

# Mark Scheme (Results)

## Summer 2010

GCE

### GCE Decision Mathematics D1 (6689/ 01)

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Decision Mathematics D1 6689  
Mark Scheme

Question Number	Scheme	Marks																																																		
Q1																																																				
(a)	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr><td>H</td><td>V</td><td>L</td><td>A</td><td>N</td><td>J</td><td>S</td><td>T</td><td>P</td><td>(N)</td></tr> <tr><td>H</td><td>L</td><td>A</td><td>J</td><td>N</td><td>V</td><td>S</td><td>T</td><td>P</td><td>(A, T)</td></tr> <tr><td>A</td><td>H</td><td>L</td><td>J</td><td>N</td><td>S</td><td>P</td><td>T</td><td>V</td><td>(L, P)</td></tr> <tr><td>A</td><td>H</td><td>J</td><td>L</td><td>N</td><td>P</td><td>S</td><td>T</td><td>V</td><td>(J)</td></tr> <tr><td>A</td><td>H</td><td>J</td><td>L</td><td>N</td><td>P</td><td>S</td><td>T</td><td>V</td><td></td></tr> </table>	H	V	L	A	N	J	S	T	P	(N)	H	L	A	J	N	V	S	T	P	(A, T)	A	H	L	J	N	S	P	T	V	(L, P)	A	H	J	L	N	P	S	T	V	(J)	A	H	J	L	N	P	S	T	V		M1 A1 A1ft  A1cso  <b>4</b>
H	V	L	A	N	J	S	T	P	(N)																																											
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A	H	J	L	N	P	S	T	V																																												
(b)	<p>1<sup>st</sup> choice <math>\left[ \frac{1+9}{2} \right] = 5</math> Nicky, reject 1 - 5</p> <p>2<sup>nd</sup> choice <math>\left[ \frac{6+9}{2} \right] = [7.5] = 8</math> Tom, reject 8 - 9</p> <p>3<sup>rd</sup> choice <math>\left[ \frac{6+7}{2} \right] = [6.5] = 7</math> Sharon, reject 7</p> <p>4<sup>th</sup> choice 6 Paul name found</p>	M1A1 A1   A1cso  <b>4</b>																																																		
	<p><b>Notes:</b></p> <p>(a) 1M1: quick sort, pivots, p, chosen and two sublists one &lt;p one &gt;p.  1A1: first pass correct and next pivots chosen correctly/consistently.  2A1ft: second pass correct, next pivots correctly/consistently chosen.  3A1: all correct, cso.</p> <p>(b) 1M1: binary search on what they think is a alphabetical list, choosing pivot, rejecting half list.  1A1: first pass correct, condone 'sticky' pivot here, bod generous  2A1: second pass correct, pivot rejected.  3A1: cso.</p> <p><b>Note:</b> If incorrect list in (a) mark (b) as a misread.</p>	<b>Total 8</b>																																																		

### Q1 Alternative solutions

#### Middle right

H	V	L	A	N	J	S	T	P	(N)	M1
H	L	A	J	N	V	S	T	P	(A T)	A1
A	H	L	J	N	S	P	T	V	(L P)	A1ft
A	H	J	L	N	P	S	T	V	(J)	
A	H	J	L	N	P	S	T	V		A1 cso

list sorted

#### Middle left

H	V	L	A	N	J	S	T	P	(N)	M1
H	L	A	J	N	V	S	T	P	(L S)	A1
H	A	J	L	N	P	S	V	T	(A V)	A1ft
A	H	J	L	N	P	S	T	V	(H)	
A	H	J	L	N	P	S	T	V		A1 cso

#### First

H	V	L	A	N	J	S	T	P	(H)	M1
A	H	V	L	N	J	S	T	P	(V)	A1
A	H	L	N	J	S	T	P	V	(L)	
A	H	J	L	N	S	T	P	V	(N)	A1ft
A	H	J	L	N	P	S	T	V	(S)	
A	H	J	L	N	P	S	T	V		A1 cso

