FOR OFFICIAL USE

National Qualifications 2022 MODIFIED

Mark

X844/76/01 Applications of Mathematics

WEDNESDAY, 4 MAY

9:00 AM – 11:05 AM

X8447601

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth

Day Month Year

Scottish candidate number

Total marks — 65

Attempt ALL questions.

You may use a calculator.

To earn full marks you must show your working in your answers.

State the units for your answer where appropriate.

You should refer to the pre-release material for Higher Applications of Mathematics which you can access electronically.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting.

Questions 5, 7 and 9 must be completed on software and then be printed.

Use **blue** or **black** ink.

Before leaving the examination room, you must place your printouts inside the front cover of this booklet. Give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

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Information and instructions for candidates

The electronic files listed below are provided for you to use during this examination:

- **'Q5 School Roll.xlsx'** — a spreadsheet file containing 1 worksheet
- **'Q7 Jump.csv'** — a spreadsheet file containing a data set
- **'Q7 Jump Answers.docx'** — a word processing file. Your output from the statistical software in questions 7 (a) (i), (b) (i), (b) (ii), and (c) must be copied and pasted into this file for printing.
- **'Q9 Car Repayments.xlsx'** — a spreadsheet containing 2 worksheets

You must display your name, SCN and centre name on all pages on each printout. Spaces have been provided in each electronic file for you to complete this information.

When printing spreadsheet files, ensure that:

- landscape orientation is used
- grid lines are shown
- row and column headings are shown
- the option 'Fit All Columns on One Page' is selected.

When printing word processing files ensure that portrait orientation is used.

Use this table to make sure you have all the printouts required.

Question	Printout	Completed (✓)
5 (a) (i) and (c) (i)	'School Roll' worksheet • value view • formula view This should include the graph.	
7 (all parts)	'Q7 Jump Answers.docx' This should include your statistical software output, and answers.	
9 (a)	'Bank Loan' worksheet • value view • formula view	
9 (b)	'Car Finance' worksheet • value view • formula view	

Total marks — 65

Attempt ALL questions

1. Jill borrows £5650 from a bank.

The annual effective rate of interest on the loan is 9%.

Jill makes level monthly repayments of £186.01 at the end of each month.

Complete the following loan schedule for Jill's loan to show the loan outstanding at the end of month 2. **3**

Time (months)	Repayment (£)	Interest content of repayment (£)	Capital content of repayment (£)	Loan outstanding (£)
0				5650
1	186.01			
2	186.01			

Space for working if required.

[Turn over

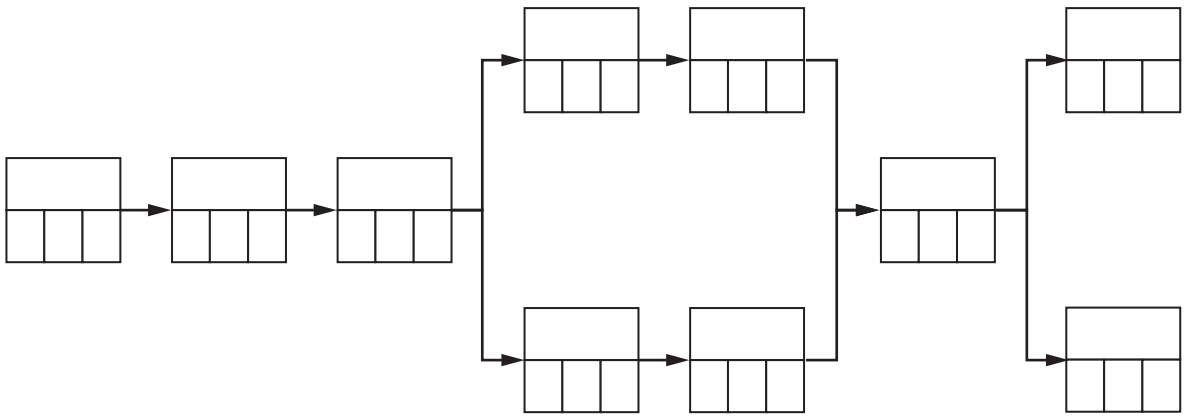
2. A company provides a team of workers to re-roof a house.

