GradeMax



Mark Scheme (Final)

January 2026

Pearson Edexcel International Advanced Level In Decision Mathematics D1

WDM11/01

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

   'M' marks
   These are marks given for a correct method or an attempt at a correct method. In Mechanics they are usually awarded for the application of some mechanical principle to produce an equation.

   e.g. resolving in a particular direction, taking moments about a point, applying a suvat equation, applying the conservation of momentum principle etc.

   The following criteria are usually applied to the equation.

   To earn the M mark, the equation
   (i) should have the correct number of terms
   (ii) be dimensionally correct i.e. all the terms need to be dimensionally correct

   e.g. in a moments equation, every term must be a 'force x distance' term or 'mass x distance', if we allow them to cancel 'g' s.

   For a resolution, all terms that need to be resolved (multiplied by sin or cos) must be resolved to earn the M mark.

   M marks are sometimes dependent (DM) on previous M marks having been earned.

   e.g. when two simultaneous equations have been set up by, for example, resolving in two directions and there is then an M mark for solving the equations to find a particular quantity – this M mark is often dependent on the two previous M marks having been earned.

   'A' marks
   These are dependent accuracy (or sometimes answer) marks and can only be awarded if the previous M mark has been earned. E.g. M0 A1 is impossible.

   'B' marks
   These are independent accuracy marks where there is no method (e.g. often given for a comment or for a graph)

   A few of the A and B marks may be f.t. – follow through – marks.

3. General Abbreviations

   These are some of the traditional marking abbreviations that will appear in the mark schemes.

- bod – benefit of doubt
- ft – follow through
- the symbol √ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- * The answer is printed on the paper
- The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

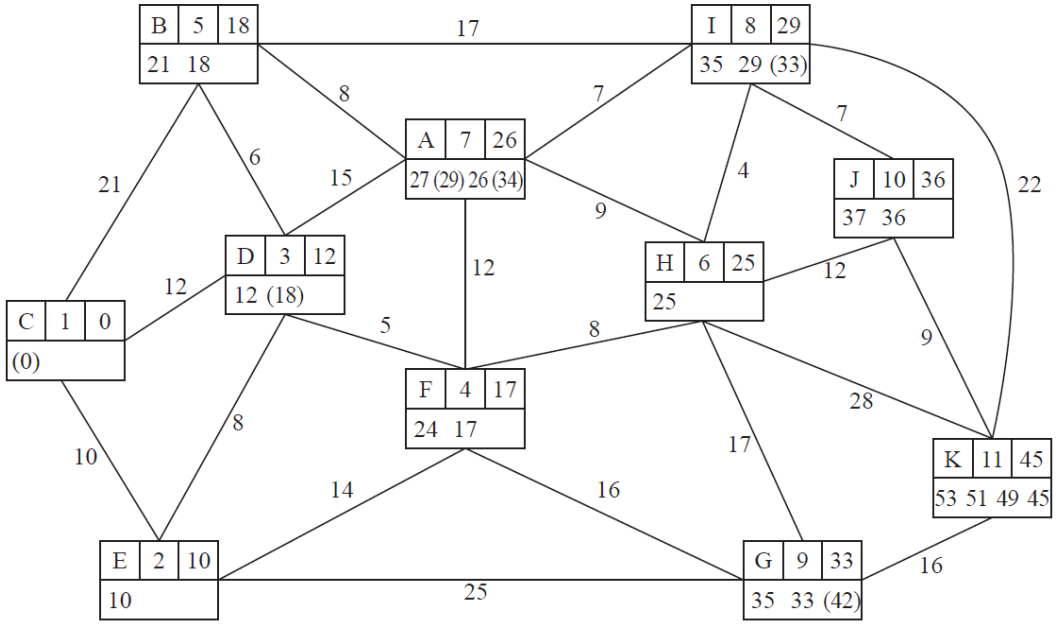
6. If a candidate makes more than one attempt at any question:
    - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
    - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

