

General Certificate of Education  
January 2005  
Advanced Subsidiary Examination



**MATHEMATICS**  
**Unit Decision 1**

**MD01**

Tuesday 25 January 2005 Morning Session

**In addition to this paper you will require:**

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

You may use a graphics calculator.

Time allowed: 1 hour 30 minutes

**Instructions**

- Use blue or black ink or ball-point pen. Pencil or coloured 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 MD01.
- 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 be given to three significant figures, unless stated otherwise.
- Fill in the boxes at the top of the insert.

**Information**

- The maximum mark for this paper is 75.
- Mark allocations are shown in brackets.

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Answer **all** questions.

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1 A student is using the algorithm below.

```
LINE 10    INPUT  $A, B$ 
LINE 20    LET  $C = A - B$ 
LINE 30    LET  $D = A + B$ 
LINE 40    LET  $E = (D * D) - (C * C)$ 
LINE 50    LET  $F = E/4$ 
LINE 60    PRINT  $F$ 
LINE 70    END
```

Trace the algorithm in the case where  $A = 5$  and  $B = 3$ .

*(4 marks)*

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

19 3 7 20 2 6 5 15

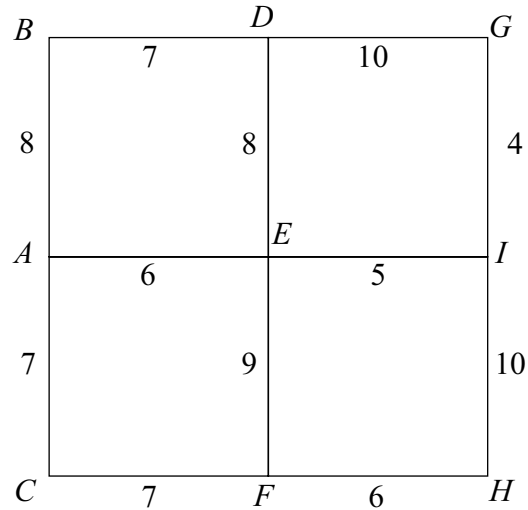
*(5 marks)*

(b) Write down the number of comparisons and the number of swaps during the first pass.

*(2 marks)*

- 3 A local council is responsible for gritting roads.

The diagram shows the length, in miles, of the roads that have to be gritted.



Total length  
= 87 miles

The gritter is based at  $A$ , and must travel along all the roads, at least once, before returning to  $A$ .

- (a) Explain why it is not possible to start from  $A$  and, by travelling along each road only once, return to  $A$ .  
(1 mark)
- (b) Find an optimal ‘Chinese postman’ route around the network, starting and finishing at  $A$ . State the length of your route.  
(6 marks)
- 4 The Head Teacher of a school is allocating five teachers, Amy ( $A$ ), Ben ( $B$ ), Celia ( $C$ ), Duncan ( $D$ ), and Erica ( $E$ ), to the five posts of Head of Year 7, 8, 9, 10 and 11. The five teachers are asked which year(s) they would be willing to take. This information is shown below.

Amy is willing to take Year 7 or Year 8.

Ben is willing to take Year 7, Year 8 or Year 10.

Celia is willing to take Year 8, Year 9 or Year 11.

