Pearson
Edexcel

Mark Scheme (Results)

Summer 2025

Pearson Edexcel International Advanced Level in Decision Mathematics D1 (WDM11) Paper 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.

EDEXCEL GCE MATHEMATICS

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: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. 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 $\surd$ 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
- $\ast$ 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.

Question	Scheme	Marks
1 (a)	(180 + 300 + 250 + 410 + 240 + 120 + 230 + 310 + 190)/600 = 3.72	**M1**
	Lower bound = 4	**A1**
		(2)
(b)	Van 1: **180** **300** 120 Van 2: **250** **240** Van 3: **410** 190 Van 4: 230 310	**M1** **A1**
		(2)
		(4 marks)

Notes	
a1M1	Calculates (2230 +/-410)/ 600 a calculation using the sum of the activities (accept a total in the range 1820 – 2640) (accept 3.71 as correct truncated value). This can be awarded for sight of the calculation or awrt 3.7
a1A1	CAO – must follow from a correct calculation or decimal (rounded or truncated), so we must see either 2230/600 o.e. or awrt 3.7 - an answer of 4 with no working scores M0
b1M1	The **correct** first five items placed correctly (the bold values) and at least seven values placed in bins (allow repeated values). Condone cumulative totals or calculation of the remaining space for M1 only
b2A1	CSO

Question	Scheme	Marks
2 **(a)**	PR PU UV PQ RS ST	**M1** **A1**
		(2)
(b)	"540" x 2 = 1080 (metres)	**M1** **A1ft**
		(2)
(c)	PRSTUVQP 880 (metres)	**M1** **A1** **A1**
		(3)
(d)	$540 - 75 + (75 + 180) = 720$ (metres)	**M1** **A1**
		(2)
		(9 marks)

Notes	
a1M1	Prim - first three arcs correctly chosen in order (PR, PU, UV, …) **or** first four nodes {P, R, U, V, …}. If any explicit rejections seen at some point then M1 (max) only. Order of nodes may be seen at the top of a matrix/table {1, -, 2, - , - , 3, 4 }. Starting at any other node can score M1 only for first three arcs chosen correctly
a1A1	CSO – all **arcs** correctly **stated** and chosen in the correct order (with no additional arcs). They must be considering arcs for this mark (do not accept a list of nodes or numbers across the top of the matrix unless the correct list of arcs (in the correct order) is also seen)
b1M1	Calculates the weight of their MST and doubles If their MST is incorrect, follow through the total for their tree (must be exactly 6 arcs)
b1A1ft	1080 or 2 x "their 540" (if any subsequent calculations are seen do not isw this is A0) (1080 implies both marks)
c1M1	NN route attempted, first five nodes correct PRSTU (accept arcs for this mark PR, RS, ST, TU, …) (do not accept numbering across the matrix here unless nodes or arcs are stated in the correct order)
c1A1	CAO – Route correct including return to P (accept arcs PR, RS, ST, TU, UV, VQ, QP) (condone if arcs stated alphabetically instead of in route order)
c2A2	CAO – 880 (metres) (if they double the length of the NN route do not isw, this is A0)
d1M1	Their "540" – 75 + two shortest from T (a new calculation to find the RMST may be seen e.g. new table with T deleted and a new MST calculation, with the correct 5 arcs circled PR PU UV PQ RS plus two shortest from T)
d1A1	CAO – A final answer of 720 implies both marks (if additional calculations seen do not isw)

Question	Scheme	Marks
3. (i)(a)	Middle Right Pivot 28 18 50 27 48 8 25 12 56 31 33 42 — 25 18 8 12 **25** 28 50 27 48 56 31 33 42 — 8, 56 **8** 18 12 **25** 28 50 27 48 31 33 42 **56** — 12, 48 **8** **12** 18 **25** 28 27 31 33 42 **48** 50 **56** — (18), 31, (50) **8** **12** **18** **25** 28 27 **31** 33 42 **48** **50** **56** — 27, 42 **8** **12** **18** **25** **27** 28 **31** 33 **42** **48** **50** **56** Middle Left Pivot 28 18 50 27 48 8 25 12 56 31 33 42 — 8 **8** 28 18 50 27 48 25 12 56 31 33 42 — 25 **8** 18 12 **25** 28 50 27 48 56 31 33 42 — 18, 48 **8** 12 **18** **25** 28 27 31 33 42 **48** 50 56 — (12), 31, 50 **8** **12** **18** **25** 28 27 **31** 33 42 **48** **50** 56 — 28, 33, (56) **8** **12** **18** **25** 27 **28** **31** **33** 42 **48** **50** **56** **M1** **A1** **A1ft** **A1**
		(4)

