

FOR OFFICIAL USE



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National
Qualifications
ADDITIONAL SPECIMEN

Mark

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S844/76/01

Applications of Mathematics

Date — Not applicable

Duration — 2 hours 30 minutes



Fill in these boxes and read what is printed below.

Full name of centre

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Town

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Forename(s)

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Surname

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Number of seat

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Date of birth

Day

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Month

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Year

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Scottish candidate number

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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 3 (a) (i), (b) (i) and (c) and 10 (a), (c) and (d) 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.



Information and instructions for candidates

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

- **Q3 Pizza delivery** — a spreadsheet file containing 1 worksheet (Pizza Delivery)
- **Q3 Pizza delivery answers** — a word processing file
- **Q10 House purchase** — a spreadsheet file containing 3 worksheets ('Historic Exchange Rates', 'Banco de Plata Savings', 'Banco de Plata Mortgage')

Your output from the statistical software in questions 3 (a) (i), (b) (i) and (c) must be copied and pasted into the file 'Q3 Pizza delivery 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 (✓)
3 (a) (i)	Graph	
3 (b) (i)	Calculation	
3 (c)	Hypothesis test	
10 (a)	'Banco de Plata Savings' worksheet <ul style="list-style-type: none">• value view• formula view	
10 (c)	'Banco de Plata Mortgage' worksheet <ul style="list-style-type: none">• value view• formula view	
10 (d)	'Banco d'Oro Mortgage' worksheet <ul style="list-style-type: none">• value view• formula view	

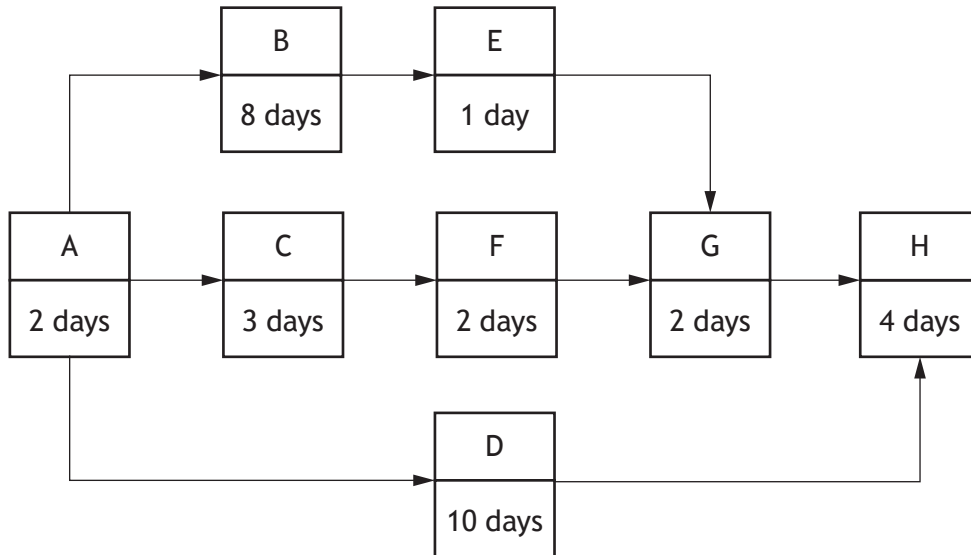


* S 8 4 4 7 6 0 1 0 2 *

Attempt ALL questions.

Total marks — 80

1. The following activity network diagram is used to plan a construction project:



(a) (i) State the definition of the 'critical path' of a project. 1

(ii) Determine the critical path for the project above. 1

(b) The project is due to start on Monday 3 February, with work only carried out on weekdays. Assuming no delays, state the earliest possible completion date. 2

[Turn over



1. (continued)

- (c) Calculate the maximum number of days that Activity C could be delayed without causing a change to the completion date.

1

- (d) Activity D initially involves the hiring of specialist equipment to be used on Activity H.

State the date you would advise that this activity is started.

