

June 2006
6689 Decision Maths D1
Mark Scheme

Question Number	Scheme	Marks
1)	eg 52 48 50 45 64 47 53 52 50 48 64 47 53 45 52 50 64 48 53 47 45 52 64 50 53 48 47 45 64 52 53 50 48 47 45 64 53 52 50 48 47 45 no further changes - list sorted	M1 A1 A1 ✓ A1 7
	M1 Bubble sort - 1 st pass complete - end term 45 or 64, consistent L→R or R→L Shuttle, Quick etc at M2	
	A1 First 2 passes correct	} condense 'shrinking' list
	A1 ✓ next 2 passes correct (if L←R next pass)	
	A1 Final pass + final statement / rewrites list c.s.o. - must see whole list	
2) (a)	A path from an unmatched vertex in X to an unmatched vertex in Y, which alternately uses arcs in/not in the matching. (where X and Y are distinct sets of vertices.)	B2, 1, 0 (2)
(b)	e.g. R-B=A-P c.s. R=B-A=P S-F=M-C=D-K c.s. S=F-M=C-D=K ∴ A=P D=K H=Y M=C R=B S=F	M1, A1 (2) M1, A1 1 A1 (3) 7
	(a) B2 A good, complete answer	
	B1 Partially correct - unmatched to unmatched or arcs in/not in the matching one enough "bad" sets etc	
	(b) M1 Path from/to R/S to/from K/P	
	A1 c.a.o incl c.s.	
	(M1) Second path from remaining LH vertex to remaining RH vertex	
	A1 c.a.o incl c.s. (penalise c.s. only once)	
	A1 <u>Must</u> ✓ from 2 correct paths c.a.o	

Notes for question 1

Q 1 Bubble R → L

52	48	50	45	64	47	53	mi
64	52	48	50	45	53	47	
64	53	52	48	50	45	47	A1
64	53	52	50	48	47	45	A1
no further change - list sorted							A1

Misreads - sorting into ascending order

(note - if candidates reverse list full credit is gained)

L → R (ascending - misread)

52	48	50	45	64	47	53	(MR) mi
48	50	45	52	47	53	64	
48	45	50	47	52	53	64	A1
45	48	47	50	52	53	64	
45	47	48	50	52	53	64	A1
No further change - list sorted							A1

4-2 for MR

R → L

52	48	50	45	64	47	53	(MR) mi
45	52	48	50	47	64	53	
45	47	52	48	50	53	64	A1
45	47	48	52	50	53	64	
45	47	48	50	52	53	64	A1
No further change - list sorted							A1

4-2 for MR

Notes for Q 2

(b)(i) $R - B = A - P$

$S - F = m - c = D - k$

(ii) $R - B = A - F = m - c = D - k$

$S - F = A - P$

(iii) $S - F = m - c = D - k$

$R - B = A - P$

(iv) $S - F = m - c = m - B = A - P$

$R - B = m - c = D - k$

$A = P$

$D = k$

$m = c$

$R = B$

$S = F$

3)(a)

$$AC + EG = 44 + 35 = 79$$

$$AE + CG = 41 + 36 = 77 \neq$$

$$AG + CE = 36 + 45 = 81$$

Repeat AD, DE, CF and FG

(b) length = $394 + 77 = 471$ km

(c) Since EG is the smallest chosen to repeat this hence start and finish at A and C.

m1
A1
A1
A ✓ (4)
B ✓ (1)
m1
A ✓ (2)
7

(a) m1 3 pairs of their odd vertices (different)

A1 One pairing and total correct - i.e. one line correct

A1 all 3 pairings and totals correct

A ✓ correct ones identified - must be 2⁺ pairings to choose from. AD DG
CF EG

(b) B1 471 (km) $394 +$ their shortest - must be 2 pairings to choose from.

