Decision Mathematics D1
Advanced/Advanced Subsidiary

Friday 17 May 2013 – Morning

Time: 1 hour 30 minutes

Materials required for examination	**Items included with question papers**
Nil	D1 Answer Book

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation or symbolic differentiation/integration, or have retrievable mathematical formulae stored in them.

Instructions to Candidates

Write your answers for this paper in the D1 answer book provided.
In the boxes on the answer book, write your centre number, candidate number, your surname, initials and signature.
Check that you have the correct question paper.
Answer ALL the questions.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.
Do not return the question paper with the answer book.

Information for Candidates

Full marks may be obtained for answers to ALL questions.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 8 questions in this question paper. The total mark for this paper is 75.
There are 12 pages in this question paper. The answer book has 20 pages. Any blank pages are indicated.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You should show sufficient working to make your methods clear to the Examiner.
Answers without working may not gain full credit.

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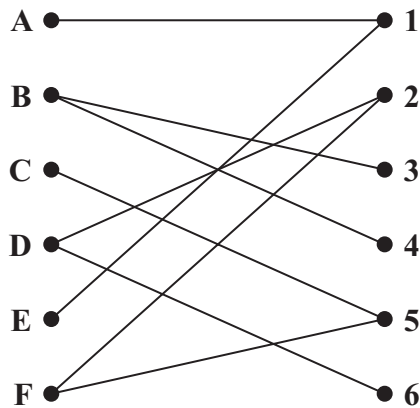
1.

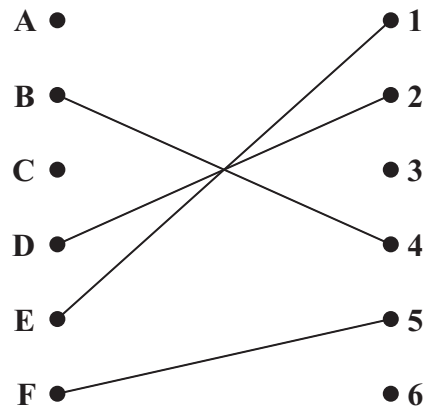**Figure 1**   **Figure 2**

Figure 1 shows the possible allocations of six people, A, B, C, D, E and F, to six tasks, 1, 2, 3, 4, 5 and 6.

Figure 2 shows an initial matching.

(a) Starting from the given initial matching, use the maximum matching algorithm to find an improved matching. You should list the alternating path you used, and your improved matching.

(3)

(b) Explain why it is not possible to find a complete matching.

(1)

After training, task 4 is added to F's possible allocation and task 6 is added to E's possible allocation.

(c) Starting from the improved matching found in (a), use the maximum matching algorithm to find a complete matching. You should list the alternating path you used and your complete matching.

(3)

(Total 7 marks)

2.

	A	B	C	D	E	F
A	–	85	110	160	225	195
B	85	–	100	135	180	150
C	110	100	–	215	200	165
D	160	135	215	–	235	215
E	225	180	200	235	–	140
F	195	150	165	215	140	–

The table shows the average journey time, in minutes, between six towns, A, B, C, D, E and F.

(a) Use Prim's algorithm, starting at A, to find a minimum spanning tree for this network. You must list the arcs that form your tree in the order in which you selected them.

(3)

(b) Draw your tree using the vertices given in Diagram 1 in the answer book.

(1)

(c) Find the weight of your minimum spanning tree.

(1)

Kruskal's algorithm may also be used to find a minimum spanning tree.