The table shows the list of tasks required to complete this job, the time required for each task, and the order in which the tasks are to be completed.

Task	Description	Preceding task	Time (hours)
A	Transport materials to location	None	3
B	Construct scaffolding	A	7
C	Remove old tiles	B	4
D	Take old tiles to recycling site	C	1
E	Inspect roofing	C	2
F	Purchase required number of roof tiles	D	1
G	Replace roofing felt	E	4
H	Replace roofing tiles	F, G	6
I	Remove scaffolding	H	3
J	Clean up	H	2

(a) Complete the PERT chart showing the earliest start time and the latest completion time for each task. **6**

(An additional diagram, if required, can be found on *page 16*.)



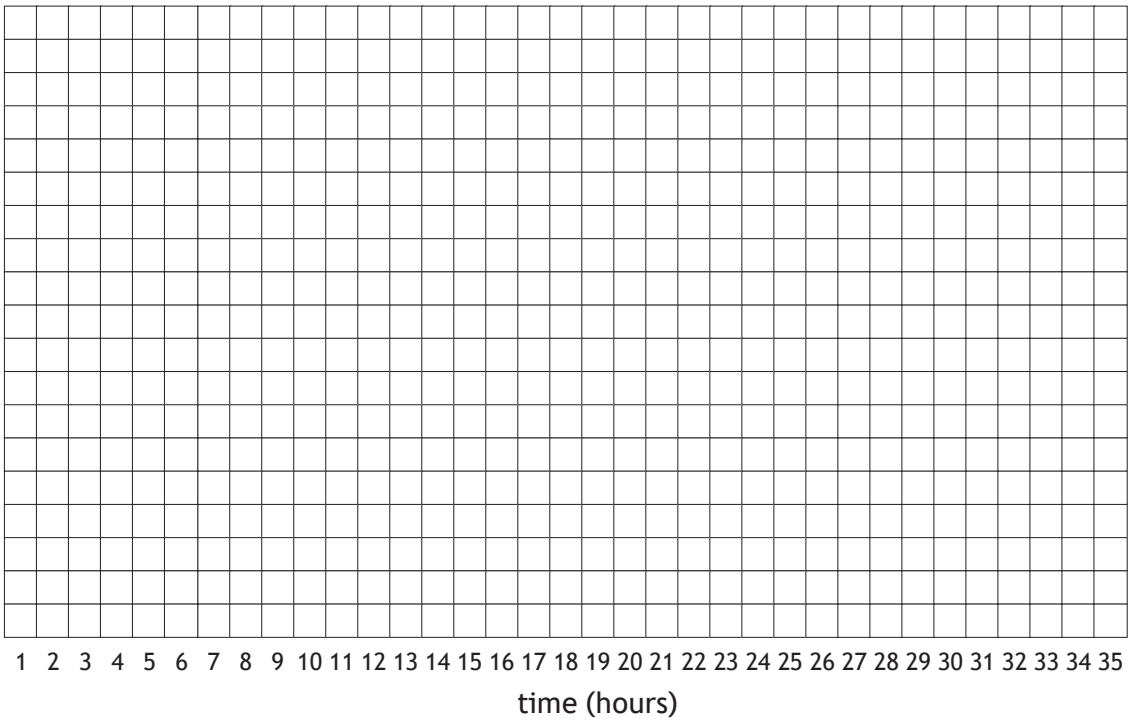
2. (continued)

(b) The roofing company works for 9 hours each day on this job.

State the minimum number of days that the company will require to complete this job. **1**

(c) Construct a Gantt chart, without float times, for this job. **3**

(An additional grid, if required, can be found on *page 16*.)



