Paper Reference(s)

**6689/01**

# Edexcel GCE

## Decision Mathematics D1

## Advanced/Advanced Subsidiary

Thursday 15 May 2008 – Morning

Time: 1 hour 30 minutes

**Materials required for examination**
Nil

**Items included with question papers**
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 to Candidates

Write your answers for this paper in the D1 answer book provided.
In the boxes on the answer book, write your centre number, candidate number, your surname, initials and signature.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.
Complete your answers in blue or black ink or pencil.
Do not return the question paper with the answer book.

### Information for Candidates

Full marks may be obtained for answers to ALL questions.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 8 questions in this question paper. The total mark for this paper is 75.
There are 8 pages in this question paper. The answer book has 16 pages. Any blank pages are indicated.

### Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You should show sufficient working to make your methods clear to the Examiner.
Answers without working may not gain full credit.

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

**1.**

29 52 73 87 74 47 38 61 41

The numbers in the list represent the lengths in minutes of nine radio programmes. They are to be recorded onto tapes which each store up to 100 minutes of programmes.

(a) Obtain a lower bound for the number of tapes needed to store the nine programmes.

**(2)**

(b) Use the first-fit bin packing algorithm to fit the programmes onto the tapes.

**(3)**

(c) Use the first-fit decreasing bin packing algorithm to fit the programmes onto the tapes.

**(3)**

**(Total 8 marks)**

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**2.**

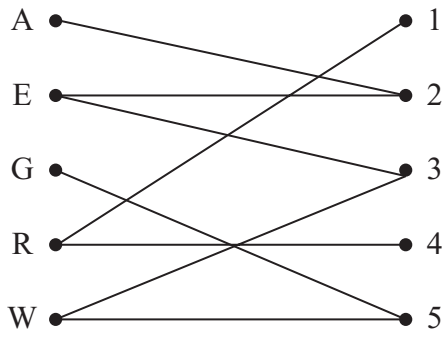



**Figure 1**

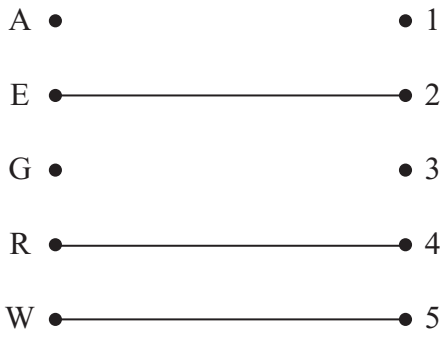



**Figure 2**

Five tour guides, Alice, Emily, George, Rose and Weidi, need to be assigned to five coach trips, 1, 2, 3, 4 and 5. A bipartite graph showing their preferences is given in Figure 1 and an initial matching is given in Figure 2.

(a) Use the maximum matching algorithm, starting with vertex G, to increase the number of matchings. State the alternating path you used.

**(2)**

(b) List the improved matching you found in (a).

**(1)**

(c) Explain why a complete matching is not possible.

**(2)**

Weidi agrees to be assigned to coach trip 3, 4 or 5.

(d) **Starting with your current maximal matching**, use the maximum matching algorithm to obtain a complete matching.

**(3)**

**(Total 8 marks)**

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**3.**

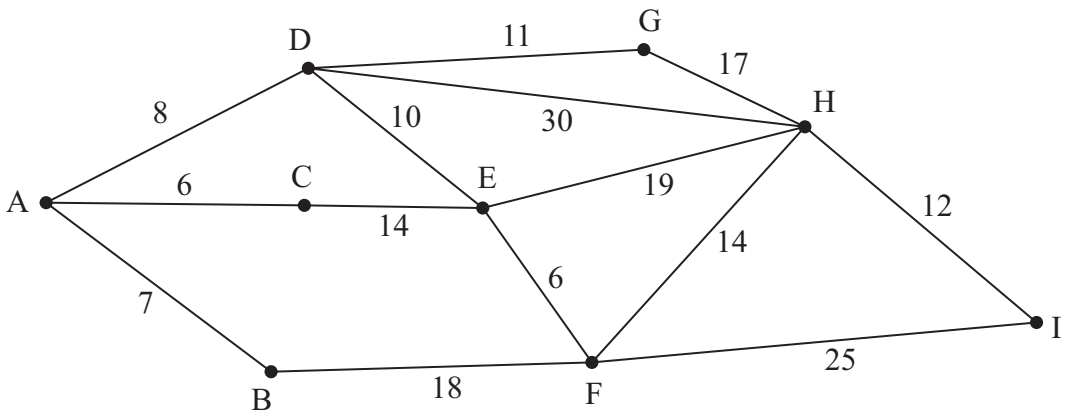



**Figure 3**

Figure 3 shows a network of roads. The number on each arc represents the length, in km, of that road.