Question Number	Scheme	Marks																																																																																																																					
<p>Q2</p> <p>(a)</p> <p>(b)</p> <p>(c)</p> <p>(d)</p> <p><b>Notes:</b></p> <p>(a) 1M1: Kruskal's algorithm – first 4 arcs selected chosen correctly.            1A1: All seven non-rejected arcs chosen correctly.            2A1: All rejections correct and in correct order and at correct time.</p> <p>(b) 1B1: condone two (double) errors            2B1: cao</p> <p>(c) 1M1: Prim's algorithm – first four arcs chosen correctly, in order, <b>or</b> first five nodes chosen correctly, in order. {A,C,D,E,B....}            1A1: First six arcs chosen correctly <b>or</b> all 8 nodes chosen correctly, in order. {A,C,D,E,B,G,F,H}            2A1: All correct and arcs chosen in correct order.</p> <p>(d) 1B1: cao</p> <table border="1"> <thead> <tr> <th>Starting at</th> <th>Minimum arcs required for M1</th> <th>Nodes</th> <th>order</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>AC CD DE DB</td> <td>ACDEB(GFH)</td> <td>15234(768)</td> </tr> <tr> <td>B</td> <td>BD DE DC</td> <td>BDEC(GFAH)</td> <td>(7)1423(658)</td> </tr> <tr> <td>C</td> <td>CD DE DB</td> <td>CDEB(GFAH)</td> <td>(7)4123(658)</td> </tr> <tr> <td>D</td> <td>DE DC DB</td> <td>DECB(GFAH)</td> <td>(7)4312(658)</td> </tr> <tr> <td>E</td> <td>ED DC DB</td> <td>EDCB(GFAH)</td> <td>(7)4321(658)</td> </tr> <tr> <td>F</td> <td>FG GE ED DC DB</td> <td>FGEDCB(AH)</td> <td>(7)654312(8)</td> </tr> <tr> <td>G</td> <td>GF GE ED DC DB</td> <td>GFEDCB(AH)</td> <td>(7)654321(8)</td> </tr> <tr> <td>H</td> <td>HG GF GE</td> <td>HGFE(DCBA)</td> <td>(8765)4321</td> </tr> </tbody> </table>	Starting at	Minimum arcs required for M1	Nodes	order	A	AC CD DE DB	ACDEB(GFH)	15234(768)	B	BD DE DC	BDEC(GFAH)	(7)1423(658)	C	CD DE DB	CDEB(GFAH)	(7)4123(658)	D	DE DC DB	DECB(GFAH)	(7)4312(658)	E	ED DC DB	EDCB(GFAH)	(7)4321(658)	F	FG GE ED DC DB	FGEDCB(AH)	(7)654312(8)	G	GF GE ED DC DB	GFEDCB(AH)	(7)654321(8)	H	HG GF GE	HGFE(DCBA)	(8765)4321	<p>DE GF DC <math>\left\{ \begin{array}{l} \text{not CE} \\ \text{BD} \end{array} \right\}</math> EG (not EF not CF) AC (not AB) GH</p> <table border="1"> <thead> <tr> <th></th> <th>A</th> <th>B</th> <th>C</th> <th>D</th> <th>E</th> <th>F</th> <th>G</th> <th>H</th> </tr> </thead> <tbody> <tr> <th>A</th> <td>-</td> <td>31</td> <td>30</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> </tr> <tr> <th>B</th> <td>31</td> <td>-</td> <td>-</td> <td><b>24</b></td> <td>-</td> <td>-</td> <td>-</td> <td>38</td> </tr> <tr> <th>C</th> <td>30</td> <td>-</td> <td>-</td> <td><b>22</b></td> <td>24</td> <td><b>29</b></td> <td>-</td> <td>-</td> </tr> <tr> <th>D</th> <td>-</td> <td><b>24</b></td> <td><b>22</b></td> <td>-</td> <td>18</td> <td>-</td> <td>-</td> <td><b>34</b></td> </tr> <tr> <th>E</th> <td>-</td> <td>-</td> <td>24</td> <td>18</td> <td>-</td> <td>28</td> <td><b>26</b></td> <td>-</td> </tr> <tr> <th>F</th> <td>-</td> <td>-</td> <td><b>29</b></td> <td>-</td> <td>28</td> <td>-</td> <td>21</td> <td>-</td> </tr> <tr> <th>G</th> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td><b>26</b></td> <td>21</td> <td>-</td> <td><b>33</b></td> </tr> <tr> <th>H</th> <td>-</td> <td>38</td> <td>-</td> <td><b>34</b></td> <td>-</td> <td>-</td> <td><b>33</b></td> <td>-</td> </tr> </tbody> </table> <p>AC CD DE BD GE GF GH</p> <p>Weight: 174</p> <p>M1 A1 A1</p> <p>B1</p> <p><b>Total 9</b></p>		A	B	C	D	E	F	G	H	A	-	31	30	-	-	-	-	-	B	31	-	-	<b>24</b>	-	-	-	38	C	30	-	-	<b>22</b>	24	<b>29</b>	-	-	D	-	<b>24</b>	<b>22</b>	-	18	-	-	<b>34</b>	E	-	-	24	18	-	28	<b>26</b>	-	F	-	-	<b>29</b>	-	28	-	21	-	G	-	-	-	-	<b>26</b>	21	-	<b>33</b>	H	-	38	-	<b>34</b>	-	-	<b>33</b>	-	<p>3</p> <p>2</p> <p>3</p> <p>1</p>
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Question Number	Scheme	Marks						
Q3								
(a)	e.g. total weight is 239, lower bound is $\frac{239}{60} = 3.98$ so 4 bins.	M1 A1  <b>2</b>						
(b)	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">Bin 1 : 41</td> <td style="width: 50%;">Bin 4 : 36</td> </tr> <tr> <td>Bin 2 : 28 + 31</td> <td>Bin 5 : 32</td> </tr> <tr> <td>Bin 3 : 42</td> <td>Bin 6 : 29</td> </tr> </table>	Bin 1 : 41	Bin 4 : 36	Bin 2 : 28 + 31	Bin 5 : 32	Bin 3 : 42	Bin 6 : 29	M1 A1 A1  <b>3</b>
Bin 1 : 41	Bin 4 : 36							
Bin 2 : 28 + 31	Bin 5 : 32							
Bin 3 : 42	Bin 6 : 29							
(c)	Full Bins : 28 + 32    31 + 29 The other 3 items (42, 41, 36) require 3 separate bins	M1 A1  <b>2</b>						
(d)	There are 5 items over 30. No two of these 5 can be paired in a bin, so at least 5 bins will be required.	B2, 1, 0  <b>2</b>						
		<b>Total 9</b>						
	<b>Notes:</b>							
(a)	1M1: Any correct statement, must involve calculation 1A1: cao (accept 4 for both marks)							
(b)	1M1: Bins 1 and 2 correct and at least 6 values put in bins 1A1: Bins 1,2,3 and 4 correct. 2A1: All correct							
(c)	1M1: Attempt to find two full bins and allocate at least 6 values 1A1: cao							
(d)	1B1: Correct argument may be imprecise or muddled (bod gets B1) 2B1: A good, clear, correct argument.(They have answered the question 'why?')							
	<b>Misread in (b) First Fit Decreasing</b>							
	Bin 1: 42    Bin 2: 41    Bin 3: 36    Bin 4: 32 28    Bin 5: 31 29 (Remove up to two A marks if earned – so M1 max in (b) if first 4 bins correct.)							