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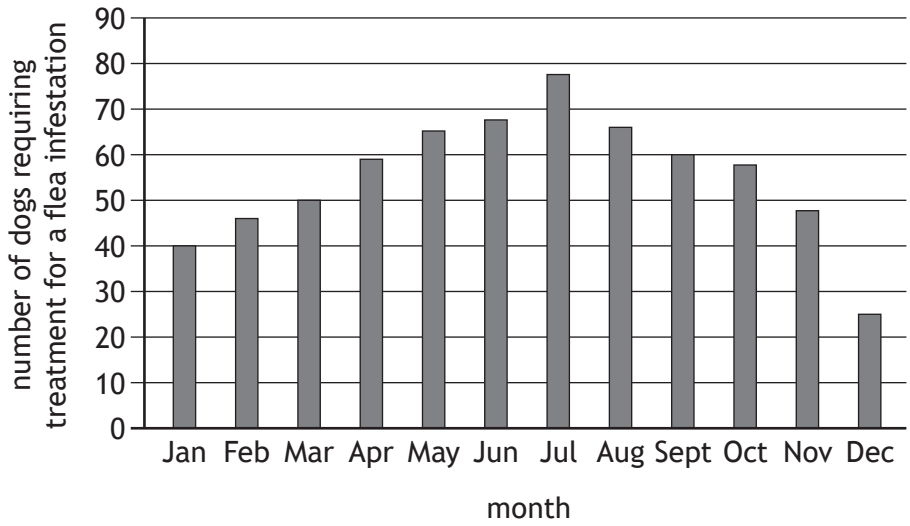
3. You must refer to the information on 'Dogs and fleas' given in the pre-release material when answering this question.

After Study 1 the following bar chart was created. It shows the number of dogs requiring treatment for a flea infestation against the month of the year.



(a) State the type of data that best describes the number of dogs requiring treatment for a flea infestation. **1**

The student vet claims this graph proves that flea infestations are more common in the warmer months across the UK.

(b) Explain why this claim is not valid. **1**

3. (continued)

The data gathered from Study 2 is shown in the table.

Area	Number of dogs inspected	Number of dogs with a flea infestation
Urban Clinic	213	30
Rural Clinic	156	43

(c) State a statistical test that would be appropriate to determine whether this data provides evidence of a difference in flea infestations between urban and rural areas. **1**

(d) State one part of the design of Study 2 that would be needed to ensure that the assumptions required to perform the test in (c) are valid. **1**

To fit in with the student vet's placements, the data from the urban clinic was collected from July to September, and the data from the rural clinic was collected from October to December.

(e) Explain how this may affect the conclusions of Study 2. **1**

[Turn over

4. Zac deposits £500 into a bank account on 1 January 2018, 1 January 2019, and 1 January 2020.

The bank pays interest into his account at the end of every year, using the following annual effective rates:

- 2018 3.3%
- 2019 2.4%
- 2020 1.0%

He makes no withdrawals from his account.

(a) Calculate the balance in Zac's account at the end of 2020. **3**

On 1 January 2021 Zac deposits another £500 into his account.

He makes no further deposits into his account in 2021.

(b) Calculate the annual effective rate of interest needed in 2021 for the account balance to be £2100 by the end of the year. **2**

5. You must refer to the spreadsheet file 'Q5 School Roll.xlsx' when answering this question.

You must complete part (a) (i) and (c) (i) using the spreadsheet file.

Parts (a) (ii), (b), and (c) (ii) must be completed in the answer spaces provided.

A school is planning a new building as it is approaching its maximum capacity.

The school roll in August 2021 was 650 pupils.

- Approximately 18% of pupils leave by the end of each school year.
- 140 new S1 pupils join the roll in August each year.

(a) (i) Complete the 'School Roll' worksheet to predict the school roll in August 2031. **3**

(ii) Comment on the precision of this prediction. **1**

(b) Comment on the relationship between time and the predicted school roll up to August 2031. **1**

The school moves forward with plans for a new building.

This will increase the capacity of the school to 800 pupils.

(c) (i) Extend the table in your worksheet to construct a graph to show what is predicted to happen to the school roll in the long term.

You must consider what happens to the school roll beyond August 2031. **2**

(ii) Use your graph to determine whether the new capacity is suitable. **1**

Print the 'School Roll' worksheet in value view and in formula view. Ensure the graph is positioned below the table and is contained on one page in the printout.

6. The average price of petrol increased at the following annual effective rates:

- March 2018 to 2019: 2.1%
- March 2019 to 2020: 0.5%
- March 2020 to 2021: 2.0%

(a) Calculate the overall percentage increase in the average price of petrol over the three years from March 2018 to March 2021. **1**

The average price of petrol in March 2021 was 136.4 pence per litre.

