General Certificate of Education
June 2005
Advanced Subsidiary Examination

MATHEMATICS **MD01**
Unit Decision 1

Monday 20 June 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 7 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.

Answer **all** questions.

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

23 3 17 4 6 19 14 3 *(5 marks)*

2 A father is going to give each of his five daughters: Grainne (G), Kath (K), Mary (M), Nicola (N) and Stella (S), one of the five new cars that he has bought: an Audi (A), a Ford Focus (F), a Jaguar (J), a Peugeot (P) and a Range Rover (R).

The daughters express preferences for the car that they would like to be given, as shown in the table.

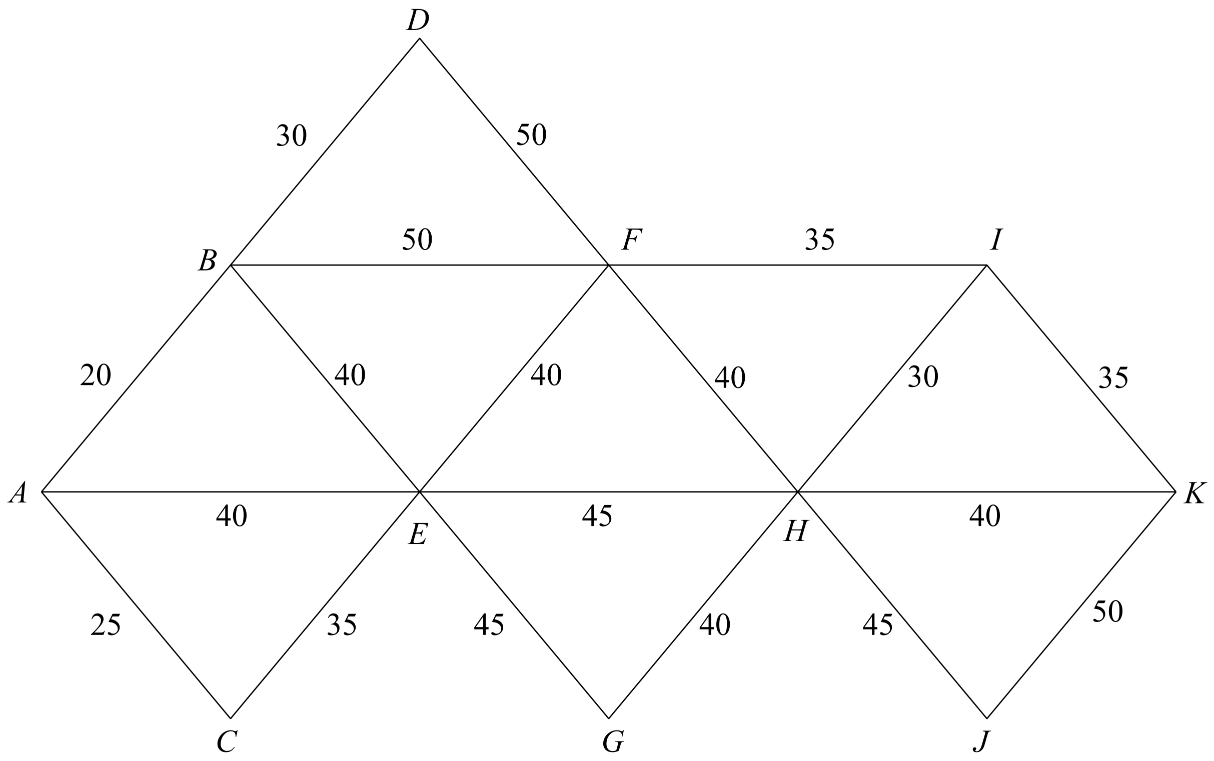
	Preferences
Grainne (G)	Audi (A) or Peugeot (P)
Kath (K)	Peugeot (P) or Ford Focus (F)
Mary (M)	Jaguar (J) or Range Rover (R)
Nicola (N)	Audi (A) or Ford Focus (F)
Stella (S)	Jaguar (J) or Audi (A)

(a) Show all these preferences on a bipartite graph. *(2 marks)*

(b) Initially the father allocates the Peugeot to Kath, the Jaguar to Mary, and the Audi to Nicola.

Demonstrate, by using alternating paths from this initial matching, how each daughter can be matched to a car which is one of her preferences. *(6 marks)*

3 A theme park has 11 rides, A, B, … K. The network shows the distances, in metres, between pairs of rides. The rides are to be connected by cabling so that information can be collated. The manager of the theme park wishes to use the minimum amount of cabling.