<table>
<tr><th>Question Number</th><th>Scheme</th><th>Marks</th></tr>
<tr><td>1.(a)</td><td>The list is not in (alphabetical) order</td><td>B1
(1)</td></tr>
<tr><td>(b)</td><td>
<table>
<tr><td>B</td><td>B</td><td></td><td></td></tr>
<tr><td>C</td><td>C</td><td></td><td></td></tr>
<tr><td>D</td><td>D</td><td></td><td></td></tr>
<tr><td>G</td><td>G</td><td>G</td><td>G</td></tr>
<tr><td>H</td><td>H</td><td>H</td><td></td></tr>
<tr><td>P</td><td></td><td></td><td></td></tr>
<tr><td>R</td><td></td><td></td><td></td></tr>
<tr><td>S</td><td></td><td></td><td></td></tr>
<tr><td>T</td><td></td><td></td><td></td></tr>
<tr><td>V</td><td></td><td></td><td></td></tr>
<tr><td>W</td><td></td><td></td><td></td></tr>
</table>
Football is not in the list</td><td>M1
A1
A1ft

A1
(4)</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td></td><td></td><td>5 marks</td></tr>
<tr><td></td><td>Notes for Question 1</td><td></td></tr>
<tr><td>a1B1</td><td>CAO - Accept alternatives such as “the list is not in ascending/descending order” or “The list is not ordered”, give BOD here.</td><td></td></tr>
<tr><td>b1M1</td><td>Orders list alphabetically (condone one slip) and correct choice of pivot
May be implied by selecting ‘6’ or ‘P’ or sight of $\frac{11+1}{2}$</td><td></td></tr>
<tr><td>b1A1</td><td>Discards P and above (or equivalent e.g. 6-11 discarded) and correctly chooses second pivot – if pivot not discarded then A0</td><td></td></tr>
<tr><td>b2A1ft</td><td>Discards their second pivot and below, if pivot chosen correctly for their list following their first discard, and correctly chooses third pivot – if pivot not discarded then A0. Must be discarding the correct ‘half’ of the list to locate F.</td><td></td></tr>
<tr><td>b3A1</td><td>CSO discards H and compares G with F concluding not in list</td><td></td></tr>
<tr><td colspan="3">Note: If they omit one item or add one item (e.g. F) they can score M1A0A0A0.

Note: If they refer to the position number throughout for a correctly ordered list this is acceptable and all marks are available.</td></tr>
</table>

Question Number	Scheme	Marks
2.(a)		M1 A1 (EDFB) A1 (HAIG) A1ft (JK)
	Quickest route from C to K is CDFHIJK	A1
	Quickest time is 45 (minutes)	A1ft
		6 Marks
	Notes for Question 2	
	In (a) it is important that all values at each node are checked very carefully – the order of the working values must be correct for the corresponding A mark to be awarded e.g. at F the working values must be 24 17 in that order (so 17 24 is incorrect) **It is also important that the order of labelling is checked carefully. The order of labelling must be a strictly increasing sequence – so 1, 2, 3, 3, 4, … will be penalised once (see notes below) but 1, 2, 3, 5, 6, … is fine. Errors in the final values and working values are penalised before errors in the order of labelling**	
a1M1	A larger value replaced by a smaller value at least twice in the working values at either A, G, I, J, K	
a1A1	All values at E, D, F and B correct and the working values in the correct order	
a2A1	All values at H, A, I and G correct and the working values in the correct order	
a3A1ft	All values in J and K correct on the follow through and the working values in the correct order. To follow through J check that the working values at J follow from the candidate's final values for the nodes that are directly attached to J (which are H and I (and K)). For example, **if** correct then the order of labelling of nodes H and I are 6 and 8 respectively so the working values at J should come from H and I in that order. The first working value at J should be their 37 (the Final value at H) + 12 (the weight of the arc HJ), the second working value at J should be their 29 (the Final value at I) + 7 (the weight of the arc IJ). Repeat the process for K (which will have working values from H, I, G and J with the order of these nodes determined by the candidate's order of labelling at H, I, G and J)	
a4A1	CAO	
a5A1ft	Follow through their final value at K **only** – if answer is 45 but the final value at K is not 45 then A0 (condone lack of minutes)	

