

GCE Examinations  
Advanced Subsidiary / Advanced Level  
**Decision Mathematics**  
**Module D1**

Paper C

**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.



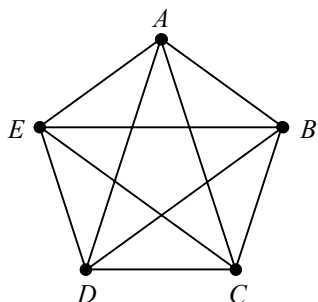
*Written by Shaun Armstrong & Dave Hayes*

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## D1 Paper C – Marking Guide

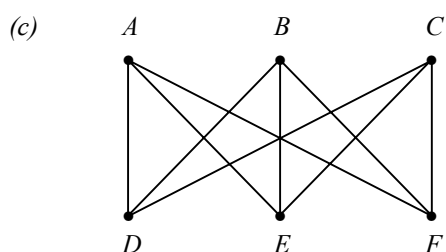
1. (a)



B1

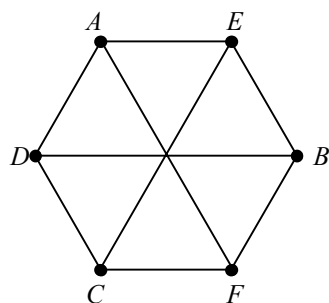
(b) e.g.  $ABCDEA$  is a Hamiltonian cycle  
 choose  $AC$  inside so  $BD$  and  $BC$  must go outside  
 put  $AD$  or  $CE$  inside, then the other cannot be placed  
 without overlapping so no planar drawing is possible

B2



B1

(d) e.g.  $AEBFCDA$  is a Hamiltonian cycle, redraw as polygon:

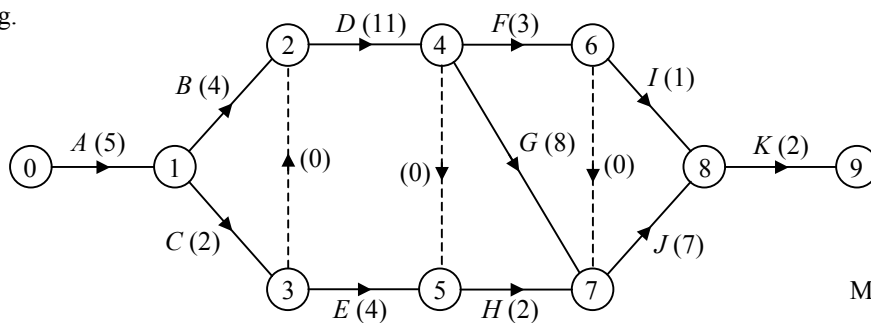


choose  $AD$  inside so  $BF$  and  $CE$  must go outside but  
 this creates a crossing outside so no planar drawing is possible

B2

(6)

2. e.g.



M3 A4

(7)

3. (a) 150 104 200 60 184 84 120 (pivot in box)

150 104 200 184 84 120 60

$L_1$

200 184 150 104 84 120 60

$L_2$

$L_3$

200 184 150 104 120 84 60

$L_4$

200 184 150 120 104 84 60

$L_5$

200 184 150 120 104 84 60

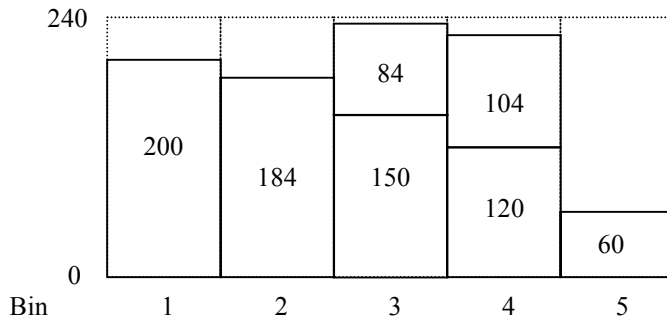
$L_6$

now complete

M2 A2

(b) sort list in decreasing order and have bins of size 240  
take each length in turn and put it in the first bin in which it can fit  
count number of bins used

