ACKNOWLEDGEMENTS

Question 10 Data source: Bureau of Infrastructure, Transport and Regional Economics (BITRE), Health impacts of transport emissions in Australia: Economic costs. BITRE working paper 63, Published by Commonwealth of Australia 2005. http://www.bitre.gov.au/publications/94/Files/wp63.pdf Downloaded Feb 2010

Question 12 Data source: Fuelwatch, West Australian Government, Department of Commerce. http://www.fuelwatch.wa.gov.au, downloaded Feb - March, 2010

Question 14 Data source: Bureau of Infrastructure, Transport and Regional Economics (BITRE), Australian Transport Statistics Yearbook 2009. http://www.bitre.gov.au/publications/10/Files/BITRE_TRANSPORT_STATS_YEARBOOK_2009.pdf

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Government of Western Australia
Curriculum Council

WACE
Western Australian Certificate of Education

Western Australian Certificate of Education
Examination, 2010

Question/Answer Booklet

MATHEMATICS 3A/3B

Section Two: Calculator-assumed

Please place your student identification label in this box

Student Number: In figures | | | | | | | | |

In words _____

_____

Time allowed for this section
Reading time before commencing work: ten minutes
Working time for this section: one hundred minutes

Materials required/recommended for this section
To be provided by the supervisor
This Question/Answer Booklet
Formula Sheet (retained from Section One)

To be provided by the candidate
Standard items: pens, pencils, pencil sharpener, eraser, correction fluid/tape, ruler, highlighters

Special items: drawing instruments, templates, notes on two unfolded sheets of A4 paper, and up to three calculators satisfying the conditions set by the Curriculum Council for this examination

Important note to candidates
No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

 Ref: 10-134

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Working time (minutes)	Marks available	Percentage of exam
Section One: Calculator-free	8	8	50	40	
Section Two: Calculator-assumed	8	8	100	80	
			Total	120	100

Instructions to candidates

1. The rules for the conduct of Western Australian external examinations are detailed in the *Year 12 Information Handbook 2010*. Sitting this examination implies that you agree to abide by these rules.

2. Write your answers in the spaces provided in this Question/Answer Booklet. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
   - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
   - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

3. **Show all your working clearly.** Your working should be in sufficient detail to allow your answers to be checked readily and for marks to be awarded for reasoning. Incorrect answers given without supporting reasoning cannot be allocated any marks. For any question or part question worth more than two marks, valid working or justification is required to receive full marks. If you repeat an answer to any question, ensure that you cancel the answer you do not wish to have marked.

4. It is recommended that you **do not use pencil**, except in diagrams.

See next page

Additional working space

Question number: _____

Additional working space

Question number: _____

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Section Two: Calculator-assumed **(80 Marks)**

This section has **eight (8)** questions. Answer **all** questions. Write your answers in the spaces provided.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
- Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Working time: 100 minutes.

Question 9 **(5 marks)**

In order to buy a new hi-fi system, Alex negotiated a personal loan of $4000 with repayments of $400 to be made at the end of each month. The table below shows the amount owing at the start of each month (A_n), the interest payable for that month (I), the repayment (R) and the amount owing at the end of each month (A_{n+1}) for the first eight months.

Month (n)	Amount owing at the start of the month (A_n)	Interest (I)	Repayment (R)	Amount owing at the end of the month (A_{n+1})
1	$4000.00	$30.00	$400.00	$3630.00
2	$3630.00	$27.23	$400.00	$3257.23
3	$3257.23	$24.43	$400.00	$2881.65
4	$2881.65	$21.61	$400.00	$2503.27
5	$2503.27	$18.77	$400.00	$2122.04
6	$2122.04	$15.92	$400.00	$1737.96
7	$1737.96	$13.03	$400.00	$1350.99
8	$1350.99	$10.13	$400.00	$961.12
9				
10				
11				
12				

(a) What is the monthly rate of interest? (1 mark)

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(b) Write a recursive rule to determine the amount owing at the end of each month. (2 marks)