(i)(b)	8 12 18 25 27 28 **31** 33 42 48 50 56 Pivot 31 31 < 40 so discard 31 and below 33 42 **48** 50 56 Pivot 48 48 > 40 so discard 48 and above 33 **42** Pivot 42 42 > 40 so discard 42 **33** 33 ≠ 40 so 40 is not in the list	**M1** **A1** **A1**
	Alternatively 56 50 48 42 33 31 **28** 27 25 18 12 8 Pivot 28 28 < 40 so discard 28 and below 56 50 48 **42** 33 31 Pivot 42 42 > 40 so discard 42 and above 33 **31** Pivot 31 31 < 40 so discard 31 33 33 ≠ 40 so 40 is not in the list	
		(3)
(ii)	$x > 15$ or $x < 19$ o.e. $x > 15$ and $x < 19$ leading to $15 < x < 19$ or $16 \leqslant x \leqslant 18$ o.e.	**B1** **B1**
		(2)
		(9 marks)

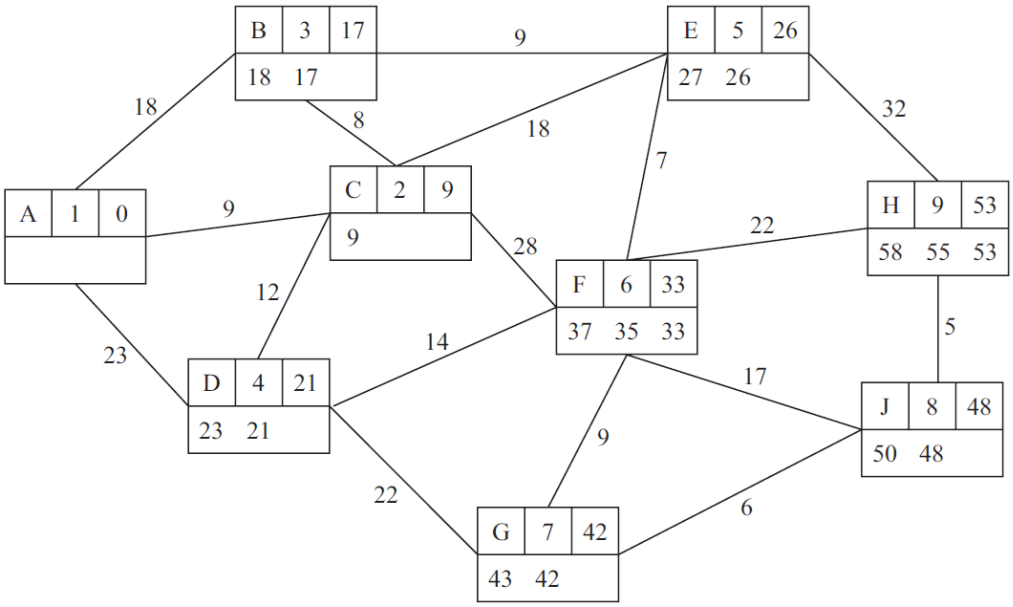
Notes	
ia1M1	Quick sort using all 12 numbers (condone one item error or omission), pivot, p, chosen (must be choosing middle left or right – choosing first/last item as the pivot is M0). After the first pass the list must read (values less than the pivot), pivot, (values greater than the pivot). **If only choosing one pivot per iteration then M1 only**
ia1A1	First and second passes correct, but not choice of pivots for 3rd pass
ia2A1ft	Third and fourth passes correct following through from their second pass and choice of pivots for the third pass. The pivots for the third, and fourth passes must be consistent (so all MR or all ML)
ia3A1	CSO (correct solution only – all previous marks in this part **must** have been awarded) including a fifth pass (with both 27 and 42 chosen as pivots MR or both 28 and 33 chosen as pivots ML)
	Special Case for (a) If the candidate sorts into descending order they can score M1 as per the main scheme (but with the values either side of the pivot reversed), A1 for a fully correct sort then A0 A0 even if the list is reversed at the end (so 2 marks max.). See below
ib1M1	Correct choice of pivot (**must be using MR**) (31 ascending or 28 descending) and discards 8 to 31 or 28 (must be using the sorted list, but could be sorted into either ascending or descending order) It must be clear which values are being discarded or the reduced list must be shown. If pivots are retained, this will score M1 only. Candidates may either compare with the actual values or the positions of items in a correctly sorted list. The actual rejections may be shown as values from the list or the positions in the list. (If they do not not have the correct 12 numbers in their sorted list in (a) they can score M1 only for using their sorted list here)
ib1A1	2nd and 3rd pass correct choice of pivots and discards (if pivot not discarded A0)
ib2A1	CSO - Final pass correct, compares with 33 and concludes 40 is not in list
ii1B1	One inequality correct – if a list of inequalities is seen, they must clearly select from this list otherwise B0
ii2B1	Both inequalities correct and combined to give a range of values (accept either form or list of values 16, 17, 18) (SC if just 16, 17, 18 seen accept this for both marks) (accept interval notation either (15, 19) or [16, 18])

