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**THINKING SKILLS**

**9694/31**

Paper 3 Problem Analysis and Solution

**October/November 2017**

**2 hours**

Additional Materials:      Electronic Calculator

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**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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This document consists of **9** printed pages, **3** blank pages and **1** insert.

- 1 Five days every week, Faridah sells ice cream at the beach from a box on the back of her bicycle. Each morning she cycles from her home to the beach with the ice cream, and some of it melts, the liquid dripping out of the box onto the road as she travels. When she gets to the beach she sells all of her remaining ice cream and then cycles back home.

There are two routes that Faridah can take to the beach. The direct route takes 10 minutes but involves cycling through the sunshine. The scenic route takes 25 minutes but stays mainly in the shade. The ice cream melts more quickly on the direct route, and Faridah finds that she loses 60 grams for every minute of the journey, whereas on the scenic route she loses only 20 grams for every minute of the journey.

- (a) Which route leads to the smaller total loss of ice cream? [2]

Faridah is considering buying a better-insulated box for her bicycle. The new box would lead to a loss of only 10 grams per minute on the direct route and only 5 grams per minute on the scenic route. Unfortunately, the new box would be a lot heavier, and each route would now take Faridah twice as long to travel as it did before.

Faridah decides that she will always use the route which results in the smaller loss of ice cream.

- (b) How much ice cream could Faridah save each day by using the better-insulated box? [1]

Buying and fitting the new box to her bicycle would cost Faridah \$15. She sells every 600 grams of ice cream for \$1.

- (c) How many weeks would it take her to recover this cost from the ice cream that she saves? [2]

Faridah decides **not** to buy the better-insulated box. Iman suggests that she should take the bus to the beach each day and walk home. The bus journey would cost \$0.80 and the ice cream loss on the bus journey would be 1 gram per minute.

- (d) What is the longest possible time that the bus journey could take if Faridah is to make more money than she would by cycling? [2]

Faridah decides to continue using her bicycle, because she enjoys the exercise. However, she considers changing to a better-quality ice cream. She can sell every 500 grams of this ice cream for \$1, but unfortunately it melts more quickly. She will lose 80 grams per minute on the direct route and 40 grams per minute on the scenic route.

Faridah wants to know how much ice cream she would need to start with each day in order to make more money by changing to the better-quality ice cream. She knows that there will be a quantity of ice cream for which she will make the same amount of money, whichever type she takes.

- (e) What is this quantity? [3]

**[Question 2 begins on the next page]**

- 2 Universal Time (UT) is the standard time at  $0^\circ$  longitude (which is the imaginary line running from pole to pole through Greenwich, London, UK). Throughout the world, the local time is defined relative to UT.

The following table shows seven regions of Australia in 2009 and the local time in each region relative to UT. For example, the time in New South Wales is UT + 10 hours, so when it is 08:00 in London it is 18:00 in New South Wales.

<i>Region</i>	<i>Abbreviation</i>	<i>Time</i>
Western Australia	WA	UT + 8 hours
Northern Territory	NT	UT + 9.5 hours
South Australia	SA	UT + 9.5 hours
Queensland	QLD	UT + 10 hours
New South Wales	NSW	UT + 10 hours
Victoria	VIC	UT + 10 hours
Tasmania	TAS	UT + 10 hours

During some months, Daylight Saving Time (DST) is in operation in four of the regions: NSW, VIC, TAS and SA. Clocks are put forward by one hour on the first Sunday in October and back by one hour on the first Sunday in April, when the period of DST ends. The changes are made a few hours after midnight.

- (a) How many different times are there across these seven regions of Australia in November? [1]

Amy leaves Western Australia at 13:00 local time on 20th December and makes a 12-hour journey to visit her parents in South Australia.

- (b) What is the local date and time when she arrives? [1]

In London, British Summer Time (BST) applies in some months. Clocks are put forward by one hour on the last Sunday in March and then back by one hour on the last Sunday in October.

Beryl catches a flight from London to Perth in Western Australia at 09:30 on 1st July. The flight time is 18 hours 55 minutes.