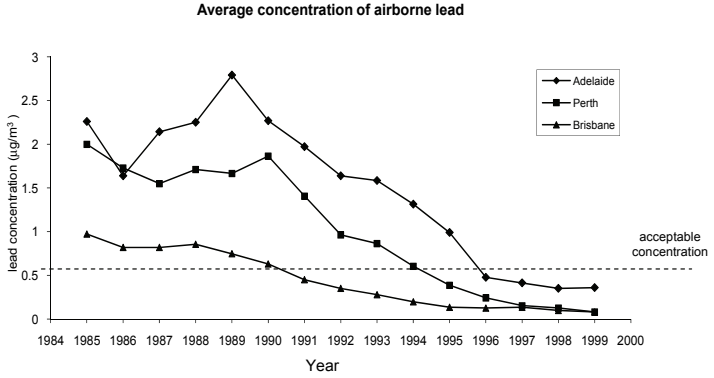
(c) What is the amount of the final payment that Alex will make? (1 mark)

(d) What is the total amount paid by Alex for the hi-fi system? (1 mark)

See next page

Question 10 **(14 marks)**

Air pollution due to airborne lead has been reduced in Australia because of the requirement, since 1985, that new petrol-powered cars must use unleaded petrol. Data for air pollution from airborne lead in Adelaide, Perth and Brisbane for the years 1985–1999 are graphed below.



The airborne lead data for Perth for 1993–1999 are tabulated below.

Year (x)	1993	1994	1995	1996	1997	1998	1999
Average concentration of airborne lead ($\mu g/m^3$) (y)	0.86	0.60	0.39	0.24	0.15	0.13	0.08

(a) Determine the correlation coefficient for the data in the table above. (1 mark)

(b) Write down the least squares regression model for these data, correct to five significant figures. (2 marks)

See next page

(c) The fertiliser costs the nursery \$3.60 per kg and the weedkiller costs \$2.40 per kg. Both types of lawn treatment are sold at \$6.00 per bag. How much profit is made on a bag of each type? (3 marks)

(d) If all Type A and Type B lawn treatments produced can be sold, how many bags of each should be made up to ensure maximum profit? (3 marks)

End of questions

Question 16 **(13 marks)**

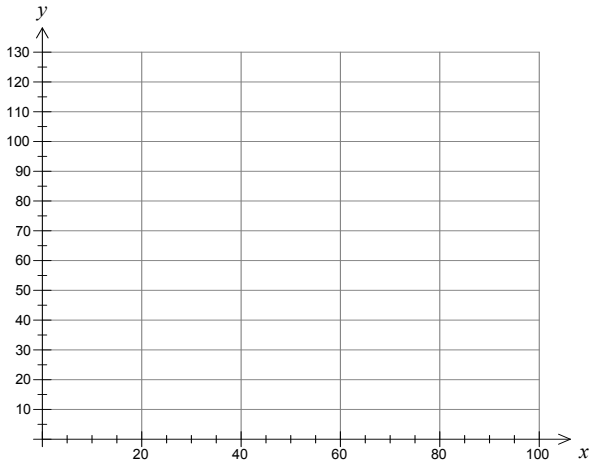
The owner of a small nursery makes two types of lawn treatment. Type A contains (by weight) two parts of fertiliser to one part of weedkiller and Type B contains one part of fertiliser to three parts of weedkiller. He sells both types in one-kilogram bags.

(a) Calculate the weights of both the fertiliser and weedkiller in Type A and Type B bags. (2 marks)

(b) The owner of the nursery has 30 kg of fertiliser and 30 kg of weedkiller available from which to make x bags of Type A and y bags of Type B lawn treatments.

(i) Write two inequalities involving x and y, other than $x \geq 0$ and $y \geq 0$. (2 marks)

(ii) Draw the two inequalities from (b) (i) on the graph and shade the feasible region. (3 marks)



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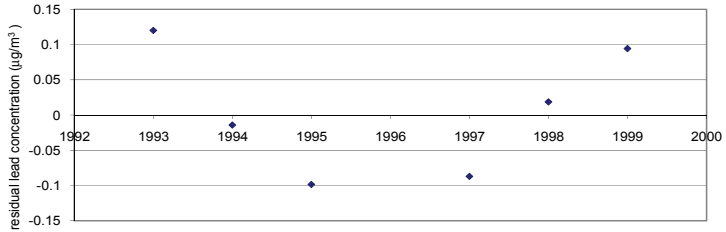
(c) The table only includes data for Perth for 1993–1999, whereas the graph shows data for 1985–1999. Describe how cropping the data has affected your answers to (a) and (b). (2 marks)

(d) Calculate the residual lead concentration for 1996 using the regression model from (b) and plot this residual on the graph below. Show all your working. (3 marks)

Residual plot, annual average airborne lead concentration, Perth



(e) Assess whether the 1993–1999 data are modelled well by the regression line. Give your reasoning. (2 marks)

See next page

(f) A scientist suggests the following recursion model for the Perth lead-concentration data:

$T_n = 0.6718\, T_{n-1}$, $T_1 = 0.86$, where $n = 1$ stands for 1993, $n = 2$ stands for 1994, and so on.

