National
Qualifications
SPECIMEN ONLY

S844/76/01 **Applications of Mathematics**

Marking Instructions

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.

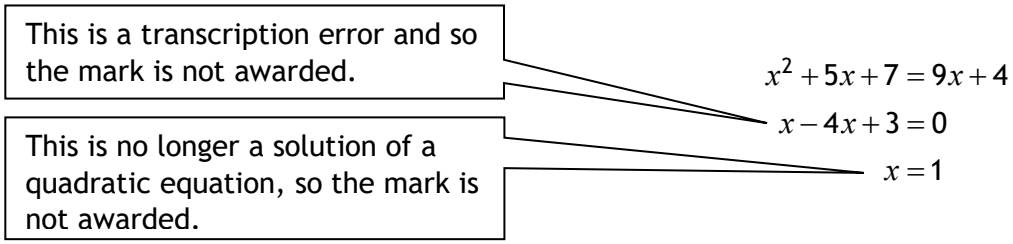
(d) If a candidate's response contains an error, all working subsequent to this error must still be marked. Only award marks if the level of difficulty in their working is similar to the level of difficulty in the illustrative scheme.

(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.

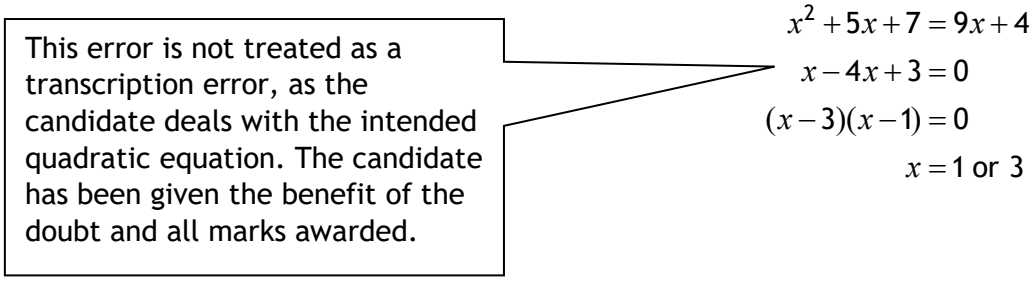
(f) Candidates may use any mathematically correct method to answer questions, except in cases where a particular method is specified or excluded.

(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



The following example is an exception to the above



(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:

	$\bullet^5$	$\bullet^6$
$\bullet^5$	$x=2$	$x=-4$
$\bullet^6$	$y=5$	$y=-7$

Horizontal: $\bullet^5$ $x=2$ and $x=-4$ Vertical: $\bullet^5$ $x=2$ and $y=5$
$\bullet^6$ $y=5$ and $y=-7$ $\bullet^6$ $x=-4$ 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

$\frac{15}{0.3}$ must be simplified to 50 $\frac{\frac{4}{5}}{3}$ 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.

