

Mark Scheme (Pre-Standardisation)

January 2008

GCE

GCE Mathematics (6689/01)

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.

January 2008
6689 Decision Mathematics D1
Mark Scheme

Question Number	Scheme	Marks
1 (a)(i)	<p>A path from an unmatched vertex in one set to an unmatched vertex in the other set - ...</p> <p>... which alternately uses arcs not in / in the matching.</p>	<p>B1</p> <p>B1 (2)</p>
(ii)	<p>A one-to-one pairing of some elements of one set with the other set</p>	<p>B1</p> <p>B1 (2)</p>
(b)	<p>e.g. $D-3=C-5$ change status $D=3-C=5$</p> <p>$E-2=A-1$ change status $E=2-A=1$</p> <p>$A=1$ $B=4$ $C=5$ $D=3$ $E=2$</p>	<p>M1 A1</p> <p>M1 A1</p> <p>A1 (5)</p> <p>9</p>

Decision Maths D1 (6689) Jan 2008

- Q1(a)i 1B1 Unmatched to unmatched
 2B1 Alternate arcs not in/in [not vertices/nodes, not 'zigzag']
 ii 3B1 One – to- one
 4B1 Elements of one set with elements of the other.
 (b) 1M1 'Path' starting at D or E, finishing at 1 or 5 – or vice versa.
 1A1 A correct path – including change status.
 2M1 'Path' from remaining unmatched (D/E) to unmatched (1/5) or v.v.
 2A1 A second correct path – incl. c.s, but don't penalise c.s. twice.
 3A1 Complete matching, must follow through from two correct paths.

Possible alternating paths and matchings

Path 1	Path 2	A	B	C	D	E
D-3-C-1	E-2-A-1-C-5	1	4	5	3	2
D-3-C-1	E-4-B-1-C-5	2	1	5	3	4
D-3-C-5	E-2-A-1	1	4	5	3	2
D-3-C-5	E-4-B-1	2	1	5	3	4
D-3-C-4-B-1	E-2-A-1-B-3-D-4-C-5	1	3	5	4	2
D-3-C-4-B-1	E-2-A-1-B-4-C-5	1	4	5	3	2
D-3-C-4-B-1	E-4-C-5	2	1	5	3	4
D-4-B-1	E-2-A-1-B-3-C-5	1	4	5	3	2
D-4-B-1	E-2-A-1-B-4-D-3-C-5	1	4	5	3	2
D-4-B-1	E-4-D-3-C-5	2	1	5	3	4
D-4-B-3-C-1	E-2-A-1-C-5	1	3	5	4	2
D-4-B-3-C-1	E-4-D-3-B-1-C-5	2	1	5	3	4
D-4-B-3-C-5	E-2-A-1	1	3	5	4	2
D-4-B-3-C-5	E-4-D-3-B-1	2	1	5	3	4
E-2-A-1	D-3-C-5	1	4	5	3	2
E-2-A-1	D-4-B-3-C-5	1	3	5	4	2
E-4-B-1	D-3-C-5	2	1	5	3	4
E-4-B-1	D-4-E-2-A-1-B-3-C-5	1	3	5	4	2
E-4-B-3-C-1	D-3-B-1-C-5	2	1	5	3	4
E-4-B-3-C-1	D-3-B-4-E-2-A-1-C-5	1	4	5	3	2
E-4-B-3-C-1	D-4-E-2-A-1-C-5	1	3	5	4	2
E-4-B-3-C-5	D-3-B-1	2	1	5	3	4
E-4-B-3-C-5	D-3-B-4-E-2-A-1	1	4	5	3	2
E-4-B-3-C-5	D-4-E-2-A-1	1	3	5	4	2

