Mark Scheme (Results)

Summer 2015

Pearson Edexcel International A Level
in Decision Mathematics 1
(WDM01/01)

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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 $\sqrt{}$ 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
    - ⌐ 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)		M1 A1 (SABDC) A1 (FE) A1ft (HG)
	Shortest distance: 23 (km) Shortest route: S – A – C – F – G	A1ft A1 **(6)**
(b)	Shortest distance: 20 (km) Shortest route: S – A – C – F – E – H	B1ft B1 **(2)** **(8 marks)**

Notes for Question 1

a1M1: A larger value replaced by a smaller value at least once in the working values at either C or E or F or G or H

a1A1: All values in S, A, B, D and C correct. The working values at C must be in the correct order. Condone lack of 0 in S's working value

a2A1: All values in F and E correct and the working values in the correct order. Penalise order of labelling only once per question (F and E must be labelled in that order and F must be labelled after S, A, B, D and C)

a3A1ft: All values in H and G correct on the follow through and the working values in the correct order. Penalise order of labelling only once per question (H and G must be labelled in that order and H labelled after all other nodes (excluding G))

a4A1ft: If their answer is not 23 follow through their final value at G (condone lack of units)

a5A1: CAO for the route (S – A – C – F – G)

b1B1ft: If their answer is not 20 follow through their final value at H (condone lack of units)

b2B1: CAO for the route (S – A – C – F – E – H)

Question Number	Scheme									Marks	
2.(a)	In the first pass we compare the first value with the second value and we swap these values if the second is larger than the first We then compare the value which is now second with the third value and swap if the third is larger than the second. We continue in this way until we reach the end of the list									M1 A1	**(2)**

(b)(i) **(ii)**	The smallest value will be in the correct final position after the first pass Maximum number of passes is $n-1$	B1 B1	**(2)**

(c)		11	9	4	13	5	1	7	12	8	M1
	1ˢᵗ pass:	11	9	13	5	4	7	12	8	**1**	
	2ⁿᵈ pass:	11	13	9	5	7	12	8	**4**	**1**	
	3ʳᵈ pass:	13	11	9	7	12	8	**5**	**4**	**1**	A1
	4ᵗʰ pass:	13	11	9	12	8	**7**	**5**	**4**	**1**	
	5ᵗʰ pass:	13	11	12	9	**8**	**7**	**5**	**4**	**1**	A1ft
	6ᵗʰ pass:	13	12	11	**9**	**8**	**7**	**5**	**4**	**1**	

Note: The superscript pass labels above should be read as: 1st, 2nd, 3rd, 4th, 5th, 6th pass.

Sort complete

A1(cso) **(4)**

(d)	Bin 1: <u>13</u> 8 Bin 2: <u>12</u> 9 Bin 3: <u>11</u> 7 1 Bin 4: 5 4	<u>M1</u> A1	**(2)**

(10 marks)

Notes for Question 2

a1M1: Comparing **first** value with **second** value, **swap** if **second** is **larger** (oe) – must be clear that the first value in the list is being compared with the second value in the list and swapping if the second is larger than the first

a1A1: Compare **second** with **third**, (third with fourth), **and so on** until the **end** of the list – must be clear that after the first comparison the second value in the list is compared with the third value and so on until the end of the list

bi1B1: CAO (on smallest value oe) – allow 1 (this is the smallest value from the list in (c))
bii2B1: CAO

c1M1: Bubble sort. Consistent direction, end number (1) in place. Do check these carefully as some candidates show the result of each comparison and swap in the first pass. Consider the placement of the candidate's numbers, rather than what the candidate labels each line of their pass. For example, assume that the first time that the 1 appears at the end of the list is the end of their first pass
c1A1: First and second passes correct – so end two numbers in place
c2A1ft: Third and fourth passes correct following through from the candidate's second pass
c3A1: CSO – including either a 'sort complete' statement **or** final list rewritten/seventh pass

d1M1: Bins 1 and 2 correct and 11 in Bin 3 (so first 5 values correctly placed) – no follow through on an incorrect list from (c)
d1A1: CSO

Question Number	Scheme	Marks

Sorting list into ascending order in (c)

- If the candidate sorts the list into ascending order and reverses the list then they can score full marks
- If the list is not reversed then mark as a misread. If the candidate says that the list needs reversing but doesn't actually show the reversed list then remove the final A mark earned

Misreads - if there is a 'misread' of a single number (this could take the form of an extra number, a number missing, or a number changed, for example, 31 rather than 13) before starting the sort in (c) then mark as a misread. If they 'misread' more than one number then M0. If they miscopy one of their own numbers during the sort then this is an accuracy error and loses the corresponding A mark(s)

Question Number	Scheme	Marks
3.(a)	e.g. P – Q – S – P	B1 **(1)**
(b)	As vertex Q appears more than once… … P – Q – R – T – Q – S is not an example of a path on G	B1 DB1 **(2)**
(c)	PS, ST, SV; QS, QR; RU, TW	M1; A1; A1 **(3)**
(d)	ST SV PS QS (not QT) QR (not PQ) (not TV) RU TW	M1 A1 A1 **(3)**
(e)		B1 **(1)**
(f)	20 < x < 31	B2,1,0 **(2)** **(12 marks)**

