National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Exemplar for Internal Achievement Standard

Mathematics and Statistics Level 3

This exemplar supports assessment against:

Achievement Standard 91576

Use critical path analysis in solving problems

An annotated exemplar is an extract of student evidence, with a commentary, to explain key aspects of the standard. It assists teachers to make assessment judgements at the grade boundaries.

New Zealand Qualifications Authority

To support internal assessment

	Grade Boundary: Low Excellence
1.	For Excellence, the student needs to use critical path analysis, with extended abstract thinking, in solving problems.

This involves one or more of: devising a strategy to investigate or solve a problem, identifying relevant concepts in context, developing a chain of logical reasoning, or proof, forming a generalisation and also using correct mathematical statements, or communicating mathematical insight.

This student's evidence is a response to the TKI task 'The new shopping mall'.

The student has identified relevant concepts in context by drawing a correct network diagram (1), giving the correct critical path (2), scheduling the activities (3), discussing float times (4) and discussing the impact on the critical path of any other delays that are significant enough to extend the projects minimum completion time (5).

The student has used correct mathematical statements throughout the response.

For a more secure Excellence, the student could clearly communicate when the manager can visit the site to see three tasks being done, by referring to the possible scheduling of activity D. |

Precedence Table

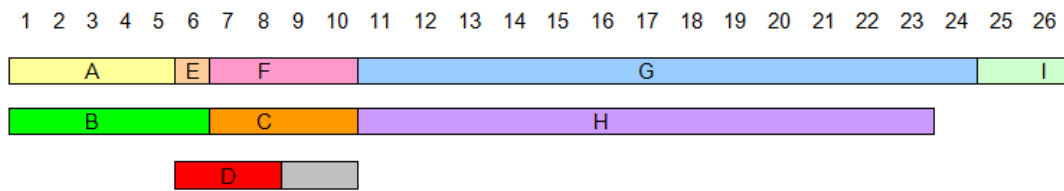|	Activity	Time (weeks)	Preceded by
A	Prepare the drawings	5	
B	Identify tenants	6	
C	Develop Prospectus	4	A
D	Select construction company	3	A
E	Prepare resource consents	1	A
F	Obtain resource consents	4	E
G	Build mall	14	D,F
H	Finalise contracts with tenants	12	B,C
I	Tenants move in	2	G,H

Network Diagram
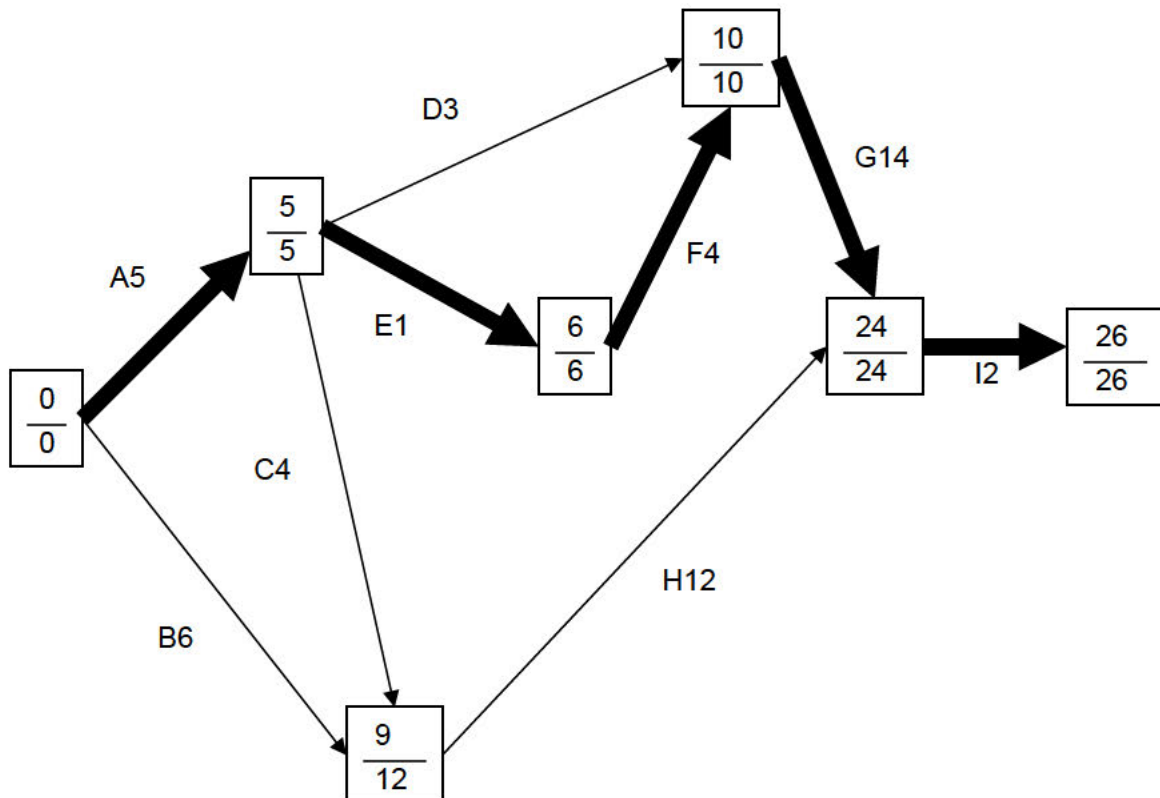
The critical path is: A, E, F, G, I

