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.

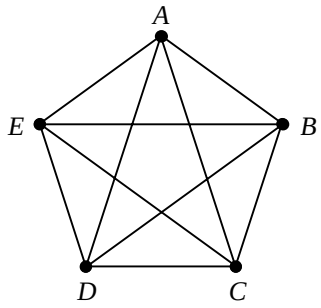
Accuracy marks (A) can only be awarded when a correct method has been used.

(B) marks are independent of method marks.

Written by Shaun Armstrong & Dave Hayes

D1 Paper C – Marking Guide

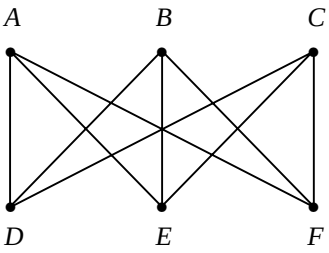
1. *(a)*



B1

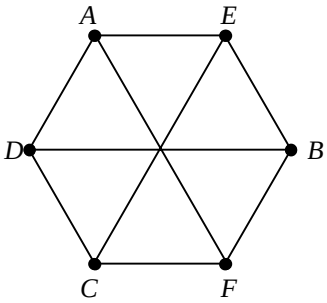
(b) e.g. *ABCDEA* is a Hamiltonian cycle
choose *AC* inside so *BD* and *BC* must go outside
put *AD* or *CE* inside, then the other cannot be placed
without overlapping so no planar drawing is possible B2

(c)



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)**

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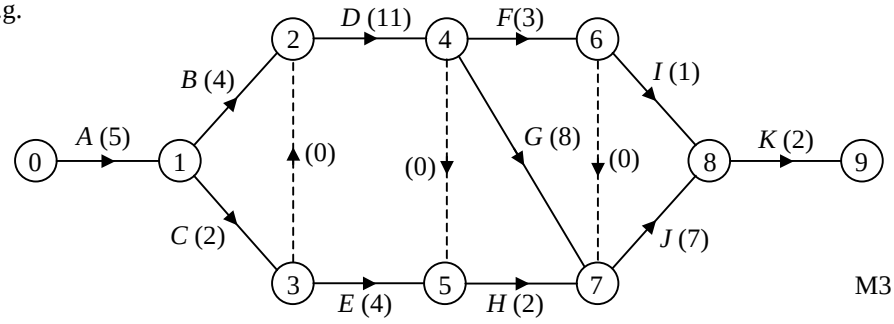
2. e.g.



M3 A4 **(7)**

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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

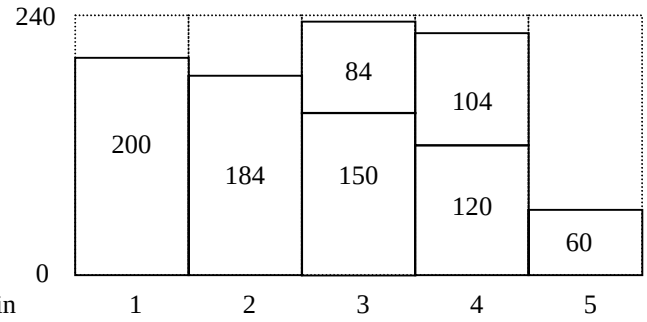
200 184 150 [120] [104] 84 60

L_5

200 184 [150] [120] 104 84 60

L_6 now complete M2 A2

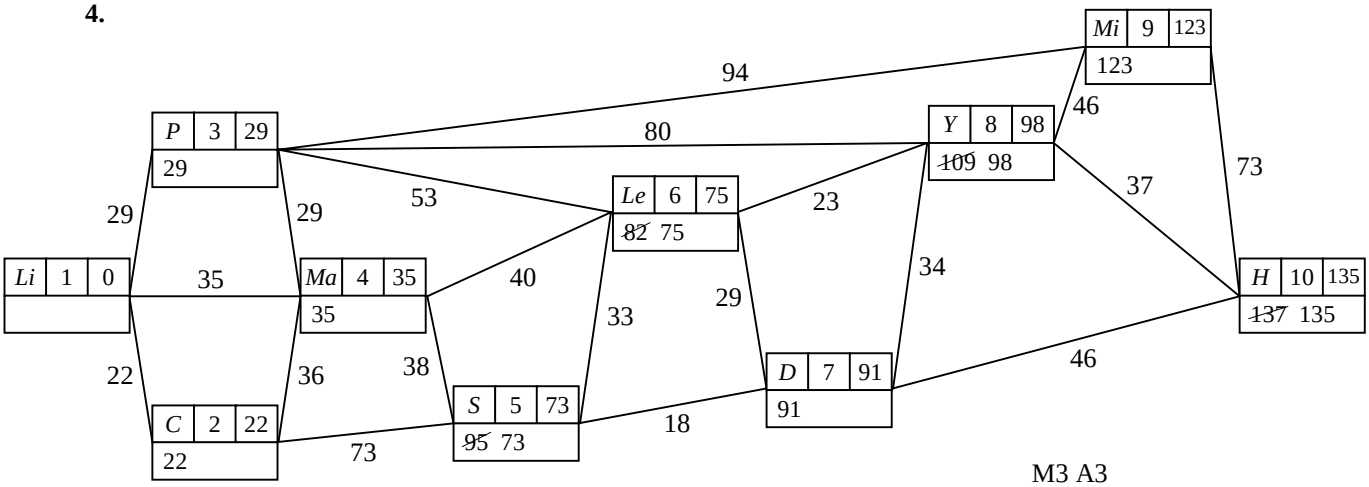
(b) sort list in decreasing order and have bins of size 240
take each length in turn and put it in the first bin in which it can fit
count number of bins used B2