- (c) What is the local date and time when Beryl arrives in Perth? [2]

In 2009, 1st April was on a Wednesday and 1st October was on a Thursday. (There are 31 days in each of March and October.)

Frank lives in London and he rings his mother in Sydney (NSW) every day at 09:00 local London time.

- (d) (i) On how many days in 2009 were the clocks in both London and Sydney one hour forward at the time that Frank rang his mother? [2]
- (ii) What is the greatest number of days in any one year for which clocks in both London and Sydney are one hour forward at the time that Frank rings his mother? [1]

In New York, USA, the time is UT – 5 hours and Daylight Saving Time operates from the second Sunday in March until the first Sunday in November, putting the clocks one hour forward.

The following table shows the time to fly between various cities.

		TO			
		New York	London	Perth	Sydney
FROM	New York	–	7 h 27 min	22 h 47 min	21 h 46 min
	London	7 h 57 min	–	18 h 55 min	22 h 30 min
	Perth	24 h 35 min	20 h 35 min	–	4 h 50 min
	Sydney	22 h 50 min	23 h 15 min	4 h 50 min	–

Gloria intends to travel from New York to Sydney, via London and Perth. She will take three separate flights, and spend at most 12 hours in each of London and Perth. She will leave New York on 15th March at 22:00 local time.

(e) What is the latest local date and time when Gloria would expect to arrive in Sydney? [3]

- 3 A Nefarious Secretive Agency, in a remote location which is not served by public transport, has a staff car park. For security reasons, visitors must use a separate car park. The agency will not publish how many people work there, but Boris thinks he can make a reasonable estimate.

He knows that the non-shiftworking staff work fixed hours from 09:00 to 17:00.

There are three teams of shiftworking staff on duty each day: the shifts are from midnight to 08:00, 08:00 to 16:00, and 16:00 to midnight. Each of the shifts requires the same number of staff.

He counts the cars in the car parks at various times.

	<i>Visitors 10:00</i>	<i>Staff 10:00</i>	<i>Staff 22:00</i>	<i>Staff midnight</i>
Tuesday	103	10654	85	170
Wednesday	106	10632	84	169
Thursday	89	10649	85	168

All staff travel by car. By looking at cars at different times of day, Boris observes that cars have 1 shiftworker, or an average of 1.1 non-shiftworkers.

Sometimes one or two people are late arriving for a shift, or leave early because they are sick.

- (a) (i) How many people began the midnight to 08:00 shift on Friday morning? [1]
- (ii) What would be Boris's best estimate for the number of staff required for each shift at this agency? [1]
- (iii) Estimate the number of non-shiftworking staff working at the agency on an average day. [3]

Boris is aware that non-shiftworking staff may be away from the office, e.g. on holiday, sick, or visiting somewhere else.

Some figures for a similar agency, the Conspicuous Independent Agency, are published. It has a total of 3233 staff. For every 5 positions needing a shiftworker to be on duty 24 hours a day, a total of 27 people need to be employed in order to cover leave, training, sickness etc.

On the same days as above, this agency's car parking had

	<i>Visitors 10:00</i>	<i>Staff 10:00</i>	<i>Staff 22:00</i>	<i>Staff midnight</i>
Tuesday	14	2730	10	20
Wednesday	22	2733	10	19
Thursday	11	2727	10	20

It can be seen that it has a lower number of staff, and also a lower proportion of shiftworkers.

- (b) Identify **two** assumptions that Boris will need to make regarding the similarities between the two agencies, so that he can use figures from one agency to make estimates about the other. [2]

- (c) (i) Estimate how many **non-shiftworkers** the Conspicuous Independent Agency employs. [2]
- (ii) Estimate how many non-shiftworking staff of this agency are away from their office on average over this period. [2]
- (d) Estimate how many staff the Nefarious Secretive Agency employs in total. [4]  
Ensure that all numbers shown in your working are identified.