Assess whether this recursion model is appropriate for predicting the 2000 lead concentration in Perth air. Give your reasoning and state any assumptions you made in your assessment of the situation. (4 marks)

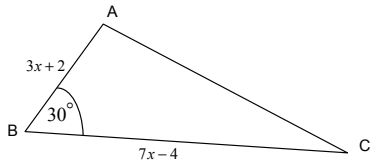
See next page

(b) From the top of a vertical cliff, a boat is seen out at sea. The angle of depression of the boat from the top of the cliff is 14°. After the boat has moved a further 600 metres directly away from the cliff, this angle has decreased to 9.5°. Determine the height of the cliff, to the nearest metre. Show your working. (4 marks)

See next page

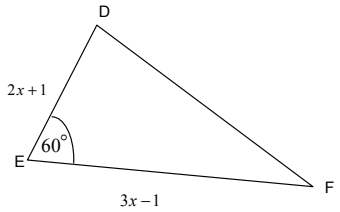
Question 15 **(8 marks)**

(a) In triangle ABC, the size of ∠ABC =30°, the side length AB = $3x+2$ and the side length BC = $7x-4$.



(i) Write an expression in terms of x for the area of this triangle. (1 mark)

In triangle DEF, the size of ∠ DEF = 60°, the side length DE = $2x+1$ and the side length EF = $3x-1$.



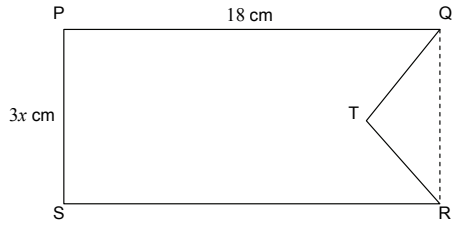
(ii) Write an expression in terms of x for the length of the side DF. (1 mark)

(iii) Given that the numerical value of the area of triangle ABC is five more than the numerical value of the perimeter of triangle DEF when the value of x is the same for both triangles, determine the value of x. (2 marks)

See next page

Question 11 **(6 marks)**

The figure shown in the diagram is obtained by removing the triangle QRT from the rectangle PQRS. The size of ∠QTR = 90° and QT = TR. PQ = 18 cm and PS = $3x$ cm.



It can be shown that QT = $\frac{3x\sqrt{2}}{2}$ cm.

(a) Verify that the area, A, of the figure PQTRS is given by
$A = 54x - \frac{9x^2}{4}$ cm^2. (2 marks)

(b) Using calculus techniques, find the value of x that will maximise the area of PQTRS. State the maximum area. (4 marks)

See next page

Question 12 **(7 marks)**

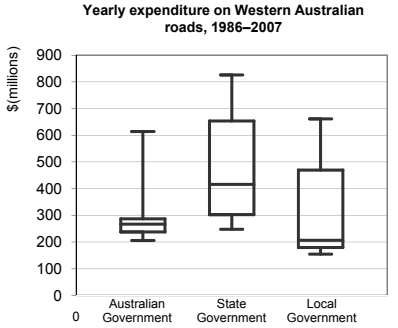
The Western Australian Government collects the prices of petrol every day from all petrol outlets in Western Australia.

On a particular day, the prices of unleaded petrol from outlets in Perth were close to being normally distributed, with 95% of outlets charging between 120.2 c/L and 129.8 c/L and 2.5% of outlets charging more than 129.8 c/L

(a) Estimate the mean price of unleaded petrol in Perth on that day. Show your reasoning. (2 marks)

(b) Estimate the percentage of outlets charging less than 126 c/L for unleaded petrol on that day. (2 marks)

(c) The boxplots for the yearly amounts spent by the Australian, State and local governments during 1986–2007 are displayed below.