∴ 5 bins needed M1 A1

(c) unused rod = (5 × 240) – (200 + 184 + 150 + 120 + 104 + 84 + 60)
= 298 ∴ 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* M1 A1
so *Li Ma Le Y H* is shortest route, length = 135 miles A2 **(10)**

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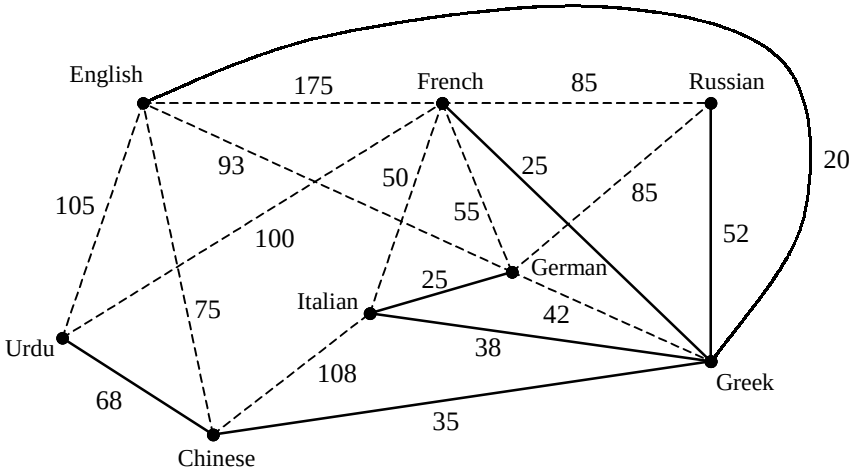
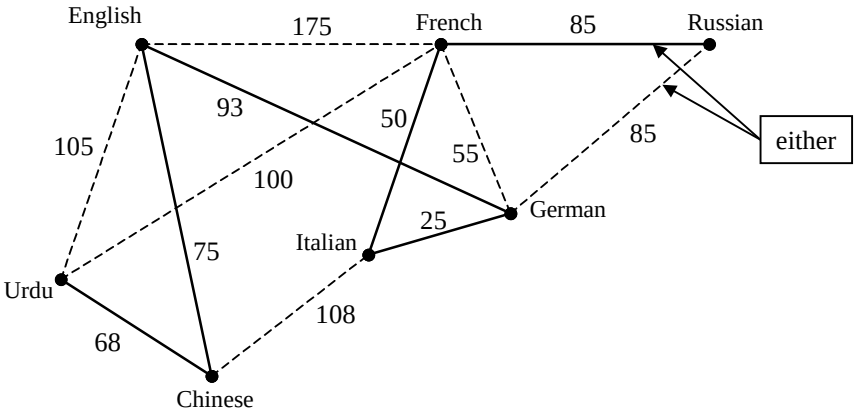
5. *(a)* arcs in ascending order by inspection:
20, 25, 25, 35, 38, 42, 50, 52, 55, 68, 75, 85, 85, 93, 100, 105, 108, 175



order: E–Gr, Gr–F, ↔ I–Ge, Gr–C, Gr–I, Gr–R, C–U; M2 A1

cost £263 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

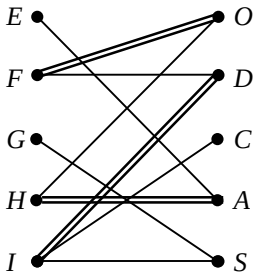
(c) e.g. translations between other languages cheaper via Greek
even though Greek translation not required B1

(d) an asymmetric array could show both costs B1

(e) Prim's B1

(f) e.g. that a translation via another language will be of as good quality
as one done directly - unlikely to be the case B2 **(12)**

6. *(a)*



A1

(b) initial matching shown by ═══ B1
search for alternating path giving e.g. $G - S$ (breakthrough) M1 A1
change status giving $G = S$ M1
alternating path e.g. $E - A = H - O = F - D = I - C$ (breakthrough) M1 A1
change status giving $E = A - H = O - F = D - I = C$ M1
complete matching e.g. $E - A, F - D, G - S, H - O, I - C$ 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)**

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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
$6x + 15y + 12z + r = 185$
$3x + 3y + z + s = 30$
$x + 4y + 4z + t = 60$
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) θ values are $12\frac{1}{3}$, 10 and 15 so pivot row is 2nd row

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

M2 A2

increase z next, θ 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 ≥ 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								