- 4 *The Proverbs* were a successful band in the 1980s, whose songs frequently made it into the music charts. The charts were published each week, with particular emphasis on which 10 songs were the most popular that week – known as the Top Ten. Five of *The Proverbs*' songs managed to reach Number One.

The table below shows all sixteen of *The Proverbs*' Top Ten hits, in the order that they were released.

<i>Song title</i>	<i>Running time (min:sec)</i>	<i>Year</i>	<i>Highest position reached</i>	<i>Number of weeks in the Top Ten</i>	<i>Number of weeks at Number One</i>
Too Many Cooks	3:40	1982	3rd	8	–
Hope Springs Eternal	4:30	1982	3rd	6	–
No Smoke Without Fire	4:10	1983	6th	5	–
First Things First	3:50	1983	1st	11	5
Sauce For The Goose	3:30	1983	1st	10	2
Half A Loaf	3:40	1983	2nd	8	–
Red Sky At Night	3:20	1984	4th	5	–
A Stitch In Time	4:20	1984	2nd	7	–
The Last Straw	4:30	1984	1st	10	3
Safety In Numbers	4:10	1984	3rd	8	–
History Repeats Itself	3:30	1985	1st	11	8
Thicker Than Water	5:20	1985	2nd	12	–
A Friend In Need	4:00	1985	3rd	9	–
Empty Vessels	3:30	1986	1st	10	4
Better Late Than Never	4:40	1986	3rd	7	–
Spilt Milk	3:20	1987	7th	3	–

The band is currently taking part in an Eighties Revival tour. On each night they have a 35-minute slot in the show, during which time they perform seven songs chosen from their Top Ten hits.

Before the tour began, the band made the following decisions regarding their performances:

- No two nights will feature the same seven songs.
- The songs will always be performed in order of their release.
- No performance will contain more than two songs that were released in the same year.
- They will not leave any song out of their performances for more than three days consecutively.
- They will not perform any song for more than three days consecutively.
- To allow time to interact with the audience, the total running time of the seven songs will never be more than 29 minutes.



Tonight is the 10th night of the tour. They have kept a record of their performances so far, identifying each song using a key word, as follows:

<i>1st Night</i>	Cooks	Smoke	Sky	Straw	History	Water	Vessels
<i>2nd Night</i>	Cooks	Goose	Loaf	Stitch	Friend	Late	Milk
<i>3rd Night</i>	Hope	Goose	Loaf	Stitch	Straw	Friend	Vessels
<i>4th Night</i>	Smoke	First	Sky	Safety	Water	Vessels	Milk
<i>5th Night</i>	Hope	First	Loaf	Sky	History	Water	Late
<i>6th Night</i>	Cooks	First	Goose	Stitch	Water	Late	Milk
<i>7th Night</i>	Hope	Smoke	Loaf	Straw	Safety	Friend	Vessels
<i>8th Night</i>	Hope	First	Goose	Straw	History	Friend	Milk
<i>9th Night</i>	Hope	Smoke	Goose	Sky	Straw	Vessels	Milk

- (a) Which of the band's Number One hits has the longest running time? [1]

Each one of the hits was only in the Top Ten during the year it was released, and at no time were two of them in the Top Ten at the same time.

- (b) In which year did *The Proverbs'* hits spend the greatest number of weeks in the Top Ten? [1]

- (c) What is the greatest number of weeks during 1985 that *The Proverbs'* hits could have been 2nd in the charts? [2]

- (d) (i) Which two songs did the band not perform until the 4th night of the tour? [2]

- (ii) On which night did they perform only one of their Number One hits? [1]

- (e) On the 9th night, how much of the band's 35-minute slot was used for interaction with the audience? [2]

The members of the band are discussing which seven songs they will perform tonight. Solomon has suggested that they should perform all five of their Number One hits and two of the three hits which reached a highest position of 2nd.

- (f) (i) Give **two** reasons why this suggestion is **not** acceptable, even though the total time of any seven of these eight songs is less than 29 minutes. [2]

- (ii) Construct a running order of seven songs for tonight that the band would accept. [4]





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