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INTERNATIONAL A LEVEL MATHEMATICS • DECISION MATHEMATICS 1

Decision 1

Chapter 6: Critical Path Analysis

Exam Questions by Topic

Pearson Edexcel International Advanced Level (WDM11/01) • Calculator allowed • Answer book pages included

Multi-step exam questions at the difficulty of the real WDM11 paper, with a full mark scheme

Chapters (tap a chapter to jump to it)		Qs	Marks	Page	My score
1	**Algorithms** Flow charts, bubble sort, quick sort, bin packing, binary search	10	80	separate file	
2	**Graphs and Networks** Vocabulary, types of graph, degrees, adjacency and distance matrices	10	80	separate file	
3	**Algorithms on Graphs** Kruskal, Prim (networks and matrices), Dijkstra	10	80	separate file	
4	**Route Inspection** Eulerian graphs, pairing odd vertices, start and finish points	10	80	separate file	
5	**The Travelling Salesman Problem** Classical and practical problems, upper and lower bounds	10	80	separate file	
6	**Critical Path Analysis** Activity networks, event times, floats, Gantt charts, scheduling	10	80	2	
7	**Linear Programming** Formulation, feasible regions, objective lines, integer solutions	10	80	separate file	

Full mark scheme Free courses More worksheets

Name ..... Class ..... Date .....

CHAPTER 6 • KEY SKILLS

6 Critical Path Analysis

Specification D1: Critical path analysis • 10 questions • 80 marks • about 96 minutes

1 Drawing networks

Activities are arcs with arrows in the middle; one start event and one end event; draw large, with a ruler.

2 Dummies

A dotted arc of zero duration: for logic (one activity depends on another that another does not) or for uniqueness (two activities with the same start and end).

3 Early event times

Forward pass: the largest of (earlier event time + duration) over arcs coming in. Top boxes increase along every path.

4 Late event times

Backward pass: the smallest of (later event time − duration) over arcs going out. Bottom boxes decrease going back.

5 Critical activities

Early = late at both ends, and late end − early start = duration. They form the critical path(s).

6 Total float

Float = late finish of the end event − early start − duration.

7 Cascade charts

Critical activities in one row; each other activity as a bar from its earliest start, with its float shown and shaded.

8 At a given time

An activity must be in progress during $(t, t+1)$ if its latest start $\leqslant t$ and earliest finish $\geqslant t+1$

9 Workers

Lower bound = total of all durations ÷ critical time, rounded up. Schedule by giving each free worker the available activity with the earliest late finish.

Skills map every skill above is tested at least once; interleaved skills come from GCSE or other chapters

Skill	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Marks	6	6	6	6	6	10	10	10	10	10
1 Drawing networks	•					•				
2 Dummies	•				•	•	•			
3 Early event times		•				•	•		•	•
4 Late event times		•				•	•		•	•
5 Critical activities		•	•			•	•	•		•
6 Total float			•	•			•	•		•
7 Cascade charts				•				•		
8 At a given time				•				•		
9 Workers							•	•	•	
Interleaved: precedence and digraphs (Chapter 2)	•				•	•				
Interleaved: inequalities and max/min reasoning (P1)				•				•		•
Interleaved: algebra with an unknown (P1)										•

Exam difficulty. Questions 1 to 5 check each skill on its own. Questions 6 to 10 are multi-step questions built like the last questions on a real WDM11 paper, where one part leads into the next.

Answer book. After each question is a copy of the page the real D1 answer book prints for it: the precedence table and space to draw, networks with early and late event boxes and a key, and time grids for cascade charts and schedules.

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1. A project is modelled by the precedence table below.

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

Draw the activity network for the project, using activity on arc. Your network must contain the minimum number of dummies.

(6)

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Question 1 continued **D1 ANSWER BOOK**

In the exam this page is printed in the separate D1 answer book. Write your working here, on the copy provided.

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

Draw your activity network here.