(c) m1 Identifies ^{358} {EG} as smallest - or identifies their smallest from 2⁺ pairings + totals

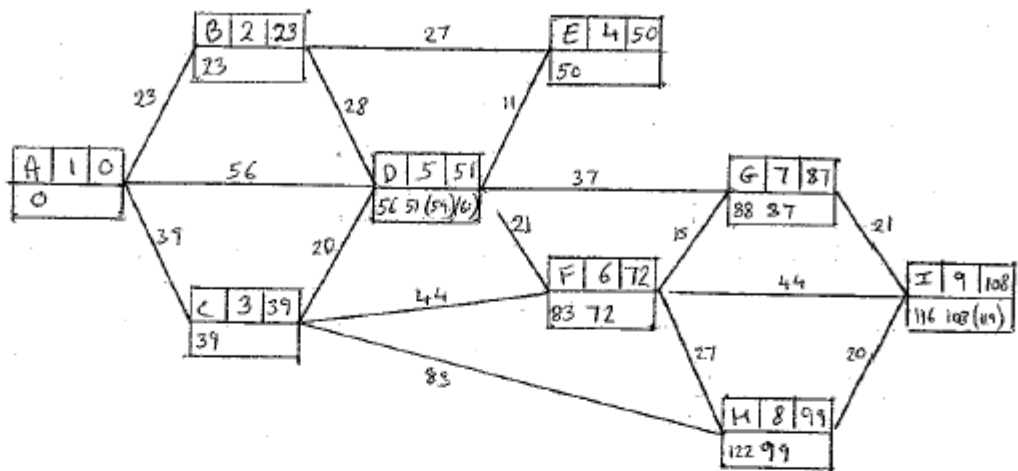
A1 ✓ from 2⁺ pairings + totals

4(a)

A path is a (finite) sequence of edges, such that the end vertex of one edge is the start vertex of the next and in which no vertex appears more than once / no cycles

B2, 1, 0 (2)

(b)



m1
A1
A1
A1✓

Shortest path: ABDFGI length: 108 miles

- (c) e.g. $108 - 21 = 87$ ← I cc - trace back from I
 $87 - 15 = 72$ ← G - include arc xy if y is already on the path
 $72 - 21 = 51$ ← F and if the difference in final labels equals the
 $51 - 28 = 23$ ← D length of arc
 $23 - 23 = 0$ ← A

A1, A1✓ (6)

B2✓/0 (2)

(d) ABEDFGI length 118 miles

m1 A1 (2)
12

(a) B2: A good, complete description

B1 close - mostly there. "bad" set B, "route" "series" may be ok

(b) m1 In D, F, G, H or I working values, large replaced by small

A1 A, B, C, E correct labels in a rising sequence

A1 D, F correct labels ✓ } penultimate order of labelling

A1✓ G, H, I correct labels ✓ } once only.

A1 Path c-a-o.

A1✓ Length ✓ from I accept 108 if a correct path

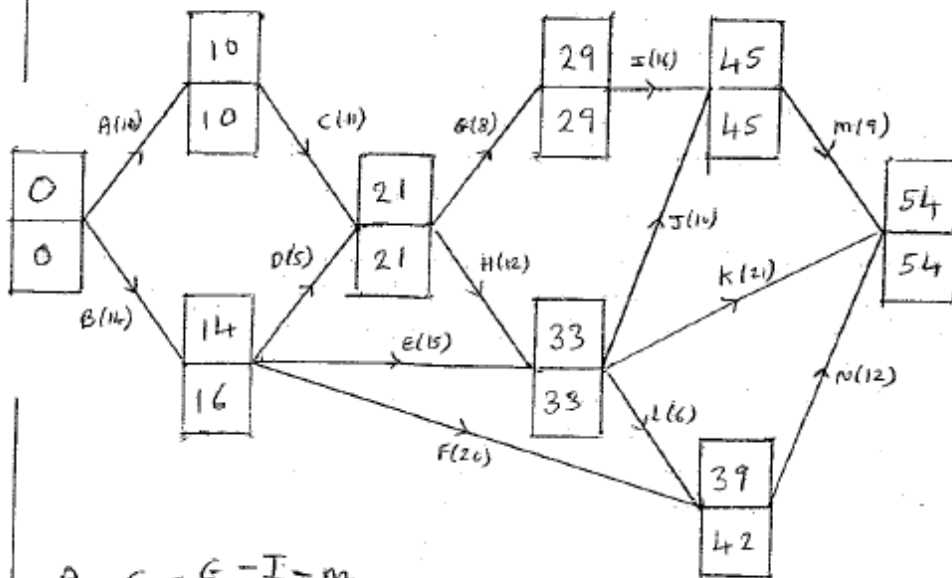
(c) B2 ✓ complete revision of one of the 2 given explanations

