National
Qualifications
2019

2019 Mathematics

National 5 - Paper 2

Finalised Marking Instructions

These marking instructions have been prepared by examination teams for use by SQA appointed markers when marking external course assessments.

General marking principles for National 5 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.

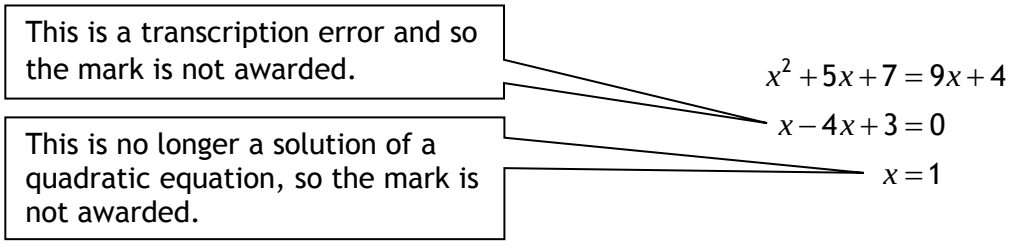
(d) If a candidate's response contains an error, all working subsequent to this error must still be marked. Only award marks if the level of difficulty in their working is similar to the level of difficulty in the illustrative scheme.

(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.

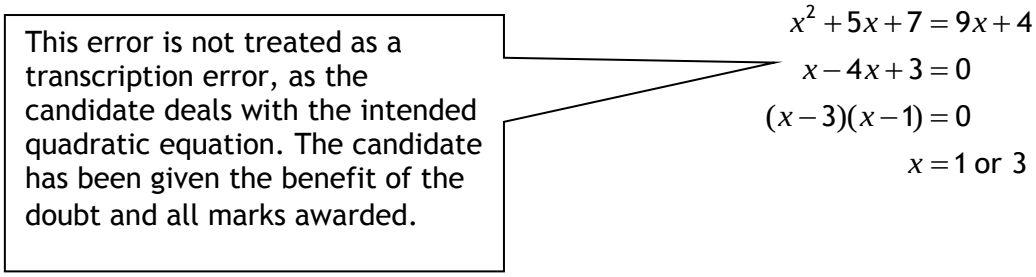
(f) Candidates may use any mathematically correct method to answer questions, except in cases where a particular method is specified or excluded.

(g) If an error is trivial, casual or insignificant, for example 6 x 6 = 12, candidates lose the opportunity to gain a mark, except for instances such as the second example in point (h) below.

(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

$\frac{15}{0{\cdot}3}$ must be simplified to 50 $\frac{4/5}{3}$ must be simplified to $\frac{4}{15}$

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

*The square root of perfect squares up to and including 100 must be known.

(k) Commonly Observed Responses (COR) are shown in the marking instructions to help mark common and/or non-routine solutions. CORs may also be used as a guide when marking similar non-routine candidate responses.

(l) 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

(m) 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.

(n) 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.

(o) 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.

(p) 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.	$\bullet^1$ know how to increase by 15%	$\bullet^1$ $\times 1{\cdot}15$	**3**
	$\bullet^2$ know how to calculate number of packages after 3 years	$\bullet^2$ $80\,000 \times 1{\cdot}15^3$	
	$\bullet^3$ evaluate	$\bullet^3$ 121 670	

Notes:

1. Correct answer without working — award 3/3

2. Where an incorrect percentage is used, the working must be followed through to give the possibility of awarding 2/3
   eg $80\,000 \times 0{\cdot}15^3 = 270$ — award 2/3 ×✓✓

3. Where an incorrect power (≥ 2) is used, the working must be followed through to give the possibility of awarding 2/3
   eg $80\,000 \times 1{\cdot}15^2 = 105\,800$, $80\,000 \times 1{\cdot}15^4 = 139\,920(\cdot 5)$ or $139\,921$ — award 2/3 ✓×✓

4. Where division is used
   (a) along with $1{\cdot}15$, $\bullet^1$ is not available
   eg $80\,000 \div 1{\cdot}15^3 = 52601(\cdot 2\ldots)$ — award 2/3 ×✓✓
   (b) along with an incorrect percentage, $\bullet^1$ and $\bullet^2$ are not available
   eg $80\,000 \div 0{\cdot}85^3 = 130266(\cdot 6\ldots)$ or 130266 — award 1/3 ××✓

Commonly observed responses:

1. $80\,000 \times 1{\cdot}015^3 = 83654(\cdot 27)$ — award 2/3 ×✓✓

2. $80\,000 \times 0{\cdot}85^3 = 49\,130$ — award 2/3 ×✓✓

3. $80\,000 \times 1{\cdot}15 = 92\,000$ — award 1/3 ✓××

4. $80\,000 \times 1{\cdot}15 \times 3 = 276\,000$ — award 1/3 ✓××

5. $80\,000 \times 0{\cdot}15 = 12\,000 \rightarrow 80\,000 + 3 \times 12\,000 = 116\,000$ — award 1/3 ✓××

6. $80\,000 \times 0{\cdot}15 \times 3 = 36\,000$ — award 0/3

Question	Generic scheme	Illustrative scheme	Max mark
2.	•1 start process •2 consistent solution	•1 $6^2+27^2+(-18)^2$ •2 33	**2**

Notes:

1. Correct answer without working, award 2/2
2. Accept $6^2+27^2+18^2$ for the award of •1
3. For a solution of $21\left(\sqrt{6^2+27^2-18^2}\right)$, with or without working, award 1/2
4. For eg $\sqrt{6^2+(-18)^2}=\sqrt{360}=18\cdot97\ldots$ or $6\sqrt{10}$ award 0/2
5. For eg $\dfrac{\sqrt{6^2+27^2+(-18)^2}}{2\times6\times27}=\dfrac{33}{324}=\dfrac{11}{108}=0\cdot1\ldots$ award 0/2