(Total for Question 1 is 6 marks)

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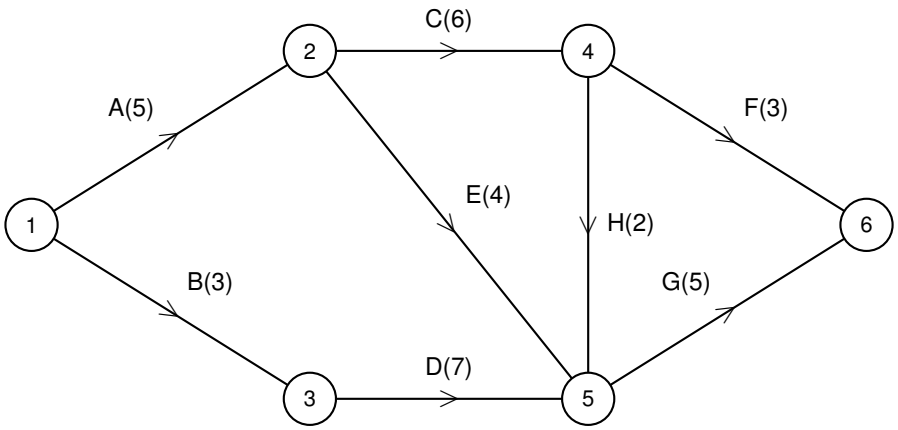


Figure 1

Figure 1 shows an activity network for a project. Each activity is shown with its duration in days.

(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 and the minimum completion time.

(2)

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Question 2 continued **D1 ANSWER BOOK**

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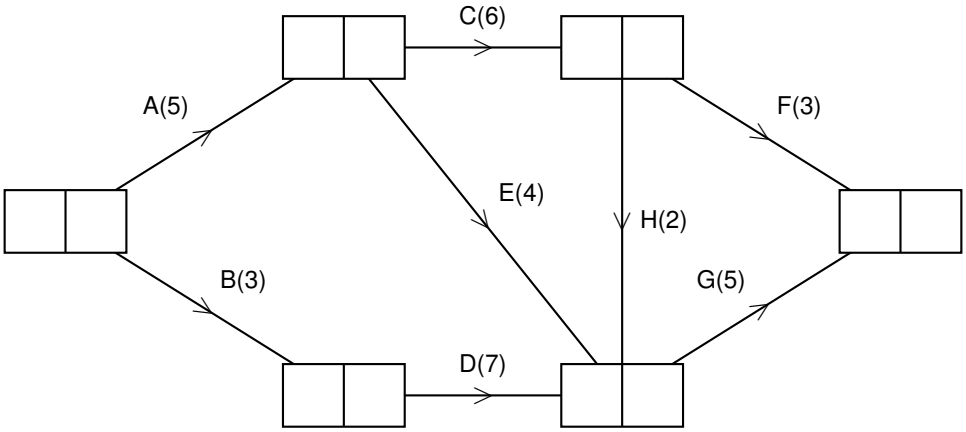


Diagram 1

Key:

Early event time	Late event time

(Total for Question 2 is 6 marks)

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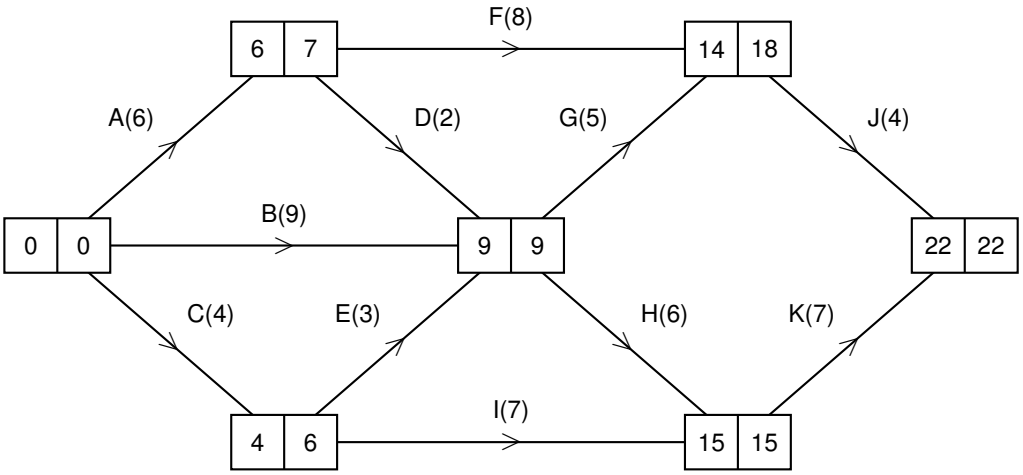


