Pearson Edexcel GCE

Decision Mathematics D1

Advanced/Advanced Subsidiary

Friday 15 June 2018 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
6689/01

You must have:
D1 Answer Book

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B). Coloured pencils and highlighter pens must not be used.
- **Fill in the boxes** on the top of the answer book with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the D1 answer book provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- When a calculator is used, the answer should be given to an appropriate degree of accuracy.
- Do not return the question paper with the answer book.

Information

- The total mark for this paper is 75.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Write your answers in the D1 answer book for this paper.

1.

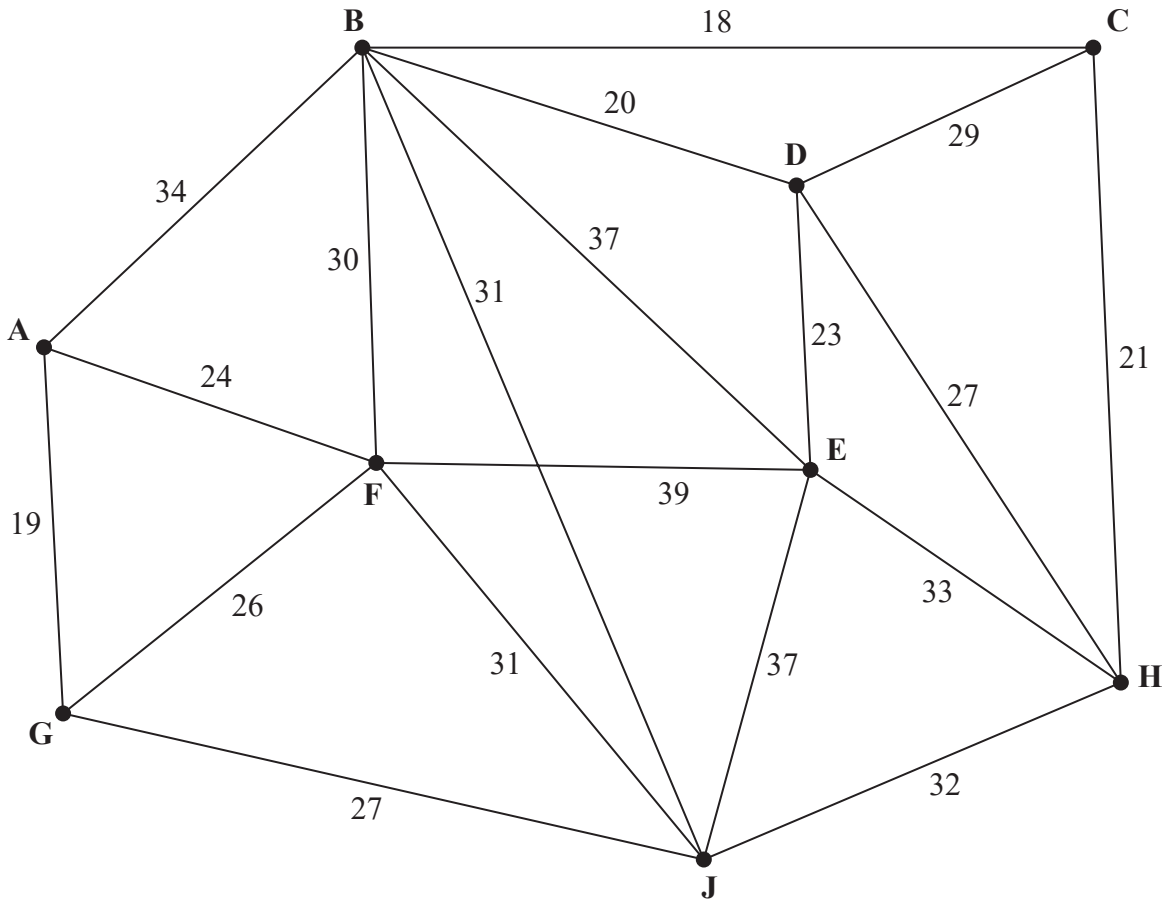


Figure 1

(a) Define the terms

(i) tree,

(ii) minimum spanning tree.

(3)

(b) Use Prim's algorithm, starting at A, to find a minimum spanning tree for the network shown in Figure 1. You must clearly state the order in which you select the arcs of the tree.

(3)

(c) Draw the minimum spanning tree using the vertices given in Diagram 1 in the answer book and state the weight of the tree.

(2)

(Total 8 marks)

2. A list of nine numbers needs to be sorted into descending order.

(a) **Describe** how to carry out the first pass of a bubble sort on the numbers in the list.