Question Number	Scheme	Marks
Q4	<p>(a) <math>BC + EG = 10.4 + 10.1 = 20.5</math> smallest  <math>BE + CG = 8.3 + 16.1 = 24.4</math>  <math>BG + CE = 14.9 + 11.9 = 26.8</math></p> <p>So repeat tunnels BA, AC and EG</p> <p>(b) Any route e.g. ACFGDCABDEGEBA  Length = <math>73.3 + \text{their } 20.5 = 93.8\text{km}</math></p> <p>(c) The new tunnel would make C and G even.  So only BE would need to be repeated.  Extra distance would be <math>10 + 8.3 = 18.3 &lt; 20.5</math> [<math>91.6 &lt; 93.8</math>]  So it would decrease the total distance.</p> <p><b>Notes:</b></p> <p>(a) 1M1: Three pairings of their four odd nodes  1A1: one row correct  2A1: two rows correct  3A1: all correct  4A1: correct <b>arcs</b> identified</p> <p>(b) 1B1: Any correct route (14 nodes)  1M1: <math>73.3 + \text{ft their least, from a choice of at least two.}</math>  1A1: cao</p> <p>(c) 1B1: A correct explanation, referring to BE and relevant numbers  (8.3, 12.2, 2.2, 18.3, 81.3, 91.6) maybe confused, incomplete or lack conclusion –bod gets B1  2B1D: A correct, clear explanation all there + conclusion (ft on their numbers.)</p>	<p>M1 A1  A1  A1</p> <p>A1</p> <p>B1  M1 A1</p> <p>B1  DB1</p> <p><b>Total 10</b></p> <p>5  3  2</p>

