General Certificate of Education
November 2004
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

MATHEMATICS (SPECIFICATION A) **MAD1**
Unit Discrete 1

Tuesday 2 November 2004 Afternoon Session

In addition to this paper you will require:
- an 8-page answer book;
- an insert for use in Questions 5 and 6 (enclosed);
- the AQA booklet of formulae and statistical tables.

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 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.

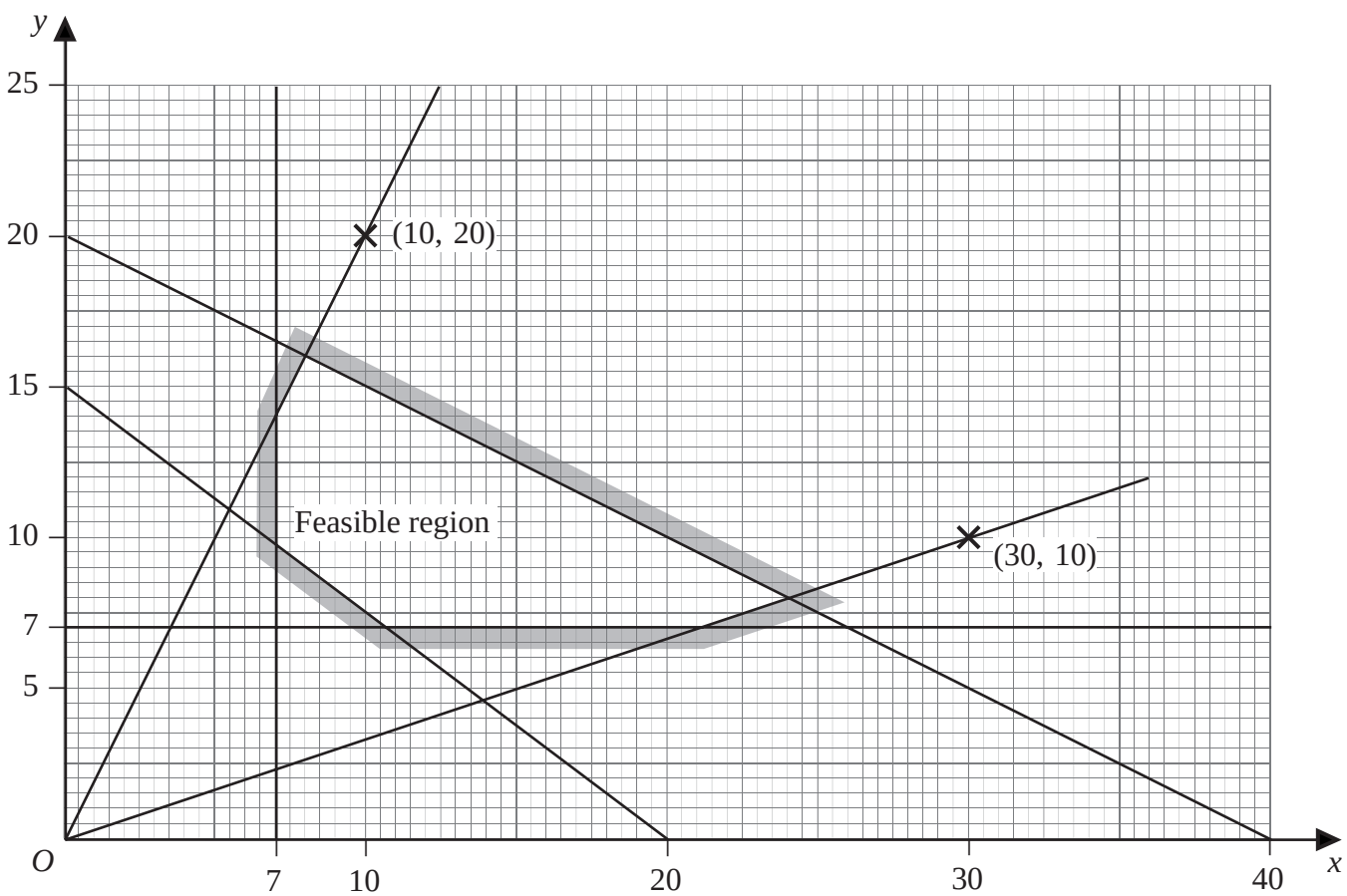
Answer **all** questions.