(2)

Mayleen used a sorting algorithm to sort a list of nine numbers into descending order.
Mayleen's list after the first pass through the algorithm is given below.

30 33 35 27 20 24 21 15 19

(b) Explain how you know that Mayleen did not use the bubble sort algorithm.

(2)

Given that Mayleen used the quick sort algorithm,

(c) write down the number that was used as a pivot for the first pass,

(1)

(d) complete the quick sort to obtain a fully sorted list in descending order. You must make your pivots clear.

(3)

(e) Use the first-fit decreasing bin packing algorithm to determine how the numbers listed can be packed into bins of size 60

(3)

A tenth number, 18, is added to the list of nine numbers.

(f) Determine whether it is possible to pack the ten numbers into 4 bins of size 60.
You must justify your answer.

(1)

(Total 12 marks)

3. (a) Draw the activity network described in the precedence table below, using activity on arc and exactly four dummies.

(5)

Activity	Immediately preceding activities
A	–
B	–
C	–
D	A
E	D
F	A, B
G	A, B, C
H	A, B, C
I	E, F, G
J	E, F, G
K	E, F, G, H

Given that D is a critical activity,

(b) state which other activities must also be critical.

(2)

(Total 7 marks)

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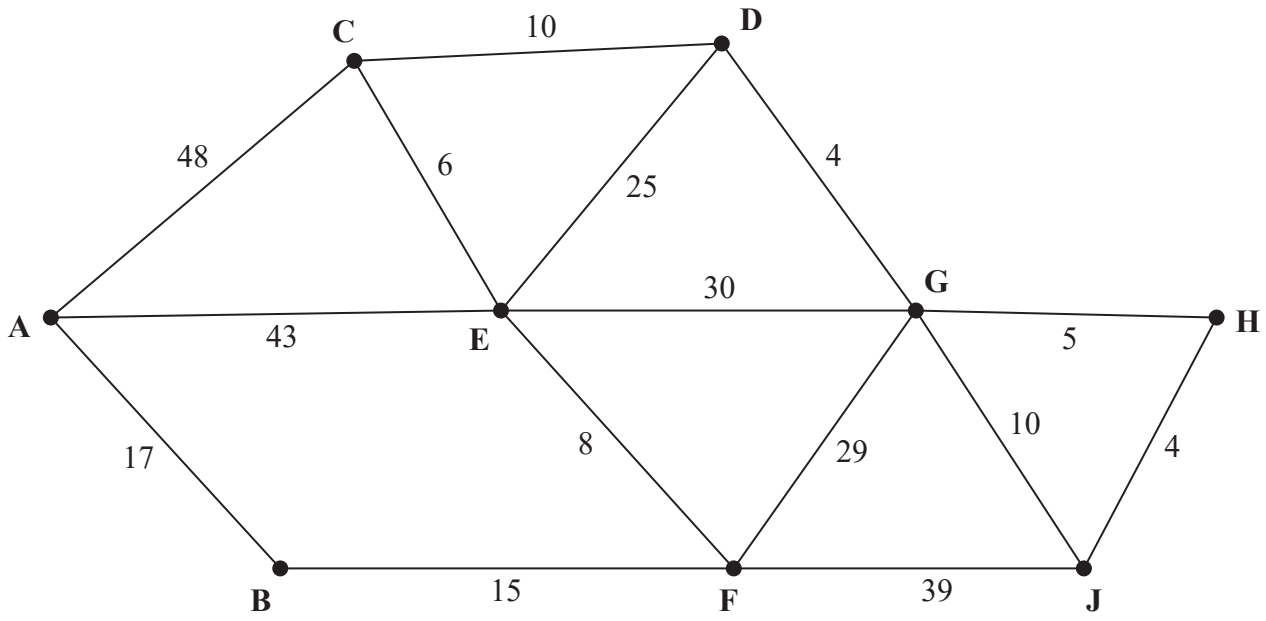


Figure 2

[*The total weight of the network is 293*]

Figure 2 models a network of roads. The number on each edge gives the time, in minutes, taken to travel along the corresponding road.

(a) Use Dijkstra's algorithm to find the shortest time needed to travel from A to J.
State the quickest route.

(6)

The road represented by edge GJ is closed due to essential maintenance. Sahil needs to travel along all the other roads to check that they are in good repair. Sahil wishes to complete his route as quickly as possible and will start and finish at the same vertex.

(b) Use the route inspection algorithm to find the duration of Sahil's quickest route. State the edges that will need to be traversed twice. You should make your method and working clear.

