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National  
Qualifications  
SPECIMEN ONLY

Mark

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**S844/76/01**

**Applications of Mathematics**

Date — Not applicable

Duration — 2 hours 5 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

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**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.



\* 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:

- ‘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 <ul style="list-style-type: none"><li>• value view</li><li>• formula view</li></ul> 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 <ul style="list-style-type: none"><li>• value view</li><li>• formula view</li></ul>	
10 (c) (i) and 10 (c) (ii)	Pay Lump Sum worksheet <ul style="list-style-type: none"><li>• value view</li><li>• formula view</li></ul>	



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



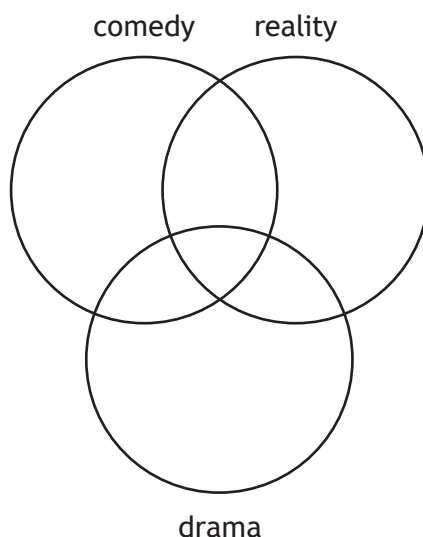
2. A group of students were asked which types of TV programmes they watch regularly from a choice of comedy, reality and drama.

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



(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.

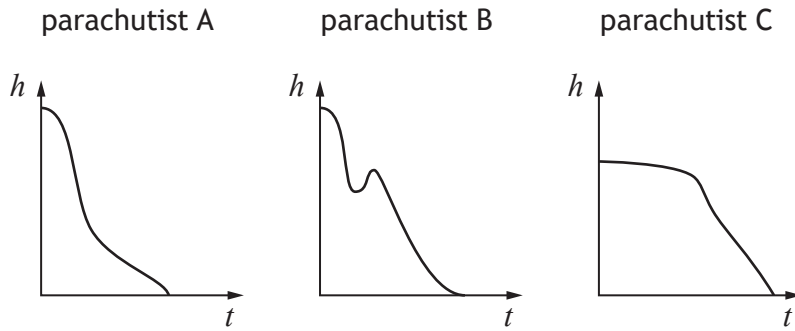
- (c) (i) Extend the table in your worksheet to construct a graph to show what is predicted to happen to the school roll in the long term.  
**You must consider what happens to the school roll beyond August 2031.** 2  
 (ii) Use your graph to determine whether the new capacity is suitable. 1

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.





6. 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



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

[Turn over



\* S 8 4 4 7 6 0 1 0 9 \*

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 14<sup>th</sup> 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.
- (ii) On the ‘Pay Lump Sum’ worksheet, calculate how much Carol would save in interest payments by making this lump sum payment.

3

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]



MARKS DO NOT  
WRITE IN  
THIS  
MARGIN

ADDITIONAL SPACE FOR ANSWERS



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WRITE IN  
THIS  
MARGIN

ADDITIONAL SPACE FOR ANSWERS





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Qualifications  
SPECIMEN ONLY

**S844/76/11**

**Applications of Mathematics  
Data booklet**

Date — Not applicable

Duration — 2 hours 5 minutes

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**Pre-release material**

This booklet will be issued to centres in advance of the date of examination.

Candidates will be issued with a clean copy of this booklet. Copies will be issued at the start of the examination session and collected at the end of the session. Candidates must not take their own copies of this booklet into the examination.

Centres should ensure that candidates are familiarised with any contexts and information contained in this booklet in preparation for the examination.

Some examination questions will be based on this material.

This booklet contains a set of two documents:

1. Mountain gorillas
2. Some helpful R commands.



\* S 8 4 4 7 6 1 1 \*



## 1. Mountain gorillas

Deforestation is happening on a massive scale throughout the world and many animals are experiencing habitat loss. Conservation teams have been campaigning against deforestation in a bid to increase wildlife populations.

