Pearson Edexcel GCE

Friday 14 June 2019

Afternoon (Time: 1 hour 30 minutes) | Paper Reference **6689/01**

Decision Mathematics D1

Advanced/Advanced Subsidiary

You must have:
D1 Answer Book

Candidates may use any calculator allowed by Pearson regulations. 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.

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P 5 5 8 6 4 A

Pearson

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

1.

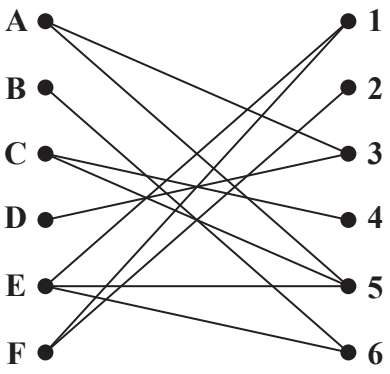

Figure 1

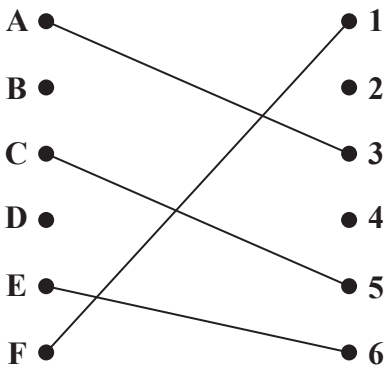

Figure 2

Figure 1 shows the possible allocations of six people, A, B, C, D, E and F, to six tasks, 1, 2, 3, 4, 5 and 6

(a) Write down the technical name given to the type of diagram shown in Figure 1.

(1)

Figure 2 shows an initial matching.

(b) Starting from the given initial matching, use the maximum matching algorithm to find a complete matching. You should list the alternating paths you use and state your improved matching after each iteration.

(6)

(Total 7 marks)

2.

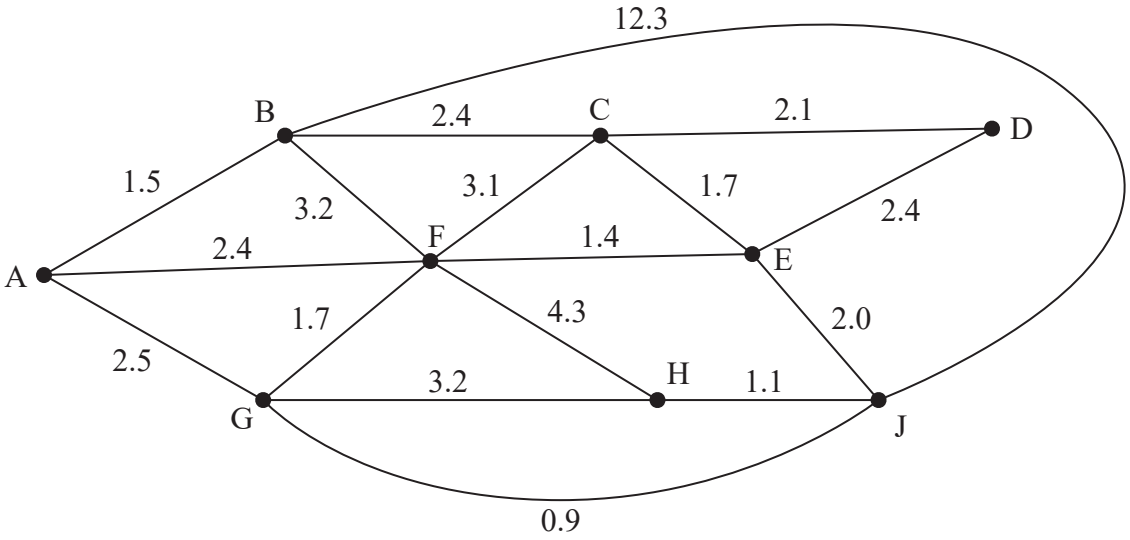

Figure 3

[*The total weight of the network is 48.2*]

A surveyor needs to check the state of a number of roads to see whether they need resurfacing. The roads that need to be checked are represented by the arcs in Figure 3. The number on each arc represents the length of that road in miles. To check all the roads, she needs to travel along each road at least once. She wishes to minimise the total distance travelled.

The surveyor's office is at F, so she starts and ends her journey at F.

(a) Find a route for the surveyor to follow. State your route and its length. You must make your method and reasoning clear.