(b) Hence calculate the average cost of filling a 45-litre tank with petrol in March 2018. **2**

7. You must refer to the information on 'Strength and conditioning' given in the pre-release material when answering this question.

You must also refer to the spreadsheet file 'Q7 Jump.csv' for the data, and the word processing file 'Q7 Jump Answers.docx' when answering this question.

You must complete parts (a) (i), (b) (i), (b) (ii), and (c) using appropriate statistical software.

You must include all output from statistical software, and your answers in the word processing file 'Q7 Jump Answers.docx'.

A strength and conditioning coach wants to increase vertical jump height performance in their trainees. The data in the spreadsheet file shows back squat weight (kg) and vertical jump height (cm).

(a) (i) Construct a scatter plot of vertical jump height on back squat weight for the data. **2**

(ii) Make an appropriate comment about the relationship between vertical jump height and back squat weight. **1**

(b) (i) Find the correlation coefficient between back squat weight and vertical jump height. **2**

(ii) Find the equation of the regression line of vertical jump height on back squat weight. **2**

(c) Use your statistical software to estimate the vertical jump height for a trainee who can back squat 165 kg, and comment on the accuracy of the predicted value. **2**

Based on the correlation, the coach advises the trainees that increasing their back squat weight will increase their vertical jump height.

(d) Explain why the statistical analysis does not support this advice. **1**

Print the word processing file 'Q7 Jump Answers.docx'.

[Turn over

8. You must refer to the information on 'Deductions from salaries' given in the pre-release material when answering this question.

Sophie starts a job selling mobile phones. Her company provides the following financial benefits **at the end of each month**:

Salary: £1000 per month

Commission: £20 for each mobile phone sold during the month

Pension scheme: Sophie pays 2.5% of her monthly earnings (salary and commission) before tax into her pension fund. The company contributes another 6.5% of the same monthly earnings.

Sophie expects to sell 150 mobile phones per month.

(a) Calculate how much income tax Sophie expects to pay each year. **3**

8. (continued)

Sophie's pension fund earns an annual effective rate of interest of 10%.

(b) Calculate the expected value of Sophie's pension fund immediately after the third pension contribution is made. **3**

Sophie has the choice to leave the company pension scheme.

(c) State one reason why Sophie would not leave the company pension scheme. **1**

[Turn over

9. You must refer to the spreadsheet file 'Q9 Car Repayments.xlsx' when answering this question.

You must complete parts (a), and (b) using the spreadsheet file.

Part (c) must be completed in the space provided.

Maria is buying a car for £15,000. She has arranged a loan for the full amount from the bank, to be paid back with level monthly repayments for 48 months. The annual effective interest rate is 9.5%.

Open the 'Bank Loan' worksheet.

(a) Complete the 'Loan Repayment Schedule' to determine the level monthly repayment amount, and the final repayment amount. **4**

The car dealership has their own finance options.

Option 1

- Pay £300 per month for 48 months, and return the car to the dealer.
- Additional charges will apply if the mileage exceeds 24 000 miles when the car is returned.

Option 2

- Pay £300 per month for 48 months, and keep the car by making an additional payment of £5000 in the final month.

Open the 'Car Finance' worksheet.

(b) Complete the 'Finance Repayment Schedule' to find the annual effective interest rate of Option 2. **3**

(c) State two reasons why Maria might decide to purchase the car using the bank loan instead of the car dealership finance options. **2**

Print the 'Bank Loan' worksheet in value view and in formula view. Print the 'Car Finance' worksheet in value view and in formula view.

10. You must refer to the information on 'Mountain gorillas' given in the pre-release material when answering this question.

The 2020 study found that the population of mountain gorillas had increased to 1004.

An expert has stated that if the mountain gorilla population in the Virunga Mountains continues to grow exponentially there will be 1600 gorillas by the year 2032.

(a) Determine if the expert's statement is correct.

Give a reason for your answer. **2**

A typical adult mountain gorilla eats 30 kg of food per day.

