Write your name here

Surname MODEL ANSWERS | Other names

Pearson Edexcel
International
Advanced Level

Centre Number | Candidate Number

Decision Mathematics D1

Advanced/Advanced Subsidiary

Thursday 12 June 2014 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
WDM01/01

Answer Book
Do not return the question paper with the answer book.

Total Marks

P44516A

5/5/1/1/

P 4 4 5 1 6 A 0 1 1 6

PEARSON

Leave blank

1. a) Quick Sort

Mid-point: $\frac{n+1}{2} = 5$

M S Q C (E) P B F O

C (B) [E] M S Q (P) F O

[B] (C) [E] M (F) O [P] S (Q)

[B] [C] [E] [F] M (O) [P] [Q] (S)

[B] [C] [E] [F] (M) [O] [P] [Q] [S]

All terms now pivots. ✓
Sort complete.
List now in ascending order.

Key. ○ - new pivot
□ - old pivot

b) Binary Search

1 2 3 4 5 6 7 8 9
B C E F (M) O P Q S $m = \left[\frac{n+1}{2}\right] = 5$

Target after M, discard 1st half of list and m.

6 7 8 9
O P (Q) S $m = \left[\frac{n+1}{2}\right] = \left[5\frac{1}{2}\right] = 3$

Target before Q, discard 2nd half of list and m.

6 7
O (P) $m = \left[\frac{n+1}{2}\right] = \left[\frac{3}{2}\right] = 2$

Target = P, end, position 7 in list. ✓

Leave blank

Question 1 continued

c) I_1 $m = \left[\frac{641+1}{2}\right] = 322$

I_2 $m = \left[\frac{322+1}{2}\right] = 172$

I_3 $m = \left[\frac{172+1}{2}\right] = 87$

I_3 $m = \left[\frac{87+1}{2}\right] = 44$

I_4 $m =$ 23

I_5 -- 12

I_6 -- 7

I_7 -- 4

I_8 -- 3

I_9 -- 2

I_{10} -- 1

ie. 10 iterations.

(Total 9 marks)

Q1

Markscheme: "every member of every set is paired ...."

Leave blank

2. (a)

(i) Complete matching: every node on the left of a bipartite graph is matched one-to-one with a node on the right.

(ii) Maximal matching does not pair all vertices, just as many as possible.
A complete matching pairs all vertices.

(b) & (c)

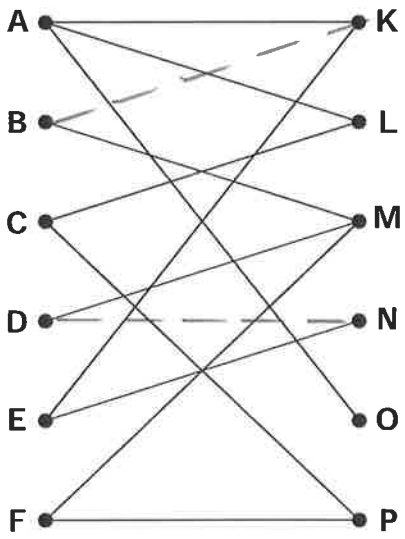


Figure 1

Improved matching

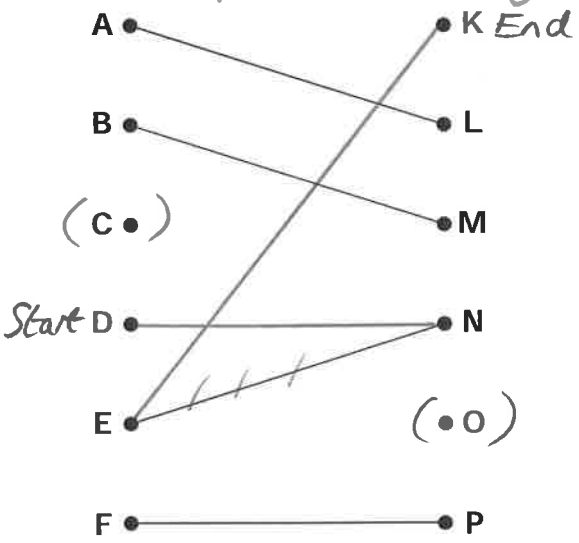


Figure 2

Alternating path:

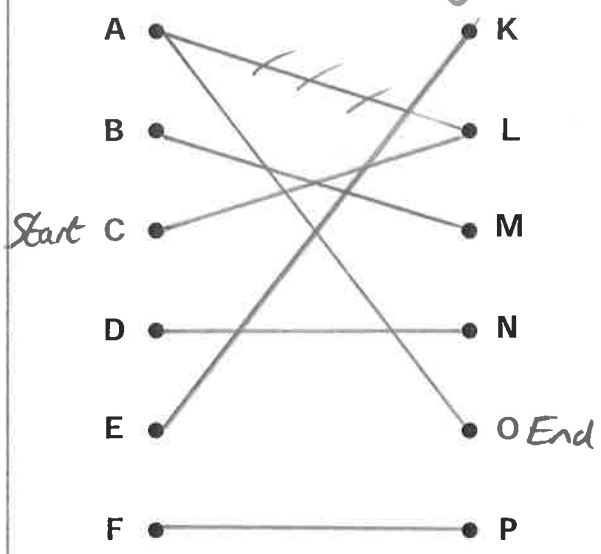
D – N = E – k breakthrough

Change status:

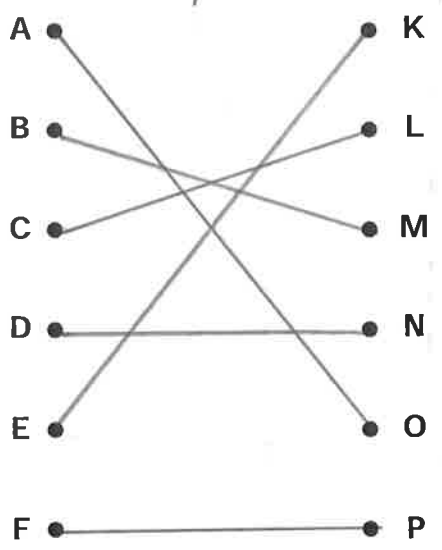
D = N – E = k

Improved matching:
A = L, B = M, C (unmatched), D = N, E = k, F = P

Question 2 continued Workings



Improved & New Complete matching



Alternating path:

C – L ≡ A – O 'Breakthrough'

Change status:

C = L – A = O

Complete matching =

A = O, B = M, C = L, D = N, E = K, F = P

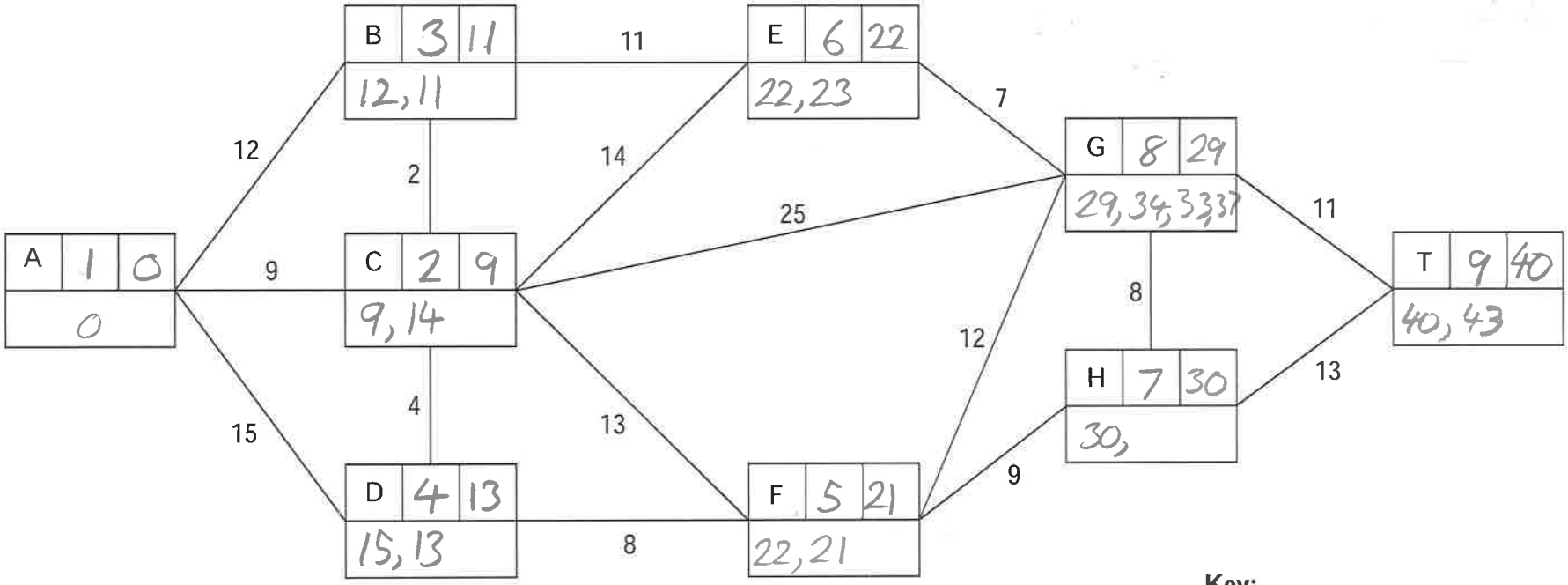
Leave blank

Q2

(Total 9 marks)

6

3. (a)



Key:

Vertex	Order of labelling	Final value
Working values		

Backscan for quickest route = T – G – E – B – C – A

Quickest route: A C B E G T ✓

Time taken: 9+2+11+7+11 = 40 ✓

Leave blank

Question 3 continued

(b)

By inspection:

Route: A C D F H T

Time: 43 minutes ✓

(c)

Add 2 minutes to each arc except either the 1ST 3 or last 2 (GT & HT). ✓

(AB, AC, AD)

(Total 10 marks)