(4)

The surveyor lives at D and wonders if she can reduce the distance travelled by starting from home and inspecting all the roads on the way to her office at F.

(b) By considering the pairings of all relevant nodes, find the arcs that will need to be traversed twice in the inspection route from D to F. You must make your method and working clear.

(5)

(c) Determine which of the two routes, the one starting at F and ending at F, or the one starting at D and ending at F, is longer. You must show your working.

(2)

(Total 11 marks)

3.

	A	B	C	D	E	F	G	H	J
A	–	3	8	5	–	–	–	–	–
B	3	–	4	–	–	–	–	–	–
C	8	4	–	–	9	4	–	–	–
D	5	–	–	–	–	7	4	9	–
E	–	–	9	–	–	4	–	–	7
F	–	–	4	7	4	–	–	8	13
G	–	–	–	4	–	–	–	4	–
H	–	–	–	9	–	8	4	–	7
J	–	–	–	–	7	13	–	7	–

The table above shows the lengths, in metres, of the paths between nine vertices, A, B, C, D, E, F, G, H and J.

(a) Use Prim's algorithm, starting at A, to find a minimum spanning tree for this table of distances. You must clearly state the order in which you select the edges and state its weight. Draw your minimum spanning tree using the vertices in the answer book.

(5)

(b) State whether your minimum spanning tree is unique. Justify your answer.

(1)

(c) Use Dijkstra's algorithm to find the length of the shortest path from A to J.

(5)

(Total 11 marks)

4.

25 9 32 16 17 23 18 12 4 8 40

The numbers in the list represent the weights, in kilograms, of eleven suitcases. The suitcases are to be transported in containers that will each hold a maximum weight of 50 kg.

(a) Calculate a lower bound for the number of containers needed. You must make your method clear.

(2)

(b) Use the first-fit bin packing algorithm to allocate the suitcases to the containers.

(2)

(c) Carry out a quick sort to produce a list of the weights in descending order. You should show the result of each pass and identify your pivots clearly.

(4)

(d) Use the first-fit decreasing bin packing algorithm to allocate the suitcases to the containers.

(3)

The two heaviest suitcases are replaced with two suitcases both of which weigh x kg. It is given that the lower bound for the number of containers needed is now one less than the number found in (a).

(e) Determine the range of values for x. You should make your working clear.

(4)

(Total 15 marks)

5.

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

(a) Draw the activity network described in the precedence table above, using activity on arc and exactly 4 dummies.

(5)

(b) Explain why one of the activities I or J must be critical.

(1)

It is given that activity C is a critical activity.

(c) State the activities that are therefore guaranteed to be critical.

(1)

(Total 7 marks)

6.

