AQA

Please write clearly in block capitals.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname ____________________

Forename(s) ____________________

Candidate signature ____________________

AS
MATHEMATICS

Unit Decision 1

Friday 22 June 2018 Morning Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
- the blue AQA booklet of formulae and statistical tables.

You may use a graphics calculator.

Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
- You must answer each question in the space provided for that question. If you require extra space, use an AQA supplementary answer book; do **not** use the space provided for a different question.
- Do not write outside the box around each page.
- Show all necessary working, otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.
- The **final** answer to questions requiring the use of calculators should be given to three significant figures, unless stated otherwise.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

Advice
- You do not necessarily need to use all the space provided.

For Examiner's Use	
Question	Mark
1	
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TOTAL	

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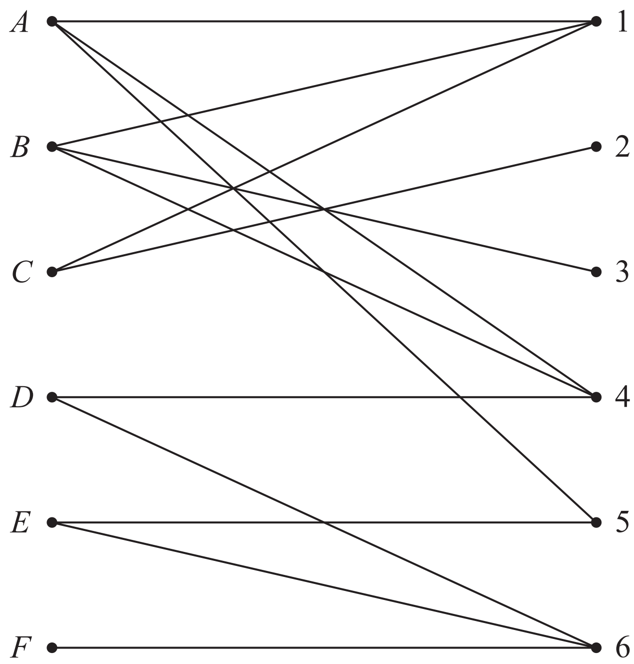
Answer **all** questions.

Answer each question in the space provided for that question.

1 Six workers, A, B, C, D, E and F, work in a machine shop where there are six different tasks, 1, 2, 3, 4, 5 and 6, to be done. The bipartite graph below shows the tasks each worker is able to complete.



Initially, worker A is assigned to task 5, worker B to task 1, worker C to task 2, and worker D to task 6.

Demonstrate, by using an alternating-path algorithm from this initial matching, how each of the workers can be assigned to a different task.

[5 marks]

QUESTION PART REFERENCE

Answer space for question 1

QUESTION PART REFERENCE

Answer space for question 1

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2 (a) (i) Use the shuttle sort algorithm to rearrange the following numbers in **descending** order, showing the new arrangement after each pass.

(The list is printed again in the answer space.)

41 51 63 41 11 19 45

[3 marks]

(ii) For the **last** pass write down the number of comparisons and the number of swaps.

[2 marks]

(b) Aziz uses the bubble sort to rearrange a list of six numbers into ascending order. When he has finished, he replaces one of the numbers by the letter x. The original list and the resulting list after each of the three passes is shown below.

16	5	7	x	9	11
5	7	x	9	11	16
5	7	9	x	11	16
5	7	9	x	11	16

Write down the interval satisfied by x.

[2 marks]

QUESTION PART REFERENCE

Answer space for question 2

(a) (i) 41 51 63 41 11 19 45

QUESTION PART REFERENCE	Answer space for question 2

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Turn over ▶

3 A student is tracing the following algorithm.
The modulus of x is written as $|x|$ where $|x| = x$ if $x \geqslant 0$ and $|x| = -x$ if $x < 0$.

Line 10 Input A, B

Line 20 Let $C = A + 2 \times B$

Line 30 Let $D = A + B$

Line 40 Let $E = C \div D$

Line 50 Let $F = E \times E - 2$

Line 60 If $|F| \geqslant 0.001$ then go to Line 90

Line 70 Print E

Line 80 Go to Line 120

Line 90 Let $A = C$

Line 100 Let $B = D$

Line 110 Go to Line 20

Line 120 Stop

(a) Trace the algorithm when the inputs are $A = 5$ and $B = 4$.

Give the value of all non-integers correct to 3 decimal places.

[4 marks]

(b) Explain the role of F in the algorithm.