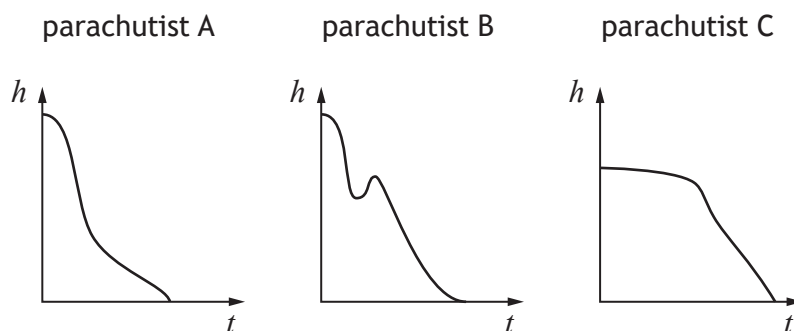
Give a reason for your answer.

2



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

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



State which graph could not model their jump.

Explain your answer clearly.

2

[Turn over



* S 8 4 4 7 6 0 1 0 5 *

3. You must refer to the spreadsheet file 'Q3 Pizza delivery' when answering this question. You must complete parts (a) (i), (b) (i) and (c) using statistical software. You must copy and paste your answers to parts (a) (i), (b) (i) and (c) into the word processing file 'Q3 Pizza delivery answers'. Parts (a) (ii), (b) (ii) and (d) must be completed in the answer spaces provided.

The data in the spreadsheet file shows the times (in minutes) for pizzas to be delivered by Pizza Palace and Pentominos.

- (a) (i) Illustrate the data on a suitable graph. 1
 (ii) Make two valid comments comparing the delivery times between the two companies. 2

- (b) (i) Calculate appropriate descriptive statistics to summarise the delivery times for each company. 2
 (ii) Give a reason for your choice. 1

- (c) Use a hypothesis test to determine if there is a significant difference in average delivery times. 3
 (d) Comment on which company you would choose if you want a pizza in a hurry. 1

Print your answers to 3(a) (i), (b) (i) and (c).

4. James started University on 1 September 2014 and finished on 30 June 2018. He received a student loan of £5000 on the 1 September each year while he studied.

Student loan interest rates (per annum)

Dates	Interest rate
1 September 2014 to 31 August 2015	1.5%
1 September 2015 to 31 August 2016	0.9%
1 September 2016 to 30 November 2017	1.25%
1 December 2017 to 31 August 2018	1.5%
1 September 2018 to 31 August 2019	1.75%

- (a) Calculate how much James owed for his student loan when he finished University.

4

Student loan repayments are only paid when somebody earns over a certain amount. This amount is called the threshold.

Loan repayments are calculated at 9% of the amount earned over the threshold.

The threshold on 6 April 2018 was £1577 per month (before deductions).

After finishing University James started a job.

He started his job on the 1 September 2018 and was paid monthly at the end of each month.

He was paid £32,000 per annum.

James makes a single loan repayment to cover the period from September to March on 31 March 2019.

- (b) Calculate the amount James owes on his student loan on 1 April 2019.

3



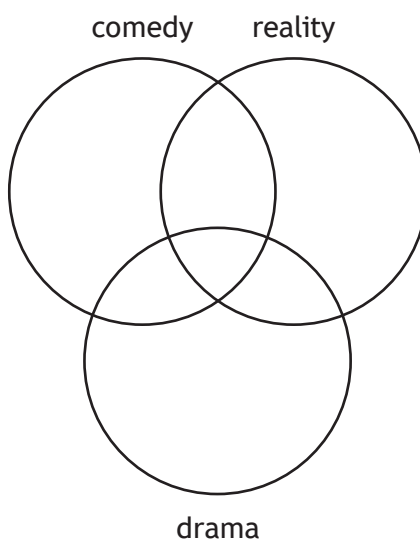
5. A group of students were asked which types of TV programmes they watch regularly from a choice of comedy, reality and drama.