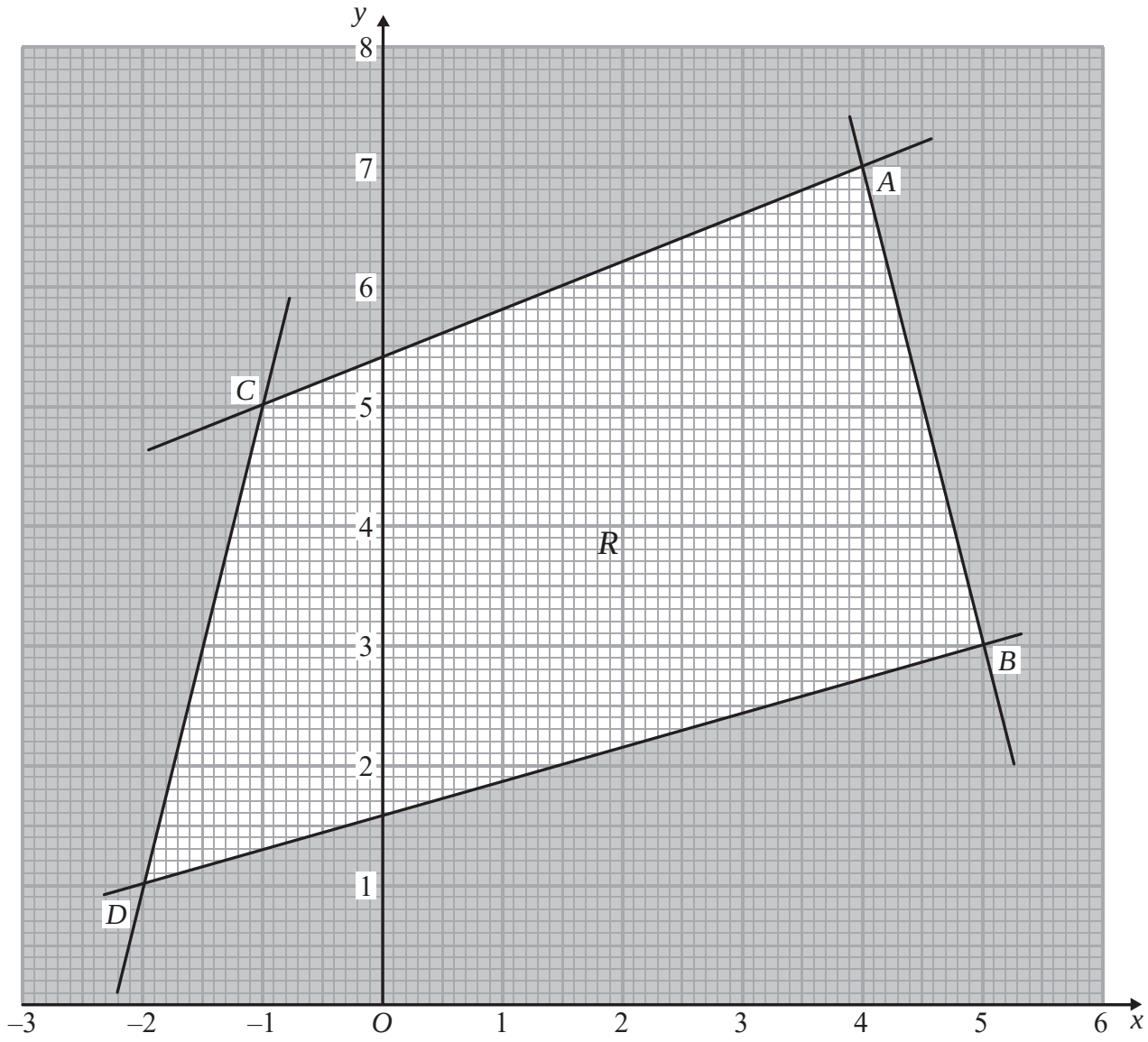

Figure 4

Figure 4 shows the constraints of a linear programming problem in x and y, where R is the feasible region.

The vertices of the feasible region are $A(4, 7)$, $B(5, 3)$, $C(-1, 5)$ and $D(-2, 1)$.

(a) Determine the inequality that defines the boundary of R that passes through vertices A and C, leaving your answer with integer coefficients only.

(3)

The objective is to maximise $P = 5x + y$

(b) Find the coordinates of the optimal vertex and the corresponding value of P.

(3)

The objective is changed to maximise $Q = kx + y$

(c) If k can take any value, find the range of values of k for which A is the only optimal vertex.

(4)

(Total 10 marks)

7.