One success story is the mountain gorilla. More than half of the world's mountain gorillas live in the Virunga Mountains, a range of extinct volcanoes that border the Democratic Republic of Congo, Rwanda and Uganda.

A study in 2008 showed there were only 680 mountain gorillas in the Virunga Mountains. A further study in 2020 showed that due to conservation efforts, including clamping down on illegal logging, the population of mountain gorillas had increased.

Mountain gorillas are considered adults when they are 10 years old and will live for an average of 35 years.

Mountain gorillas survive on a **mainly** vegetarian diet consisting of bamboo shoots, fruit, and berries. Given the opportunity, mountain gorillas will also eat ants and termites, but their diet will remain mostly vegetarian.

## 2. Some helpful R commands

### Entering data to R Studio

To read in data from an Excel csv file called `excel_data.csv` to R Studio and name it `mydata`, first use the drop down menus in R Studio **Session > Set Working Directory > Choose Directory** to indicate the location of `excel_data.csv` on your computer. The following code will then read the data into R Studio:

```
mydata<-read.csv("excel_data.csv")
```

`attach(mydata)` — this adds the variable names

At the end of the analysis remember to use `detach(mydata)` to disassociate the variable names.

### (a) Graphics

If you have the numeric variables X and Y:

`hist(X, main="Title", xlab="x-axis label", ylab="Frequency")` — this produces a histogram of the variable named X, it adds a title and axis labels

`boxplot(Y, main="Title", ylab="y-axis label")` — produces a boxplot of the numerical variable Y

`boxplot(X,Y, main="Title", xlab="x-axis label", ylab="y-axis label", names=c("X", "Y"))` — produces a comparative boxplot of the numerical variables X and Y

`plot(X,Y, main="Scatterplot of Y on X", xlab="x-axis label", ylab="y-axis label")` — produces a scatterplot of Y on X

If you have the categorical variable X:

`table(X)` — computes the number of observations in each level of the categorical variable X

`pie(table(X), main="Title")` — this gives a simple pie chart of the categories in variable X with the specified title

`barplot(table(X), main="Title", xlab="x-axis label", ylab="Frequency")` — this gives a bar chart of the categorical variable X with the required title and axis labels

## **(b) Descriptive Statistics**

`mean(X)` — computes the mean of the numerical variable X

`sd(X)` — computes the standard deviation of the numerical variable X

`summary(X)` — computes the mean, median, minimum, maximum and upper and lower quartiles of the numerical variable X

`IQR(X)` — computes the interquartile range of the numerical variable X

`prop.table(table(X))` — returns the proportion of observations in each level of the categorical variable X

`prop.table(table(X))*100` — returns the percentage of observations in each level of the categorical variable X

`table(X, Y)` — produces a cross-tabulation between the two categorical variables X and Y

## **(c) Correlation and Regression**

`cor.test(X, Y)` — computes the correlation between X and Y and performs a test of the null hypothesis of zero correlation

`lm(Y~X)` — fits a linear regression line to the data (lm command stands for linear model)

`abline(lm(Y~X))` — adds the least squares linear regression line to an existing scatterplot of Y on X

`summary(lm(Y~X))` — displays the coefficient of determination (R-squared)

### To predict with your Linear Model:

`predict(lm(Y ~ X), newdata=data.frame(X=C), interval = "pred")` — computes the predicted value of Y when X=C along with a 95% prediction interval

## **(d) Hypothesis Testing**

`t.test(X, Y)` — performs a two-sample t-test between X and Y

`t.test(X, Y, paired=TRUE)` — performs a paired t-test between X and Y

`prop.test(x = c(a, b), n = c(n1, n2))` — performs a two-sample test for equality of proportions

**[END OF DATA BOOKLET]**



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**S844/76/01**

**Applications of Mathematics**

## Marking Instructions

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These marking instructions have been provided to show how SQA would mark this specimen question paper.