Question Number	Scheme	Marks
Q5	<p>e.g.</p> <p>(a) <math>G - 3 = E - 2 = A - 4 = S - 6</math>            Change status <math>G = 3 - E = 2 - A = 4 - S = 6</math></p> <p>Improved matching  <math>A = 4</math> (C unmatched) <math>E = 2</math> <math>G = 3</math> <math>J = 5</math> <math>S = 6</math></p> <p>(b) e.g. Both C and J can only be matched to 5            Both 1 and 6 can only be done by S</p> <p>(c) <math>C - 5 = J - 4 = A - 2 = E - 6 = S - 1</math>            Change status <math>C = 5 - J = 4 - A = 2 - E = 6 - S = 1</math></p> <p>Complete matching  <math>A = 2</math> <math>C = 5</math> <math>E = 6</math> <math>G = 3</math> <math>J = 4</math> <math>S = 1</math></p> <p><b>Notes:</b></p> <p>(a) 1M1: Path from G to 6 or 1            1A1: CAO including change status (stated or shown), chosen path clear.            2A1: CAO must fit from stated path, diagram ok</p> <p>(b) 1B1: Correct answer, may be imprecise or muddled (bod gets B1)            all relevant nodes should be referred to and must be correct, but condone one (genuine) slip.            2B1: Good, clear, correct answer.</p> <p>(c) 1M1: Path from C to 1 or 6 [whichever they didn't use before.]            1A1: CAO including change status (stated or shown), chosen path clear. (Don't penalise change status twice.)            2A1: CAO must fit from stated path, diagram ok</p> <p><b>Alt</b></p> <p>(a) <math>G - 3 = E - 2 = A - 4 = S - 1</math> c.s. <math>G = 3 - E = 2 - A = 4 - S = 1</math>  <math>A = 4</math>, (C unmatched), <math>E = 2</math>, <math>G = 3</math>, <math>J = 5</math>, <math>S = 1</math></p> <p>(c) <math>C - 5 = J - 4 = A - 2 = E - 6</math> c.s. <math>C = 5 - J = 4 - A = 2 - E = 6</math>  <math>A = 2</math>, <math>C = 5</math>, <math>E = 6</math>, <math>G = 3</math>, <math>J = 4</math>, <math>S = 1</math></p>	<p>M1 A1</p> <p>A1</p> <p>B2, 1, 0</p> <p>M1 A1</p> <p>A1</p> <p><b>3</b></p> <p><b>2</b></p> <p><b>3</b></p> <p><b>Total 8</b></p>