(6)

Given that Sahil will start and finish at vertex C,

(c) state the number of times that Sahil will visit vertex E and vertex F in his inspection route.

(2)

(Total 14 marks)

5.

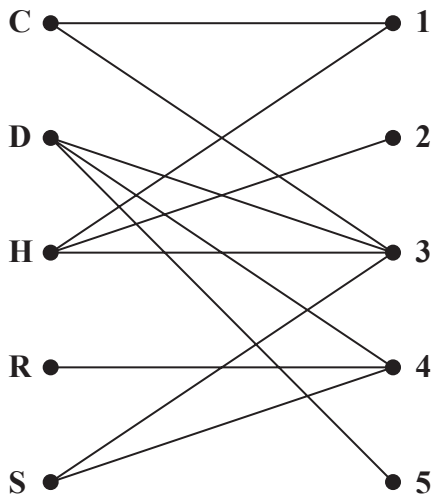


Figure 3

Figure 3 shows the possible allocations of five workers, Cole (C), Dorothy (D), Harold (H), Richard (R) and Stephen (S), to five tasks, 1, 2, 3, 4 and 5.

In an initial matching, each of **three** workers is allocated to a different task.

For this initial matching, there are three possible alternating paths that start at C.

One alternating path is

$$C - 3 = S - 4 = D - 5$$

A second alternating path is

$$C - 1 = H - 2$$

(a) Use this information to deduce the initial matching.

(1)

(b) Find the third alternating path that starts at C.

(1)

(c) List the improved matching generated by using the alternating path $C - 3 = S - 4 = D - 5$

(1)

(d) Starting from the improved matching found in (c), use the maximum matching algorithm to obtain a complete matching. You must list the alternating path you use and the final matching.

(3)

(Total 6 marks)

6.

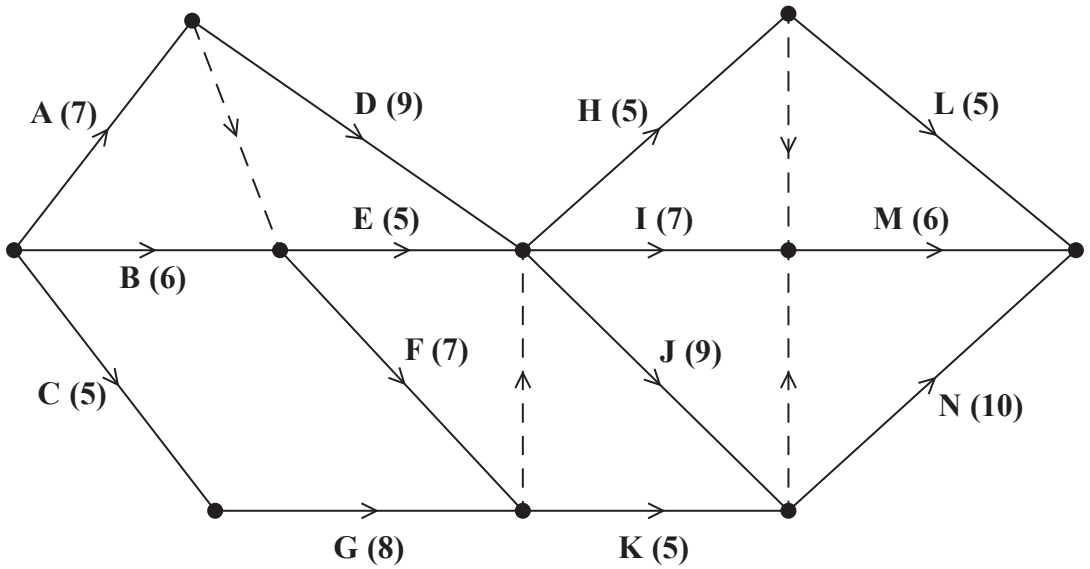


Figure 4

A project is modelled by the activity network shown in Figure 4. The activities are represented by the arcs. The number in brackets on each arc gives the time, in days, to complete the corresponding activity. Each activity requires one worker. The project is to be completed in the shortest possible time.

(a) Complete Diagram 1 in the answer book to show the early event times and the late event times.

(4)

(b) State the critical activities.

(1)

(c) Draw a cascade (Gantt) chart for this project on the grid in the answer book.

(4)

(d) Use your cascade chart to determine the minimum number of workers needed to complete the project in the shortest possible time. You must make specific reference to times and activities. (You do **not** need to provide a schedule of the activities.)