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

21, 13, 35, 46, 7, 12, 49, 25

(5 marks)

2 The following graph shows the feasible region of a linear programming problem.



(a) Find the **six** inequalities that define the feasible region. *(7 marks)*

(b) On the feasible region find the maximum value of $2x + 5y$ and state the coordinates of the point where this value occurs. *(3 marks)*

3 (a) Draw the graph K_4. *(2 marks)*

(b) (i) Find the total number of edges in K_6. *(1 mark)*

(ii) State the number of edges in a minimum spanning tree of K_6. *(1 mark)*

(iii) Give a reason why K_6 is **not** Eulerian. *(1 mark)*

(c) For the graph K_n, state in terms of n:

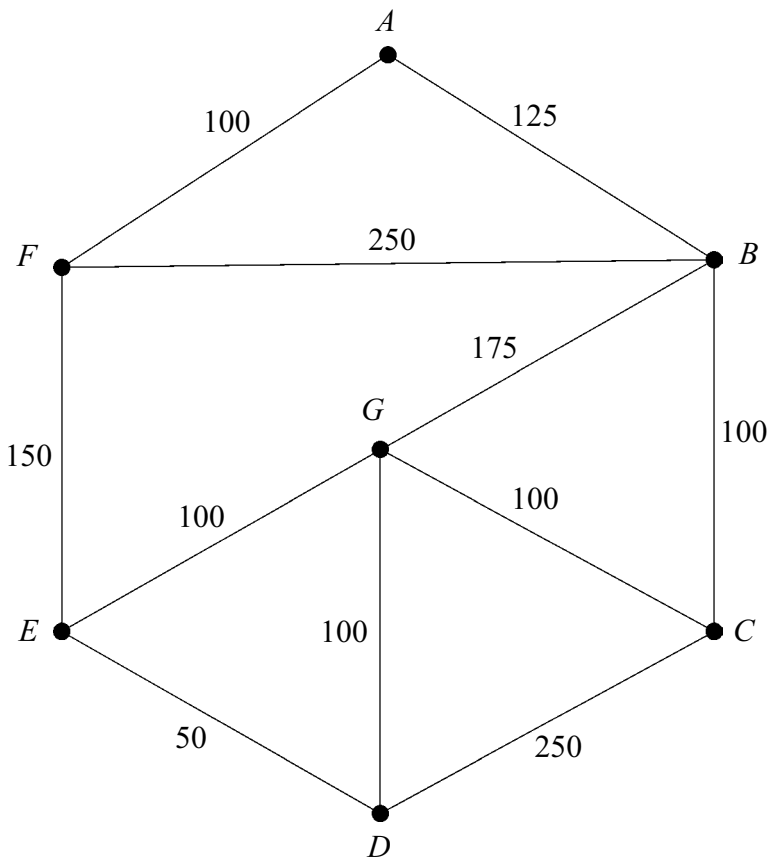
(i) the total number of edges; *(1 mark)*

(ii) the number of edges in a minimum spanning tree; *(1 mark)*

(iii) the condition for K_n to be Eulerian. *(1 mark)*

TURN OVER FOR THE NEXT QUESTION

4 Brendan sells fish from his van. He travels around the streets of an estate. The diagram shows the network of streets he travels along. The number on each arc represents the length, in metres, of that street.