Commonly Observed Responses:
No working necessary

1. $\sqrt{1089}$ or 1089 award 1/2 ✓×

Question	Generic scheme	Illustrative scheme	Max mark
3.	•1 correct substitution into area of triangle formula •2 calculate area	•1 $\frac{1}{2}\times45\times70\times\sin129$ •2 $1224(\cdot004\ldots)(\text{cm}^2)$	**2**

Notes:

1. Correct answer without working award 2/2
2. For $45\times70\times\sin129=2448(\cdot0\ldots)$ award 1/2 ×✓
3. Inappropriate use of RAD or GRAD should only be penalised once in Qu 3, 7, 11, 14 or 19
   (a) $\pm$ 304·7…(RAD) [no working necessary] award 1/2 ✓×
   (b) 1414·3… (GRAD) [no working necessary] award 1/2 ✓×
4. Where cosine rule is used award 0/2

Commonly observed responses:

1. $\frac{1}{2}\times45\times70\times\sin129=\sqrt{1224\cdot\ldots}=34\cdot9\ldots$ award 1/2

Question			Generic scheme	Illustrative scheme	Max mark
4.			$\bullet^1$ correct method $\bullet^2$ answer	$\bullet^1$ $0{\cdot}08\times3{\cdot}6\times10^{-6}$ or equivalent $\bullet^2$ $2{\cdot}88\times10^{-7}$(kg)	2

Notes:

1. Correct answer without working — award 2/2
2. Accept $2{\cdot}9\times10^{-7}$ (no working necessary) — award 2/2
3. Accept $100\% = 3{\cdot}6\times10^{-6} \rightarrow 1\% = \ldots \rightarrow 8\% = \ldots$ for the award of $\bullet^1$
4. For $0{\cdot}000\,000\,288$ or $\dfrac{9}{31\,250\,000}$ (no working necessary) — award 1/2 ✓×
5. For ($0{\cdot}08\times3{\cdot}6 = 0{\cdot}288 \rightarrow$) $0{\cdot}288\times10^{-6}$ (no working necessary) — award 1/2 ✓×
6. $\bullet^2$ is available for correctly carrying out calculation(s) involving a number expressed in scientific notation and a change in the power of 10; the answer must be given in scientific notation.

Commonly observed responses:

1. $0{\cdot}08\times3{\cdot}6\times10^{-6} = 2{\cdot}8\times10^{-7}$ — award 1/2 ✓×
2. $0{\cdot}08\times3\,600\,000 = 2{\cdot}88\times10^{5}$ — award 1/2 ×✓
3. $3{\cdot}6\times10^{-6}\div8 = 4{\cdot}5\times10^{-7}$ — award 1/2 ×✓
4. (a) $3{\cdot}6\times10^{-6}\div8\% = 4{\cdot}5\times10^{-5}$ — award 1/2 ×✓
   (b) $3{\cdot}6\times10^{-6}\div8\% = 4{\cdot}5\times10^{-7}$ — award 0/2

Question	Generic Scheme	Illustrative Scheme	Max Mark
5.	$\bullet^1$ state coordinates of A $\bullet^2$ state coordinates of B	$\bullet^1$ (3,0,0) $\bullet^2$ (3,3,8)	**2**

Notes:

1. The maximum mark available is 1/2 where brackets are omitted and/or answers are given in component form
   See COR 1.

2. (a) For (3,0,0) and (3,3,8) award 2/2
   (b) For B(3,0,0) and A(3,3,8) award 1/2

3. For eg (0,0,3) **and** (8,3,3) [repeated error] award 1/2

4. $\bullet^2$ is available for answers of the form $A(x,0,0) \rightarrow B(x,x,8)$
   See COR 2.

5. Answer(s) given in two dimensions
   (a) Where both answers are given in 2D award 0/2
   (b) Where one answer is given in 2D and one in 3D
   (i) award 1/2 for the correct answer eg (3,0) and (3,3,8) award 1/2
   (ii)follow through mark is not available eg (6,0) and (6,6,8) award 0/2

Commonly observed responses:

1. (a) $\begin{pmatrix}3\\0\\0\end{pmatrix}$ and $\begin{pmatrix}3\\3\\8\end{pmatrix}$ award 1/2 ×✓

   (b) $\begin{matrix}3\\0\\0\end{matrix}$ and $\begin{matrix}3\\3\\8\end{matrix}$ award 1/2 ×✓

2. (a) (6,0,0) and (6,6,8) award 1/2 ×✓
   (b) (6,0,0) and (6,3,8) award 0/2

Question	Generic scheme	Illustrative scheme	Max mark
6.	$\bullet^1$ correct substitution into quadratic formula $\bullet^2$ evaluate discriminant $\bullet^3$ calculate both roots correct to one decimal place	$\bullet^1$ $\dfrac{-9 \pm \sqrt{9^2 - 4 \times 3 \times (-2)}}{2 \times 3}$ $\bullet^2$ 105 (stated or implied by $\bullet^3$) $\bullet^3$ $-3{\cdot}2,\ 0{\cdot}2$	**3**

Notes:

1. Correct answer without working — award 0/3

2. $\bullet^3$ is only available when $b^2 - 4ac > 0$, **and** the roots require rounding.

