GCE Examinations

Advanced Subsidiary / Advanced Level

Decision Mathematics
Module D1

Paper D

MARKING GUIDE

This guide is intended to be as helpful as possible to teachers by providing concise solutions and indicating how marks should be awarded. There are obviously alternative methods that would also gain full marks.

Method marks (M) are awarded for knowing and using a method.

Accuracy marks (A) can only be awarded when a correct method has been used.

(B) marks are independent of method marks.



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D1 Paper D – Marking Guide

1. *(a)*

order:	4	3	5	1	2
	Durness	Helmsdale	Inverness	Thurso	Wick
~~Durness~~	–	(68)	~~123~~	~~81~~	~~92~~
~~Helmsdale~~	~~68~~	–	~~102~~	~~72~~	(64)
~~Inverness~~	~~123~~	(102)	–	~~148~~	~~127~~
~~Thurso~~	~~81~~	~~72~~	~~148~~	–	~~48~~
~~Wick~~	~~92~~	~~64~~	~~127~~	(48)	–

giving $T \overset{48}{—} W \overset{64}{—} H \overset{68}{—} D$, H — 102 — I M3 A2

(b) 282 km A1 **(6)**

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2. *(a)* e.g. choose middle name, latter if middle pair
interrogate, giving answer or list of about half the previous list
repeat until celebrity found B4

(b) with list of 1 name, need 1 interrogation
with list of 2 names, need a maximum of 2 interrogations
with list of 4 names, need a maximum of 3 interrogations etc.
with list of 2^n names, need a maximum of $(n + 1)$ interrogations
$2^{20} = 1\,048\,576$ so with 1 million need a maximum of 21 interrogations. M2 A1 **(7)**
(accept 20)

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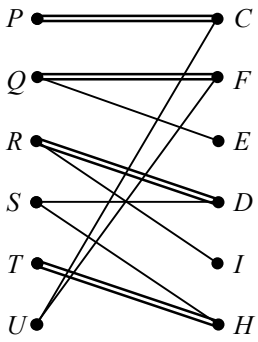
3. *(a)* if $y = 0$, lowest weight = 22 (*SADT*)
if y large, lowest weight = 27 (*SBDT*)
$\therefore$ lowest weight between 22 and 27 inclusive M2 A1

(b) if $y = 0$, minimum cut = 14, $\{S, A, B, C, E\} \mid \{D, T\}$
if y large, minimum cut = 22, $\{S, A, B, C, D, E\} \mid \{T\}$
maximum flow = minimum cut $\therefore$ between 14 and 22 inclusive M2 A1

(c) (i) e.g. shortest route by road between 2 towns B1
(ii) e.g. maximum traffic flow between 2 towns B1 **(8)**

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4. *(a)*



A1

(b) initial matching shown by ═══ B1

(c)

search for alternating path giving e.g. $S - D = R - I$ (breakthrough)	M1 A1
change status giving $S = D - R = I$	M1
search for alternating path giving e.g. $U - F = Q - E$ (breakthrough)	M1 A1
change status giving $U = F - Q = E$	M1
complete matching e.g. $P - C, Q - E, R - I, S - D, T - H, U - F$	A1

(d) *P* and *U* both now only interested in *C* which only one can have B2 **(11)**

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5. *(a)*

e.g. locate all odd vertices and identify all ways of pairing these for each way find total of minimum times between pairs choose lowest total minimum time is total of all arcs + lowest total found above	B3

(b)

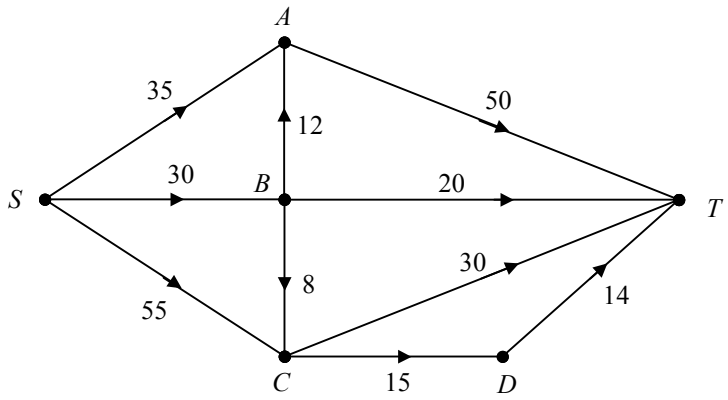
odd vertices are *A*, *B*, *C* and *D*	B1
minimum *AB* and *CD* = 20 + 80 = 100 *AC* and *BD* = 40 + 60 = 100 *AD* and *BC* = 40 + 20 = 60; lowest is 60	M1 A1
total = sum of all arcs + 60 = 1460 + 60 = 1520 seconds	A1
route: e.g. *FGHIJKLDEAGIBCDEABCJLF*	A1