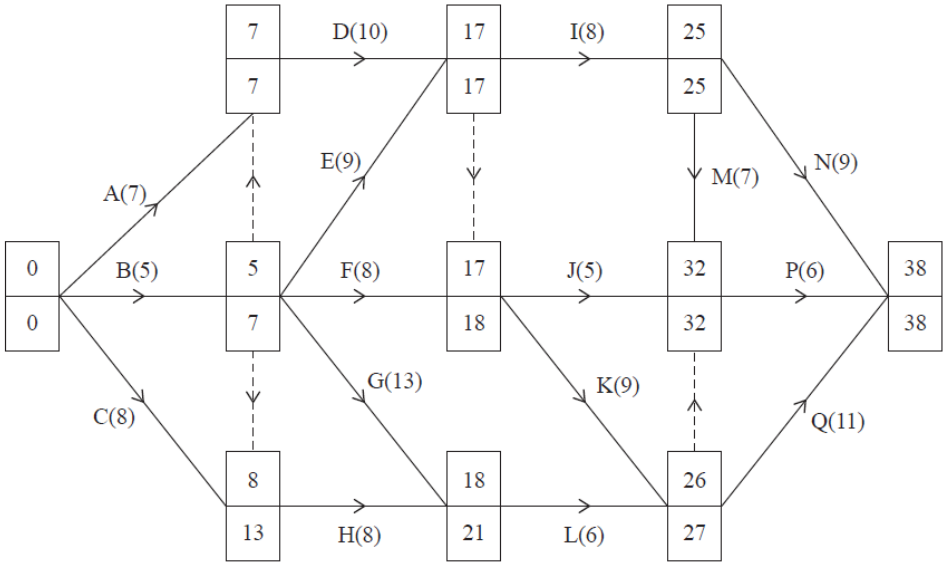
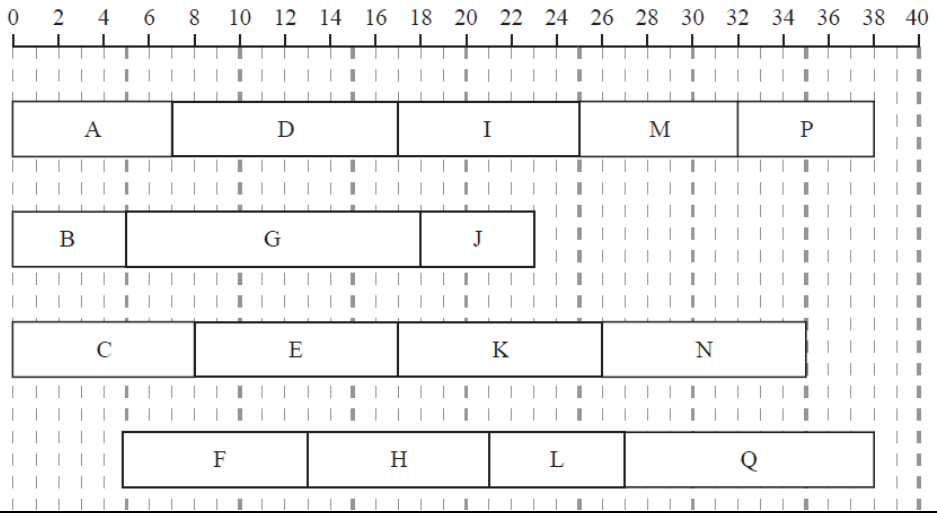
Question Number	Scheme	Marks
3(i) (a)	Start by adding the required arc and then continue (with Kruskal's algorithm until tree is completed)	B1 **(1)**
(b)	BJ add BC add FG add DJ add CD reject {AB add} either order {EF add} HJ add AH reject GH add (DE FJ reject)	M1 A1 A1 **(3)**
(c)	207 (metres)	B1 **(1)**
(ii)(a)	Consider all pairings of B, D, F and H	M1
	BD + FH 43 + 49 = 92 BF + DH 77 + 48 = 125 BH + DF 51 + 55 = 106	A1 A1
	Length of route = 323 + 92 = 415 (metres)	A1
	Repeat BC CD FG GH	A1 **(5)**
(b)	Must now consider B, D, H and J BJ + DH 42 + 48 = 90 BD + HJ 26 + 43 = 69 BH + DJ 51 + 22 = 73	M1 A1
	Difference in length = 92 – 69 = 23 (metres)	A1 **(3)**
		13 Marks
	Notes for Question 3	
(i)aB1	CAO. We need **both** elements to be mentioned i.e. selecting the (specific) arc first AND continuing to select arcs (by Kruskal's)	
bM1	First 4 arcs (BJ to DJ) added in the correct order and at least one rejection seen	
b1A1	Next 4 arcs (CD to HJ) dealt with correctly in the correct order	
b2A1	CSO all arcs added/rejected in the correct order (DE and FJ do not need to be seen)	
cB1	CAO	
(ii)aM1	The correct three pairings of the correct four nodes (B, D, F and H)	
a1A1	Two rows correct including pairings **and** totals	
a2A1	All three rows correct including pairings **and** totals	
a3A1	CAO but must have three pairings of the correct nodes	
a4A1	CAO must be arcs so BCD and FGH is A0	
(ii)bM1	The correct three pairings of the correct four nodes (B, D, H and J)	
b1A1	All three rows correct including pairings **and** totals	
b2A1	CAO	