(d) State three differences between Prim's algorithm and Kruskal's algorithm.
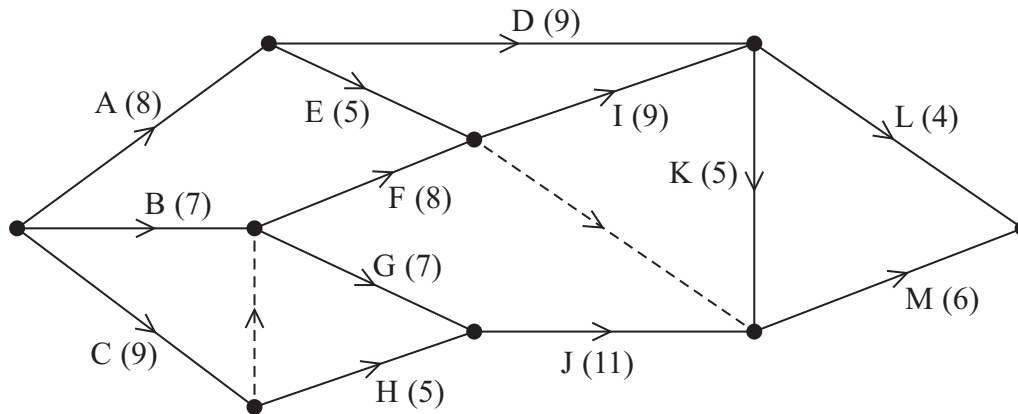
(3)

(Total 8 marks)

3.

Figure 3

A project is modelled by the activity network shown in Figure 3. The activities are represented by the arcs. The number in brackets on each arc gives the time, in days, to complete the activity. Each activity requires one worker. The project is to be completed in the shortest possible time.

(a) Complete Diagram 1 in the answer book to show the early event times and late event times.

(4)

(b) Calculate the total float for activity H. You must make the numbers you use in your calculation clear.

(2)

(c) Calculate a lower bound for the number of workers needed to complete the project in the shortest possible time. Show your calculation.

(2)

Diagram 2 in the answer book shows a partly completed scheduling diagram for this project.

(d) Complete the scheduling diagram, using the minimum number of workers, so that the project is completed in the minimum time.

(4)

(Total 12 marks)

4.

1. Sam (S)
2. Janelle (J)
3. Haoyu (H)
4. Alfie (A)
5. Cyrus (C)
6. Komal (K)
7. Polly (P)
8. David (D)
9. Tom (T)
10. Lydia (L)

A binary search is to be performed on the names in the list above to locate the name Lydia.

(a) Using an appropriate algorithm, rearrange the list so that a binary search can be performed, showing the state of the list after each complete iteration. State the name of the algorithm you have used.

(4)

(b) Use the binary search algorithm to locate the name Lydia in the list you obtained in (a). You must make your method clear.
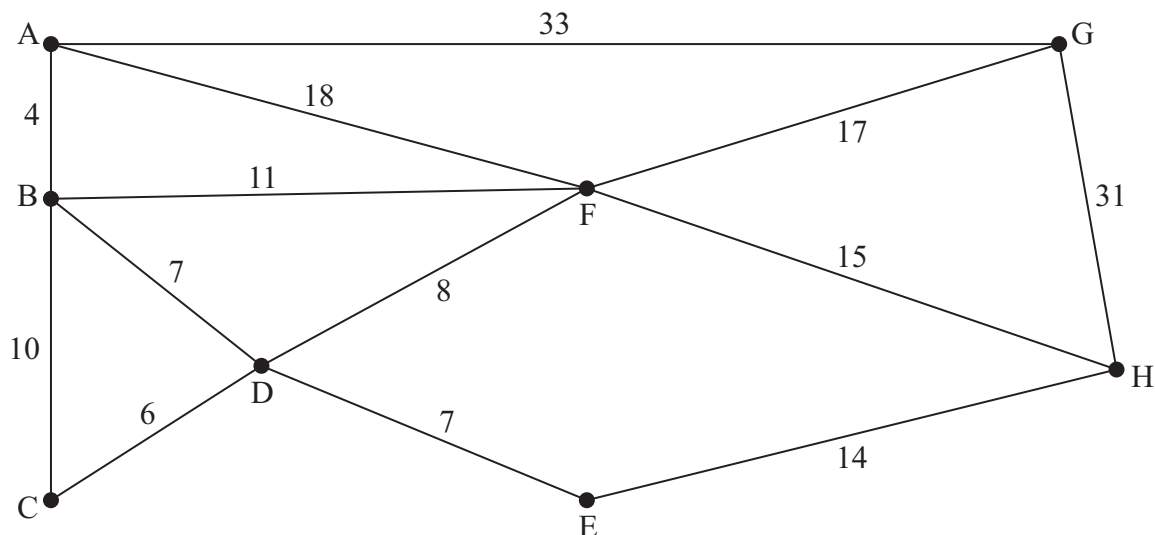
(4)

(Total 8 marks)

5.

