General Certificate of Education
January 2005
Advanced Subsidiary Examination

MATHEMATICS (SPECIFICATION A) MAD1
Unit Discrete 1

Wednesday 12 January 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 3 and 5 (enclosed).

You may use a graphics calculator.

Time allowed: 1 hour 20 minutes

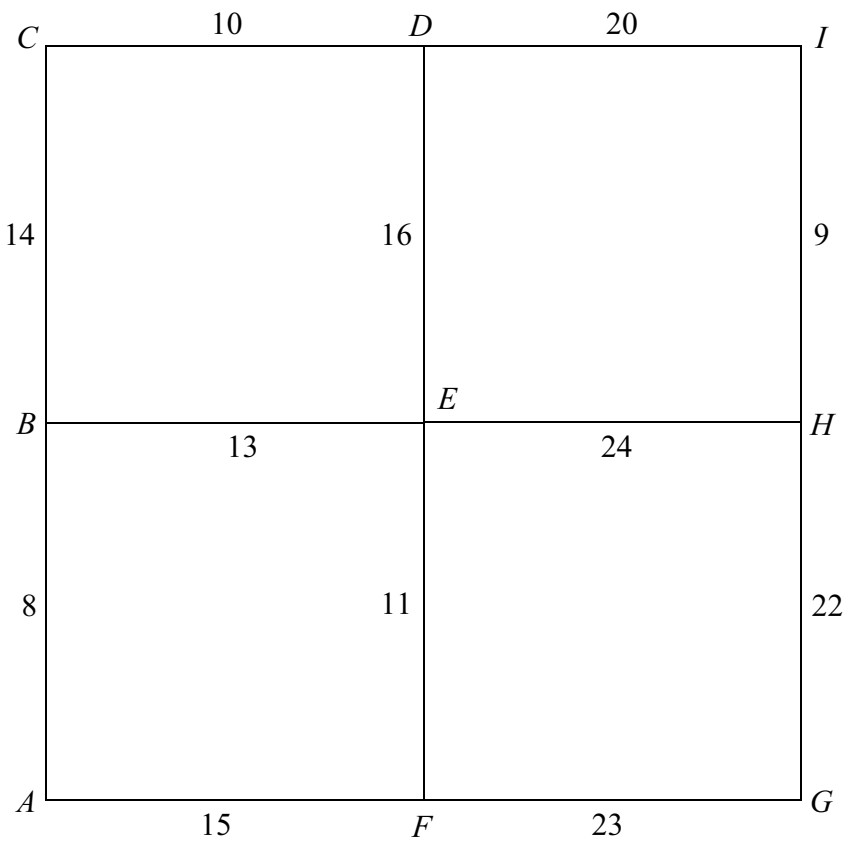
Instructions
- Use blue or black ink or ball-point pen. Pencil should only be used for drawing.
- Write the information required on the front of your answer book. The *Examining Body* for this paper is AQA. The *Paper Reference* is MAD1.
- Answer **all** questions.
- All necessary working should be shown; 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 3 and 5, 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 3 and 5 are available on request.

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

Answer **all** questions.

1 The following network has 9 vertices. The numbers represent the weights of the edges.



(a) Use Kruskal's algorithm, showing the order in which you select the edges, to find the minimum spanning tree for the network. *(4 marks)*

(b) State the weight of your minimum spanning tree. *(1 mark)*

(c) Draw your minimum spanning tree. *(1 mark)*

2 A class has five boys, Ahmed, Bob, Chris, Dave and Eric, and five girls, Rebecca, Serena, Toyah, Ulrika and Vivian. They are going to go to an end of term dance. The girls with whom each boy is willing to dance are shown in the following table.

Boy	Girls
Ahmed	Vivian, Ulrika
Bob	Vivian, Ulrika
Chris	Vivian, Rebecca, Ulrika
Dave	Serena, Rebecca, Toyah
Eric	Vivian, Rebecca, Toyah

(a) Show this information on a bipartite graph. *(2 marks)*

(b) Initially, Ahmed is to dance with Ulrika, Bob is to dance with Vivian, Dave is to dance with Rebecca and Eric is to dance with Toyah.

