GCE Examinations

Advanced Subsidiary / Advanced Level

Decision Mathematics

Module D1

Paper A

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.

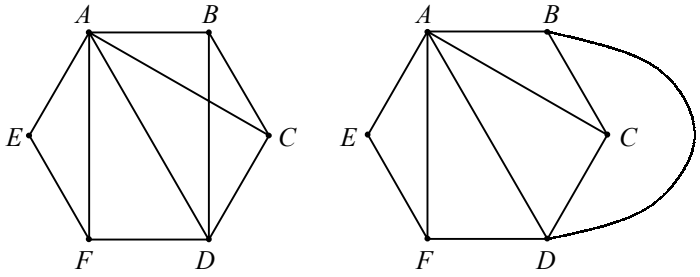
(B) marks are independent of method marks.

Written by Shaun Armstrong & Dave Hayes

D1 Paper A – Marking Guide

1. *(a)* e.g. *ABCDFEA* B2

(b)



e.g. start with *AC* on inside, move *BD* outside, giving plane drawing M3 A2 **(7)**

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2. *(a)*

35 23 10 46 24 11
35 23 10 46 24 11
35 23 10 46 24 11
35 23 46 10 24 11
35 23 46 24 10 11
35 23 46 24 11 10

35 23 46 24 11
35 23 46 24 11
35 46 23 24 11
35 46 24 23 11
35 46 24 23 11

35 46 24 23
46 35 24 23
46 35 24 23
46 35 24 23

46 35 24
46 35 24
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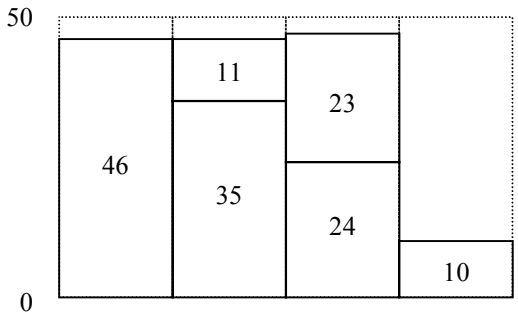
46 35
46 35

giving 46 35 24 23 11 10 M2 A2

(b) 7 + 6 + 5 + 4 + 3 + 2 + 1 = 28 A1

(c)



M1 A1

11 could not go into 1st bin but could fit in 2nd bin B1 **(8)**

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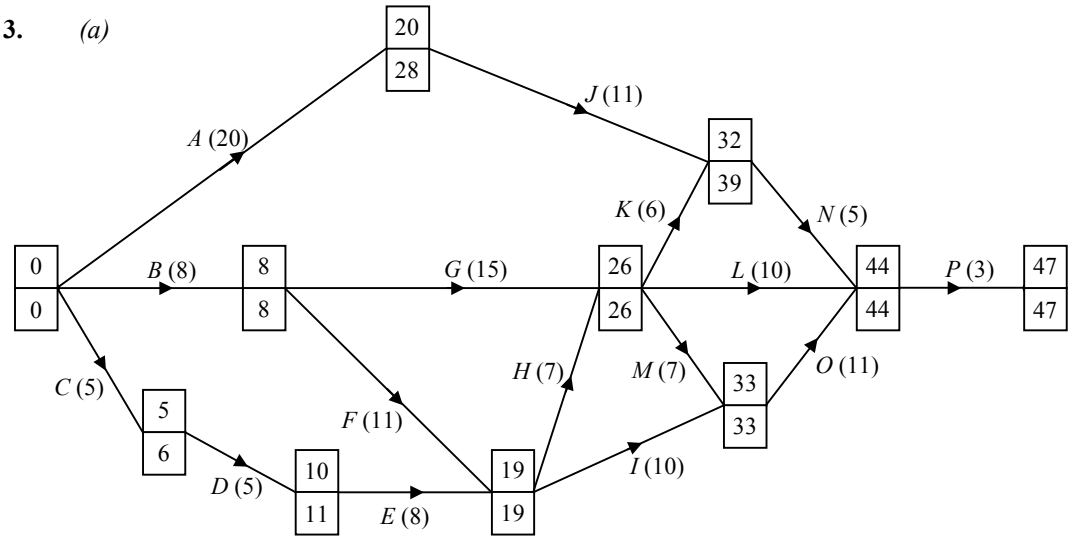
3. *(a)*



