Mark Scheme (Pre-Standardisation)
January 2008

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.

Question Number	Scheme	Marks
1 (a)(i)	A path from an unmatched vertex in one set to an unmatched vertex in the other set ....which alternately uses arcs not in / in the matching.	B1 B1 (2)
(ii)	A one-to-one pairing of some elements of one set with the other set	B1 B1 (2)
(b)	e.g. $D-3=C-5$ change status $D=3-C=5$ $E-2=A-1$ change status $E=2-A=1$ $A=1$ $B=4$ $C=5$ $D=3$ $E=2$	m1 A1 m1 A1 A1 (5) [9]

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)	E.g.	M1
	18 20 11 7 17 ⑮ 14 21 23 16 9	A1
	11 7 ⑭ 9 ⑮ 18 20 17 ㉑ 23 16	A1✓
	11 ⑦ 9 ⑭ 18 20 ⑰ 16 ㉑ ㉓	A1✓
	⑦ 11 ⑨ ⑯ ⑰ 18 ⑳ ㉓	
	⑨ ⑪ ⑯ ⑱ ⑳	
	⑪ ⑱	
	7 9 11 14 15 16 17 18 20 21 23	A1 (5)
(b)	CF ✓	M1
	GI ✓	
	{ BC or BF — accept one, reject one	A1
	{ CD ✓	
	EF ✓	
	DF ✗	A1
	HI ✓	
	BE ✗	
	AB ✓	
	AC ✗	A1 (4)
	EG ✓	
	Tree complete	
(c)	107 m	B1 (1)
		10

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		(16)	[17]	18	(20)	21	23
	(11)	9	[14]		[16]		(18)	[20]	(21)	23
	(9)	[11]					18		[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)		(15)	14	16	[17]			[21]	(23)
	[9]		(14)	[15]	(16)					[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]	
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	
[23]	(21)		[18]					[11]	(9)	
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]	(11)	7	17	15	14	16	9
(21)	23	(20)		(17)	15	14	16	[11]	(7)	9
(23)	[21]			(17)	(15)	14	16		(9)	[7]
[23]					16	[15]	(14)		[9]	
23	21	20	18	17	16	15	14	11	9	7
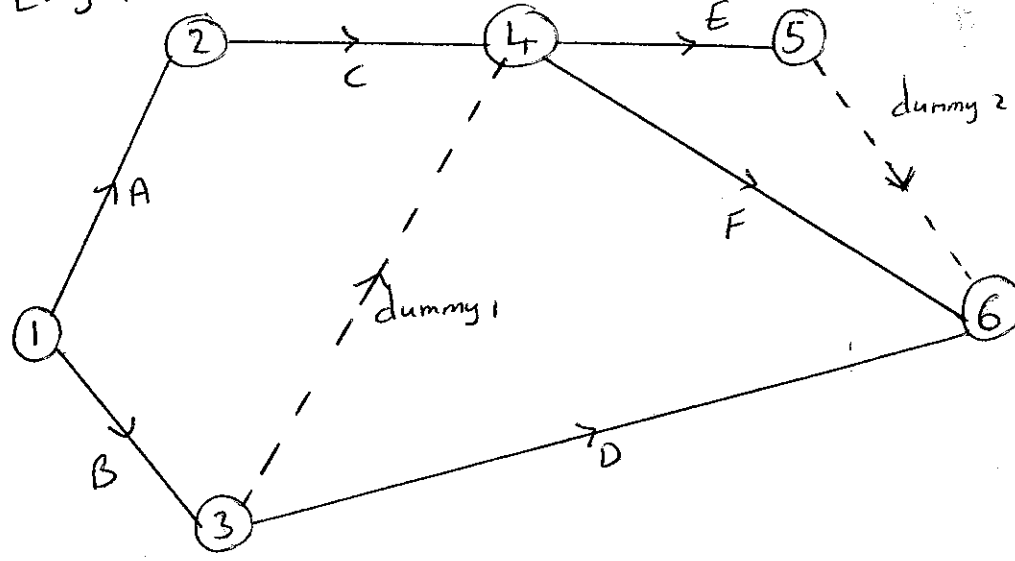
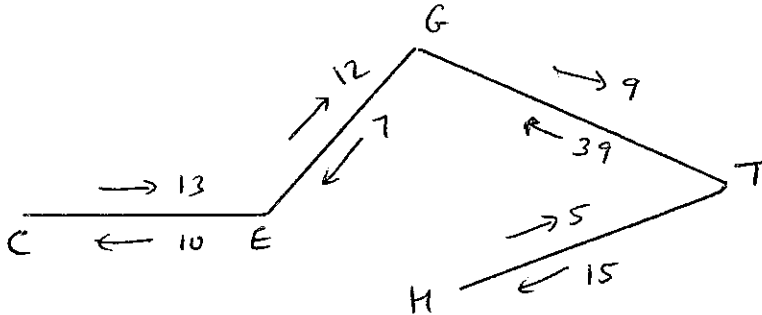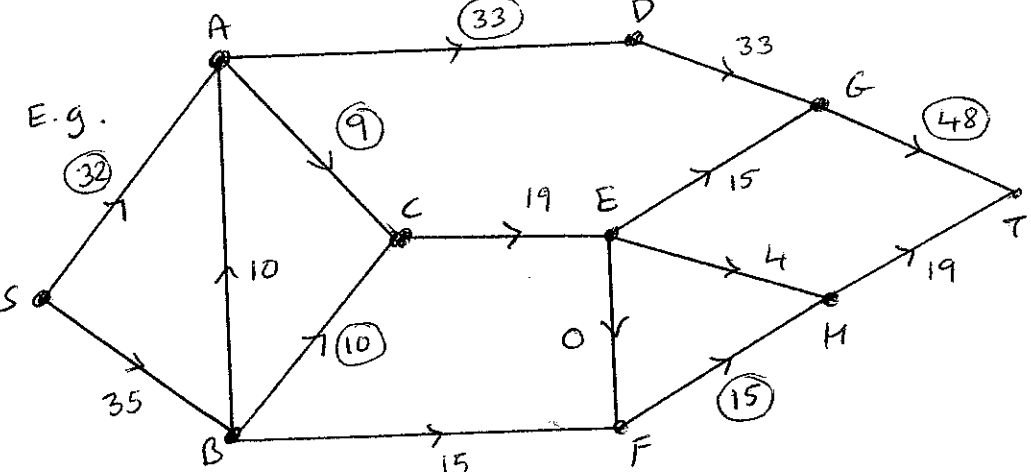| Question Number	Scheme	Marks
3 (a)	$CD + FG = 0.7 + 0.6 = 1.3$ * $CF + DG = 0.5 + 0.9 = 1.4$ $CG + DF = 1.1 + 0.5 = 1.6$ repeat CD and FG A possible route e.g. $A C D C F G F D G E D A E B A$ length : $11 + 1.3 = 12.3 km$	M1 A1 A1 A1 A1 A1✓ (6)
(b)	(i) Each arc has to be traversed twice (ii) $2 \times 11 = 22 km$	B1 (1) B2,0 (2) $\boxed{9}$