Commonly observed responses:

1. $105\ (b^2 - 4ac)$ — award 1/3 ×✓×

2. $\dfrac{-9 \pm \sqrt{9^2 - 4 \times 3 \times (-2)}}{2 \times 3} = \dfrac{-9 \pm \sqrt{57}}{6} = -2{\cdot}8, -0{\cdot}2$ — award 2/3 ✓×✓

3. $\dfrac{-9 \pm \sqrt{9^2 - 4 \times 3 \times 2}}{2 \times 3} = \dfrac{-9 \pm \sqrt{57}}{6} = -2{\cdot}8, -0{\cdot}2$ — award 1/3 ××✓

4. $\dfrac{-9 \pm \sqrt{9^2 - 4 \times 3 \times (-2)}}{2 \times 3} = \dfrac{-9 \pm \sqrt{105}}{6} = -10{\cdot}7, -7{\cdot}3$ — award 2/3 ✓✓×

5. $-9\dfrac{\pm\sqrt{9^2 - 4 \times 3 \times (-2)}}{2 \times 3} = -9\dfrac{\pm\sqrt{105}}{6} = -10{\cdot}7, -7{\cdot}3$ — award 2/3 ×✓✓

Question	Generic Scheme	Illustrative Scheme	Max Mark
7.	• [1] correct substitution into cosine rule to find angle Z • [2] evaluate • [3] calculate angle	• [1] $(\cos Z =)\dfrac{7\cdot 2^2+8\cdot 5^2-6\cdot 3^2}{2\times 7\cdot 2\times 8\cdot 5}$ • [2] $(\cos Z =)\dfrac{84\cdot 4}{122\cdot 4}\left(=\dfrac{211}{306}=0\cdot 689\ldots\right)$ • [3] $(Z =)46\cdot 406\ldots$	**3**

Notes:

1. Correct answer without working award 0/3

2. Where two or three more angles are calculated correctly
   (a) all three angles are calculated correctly; 46·4 need not be identified — award 3/3
   (b) two angles are calculated correctly and 46·4 has been clearly identified — award 3/3
   (c) two angles are calculated correctly and 46·4 has **NOT** been clearly identified — award 2/3 ✓✓×

3. Do not penalise omission of degrees sign

4. Disregard errors due to premature rounding provided there is evidence

5. Inappropriate use of RAD or GRAD should only be penalised once in Qu 3, 7, 11, 14 or 19
   (a) $0\cdot 81\ldots$ (RAD)
   (b) $51\cdot 56\ldots$ (GRAD)

Commonly observed responses:

1. $\dfrac{8\cdot 5^2+6\cdot 3^2-7\cdot 2^2}{2\times 8\cdot 5\times 6\cdot 3}\left(=\dfrac{60\cdot 1}{107\cdot 1}=\dfrac{601}{1071}=0\cdot 561\ldots\right)\rightarrow 55\cdot 86\ldots$ — award 2/3 ×✓✓

2. $\dfrac{7\cdot 2^2+6\cdot 3^2-8\cdot 5^2}{2\times 7\cdot 2\times 6\cdot 3}\left(=\dfrac{19\cdot 28}{90\cdot 72}=\dfrac{241}{1134}=0\cdot 212\ldots\right)\rightarrow 77\cdot 72\ldots$ — award 2/3 ×✓✓

3. $(\cos Z =)\dfrac{7\cdot 2^2+8\cdot 5^2-6\cdot 3^2}{2\times 7\cdot 2\times 8\cdot 5}=\sqrt{0\cdot 689\ldots}\rightarrow Z=33\cdot 8\ldots$ — award 2/3 ✓×✓

Question			Generic Scheme	Illustrative Scheme	Max Mark
8.			$\bullet^1$ correct substitution into formula for volume of sphere	$\bullet^1$ $\frac{4}{3}\times\pi\times12^3$	**5**
			$\bullet^2$ correct substitution into formula for volume of cylinder	$\bullet^2$ $\pi\times12^2\times58$	
			$\bullet^3$ know to add volume of **hemisphere** to volume of cylinder	$\bullet^3$ $\frac{1}{2}\times\frac{4}{3}\times\pi\times12^3+\pi\times12^2\times58$	
			$\bullet^4$ all calculations correct (must involve the sum or difference of two different calculations both involving π)	$\bullet^4(3619{\cdot}1\ldots+26238{\cdot}5\ldots)=29\,857{\cdot}\ldots$	
			$\bullet^5$ round final answer to 3 significant figures **and** state correct units	$\bullet^5$ 29 900 cm^3	

Question	Generic scheme	Illustrative scheme	Max mark

Notes:

1. Correct answer without working — award 0/5

2. Accept 29 900 ml or 29·9 litres

3. Accept variations in π

   eg $\frac{1}{2}\times\frac{4}{3}\times 3{\cdot}14\times 12^3+3{\cdot}14\times 12^2\times 58=29842{\cdot}56=29800\,\text{cm}^3$

4. $\bullet^5$ is not available if final answer is given in terms of π

   eg $\frac{2}{3}\times\pi\times 12^3+\pi\times 12^2\times 58=1152\pi+8352\pi=9504\pi\,\text{cm}^3$ — award 4/5 ✓✓✓✓×

5. In awarding $\bullet^5$

   (a) Intermediate calculations need not be shown

   eg $\frac{1}{2}\times\frac{4}{3}\times\pi\times 12^3+\pi\times 12^2\times 58=29900\,\text{cm}^3$ — award 5/5

   (b) Where intermediate calculations are shown, they must involve at least four significant figures

   eg $3619{\cdot}1\ldots+26238{\cdot}5\ldots=3620+26200=29820=29800\,\text{cm}^3$ — award 4/5 ✓✓✓✓×

Commonly observed responses:

1. $\frac{1}{2}\times\frac{4}{3}\times\pi\times 24^3+\pi\times 24^2\times 58=134000\,\text{cm}^3$ — award 4/5 ×✓✓✓✓

2. $\frac{1}{2}\times\frac{4}{3}\times\pi\times 24^2+\pi\times 24^2\times 58=106000\,\text{cm}^3$ — award 4/5 ×✓✓✓✓

