

**MATHEMATICS  
APPLICATIONS  
UNITS 3 and 4**

**Section One:  
Calculator-free**

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

WA student number: In figures

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In words

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Your name

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**Time allowed for this section**

Reading time before commencing work: five minutes

Working time: fifty minutes

Number of additional answer booklets used (if applicable):

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**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	8	8	50	52	35
Section Two: Calculator-assumed	13	13	100	98	65
<b>Total</b>					100

## Instructions to candidates

1. The rules for the conduct of Trinity College examinations are detailed in the *Instructions to Candidates* distributed to students prior to the 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 answer 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 One: Calculator-free**

**35% (52 Marks)**

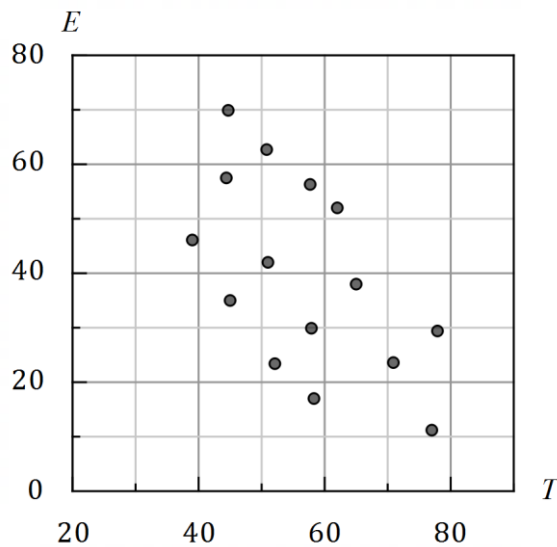
This section has **eight** questions. Answer **all** questions. Write your answers in the spaces provided.

Working time: 50 minutes.

**Question 1**

**(5 marks)**

A sample of fifteen people were asked to take between 30 and 90 minutes to practice a new skill and then their percentage error score in performing the skill  $E$  recorded against their practice time  $T$  minutes. The results are shown on the scatterplot below.



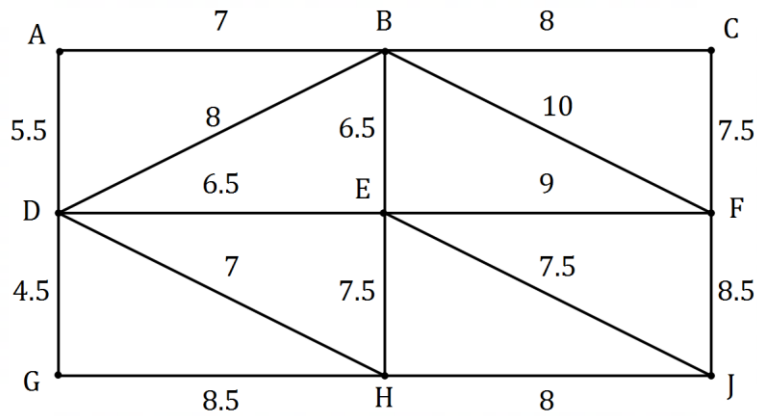
- (a) Describe the association between  $T$  and  $E$  in terms of direction, form and strength. (3 marks)
- (b) (i) Estimate, to one decimal place, the value of the correlation coefficient between the variables. (1 mark)
- (ii) Hence or otherwise, determine the percentage of the variation in the error scores that can be explained by the variation in the practice times for this sample. (1 mark)

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Question 2

(7 marks)

The vertices on the graph below represent nine pumping stations. The edge weights are the number of hours required to install new electrical cabling between connected stations.

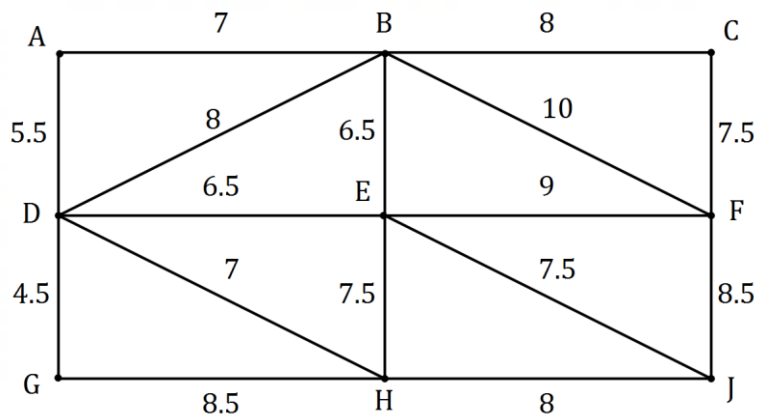


- (a) Clearly show the minimum spanning tree on the graph. (2 marks)

A contractor charges \$100 per hour to install the cabling.

