

# Critical Path Analysis

Activity Networks & Precedence Tables / Dummy Activities / Critical Path Analysis / Gantt (Cascade) Charts / Resource Histograms / Resource Levelling / Scheduling Activities

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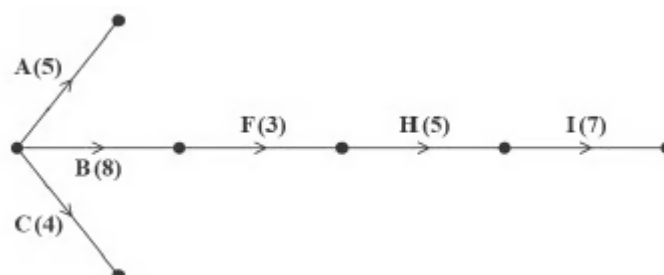
Total Marks

/102

1 (a)

Activity	Time taken (days)	Immediately preceding activities
A	5	-
B	8	-
C	4	-
D	14	A
E	10	A
F	3	B, C, E
G	7	C
H	5	D, F, G
I	7	H
J	9	H

The table above shows the activities required for the completion of a building project. For each activity, the table shows the time it takes, in days, and the immediately preceding activities. Each activity requires one worker. The project is to be completed in the shortest possible time.



**Figure 2**

Figure 2 shows a partially completed activity network used to model the project. The activities are represented by the arcs and the number in brackets on each arc is the time taken, in days, to complete the corresponding activity.

Add the missing activities and necessary dummies to Diagram 1 in the [answer book](#).

**(3 marks)**

- (b)** Complete Diagram 1 in the [answer book](#) to show the early event times and the late event times.

**(3 marks)**

- (c)** State the critical activities.

**(1 mark)**

- (d)** At the beginning of the project it is decided that activity G is no longer required.

Explain what effect, if any, this will have on

- (i) the shortest completion time of the project if activity G is no longer required,
- (ii) the timing of the remaining activities.

**(3 marks)**

2 (a)

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

Draw the activity network described in the precedence table above, using activity on arc. Your activity network must contain the minimum number of dummies.

(5 marks)

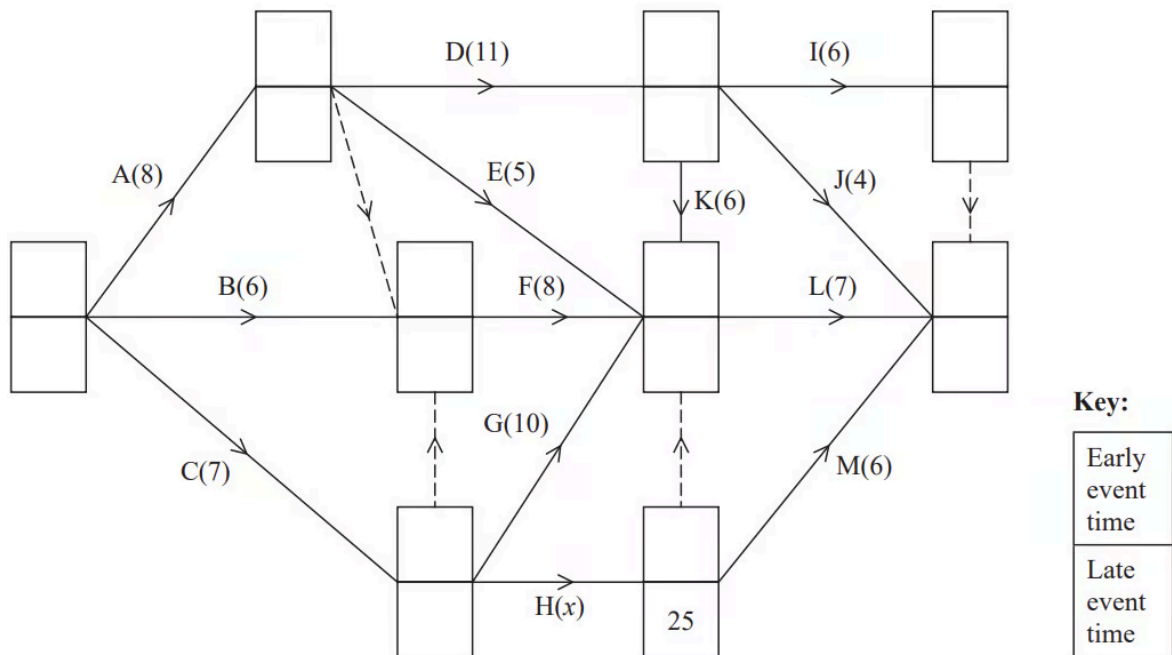
(b) Every activity shown in the precedence table has the same duration.

