determine the coefficient of determination for the linear association and interpret its value. (2 marks)

(c) State, with reasons, whether the nature of the relationship between the variables is linear or non-linear. (2 marks)

Question 15 (8 marks)

A photocopier was purchased for . Its value depreciates at a rate of cents per copy. Let be the value of the photocopier in dollars after copies have been made, where .

(a) State the value of the constant and the value of the constant . (2 marks)

(b) Determine . (1 mark)

(c) Determine when . (2 marks)

(d) Calculate the value of the photocopier after copies have been made. (1 mark)

(e) The photocopier will be replaced as soon as its value falls below . Determine the number of copies the photocopier will make before it is replaced. (2 marks)

Question 16 (7 marks)

The scores of a sample of students who sat two tests are shown in the table below.

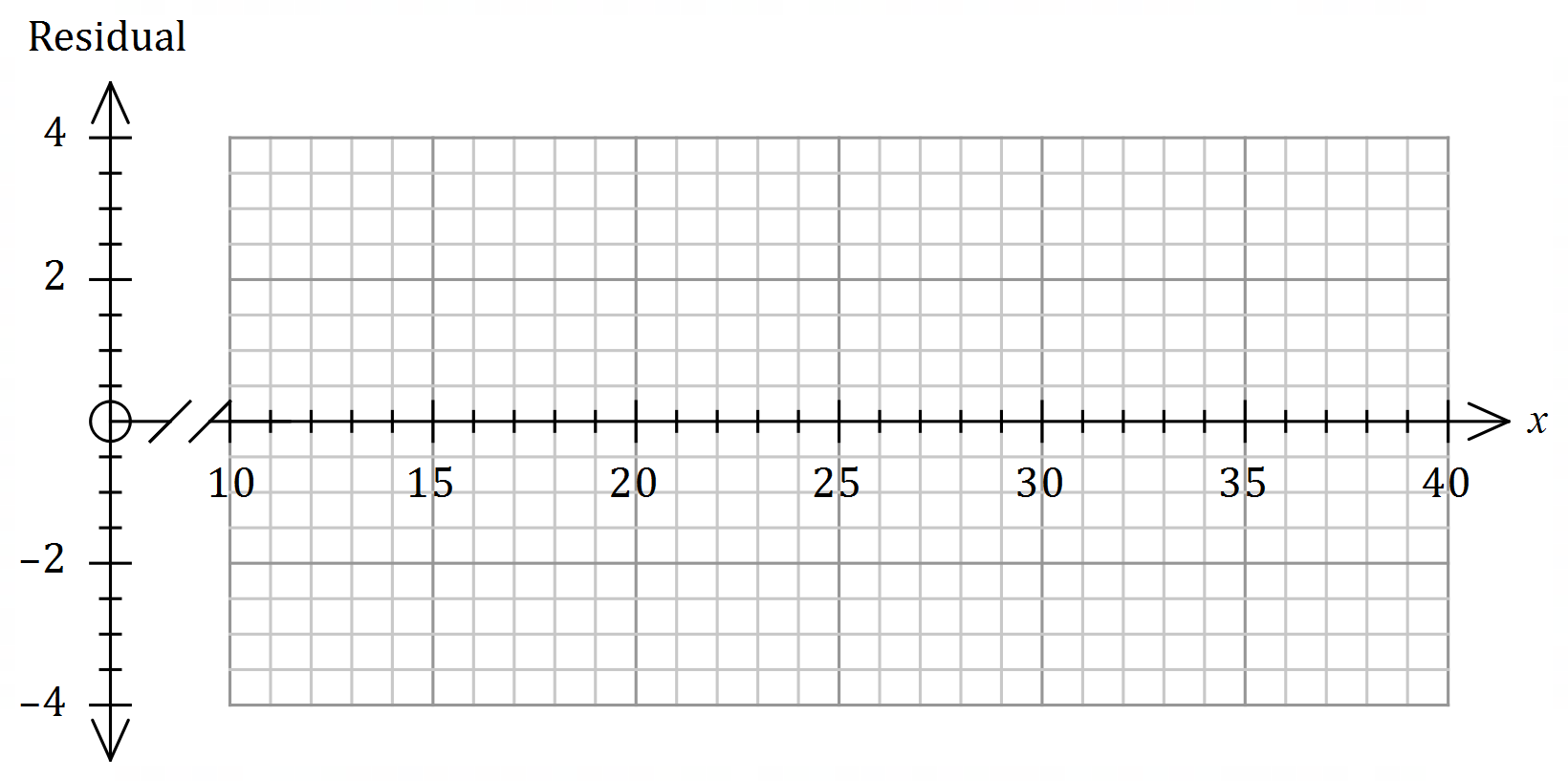
|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Student |  |  |  |  |  |  |  |  |
| Test A |  |  |  |  |  |  |  |  |
| Test B |  |  |  |  |  |  |  |  |
| Residual |  |  |  |  |  |  |  |  |

Two students missed Test B and their teacher planned to predict their marks for this test using their scores from Test A and the linear relationship modelled by the least-squares line between the response () and explanatory () variables.

The equation is and the correlation coefficient is . This equation was used to determine the residuals shown in the table above.