Question Number	Scheme	Marks																																																																		
2(a)	<p>E.g.</p> <table style="border-collapse: collapse; width: 100%;"> <tr> <td style="padding: 5px;">18</td><td style="padding: 5px;">20</td><td style="padding: 5px;">11</td><td style="padding: 5px;">7</td><td style="padding: 5px;">17</td><td style="padding: 5px;">(15)</td><td style="padding: 5px;">14</td><td style="padding: 5px;">21</td><td style="padding: 5px;">23</td><td style="padding: 5px;">16</td><td style="padding: 5px;">9</td> </tr> <tr> <td style="padding: 5px;">11</td><td style="padding: 5px;">7</td><td style="padding: 5px;">(14)</td><td style="padding: 5px;">9</td><td style="padding: 5px;">[15]</td><td style="padding: 5px;">18</td><td style="padding: 5px;">20</td><td style="padding: 5px;">17</td><td style="padding: 5px;">(21)</td><td style="padding: 5px;">23</td><td style="padding: 5px;">16</td> </tr> <tr> <td style="padding: 5px;">11</td><td style="padding: 5px;">(7)</td><td style="padding: 5px;">9</td><td style="padding: 5px;">[14]</td><td style="padding: 5px;">↓</td><td style="padding: 5px;">18</td><td style="padding: 5px;">20</td><td style="padding: 5px;">(17)</td><td style="padding: 5px;">16</td><td style="padding: 5px;">[21]</td><td style="padding: 5px;">(23)</td> </tr> <tr> <td style="padding: 5px;">[7]</td><td style="padding: 5px;">11</td><td style="padding: 5px;">(9)</td><td style="padding: 5px;">↓</td><td style="padding: 5px;">↓</td><td style="padding: 5px;">(16)</td><td style="padding: 5px;">[17]</td><td style="padding: 5px;">18</td><td style="padding: 5px;">(20)</td><td style="padding: 5px;">↓</td><td style="padding: 5px;">[23]</td> </tr> <tr> <td style="padding: 5px;">↓</td><td style="padding: 5px;">[9]</td><td style="padding: 5px;">(11)</td><td style="padding: 5px;">↓</td><td style="padding: 5px;">↓</td><td style="padding: 5px;">[16]</td><td style="padding: 5px;">↓</td><td style="padding: 5px;">(18)</td><td style="padding: 5px;">[20]</td><td style="padding: 5px;">↓</td><td style="padding: 5px;">↓</td> </tr> <tr> <td style="padding: 5px;">7</td><td style="padding: 5px;">9</td><td style="padding: 5px;">[11]</td><td style="padding: 5px;">14</td><td style="padding: 5px;">15</td><td style="padding: 5px;">16</td><td style="padding: 5px;">17</td><td style="padding: 5px;">18</td><td style="padding: 5px;">20</td><td style="padding: 5px;">21</td><td style="padding: 5px;">23</td> </tr> </table>	18	20	11	7	17	(15)	14	21	23	16	9	11	7	(14)	9	[15]	18	20	17	(21)	23	16	11	(7)	9	[14]	↓	18	20	(17)	16	[21]	(23)	[7]	11	(9)	↓	↓	(16)	[17]	18	(20)	↓	[23]	↓	[9]	(11)	↓	↓	[16]	↓	(18)	[20]	↓	↓	7	9	[11]	14	15	16	17	18	20	21	23	<p>mi AI AI ✓ AI ✓ AI (5)</p>
18	20	11	7	17	(15)	14	21	23	16	9																																																										
11	7	(14)	9	[15]	18	20	17	(21)	23	16																																																										
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7	9	[11]	14	15	16	17	18	20	21	23																																																										
(b)	<p>CF ✓ GI ✓ { BC or BF - accept one, reject one { CD ✓ EF ✓ DF x HI ✓ BE x AB ✓ AC x EG ✓ Tree complete</p>	<p>mi AI AI (4)</p>																																																																		
(c)	107m	<p>BI (1) [10]</p>																																																																		

- Q2(a) 1M1** Pivot chosen & 2 sublists, one < pivot, one > pivot
1A1 1st pass correct, all of the next set of pivots chosen, and done so consistently (condone 1 term lists)
1A1ft as above for 2nd pass.
1A1ft All correct, follow through, pivots must be chosen consistently
- (b) 1M1** Using Kruskal – CF then GI
1A1 First 4 arcs chosen correctly
2A1 All arcs chosen correctly (condone lack of rejection here)
3A1 All correct including rejections
- (c) B1** cao

