H

National Qualifications 2023 MODIFIED

Mark

X844/76/01

Applications of Mathematics

WEDNESDAY, 3 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, 8 and 11 must be completed on software and then be printed.

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

Before leaving the examination room you must place this booklet and your printouts inside the clear envelope provided. You must give this envelope to the Invigilator; if you do not, you may lose all the marks for this paper.

SQA ©

Information and instructions for candidates

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

- **'Q5 Coffee.csv'** — a spreadsheet file containing a data set
- **'Q5 Coffee Answers.docx'** — a word processing file. Your output from the statistical software in questions 5 (a), (b) (i), and (c) (i) must be copied and pasted into this file for printing.
- **'Q8 Warehouse.xlsx'** — a spreadsheet file containing 1 worksheet
- **'Q11 Ramsay's Loan.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.

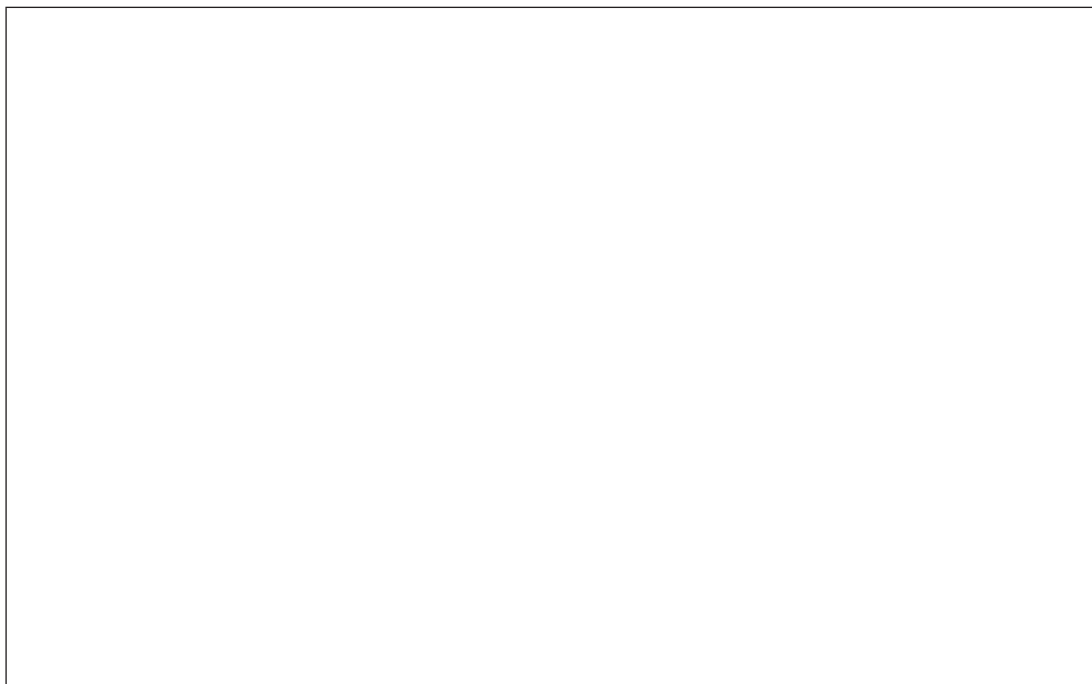| Question	Printout	Completed (✓)
5 (all parts)	'Q5 Coffee Answers.docx' This should include your statistical software output, and answers.	
8 (a) and (b) (i)	'Warehouse Stock' worksheet • value view • formula view	
11 (a)	'Bank Loan' worksheet • value view • formula view	
11 (b)	'Loan Company' worksheet • value view • formula view	

Total marks — 65

Attempt ALL questions

1. A school year in Scotland usually lasts 190 days.

   Estimate the total number of hours that a typical pupil in Scotland will spend in school during their lifetime.

   State any further assumptions you make. 3

[Turn over

2. In a cooking competition, a contestant has 80 minutes to make a crème brûlée.

There are several tasks that need to be completed to make the crème brûlée.

