Paper Reference(s)

6690/01

Edexcel GCE

Decision Mathematics D2

Advanced/Advanced Subsidiary

Monday 11 June 2007 – Afternoon

Time: 1 hour 30 minutes

Materials required for examination
Nil

Items included with question papers
D2 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, differentiation and integration, or have retrievable mathematical formulas stored in them.

Instructions to Candidates

Write your answers for this paper in the D2 answer book provided.
In the boxes on the answer book, write your centre number, candidate number, your surname, intial(s) and signature.
Check that you have the correct question paper.
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 6 questions in this question paper. The total mark for this question paper is 75.
There are 8 pages in this question paper. The answer book has 16 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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Write your answers in the D2 answer book for this paper.

1.

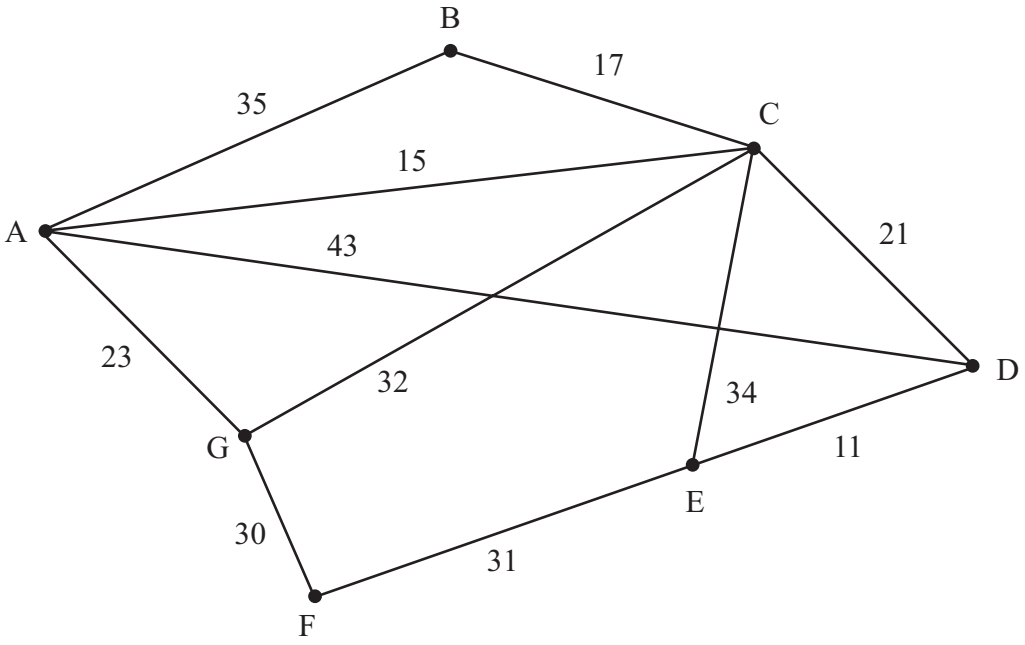

Figure 1

The network in Figure 1 shows the distances, in miles, between seven gift shops, *A, B, C, D, E, F* and *G*.

The area manager needs to visit each shop. She will start and finish at shop A and wishes to minimise the total distance travelled.

(a) By inspection, complete the two copies of the table of least distances in your answer book.

(4)

(b) Starting at A, and making your method clear, find an upper bound for the route length, using the nearest neighbour algorithm.

(3)

(c) By deleting A, and all of its arcs, find a lower bound for the route length.

(4)

(Total 11 marks)

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2. Denis (D) and Hilary (H) play a two-person zero-sum game represented by the following pay-off matrix for Denis.

	H plays 1	H plays 2	H plays 3
D plays 1	2	-1	3
D plays 2	-3	4	-4

(a) Show that there is no stable solution to this game.

(3)

(b) Find the best strategy for Denis and the value of the game to him.

(10)

(Total 13 marks)

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3. To raise money for charity it is decided to hold a Teddy Bear making competition. Teams of four compete against each other to make 20 Teddy Bears as quickly as possible.

There are four stages: first *cutting,* then *stitching,* then *filling* and finally *dressing*.

Each team member can only work on one stage during the competition. As soon as a stage is completed on each Teddy Bear the work is passed immediately to the next team member.

The table shows the time, in seconds, taken to complete each stage of the work on one Teddy Bear by the members *A, B, C* and *D* of one of the teams.

	cutting	*stitching*	*filling*	*dressing*
A	66	101	85	36
B	66	98	74	38
C	63	97	71	34
D	67	102	78	35

(a) Use the Hungarian algorithm, reducing rows first, to obtain an allocation that minimises the time taken by this team to produce one Teddy Bear. You must make your method clear and show the table after each iteration.

(9)

(b) State the minimum time it will take this team to produce one Teddy Bear.

(1)

Using the allocation found in (a),

(c) calculate the minimum total time this team will take to complete 20 Teddy Bears. You should make your reasoning clear and state your answer in minutes and seconds.

(3)

(Total 13 marks)

4. A group of students and teachers from a performing arts college are attending the Glasenburgh drama festival. All of the group want to see an innovative modern production of the play 'The Decision is Final'. Unfortunately there are not enough seats left for them all to see the same performance.

There are three performances of the play, 1, 2, and 3. There are two types of ticket, Adult and Student. Student tickets will be purchased for the students and Adult tickets for the teachers.

The table below shows the price of tickets for each performance of the play.