Demonstrate, by using an alternating path from this initial matching, how each boy can be paired with a girl with whom he is willing to dance. *(3 marks)*

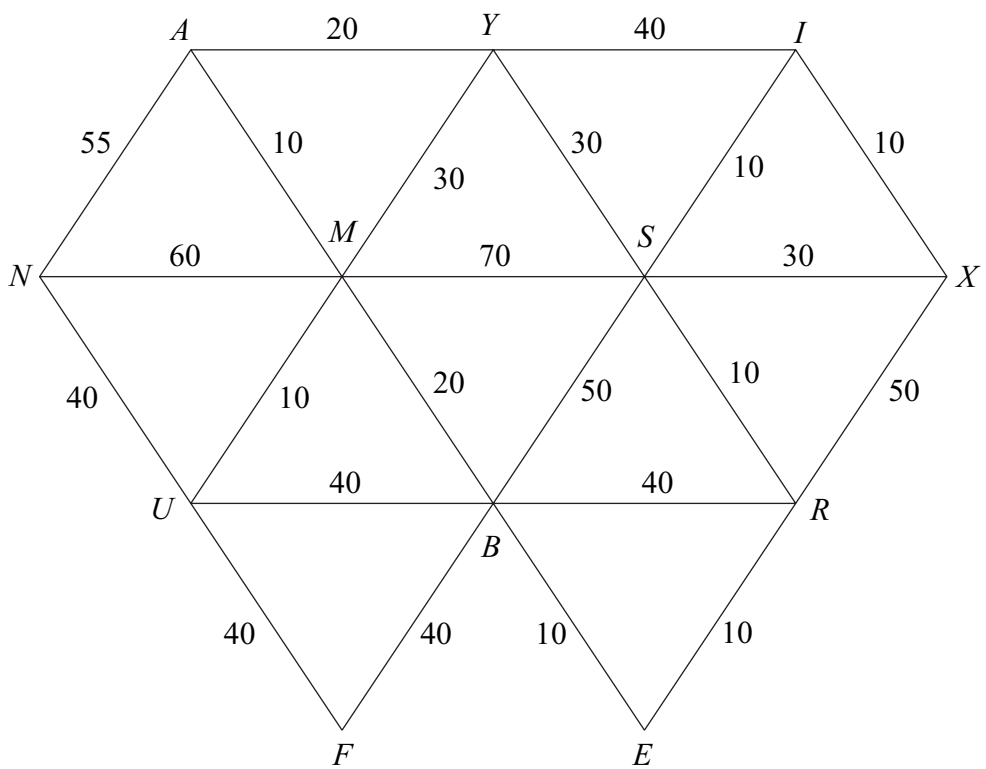
(c) Rebecca insists on dancing with Dave.

Explain why a complete matching is now impossible. *(1 mark)*

TURN OVER FOR THE NEXT QUESTION

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

Patrick has been sent as a prisoner to a new prison, which is in the form of a remote village. The diagram shows the houses where the prisoners live and paths connecting them. The number on each path represents the time, in seconds, it takes for Patrick to walk along that path. Patrick lives in house *N*.



(a) (i) Use Dijkstra's algorithm on **Figure 1** to find the minimum time it would take for Patrick to walk from *N* to each of the other houses in the village. *(6 marks)*

(ii) List Patrick's quickest route from *N* to *X*. *(1 mark)*

(iii) On a particular day, the path *RS* is blocked.

Find the minimum extra time it would take for Patrick to walk from *N* to *X*. *(2 marks)*

(b) On a day when all the paths are clear, Patrick walks along all the paths, looking for a possible escape route.

The total of all the times on the diagram is 725 seconds.

Find the minimum time taken for Patrick to walk along all the paths, starting and finishing at his house, *N*. *(4 marks)*

4 David is going to buy a holiday home in one of five villages: Aragona (*A*), Belvedere (*B*), Comitini (*C*), Grotte (*G*) and St Vincenzo (*V*). David is going to visit the five villages. He intends to travel from one village to the next until he has visited all of the villages, before returning to his starting village.

The distances, in kilometres, between the villages are shown in the following table.

	Aragona (*A*)	**Belvedere** (*B*)	**Comitini** (*C*)	**Grotte** (*G*)	**St Vincenzo** (*V*)
Aragona (*A*)	—	11	10	13	8
Belvedere (*B*)	11	—	13	11	9
Comitini (*C*)	10	13	—	5	4
Grotte (*G*)	13	11	5	—	6
St Vincenzo (*V*)	8	9	4	6	—

(a) (i) Find the length of the tour *AGCVBA*. *(1 mark)*

(ii) Find the length of the tour obtained by using the nearest neighbour algorithm starting from *A*. *(4 marks)*

(b) (i) By deleting *A*, find a lower bound for the length of a minimum tour. *(3 marks)*

(ii) By deleting *G*, find another lower bound for the length of a minimum tour. *(3 marks)*

(c) The length of a minimum tour is *T* kilometres.

Write down the smallest interval for *T* which can be obtained from your answers to parts (a) and (b). *(2 marks)*

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

A hotel manageress is to order some sunbeds. There are two types available: wooden and plastic.

She must order at least 30 wooden sunbeds and at least 60 plastic sunbeds.

She can order at most 200 sunbeds.

Each wooden sunbed costs £40 and occupies an area of 2 square metres.

Each plastic sunbed costs £12 and occupies an area of 3 square metres.

She has £3600 to spend and the sunbeds must occupy an area of at least 300 square metres.