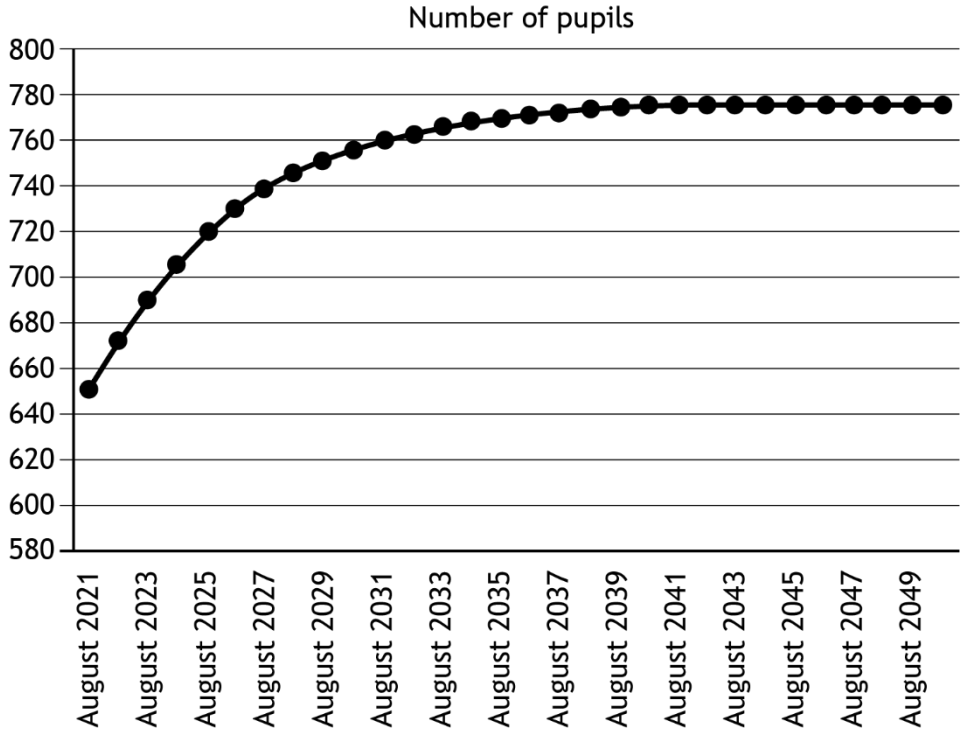
Marking instructions for each question

Question			Generic scheme	Illustrative scheme	Max mark
1.			$\bullet^1$ state an assumption about the number of hours sleep per night for an average person	$\bullet^1$ 6–10 hours	**4**
			$\bullet^2$ state an assumption about life expectancy for an average adult	$\bullet^2$ 65–90 years	
			$\bullet^3$ use a suitable number of days or weeks	$\bullet^3$ 365 days	
			$\bullet^4$ appropriate calculation leading to answer	$\bullet^4$ eg $8\times365\times75$ $=219000$ hours	
2.	(a)		$\bullet^1$ Interpret 'watch **all three**'	$\bullet^1$ 8 placed where three circles overlap	**3**
			$\bullet^2$ Interpret 'watch **none**'	$\bullet^2$ 2 placed 'outside' circles	
			$\bullet^3$ Complete Venn diagram	$\bullet^3$ Remaining values completed correctly	
	(b)		$\bullet^4$ Find total number of students	$\bullet^4$ 75	**2**
			$\bullet^5$ Determine probability	$\bullet^5$ $\frac{4}{75}$	

Question			Generic scheme	Illustrative scheme	Max mark
3.	(a)		Method 1 •1 Calculate balance on 1 January 2019 •2 Calculate balance 1 January 2020 •3 Calculate balance at end of 2020	Method 1 •1 $(500\times1.033+500)=1016.50$ •2 $(1016.50\times1.024+500)=1540.90$ •3 $(1540.90\times1.01)=1556.30$	**3**
			Method 2 •1 Accumulate initial deposit •2 Accumulate second deposit •3 Accumulate third deposit and calculate balance at end of 2020	Method 2 •1 $(500\times1.033\times1.024\times1.01)=534.18$ •2 $(500\times1.024\times1.01)=517.12$ •3 $(500\times1.01+534.18+517.12)$ $=1556.30$	
Notes: 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)		•4 Calculate balance 1 January 2021 •5 Calculate interest rate	•4 $1556.30+500=£2056.30$ •5 $\left(\left(\frac{2100}{2056.30}-1\right)\times100\right)=2.125...\%$	**2**
Notes: 1. •4 still available following from •3 2. Final answer in the form of 1.02125... •5 not available, 3. Final answer must be stated explicitly in percentage form					
4.	(a)	(i)	•1 calculate appropriate school roll at end of year in cell D8 •2 use appropriate formula in C14 •3 calculate school roll in August 2031	•1 eg =1-D7 •2 eg =ROUND($D$5*C8+$D$6,0) •3 761 (pupils)	**3**
		(ii)	•4 appropriate comment	•4 eg the number of pupils leaving each year is approximate	**1**
Notes: 1. •1 Can be implied by •2 (answer may not be in cell D9) 2. •2 can be found without the need for •1 eg =ROUND(C14(1-$D$8)+$D$10,0) 3. •3 is only available for a whole number answer 4. Rounding not needed, final answer will be 760, award 3/3					
	(b)		•5 appropriate comment about roll	•5 the school roll gradually increases each year	**1**
Notes: 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)	•[6] extend spreadsheet to (at least) August 2042 •[7] construct graph	•[6] evidence of 776 in C32 •[7] see below	**2**

Notes:



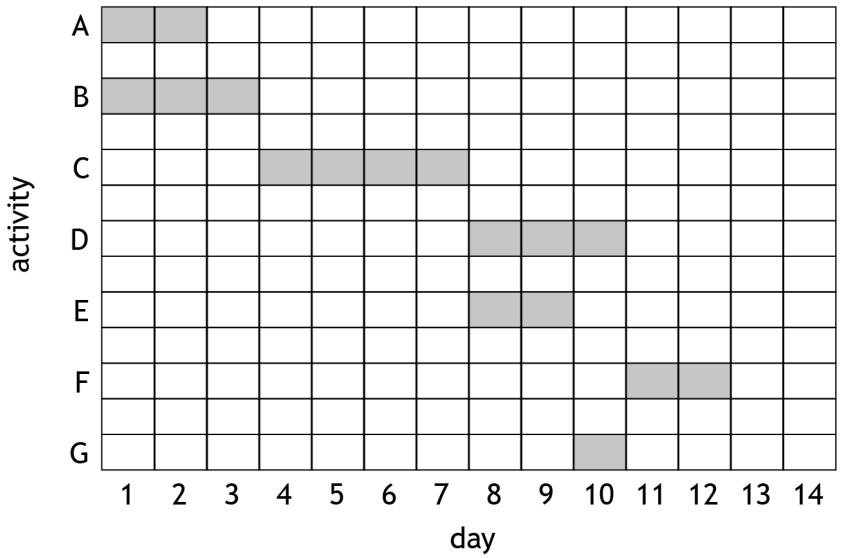
1. Labels not required as specifically assessed in a separate question.

		(ii)	•[8] conclusion with justification	•[8] Yes, the population is not expected to exceed 800 pupils.	**1**
5.	(a)		•[1] essential: select activity and give definition •[2] critical: select activity and give definition	•[1] A, E or G: an activity which is needed for the project to be finished but tends to have more flexibility in time constraints. •[2] 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.	**2**
	(b)		•[3] explanation of values	•[3] 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.	**1**

Question			Generic scheme	Illustrative scheme	Max mark
5.	(c)		•[4] correct labels and scales on diagram •[5] task A or B plotted correctly •[6] all remaining tasks plotted correctly •[7] complete chart with linked tasks	•[4] 'Activity' and letters vertically, 'Day' and numbers horizontally •[5] Task A or B correct duration and position •[6] All tasks correct duration and position •[7] A&B to C, C to D&E, D to F and E to G	**4**

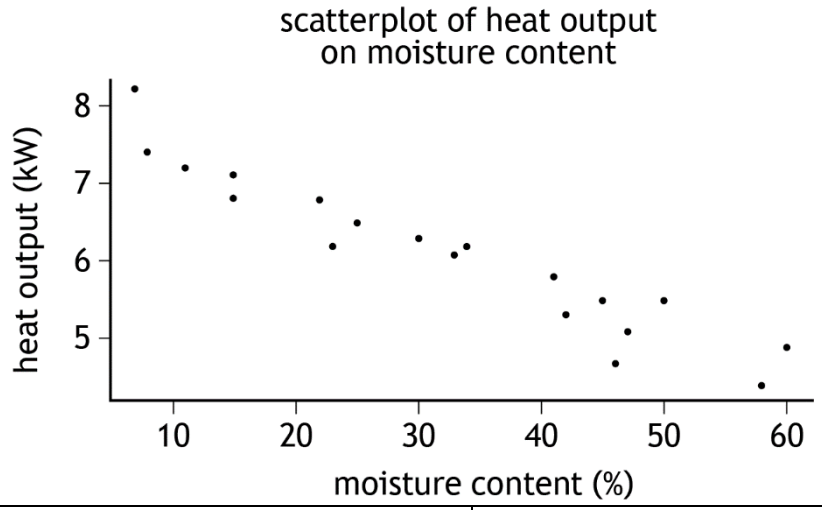
Notes:

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.			•[1] State graph •[2] Give appropriate explanation	•[1] Graph B •[2] Explain that the parachutist cannot go upwards at any point during the jump	**2**

