edexcel

Mark Scheme (Results)

Summer 2014

Pearson Edexcel GCE in Decision Mathematics 1R (6689/01R)

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

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.

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 $\sqrt{}$ 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)
- 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.

Question Number	Scheme	Marks
1. (a)	Bin 1: 31 10 19 Bin 2: 38 12 Bin 3: 45 Bin 4: 47 Bin 5: 35 Bin 6: 28	M1 A1 A1 **(3)**
(b)	e.g. middle right 31 10 38 45 19 47 35 28 12 Pivot 19 31 38 45 47 35 28 19 10 12 Pivots 47, 12 47 31 38 45 35 28 19 12 10 Pivots 45 (10) 47 45 31 38 35 28 19 12 10 Pivot 35 47 45 38 35 31 28 19 12 10 Pivot 28 (38) 47 45 38 35 31 28 19 12 10 (sort complete)	M1 A1 A1ft A1 **(4)**
(c)	Bin 1: 47 12 Bin 2: 45 10 Bin 3: 38 19 Bin 4: 35 Bin 5: 31 28	M1 A1 **(2)**
(d)	$\dfrac{265}{60} \approx 4.417$ so yes 5 bins is optimal	M1 A1 **(2)** **11 marks**

Notes for Question 1

a1M1: First four items placed correctly in bins 1, 2 and 3. (Condone cumulative totals here only.)

a1A1: First eight terms placed correctly.

a2A1: CSO – all correct.

b1M1: Quick sort – pivots, p, selected and first pass gives <p, p, >p. **If only choosing one pivot per iteration M1 only**.

b1A1: First pass correct, next two pivots chosen correctly for second pass.

b2A1ft: Second and third passes correct (follow through from their first pass and choice of pivots) – and net pivot(s) chosen consistently for fourth pass.

b3A1: CSO including choice of pivots for the fifth pass and 'sort complete' – this could be shown **either** by a 'stop' statement **or** final list being re-written **or** using each item as a pivot.

c1M1: Must be using list in descending order (independent of (b)). First seven terms placed correctly.

c1A1: CAO

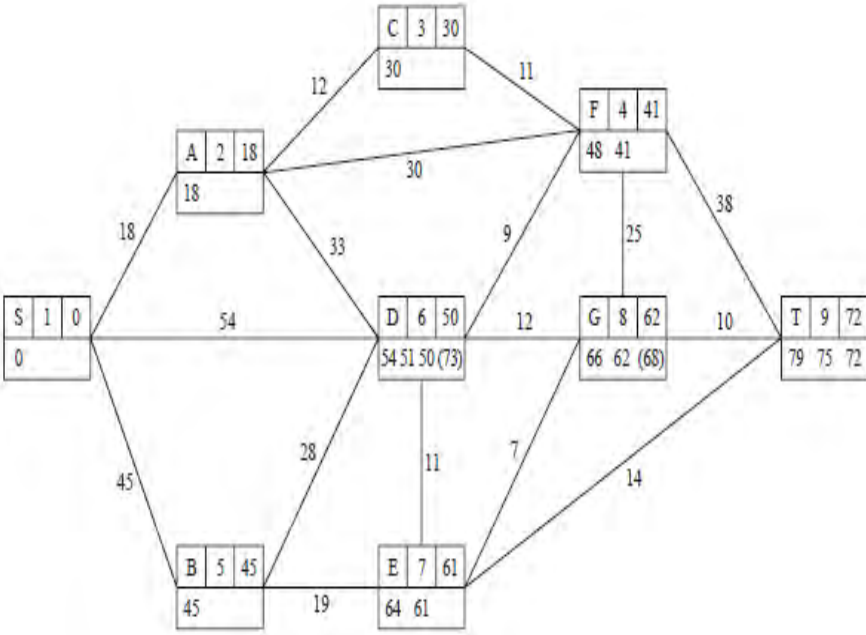d1M1: E.g. Attempt to find lower bound $(265 \pm 47) / 60$, (oe) could remark on number of items >30. The argument must be numerical in nature.

d1A1: CSO including 5.

SC for (c): if the 'sorted' list they use in (c) has one 'error' from (b) (e.g. a missing number, an extra number or one number incorrectly placed) then M1 only can be awarded in (c) (for the first seven items). If there is more than one 'error' then M0. Allow full marks in (c) if a correct list is used in (c) even if the list is incorrect at the end of (b).

Question Number	Scheme	Marks
	Sorting list into ascending order in (b)	

Sorting list into ascending order in (b)
- If the candidate sorts the list into ascending order and reverse the list **in (b)** then they can score full marks in (b).
- If the list is not reversed in (b) then mark as a misread (so remove the last two A marks earned in (b)). If the list is reversed at the start of (c) but not in (b) then still treat this as a misread. If the list is still in ascending order in (c) award no marks for first fit increasing. If the candidate says that the list needs reversing in (b) but doesn't actually show the reversed list in (b) then remove the final A mark in (b).