Minimum length of time required to complete project: 26 weeks

Minimum number of supervisors: 3

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |

A   E   F   G   I

B   C   H

D

(3)

Recommended weeks for manager's visit: if he is to see three jobs in process he would have to visit from weeks 6 to 10 depending on the scheduling of D.

Task D would have to be delayed 3 or more weeks for the critical path to change. Otherwise the critical path will stay the same with (A, E, F, G, I). If task D was delayed by 3 or more weeks the new critical path would be (A, D, G, I).

The impact of any other delays significant enough to extend the projects minimum completion time:
There are 4 tasks that are not used in the critical path. These tasks could become part of the new critical path. Task (H) has a float of 3 weeks. Therefore if Task (H) was delayed by three weeks or more it would create a new critical path of (A, C, H, I). Also task (C) can only be part of the critical path if Task (H) is delayed. Task (C) has a float of 0. For task (B) to be part of the critical path it would need to be delayed by 3 or more weeks but only if Task (C) is delayed. This would make the critical path (B, H, I). The easiest way for the critical path to be effected is if Task (D) was delayed 3 or more weeks because it has a float of two weeks and does not rely on any other tasks to be delayed all possible paths would effect the recent critical path and extend the minimum completion time.
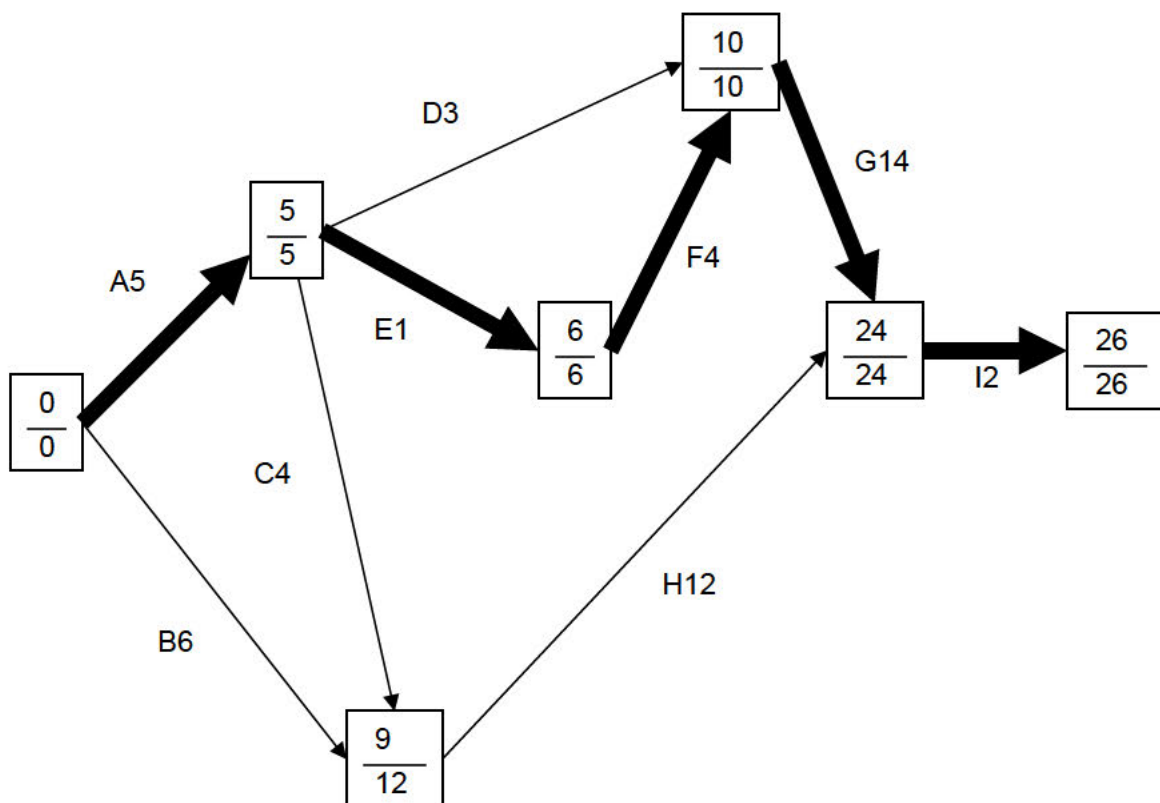
(5)

