

MARK SCHEME for the October/November 2014 series

9694 THINKING SKILLS

9694/32

Paper 3 (Problem Analysis and Solution),
maximum raw mark 50

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

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Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9694	32

1 (a) (i) Which of these squares might be found in a different position after shipping? [2]

1 and 2 (1 mark for both) and 4 (1 mark)

(ii) Draw a rearrangement of these pieces inside a 5×12 rectangle which would result in fewer pieces being able to move. [1]



(b) How many unit squares would be needed to fill all the gaps? [1]

There is no requirement to find the arrangement.

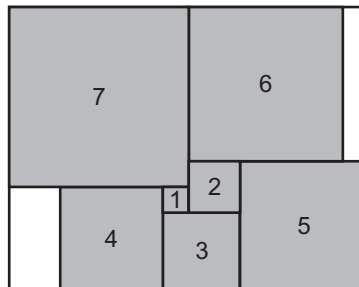
$$19 \times 27 = 513$$

$$1 + 4 + 9 + 16 + 25 + 36 + 49 + 64 + 81 + 100 + 121 = 506$$

$$513 - 506 = \underline{7}$$

(c) Which one of these seven squares can never move, no matter how many of the others do? [1]

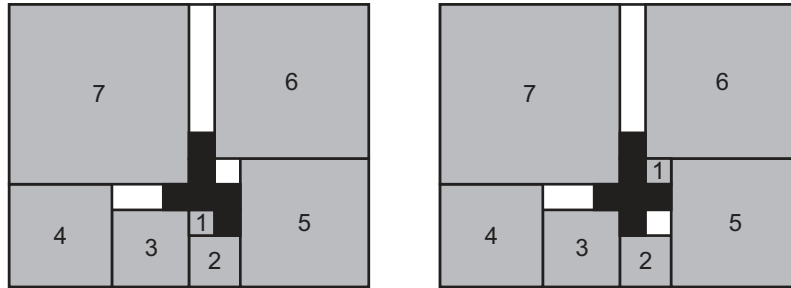
Only the 5 by 5 (bottom right hand) is stuck.



Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9694	32

- (d) Design such a 'filler' piece, and show where the smallest square should be placed relative to it. [2]

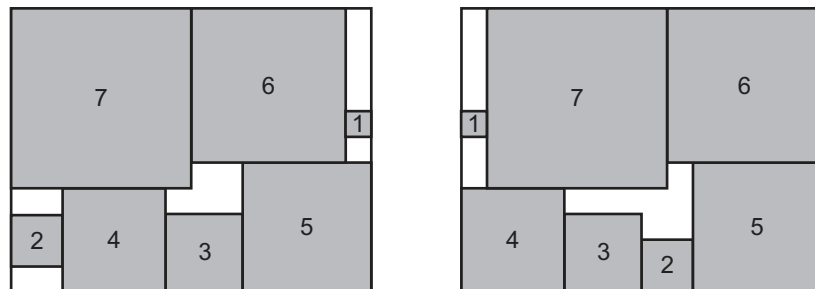
Examples of possible shapes are shown below. Award 1 mark for an appropriate filler, and a further mark for the placement of the smallest square.



If 2 marks cannot be given, award one for an arrangement which allows only one item to move, or the six units are not used as a single piece, or it uses 7 units.

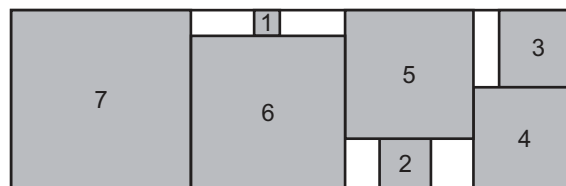
- (e) Draw another arrangement of the seven squares, without any extra pieces, within this 11×14 rectangle, so that none of the squares bigger than 3×3 can move. [3]

Various arrangements are possible, and need to check only 1×1 , 2×2 , 3×3 move e.g.



Allow 2 marks if one larger square can still move.

If 2 marks cannot be awarded, allow 1 mark for an arrangement in which two pieces are fixed OR the 7×7 square is fixed OR an arrangement using a 22×7 rectangle.



Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9694	32

- 2 (a) What 4-digit PIN would $87 +$ produce? [1]

8529

- (b) How many different 4-digit PINs can be produced using two digits and an addition sign in this way? [1]

100

- (c) What rule would produce the PIN 2642? [1]

28 –

- (d) List all the rules that would produce the PIN 6666. [2]

60 +, 60 –, 61 ×, 66 ×

1 mark for two correct solutions

- (e) In this part, consider only PINs with four different digits. Give an example of such a PIN which can be produced using two different rules, both using multiplication. State the rules. [2]

22 × and 27 × give 2486

42 × and 47 × give 4862

62 × and 67 × give 6248

82 × and 87 × give 8624

23 × and 28 × give 2684

43 × and 48 × give 4268

63 × and 68 × give 6842

83 × and 88 × give 8426

Award 2 marks for two correct rules – even if the code is not stated.

Award 1 mark for a code on its own.

- (f) List all of the 4-digit PINs of the form 31__ which would not be allowed (i.e. are produced by one of the possible rules)? [2]

3179, 3113, 3159, 3197

1 mark for any two of these

- (g) Show that at least 97% of all possible 4-digit PINs are still allowed. [1]

The PIN-cracking program cannot produce more than $(10 \times 10 \times 3)$ out of 10000 PINs.

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9694	32

- 3 (a) (i) Give the coordinates of a point that ends up in the same place as it started, after one roll-out. [1]

(1, 1) OR (0, 0)

- (ii) Where does the point (0.4, 0.1) move to after a roll-out? [1]

(0.8, 0.05)

- (iii) Where does the point $(\frac{3}{5}, \frac{3}{5})$ move to after a roll-out? [1]

$(\frac{1}{5}, \frac{4}{5})$

- (b) (i) How many layers of ground spice will there be after three roll-outs? [1]

$2 \times 2 \times 2 = \underline{8}$

- (ii) How many roll-outs are needed before all points are within 1/10 of a unit from some spice? [1]

The points near the bottom will need a layer at or below $y = 1/10$. After 3 roll outs the lowest layer is $y = 1/8$, but after four we have spice at $y = 1/16$.

- (c) (i) Into how many pieces will the butter have been cut after the fourth roll-out? [2]

after 1st roll out : 0.2 – 0.8

after 2nd roll out : 0.4 – 1 & 0 – 0.6

after 3rd roll out : 0.8 – 1 & 0 – 1 & 0 – 1 & 0 – 0.2

after 4th roll out : 0.6 – 1 & 0 – 1 & 0 – 1 & 0 – 1 & 0 – 1 & 0 – 0.4

So the butter will have been cut into 6 pieces

If 2 marks cannot be awarded, award 1 mark for working with one arithmetic error OR a correct analysis (with awareness of lengths) up to the end of the 2nd roll out.

- (ii) Draw a pair of diagrams to show how two lumps of butter, of any simple shape, could combine to form one lump during a roll-out. One diagram should show the position of the two lumps before the roll-out, and the other diagram should show the single combined lump after the roll-out. [2]

For example:



1 mark for correct diagram before, 1 mark for matching diagram afterwards.

Page 6	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9694	32

- (d) (i) How many roll-outs in total are needed before the point (1/7, 4/7) returns to where it started? List all the points in the cycle. [2]

Cycle is (1/7, 4/7) (2/7, 2/7) (4/7, 1/7) [1 mark]

3 roll-outs needed [1 mark]

- (ii) Give an example of a point on a different cycle of the same length. (This cycle must not include (1/7, 4/7).) [1]

Any one of (6/7, 3/7), (5/7, 5/7) and (3/7, 6/7). Allow more than one of these but nothing else.

- (e) (i) How many roll-outs in total are needed before the point (1/127, 64/127) returns to where it started? [1]

7

- (ii) Identify a point which moves back to its starting position after 2 roll-outs. [1]

(1/3, 2/3) or (2/3, 1/3) (allow both)

- (iii) Identify a point which moves back to its starting position after 5 roll-outs. [1]

Any of (1/31, 16/31) (2/31, 8/31) (4/31, 4/31) (8/31, 2/31) (16/31, 1/31) or any component-wise sum of these, such as (5/31, 20/31).

