Cambridge International Examinations
Cambridge International Advanced Level

THINKING SKILLS **9694/31**

Paper 3 Problem Analysis and Solution **October/November 2016**

MARK SCHEME

Maximum Mark: 50

Published

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1 (a) Explain why it would not be possible to place units at A2 and B2 to form a table for 4. [1]

Because there would have to be a chair at A1 and it would not be possible to get to it.
Condone solutions which state/imply that A1 and B1 can't be served, OR A1 and A3 can't be served.

(b) How many different positions are there for a table for 6? [3]

54 (full marks for this value, or equivalent expression)

If the tables are positioned in a horizontal row then they cannot be on row A, B, F or G. It would be possible to access positions all around the table for any of the 8 positions on any of the other rows.

Similarly, if the tables are positioned in a vertical column then they cannot be on column 1, 2 or 9 or 10 and any of the 5 positions on any of the other columns could be accessible.

Total number of possibilities is $3 \times 8 + 6 \times 5$.

Partial credit:

- Identifying either that rows A, B, F and G or that columns 1, 2, 9 or 10 are not useable. Or that C,D,E possible/3,4,5,6,7,8 possible [1] .Allow 'only 3 rows possible' or 'only 6 columns possible'
- Correct number of tables for any individual row or column [1]
- Calculation of either 3×8 OR 6×5 [2]

(c) What is the largest number of tables for 4 that could be fitted into the room? Give an example of the positions for the tables to achieve this, by listing the grid references.[3]

6

For example, tables could be placed at B2–C2, E2–F2, B5–B6, E5–E6, B8–B9 and E8–E9.

The rules for placement of tables mean that each individual table must lie in a 3×2 grid of squares which cannot contain any part of other tables and the three squares on each side of the long edge must be empty. Therefore a maximum of three tables can be placed on any row across the diagram and there can be at most two rows (regardless of the orientation of the tables). The maximum possible is therefore 6 and it is then easy to find a working example.

1 mark for 'all tables can be accessed from both exits' [5 or more tables]
1 mark for 'diners can be seated without adjacency infringements' [5 or more tables]
1 mark for a viable arrangement of 6 tables

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(d) Show, by listing the grid references of the tables, that it is possible to fit 26 customers in the room. [3]

For example:

- Two tables for 6: D1–3, D5–7
- One table for 4: D9–10
- Five tables for 2: A2, A5, A9, G3, G7

1 mark for 'all tables can be accessed from both exits' [at least one 4 and 6 : 24 or more diners]
1 mark for 'diners can be seated without adjacency infringements' [at least one 4 and 6 : 24 or more diners]
1 mark for an arrangement tables for 26 which satisfies all constraints (including a table for 2)

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2 (a) How many possible mutations are there for each codon? [1]

3 + 3 + 3 = 9 (or equivalent expression)

(b) List all the possible silent mutations of the codon CUG. [2]

CUA, CUC, CUU [1 mark]
UUG [1 mark]

Any additional codons: no marks awarded

(c) Give four examples of codons with exactly two possible silent mutations. [3]

AUU AUC AUA
UAA
AGA AGG
UUA UUG

Deduct one mark for any incorrect judgment – ignore any surplus correct codons.
E.g. 2 correct and 2 incorrect makes 2 judgment errors: 1 mark
3 correct codons, makes 1 judgment error: 2 marks

(d) Give a sequence of codons which would produce the sequence of building blocks in the example above (*glu arg ile lys glu leu arg*) and bear the watermark 1010101. [3]

There are several options. For example: GAG AGA AUC AAA GAG CUA AGG

glu	*arg*	*ile*	*lys*	*glu*	*leu*	*arg*
1	0	1	0	1	0	1
GAG	AGA	AUC	AAA	GAG	CUA	AGG
	CGU				UUA	CGG
	CGA				CUU	CGC

Partial credit:
1 mark getting the correct watermark
1 mark for six codons correct (from the table)

(e) Which two building blocks, if needed, might not have a codon which would fit the desired watermark? [1]

AUG and UGG are the only codons with no silent mutations, so *met* and *trp*.

Accept codons instead of building blocks.
No marks awarded if any extras given.

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3 (a) What is the shortest amount of time that it could take for car 6 to pass the camera? [1]

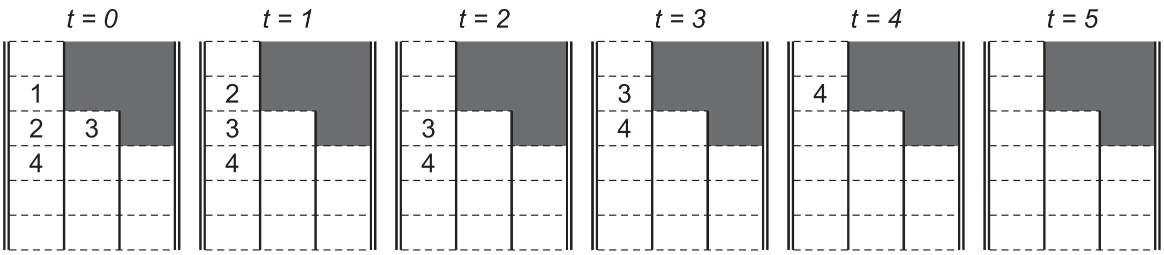
<u>5</u> seconds.