Figure 2

Figure 2 shows an activity network, with durations in hours. The early and late event times are shown at each event (early on the left, late on the right).

(a) Calculate the total float of each of the activities C, F and I, showing your working.

(3)

(b) State the critical path.

(1)

(c) Activity C is delayed by 3 hours. Explain the effect on the project.

(2)

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Question 3 continued **D1 ANSWER BOOK**

In the exam this page is printed in the separate D1 answer book. Write your working here, on the copy provided.

Activity	Early start	Late finish	Duration	Total float
C				
F				
I				

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(Total for Question 3 is 6 marks)

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4. The table gives the duration, earliest start time and total float, in days, of each activity in a project. The minimum completion time is 18 days.

Activity	Duration	Earliest start	Total float
A	4	0	0
B	6	0	1
C	5	4	0
D	2	6	1
E	8	4	3
F	4	9	2
G	3	9	0
H	5	6	1
I	3	13	2
J	6	12	0

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

(4)

(b) Use your chart to state the activities that must be happening at time 7.5 days.

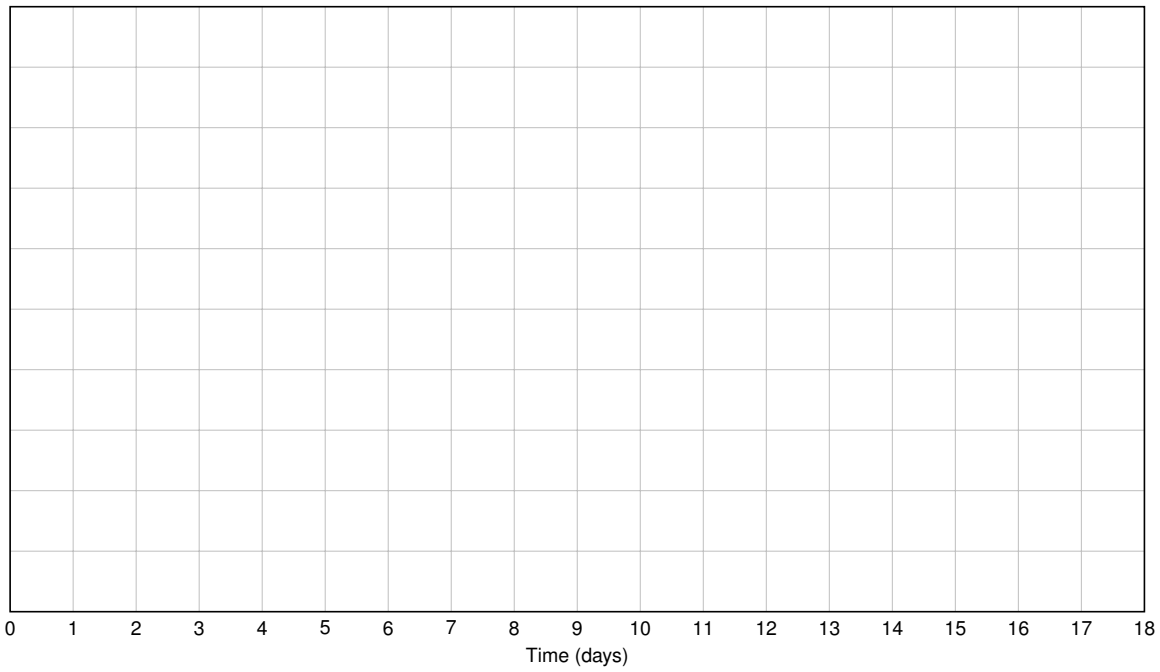
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Question 4 continued **D1 ANSWER BOOK**