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## General marking principles for Higher Applications of Mathematics

*Always apply these general principles. Use them in conjunction with the detailed marking instructions, which identify the key features required in candidates' responses.*

*For each question, the marking instructions are generally in two sections:*

*generic scheme – this indicates why each mark is awarded*

*illustrative scheme – this covers methods which are commonly seen throughout the marking*

*In general, you should use the illustrative scheme. Only use the generic scheme where a candidate has used a method not covered in the illustrative scheme.*

- (a) Always use positive marking. This means candidates accumulate marks for the demonstration of relevant skills, knowledge and understanding; marks are not deducted for errors or omissions.
- (b) If you are uncertain how to assess a specific candidate response because it is not covered by the general marking principles or the detailed marking instructions, you must seek guidance from your team leader.
- (c) One mark is available for each •. There are no half marks.
- (d) If a candidate's response contains an error, all working subsequent to this error must still be marked. Only award marks if the level of difficulty in their working is similar to the level of difficulty in the illustrative scheme.
- (e) Only award full marks where the solution contains appropriate working. A correct answer with no working receives no mark, unless specifically mentioned in the marking instructions.
- (f) Candidates may use any mathematically correct method to answer questions, except in cases where a particular method is specified or excluded.
- (g) If an error is trivial, casual or insignificant, for example  $6 \times 6 = 12$ , candidates lose the opportunity to gain a mark, except for instances such as the second example in point (h) overleaf.

- (h) If a candidate makes a transcription error (question paper to script or within script), they lose the opportunity to gain the next process mark, for example

This is a transcription error and so the mark is not awarded.	$x^2 + 5x + 7 = 9x + 4$
This is no longer a solution of a quadratic equation, so the mark is not awarded.	$x - 4x + 3 = 0$
	$x = 1$

The following example is an exception to the above

This error is not treated as a transcription error, as the candidate deals with the intended quadratic equation. The candidate has been given the benefit of the doubt and all marks awarded.	$x^2 + 5x + 7 = 9x + 4$
	$x - 4x + 3 = 0$
	$(x - 3)(x - 1) = 0$
	$x = 1 \text{ or } 3$

- (i) **Horizontal/vertical marking**

If a question results in two pairs of solutions, apply the following technique, but only if indicated in the detailed marking instructions for the question.

Example:

	• <sup>5</sup>	• <sup>6</sup>
• <sup>5</sup>	$x = 2$	$x = -4$
• <sup>6</sup>	$y = 5$	$y = -7$

Horizontal: • <sup>5</sup> $x = 2$ and $x = -4$	Vertical: • <sup>5</sup> $x = 2$ and $y = 5$
• <sup>6</sup> $y = 5$ and $y = -7$	• <sup>6</sup> $x = -4$ and $y = -7$

You must choose whichever method benefits the candidate, **not** a combination of both.

- (j) In final answers, candidates should simplify numerical values as far as possible unless specifically mentioned in the detailed marking instruction. For example

$\frac{15}{12}$ must be simplified to $\frac{5}{4}$ or $1\frac{1}{4}$	$\frac{43}{1}$ must be simplified to 43
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$\frac{15}{0.3}$ must be simplified to 50	$\frac{4}{\cancel{5}}/3$ must be simplified to $\frac{4}{15}$
---	---

$\sqrt{64}$  must be simplified to 8\*

\*The square root of perfect squares up to and including 144 must be known.

(k) Do not penalise candidates for any of the following, unless specifically mentioned in the detailed marking instructions:

- working subsequent to a correct answer
- correct working in the wrong part of a question
- legitimate variations in numerical answers/algebraic expressions, for example angles in degrees rounded to nearest degree
- omission of units
- bad form (bad form only becomes bad form if subsequent working is correct), for example

$(x^3 + 2x^2 + 3x + 2)(2x + 1)$  written as

$(x^3 + 2x^2 + 3x + 2) \times 2x + 1$

$= 2x^4 + 5x^3 + 8x^2 + 7x + 2$

gains full credit

- repeated error within a question, but not between questions or papers

(l) In any ‘Show that . . .’ question, where candidates have to arrive at a required result, the last mark is not awarded as a follow-through from a previous error, unless specified in the detailed marking instructions.

(m) You must check all working carefully, even where a fundamental misunderstanding is apparent early in a candidate’s response. You may still be able to award marks later in the question so you must refer continually to the marking instructions. The appearance of the correct answer does not necessarily indicate that you can award all the available marks to a candidate.

