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.

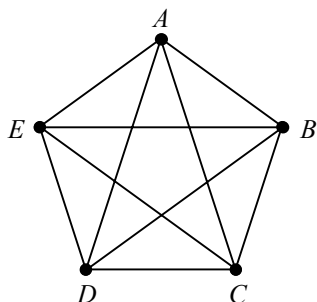(B) marks are independent of method marks.
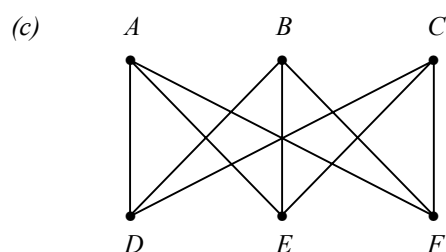
D1 Paper C – Marking Guide
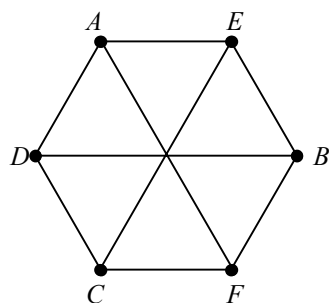
1. *(a)*

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

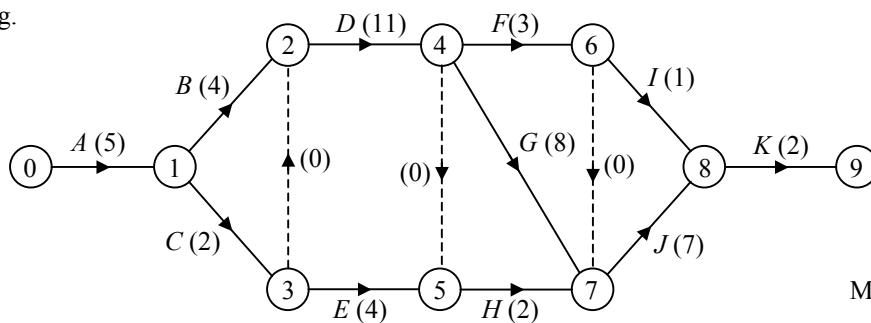*(d)* e.g. *AEBFCDA* is a Hamiltonian cycle, redraw as polygon:

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

B2   **(6)**

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]
$\underbrace{}_{L_1}$

$\underbrace{200}_{L_2}$ [184] $\underbrace{150 \quad 104 \quad [84] \quad 120}_{L_3}$ 60

200 184 $\underbrace{150 \quad [104] \quad 120}_{L_4}$ [84] 60

200 184 $\underbrace{150 \quad [120]}_{L_5}$ [104] 84 60

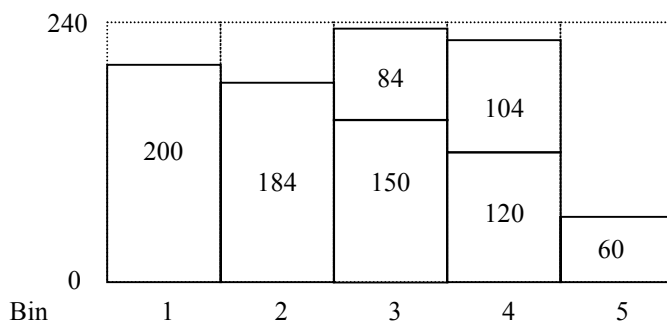200 184 $\underbrace{150}_{L_6}$ [120] 104 84 60