	Free float	Total Float
A	0	0
B	3	6
C	0	3
D	2	2
E	0	0
F	0	0
G	0	0
H	3	3
I	0	0

(4)

	Grade Boundary: High Merit
2.	For Merit, the student needs to use critical path analysis, with relational thinking, in solving problems.

This involves one or more of: selecting and carrying out a logical sequence of steps, connecting different concepts or representations, demonstrating understanding of concepts, forming and using a model and also relating findings to a context, or communicating thinking using appropriate mathematical statements.

This student's evidence is a response to the TKI task 'The new shopping mall'.

The student has connected different concepts or representations by drawing a correct network diagram (1), giving the correct critical path (2) and completing the scheduling using a Gantt chart (3).

They have also completed a backward and forward scan, allocated supervisors, determined the time for the manager's visit and included a discussion of varying start times for task D (4).

The student started to discuss the float times for other tasks (5), and related the findings to the context throughout the response.

To reach Excellence, the student could develop the investigation of delays to tasks other than task D. |

Precedence Table

	Activity	Time (weeks)	Preceded by
A	Prepare the drawings	5	
B	Identify tenants	6	
C	Develop Prospectus	4	A
D	Select construction company	3	A
E	Prepare resource consents	1	A
F	Obtain resource consents	4	E
G	Build mall	14	D,F
H	Finalise contracts with tenants	12	B,C
I	Tenants move in	2	G,H

①

The critical path is: A, E, F, G, I

Minimum time = 26 weeks

Minimum number of workers required = 3

②

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
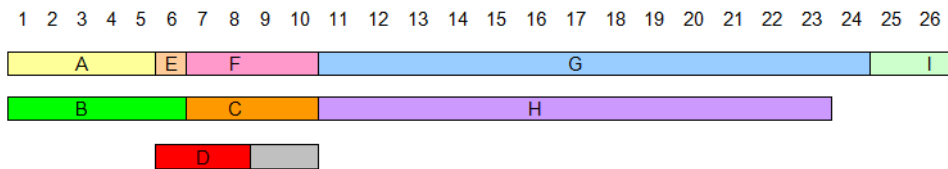
③

Recommended time the manager can visit and see at least 3 different tasks in action = 6, 7, 8, 9 and 10 as it would depend on task D start time. For example if Task D started week 6 then the supervisor would see Task E, task B and task D. If Task D started in week 7 than the supervisor would see task F, Task C and Task D etc.

④

For task D the total and free float is 2 weeks. Therefore if task D is delayed by 2 or less weeks there will be no effect as it will not change the earliest start time for a preceding task or alter the critical path. However, if the task is delayed for more than 2 weeks it will become part of the new critical path (A – D – G – I) which means the minimum finishing time will be extended.

|	Free float	Total Float
A	0	0
B	3	6
C	0	3
D	2	2
E	0	0
F	0	0
G	0	0
H	3	3
I	0	0

⑤

The above total shows the float (weeks that could be used as delays). This could cause implications for the scheduling of supervisors because if they exceed the float they will need to either extend their hours of hire new staff depending on the time of the delay.

	Grade Boundary: Low Merit
3.	For Merit, the student needs to use critical path analysis, with relational thinking, in solving problems.

