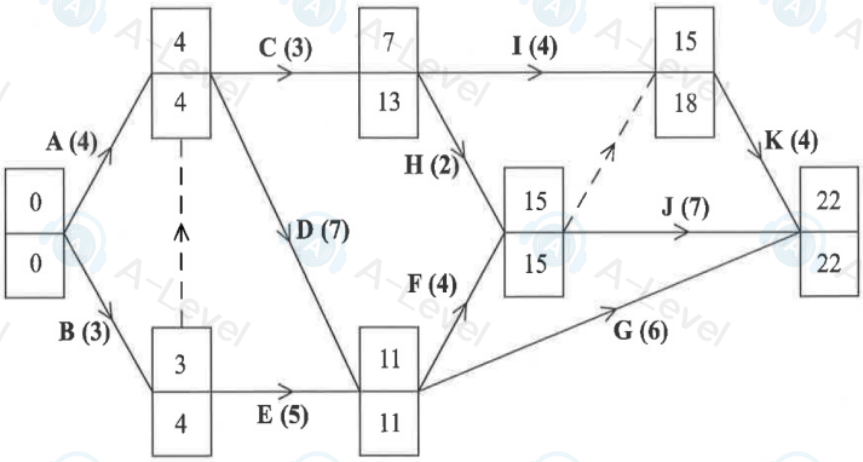
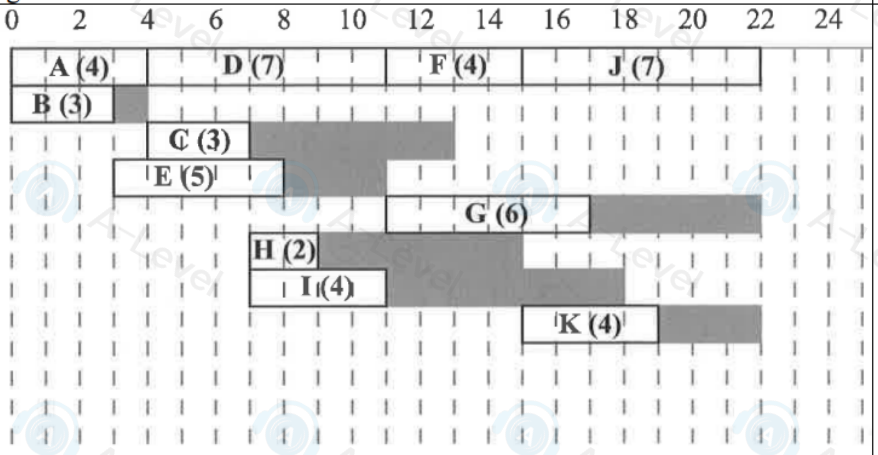
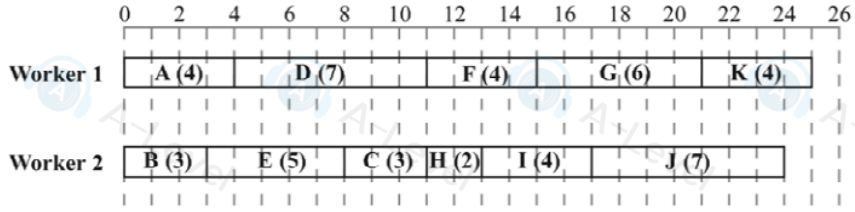
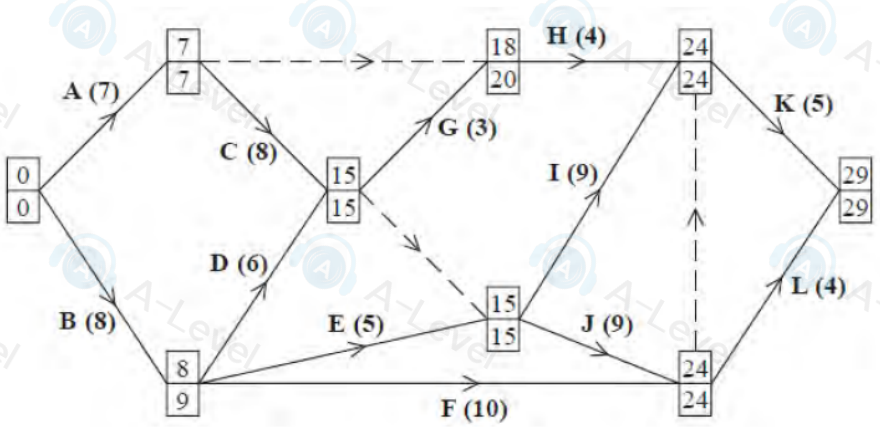
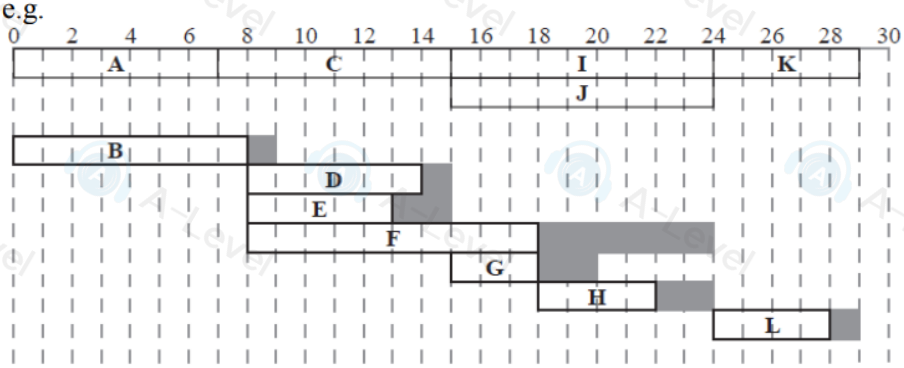
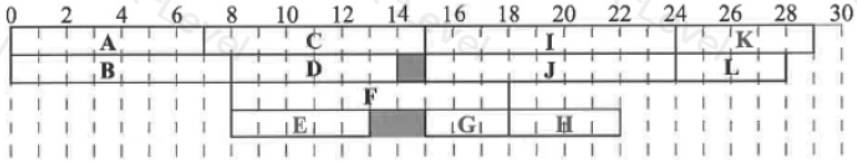
Question Number	Scheme	Marks
7.(a)		M1 A1 A1 **(3)**
(b)	ADFJ Length 22	B1 B1 **(2)**
(c)		M1 A1 M1 A1 **(4)**
(d)	i) D & E ii) J & G	B1 B1 **(2)**
(e)	e.g. 	M1 A1 A1 **(3)** **(14 marks)**

