Semester 2 (Units 3 and 4) Examination, 2016

Question/Answer Booklet

MATHEMATICS APPLICATIONS

Section One: Calculator-free

Student Name/Number: _____

Teacher Name: _____

Time allowed for this section
Reading time before commencing work: five minutes
Working time for this section: fifty minutes

Materials required/recommended for this section
To be provided by the supervisor: This Question/Answer Booklet
        Formula Sheet

To be provided by the candidate:
Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: nil

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.

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	6	6	50	51	35
Section Two: Calculator-assumed	10	10	100	109	65
					100

Instructions to candidates

1. The rules for the conduct of these exams are detailed in the *College assessment policy*. Sitting this examination implies that you agree to abide by these rules.

2. Write your answers in this Question/Answer Booklet.

3. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

4. 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 that you are continuing to answer at the top of the page.

5. **Show all 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 any question, ensure that you cancel the answer you do not wish to have marked.

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

7. The Formula Sheet is **not** to be handed in with your Question/Answer Booklet.

Section One: Calculator-free 35% (51 Marks)

This section has **6** 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 that you are continuing to answer at the top of the page.

Suggested working time: **50 minutes**.

Questions commence on the next page

Question 1 **(7 marks)**

Luca and Mila need to clean up their bedrooms because there are toys and clothes all over the floor. They have devised a plan to clean up the floor throughout the day by removing a number of items every hour and increasing the number of items by a set amount each time.

Luca will start by removing 20 items then increasing this number by 11 each hour.
Mila will start by removing 30 items then increasing this number by 8 each hour.

(a)   Display the number of items removed by each child in the table provided.   (2 marks)

Time	Start 9 am	10 am	11 am	noon
Luca				
Mila				

(b)   Determine the linear recurrence rule which describes the number of items that Luca will remove each hour.   (2 marks)

(c)   Deduce the non-recursive rule for the nth term for Mila's pattern of removal.   (2 marks)

(d)   Use your rule from part (c) to write the expression to determine the number of items that Mila will remove at 8 pm if she continues her pattern of removal.   (1 mark)

see next page

QUESTION 2 **(9 marks)**

Three volunteer bus drivers have given their available times to the local aged care facility.
Jean can do 3 hours on Mondays, 5 on Tuesdays and 2 on Wednesdays.
Ray can do 2 hours on Mondays, 4 on Tuesdays and 3 on Wednesdays.
Mario can do 4 hours on Mondays, 5 on Tuesdays and 1 on Wednesdays.

(a) Create a table to display the available times for the three volunteer drivers. (1 mark)

(b) Create a labelled matrix to display the available times for the three volunteer drivers.
(1 mark)

(c) Determine the optimum assignment of drivers, so that the aged care facility receives the maximum number of hours possible from the three drivers while still using one driver per day. (1 mark)

QUESTION 2 (cont'd)

Five other volunteers offer their time to come and teach crafts to the senior citizens. Members of staff at the facility want to maximize the time given but only have one volunteer come in each day to teach crafts. The times and days for each volunteer are given in the table below.

Judy uses the Hungarian algorithm on the table to determine the optimum solution to the problem. Various steps of her solution are shown.

Times and days for each volunteer

	Mon	Tue	Wed	Thurs	Fri
Ned	1	3	4	5	6
Eva	2	3	4	5	4
Mary	7	6	2	2	1
Sue	1	7	6	2	1
Jon	4	3	6	7	7

STEP A

Mon	Tue	Wed	Thurs	Fri
6	4	3	2	1
5	4	3	2	3
0	1	5	5	6
6	0	1	5	6
3	4	1	0	0

STEP B

	Mon	Tue	Wed	Thurs	Fri
Ned	5	4	2	1	0
Eva	3	2	1	0	1
Mary	0	1	5	5	6
Sue	6	0	1	5	6
Jon	3	4	1	0	0

STEP E

	Mon	Tue	Wed	Thurs	Fri
Ned	5	4	1	1	0
Eva	3	2	0	0	1
Mary	0	1	4	5	6
Sue	6	0	0	5	6
Jon	3	4	0	0	0

(d) Describe how the table in STEP A was created from the original data.   (1 mark)

(e) Describe how the table in STEP B was created from the table in STEP A.   (1 mark)

(f)   In STEP E, three cells in the table are shaded. Describe what this shading represents?