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(Total for Question 4 is 6 marks)

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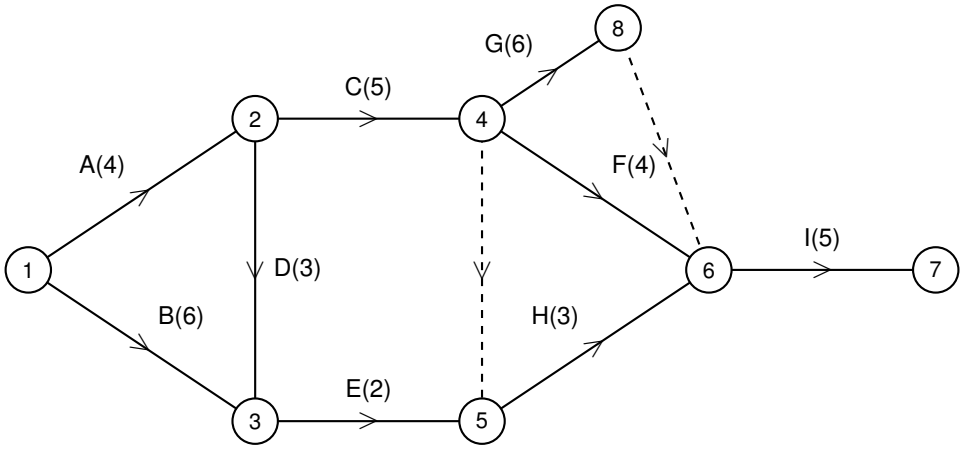


Figure 3

Figure 3 shows an activity network for a project. The dotted arcs are dummies.

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

(4)

(b) Explain why each of the two dummies is needed.

(2)

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Question 5 continued D1 ANSWER BOOK

In the exam this page is printed in the separate D1 answer book. Write your working here, on the copy provided.

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

(Total for Question 5 is 6 marks)

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6. A project is modelled by the precedence table below. Each activity takes 1 or 2 days, as shown.

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

Durations: A 2, B 1, C 2, D 1, E 2, F 1, G 2, H 1, I 2

(a) Draw the activity network for the project, using activity on arc and exactly five dummies.

(6)

(b) Find the early and late event times on your network, and hence state the critical activities and the minimum completion time.

(4)

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Question 6 continued D1 ANSWER BOOK

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

Draw your activity network here.

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Question 6 continued

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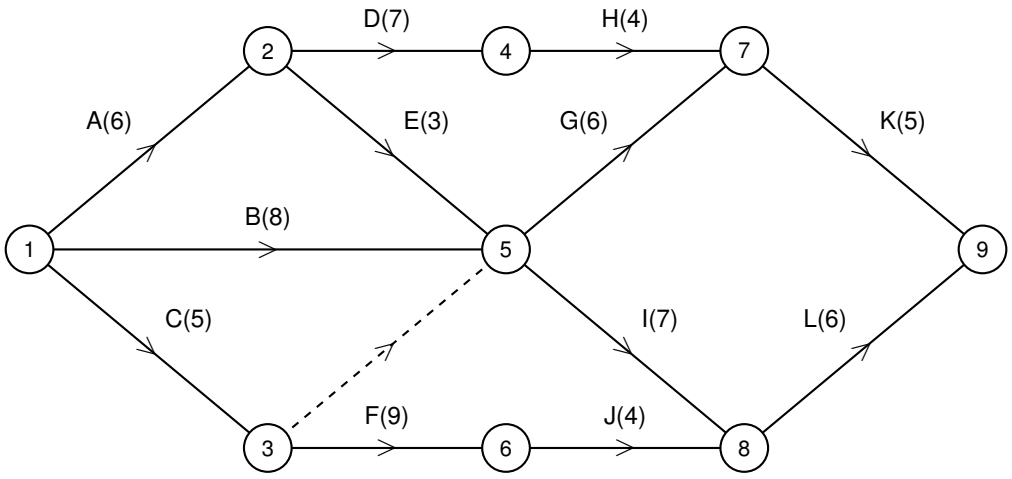