Question Number	Scheme	Marks
<p>Q6</p> <p>(a)</p> <p>Route: SBEFHT Time: 87 minutes</p> <p>(b) Accept demonstration of relevant subtractions, or general explanation.</p> <p>(c) Route: EFHT</p> <p><b>Notes:</b></p> <p>(a) 1M1: Smaller number replacing larger number in the working values at C or D or G or H or T. (generous – give bod)            1A1: All values in boxes S, A, B, E and F correct            2A1ft: All values in boxes C and D (ft) correct. Penalise order of labelling errors just once.            3A1: All values in boxes G, H and T correct            1B1: CAO (not ft)            2B1ft: Follow through from their T value, condone lack of units here.</p> <p>(b) 1B1ft: Partially complete account, maybe muddled, bod gets B1            2B1ft: Complete, clear account.</p> <p>(c) 1B1: CAO</p>		<p>M1 A1 A1ft A1</p> <p>B1 B1ft</p> <p style="text-align: right;"><b>6</b></p> <p>B2ft,1ft, 0</p> <p style="text-align: right;"><b>2</b></p> <p>B1</p> <p style="text-align: right;"><b>1</b></p> <p style="text-align: right;"><b>Total 9</b></p>

Question Number	Scheme	Marks
<p>Q7</p> <p>(a) To indicate the strict inequality</p> <p>(b) <math>3x = 2y</math> and <math>5x + 4y = 80</math> added to the diagram. R correctly labelled.</p> <div> </div> <p style="text-align: center;">Diagram 1</p> <p>(c) [Minimise C =] <math>500x + 800y</math></p> <p>(d) Point testing or Profit line Seeking integer solutions (11, 7) at a cost of £ 11 100.</p>		<p>B1</p> <p style="text-align: right;">1</p> <p>B1, B1</p> <p>B1</p> <p style="text-align: right;">3</p> <p>B1, B1</p> <p style="text-align: right;">2</p> <p>M1 A1</p> <p>M1</p> <p>B1, B1</p> <p style="text-align: right;">5</p> <p><b>Total 11</b></p>

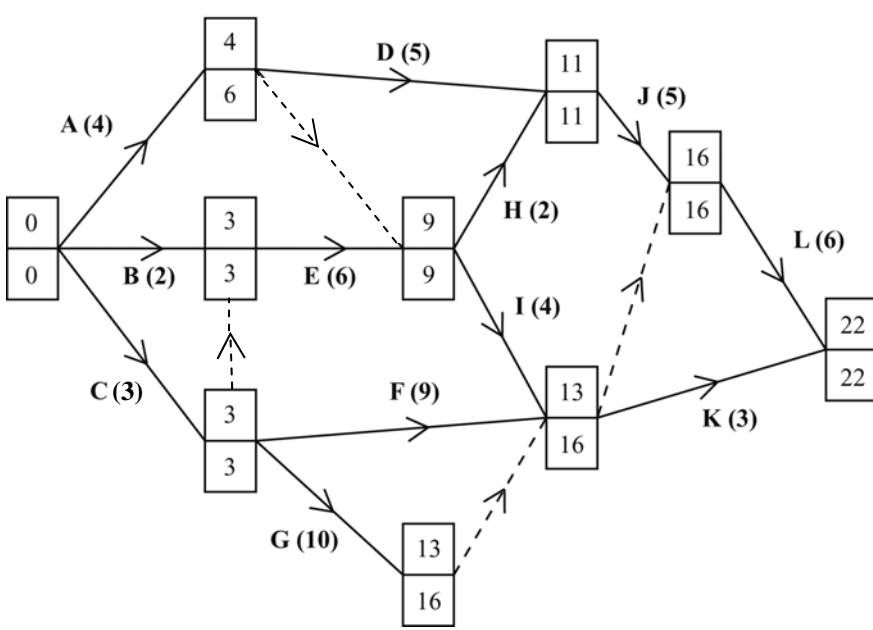
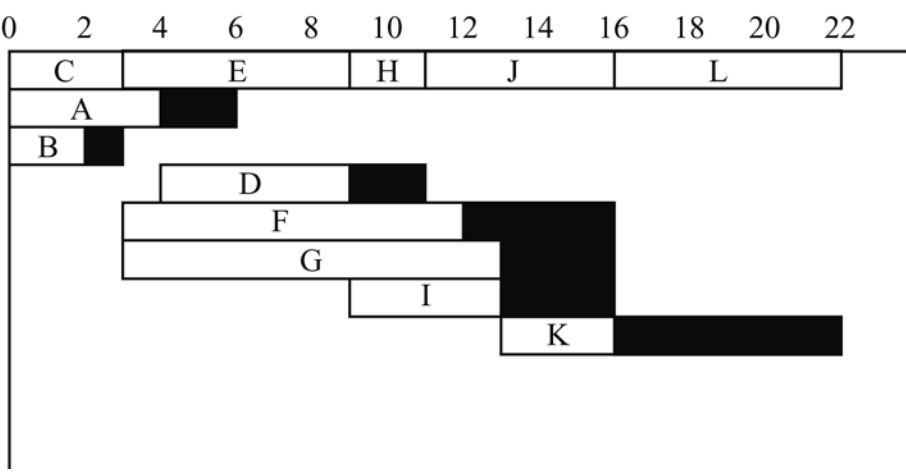
**Notes:**