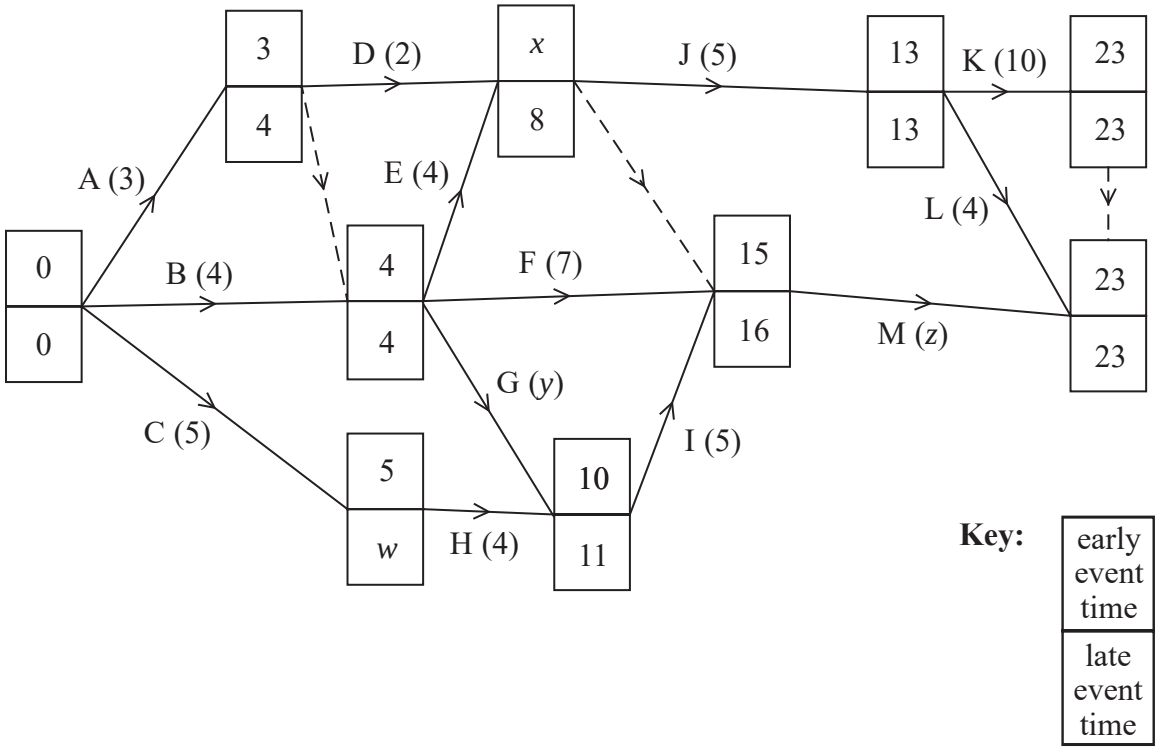

Figure 5

The network in Figure 5 shows the activities that need to be undertaken in order to complete a project. Each activity is represented by an arc. The number in brackets is the duration of the activity in hours. The early event times and late event times are shown at each node. The project can be completed in 23 hours.

Given that the total float on activity G is 1 hour,

(a) find the values of w, x, y and z.

(4)

(b) Explain the purpose of the dummy activity that has a late event time of 16

(1)

(c) List the critical activities.

(1)

This project is being completed by a company that has only two permanent workers available. The project must be completed in 23 hours and, in order to achieve this, the company is prepared to hire additional workers at a cost of £35 per hour payable only for the time that the workers are engaged in activities. The company wishes to minimise the money spent on additional workers. Any worker can undertake any activity and each activity requires only one worker. Once an activity has been started it must be completed without interruption and by the same worker.

(d) Explain why the company cannot complete the project in 23 hours using only their permanent workers.

(1)

(e) Schedule the activities to workers on Grid 1 in the answer book so that the project is completed in 23 hours using the minimum number of workers and at minimum cost to the company.

(3)

(f) Calculate the minimum extra cost to the company. You must make your working clear.

(2)

Due to bad weather, activity H may take 7 hours to complete.

(g) Explain what affect this would have on the minimum time taken to complete the whole project. (You do not need to reschedule the project.)

(2)

(Total 14 marks)

TOTAL FOR PAPER: 75 MARKS

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Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel GCE

Centre Number | Candidate Number

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Decision Mathematics D1

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Answer Book
Do not return the question paper with the answer book.

Total Marks

Turn over ▶

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1.

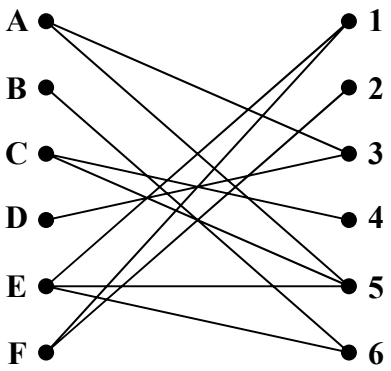

Figure 1

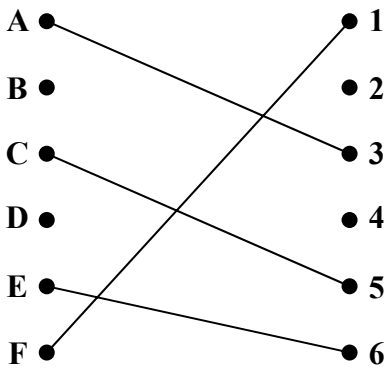

Figure 2

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Question 1 continued

A ●	**● 1**	**A ●**	**● 1**
B ●	**● 2**	**B ●**	**● 2**
C ●	**● 3**	**C ●**	**● 3**
D ●	**● 4**	**D ●**	**● 4**
E ●	**● 5**	**E ●**	**● 5**
F ●	**● 6**	**F ●**	**● 6**

Q1

(Total 7 marks)

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2.