Refer to the boxplots to answer the following questions about the 1986–2007 expenditure on Western Australian roads.

(i) Did the amounts spent by the Australian Government tend to be more or less than the amounts spent by the State Government? Give your reasoning. (3 marks)

(ii) An auditor stated that 'it is difficult to judge from the boxplots whether the amounts spent by the Australian Government tended to be more or less than the amounts spent by local governments'. Do you agree with this judgement? Give a reason for your answer. (2 marks)

(iii) Which level of government tended to be most consistent with the amounts spent – Australian, State or local government? Give your reasoning. (2 marks)

Question 14 **(13 marks)**

Most roads in Western Australia are built by the Australian, State or local governments. The table shows the amounts that the Australian Government spent on Western Australian roads for the years 1986–2007. The amounts have been adjusted for inflation so they can be compared.

Spending ($million) by the Australian Government on Western Australian roads

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
$(million)	351	313	289	284	273	273	287	339	229	223	252

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
$(million)	261	256	270	238	206	264	226	226	246	614	301

The minimum and maximum amounts spent were $206 million (2001) and $614 million (2006) respectively. The amounts in $(million) are listed in ascending order below.

$(million)	206	223	226	226	229	238	246	252	256	261	264
	270	273	273	284	287	289	301	313	339	351	614

(a) Calculate the other statistics that would be required to construct a boxplot for the amounts spent. (3 marks)

(b) It appears that the amount of $614 million may be an outlier for the above data. Verify whether this is the case. Show your working. (3 marks)

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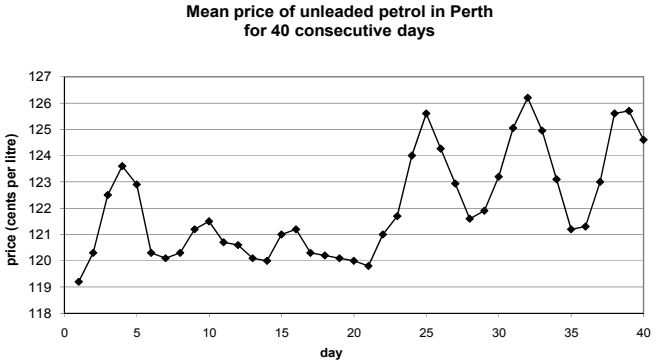
The graph below shows the mean price of unleaded petrol in Perth for 40 consecutive days early in 2010.



(c) Is a six-, seven-, eight- or nine-point moving average appropriate for identifying the trend in the mean prices? Justify your answer. (2 marks)

(d) The first 15 data points from the graph are tabulated below. Calculate the appropriate moving average for day 10. (1 mark)

Day	c/L
1	119.2
2	120.3
3	122.5
4	123.6
5	122.9
6	120.3
7	120.1
8	120.3
9	121.2
10	121.5
11	120.7
12	120.6
13	120.1
14	120.0
15	121.0

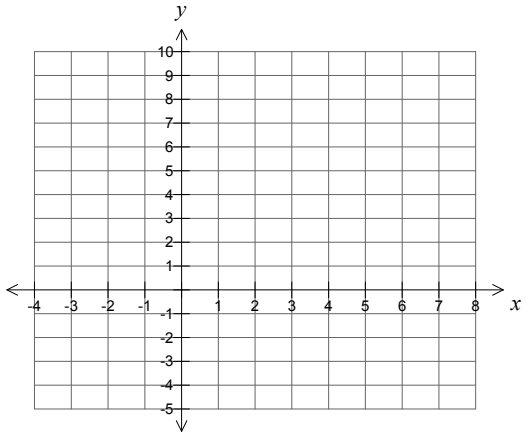
See next page

Question 13 **(14 marks)**

Consider the function $y = -\frac{1}{2}x^2 + 2x + 6$.

(a) Using calculus techniques, determine the coordinates of the turning point for the function. (3 marks)

(b) Sketch the curve for $-3 \le x \le 7$ on the axes below labelling all intercepts and the turning point. (4 marks)



(c) (i) Determine the equations of the tangents at the x-intercepts. Show your working. (4 marks)

(ii) Determine the coordinates of point C, the point of intersection of the tangents in (c)(i). (1 mark)

(d) If the function is translated 4 units to the left, state the new coordinates of the x and y intercepts. (2 marks)