(a) Use Dijkstra's algorithm to find the shortest route from A to I. State your shortest route and its length.

**(5)**

Sam has been asked to inspect the network and assess the condition of the roads. He must travel along each road at least once, starting and finishing at A.

(b) Use an appropriate algorithm to determine the length of the shortest route Sam can travel. State a shortest route.

**(4)**

(The total weight of the network is 197km)

**(Total 9 marks)**

**4.**

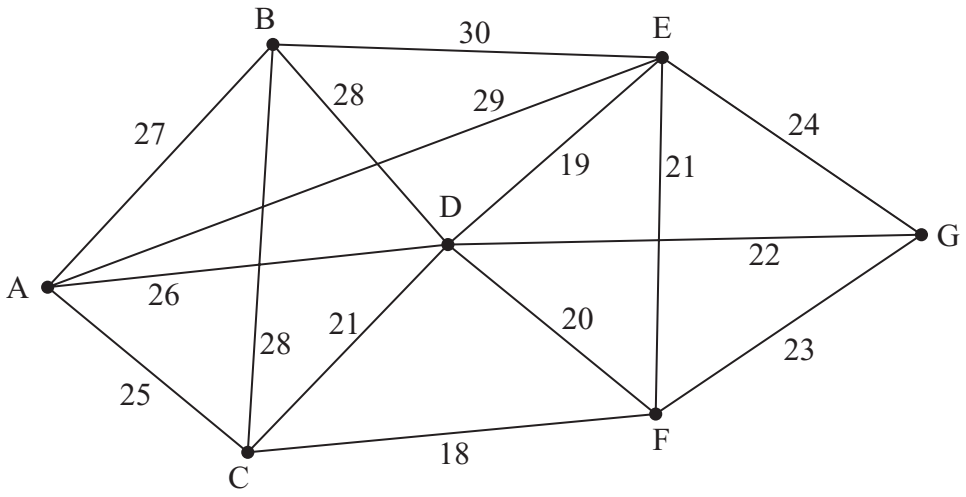



**Figure 4**

(a) State two differences between Kruskal's algorithm and Prim's algorithm for finding a minimum spanning tree.

**(2)**

(b) Listing the arcs in the order that you consider them, find a minimum spanning tree for the network in Figure 4, using

(i) Prim's algorithm,

(ii) Kruskal's algorithm.

