

General Certificate of Education
June 2005
Advanced Subsidiary Examination



MATHEMATICS (SPECIFICATION A)
Unit Discrete 1

MAD1

Wednesday 25 May 2005 Afternoon Session

In addition to this paper you will require:

- an 8-page answer book;
- the AQA booklet of formulae and statistical tables;
- an insert for use in Questions 4 and 6 (enclosed).

You may use a graphics calculator.

Time allowed: 1 hour 20 minutes

Instructions

- Use blue or black ink or ball-point pen. Pencil should only be used for drawing.
- Write the information required on the front of your answer book. The *Examining Body* for this paper is AQA. The *Paper Reference* is MAD1.
- Answer **all** questions.
- All necessary working should be shown; otherwise marks for method may be lost.
- The **final** answer to questions requiring the use of tables or calculators should normally be given to three significant figures.
- Tie loosely any additional sheets you have used, including the insert for use in Questions 4 and 6, to the back of your answer book before handing it to the invigilator.

Information

- The maximum mark for this paper is 60.
- Mark allocations are shown in brackets.
- Further copies of the insert for use in Questions 4 and 6 are available on request.

Advice

- Unless stated otherwise, formulae may be quoted, without proof, from the booklet.

Answer **all** questions.

- 1 Six people A, B, C, D, E and F are to be allocated to six tasks U, V, W, X, Y and Z. The following table shows the tasks that each of the people is able to undertake.

	A	B	C	D	E	F
U	0	1	1	0	0	0
V	1	1	0	0	0	0
W	0	0	1	1	0	0
X	0	0	1	1	1	0
Y	0	0	0	0	0	1
Z	0	0	0	0	1	1

- (a) Represent this information on a bipartite graph. *(2 marks)*
- (b) Initially, B is assigned to task V, C to task U, D to task X, and F to task Z.

Demonstrate, by using an algorithm from this initial matching, how each person can be allocated to a task. *(5 marks)*

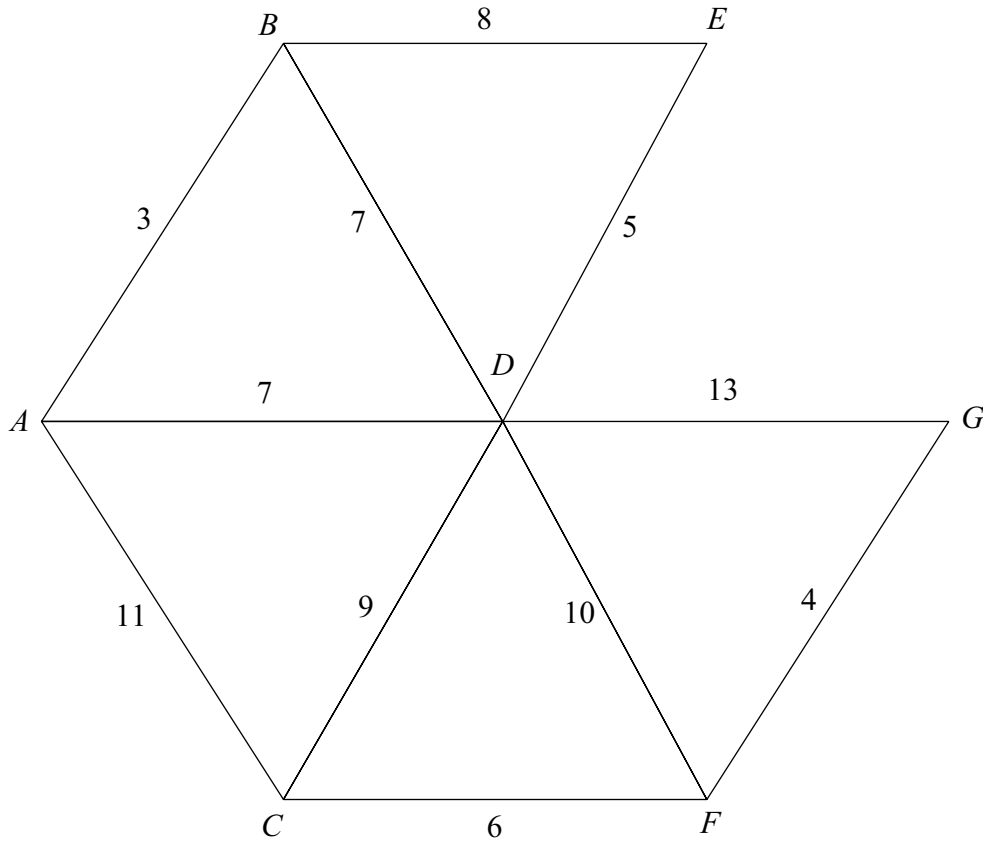
- 2 (a) Use a Shell sort to rearrange the following numbers into ascending order, showing the new arrangement after each pass.