Question			Generic scheme	Illustrative scheme	Max mark
7.	(a)		•[1] Calculate overall percentage increase	•[1] $\left(\left(\left(1.021\times1.005\times1.02\right)-1\right)\times100\right)=4.66...$	**1**
Notes: 1. Percentage must be explicitly stated ie 1.021 x 1.005 x 1.02 = 1.0466... award 0/1					
	(b)		Method 1 •[2] Calculate the price of petrol in 2018 •[3] Calculate the cost of filling the tank	Method 1 •[2] $\left(136\div1.0466...\right)=130.3$ •[3] $\left(45\times1.303\right)=58.64$	**2**
			Method 2 •[2] Calculate cost of tank in 2021 •[3] Calculate the cost of filling the tank	Method 2 •[2] $\left(1.364\times45\right)=61.38$ •[3] $\left(61.38\div1.0466...\right)=58.64$	
Notes: 1. Accept 58.63, 58.65 2. Accept answers in pounds or pence					
8.	(a)	(i)	•[1] generate scatterplot •[2] appropriate title and axis labels	•[1] (See below) •[2] (See below)	**2**
Notes: 					
		(ii)	•[3] appropriate comment •[4] appropriate comment	•[3] eg linear relationship •[4] eg strong or negative association	**2**
	(b)		•[5] generate coefficient and intercept •[6] communicate equation	•[5] output from software (see below) •[6] $\text{heat output}=-0.06\times\text{moisture content}+7.96$	**2**

Question			Generic scheme	Illustrative scheme	Max mark
Notes: Coefficients: (Intercept) moisture 7.95778 -0.05751					
8.	(c)		•7 generate fitted value and prediction interval •8 appropriate interpretation	•7 (See below) •8 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.	**2**
Notes: fit lwr upr 5.944833 5.266433 6.623232					
	(d)		•9 appropriate explanation	•9 the lower the percentage moisture content of the woodchip the greater the heat output.	**1**
9.	(a)		•1 calculate the probability of no issues occurring •2 calculate the probability of at least one issue occurring •3 calculate the expected penalty	•1 $(1-0.3)\times(1-0.1)=0.63$ •2 $1-0.63=0.37$ •3 $0.37\times£10000=£3700$	**3**
	(b)		•4 calculate expected penalty with control measure 1	•4 $£1000+0.1\times£10000=£2000$	**1**
	(c)		•5 decision with reason	•5 Control measure 1 should be taken as it has the lowest expected cost	**1**
10.	(a)		•1 calculate monthly interest rate •2 calculate interest accrued over 34 months	•1 0.103…% or $1.0125^{\frac{\dots}{12}}$ •2 £89.56	**2**
	(b)		•3 calculate monthly interest rate •4 create formulae for interest, repayment and balance •5 complete remainder of loan schedule for 48 months •6 calculate monthly repayment and adjust final repayment	•3 0.399…% •4 D13, E13 and F13 (see spreadsheet) •5 check cells D60, E60, F60 (see spreadsheet) •6 £183.49 and £183.28	**4**

Question			Generic scheme	Illustrative scheme	Max mark
10.	(c)	(i)	•[7] copy over spreadsheet and calculate outstanding balance •[8] change repayment amount at appropriate time •[9] calculate new monthly payments and adjust final repayment	•[7] £3322.54 •[8] C27 (see spreadsheet) •[9] £104.71 and 104.44	**3**
			•[10] calculate total interest •[11] calculate interest saved	•[10] £628.73 •[11] £178.58	**2**
	(d)		•[12] state valid reason	•[12] eg money remains accessible	**1**
11.	(a)		•[1] find multiplying factor •[2] calculate the population in 2032 and state conclusion	•[1] $\frac{1004}{680}$ •[2] $\left(\text{eg } 1004 \times \frac{1004}{680}\right) \approx 1482$ The expert is incorrect since $1482 < 1600$.	**2**
Notes: 1. (1600/680) x 1004 leading to 2032 and the expert is correct since 2032>1600 award ½ 2. •[2] can only be awarded for relating a calculated answer to the expert's prediction, no need for a numerical comparison					
	(b)		•[3] estimate total amount of food eaten in adulthood •[4] state assumption about maximum amount of termites and ants in diet •[5] estimate amount of termites and ants eaten based assumption	•[3] $\text{eg } 30\,\text{kg} \times 365\,\text{days} \times 25\,\text{years} = 273\,750\,\text{kg}$ •[4] eg assume 49% as a maximum percentage of diet (since mainly vegetarian). •[5] $\text{eg}\left(49\% \times 273\,750\right) \approx 134\,000\,\text{kg}$	**3**
Notes: 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]