Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Further Mathematics

Advanced Subsidiary
Further Mathematics options
Decision Mathematics 1

Sample Assessment Material for first teaching September 2017
Time: 50 minutes

Paper Reference
8FM0/2H

You must have:
Decision Mathematics 1 question insert
Mathematical Formulae and Statistical Tables, calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for algebraic 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).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer the questions in the spaces 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.
- Answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 5 questions in this question paper. The total mark for this paper is 40.
- 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.

Turn over ▶

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S 5 8 5 3 4 A 0 1 1 8

Pearson

Answer ALL questions. Write your answers in the answer book provided.

1.

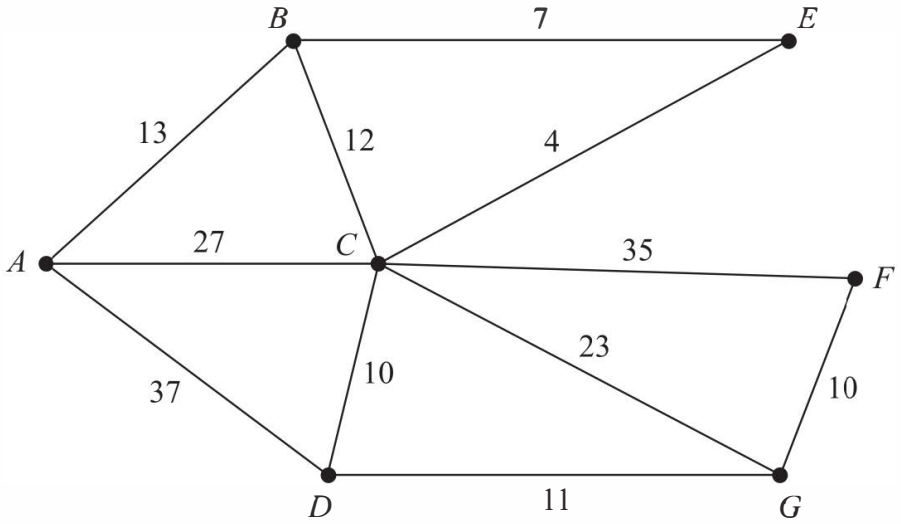


Figure 1

[*The total weight of the network is 189*]

Figure 1 represents a network of pipes in a building. The number on each arc is the length, in metres, of the corresponding pipe.

(a) Use Dijkstra's algorithm to find the shortest path from A to F. State the path and its length.

(5)

On a particular day, Gabriel needs to check each pipe. A route of minimum length, which traverses each pipe at least once and which starts and finishes at A, needs to be found.

(b) Use an appropriate algorithm to find the pipes that will need to be traversed twice. You must make your method and working clear.

(4)

(c) State the minimum length of Gabriel's route.

(1)

A new pipe, BG, is added to the network. A route of minimum length that traverses each pipe, including BG, needs to be found. The route must start and finish at A.

