Mark Scheme (Pre-standardisation)

January 2016

Pearson Edexcel International A Level in Decision Mathematics 1 (WDM01) 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.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

PEARSON EDEXCEL IAL 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.

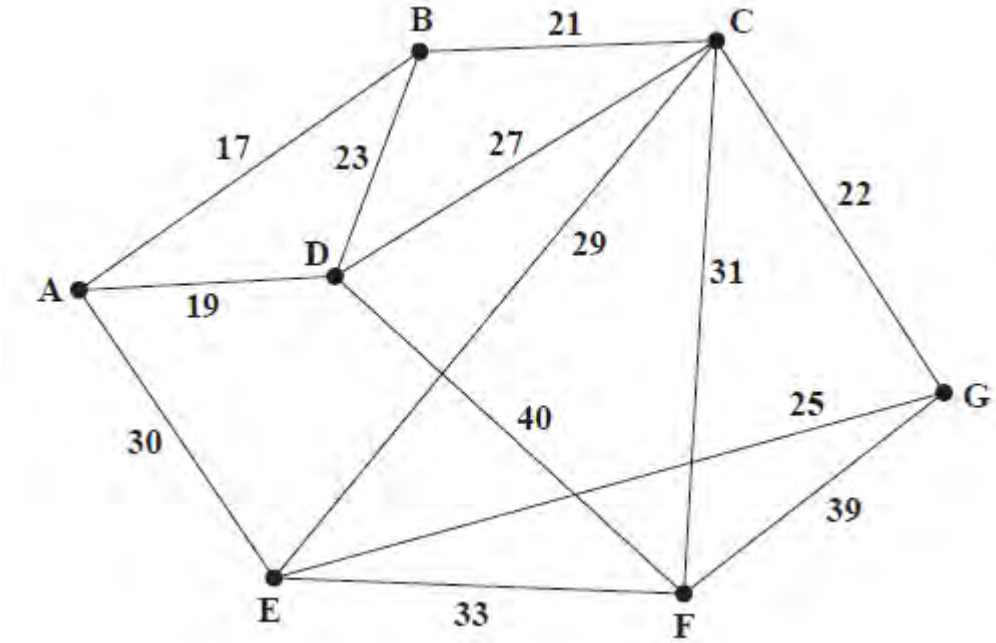
- bod – benefit of doubt
- ft – follow through
- the symbol $\surd$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special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

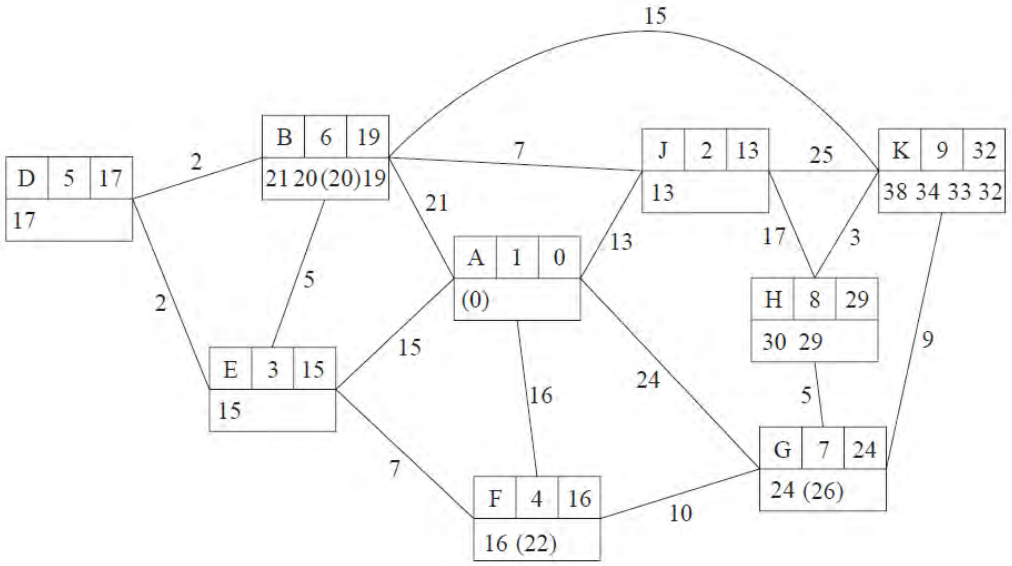
6. If a candidate makes more than one attempt at any question:
    - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
    - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