She must order at least 50% more plastic sunbeds than wooden sunbeds.

The manageress orders x wooden sunbeds and y plastic sunbeds.

(a) State, giving a reason in each case, why the manageress's situation can be modelled by the following inequalities:

$$x \geqslant 30, \quad y \geqslant 60, \quad x + y \leqslant 200, \quad 2x + 3y \geqslant 300, \quad 10x + 3y \leqslant 900 \quad \text{and} \quad 2y \geqslant 3x.$$

(4 marks)

(b) On **Figure 2**, draw a suitable diagram to illustrate the situation graphically, indicating the feasible region. *(6 marks)*

(c) State which inequality does **not** affect the feasible region. *(1 mark)*

(d) The hotel is awarded points on the number of sunbeds available for guests. Each wooden sunbed gains four points and each plastic sunbed gains five points.

By using an objective line, or otherwise, find the maximum number of points the hotel can be awarded and the number of each type of sunbed that corresponds to this maximum.

(3 marks)

6 The following algorithm is to be used on different numbers.

(The function INT gives the integer part of any number, for example INT(2.5) = 2.)

```
LINE 10    INPUT N
LINE 20    LET K = 0
LINE 30    LET A = N – 2 * INT (N / 2)
LINE 40    LET K = K+1
LINE 50    PRINT A
LINE 60    LET N = INT (N / 2)
LINE 70    IF N > 0 THEN GOTO LINE 30
LINE 80    END
```

(a) Show that, if the input value of N is 5, then the algorithm will print 1, 0, 1. *(4 marks)*

(b) Trace the algorithm in the case where the input value of N is 11. *(2 marks)*

(c) Find the final value of K in the case where the input value of N is 40. *(2 marks)*

END OF QUESTIONS

Surname		Other Names	
Centre Number						Candidate Number				
Candidate Signature										

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Insert for use in answering Questions 3 and 5.

Fill in the boxes at the top of this page.

Fasten this insert securely to your answer book.