Explain why activity B cannot be critical.

(1 mark)

(c) State which other activities are not critical.

(1 mark)



3 (a)

**Figure 3**

The network in Figure 3 shows the activities that need to be undertaken to complete a project. Each activity is represented by an arc and the duration of the activity, in days, is shown in brackets. The early event times and late event times are to be shown at each vertex and one late event time has been completed for you.

The total float of activity H is 7 days.

Explain, with detailed reasoning, why  $x = 11$

**(2 marks)**

- (b) Determine the missing early event times and late event times, and hence complete Diagram 1 in your [answer book](#).

**(3 marks)**

- (c)** Each activity requires one worker and the project must be completed in the shortest possible time using as few workers as possible.

Calculate a lower bound for the number of workers needed to complete the project in the shortest possible time.

**(1 mark)**

- (d)** Schedule the activities using Grid 1 in the [answer book](#).

**(3 marks)**

4 (a)

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

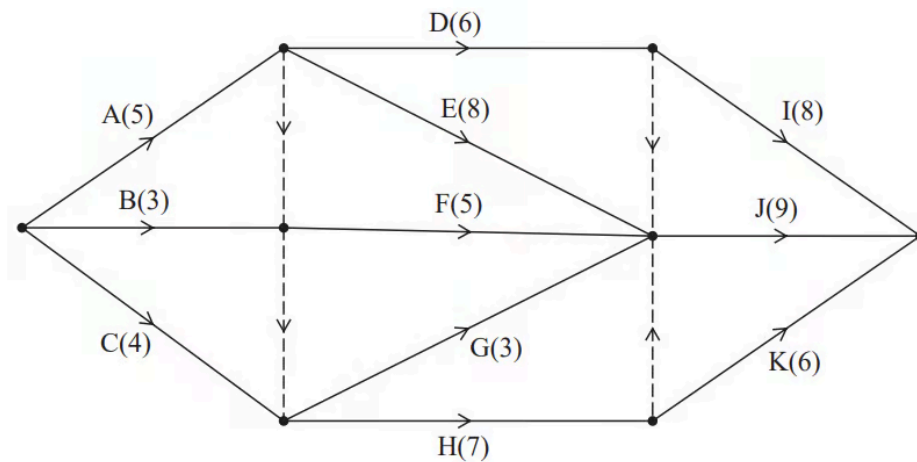
Draw the activity network described in the precedence table above, using activity on arc.  
Your activity network must contain only the minimum number of dummies.

(5 marks)

(b) Given that all the activities shown in the precedence table have the same duration,

State the critical path for the network.

(1 mark)



5 (a)

Figure 1

A project is modelled by the activity network shown in Figure 1. The activities are represented by the arcs. The number in brackets on each arc gives the time, in hours, to complete the corresponding activity. Each activity requires one worker. The project is to be completed in the shortest possible time.

Complete the precedence table in the [answer book](#).

(2 marks)

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

(3 marks)

- (c) (i) State the minimum project completion time.
- (ii) List the critical activities.



**(2 marks)**

- (d)** Calculate the maximum number of hours by which activity H could be delayed without affecting the shortest possible completion time of the project. You must make the numbers used in your calculation clear.

