Pearson Edexcel International Advanced Level

Decision Mathematics D1

Advanced/Advanced Subsidiary

Tuesday 9 June 2015 – Morning
Time: 1 hour 30 minutes

Paper Reference
WDM01/01

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.

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P 4 4 8 5 2 A

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

1.

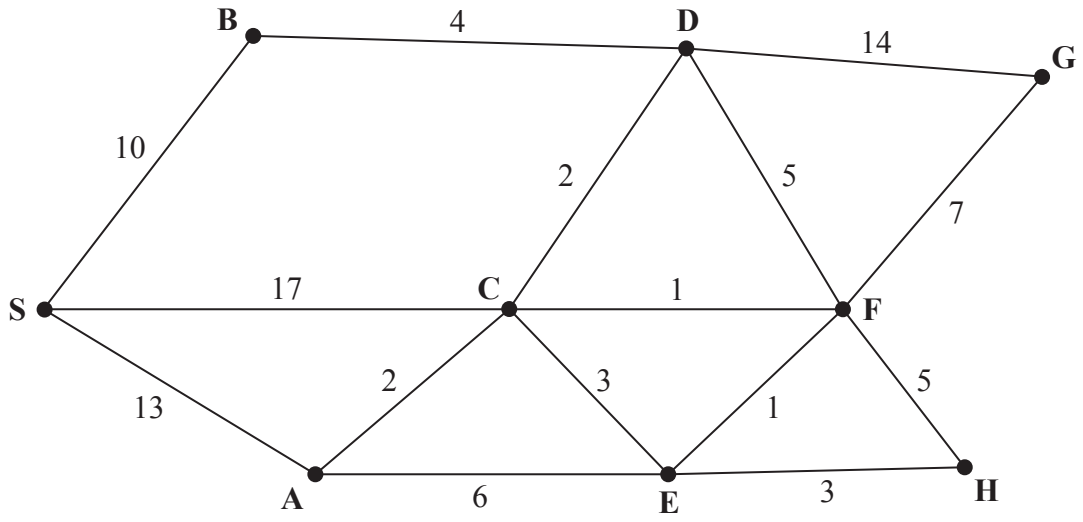

Figure 1

Figure 1 represents a network of roads. The number on each arc gives the length, in km, of the corresponding road.

(a) Use Dijkstra's algorithm to find the shortest distance from S to G. State the shortest route.

(6)

(b) State both the shortest distance and the shortest route from S to H.

(2)

(Total 8 marks)

2. A list of n numbers needs to be sorted into **descending** order starting at the left-hand end of the list.

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

(2)

(b) (i) State which number in the list is guaranteed to be in the correct final position after the first pass.

(ii) Write down the maximum number of passes required to sort a list of n numbers.

(2)

(c) The numbers below are to be sorted into **descending** order. Use a bubble sort, starting at the left-hand end of the list, to obtain the sorted list. You need only give the state of the list after each pass.

11 9 4 13 5 1 7 12 8

(4)

(d) Apply the first-fit decreasing bin packing algorithm to your ordered list to pack the numbers into bins of size 21

(2)

(Total 10 marks)

3.

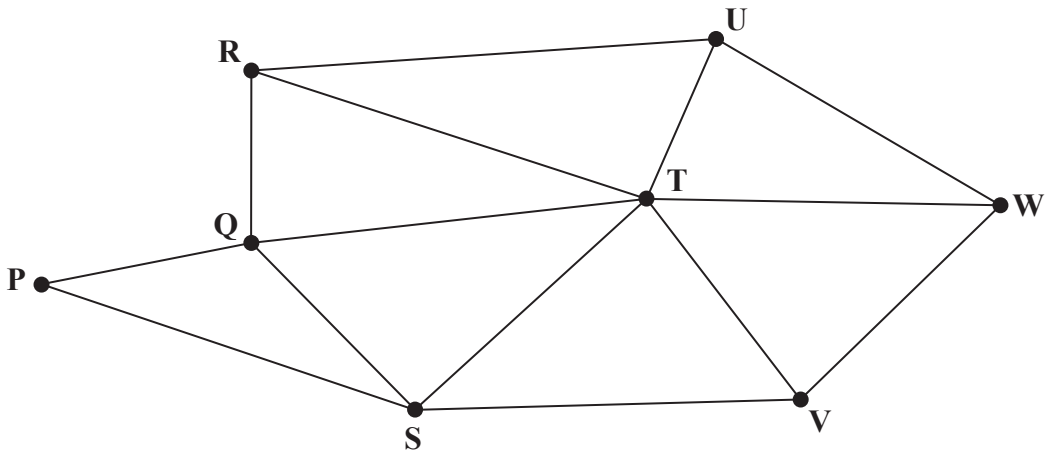

Figure 2

Figure 2 shows a graph G.