Special Case Descending Max M1 A1 A0 A0
Middle Right

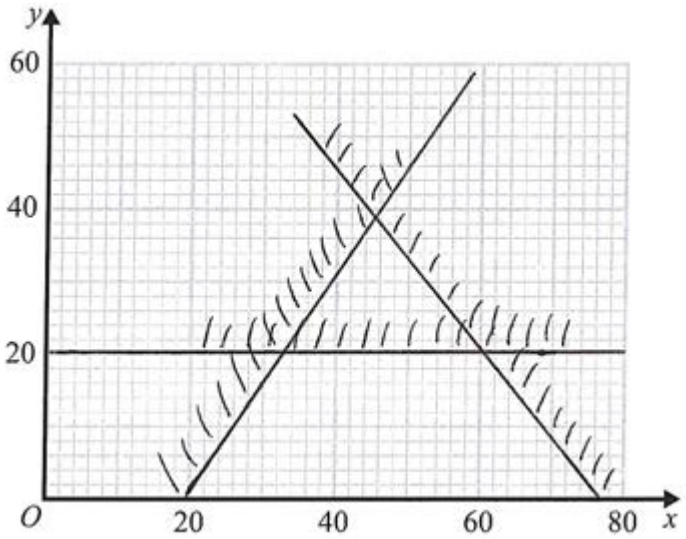
												Pivot
28	18	50	27	48	8	25	12	56	31	33	42	25
28	50	27	48	56	31	33	42	**25**	18	8	12	56, 8
56	28	50	27	48	31	33	42	**25**	18	12	**8**	48, 12
56	50	**48**	28	27	31	33	42	**25**	18	**12**	**8**	(50), 31, (18)
56	**50**	**48**	33	42	**31**	28	27	**25**	**18**	**12**	**8**	42, 27
56	50	48	42	33	31	28	27	25	18	12	8	

Middle Left

												Pivot
28	18	50	27	48	8	25	12	56	31	33	42	8
28	18	50	27	48	25	12	56	31	33	42	**8**	25
28	50	27	48	56	31	33	42	**25**	18	12	**8**	48, 18
50	56	**48**	28	27	31	33	42	**25**	**18**	12	**8**	50, 31, (12)
56	**50**	**48**	33	42	**31**	28	27	**25**	**18**	**12**	**8**	33, 28
56	50	48	42	33	31	28	27	25	18	12	8	

Question	Scheme	Marks
4. **(a)(i)**	 Fastest route: ACBEFGJH	**M1** **A1** (ACBD) **A1** (EFG) **A1ft** (JH) **A1**
(ii)	Fastest time: 53 (minutes)	**A1ft**
		(6)
(b)	Either calculates new fastest route AF(35) + FH(22) = 57 Or calculates the change to sections of the route e.g. ACDF compared with ACBEF and FGJH compared with FJH Difference 57 – "53" = 4 (minutes) or 2 + 2 = 4 (minutes)	**M1** **A1ft**
		(2)
		(8 marks)

