FOR OFFICIAL USE

National
Qualifications
ADDITIONAL SPECIMEN

Mark

S844/76/01 Applications of Mathematics

Date — Not applicable

Duration — 2 hours 30 minutes

* S 8 4 4 7 6 0 1 *

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 — 80

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 6 (b), (c) (i) and (c) (ii), 8 (a) (i), (b) and (c), 10 (a) (i), (c) and (d), and 11 (a) and (b) 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 ©

* S 8 4 4 7 6 0 1 0 1 *

Information and instructions for candidates

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

- **Q6 Carol's Gift** — a spreadsheet file containing 1 worksheet (Original Loan)
- **Q8 Biomass Data** — a spreadsheet file containing 1 worksheet (Biomass Data)
- **Q8 Biomass Answers** — a word processing file
- **Q10 Visits Abroad Data** — a spreadsheet file containing 1 worksheet (Visits Abroad Data)
- **Q10 Visits Abroad Answers** — a word processing file
- **Q11 Karen's Pension** — a spreadsheet file containing 2 worksheets (Pension Fund, Savings Account)

Your output from the statistical software in questions 8 (a) (i), (b) and (c) must be copied and pasted into the file **Q8 Biomass Answers** for printing. Your output from the statistical software in questions 10 (a) (i), (c) and (d) must be copied and pasted into the file **Q10 Visits Abroad Answers** for printing.

You must display your name, SCN and the question number on all electronic files for printing.

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

Question	Printout	Completed (✓)
6 (b)	Original Loan worksheet • value view • formula view	
6 (c) (i) and 6 (c) (ii)	Pay Lump Sum worksheet • value view • formula view	
8 (a) (i)	Scatter diagram	
8 (b)	Statistical software output	
8 (c)	Statistical software output	
10 (a) (i)	Statistical diagram	
10 (c)	Statistical software output	
10 (d)	Statistical software output	
11 (a)	Pension Fund worksheet • value view • formula view	
11 (b)	Savings Account worksheet • value view • formula view	

Attempt ALL questions

Total marks — 80

MARKS | DO NOT WRITE IN THIS MARGIN

1. Estimate the number of hours sleep a typical person in Scotland has during their lifetime.

State any assumptions you make. **4**

2. Zosia has a savings account. The effective rates of interest were as follows:

- 3% per **year** during calendar years 2017 and 2018
- 2% per **half year** from 1 January 2019 until 1 July 2020
- 1% per **month** from 1 July 2020.

She made a deposit of £500 into her savings account on 1 July 2017.

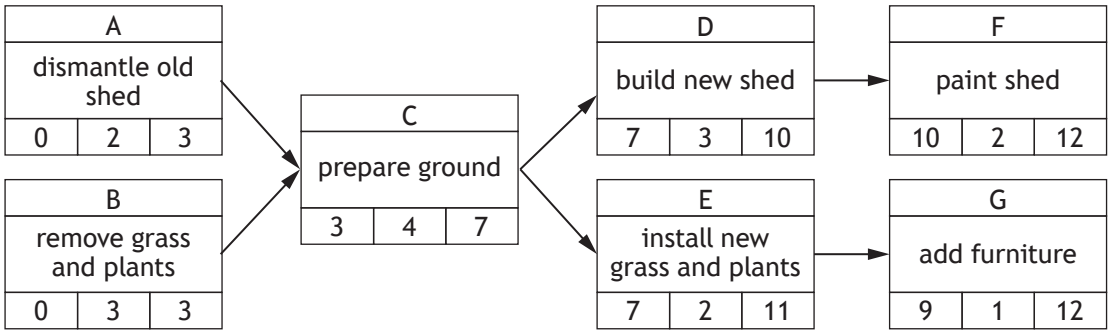
(a) Calculate the balance of Zosia's savings account on 1 January 2019. **1**

Zosia made further deposits and withdrawals as shown in the table.