(a) Determine the value of in the table above. (2 marks)

(b) Construct a residual plot for the data on the axes below. (2 marks)



(c) Using the residual plot and other relevant factors, comment on the teacher's plan.

(3 marks)

Question 17 (8 marks)

The value , in dollars, of a property years after it was bought can be represented by the rule .

(a) State the value of the property when it was bought and the annual percentage increase in its value. (2 marks)

(b) Determine the value of the property after years.

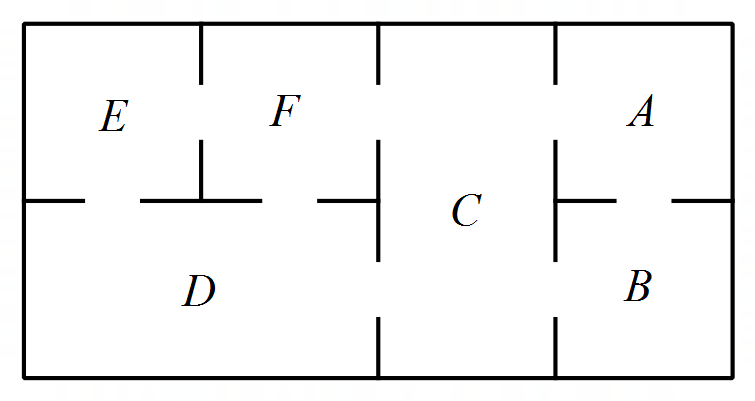
(1 mark)

(c) Determine, to the nearest year, how long it will take for the value of the property to approximately double. (2 marks)

(d) If the annual percentage increase in value of the property changed to after years, determine the value of the property years after it was bought. (3 marks)

Question 18 (8 marks)

A warehouse has dividing walls that split its interior into six areas, as shown in the plan below. The gaps in the dividing walls are doorways that allow people to move from one area to another.



(a) Construct a graph to represent the warehouse areas and doorways, with each area being a vertex and each doorway an edge. (2 marks)

(b) An inspector started in one area and followed a route that went through all doorways exactly once before stopping in another area. State where their route started and stopped and explain how the Eulerian properties of the graph in (a) help to identify these locations.

(3 marks)

(c) Another inspector wishes to start in an area, follow a route that visits all the other areas exactly once and end up back where they started. Comment on whether this is possible, referring to the Hamiltonian properties of the graph in (a) to justify your response.

(3 marks)

Question 19 (7 marks)

The average mid-year commuting times for full-time workers in Perth ( minutes) and Sydney  
( minutes) between the years () and () are shown in the table below.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Year, |  |  |  |  |  |  |  |  |
| Perth, |  |  |  |  |  |  |  |  |
| Sydney, |  |  |  |  |  |  |  |  |

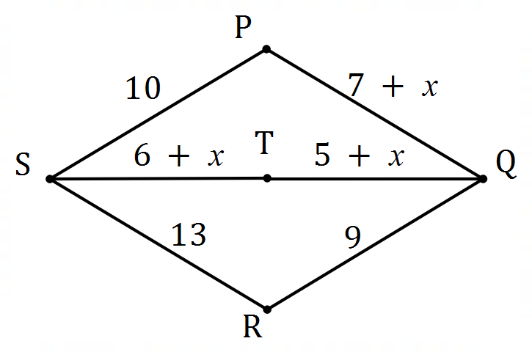
The least-squares line to model the linear relationship between and is and .

(a) Determine the least-squares line to model the linear relationship between and and state the correlation coefficient for this association. (2 marks)

(b) Predict the average commuting times in Perth and Sydney in the year and state, with justification, which prediction you are most confident in. (3 marks)

(c) Predict the year in which the average commuting time will be the same in both cities and comment on how confident you are of this prediction. (2 marks)

Question 20 (7 marks)

The edges in the graph (not to scale) represent roads  
and the weight on each edge is the time, in minutes,  
that it takes to drive along that road. The times to  
drive along and vary throughout the day.

The variable can only take whole number values.

An inspector wishes to drive along each road at  
least once, starting and finishing at , in the  
minimum possible time.

(a) Briefly explain why the edges on a path between and will have to be repeated.

(1 mark)

(b) List all possible paths between and , and state how long each would take, in terms of where appropriate. (2 marks)

(c) Determine all possible values of so that would be one of the repeated edges.

(2 marks)

(d) For the case when , determine the time required for the inspectors' drive. (2 marks)

Question 21 (8 marks)

A nail is hammered into a piece of wood. The distances moved by the tip of the nail during the first, second and third hits are , and mm respectively.

(a) Show that the distances can be modelled by a geometric sequence. (2 marks)

(b) Write a rule for the distance moved by the tip of the nail during the hit of the hammer in the form . (1 mark)

(c) Determine which hit first moves the tip of the nail less than mm, and state the distance moved during this hit, rounded to one decimal place. (2 marks)

(d) The piece of wood is mm thick. State, with justification, whether the tip of the nail will pass all the way through the piece of timber, stating any assumptions that you make.

(3 marks)

Supplementary page

Question number: \_\_\_\_\_\_\_\_\_

Supplementary page

Question number: \_\_\_\_\_\_\_\_\_

Supplementary page

Question number: \_\_\_\_\_\_\_\_\_

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