(a) Write down an example of a cycle on G.

(1)

(b) State, with a reason, whether or not P – Q – R – T – Q – S is an example of a path on G.

(2)

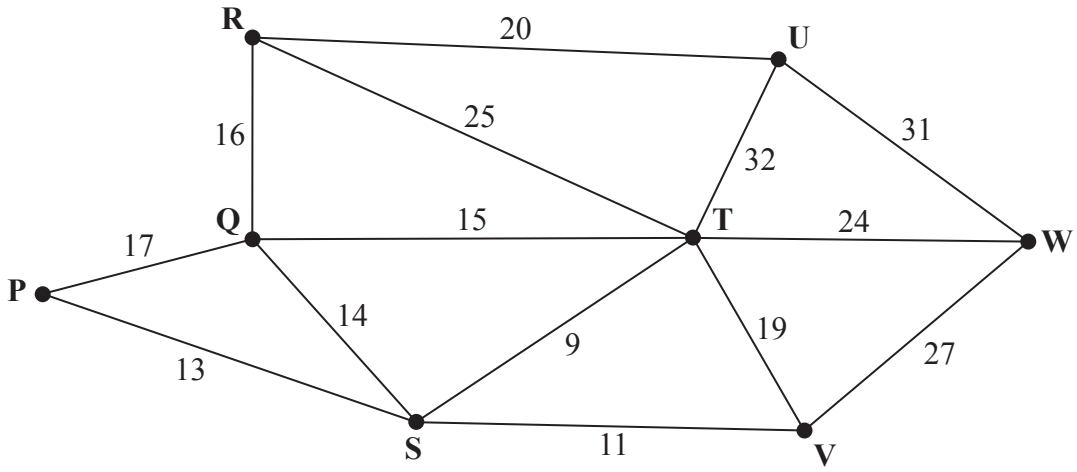

Figure 3

The numbers on the 14 arcs in Figure 3 represent the distances, in km, between eight vertices, P, Q, R, S, T, U, V and W, in a network.

(c) Use **Prim's** algorithm, starting at P, to find the minimum spanning tree for the network. You must clearly state the order in which you select the arcs of your tree.

(3)

(d) Use **Kruskal's** algorithm to find the minimum spanning tree for the network. You should list the arcs in the order in which you consider them. In each case, state whether you are adding the arc to the minimum spanning tree.

(3)

(e) Draw the minimum spanning tree using the vertices given in Diagram 1 in the answer book.

(1)

The weight on arc RU is now increased to a value of x. The minimum spanning tree for the network is still unique and includes the same arcs as those found in (e).

(f) Write down the smallest interval that must contain x.

(2)

(Total 12 marks)

4. (a) Define the term ‘alternating path’.

(2)

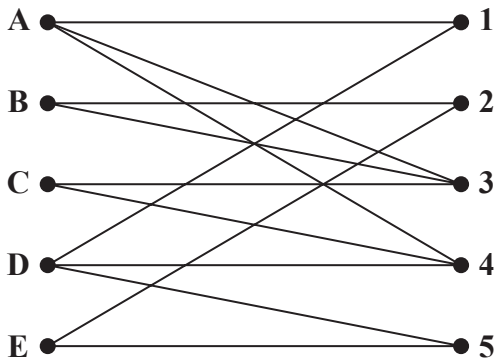

Figure 4

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

An initial matching has three people allocated to three of the tasks.

Starting from this initial matching, one possible alternating path that starts at E is

$$E - 2 = B - 3 = A - 4 = D - 1$$

(b) Use this information to

(i) deduce this initial matching,

(ii) list the improved matching generated by the given alternating path.

(2)

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

(3)

(Total 7 marks)

5.