(1 mark)

(g)   Judy recognises that there are two possible solutions. Determine the optimum time available for volunteers to teach crafts in a particular week and describe the associated allocations.   (3 marks)

Question 3 **(7 marks)**

A company has just moved into new premises and cables linking the computers in the offices need to be installed. The length (in metres) of cable needed is given in the table below.

Where there is no direct link between computers A, B, C, D and E a "___" is shown.

	A	B	C	D	E
A	__	11	20	__	26
B	11	__	17	12	15
C	20	17	__	10	8
D	__	12	10	__	14
E	26	15	8	14	__

(a)   Determine the least amount of cable required to connect all computers. Show the process by which you determined your solution. (3 marks)

(b)   Use a minimum spanning tree to display the least amount of cable needed to connect all
       computers.   (2 marks)

(c)   Explain why the minimum spanning tree between the offices is a Hamiltonian path.
                                                                                     (2 marks)

Question 4 **(9 marks)**
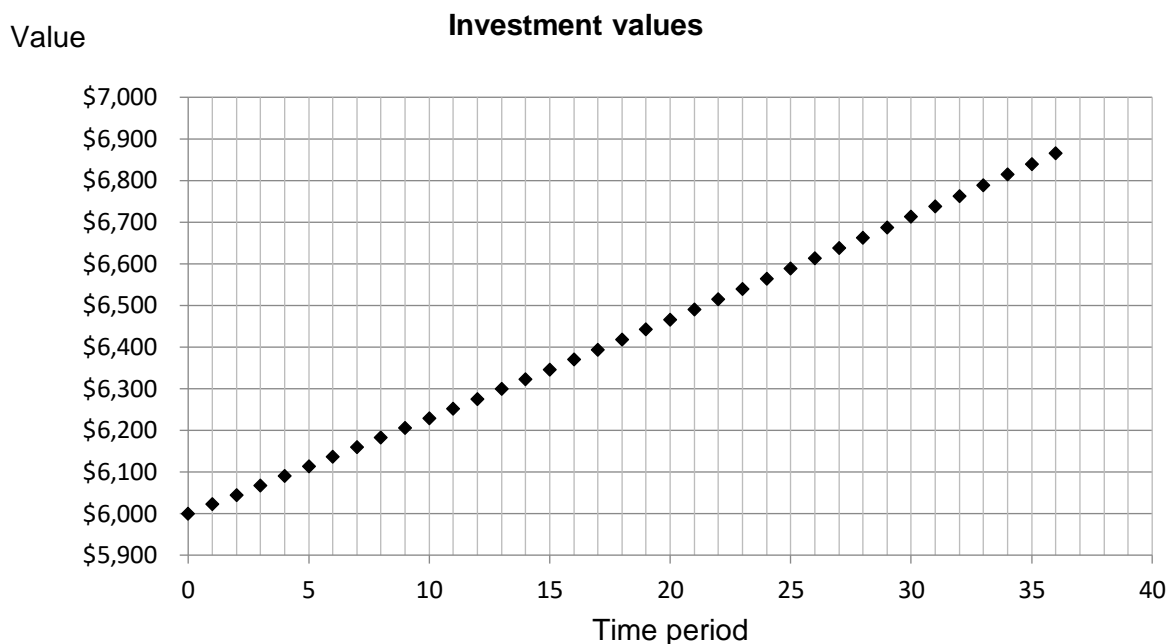
Investment values

The graph shows the value of an investment over a period of **3** years. The annual interest rate is 4.5% and interest only is added regularly to the investment account.