(a) Use Prim's algorithm, starting from A, to find the minimum spanning tree for the network. *(5 marks)*

(b) State the length of cabling required. *(1 mark)*

(c) Draw your minimum spanning tree. *(3 marks)*

(d) The manager decides that the edge AE must be included. Find the extra length of cabling now required to give the smallest spanning tree that includes AE. *(2 marks)*

TURN OVER FOR THE NEXT QUESTION

4 (a) In the complete graph K_7, every one of the 7 vertices is connected to each of the other 6 vertices by a single edge.

Find or write down:

(i) the number of edges in the graph; *(1 mark)*

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

(iii) the number of edges in a Hamiltonian cycle. *(1 mark)*

(b) (i) Explain why the graph K_7 is Eulerian. *(1 mark)*

(ii) Write down the condition for K_n to be Eulerian. *(1 mark)*

(c) A connected graph has 6 vertices and 10 edges.

Draw an example of such a graph which is Eulerian. *(2 marks)*

5 A student is using the following algorithm with different values of X.

```
LINE 10    INPUT X
LINE 20    LET K = 1
LINE 30    LET Y = (X * X + 16) / (2 * X)
LINE 40    PRINT Y
LINE 50    LET X = Y
LINE 60    LET K = K + 1
LINE 70    IF K = 4 THEN GO TO LINE 90
LINE 80    GO TO LINE 30
LINE 90    STOP
```

(a) Trace the algorithm, giving your answers to three decimal places where appropriate:

(i) in the case where the input value of X is 2; *(4 marks)*

(ii) in the case where the input value of X is -6. *(3 marks)*

(b) Another student used the same algorithm but omitted LINE 70. Describe the outcome for this student. *(1 mark)*

6 Mia is on holiday in Venice. There are five places she wishes to visit: Rialto (R), St Mark's (S), Murano (M), Burano (B) and Lido (L). Boat services connect the five places. The table shows the times, in minutes, to travel between the places.

Mia wishes to keep her travelling time to a minimum.

	Rialto (R)	St Mark's (S)	Murano (M)	Burano (B)	Lido (L)
Rialto (R)	—	15	55	75	25
St Mark's (S)	15	—	90	60	20
Murano (M)	55	90	—	25	80
Burano (B)	75	60	25	—	50
Lido (L)	25	20	80	50	—

(a) (i) Find the length of the tour *SRMBLS*. *(2 marks)*

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

(b) By deleting Burano (B), find a lower bound for the length of the minimum tour. *(5 marks)*

(c) Sketch a network showing the edges that give the lower bound found in part (b) and comment on its significance. *(2 marks)*