The contestant's timings for each task are shown.

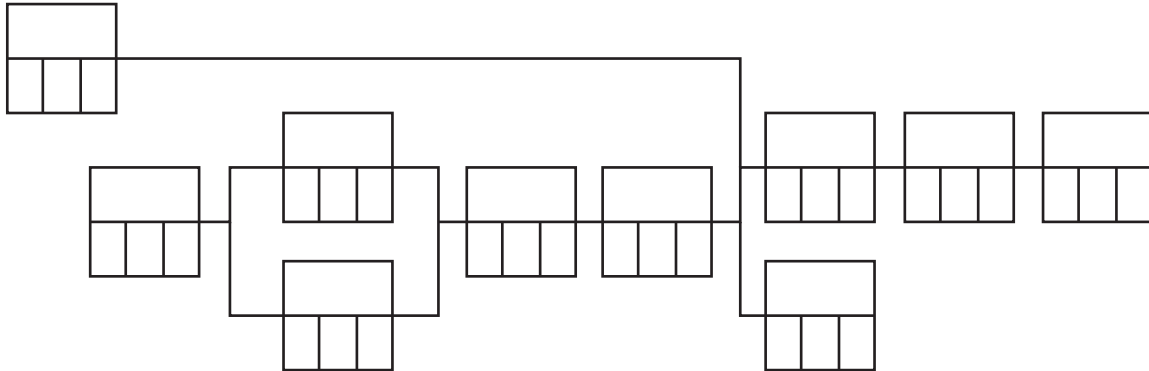| Task	Description	Preceding task	Time (minutes)
A	heat oven	none	8
B	gather ingredients and prepare bowls	none	10
C	whisk egg yolks and sugar	B	5
D	heat double cream in pan	B	4
E	add cream to egg yolk mixture	C, D	2
F	sieve mixture and put into bowls	E	4
G	put bowls into oven and cook	A, F	35
H	tidy workspace	F	12
I	sprinkle caster sugar over each bowl and caramelise	G	3
J	plate up and serve	I	5

2. (continued)

(a) Complete the PERT chart below to allow the contestant to determine the earliest start time and latest completion time for each task.

6

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

When the contestant puts the bowls into the oven, they realise the oven has not been heated.

(b) Determine whether they can still finish on time.

Give a reason for your answer.

2

[Turn over

3. An online survey is sent out by email to people on the electoral register who live in Renfrewshire.

The aim of the survey is to determine which political party people intend to vote for in an upcoming election.

The survey asks participants to answer the following questions:

- State your age in years.

- State your gender.
  Please select from: male, female, non-binary, other, prefer not to say.

- Which political party do you intend to vote for in the upcoming election?

- Did you vote in the last election?
  Please select from: yes, no, don't know, prefer not to say.

- If yes, state which political party you did vote for in the last election.

(a) State the type of data that best describes

    (i) age   **1**

    (ii) gender.   **1**

The results of the online survey are to be used to predict the outcome of an upcoming national election.

(b) Give two reasons why these results do not provide a representative sample of the national population to allow the prediction to be accurate.   **2**

4. You must refer to the information on 'Scottish Tax Bands 2022/23' given in the pre-release material when answering this question.

James works for a large building company. He is a permanent employee and earns a gross annual salary of £36,700.

James pays 4.7% of his gross annual salary into his pension and pays £3071.45 National Insurance per annum.

Calculate his **net annual salary** after all deductions. **4**

[Turn over

5. You must refer to the spreadsheet file 'Q5 Coffee.csv' for the data, and the word file 'Q5 Coffee Answers.docx' when answering this question.

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

   You must include all output from statistical software, and your answers in the word processing file 'Q5 Coffee answers.docx'.

A specialist coffee shop sells 22 different drinks.