(a) How much money was invested? (1 mark)

(b) Give an estimate for the value of the investment after three years. (1 mark)

(c) How often is interest added to the account? (1 mark)

(d) Determine the recurrence relation that describes the changes to the value of the investment over this time period. (3 marks)

(e) The graph appears to be linear but the relationship between the two variables is not
     linear. (3 marks)
  (i) What type of relationship exists between these two variables?

  (ii) How do you know the relationship is not linear?

  (iii) Explain why the graph appears to be linear when the relationship is not linear.

Question 5 **(11 marks)**

The graph below shows Matt and Amy's quarterly gas consumption from July 2009 until October 2015.

Units used   **Quarterly gas consumption**
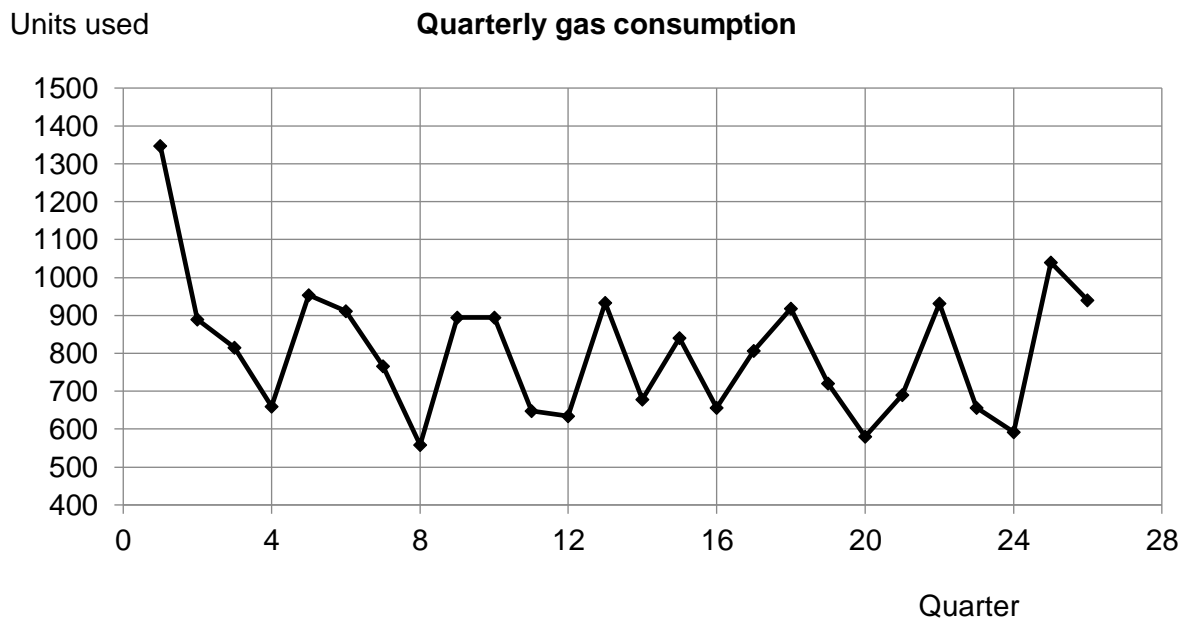
(a)   How many times per year is the gas consumption recorded?   (1 mark)

(b)   Estimate the number of units recorded for the first account of 2014.   (1 mark)

(c)   For two consecutive accounts, the number of units consumed did not vary.

           (i)   Estimate the number of units used.   (1 mark)

           (ii)   Identify the time period over which the consumption did not vary.   (1 mark)

The data contained an outlier which was removed for the calculation of the seasonal indices.
The seasonal indices were as follows:

January 95%   April 79%   July 114%   October 113%

(d)   When did the outlier occur?   (1 mark)

(e)   Give a reason for removing the outlier before calculating the seasonal indices.
                                                                                        (1 mark)

The seasonal index for January is the average for all January figures for the "percentage of
yearly average" and these figures are 98%, 98%, 90%, 104%, 99% and 81%.