TURN OVER FOR THE NEXT QUESTION

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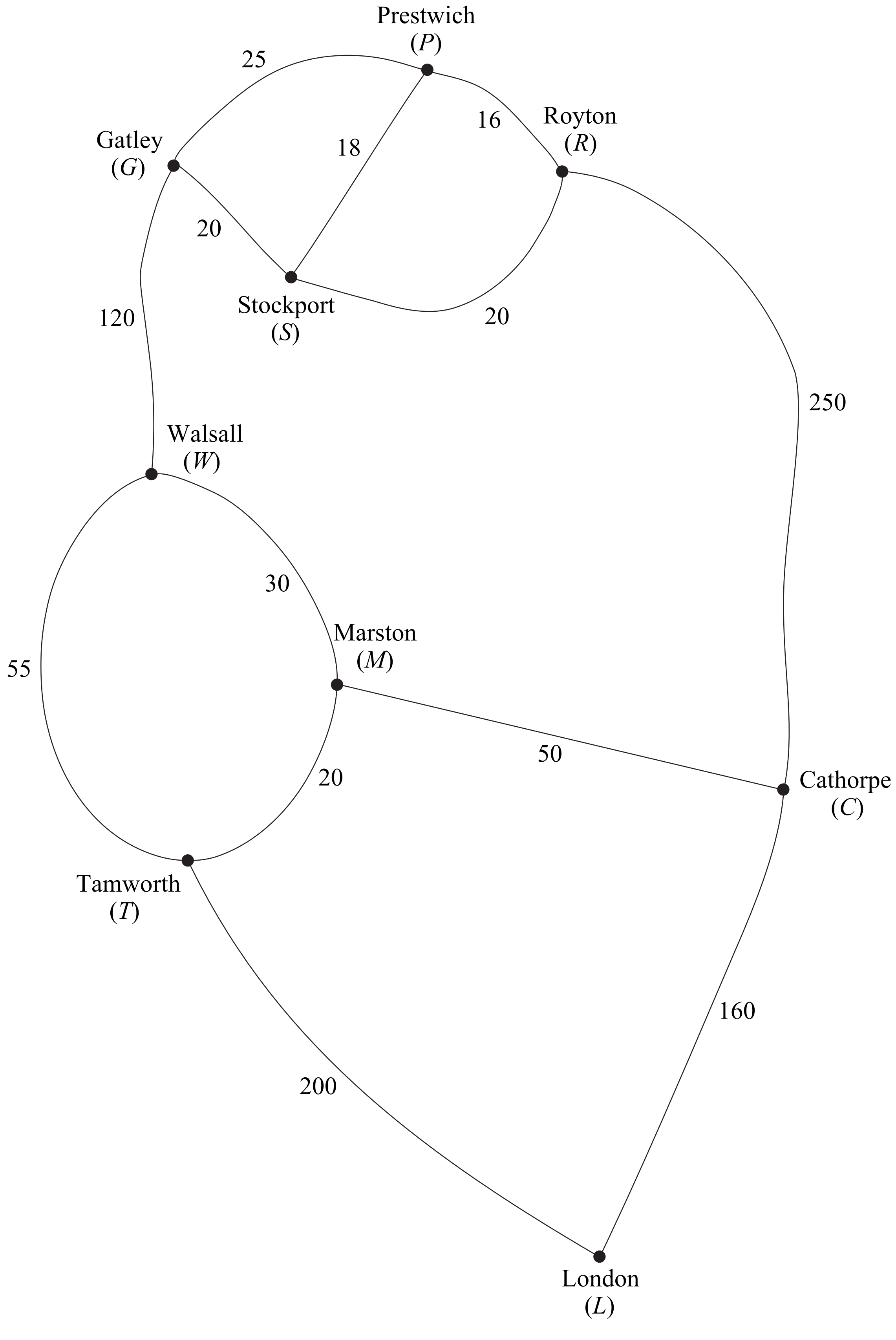
7 [**Figure 1**, printed on the insert, is provided for use in this question.]

The diagram shows some of the main roads connecting Royton to London. The numbers on the edges represent the travelling times, in minutes, between adjacent towns. David lives in Royton and is planning to travel along some of the roads to a meeting in London.



(a) (i) Use Dijkstra's algorithm on **Figure 1** to find the minimum travelling time from Royton to London. *(6 marks)*

(ii) Write down the route corresponding to this minimum travelling time. *(1 mark)*

(b) On a particular day, before David leaves Royton, he knows that the road connecting Walsall and Marston is closed.

Find the minimum extra time required to travel from Royton to London on this day. Write down the corresponding route. *(3 marks)*

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

A company makes two types of boxes of chocolates, executive and luxury.

Every hour the company must make at least 15 of each type and at least 35 in total.

Each executive box contains 20 dark chocolates and 12 milky chocolates.

Each luxury box contains 10 dark chocolates and 18 milky chocolates.

Every hour the company has 600 dark chocolates and 600 milky chocolates available.

The company makes a profit of £1.50 on each executive box and £1 on each luxury box.

The company makes and sells x executive boxes and y luxury boxes every hour.

The company wishes to maximise its hourly profit, £P.

(a) Show that one of the constraints leads to the inequality $2x + 3y \leqslant 100$. *(1 mark)*

(b) Formulate the company's situation as a linear programming problem. *(4 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. *(6 marks)*

(d) Use your diagram to find the maximum hourly profit. *(2 marks)*

END OF QUESTIONS

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Centre Number						Candidate Number			
Candidate Signature									

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Insert for use in Questions 7 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