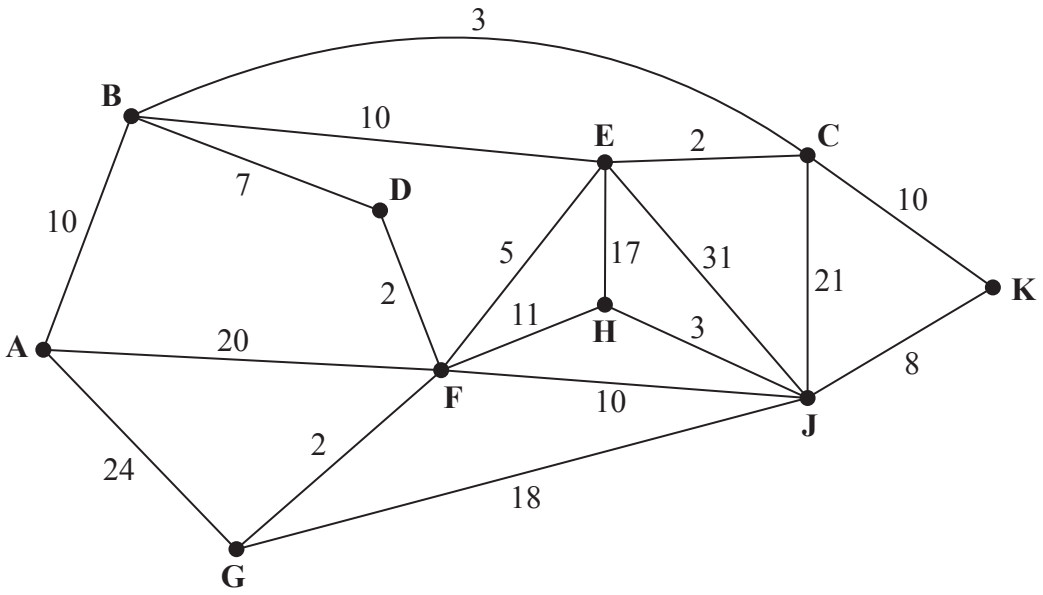

Figure 5

[*The total weight of the network is 214*]

Figure 5 models a network of canals that have to be inspected. The number on each arc represents the length, in km, of the corresponding canal. Priya needs to travel along each canal at least once and wishes to minimise the length of her inspection route.

She must start and finish at A.

(a) Use the route inspection algorithm to find the length of her route. State the arcs that will need to be traversed twice. You should make your method and working clear.

(6)

(b) State the number of times that vertex F would appear in Priya's route.

(1)

It is now decided to start the inspection route at H. The route must still travel along each canal at least once but may finish at any vertex.

(c) Determine the finishing point so that the length of the route is minimised. You must give reasons for your answer and state the length of the minimum route.

(3)

(Total 10 marks)

6.