Date	
1 January 2019	£100 withdrawal
1 January 2020	£150 deposit
1 January 2021	£80 withdrawal

(b) Calculate the balance of Zosia's savings account on 1 May 2022. **3**

3. The activity network for a garden renovation project is shown below.



(a) Explain, using examples from this project, the difference between an activity that is **essential** for the project and an activity which is **critical** for the project. **2**

(b) Describe the meaning of each of the three values in Activity C's node. **1**

(c) Produce a Gantt Chart for the above project. You do not need to include float times in your diagram. **4**

4. Joseph bought his flat 10 years ago for £100,000.

Joseph is buying a new home insurance policy. Some key points of the policy are:

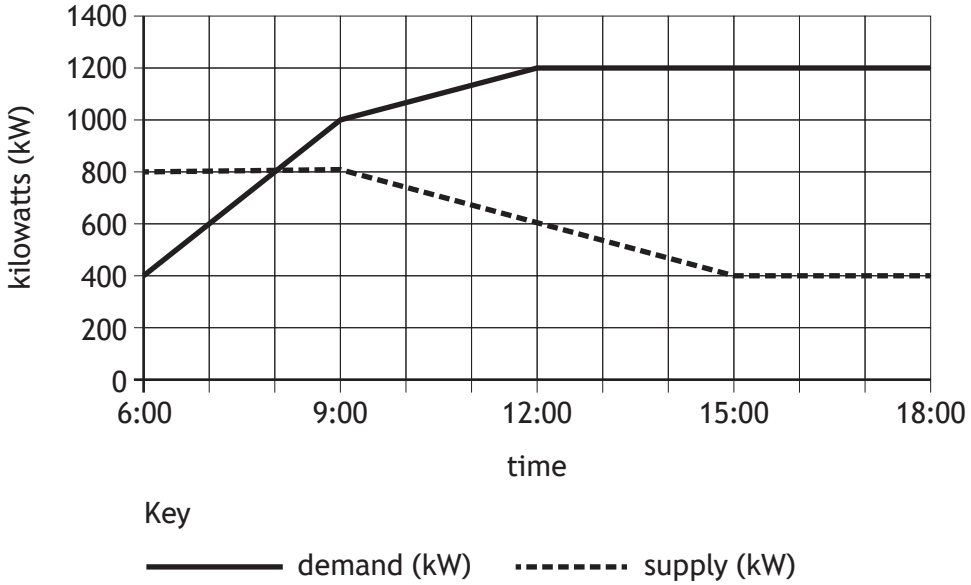
- Type of policy: Buildings and contents cover.
- Total value insured: £100,000.
- Term: 5 years.
- Coverage: The policy will pay out in part or in full, as necessary, up to the above amount, in the event of burglary or natural disaster (for example, flooding or earthquake).
- Annual premium: £300.

Give **three** reasons why Joseph may decide not to buy this insurance policy. **3**

5. An island generates its own electricity. It has a small wind farm and a diesel generator. The diesel generator is used when the demand for electricity exceeds the supply. The engineer who runs the system uses a mathematical model based on past data to predict supply and demand of electricity.

The rate at which electrical energy is supplied or demanded is measured in kilowatts (kW). The total amount supplied or demanded is measured in kilowatt-hours (kWh).

The graph **below** shows the predicted rate at which the wind farm can supply energy and the predicted rate of electricity demand over a 12-hour period.



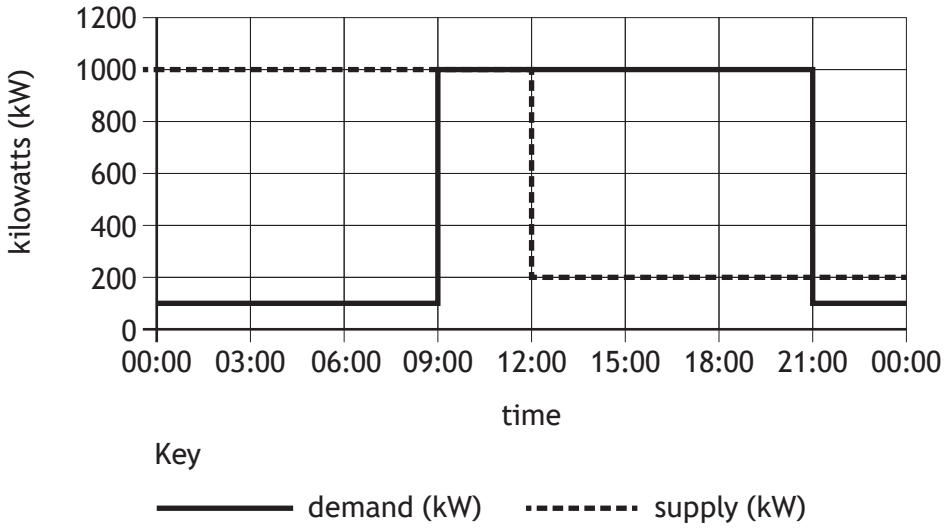
(a) (i) State the number of hours the diesel generator is required during this period. **1**