Notes for Question 7

a1M1: All top boxes and all bottom boxes completed. Values generally increasing from left to right (for top boxes), and values generally decreasing from right to left (for bottom boxes). Condone missing 0 **or** 22 for M only (for bottom boxes). Condone one rogue value in top boxes **and** one rogue value in bottom boxes.
a1A1: CAO for top boxes.
a2A1: CAO for bottom boxes.
b1B1: CAO path.
b2B1: CAO length.
c1M1: At least 8 different activities including at least 4 floats.
c1A1: Critical activities dealt with correctly.
c2M1: The correct 11 activities (only once) including at least 7 floats.
c2A1: Non-critical activities dealt with correctly.
d1B1: CAO
d2B1: CAO
e1M1: 2 lines for 2 workers or 3 lines for 3 workers, all 11 activities present (just once) with time ≤ 25.
e1A1: 2 workers. Condone one error either precedence or activity length. Time must be 25.
e2A1: 2 workers. No errors.

Activity	Duration	IPA
A	4	-
B	3	-
C	3	A, B
D	7	A, B
E	5	B
F	4	D, E
G	6	D, E
H	2	C
I	4	C
J	7	F, H
K	4	F, H, I

Question Number	Scheme	Marks
7. (a)		1M1 1A1 2M1 2A1 **(4)**
(b)	e.g. 	1M1 1A1 2M1 2A1 **(4)**
(c)	Four workers e.g. between 17 < time < 18, four activities I, J, F and G need to be happening	1B1 2B1 **(2)**
(d)	e.g. 	M1 1A1 2A1 3A1 **(4)** **14 marks**

Notes

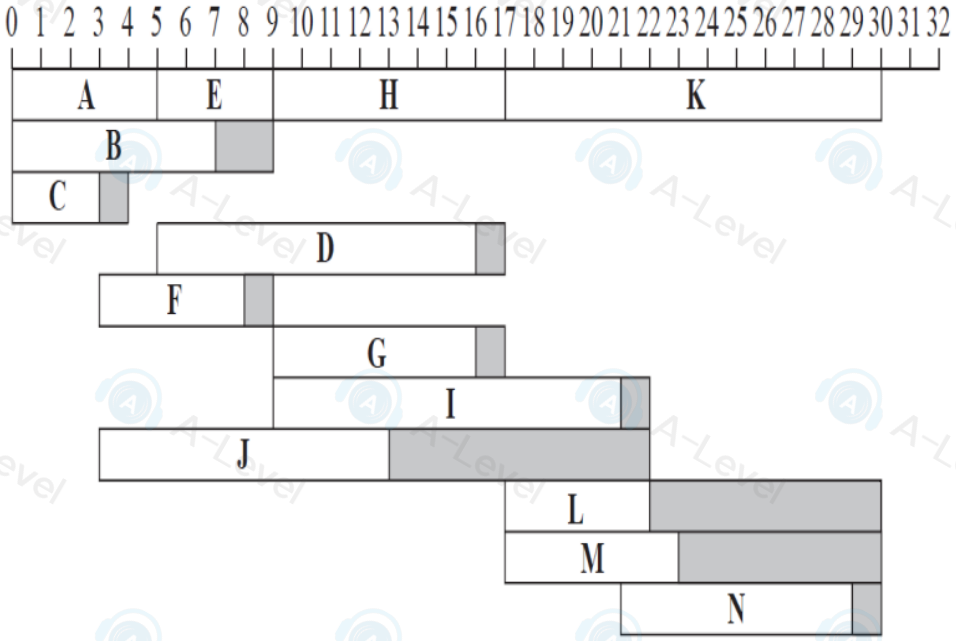
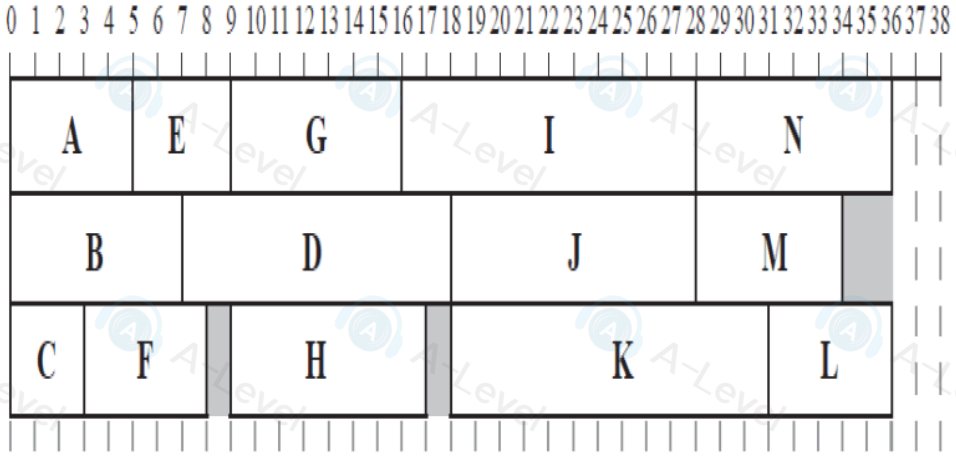
a1M1: All top boxes complete, values generally increasing left to right, condone one rogue value.
a1A1: CAO

