Pearson Edexcel Level 3 GCE

Paper reference **8FM0/27**

Further Mathematics

Advanced Subsidiary
Further Mathematics options
27: Decision Mathematics 1
(Part of options D, F, H and K)

You must have:
Mathematical Formulae and Statistical Tables (Green), calculator,
D1 Answer Book (enclosed)

Candidates may use any calculator allowed by Pearson regulations. 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).
- **Fill in the boxes** at 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 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.
- Inexact answers should be given to three significant figures unless otherwise stated.
- Do not return the question paper with the D1 Answer Book.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- The total mark for this part of the examination is 40. There are 4 questions.
- 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.
- Good luck with your examination.

Turn over ▶

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Write your answers in the answer book provided.

1. 3.5 6.3 2.9 5.4 3.1 2.8 3.7 1.7 4.1 3.3 2.2

The numbers listed above are to be sorted into descending order.

(a) (i) Perform **one** pass of a bubble sort, starting at the left-hand end of the list. You must write down the list that results at the end of this first pass.

(ii) Write down the number of comparisons and the number of swaps performed during this first pass.

(3)

After a second pass using this bubble sort, the updated list is

6.3 5.4 3.5 3.1 3.7 2.9 4.1 3.3 2.8 2.2 1.7

(b) Use a quick sort on this updated list to obtain the fully sorted list. You should show the result of each pass and identify your pivots clearly.

(3)

(c) Apply the first-fit decreasing bin packing algorithm to the fully sorted list to pack the numbers into bins of size 11.5

(3)

(d) Determine whether your answer to part (c) uses the minimum number of bins. You must justify your answer.

(2)

(Total for Question 1 is 11 marks)

2.

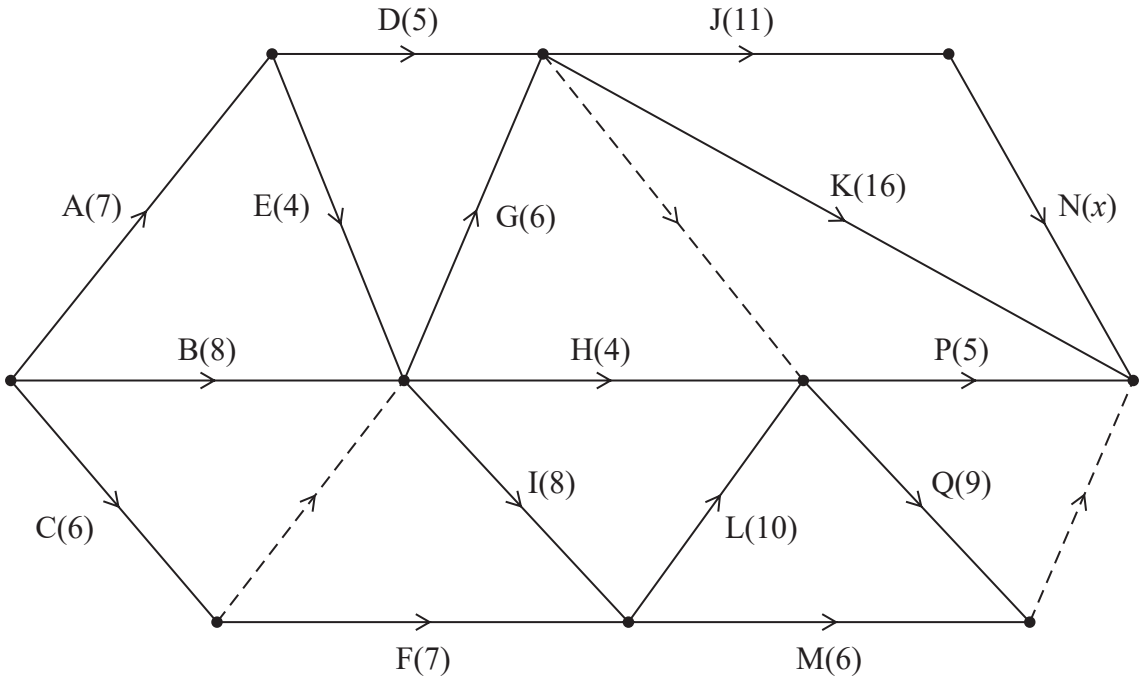


Figure 1

A project is modelled by the activity network shown in Figure 1. The activities are represented by the arcs. The number in brackets on each arc gives the time, in hours, to complete the corresponding activity. The exact duration, x, of activity N is unknown, but it is given that $5 < x < 10$

Each activity requires one worker. The project is to be completed in the shortest possible time.