For each drink the following data are provided:

- carbohydrate content (grams)
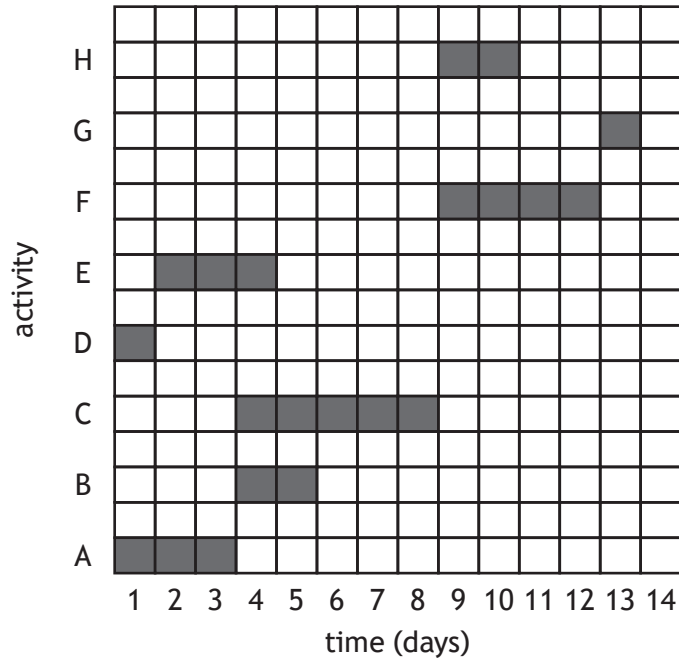
- number of calories (kCals).

The number of calories is dependent on the carbohydrate content of the drink.

(a) Construct a scatter plot of number of calories on carbohydrate content. **2**

(b) (i) Find the correlation coefficient between number of calories and carbohydrate content. **2**

   (ii) Interpret the correlation coefficient. **1**

(c) (i) Find the equation of the regression line of number of calories on carbohydrate content. **2**

   (ii) Interpret the slope and intercept parameters. **2**

(d) Estimate the number of calories in a drink which has 59 g of carbohydrate. **1**

Print the word processing file 'Q5 Coffee Answers.docx'.

6. The Gantt chart below shows the activities required to complete a project.

Activity G is dependent on activities F and H.

Activity F is dependent on activities B, C and E.

Activity E is dependent on activity D.

Activities C and B are dependent on activity A.

(a) State the critical path for this project.

1

(b) State the duration of the float time for activity B.

1

(c) State one **advantage** of using a Gantt chart.

1

7. Taylor opens a savings account on 1 April 2021 with an initial deposit of £400.

The effective rates of interest for the savings account are as follows.

Dates	Interest rate
1 April 2021 to 31 January 2022	1.2% per **year**
1 February 2022 to 31 July 2022	0.11% per **month**
From 1 August 2022	1.7% per **year**

Taylor makes further deposits of £200 on 1 August 2021 and £250 on 1 April 2022.

(a) Calculate the balance in Taylor's savings account on 31 July 2022.　　**4**

Taylor made a **final** deposit into this account on 1 August 2022.

On 1 December 2022, their savings account balance was £1000.

(b) Calculate how much they deposited on 1 August 2022.　　**2**

8. You must refer to the spreadsheet file 'Q8 Warehouse.xlsx' when answering this question.

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

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

A warehouse company currently has 1750 units of stock. They deliver 20% of their current stock each week, and receive 300 units of new stock per week.

(a) Complete the 'Warehouse Stock' worksheet to identify (in cell C10) the predicted number of units of stock in the warehouse at the end of week 26. **3**

(b) (i) Extend the table in your worksheet to construct a graph to show the units of stock for 52 weeks. **2**

(ii) Using the graph constructed in (b)(i), state which type of mathematical model best describes the units of stock in the warehouse. **1**

After 52 weeks, the warehouse company plans to move to a smaller building with space for 1400 units of stock.

(c) Comment on whether the smaller building will have enough space for the stock.

Justify your answer. **1**

(d) State one reason why this mathematical model may not be realistic. **1**

Print the 'Warehouse Stock' worksheet in value view and formula view. Ensure the graph is positioned beside the table and is contained on one page in the printout.