23, 12, 17, 18, 5, 9, 19, 16 *(6 marks)*

- (b) For the **first** pass, write down:

- (i) the number of comparisons; *(1 mark)*
- (ii) the number of exchanges (swaps). *(1 mark)*

3 The following network shows the lengths, in miles, of roads connecting seven villages.



- (a) Use Kruskal's algorithm to find a minimum spanning tree for the network. *(4 marks)*
- (b) State the length of your minimum spanning tree. *(1 mark)*
- (c) There are two minimum spanning trees for this network.

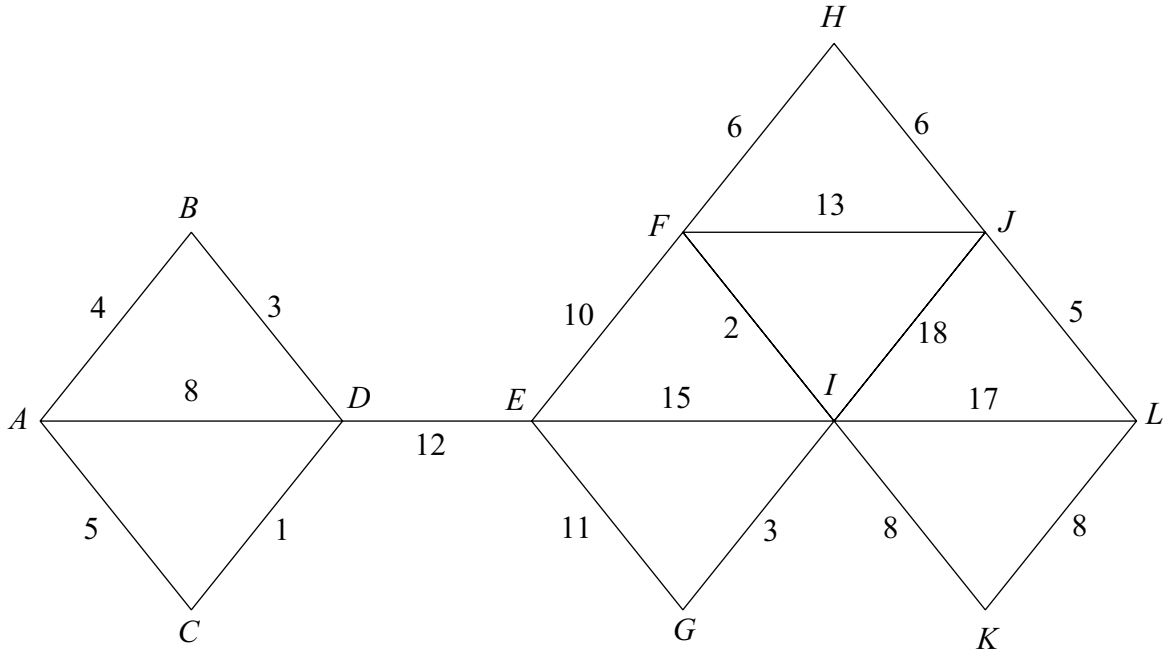
Draw both of these minimum spanning trees. *(2 marks)*

TURN OVER FOR THE NEXT QUESTION

Turn over ►

4 [Figure 1, printed on the insert, is provided for use in answering this question.]

The following network shows the times, in minutes, taken by a policeman to walk along roads connecting 12 places on his beat.



(The total of all the times in the diagram is 155 minutes.)

- (a) (i) The policeman is based at A and has to visit a school situated at L . Use Dijkstra's algorithm on **Figure 1** to find the minimum time to walk from A to L . (6 marks)
- (ii) Write down the corresponding route. (1 mark)
- (b) Each day, the policeman has to walk along each road at least once, starting and finishing at A .
- (i) For an optimal Chinese postman route find the minimum time needed for the policeman to complete his tour. (3 marks)
- (ii) State the number of times that the vertex F would appear in a route corresponding to this minimum time. (1 mark)

- 5 Renata is visiting a theme park. There are five film sets: Alien (A), Backdraft (B), Conan (C), Die Hard (D) and E.T. (E). The table shows the times, in minutes, taken by Renata to walk from one film set to another.

Renata wants to visit all of the five film sets starting and finishing at A.