Alternative correct solutions

Middle left

18	20	11	7	17	15	14	21	23	16	9
11	7	14	9	15	18	20	17	21	23	16
7	11	14	9	14	16	17	18	20	21	23
	11	9	14		16		18	20	21	23
	9	11					18	20	21	23
7	9	11	14	15	16	17	18	20	21	23

First

18	20	11	7	17	15	14	21	23	16	9
11	7	17	15	14	16	9	18	20	21	23
7	9	11	17	15	14	16		20	21	23
7	9		17	15	14	16	17		21	23
	9		15	14	16				21	23
7	9	11	14	15	16	17	18	20	21	23

Misreads – loose last 2 A marks earned (NOTE: Reversing list at end removes MR)

Middle right

18	20	11	7	17	15	14	21	23	16	9
18	20	17	21	23	16	15	11	7	14	9
23	21	18	20	17	16		14	11	7	9
23		18	20	17	16			11	9	7
		20	18		16			11	9	7
23	21	20	18	17	16	15	14	11	9	7

Middle left

18	20	11	7	17	15	14	21	23	16	9
18	20	17	21	23	16	15	11	7	14	9
18	20	21	23	17	16		11	14	9	7
21	23	20	18		16		14	11	9	7
23	21		18					11	9	7
23	21	20	18	17	16	15	14	11	9	7

First

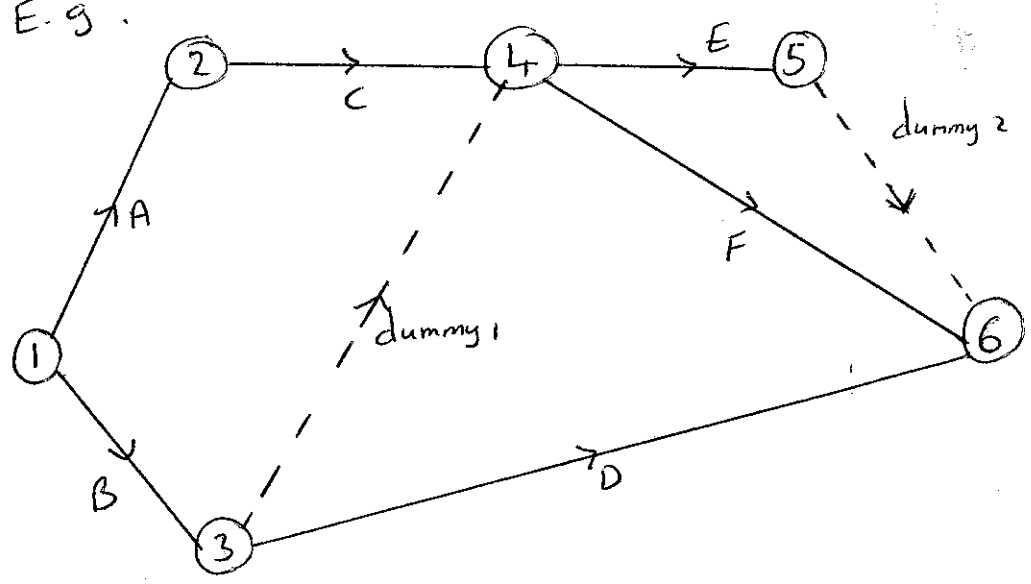
18	20	11	7	17	15	14	21	23	16	9
20	21	23	18	17	7	17	15	14	16	9
21	23	20		17	15	14	16	11	7	9
23	21			17	15	14	16	9	7	9
23	21	20	18	17	16	15	14	11	9	7