**(6)**

**(Total 8 marks)**

**5.**

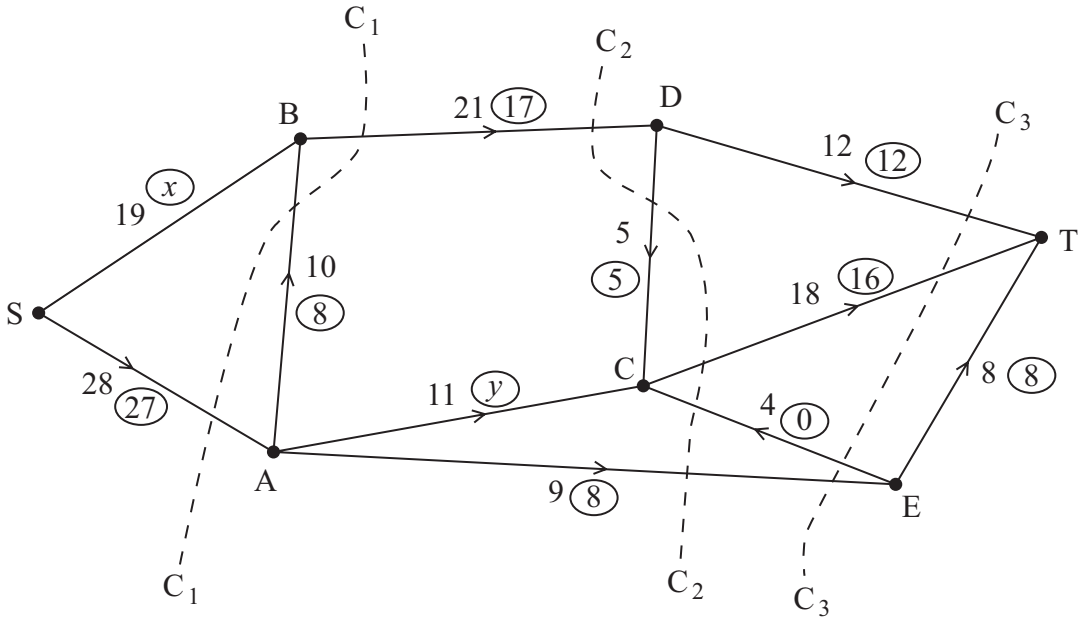



**Figure 5**

Figure 5 shows a capacitated, directed network of pipes. The number on each arc represents the capacity of that pipe. The numbers in circles represent a feasible flow.

(a) State the values of $x$ and $y$.

**(2)**

(b) List the saturated arcs.

**(2)**

(c) State the value of the feasible flow.

**(1)**

(d) State the capacities of the cuts $C_1$, $C_2$, and $C_3$.

**(3)**

(e) By inspection, find a flow-augmenting route to increase the flow by one unit. You must state your route.

**(1)**

(f) Prove that the new flow is maximal.

**(2)**

**(Total 11 marks)**

**6.** The tableau below is the initial tableau for a maximising linear programming problem in $x$, $y$ and $z$.

| Basic variable | $x$ | $y$ | $z$ | $r$ | $s$ | $t$ | Value |
|---|---|---|---|---|---|---|---|
| $r$ | 4 | $\frac{7}{3}$ | $\frac{5}{2}$ | 1 | 0 | 0 | 64 |
| $s$ | 1 | 3 | 0 | 0 | 1 | 0 | 16 |
| $t$ | 4 | 2 | 2 | 0 | 0 | 1 | 60 |
| $P$ | –5 | $\frac{-7}{2}$ | –4 | 0 | 0 | 0 | 0 |

(a) Taking the most negative number in the profit row to indicate the pivot column at each stage, perform two complete iterations of the simplex algorithm. State the row operations you use.

**(9)**

(b) Explain how you know that your solution is not optimal.

**(1)**

**(Total 10 marks)**

**7.**

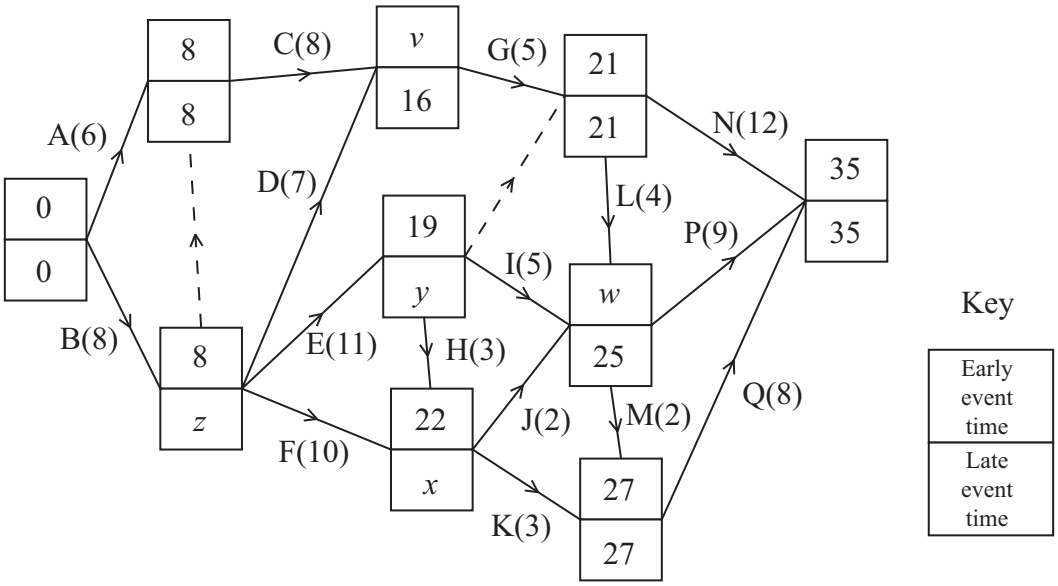



**Figure 6**

The network in Figure 6 shows the activities that need to be undertaken to complete a building project. Each activity is represented by an arc. The number in brackets is the duration of the activity in days. The early and late event times are shown at each vertex.