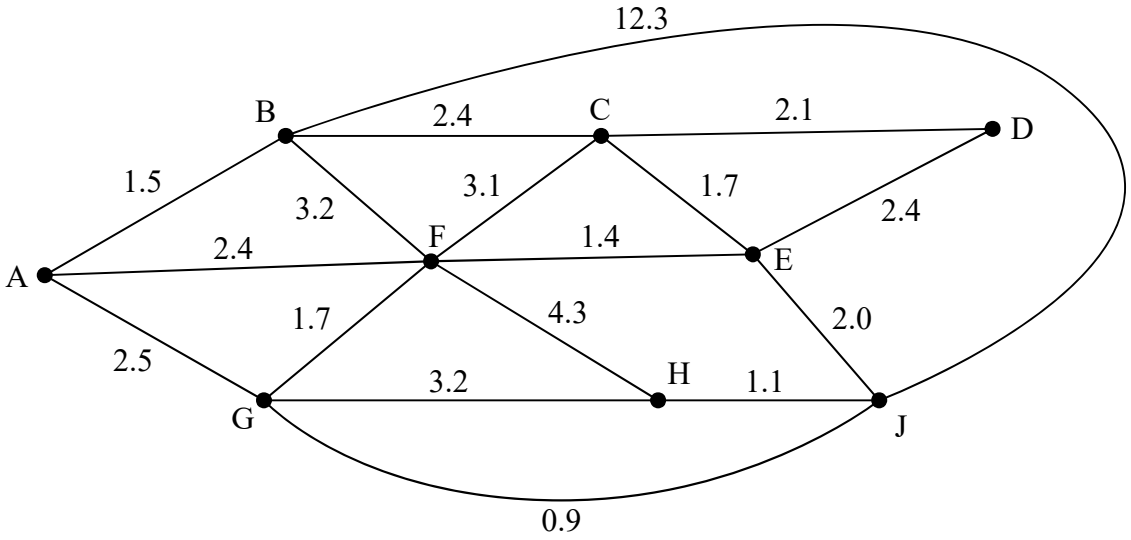


Figure 3

[*The total weight of the network is 48.2*]

Leave blank

Question 2 continued

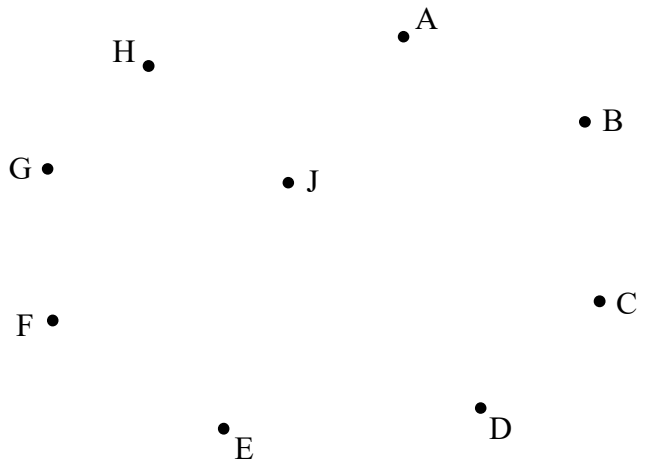
(Total 11 marks)

Q2

Leave blank

3.

	A	B	C	D	E	F	G	H	J
A	–	3	8	5	–	–	–	–	–
B	3	–	4	–	–	–	–	–	–
C	8	4	–	–	9	4	–	–	–
D	5	–	–	–	–	7	4	9	–
E	–	–	9	–	–	4	–	–	7
F	–	–	4	7	4	–	–	8	13
G	–	–	–	4	–	–	–	4	–
H	–	–	–	9	–	8	4	–	7
J	–	–	–	–	7	13	–	7	–