Question Number	Scheme	Marks
4 (a)	(In second pass) 44 compared with x and does not swap x compared with 58 and does not swap	B1 B1 **(2)**
(b)	35 24 44 32 21 x 54 31 58 61 73	M1 A1 **(2)**
(c)	$21+24+31+32+35+44+54+58+61+73+x>480$ $x>47$ Bin 1: 73 61 24 Bin 2: 58 54 x $x+58+54\leqslant 160$ $x\leqslant 48$ $x=48$	M1 M1 A1 **(3)**
		7 marks
	Notes for Question 4	
a1B1	Compares 44 with x and states does not change or equivalent. Whilst a reference to the second pass needn't be stated, incorrect statements should be penalised, e.g. "x is compared **to 44 in the first pass**…" is B0.	
a2B1	Compares x with 58 and states does not change or equivalent.	
bM1	Eleven terms including the x present, works L to R with 44 swapped with 24, and 58 in correct position.	
bA1	CAO	
c1M1	Considers sum of all values >480 and obtains inequality for x **or equivalent work,** such as setting up lower bound calculation of total weights e.g. $\frac{433+x}{120}>4$ leading to $x>47$ or $x\geqslant 48$ or $48\leqslant x\leqslant 57$.	
c2M1	Considers bin 2 and obtains inequality for x **or equivalent**.	
cA1	CSO	

Question Number	Scheme	
5.	$1.2x + 2.5y + 4z \leqslant 60 \quad \Rightarrow \quad 12x + 25y + 40z \leqslant 600$ $4\frac{1}{3}x + 7\frac{1}{2}y + 9z \leqslant 200 \quad \Rightarrow 26x + 45y + 54z \leqslant 1200$ $x \geqslant \frac{40}{100}(x + y + z) \quad \Rightarrow \quad 3x \geqslant 2y + 2z$ $x \geqslant 2y$ $z \leqslant \frac{30}{100}(x + y + z) \quad \Rightarrow \quad 7z \leqslant 3x + 3y$ $x,\ y,\ z \geqslant 0$ Maximise $(P =)\ 275x + 425y + 650z$	M1 A1 A1 M1 A1 A1 B1B1
		7 marks