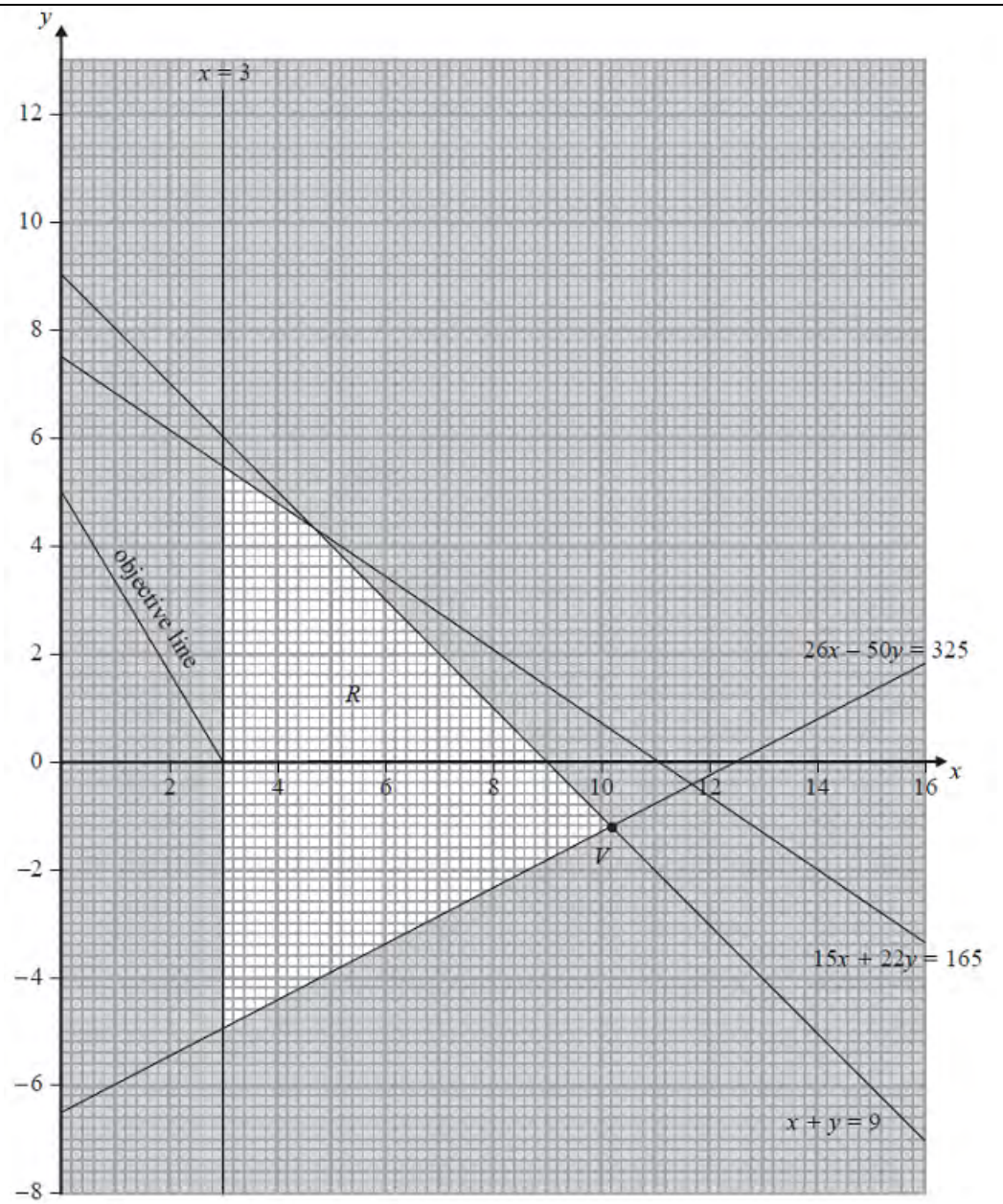
7. Ignore wrong working or incorrect statements following a correct answer.