(ii) Determine the maximum rate at which the diesel generator should be able to generate electricity during this period. **1**

5. (continued)

The engineer designs an energy storage system, which will allow the islanders to store some of the energy supplied by the wind farm and use this energy when they need it.

The graph **below** shows the predicted rates of electricity supply and electricity demand over a 24 hour period.



(b) (i) Determine the total amount of electrical energy used over this period. **1**

(ii) Determine the minimum amount of energy the storage system must be able to store to meet the demand. **2**

[Turn over

6. You must refer to the spreadsheet file 'Q6 Carol's Gift' when answering this question. You must complete parts (b), (c) (i) and (c) (ii), using the spreadsheet file. Parts (a) and (d) must be completed in the answer spaces provided.

Carol has received a gift of £2500, and is considering what to do with it.

She has a savings account that pays interest at an annual effective rate of 1.25%.

(a) Calculate how much **interest** Carol would earn if she invested this gift in her savings account for 34 months. **2**

Carol also has a personal loan. She originally borrowed £8000 to be repaid by level monthly repayments for 48 months, with the first repayment made one month after she took out the loan. Interest is charged at an annual effective rate of 4.9%.

(b) Open the 'Original Loan' worksheet. Complete formulae in the loan schedule and calculate the level monthly repayment amount, and the final repayment amount. **4**

Carol has just made the 14th monthly repayment on the loan. She decides to find out the impact of using the £2500 gift as a lump sum payment to reduce the outstanding balance on her loan.

The loan provider agrees to recalculate a new level monthly repayment amount, to be paid in each of the remaining 34 months.

(c) (i) Copy the 'Original Loan' worksheet. Rename the copy to 'Pay Lump Sum'.

Adjust the 'Pay Lump Sum' worksheet as required, and hence calculate Carol's new level monthly repayment. **3**

(ii) On the 'Pay Lump Sum' worksheet, calculate how much Carol would save in interest payments by making this lump sum payment. **2**

(d) State one reason why Carol might choose to pay the gift into her savings account, rather than use it to reduce the balance on her loan. **1**

Print your answers to Q6 (b), (c) (i) and (c) (ii) in:

- value view
- formula view.

7. Ecologists are carrying out a survey of plants at the side of a road. The side of the road is 500 metres long.

To count the number of plant species, the ecologists divide the side of the road into strips 20 metres long and study a few of these strips in detail.

In a randomly selected strip they study, they count 30 different species of plant. One ecologist argues that this means that in total there should be 750 different species of plant at the side of the road.

(a) (i) Explain why this is likely to be an overestimate. **1**

(ii) Suggest briefly how you might go about getting a better estimate without studying every strip at the side of the road. **1**

Rare daffodils grow in a section at the side of the road which is 170 metres long. An ecologist counts 7 rare daffodils in a random patch 1 square metre in area. They estimate that the side of the road is on average 2 metres wide with an error of ± 0.4 metres.

(b) Estimate the total number of rare daffodils at the side of the road and give an estimate of the relative error in this number. **5**

[Turn over

8. You must refer to the spreadsheet file 'Q8 Biomass Data' when answering this question. You must complete parts (a) (i), (b) and (c) using **statistical software**. You must copy and paste your answers to parts (a) (i), (b) and (c) into the word processing file 'Q8 Biomass Answers'. Parts (a) (ii), (b), (c), and (d) must be completed in the answer spaces provided.

The UK has a varied mix of renewable technologies and fuels including biomass which is a key fuel source for the decarbonisation of electricity generation and heat provision. Woodchips are an example of a source of biomass.