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)

(b) Total float on $D = 18 - 5 - 9 = 4$ ✓

$G = 25 - 8 - 10 = 7$

$I = 25 - 20 - 3 = 2$

M1

A2,1√,0

B1 (4)

(c) Critical activities: B E J M

B1 (1)

(d) Lower bound $= \dfrac{102}{35} = 2.914$

$\therefore$ 3 workers

M1

A1 (2)

[11]

Marks (right column, top): m1 A1   m1 A1   (4)

Question Number	Scheme	Marks
5) (a)	E.g. Dummy 1 is needed to show dependancy. E and F depend on C and B, but D depends on B only Dummy 2 is needed so that each activity can be uniquely represented in terms of its events.	M1 A1 A1 A1 (4) B3,2,1,0 (3) 7

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

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. S B A C E G T – 9
	        S B A D G E H T – 1
	        S B F E H T – 3
		m1 A1 A1 A1 (4)

(d)		m1 A1 (2)
(e)	Flow value 67	B1 (1)
(f)	Max flow – min cut theorem cut through A D, A C, B C, E F, F H	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 seperated; 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)	$y \geqslant 2x$	B 2, 1, 0 (2)
(b)	$x + 2y = 160$ Correctly drawn $y = 60$ correctly drawn and distinctive (strict inequality) Shading correct	B 4, 3, 2, 1, 0 (4)
(c)	R correct	B1✓ (1)
(d)	Profit line added or Point testing seen correctly done 70 boxes identified	m1 A1 A1 (3)
(e)	$(P =) \ 1.2x + 1.4y$	B1 (1)
(f)	Profit line added or Point testing seen correctly done (32, 64) identified.	m1 A1✓/A1 A1 (4)
(g)	£128.00	A1✓ (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).