Figure 4

Figure 4 shows an activity network for a building project, with durations in days.

(a) Explain why the dummy is needed.

(2)

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

(4)

(c) State the critical path.

(1)

(d) Calculate the total float on activity H.

(1)

(e) Calculate a lower bound for the number of workers needed to complete the project in the minimum time.

(2)

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Question 7 continued **D1 ANSWER BOOK**

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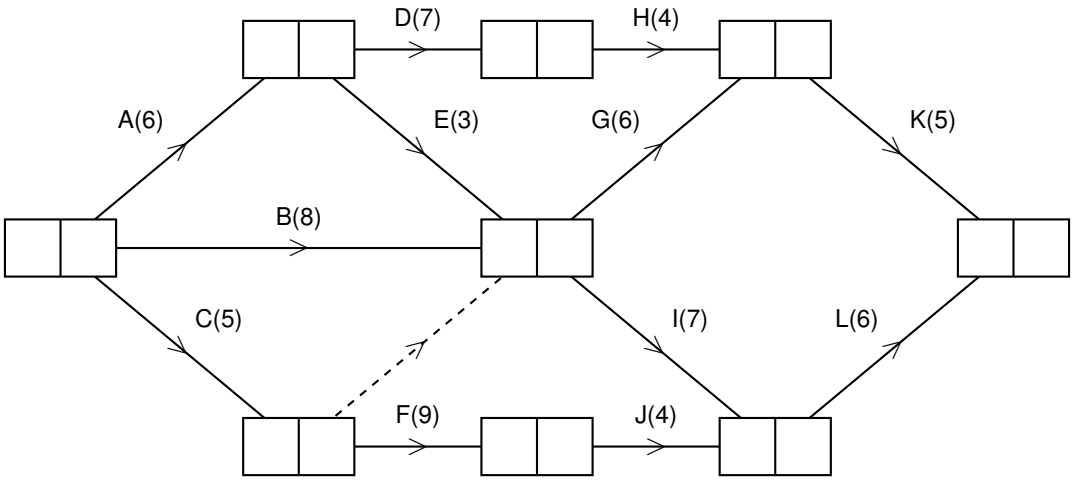


Diagram 2

Key:

Early event time	Late event time

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Question 7 continued

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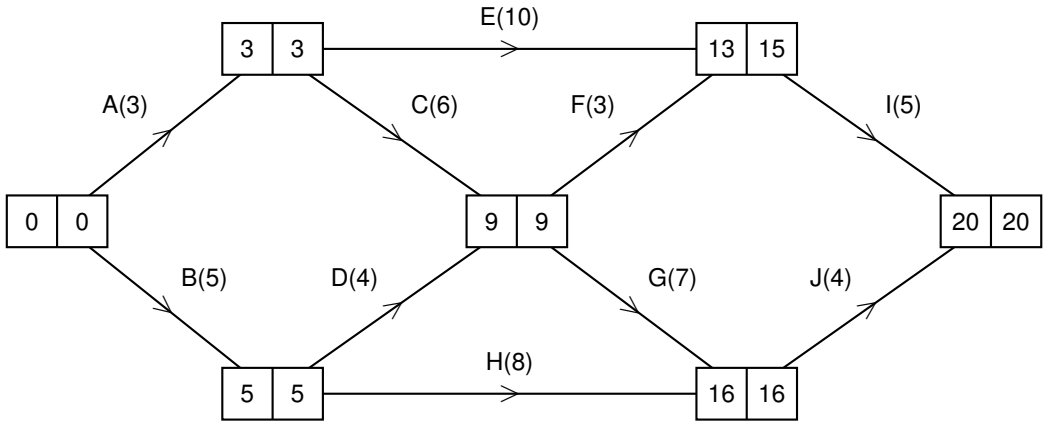