Q3

Leave blank

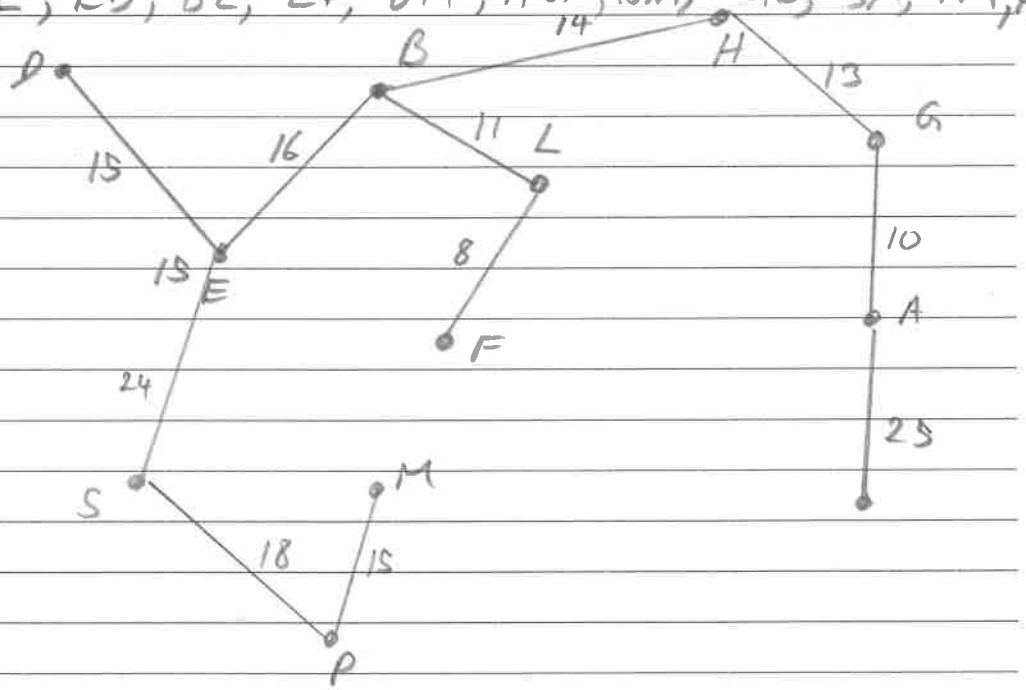
Leave blank

4. Many answers, select 3, e.g.

a)

- Prims starts with any vertex. Kruskals starts with shortest arc. ✓
- Kruskals avoids cycles by checking. ✓
- Kruskals starts with arcs in ascending order. ✓

b) DE, EB, BL, LF, BH, HG, GA, ES, SP, PM, AR ✓



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Question 4 continued

c) By inspection, odd valencies at E, L, G, S

$EL + GS = EL + (GL + LF + FS) =$
$= 17 + (15 + 8 + 32) = 72$

$EG + LS = (EL + LG) + (LF + FS)$
$= (17 + 15) + (8 + 32) = 72$

$ES + LG = ES + LG$
$= 24 + 15 = 39$ (smallest) ✓

∴ Repeat arcs ES and LG ✓

d) If he starts at G & finishes at S, network is now Semi-Eulerian.

He only needs to repeat arc EL which has the smallest length of 17 m.

Total length (weight) is $341 + 17 = 358$ m ✓

Q4

(Total 13 marks)

Leave blank

5. (a)

(b)