Figure 4

[The total weight of the network is 181 miles]

Figure 4 represents a network of power cables that have to be inspected. The number on each arc represents the length, in km, of that cable.

A route of minimum length that traverses each cable at least once and starts and finishes at A needs to be found.

(a) Use the route inspection algorithm to find the arcs that will need to be traversed twice. You must make your method and working clear.

(5)

(b) Write down a possible shortest inspection route, giving its length.

(2)

It is now decided to start and finish the inspection route at two distinct vertices. The route must still traverse each cable at least once.

(c) Determine possible starting and finishing points so that the length of the route is minimised. You must give reasons for your answer.

(3)

(Total 10 marks)

6.

Activity	Immediately preceding activities
A	–
B	–
C	A
D	A
E	B
F	C D
G	D
H	F G
I	H
J	H
K	I J

(a) Draw the activity network described in the precedence table, using activity on arc and exactly two dummies.

(5)

(b) Explain why each of the two dummies is necessary.
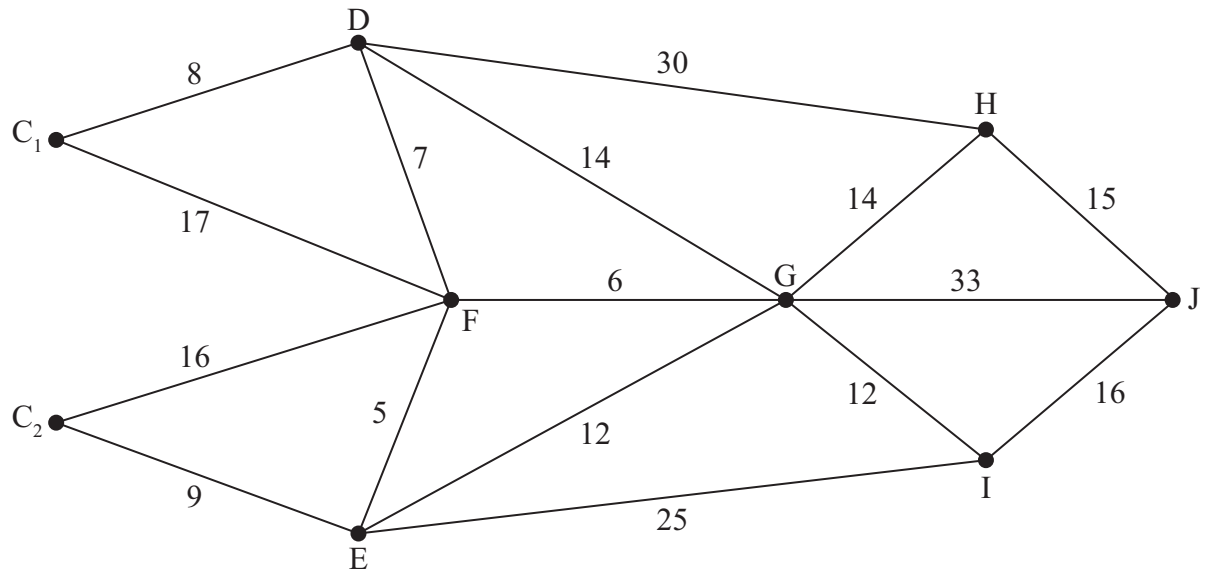
(2)

(Total 7 marks)

7.

Figure 5

Figure 5 represents a network of roads. The number on each arc represents the length, in miles, of the corresponding road. A large crane is required at J and it may be transported from either C_1 or C_2. A route of minimum length is required.

