GCE Examinations

Advanced Subsidiary / Advanced Level

Decision Mathematics
Module D1

Paper E

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.



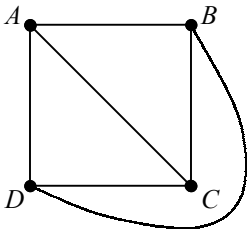
Written by Shaun Armstrong & Dave Hayes

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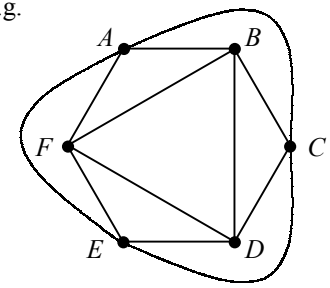
D1 Paper E – Marking Guide

1. *(a)* Graph 1 e.g.



B1

Graph 2 e.g.



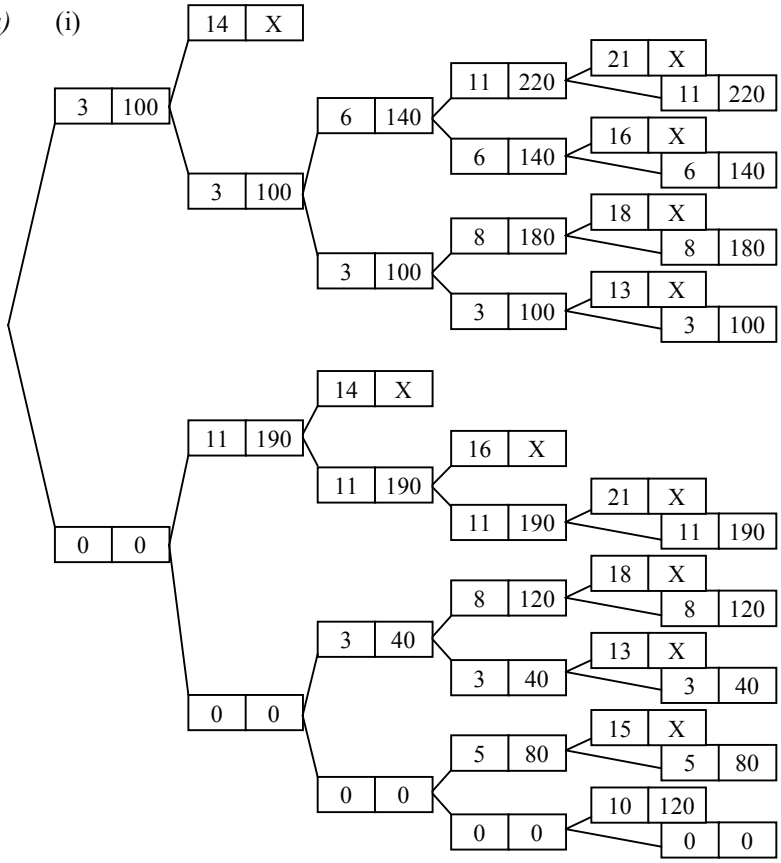
B2

(b) K_4 as each vertex is joined by exactly one arc to each other vertex and no vertex is joined to itself. B2

(c) yes, can add any of *AD*, *BE* or *CF* - all vertices remain connected, still at most 1 arc between each pair of vertices, and no loops B1 **(6)**

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2. *(a)* (i)



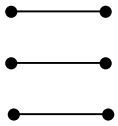
M2 A2

(ii) Kendal, Arlington and Elford, value £220 000 M1 A1

(b) more than 2 branches at each node,
consider K, M, A, E, G each time until terminated B1 **(7)**

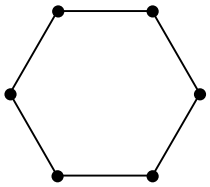
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3. *(a)*



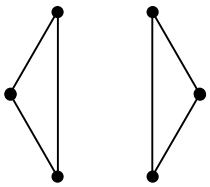
B1

(b) (i)



B1

(ii)



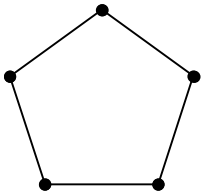
B1

(c) 2 or 4 A1

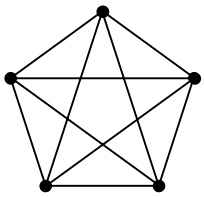
must be an even number of odd nodes ∴ x can't be odd

also, to be simple, $x \leq 4$ B1

(d) $x = 2$:



$x = 4$:



B2 **(7)**

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4. *(a)* $x_1 + x_2 + x_3 + x_4 = 200 + 350 + 250 + 200$