Misreads
- If they have misread a number **at the start of (a)**, **so genuinely miscopied** a number (before starting the question) then please mark the whole question as a misread (so remove the final two A/B marks earned).
- If they make an error during the quick sort then mark this as an error. They can still earn the M mark in (c) (see SC above).

Middle left

31	10	38	45	19	47	35	28	12	Pivot 19	
31	38	45	47	35	28	19	10	12	Pivot 45, 10	M1 A1
47	45	31	38	35	28	19	12	10	Pivot (47), 38, (12)	
47	45	38	31	35	28	19	12	10	Pivot 35	A1ft
47	45	38	35	31	28	19	12	10	Pivot 31	
47	45	38	35	31	28	19	12	10	list in order	A1cso

Ascending order (middle right)

31	10	38	45	19	47	35	28	12	Pivot 19	
10	12	19	31	38	45	47	35	28	Pivot 12, 47	M1 A1
10	12	19	31	38	45	35	28	47	Pivot (10), 45	
10	12	19	31	38	35	28	45	47	Pivot 35	A1ft
10	12	19	31	28	35	38	45	47	Pivot 28, (38)	
10	12	19	28	31	35	38	45	47	list in order	A1cso

Ascending order (middle left)

31	10	38	45	19	47	35	28	12	Pivot 19	
10	12	19	31	38	45	47	35	28	Pivot 10, 45	M1 A1
10	12	19	31	38	35	28	45	47	Pivot (12), 38, (47)	
10	12	19	31	35	28	38	45	47	Pivot 35	A1ft
10	12	19	31	28	35	38	45	47	Pivot 31	
10	12	19	28	31	35	38	45	47	list in order	A1cso
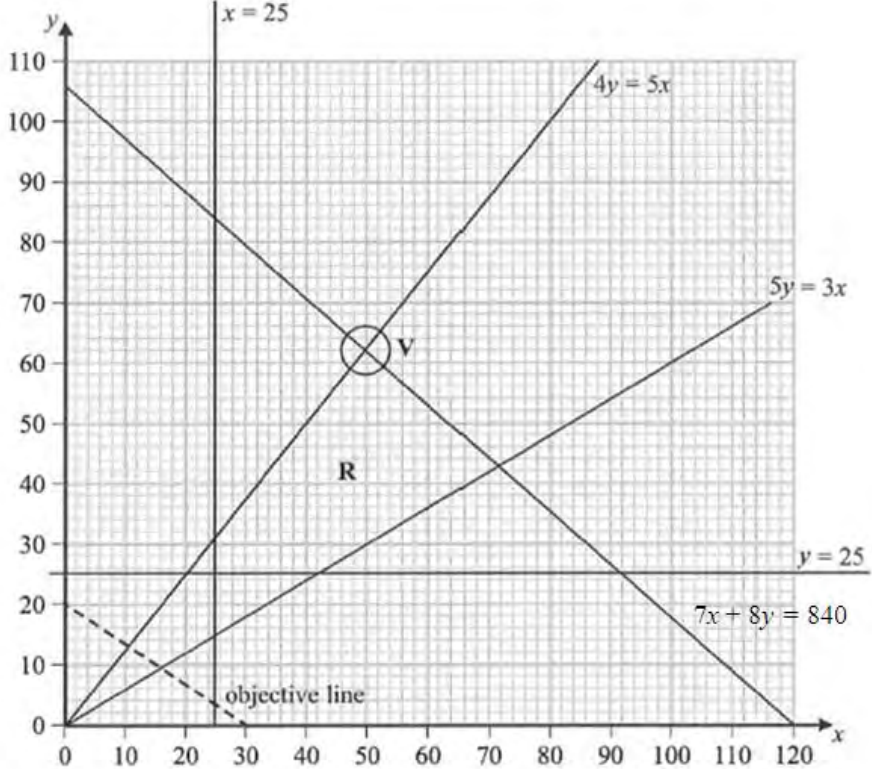
Question Number	Scheme	Marks	
2. (a)	e. g. Activities 1 and 3 both can only be done by Hugo	B2, 1, 0	**(2)**
(b)	J to 1 should be chosen e. g. J to 1 would release H to do 3. e. g. if H is retrained then tasks 1 and 3 can still only be done by H.	M1 A1	**(2)**
(c)	A – 2 = P – 4 = C – 5 = J – 1 = H – 3 Change status A = 2 – P = 4 – C = 5 – J = 1 – H = 3 Complete matching: A = 2, C = 5, H = 3, J = 1 and P = 4	M1 A1 A1 **7 marks**	**(3)**