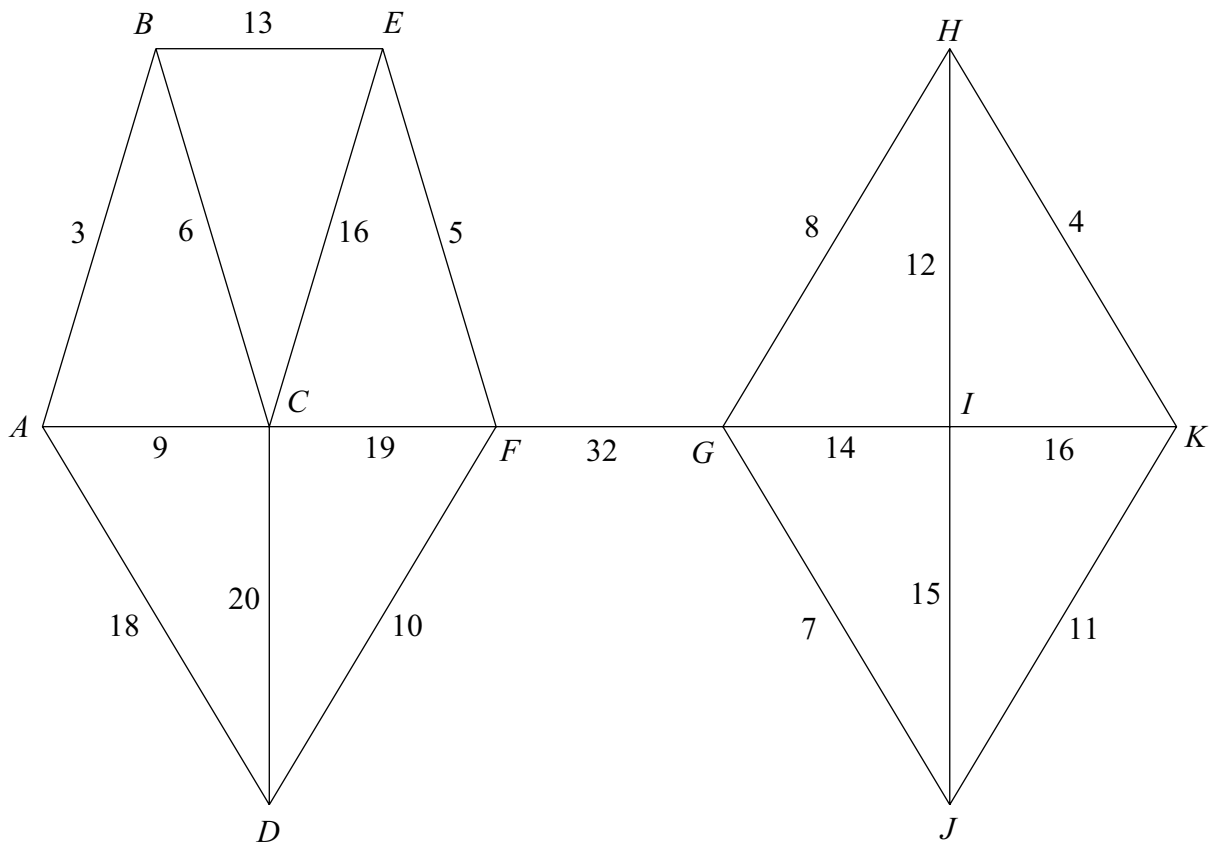
Duncan will take only Year 9.

Erica will take only Year 11.

- (a) Show this information on a bipartite graph.  
(3 marks)
- (b) Initially the Head Teacher assigns Amy to Year 8, Ben to Year 10, Celia to Year 9 and Erica to Year 11.

Demonstrate, by using an alternating path from this initial matching, how each teacher can be matched to a year that they are willing to take.  
(4 marks)

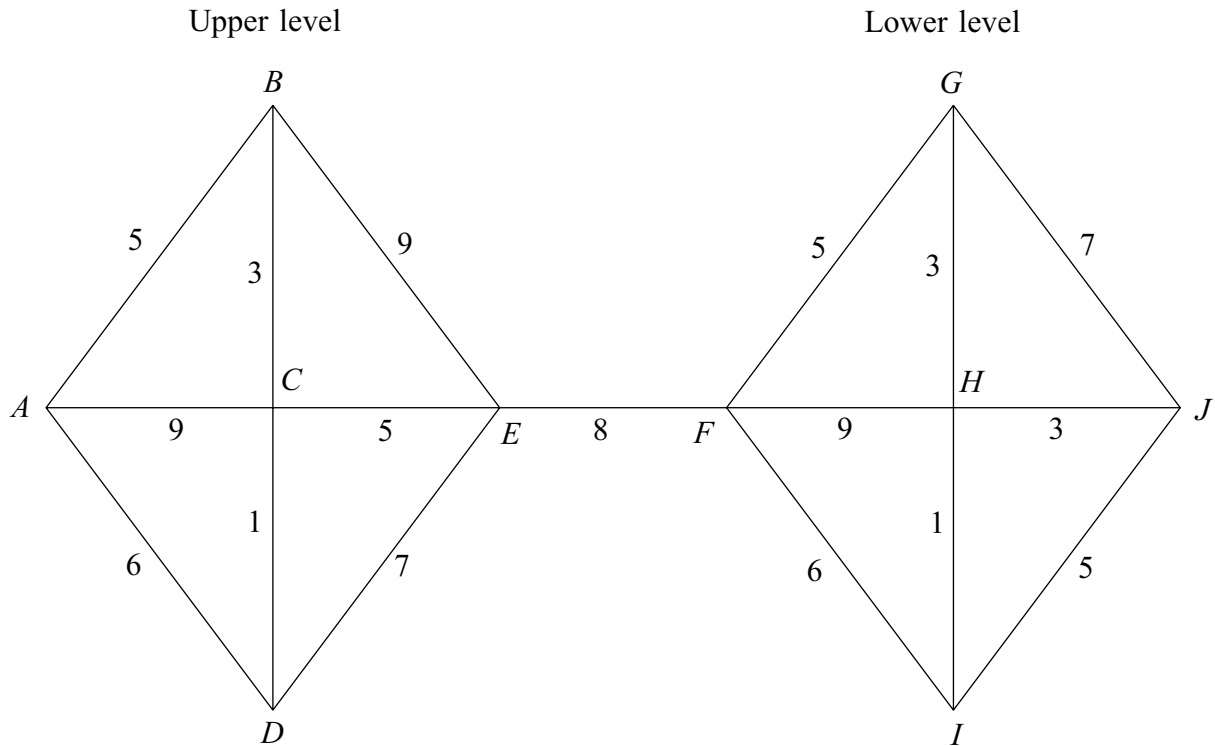
5 The network shows the lengths, in miles, of roads connecting eleven villages.