Question Number	Scheme	Marks

Notes for Question 7 continued

a2M1: All bottom boxes complete, values generally decreasing right to left, condone one rogue value. Condone missing 0 or 29 for the M only.
a2A1: CAO
b1M1: Not a scheduling diagram. At least 9 activities including at least 4 floats.
b1A1: Critical activities dealt with correctly.
b2M1: All 12 activities including at least 7 floats.
b2A1: Non-critical activities dealt with correctly.
c1B1: A correct answer of 4, with the correct activities (IJFG) and some mention of time.
c2B1: A correct statement with details of time and activities. Note strict inequality on time – note that **on** day 18 is equivalent to $17 < \text{time} < 18$.
d1M1: Not a cascade chart. 4 'workers' used at most. At least 7 activities.
d1A1: ABCIJK correct. A – 7; B – 8: C – 8; I – 9; J – 9; K – 5. B completed by its late finish time (9).
d2A1: 4 workers. All 12 activities present (just once). Condone one error either precedence, or activity length, on activities D, E, F, G, H, L.
d3A1: 4 workers. All 12 activities present (just once). No errors on activities D, E, F, G, H, L

Activity	Duration	I.P.A.		Activity	Duration	I.P.A.
A	7	-		**G**	**3**	**C D**
B	8	-		**H**	**4**	**A G**
C	8	A		I	9	C D E
D	**6**	**B**		J	9	C D E
E	**5**	**B**		K	5	F H I J
F	**10**	**B**		**L**	**4**	**F J**

Question Number	Scheme	Marks
7. (a)	$w = 11, x = 21, y = 17, z = 4$	B3, 2, 1, 0 **(3)**
(b)		M1 A1 M1 A1 **(4)**
(c)	At time 12.5, activities H, D, G, I and J must all be happening so 5 workers	M1 A1 **(2)**
(d)	e.g. 	M1 A1 A1 **(3)** **12 marks**

Question Number	Scheme	Marks

Notes for Question 7

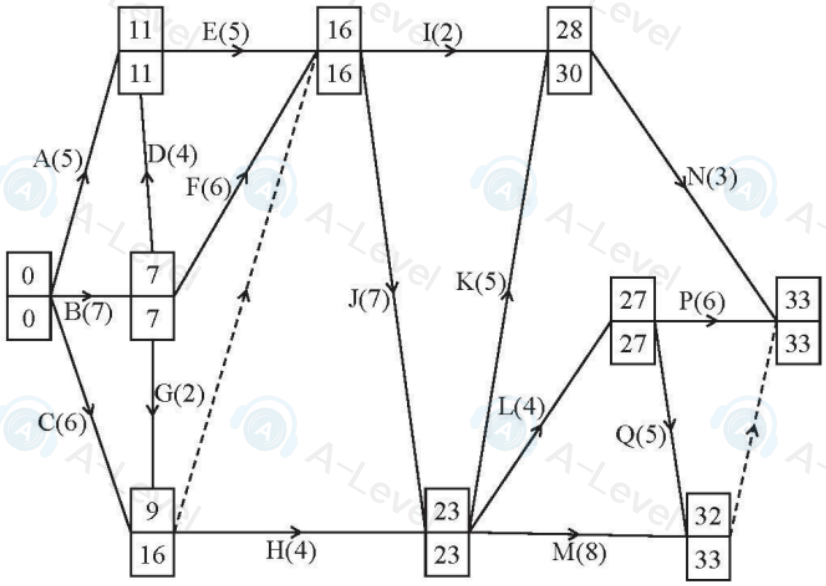
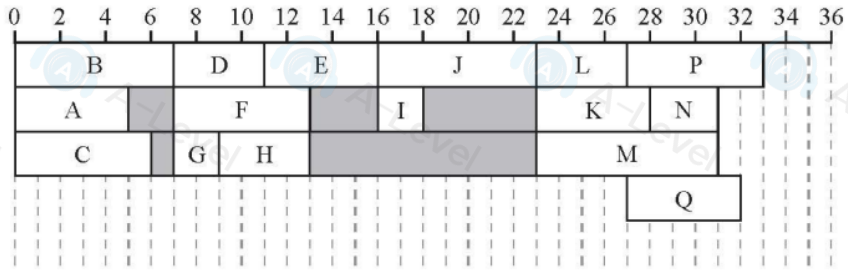
a1B1: Any two values correct (it must be clear which value corresponds to which letter)
a2B1: Any three values correct
a3B1: All four values correct