It is decided to use Dijkstra's algorithm to find the shortest routes between C_1 and J and between C_2 and J.

(a) Explain why J, rather than C_1 or C_2, should be chosen as the starting vertex.

(1)

(b) Use Dijkstra's algorithm to find the shortest route needed to transport the crane. State your route and its length.

(6)

(Total 7 marks)

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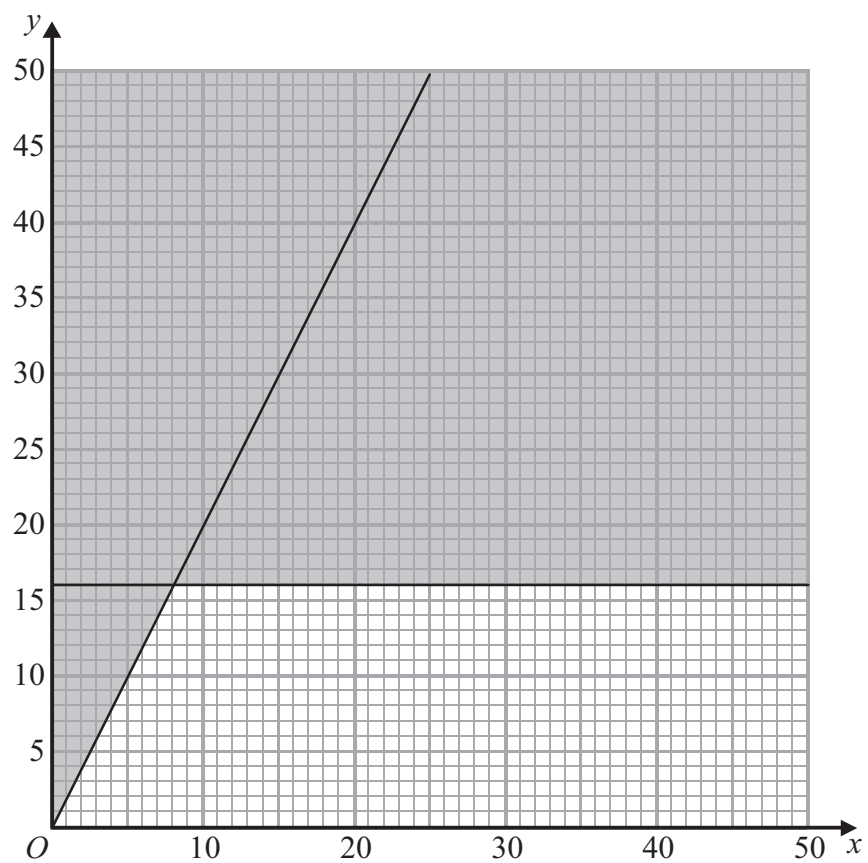
QUESTION 8 STARTS ON THE NEXT PAGE

8.

Figure 6

A company makes two types of garden bench, the 'Rustic' and the 'Contemporary'. The company wishes to maximise its profit and decides to use linear programming.

Let x be the number of 'Rustic' benches made each week and y be the number of 'Contemporary' benches made each week.

The graph in Figure 6 is being used to solve this linear programming problem.

Two of the constraints have been drawn on the graph and the rejected region shaded out.

(a) Write down the constraints shown on the graph giving your answers as inequalities in terms of x and y.

(3)

It takes 4 working hours to make one 'Rustic' bench and 3 working hours to make one 'Contemporary' bench. There are 120 working hours available in each week.

(b) Write down an inequality to represent this information.

(2)

Market research shows that 'Rustic' benches should be at most $\dfrac{3}{4}$ of the total benches made each week.

(c) Write down, and simplify, an inequality to represent this information. Your inequality must have integer coefficients.

(2)

(d) Add two lines and shading to Diagram 1 in your answer book to represent the inequalities of (b) and (c). Hence determine and label the feasible region, R.

