THINKING SKILLS **9694/31**

Paper 3 Problem Analysis and Solution **May/June 2015**

2 hours

Additional Materials: Electronic Calculator

READ THESE INSTRUCTIONS FIRST

An answer booklet is provided inside this question paper. You should follow the instructions on the front cover of the answer booklet. If you need additional answer paper ask the invigilator for a continuation booklet.

Answer **all** the questions.

Show your working. Marks may be awarded for correct steps towards a solution, even if the final answer is not correct. Marks may be lost if working needed to support an answer is not shown.

Calculators should be used where appropriate.

The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **7** printed pages, **1** blank page and **1** insert.

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Cambridge
International Examinations

[Turn over

1 Kerry has been commissioned to produce a design for the way that a wall will be painted. She has decided that the design will be created by painting the bricks of the wall so that any individual brick is painted in one particular colour. The area to be painted is shown below.
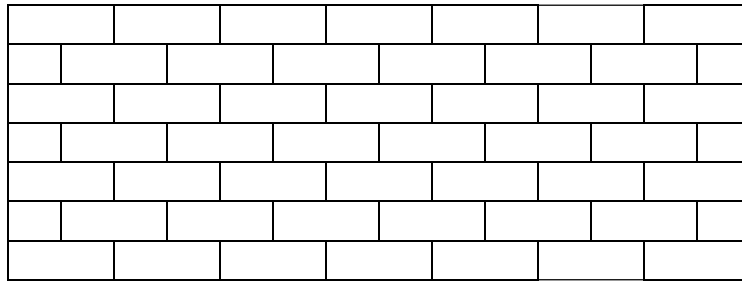
Kerry wants to make the design so that every brick touches **exactly one** other brick of the same colour. Some of the bricks at the edges are smaller but will be treated in the same way.

Before working on the full design Kerry works out a design for a smaller wall. The numbers in the bricks represent different colours.

(a) Explain why the small brick on the left in the second row must be coloured using colour 1. [1]

(b) Copy the diagram of the small wall and complete the design using only colours 1, 2 and 3. [1]

The diagram below shows how Kerry has started to colour the wall.

Each whole brick is identified by one capital and two lower case letters. For example, brick Bjk is coloured using colour 2 and brick Flm is coloured using colour 4. The smaller bricks are identified using one capital letter and one lower case letter, e.g. Ba.

Kerry will only use four colours for her design.

(c) What colour must brick Ckl be painted? Explain your answer. [1]

(d) Explain why bricks Acd and Bde must be the same colour. [2]

(e) Write down the colours of all of the bricks in row D, in order from left to right. [2]

(f) Draw all the different ways that Kerry can colour the set of bricks {Fa, Fbc, Gab, Gcd}. [3]

2 The Goscinny train company announced a significant decrease in the fare from Babaorum to Laudanum: a Single ticket in either direction would be reduced from $36 to $24.

The trains are never full, indeed there are always plenty of spare seats. Each ticket is only valid on a specified day, and no refunds are given for unused tickets.

What was not mentioned in the advertising was that they would no longer offer a Day Return ticket for $37, which allowed one trip in each direction. They would now simply charge $48 for a pair of $24 tickets for those wanting to go in both directions on the same day.

(a) Charles travels from Babaorum to Laudanum and back 5 times each week. He used to buy Day Return tickets every time. How much more does he now have to pay each week? [2]

Some travellers used to buy a Day Return even if they were not certain that they would use the return portion.

(b) What must the probability of needing the return portion have exceeded to have made it worthwhile to risk buying a Day Return ticket? [1]

It was thought that a few travellers who only needed a Single would buy a Day Return and sell the other portion to someone wanting just a Single in the other direction. After the change there was nothing to be gained from doing this.

(c) Before the change, what range of prices would have made both a saving for the person selling the half-used ticket, and a saving for the person buying it? [1]

(d) Assume that people only bought tickets they were certain to use themselves.

If people's requirements for journeys remained the same, what proportion of tickets would have to have been Singles to result in no change in the company's income? [2]

The numbers of tickets sold for travel on the Wednesday before the change were 20 Singles and 50 Day Returns, but there were 30 Singles sold separately and 76 Singles sold in pairs for the Wednesday after the change.

The number of passenger journeys was:

	From Babaorum	From Laudanum
Before	52	56
After	51	52

The inspectors checked that each passenger had a valid ticket.

(e) What was the change in the total income? [2]

(f) How many journeys were paid for but not used

    (i) on the Wednesday before the change? [1]

    (ii) on the Wednesday after the change? [1]

3 Claudel is a sculptress who is considering how she can best make a profit from her skills. She makes her calculations based on the following:

- She will work 200 hours in each calendar month.
- Each commission will earn her $900, after paying for materials, and takes 30 hours of sculpting work.
- Each commission also requires 10 hours of unskilled work. She can either do this herself or hire an assistant. The minimum wage for an assistant is $10 per hour.
- New commissions are always available.