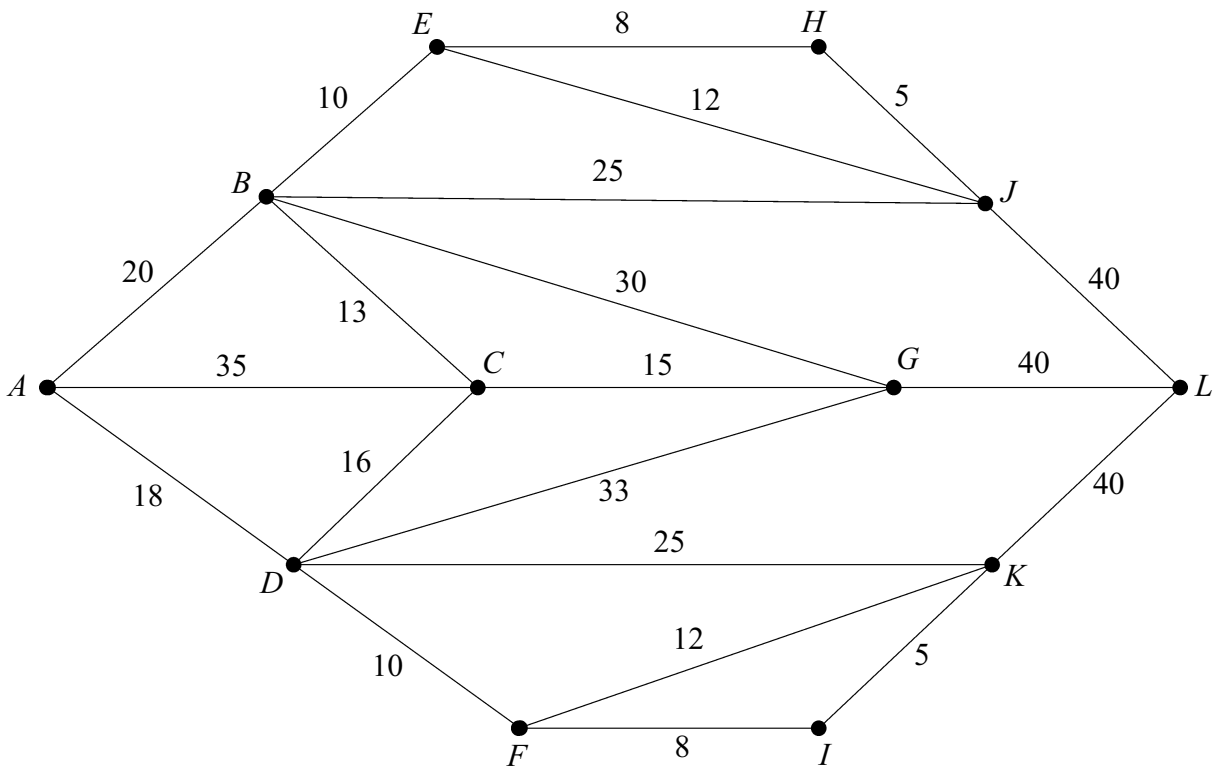
(a) (i) Give a reason why it is **not** possible to start at A, travel along each street once only and return to A. *(1 mark)*

(ii) Find the length of an optimal Chinese Postman route around the network, starting and finishing at A. State the number of times each vertex is visited. *(7 marks)*

(b) The streets of another estate have 6 odd vertices. Find the number of ways of pairing these odd vertices. *(2 marks)*

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

The diagram shows a network of railway lines connecting 12 stations. The number on each arc represents the travelling time, in minutes, between two stations.