- (a) Use Prim's algorithm, starting from  $A$ , to find the minimum spanning tree for the network. *(4 marks)*
- (b) State the length of your minimum spanning tree. *(1 mark)*
- (c) Draw your minimum spanning tree. *(3 marks)*
- (d) A student used Kruskal's algorithm to find the same minimum spanning tree. Find the seventh and eighth edges that the student added to his spanning tree. *(2 marks)*

6 [Figure 1, printed on a separate sheet, is provided for use in this question.]

A theme park is built on two levels. The levels are connected by a staircase. There are five rides on each of the levels. The diagram shows the ten rides:  $A, B, \dots, J$ . The numbers on the edges represent the times, in minutes, taken to travel between pairs of rides.



- (a) Use Dijkstra's algorithm on **Figure 1** to find the minimum time to travel from  $A$  to  $J$ .  
(6 marks)
- (b) A new staircase is built connecting rides  $B$  and  $G$ . The time taken to travel from  $B$  to  $G$  using this staircase is  $x$  minutes, where  $x$  is an integer. The time taken to travel from  $A$  to  $G$  is reduced, but the time taken to travel from  $A$  to  $J$  is not reduced.

Find two inequalities for  $x$  and hence state the value of  $x$ .  
(4 marks)

- 7 Rob delivers bread to six shops  $A, B, C, D, E$  and  $F$ . Each day, Rob starts at shop  $A$ , travels to each of the other shops before returning to shop  $A$ . The table shows the distances, in miles, between the shops.

	$A$	$B$	$C$	$D$	$E$	$F$
$A$	–	8	6	9	12	7
$B$	8	–	10	14	13	8
$C$	6	10	–	7	16	10
$D$	9	14	7	–	15	5
$E$	12	13	16	15	–	11
$F$	7	8	10	5	11	–

- (a) (i) Find the length of the tour  $ABCDEF A$ . (2 marks)
- (ii) Find the length of the tour obtained by using the nearest neighbour algorithm starting from  $A$ . (4 marks)
- (b) By deleting  $A$ , find a lower bound for the length of a minimum tour. (5 marks)
- (c) By deleting  $F$ , another lower bound of 45 miles is obtained for the length of a minimum tour.

The length of a minimum tour is  $T$  miles. Write down the smallest interval for  $T$  which can be obtained from your answers to parts (a) and (b), and the information given in this part. (3 marks)

8 [Figure 2, printed on a separate sheet, is provided for use in this question.]

A bakery makes two types of pizza, large and medium.

Every day the bakery must make at least 40 of each type.

Every day the bakery must make at least 120 in total but not more than 400 pizzas in total.

Each large pizza takes 4 minutes to make, and each medium pizza takes 2 minutes to make. There are four workers available, each for five hours a day, to make the pizzas.