$\therefore\ x_4 = 1000 - x_1 - x_2 - x_3$ A1

(b) $C = 1000x_1 + 1800x_2 + 1600x_3 + 1900x_4 + 500(x_1 - 200)$

$+ 500(x_1 + x_2 - 550) + 500(x_1 + x_2 + x_3 - 800)$ M2 A1

sub in for x_4 giving $600x_1 + 900x_2 + 200x_3 + 1\,125\,000$ M1 A1

(c) $P = (1000 \times 4000) - C = 2\,875\,000 - 600x_1 - 900x_2 - 200x_3$ A1

(d) 2 of $x_1 + x_2 \geq 550$

$x_1 + x_2 + x_3 \geq 800$

$x_1 + x_2 + x_3 \leq 1000$ A2

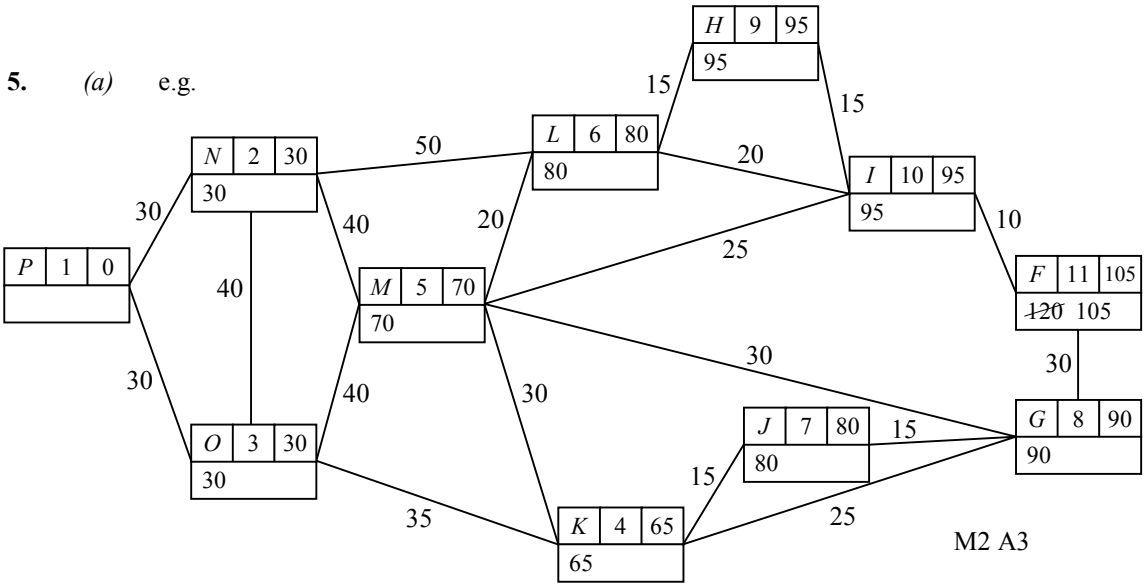
(e) there are 3 independent variables B1

(f) $x_1 = x_2 = x_3 = 0$ is not in the feasible region B1

need to start with feasible solution e.g. $x_1 = 200$, $x_2 = 350$ and $x_3 = 250$ B1 **(12)**

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5. *(a)* e.g.



M2 A3

label F – label I = 10 = weight IF
label I – label M = 25 = weight MI
label M – label N = 40 = weight NM
label M – label O = 40 = weight OM
label N – label P = 30 = weight PN
label O – label P = 30 = weight PO M1 A1
so $P\ N\ M\ I\ F$ (or $P\ O\ M\ I\ F$) is a route of minimum length (105 miles) A1

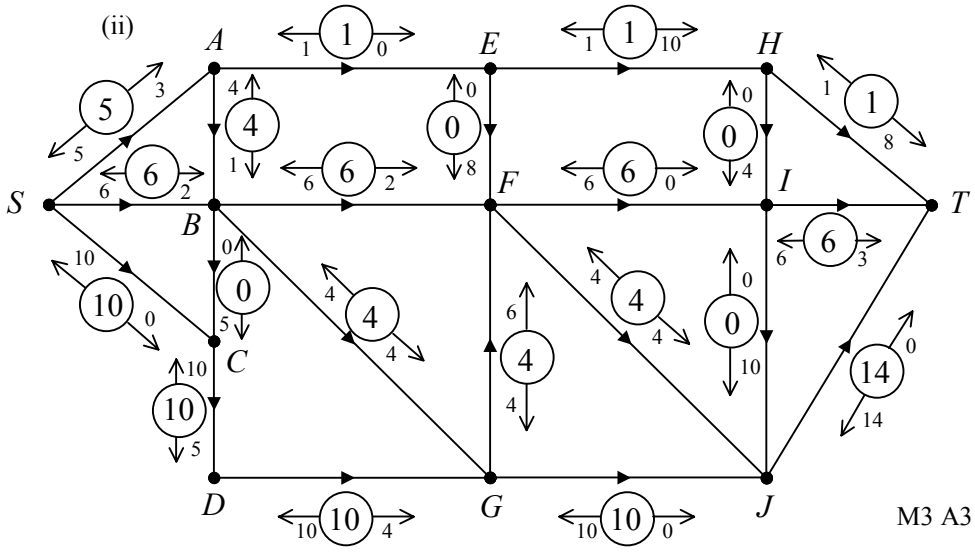
(b) odd vertices are P and F B1
minimum PF = 105 A1
total = sum of all arcs + 105 = 1815 + 105 = 1920 metres M1 A1 **(12)**

