Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
TOTAL	

Free-Standing Mathematics Qualification
Advanced Level
June 2012

Using and Applying Decision Mathematics

6994/2

Unit 14

Thursday 17 May 2012 1.30 pm to 3.00 pm

For this paper you must have:
- a clean copy of the Data Sheet (enclosed)
- a calculator
- a ruler.

Time allowed
- 1 hour 30 minutes

Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
- You must answer each question in the space provided for that question. If you require extra space, use an AQA supplementary answer book; do **not** use the space provided for a different question.
- Do not write outside the box around each page.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.
- The **final** answer to questions requiring the use of calculators should be given to three significant figures, unless stated otherwise.
- You may **not** refer to the copy of the Data Sheet that was available prior to this examination. A clean copy is enclosed for your use.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.
- You may use either a scientific calculator or a graphics calculator.

Advice
- You do not necessarily need to use all the space provided.

Section A

Answer **all** questions.

Answer each question in the space provided for that question.

Use **School pop concert** *on page 2 of the Data Sheet.*

1 The headteacher has given permission for a school pop concert to be held and some staff have volunteered to assist. The work involved has been divided into a number of tasks, as shown in the table. The minimum time required to complete each task is also shown.

Activity	Immediate predecessor	Duration (hours)
A: Appoint committee to organise event	–	3
B: Decide on date	A	3
C: Book bands	A	6
D: Produce posters	B, C	8
E: Produce tickets	B, C	4
F: Arrange order of bands	C	2
G: Decide on time allocation for each band	C	2
H: Appoint compère	A	1
I: Arrange for sound engineer and lighting	B	4
J: Arrange practice sessions	F	6
K: Sell tickets	E	12
L: Concert	D, G, H, I, J, K	2

(a) Construct an activity network for the project. *(5 marks)*

(b) Find the earliest start time for each activity. *(2 marks)*

(c) Find the latest finish time for each activity. *(3 marks)*

(d) List the critical activities. *(1 mark)*

(e) Using the grid on page 5, construct a Gantt (cascade) diagram for the project. *(4 marks)*

(f) Given that only one person is available to complete all the activities, find the minimum completion time for the project. *(1 mark)*