(n) You should mark legible scored-out working that has not been replaced. However, if the scored-out working has been replaced, you must only mark the replacement working.

(o) If candidates make multiple attempts using the same strategy and do not identify their final answer, mark all attempts and award the lowest mark. If candidates try different valid strategies, apply the above rule to attempts within each strategy and then award the highest mark.

For example:

Strategy 1 attempt 1 is worth 3 marks.	Strategy 2 attempt 1 is worth 1 mark.
Strategy 1 attempt 2 is worth 4 marks.	Strategy 2 attempt 2 is worth 5 marks.
From the attempts using strategy 1, the resultant mark would be 3.	From the attempts using strategy 2, the resultant mark would be 1.

In this case, award 3 marks.

Marking instructions for each question

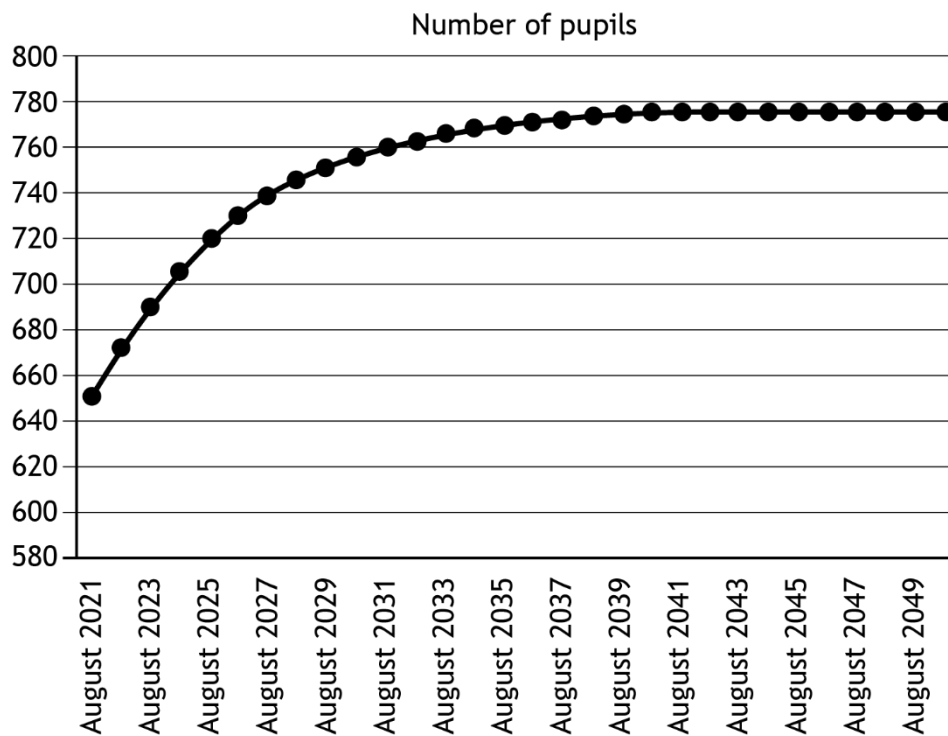
Question		Generic scheme	Illustrative scheme	Max mark
1.		<ul style="list-style-type: none"> <li>•<sup>1</sup> state an assumption about the number of hours sleep per night for an average person</li> <li>•<sup>2</sup> state an assumption about life expectancy for an average adult</li> <li>•<sup>3</sup> use a suitable number of days or weeks</li> <li>•<sup>4</sup> appropriate calculation leading to answer</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> 6-10 hours</li> <li>•<sup>2</sup> 65-90 years</li> <li>•<sup>3</sup> 365 days</li> <li>•<sup>4</sup> eg <math>8 \times 365 \times 75 = 219000</math> hours</li> </ul>	4
2.	(a)	<ul style="list-style-type: none"> <li>•<sup>1</sup> Interpret 'watch all three'</li> <li>•<sup>2</sup> Interpret 'watch none'</li> <li>•<sup>3</sup> Complete Venn diagram</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> 8 placed where three circles overlap</li> <li>•<sup>2</sup> 2 placed 'outside' circles</li> <li>•<sup>3</sup> Remaining values completed correctly</li> </ul>	3
	(b)	<ul style="list-style-type: none"> <li>•<sup>4</sup> Find total number of students</li> <li>•<sup>5</sup> Determine probability</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>4</sup> 75</li> <li>•<sup>5</sup> <math>\frac{4}{75}</math></li> </ul>	2