Figure 5

Figure 5 shows an activity network for a project, with durations in days and the early and late event times.

(a) Find the total float on each of the activities E, F, H and I, and explain why there are two critical paths.

(3)

(b) Draw a cascade chart for the project on the grid in the answer book.

(4)

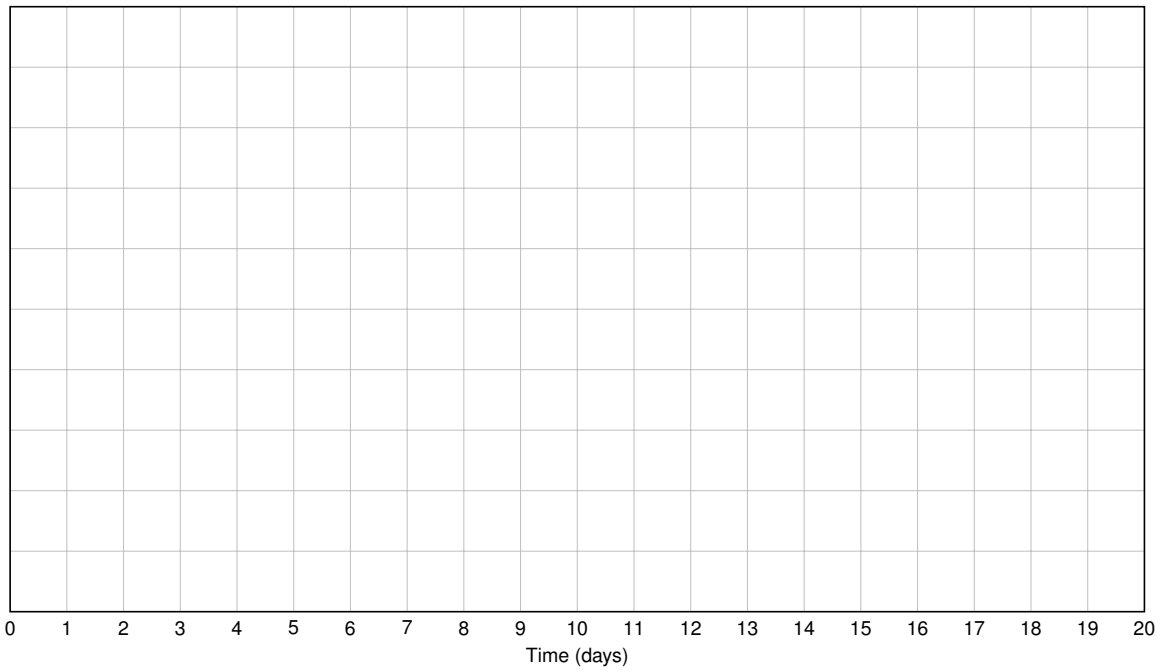
(c) Using your cascade chart, state which activities must be happening during day 13, and hence the minimum number of workers needed at that time. Give the time interval precisely.