(f)   Give a reason to justify the decrease to 81% in 2015.   (1 mark)

(g)   Describe how the seasonal index of 81% would have been calculated.   (1 mark)

(h)   For which account was the consumption usually much less than the other accounts
         during the year. Give TWO reasons to justify your conclusion.   (3 marks)

Question 6   **(8 marks)**

Danny and Nikki have borrowed $25 000 to buy a new car. Over the first year they pay back their loan in repayments of $500. The graph shows the amount owed over the first year.
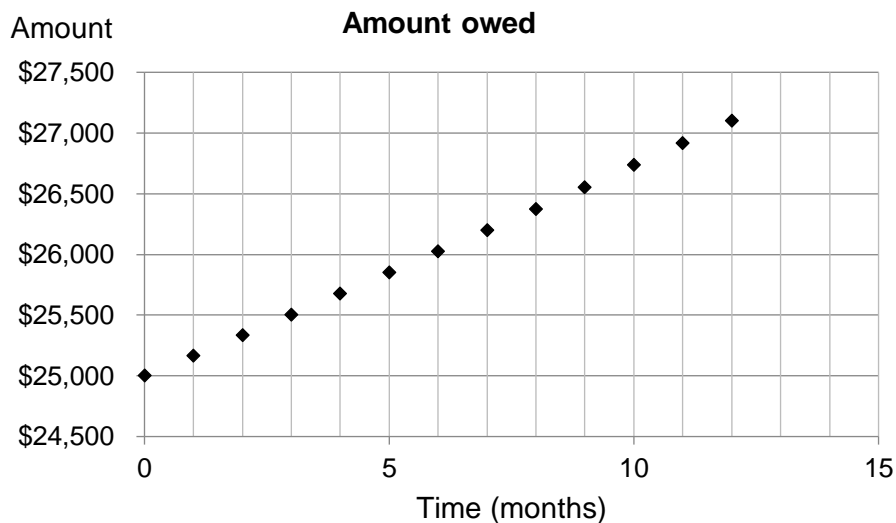
(a)   Explain why the value of their loan is not decreasing.   (1 mark)

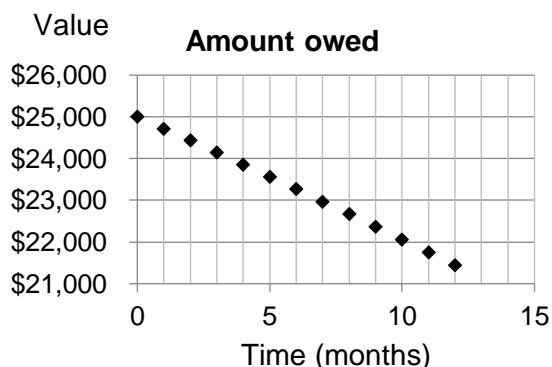A better graph for Danny and Nikki appears below. Each point represents the amount owed following a repayment on the loan.
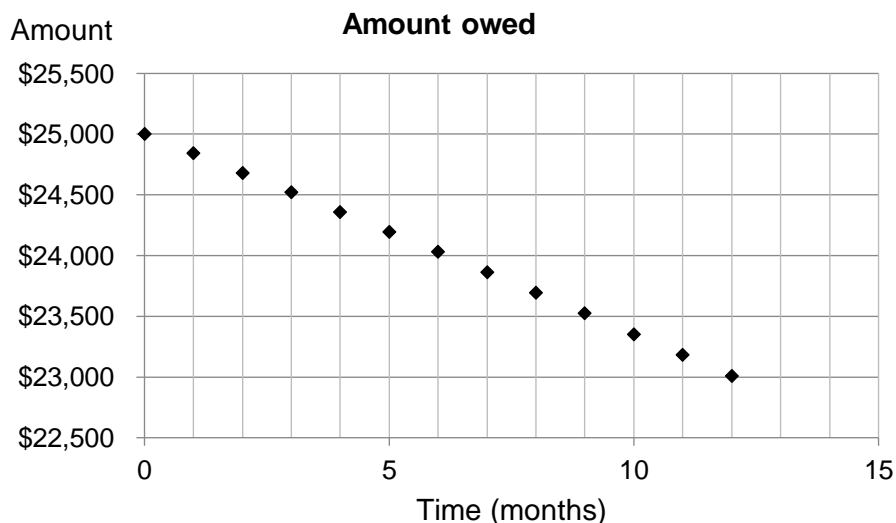
(b)   Estimate the amount they have paid off the loan over the period of one year.