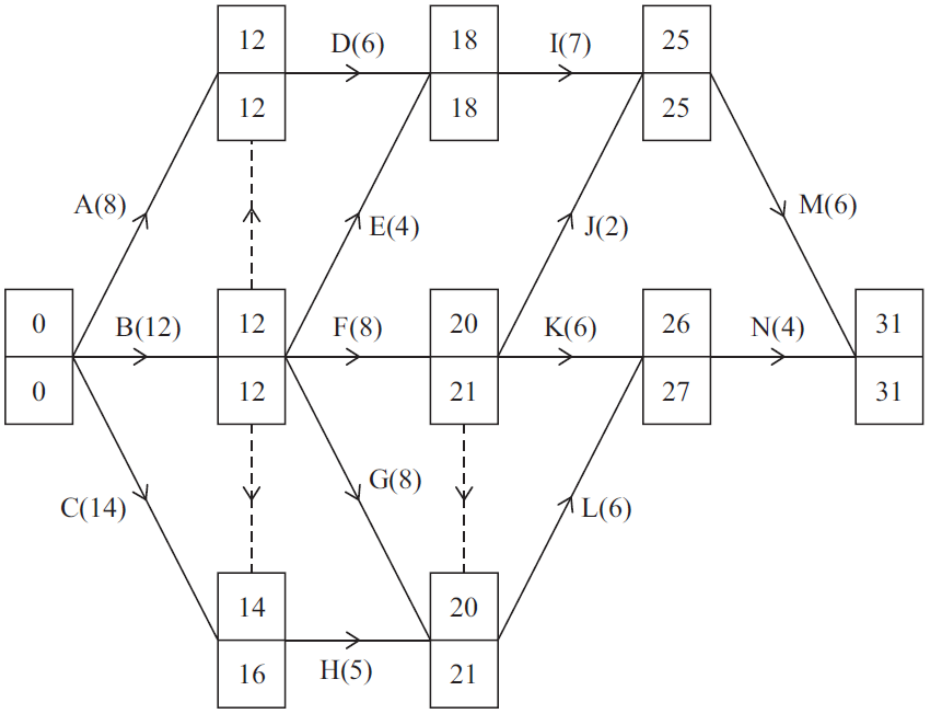
	Notes
	In (a) it is important that all values at each node are checked very carefully – the order of the working values must be correct for the corresponding A mark to be awarded e.g. at E the working values must be 27 26 in that order (so 26 27 is incorrect) **It is also important that the order of 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**
ai1M1	A larger value replaced by a smaller value at least twice in the working values at either B, D, E, F, G, H, J
ai1A1	All values at A, C, B and D correct and the working values in the correct order
ai2A1	All values at E, F and G correct and the working values in the correct order
ai3A1ft	All values in J and H 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 F and G). For example, if correct then the order of labelling of nodes F and G are 6 and 7 respectively so the working values at J should come from F and G in that order. The first working value at J should be their 50 (the Final value at F) + 17 (the weight of the arc FJ), the second working value at J should be their 48 (the Final value at G) + G (the weight of the arc GJ). Repeat the process for H (which will have working values from E, F and J with the order of these nodes determined by the candidate's order of labelling at E, F and J)
ai4A1	CAO
aiiA1ft	Follow through their final value at H **only** – if answer is 53 but the final value at H is not 53 then A0 (condone lack of minutes)
bM1	Either calculates the revised time of 57 minutes Or compares the route in stages e.g. ACBEF against ACDF difference 2 and FGJH against FJH difference 2. If their final value at H is not 53 follow through their final value at F and shortest from F to H for these calculations
bA1ft	4 (minutes) (may be seen as 2 + 2 = 4) or follow through 57 - their fastest to H (which may be in sections AF + FH)

Question	Scheme	Marks
5 (a)	Maximise ($P =$) $x + y + z$	**B1**
		(1)
(b)	$12.50x + 10y + 15z \leqslant 1400$ $\Rightarrow \ 5x + 4y + 6z \leqslant 560$ *	**M1** **A1**
		(2)
(c)	$x \geqslant \frac{40}{100}(x + y + z)$ $\Rightarrow 3x \geqslant 2y + 2z$ $3y \leqslant 2z$	**M1** **A1** **B1**
		(3)
(d)	$3x \geqslant 2y + 2 \times 30$ $\Rightarrow \ 3x - 2y \geqslant 60$ *	**M1** **A1**
		(2)
(e)	 Optimal point (60, 20) 60 red (rose bushes), 20 yellow (rose bushes)	**M1** **A1** **A1** **A1**
		(4)
		(12 marks)