B1 ✓ All there but one step "bad" set B, - easy mark

(d) m1 Route A to I including E

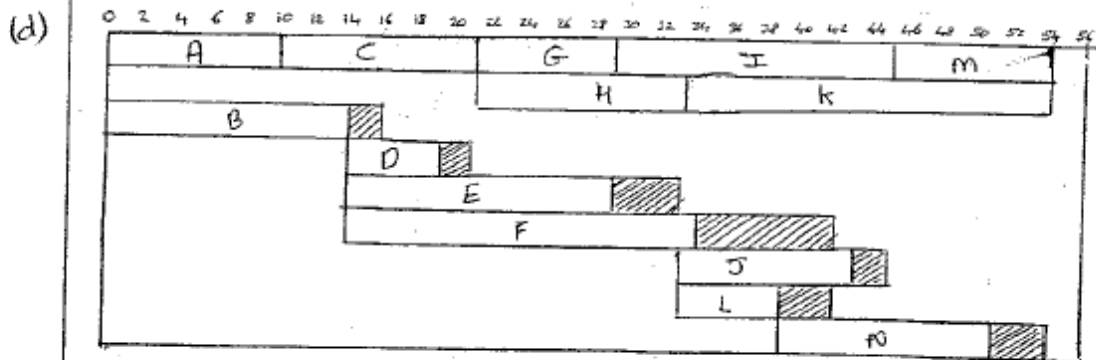
A1 c-a-o

5 (a)



(b) A - C - G - I - M
 H - K

(c) Float on D = 21 - 5 - 14 = 2
 Float on F = 42 - 20 - 14 = 8



(e) Day 15: C
 Day 25: G, H, E, F

m1
 A1 (2)

m1
 A1 (2)

A1 (1)

B1 ✓
 m, A1 (3)

m1
 A1
 A1 ✓
 A1

(4)

B1
 B2, U (3)

15

Q5(a) M1 All top boxes completed \rightarrow increasing generally

A1 C.A.O.

M1 All lower boxes completed \leftarrow decreasing generally

A1 C.A.O.

(b) A1 C.A.O. as 7 listed - no extras

(c) B1 \checkmark C.A.O. \checkmark from diagram

M1 method correct or \checkmark correct answer

A1 \checkmark C.A.O. \checkmark from diagram

Top & bottom or both ends

must see appropriate working for M1

(d) M1 At least one of their critical paths + 3 non-critical ^{must be complete answers} listed including floats

A1 critical activities correct

A1 \checkmark 4 non-critical activities correct \checkmark from diagram must include a float for activity

A1 C.A.O. - on non-critical

(e) B1 C.A.O.

B2 C.A.O.

B1 if one extra or one omission

6) (a)

$$7x + 10y + 10z + r = 3600$$

$$6x + 9y + 12z + s = 3600$$

$$2x + 3y + 4z + t = 2400$$

$$P - 35x - 55y - 60z = 0$$

B2, 1, 0

B2, 0 (4)

(b)

b.v.	x	y	z	r	s	t	value	Row ops.
r	2	5/2	0	1	-5/6	0	600	$R_1 - 10R_2$
z	1/2	3/4	1	0	1/12	0	300	$R_2 \div 12$
t	0	0	0	0	-1/3	1	1200	$R_3 - 4R_2$
P	-5	-10	0	0	5	0	18000	$R_4 + 60R_2$

m1

A1

m1

A1 ✓

B1

(5)

b.v.	x	y	z	r	s	t	value	Row ops.
y	4/5	1	0	2/5	-1/3	0	240	$R_1 \div 5/2$
z	-1/10	0	1	-3/10	1/3	0	120	$R_2 - 3/4 R_1$
t	0	0	0	0	-1/3	1	1200	$R_3 \text{ stat}$
P	3	0	0	4	5/3	0	20400	$R_4 + 10R_1$

m1

A1 ✓

m1

A1

(4)