This involves one or more of: selecting and carrying out a logical sequence of steps, connecting different concepts or representations, demonstrating understanding of concepts, forming and using a model and also relating findings to a context, or communicating thinking using appropriate mathematical statements.

This student's evidence is a response to the TKI task 'The new shopping mall'.

The student has connected different concepts or representations by drawing a correct network diagram (1), giving the correct critical path (2) and completing the scheduling (3). They have also completed a backward and forward scan, allocated supervisors and determined the time for the manager's visit (4).

For a more secure Merit, the student could consider the implications of varying start times for task D which do not delay the project, and fully justify the impact on the project if task D were to take longer than three weeks to complete. |
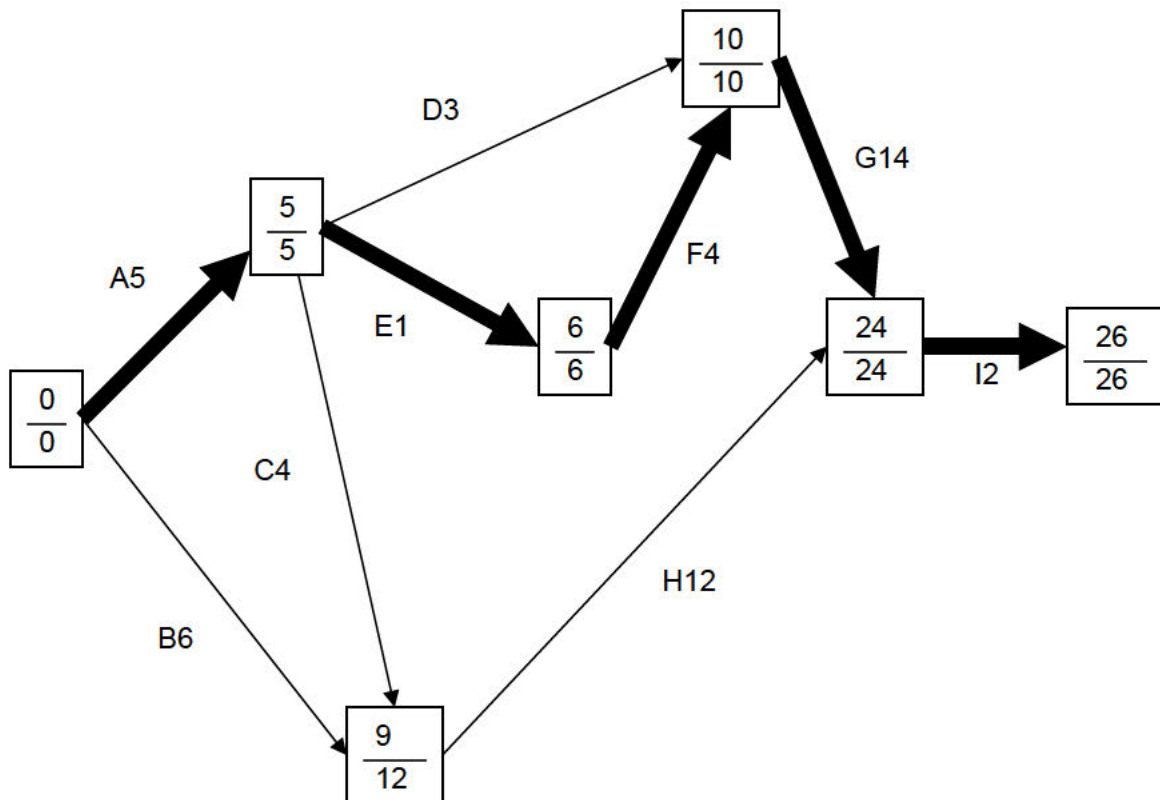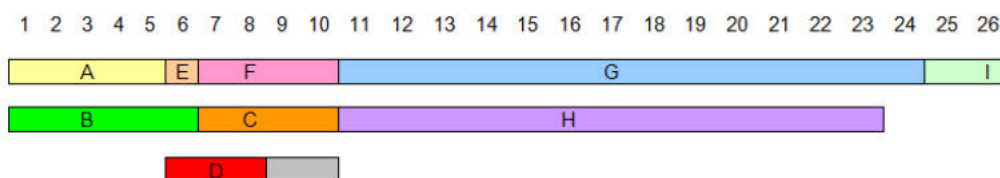
The critical path is: A, E, F, G, I = 26

The construction of the new Albany mall will take 26 weeks and need 3 workers.