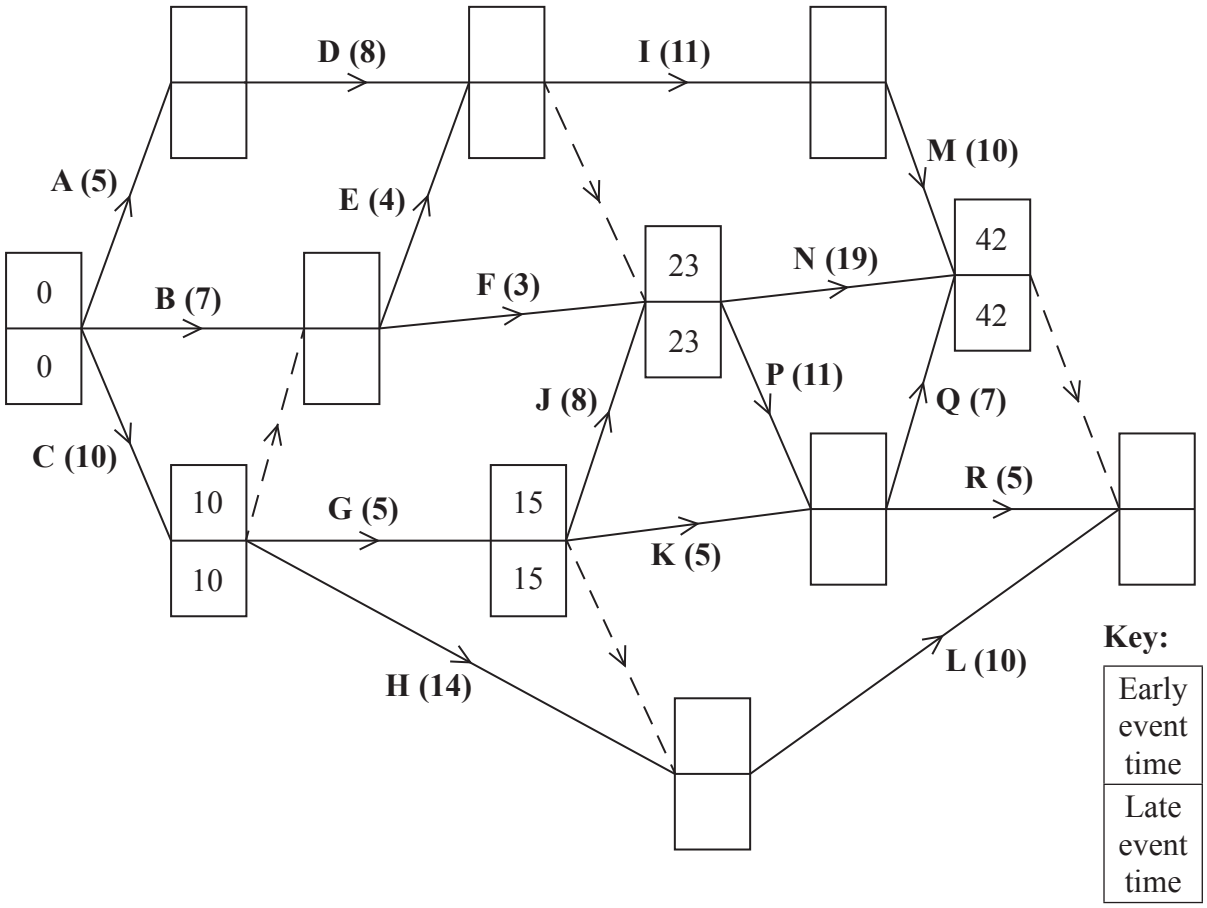

Figure 6

[*The sum of the durations of all the activities is 142 days*]

A project is modelled by the activity network shown in Figure 6. The activities are represented by the arcs. The number in brackets on each arc gives the time, in days, to complete the activity. Each activity requires one worker. The project is to be completed in the shortest possible time.

(a) Complete the precedence table in the answer book.

(2)

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

(4)

(c) Calculate the total float for activity D. You must make the numbers you use in your calculation clear.

(1)

(d) Calculate a lower bound for the number of workers needed to complete the project in the minimum time. You must show your working.

(1)

Diagram 2 in the answer book shows a partly completed scheduling diagram for this project.

(e) Complete the scheduling diagram, using the minimum number of workers, so that the project is completed in the minimum time.

(4)

(Total 12 marks)

7. Ian plans to produce two types of book, hardbacks and paperbacks. He will use linear programming to determine the number of each type of book he should produce.

Let x represent the number of hardbacks Ian will produce.

Let y represent the number of paperbacks Ian will produce.

Each hardback takes 1 hour to print and 15 minutes to bind.

Each paperback takes 35 minutes to print and 24 minutes to bind.

The printing machine must be used for at least 14 hours. The binding machine must be used for at most 8 hours.

(a) (i) Show that the printing time restriction leads to the constraint $12x + 7y \geqslant k$, where k is a constant to be determined.

(ii) Write the binding time restriction in a similar simplified form.

(4)

Ian decides to produce at most twice as many hardbacks as paperbacks.

(b) Write down an inequality to model this constraint in terms of x and y.

(2)

(c) Add lines and shading to Diagram 1 in the answer book to represent the constraints found in (a) and (b). Hence determine, and label, the feasible region R.

(4)

Ian wishes to maximise $P = 60x + 36y$, where P is the total profit in pounds.

(d) (i) Use the objective line (ruler) method to find the optimal vertex, V, of the feasible region. You must draw and clearly label your objective line and the vertex V.

(ii) Determine the exact coordinates of V. You must show your working.

(4)

(e) Given that P is Ian's expected total profit, in pounds, find the number of each type of book that he should produce and his maximum expected profit.

(2)

(Total 16 marks)

TOTAL FOR PAPER: 75 MARKS

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Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number	Candidate Number