(c)

odd vertices now *C* and *D*, minimum *CD* = 200	
new total = 1440 + 200 = 1640 seconds	M1 A1
removal of arc has increased total time as it provided a useful link	B1 **(11)**

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6. *(a)*

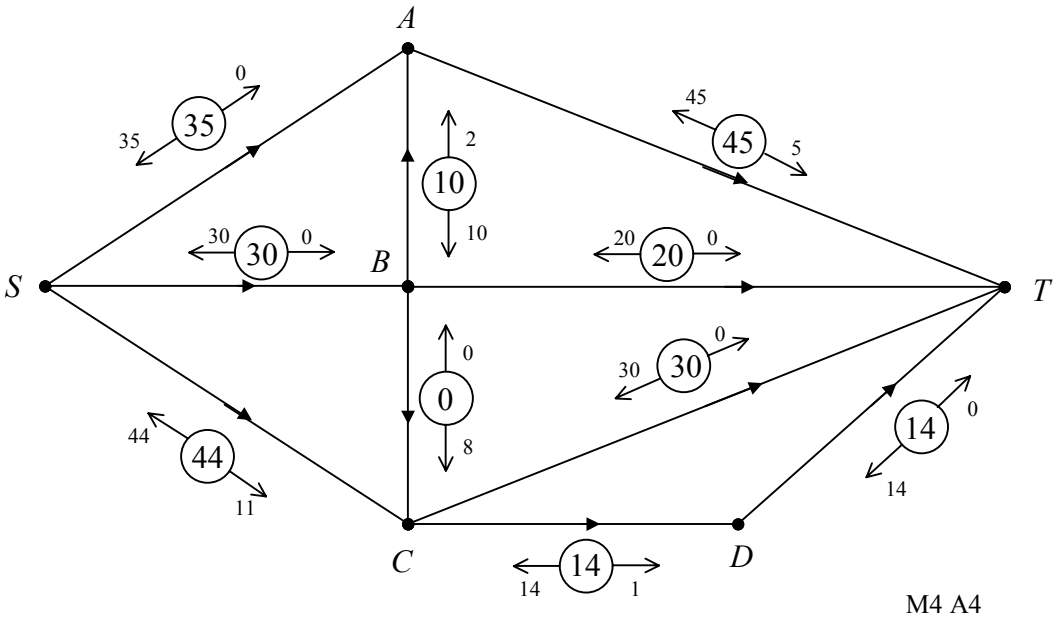


M2 A1

(b) $50 + 20 + 30 + 15 = 115$ A1

(c) minimum cut = $\{S, C, D\} \mid \{A, B, T\} = 109$ M1 A1

(d) e.g. start with $SAT = 35$, $SBT = 20$, $SCT = 30$
augment $SBAT$ by 10 and $SCDT$ by 14 giving maximum flow below



M4 A4

(e) this is maximum flow as it is equal to the minimum cut B1

(f) e.g. maximum traffic flow between 2 points on a one-way system B1 **(16)**

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7. *(a)* maximise $R = 4x + 10y + 2z$ given

$x - y \leq 5$

$-y + 2z \leq 0$

$2x + 4y + z \leq 40$

$x \geq 0,\ y \geq 0,\ z \geq 0$ M2 A2

(b) to change inequalities into equations B1

(c) only one positive value so pivot row is 3rd row

2nd tableau is:

Basic Var.	x	y	z	r	s	t	Value
r	$\frac{3}{2}$	0	$\frac{1}{4}$	1	0	$\frac{1}{4}$	15
s	$\frac{1}{2}$	0	$\frac{9}{4}$	0	1	$\frac{1}{4}$	10
y	$\frac{1}{2}$	1	$\frac{1}{4}$	0	0	$\frac{1}{4}$	10
R	1	0	$\frac{1}{2}$	0	0	$\frac{5}{2}$	100

M3 A3

(d) final tableau as all values on the objective row are ≥ 0 B1

(e) centre provides 10 courses for adults (not pensioners) and gets £100 revenue per day B2

(f) no. e.g. the slack variable s associated with this constraint is not zero so optimal solution without this constraint would be the same B2 **(16)**

Total **(75)**

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Performance Record – D1 Paper D

Question no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Total
Topic(s)	Prim's	binary-search	weighted network, flows	matching	route inspection	flows	simplex	
Marks	6	7	8	11	11	16	16	75
Student								

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