- (b) Determine the cost to install new electrical cabling using the minimum spanning tree. (2 marks)

- (c) A tenth pumping station  $K$  is to be included. The time to install cable between  $K$  and  $B$  is 5.5 hours and between  $K$  and  $F$  is 6.5 hours. *Note: a second copy of the diagram has been provided to use while answering question (c).*

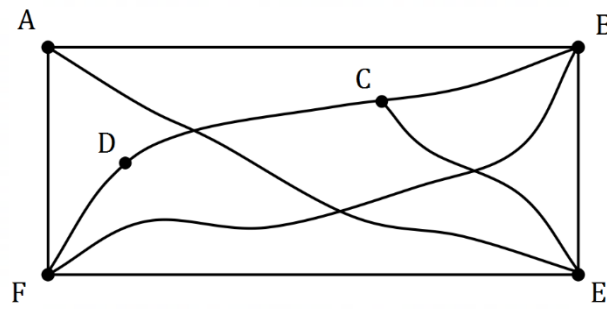


- (i) Use this information to add pumping station  $K$  to the second copy of the graph provided above. (1 mark)
- (ii) If the new cabling is now installed using the minimum spanning tree that includes  $K$ , determine the extra cost of the installation. (2 marks)

Question 3

(7 marks)

Graph  $G$  is shown at right.



- (a) Adding all missing vertices to those shown below, draw graph  $G$  in the plane, to clearly show that it is planar. (2 marks)



- (b) Show that graph  $G$  satisfies Euler's formula. (2 marks)

- (c) Graph  $G$  is semi-Eulerian. Describe two features of the trail it contains to be classified as semi-Eulerian. (2 marks)

- (d) Describe where an edge can be added to graph  $G$  so that it contains an Eulerian trail. (1 mark)

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**Question 4**

**(6 marks)**

Arif, Brenton, Carter and Dana have been chosen for the  $4 \times 50$  m medley relay team in a swimming carnival. This relay is swum by four different swimmers, each swimming one of four different strokes. Their best times, in seconds, to swim 50 m freestyle, backstroke, breaststroke and butterfly are shown in the following table.

	Freestyle	Backstroke	Breaststroke	Butterfly
Arif	32	42	36	35
Brenton	33	43	38	37
Carter	31	42	36	35
Dana	32	41	35	36

- (a) Show use of the Hungarian algorithm to determine which stroke each boy should swim so that the team completes the  $4 \times 50$  m medley relay in the shortest possible time. (4 marks)

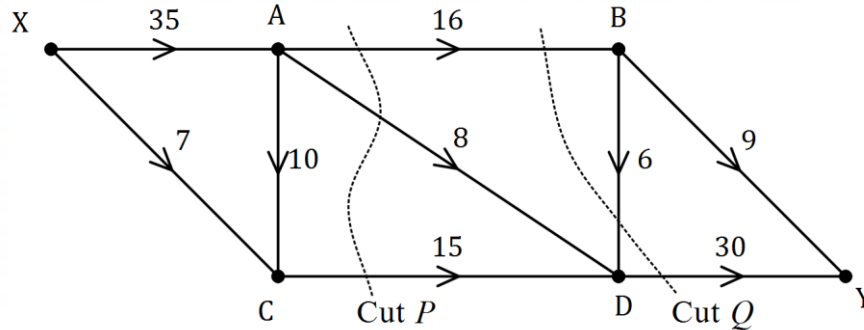
- (b) The record for the  $4 \times 50$  m medley relay is 2 minutes and 23 seconds. If all the boys swim their assigned leg in their best time, will they break the record? Justify your answer. (2 marks)

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Question 5

(8 marks)

A directed subgraph of a distribution network is shown below. The vertices represent distribution centres and the weight on each edge is the maximum volume of parcels, in cubic metres, that can be transported from one distribution centre to another every day.