[1 mark]

QUESTION PART REFERENCE	**Answer space for question 3**

QUESTION PART REFERENCE

Answer space for question 3

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4 Gert is a van driver, employed to make deliveries from a depot in town A to shops in 11 other towns, B, C, … L. The diagram below shows the roads connecting the towns. The distances, in kilometres, between pairs of towns are shown on the edges.

(a) (i) Use Dijkstra's algorithm on the diagram to find the minimum distance from A to each of the towns.

[5 marks]

(ii) Write down the route corresponding to the minimum distance between the depot at A and town L.

[1 mark]

(b) On a particular day, Gert has only one delivery to make, in town L. He wants to drive from A to L by the shortest possible route but also wants to visit C on the way.

(i) Find the minimum distance of Gert's journey from A to L via C.

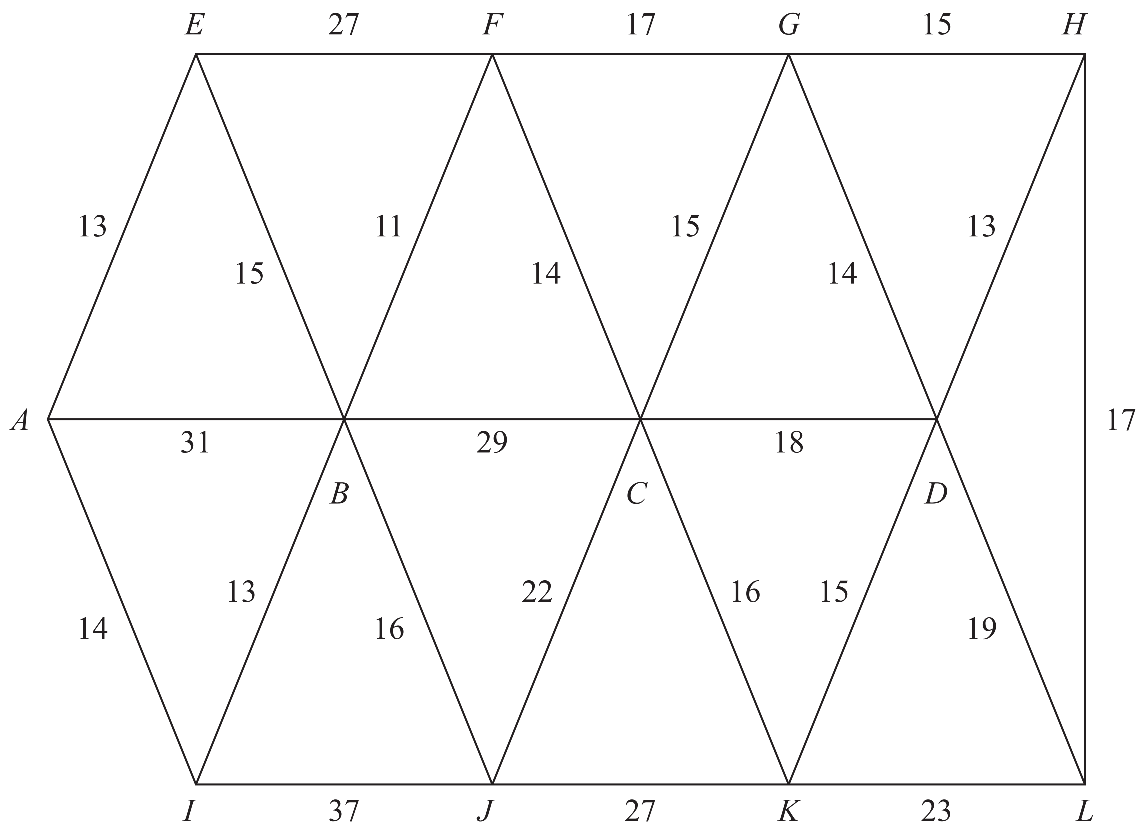
[2 marks]

(ii) Write down the corresponding route.

[1 mark]