(c)

$$P = 20400 \quad x = 0 \quad y = 240 \quad z = 120$$

$$r = 0 \quad s = 0 \quad t = 1200$$

m1

A2, 1, 0

16

D1 June 2006 Q6(b) - wrong pivot choice

(i) 10 in z column

b.v.	x	y	z	r	s	t	value	Row ops	mo
z	$\frac{7}{10}$	1	1	$\frac{1}{10}$	0	0	360	$R_1 \div 10$	m1
s	$-\frac{12}{5}$	-3	0	$-\frac{6}{5}$	1	0	-720	$R_2 - 12R_1$	A1 ✓
t	$-\frac{4}{5}$	-1	0	$-\frac{2}{5}$	0	1	960	$R_3 - 4R_1$	B0
f	7	5	0	6	0	0	21600	$R_4 + 60R_1$	m0 m0

(ii) 4 in z column

b.v.	x	y	z	r	s	t	value	Row ops	mo
r	2	$\frac{5}{2}$	0	1	0	$-\frac{5}{2}$	-2400	$R_1 - 10R_3$	m1 A1 ✓
s	0	0	0	0	1	-3	-3600	$R_2 - 12R_3$	B0
z	$\frac{1}{2}$	$\frac{3}{4}$	1	0	0	$\frac{1}{4}$	600	$R_3 \div 4$	m0
f	-5	-10	0	0	0	15	36000	$R_4 + 60R_3$	m0

D1 June 2006 Q6(b) Misreads.

(i) chooses 7 in x column

b.v.	x	y	z	r	s	t	value	Row ops.
x	1	$\frac{10}{7}$	$\frac{10}{7}$	$\frac{1}{7}$	0	0	$514\frac{2}{7}$	$R_1 \div 7$
s	0	$\frac{3}{7}$	$\frac{26}{7}$	$-\frac{6}{7}$	1	0	$514\frac{6}{7}$	$R_2 - 6R_1$
t	0	$\frac{1}{7}$	$\frac{8}{7}$	$-\frac{2}{7}$	0	1	$1371\frac{3}{7}$	$R_3 - 2R_1$
p	0	-5	-10	5	0	0	18000	$R_4 + 35R_1$

$\frac{360}{49}$
 $\frac{150}{49}$
 $\frac{1200}{49}$

1st 5 marks as below

b.v.	x	y	z	r	s	t	value	Row ops.
x	1	$\frac{5}{4}$	0	$\frac{1}{2}$	$-\frac{5}{12}$	0	509.9125...	$R_1 - \frac{10}{7}R_2$
z	0	$\frac{1}{8}$	1	$-\frac{1}{4}$	$\frac{7}{24}$	0	150	$R_2 \div \frac{24}{7}$
t	0	0	0	0	$-\frac{1}{3}$	1	1367.930...	$R_3 - \frac{8}{7}R_2$
p	0	$-\frac{15}{4}$	0	$\frac{5}{2}$	$\frac{35}{12}$	0	18030.612...	$R_4 + 10R_2$

407.93

1200

M1

A1

to my final tableau

-2 for Misread

(ii) chooses 10 in y column

b.v.	x	y	z	r	s	t	value	Row ops.
y	$\frac{7}{10}$	1	1	$\frac{1}{10}$	0	0	360	$R_1 \div 10$
s	$-\frac{3}{10}$	0	3	$-\frac{9}{10}$	1	0	360	$R_2 - 9R_1$
t	$-\frac{1}{10}$	0	1	$-\frac{3}{10}$	0	1	1320	$R_3 - 3R_1$
p	$\frac{7}{2}$	0	-5	$5\frac{1}{2}$	0	0	19800	$R_4 + 55R_1$

1st 5 marks as scheme

to my final tableau

Next 4 marks as scheme

-2 for Misread

6 (a) B2 } First 3 equations c.a.o -1 each error, but penalise only 1 error per equation
 B1 } inequalities get B₀
 B2 c.a.o (B1 for a "little st.")

(b) M1 Correct pivot chosen and some attempt to deal with whole row

A1 pivot row correct c.a.o including b.v.