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

Total Marks

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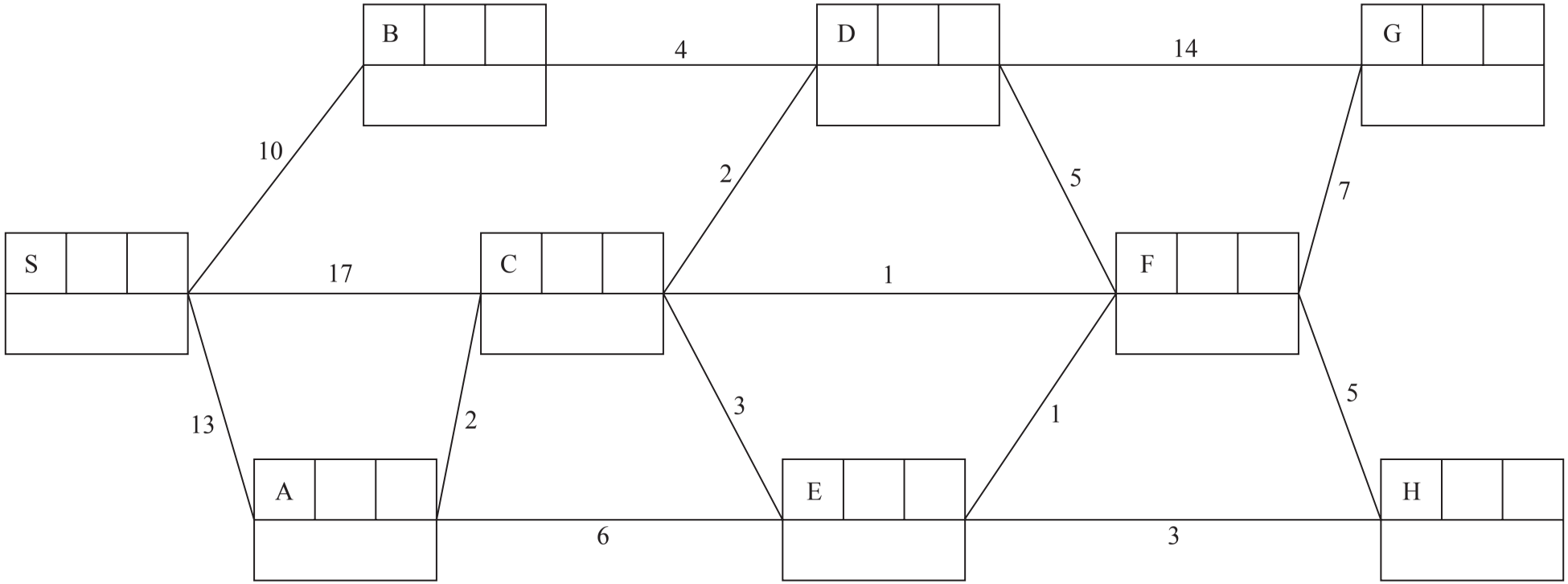
1.



Key:

Vertex	Order of labelling	Final value
Working values		

Leave blank

Question 1 continued

(a) Shortest distance from S to G: .....

Shortest route from S to G: .....

(b) Shortest distance from S to H: .....

Shortest route from S to H: .....

Leave blank

Q1

(Total 8 marks)

Leave blank

2.

Leave blank

Question 2 continued

11 9 4 13 5 1 7 12 8

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Question 2 continued

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Question 2 continued

Q2

(Total 10 marks)

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3.

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Question 3 continued

(e)

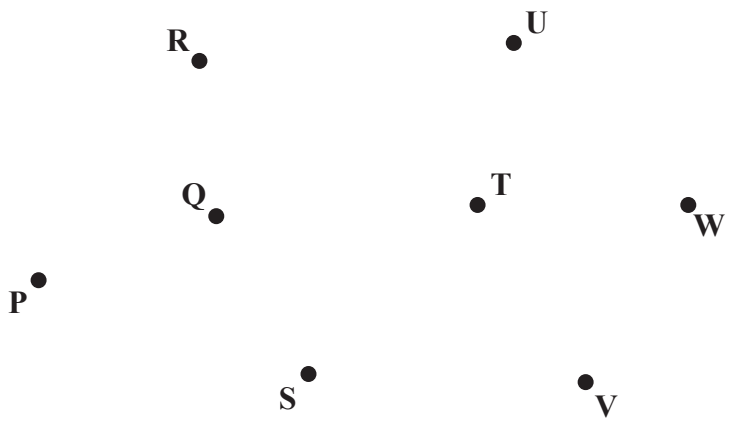

Diagram 1

Q3

(Total 12 marks)

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4. (a)

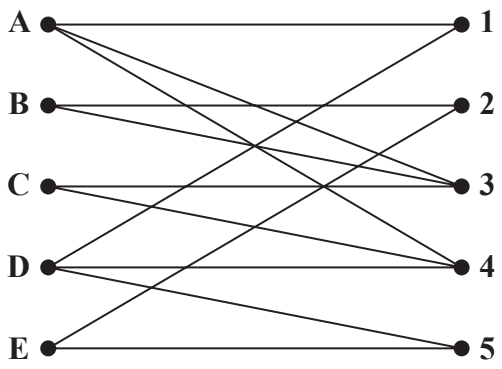

Figure 4

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Question 4 continued

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

Q4

(Total 7 marks)

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5.