(a) Find the values of *v, w, x, y* and *z*.

**(3)**

(b) List the critical activities.

**(1)**

(c) Calculate the total float on each of activities H and J.

**(2)**

(d) Draw a cascade (Gantt) chart for the project.

**(4)**

The engineer in charge of the project visits the site at midday on day 8 and sees that activity E has not yet been started.

(e) Determine if the project can still be completed on time. You must explain your answer.

**(2)**

Given that each activity requires one worker and that the project must be completed in 35 days,

(f) use your cascade chart to determine a lower bound for the number of workers needed. You must justify your answer.

**(2)**

**(Total 14 marks)**

**8.** Class 8B has decided to sell apples and bananas at morning break this week to raise money for charity. The profit on each apple is 20p, the profit on each banana is 15p. They have done some market research and formed the following constraints.

- They will sell at most 800 items of fruit during the week.
- They will sell at least twice as many apples as bananas.
- They will sell between 50 and 100 bananas.

Assuming they will sell all their fruit, formulate the above information as a linear programming problem, letting $a$ represent the number of apples they sell and $b$ represent the number of bananas they sell.

Write your constraints as inequalities.

**(Total 7 marks)**

**TOTAL FOR PAPER: 75 MARKS**

**END**

| Centre No. | | | | | | Paper Reference | | | | | | | Surname | Initial(s) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Candidate No. | | | | | | 6 | 6 | 8 | 9 | / | 0 | 1 | Signature | |

Paper Reference(s)