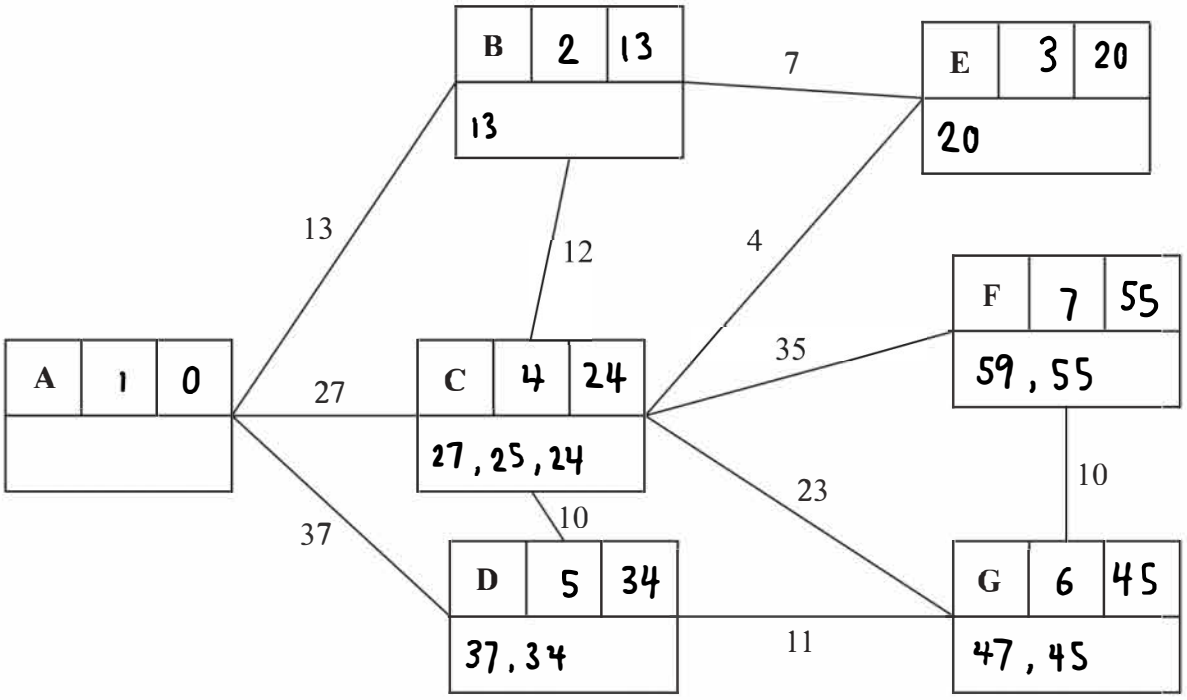
Gabriel works out that the addition of the new pipe increases the length of the route by twice the length of BG.

(d) Calculate the length of BG. You must show your working.

(2)

(Total for Question 1 is 12 marks)

1.



Key:

Vertex	Order of labelling	Final value
Working values		

Shortest path: ABECDGF

Length of shortest path: 55m

calculate using values in grid e.g. 45 − 13 = 32

b) odd vertices : A, B, D, G

AB + DG = 13 + 11 = 24 → shortest

AD + BG = 34 + 32 = 66 A(BEC)D + B(ECD)G

AG + BD = 45 + 21 = 66 A(BECD)G + B(EC)D

∴ repeat AB, DG

c) 24 + 189 = 213 m

d) odd nodes : A & D

arcs repeated : AB, BE, EC, CD

let length of BG = n. total length : 189 + 34 + n = 223 + n (length of AD)

223 + n − 213 = 2n, n = 10 ∴ BG = 10 m

Question 1 continued

(Total for Question 1 is 12 marks)

2.