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6. *(a)* 1 + 8 + 8 + 15 = 32 M1 A1

(b) (i) e.g. augment $SABGFJT$ by 4 giving:

(ii)



M3 A3

max flow = 21 A1

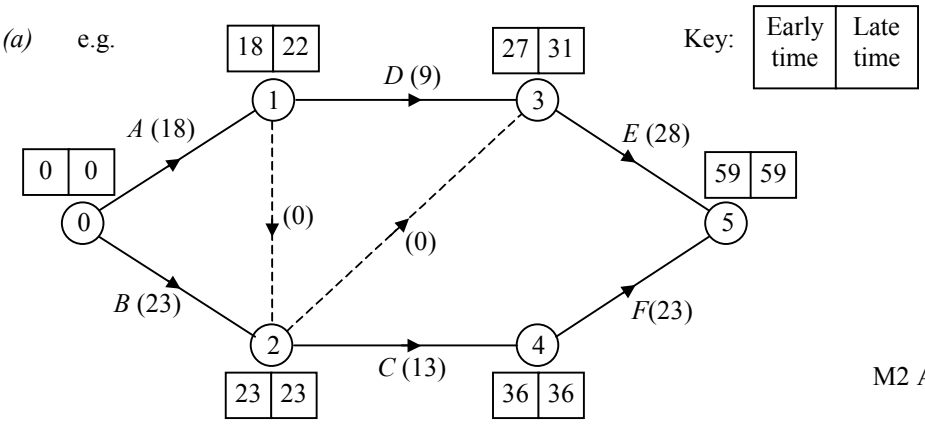
(c) max flow as = min cut of 21 $\{S, A, B, C, D, F, G, J\} \mid \{E, H, I, T\}$ M1 A1

(d) new min cut = 24 $\{S, A\} \mid \{B, C, D, E, F, G, H, I, J, T\}$
$\therefore$ max flow could increase by 3 M1 A1

(e) AE (as both 1st and 2nd min cut pass through it) A1
new min cut = 26 so new max flow = 26 A1 **(15)**

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7. *(a)* e.g.

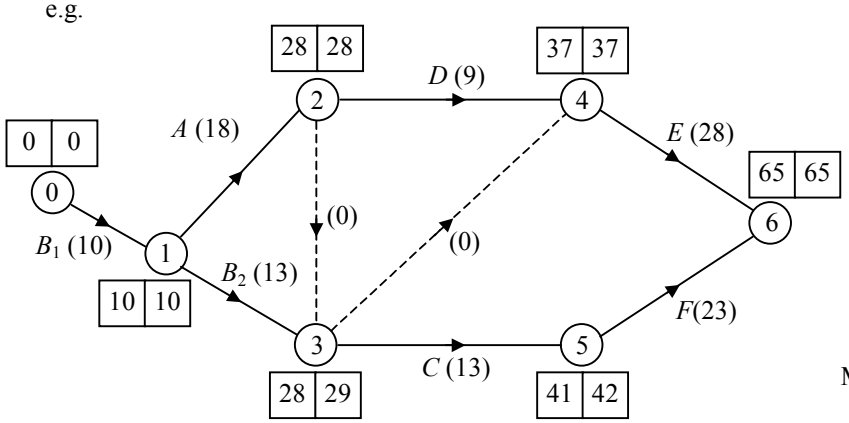


M2 A2

(b) labelling above, critical path is *B C F*, minimum duration = 59 minutes M1 A2

(c) float time of $A = 22 - 0 - 18 = 4$ minutes
$D = 31 - 18 - 9 = 4$ minutes
$E = 59 - 27 - 28 = 4$ minutes M1 A2

(d) e.g.



M1 A2

(e) new critical path is B_1 *A D E*, minimum duration = 65 minutes M1 A2 **(16)**

Total **(75)**

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Performance Record – D1 Paper E

Question no.	1	2	3	4	5	6	7	Total
Topic(s)	graphs, planarity	tree diagram	graphs	linear program'g.	Dijkstra's, route inspection	flows	activity network, critical path	
Marks	6	7	7	12	12	15	16	75
Student								

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