

General Certificate of Education  
June 2004  
Advanced Subsidiary Examination



**MATHEMATICS (SPECIFICATION A)**  
**Unit Discrete 1**

**MAD1**

Friday 28 May 2004 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 5 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 may have used, including the insert for use in Questions 5 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 5 and 6 are available on request.

**Advice**

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

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Answer **all** questions.

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- 1 (a) Draw a bipartite graph representing the following adjacency matrix.

	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>A</b>	1	0	0	0	1
<b>B</b>	0	1	1	1	0
<b>C</b>	1	0	0	0	1
<b>D</b>	0	1	1	1	0
<b>E</b>	1	0	0	0	1

(2 marks)

- (b) Given that *A*, *B*, *C*, *D* and *E* represent five people and 1, 2, 3, 4 and 5 represent five tasks to which they are to be assigned, explain why a complete matching is impossible.

(2 marks)

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

17, 26, 5, 14, 6, 33, 28, 25

(6 marks)

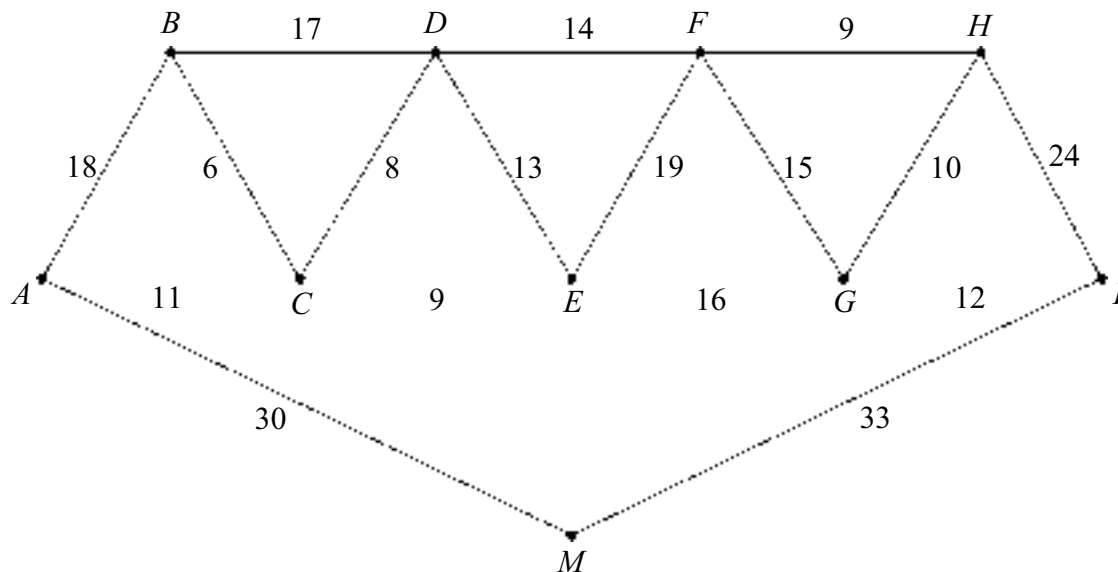
- 3 Peppi is a mobile hairdresser based at Chadderton ( $C$ ). His day's appointments are at six places: Ashton ( $A$ ), Bardsley ( $B$ ), Chadderton ( $C$ ), Derker ( $D$ ), Edenfield ( $E$ ) and Failsworth ( $F$ ). He intends to travel from one place to the next until he has visited all of the places, starting and finishing at Chadderton. The following table shows the times, in minutes, taken to travel between the six places.

	<b>Ashton (<math>A</math>)</b>	<b>Bardsley (<math>B</math>)</b>	<b>Chadderton (<math>C</math>)</b>	<b>Derker (<math>D</math>)</b>	<b>Edenfield (<math>E</math>)</b>	<b>Failsworth (<math>F</math>)</b>
<b>Ashton (<math>A</math>)</b>	–	18	14	17	31	15
<b>Bardsley (<math>B</math>)</b>	18	–	16	22	27	18
<b>Chadderton (<math>C</math>)</b>	14	16	–	13	22	15
<b>Derker (<math>D</math>)</b>	17	22	13	–	29	18
<b>Edenfield (<math>E</math>)</b>	31	27	22	29	–	30
<b>Failsworth (<math>F</math>)</b>	15	18	15	18	30	–