(2)

(Total 11 marks)

7. A café sells two types of scone, plain and fruit.

The café manager knows that each week she should order

- at least 400 scones in total
- at most 350 fruit scones

In addition, for every 3 fruit scones ordered, at most 5 plain scones should be ordered.

Each plain scone costs £0.11 and is sold at a profit of £0.75
Each fruit scone costs £0.14 and is sold at a profit of £1

The manager has £77 to spend each week on scones. The manager wants to maximise her profit and it can be assumed that all scones ordered will be sold.

Let x represent the number of plain scones and let y represent the number of fruit scones that are sold.

(a) Formulate this information as a linear programming problem. State the objective and list the constraints as simplified inequalities with integer coefficients.

(6)

(b) Represent these constraints on Diagram 1 in the answer book.
Hence determine the feasible region and label it R.

(4)

(c) Use the objective line method to find the optimal vertex, V, of the feasible region. You must make your objective line clear and label the optimal vertex V.

(3)

(d) Calculate the exact coordinates of V.

(2)

(e) State the number of each type of scone that the manager should order and calculate the maximum profit.

(2)

(Total 17 marks)

TOTAL FOR PAPER: 75 MARKS

END

Write your name here

Surname	Other names

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Centre Number	Candidate Number

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1.

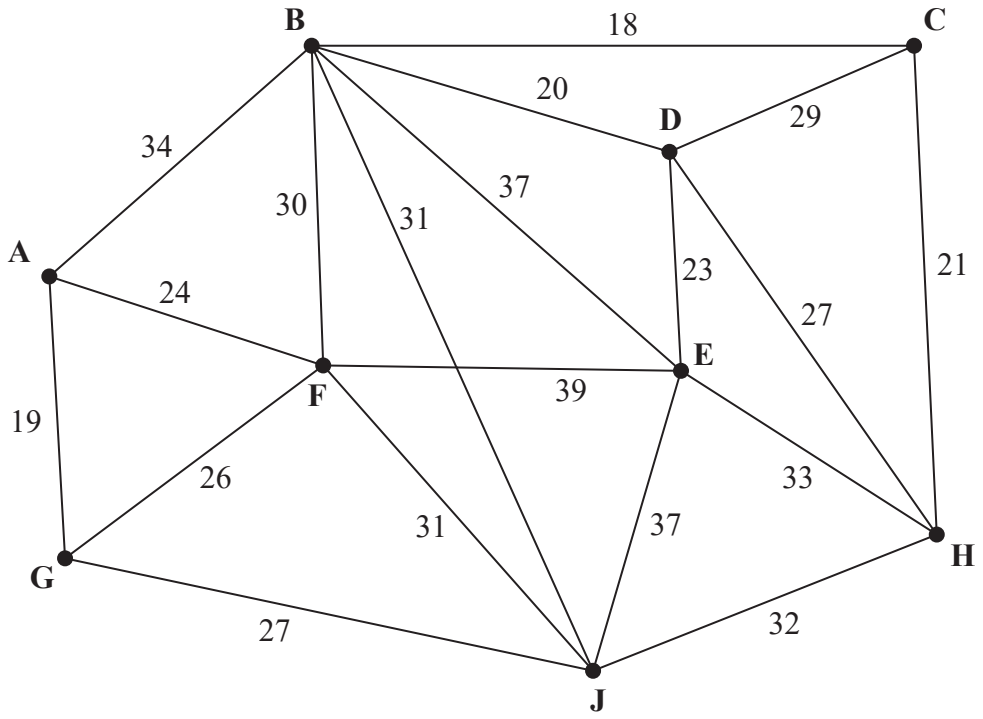


Figure 1

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Question 1 continued

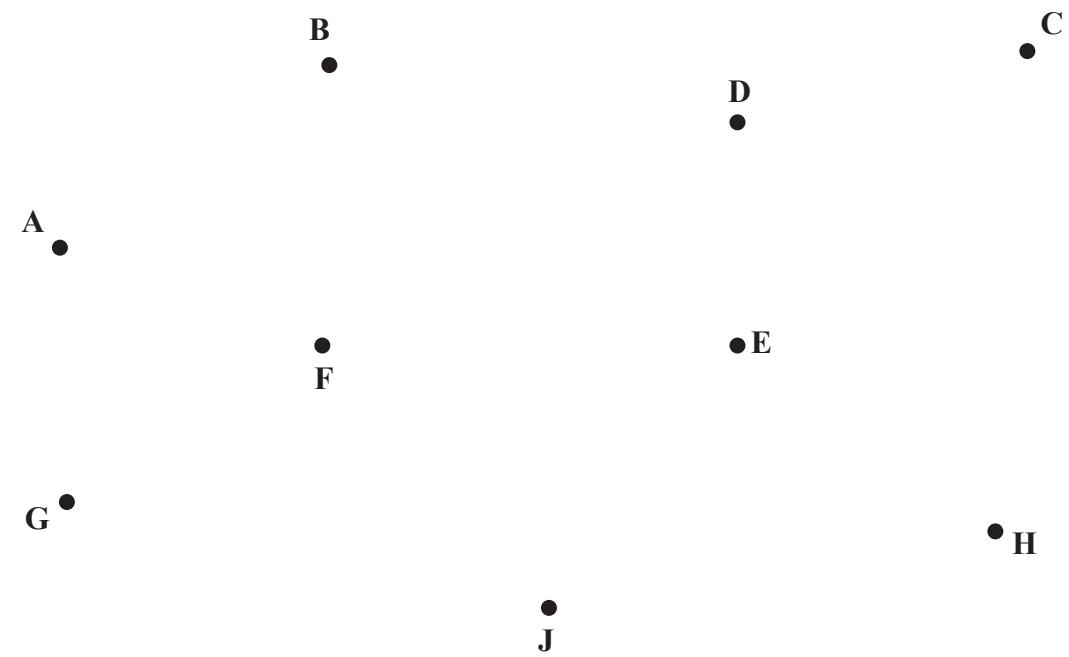


Diagram 1

Weight: _____

Q1

(Total 8 marks)

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Question 2 continued

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Question 2 continued

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Question 2 continued

Q2

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3.

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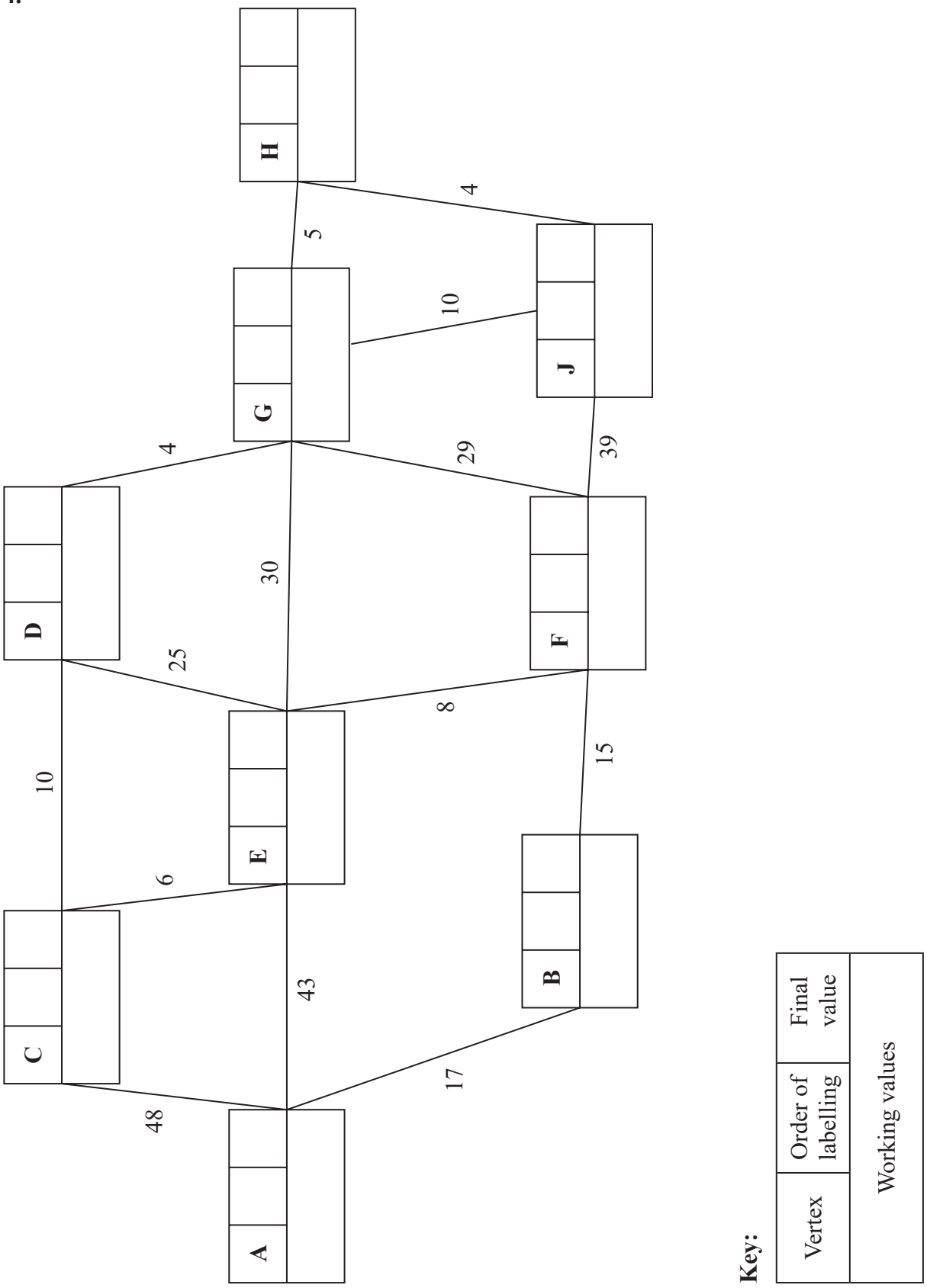
Question 3 continued