Question Number	Scheme	Marks
1.		
(a)	Alternating path D – 1 = C – 6 Change status D = 1 – C = 6 Improved matching A=4, (B unmatched), C = 6, D = 1, E = 3, F = 2	M1 A1 **(2)**
(b)	e.g. Tasks 4 and 5 can only be done by A e.g. B can only do 2, E can only do 3, and F can only do 2 or 3. So there are three workers to match to just two tasks.	B1 **(1)**
(c)	E to 4 should be chosen e.g. E to 4 would release A to 5 e.g. if A is retrained then tasks 4 and 5 can still only be done by A	M1 A1 **(2)**
(d)	Alternating path B – 2 = F – 3 = E – 4 = A – 5 Change status B = 2 – F = 3 – E = 4 – A = 5 Complete matching A = 5, B = 2, C = 6, D = 1, E =4, F = 3	M1 A1 A1 **(3)**
		8 marks
	Notes:	
a1M1	An alternating path from D to 6 (or vice versa) including change status (either stated or shown)	
a1A1	Cao – correct improved matching (from correct stated path). Accept on a clear diagram (with five arcs only).	
b1B1	Cao	
c1M1	E to 4 selected with a reason given. One of A, 4 or 5 must be mentioned.	
c1A1	A correct reason given – must explicitly explain why E to 4 allows a complete matching to occur.	
d1M1	An alternating path from B to 5 (or vice versa)	
d1A1	Cao – a correct path including change status either stated or shown. Chosen path clear.	
d2A1	Cao – must follow from the correct stated path. Accept on a clear diagram (with six arcs only).	