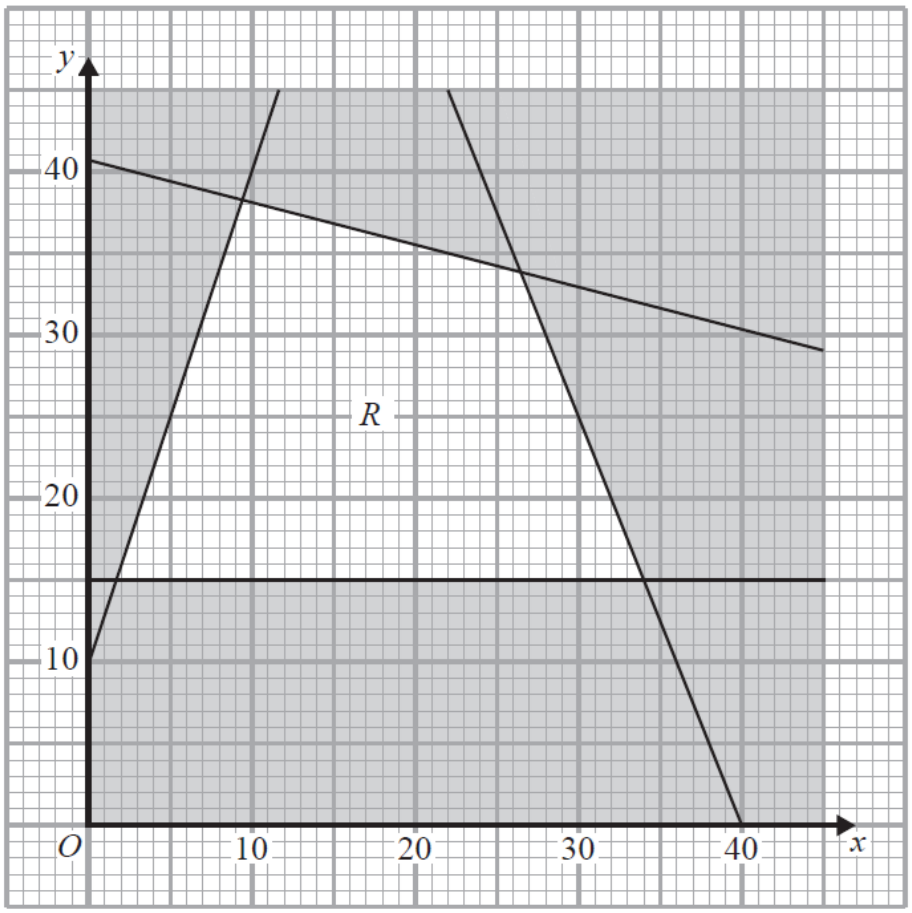
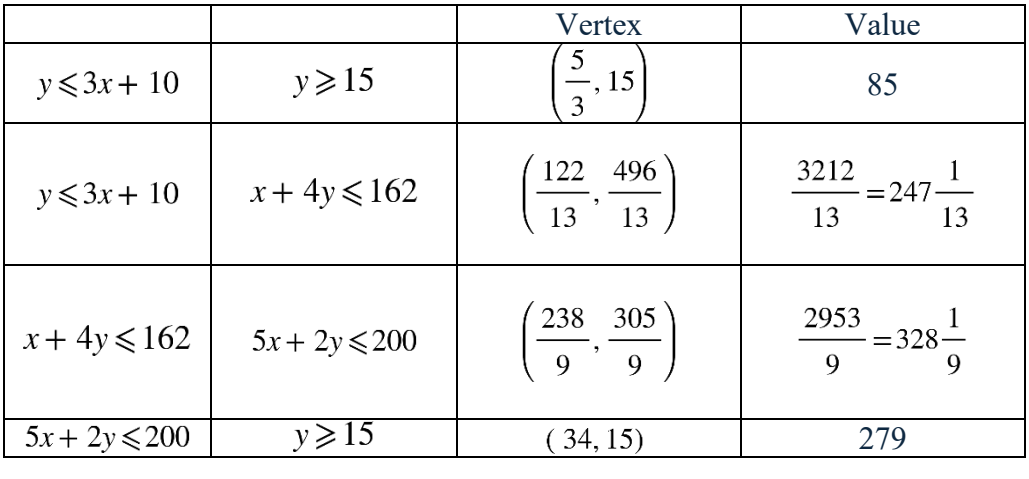
	Notes for Question 5	
a1M1	Attempts constraints for quantity of wood and production time (do not need to be simplified) Look for $1.2x + 2.5y + 4z \bullet 60$ and $4\frac{1}{3}x + 7\frac{1}{2}y + 9z \bullet 200$ where $\bullet$ is any inequality or equals. Condone e.g. 4.33 or 4.2 instead of $4\frac{1}{3}$ for the M mark	
a1A1	CAO One of these constraints fully simplified	
a2A1	CAO Both constraints fully simplified	
a2M1	Attempts at least two other non-trivial constraints (any inequality or equals)	
a3A1	Two other non-trivial constraints correct – fully simplified with integer coefficients	
a4A1	All other non-trivial constraints correct – fully simplified with integer coefficients – and trivial constraints stated	
a1B1	Objective function correct	
a2B1	Maximise stated and objective function correct Accept e.g. '$P_{\max}$ = …' or 'Max' but not 'Maximum P='.	