The bakery makes a profit of £3 on each large pizza sold and £1 on each medium pizza sold.

Each day, the bakery makes and sells  $x$  large pizzas and  $y$  medium pizzas.

The bakery wishes to maximise its profit, £ $P$ .

- (a) Show that one of the constraints leads to the inequality

$$2x + y \leq 600 \quad (1 \text{ mark})$$

- (b) Formulate this situation as a linear programming problem. (3 marks)

- (c) On **Figure 2**, draw a suitable diagram to enable the problem to be solved graphically, indicating the feasible region and an objective line. (5 marks)

- (d) Use your diagram to find the maximum daily profit. (2 marks)

- (e) The bakery introduces a new pricing structure in which the profit is £2 on each large pizza sold and £2 on each medium pizza sold.

- (i) Find the new maximum daily profit for the bakery. (3 marks)

- (ii) Write down the number of different combinations that would give the new maximum daily profit. (2 marks)

**END OF QUESTIONS**

Surname						Other Names					
Centre Number						Candidate Number					
Candidate Signature											

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Insert for use in Questions 6 and 8.

Fill in the boxes at the top of this page.

Fasten this insert securely to your answer book.

**TURN OVER FOR FIGURE 1**



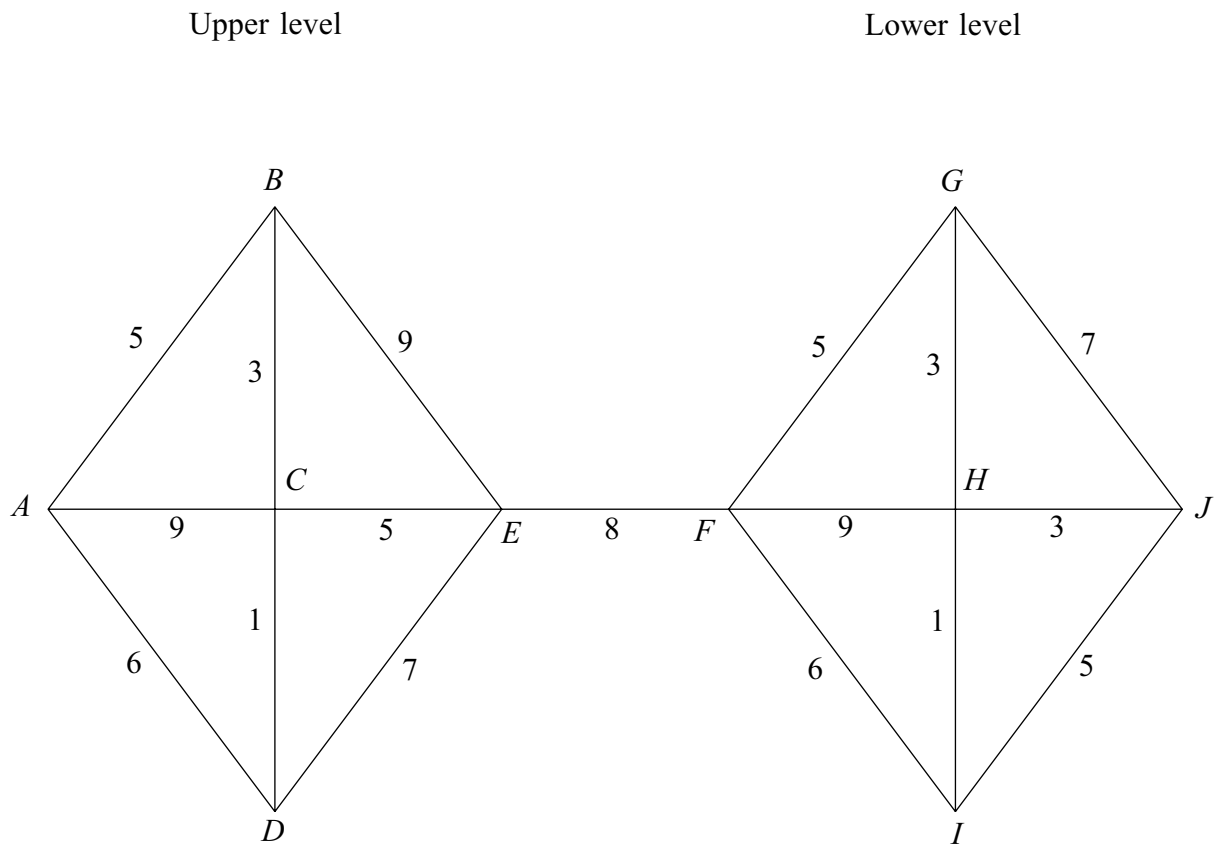


Figure 1 (for Question 6)