M2 A3

(b) *B*, *F*, *H*, *M*, *O*, *P* — M1 A1

(c) 47 days — A1 **(8)**

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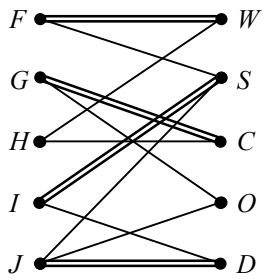
4. *(a)*



M1 A1

(b) initial matching shown by ═══ — B1

search for alternating path giving e.g. $H - C = G - O$ (breakthrough) — M1 A1

change status giving $H = C - G = O$ — M1

complete matching e.g. $F - W$, $G - O$, $H - C$, $I - S$, $J - D$ — M1 A1 **(8)**

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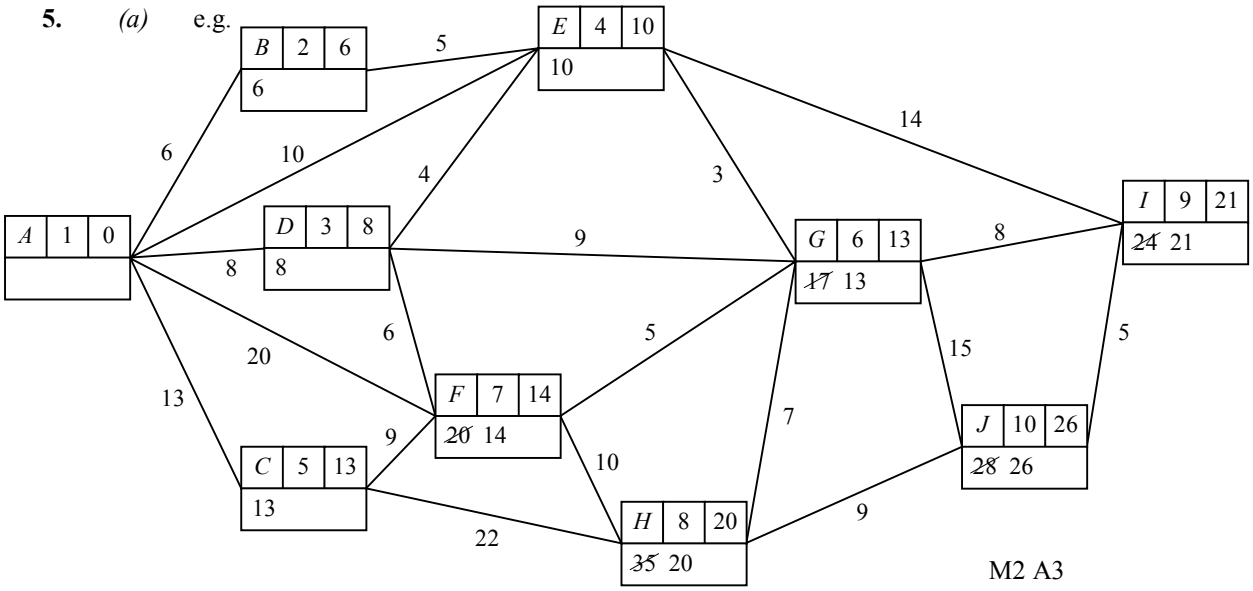
5. *(a)* e.g.



M2 A3

label J – label I = 5 = weight IJ
label I – label G = 8 = weight GI
label G – label E = 3 = weight EG
label E – label A = 10 = weight AE — M1 A1
so $A\ E\ G\ I\ J$ is path of least weight; weight = 26 — A2

(b) there are no other paths of least weight — B1
these would have been revealed by the backward scan — B1