- (a) 1B1: CAO  
(b) 1B1:  $3x = 2y$  passing through 1 small square of (0,0) and (12, 18), but must reach  $x = 15$   
2B1:  $5x + 4y = 80$  passing through 1 small square of (0, 20) and (16, 0)  
(extended if necessary) but must reach  $y = 6$   
3B1: R CAO (condoning slight line inaccuracy as above.)  
(c) 1B1: Accept expression and swapped coefficients. Accept  $5x + 8y$  for 1 mark  
2B1: CAO (expression still ok here)  
(d) 1M1: Profit line [gradient accept reciprocal, minimum length line passes through (0, 2.5) (4, 0)] **OR** testing 2 points in their FR near two different vertices.  
1A1: Correct profit line **OR** 2 points correctly tested in correct FR (my points)

e.g

$(7\frac{3}{11}, 10\frac{10}{11}) = 12\,363\frac{7}{11}$	or	$(7, 11) = 12\,300$
		$(8, 10) = 12\,000$
		$(8, 11) = 12\,800$
$(11\frac{1}{3}, 6) = 10\,400$	or	$(11, 6) = 10\,300$
$(15, 6) = 12\,300$	or	$(15, 7) = 13\,100$
$(15, 22\frac{1}{2}) = 25\,500$	or	$(15, 22) = 25\,100$
		$(11, 7) = 11\,100$

- 2M1: Seeking integer solution in correct FR (so therefore no  $y = 6$  points)  
1B1: (11,7) CAO  
2B1: £11 100 CAO

Question Number	Scheme	Marks
<p>Q8</p> <p>(a)</p>  <p>(b)</p> <p>Critical activities: C E H J L</p> <p>(c)</p>  <p>(d)</p> <p>4 workers needed e.g. at time 8 ½ (noon on day 9) activities E, D, F and G must be happening.</p>	<p>M1 A1 M1 A1</p> <p><b>4</b></p> <p>B1</p> <p><b>1</b></p> <p>M1 A1 A1 A1</p> <p><b>4</b></p> <p>B2, 1, 0</p> <p><b>2</b></p> <p><b>Total 11</b></p>	

**Notes for Q8**

- (a) 1M1: Top boxes completed generally increasing left to right.  
1A1: CAO.  
2M1: Bottom boxes completed generally decreasing right to left.  
2A1: CAO.
- (b) 1B1: Critical activities cao.
- (c) 1M1: At least 10 activities placed, at least five floats. Scheduling diagram gets M0.  
1A1: my critical activities correct.  
2A1: condone one error on my non-critical activities.  
3A1: my non-critical activities correct.
- (d) 1B1: A correct statement, details of either time ( $7 < \text{time} < 9$ ,  $8 < \text{day} < 10$ ), or activities, bod gets B1. Allow 1 B mark (only) on ft from their 12 activity, 7 float diagram.  
2B1: A correct, complete full statement details of time and activities.





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