(3)

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Question 8 continued **D1 ANSWER BOOK**

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Question 8 continued

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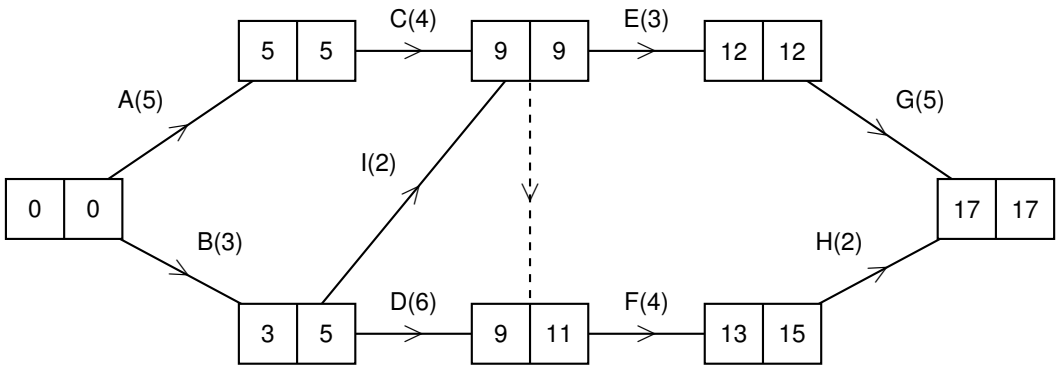


Figure 6

Figure 6 shows an activity network for a project, with durations in days. The minimum completion time is 17 days.

(a) Calculate a lower bound for the number of workers needed to complete the project in 17 days.

(2)

(b) On the grid in the answer book, draw a scheduling diagram to show how this number of workers can complete the project in 17 days. Each activity needs one worker.

(5)

(c) Activity D takes 3 days longer than planned. State, with a reason, the effect on the minimum completion time.

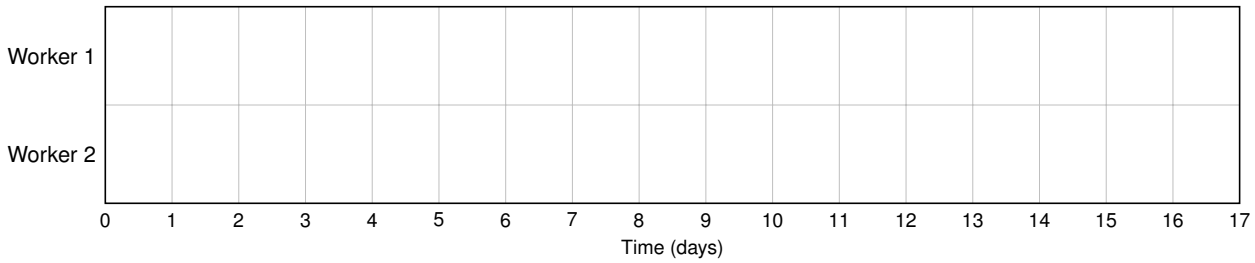
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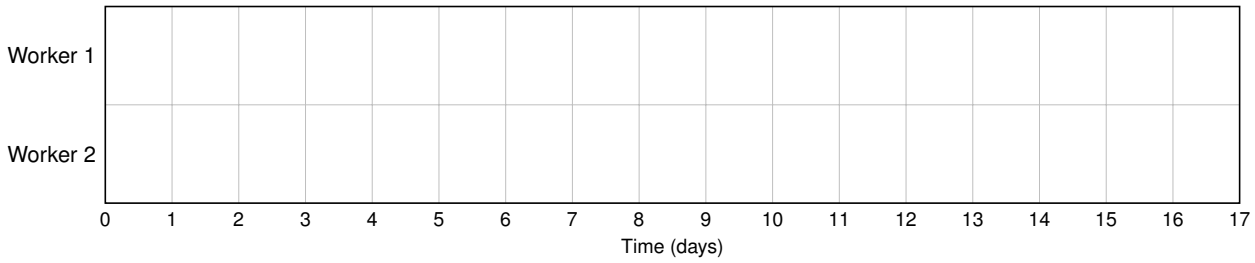
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Question 9 continued