(b) Which of the nine cars could be the last to pass the camera? List all of them. [2]

3, 5, 6, 7, 8, 9

1 mark for 3, 5
1 mark for 6, 7, 8, 9
Withhold 1 mark for each extra car

(c) Show that car 4 could pass the camera in 5 seconds, if it allows car 3 to leave in front of it. You should use diagrams to show the positions of the relevant cars at the end of each second. [3]



1 mark for diagrams which clearly show a delay when 3 moves sideways.
1 mark for demonstrating that 5 seconds are represented/needed (dep)
1 mark for a correct sequence of diagrams

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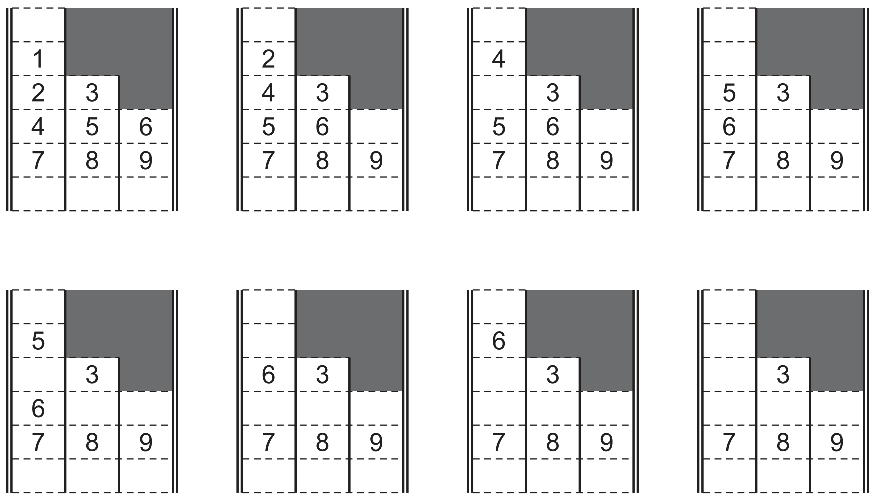
(d) What is the shortest time that car 6 could take to pass the camera? State a possible order of cars passing the camera that would enable this to happen, including any gaps where no cars passed during the 1-second time interval. [2]

7 seconds
1 – 2 – 4 – gap – 5 – gap – 6 OR
1 – 2 – gap – 3 – 5 – gap – 6 OR
1 – 2 – gap – 3 – 4 – gap – 6

1 mark for a correct list; 1 mark correct time (dep)

Award 1 mark for one inappropriate insertion or omission of gap
OR description of car movements + correct time, but no clear description of gaps
Possible time frames shown below (not needed for full mark answer)



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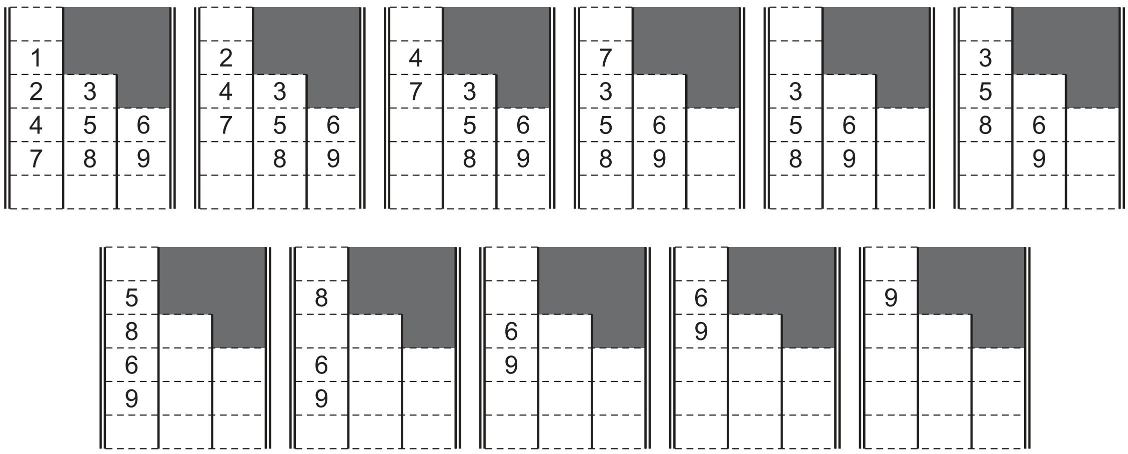
(e) Consider a case where the nine cars in the diagram pass the camera in the minimum total time. State a possible order of the cars passing the camera, including any gaps. **[2]**

The cars can exit in 11 seconds.
Simplest method is 2 synchronised lane changes, in which all the cars in the middle lane move into the left-hand lane, at the same time as the right-hand cars move into the middle lane. These introduce 2 gaps in the sequence.
Cars would leave in the following order: <u>1 – 2 – 4 – 7 – gap – 3 – 5 – 8 – gap – 6 – 9</u> (taking 11 seconds).