Q3

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4.



Shortest time: _____

Quickest route: _____

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Question 4 continued

(c)

Vertex E: _____

Vertex F: _____

Q4

(Total 14 marks)

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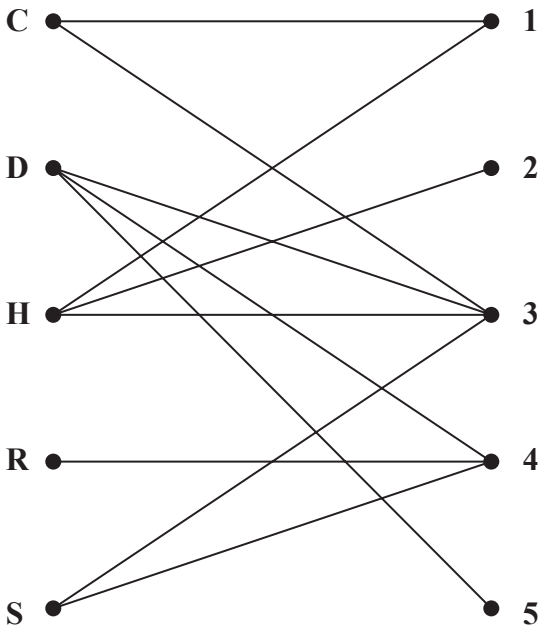


Figure 3

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Question 5 continued

Q5

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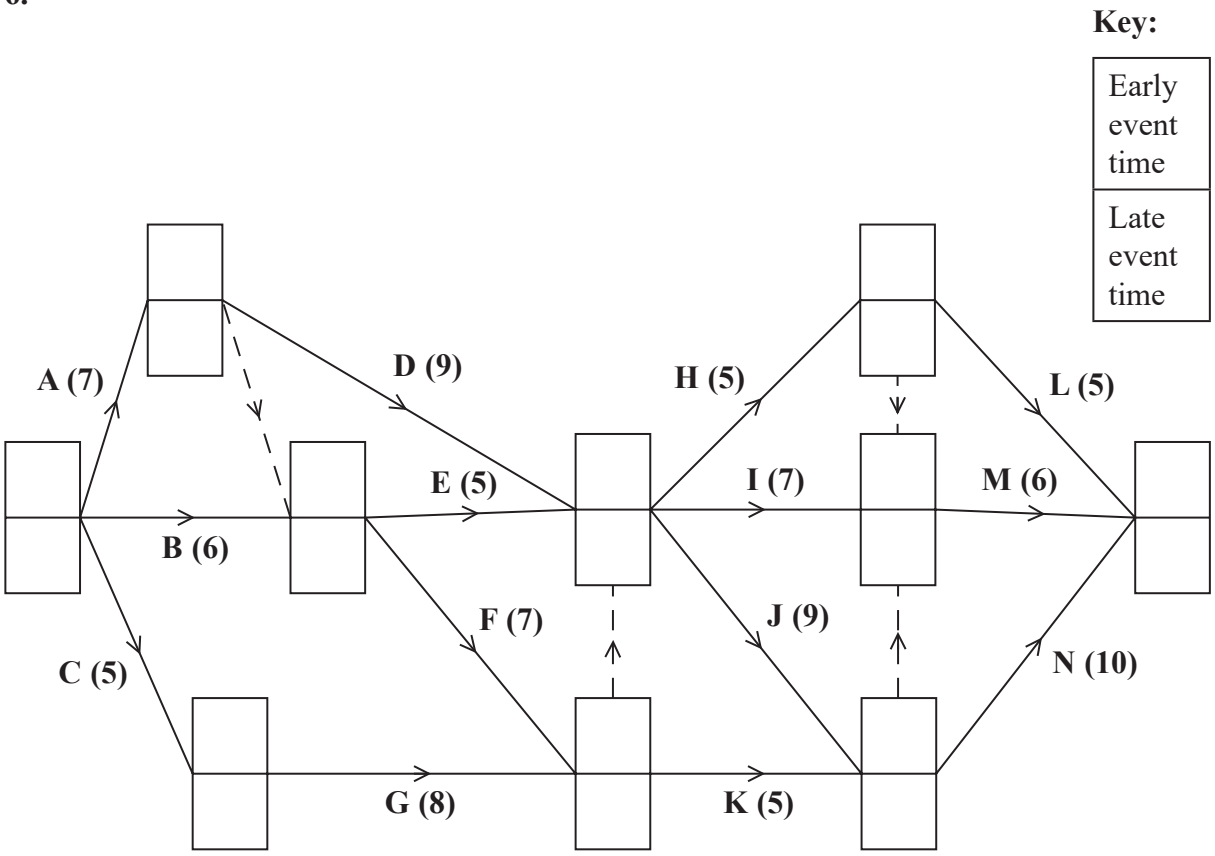