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

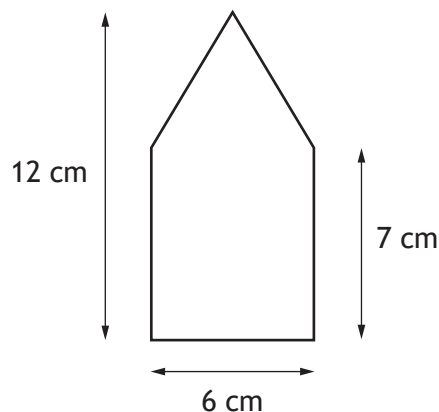


- (b) If a student is selected randomly, find the probability that they watch reality and drama TV programmes but not comedy TV programmes.

2

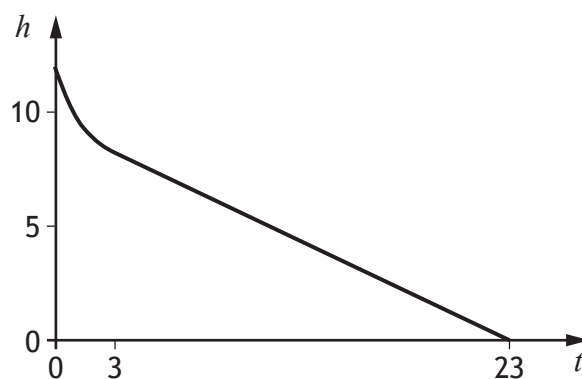
6. A candle company produces a candle. The top part of the candle is in the shape of a cone with a cylinder at the bottom.

The cylinder has a diameter of 6 cm and a height of 7 cm. The total height of the candle is 12 cm, as shown in the diagram.



As the candle burns, the height of the candle is recorded.

The graph shows how the candle's height, h cm, varies with time, t hours.



- (a) Explain why the initial part of the graph is not a straight line.

1

[Turn over



6. (continued)

After the upper part of the candle has burned the height, h cm, follows the model, $h = mt + c$.

- (b) Calculate the rate of change in the graph, which is represented by m in the model.

3

The company wants to change the length of the candle burn, they also want the diameter of both parts to stay the same and also the length of the initial burn to remain the same.

- (c) Calculate the total height of the new candle if they wish it to burn for 40 hours.

3

7. Zainab currently works 3 days per week part-time and earns a gross salary of £12,500 per year.

(For all calculations assume there are 52 weeks in a year.)

The Scottish tax bands and National Insurance contributions given in the Pre-release material apply throughout this question.

(a) Calculate how much Zainab earns in a year in her current job after any tax and National Insurance contributions.

3

- Zainab pays £45 per day for childcare and £10 per day for travel.
- Zainab is entitled to 25 days annual leave working full-time or $\frac{3}{5}$ of these working part-time.
- Childcare and travel are not required during annual leave.
- Zainab is paid in 12 equal monthly payments per year.

(b) Calculate how much Zainab will earn per month, on average, after all her costs are deducted.

3

[Turn over



7. (continued)

Zainab has been offered a full-time promotion.

- The promoted position has a gross salary of £24,450.
- Full-time positions are 5 days per week.

(c) Zainab states she will be more than £248 better off per month working full-time.

Determine if she is correct.

Justify your answer by calculations.

4

(d) Zainab decides to accept the full-time promotion.

State two reasons for this decision.

2



8. A storage company charges £30 per week for a storage room when booked in advance.

If the room is needed for longer than booked, the hire charge for each extra week is £40.

Greg is moving house and needs to put his belongings into storage.

It is expected that he will move into his new home in 4 weeks.

It is estimated that there is a 40% chance that the move will be delayed, and the storage room will be needed for longer than 4 weeks.

It is estimated that, if the move is delayed, there is a 90% chance that the room will be needed for 1 extra week and a 10% chance that it will be needed for 2 extra weeks.

Greg has three options:

Option A

Hire the room for 4 weeks.

If the move is delayed, pay the increased hire charge.