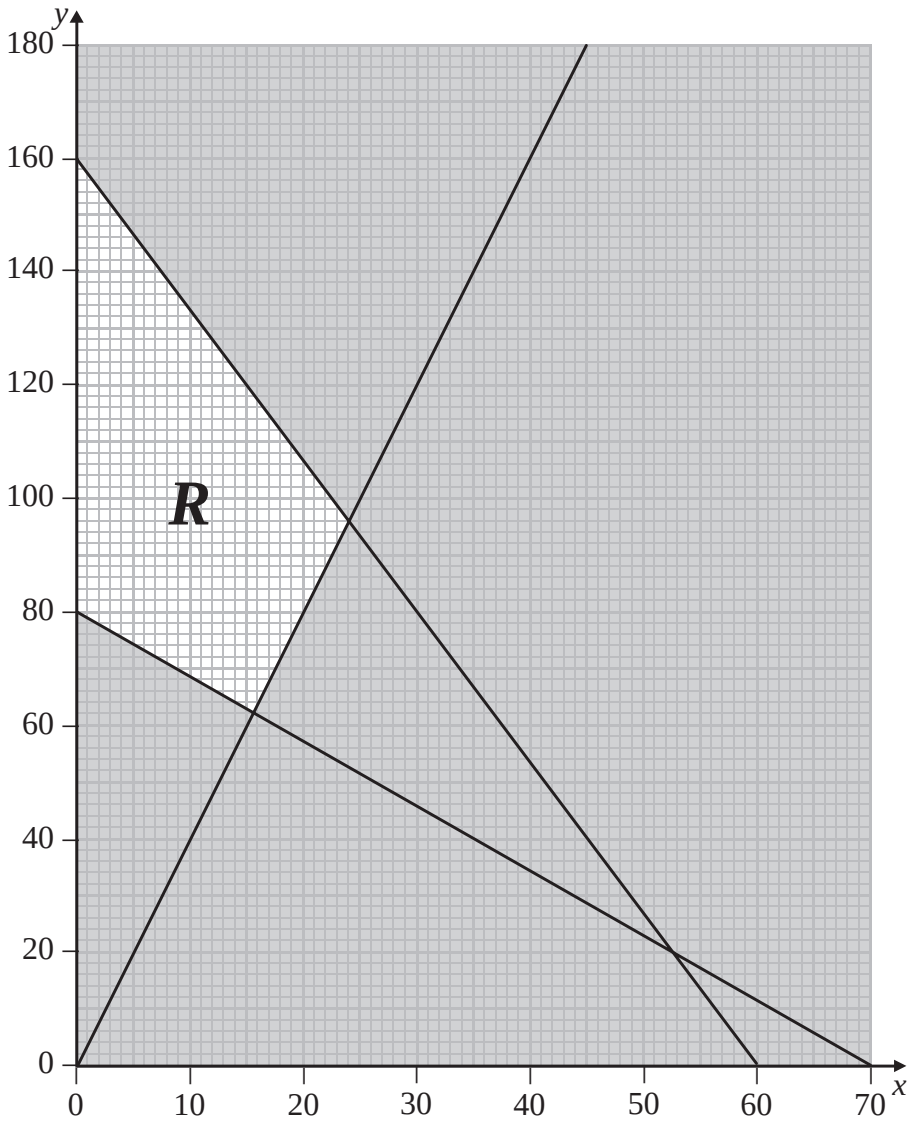


Figure 2

A teacher buys pens and pencils. The number of pens, x, and the number of pencils, y, that he buys can be represented by a linear programming problem as shown in Figure 2, which models the following constraints:

$$8x + 3y \leqslant 480$$
$$8x + 7y \geqslant 560$$
$$y \geqslant 4x$$
$$x, y \geqslant 0$$

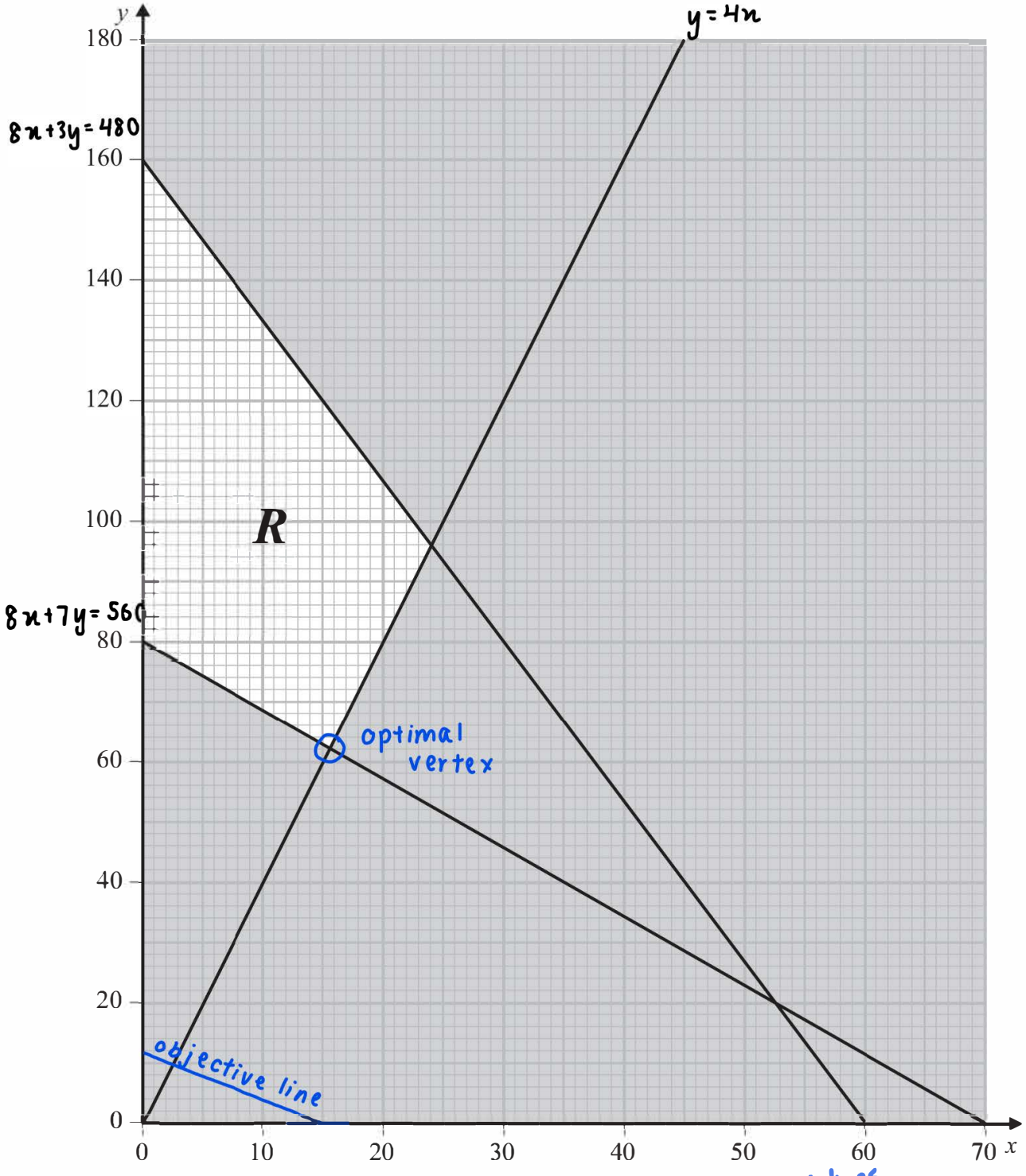
The total cost, in pence, of buying the pens and pencils is given by