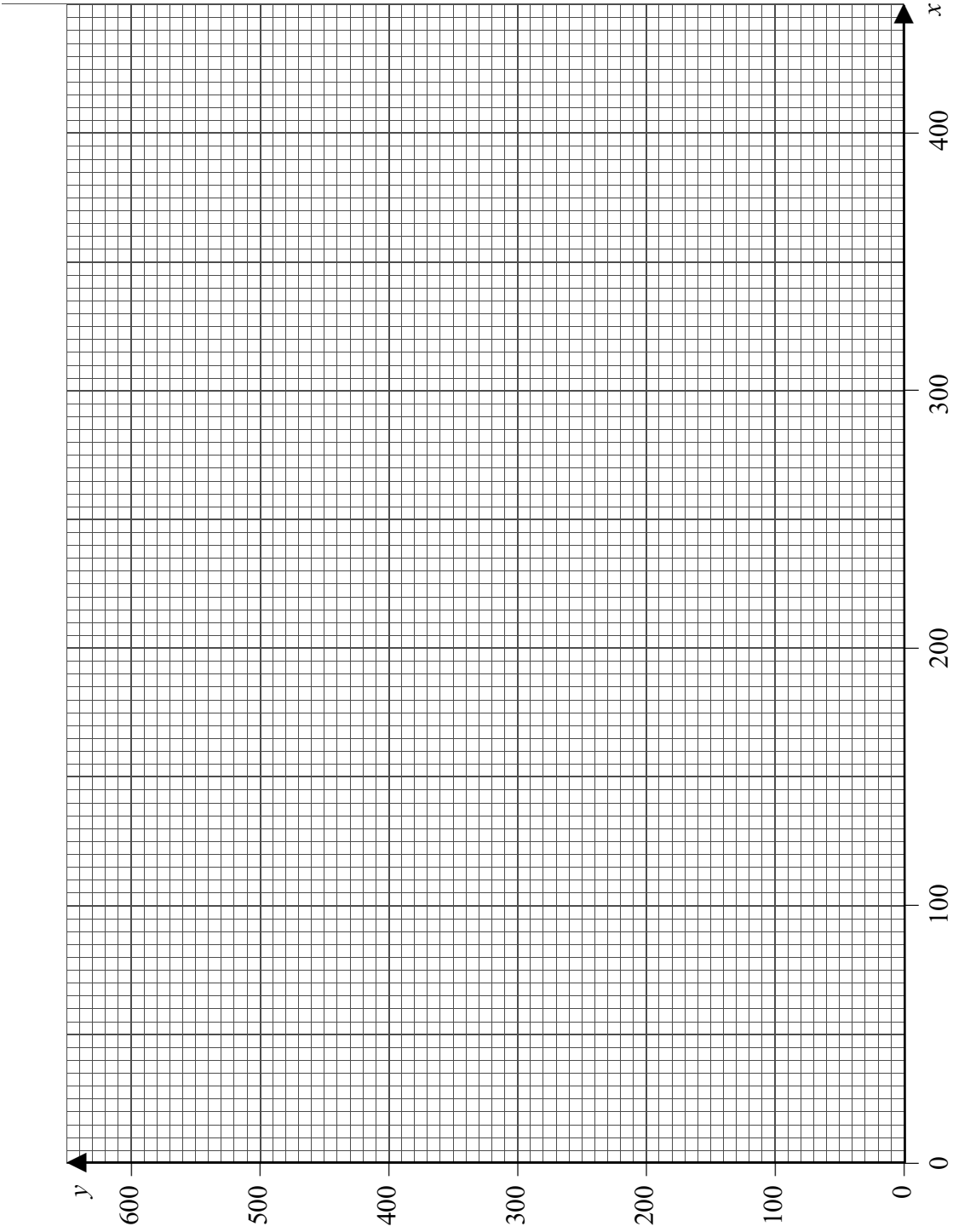


Figure 2 (for Question 8)

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