Question Number	Scheme	Marks
6.(a)	ACDFEBGHA length 192 ACDFEHGBA length 185	M1 A1 A1 A1
		(4)
(b)	ACDFEHGBA 185 as this is the shorter length.	B1ft
		(1)
(c)	BC CD DF FE EH HG or BC CD CE FE EH HG Length 127 (accept 22 + 18 + 21 + 17 + 25 + 24) Adds AB AC 127+19+24=170	M1 A1 dM1 A1
		(4)
(d)	$172 \leqslant d \leqslant 185$	B1ft
		(1)
		10 marks
	Notes for Question 6	
a1M1	Nearest Neighbour – first four arcs correctly chosen in order (AC, CD, DF, FE …) **or** first five nodes {A, C, D, F, E, … } correctly chosen in order. Order of nodes may be seen at the top of a matrix/table {1, -, 2, 3, 5, 4, -, - }.	
a1A1	One NN route correct, either listed as arcs or ACDFEBGHA or ACDFEHGBA	
a2A1	Both NN routes correct, either listed as arcs or ACDFEBGHA and ACDFEHGBA	
a3A1	Both lengths correct – must be clearly linked to the correct route	
b1B1ft	CAO Route and reason. Must have found two routes with distinct lengths.	
c1M1	Prim starting at B to find RMST – first four arcs correct either (BC, CD, DF, FE …) or (BC CD CE FE …) or first five nodes {B, C, D, F, E, … } or {B, C, D, E, F …} Order of nodes may be seen at the top of a matrix/table, where A may or may not have been crossed out, either { -, 1, 2, 3, 5, 4, -, - } or {-, 1, 2, 3, 4, 5, -, - }.	
c1A1	CAO RMST and 127 (or 22 + 18 + 21 + 17 + 25 + 24) seen (if 127 with no working then M0) – arcs for RMST must be stated, not just seen e.g. circled in table.	
c2dM1	Dependent on previous M – adds two shortest arcs from A (AB and AC). Sight of '127'+19 +24 or '127+43' or '22 + 18 + 21 + 17 + 25 + 24 + 19 + 24' is sufficient here.	
c2A1	CAO Note: M1A0M1A1 is possible in (c).	
d1B1ft	CAO – allow strict inequalities Follow through their smaller value from (a) as the upper bound and the larger of 172 and their answer to (c) for their lower bound. Their lower bound must be less than their upper bound.	