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.
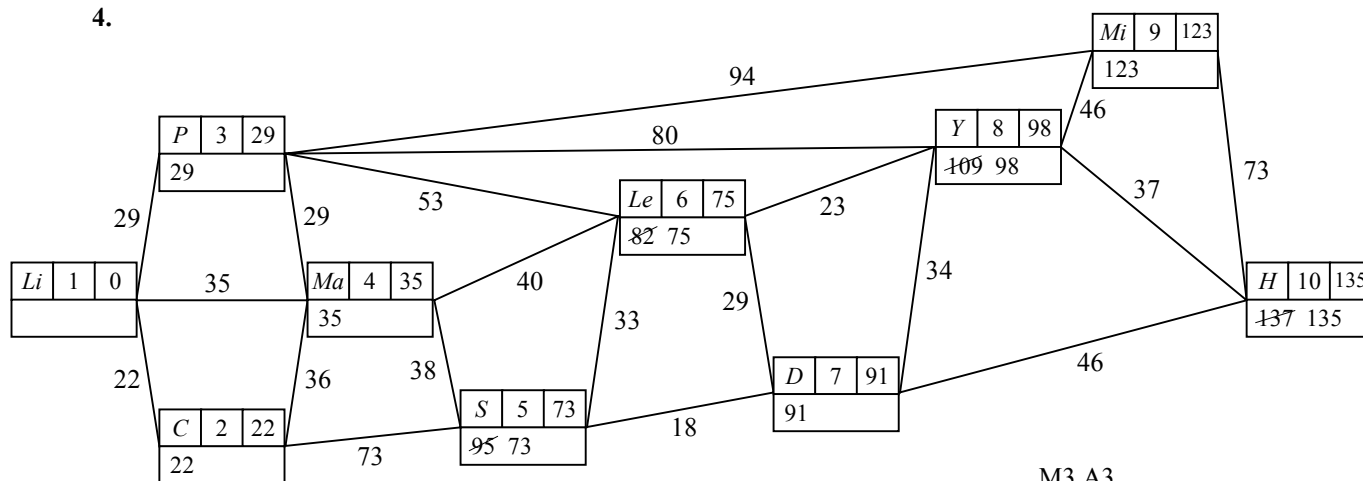
M3 A3

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:
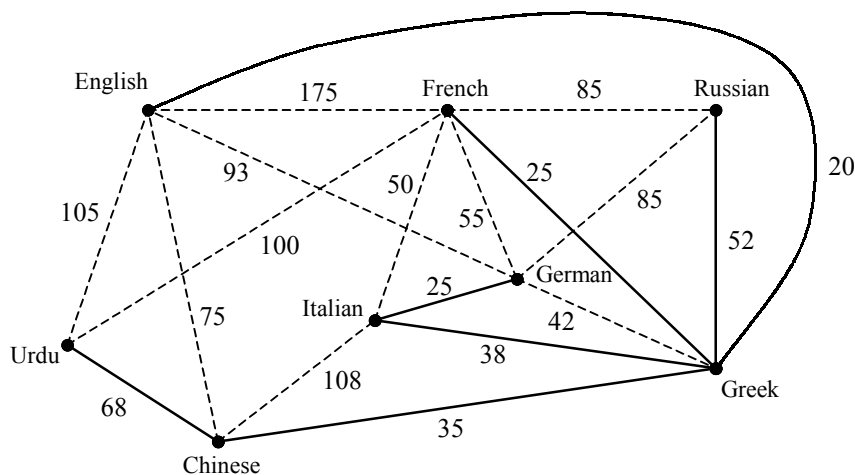20, 25, 25, 35, 38, 42, 50, 52, 55, 68, 75, 85, 85, 93, 100, 105, 108, 175

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
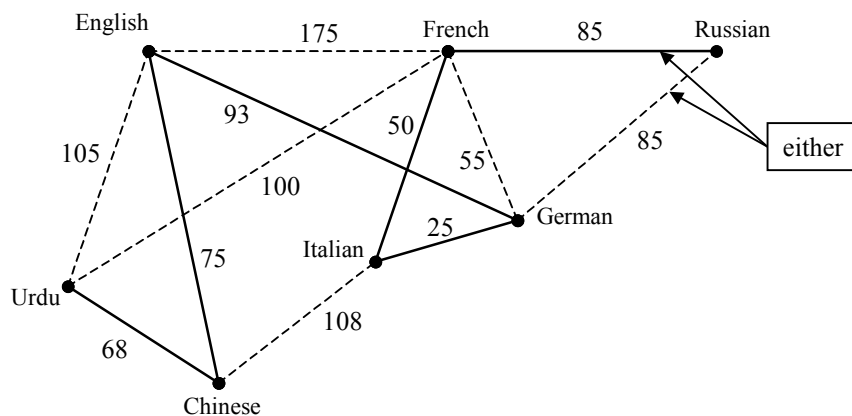
I–Ge, I–F, C–U, C–E, F–R (or Ge–R), Ge–E; cost £396   M1 A1

(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

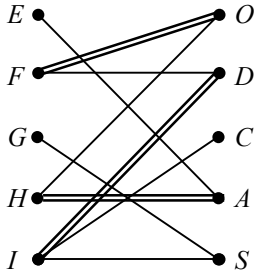search for alternating path giving e.g. $G - S$ (breakthrough)   M1 A1

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

$6x \ + 15y \ + 12z \ + r \qquad\qquad = 185$

$3x \ \ + 3y \qquad + z \qquad + s \qquad = 30$

$x \ \ + 4y \ \ + 4z \qquad\qquad + t = 60$

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	$^-9$	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, 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)**

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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								

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