- (a) (i) Use the nearest neighbour algorithm, starting and finishing at Chadderton, to find a possible route for Peppi and the total travelling time it would take. *(5 marks)*
- (ii) Explain why your answer to part (a) (i) gives an upper bound for Peppi's minimum possible total travelling time. *(2 marks)*
- (b) By deleting Chadderton, find a lower bound for the minimum total travelling time. *(5 marks)*
- (c) Given that the minimum total travelling time is  $T$  minutes, use your answers to parts (a) and (b) to write down an interval within which  $T$  must lie. *(1 mark)*

**TURN OVER FOR THE NEXT QUESTION**

- 4 Every Christmas Sam puts lights on nine trees,  $A, B, C, D, E, F, G, H$  and  $I$ , in his garden. The trees have to be connected together either directly or indirectly by cabling and also connected to the mains electricity supply,  $M$ , at the house. The cabling has to be laid alongside the garden paths. The diagram shows the lengths of the paths, in metres.



The total length of the paths is 264 metres.

- (a) (i) Use Kruskal's algorithm to find the minimum length of cabling required. State this minimum length. (5 marks)
- (ii) Draw the minimum spanning tree. (2 marks)
- (b) The table shows the minimum lengths of paths between  $A, B, H$  and  $I$ .

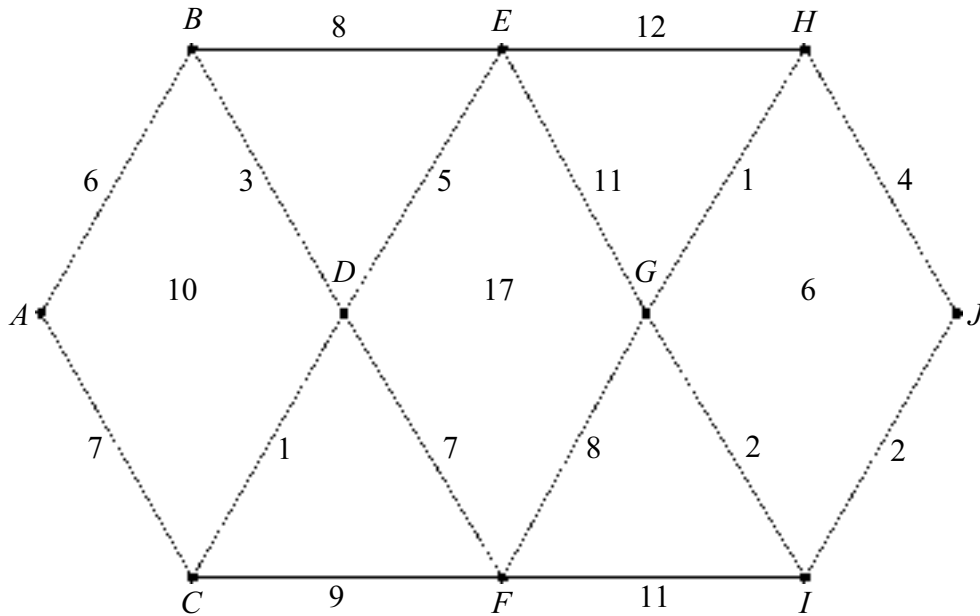
	$A$	$B$	$H$	$I$
$A$	–	17	42	48
$B$	17	–	37	43
$H$	42	37	–	22
$I$	48	43	22	–

Sam decides to walk along all the paths, starting and finishing at  $M$ .

Find the length of an optimal Chinese Postman route for Sam. (4 marks)

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

The following diagram shows the lengths of roads, in miles, connecting 10 villages.



- (a) Use Dijkstra's algorithm on **Figure 1** to find the shortest distance from  $A$  to  $J$ . Show your working at each vertex. (7 marks)
- (b) Write down the corresponding route. (2 marks)
- (c) Write down the shortest distance from  $A$  to  $H$ . (1 mark)

**TURN OVER FOR THE NEXT QUESTION**

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

Teresa is a florist. Every day she makes two types of bouquet, standard and luxury.

Each standard bouquet has 3 roses, 6 carnations and 4 lilies.

Each luxury bouquet has 6 roses, 3 carnations and 4 lilies.

Every day, Teresa has 600 roses, 600 carnations and 480 lilies available.