**(1 mark)**

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

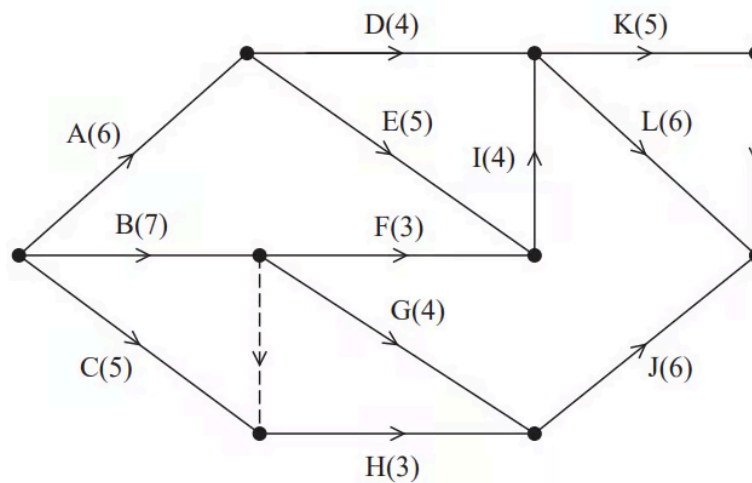
**(2 marks)**

- (f)** Draw a cascade chart for this project on Grid 1 in the [answer book](#).

**(3 marks)**

- (g)** Using the answer to (f), explain why it is not possible to complete the project in the shortest possible time using the number of workers found in (e).

**(1 mark)**



6 (a)

Figure 1

The network in Figure 1 shows the activities that need to be undertaken to complete a project. Each activity is represented by an arc and the duration, in hours, of the corresponding activity is shown in brackets.

Explain why each of the dummy activities is required.

(2 marks)

- (b) Complete the table in the [answer book](#) to show the immediately preceding activities for each activity.

(2 marks)

- (c) (i) Complete Diagram 1 in the [answer book](#) to show the early event times and the late event times.  
(ii) State the minimum completion time for the project.  
(iii) State the critical activities.

**(6 marks)**

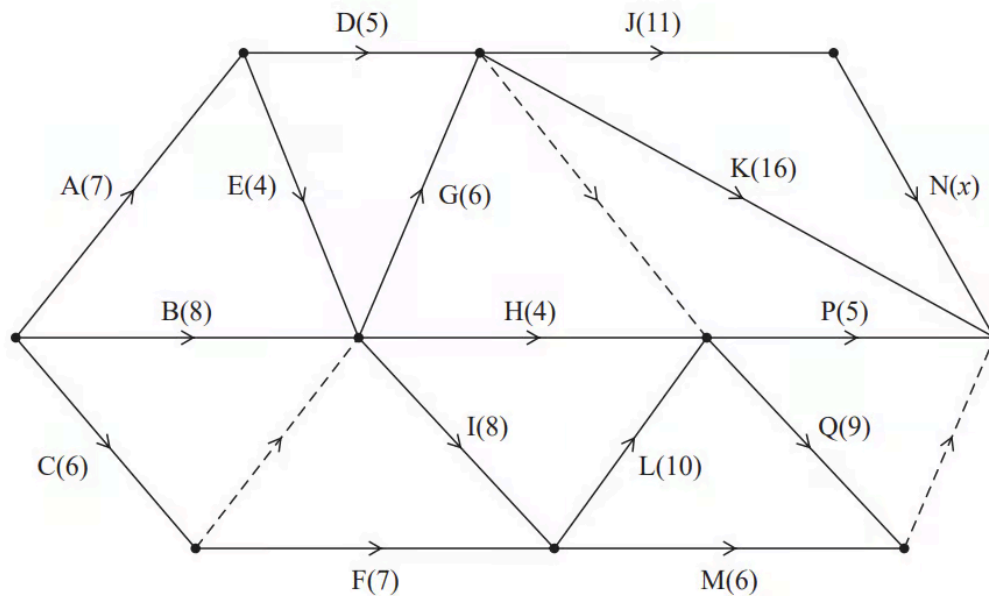
- (d)** Each activity requires one worker. Each worker is able to do any of the activities. Once an activity is started it must be completed without interruption.