	Alien (A)	Backdraft (B)	Conan (C)	Die Hard (D)	E.T. (E)
Alien (A)	–	7	11	9	3
Backdraft (B)	7	–	8	6	12
Conan (C)	11	8	–	5	4
Die Hard (D)	9	6	5	–	10
E.T. (E)	3	12	4	10	–

- (a) Renata decides to visit the film sets in the order ABCDEA. Find the walking time of this tour. *(1 mark)*
- (b) Explain why this answer can be considered as being an upper bound for the minimum walking time of Renata's tour. *(2 marks)*
- (c) Use the nearest neighbour algorithm, starting from A, to find another upper bound. *(4 marks)*
- (d) By deleting A, find a lower bound for Renata's tour. *(4 marks)*
- (e) Renata thinks that she can reduce her walking time to 20 minutes. Explain why this is impossible. *(1 mark)*

TURN OVER FOR THE NEXT QUESTION

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6 [Figure 2, printed on the insert, is provided for use in answering this question.]

A small company makes two different types of boxes of Christmas crackers: luxury and standard.

Each hour, the company must make at least five boxes of each type, but not more than 25 standard boxes.

Each luxury box requires 20 toys, and each standard box 10 toys.

There are 600 toys available each hour.

The company must make at least half as many standard boxes as luxury boxes.

Each luxury box is sold at a profit of £3 and each standard box at a profit of £1.

The company makes x luxury boxes and y standard boxes each hour.

The company wishes to maximise its profit, £ P per hour.

- (a) Show that two of the constraints lead to the inequalities $2y \geq x$ and $2x + y \leq 60$.
(2 marks)
- (b) Formulate the company's situation as a linear programming problem. (2 marks)
- (c) On **Figure 2**, draw a suitable diagram to enable the problem to be solved graphically, indicating the feasible region and the direction of the objective line. (5 marks)
- (d) Use your diagram to find the company's maximum hourly profit. (2 marks)
- (e) The company changes its pricing structure so that the profit is now £2 for each box, for both luxury and standard. On a particular day the company makes boxes for exactly 7 hours. Only complete boxes are sold. Find the maximum profit on this day. State the two different combinations of boxes that correspond to this maximum. (4 marks)

END OF QUESTIONS

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Surname						Other Names					
Centre Number						Candidate Number					
Candidate Signature											

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Insert for use in answering Questions 4 and 6.

Fill in the boxes at the top of this page.

Fasten this insert securely to your answer book.