9. The Consumer Price Index (CPI) in the UK in April 2021 was 110.4, relative to a baseline of 100 in April 2015.

(a) Explain what this figure means in terms of relative purchasing power. **1**

The price of a new 3-door car rose in line with CPI between April 2015 and April 2021.

In 2021, the price of a new 3-door car was £14,108.

(b) Calculate the price of a new 3-door car in April 2015. **1**

The National Living Wage is the minimum hourly rate to be paid to any employee aged 23 or older.

In April 2021, the National Living Wage was £8.91. This was raised to £9.50 in April 2022.

(c) Given that the CPI in April 2022 was 119.0, determine whether this rise in the National Living Wage was in line with inflation. **2**

10. You must refer to the information on 'E10 Petrol' given in the pre-release material when answering this question.

At the end of June 2021, the UK government replaced the standard E5 fuel with E10 in a bid to reduce national CO_2 emissions.

A newspaper article stated that:

'**Since the nationwide introduction of E10 fuel, CO_2 emissions have reduced to the effect of taking 550 000 cars off the road by the end of 2022.**'

(a) (i) Calculate the CO_2 emissions of 550 000 cars. **1**

(ii) Suggest a reason why the information from the newspaper article might not be appropriate as part of any further research on reducing CO_2 emissions. **1**

The fuel economy of a car, F miles per gallon (mpg), is reduced when it carries an additional load of m kilograms.

The fuel economy of a small car is modelled using the following equation:

$$F = 73.6 \times 0.98^{\frac{m}{45}}$$

(b) (i) State the independent variable. **1**

(ii) Estimate the fuel economy of the small car when it is carrying an additional load of 150 kg. **1**
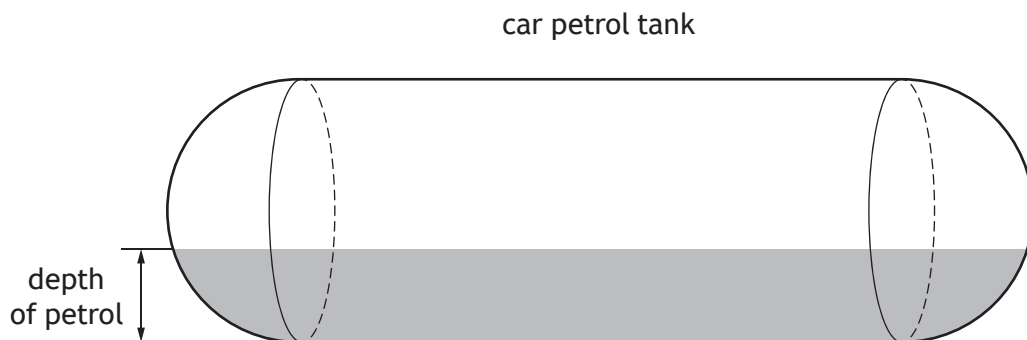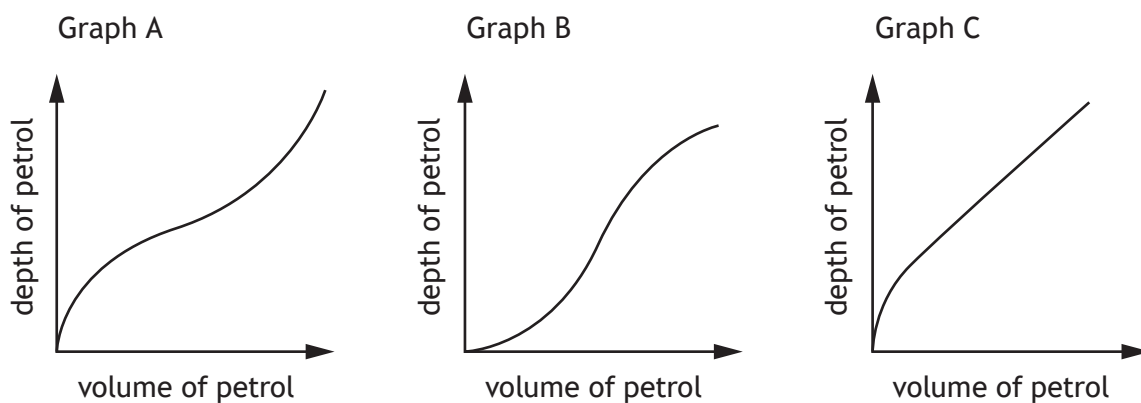
10. (continued)