(1 mark)

Similar graphs are available for analysis. For each graph one change has been made to the conditions of the loan. (6 marks)
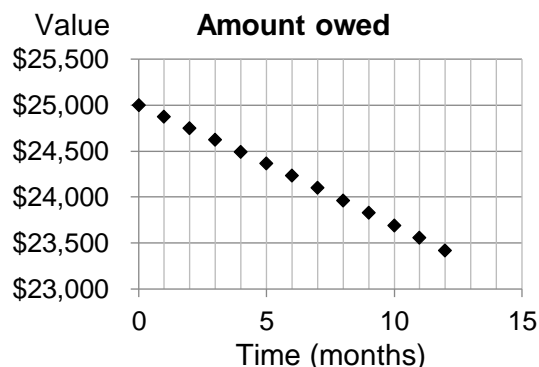
Use the letter(s) from the graphs below to identify which graph(s) show:

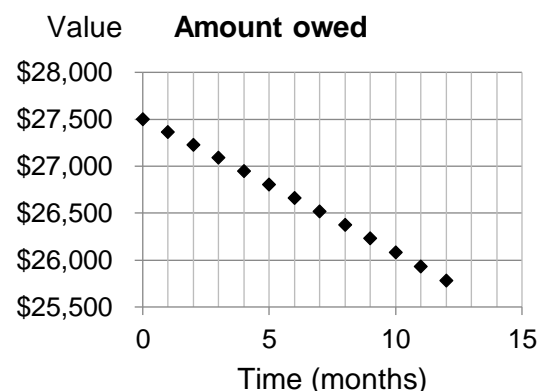| Change to feature of the loan	Letter from graph below
An increased amount is borrowed	
An increase in the rate at which interest is charged on the loan	
An increase in the size of the repayments	
An increase in the frequency of compounding	
An increase in the time taken to pay off the loan	
An increase in the overall amount paid back	

Graph A

Value   **Amount owed**

$26,000
$25,000
$24,000
$23,000
$22,000
$21,000

0   5   10   15
Time (months)

Graph B

Value   **Amount owed**

$25,500
$25,000
$24,500
$24,000
$23,500
$23,000

0   5   10   15
Time (months)

Graph C

Value   **Amount owed**

$25,500
$25,000
$24,500
$24,000
$23,500
$23,000
$22,500

0   10   20   30
Time (fortnights)

Graph D

Value   **Amount owed**

$28,000
$27,500
$27,000
$26,500
$26,000
$25,500

0   5   10   15
Time (months)
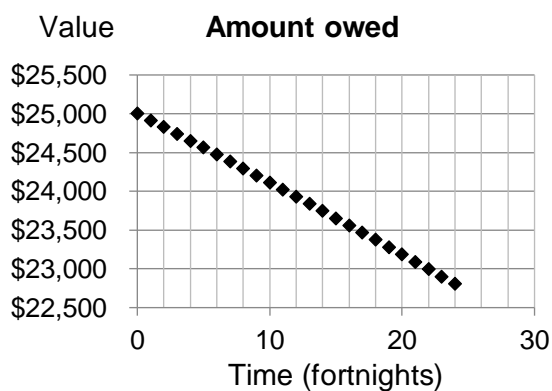
End of Questions

Additional working space
Question number: _____

Acknowledgements