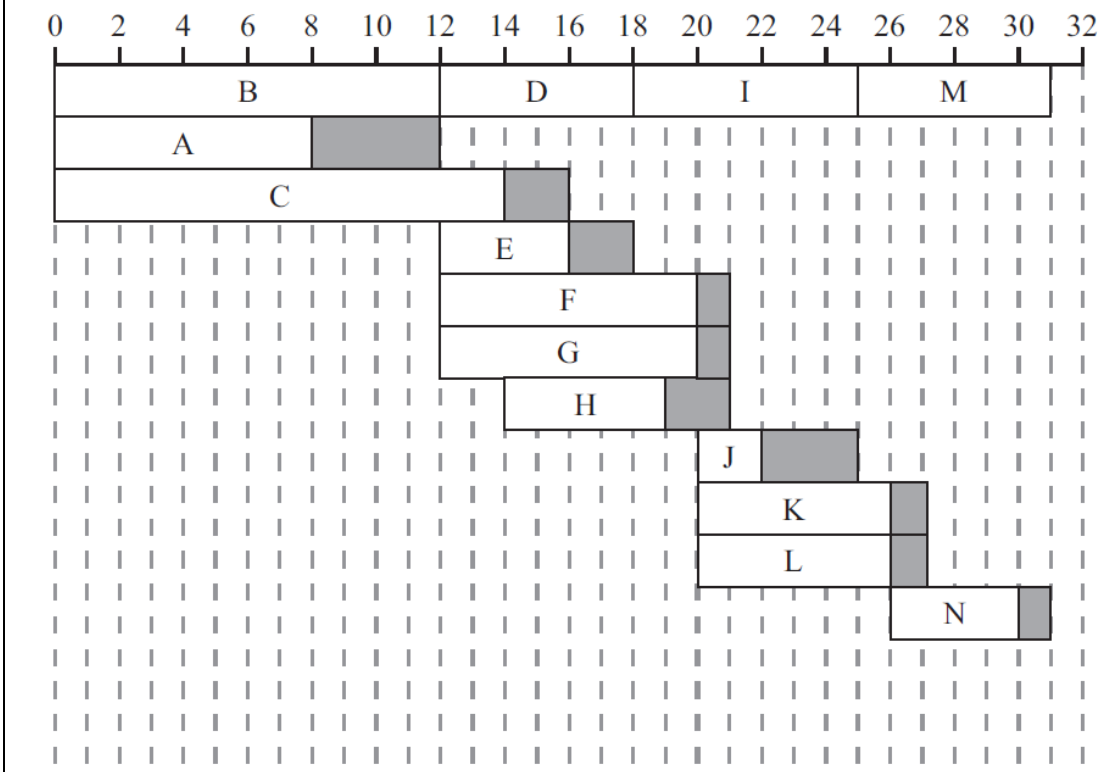
Notes	
aB1	CAO – must have maximise (accept max but not maximum) and $x + y + z$
bM1	Forms inequality using the costs and attempts to simplify. If a correct equation is formed and then changed to an inequality this is M1 A0
bA1	CSO *
cM1	Attempts to form inequality with either 0.4 or 40/100 (o.e. fraction) combined with ($x + y + z$). Accept any inequality or equals for this mark
cA1	CAO – **fully** simplified with integer coefficients
cB1	CAO
dM1	Substitutes $z = 30$ into their $3x \geqslant 2y + 2z$ and attempts to simplify (Allow recovery if their inequality is not fully simplified e.g. $6x \geqslant 4y + 4z$)
dA1	CSO *
eM1	Draws at least two of the three lines with at least one correct (Condone no consideration of $y \geqslant 0$)
e1A1	Any two lines correct $y = 20$ $5x + 4y = 380$ passes through (60, 20) and (76, 0) $3x - 2y = 60$ passes through (20, 0) and (40, 30) (must be within ½ small square from these points)
e2A1	All three lines correct
e3A1	CSO – must have drawn the correct region (we do not require shading or for the feasible region to be marked with *R*, but if this is done, the region selected must be correct) The answer must be in context so $x = 60$, $y = 20$ is A0 Accept 60 red and 20 yellow with no mention of rose bushes. We do not need to see any mention of white roses here.