3. $\frac{1}{2}\times\frac{4}{3}\times\pi\times 12^3+\pi\times 12^2\times 70=35300\,\text{cm}^3$ — award 4/5 ✓×✓✓✓

4. $\frac{1}{2}\times\frac{4}{3}\times\pi\times 24^3+\pi\times 24^2\times 70=156000\,\text{cm}^3$ — award 3/5 ××✓✓✓

5. $\frac{4}{3}\times\pi\times 12^3+\pi\times 12^2\times 58=33500\,\text{cm}^3$ — award 4/5 ✓✓×✓✓

6. $\frac{1}{2}\times\frac{4}{3}\times\pi\times 12^3+\pi\times 24\times 58=7990\,\text{cm}^3$ — award 4/5 ✓×✓✓✓

7. $\frac{4}{3}\times\pi\times 12^3=7240\,\text{cm}^3$ — award 2/5 ✓×××✓

8. $\frac{1}{2}\times\frac{4}{3}\times\pi\times 12^3=3620\,\text{cm}^3$ — award 2/5 ✓×××✓

9. $\pi\times 12^2\times 58=26200\,\text{cm}^3$ — award 2/5 ×✓××✓

Question	Generic scheme	Illustrative scheme	Max mark
9.	$\bullet^1$ know that $102{\cdot}5\% = £977{\cdot}85$	$\bullet^1$ $102{\cdot}5(\%) = 977{\cdot}85$	**3**
	$\bullet^2$ begin valid strategy	$\bullet^2$ $977{\cdot}85 \div 102{\cdot}5$ or equivalent	
	$\bullet^3$ complete calculation within valid strategy	$\bullet^3$ (£)23·85	

Notes:

1. Correct answer without working award 3/3

2. $2{\cdot}5\%\text{of}\,977{\cdot}85 = 24{\cdot}45$
   (a) **and** evidence of $\bullet^1$ award 1/3 ✓××
   (b) otherwise award 0/3

3. $97{\cdot}5\%\text{of}\,977{\cdot}85 = 953{\cdot}40$
   (a) **and** evidence of $\bullet^1$ award 1/3 ✓××
   (b) otherwise award 0/3

Commonly observed responses:

1. $\dfrac{977{\cdot}85}{1{\cdot}025} = 954$ award 2/3 ✓✓×

2. (a) $97{\cdot}5\% = 977{\cdot}85 \rightarrow \dfrac{977{\cdot}85}{0{\cdot}975} = 1002{\cdot}92$ award 1/3 ×✓×

   (b) $\dfrac{977{\cdot}85}{0{\cdot}975} = 1002{\cdot}92$ award 0/3

3. (a) $2{\cdot}5\% = 977{\cdot}85 \rightarrow \dfrac{977{\cdot}85}{0{\cdot}025} = 39\,114$ award 1/3 ×✓×

   (b) $\dfrac{977{\cdot}85}{0{\cdot}025} = 39\,114$ award 0/3

Question			Generic scheme	Illustrative scheme	Max mark
10.			•^{1} correct bracket with square •^{2} complete process	•^{1} $(x+5)^2\ldots$ •^{2} $(x\ldots5)^2-40$	**2**

Notes:

1. Correct answer without working award 2/2

2. Answer for •^{2} must be consistent with •^{1}

   eg (a) $(x\pm10)^2-115$ award 1/2 ×✓

   (b) $(x\pm10)^2-40$ award 0/2

Commonly observed responses:

No working necessary.

1. Award 2/2 for (a) $(x+5)^2+(-40)$ or $(x+5)^2+-40$

   (b) $(x+5)(x+5)-40$

2. Award 1/2 ×✓ for (a) $(x\pm5)-40$

   (b) $(x^2\pm5)-40$

   (c) $(x^2\pm5)^2-40$

   (d) $(x\pm5x)^2-40$

Question			Generic scheme	Illustrative scheme	Max mark
11.			**Method 1**	**Method 1**	**4**
			•1 use perimeter to find length of BC and use a valid strategy (Converse of Pythagoras' Theorem)	•1 eg $600^2 + 250^2$ and 650^2	
			•2 evaluate	•2 $600^2 + 250^2 = 422\ 500$ and $650^2 = 422\ 500$	
			•3 explicit comparison	•3 $600^2 + 250^2 = 650^2$	
			•4 conclusion with valid reason	•4 Yes, as angle is a right angle.	
			Method 2	**Method 2**	
			•1 use perimeter to find length of BC and use a valid strategy (correct substitution into cosine rule)	•1 $(\cos B =)\dfrac{600^2 + 250^2 - 650^2}{2 \times 600 \times 250}$	
			•2 evaluate	•2 $(\cos B =) 0$	
			•3 calculate angle	•3 $(B =) 90$ [stated explicitly]	
			•4 conclusion with reason	•4 Yes, as angle is a right angle	

Question	Generic scheme	Illustrative scheme	Max mark

Notes:

1. For method 1 there must be an explicit comparison stated for the award of $\bullet^3$

2. The conclusion must include a reference to 90° or a right angle.

3. (a) Where candidate starts by stating that eg $650^2 = 600^2 + 250^2$, $\bullet^1$ and $\bullet^3$ are not available

   $650^2 = 600^2 + 250^2$ $\times\bullet^1\ \times\bullet^3$ (marks not available)

   $422\,500 = 422\,500$ $\checkmark\bullet^2$ (evaluation)

   Yes, as it's right-angled $\checkmark\bullet^4$ (conclusion and reason) award 2/4 $\times\checkmark\times\checkmark$

   (b) Where candidate starts by stating that eg **If triangle is right-angled then** $650^2 = 600^2 + 250^2$ $\bullet^3$ is not available

   If triangle is right-angled then $650^2 = 600^2 + 250^2$ $\checkmark\bullet^1\ \times\bullet^3$ ($\bullet^3$ not available)

   $422\,500 = 422\,500$ $\checkmark\bullet^2$ (evaluation)

   Yes $\checkmark\bullet^4$ (conclusion; reason implicit in $\checkmark\bullet^1$) award 3/4 $\checkmark\checkmark\times\checkmark$

4. (a) Where there is no working to indicate how 250 has been obtained, then assume it has been obtained using the perimeter.