# 6689/01

# Edexcel GCE

## Decision Mathematics D1

### Advanced/Advanced Subsidiary

Thursday 15 May 2008 – Morning

**Answer Book**

**Do not return the question paper with the answer book**

Examiner's use only

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Team Leader's use only

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**1.**

**(Total 8 marks)**

**Q1**

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**2.**

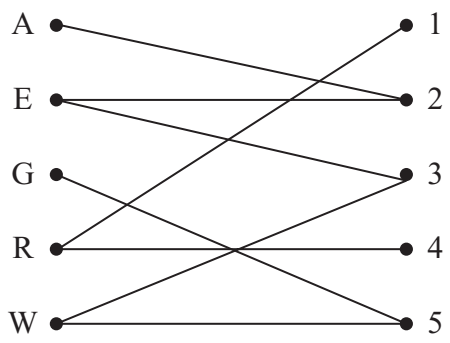



**Figure 1**

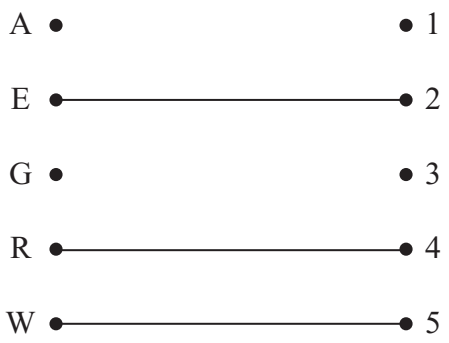



**Figure 2**



N 3 1 4 8 2 A 0 4 1 6

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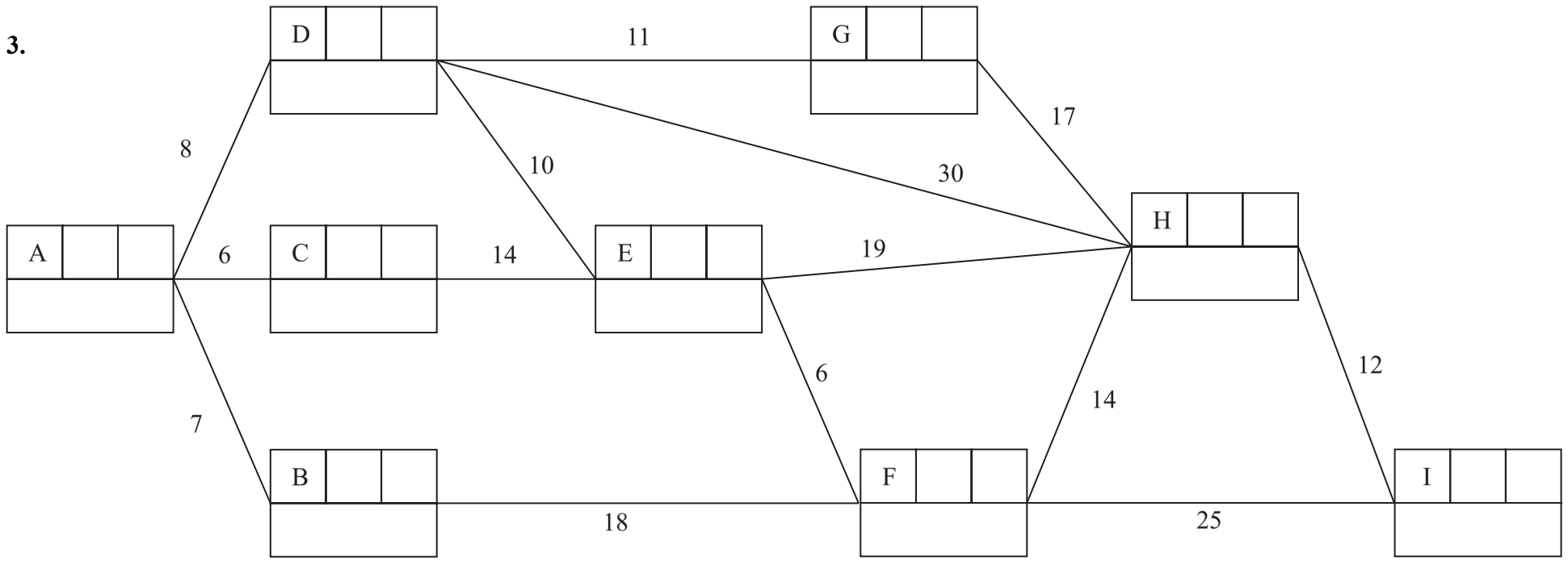
A •
E •
G •
R •
W •