Question Number	Scheme	Marks
7.(a)		B1 (HIJ) B1 (KLM) B1 (NPQ) **(3)**
(b)		M1 A1 M1 A1 **(4)**
(c)	A D I M P	B1 **(1)**
(d)	$\frac{7+5+\ldots+6+11}{38} \quad \Rightarrow \frac{129}{38}=3.3947\ldots$ Therefore 4 workers	M1 A1 **(2)**
(e)	e.g. 	M1 A1 A1 A1 **(4)**
		14 marks

Activity	IPA	Activity	IPA
A	-	I	D E
B	-	J	D E F
C	-	K	D E F
D	A B	L	G H
E	B	M	I
F	B	N	I
G	B	P	J K L M
H	B C	Q	K L

<table>
<tr><td></td><td>Notes for Question 7</td><td></td></tr>
<tr><td>a1B1</td><td>Activities H to J correct</td><td></td></tr>
<tr><td>a2B1</td><td>Activities K to M correct</td><td></td></tr>
<tr><td>a3B1</td><td>Activities N to Q correct</td><td></td></tr>
<tr><td>b1M1</td><td>All top boxes complete, values generally increasing in the direction of the arrows (‘left to right’), condone one rogue</td><td></td></tr>
<tr><td>b1A1</td><td>CAO (top boxes)</td><td></td></tr>
<tr><td>b2M1</td><td>All bottom boxes complete, values generally decreasing in the opposite direction of the arrows (‘right to left’), condone one rogue. Condone missing 0 and/or their 24 (at the end event) for the M mark only</td><td></td></tr>
<tr><td>b2A1</td><td>CAO (bottom boxes)</td><td></td></tr>
<tr><td>cB1</td><td>CAO</td><td></td></tr>
<tr><td>d1M1</td><td>Attempts total length (accept 129 ± 13) ÷ “38” Accept awrt 3.4 for M1</td><td></td></tr>
<tr><td>d1A1</td><td>CAO 4 workers and correct calculation (an answer of 4 with no working scores M0)</td><td></td></tr>
<tr><td>e1M1</td><td>Not a cascade (Gantt) chart. 5 ‘workers’ used at most and at least 11 activities placed</td><td></td></tr>
<tr><td>e1A1</td><td>4 workers. All 16 activities present (just once). Condone at most three errors. An activity can give rise to at most three errors; one on duration, one on time interval and only one on IPA</td><td></td></tr>
<tr><td>e2A1</td><td>4 workers. All 16 activities present (just once). Condone one error either precedence or time interval or activity length; An activity can give rise to at most three errors; one on duration, one on time interval and only one on IPA</td><td></td></tr>
<tr><td>e3A1</td><td>4 workers. All 16 activities present (just once). No errors.</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td>The table below is helpful in checking an activities duration, time interval and IPA
<table>
<tr><th>Activity</th><th>Duration</th><th>Time Interval</th><th>IPA</th></tr>
<tr><td>A</td><td>7</td><td>0 – 7</td><td>-</td></tr>
<tr><td>B</td><td>5</td><td>0 – 7</td><td>-</td></tr>
<tr><td>C</td><td>8</td><td>0 – 13</td><td>-</td></tr>
<tr><td>D</td><td>10</td><td>7 – 17</td><td>A B</td></tr>
<tr><td>E</td><td>9</td><td>5 – 17</td><td>B</td></tr>
<tr><td>F</td><td>8</td><td>5 – 18</td><td>B</td></tr>
<tr><td>G</td><td>13</td><td>5 – 21</td><td>B</td></tr>
<tr><td>H</td><td>8</td><td>8 – 21</td><td>B C</td></tr>
<tr><td>I</td><td>8</td><td>17 – 25</td><td>D E</td></tr>
<tr><td>J</td><td>5</td><td>17 – 32</td><td>D E F</td></tr>
<tr><td>K</td><td>9</td><td>17 – 27</td><td>D E F</td></tr>
<tr><td>L</td><td>6</td><td>18 – 27</td><td>G H</td></tr>
<tr><td>M</td><td>7</td><td>25 – 32</td><td>I</td></tr>
<tr><td>N</td><td>9</td><td>25 – 38</td><td>I</td></tr>
<tr><td>P</td><td>6</td><td>32 – 38</td><td>J K L M</td></tr>
<tr><td>Q</td><td>11</td><td>26 – 38</td><td>K L</td></tr>
</table></td><td></td></tr>
</table>

