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Mark

S844/76/01

Applications of Mathematics

Date — Not applicable

Duration — 2 hours 5 minutes

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 4, 8 and 10 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:

- **'Q4 School Roll.xlsx'** — a spreadsheet file containing 1 worksheet
- **'Q8 Biomass Data'** — a spreadsheet file containing 1 worksheet (Biomass Data)
- **'Q8 Biomass Answers'** — a word processing file
- **'Q10 Carol's Gift'** — a spreadsheet file containing 1 worksheet (Original Loan)

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.

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 (✓)
4 (a) (i) and (c) (i)	'School Roll' worksheet • value view • formula view This should include the graph.	
8 (a) (i)	Scatter diagram	
8 (b)	Statistical software output	
8 (c)	Statistical software output	
10 (b)	Original Loan worksheet • value view • formula view	
10 (c) (i) and 10 (c) (ii)	Pay Lump Sum worksheet • value view • formula view	

Total marks — 65

Attempt ALL questions

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

   State any assumptions you make. **4**

    [Turn over

2. A group of students were asked which types of TV programmes they watch regularly from a choice of comedy, reality and drama.

The results were as follows:

- 60 watch comedy
- 55 watch reality
- 21 watch drama
- 45 watch both comedy and reality
- 12 watch both reality and drama
- 14 watch both drama and comedy
- 8 watch **all three** of these programmes regularly
- 2 watched **none** of these programmes regularly.

(a) Complete the Venn diagram to show this information: **3**

comedy   reality
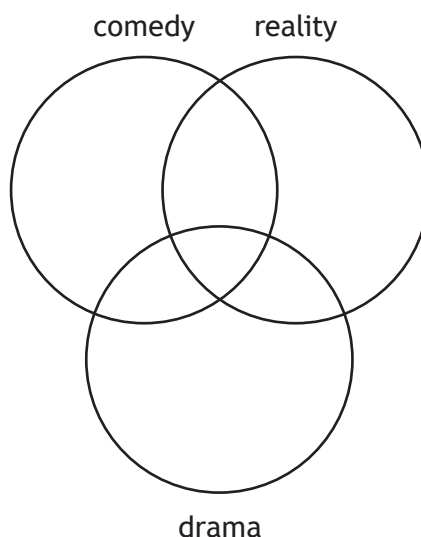
drama

(b) If a student is selected randomly, find the probability that they watch reality and drama TV programmes but not comedy TV programmes. **2**

3. 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**

4. You must refer to the spreadsheet file 'Q4 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.

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

A				C			D				F		
dismantle old shed				prepare ground			build new shed				paint shed		
0	2	3		3	4	7	7	3	10		10	2	12

B				E			G		
remove grass and plants				install new grass and plants			add furniture		
0	3	3		7	2	11	9	1	12

(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**

6. The three diagrams, below, show how parachutists' heights vary above the ground over a period of time.

parachutist A   parachutist B   parachutist C
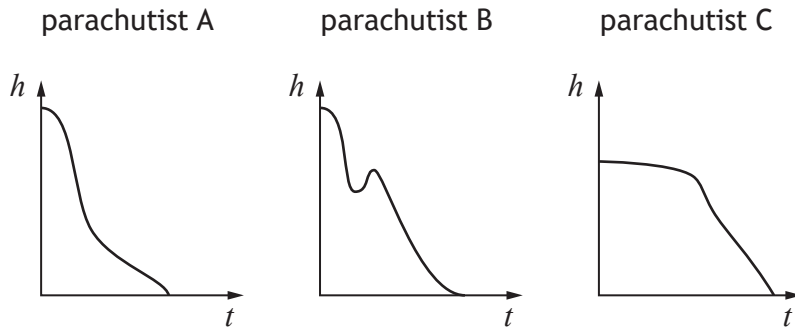
State which graph could not model their jump.

Explain your answer clearly.

2

7. 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**

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 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 Q10 (b), (c) (i) and (c) (ii) in:

• value view

• formula view.

11. 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 SPECIMEN QUESTION PAPER]