The manager will be able to see all three workers during weeks 6 – 10. Task D (Selecting the construction company) may be able to take a further two weeks delay. If task D is delayed any more than 2 weeks, construction will also be delayed thus making the project longer than 26 weeks.

Delays in tasks A, E, F, G and I will mean the projects minimum completion time will be extended. I is the last task and cannot happen until G and H have finished. This means that if there are any delays in the construction of the mall, tenants will have to wait until they have finished before moving in.

Also B, C, D, and H are not part of the critical path, if they were to be delayed, they would affect project time. This is because task G depends on D. If all 3 workers work hard and do not waste time the project will finish on time.

	Grade Boundary: High Achieved
4.	For Achieved, the student needs to use critical path analysis in solving problems. This involves selecting and using methods, demonstrating knowledge of concepts and terms and communicating using appropriate representations. This student's evidence is a response to the TKI task 'The new shopping mall'. The student has selected and used a network diagram (1), identified the critical events for the project (2) and completed scheduling using a Gantt chart (3). They have also demonstrated knowledge of these concepts and terms and communicated using appropriate representations. To reach Merit, the student could provide further explanation as to why they would recommend the manager visits during weeks 6 to 10, and discuss in more detail what could happen if task D was delayed by more than 2 weeks.
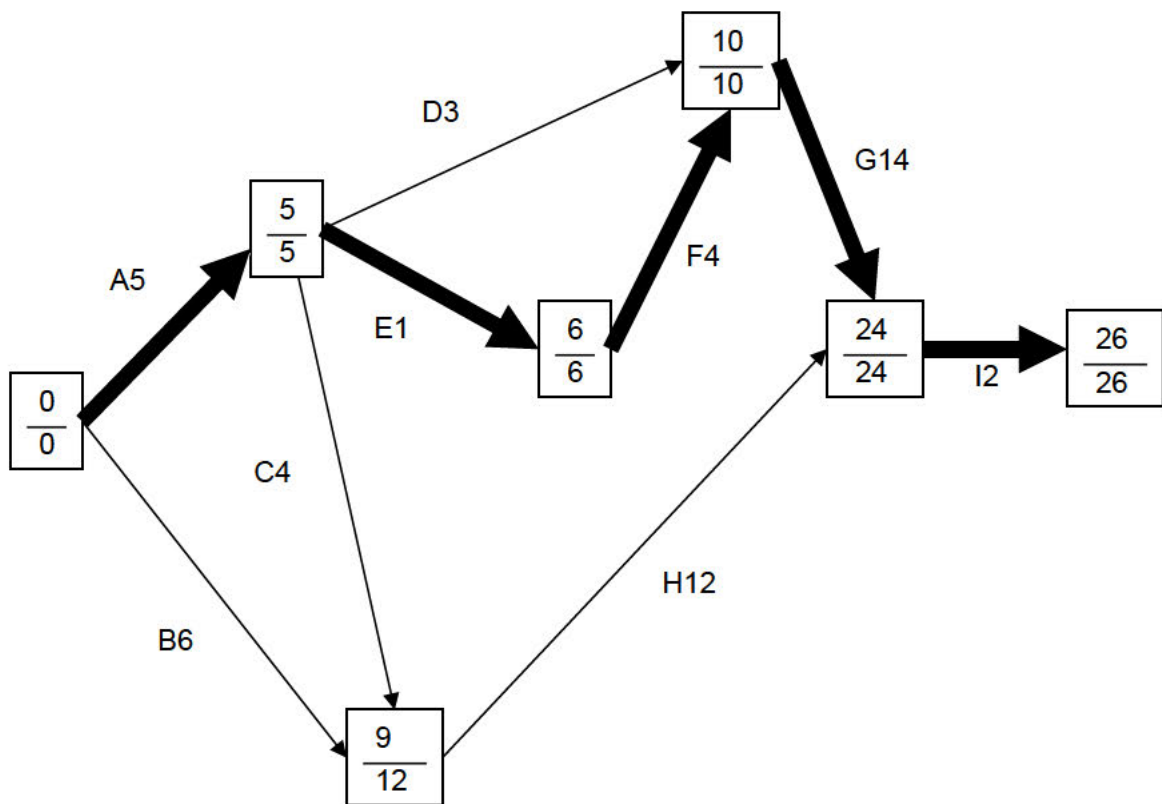
The critical path is: A, E, F, G, I = 26 weeks
The job will require the minimum of 3 workers
Project requires at least 3 supervisors.
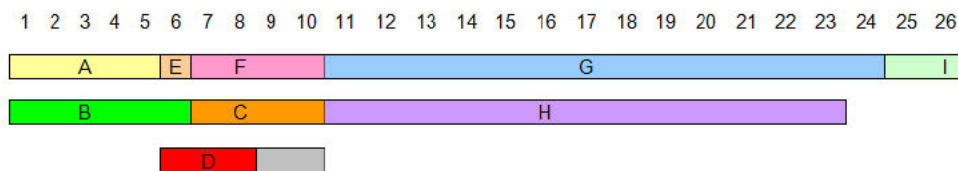
The managers should come week 6 – 10 if they wish to view the 3 tasks being actioned at the same time.