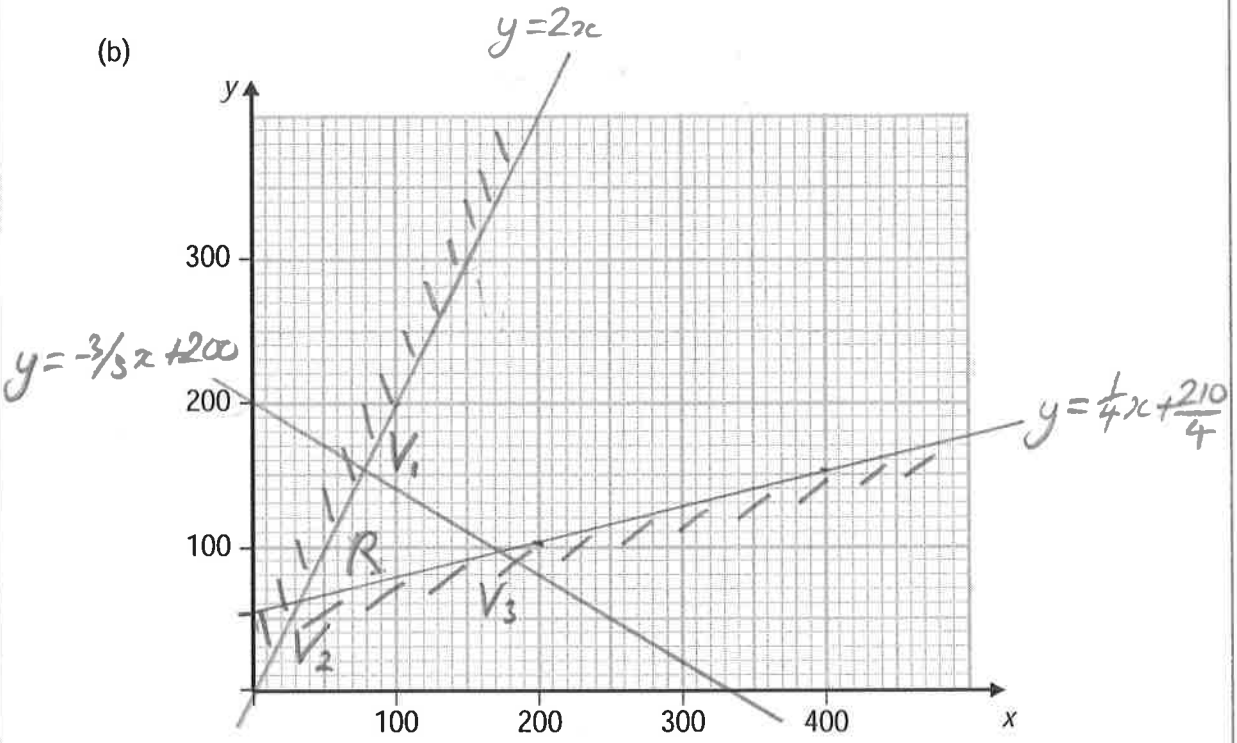


Diagram 1

Inequality	Line
a) $3x + 5y \leq 1000$	$\Rightarrow y = -\frac{3}{5}x + \frac{1000}{5}$
$y \leq 2x$	$\Rightarrow y = 2x$
$4y - x \geq 210$	$\Rightarrow y = \frac{1}{4}x + \frac{210}{4}$

c) Objective function :

Maximise $P = x + y$

Leave blank

5. (a) Inequality: $3x + 5y \leq 1000$ ✓

(b)

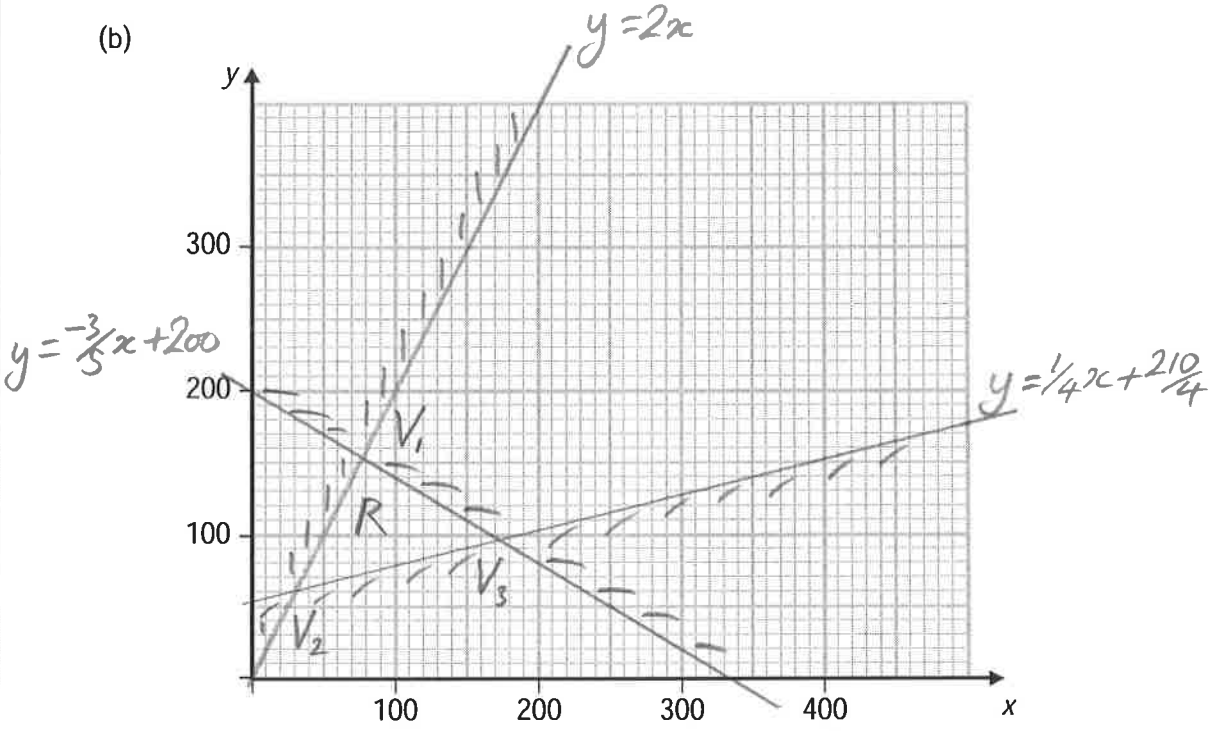


Diagram 1

Inequality	Line in form $y = mx + c$
$3x + 5y \leq 1000$	$\Rightarrow y = -\frac{3}{5}x + \frac{1000}{5}$
$y \leq 2x$	$\Rightarrow y = 2x$
$4y - x \geq 210$	$\Rightarrow y = \frac{1}{4}x + \frac{210}{4}$

c) Objective function

Maximise $P = x + y$

Question 5 continued

Leave blank

Vertex V_1 $y = 2x = -\frac{3}{5}x + 200$

$\frac{10}{5}x + \frac{3}{5}x = 200$

$x = 1000/13 = 76.9 \simeq 76$ integer

$\therefore y = 2x = 2000/13$

Vertex V_2 $y = 2x = \frac{1}{4}x + 210/4$

$\frac{8}{4}x - \frac{1}{4}x = \frac{210}{4}$

$x = 210/7 = 30$

$\therefore y = 2x = 60$

Vertex V_3 $y = -\frac{3}{5}x + 200 = \frac{1}{4}x + 210/4$

$-\frac{12}{5}x - x = 210 - 800$ $(\times 4)$

$\frac{17}{5}x = 590$

$x = 2950/17 \simeq 173$ integer

$\therefore y = 1630/17 = 96$ integer

Q4

(Total 13 marks)

Leave blank

Question 5 continued

Calculating optimal solution:

Vertex V_1 $P = x + y$

$P = \frac{1000}{13} + \frac{2000}{13} = \frac{3000}{13} \simeq 230$ ✓

Vertex V_2 $P = x + y$

$P = 30 + 60 = 90$ ✓

Vertex V_3 $P = \frac{2950}{17} + \frac{1630}{17} = \frac{4850}{17} \simeq 269$ ✓

Therefore optimal number of soft toys $= 269$ ✓

using vertex V_3

Leave blank

Question 5 continued

Q5

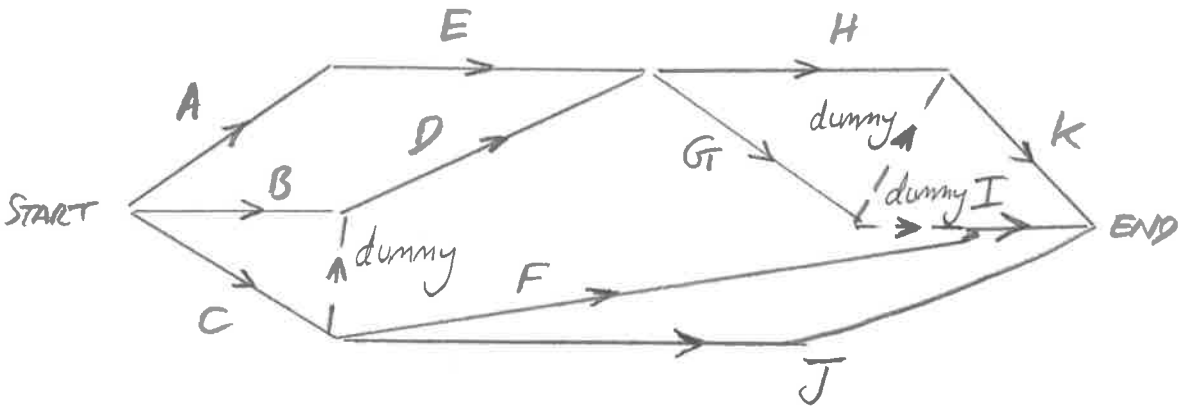
(Total 13 marks)

Leave blank

6. a)

Final network:

3 dummies!



b) Dummies:

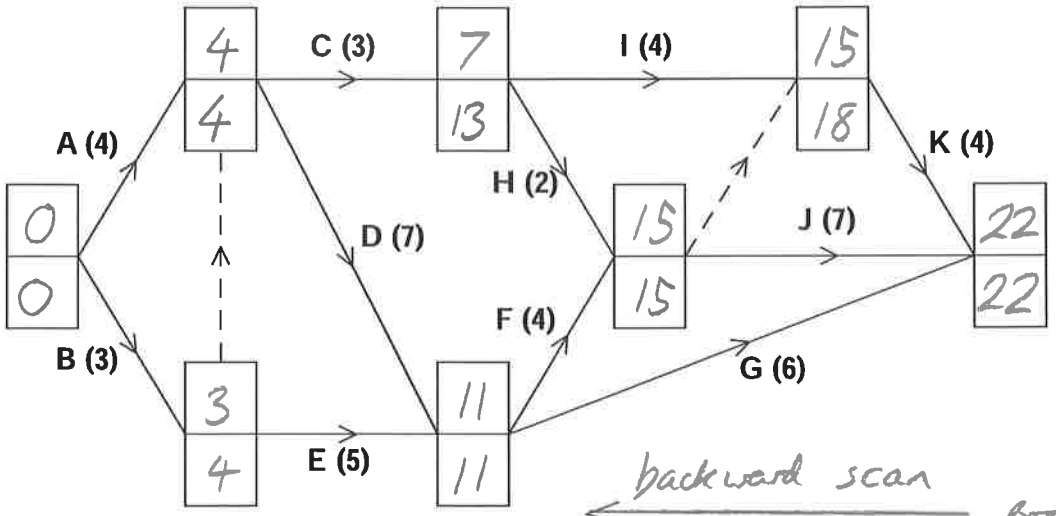
- required when 2 activities rely on immediately preceding activities
- shows precedence / dependency
- allows an activity to be represented uniquely

Q6

(Total 7 marks)

Leave blank

7. (a) Top forward scan (largest if choice) →



← backward scan (smallest if choice) Bottom

Diagram 1

(b) Critical Path A D F J ✓

Length 4+7+4+7 = 22

(c) ANSWER THIS ON DIAGRAM 2 (LARGE GRID) ON OPPOSITE PAGE.

(d) Time 7.5 DE ✓

Time 16.5 JG ✓

(e) ANSWER THIS ON DIAGRAM 3 (SMALL GRID) ON OPPOSITE PAGE.