<div align="center">Notes for Question 3</div>

a1B1: Any closed path on G (**must** begin **and** end with the same vertex) – check that no vertex (except the start and end vertex) appears more than once

b1B1: No + attempt at a reason – **any** mention of cycle/circle/loop etc. **or repeated** vertex/node/point etc. is sufficient for this mark (condone incorrect technical language) – give bod

b2DB1: No + correct reason – no bod – must refer to vertex Q appearing twice (in the walk – **not** just that a vertex is repeated) or that it contains the cycle Q – R – T – Q (**not** just that it contains a cycle). All technical language must be correct for this mark

c1M1: Prim's – First three arcs correctly chosen in order (PS, ST, SV, … or weights 13, 9, 11, …) **or** first four nodes {P, S, T, V, …} correctly chosen in order. If any 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, -}

c1A1: First five arcs correctly chosen in order (PS, ST, SV, QS, QR, … or weights 13, 9, 11, 14, 16, …) **or** all eight nodes {P, S, T, V, Q, R, U, W} correctly chosen in order. Order of nodes may be seen at the top of a matrix so for the first two marks accept {1, 5, 6, 2, 3, 7, 4, 8} (**no** missing numbers)

c2A1: CSO – all **arcs** correctly **stated** and chosen in the correct order. They must be considering arcs for this final mark (do not accept a list of the weights of each arc, nodes or numbers across the top of the matrix unless the correct list of arcs (in the correct order) is also seen)

Misread: Starting at a node other than P scores **M1 only** – **must** have the first three arcs (or four nodes or numbers) correct (and in the correct order) – condone rejections seen for this mark

Question Number	Scheme	Marks

d1M1: Kruskal's – first four arcs (ST, SV, PS, QS,… or weights 9, 11, 13, 14,…) chosen correctly in order and **at least one rejection seen at some point**

d1A1: All seven arcs (ST, SV, PS, QS, QR, RU, TW or weights 9, 11, 13, 14, 16, 20, 24) chosen correctly in order and no additional arcs

d2A1: CSO – all selections and rejections correct (in correct order and at the correct time) – do not accept weights only for this mark

- Listing all the arcs in order and then listing those arcs in the tree in the correct order is fine for **full marks** (this implies that rejections are correct and at the correct time)
- Listing all the arcs in order and just drawing the MST is **M0**

e1B1: CAO (condone lack of/incorrect weights on arcs)

f1B1: $x < 31$ or $x \le 31$ or $x < 30$ or $x \le 30$

f2B1: Either $20 < x < 31$ or $21 \le x \le 30$

Question Number	Scheme	Marks
4.(a)	A path from an unmatched vertex in one set to an unmatched vertex in the other set…	B1
	…which alternately uses arcs not in/in the matching	B1 **(2)**
(b)	Initial matching: A = 3, B = 2, D = 4 (C and E unmatched)	B1
	Improved matching: A = 4, B = 3, D = 1, E = 2 (C unmatched)	B1 **(2)**
(c)	e.g. (**see below for alternatives**)	
	Alternating path: C – 3 = B – 2 = E – 5	M1
	Change status to give: C = 3 – B = 2 – E = 5	A1
	Complete matching: A = 4, B = 2, C = 3, D = 1, E = 5	A1 **(3)**
		(7 marks)

Notes for Question 4

Possible paths	A	B	C	D	E
C – 3 – B – 2 – E – 5	4	2	3	1	5
C – 4 – A – 1 – D – 5	1	3	4	5	2
C – 4 – A – 3 – B – 2 – E – 5	3	2	4	1	5

a1B1: **Unmatched** to **unmatched** (vertex/node may be implied but do not accept arc) – technical language (if used) must be correct

a2B1: (Alternate) **arcs not in/in** (arc(s) (**not** vertices/nodes) must be explicitly mentioned)

In (b) ignore the candidates labelling in this part – for example, give bod on candidates who call the initial matching the improved matching (and vice-versa) or those that state the initial matching under (ii). Condone lack of unmatched vertices stated. Both the initial and improved matching may be stated **or** drawn – do check carefully the top of the second page for these drawn there. Only accept a clear diagram with exactly three or four arcs

b1B1: CAO (A = 3, B = 2, D = 4)

b2B1: CAO (A = 4, B = 3, D = 1, E = 2)

c1M1: An alternating path from C to 5 (or vice – versa)

c1A1: CAO – a correct path including change status **either** stated **or** shown. Chosen path clear

c2A1: CAO – must follow from correct stated path. Accept on a clear diagram (with five arcs only).