(a) Determine the capacity of cut  $P$  and the capacity of cut  $Q$  shown above. (2 marks)

(b) Determine the maximum volume of parcels that can be transported

(i) from centre  $X$  to centre  $C$  in a day. (1 mark)

(ii) from centre  $A$  to centre  $D$  in 5 days. (2 marks)

(c) By listing the different paths and their flow rate, determine the maximum volume of parcels that can be transported from centre  $X$  to centre  $Y$  in 10 days. (3 marks)

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Question 6

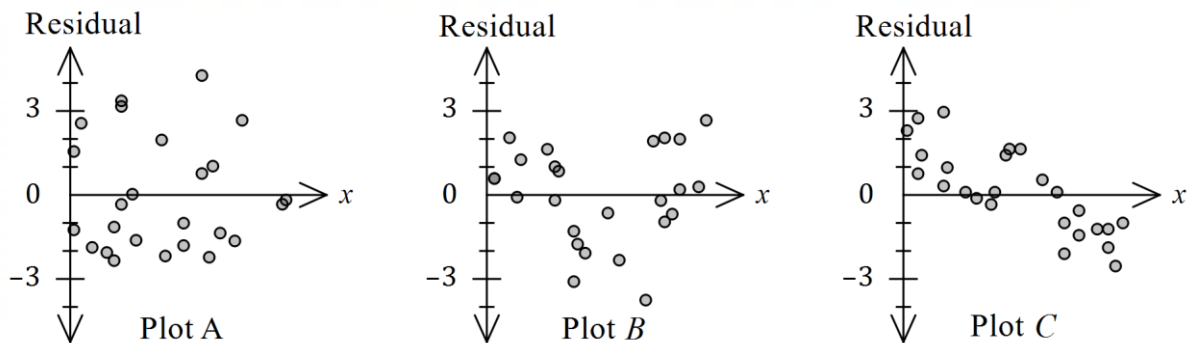
(6 marks)

Lucas the Lupin farmer is experimenting with a new species of Lupin plant. He varied the amount of fertiliser ( $F$ ), in grams used during each week and recorded the number of kilograms ( $L$ ) of Lupin yielded per 100 square meters. Lucas was tasked with writing a report to present to other local farmers explaining the use of his linear model that was fitted to the data set.

Lucas' report included the following summary.

$$r_{FL} = 0.78 \text{ and } \hat{L} = 13F + 150$$

- (a) Identify the explanatory variable. (1 mark)
- (b) Use the equation of the least-squares regression line to predict the total number of kilograms of Lupin produced when 10 grams of fertiliser is used. (2 marks)



When Lucas started writing a report of his findings, he realised that he had accidentally included three residual plots in his report. One of them is the correct plot for his linear regression and the other two are residual plots for other data sets where linear regression is not appropriate.

- (c) State, with justification, which residual plot is most likely to be the correct plot for Lucas' report. Explain why the other two plots are not likely to be the correct plots. (3 marks)

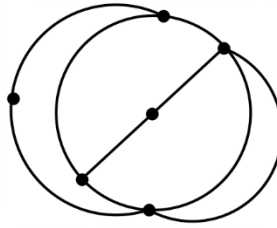


**Question 7**

**(6 marks)**

Graph  $G$  is shown.

It represents a communication network of a group of six diplomats.



(a) State, with reasons, if graph  $G$  is a simple graph. (2 marks)

(b) For graph  $G$ , determine the length of the longest  
(i) closed trail it contains. (1 mark)

(ii) open path it contains. (1 mark)

(c) Explain why graph  $G$  is a Hamiltonian graph. (2 marks)

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**Question 8**

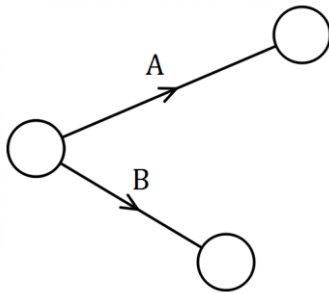
**(7 marks)**

A project involves the completion of activities *A* to *H*, as shown in the following table. Note that only three of the activity durations are shown.

Activity	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>	<i>G</i>	<i>H</i>
Immediate predecessor(s)	–	–	<i>A</i>	<i>A</i>	<i>B</i>	<i>B</i>	<i>D, E</i>	<i>E, F</i>
Duration (weeks)		9	24				13	
Float (weeks)	2	0	11	2	0	9	0	4

The minimum completion time for the project is 38 weeks.

- (a) Complete the activity network to represent the above information. (3 marks)



- (c) List the tasks that lie on the critical path. (1 mark)

- (b) Determine a possible duration for each of the activities *A, D, E, F* and *H*. (3 marks)

Supplementary page

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

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