	Adult	Student
Performance 1	£5.00	£4.50
Performance 2	£4.20	£3.80
Performance 3	£4.60	£4.00

There are 18 teachers and 200 students requiring tickets.
There are 94, 65 and 80 seats available for performances 1, 2, and 3 respectively.

(a) Complete the first table in the answer book.

(2)

(b) Explain why a dummy column was added to the table in the answer book.

(1)

(c) Use the north-west corner method to obtain a possible solution.

(1)

(d) Taking the most negative improvement index to indicate the entering square, use the stepping stone method **once** to obtain an improved solution. You must make your shadow costs and improvement indices clear.

(6)

After a further iteration the table becomes:

	Adult	Student	Dummy
Performance 1		73	21
Performance 2	18	47	
Performance 3		80	

(e) Demonstrate that this solution gives the minimum cost, and find its value.

(6)

(Total 16 marks)

5. Anna (A) and Roland (R) play a two-person zero-sum game which is represented by the following pay-off matrix for Anna.

	R plays 1	R plays 2	R plays 3
A plays 1	6	-2	-3
A plays 2	-3	1	2
A plays 3	5	4	-1

Formulate the game as a linear programming problem **for player R**. Write the constraints as inequalities. Define your variables clearly.

(Total 8 marks)

Turn over for Question 6

6.

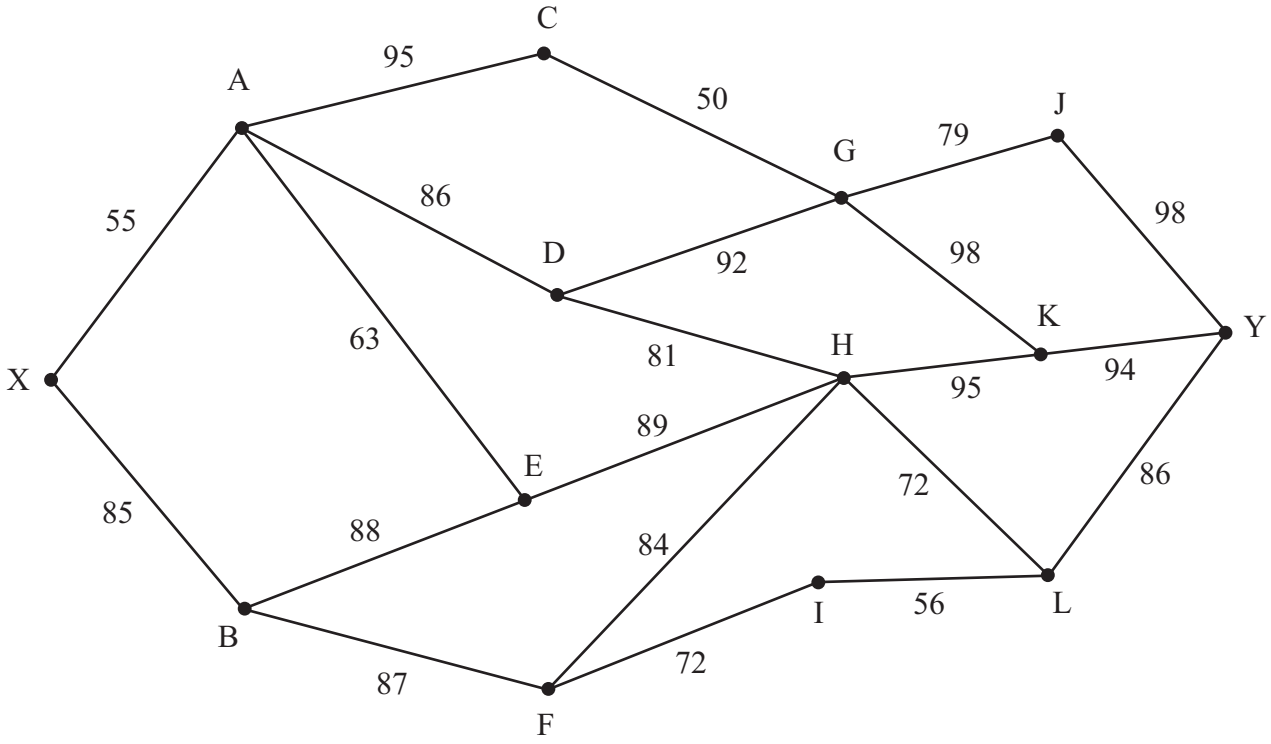

Figure 2

Agent Goodie has successfully recovered the stolen plans from Evil Doctor Fiendish and needs to take them from Evil Doctor Fiendish's secret headquarters at X to safety at Y. To do this he must swim through a network of underwater tunnels. Agent Goodie has no breathing apparatus, but knows that there are twelve points, *A, B, C, D, E, F, G, H, I, J, K* and *L*, at which there are air pockets where he can take a breath.

The network is modelled in Figure 2, and the number on each arc gives the time, in seconds, it takes Agent Goodie to swim from one air pocket to the next.

Agent Goodie needs to find a route through this network that minimises the longest time between successive air pockets.

(a) Use dynamic programming to complete the table in the answer book and hence find a suitable route for Agent Goodie.

(12)

Unfortunately, just as Agent Goodie is about to start his journey, tunnel XA becomes blocked.

(b) Find an optimal route for Agent Goodie avoiding tunnel XA.

(2)

(Total 14 marks)

TOTAL FOR PAPER: 75 MARKS

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