The heat output of woodchips used to generate energy varies depending on moisture content. The data in the spreadsheet file shows moisture content (%) and the associated heat outputs (kilowatts) of various random samples of woodchip.

(a) (i) Construct a scatter diagram for the data. **2**

(ii) Make two comments about the scatter diagram. **2**

(b) Find the equation of the regression line of heat output on percentage moisture content. **2**

(c) Estimate the heat output of woodchips with a moisture content of 35% and interpret this estimate by referring to a prediction interval. **2**

(d) Explain the implication of your analysis for anyone intending to use woodchips as a source of heat. **1**

Print your answers to Q8 (a) (i), (b) and (c).

9. A TV production company is responsible for the delivery of a new quiz show to a national television channel.

If the production is delayed, the company will be charged an additional £10,000.

For the purposes of the cost benefit analysis, it is assumed that there are only two events that will cause a delay:

- 0.3 probability that a key member of staff will fall ill
- 0.1 probability that there will be equipment failure.

(a) Calculate the expected value of costs that should be considered for the cost benefit analysis. **3**

It is possible to use the following control measures:

- Control Measure 1 — Employ back up staff who can replace anyone unwell, at a cost of £1000.
- Control Measure 2 — Spend £3000 on an equipment inspection to ensure all equipment is functioning correctly.

(b) Calculate the expected value of costs if control measure 1 is taken. **1**

The expected value of costs if control measure 2 is taken is £6000.

(c) State which control measure(s) should be taken.

Give a reason to support your recommendation. **1**

[Turn over

10. You must refer to the spreadsheet file 'Q10 Visits Abroad' when answering this question. You must complete parts (a) (i), (c) and (d) using statistical software. You must copy and paste your answers to parts (a) (i), (c) and (d) into the word processing file 'Q10 Visits Abroad Answers'. Parts (a) (ii), (b) and (d) must be completed in the answer spaces provided.

The data in the spreadsheet file shows the number of visits abroad (in thousands) by UK nationals to various countries in 2018 and 2019.

(a) (i) Construct boxplots for the data. **1**

(ii) Make three comments about your diagram making specific reference to any unusual data. **3**

(b) Generate descriptive statistics to form a subjective impression of whether there is difference in average visitor numbers between years. **2**

(c) Comment on the assumption associated with the appropriate hypothesis test for this data. **1**

(d) Use a hypothesis test to determine if there is any statistically significant difference between visitor numbers in 2018 vs 2019. **3**

Print your answers to Q10 (a) (i), (c) and (d).

11. You must refer to the spreadsheet file 'Q11 Karen's Pension' when answering this question. You must complete parts (a) and (b) using the spreadsheet file. Part (c) must be completed in the answer space provided.

Karen decides to start saving regularly towards her retirement. She aims to retire from work on her 65th birthday.

Karen wants to estimate how much she will need to save by age 65 to cover her costs of living in retirement.

She expects these costs of living will be payable at the start of each month, from her 65th birthday, up to and including her 80th birthday. She estimates the costs will initially be £1500 at age 65 and will increase every month with inflation, at an effective rate of 2.5% per year.

Karen also expects that she will be able to earn an effective rate of interest of 4% per year on her savings during her retirement.

(a) Open the 'Pension Fund' worksheet. Complete the relevant formulae in the spreadsheet to show that she must save approximately £243,960 by her 65th birthday to cover her expected costs of living in retirement. **5**

Karen has just celebrated her 20th birthday, and her monthly salary is £2600, which is constant and paid to her at the start of each month. She plans to make regular level contributions to her savings directly from her salary, in order to meet her expected costs of living in retirement. She decides to make these contributions immediately when her salary is received, every month between now and age 65.

Karen expects to earn an effective rate of interest of 5% per year on her savings before retirement.

(b) Use the 'Savings Account' worksheet to calculate what proportion of her salary she must save each month to meet her expected costs of living in retirement. **7**

(c) Describe **two** risks that could result in Karen not having enough savings to cover her living costs in retirement. **2**

Print your answers to Q11 (a) and (b) in:

- value view
- formula view.

[END OF ADDITIONAL SPECIMEN QUESTION PAPER]