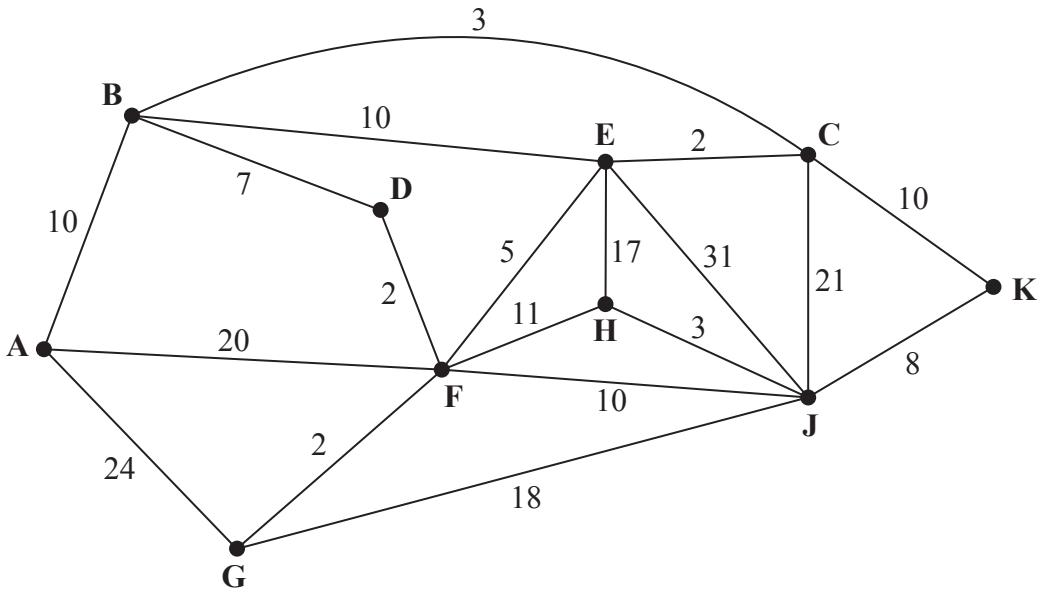

Figure 5

[*The total weight of the network is 214*]

Leave blank

Question 5 continued

Q5

(Total 10 marks)

Leave blank

6. (a)

Activity	Immediately preceding activities
A	-
B	-
C	-
D	A
E	
F	

Activity	Immediately preceding activities
G	C
H	C
I	
J	G
K	G
L	

Activity	Immediately preceding activities
M	I
N	
P	
Q	
R	

(b)

