CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Level

MARK SCHEME for the October/November 2014 series

9694 THINKING SKILLS

9694/31 Paper 3 (Problem Analysis and Solution), maximum raw mark 50

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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)

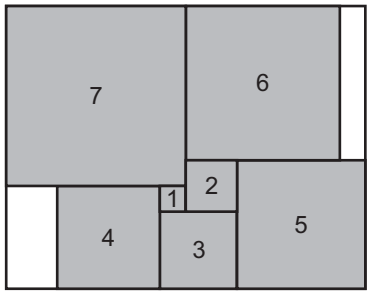
(ii) Draw a rearrangement of these pieces inside a 5 × 12 rectangle which would result in fewer pieces being able to move. [1]

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

There is no requirement to find the arrangement.
$19 \times 27 = 513$
$1 + 4 + 9 + 16 + 25 + 36 + 49 + 64 + 81 + 100 + 121 = 506$
$513 - 506 = 7$

(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.



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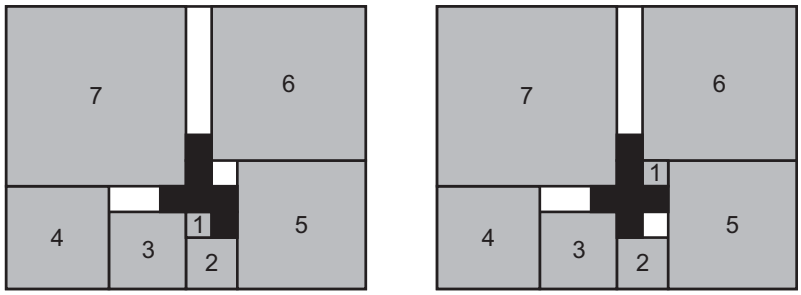
(d) Design such a 'filler' piece, and show where the smallest square should be placed relative to it. [2]

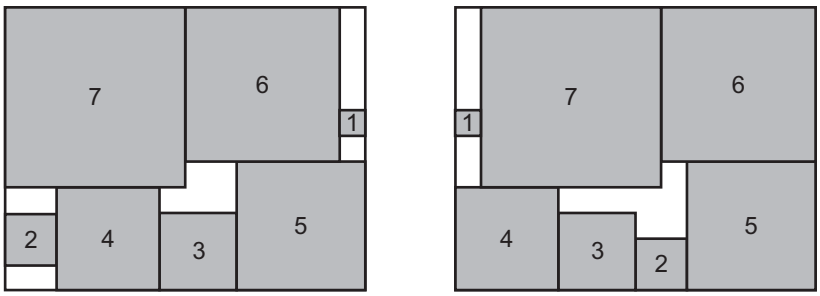
Examples of possible shapes are shown below. Award 1 mark for an appropriate filler, and a further mark for the placement of the smallest square.



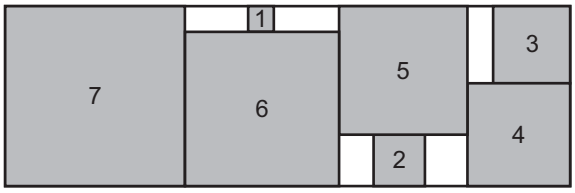
If 2 marks cannot be given, award one for an arrangement which allows only one item to move, or the six units are not used as a single piece, or it uses 7 units.

(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.



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2 (a) What 4-digit PIN would 8 7 + produce? [1]

8 5 2 9

(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 2 6 4 2? [1]

2 8 –

(d) List all the rules that would produce the PIN 6 6 6 6. [2]

6 0 +, **6 0 –**, **6 1** ×, **6 6** ×

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]

2 2 × and **2 7** × give 2 4 8 6
4 2 × and **4 7** × give 4 8 6 2
6 2 × and **6 7** × give 6 2 4 8
8 2 × and **8 7** × give 8 6 2 4
2 3 × and **2 8** × give 2 6 8 4
4 3 × and **4 8** × give 4 2 6 8
6 3 × and **6 8** × give 6 8 4 2
8 3 × and **8 8** × give 8 4 2 6

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 3 1 _ _ which would not be allowed (i.e. are produced by one of the possible rules)? [2]

3 1 7 9, 3 1 1 3, 3 1 5 9, 3 1 9 7

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 × 10 × 3) out of 10 000 PINs.

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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]

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

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

$2 \times 2 \times 2 = 8$

(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.

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(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]

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(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.

$1 \times \$18 + 4 \times \$24 = \$114$

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]

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

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)

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(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).

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