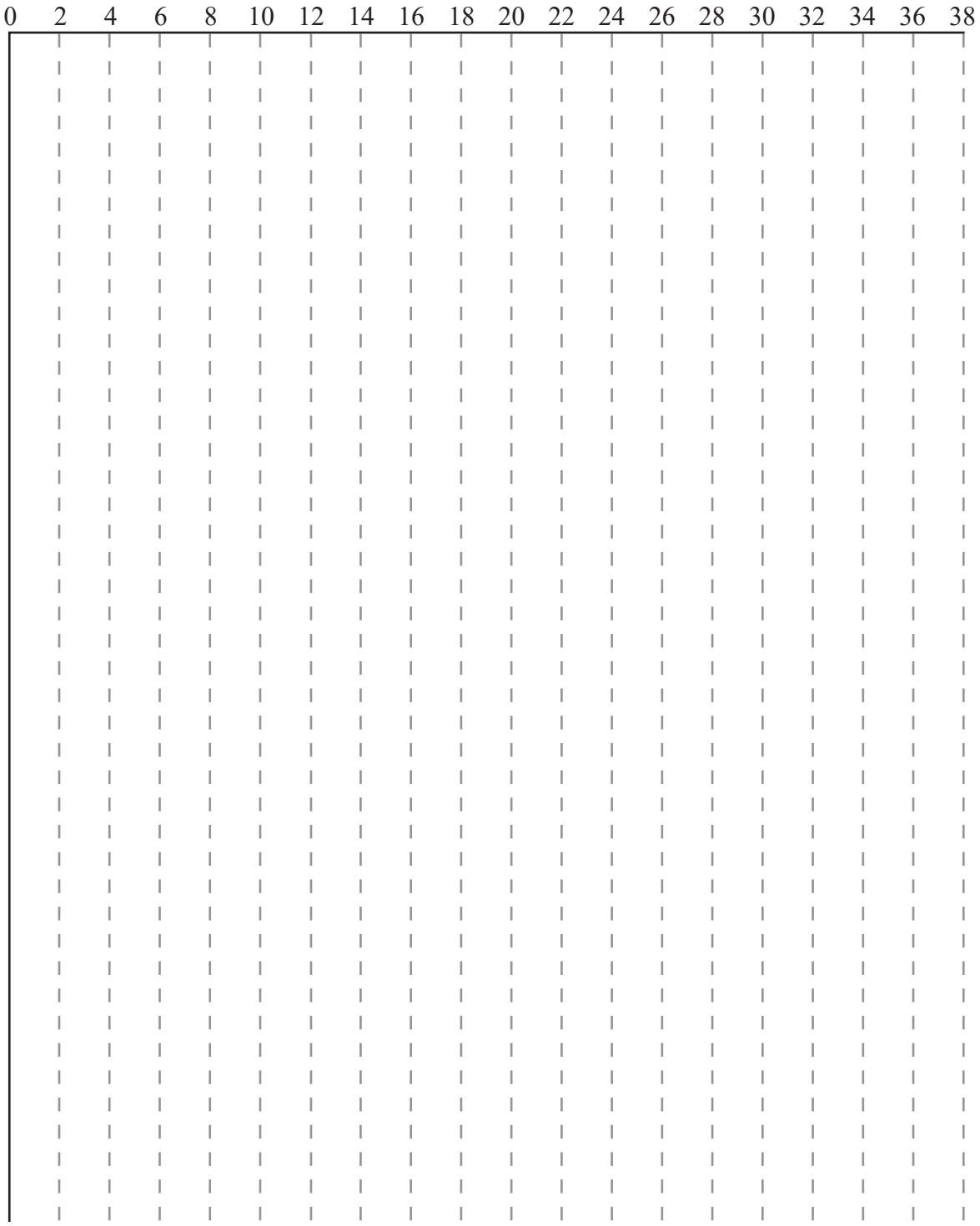
Diagram 1

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Question 6 continued



Q6

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Question 7 continued

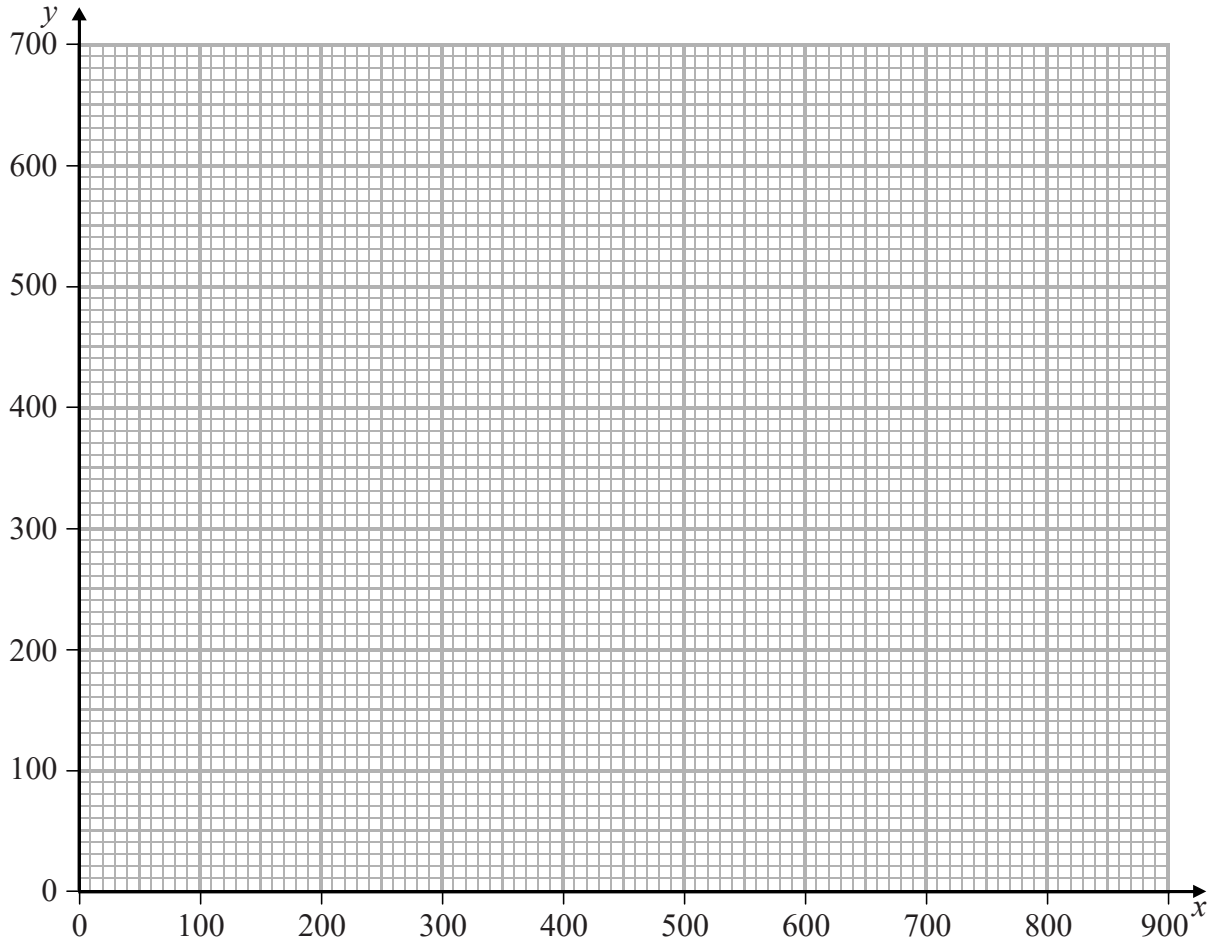


Diagram 1

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Question 7 continued

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Question 7 continued

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Question 7 continued

Q7

(Total 17 marks)

TOTAL FOR PAPER: 75 MARKS

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