Question		Generic scheme	Illustrative scheme	Max mark	
3.	(a)	<p>Method 1</p> <ul style="list-style-type: none"> <li>•<sup>1</sup> Calculate balance on 1 January 2019</li> <li>•<sup>2</sup> Calculate balance 1 January 2020</li> <li>•<sup>3</sup> Calculate balance at end of 2020</li> </ul>	<p>Method 1</p> <ul style="list-style-type: none"> <li>•<sup>1</sup> <math>(500 \times 1.033 + 500) = 1016.50</math></li> <li>•<sup>2</sup> <math>(1016.50 \times 1.024 + 500) = 1540.90</math></li> <li>•<sup>3</sup> <math>(1540.90 \times 1.01) = 1556.30</math></li> </ul>	3	
		<p>Method 2</p> <ul style="list-style-type: none"> <li>•<sup>1</sup> Accumulate initial deposit</li> <li>•<sup>2</sup> Accumulate second deposit</li> <li>•<sup>3</sup> Accumulate third deposit and calculate balance at end of 2020</li> </ul>	<p>Method 2</p> <ul style="list-style-type: none"> <li>•<sup>1</sup> <math>(500 \times 1.033 \times 1.024 \times 1.01) = 534.18</math></li> <li>•<sup>2</sup> <math>(500 \times 1.024 \times 1.01) = 517.12</math></li> <li>•<sup>3</sup> <math>(500 \times 1.01 + 534.18 + 517.12) = 1556.30</math></li> </ul>		
<b>Notes:</b>					
1. If a candidate does not consider the additional £500 each year then only mark 1 in method 2 is available.					
2. Final answer must be to 2 decimal places, ignore any rounding errors or truncation					
	(b)	<ul style="list-style-type: none"> <li>•<sup>4</sup> Calculate balance 1 January 2021</li> <li>•<sup>5</sup> Calculate interest rate</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>4</sup> <math>1556.30 + 500 = \text{£}2056.30</math></li> <li>•<sup>5</sup> <math>\left( \left( \frac{2100}{2056.30} - 1 \right) \times 100 \right) = 2.125\% \dots</math></li> </ul>	2	
<b>Notes:</b>					
1. • <sup>4</sup> still available following from • <sup>3</sup>					
2. Final answer in the form of 1.02125... • <sup>5</sup> not available,					
3. Final answer must be stated explicitly in percentage form					
4.	(a)	(i)	<ul style="list-style-type: none"> <li>•<sup>1</sup> calculate appropriate school roll at end of year in cell D8</li> <li>•<sup>2</sup> use appropriate formula in C14</li> <li>•<sup>3</sup> calculate school roll in August 2031</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> eg =1-D7</li> <li>•<sup>2</sup> eg =ROUND(\$D\$5*C8+\$D\$6,0)</li> <li>•<sup>3</sup> 761 (pupils)</li> </ul>	3
		(ii)	<ul style="list-style-type: none"> <li>•<sup>4</sup> appropriate comment</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>4</sup> eg the number of pupils leaving each year is approximate</li> </ul>	1
<b>Notes:</b>					
1. • <sup>1</sup> Can be implied by • <sup>2</sup> (answer may not be in cell D9)					
2. • <sup>2</sup> can be found without the need for • <sup>1</sup> eg =ROUND(C14(1-\$D\$8)+\$D\$10,0)					
3. • <sup>3</sup> is only available for a whole number answer					
4. Rounding not needed, final answer will be 760, award 3/3					
	(b)		<ul style="list-style-type: none"> <li>•<sup>5</sup> appropriate comment about roll</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>5</sup> the school roll gradually increases each year</li> </ul>	1
<b>Notes:</b>					
1. Accept positive linear relationship					
2. Answer must be consistent with candidates working in (a)					