QUESTION PART REFERENCE

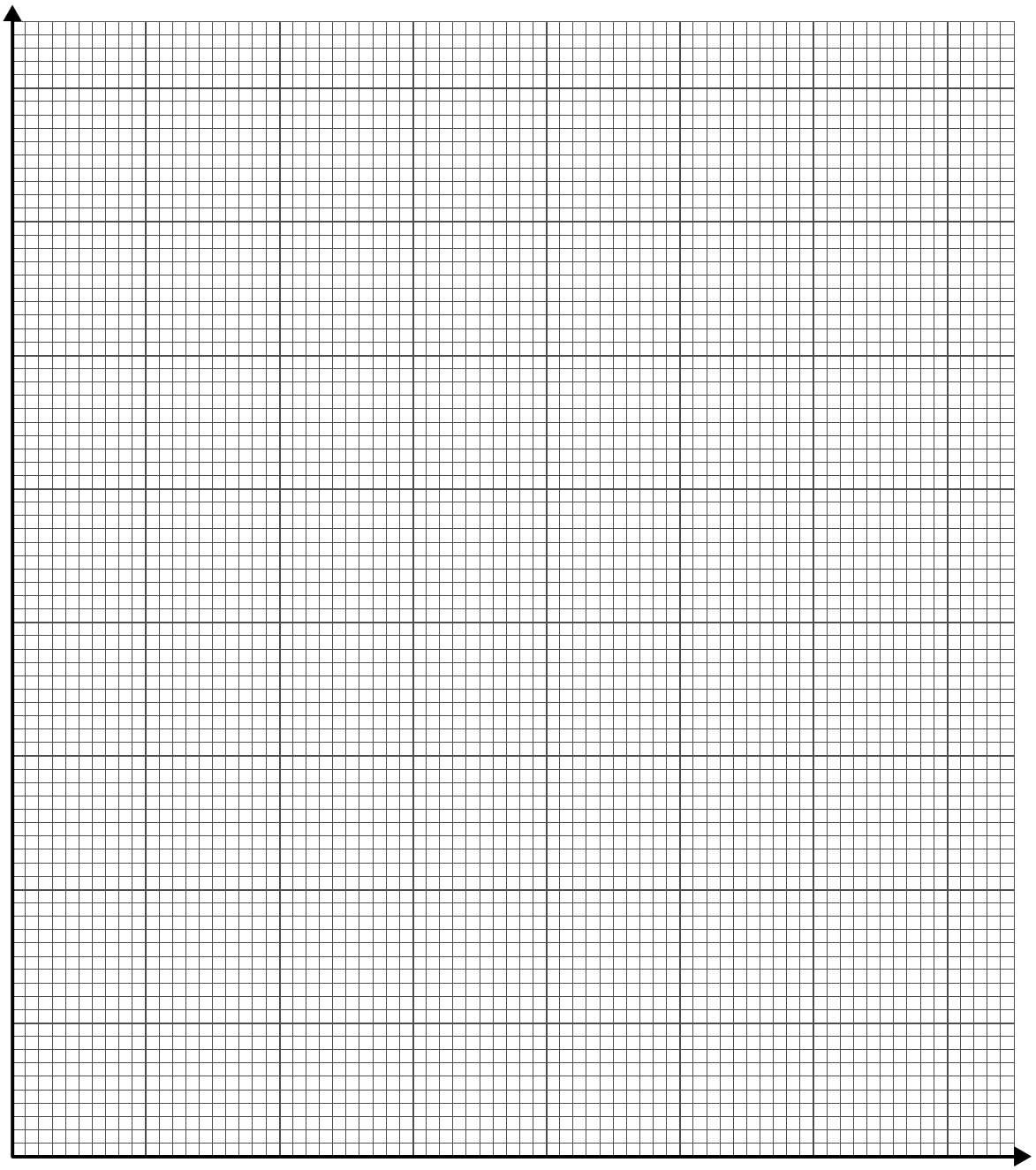
Answer space for question 1

QUESTION PART REFERENCE

Answer space for question 1

QUESTION PART REFERENCE

Answer space for question 1



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Section B

Answer **all** questions.

Answer each question in the space provided for that question.

Use **Golf courses** *on page 3 of the Data Sheet.*

2 **Table 1** and **Table 2**, on page 8, show the shortest distances between pairs of golf courses.

Phil, a golfer, intends to travel from one golf course to the next until he has visited each of the seven courses shown in **Table 1** and **Table 2**, before returning to his starting course.

(a) Explain why the distance from W to F, shown in the tables, is 16. *(1 mark)*

(b) (i) On **Table 1** on page 8, use the nearest neighbour algorithm, starting from F, to find an upper bound for the length of Phil's minimum tour. *(5 marks)*

(ii) Write down Phil's actual route if he were to follow the tour corresponding to the answer in part **(b)(i)**. *(2 marks)*

(iii) On **Table 2** on page 8, use the nearest neighbour algorithm, starting from S, to find another upper bound for the length of Phil's minimum tour. *(4 marks)*

(c) (i) On **Table 3** on page 8, use Prim's algorithm, starting from F, to find the length of a minimum spanning tree for the places F, D, G, W, O and R. State the order in which you select the edges. *(5 marks)*

(ii) Hence find a lower bound for the length of Phil's minimum tour. *(3 marks)*

(d) The following lower bounds for the length of Phil's minimum tour were also found: 102, 110, 109, 115, 118 and 134. Given that the length of Phil's minimum tour is T miles, write down the smallest interval within which T must lie. *(3 marks)*

QUESTION PART REFERENCE	**Answer space for question 2**

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QUESTION PART REFERENCE

Answer space for question 2

QUESTION PART REFERENCE

Answer space for question 2

Table 1

	S	F	D	G	W	O	R
S	–	5	12	9	18	34	57
F	5	–	17	7	16	32	55
D	12	17	–	21	27	46	66
G	9	7	21	–	9	25	48
W	18	16	27	9	–	21	39
O	34	32	46	25	21	–	41
R	57	55	66	48	39	41	–

