National
Qualifications
2023

2023 Mathematics

Paper 2

National 5

Finalised Marking Instructions

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

$$x^2 + 5x + 7 = 9x + 4$$
$$x - 4x + 3 = 0$$
$$x = 1$$

This is a transcription error and so the mark is not awarded.

This is no longer a solution of a quadratic equation, so the mark is not awarded.

The following example is an exception to the above

$$x^2 + 5x + 7 = 9x + 4$$
$$x - 4x + 3 = 0$$
$$(x-3)(x-1) = 0$$
$$x = 1 \text{ or } 3$$

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.

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

Vertical: $\bullet^5$ $x = 2$ and $y = 5$
$\bullet^6$ $x = -4$ 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 144 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.			•[1] know how to decrease by 11% and 6% •[2] know how to calculate value of caravan •[3] evaluate	•[1] × 0.89 **and** × 0.94 •[2] 20 000 × 0.89 × 0.94^2 •[3] (£) 15,728.08	**3**

Notes:

1. Correct answer without working — award 3/3

2. Accept 15 728 or 15 728.10. However, do not accept 15 728.1

3. Disregard rounding subsequent to correct answer.

4. Where incorrect percentages are used, the working must be followed through to give the possibility of awarding 2/3.

5. Where a single repeated percentage change is applied, •[1] and •[2] are not available
   eg 20 000 × 0.83^3 = 11435.74 — award 1/3 ××✓1

6. Where division is used:
   (a) along with 0.89 **and** 0.94^2 •[1] is not available.
   (b) along with incorrect percentage •[1] and •[2] are not available.

Commonly Observed Responses:

1. 20 000 × 0.89 × 0.94 = 16732 — award 2/3 ✓×✓1
2. (a) 20 000 × 0.89 × 0.83^2 = 12 262.42 — award 2/3 ×✓1✓1
   (b) 20 000 × 0.89 × 0.83 × 0.77 = 11 375.98 — award 2/3 ×✓1✓1
3. 20 000 × 0.11 × 0.06^2 = 792 — award 2/3 ×✓1✓1
4. 20 000 × 1.11 × 1.06^2 = 24 943.92 — award 2/3 ×✓1✓1
5. (a) 20 000 × 0.83^3 = 11 435.74 — award 1/3 ××✓1
   (b) 20 000 × 0.83^2 = 13 778 — award 1/3 ××✓1
6. (a) 20 000 × 0.77^3 = 9130.66 — award 1/3 ××✓1
   (b) 20 000 × 0.77^2 = 11 858 — award 1/3 ××✓1
7. 20 000 × 0.89 × (1 – 0.06 × 2) = 15 664 — award 1/3 ✓×✓2

Question			Generic scheme	Illustrative scheme	Max mark
2.			•¹ correct method •² evaluate •³ express in scientific notation rounded to 3 significant figures	•¹ $300 \div (6.64 \times 10^{-24})$ •² $4.51(8\ldots) \times 10^{25}$ or equivalent •³ 4.52×10^{25}	**3**

Notes:

1. Correct answer without working — award 3/3
2. (a) For the award of •¹ accept $300 \div 6.64 \times 10^{-24}$
3. (b) However, **BEWARE** of incorrect use of calculator using power button

   $300 \div 6.64 \times 10^{-24} = 4.51(8\ldots) \times 10^{-23} = 4.52 \times 10^{-23}$ — award 2/3 ✓×✓1
4. If "$\times 10$" is omitted at •², the final mark is available for rounding to 3 significant figures with consistent power

   eg $300 \div \left(6.64 \times 10^{-24}\right) \rightarrow 4.51(8\ldots)^{25} \rightarrow 4.52^{25}$ — award 2/3 ✓×✓1

Commonly Observed Responses:

Brackets not required

1. $(6.64 \times 10^{-24}) \div 300 = 2.21\ (3\ldots) \times 10^{-26}$ — award 2/3 ×✓1✓1
2. $(6.64 \times 10^{-24}) \times 300 = 1.992 \times 10^{-21} = 1.99 \times 10^{-21}$ — award 2/3 ×✓1✓1
3. $300 \div \left(6.64 \times 10^{-24}\right) \rightarrow 4.51(8\ldots) \times 10^{25} \rightarrow 4.52$ — award 2/3 ✓✓×
4. (a) $300 \div \left(6.64 \times 10^{-24}\right) \rightarrow 4.51(8\ldots)^{25} \rightarrow 4.52^{25}$ — award 2/3 ✓×✓1