A customer is filling up their tank with petrol.

The shape of the petrol tank inside the car is a horizontal cylinder with two hemispheres on either side as shown in the diagram.

car petrol tank

depth of petrol

The three diagrams below show how the depth of petrol varies with the volume of petrol in the tank.

Graph A

depth of petrol

volume of petrol

Graph B

depth of petrol

volume of petrol

Graph C

depth of petrol

volume of petrol

(c) Explain which graph could model the depth of petrol in the tank.   **2**

11. | You must refer to the spreadsheet file 'Q11 Ramsay's Loan.xlsx' when answering this question.

You must complete parts (a)(i), (a)(ii), (c)(i), and (c)(ii) using the spreadsheet file.

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

Ramsay applies to take out a loan of £6000 with a term of 3 years from a bank.

Level monthly repayments are made at the end of each month.

The effective annual interest rate is 6.3%.

Open the 'Bank Loan' worksheet.

(a) (i) Complete the 'Bank loan repayment schedule' to determine the level monthly repayment amount, and the final repayment amount. **4**

(ii) Determine the total interest paid over the term of the loan. **1**

Ramsay's application for this loan was rejected.

(b) State one reason why a bank might reject a loan application. **1**

Ramsay decides to borrow the money from a loan company.

The loan company offers Ramsay £6000 for 3 years with fixed level monthly repayments of £250 made at the end of each month.

Open the 'Loan Company' worksheet.

(c) (i) Complete the 'Loan company repayment schedule' to find the annual effective rate of interest. **2**

(ii) Determine the difference in total interest paid (in £) between the two loans. **1**
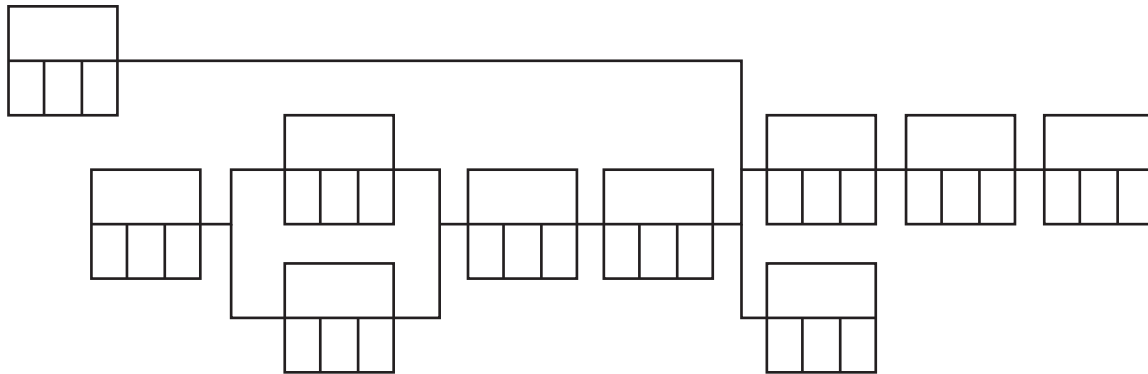
Print the 'Bank Loan' worksheet in value view and formula view. Print the 'Loan Company' worksheet in value view and formula view.

[END OF QUESTION PAPER]

ADDITIONAL SPACE FOR ANSWERS

Additional diagram for question 2 (a)

ADDITIONAL SPACE FOR ANSWERS

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