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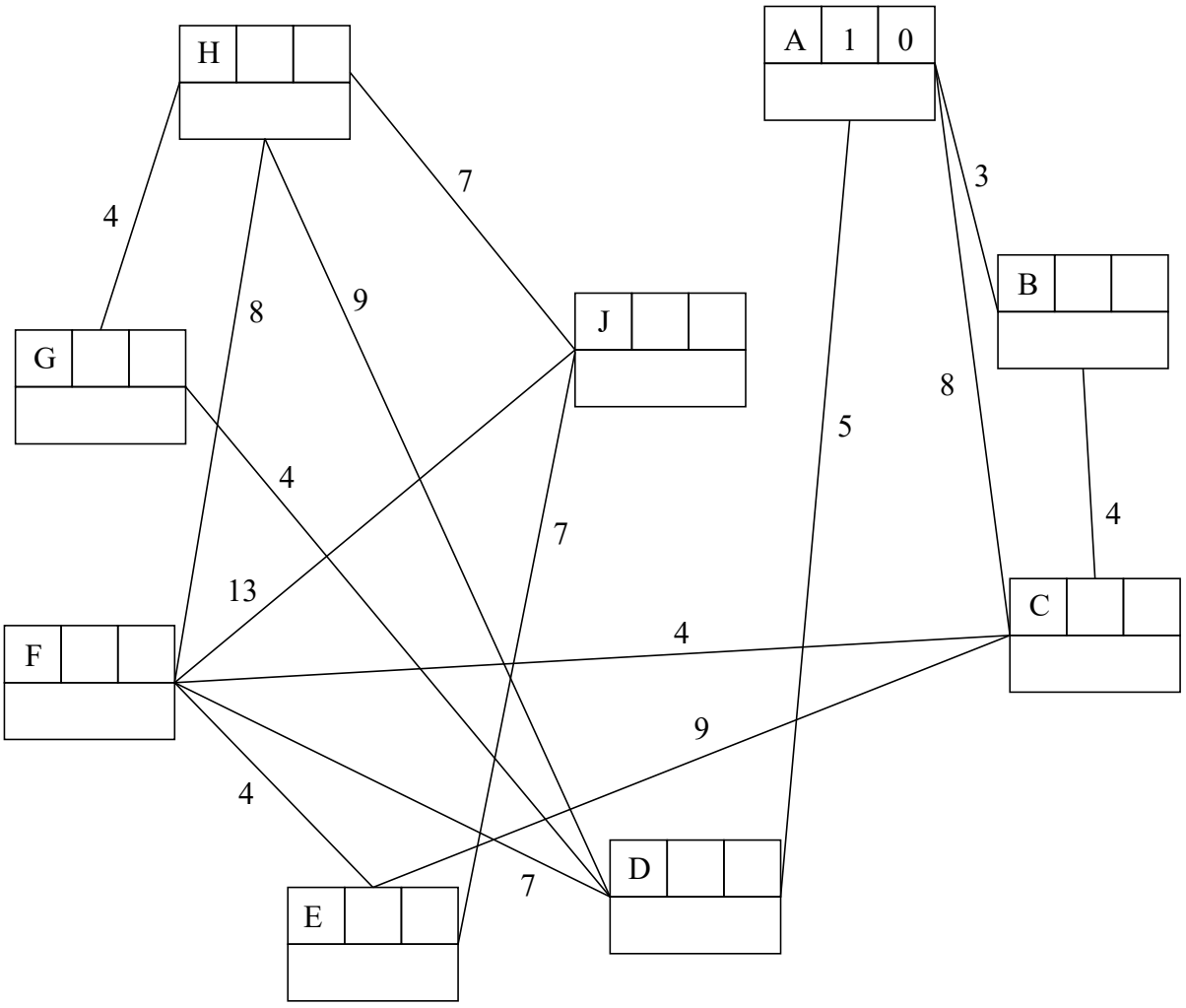
Question 3 continued



Key:

Vertex	Order of labelling	Final value
Working values		

Length of shortest path: _____

Q3

(Total 11 marks)

Leave blank

4.

25 9 32 16 17 23 18 12 4 8 40

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DO NOT WRITE IN THIS AREA

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Leave blank

Question 4 continued

25 9 32 16 17 23 18 12 4 8 40

Leave blank

Question 4 continued

Leave blank

Question 4 continued

Q4

(Total 15 marks)

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5.

Leave blank

Question 5 continued

Q5

(Total 7 marks)

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6.