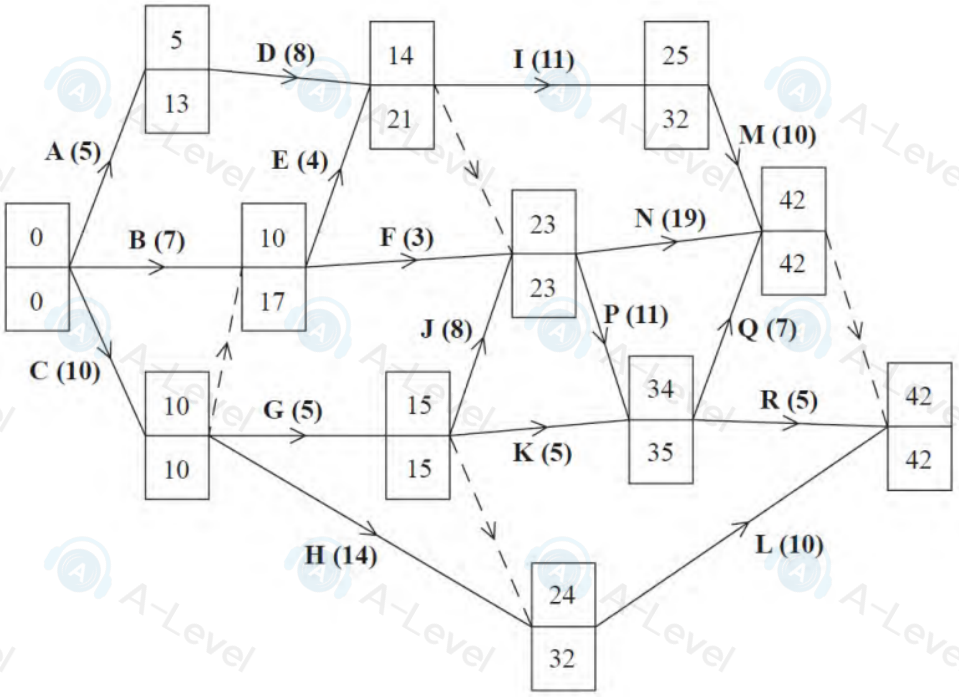
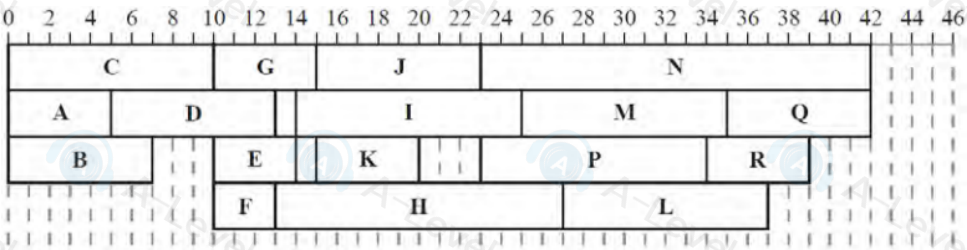
b1M1: At least 10 activities including 6 floats. A scheduling diagram scores M0
b1A1: Critical activities dealt with correctly and five other non-critical activities dealt with correctly
b2M1: Exactly 14 activities (just once) including all 10 floats (on the correct non-critical activities) – this mark is not dependent on the previous A mark
b2A1: CAO

c1M1: A statement with the correct number of workers (5) and the correct activities (H, D, G, I and J) with **any** mention of time (need not be correct)
c1A1: A correct, complete statement with details of both time ($12 < \text{time} < 13$) and activities. Allow 'on day 13' or 'during day 13' as equivalent to this time interval but not 'at day 13' – note strict inequality for the time, for example, at time 12 is A0. Accept the time interval '$12 < \text{time} < 13$' for this mark or a time that implies a time strictly between $t = 12$ and $t = 13$

d1M1: Not a cascade chart. At most 4 workers used and at least 12 activities placed. The completion time must be no greater than 36
d1A1: 3 workers. All 14 activities present (just once). Condone two errors either precedence or activity duration. The completion time must be no greater than 36 – see table below for IPA and duration for each activity. One activity can give rise to at most two errors; one on duration and one on IPA
d2A1: 3 workers. All 14 activities present (just once). No errors. The completion time must be 36

Activity	Duration	IPA
A	5	-
B	7	-
C	3	-
D	11	A
E	4	A
F	5	C
G	7	B, E, F
H	8	B, E, F
I	12	B, E, F
J	10	C
K	13	D, G, H
L	5	D, G, H
M	6	H
N	8	I, J

Question Number	Scheme	Marks
1. (a)		M1 A1 M1 A1 **(4)**
(b)	Activity H can be delayed by 23 – 9 – 4 = 10 (days)	B1ft **(1)**
(c)	Lower bound = $\frac{5+7+6+\ldots+6+5}{33} = \frac{79}{33} = 2.393\ldots = 3$ workers	M1 A1 **(2)**
(d)	e.g. 	M1 A1 A1 **(3)**
		10 marks

<table>
<tr><th>Question Number</th><th>Scheme</th><th>Marks</th></tr>
<tr><td>6.(a)</td><td>
<table>
<tr><th>Activity</th><th>Immediately preceded by</th><th>Activity</th><th>Immediate preceded by</th><th>Activity</th><th>Immediately preceded by</th></tr>
<tr><td>A</td><td>-</td><td>G</td><td>C</td><td>M</td><td>I</td></tr>
<tr><td>B</td><td>-</td><td>H</td><td>C</td><td>N</td><td>D E F J</td></tr>
<tr><td>C</td><td>-</td><td>I</td><td>D E</td><td>P</td><td>D E F J</td></tr>
<tr><td>D</td><td>A</td><td>J</td><td>G</td><td>Q</td><td>K P</td></tr>
<tr><td>E</td><td>B C</td><td>K</td><td>G</td><td>R</td><td>K P</td></tr>
<tr><td>F</td><td>B C</td><td>L</td><td>G H</td><td></td><td></td></tr>
</table>
</td><td>B2,1,0 (2)</td></tr>
<tr><td>(b)</td><td>
</td><td>M1
A1
M1
A1 (4)</td></tr>
<tr><td>(c)</td><td>Float on D = 21 – 5 – 8 = 8</td><td>B1 (1)</td></tr>
<tr><td>(d)</td><td>Lower bound is $\frac{142}{42} = 3.38 \ldots = 4$</td><td>B1 (1)</td></tr>
<tr><td>(e)</td><td>e.g.