She makes a profit of £1.50 on each standard bouquet sold and £2.50 on each luxury bouquet sold. Each day, Teresa sells all the bouquets she makes.

Each day, Teresa makes  $x$  standard bouquets and  $y$  luxury bouquets, and she wishes to maximise her daily profit, £ $P$ .

(a) Show that  $x$  and  $y$  must satisfy the following inequalities.

$$x + 2y \leq 200$$

$$2x + y \leq 200$$

$$x + y \leq 120 \quad (3 \text{ marks})$$

(b) Draw a suitable diagram to enable the problem to be solved graphically, indicating the feasible region and the direction of the objective line. (7 marks)

(c) Use your diagram to find Teresa's maximum daily profit. (2 marks)

(d) One day Teresa decides to make more standard bouquets than luxury bouquets.

Find her maximum possible profit on this day. (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 Questions 5 and 6.

Fill in the boxes at the top of this page.

Fasten this insert securely to your answer book.

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**TURN OVER FOR FIGURE 1**

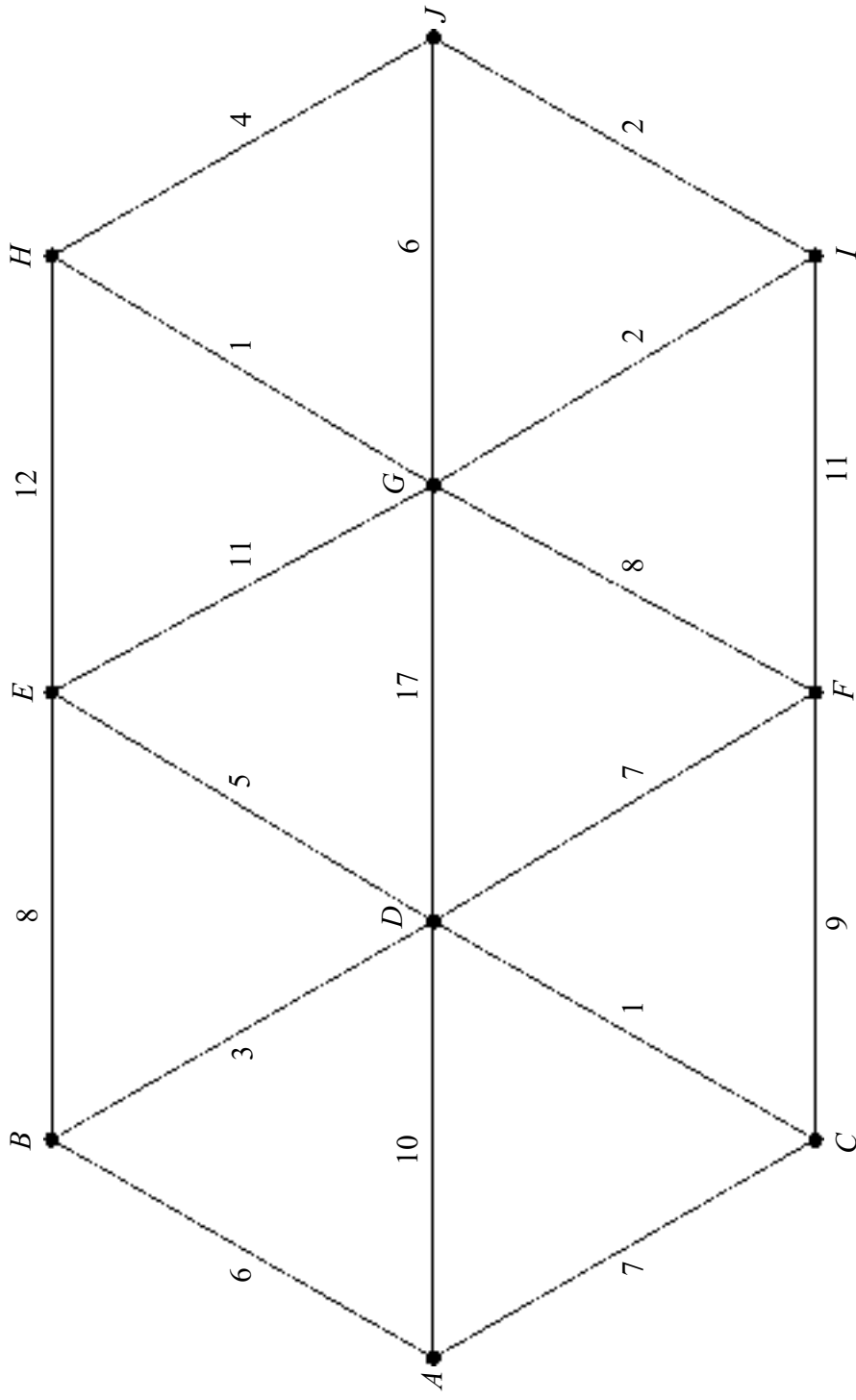
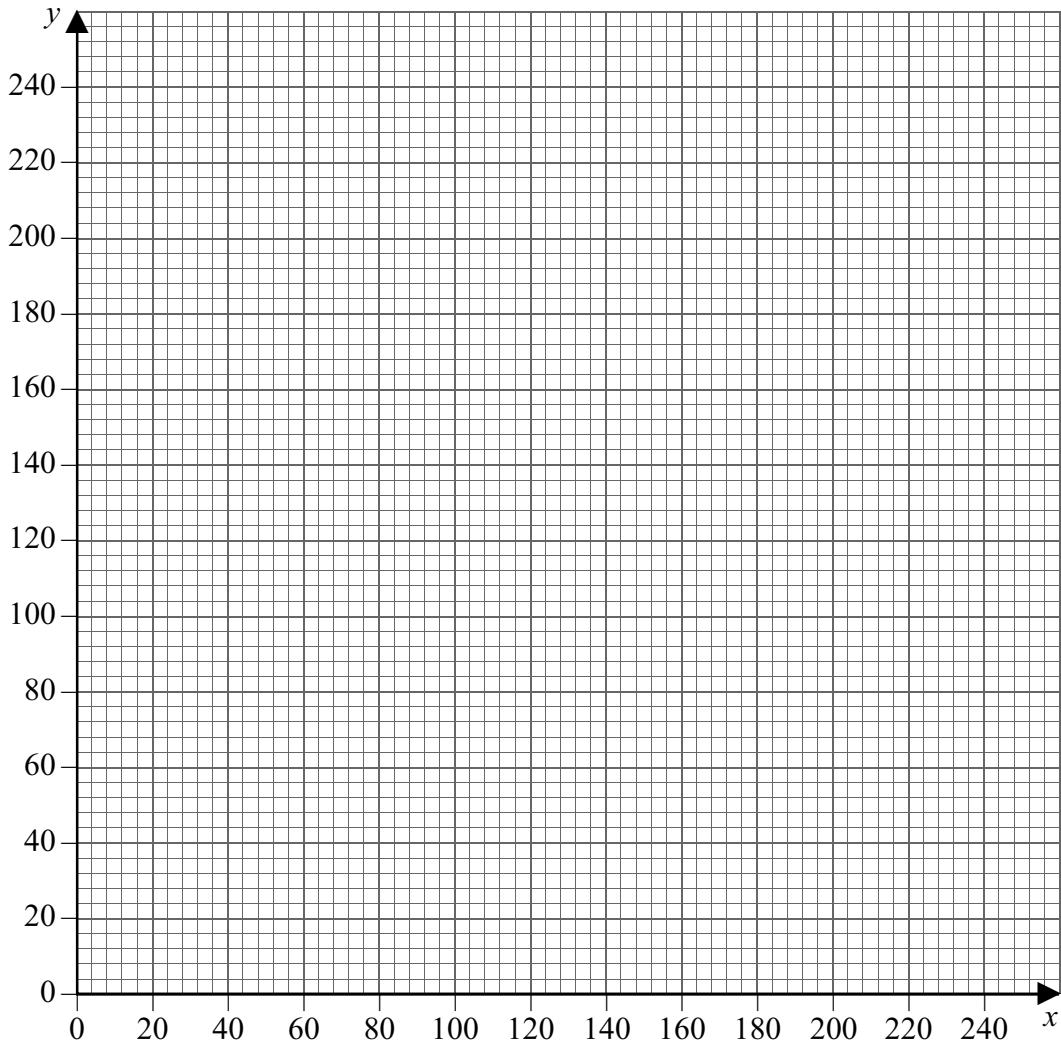


Figure 1 (for Question 5)



**Figure 2 (for Question 6)**

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