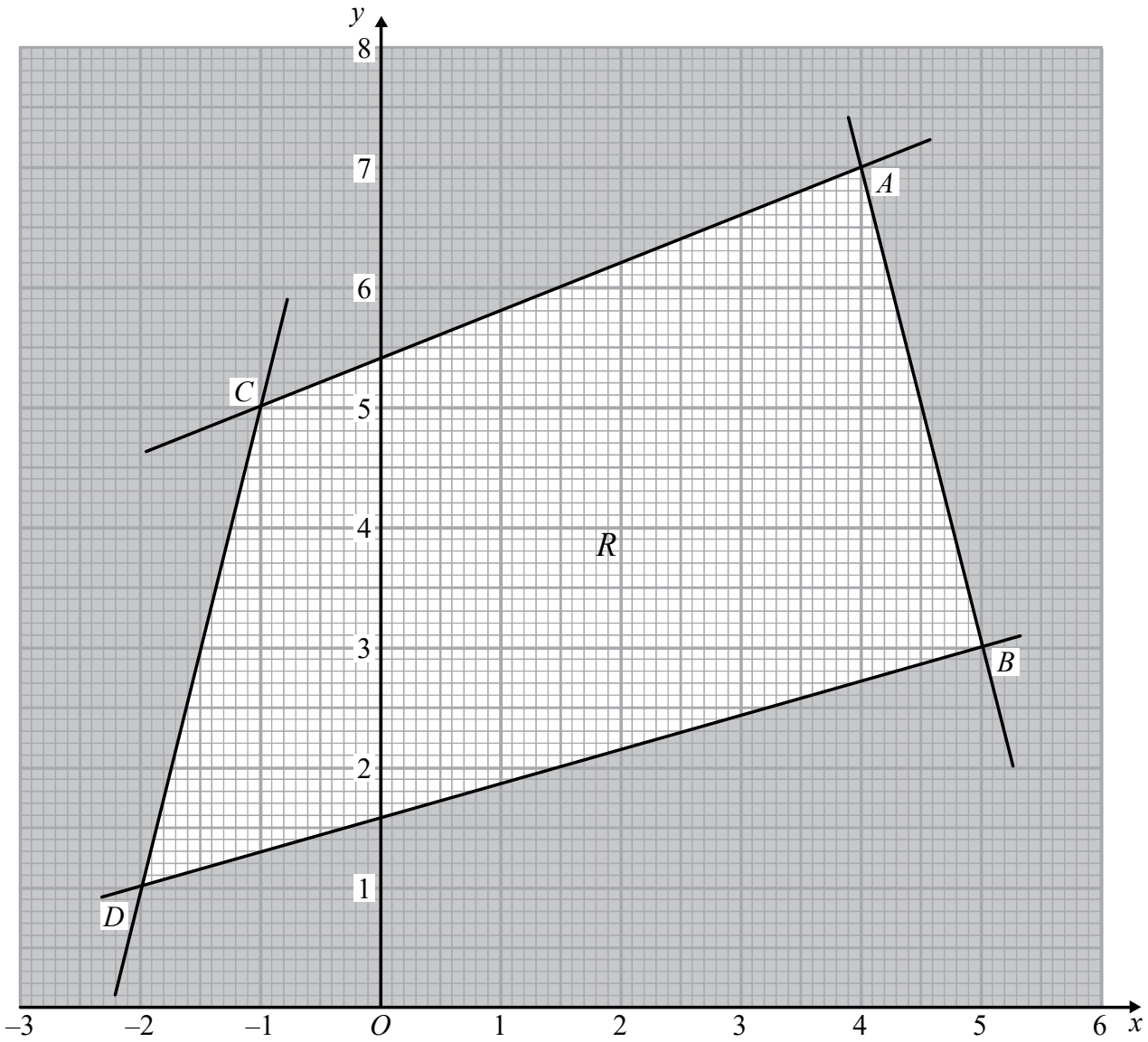

Figure 4

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Question 6 continued

Leave blank

Question 6 continued

Leave blank

Question 6 continued

(Total 10 marks)

Q6

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7.