</td><td>M1
A1
A1
A1 (4)

(12 marks)</td></tr>
</table>

Question Number	Scheme	Marks

Notes for Question 6

a1B1: Any four rows correct
a2B1: All eight rows correct

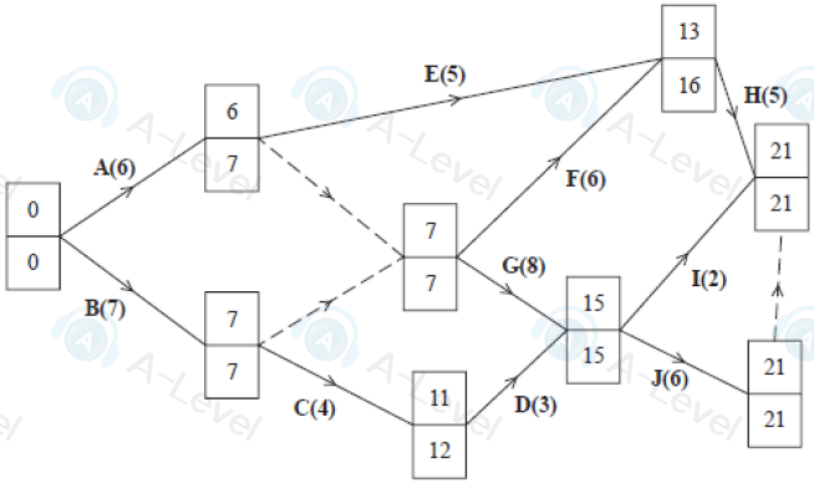
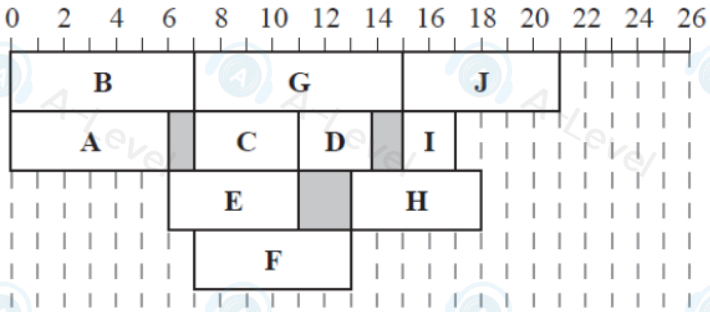
b1M1: **All** top boxes complete, values generally increasing in the direction of the arrows ('left to right'), condone one rogue
b1A1: CAO
b2M1: **All** bottom boxes complete, values generally decreasing in the opposite direction of the arrows ('right to left'), condone one rogue.
b2A1: CAO

c1B1: CAO – correct calculation seen

d1B1: CAO – either a **correct** calculation seen **or** awrt 3.4 **then** 4. An answer of 4 with no working scores B0

e1M1: Not a cascade chart. 5 workers used at most, at least 8 new (14 in total) activities placed
e1A1: 4 workers. All 11 new (17 in total) activities present (just once). Condone **two** errors **either** precedence **or** time interval **or** activity length
e2A1: 4 workers. All 11 new (17 in total) activities present (just once). Condone **one** error **either** precedence **or** time interval **or** activity length
e3A1: CAO

Activity	Duration	Time interval	IPA
D	8	5 – 21	A
E	4	10 – 21	B, C
F	3	10 – 23	B, C
H	14	10 – 32	C
I	11	14 – 32	D, E
K	5	15 – 35	G
L	10	24 – 42	G, H
M	10	25 – 42	I
P	11	23 – 35	D, E, F, J
Q	7	34 – 42	K, P
R	5	34 – 42	K, P

<table>
<tr><th>Question Number</th><th>Scheme</th><th>Marks</th></tr>
<tr><td>5. (a)</td><td>
<table>
<tr><th>Activity</th><th>Immediately preceding activities</th><th>Activity</th><th>Immediately preceding activities</th></tr>
<tr><td>A</td><td>-</td><td>F</td><td>A, B</td></tr>
<tr><td>B</td><td>-</td><td>G</td><td>A, B</td></tr>
<tr><td>C</td><td>B</td><td>H</td><td>E, F</td></tr>
<tr><td>D</td><td>C</td><td>I</td><td>D, G</td></tr>
<tr><td>E</td><td>A</td><td>J</td><td>D, G</td></tr>
</table>
</td><td>B2, 1, 0 (2)</td></tr>
<tr><td>(b)</td><td>
</td><td>M1
A1
A1 (3)</td></tr>
<tr><td>(c)</td><td>Minimum project completion time is 21 (hours)
Critical activities: B, G, J</td><td>B1ft
B1 (2)</td></tr>
<tr><td>(d)</td><td>E could be delayed by 16 – 5 – 6 = 5 (hours)</td><td>B1 (1)</td></tr>
<tr><td>(e)</td><td>Lower bound = $\frac{52}{21} = 2.476...$ so 3 workers required</td><td>B1 (1)</td></tr>
<tr><td>(f)</td><td>e.g.