• 1
• 2
• 3
• 4
• 5

**Q2**

**(Total 8 marks)**

**3.**




**shortest route:** _____

**length:** _____

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**Q3**

**(Total 9 marks)**

Leave blank

**4.**

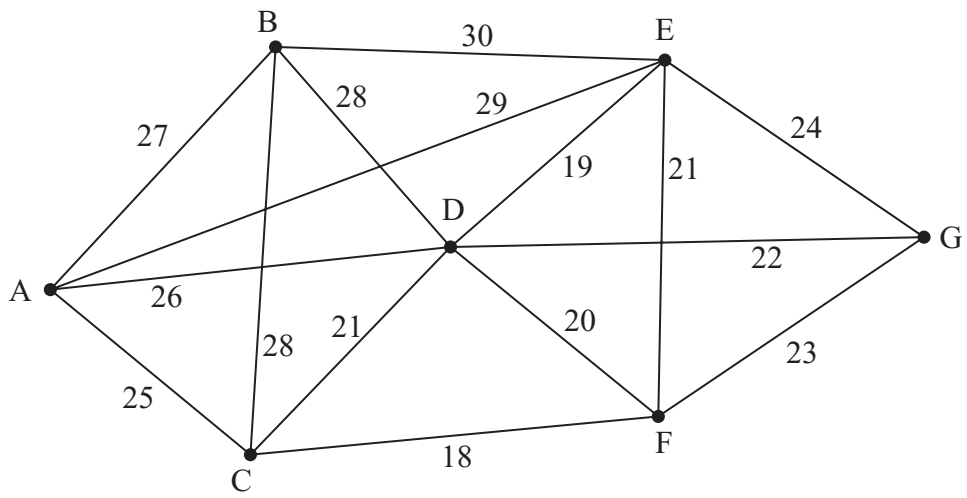



**Figure 4**

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**Q4**

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**5.**

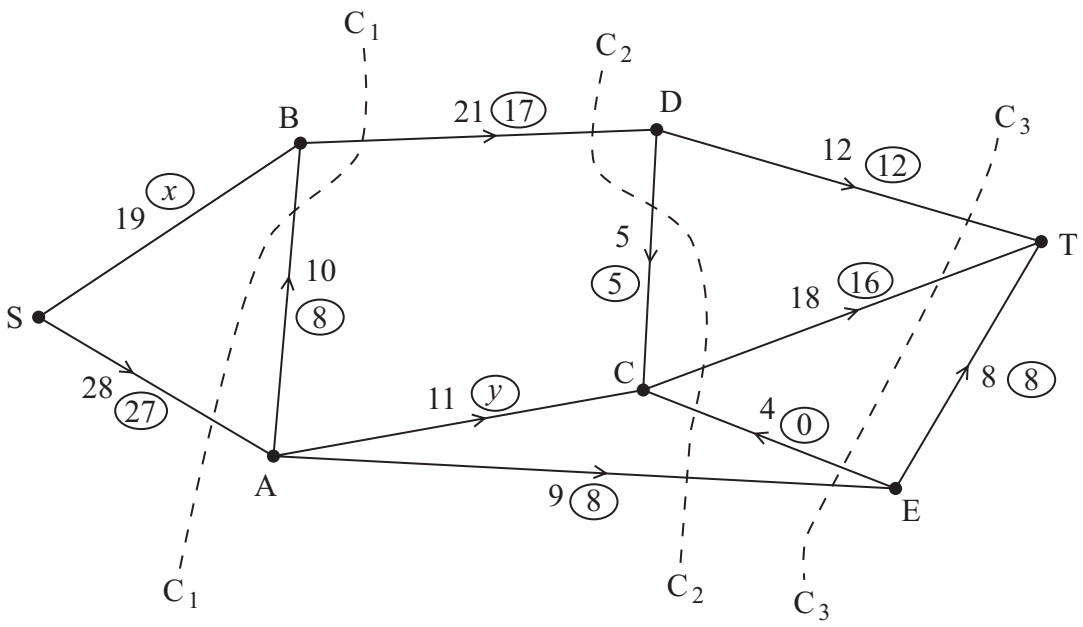



**Figure 5**



N 3 1 4 8 2 A 0 1 0 1 6

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**(Total 11 marks)**

**Q5**

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**6.**

| Basic variable | $x$ | $y$ | $z$ | $r$ | $s$ | $t$ | Value |
|---|---|---|---|---|---|---|---|
| $r$ | 4 | $\frac{7}{3}$ | $\frac{5}{2}$ | 1 | 0 | 0 | 64 |
| $s$ | 1 | 3 | 0 | 0 | 1 | 0 | 16 |
| $t$ | 4 | 2 | 2 | 0 | 0 | 1 | 60 |
| $P$ | –5 | $\frac{-7}{2}$ | –4 | 0 | 0 | 0 | 0 |

*You may not need to use all of these tableaux*

| b.v. | $x$ | $y$ | $z$ | $r$ | $s$ | $t$ | Value | Row operations |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
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| $P$ | | | | | | | | |

| b.v. | $x$ | $y$ | $z$ | $r$ | $s$ | $t$ | Value | Row operations |
|---|---|---|---|---|---|---|---|---|
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| $P$ | | | | | | | | |

| b.v. | $x$ | $y$ | $z$ | $r$ | $s$ | $t$ | Value | Row operations |
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| $P$ | | | | | | | | |

| b.v. | $x$ | $y$ | $z$ | $r$ | $s$ | $t$ | Value | Row operations |
|---|---|---|---|---|---|---|---|---|
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| $P$ | | | | | | | | |

| b.v. | $x$ | $y$ | $z$ | $r$ | $s$ | $t$ | Value | Row operations |
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| $P$ | | | | | | | | |

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**(Total 10 marks)**

**Q6**

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**7.** (a) $v =$ _____, $w =$ _____, $x =$ _____,