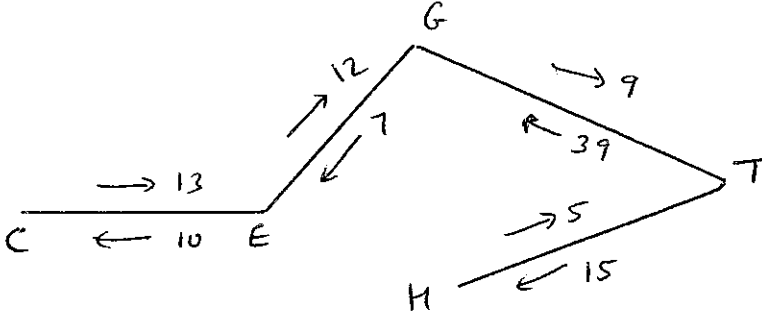
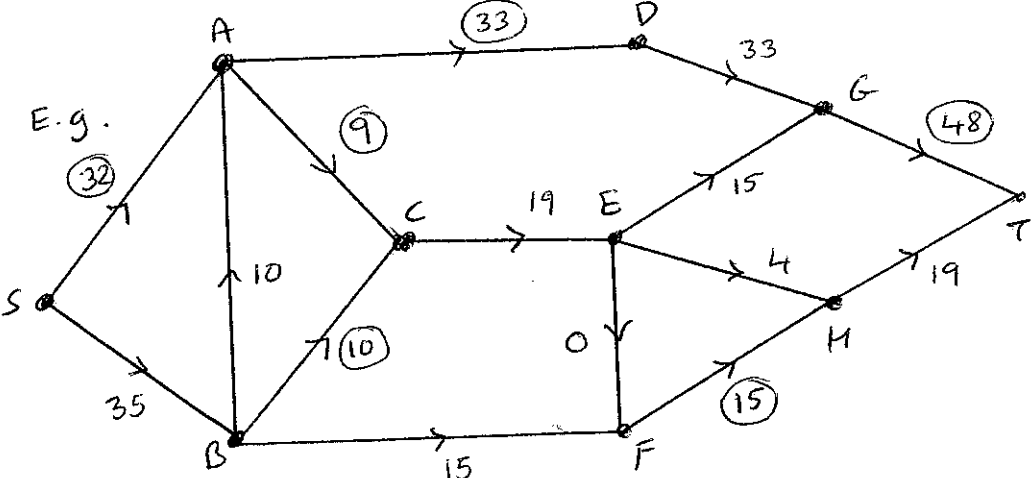
Question Number	Scheme	Marks
3 (a)	$CD + FG = 0.7 + 0.6 = 1.3 \neq$ $CF + DG = 0.5 + 0.9 = 1.4$ $CG + DF = 1.1 + 0.5 = 1.6$ <p>repeat CD and FG</p> <p>A possible route e.g.</p> $A C D C F G F D G E D A E B A$ <p>length: $11 + 1.3 = 12.3 \text{ km}$</p> <p>(b) (i) Each arc has to be traversed twice</p> <p>(ii) $2 \times 11 = 22 \text{ km}$</p>	m1A1 A1 A1 A1 A1✓ (6) B1 (1) B2,0 (2) 9

- Q3(a)** 1M1 3 distinct pairings of their 4 odd nodes
1A1 one line correct (condone missing total)
2A1 2 lines correct including totals
3A1 All three lines correct including totals
4A1 15 letters, repeat CD and FG, start/finish A, A to G there.
5A1ft 11+ thier minimum
- (b)i 1B1 cao 'twice' probably the trigger
ii 2B1 22
3B1 22km

Question Number	Scheme	Marks
4) (a)	<p>(b) Total float on D = $18 - 5 - 9 = 4$ $G = 25 - 8 - 10 = 7$ $I = 25 - 20 - 3 = 2$</p> <p>(c) Critical activities: B E J m</p> <p>(d) Lower bound = $\frac{102}{35} = 2.914$ $\therefore 3$ workers</p>	<p>m1 A1</p> <p>m1 A1</p> <p>(4)</p> <p>m1</p> <p>A2, 1, 0</p> <p>B1 (4)</p> <p>B1 (1)</p> <p>m1</p> <p>A1 (2)</p> <p>III</p>

- Q4(a)** 1M1 Top 3 boxes completed, generally ascending L to R
1A1 cao
2M1 Bottom 4 boxes completed, generally descending R to L
2A1 cao
- (b) 1M1 Correct (ft) three numbers visible for at least one calculation.
1A1ft one correct value (ft on D)
1A1 2 correct values
1B1 3 correct values (even if no working seen)
- (c) 1B1 cao
- (d) 1M1 $102 \div 35$
1A1 cao