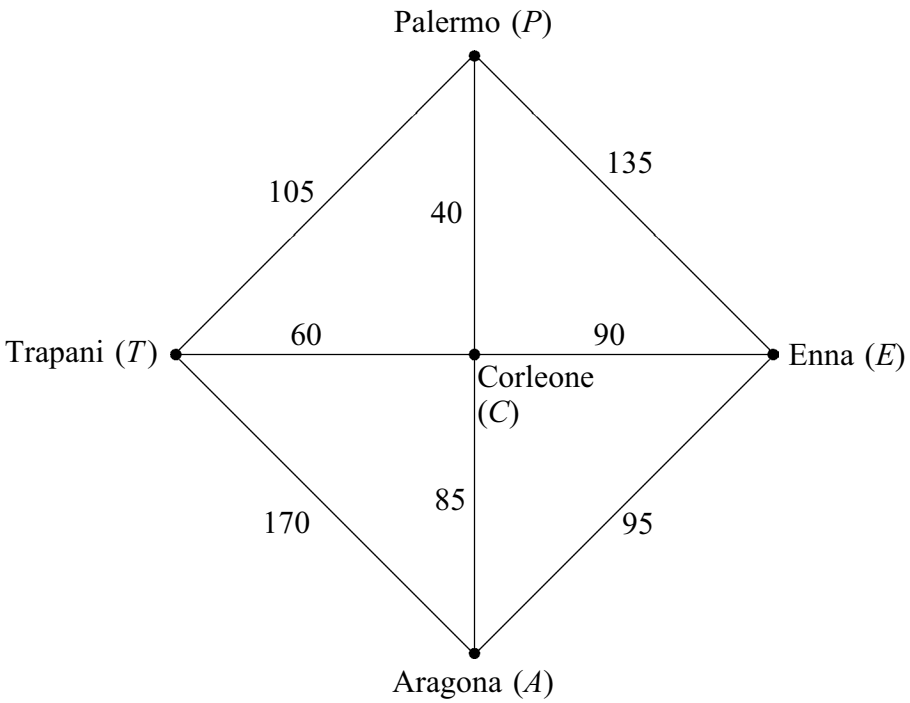
(a) (i) Given that there is no time delay in travelling through a station, use Dijkstra's algorithm on **Figure 1** to find the shortest travelling time from A to L. State the corresponding route. *(7 marks)*

(ii) Find, by inspection, the shortest travelling time from B to L. *(1 mark)*

(b) A new railway line is to be built connecting stations B and L. The time taken to travel along this line will be x minutes. The new line will reduce the travelling time from B to L but **not** the travelling time from A to L. Find the range of possible values of x. *(3 marks)*

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

A Sicilian market trader, Vito, who lives in Corleone (C), has to visit the towns Palermo (P), Aragona (A), Enna (E) and Trapani (T) on a particular day before returning to Corleone. He is trying to find the route that will minimise his travelling distance. The following diagram shows the distances, in kilometres, between the towns.



(a) Complete **Figure 2**, in which the entries are the shortest distances, in kilometres, between pairs of vertices. *(3 marks)*

(b) Use the nearest neighbour algorithm on **Figure 2** to find an upper bound for the minimum length of a tour of this network that starts and finishes at Corleone. *(4 marks)*

(c) Vito decides to follow the route given by the nearest neighbour algorithm. Write down his route. *(2 marks)*

7 The Vino family buys three types of wine: ordinary red, vintage red and white.

Each year the family buys at least 10 bottles of each type and at least 100 bottles in total.

Each bottle of ordinary red costs £2, each bottle of vintage red costs £5 and each bottle of white costs £3. The family spends no more than £400 per year on wine.

At least 40% of the total number of bottles bought in the year must be vintage red.

The number of bottles of white must not exceed 60% of the total number of bottles of red.

Given that the family buys x bottles of ordinary red, y bottles of vintage red and z bottles of white, find seven inequalities that model this situation, simplifying each inequality where possible. *(7 marks)*

END OF QUESTIONS

Surname		Other Names	
Centre Number						Candidate Number				
Candidate Signature										

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Insert for use in answering Questions 5 and 6.

Fill in the boxes at the top of this page.

Fasten this insert securely to your answer book.