D1 ANSWER BOOK

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Question 9 continued

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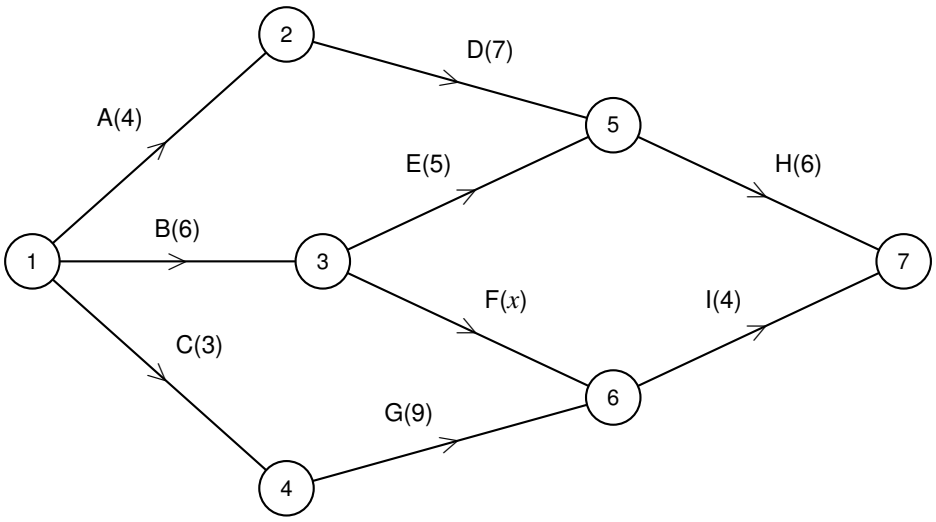


Figure 7

Figure 7 shows an activity network, with durations in hours. The duration of activity F is x hours.

(a) Given that $x = 4$, complete the early and late event times in the answer book, and state the critical activities and the minimum completion time.

(5)

(b) Find the range of values of x for which F is a critical activity, and the minimum completion time, in terms of x, in this case.

(3)

(c) Find the total float on F in terms of x when F is not critical.

(2)

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Question 10 continued D1 ANSWER BOOK

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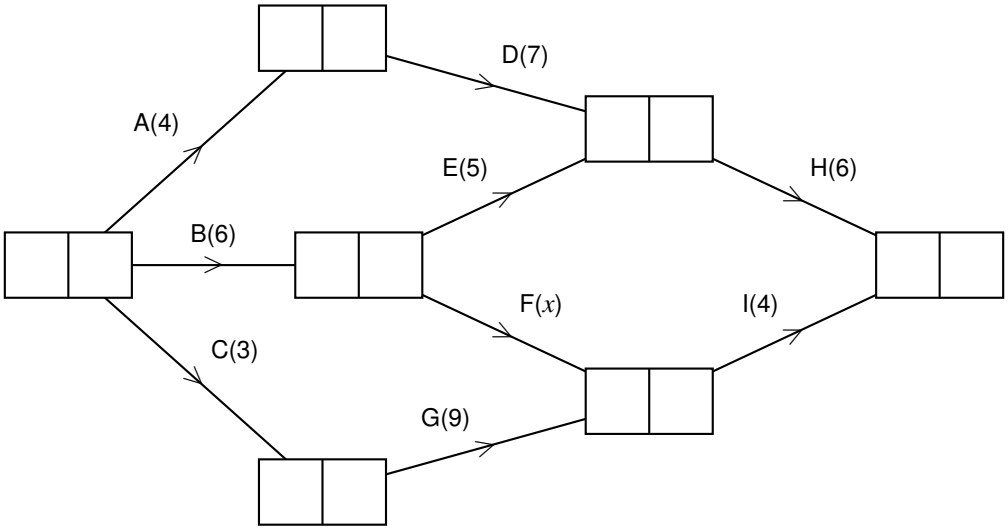


Diagram 3

Key:

Early event time	Late event time

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Question 10 continued

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TOTAL FOR CHAPTER 6 IS 80 MARKS

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