Notes for Question 2
a1B1: A statement with the correct employees and tasks that attempts a reason why a complete matching is not possible. BOD gets the mark here. Note e.g. 'Hugo is the only one who can do both 1 and 3' or 'Hugo can only do 1 and 3' are both B1 only. a2B1: Fully correct, including all pertinent names and activities. No incorrect information given. b1M1: J to 1 selected with a reason given. One of H, 1 or 3 must be mentioned. b1A1: A correct reason given – must explicitly explain why J with 1 allows a complete matching to occur e.g. H can now do 3, or the candidate explains that if Hugo is re-trained there are still two tasks, 1 and 3, that can only be done by one employee, H. c1M1: An alternating path from A to 3 (or vice versa). c1A1: CAO – a correct path including change status either stated **or** shown. Chosen path clear. c2A1: CAO must follow from the correct stated path. Accept on a clear diagram (with five arcs only).

Question Number	Scheme	Marks
3. (a)		M1 A1 (SACFB) A1 (DE) A1ft (GT)
	Shortest path S to T: SACFDGT Time of shortest path S to T is 72 (minutes)	A1 A1ft **(6)**
(b)	Shortest paths S to T including E: SACFDET Time is 75 (minutes), so 3 (minutes) longer.	DB1 B1, B1ft **(3)** **9 marks**

Notes for Question 3

a1M1: A larger value replaced by smaller value at least once in the working values at either D or E or F or G or T.

a1A1: All values in S, A, C, F and B correct and the working values in the correct order, including order of labelling.

a2A1: All values in D and E correct and the working values in the correct order. Penalise order of labelling only once per question.

a3A1ft: All values in G and T correct on the follow through and the working values in the correct order. Penalise order of labelling only once per question.

a4A1: CAO for the route.

a5A1ft: Follow through on their final value at T – if their answer is not 72 follow through their final value at T.

b1DB1: Must have scored the M mark in (a). Path correct.

b1B1: CAO time of new route correct.

b2B1ft: Time difference correct (ft their previous times).

Question Number	Scheme	Marks
4. (a)	B(E)D + FI $= 32 + 38 = 70$ B(C)F + D(E)I $= 25 + 36 = 61*$ B(E)I + D(E)F $= 20 + 52 = 72$ Length $= 359 + 61 = 420$	M1 A1 A1 A1 A1ft **(5)**
(b)	Time taken $= \dfrac{420}{15} \times 120 = 3360$ (seconds)	M1 A1 **(2)**
(c)	e.g. If we start at an odd vertex we will **finish** at another **odd** vertex. This removes the need to repeat the route between them. So we just have to consider **one repeated route** rather than two.	B2,1,0 **(2)**
(d)	Choose to repeat the **shortest** route **BI** (20) Therefore **start at D** (and finish at F) New length $= 359 + 20 = 379$ Time taken $= \dfrac{379}{15} \times 120 + 2 \times 119 = 3270$ (seconds)	B1 B1 B1 B1 **(4)**
		13 marks

Notes for Question 4

a1M1: Three pairings of the **correct** four odd nodes.

a1A1: One row correct including pairing **and** total.

a2A1: Two rows correct including pairing **and** total.

a3A1: Three rows correct including pairing **and** total.

a4A1ft: 420 or 359 + their least.

b1M1: Their length $\div$ 15 $\times$ 120 – from at least two totals seen in (a).

b1A1: CAO

c1B1: One of (i) idea of finishing at an odd vertex (ii) only having to repeat one route rather than two.

c2B1: Correct complete argument – including both (i) and (ii) from c1B1.

d1B1: Identifies BI as the **shortest** route.

d2B1: start at D – dependent on identifying BI (20) as the repeat.

d3B1: CAO

d4B1: CAO

Question Number	Scheme	Marks
5. (a)		B1 B1 B1 B1 R **(4)**
(b)	Drawing an objective line accept reciprocal gradient correct objective line minimum length equivalent to (0, 10) to (15,0) V labelled correctly	M1 A1 A1 **(3)**
(c)	$V\left(49\dfrac{7}{17}, 61\dfrac{13}{17}\right)$	M1 A1**(2)**
(d)	Testing the correct inequalities for points with integer coordinates (50, 61)	M1 A1 **(2)** **11 marks**

Notes for Question 5
In (a) lines **must** pass through one small square of the points stated:

$7x + 8y = 840$ passes through (0, 105), (40, 70), (80, 35), (120, 0)
$4y = 5x$ passes through (0, 0), (40, 50), (80, 100)
$5y = 3x$ passes through (0, 0), (50, 30), (100, 60)

a1B1: One line other than $x = 25$ or $y = 25$ correctly drawn.
a2B1: Two lines other than $x = 25$ or $y = 25$ correctly drawn.
a3B1: All five lines correctly drawn.
a4B1: Region, R, correctly labelled – not just implied by shading – must have scored all three previous marks in this part.
b1M1: Drawing the correct objective line or its reciprocal. Line must be correct to within one small square if extended from axis to axis.
b1A1: Correct objective line.
b2A1: V labelled clearly on their graph. This mark is dependent on the correct five line segments that define the boundary of the feasible region.
cM1: Simultaneous equation being used to find **their** V (but not from $x = 25$ or $y = 25$). Must get to $x = ...$ and $y = ...$
cA1: Correct coordinates of V stated **exactly** as $\left(\frac{840}{17}, \frac{1050}{17}\right)$ or $\left(49\frac{7}{17}, 61\frac{13}{17}\right)$. If the correct coordinates are stated exactly with no working then this scores M1A0.
d1M1: Testing the correct inequalities for at least three of (49, 61), (49, 62), (50, 61), (50, 62).
d1A1: CAO (50, 61).

Question Number	Scheme	Marks
6. (i)		M1 (7 activities + 1 dummy) A1 (start + ABCE) A1 (DFG + 1st dummy) A1 (HIJ + 2nd dummy) A1cso
(ii)	1st dummy – G depends on A only, but D depends on A and C. 2nd dummy – This is so that H and I will not share the same start and end events **or** so that H and I can be uniquely described in terms of their end events.	B1 B1 **7 marks**

<div align="center">

Notes for Question 7

</div>

In (i) condone lack of, or incorrect, numbered events throughout – also 'dealt with correctly' means that the activity starts from the correct event but not necessarily finishes at the correct event. **Activity on node is M0.**

Ignore incorrect or lack of arrows for the first four marks in (i) only.

1M1: 7 activities (labelled on arc) and one dummy placed.
1A1: One start + activities A, B, C and E dealt with correctly.
2A1: Activities D, F and G and the 1st dummy dealt with correctly.
3A1: Activities I, H and J and the 2nd dummy dealt with correctly.
4A1: CSO – **all** arrows present and correctly placed with one finish.
1B1: CAO - all relevant activities must be referred to – so activities D, G, A and C must all be mentioned for this mark
2B1: CAO – please note that e.g. 'so that activities can be defined uniquely' is **not** sufficient to earn this mark. There must be mention of describing activities uniquely **in terms of the event at each end**. However, give bod on statements that imply that an activity begins at ends at the same event.

Question Number	Scheme	Marks
7. (a)		M1 A1 M1 A1 **(4)**
(b)	Total float for D = 12 – 4 – 4 = 4	M1 A1 **(2)**
(c)	$\dfrac{52}{22} \approx 2.36$ so 3 workers	M1 A1 **(2)**
(d)	e.g. 	M1 A1 A1 **(3)** **11 marks**

Notes for Question 7

a1M1: All top boxes complete, values generally increasing left to right, condone one rogue.
a1A1: CAO
a2M1: All bottom boxes complete, values generally decreasing right to left, condone one rogue.
Condone missing 0 **or** 22 for the M only.
a2A1: CAO
b1M1: Correct calculation for their activity D seen – their three numbers correct. Final value must be non-negative.
b1A1: CAO – no ft on this mark. The answer of 4 (with no working) scores no marks.
c1M1: Attempt to find lower bound: [42-62 / their finish time].
c1A1: CAO – correct calculation seen then 3. No working scores M0 A0.
d1M1: Not a cascade chart. 3 'workers' used at most and at least 7 activities placed.
d2A1: 3 workers. All 11 activities present (just once). Condone one error either precedence, time interval or activity length.
d3A1: 3 workers. All 11 activities present (just once). No errors.

For reference:

Activity	Duration	Time interval	IPA
A	4	0 – 7	-
B	5	0 – 5	-
C	3	0 – 5	-
D	4	4 – 12	A
E	2	4 – 9	A
F	3	5 – 9	B
G	4	5 – 9	B, C
H	6	9 – 15	E, F, G
I	4	9 – 15	G
J	10	9 – 22	D, E, F
K	7	15 – 22	H, I

Question Number	Scheme	Marks
8.	Minimise $C = 3x + 2y$	B1
	Subject to:	
	$x + y \geq 1000$	B1
	$\frac{1}{4}(x + y) \leq x,$ simplifies to $y \leq 3x$	M1 A1
	$2x \leq y$	M1 A1
	$(x, y \geq 0)$	
		6 marks

<div align="center">Notes for Question 8</div>

1B1: CAO – expression correct and 'minimise'.

2B1: CAO

1M1: Correct method – must see $\frac{1}{4}(x + y) \blacksquare x$ where $\blacksquare$ is any inequality or =. The bracket must be present or implied by later working.

1A1: CAO – simplified – answer must have integer coefficients.

2M1: Correct method – one of $2x \blacksquare y$ or $x \blacksquare 2y$ where $\blacksquare$ is any inequality or =.

2A1: CAO – answer must have integer coefficient.