</td><td>M1
A1
A1 (3)</td></tr>
<tr><td>(g)</td><td>Activities A, E and H are now critical
The minimum project completion time is now 22 (hours)</td><td>B1
B1 (2)</td></tr>
<tr><td></td><td></td><td>14 marks</td></tr>
</table>

Question Number	Scheme	Marks

Notes for Question 5

a1B1: **Any** 7 of the 10 rows correct (allow A and B blank)
a2B1: CAO (allow A and B blank)

b1M1: All top boxes and all bottom boxes completed. Values generally increasing left to right (for top boxes) and values generally decreasing from right to left (for bottom boxes). Condone missing 0 or 21 for M only (in bottom boxes). Condone one rogue value in top boxes and one rogue value in bottom boxes. For a rogue in the top boxes if values do not increase in the direction of the arrows then if one value is ignored and then the values do increase in the direction of the arrows then this is considered to be only one rogue value (with a similar definition for bottom boxes but in reverse)

b1A1: CAO (top boxes)
b2A1: CAO (bottom boxes)

c1B1: Follow through candidate's value provided that the M mark was earned in (b)
c2B1: CAO on critical activities (B, G, J)

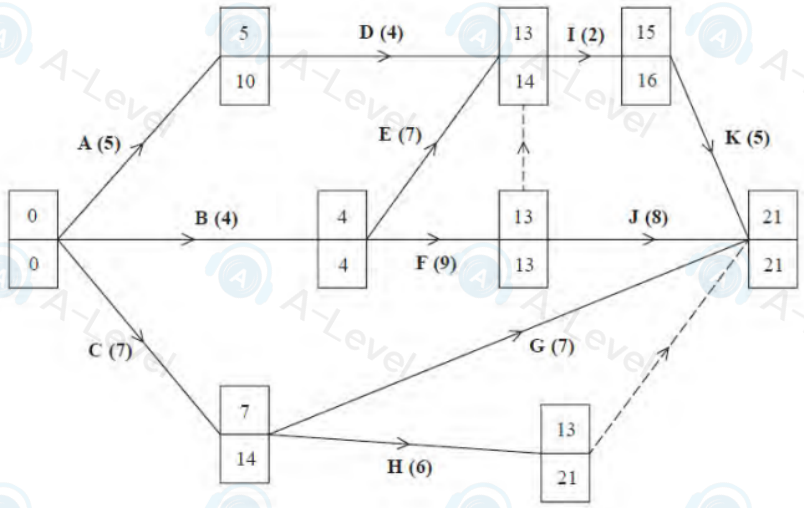
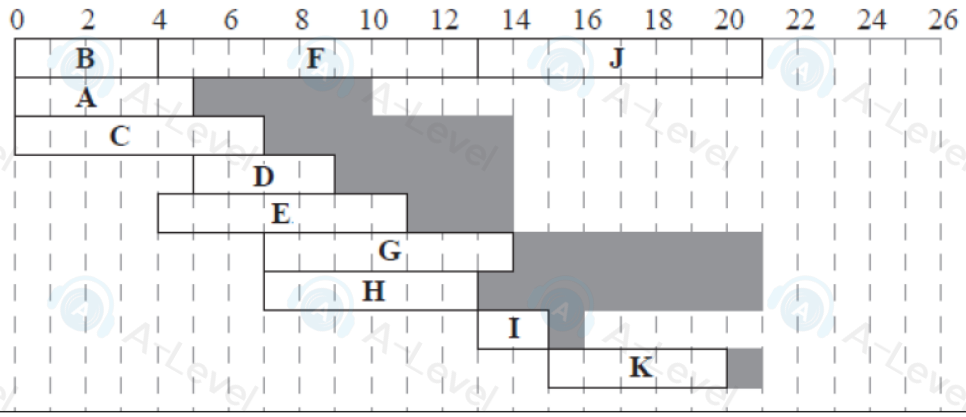
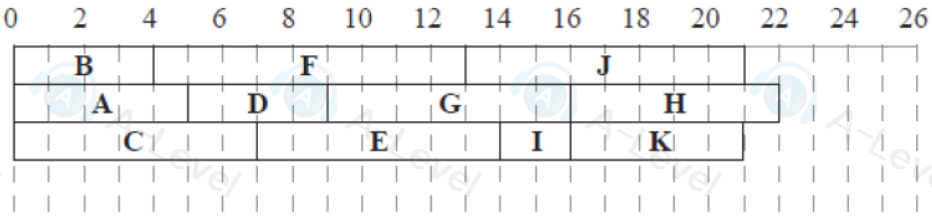
d1B1: Correct calculation with all three numbers present. An answer of 5 with no working scores B0

e1B1: **Correct calculation** seen then 3 – an answer of 3 with no working scores B0