   (b) $\left(6.64 \times 10^{-24}\right) \times 300 = 1.992^{-21} = 1.99^{-21}$ — award 1/3 ××✓1

Question			Generic scheme	Illustrative scheme	Max mark
3.			**Method 1** $\bullet^1$ appropriate fraction $\bullet^2$ consistent substitution into arc length formula (must involve a fraction) $\bullet^3$ calculate arc length **Method 2** $\bullet^1$ appropriate fraction $\bullet^2$ consistent substitution into arc length ratio $\bullet^3$ calculate arc length	**Method 1** $\bullet^1$ $\frac{106}{360}$ $\bullet^2$ $\frac{106}{360}\times 2\times\pi\times 9.15$ $\bullet^3$ 16.9(27…) or 17 (m) **Method 2** $\bullet^1$ $\frac{106}{360}$ $\bullet^2$ $\frac{106}{360}=\frac{\text{arc}}{2\times\pi\times 9.15}$ $\bullet^3$ $16.9(27\ldots)$ or 17 (m)	3

Notes:

1. Correct answer without working — award 0/3
2. Do not penalise variations in π.

   eg $\frac{106}{360}\times 2\times 3.14\times 9.15=16.9(19\ldots)$ — award 3/3

3. Premature rounding: rounded working must be to at least 2 significant figures

   eg (a) $\frac{106}{360}\times 2\times\pi\times 9.15=0.29\times 2\times\pi\times 9.15=16.6(7\ldots),16.7$ or 17 — award 3/3

   (b) $\frac{106}{360}\times 2\times\pi\times 9.15=0.3\times 2\times\pi\times 9.15=17(.24\ldots)$ — award 2/3 ✓✓×

4. Accept $2\times\pi\times 9.15-\frac{254}{360}\times 2\times\pi\times 9.15=16.9(27\ldots)$ or 17 — award 3/3
5. For subsequent incorrect working, $\bullet^3$ is not available

   eg $2\times\pi\times 9.15-\frac{106}{360}\times 2\times\pi\times 9.15=40.5(6\ldots)$ or 41 — award 2/3 ✓✓×

Commonly Observed Responses:

1. $\frac{106}{360}\times\pi\times 9.15=8(.46\ldots)$ — award 2/3 ✓×✓1
2. $\frac{106}{360}\times\pi\times 9.15^2=77(.44\ldots)$ — award 2/3 ✓×✓1
3. $\frac{254}{360}\times 2\times\pi\times 9.15=41$ or $40(.56\ldots)$ — award 2/3 ×✓1✓1
4. $\frac{254}{360}\times\pi\times 9.15=20(.28\ldots)$ — award 1/3 ××✓1
5. $\frac{254}{360}\times\pi\times 9.15^2=186$ or $185(.57\ldots)$ — award 1/3 ××✓1
6. $2\times\pi\times 9.15=57(.49\ldots)$ — award 0/3

Question			Generic Scheme	Illustrative scheme	Max mark
4.			•¹ correct substitution into sine rule •² rearrange equation •³ calculate angle JKL	•¹ $\frac{\sin K}{10}=\frac{\sin 25}{7}$ or $\frac{10}{\sin K}=\frac{7}{\sin 25}$ •² $\sin K=\frac{10\sin 25}{7}$ •³ 37 (.1…)	3

Notes:

1. Correct answer without working — award 0/3

2. Do not penalise omission of degrees sign.

3. Disregard premature rounding provided the final answer can be rounded to 37.
   eg

   (a) $\sin K=\frac{10\sin 25}{7}=0.6\rightarrow 36.869\ldots$ — award 3/3

   (b) $\sin K=\frac{10\sin 25}{7}=\frac{10\times 0.4}{7}\rightarrow 34.849\ldots$ — award 2/3 ✓✓×