Question Number	Scheme	Marks
8. (a)		B1 B1 B1 **(3)**
(b)	 Optimal vertex is $\left(\frac{238}{9}, \frac{305}{9}\right)$	M1 A1 A1 A1
		(4)

(c)	<table><tr><td></td><td>$x+4y\leqslant 162$</td><td>$5x+2y\leqslant 200$</td><td>Y/N</td><td>Value</td></tr><tr><td>26, 33</td><td>158</td><td>196</td><td>Y</td><td>321</td></tr><tr><td>26, 34</td><td>162</td><td>198</td><td>Y</td><td>326</td></tr><tr><td>27, 33</td><td>159</td><td>201</td><td>N</td><td></td></tr><tr><td>27, 34</td><td>163</td><td>203</td><td>N</td><td></td></tr></table> Optimal solution is $x = 26$, $y = 34$ value 326	dM1 A1 A1
		(3)
(d)	Considers limiting cases $P=kx+y$ parallel to $x+4y=162$ and $5x+2y=200$ $\frac{1}{4}<k<\frac{5}{2}$	M1 A1
		(2)
		12 marks
	Notes for Question 8	
a1B1	Two lines correctly drawn $y = 15$ should pass through two points of the form (…, 15) $y = 3x+10$ must pass through (0, 10) and (10, 40) $5x+2y = 200$ must pass through (24, 40) and (32, 20) Lines should pass within one small square of these points.	
a2B1	All three lines correct	
a3B1	All lines correct and feasible region labelled with *R*.	
b1M1	Attempts to solve at least 3 pairs of simultaneous equations to find the coordinates of vertices (may be implied by three correct coordinate pairs)	
b1A1	2 pairs of coordinates (excluding $\left(\frac{5}{3}, 15\right)$) and their corresponding values of objective function correct (accept decimal equivalents to at least 1 decimal place)	
b2A1	All 3 pairs of coordinates (excluding $\left(\frac{5}{3}, 15\right)$) and their corresponding values of objective function correct (accept decimal equivalents to at least 1 decimal place)	
b3A1	Optimal vertex stated or clearly identified (must be exact coordinates)	

c1dM1	Dependent on obtaining an optimal vertex from a choice of at least two vertices considered in (b); in part (b) there must be working, even if incorrect, leading to identifying an optimal vertex. Considers integer solutions around their optimal point (at least 3 integer points considered). We need to see them engage with the values, not just list points around their optimal point (e.g. a rectangle with vertices labelled is not sufficient). We want to see at minimum a calculation or values embedded in the objective function for these vertices.	
c1A1	Three points correct ((27, 34) not required) – i.e the two feasible integer solutions with correct values, and a rejection of one of the coordinate(s) outside the feasible region. Accept if (27, 33) is not used at any point in calculations – we can accept this as implicit rejection of this point.	
c2A1	CAO Correct integer coordinate stated with correct value for the objective function. Accept the coordinate given in the form $x = \ldots$, $y = \ldots$ Must score the previous A mark.	
d1M1	Considers limiting cases – may be implied by correct answer. Note that **both** limiting cases must be considered; e.g. reaching $k < \frac{5}{2}$ only is M0. **Alt Method for d):** Some candidates might consider the value of the objective function at the vertices $\left(\frac{122}{13}, \frac{496}{13}\right), \left(\frac{238}{9}, \frac{305}{9}\right)$ and $(34, 15)$ M1: **Both** of the following inequalities considered: $\frac{238}{9}x + \frac{305}{9} > \frac{122}{13}x + \frac{496}{13}$ **and** $\frac{238}{9}x + \frac{305}{9} > 34x + 15$	
d1A1	CAO (Condone non-strict inequalities)	