B2



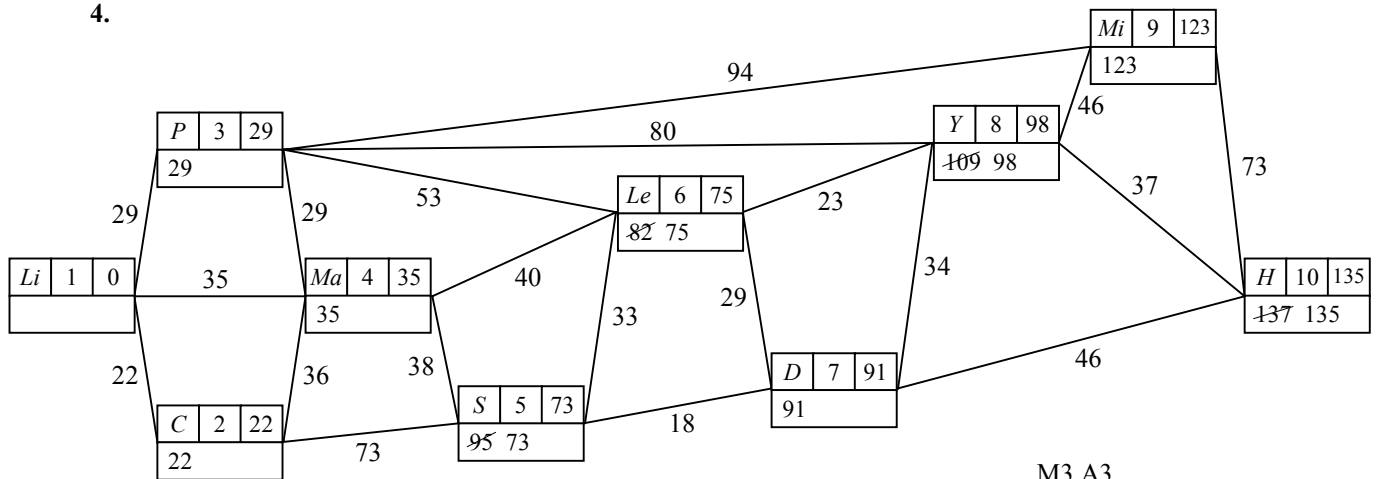
$\therefore$  5 bins needed

M1 A1

(c) unused rod =  $(5 \times 240) - (200 + 184 + 150 + 120 + 104 + 84 + 60)$   
 $= 298 \therefore$  not possible

B1 (9)

4.

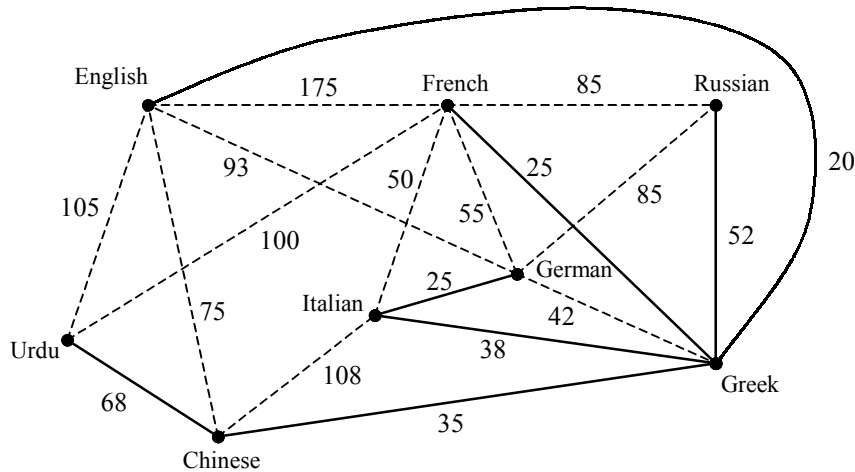


M3 A3

label H – label Y = 37 = weight YH  
label Y – label Le = 23 = weight LeY  
label Le – label Ma = 40 = weight MaLe  
label Ma – label Li = 35 = weight LiMa  
so Li Ma Le Y H is shortest route, length = 135 miles

M1 A1  
A2 (10)

5. (a) arcs in ascending order by inspection:  
20, 25, 25, 35, 38, 42, 50, 52, 55, 68, 75, 85, 85, 93, 100, 105, 108, 175