(3)

The profit on each 'Rustic' bench and each 'Contemporary' bench is £45 and £30 respectively.

(e) Write down the objective function, P, in terms of x and y.

(1)

(f) Determine the coordinates of each of the vertices of the feasible region and hence use the vertex method to determine the optimal point.

(4)

(g) State the maximum weekly profit the company could make.

(1)

(Total 16 marks)

TOTAL FOR PAPER: 75 MARKS

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Paper Reference(s)

6689/01R

Edexcel GCE

Decision Mathematics D1
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Answer Book

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1.

Figure 1

Figure 2

Question 1 continued

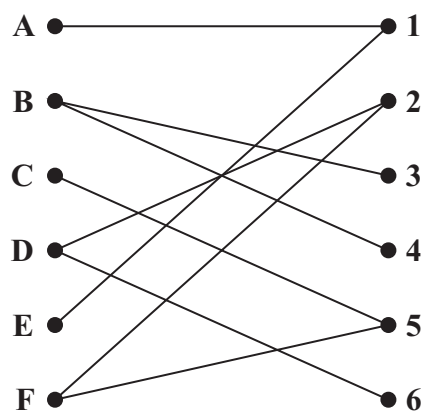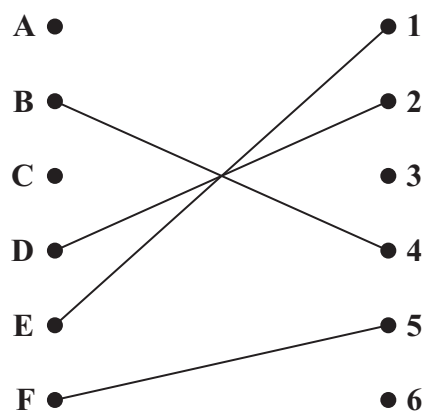A ●   ● 1   A ●   ● 1

B ●   ● 2   B ●   ● 2

C ●   ● 3   C ●   ● 3

D ●   ● 4   D ●   ● 4

E ●   ● 5   E ●   ● 5

F ●   ● 6   F ●   ● 6

Q1

(Total 7 marks)

2.

	A	B	C	D	E	F
A	–	85	110	160	225	195
B	85	–	100	135	180	150
C	110	100	–	215	200	165
D	160	135	215	–	235	215
E	225	180	200	235	–	140
F	195	150	165	215	140	–

Question 2 continued
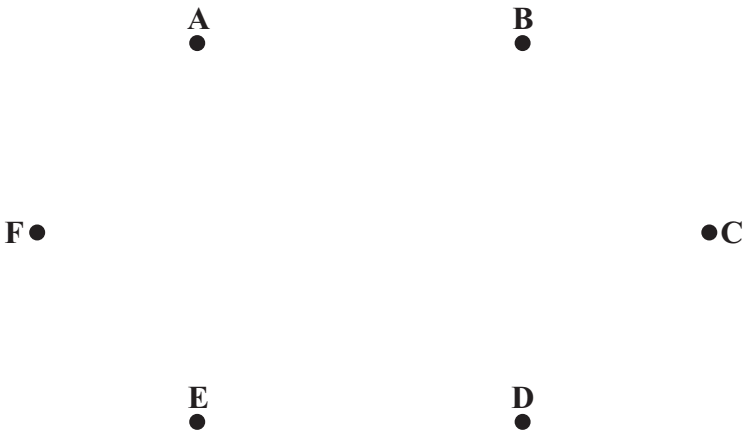
A •   B •

F •   • C

E •   D •

Diagram 1

(Total 8 marks)

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3.

D (9)

A (8)

E (5)

I (9)

L (4)

B (7)

F (8)

K (5)

C (9)

G (7)

M (6)

J (11)

H (5)

Key

Early event time
Late event time

Diagram 1

Question 3 continued

Diagram 2

(Total 12 marks)

Q3

4.

<div align="center">S   J   H   A   C   K   P   D   T   L</div>

Question 4 continued

(Total 8 marks)

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5.