Question	Scheme	Marks
6 (a)	Considers pairings of nodes F, J, K and M FJ + KM = 32+14 = 46 FK + JM = 15+26 = 41 FM + JK = 13+17 = 30 Repeat FG GM JL LK Total length = 338 + 30 = 368 (km)	**M1** **A1** **A1** **A1** **A1ft**
	Special Case Max M1 A1 A0 A0 A0 Considers pairings of A, F, K and M AF + KM = 26 + 14 = 40 AK + FM = 41 + 13 = 54 AM + FK = 39 + 15 = 54	
		(5)
(b)	Now only repeat needed is KM, length 14 e.g. New length 338 + 18 + 14 = 370 (km) (Increases length by) 2 (km)	**M1** **A1**
		(2)
		(7 marks)

Notes	
a1M1	The correct three pairings of the correct four nodes F, J, K and M with one row correct (including total)
a1A1	Two rows correct including pairings **and** totals
a2A1	All three rows correct including pairings **and** totals
a3A1	CAO for the repeated arcs
a4A1ft	338 + their smallest from a choice of three totals
M1 **A1** **A0** **A0** **A0**	**Special Case – considers A, F, K, M** Three pairings of the four nodes with one row correct (including total) All three rows correct including pairings and totals No further marks available
b1M1	Considers KM (may be implied by a correct calculation) as only pair of odd nodes and calculates new length 338 + 18 +14 or calculates 18 + 14 as new additional length
b1A1	CAO – 2 (km) (must not come from any incorrect working)

Question	Scheme	Marks
7. **(a)**		**B1** (DEFGH) **B1** (IJK) **B1** (LMN)
		(3)
(b)		**M1** **A1** **M1** **A1**
		(4)

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

(c)	Lower bound = (8+12+14+6+4+8+8+5+7+2+6+6+6+4)/31 = 96/31 = 3.1 Therefore 4 workers required	**M1** **A1**
		(2)
(d)		**M1** **A1** **A1** **A1**
		(4)
(e)	At $13 < t < 14$ activities D, C, F and G must be happening and at $16 < t < 17$ activities D, F, G and H must be happening. Also activity E must be happening at either $13 < t < 14$ or $16 < t < 17$ so a total of five workers	**M1** **A1** **A1**
		(3)
		(16 marks)

Notes	
a1B1	Activities D, E, F, G and H correct
a2B1	Activities I, J and K correct
a3B1	Activities L, M and N correct
b1M1	**All** top boxes complete, values generally increasing in the direction of the arrows ('left to right'), condone one rogue value which is a number in a top box greater than the subsequent value
b1A1	CAO (top boxes)
b2M1	**All** bottom boxes complete, values generally decreasing in the opposite direction of the arrows ('right to left'), condone one rogue value which is a number in a bottom box greater than the previous value. Condone missing 0 and/or their 31 (at the end event) for the M mark only
b2A1	CAO (bottom boxes)
c1M1	Calculates 96 (+/-14)/"31" – a calculation using the sum of the activities (accept a total in the range 82 – 110) divided by their finish time or sight of awrt 3.1
c1A1	4 workers but must follow from a correct calculation (awrt 3.1) with no incorrect working seen (note an answer of 4 with no working is M0)
d1M1	Cascade Chart not a schedule. At least 9 activities including at least 5 floats
d1A1	Critical activities (BDIM) and at least 3 non-critical activities correct
d2A1	At least 7 non-critical activities correct
d3A1	CAO All 14 activities present (just once). No errors**.**
e1M1	A statement mentioning one of the following • 4 workers, 4 of D C E F G stated and time 13 – 14 • 4 workers, 4 of D E F G H stated and time 16 – 17 • 5 workers, either D C E F G or D E F G H stated and any time interval
e1A1	A correct statement of 5 workers with details of both the time **and** activities for one of the intervals. Candidates must give a time within one of the correct intervals. Either $13 < t < 14$, e.g. 13.5 (or 'on/during day 14') and state the correct activities D, C, E, F and G or $16 < t < 17$ (or e.g. 16.5 or 'on/during day 17') and the correct activities D, E, F, G and H. Please note an inequality for the time interval implying a time of 13, 14, 16 or 17 is incorrect. Answers given as an interval of time are acceptable provided the time interval stated is correct for all its possible values (e.g. time 13 – 14 or 'between 13 and 14' is A0)
e2A1	A fully correct statement mentioning both intervals and both correct groups of activities and stating 5 workers