Leave blank

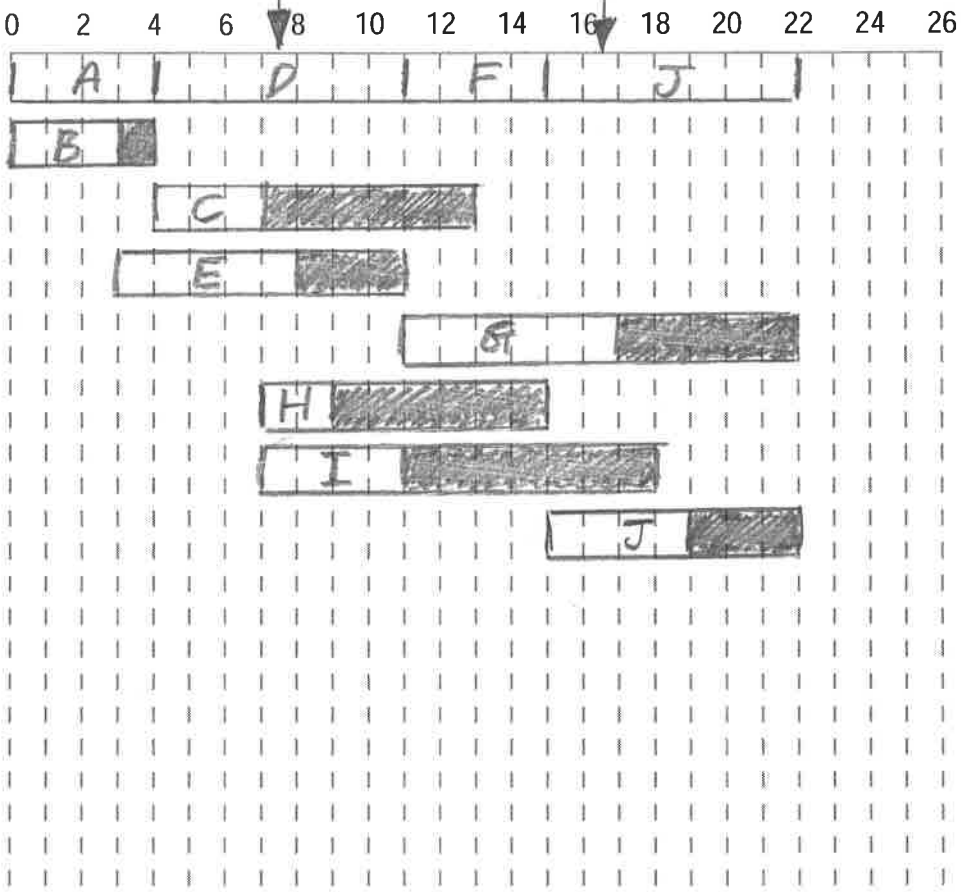
Question 7 continued

DE 7.5

JG 16.5

Gantt / cascade chart

(c)



✓

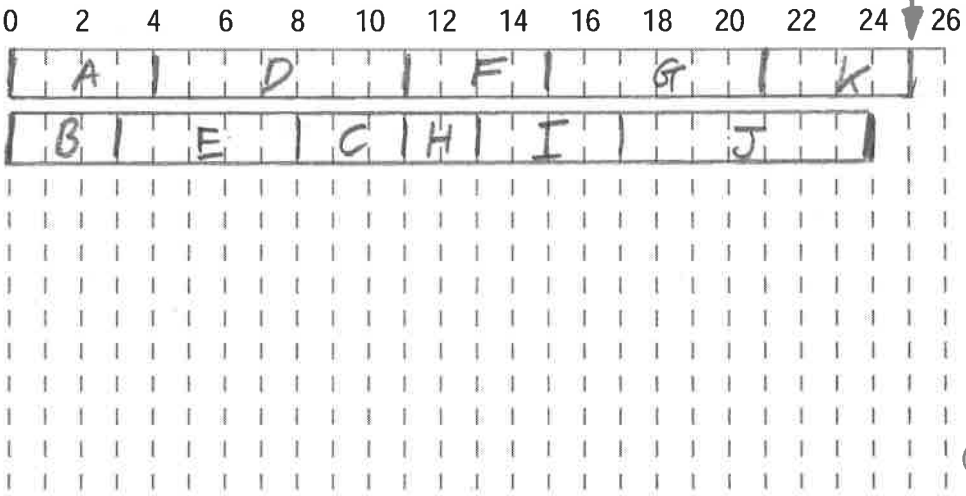
Diagram 2

Schedule

25

✓

(e)



Question allows for some critical activities to be moved (J). Order + timing retained.

Diagram 3

Q7

(Total 14 marks)

TOTAL FOR PAPER: 75 MARKS

END

Pearson Edexcel International Advanced Level

Decision Mathematics D1

Advanced/Advanced Subsidiary

Thursday 12 June 2014 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
WDM01/01

You must have:
D1 Answer Book

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B). Coloured pencils and highlighter pens must not be used.
- **Fill in the boxes** on the top of the answer book with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the D1 answer book provided
  – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- When a calculator is used, the answer should be given to an appropriate degree of accuracy.
- Do not return the question paper with the answer book.

Information

- The total mark for this paper is 75.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

P44516A

5/5/1/1/

Turn over

PEARSON

Write your answers in the D1 answer book for this paper.

1.

McCANN
SMITH
QUAGLIA
CONGDON
EVES
PATEL
BUSH
FOX
OSBORNE

(a) Use a quick sort to produce a list of these names in alphabetical order. You must make your pivots clear.

(4)

(b) Use the binary search algorithm on your list to locate the name PATEL. State the number of iterations you use.

(3)

The binary search algorithm is to be used to search for a name in an alphabetical list of 641 names.

(c) Find the maximum number of iterations needed, justifying your answer.

(2)

(Total 9 marks)

2. (a) (i) Define the term **complete** matching.

(ii) Explain the difference between a complete matching and a maximal matching.