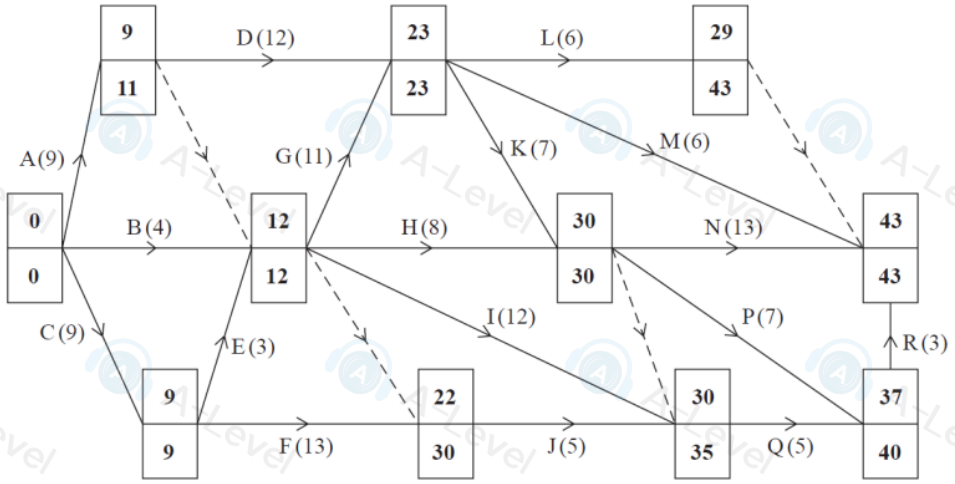
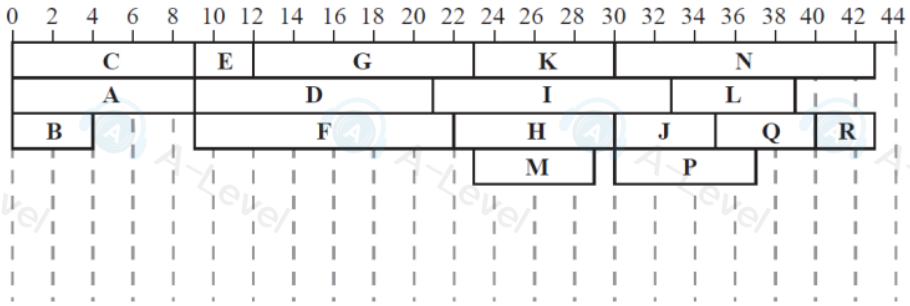
f1M1: Not a cascade chart. 4 'workers' used at most and at least 9 unique activities placed
f1A1: 4 workers. All 10 activities present (just once). Condone at most two errors. An activity can give rise to at most three errors; one on duration, one on time interval and only one on IPA
f2A1: 4 workers. All 10 activities present (just once). No errors

Activity	Duration	Time interval	IPA
A	6	0 -7	-
B	7	0 - 7	-
C	4	7 – 12	B
D	3	11 – 15	C
E	5	6 – 16	A
F	6	7 – 16	A, B
G	8	7 – 15	A, B
H	5	13 – 21	E, F
I	2	15 – 21	D, G
J	6	15 – 21	D, G

g1B1: Correctly stating the activities that are now critical (A, E and H) – no extras
g2B1: Correctly stating new project completion time (22 – no units required)

Question Number	Scheme	Marks
6.		
(a) (i)	The dummy from event 5 to event 6 is needed to show that J depends on F but I depends on D, E and F	B1
(ii)	The dummy from event 7 to event 9 is because activities G and H must be able to be described uniquely in terms of the events at each end	B1 **(2)**
(b)		M1 A1 M1 A1 **(4)**
(c)	21 (hours)	B1 **(1)**
(d)	$\frac{64}{21} \approx 3.048$ so at least 4 workers required	M1 A1 **(2)**
(e)		M1 A1 M1 A1 **(4)**
(f)	e.g. 	M1 A1 A1 **(3)**
		16 marks

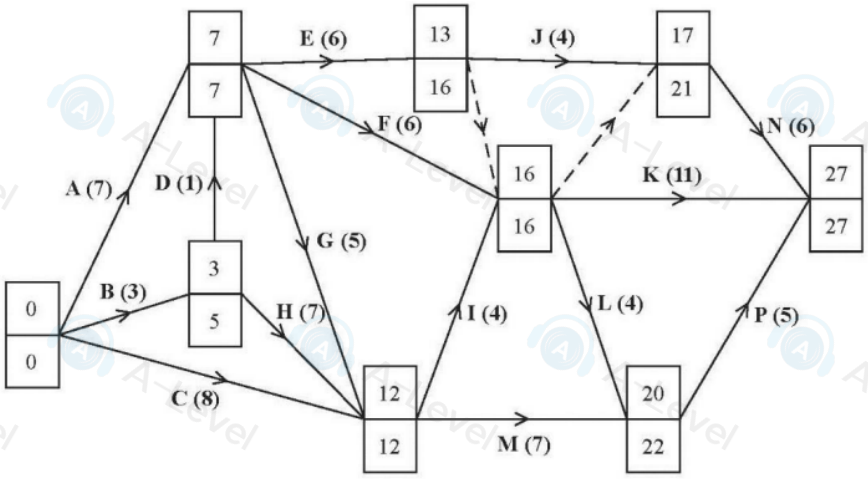
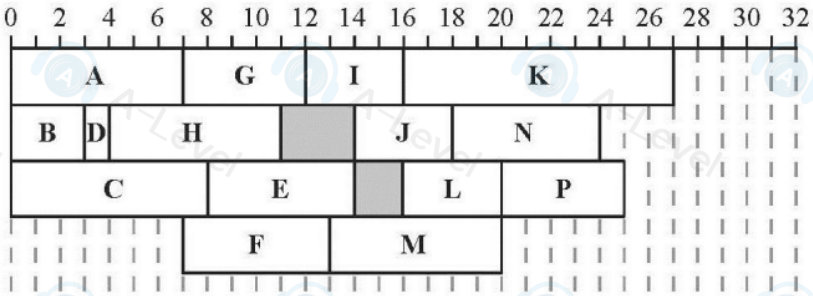
Question Number	Scheme	Marks
	Notes:	
a1B1	Cao – all relevant activities must be referred to - so activities I, J, F and either D or E must be mentioned.	
a2B1	Cao – mention of describing activities uniquely in terms of the events at each end.	
b1M1	All top boxes complete, values generally increasing from left to right, condone one 'rogue'	
b1A1	Cao on top boxes	
b2M1	All bottom boxes complete, values generally decreasing right to left, condone one 'rogue'	
b2A1	Cao on bottom boxes	
c1B1	Cao	
d1M1	Attempt to find lower bound: [55 – 73 / their finish time] or [sum of the activities / their finish time]	
d1A1	Cao – correct calculation seen then 4.	
e1M1	At least 8 activities added including 5 floats. Scheduling diagram scores M0.	
e1A1	Critical activites dealt with correctly and four other non-critical activities dealt with correctly.	
e2M1	All 11 activities including all 8 floats	
e2A1	Cao	
f1M1	Not a cascade chart. 3 workers used and at least 9 activities placed.	
f1A1	3 workers, All 11 activities present (just once). Condone one error either precedence or activity length.	
f2A1	3 workers. All 11 activities present (just once). No errors.	