4. Where cosine rule or area of triangle formula is used — award 0/3

5. Inappropriate use of GRAD or RAD should only be penalised once in Qu's 4, 8, 11 or 15

   (a) $36(.8\ldots)$ (GRAD)

   (b) However, where RAD is used, $\frac{10\sin 25}{7}=-0.190\ldots$, so •³ is unavailable

Commonly Observed Responses:

1. $\frac{K}{\sin 10}=\frac{25}{\sin 7}\rightarrow K=\frac{25\sin 10}{\sin 7}\rightarrow 35.6\ldots$ — award 1/3 ×✓1✓2

2. $\frac{10}{\sin K}=\frac{7}{\sin 25}\rightarrow \sin K=\frac{7\times 10}{\sin 25}\rightarrow 165.6\ldots$ — award 1/3 ✓××

3. $\frac{10}{K}=\frac{7}{25}\rightarrow K=\frac{25\times 10}{7}\rightarrow 35.71\ldots$ — award 0/3 ×✓2✓2

4. (a) $\frac{10}{\sin K}=\frac{7}{\sin 25}\rightarrow\frac{10\sin 25}{7}\rightarrow\ 37(.1\ldots)$ — award 3/3

   (b) $\frac{10}{\sin K}=\frac{7}{\sin 25}\rightarrow K=\frac{10\sin 25}{7}\rightarrow\ 37(.1\ldots)$ — award 3/3

   (c) $\frac{10}{\sin K}=\frac{7}{\sin 25}\rightarrow K=\frac{7\sin 25}{10}\rightarrow\ 17(.2\ldots)$ — award 2/3 ✓×✓1

   (d) $\frac{10}{\sin K}=\frac{7}{\sin 25}\rightarrow K=\frac{10\sin 25}{7}\rightarrow\ 0.6(03\ldots)$ — award 1/3 ✓××

Question			Generic Ssheme	Illustrative scheme	Max mark
5.			•[1] calculate size of interior or exterior angle of the decagon •[2] calculate size of shaded angle	•[1] interior angle = 144 or exterior angle = 36 •[2] 126	**2**

Notes:

1. Correct answer without relevant working — award 0/2

2. Degrees signs are not required.

3. Full marks may be awarded for information marked on the diagram.

4. For the award of •[1]
   (a) the **exterior** angle of 36 must be clearly indicated on the diagram or explicitly stated outwith the diagram as "exterior angle = 36".
   (b) accept 72 + 72 or two 72 angles marked on the diagram (either adjacent or within the same triangle).

5. •[2] is only available where the exterior angle is acute and consistent with working at •[1]
   eg angles in triangle 40, 70, 70 (indicated on diagram) $\rightarrow$ exterior angle 40
   $\rightarrow$ shaded angle = 130 — award 1/2 ×✓1

6. Where the exterior angle is **not** indicated on diagram or explicitly stated as "exterior angle = 36", for: 90 + 36 = 126 — award 1/2 ^ ✓1

7. Accept clear working outwith the diagram, but the final answer must be clearly indicated.

Commonly Observed Responses:

1. (a) 90 + (180 – 72 – 72) = 126 — award 2/2
   (b) 90 + (360 −90 − 90 – 72 – 72) = 126 — award 2/2

2. Angles in triangle 36, 72, 72 (indicated on diagram) $\rightarrow$ exterior angle 18
   $\rightarrow$ shaded angle = 108 — award 1/2✓×

Question			Generic scheme	Illustrative scheme	Max mark
6.			•[1] evidence that 108% is 94500 •[2] start valid strategy •[3] complete calculation within a valid strategy	•[1] $108\% = 94\ 500$ •[2] $1\% = \frac{94\ 500}{108}$ •[3] (£) 87,500	3

Notes:

1. Correct answer without working — award 3/3

2. (a) $108\% = 94\ 500 \rightarrow$ 8% of 94500 = 7560 — award 1/3 ✓××
   (b) 8% of 94 500 = 7560 — award 0/3

3. (a) $108\% = 94\ 500 \rightarrow$ 108% of 94500 = 102 060 — award 1/3 ✓××
   (b) 108% of 94 500 = 102 060 — award 0/3