Question Number	Scheme	Marks
5) (a)	<p>E.g.</p>  <p>Dummy 1 is needed to show <u>dependancy</u>. E and F depend on C and B, but D depends on B only</p> <p>Dummy 2 is needed so that each activity can be <u>uniquely</u> represented in terms of its events.</p>	<p>M1 A1 A1 A1 (4)</p> <p>B3,2,1,0 (3)</p> <p style="border: 1px solid black; display: inline-block; padding: 2px 5px;">7</p>
	<p>Q5(a) 1M1 Activity on arc, all activities present, condone lack of events 1A1 A,B,C,D and first dummy correct 2A1 E, F and second dummy correct (on E or F) 3A1 All arrows – including on dummies, one start and one finish (b) 1B1 Dummy 1 correctly justified – give bod 2B1 Dummy 2 correctly justified – give bod 3B1 A bonus for two good answers</p>	

Question Number	Scheme	Marks
6 (a)	A cut divides the vertices into two sets, one set containing the source(s) and the other the sink(s).	B2, 1, 0 (2)
(b)		m1 A1 (2)
(c)	E.g. SBACEGT - 9 SBADGET - 1 SBFEHT - 3	m1 A1 A1 A1 (4)
(d)	E.g. 	m1 A1 (2)
(e)	Flow value 67	B1 (1)
(f)	Max flow-min cut theorem cut through AD, AC, BC, EF, FH	m1 A1 (2) 13

- Q6(a)** **1B1** Close, bod, probably 2 out of three points below
2B1 Good complete answer, 2 'sets'; source and sink separated; vertices
- (b)** **1M1** Two numbers on each arc
1A1 cao
- (c)** **1M1** 1 correct route and a flow value stated. Any flow > 9 gets M0
1A1 1 valid route with valid flow
2A1 2 distinct valid routes with valid flows found to > 3
3A1 All routes and flows found to 13
- (d)** **1M1** Consistent flow pattern > 55
1A1 cao
- (e)** **1B1** cao
- (f)** **1M1** Depends flow of 67, 3 out of 4 words in theorem, cut attempted
1A1 valid cut

Routes

Do not use: SA or BC

Increases needed for solution:

(NOTE treat back flows as negative e.g. EG+9 and GE+1 gives EG+8)

SB + 13	AC+9	AD+1	BA+10	BF+3
CE+9	DG+1	EG+8	EH+4	GT+9

Question Number	Scheme	Marks
7) (a)	$y \geq 2x$	B 2, 1, 0 (2)
(b)	$x + 2y = 160$ correctly drawn $y \leq 60$ correctly drawn and distinctive (strict inequality) Shading correct	B 4, 3, 2, 1, 0 (4)
(c)	R correct	B 1 ✓ (1)
(d)	Profit line added or Point testing seen correctly done 70 boxes identified	M 1 A 1 A 1 (3)
(e)	(P=) $1.2x + 1.4y$	B 1 (1)
(f)	Profit line added or Point testing seen correctly done (32, 64) identified.	M 1 A 1/A 1 A 1 (4)
(g)	£128.00	A 1 ✓ (1)
		16

- Q7(a)** **1B1** 2 (or ½) one correct side, condone any inequality or equals, or bod
2B1 cao
- (b)** **1B1** } Errors to look for: $y = 60$ distinct in some way
2B1 } -1 e.e. lines correct to ≤ 1 small square 1 at axis
3B1 } Labels on lines
4B1 } Ruler
- (c)** **1B1ft** R 'correct', ft their lines, but shading needs to be correct
- (d)** **1M1** Attempt at profit line (axis to axis) or point testing 2 points
1A1 Profit line correct (within 1 sm square) or three points tested correctly
2A1 cao
- (e)** **1B1** cao
- (f)** **1M1** Attempt at profit line (axis to axis) or point testing 2 points
1A1ft correct but ft their R and their (e) for profit line and 3 point testing
2A1 correct (so a mark for correct with no need to ft)
3A1 cao (32, 64) only
- (g)** **4A1** cao follow through (ignore units).