Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

THINKING SKILLS	**9694/31**
Paper 3 Problem Analysis and Solution	**May/June 2018**
	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.

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[Turn over

1 David is assembling an examination paper which must consist of exactly 10 questions and a total of 50 marks. He has a question bank of prepared questions of four types, each of which has a fixed number of marks.

Question type	Number of marks
Short	2
Procedural	4
Conceptual	5
Long	10

(a) Explain why it is impossible for David to use more than three Long questions. [2]

David wants to make sure that there is at least one question of each type. He decides to use just one Long question.

(b) State how many Short, Procedural and Conceptual questions he must use. [2]

David now receives an email from the Chief Examiner:

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David

Sorry, I forgot to say that the total number of Short and Procedural
questions must be larger than the total number of Conceptual and Long
questions.

Please make sure that your examination paper takes account of this.

Chief Examiner
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David now decides to use exactly two Long questions. He still wants to make sure that there is at least one question of each type.

(c) State how many Short, Procedural and Conceptual questions he must use now. [2]

David now receives another email from the Chief Examiner:

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David

Due to the difficulties in assembling examination papers, I have now
decided that it is permissible for a paper to have no Conceptual
questions, provided that there are at least two Long questions. The
total number of Short and Procedural questions on any paper must
still always be larger than the total number of Conceptual and Long
questions.

Please assemble as many examination papers as you can using the
questions available in the question bank.

Good Luck!

Chief Examiner
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David looks in the question bank to see how many of each kind of question he has:

Question type	Number of questions in the bank
Short	16
Procedural	27
Conceptual	18
Long	16

Each question can only be used once. He decides that he will use exactly three Long questions for each examination paper.

(d) Explain why the maximum number of separate examination papers David can assemble from this bank is four. [2]

David realises that he could use different numbers of Long questions in different papers.

(e) What is the maximum number of separate examination papers he can assemble from this bank? [2]

2 Starting in January, Clarissa took up the offer of a subscription for printer ink. Instead of having to pay each time an ink cartridge was empty, she signed up to a deal which claimed to provide "up to 50 pages per calendar month for $2". Any of these pages that are unused from one month may be used in the next month, but not after that. If more pages are used they are charged at $1 for at most 10 extra pages. A warning email is sent if there are only 4 pages left to print before an additional charge would be made.

(a) To the nearest cent, what would be the prices per page for 32, for 43, and for 54 pages in the first month of a subscription? [2]

Clarissa kept a note of the pages she used each month. Occasionally she forgot to record some of the pages, but she is sure that it was never more than two pages in a month.

	January	February	March	April	May
Pages noted	48	51	43	55	44
Warning date	25th	27th	none	28th	none
Cost	$3	$3	$2	$2	$2

Clarissa was not sure if the deal had been correctly translated into English. In particular, she suspected that the phrase "up to 50" might have meant "fewer than 50", instead of "no more than 50".

(b) Explain how Clarissa can tell which of these two meanings does in fact apply. [2]

(c) Clarissa paid the additional charge of $1 twice in this period.

Can any unused pages from the extra 10 be used in the next month? Use information from the table to justify your answer. [2]

At the beginning of June, Clarissa upgraded her subscription. The charges remained the same, but she would now be told how many pages would carry over to the next month. At the end of June, she was told that 5 pages would be carried over into July.

Clarissa was certain that she had printed exactly 36 pages in July, and so was surprised to find that she was charged $3. She had not noticed her warning email.

Her friend Gill explained that, with the new subscription, all documents were treated as two-sided; therefore, if any document had an odd number of pages a blank page would be included at the end. The blank pages also count against the allowance.

(d) (i) What is the minimum number of blank pages in July? [1]

(ii) What is the maximum number of three-page documents that Clarissa could have printed in July? [3]

3 Leon is an architect and he uses coloured plastic building blocks to help him model new housing developments. Each building block measures 2 cm by 1 cm by 1 cm.

He represents a house by building a 'shell' which consists only of the four outside walls of a rectangular box (with no floor and no roof). The base of a model of a Type A house measures 8 cm by 4 cm and the walls are 6 cm high.

(a) Use a diagram of the shell, seen from above, to show that 60 blocks are needed to model a Type A house. [1]

The base of a model of a Type B house measures 5 cm by 5 cm and the walls are 5 cm high.

(b) How many building blocks are needed to model a Type B house? [1]

In Leon's model of the housing development, *Parklands*, each Type A house has a garden adjacent to it with area 16 square centimetres, and each Type B house has a garden adjacent to it with area 10 square centimetres.

Red blocks are used to model Type A houses and blue blocks are used to model Type B houses. The gardens are modelled with green building blocks, covering the entire area of the garden. Building blocks are sold in packets of a single colour, in various quantities, as shown in the following table.

Number of blocks per packet	Cost
50	$6
200	$22
500	$55

(c) What is the least total cost of the blocks needed for 20 Type A houses and 20 Type B houses, each with their garden? [3]

Leon has $200 to spend on red blocks.

(d) What is the maximum number of Type A houses (without their gardens) that Leon can model with this money? [2]

In Leon's model, 1 square centimetre represents 4 square metres.