(a) Complete the precedence table in the answer book.

(2)

(b) Complete Diagram 1 in the answer book to show the early event times and the late event times.

(4)

(c) List the critical activities.

(1)

It is given that activity J can be delayed by up to 4 hours without affecting the shortest possible completion time of the project.

(d) Determine the value of x. You must make the numbers used in your calculation clear.

(1)

(e) Draw a cascade chart for this project on Grid 1 in the answer book.

(4)

(Total for Question 2 is 12 marks)

3. Donald plans to bake and sell cakes. The three types of cake that he can bake are brownies, flapjacks and muffins.

Donald decides to bake 48 brownies and muffins in total.

Donald decides to bake at least 5 brownies for every 3 flapjacks.

At most 40% of the cakes will be muffins.

Donald has enough ingredients to bake 60 brownies or 45 flapjacks or 35 muffins.

Donald plans to sell each brownie for £1.50, each flapjack for £1 and each muffin for £1.25
He wants to maximise the total income from selling the cakes.

Let x represent the number of brownies, let y represent the number of flapjacks and let z represent the number of muffins that Donald will bake.

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

You should **not** attempt to solve the problem.

(Total for Question 3 is 9 marks)

4.

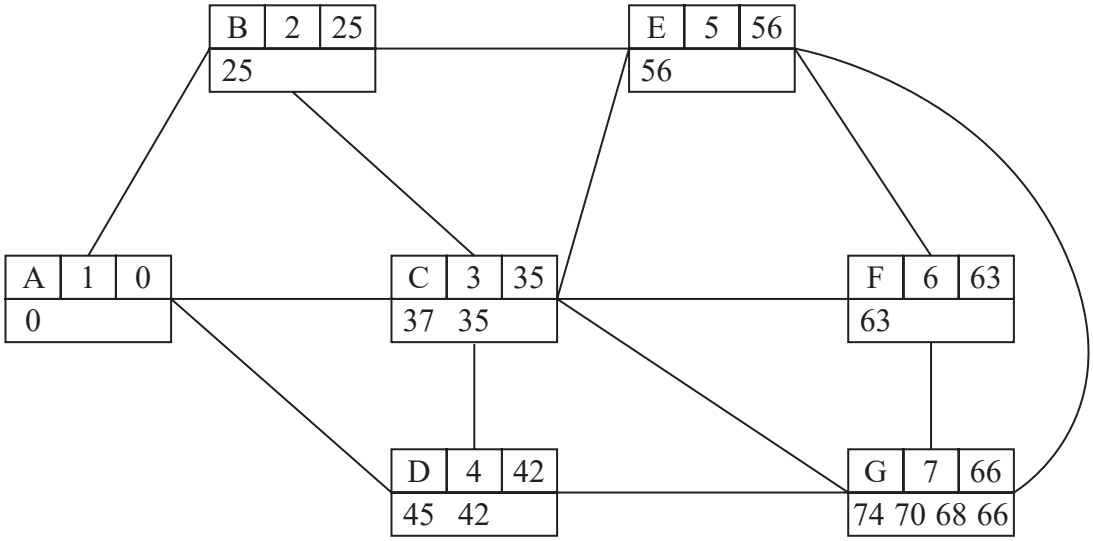


Figure 2

Dijkstra's algorithm has been applied to the network in Figure 2.

A working value has only been replaced at a node if the new working value is smaller.

(a) State the length of the shortest path from A to G.

(1)

(b) Complete the table in the answer book giving the weight of each arc listed.
(Note that arc CE and arc EF are not in the table.)

(3)

(c) State the shortest path from A to G.

(1)

It is now given that
- when Prim's algorithm, starting from A, is applied to the network, the order in which the arcs are added to the tree is AB, BC, CD, CE, EF and FG
- the weight of the corresponding minimum spanning tree is 80
- the shortest path from A to F via E has weight 67

(d) Determine the weight of arc CE and the weight of arc EF, making your reasoning clear.

(3)

(Total for Question 4 is 8 marks)

TOTAL FOR DECISION MATHEMATICS 1 IS 40 MARKS

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Please check the examination details below before entering your candidate information

Candidate surname StemUp Model Solution | Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

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

Total Marks

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1.