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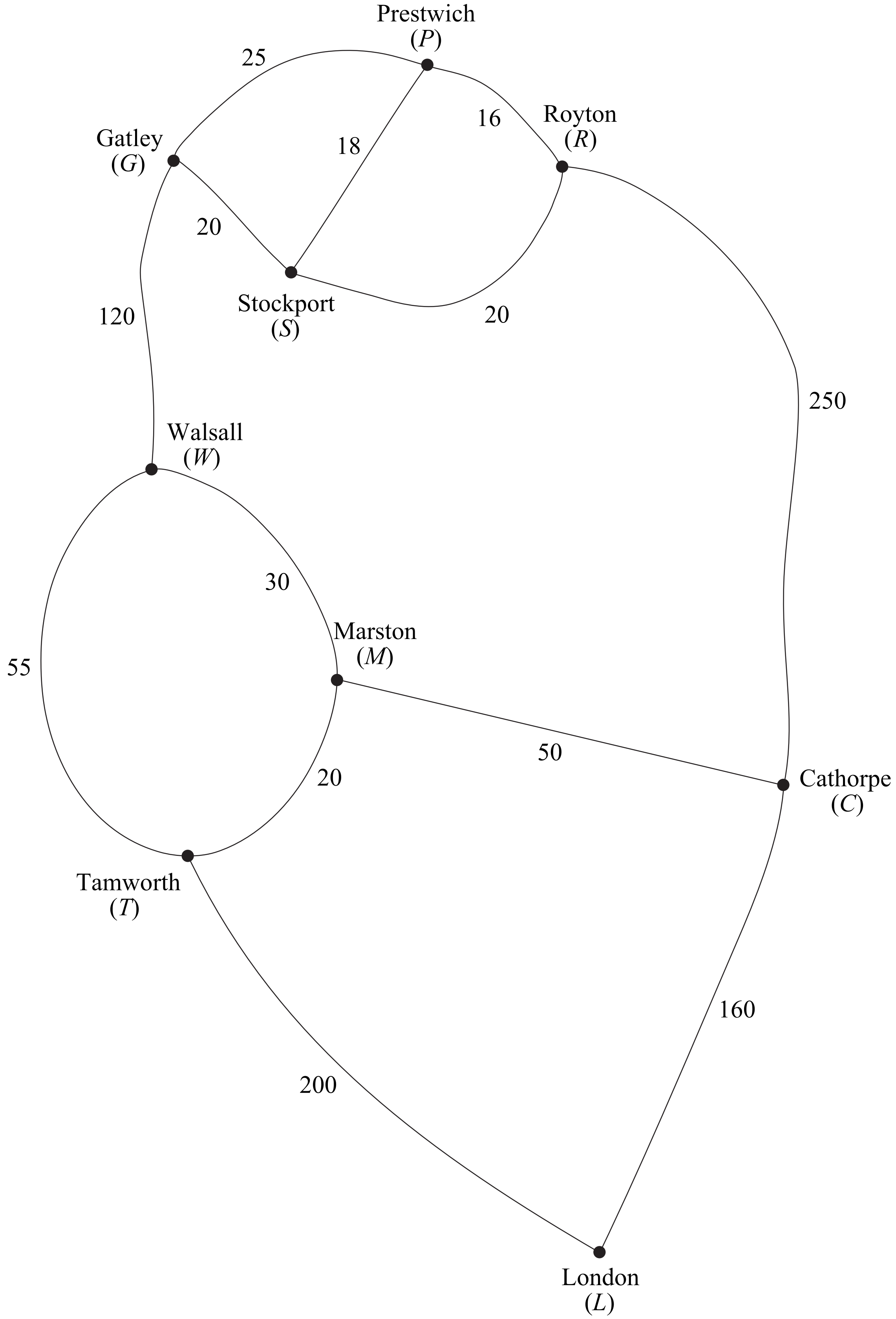

Figure 1 (for Question 7)