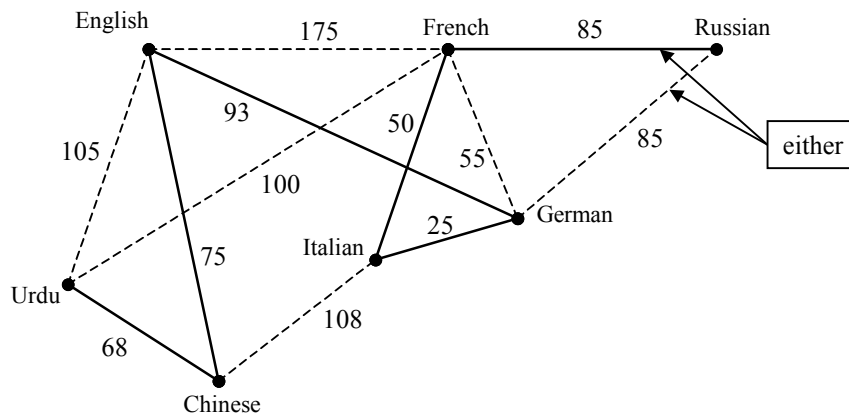


order: E-Gr, Gr-F,  $\leftrightarrow$  I-Ge, Gr-C, Gr-I, Gr-R, C-U;  
cost £263

M2 A1

A1

- (b) (i) 25, 50, 55, 68, 75, 85, 85, 93, 100, 105, 108, 175



I-Ge, I-F, C-U, C-E, F-R (or Ge-R), Ge-E; cost £396

M1 A1

- (ii) previous tree still minimum, cost = £263

A1

- (c) e.g. translations between other languages cheaper via Greek even though Greek translation not required  
(d) an asymmetric array could show both costs  
(e) Prim's  
(f) e.g. that a translation via another language will be of as good quality as one done directly - unlikely to be the case

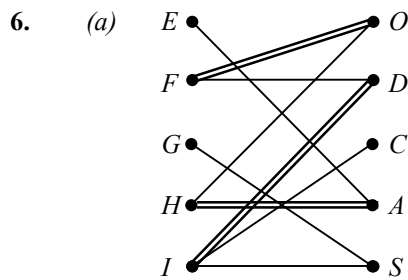
B1

B1

B1

B2

(12)



A1

- (b) initial matching shown by **=====**  
 search for alternating path giving e.g.  $G - S$  (breakthrough)  
 change status giving  $G = S$   
 alternating path e.g.  $E - A = H - O = F - D = I - C$  (breakthrough)  
 change status giving  $E = A - H = O - F = D - I = C$   
 complete matching e.g.  $E - A, F - D, G - S, H - O, I - C$

B1

M1 A1

M1

M1 A1

M1

M1 A1

- (c) e.g. there is now a cycle:  $H - C = I - D = F - O = H$   
 change status giving  $H = C - I = D - F = O - H$   
 alternative matching  $E - A, F - O, G - S, H - C, I - D$

M2 A1

(13)

7. (a)  $6x + 15y + 12z \leq 185$   
 $3x + 3y + z \leq 30$   
 $x + 4y + 4z \leq 60$

A3

- (b) there are 3 independent variables

B1

- (c) rewriting with slack variables gives

$$\begin{aligned} 6x + 15y + 12z + r &= 185 \\ 3x + 3y + z + s &= 30 \\ x + 4y + 4z + t &= 60 \end{aligned}$$

need to maximise  $I = 40x + 90y + 60z$ , considering 10's of pounds gives  
 objective function  $P - 4x - 9y - 6z = 0$ , hence given tableau

A1

- (d)  $\theta$  values are  $12\frac{1}{3}$ , 10 and 15 so pivot row is 2<sup>nd</sup> row

Basic Var.	$x$	$y$	$z$	$r$	$s$	$t$	Value
$r$	-9	0	7	1	-5	0	35
$y$	1	1	$\frac{1}{3}$	0	$\frac{1}{3}$	0	10
$t$	-3	0	$\frac{8}{3}$	0	$-\frac{4}{3}$	1	20
$P$	5	0	-3	0	3	0	90

M2 A2

increase  $z$  next,  $\theta$  values are 5, 30 and  $7\frac{1}{2}$  so pivot row is 1st row

Basic Var.	$x$	$y$	$z$	$r$	$s$	$t$	Value
$z$	$-\frac{9}{7}$	0	1	$\frac{1}{7}$	$-\frac{5}{7}$	0	5
$y$	$\frac{10}{7}$	1	0	$-\frac{1}{21}$	$\frac{4}{7}$	0	$8\frac{1}{3}$
$t$	$\frac{3}{7}$	0	0	$-\frac{8}{21}$	$\frac{4}{7}$	1	$6\frac{2}{3}$
$P$	$\frac{8}{7}$	0	0	$\frac{3}{7}$	$\frac{6}{7}$	0	105

M2 A2

optimal solution as all values on the objective row are  $\geq 0$

B1

- (e) 0 of  $X$ ,  $8\frac{1}{3}$  of  $Y$  and 5 of  $Z$ , giving  $P = 105$  so profit = £1050

A1

- (f) try integer coordinates around the optimal solution

e.g. (0, 8, 5) (1, 8, 5) (0, 9, 5) etc. checking feasible and seeking optimum

B2

(18)

Total

(75)

### Performance Record – D1 Paper C

Question no.	1	2	3	4	5	6	7	Total
Topic(s)	graphs, planarity	activity network	quick sort, bin packing	Dijkstra's	Kruskal's	matching	simplex	
Marks	6	7	9	10	12	13	18	75
Student								