QUESTION PART REFERENCE

Answer space for question 4



QUESTION PART REFERENCE

Answer space for question 4

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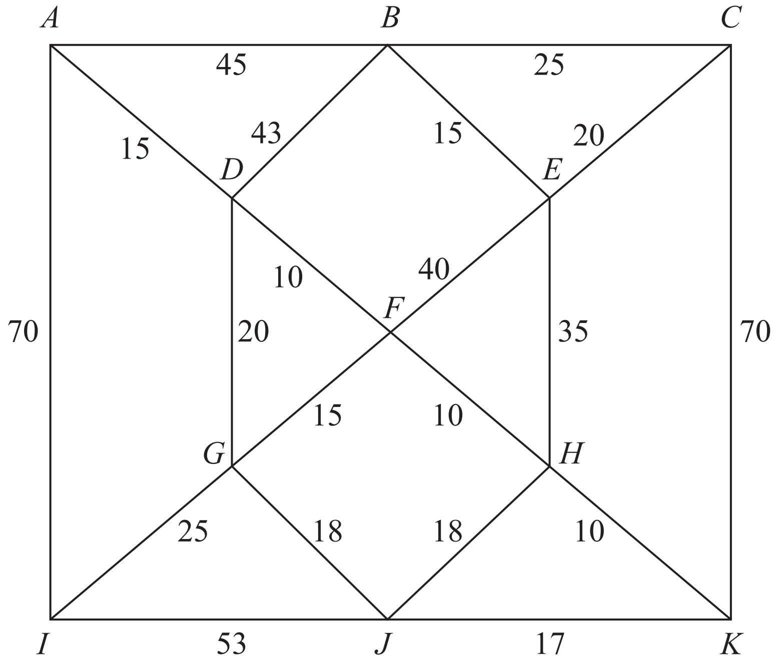
5 The diagram below shows a network representation of the paths in an ornamental garden. The lengths of the paths are shown in metres.



The total length of the paths is 574 metres

(a) (i) A gardener has to spray weed-killer on all the paths.

Find the length of an optimal Chinese postman route, starting and finishing at A.

(ii) The gardener sprays weed-killer continuously during this Chinese postman route.

Find the total length of the paths that have been sprayed twice.

[6 marks]

(b) The following day the gardener inspects all of the paths. The gardener may start the inspection at any vertex and finish it at any other vertex.

Find the length of the minimum distance the gardener walks during this inspection.

State the start and finish vertices of the route corresponding to this minimum distance.

[2 marks]

QUESTION PART REFERENCE	**Answer space for question 5**

QUESTION PART REFERENCE

Answer space for question 5

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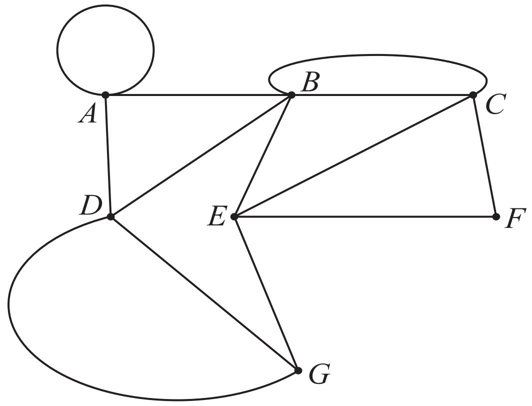
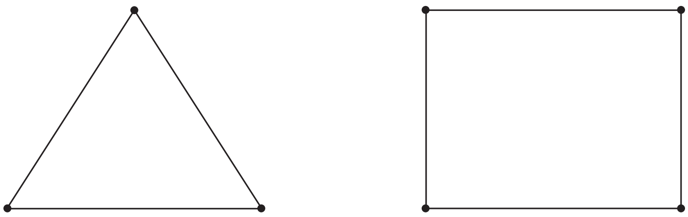
6 (a) Use an adjacency matrix to represent the graph below.

[3 marks]



(b) The diagram below shows a graph consisting of seven vertices and seven edges.



Add as few edges as possible to make the copy of this graph in the answer space opposite:

(i) Hamiltonian

(ii) Semi-Eulerian

[2 marks]

(c) Explain why it is not possible to draw a graph with an odd number of vertices each of an odd order.

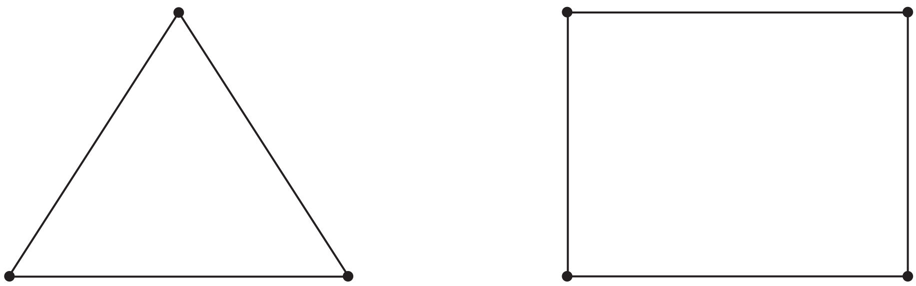
[2 marks]