(e) In the actual development, what will be the area occupied by 20 Type A houses and 20 Type B houses, all with their gardens? [2]
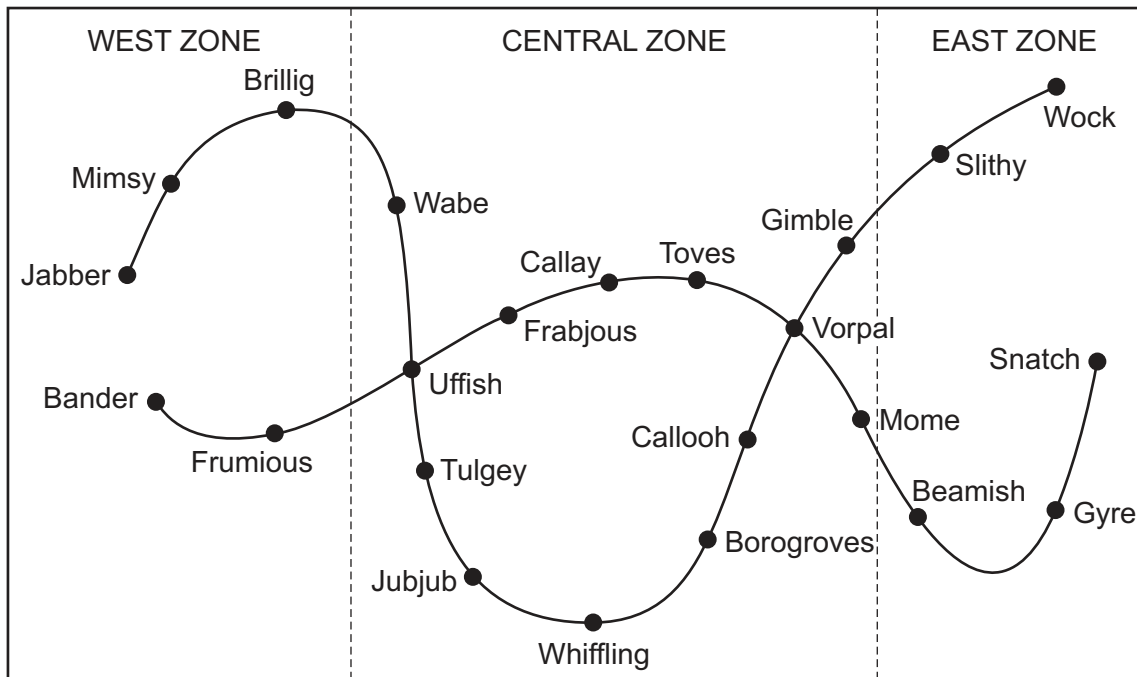
In another housing development, *Grasslands*, Leon introduces a new type of house, Type C. Each Type C model house has a base area of 50 square centimetres and a garden of 50 square centimetres. The actual area of *Grasslands* is 30 000 square metres.

Leon wants there to be as many houses as possible, but regulations require that they must be built in sets of 10: in every set, 5 must be Type A, 4 must be Type B and 1 must be Type C. Any land not occupied by houses and their gardens will be used for car parking.

(f) (i) How many houses of each type will there be in *Grasslands*? [4]

   (ii) What area of land will be used for car parking in *Grasslands*? [2]

4 The *Quadrille* is the underground railway system of the city of Lewcar. It has two lines: the Jabber–Wock line and the Bander–Snatch line.

This is a map of the *Quadrille*.

Trains on the Jabber–Wock line depart from both Jabber and Wock at 06:20 and every 10 minutes throughout the day until 23:10.

Trains on the Bander–Snatch line depart from both Bander and Snatch at 06:30 and every 15 minutes throughout the day until 23:15.

On both lines, trains depart from each station 3 minutes after departure from the previous station. Trains arrive at Wock, Snatch, Jabber and Bander 2 minutes after departure from Slithy, Gyre, Mimsy and Frumious respectively.

The two lines are close enough to each other at Uffish and Vorpal that it is always possible to change from one train to another when both have the same departure time.

All tickets are for single journeys only. The cost of a journey depends upon the zones of departure and arrival.

<u>Standard Journey Fares</u>

		To:		
		West zone	Central zone	East zone
	West zone	$2.50	$3.50	$4.00
From:	Central zone	$3.50	$3.00	$3.50
	East zone	$4.00	$3.50	$2.50

Note: It is permissible to change lines during a journey.

There are three types of *Quadrille* Discount Cards available. These are pre-paid cards which offer discounted travel.

Card	Cost	Discount
Lobster	$25	30% off standard fares
Turtle	$50	40% off standard fares
Porpoise	$100	50% off standard fares

There is no charge for the cards themselves, so the whole amount paid for a card is credit available to pay for journeys. However, on any day that a card is used, the first journey of the day will cost an additional $1.00. This means that, for instance, a Lobster Card holder who makes a number of journeys within the Central zone on the same day will be charged $3.10 for the first journey and $2.10 for each of the others.

Purchasers of *Quadrille* Discount Cards also need to be aware that cards cannot be used for part payment for a journey, so if the credit remaining falls below the minimum journey fare, that credit becomes unavailable for use and is lost.

(a) What is the latest time each day that any train arrives at its final destination? [2]

(b) How many trains in total are there on the lines between Jabber and Wock and between Bander and Snatch at 11:05 each day? [2]

(c) Charles only uses the *Quadrille* to travel to and from work, making the journey from Brillig to Callay and back again every day. He finds that he makes considerable savings by using a Porpoise Card, even though he is not able to make use of all the credit.

    (i) How many days of travel does Charles get from one Porpoise Card? [3]

    (ii) How much does he save, compared with paying standard fares, during this time? [1]

(d) Yesterday Alice used her Turtle Card to pay for three journeys on the *Quadrille*. First she travelled from Wabe to Slithy. Later she travelled from Slithy to Bander, changing at Vorpal, and finally from Bander back to Wabe.

    (i) What was the total cost of Alice's three journeys? [2]

For her journey to Bander, Alice was on the platform at Slithy at 14:37. She boarded the first available train at both Slithy and Vorpal.

    (ii) At what time did her train arrive at Bander? [3]

    (iii) What would have been the earliest time that she could have arrived at Bander if she had changed at Uffish instead of Vorpal? [2]

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