Question	Scheme	Marks
8. **(a)**	$y \leqslant 2x + 5$ $x + 5y \leqslant 150$ $2x + y \leqslant 70$ $5y \geqslant 3x - 15$	**B1** **B1**
		(2)
(b)	$3x + 2y = 48$ $\qquad$ $x + 5y = 150$ $5y = 3x - 15 \Rightarrow \left(\frac{90}{7}, \frac{33}{7}\right)$ $\quad 2x + y = 70 \Rightarrow \left(\frac{200}{9}, \frac{230}{9}\right)$ $\frac{90}{7}a + \frac{33}{7}b = \frac{1419}{7} \Rightarrow 30a + 11b = 473$ $\frac{200}{9}a + \frac{230}{9}b = \frac{1730}{3} \Rightarrow 20a + 23b = 519$ $a = 11 \quad b = 13$ or $P = 11x + 13y$	**M1** **A1** **M1** **A1**
		(4)
(c)	Considers the gradient of $Q = 3x + 2y$ and attempts to find a limiting value for k Considers the gradient of $Q = 2x + y$ and attempts to find a limiting value for k e.g. $-\frac{1}{k} < -\frac{3}{2}$ and $-\frac{1}{k} > -2$ $\Rightarrow k < \frac{2}{3}$ or $k > \frac{1}{2}$ $\frac{1}{2} < k < \frac{2}{3}$	**M1** **M1** **A1** **A1**

	Alternative 1 Compares value of objective function at A and E Compares value of objective function at C and D $\frac{38}{7} + \frac{111}{7}k < \frac{90}{7} + \frac{33}{7}k \quad \Rightarrow k < \frac{2}{3}$ $\frac{200}{9} + \frac{230}{9}k > \frac{365}{13} + \frac{180}{13}k \quad \Rightarrow k > \frac{1}{2}$ giving $\frac{1}{2} < k < \frac{2}{3}$	**M1** **M1** **A1** **A1**
	Alternative 2 Rearranges $3x + 2y = 48$ to compare with $x + ky$ Rearranges $2x + y = 70$ to compare with $x + ky$ $x + \frac{2}{3}y = 16 \quad \Rightarrow k < \frac{2}{3}$ $x + \frac{1}{2}y = 35 \quad \Rightarrow k > \frac{1}{2} \qquad \frac{1}{2} < k < \frac{2}{3}$	**M1** **M1** **A1** **A1**
		(4)
	For reference the coordinates of all points of intersection A $\left(\frac{38}{7}, \frac{111}{7}\right)$ $3x + 2y = 48$ and $y = 2x + 5$ B $\left(\frac{125}{11}, \frac{305}{11}\right)$ $y = 2x + 5$ and $x + 5y = 150$ C $\left(\frac{200}{9}, \frac{230}{9}\right)$ $x + 5y = 150$ and $2x + y = 70$ D $\left(\frac{365}{13}, \frac{180}{13}\right)$ $2x + y = 70$ and $5y = 3x - 15$ E $\left(\frac{90}{7}, \frac{33}{7}\right)$ $5y = 3x - 15$ and $3x + 2y = 48$	
		(10 marks)

Notes	
a1B1	Any two inequalities correct (accept equivalent rearrangements)
a2B1	CAO – all four correct (ignore any mention of $3x + 2y \geq 48$ (SC B1 B0 for all four strict inequalities)
b1M1	Attempts to solve both correct pairs of simultaneous equations (candidates may use their calculator to solve these, so the correct values for both points implies both marks) Ignore any additional work to find other points of intersection
b1A1	CAO – both pairs of coordinates (accept awrt (12.9, 4.7) and (22.2, 25.6)) Ignore additional points of intersection
b2M1	Forms a pair of simultaneous equations using their minimum and maximum points and solves to obtain *a* and *b* (may be unsimplified). If they have calculated additional points of intersection, then they must use their answer for the correct two points here
b2A1	CAO – must be exact values (either stating *a* and *b* or as function *P* =)
c1M1	Considers $3x + 2y$ and attempts to find a value for *k* by comparing gradients or compares the value of the objective function at A and E (accept the use of *m* for -1/*k* to compare gradients even if not clearly defined)
c2M1	Considers $2x + y$ and attempts to find a value for *k* by comparing gradients or compares the value of the objective function at C and D
c1A1	Either $k < \frac{2}{3}$ or $k > \frac{1}{2}$ (allow use of $\leqslant$ and $\geqslant$) (If gradients are compared please check inequalities carefully to ensure that any working shown is fully correct) (this mark can be awarded following either of the M marks so M0 M1 A1 A0 or M1 M0 A1 A0 are possible)
c2A1	Both values correct and correct interval stated (allow use of $\leq$) (both M marks must be awarded and must not come from incorrect working)

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