Turn over ►

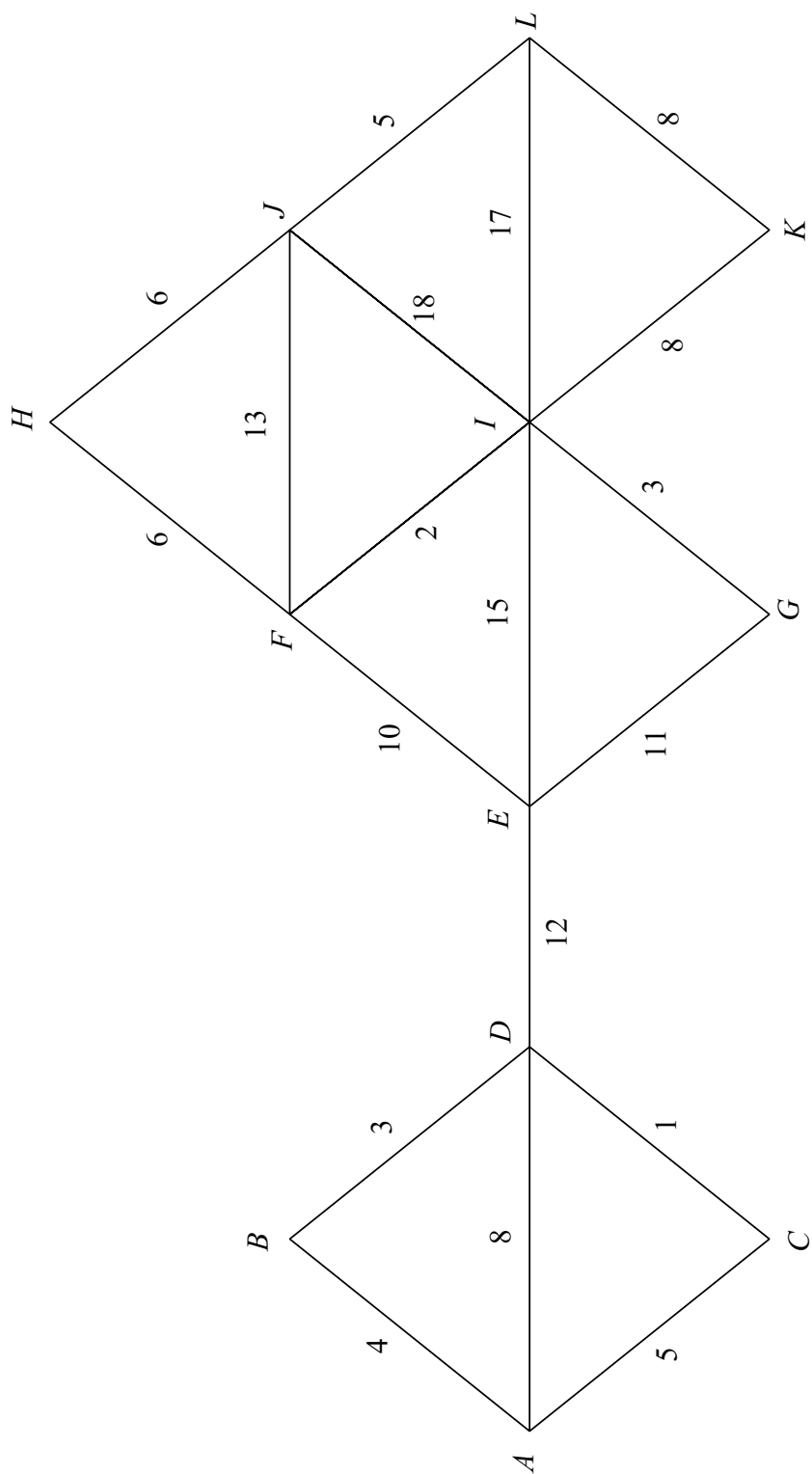


Figure 1 (for Question 4)

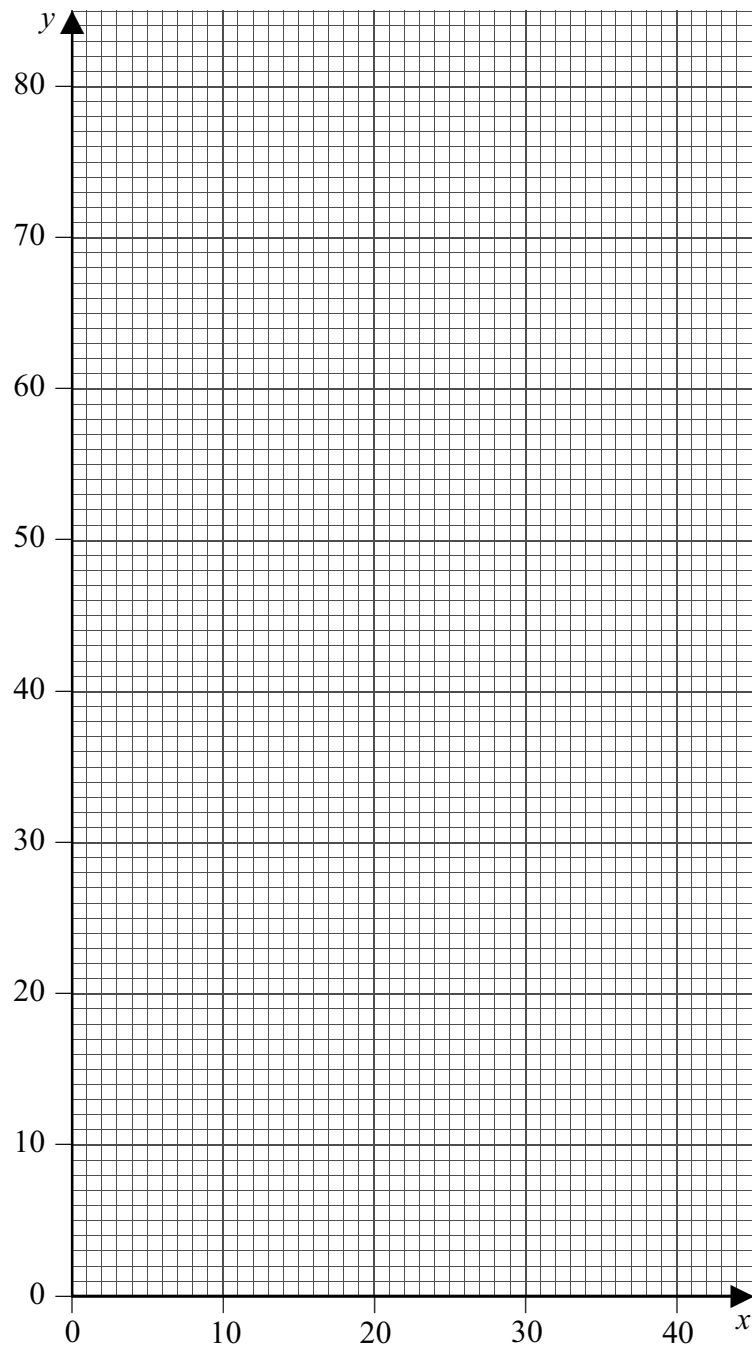


Figure 2 (for Question 6)

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