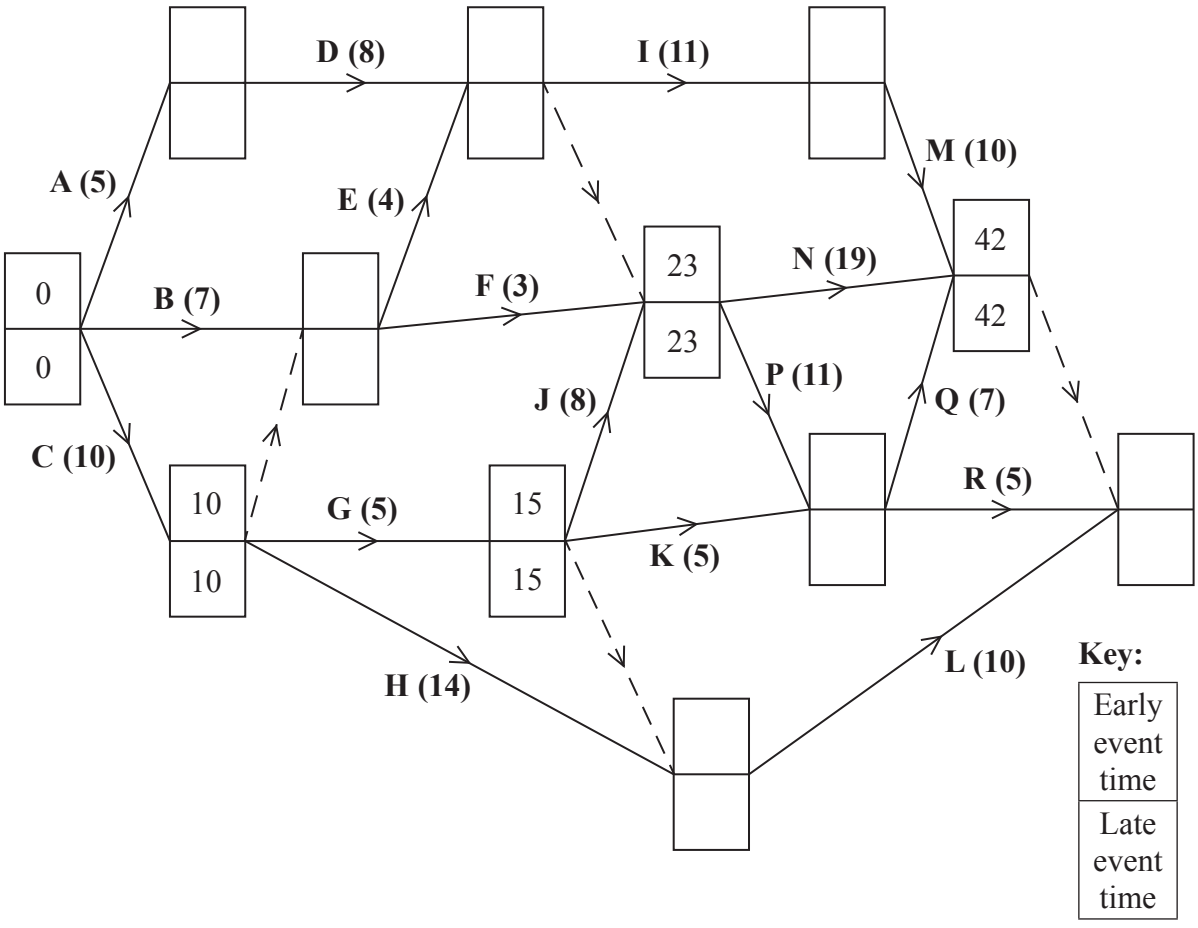

Diagram 1

Question 6 continued

(e)