1 mark for a solution with a gap after 7 or 8
OR a feasible exit strategy with gaps after . For example:
1 – 2 – gap – 3 – 4 – gap – 5 – 7 – gap – 6 – 8 – gap – 9 : 13 seconds
1 – 2 – 3 – gap – 5 – gap – 4 – gap – 8 – gap – 6 – gap – 7 – 9 : 14 seconds



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(f) If there were 30 cars on the highway, using all three lanes, what is the shortest amount of time in which all of them could pass the camera? [2]

The same method as for part **(e)** can be applied, i.e. all the sideways movement leads to just two gaps. Therefore the additional 21 cars will add an additional 21 seconds, making a total of 32 seconds.

Some explanatory work needed for 2 marks (e.g. 30 + 2)
FT their (e) + 21 (except 9 + 21 = 30)
Award 1 mark for evidence that the candidate has considered 2 grouped lane shifts.

(g) Given this assumption, state the order in which the nine cars would pass the camera, including any gaps. [3]

The order is:

1 – 2 – gap – 3 – gap – 5 – gap – 6 – gap – 9 – gap – 8 – 4 – 7

1 mark for 1, 2, 3, 5 as the first cars, listed in that order.
1 mark for 6, 9, 8, 4, 7 as the next cars, in that order.
1 mark for all the gaps in the correct places.

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4 (a) (i) Who is the only competitor who took less time to complete one of the puzzles than the previous puzzle? [1]

Fleur (41 minutes for puzzle 3, following 43 minutes for puzzle 2)

(ii) Which competitor's times have increased by the same amount, from one puzzle to the next, throughout the tournament? [1]

Chloe (an increase of 11 minutes each time)

(b) (i) Gavin was the first competitor to complete puzzle 4. What was his score for this puzzle? [2]

28 (60 – 44 + 12)

If 2 marks cannot be awarded, award 1 mark for an answer of 16 (failing to add on the 12 points for completing the puzzle first)
OR 75/55 – 44 + 12 (wrong time limit)
OR an arithmetic error in the calculation of 60 – 44 + 12.

(ii) Each puzzle was completed first by a different competitor. Which two competitors were not the first to complete any of the puzzles? [1]

Ahmed and Darren

(c) What time should be displayed on the scoreboard for Fleur's puzzle 4? [3]

54 (minutes)
64 – 30 – 2 – 14 – 12 = 6 points. Time limit was 60 minutes.

If 3 marks cannot be awarded, award 2 marks for either of the following:

- sight of 6 (points for puzzle 4)
- at least three correct scores for puzzles 1, 2, 3 and 5 AND a correct number of minutes
  30 for puzzle 1; 2 for puzzle 2; 14 for puzzle 3; 12 for puzzle 5

If 2 marks cannot be awarded, award 1 mark for either of the following:

- an answer of 42 (minutes) (which fails to take any account of the additional points awarded for being first, second or third to complete a puzzle)
- an attempt to subtract an incorrect total number of points for puzzles 1, 2, 3 and 5 (max one error) from 64.

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(d) (i) The score for which puzzle will not count towards Ben's final score? **[2]**

(puzzle) 1

If 2 marks cannot be awarded, award 1 mark for at least four correct scores for the puzzles:

8 for puzzle 1; 16 for puzzle 2; 30 for puzzle 3;
11 for puzzle 4; 24 for puzzle 5; 13 for puzzle 6.

SC1: 8 with no further working
This mark can be awarded for sight of these figures in ***(d)(ii)****.*

(ii) What is Ben's final score? **[1]**

94

(iii) Give the order in which the other competitors have finished behind Ben and Darren. **[4]**

Chloe (3rd); Hazel (4th); Ahmed (5th); Gavin (6th); Ekta (7th); Fleur (8th)

If 4 marks cannot be awarded, award 1 mark for 1 correct; 2 marks for 3 correct; 3 marks for 5 correct (regardless of order):

Chloe	90 (points)
Hazel	89
Ahmed	85
Gavin	83
Ekta	81
Fleur	76 (possible FT from **(c)**)

OR 2 marks for the list of the 6 competitors' total scores for all 6 puzzles
OR 1 mark for any 4 correct:

Ahmed	92
Chloe	99
Ekta	86
Fleur	78 (possible FT from **(c)**)
Gavin	90
Hazel	97

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