Question			Generic scheme	Illustrative scheme	Max mark
4.	(c)	(i)	<ul style="list-style-type: none"> <li>•<sup>6</sup> extend spreadsheet to (at least) August 2042</li> <li>•<sup>7</sup> construct graph</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>6</sup> evidence of 776 in C32</li> <li>•<sup>7</sup> see below</li> </ul>	2

Notes:



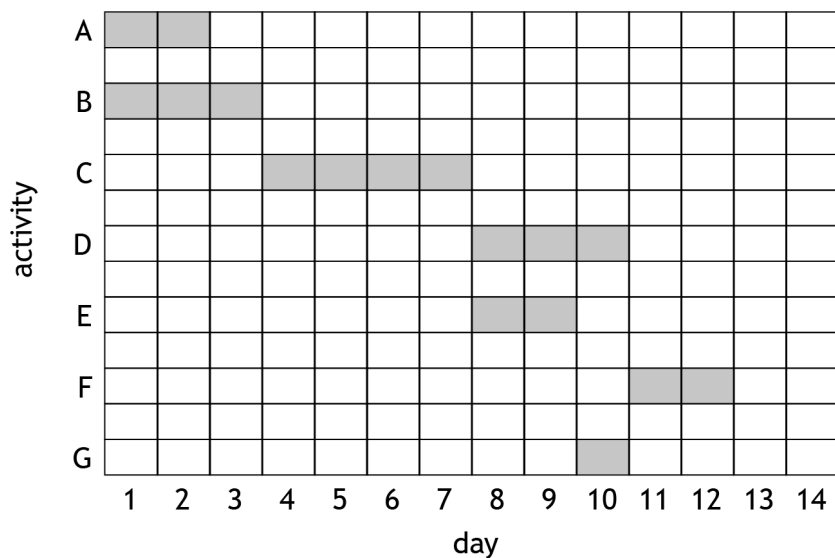
1. Labels not required as specifically assessed in a separate question.

		(ii)	<ul style="list-style-type: none"> <li>•<sup>8</sup> conclusion with justification</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>8</sup> Yes, the population is not expected to exceed 800 pupils.</li> </ul>	1
5.	(a)		<ul style="list-style-type: none"> <li>•<sup>1</sup> essential: select activity and give definition</li> <li>•<sup>2</sup> critical: select activity and give definition</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> A, E or G: an activity which is needed for the project to be finished but tends to have more flexibility in time constraints.</li> <li>•<sup>2</sup> B, C, D or F: an activity in the 'critical path', any delays to these activities would cause a delay in the project end date.</li> </ul>	2
	(b)		<ul style="list-style-type: none"> <li>•<sup>3</sup> explanation of values</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>3</sup> Activity cannot start before the end of day 3. The duration of the activity is 4 days. The latest possible finish time of the activity is the end of day 7.</li> </ul>	1

Question		Generic scheme	Illustrative scheme	Max mark
5.	(c)	<ul style="list-style-type: none"> <li>•<sup>4</sup> correct labels and scales on diagram</li> <li>•<sup>5</sup> task A or B plotted correctly</li> <li>•<sup>6</sup> all remaining tasks plotted correctly</li> <li>•<sup>7</sup> complete chart with linked tasks</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>4</sup> 'Activity' and letters vertically, 'Day' and numbers horizontally</li> <li>•<sup>5</sup> Task A or B correct duration and position</li> <li>•<sup>6</sup> All tasks correct duration and position</li> <li>•<sup>7</sup> A&amp;B to C, C to D&amp;E, D to F and E to G</li> </ul>	4