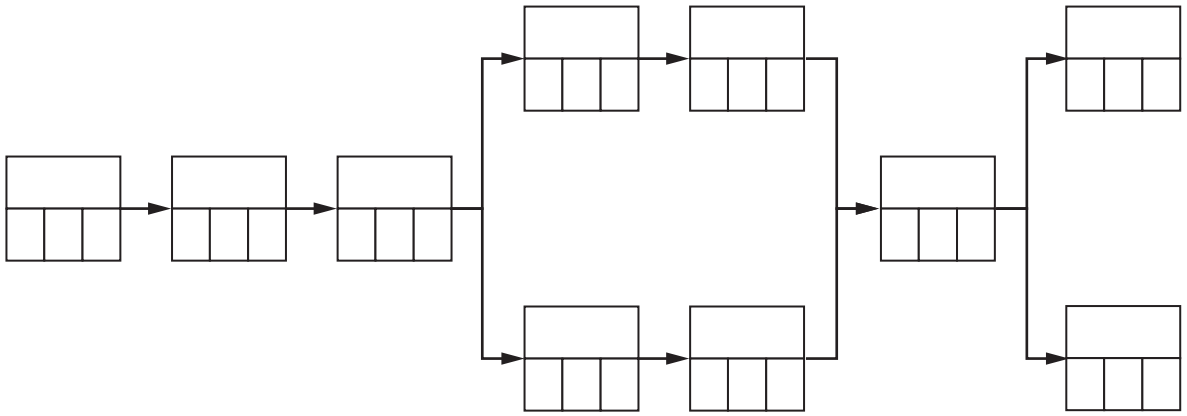
(b) Estimate the **maximum** amount of termites and ants (in kg) that a typical mountain gorilla will eat during their adult lifetime.

State any assumptions you have made. **3**

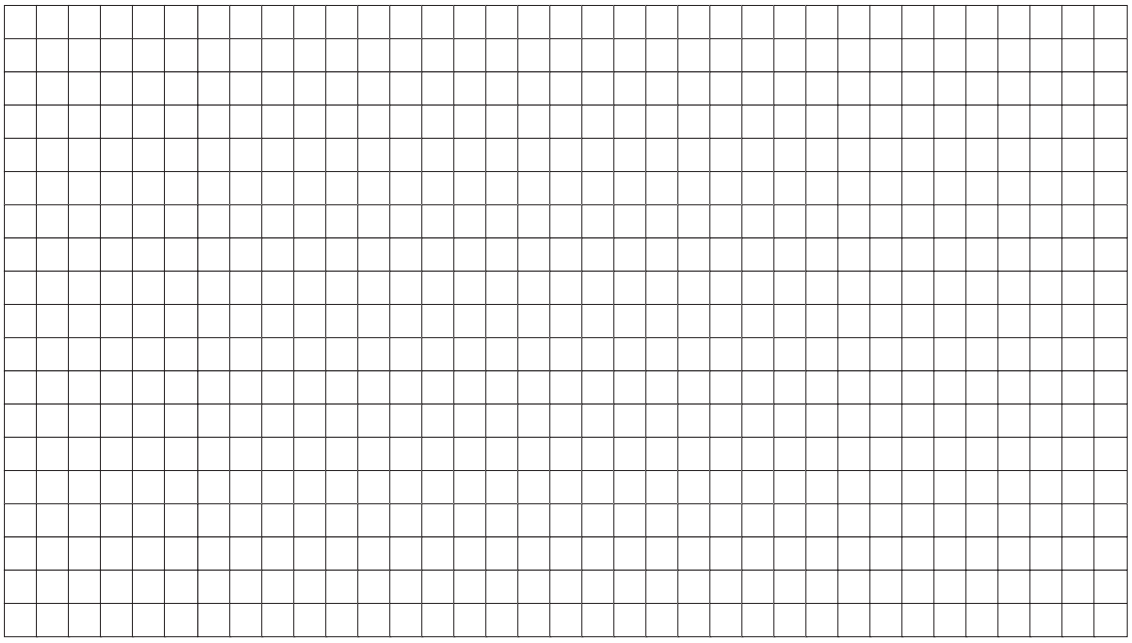
[END OF QUESTION PAPER]

ADDITIONAL SPACE FOR ANSWERS

Additional diagram for question 2 (a)



Additional grid for question 2 (c)



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