On Grid 1 in the [answer book](#), draw a resource histogram to show the number of workers required at each time when each activity begins at its earliest possible start time.

**(3 marks)**

- (e)** Determine whether or not the project can be completed in the minimum possible time using fewer workers than the number indicated by the resource histogram in (d). You must justify your answer with reference to the resource histogram and the completed Diagram 1.

**(2 marks)**



7 (a)

Figure 1

A project is modelled by the activity network shown in Figure 1. The activities are represented by the arcs. The number in brackets on each arc gives the time, in hours, to complete the corresponding activity. The exact duration,  $x$ , of activity N is unknown, but it is given that  $5 < x < 10$ .

Each activity requires one worker. The project is to be completed in the shortest possible time.

Complete the precedence table in the [answer book](#).

(2 marks)

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

**(4 marks)**

- (c)** List the critical activities.

**(1 mark)**

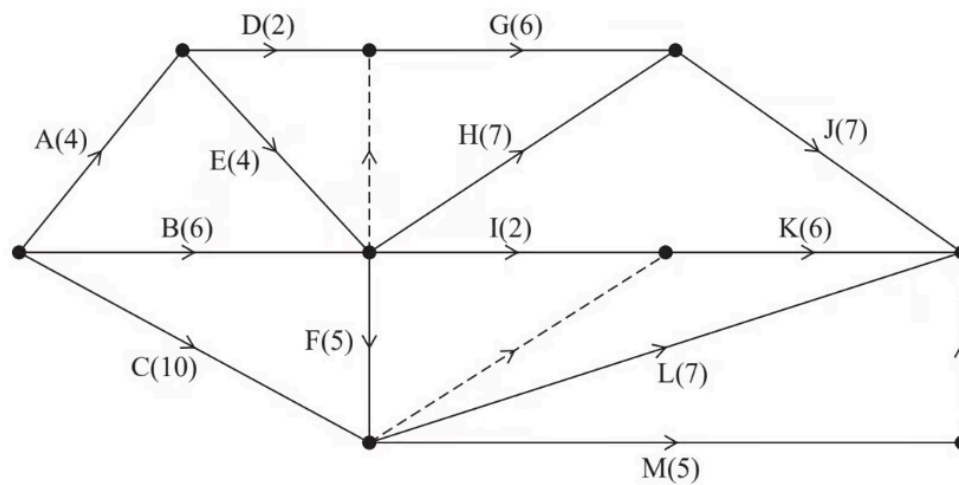
- (d)** It is given that activity J can be delayed by up to 4 hours without affecting the shortest possible completion time of the project.

Determine the value of  $x$ . You must make the numbers used in your calculation clear.

**(1 mark)**

- (e)** Draw a cascade chart for this project on Grid 1 in the [answer book](#).

**(4 marks)**



8 (a)

Figure 2

A project is modelled by the activity network shown in Figure 2. The activities are represented by the arcs. The number in brackets on each arc gives the time, in hours, to complete the corresponding activity.

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

(4 marks)

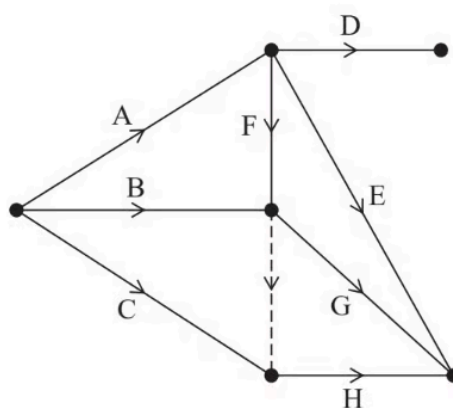
- (b) Each activity requires one worker and the project must be completed in the shortest possible time using as few workers as possible.