M1 correct row operations used (all 3) - at least 1 non-zero or 1 term correct in each row. whole row $\checkmark \Rightarrow M_0$

A1 \checkmark non-pivot row correct; \checkmark on error in pivot choice only

(5) B1 Row operations correctly stated. (condone lack of $R_2 \div 12$) must be in form of new pivot row

\Rightarrow M1 \checkmark correct pivot chosen, \checkmark from previous tableau. No negatives in value of previous tableau or M_0 + some attempt to deal with whole row

A1 \checkmark c.a.o including b.v. but \checkmark from previous table.

\Rightarrow M1 correct row operations used (all 3) - at least 1 non-zero or 1 term correct in each row. whole row $\checkmark \Rightarrow M_0$

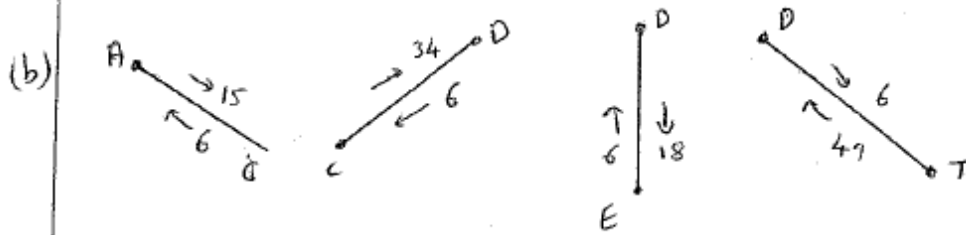
(4) A1 c.a.o.

(c) M1 3 variables stated - must have completed b.v. and value columns (or 1's and zeros) in tableau. Any negative M_0
 If reading top \rightarrow bottom M_0 . must be a final tableau - inequalities M_0

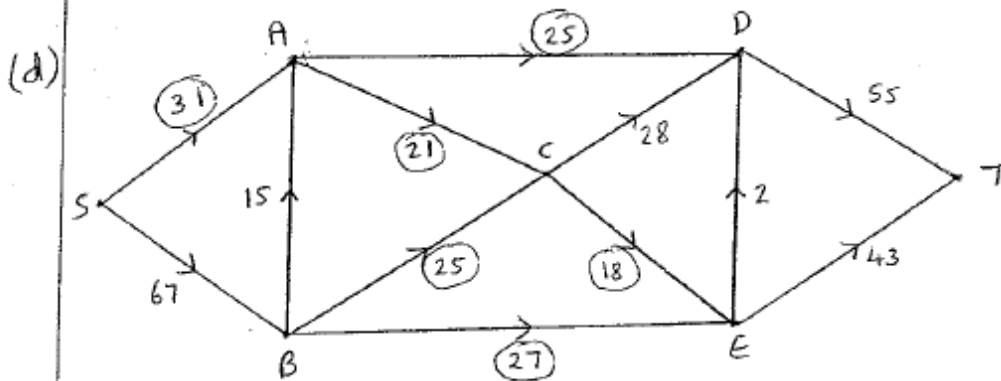
A2 \checkmark all 7 correct

A1 \checkmark at least 4 correct

7) (a) $C_1 = 103$, $C_2 = 177$, flow = 76



(c) e.g. SBCDT - 6
 SBCDET - 1
 SBACDET - 15
 max. flow is 98



(e) maximum flow = minimum cut
 cut through AD, AC, BC and BE

B_1, B_1, B_1
 (3)

m_1
 A_1 (2)

m_1
 $A_3, 2, 1, 0$

B_1 (5)

m_1
 A_1 (2)

m_1
 A_1 (2)

14

7) a) B1 103 cao

B1 177 cao

B1 76 cao

(b) m1 2 numbers added to each of the 4ers

A1 cao

(c) m1 1 correct routes + flows found (flow > 15 gets me) (condone initial flow aug making route only if clearly separated from the rest)

A3 all routes + flows found to 22 more

A2 2 ~~ca~~ routes + flows found to ~~12~~ 12+

A1 1 ~~ca~~ route + flows found to 6+

B1 98 cao

(d) m1 consistent flow of 77+, complete, clear (doesn't need to ✓ from (c))

A1 c.a.o

(e) m1 Flow of 98 + cut attempted + max flow min cut theorem referred to (3 out of 4)

A1 cao