Task D could be delayed by 2 weeks before it would affect the critical path as it has a 2 weeks of free float, any delay over 2 weeks would increase minimum completion time.

Any delay of A, E, F, G, I would change the critical path length also if any of B, C, H were delayed by more than 2 weeks this would effect the critical path.

	Grade Boundary: Low Achieved
5.	For Achieved, the student needs to use critical path analysis in solving problems.

This involves selecting and using methods, demonstrating knowledge of concepts and terms and communicating using appropriate representations.

This student's evidence is a response to the TKI task 'The new shopping mall'.

The student has selected and used a network diagram (1) and identified the critical events for the project (2). They have also demonstrated knowledge of these concepts and terms and communicated using appropriate representations.

For a more secure Achieved, the student could give the length of the critical path in context and discuss the scheduling of tasks, and/or discuss the float times of all activities. |
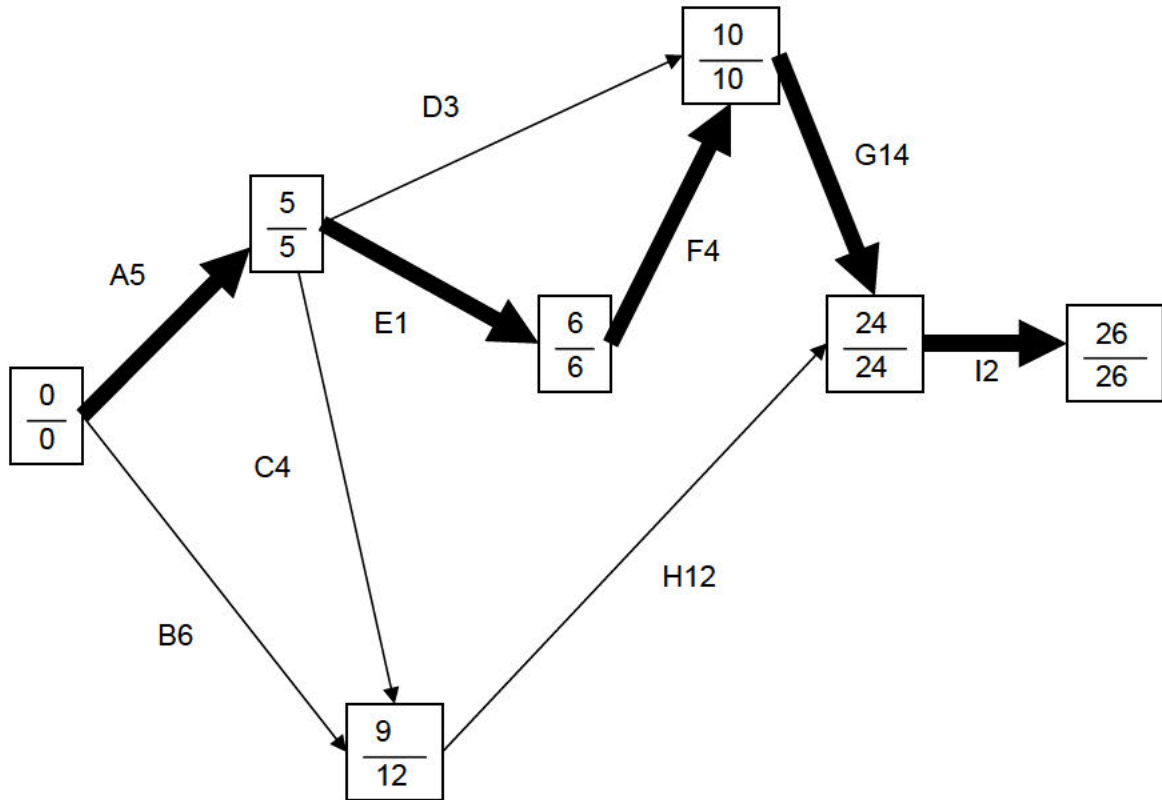
The critical path is: A, E, F, G, I = 26