(a)(i) 6.3 3.5 5.4 3.1 2.9 3.7 2.8 4.1 3.3 2.2 1.7

(ii) Number of comparisons = 10, number of swaps = 7

(b) Quick sort, middle right pivots (ringed):

6.3	5.4	3.5	3.1	3.7	(2.9)	4.1	3.3	2.8	2.2	1.7	pivot 2.9
6.3	5.4	3.5	(3.1)	3.7	4.1	3.3	2.9	2.8	(2.2)	1.7	pivots 3.1, 2.2
6.3	5.4	3.5	(3.7)	4.1	3.3	3.1	2.9	2.8	2.2	1.7	pivot 3.7
6.3	(5.4)	4.1	3.7	3.5	(3.3)	3.1	2.9	2.8	2.2	1.7	pivots 5.4, 3.3
6.3	5.4	4.1	3.7	3.5	3.3	3.1	2.9	2.8	2.2	1.7	sorted

Sorted list: 6.3 5.4 4.1 3.7 3.5 3.3 3.1 2.9 2.8 2.2 1.7

(c) First-fit decreasing, bins of size 11.5:

Bin 1:	6.3	4.1		(total 10.4)
Bin 2:	5.4	3.7	2.2	(total 11.3)
Bin 3:	3.5	3.3	3.1	(total 9.9)
Bin 4:	2.9	2.8	1.7	(total 7.4)

(d) Total = 6.3 + 5.4 + 4.1 + 3.7 + 3.5 + 3.3 + 3.1 + 2.9 + 2.8 + 2.2 + 1.7 = 39

Lower bound = 39 ÷ 11.5 = 3.391..., so at least 4 bins are needed.

Part (c) uses 4 bins, so yes, it uses the minimum number of bins.

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Question 1 continued

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Question 1 continued

(Total for Question 1 is 11 marks)

2. (a)

Activity	Immediately preceding activities
A	–
B	–
C	–
D	A
E	A
F	C

Activity	Immediately preceding activities
G	B, C, E
H	B, C, E
I	B, C, E
J	D, G
K	D, G
L	F, I

Activity	Immediately preceding activities
M	F, I
N	J
P	D, G, H, L
Q	D, G, H, L

(b)