(3)

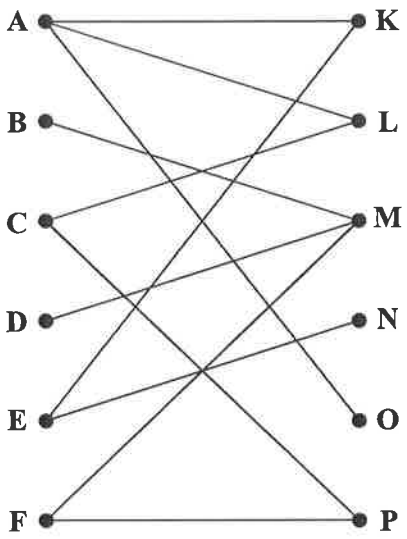


Figure 1

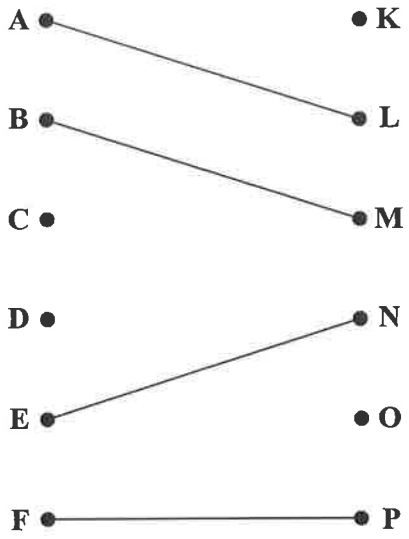


Figure 2

Figure 1 shows the possible allocations of dancing partners for the Truly Come Ballroom dancing competition. Six women, Annie (A), Bella (B), Chloe (C), Danika (D), Ella (E) and Faith (F), are to be paired with six men, Kieran (K), Lucas (L), Michael (M), Nasir (N), Oliver (O) and Paul (P).

Figure 2 shows an initial matching.

(b) Use the maximum matching algorithm **once** to find an improved matching. You must state the alternating path you use and list your improved matching.

(3)

After dance practice, it is decided that Bella could also be paired with Kieran, and Danika could also be paired with Nasir.

(c) Starting with your improved matching from part (b), use the maximum matching algorithm to obtain a complete matching. You must state the alternating path you use and list your final matching.

(3)

(Total 9 marks)

3.

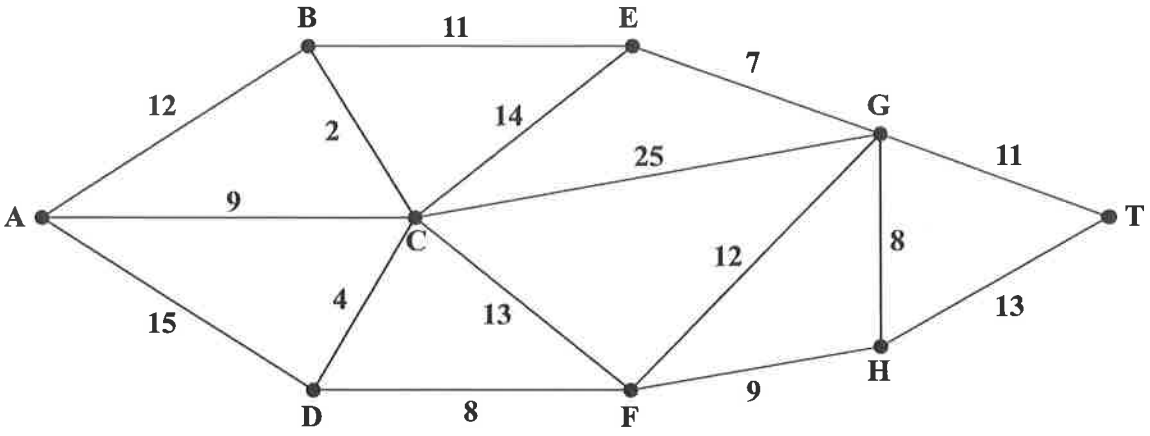


Figure 3

Figure 3 shows a network representing the time taken, in minutes, to travel by train between nine towns, A, B, C, D, E, F, G, H and T.

A train is to travel from A to T without stopping.

(a) Use Dijkstra's algorithm to find the quickest route from A to T and the time taken.

(6)

At present, the train travels from A to T via F without stopping.

(b) Use your answer to (a) to find the quickest route from A to T via F and the time taken.

(2)

A train is to travel from A to T, stopping for 2 minutes at each town it passes through on its route.

(c) Explain how you would adapt the network so that you could use Dijkstra's algorithm to find the quickest route for this train. **You do not need to find this route.**

(2)

(Total 10 marks)

4. (a) State three differences between Prim's algorithm and Kruskal's algorithm for finding a minimum spanning tree.