Question Number	Scheme	Marks
5.(a)	A(BC)E + H(F)G = 15 + 13 = 28* A(BDF)H + E(F)G = 30 + 7 = 37 A(BDF)G + E(F)H = 21 + 16 = 37 Repeat arcs: AB, BC, CE, HF, FG Length: 214 + 28 = 242 (km)	M1 A1 A1 A1 A1 A1ft **(6)**
(b)	4	B1 **(1)**
(c)	EG (7) is the shortest link between two odd nodes excluding H Repeat EG (7) since this is the shortest path excluding H We finish at A Length of route = 214 + 7 = 221 (km)	M1 A1 A1 **(3)** **(10 marks)**

<div align="center">Notes for Question 5</div>

a1M1: Three distinct pairings of the correct four odd nodes

a1A1: One row correct including pairings **and** totals

a2A1: Two rows correct including pairings **and** totals

a3A1: All three rows correct including pairings **and** totals

a4A1: The smallest repeat **arcs** (accept ABCE, HFG but not AE, HG)

a5A1ft: Correct answer of 242 **or** 214 + their least

b1B1: CAO (4)

c1M1: Identifies the need to repeat one path of the three (AE, EG, AG) which does not include H (maybe implicit) or listing of only these possible repeats – this mark is dependent on either scoring the M mark in (a) or stating all three posssible paths

c1A1: Identifies EG as the least **and** A as the finishing point. They have to explicitly state the EG is the least path (but they do not need to include that it is the least of those that do not include H as this is the least of all six possible paths)

c2A1: CAO (221)

Question Number	Scheme	Marks

6.(a)

Activity	Immediately preceded by	Activity	Immediate preceded by	Activity	Immediately preceded by
A	-	G	C	M	I
B	-	H	C	N	D E F J
C	-	I	D E	P	D E F J
D	A	J	G	Q	K P
E	B C	K	G	R	K P
F	B C	L	G H		

Marks: B2,1,0 **(2)**

(b)

M1
A1
M1
A1 **(4)**

(c) Float on D = 21 − 5 − 8 = 8 — B1 **(1)**

(d) Lower bound is $\frac{142}{42} = 3.38 \ldots = 4$ — B1 **(1)**

(e) e.g.

M1
A1
A1
A1 **(4)**

(12 marks)

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

Question Number	Scheme	Marks
7.(a)	$60x + 35y \geq 840$ or $x + \dfrac{7}{12}y \geq 14 \Rightarrow 12x + 7y \geq 168$	M1 A1
	$15x + 24y \leq 480$ or $\dfrac{1}{4}x + \dfrac{2}{5}y \leq 8 \Rightarrow 5x + 8y \leq 160$	M1 A1 **(4)**
(b)	$2y \geq x$	M1 A1 **(2)**
(c)		B1 $12x + 7y = 168$ B1 $5x + 8y = 160$ B1 $2y = x$ B1 R correct **(4)**
(d)(i) **(d)(ii)**	Objective line correctly drawn (and labelled) Optimal vertex labelled $V\left(\dfrac{160}{9}, \dfrac{80}{9}\right)$	B1 DB1 M1 A1 **(4)**
(e)	Make 17 hardbacks and 9 paperbacks, expected profit (£)1344	B1 B1 **(2)** **(16 marks)**

Question Number	Scheme	Marks

Notes for Question 7

a1M1: Two of three coefficients correct with correct inequality sign in unsimplfied form **or** all three coefficients correct with any sign $(=, <, >, \leq, \geq)$

a1A1: CAO (the correct answer with no working can imply M1 only)

a2M1: Two of the three coefficients correct with correct inequality sign in either unsimplified or simplified form **or** all three coefficients correct with any sign $(=, <, >, \leq, \geq)$

a2A1: CAO (the correct answer with no working can imply M1A1)

b1M1: **Either** both coefficients correct (accept $=, <, >, \leq, \geq$ here) **or** $y \geq 2x$

b1A1: CAO

c1B1: $12x + 7y = 168$ drawn correctly, does not pass outside of a small square of (0, 24) and (14, 0). Ignore shading

c2B1: $5x + 8y = 160$ drawn correctly, does not pass outside of a small square of (0, 20) and (32, 0). Ignore shading

c3B1: $2y = x$ drawn correctly, does not pass outside of a small square of (0, 0), (16, 8) and sufficiently long enough to define the feasible region. Ignore shading

c4B1: R labelled correct (not just implied by shading) – must have earned all previous marks in this part

di1B1: Drawing the correct objective line on the graph, use line drawing tool to check if necessary. Line must not pass outside of a small square if extended from axis to axis

di2DB1: V labelled clearly on their graph. This mark is dependent on **both** the correct three line segments that define the boundary of the feasible region **and** the correct objective line

dii1M1: The simultaneous equations $5x + 8y = 160$ and $x = 2y$ being used in an attempt to find V – must get to x=··· or y=··· (condone one error in the solving of the simultaneous equations)

dii1A1: CAO $\left(\dfrac{160}{9}, \dfrac{80}{9}\right)$ or $\left(17\dfrac{7}{9}, 8\dfrac{8}{9}\right)$ (coordinates must be exact) – the correct answer with no working can imply M1A1

e1B1: CAO (17, 9) – accept $x = 17, y = 9$

e2B1: CAO ((£)1344)