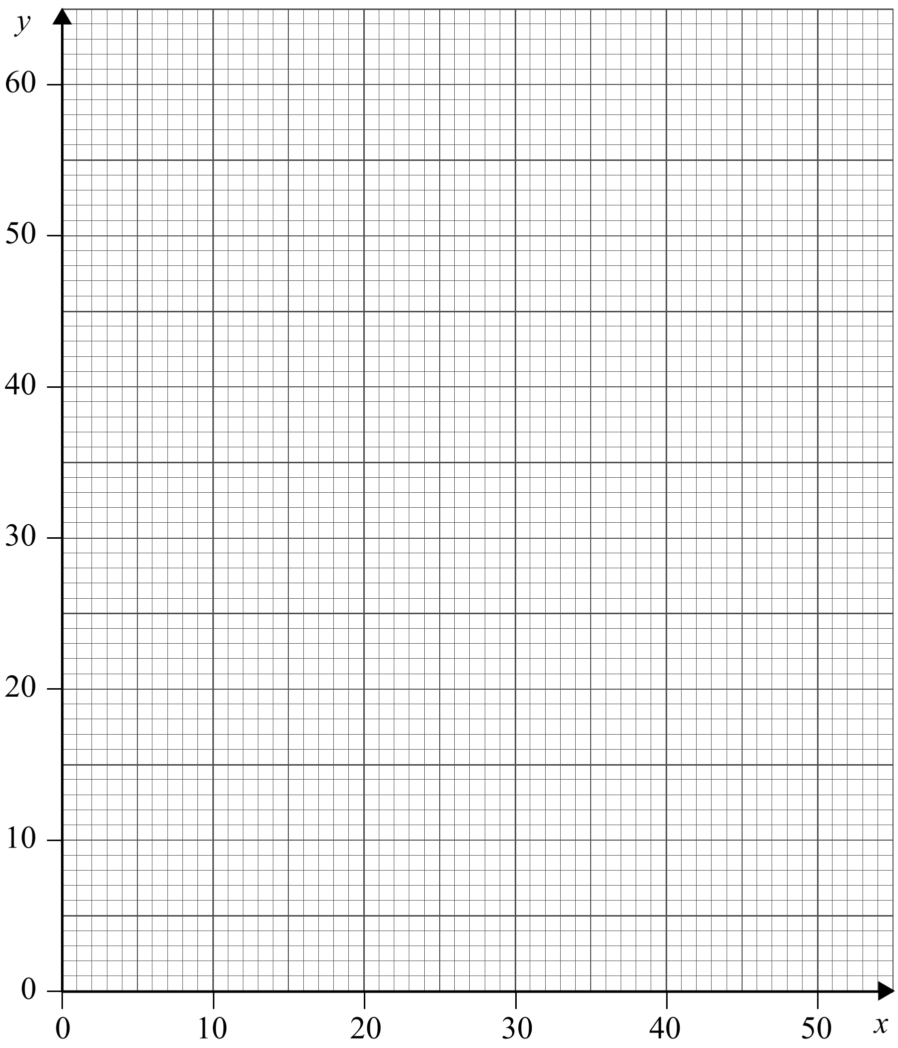

Figure 2 (for Question 8)

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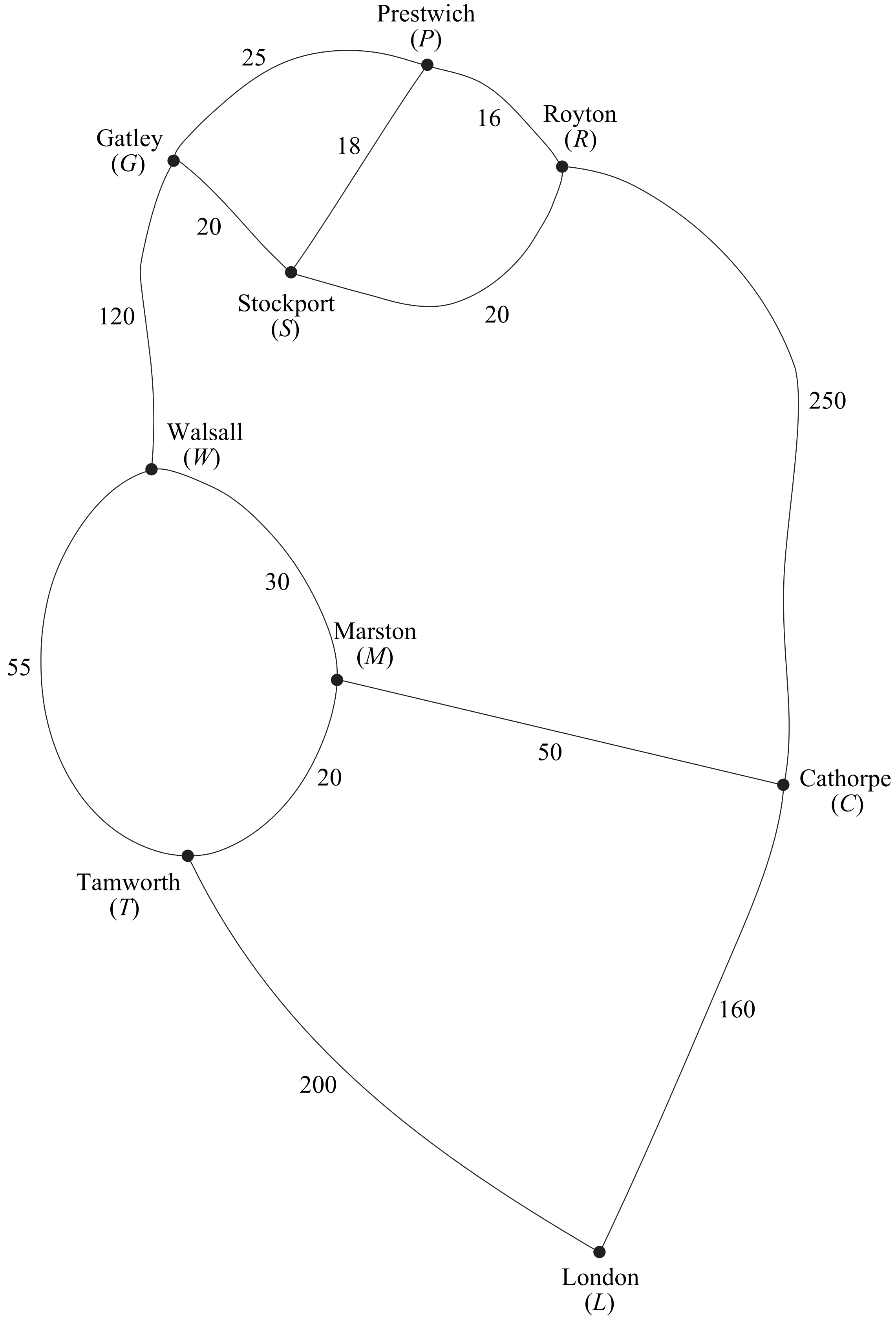

