Mark Scheme (Final)
Summer 2007

GCE

GCE Mathematics (6689/01)

Edexcel Limited. Registered in England and Wales No. 4496750
Registered Office: One90 High Holborn, London WC1V 7BH

A PEARSON COMPANY

June 2007
6689 Decision Mathematics
Mark Scheme

Question Number	Scheme	Marks
1)	A graph is planar if it can be drawn in a plane in such a way that no two edges meet each other, except at a vertex to which they are both incident	B2,1,0 $\boxed{2}$
2) (a)	To obtain a complete matching the number of vertices on each side must be equal.	B2,1,0 (2)
(b)	e.g. L – 3 = H – 5 = J – 1a = A – 4 c.s. L = 3 – H = 5 – J = 1a – A = 4 A = 4 H = 5 L = 3 E = 1b J = 1a m = 2	m1 A1 A1 (3)
(c)	H and L can now both only do 3. So a complete matching is not possible (other answers possible)	B2,1,0 (2) $\boxed{7}$

3) (a)

A	x	y	x even?	x = 0 ?
0	54	63	Y	
	27	126	N	
126	26			N
	13	252	N	
378	12			N
	6	504	Y	
	3	1008	N	
1386	2			N
	1	2016	N	
3402	0			Y

m1 A1

A1✓

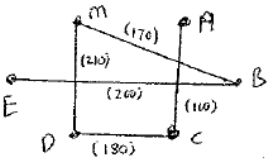
m1

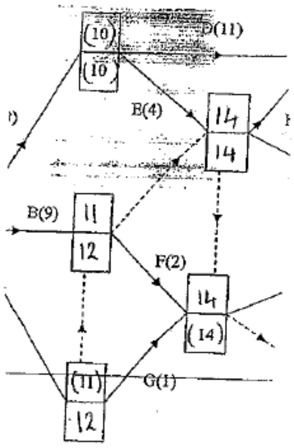
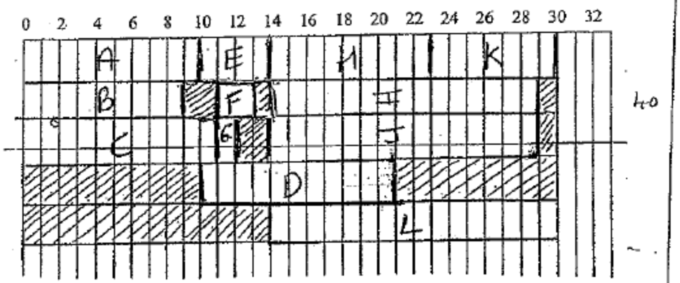
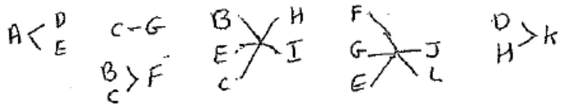
A1✓

A1

A = 3402 B1✓ (7)

(b) The product xy. B2,1,0 (2)

4) (a)	odd vertices B. D, F, H	
	BD + FH = 21 + 20 = 41	M1 A1
	BF + DH = 19 + 20 = 39 *	A1
	BH + DF = 23 + 18 = 41	A1
	[Repeat BE, EF, DG and GH]	
	shortest route = 125 + 39 = 164 km	A1✓ (5)
(b)	Seek to keep the least pairing – DF/18	B1✓
	Therefore start/finish at B and H.	B1✓ (2)
		$\boxed{7}$
5) (a)	MB, BE, MD, DC, CA	M1 A1 A1 (3)
(b)		B1✓ (1)
(c)	170 + 200 + 210 + 180 + 100 = 860	B1. (1)
(d)	(A cycle is formed when an arc is used that connects two vertices already connected to each other in the tree)	B2, 1, 0
	Prim's algorithm always selects arcs that bring a vertex not in the tree into the tree, so cycles can't happen	(2)
		$\boxed{7}$

6) (a)		(a) B3, 2, 1, 0 (3)
	(b) A E H K A E L	(b) B2, 1, 0 (2)
	(c) Idea of 'critical' – zero float, no delay, immediate – if late project will finish late etc. Idea of 'path' – from start to end event + continuous – the event forming end of one activity forms the start of the next – sequence or series or link or run - - - S.c. "longest path" gets 1st B1 only.	(c) B1 B1 (2)
(d)	$\frac{110}{30}$ $(= 3.7/36)$ ∴ 4 workers	M1 A1 (2)
(e)	D, H, I, J, L	B2, 1, 0 (2)
(f)	It will not be possible to find a solution with 4 workers to complete the project in the minimum time. 5 workers will be needed. Accept "an extra worker is required"	B1 (1)
(g)	e.g. 	M1 A1 A1 (3)
		15

7) (a) $P - 2x - 4y - 3z = 0$ (o.e.) B2, 0 (2)

(b) $12x + 4y + 5z \leq 246$ B1

$9x + 6y + 3z \leq 153$ B1

$5x + 2y - 2z \leq 171$ B1 (3)

(c)

basic variable	x	y	z	r	s	t	Value
r	12	4	5	1	0	0	246
s	9	⑥	3	0	1	0	153
t	5	2	-2	0	0	1	171
P	-2	-4	-3	0	0	0	0

b.v.	x	y	z	r	s	t	Value	Row operations
r	6	0	3	1	$-2/3$	0	144	$R_1 - 4R_2$
y	$3/2$	1	$1/2$	0	$1/6$	0	25.5	$R_2 \div 6$
t	2	0	-3	0	$-1/3$	1	120	$R_3 - 2R_2$
P	4	0	-1	0	$2/3$	0	102	$R_4 + 4R_2$

M1 A1
M1 A1√
B1√

b.v.	x	y	z	r	s	t	Value	Row operations
z	2	0	1	$1/3$	$-2/9$	0	48	$R_1 \div 3$
y	$1/2$	1	0	$-1/6$	$5/18$	0	1.5	$R_2 - \frac{1}{2}R_1$
t	8	0	0	1	-1	1	264	$R_3 + 3R_1$
P	6	0	0	$1/3$	$4/9$	0	150	$R_4 + R_1$

M1 A1
M1 A1
(9)

(d) $P = 150$ $x = 0$ $y = 1.5$ $z = 48$ M1 A1√

$r = 0$ $s = 0$ $t = 264$ A1√ (3)

(e) (The third constraint) $t \neq 0$ B1√ (1)

$\boxed{18}$

8) (a)	85	B1
(b)	$c_1 = 140$, $c_2 = 104$	B1, B1 (3)
(c)	e.g. S B D F H J T - 4 S B D F G T - 1 S B D F C H I T - 2 S B D F C H J T - 2 S B D E G T - 10	M1 A1 A1 A1 A1 (5)
(d)	max flow - min cut theorem, flow is 104, mincut is C_2	M1 A1 (2)
		$\boxed{10}$