   (b) Where working shows that 250 has been obtained by the use of Pythagoras' theorem, $\bullet^1$ is not available; apply the MIs for the award of $\bullet^2$, $\bullet^3$ and $\bullet^4$

5. Inappropriate use of RAD or GRAD should only be penalised once in Qu 3, 7, 11, 14 or 19
   (a) 1·57… (RAD), no, angle is not a right angle
   (b) 100 (GRAD), no, angle is not a right angle

Commonly observed responses:

1. Variation on Method 1: award 4/4

   eg $600^2 + 250^2 = 422500$

   $\sqrt{422500} = 650$

   $600^2 + 250^2 = 650^2$

   Yes, as angle is a right angle

2. $(\cos A =)\dfrac{600^2 + 650^2 - 250^2}{2\times 600\times 650} = \dfrac{12}{13} \rightarrow A = 22\cdot 6\ldots$ award 2/4 $\times\checkmark\checkmark\times$

3. **If triangle is right-angled then** $BC^2 = 650^2 - 600^2$ $\checkmark\bullet^1$

   $BC = 250$ $\checkmark\bullet^2$ (evaluation)

   $1500 - 650 - 600 = 250 = BC$ $\checkmark\bullet^3$ (explicit comparison of BC obtained from Pythagoras' with BC obtained from perimeter)

   Yes $\checkmark\bullet^4$ (conclusion; reason implicit in $\checkmark\bullet^1$) award 4/4

4. $BC^2 = 650^2 - 600^2$ $\times\bullet^1$ (mark not available)

   $BC = 250$ $\checkmark\bullet^2$ (evaluation)

   $1500 - 650 - 600 = 250 = BC$ $\checkmark\bullet^3$ (explicit comparison of BC obtained from Pythagoras' with BC obtained from perimeter)

   Yes, as angle is a right angle $\checkmark\bullet^4$ (conclusion and reason) award 3/4 $\times\checkmark\checkmark\checkmark$

Question			Generic scheme	Illustrative scheme	Max mark
12.	(a)		**Method 1** •1 linear scale factor	•1 $\frac{30}{50}$	**3**
			•2 know to multiply area by square of linear scale factor	•2 $2750\times\left(\frac{30}{50}\right)^2$	
			•3 find area of smaller sector (calculation must include a power of the linear scale factor)	•3 990 (cm^2)	
			Method 2 •1 linear scale factor	•1 $\frac{50}{30}$	
			•2 know to divide area by square of linear scale factor	•2 $2750\div\left(\frac{50}{30}\right)^2$	
			•3 find area of smaller sector (calculation must include a power of the linear scale factor)	•3 990 (cm^2)	
			Method 3 **[Combination of (b) and (a)]** •4•5•6 calculate size of angle ACB (see part (b) below)	•4•5•6 126(·05...)	
			•1 appropriate fraction	•1 $\frac{126(\cdot 05...)}{360}$	
			•2 consistent substitution into area of sector formula	•2 $\frac{126(\cdot 05...)}{360}\times\pi\times 30^2$	
			•3 calculate area of smaller sector	•3 990 (cm^2)	

Question	Generic scheme	Illustrative scheme	Max mark

Notes:

1. Correct answer without working — award 0/3.
2. $\bullet^3$ is not available where there is invalid subsequent working
   eg $2750 - 990 = 1760$ — award 2/3 ✓✓×
3. Method 3: Accept $\frac{126}{360} \times \pi \times 30^2 = 989{\cdot}6(0...)$

Commonly observed responses:

1. $2750 \times \frac{30}{50} = 1650$ — award 1/3 ✓××
2. $2750 \times \left(\frac{30}{50}\right)^3 = 594$ — award 2/3 ✓×✓
3. $2750^2 \times \frac{30}{50} = 4\,537\,500$ — award 1/3 ✓××
4. $2750 \times \left(\frac{50}{30}\right)^2 = 7638(\cdot 8...)$ or 7639 — award 2/3 ✓×✓
5. $2750 \times \left(\frac{50}{30}\right)^2 = 2750 \times 1{\cdot}67^2 = 7669(\cdot 4...)$ — award 1/3 ✓××
   (Premature rounding leads to inaccurate answer)
6. $2750 \div \left(\frac{50}{30}\right)^2 = 2750 \div 1{\cdot}67^2 = 986(\cdot 0...)$ — award 2/3 ✓✓×
   (Premature rounding leads to inaccurate answer)

Question			Generic scheme	Illustrative scheme	Max mark
12.	(b)		**Method 1** $\bullet^4$ expression for sector area $\bullet^5$ know how to find angle $\bullet^6$ calculate angle **Method 2** $\bullet^4$ sector area: circle area ratio $\bullet^5$ know how to find angle $\bullet^6$ calculate angle	$\bullet^4$ $\frac{\text{angle}}{360}\times\pi\times50^2$ $\bullet^5$ $\frac{2750\times360}{\pi\times50^2}$ $\bullet^6$ $126\left(\cdot05\ldots\right)$ $\bullet^4$ $\frac{2750}{\pi\times50^2}$ $\left(=0\cdot35\ldots\right)$ $\bullet^5$ $\frac{2750\times360}{\pi\times50^2}$ $\bullet^6$ $126\left(\cdot05\ldots\right)$	**3**

Question	Generic scheme	Illustrative scheme	Max mark

Notes:

1. Correct answer without working award 0/3

2. Alternative Method 1: $\frac{\text{angle}}{360}\times\pi\times30^2 \rightarrow \frac{990\times360}{\pi\times30^2}=126\left(\cdot05\ldots\right)$

3. Alternative Method 2: $\frac{990}{\pi\times30^2} \rightarrow \frac{990\times360}{\pi\times30^2}=126\left(\cdot05\ldots\right)$

4. Where any of the above alternative methods are used, an incorrect answer to part (a) must be followed through with possibility of awarding 3/3 for part (b)

5. Accept variations in π

6. Premature rounding of $\frac{2750}{\pi\times50^2}$ must be to at least 2 decimal places

7. For the award of $\bullet^6$, the calculation must involve a division by a product.
   The calculation must include a sector area, π, 360 and the candidate's chosen radius or diameter.