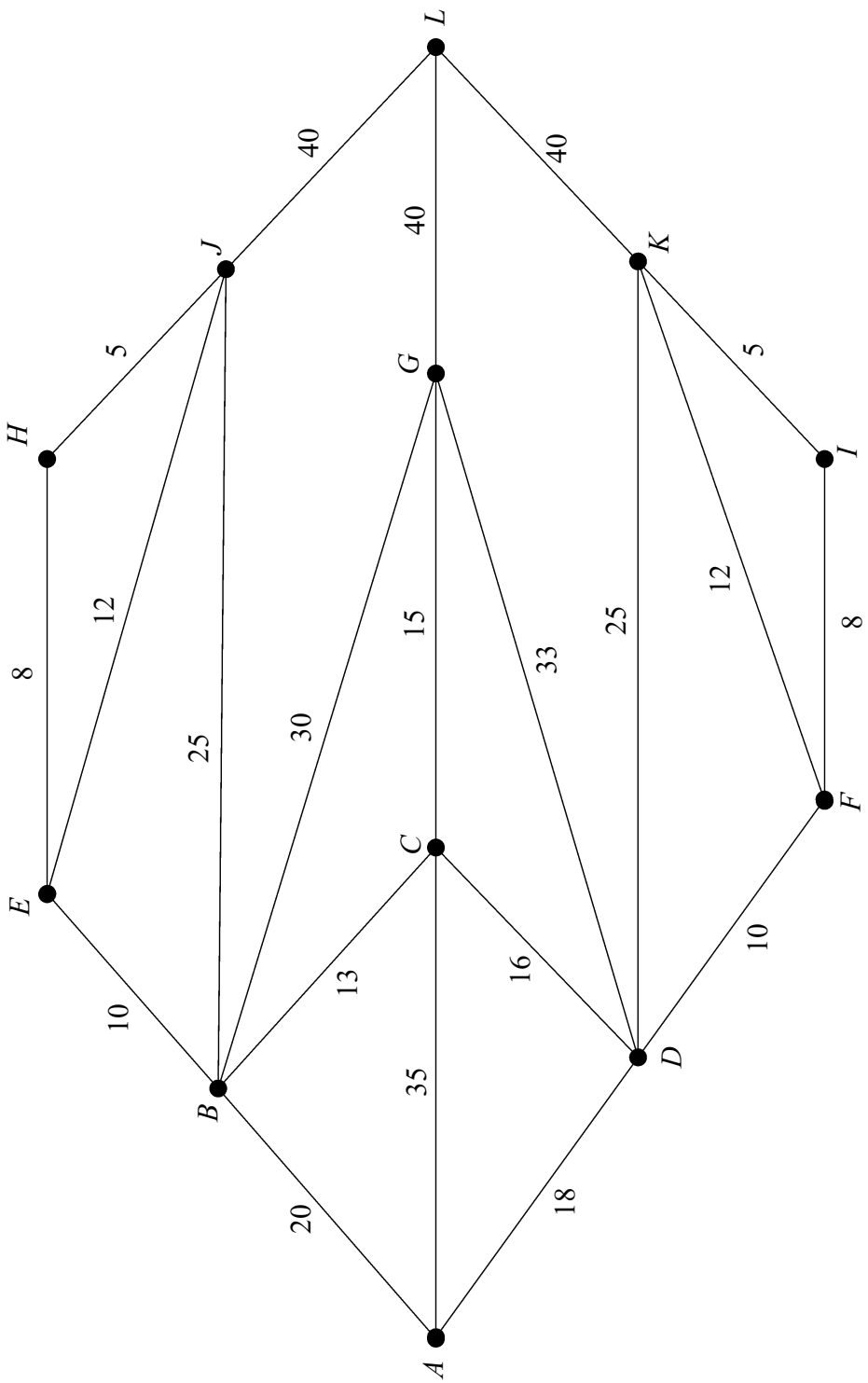

Figure 1 (for Question 5)

	Aragona (*A*)	**Corleone (*C*)**	**Enna (*E*)**	**Palermo (*P*)**	**Trapani (*T*)**
Aragona (*A*)	–	85	95	125	145
Corleone (*C*)	85	–	90	40	60
Enna (*E*)	95	90	–		
Palermo (*P*)	125	40		–	
Trapani (*T*)	145	60			–

Figure 2 (for Question 6)