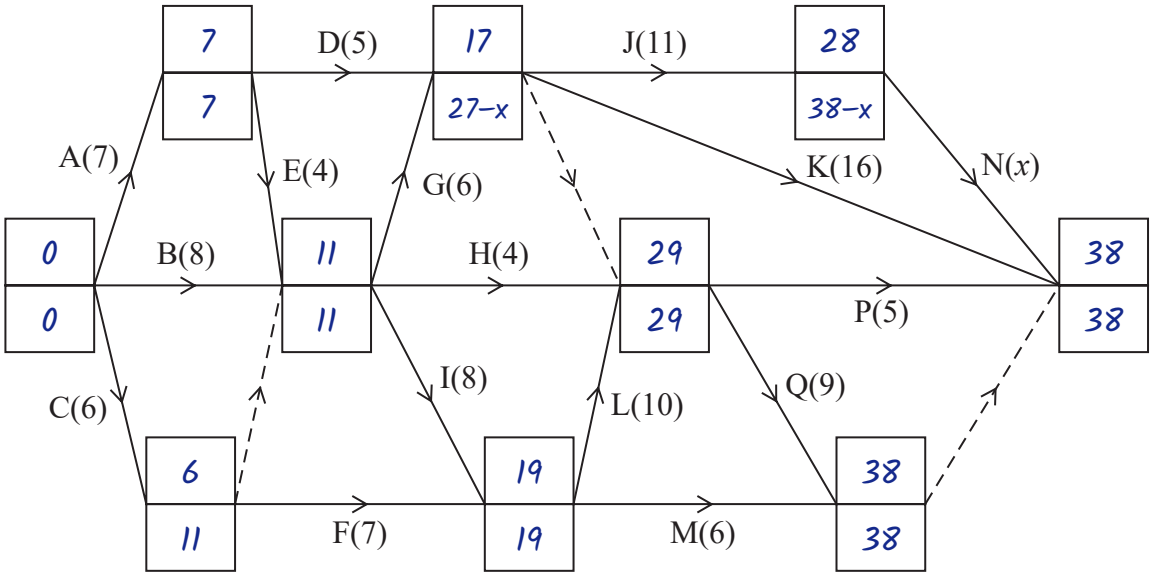


Diagram 1

(c) Critical activities: A, E, I, L and Q

(d) Total float on J = (late time at end of J) – (early time at start of J) – 11

(38 – x) – 17 – 11 = 4

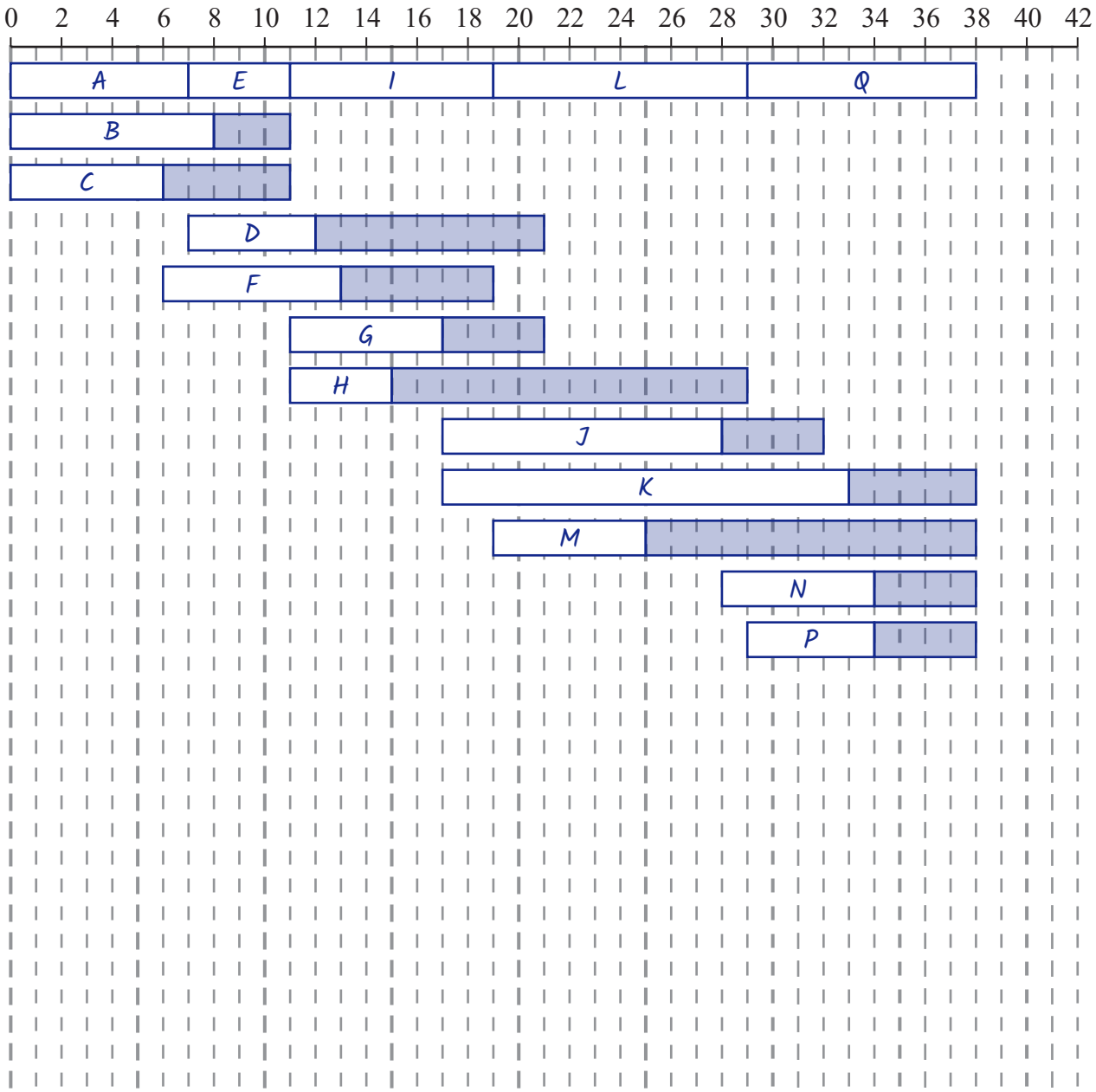
10 – x = 4 ⇒ x = 6

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Question 2 continued

(e) Cascade chart on Grid 1 (using x = 6). Shaded sections show the float of each non-critical activity; critical activities are on the top row.



Grid 1

(Total for Question 2 is 12 marks)

3.