Commonly observed responses:

1. (a) 1650 $\rightarrow$ (b) $\frac{1650\times360}{\pi\times30^2}=210\left(\cdot08\ldots\right)$ award 3/3

2. (a) 1650 $\rightarrow$ (b) $\frac{1650\times360}{\pi\times50^2}=75\left(\cdot63\ldots\right)$ award 2/3 ×✓✓

3. $\frac{2750\times360}{\pi\times100^2}=31\cdot5\left(1\ldots\right)$ award 2/3 ×✓✓

4. $\frac{2750\times360}{\pi\times100}=3151\left(\cdot2\ldots\right)$ award 2/3 ×✓✓

5. $\frac{2750\times360}{\pi\times100}=\sqrt{3151\left(\cdot2\ldots\right)}=56\left(\cdot1\ldots\right)$ award 1/3 ××✓

6. $\frac{2750}{360}\times\pi\times50^2=59995\left(\cdot6\ldots\right)$ award 0/3

Question	Generic scheme	Illustrative scheme	Max mark
13.	$\bullet^1$ correct substitution into gradient formula	$\bullet^1$ $\frac{4p^2-9}{4p-6}$ *or* $\frac{9-4p^2}{6-4p}$	**3**
	$\bullet^2$ factorise using difference of two squares	$\bullet^2$ $(2p+3)(2p-3)$ or $(3+2p)(3-2p)$	
	$\bullet^3$ factorise using common factor **and** simplify	$\bullet^3$ $\frac{(2p+3)(2p-3)}{2(2p-3)}=\frac{2p+3}{2}$ or $\frac{(3+2p)(3-2p)}{2(3-2p)}=\frac{3+2p}{2}$	

Notes:

1. Correct answer without working — award 0/3.
2. Accept $p+\frac{3}{2}$ for $\bullet^3$
3. For subsequent incorrect working $\bullet^3$ is not available

   eg $\frac{\cancel{2}p+3}{\cancel{2}}=p+3$ — award 2/3 ✓✓×

Commonly observed responses:

Question			Generic scheme	Illustrative scheme	Max mark
14.			•1 rearrange equation •2 find one value of x •3 find second value of x	•1 $\cos x = -\frac{1}{5}$ or equivalent •2 $101{\cdot}5(3\ldots)$ •3 $258{\cdot}4(6\ldots)$	**3**

Notes:

1. Correct answer without working award 0/3.

2. Accept (a) 102 and 258 (b) 101·6 (180—78·4) and 258·4 (180+78·4) with valid working.

3. Do not penalise omission of degrees sign.

4. If $\cos x < 0$ then •2 and •3 are only available for consistent 2nd and 3rd quadrant angles

   eg $\cos x = -\frac{1}{5} \rightarrow$ (a) 78·5, 101·5 award 2/3 ✓×✓
   (b) 78·5, 258·5 award 2/3 ✓×✓
   (c) 78·5, 281·5 award 1/3 ✓××

5. If $\cos x > 0$ then •2 is not available (working eased) but •3 is available for consistent 4th quadrant angle

   eg $\cos x = \frac{1}{5} \rightarrow$ (a) 78·5, 101·5 award 0/3
   (b) 78·5, 258·5 award 0/3
   (c) 78·5, 281·5 award 1/3 ××✓
   (d) 101·5, 258·5 award 0/3

6. If 78·5 is **clearly** included as one of the **final** answers then award marks as follows:

   eg $\cos x = -\frac{1}{5} \rightarrow$ (a) 78·5, 101·5, 258·5 award 2/3 ✓×✓
   (b) 78·5, 101·5, 281·5 award 1/3 ✓××
   (c) 78·5, 101·5, 258·5, 281·5 award 1/3 ✓××

7. (a Inappropriate use of RAD should only be penalised once in Qu 3, 7, 11, 14 or 19

   $\cos^{-1}\left(\frac{1}{5}\right) = 1{\cdot}3\ldots \rightarrow 178{\cdot}6\ldots$, $181{\cdot}3\ldots$

   (b) However, for $\cos^{-1}\left(-\frac{1}{5}\right) = 1{\cdot}7\ldots \rightarrow 1{\cdot}7\ldots$, $358{\cdot}3\ldots$ award 1/3 ✓×× since the answers are not 2nd and 3rd quadrant angles

8. Inappropriate use of GRAD should only be penalised once in Qu 3, 7, 11, 14 or 19

   (a) $\cos^{-1}\left(\frac{1}{5}\right) = 87{\cdot}1\ldots \rightarrow 92{\cdot}8\ldots$, $267{\cdot}1\ldots$

   (b) $\cos^{-1}\left(-\frac{1}{5}\right) = 112{\cdot}8\ldots \rightarrow 112{\cdot}8\ldots$, $247{\cdot}2\ldots$

Commonly observed responses:

1. $\cos x = \frac{3}{5} \rightarrow$ 53·1, 306·9 award 1/3 ××✓

Question			Generic scheme	Illustrative scheme	Max mark
15.			$\bullet^1$ correct denominator $\bullet^2$ correct numerator $\bullet^3$ express in simplest form (remove brackets in numerator and collect like terms)	$\bullet^1$ $(x-2)(x+5)$ $\bullet^2$ $4(x+5)-3(x-2)$ $\bullet^3$ $\dfrac{x+26}{(x-2)(x+5)}$	**3**

Notes:

1. Correct answer without working award 3/3

2. Accept $\dfrac{4(x+5)}{(x-2)(x+5)}-\dfrac{3(x-2)}{(x-2)(x+5)}$ for the award of $\bullet^1$ and $\bullet^2$

3. Do not accept $x-2(x+5)$ or $(x-2)x+5$ for the award of $\bullet^1$ unless the correct expansion appears in the final answer

4. Where a candidate chooses to expand the brackets in the denominator, then $\bullet^3$ is only available for a correct expansion **eg**

   (a) $\dfrac{4(x+5)}{(x-2)(x+5)}-\dfrac{3(x-2)}{(x-2)(x+5)}=\dfrac{x+26}{x^2+3x-10}$ award 3/3

   (b) $\dfrac{4(x+5)}{(x-2)(x+5)}-\dfrac{3(x-2)}{(x-2)(x+5)}=\dfrac{x+26}{x^2-10}$ award 2/3 ✓✓×

   (c) $\dfrac{4(x+5)}{x^2-10}-\dfrac{3(x-2)}{x^2-10}=\dfrac{x+26}{x^2-10}$ award 2/3 ×✓✓

5. For subsequent incorrect working, $\bullet^3$ is not available eg

   $\dfrac{x+26}{x^2+3x-10}=\dfrac{26}{x^2-7}$ award 2/3 ✓✓×

Commonly observed responses:

1. $\dfrac{4x+20}{(x-2)(x+5)}-\dfrac{3x-6}{(x-2)(x+5)}=\dfrac{x+14}{(x-2)(x+5)}$ award 2/3 ✓✓×

2. $\dfrac{4x+5}{(x-2)(x+5)}-\dfrac{3x-2}{(x-2)(x+5)}=\dfrac{x+7}{(x-2)(x+5)}$ award 1/3 ✓××

Question			Generic scheme	Illustrative scheme	Max mark
16.			•1 apply $a^m \times ka^n = ka^{m+n}$ •2 evidence of $\sqrt{a} = a^{\frac{1}{2}}$ •3 complete simplification	•1 eg $a^4 \times 3a = 3a^5$ •2 $a^{\frac{1}{2}}$ •3 $3a^{\frac{9}{2}}$	**3**

Notes:

1. Correct answer without working award 3/3.

2. Accept $3a^{4\frac{1}{2}}$ or $3a^{4\cdot5}$ (as bad form).

3. (a) Accept $3\sqrt{a^9}$.

   (b) Do not penalise $3a^{\frac{9}{2}} = 3\sqrt[9]{a^2}$.

4. Where candidate starts by rationalising the denominator, •1 is available for

   eg (i) obtaining $3a^5$ as follows: $\frac{a^4 \times 3a}{\sqrt{a}} \times \frac{\sqrt{a}}{\sqrt{a}} = \frac{3a^5 \times \sqrt{a}}{a}$

   (ii) obtaining $3a^4$ as follows: $\frac{a^4 \times 3a}{\sqrt{a}} \times \frac{\sqrt{a}}{\sqrt{a}} = 3a^4 \times \sqrt{a}$ or $a^4 \times 3\sqrt{a}$

5. **BEWARE** •1 is not available where $3a^5$ has been obtained incorrectly

   eg $\frac{a^4 \times 3a}{\sqrt{a}} \times \frac{\sqrt{a}}{\sqrt{a}} = \frac{a^4 \times 3a \times \sqrt{a}}{a} = \frac{\sqrt{3a^5}}{a}$

Commonly observed responses:

Question	Generic scheme	Illustrative scheme	Max mark
17.	$\bullet^1$ expand brackets $\bullet^2$ simplify expression	$\bullet^1$ $\sin^2 x+\sin x\cos x+\cos x\sin x+\cos^2 x$ $\bullet^2$ $1+2\sin x\cos x$	**2**

Notes:

1. Correct answer without working — award 0/2

2. Do not penalise omission of degrees sign

3. Accept $1+\sin 2x$

4. Accept $(\sin x)^2$ and $(\cos x)^2$ or $\sin x\sin x$ and $\cos x\cos x$

   eg (a) $(\sin x)^2+2\sin x\cos x+(\cos x)^2=1+2\sin x\cos x$ — award 2/2

   (b) $\sin x\sin x+2\sin x\cos x+\cos x\cos x=1+2\sin x\cos x$ — award 2/2

5. Do not accept $\sin x^2$ and $\cos x^2$.

   eg $\sin x^2+2\sin x\cos x+\cos x^2=1+2\sin x\cos x$ — award 1/2 ×✓

6. $\bullet^1$ is not available if there are no variables

   eg $\sin^2+2\sin\cos+\cos^2=1+2\sin\cos$ — award 1/2 ×✓

7. $\bullet^2$ is not available if there is invalid subsequent working

8. Alternative acceptable strategy:

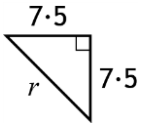
   $\bullet^1$ $\left(\frac{o}{h}\right)^2+\left(\frac{o}{h}\right)\left(\frac{a}{h}\right)+\left(\frac{a}{h}\right)\left(\frac{o}{h}\right)+\left(\frac{a}{h}\right)^2$

   $\bullet^2$ $\left(\frac{o}{h}\right)^2+2\left(\frac{o}{h}\right)\left(\frac{a}{h}\right)+\left(\frac{a}{h}\right)^2=1+2\sin x\cos x$ — award 2/2