**Notes:**

1. Example solution:



2. Activity A can be started 1 day later.

3. Activity E & G can be started 1 or 2 days later.

6.		<ul style="list-style-type: none"> <li>•<sup>1</sup> State graph</li> <li>•<sup>2</sup> Give appropriate explanation</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> Graph B</li> <li>•<sup>2</sup> Explain that the parachutist cannot go upwards at any point during the jump</li> </ul>	2
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Question			Generic scheme	Illustrative scheme	Max mark
7.	(a)		<ul style="list-style-type: none"> <li>•<sup>1</sup> Calculate overall percentage increase</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> <math display="block">(((1.021 \times 1.005 \times 1.02) - 1) \times 100) = 4.66\dots</math></li> </ul>	1
<b>Notes:</b>					
1. Percentage must be explicitly stated ie $1.021 \times 1.005 \times 1.02 = 1.0466\dots$ award 0/1					
	(b)		<p style="text-align: center;">Method 1</p> <ul style="list-style-type: none"> <li>•<sup>2</sup> Calculate the price of petrol in 2018</li> <li>•<sup>3</sup> Calculate the cost of filling the tank</li> </ul>	<p style="text-align: center;">Method 1</p> <ul style="list-style-type: none"> <li>•<sup>2</sup> <math>(136 \div 1.0466\dots) = 130.3</math></li> <li>•<sup>3</sup> <math>(45 \times 1.303) = 58.64</math></li> </ul>	2
			<p style="text-align: center;">Method 2</p> <ul style="list-style-type: none"> <li>•<sup>2</sup> Calculate cost of tank in 2021</li> <li>•<sup>3</sup> Calculate the cost of filling the tank</li> </ul>	<p style="text-align: center;">Method 2</p> <ul style="list-style-type: none"> <li>•<sup>2</sup> <math>(1.364 \times 45) = 61.38</math></li> <li>•<sup>3</sup> <math>(61.38 \div 1.0466\dots) = 58.64</math></li> </ul>	
<b>Notes:</b>					
1. Accept 58.63, 58.65					
2. Accept answers in pounds or pence					
8.	(a)	(i)	<ul style="list-style-type: none"> <li>•<sup>1</sup> generate scatterplot</li> <li>•<sup>2</sup> appropriate title and axis labels</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> (See below)</li> <li>•<sup>2</sup> (See below)</li> </ul>	2
<b>Notes:</b>					
<p>scatterplot of heat output on moisture content</p>					
		(ii)	<ul style="list-style-type: none"> <li>•<sup>3</sup> appropriate comment</li> <li>•<sup>4</sup> appropriate comment</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>3</sup> eg linear relationship</li> <li>•<sup>4</sup> eg strong or negative association</li> </ul>	2
	(b)		<ul style="list-style-type: none"> <li>•<sup>5</sup> generate coefficient and intercept</li> <li>•<sup>6</sup> communicate equation</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>5</sup> output from software (see below)</li> <li>•<sup>6</sup> <math>\text{heat output} = -0.06 \times \text{moisture content} + 7.96</math></li> </ul>	2

Question		Generic scheme	Illustrative scheme	Max mark
<b>Notes:</b> Coefficients: (Intercept)      moisture 7.95778            -0.05751				
8.	(c)	<ul style="list-style-type: none"> <li>•<sup>7</sup> generate fitted value and prediction interval</li> <li>•<sup>8</sup> appropriate interpretation</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>7</sup> (See below)</li> <li>•<sup>8</sup> The estimated heat output of woodchip with a moisture content of 35% is 5.9 kW, however the true value is likely to be between 5.3 and 6.6 kW.</li> </ul>	2
<b>Notes:</b> fit      lwr      upr 5.944833 5.266433 6.623232				
	(d)	<ul style="list-style-type: none"> <li>•<sup>9</sup> appropriate explanation</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>9</sup> the lower the percentage moisture content of the woodchip the greater the heat output.</li> </ul>	1
9.	(a)	<ul style="list-style-type: none"> <li>•<sup>1</sup> calculate the probability of no issues occurring</li> <li>•<sup>2</sup> calculate the probability of at least one issue occurring</li> <li>•<sup>3</sup> calculate the expected penalty</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> <math>(1-0.3) \times (1-0.1) = 0.63</math></li> <li>•<sup>2</sup> <math>1-0.63 = 0.37</math></li> <li>•<sup>3</sup> <math>0.37 \times \text{£}10000 = \text{£}3700</math></li> </ul>	3
	(b)	<ul style="list-style-type: none"> <li>•<sup>4</sup> calculate expected penalty with control measure 1</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>4</sup> <math>\text{£}1000 + 0.1 \times \text{£}10000 = \text{£}2000</math></li> </ul>	1
	(c)	<ul style="list-style-type: none"> <li>•<sup>5</sup> decision with reason</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>5</sup> Control measure 1 should be taken as it has the lowest expected cost</li> </ul>	1
10.	(a)	<ul style="list-style-type: none"> <li>•<sup>1</sup> calculate monthly interest rate</li> <li>•<sup>2</sup> calculate interest accrued over 34 months</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> 0.103...% or <math>1.0125^{12}</math></li> <li>•<sup>2</sup> £89.56</li> </ul>	2
	(b)	<ul style="list-style-type: none"> <li>•<sup>3</sup> calculate monthly interest rate</li> <li>•<sup>4</sup> create formulae for interest, repayment and balance</li> <li>•<sup>5</sup> complete remainder of loan schedule for 48 months</li> <li>•<sup>6</sup> calculate monthly repayment and adjust final repayment</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>3</sup> 0.399...%</li> <li>•<sup>4</sup> D13, E13 and F13 (see spreadsheet)</li> <li>•<sup>5</sup> check cells D60, E60, F60 (see spreadsheet)</li> <li>•<sup>6</sup> £183.49 and £183.28</li> </ul>	4