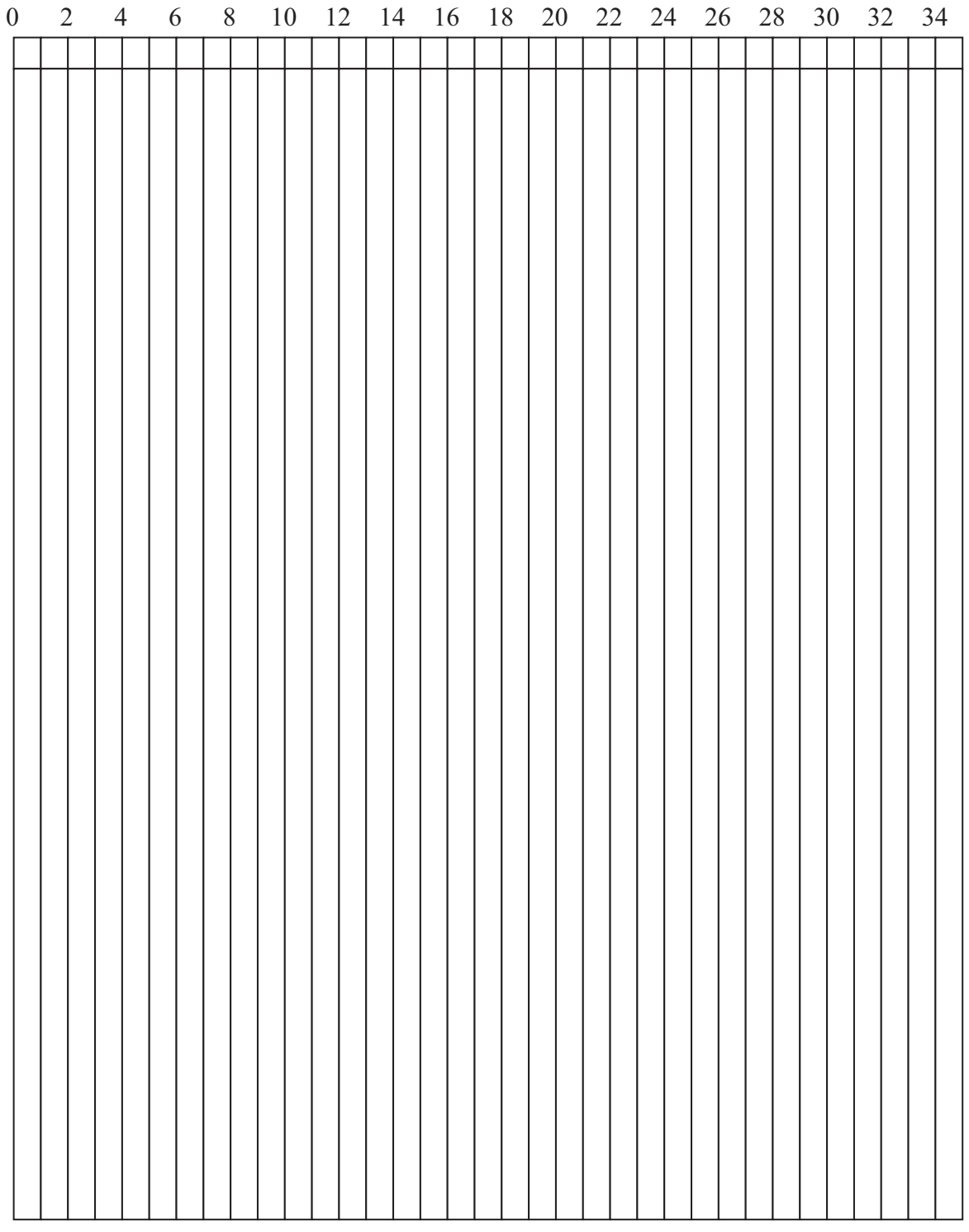
$y =$ _____, $z =$ _____,

(b) Critical activities _____

(c) Total float on activity H _____

Total float on activity J _____

(d)






N 3 1 4 8 2 A 0 1 4 1 6

Leave blank

(e)

(f)

**(Total 14 marks)**

**Q7**

**8.**

Leave blank

**Q8**

**(Total 7 marks)**

**TOTAL FOR PAPER: 75 MARKS**

**END**