Brownies + muffins: $x + z = 48 \Rightarrow z = 48 - x$

At least 5 brownies for every 3 flapjacks: $x/y \geq 5/3 \Rightarrow 3x \geq 5y$

At most 40% muffins: $z \leq (2/5)(x + y + z) \Rightarrow 5z \leq 2x + 2y + 2z$

$\Rightarrow 3z \leq 2x + 2y$

Ingredients: $x/60 + y/45 + z/35 \leq 1 \Rightarrow 21x + 28y + 36z \leq 1260$

Objective: maximise $P = 1.5x + y + 1.25z$

Substitute $z = 48 - x$:

$P = 1.5x + y + 1.25(48 - x) = 0.25x + y + 60$

$3(48 - x) \leq 2x + 2y \Rightarrow 144 - 3x \leq 2x + 2y \Rightarrow 5x + 2y \geq 144$

$21x + 28y + 36(48 - x) \leq 1260 \Rightarrow -15x + 28y + 1728 \leq 1260 \Rightarrow 15x \geq 28y + 468$

$z \geq 0 \Rightarrow x \leq 48$

Linear programming formulation:

Maximise $P = 0.25x + y + 60$

subject to: $3x \geq 5y$

$5x + 2y \geq 144$

$15x - 28y \geq 468$

$x \leq 48, \quad x, y \geq 0 \quad (x, y \text{ integers})$

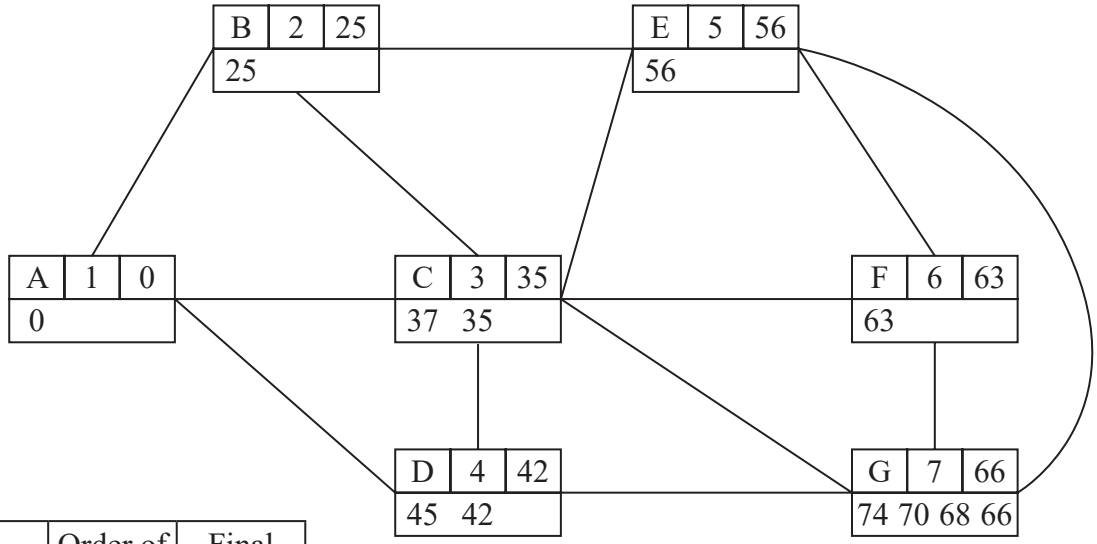
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Question 3 continued

(Total for Question 3 is 9 marks)

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4.



Key:

Vertex	Order of labelling	Final value
Working values		

(a) length of the shortest path from A to G: 66

(b)

Arc	Weight
AB	25
AC	37
AD	45
BC	10
BE	31
CD	7
CF	28
CG	39
DG	28
EG	12
FG	3

AB = 25, AC = 37, AD = 45; BC = 35 − 25 = 10; CD = 42 − 35 = 7; BE = 56 − 25 = 31

CF = 63 − 35 = 28; CG = 74 − 35 = 39; DG = 70 − 42 = 28; EG = 68 − 56 = 12

FG = 66 − 63 = 3

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Question 4 continued

(c) shortest path from A to G: A B C F G

(d) Prim: AB + BC + CD + CE + EF + FG = 80

25 + 10 + 7 + CE + EF + 3 = 80 ⇒ CE + EF = 35

Shortest path from A to F via E is A B E F:

AB + BE + EF = 67 ⇒ 25 + 31 + EF = 67 ⇒ 56 + EF = 67 ⇒ EF = 11

CE = 35 − 11 = 24

Weight of arc CE = 24, weight of arc EF = 11

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Question 4 continued

(Total for Question 4 is 8 marks)

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