- 4 (a) During the festival, which play will be performed

- (i) more times than any of the others? [1]

The Tempest (11 performances)

- (ii) fewer times than any of the others? [1]

Timon of Athens (3 performances)

The others are as follows:

As You Like It, Twelfth Night, Measure for Measure – 10 each

Romeo and Juliet, Othello – 9 each

Love's Labour's Lost – 5

King Lear, Cymbeline – 4 each

- (b) Which two dates repeat the schedule of 11 July? [2]

The scheduled plays for these dates are As You Like It, Othello and Measure for Measure.

16 July (accept Tuesday Week 3) [1 mark]

21 July (accept Sunday Week 3) [1 mark]

Page 7	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9694	32

- (c) (i) List all the dates on which Kate will watch either Mark or Antony performing at the festival. [2]

They both perform on 9 July / Tuesday Week 2 and 25 July / Thursday Week 4.

10 July / Wednesday Week 2 (Antony)

15 July / Monday Week 3 (Antony)

17 July / Wednesday Week 3 (Mark)

20 July / Saturday Week 3 (Antony)

23 July / Tuesday Week 4 (Mark)

Award 1 mark for three or four correct dates and/or no more than one incorrect date.

- (ii) What is the total cost of Kate's tickets? [2]

She will miss both opening nights because they clash.

$$1 \times \$18 + 4 \times \$24 = \underline{\$114}$$

Award 1 mark for evidence of appreciation of 1 ticket @ \$18 (Week 2) OR 4 tickets @ \$24 (Weeks 3 and 4).

If one or more dates are missing or incorrect in (i), allow 1 follow through mark in (ii) if the costs are unambiguous and appropriate.

- (d) What is the lowest possible total price that he could pay to see all 10 plays? [3]

$$6 \times \$15 + 3 \times \$18 + 1 \times \$24 = \underline{\$168}$$

Award 2 marks for 6 @ \$15, 3 @ \$18 and 1 @ \$24 incorrectly totalled, or not totalled.

OR award 1 mark each for evidence of appreciation of the following:

- There are 6 evenings on which (one or more) first performances occur;
- (It is not possible to see both Timon of Athens and Cymbeline during weeks 1 and 2, so) either Timon of Athens or Cymbeline must be seen during week 3 or week 4.

SC : award 1 mark for one incorrect categorization of play (e.g. 5@15, 4@18, 1@ 24 = \$171)

Page 8	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9694	32

(e) (i) Explain why Richard must go to see Timon of Athens first (on 18 July)? [1]

If he went on 24 July, he could only see King Lear by going to Corioli Park on consecutive evenings.

(ii) In what order will Richard see the 10 plays? [3]

(Timon of Athens)

The Tempest

Romeo and Juliet

As You Like It

Cymbeline

King Lear

Measure for Measure

Love's Labour's Lost

Othello

(Twelfth Night)

Deduct 1 mark:

for each duplication/omission of play seen

for each repetition of venue

if Twelfth Night is not seen last

if two plays' dates have been swapped.

- The Tempest must be 19 July / Friday Week 3 / second (because he will have gone to Corioli Park the previous evening to see Timon of Athens, and he is leaving Twelfth Night until last).
- Measure for Measure must be 24 July / Wednesday Week 4 / seventh (because Timon of Athens is first and he is leaving Twelfth Night until last).
- Cymbeline must be 22 July / Monday Week 4 / fifth (because Cymbeline on 25 July / Thursday Week 4 would mean going again to Elsinore Common the evening after Measure for Measure).
- King Lear must be 23 July / Tuesday Week 4 / sixth (because the dates for Twelfth Night and The Tempest have already been decided).
- Love's Labour's Lost must be 25 July / Thursday Week 4 / eighth (because the dates for Cymbeline and King Lear have already been decided).
- Romeo and Juliet must be 20 July / Saturday Week 3 / third (because the dates for Measure for Measure and Love's Labour's Lost have already been decided).
- As You Like It must be 21 July / Sunday Week 3 / fourth (because the date for Measure for Measure has already been decided, and he will have gone to Corioli Park the previous evening to see Romeo and Juliet).
- Othello must be 26 July / Friday Week 4 / ninth (because the date for The Tempest has already been decided, and he will have gone to Belmont Gardens the previous evening to see Love's Labour's Lost).