Table 2

	S	F	D	G	W	O	R
S	–	5	12	9	18	34	57
F	5	–	17	7	16	32	55
D	12	17	–	21	27	46	66
G	9	7	21	–	9	25	48
W	18	16	27	9	–	21	39
O	34	32	46	25	21	–	41
R	57	55	66	48	39	41	–

Table 3

	F	D	G	W	O	R
F	–	17	7	16	32	55
D	17	–	21	27	46	66
G	7	21	–	9	25	48
W	16	27	9	–	21	39
O	32	46	25	21	–	41
R	55	66	48	39	41	–

QUESTION PART REFERENCE

Answer space for question 2

3 Phil, the golfer, completes his tour and finishes at Reddish (R). He realises that he has not paid his fees at Swinton (S). He needs to return to Swinton by the quickest route.

The diagram opposite shows the locations of some places near Swinton and Reddish. The number on each edge shows the time, in minutes, to travel directly between a pair of places.

(a) Use Dijkstra's algorithm, on the diagram opposite, to find the shortest travelling time from R to S. Show all temporary labels. State the corresponding route. *(6 marks)*

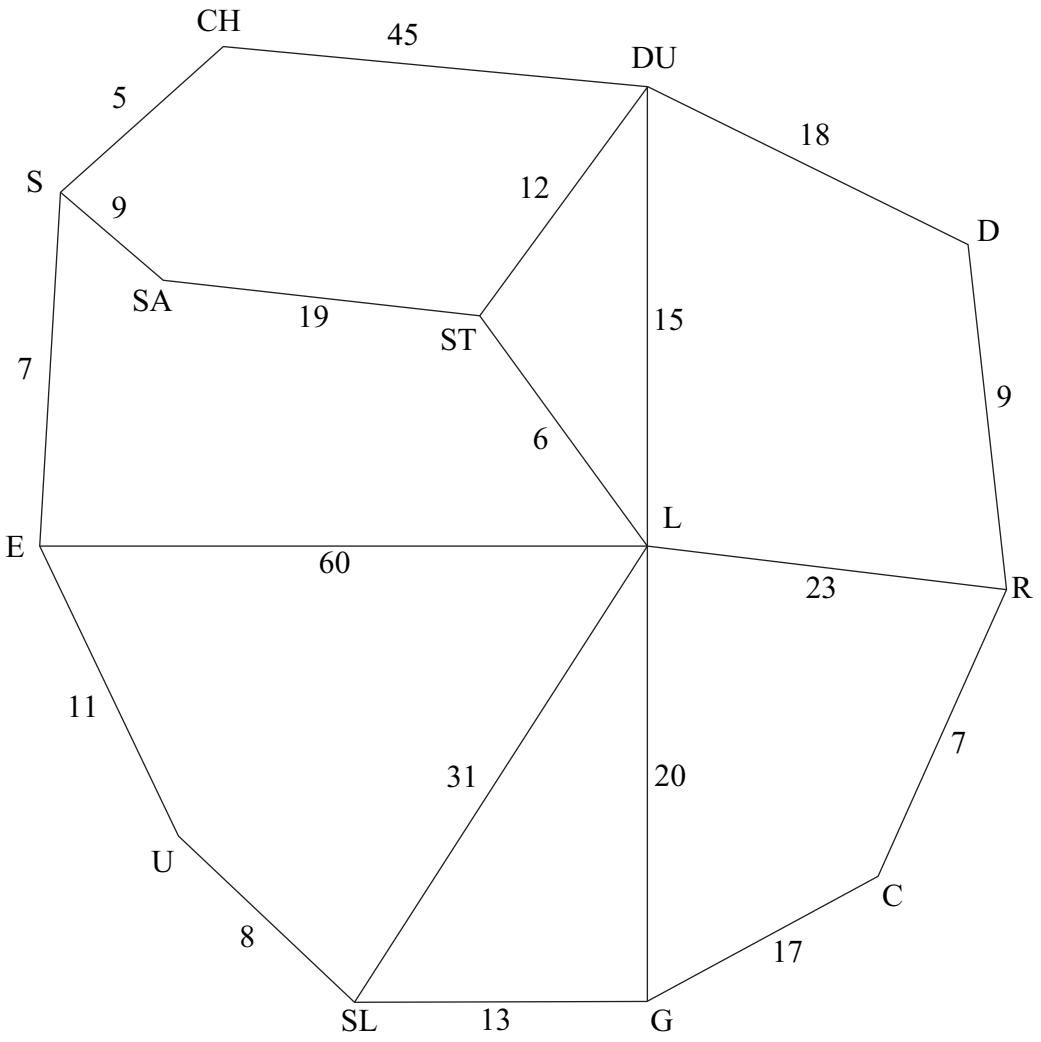
(b) On another day, Phil discovers that the road between Levenshulme (L) and Stretford (ST) is closed because of a fallen tree. Find Phil's shortest travelling time from R to S on this day. *(2 marks)*