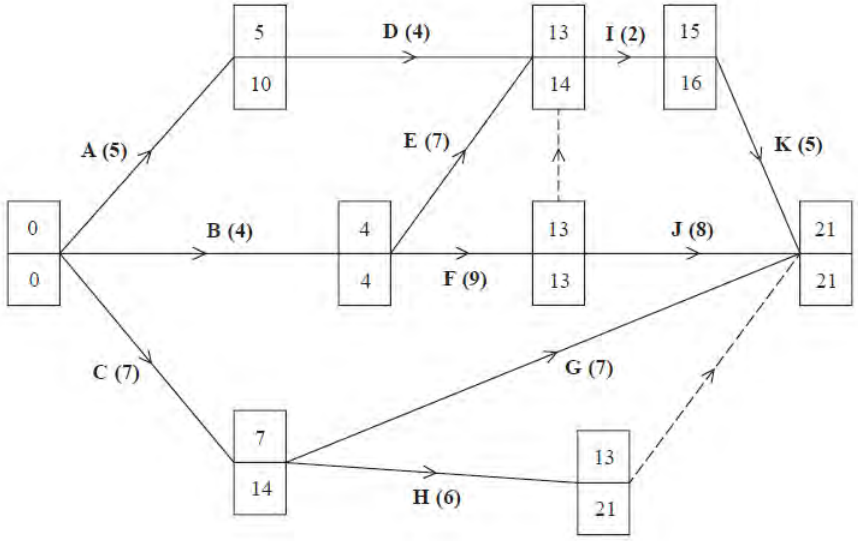
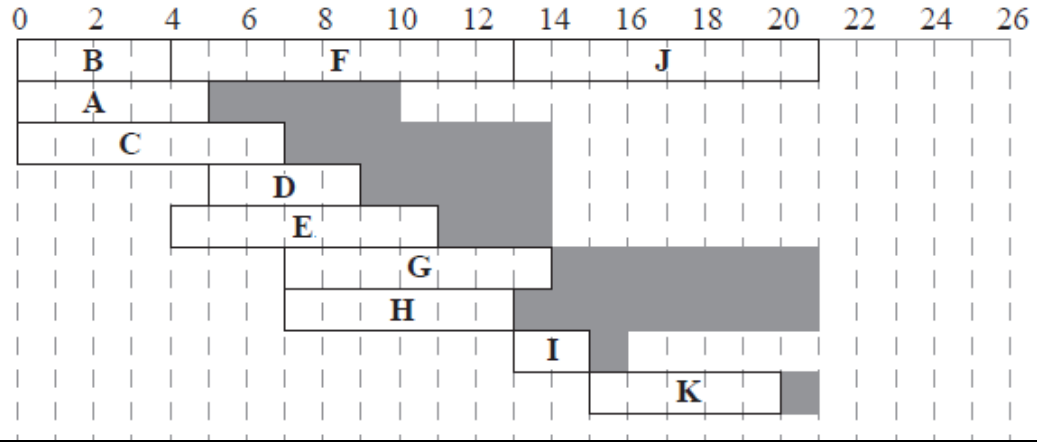
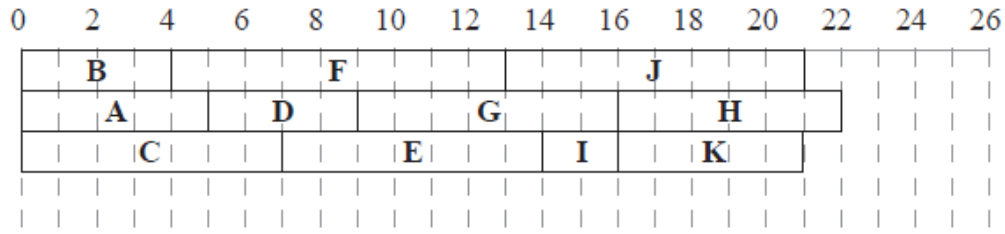
Question Number	Scheme	Marks
2.		
(a)	e.g. accept (i) **Every pair** of vertices connected by a **path** (ii) Connected graph with no cycles (iii) All nodes connected	B1 B1 B1 **(3)**
(b)	$n-1$	B1 **(1)**
(c)		M1 A1 **(2)**
(d)	Kruskal: AB, AD, BC, CG, reject BD, EG, reject CD, reject CE, reject AE, CF	M1 A1 A1 **(3)**
(e)	135 (km)	B1 **(1)**
		10 marks
	Notes:	
a1B1	Must see 'all pairs' and 'path' but not describing complete graph	
a2B1	Cao	
a3B1	Cao (accept definition of minimum spanning tree)	
b1B1	Cao	
c1M1	Either all arcs correct (ignore weights) or all but two arcs correct (including correct weight)	
c1A1	Cao	
d1M1	Kruskal's – first three arcs correctly chosen and at least one rejection seen at some point	
d1A1	All six arcs selected correctly AB, AD, BC, CG, EG, CF	
d2A1	Cso – all selections and rejections correct (in correct order and at the correct time)	
e1B1	Cao (ignore lack of units)	

Question Number	Scheme	Marks
3.		
(a)	Bin 1: 12.1 9.3 10.9 Bin 2: 15.7 6.4 7.9 Bin 3: 17.4 8.1 Bin 4: 20.1 Bin 5: 14.0	M1 A1 A1 **(3)**
(b)(i)	12.1 15.7 10.9 17.4 9.3 20.1 7.9 8.1 14.0 6.4 15.7 12.1 17.4 10.9 20.1 9.3 8.1 14.0 7.9 6.4	M1 A1
(ii)	Comparisons = 9 + 8 = 17 Swaps = 7 + 5 = 12	B1 B1 **(4)**
(c)	12. 1 9.3 15.7 10.9 17.4 6.4 20.1 7.9 8.1 14.0 Pivot 6.4 12.1 9.3 15.7 10.9 17.4 20.1 7.9 8.1 14.0 6.4 Pivot 17.4 20.1 17.4 12.1 9.3 15.7 10.9 7.9 8.1 14.0 6.4 Pivot (20.1) 10.9 20.1 17.4 12.1 15.7 14.0 10.9 9.3 7.9 8.1 6.4 Pivots 15.7 7.9 20.1 17.4 15.7 12.1 14.0 10.9 9.3 8.1 7.9 6.4 Pivots 14.0 8.1 20.1 17.4 15.7 14.0 12.1 10.9 9.3 8.1 7.9 6.4 Sort complete	M1 A1 A1ft A1 **(4)**
(d)	Bin 1: 20.1 12.1 Bin 2: 17.4 14.0 Bin 3: 15.7 10.9 6.4 Bin 4: 9.3 8.1 7.9	M1 A1 A1 **(3)**
(e)	e.g. $\frac{121.9}{33} \approx 3.694$ so yes 4 bins is optimal	B1 **(1)**
		15 marks
	Notes:	
a1M1	First four items placed correctly	
a1A1	First eight items placed correctly	
a2A1	Cso	
b1M1	Bubble sort – 6.4 at the end of the list after the first pass	
b1A1	Cao	
b1B1	Cao on total number of comparisons (allow 9 and 8 seen and referred to correctly)	
b2B1	Cao on total number of swaps (allow 7 and 5 seen and referred to correctly)	
c1M1	Quick sort – pivots, p, selected and first pass given >p, p, <p. If only choosing one pivot per iteration then M1.	
c1A1	First pass correct, next pivot chosen correctly for second pass.	
c2A1ft	Second and third passes correct (follow through from their first pass and choice of pivots) – and next pivot(s) chosen consistently for fourth pass.	
c3A1	Cso including choice of pivots for the fifth pass and 'sort complete'	
d1M1	First four items placed correctly	
d1A1	First eight items placed correctly	
d2A1	Cso	
e1B1	Cao	