Option B

Hire the room for 5 weeks.

If the move is further delayed, pay the increased hire charge.

Option C

Hire the room for 6 weeks.

- (a) Calculate the expected cost of Option C.

1

[Turn over



8. (continued)

(b) Calculate the probability of the following events occurring:

(i) the room will be needed for 1 extra week

1

(ii) the room will be needed for 2 extra weeks.

1

(c) Calculate the expected cost of **Option A**.

3

(d) Calculate the expected cost of **Option B**.

2

(e) Based on the cost analysis, make a recommendation of which option Greg should choose.

Justify your answer.

1



9. A food company produces evaporated milk.

The average amount of evaporated milk produced is 1600 litres per hour.

The evaporated milk is sold in cans.

The cans are cylindrical in shape with a diameter of 6 cm and a height of 11.7 cm.

The food company must buy 1 m by 1 m sheets of steel to make the cans.

- (a) (i) State the relationship between the evaporated milk production rate, R (expressed in litres per month), the volume of a can, V (expressed in litres), and the number of cans required per month, N .

1

- (ii) Estimate the number of cans that the food company must produce per month, stating any assumptions that you make.

2

- (iii) Estimate the number of sheets, to the nearest 1000, that the food company must buy per month, stating any assumptions that you make.

2

[Turn over



9. (continued)

- (b) If production is more than expected, the food company can buy up to 3000 extra sheets of steel per month.

Calculate the percentage evaporated milk production can vary without running out of cans.

2



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

10. You must refer to the spreadsheet file Q10 House purchase when answering this question. You must complete parts (a), (c) and (d) using the spreadsheet file. Parts (b) and (e) must be completed in the answer spaces provided.

Sophie intends to buy a house in Spain. She opens a bank account with Banco de Plata to save for the deposit.

On the 1 January 2014 she made an initial deposit of £17,000 followed by a series of annual payments as shown on the ‘Banco de Plata Savings’ worksheet.

The annual effective rates of interest (AER) for the five-year period are shown in the worksheet.

- (a) Using the relevant exchange rates from the ‘Historic Exchange Rates’ worksheet, complete the ‘Banco de Plata Savings’ worksheet to show that the balance at 1 January 2019 will be €41,486.05.

Print the ‘Banco de Plata Savings’ worksheet in:

- value view
- formula view.

3

Sophie must pay a 30% deposit to get a mortgage with Banco de Plata with a fixed interest rate of 2.5% per annum effective for 20 years.

- (b) Calculate the maximum value of property Sophie can afford to buy.

1

Sophie decides to buy a property with this maximum value. She uses her savings to fund the deposit and takes out a mortgage with Banco de Plata to cover the remaining balance of the property.

The loan will be repaid by making level annual repayments at the end of each year.

- (c) Open the ‘Banco de Plata Mortgage’ worksheet. Complete formulae in the loan schedule and hence calculate the total amount repayable to Banco de Plata over the 20-year term.

Print the ‘Banco de Plata Mortgage’ worksheet in:

- value view
- formula view.

5

[Turn over



10. (continued)

Another Spanish bank, Banco d'Oro, offers Sophie a mortgage of the same amount. The level annual repayment is calculated assuming the annual effective interest rate is 1.5% fixed for 25 years.

After the repayment made at time 5 years, Banco d'Oro changes the interest rate to 3.5% for the remainder of the term of the loan.

The loan will be repaid by making level annual repayments at the end of each year.

- (d) Create a new worksheet by copying over the 'Banco de Plata Mortgage' worksheet and rename it 'Banco d'Oro Mortgage'. By adapting the formulae, calculate the total amount repayable to Banco d'Oro over the full 25-year term.

Print the 'Banco d'Oro Mortgage' worksheet in:

- value view
- formula view.

3

- (e) State one advantage and one disadvantage of Sophie taking out the Banco d'Oro mortgage instead of the Banco de Plata mortgage.

2

[END OF SPECIMEN QUESTION PAPER]