(3)

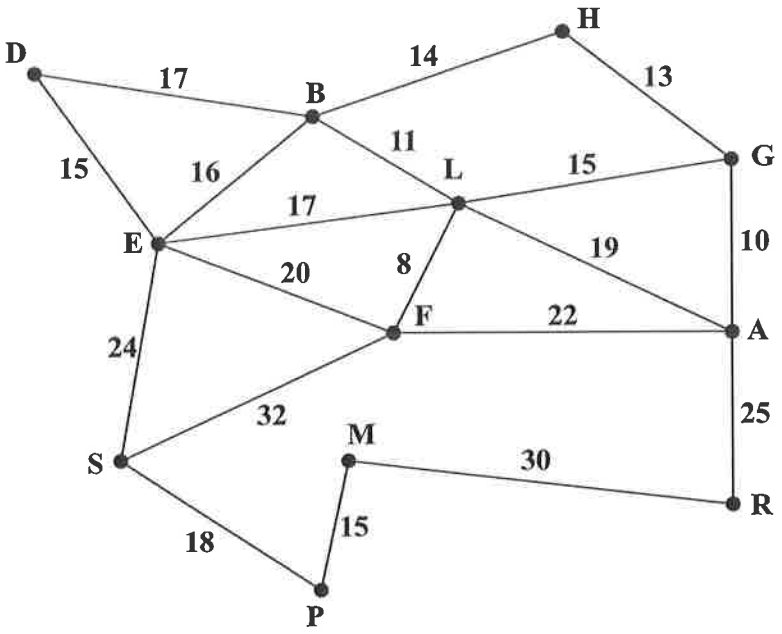


Figure 4

[*The total weight of the network is 341*]

(b) Use Prim's algorithm, starting at D, to find a minimum spanning tree for the network shown in Figure 4. You must list the **arcs** in the order in which you select them.

(3)

Figure 4 models a network of school corridors. The number on each arc represents the length, in metres, of that corridor. The school caretaker needs to inspect each corridor in the school to check that the fire alarms are working correctly. He wants to find a route of minimum length that traverses each corridor at least once and starts and finishes at his office, D.

(c) Use the route inspection algorithm to find the corridors that will need to be traversed twice. You must make your method and working clear.

(4)

The caretaker now decides to start his inspection at G. His route must still traverse each corridor at least once but he does not need to finish at G.

(d) Determine the finishing point so that the length of his route is minimised. You must give reasons for your answer and state the length of his route.

(3)

(Total 13 marks)

5. Michael and his team are making toys to give to children at a summer fair. They make two types of toy, a soft toy and a craft set.

Let x be the number of soft toys they make and y be the number of craft sets they make.

Each soft toy costs £3 to make and each craft set costs £5 to make.

Michael and his team have a budget of £1000 to spend on making the toys for the summer fair.

(a) Write down an inequality, in terms of x and y, to model this constraint.

(1)

Two further constraints are:

$$y \leqslant 2x$$

$$4y - x \geqslant 210$$

(b) Add lines and shading to Diagram 1 in the answer book to represent all of these constraints. Hence determine the feasible region and label it R.

(4)

Michael's objective is to make as many toys as possible.

(c) State the objective function.

(1)

(d) Determine the exact coordinates of each of the vertices of the feasible region, and hence use the vertex method to find the optimal number of soft toys and craft sets Michael and his team should make. You should make your method clear.

(7)

(Total 13 marks)

6. (a) Draw the activity network described in this precedence table, using activity on arc and dummies only where necessary.

(5)

Activity	Immediately preceding activities
A	–
B	–
C	–
D	*B, C* Dummy.
E	*A*
F	*C*
G	*D, E*
H	*D, E*
I	*F, G* Dummy.
J	*C*
K	*G, H* Dummy.

(b) Explain the possible reasons dummies may be needed in activity networks.

(2)

(Total 7 marks)

7.

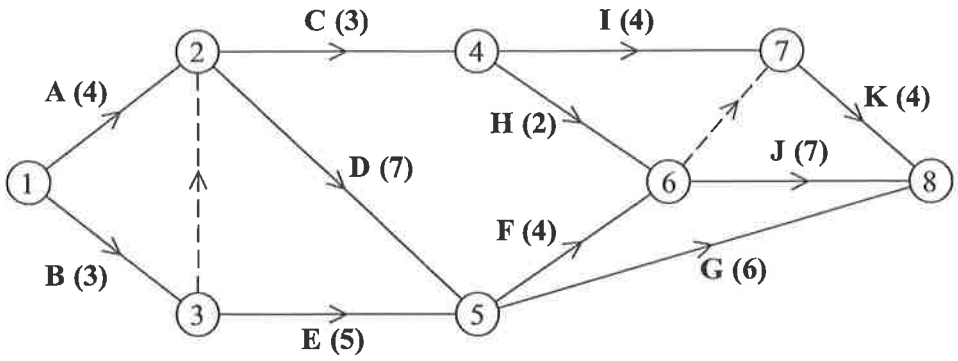


Figure 5

A company models a project by the activity network shown in Figure 5. The activities are represented by the arcs. The number in brackets on each arc gives the time, in days, to complete the activity. Each activity requires exactly one worker. The project is to be completed in the shortest possible time.

(a) Add early and late event times to Diagram 1 in the answer book.

(3)

(b) State the critical path and its length.

(2)

(c) On Diagram 2 in the answer book, construct a cascade (Gantt) chart.

(4)

(d) By using your cascade chart, state which activities **must** be happening at

(i) time 7.5

(ii) time 16.5

(2)

It is decided that the company may use up to 25 days to complete the project.

(e) On Diagram 3 in the answer book, construct a scheduling diagram to show how this project can be completed within 25 days using as few workers as possible.

(3)

(Total 14 marks)

TOTAL FOR PAPER: 75 MARKS

END