Question Number	Scheme	Marks
4.		
(a)	 Quickestest route: A – G – H – K Shortest time: 32 (mins)	M1 A1 (JEFD) A1 (BG) A1ft (HK) A1 A1ft **(6)**
(b)	Route from B to K via A: B – D – E – A – G – H – K Length: 51 (mins)	B1 B1ft **(2)**
(c)	A(ED)B + F(G)H = 19 + 15 = 34 AF + B(K)H = 16 + 18 = 34 A(G)H + B(DE)F = 29 + 11 = 40 Arcs AF, BK, KH or AE, ED, DB, FG, GH will be traversed twice Route length = 196 + 34 = 230 (mins)	M1 A1 A1 A1 A1A1 A1ft **(7)**
		15 marks
	Notes:	
a1M1:	A larger value replaced by a smaller value at least once at B or H or K.	
a1A1:	All values in J, F, E and D correct.	
a2A1:	All values in B and G correct.	
a3A1ft:	Al values in H and K correct on the follow through.	
a4A1:	Cao (shortest path)	
a5A1ft:	Shortest length correct on the follow through	
b1B1:	Cao (route)	
b2B1ft:	Their final value at B + their final value at K	
c1M1:	Three distinct pairings of their four odd nodes	
c1A1:	Any one row correct including pairing and total	
c2A1:	Any two rows correct including pairing and total	
c3A1:	All three rows correct including pairing and total	
c4A1:	Cao – one combination of arcs that need traversing twice	
c5A1:	Cao – both combination of arcs that need traversing twice	
c6A1ft:	196 + their smallest repeat out of a choice of at least two totals seen	

Question Number	Scheme	Marks
5.		
(a), (b)		B1 B1 B1 B1 (R) **(4)** B1 B1 **(2)**
(c)	$V\left(\frac{775}{76}, -\frac{91}{76}\right)$ P = $\frac{1801}{38}$	M1 A1 A1 **(3)**
(d)	$x = 3, y = -4$ minimum value is 3	B1 B1 **(2)**
		11 marks
	Notes:	
a1B1:	Any two lines correctly drawn	
a2B1:	Any three lines correctly drawn	
a3B1:	All four lines correctly drawn	

Question Number	Scheme	Marks
a4B1:	Region, R, correctly labelled – not just implied by shading – dependent on scoring the first three marks in this part.	
b1B1:	Correct objective line	
b2B1:	V labelled clearly on their graph. This mark is dependent on the correct five line segments that define the boundary of the feasible region.	
c1M1:	Simultaneous equations being used to find their V. Must get to $x = \ldots$ and $y = \ldots$	
c1A1:	Correct coordinates of V stated exactly	
c2A1:	Correct value for P	
d1B1:	Cao – for x and y	
d2B1:	Cao (value of $5x + 3y$)	

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.	

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