Commonly observed responses:

1. $(\sin x+\cos x)^2=\sin^2 x+\cos^2 x=1$ — award 0/2

2. $(\sin x+\cos x)^2=\sin^2 x+\sin x\cos x+\cos^2 x=1+\sin x\cos x$ — award 1/2 ×✓

Question	Generic scheme	Illustrative scheme	Max mark
18.	$\bullet^1$ marshal facts and recognise right-angled triangle	$\bullet^1$ 	**4**
	$\bullet^2$ consistent Pythagoras statement	$\bullet^2$ $7{\cdot}5^2 + 7{\cdot}5^2$	
	$\bullet^3$ calculate radius of larger circle	$\bullet^3$ 10·6…	
	$\bullet^4$ calculate CD	$\bullet^4$ 25·6…(cm)	

Notes:

1. Correct answer without working award 0/4.
2. In the absence of a diagram, or a diagram without right angle indicated, accept $7{\cdot}5^2 + 7{\cdot}5^2$ as evidence for the award of $\bullet^1$ and $\bullet^2$.
3. **BEWARE**
   Where a diagram is shown, working must be consistent with the diagram.
4. $\bullet^2$ and $\bullet^3$ are available for a valid trigonometric method.
5. $\bullet^3$ is available for a consistent calculation of a length using Pythagoras or trigonometry
6. $\bullet^4$ is only available following a Pythagoras (or trigonometric) calculation within a right-angled triangle involving 7·5 or 15.
7. Disregard errors due to premature rounding provided there is evidence.

Commonly observed responses:

1. [Triangle SBT with SB = ST = 15] $r^2 = 15^2 + 15^2 \rightarrow r = 21{\cdot}2 \rightarrow \text{CD} = 51{\cdot}2$
   (a) working inconsistent with correct diagram award 3/4 ✓×✓✓
   (b) working consistent with candidate's diagram award 3/4 ×✓✓✓
   (c) no diagram award 2/4 ××✓✓
2. [Square with side AB] $d^2 = 15^2 + 15^2 \rightarrow r = 10{\cdot}6 \rightarrow \text{CD} = 25{\cdot}6$
   If consistent with a correct diagram award 4/4; otherwise apply COR 1 MIs
3. [Triangle ATB] $r^2 + r^2 = 15^2 \rightarrow r = 10{\cdot}6 \rightarrow \text{CD} = 25{\cdot}6$
   Apply MIs and Note 2 becomes accept $r^2 + r^2 = 15^2$ as evidence for the award of $\bullet^1$ and $\bullet^2$

Question			Generic scheme	Illustrative scheme	Max mark
19.			**Method 1** •[1] correct substitution into sine rule	•[1] $\frac{BK}{\sin 34} = \frac{350}{\sin 94}$	**5**
			•[2] re-arrange formula	•[2] $BK = \frac{350 \sin 34}{\sin 94}$	
			•[3] calculate BK	•[3] $196 (\cdot 195\ldots)$	
			•[4] consistent substitution into appropriate trig formula	•[4] $\sin 52 = \frac{h}{196}$ or $\frac{h}{\sin 52} = \frac{196}{\sin 90}$	
			•[5] calculate height **using trigonometry**	•[5] 154·6 (m)	
			Method 2 •[1] correct substitution into sine rule	•[1] $\frac{BM}{\sin 52} = \frac{350}{\sin 94}$	
			•[2] re-arrange formula	•[2] $BM = \frac{350 \sin 52}{\sin 94}$	
			•[3] calculate BM	•[3] $276 (\cdot 477\ldots)$	
			•[4] consistent substitution into appropriate trig formula	•[4] $\sin 34 = \frac{h}{276}$ or $\frac{h}{\sin 34} = \frac{276}{\sin 90}$	
			•[5] calculate height **using trigonometry**	•[5] 154·6 (m)	

Question	Generic scheme	Illustrative scheme	Max mark

Notes:

1. Correct answer without working award 0/5.

2. Do not penalise omission of degrees signs.

3. Disregard errors due to premature rounding provided there is evidence.
   However, do not accept sin34, sin52 or sin94 rounded to less than 3 decimal places.
   eg $BM = \frac{350\sin 52}{\sin 94} = \frac{275\cdot 8}{0\cdot 99} = 275\cdot 59 \rightarrow h = 275\cdot 59\sin 34 = 155\cdot 8$ award 4/5 ✓✓×✓✓

4. Where both BK and BM are calculated but one is calculated incorrectly, if there is
   (a) further working then apply the MIs based on the length used to calculate the height
   (b) no further working disregard incorrect length ie award 3/5

5. Alternative strategy for •4 and •5
   eg •4 $A = \frac{1}{2}\times 350\times 196(\cdot 195\ldots)\times\sin 52 (= 27055\cdot\ldots)$
   •5 $\frac{1}{2}\times 350\times h = 27055\cdot\ldots \rightarrow h = 154\cdot 6$

6. Inappropriate use of GRAD or RAD should only be penalised once in Qu 3, 7, 11, 14 or 19
   (a) 130·4... (GRAD)
   (b) ±744·9... (RAD); •5 is **not** available due to the negative length. However, •3 **is** available if use of RAD has already been penalised in Qu 3, 7, 11, 14 or 19

Commonly observed responses:

1. $\frac{x}{\sin 52} = \frac{350}{\sin 34} \rightarrow x = 493(\cdot\ldots)$ award 2/5 ×✓✓××

2. eg $\frac{BK}{34} = \frac{350}{94} \rightarrow BK = 126(\cdot 59\ldots) \rightarrow h = 126(\cdot 59\ldots)\times\sin 52 = 99(\cdot 75\ldots)$ award 2/5 ×××✓✓

[END OF MARKING INSTRUCTIONS]