(a) Show that Claudel is able to make $4500 per month if she does the unskilled work herself. [1]

When doing her calculations, Claudel decides to include the appropriate fraction of earnings for any commission that is only partially completed. For example, if she is halfway through a commission at the end of a month, she considers that as $450 earned. When paying an assistant, she treats the unskilled work in the same way.

(b) If Claudel hires a part-time assistant at the beginning of the first month, what is the maximum profit she can make by the end of that month? [3]

(c) What is the maximum that Claudel could pay an assistant per hour and ensure that she still makes the same amount of profit in the **first year** as she would on her own? [3]

Claudel decides that she will pay any unskilled assistants that she hires at the minimum wage of $10 per hour. She can either do the sculpting work herself, or pay skilled artisans at a rate of $15 per hour. Each assistant or artisan will work no more than 200 hours per calendar month. Each artisan requires continual support and quality control: supervising their work requires her to spend 12 minutes with each artisan per hour of work. This time is not spent sculpting – and therefore the artisan only spends 48 minutes sculpting in every hour (which amounts to 4 hours sculpting, in every 5 hours of paid work). Skilled artisans will not do unskilled work.

(d) How much profit could Claudel make per month if she employed one skilled artisan full-time and a part-time unskilled assistant? [3]

Claudel is considering hiring several artisans and doing no work herself other than supervising.

(e) How many artisans working full time would make it necessary to hire a second assistant? [2]

She discovers that if she pursues her plan, she will have to register as a 'small business'. The only extra cost involved in this process is that of registering employees, which will cost $1000 per year for each of her employees, paid in advance.

(f) Calculate the maximum profit Claudel could make per year. [3]

[Question 4 begins on the next page]

 [Turn over

4   Last month, in Juneau, Alaska, Pasta Masta opened its 500th restaurant in the USA. There are now Pasta Masta restaurants in 16 States.

To celebrate, Pasta Masta has been running the *Great State Giveaway* promotion, giving customers the opportunity to win up to $500. For every main course ordered, customers receive a sealed envelope containing one card, which could be a Prize Card, Wild Card or Bonus Card.

Prize Cards

TENN	SOTA	MING	KEN	ZONA	GAN	ORNIA	ALA	MONT
$270	$260	$250	$240	$230	$220	$210	$200	$190

MICHI	HOMA	ANA	RIDA	FLO	NEBRA	TUCKY	ESSEE	NEV
$180	$170	$160	$150	$140	$130	$120	$110	$100

CALIF	WYO	SKA	OKLA	MINNE	BAMA	ARI	VER	INDI
$90	$80	$70	$60	$50	$40	$30	$20	$10

Wild Cards

A–A	M–N–	–O–A
$0	$0	$0

Bonus Cards

+	+	+	+	+
$100	$80	$60	$40	$20

Each dash on these cards can represent any required letter.

A cash prize can be claimed by combining two cards to spell the name of one of the 16 States with Pasta Masta restaurants:

ALABAMA	MINNESOTA
ALASKA	MONTANA
ARIZONA	NEBRASKA
CALIFORNIA	NEVADA
FLORIDA	OKLAHOMA
INDIANA	TENNESSEE
KENTUCKY	VERMONT
MICHIGAN	WYOMING

The prize is the sum of the amounts on the two cards. It can be increased by the appropriate amount if the claimant also submits a bonus card. However, only one bonus card may be used with each claim.

(a) Mary has two cards that spell KENTUCKY, and a +$60 bonus card. How much can she claim? [1]

(b) Which State must be formed in order to be able to claim the top prize of $500? [1]

(c) What is the largest prize that can be claimed by combining a –O–A wild card with another card, but no bonus card? [1]

(d) (i) Which State can only be formed by combining a prize card and a wild card? [1]

    (ii) Which State can be formed by combining two wild cards? [1]

(e) Louis won $330 with FLO + RIDA + $40.

    Give **three** other examples of a single claim that would win $330. [3]

Tex and Carol have both been collecting *Great State Giveaway* cards.

Tex has ALA, INDI, ORNIA, VER, +$100 and +$80.
Carol has ANA, BAMA, ESSEE, NEBRA, –O–A and +$20.

They have eaten together at Pasta Masta this evening, and have just opened their envelopes. Tex has MONT and Carol has SKA, so both of them can now claim a prize.

(f) (i) How much can Tex claim? [1]

    (ii) How much can Carol claim? [1]

They realise that they can win more in total if they put all their cards together.

(g) What is the maximum they can claim in total? [3]

George has been collecting cards for a long time, but is still not able to claim a prize.

(h) What is the maximum number of different **prize cards** that someone could have and still not be able to claim a prize? [2]

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