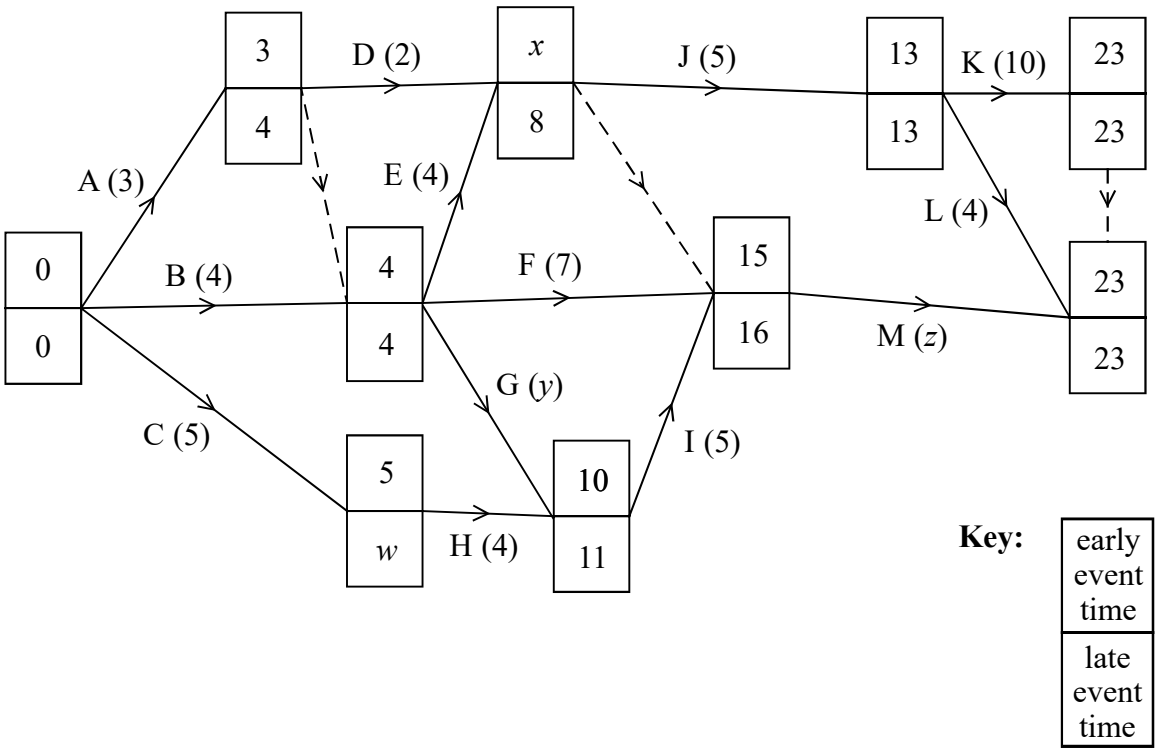

Figure 5

$w =$ _____, $x =$ _____, $y =$ _____, $z =$ _____

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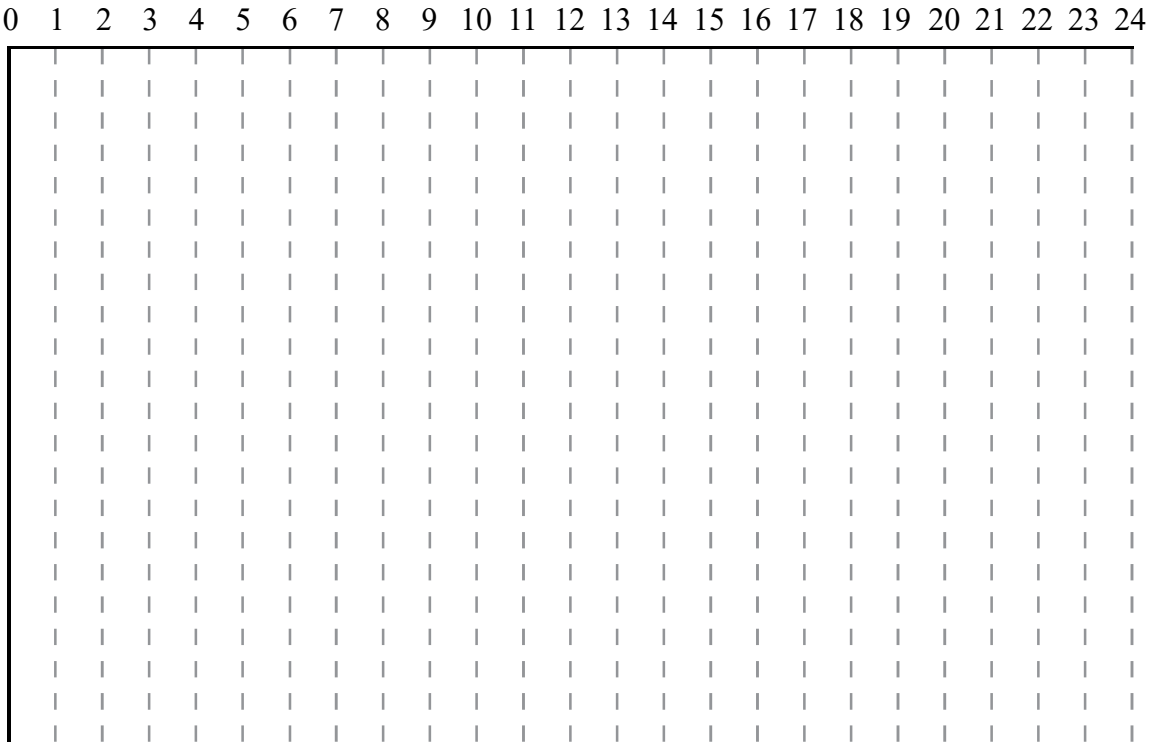
Question 7 continued

Leave blank

Question 7 continued



Grid 1

Q7

(Total 14 marks)

TOTAL FOR PAPER: 75 MARKS

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