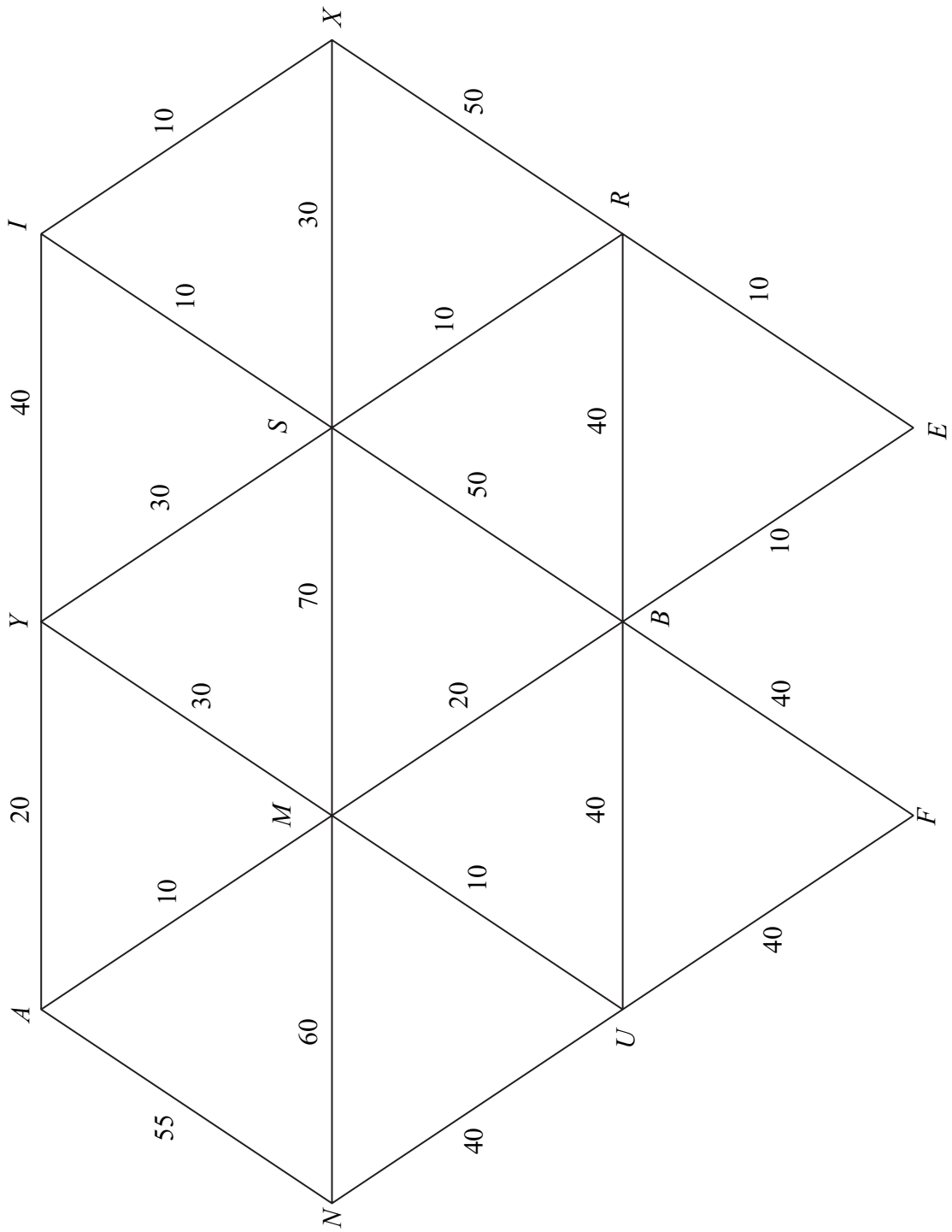

Figure 1 (for Question 3)

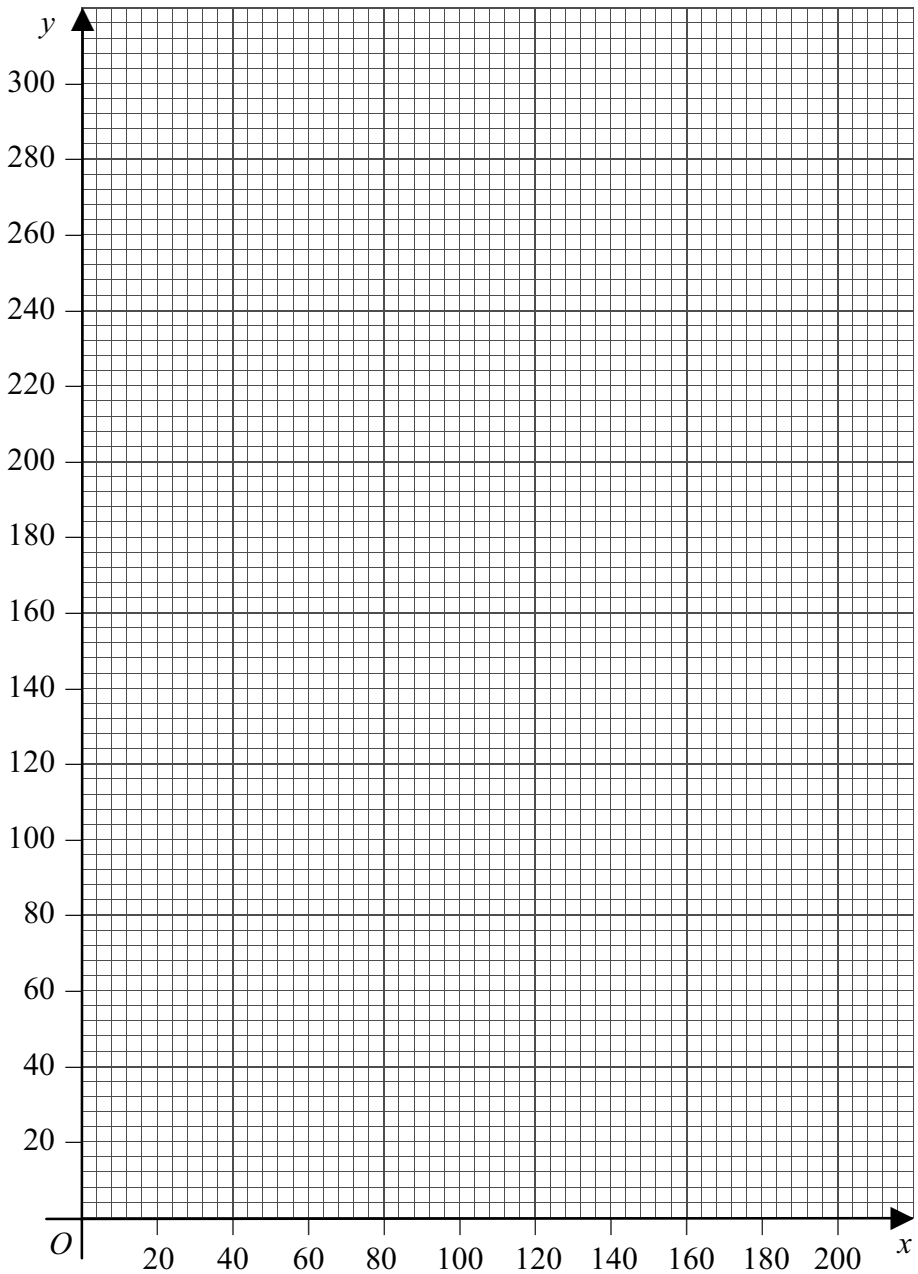

Figure 2 (for Question 5)

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