(c) e.g. finding shortest distance by road between two towns — B1 **(12)**

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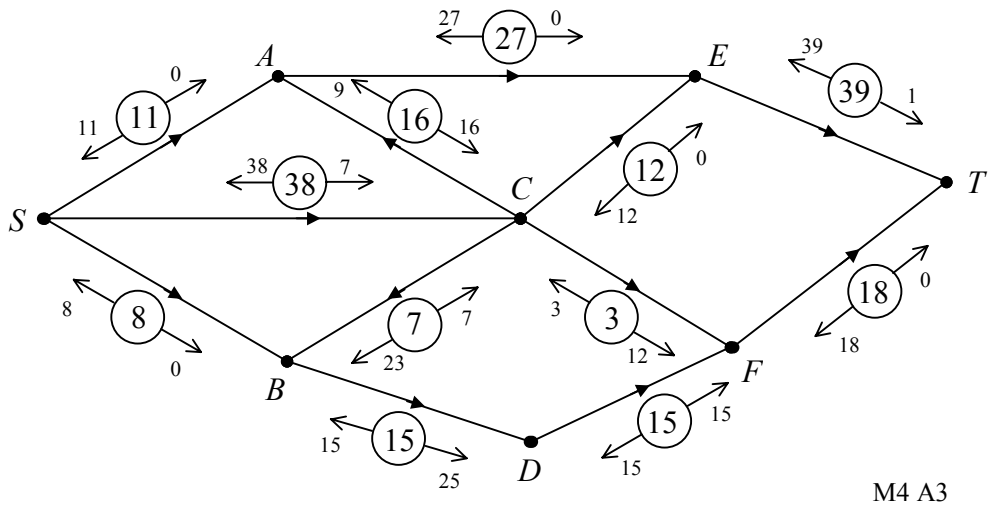
6. *(a)* $C_1 = 80$; $C_2 = 94$ — A2

(b) minimum cut: $\{S, A, B, C, D, F\} \mid \{E, T\} = 57$ — M1 A1

(c) $x = 15$, $y = 10$, $z = 36$ — A3

(d) augment $SCET$ by 2 and $SCAET$ by 1 giving maximum flow below



M4 A3

this is maximum flow as it is equal to the minimum cut — B1 **(15)**

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7. *(a)* maximise $P = 10x + 12y + 8z$ given

$$x + 2y + 4z \le 20$$
$$4x + 3y + 14z \le 75$$
$$5x + 2y + 10z \le 60$$
$$x \ge 0,\ y \ge 0,\ z \ge 0$$

M2 A2

(b) using slack variables s, t and u gives

$$\begin{aligned} x + 2y + 4z + s \qquad\qquad &= 20 \\ 4x + 3y + 14z \qquad + t \qquad &= 75 \\ 5x + 2y + 10z \qquad\qquad + u &= 60 \end{aligned}$$

objective function becomes

$$R - 10x - 12y - 8z = 0$$

hence the given initial tableau — M1 A1

(c) to change inequalities into equations — B1

(d) θ values are 10, 25 and 30 so pivot row is 1st row

2nd tableau is:

Basic Var.	x	y	z	s	t	u	Value
y	$\frac{1}{2}$	1	2	$\frac{1}{2}$	0	0	10
t	$\frac{5}{2}$	0	8	$-\frac{3}{2}$	1	0	45
u	4	0	6	$^-1$	0	1	40
R	$^-4$	0	16	6	0	0	120

M2 A2

choose to increase x next
θ values are 20, 18 and 10 so pivot row is 3rd row

3rd tableau is:

Basic Var.	x	y	z	s	t	u	Value
y	0	1	$\frac{5}{4}$	$\frac{5}{8}$	0	$-\frac{1}{8}$	5
t	0	0	$\frac{17}{4}$	$-\frac{7}{8}$	1	$-\frac{5}{8}$	20
x	1	0	$\frac{3}{2}$	$-\frac{1}{4}$	0	$\frac{1}{4}$	10
R	0	0	22	5	0	1	160

M2 A2

(e) optimal solution as all values on the objective row are ≥ 0 — B1
company donates 10 two-person and 5 four-person boats — B1 **(17)**

Total **(75)**

Performance Record – D1 Paper A

Question no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Total
Topic(s)	graphs, planarity	bubble sort, bin packing	critical path	matching	Dijkstra's	flows	simplex	
Marks	7	8	8	8	12	15	17	75
Student								