QUESTION PART REFERENCE

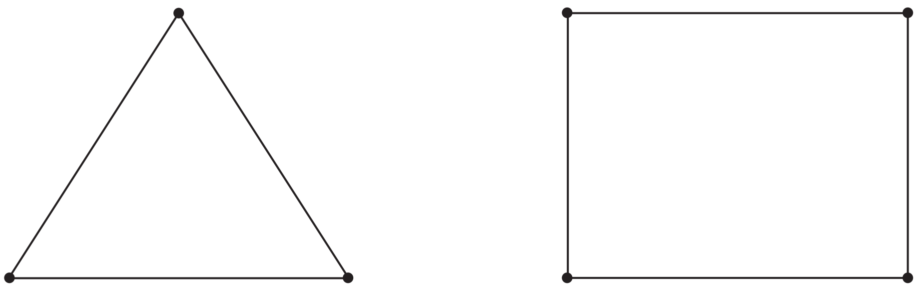
Answer space for question 6

(a)

(b)(i) Hamiltonian



(b)(ii) Semi-Eulerian



(c)

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7 The cost of gritting some of the major roads in Scotland is being investigated. The lengths of direct roads, in kilometres, between pairs of eight towns are shown in the table below.

	Ayr (A)	Edinburgh (E)	Fort William (F)	Glasgow (G)	Inverness (I)	Perth (P)	Stranraer (S)	Thurso (T)
Ayr (A)	–	127	227	53	333	153	88	529
Edinburgh (E)	127	–	225	69	261	72	200	457
Fort William (F)	227	225	–	187	108	171	309	285
Glasgow (G)	53	69	187	–	280	100	135	476
Inverness (I)	333	261	108	280	–	188	415	196
Perth (P)	153	72	171	100	188	–	235	385
Stranraer (S)	88	200	309	135	415	235	–	612
Thurso (T)	529	457	285	476	196	385	612	–

(a) (i) **On the table in the answer space, on the page opposite**, use Prim's algorithm, starting from Edinburgh (E), to find a minimum spanning tree for the eight towns in the table. Show clearly the order in which you select the towns.

(ii) State the length of your minimum spanning tree.

(iii) Draw your minimum spanning tree.

[6 marks]

(b) If Kruskal's algorithm is used to find the same minimum spanning tree, state which edge would be:

(i) the first to be included in the tree

(ii) the sixth to be included in the tree.

[2 marks]

(c) The road between Perth (P) and Edinburgh (E) must be closed and cannot be accessed for gritting.

The cost of gritting roads is an average of £15 per kilometre.

Find the minimum extra cost to re-establish a minimum spanning tree for the eight towns using available roads in the table.

[2 marks]

QUESTION PART REFERENCE

Answer space for question 7

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(a) (i)

	Ayr (A)	Edinburgh (E)	Fort William (F)	Glasgow (G)	Inverness (I)	Perth (P)	Stranraer (S)	Thurso (T)
Ayr (A)	–	127	227	53	333	153	88	529
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QUESTION PART REFERENCE

Answer space for question 7

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8 Bradley is a keen cyclist who regularly trains for races by cycling through the villages near his home in village D. The table below shows the distances in kilometres between six of the villages – A, B, C, D, E and F.

Bradley wants to find the lengths of different tours of these villages.

	A	B	C	D	E	F
A	–	3	5	8	15	16
B	3	–	17	6	14	19
C	5	17	–	20	16	13
D	8	6	20	–	9	21
E	15	14	16	9	–	11
F	16	19	13	21	11	–

(a) Use the nearest neighbour algorithm, starting at D, to find a tour of the 6 villages for Bradley, and find its length.

[4 marks]

(b) By deleting D, find a lower bound for the minimum length of Bradley's tour.

[4 marks]

(c) Explain fully what can be deduced from your answers to parts **(a)** and **(b)**.

[2 marks]

QUESTION PART REFERENCE

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9 Mrs Vardy has agreed to make cakes for a stall at a fundraising event in aid of her children's youth club. She has decided to make three different types of cake – plain, fruit and chocolate.

For each plain cake she needs $50\,\text{g}$ of flour, for each fruit cake she needs $200\,\text{g}$ of flour and for each chocolate cake she needs $300\,\text{g}$ of flour.

For each plain cake she needs 2 eggs, for each fruit cake she needs 2 eggs and for each chocolate cake she needs 3 eggs.

She and her children decide that there should be at least as many fruit cakes as plain cakes but no more than twice as many fruit cakes as plain cakes.

Mrs Vardy only has $13.5\,\text{kg}$ of flour available and she must use at least 54 eggs.

She has enough of all the other ingredients to make as many cakes as possible.

Mrs Vardy makes x plain cakes, y fruit cakes and z chocolate cakes.

(a) Write down four inequalities, in addition to $x,\ y,\ z \geqslant 0$, that represent the constraints of this situation.