Question number	Scheme	Marks
4.(a)	<table><tr><th>Activity</th><th>Immediately preceded by</th><th>Activity</th><th>Immediately preceded by</th><th>Activity</th><th>Immediately preceded by</th></tr><tr><td>A</td><td>-</td><td>G</td><td>A, B, E</td><td>M</td><td>D, G</td></tr><tr><td>B</td><td>-</td><td>H</td><td>A, B, E</td><td>N</td><td>H, K</td></tr><tr><td>C</td><td>-</td><td>I</td><td>A, B, E</td><td>P</td><td>H, K</td></tr><tr><td>D</td><td>A</td><td>J</td><td>A, B, E, F</td><td>Q</td><td>H, I, J, K</td></tr><tr><td>E</td><td>C</td><td>K</td><td>D, G</td><td>R</td><td>P, Q</td></tr><tr><td>F</td><td>C</td><td>L</td><td>D, G</td><td></td><td></td></tr></table>	B2, 1, 0 **(2)**
(b)		M1 A1 M1 A1 **(4)**
(c)	Critical activities: C, E, G, K and N	B1 **(1)**
(d)	Float on J = 35 – 22 – 5 = 8	B1ft **(1)**
(e)	Lower bound is $\frac{133}{43} = 3.0930... = 4$	B1 **(1)**
(f)	e.g. 	M1 A1 A1 A1 **(4)**
		(13 marks)

Notes for Question 4

a1B1: Any four (of the eight blank) rows correct
a2B1: All eight rows correct

b1M1: All top boxes complete, values generally increasing in the direction of the arrows (so generally going from 'left to right' across the network), condone one 'rogue' value (if values do not increase in the

Question Number	Scheme	Marks
7. (a)		M1 A1 M1 A1 **(4)**
(b)	Critical:- e.g. zero float, no delay, immediate, if delayed project will finish late, etc. Path:- e.g. from start event to end event continuously, the event forming end of one activity forms the start of the next, etc.	B1 B1 **(2)**
(c)	Critical path: AGIK	B1 **(1)**
(d)(i) **(ii)**	4 day delay on J – no effect on the project completion date (float on J is 4) 4 day delay on M – project finishes 1 day late (float on M is 3)	B1 B1 **(2)**
(e)	$\frac{84}{27} = 3.111...$, so a minimum of 4 workers needed	M1 A1 **(2)**
(f)		M1 A1 A1 **(3)** **14 marks**

Question Number	Scheme	Marks

Notes for Question 7

a1M1: All top boxes complete, values generally increasing in the direction of the arrows ('left to right'), condone one 'rogue' value – condone a missing 0 in the first box for the M mark only
a1A1: CAO (top boxes)
a2M1: All bottom boxes complete, values generally decreasing in the opposite direction of the arrows ('right to left'), condone one 'rogue' value – condone a missing 0 in the first box for the M mark only
a2A1: CAO (bottom boxes)

b1B1: CAO for defining 'critical' part
b2B1: CAO for defining 'path' part

c1B1: CAO (AGIK)

d1B1: CAO – as a minimum accept 'no effect' but not just '0'
d2B1: CAO – as a minimum accept '1 day late' or 'finishes at their 27 + 1' e.g. at time 28 but not just '28'

e1M1: Attempt to find lower bound: (a value in the interval [73 – 95] / their finish time) or (sum of the activities / their finish time) or as a minimum accept awrt 3.1
e1A1: CAO – either a correct calculation seen or awrt 3.1 **then** 4. An answer of 4 with no working is M0A0

f1M1: Not a cascade chart. 4 'workers' used at most and at least 9 activities placed
f1A1: 4 workers. All 15 activities present (just once). Condone at most two errors. An activity can give rise to at most three errors; one on duration, one on time interval and only one on IPA
f2A1: 4 workers. All 15 activities present (just once). No errors

Activity	Duration	Time interval	IPA
A	7	0 – 7	-
B	3	0 – 5	-
C	8	0 – 12	-
D	1	3 – 7	B
E	6	7 – 16	A, D
F	6	7 – 16	A, D
G	5	7 – 12	A, D
H	7	3 – 12	B
I	4	12 – 16	C, G, H
J	4	13 – 21	E
K	11	16 – 27	E, F, I
L	4	16 – 22	E, F, I
M	7	12 – 22	C, G, H
N	6	17 – 27	F, I, J
P	5	20 – 27	L, M