Figure 4

[*The total weight of the network is 181 miles*]

Question 5 continued

Turn over

6.

Question 6 continued

7.

Edges and vertices of the network:

- J
- H — J: 15
- I — J: 16
- G — J: 33
- H — G: 14
- I — G: 12
- D — H: 30
- E — I: 25
- D — G: 14
- F — G: 6
- E — G: 12
- D — F: 7
- F — E: 5
- C₁ — D: 8
- C₁ — F: 17
- C₂ — F: 16
- C₂ — E: 9
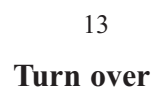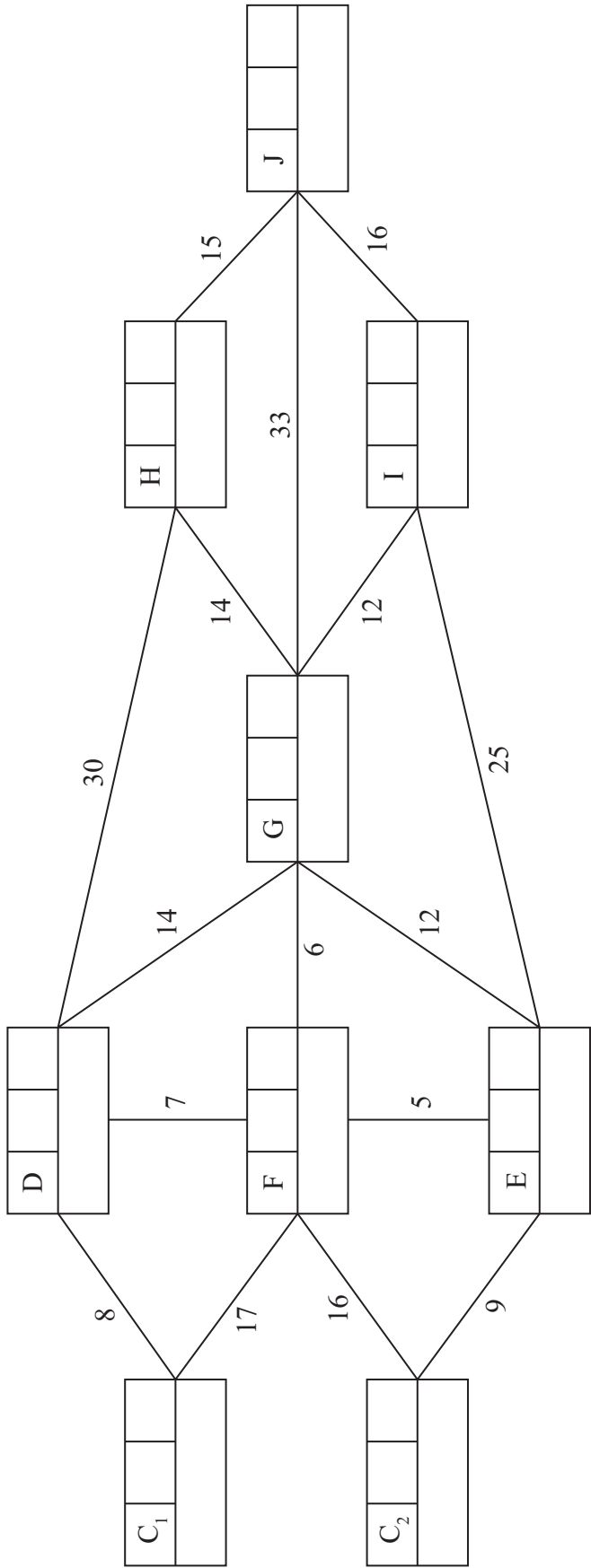
Key

Vertex	Order of labelling	Final value
	Working values	

Question 7 continued

Shortest route ....

length ....

(Total 7 marks)

Q7

8.

Question 8 continued

Diagram 1

Q8

(Total 16 marks)

TOTAL FOR PAPER: 75 MARKS

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