QUESTION PART REFERENCE

Answer space for question 3

QUESTION PART REFERENCE

Answer space for question 3



C – Cheadle
CH – Cheetham Hill
D – Denton
DU – Dukinfield
E – Eccles
G – Gatley
L – Levenshulme
R – Reddish
S – Swinton
SA – Salford
SL – Sale
ST – Stretford
U – Urmston

Section C

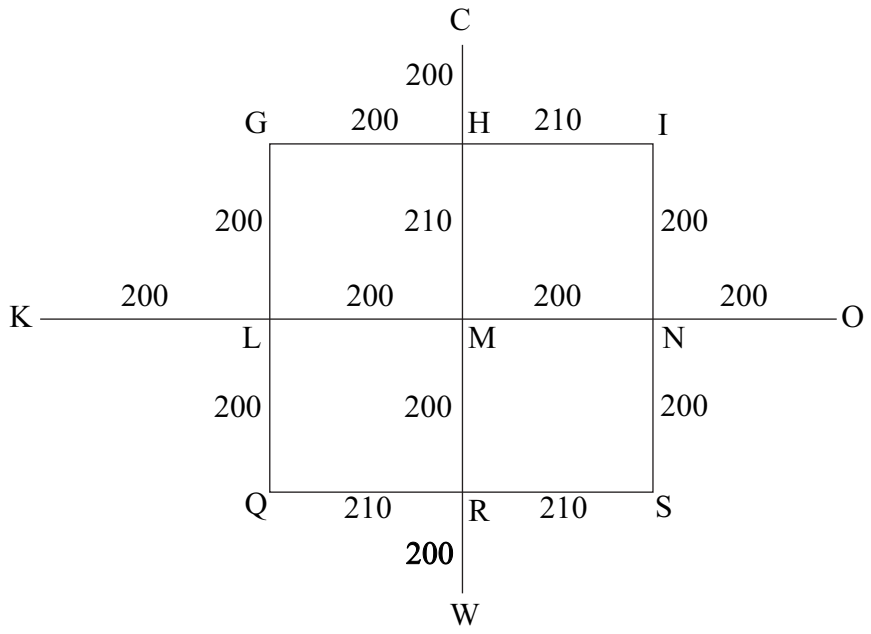
Answer **all** questions.

Answer each question in the space provided for that question.

Use **Housing estate** *on page 4 of the Data Sheet.*

4 The diagram below shows a network of roads and the locations of 13 houses on a housing estate. The number on each edge represents the distance, in metres, between a pair of houses.

The total length of all the roads is 3240 metres.



Raimondo, an ice-cream salesman, travels along all of the roads shown on the diagram at least once.

(a) Find the length of an optimal Chinese postman route around the roads shown on the diagram above, starting and finishing at C. *(6 marks)*

(b) In an optimal route corresponding to your answer in part **(a)**, state the number of times:

(i) the letter M would appear; *(1 mark)*

(ii) the letter R would appear. *(1 mark)*

(c) (i) Given that Raimondo can start and finish at different houses, find the length of an optimal route around the estate. *(3 marks)*

(ii) State two vertices which could be the start and finish points of an optimal route which achieves the answer found in part **(c)(i)**. *(2 marks)*

QUESTION PART REFERENCE

Answer space for question 4

QUESTION PART REFERENCE

Answer space for question 4

QUESTION PART REFERENCE

Answer space for question 4

QUESTION PART REFERENCE

Answer space for question 4

END OF QUESTIONS