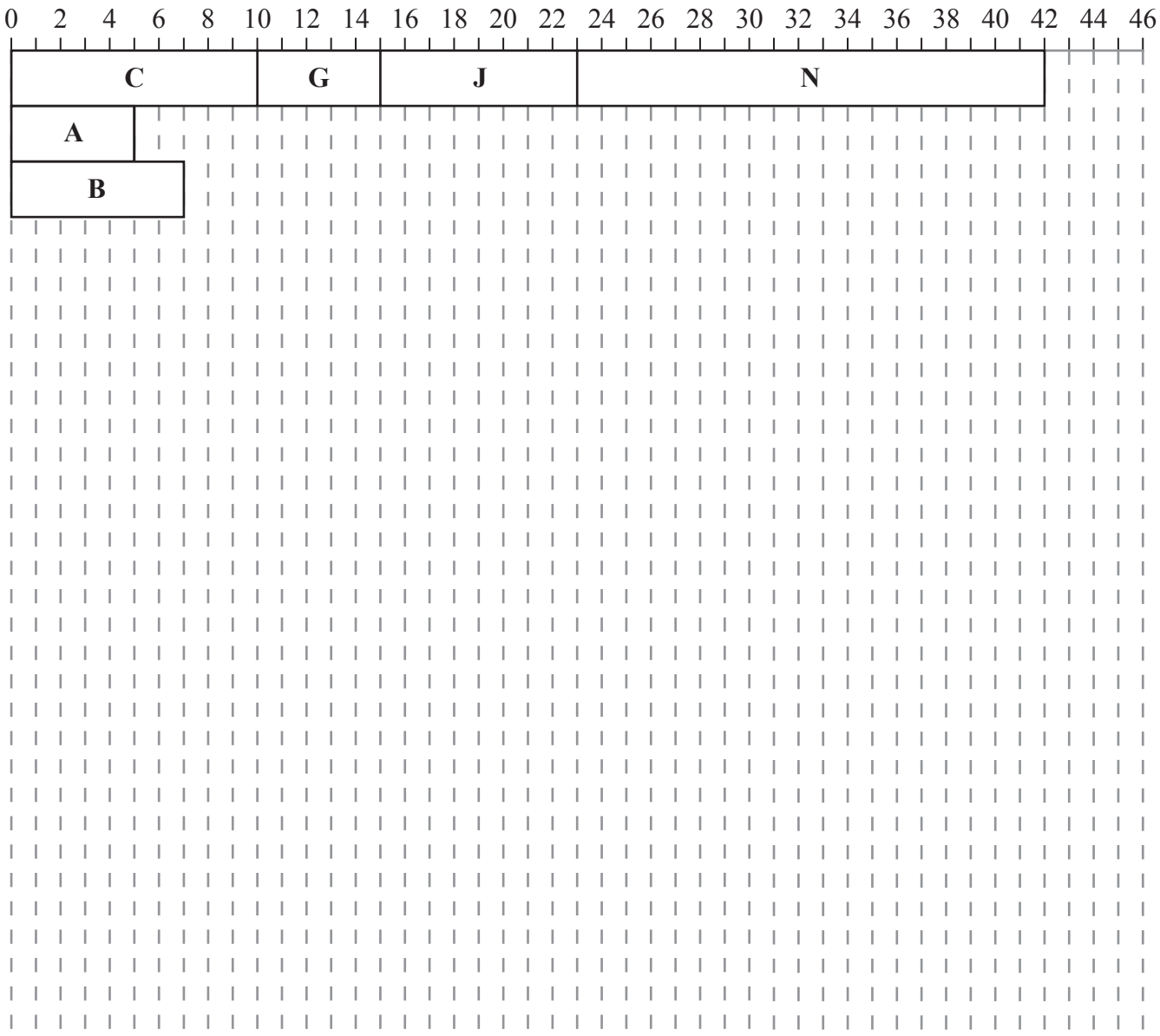

Diagram 2

Q6

(Total 12 marks)

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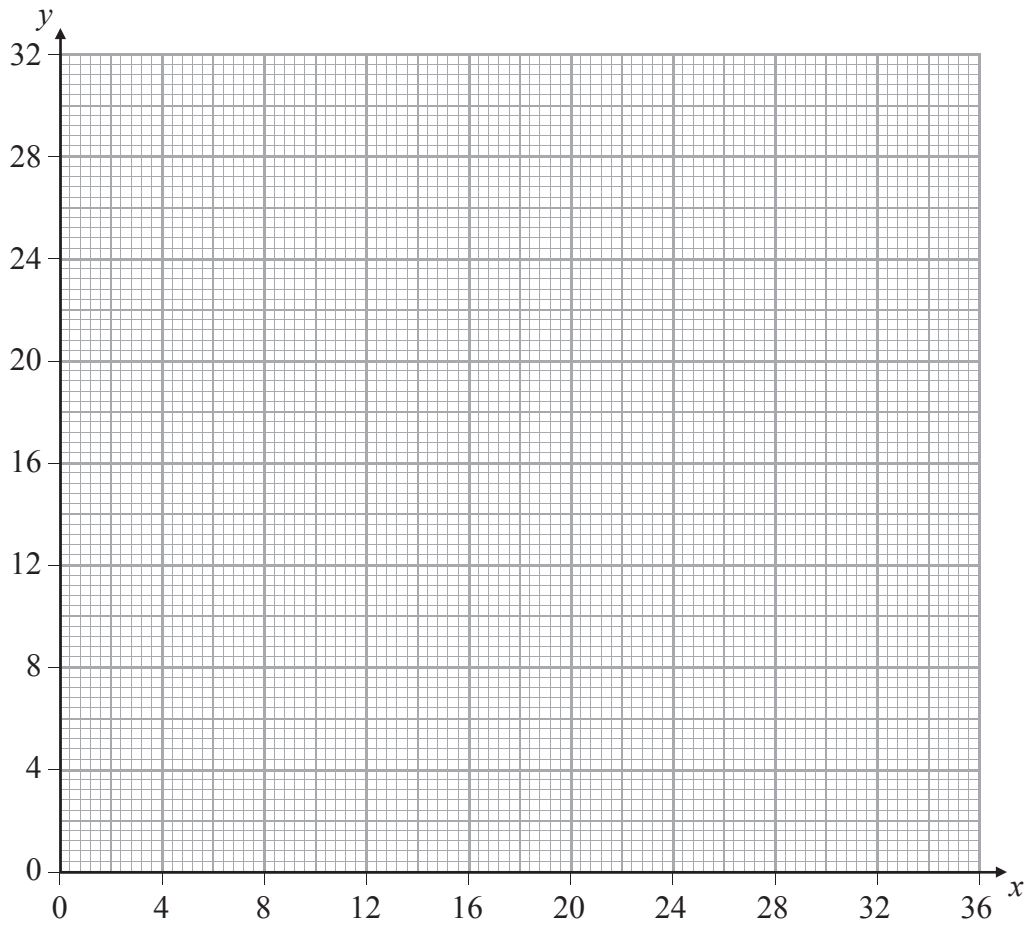

Diagram 1

Leave blank

Question 7 continued

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Question 7 continued

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Question 7 continued

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Question 7 continued

Q7

(Total 16 marks)

TOTAL FOR PAPER: 75 MARKS

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