[3 marks]

(b) She and her children decide that a quarter of the cakes made should be chocolate.

(i) Show that two of the inequalities in part **(a)** become:

$$x + 2y \leqslant 90 \qquad x + y \geqslant 18$$

[3 marks]

(ii) On the grid opposite, illustrate all the constraints and label the feasible region.

[4 marks]

(c) Mrs Vardy sells each plain cake for £3, each fruit cake for £4 and each chocolate cake for £6.

Draw an objective line on your graph.

By using this line, or otherwise, find the least amount of money that Mrs Vardy would earn if she sells all the cakes that she makes.

State the number of each type of cake made.

[4 marks]

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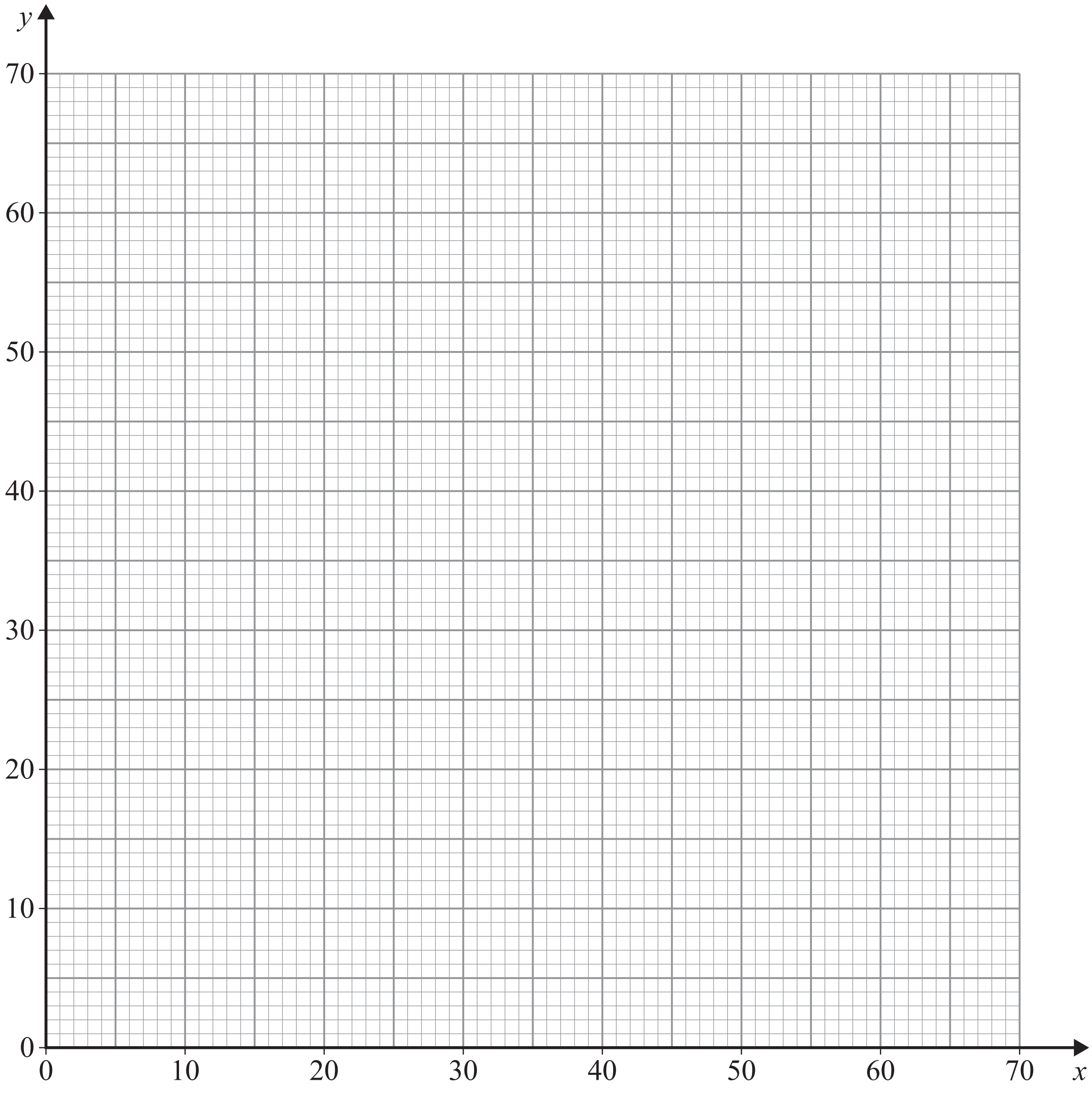
(b)(ii)
(c)



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END OF QUESTIONS

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