Calculate a lower bound for the number of workers needed to complete the project in the shortest possible time. You must show your working.

(2 marks)

(c) Schedule the activities using Grid 1 in the [answer book](#).

**(3 marks)**



9 (a)

Figure 5

Figure 5 shows a partially completed activity network for a project that consists of 14 activities.

Complete the precedence table in the [answer book](#) for the 8 activities in Figure 5.

(2 marks)

(b) The precedence table for the remaining 6 activities is given below.

Activity	Immediately preceding activities
I	D, E, G, H
J	D, E, G, H
K	E, G, H
L	I, J, K
M	J, K
N	J, K

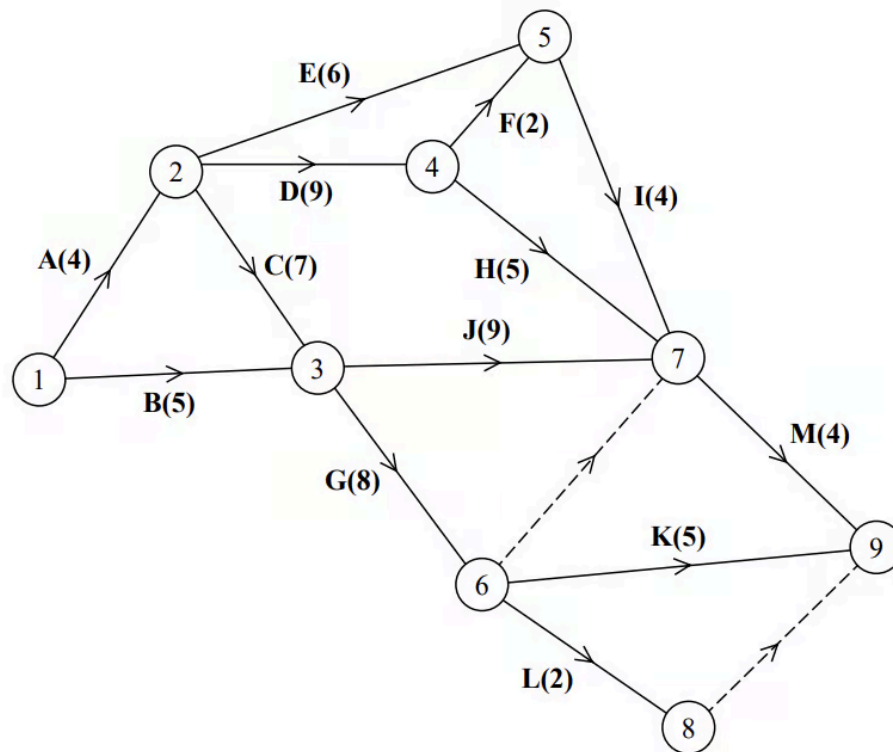
Complete the activity network in the [answer book](#) for the project. Your completed activity network must contain only the minimum number of dummies.



**(4 marks)**

- (c)** Given that all 14 activities have the same duration,  
explain why activity D cannot be critical.

**(2 marks)**



10 (a)

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 that activity. Each activity requires one worker. The project is to be completed in the shortest possible time.

Calculate the early time and the late time for each event, using Diagram 1 in the [answer book](#).

(3 marks)

(b) On Grid 1 in the [answer book](#), complete the cascade (Gantt) chart for this project.

**(3 marks)**

- (c)** On Grid 2 in the [answer book](#), draw a resource histogram to show the number of workers required each day when each activity begins at its earliest time.

**(3 marks)**

- (d)** The supervisor of the project states that only three workers are required to complete the project in the minimum time.

Use Grid 2 to determine if the project can be completed in the minimum time by only three workers. Give reasons for your answer.

**(3 marks)**