Question			Generic scheme	Illustrative scheme	Max mark
10.	(c)	(i)	<ul style="list-style-type: none"> <li>•<sup>7</sup> copy over spreadsheet and calculate outstanding balance</li> <li>•<sup>8</sup> change repayment amount at appropriate time</li> <li>•<sup>9</sup> calculate new monthly payments and adjust final repayment</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>7</sup> £3322.54</li> <li>•<sup>8</sup> C27 (see spreadsheet)</li> <li>•<sup>9</sup> £104.71 and 104.44</li> </ul>	3
			<ul style="list-style-type: none"> <li>•<sup>10</sup> calculate total interest</li> <li>•<sup>11</sup> calculate interest saved</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>10</sup> £628.73</li> <li>•<sup>11</sup> £178.58</li> </ul>	2
	(d)		<ul style="list-style-type: none"> <li>•<sup>12</sup> state valid reason</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>12</sup> eg money remains accessible</li> </ul>	1
11.	(a)		<ul style="list-style-type: none"> <li>•<sup>1</sup> find multiplying factor</li> <li>•<sup>2</sup> calculate the population in 2032 and state conclusion</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>1</sup> <math>\frac{1004}{680}</math></li> <li>•<sup>2</sup> <math>\left(\text{eg } 1004 \times \frac{1004}{680}\right) \approx 1482</math> The expert is incorrect since <math>1482 &lt; 1600</math>.</li> </ul>	2
<b>Notes:</b> 1. $(1600/680) \times 1004$ leading to 2032 and the expert is correct since $2032 > 1600$ award $\frac{1}{2}$ 2. • <sup>2</sup> can only be awarded for relating a calculated answer to the expert's prediction, no need for a numerical comparison					
	(b)		<ul style="list-style-type: none"> <li>•<sup>3</sup> estimate total amount of food eaten in adulthood</li> <li>•<sup>4</sup> state assumption about maximum amount of termites and ants in diet</li> <li>•<sup>5</sup> estimate amount of termites and ants eaten based assumption</li> </ul>	<ul style="list-style-type: none"> <li>•<sup>3</sup> eg <math>30 \text{ kg} \times 365 \text{ days} \times 25 \text{ years} = 273\,750 \text{ kg}</math></li> <li>•<sup>4</sup> eg assume 49% as a maximum percentage of diet (since mainly vegetarian).</li> <li>•<sup>5</sup> eg <math>(49\% \times 273\,750) \approx 134\,000 \text{ kg}</math></li> </ul>	3
<b>Notes:</b> 1. Accept answers between 130 000 and 140 000 since the data in the question is given two significant figures.					

[END OF SPECIMEN MARKING INSTRUCTIONS]

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**Change since last published:**

Changes to details of 2. Some helpful R commands in the data booklet.