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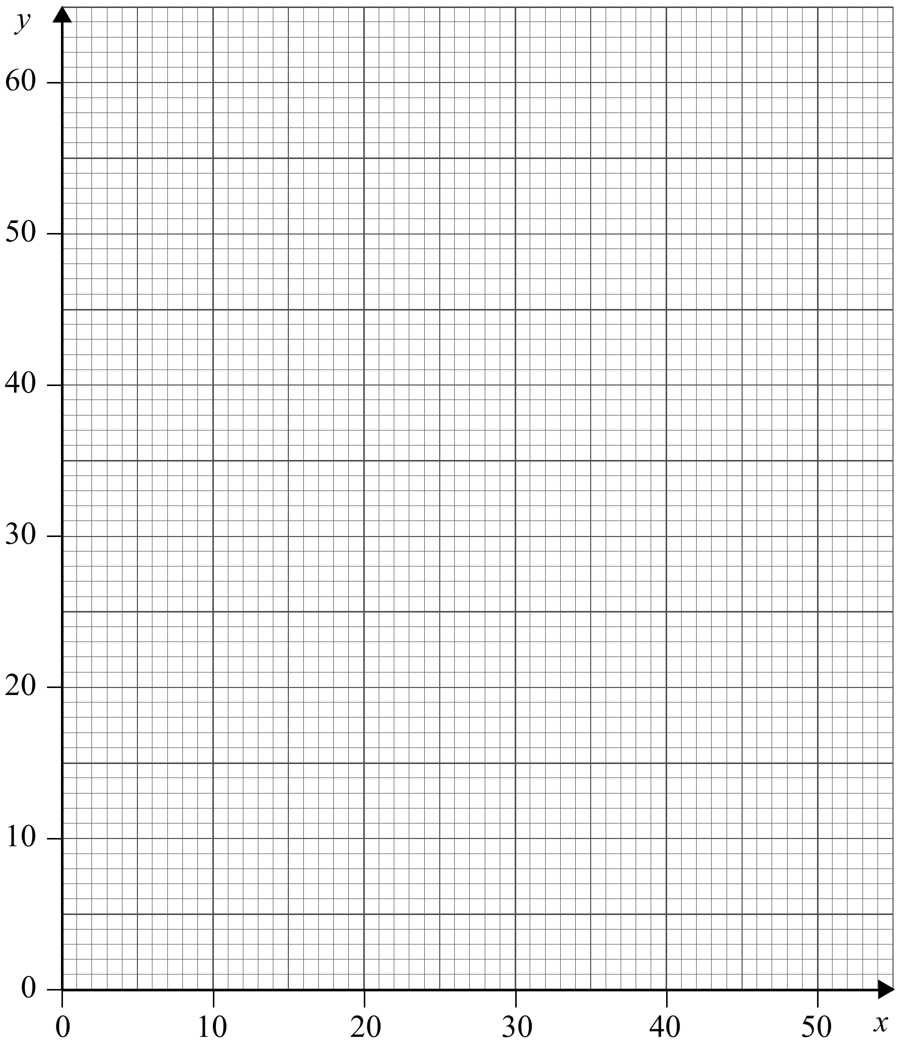

Figure 2 (for Question 8)

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