$$C = 12x + 15y$$

Determine the number of pens and the number of pencils which should be bought in order to minimise the total cost. You should make your method and working clear.

(Total for Question 2 is 7 marks)

2.



need integer values → test points about optimal vertex

$y = 4x$ — ①

$8x + 7y = 560$ — ②

Substitute ① into ②

$8x + 7(4x) = 560$

$36x = 560$

$x = 15.56$

$y = 62.22$

x	y	
15	62	$8x + 7y = 554 < 560$ ∴ n/a
15	63	$8x + 7y = 561$
16	62	$y < 4x$ ∴ n/a
16	63	$y < 4x$ ∴ n/a

$x = 15$, $y = 63$

15 pens and 63 pencils should be bought

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Question 2 continued

(Total for Question 2 is 7 marks)

3.

Activity	Time taken (days)	Immediately preceding activities
A	5	-
B	7	-
C	3	-
D	4	A, B
E	4	D
F	2	B
G	4	B
H	5	C, G
I	10	C, G

The table above shows the activities required for the completion of a building project. For each activity, the table shows the time taken in days to complete the activity and the immediately preceding activities. Each activity requires one worker. The project is to be completed in the shortest possible time.

(a) Draw the activity network described in the table, using activity on arc. Your activity network must contain the minimum number of dummies only.

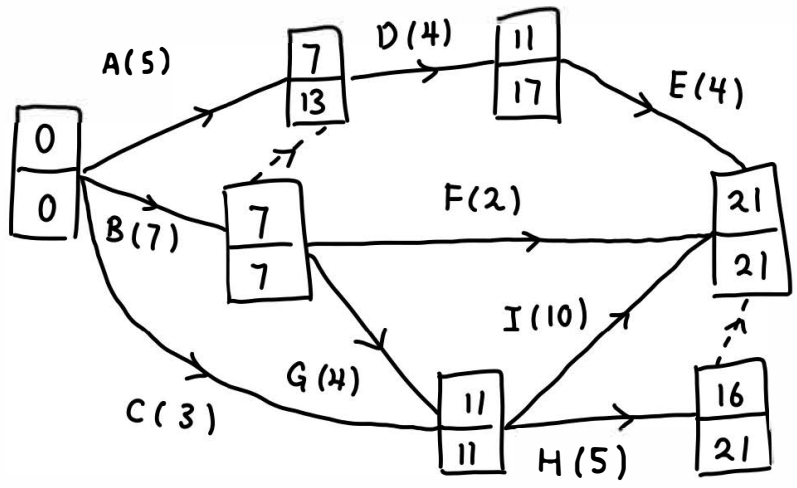
(3)

(b) (i) Show that the project can be completed in 21 days, showing your working.