The job will require the minimum of 3 workers

For Task D, I can see that there is float time of 2 weeks this means that the task could be delayed by 2 weeks with no consequence to the critical path.

	Grade Boundary: High Not Achieved
6.	For Achieved, the student needs to use critical path analysis in solving problems. This involves selecting and using methods, demonstrating knowledge of concepts and terms and communicating using appropriate representations. This student's evidence is a response to the TKI task 'The new shopping mall'. The student has selected and used a network diagram (1). To reach Achieved, the student needs to select and use at least one more method from Explanatory Note 4, for example the student could state what activities form the critical path.
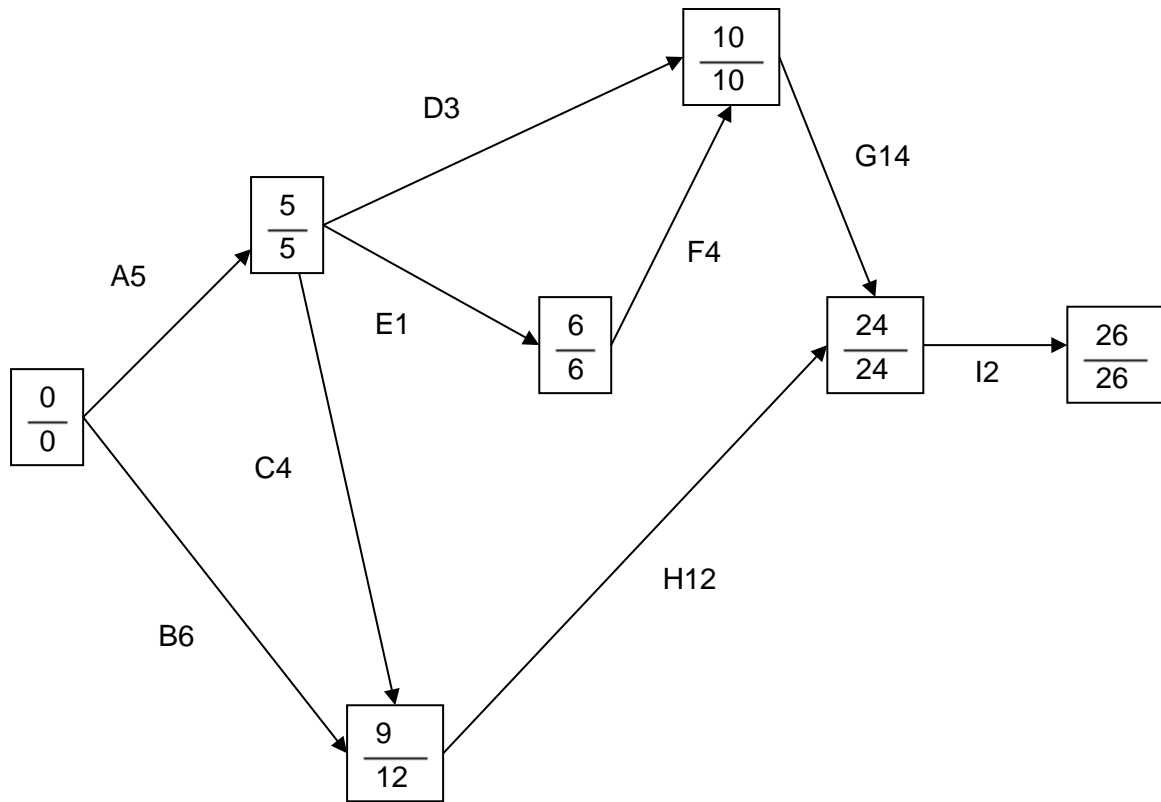
The minimum time to complete: 26 weeks

The start finish times are 0 – 26 weeks.