(ii) Identify the critical activities.

(4)

(Total for Question 3 is 7 marks)



i. the number at the end of activity E indicates this project can be completed in 21 days

ii) B, G, I

3. (a) and (b)

(Total for Question 3 is 7 marks)

4. (a) Explain why it is not possible to draw a graph with exactly 5 nodes with orders 1, 3, 4, 4 and 5

(1)

A connected graph has exactly 5 nodes and contains 18 arcs. The orders of the 5 nodes are $2^{2x} - 1$, 2^x, $x + 1$, $2^{x+1} - 3$ and $11 - x$.

(b) (i) Calculate x.

(ii) State whether the graph is Eulerian, semi-Eulerian or neither. You must justify your answer.

(6)

(c) Draw a graph which satisfies all of the following conditions:

- The graph has exactly 5 nodes.
- The nodes have orders 2, 2, 4, 4 and 4
- The graph is not Eulerian.

(2)

(Total for Question 4 is 9 marks)

a) a graph cannot contain an odd number of odd nodes Euler's lemma

b) i) total order = 18×2
$= 36$

$(2^{2x} - 1) + 2^x + (x+1) + (2^{x+1} - 3) + (11 - x) = 36$

$2^{2x} + (2^x \times 2) + 2^x = 28$

$(2^x)^2 + 3(2^x) = 28$

let $u = 2^x$

$u^2 + 3u - 28 = 0$

$(u - 4)(u + 7) = 0$

$u = 4$ $\quad u = 7$

$2^x = 4$ $\quad 2^x = 7$

$x = 2$ $\quad x = 2.807$ n/a

ii) order of nodes :

$2^{2x} - 1 = 15$

$2^x = 4$ > 2 odd nodes

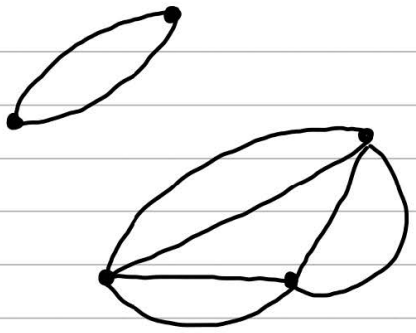
$x + 1 = 3$ ∴ neither Eulerian / semi-Eulerian

$2^{x+1} - 3 = 5$

$11 - x = 9$

4.

c)



even nodes → to be non-Eulerian, must be disconnected

(Total for Question 4 is 9 marks)

5. Jonathan makes two types of information pack for an event, *Standard* and *Value*.

Each *Standard* pack contains 25 posters and 500 flyers.

Each *Value* pack contains 15 posters and 800 flyers.

He must use at least 150 000 flyers.

Between 35% and 65% of the packs must be *Standard* packs.

Posters cost 20p each and flyers cost 4p each.

Jonathan wishes to minimise his costs.

Let x and y represent the number of *Standard* packs and *Value* packs produced respectively.

Formulate this as a linear programming problem, stating the objective and listing the constraints as simplified inequalities with integer coefficients.

You should not attempt to solve the problem.

(Total for Question 5 is 5 marks)

TOTAL FOR PAPER IS 40 MARKS

objective : minimise $C = (25\times0.20 + 500\times0.04)x + (15\times0.20 + 800\times0.04)y$

$C = 25x + 35y$

constraints : $500x + 800y \geqslant 150\,000 \rightarrow 5x + 8y \geqslant 1500$

$0.35(x+y) \leqslant x \leqslant 0.65(x+y)$

$\frac{7}{20}(x+y) \leqslant x$

$x+y \leqslant \frac{20}{7}x$

$y \leqslant \frac{13}{7}x$

$7y \leqslant 13x$

$x \leqslant \frac{13}{20}(x+y)$

$\frac{20}{13}x \leqslant x+y$

$\frac{7}{13}x \leqslant y$

$7x \leqslant 13y$

$x, y \geqslant 0$