4. (a) $108\% = 94\ 500 \rightarrow$ 92% of 94 500 = 86940 — award 1/3 ✓××
   (b) 92% of 94 500 = 86 940 — award 0/3

Commonly Observed Responses:

1. $\frac{94500}{1.08} = 87\ 500$ — award 3/3

2. $1\% = \frac{94500}{92} \rightarrow 102\ 717\left(.39\right)$ — award 2/3 ×✓1✓1

Question			Generic scheme	Illustrative scheme	Max mark
7.			**Method 1** •¹ add r •² multiply by 3 •³ divide by n **Method 2** •¹ multiply by 3 •² add $3r$ •³ divide by n	**Method 1** •¹ $P+r=\frac{1}{3}mn$ •² $mn = 3(P + r)$ •³ $m=\frac{3(P+r)}{n}$ or equivalent **Method 2** •¹ $3P = mn - 3r$ •² $mn = 3P + 3r$ •³ $m=\frac{3P+3r}{n}$ or equivalent	3

Notes:

1. Correct answer without working — award 0/3

2. For subsequent incorrect working, •³ is not available.

Commonly Observed Responses:

1. (a) $P+r=\frac{1}{3}mn \rightarrow \frac{P+r}{n}=\frac{1}{3}m \rightarrow m=\frac{P+r}{n}\times 3$ or $m=3\frac{P+r}{n}$ — award 3/3

   (b) $P+r=\frac{1}{3}mn \rightarrow \frac{P+r}{n}=\frac{1}{3}m \rightarrow m=\frac{P+r}{n}\times 3 \rightarrow m=\frac{3(P+r)}{3n}$ — award 2/3 ✓✓×

   (c) $P+r=\frac{1}{3}mn \rightarrow \frac{P+r}{n}=\frac{1}{3}m \rightarrow m=\frac{P+r}{\frac{1}{3}n}$ — award 2/3 ✓✓✓2

2. (a) $P+r=\frac{1}{3}mn \rightarrow mn=3P+r \rightarrow m=\frac{3P+r}{n}$ — award 2/3 ✓×✓1

   (b) $3P=mn-r \rightarrow mn=3P+r \rightarrow m=\frac{3P+r}{n}$ — award 2/3 ×✓1✓1

3. $Pr=\frac{1}{3}mn \rightarrow 3Pr=mn \rightarrow m=\frac{3Pr}{n}$ — award 1/3 ×✓2✓1

Question			Generic scheme	Illustrative scheme	Max mark
8.			**Method 1**	**Method 1**	4
			•[1] valid strategy	•[1] $4^2 + 7^2$ **and** 8^2	
			•[2] evaluation	•[2] $4^2 + 7^2 = 65$ **and** $8^2 = 64$	
			•[3] explicit comparison	•[3] $4^2 + 7^2 \neq 8^2$	
			•[4] conclusion with valid reason	•[4] No, as angle is not a right angle	
			Method 2	**Method 2**	
			•[1] valid strategy	•[1] $4^2 + 7^2 = 65$	
			•[2] evaluation	•[2] $\sqrt{65} = 8.06\ldots$	
			•[3] explicit comparison	•[3] $8 \neq 8.06\ldots$	
			•[4] conclusion with valid reason	•[4] No, as angle is not a right angle	
			Method 3	**Method 3**	
			•[1] valid strategy	•[1] $(\cos x =)\dfrac{4^2+7^2-8^2}{2\times4\times7}$	
			•[2] evaluate $\cos x$	•[2] $(\cos x =)\dfrac{1}{56}$	
			•[3] calculate angle	•[3] 88(.97)	
			•[4] conclusion with valid reason	•[4] No, as angle is not a right angle	

Question	Generic scheme	Illustrative scheme	Max mark
8. (continued)			

Notes:

1. **$\bullet^1$ is not available where a candidate starts by stating that $4^2 + 7^2 = 8^2$ or $4^2 + 7^2 \neq 8^2$**

   $4^2 + 7^2 = 8^2$ or $4^2 + 7^2 \neq 8^2$ $\times\bullet^1$

   $65 \neq 64$ $\checkmark\bullet^2\checkmark\bullet^3$

   No, as angle is not a right angle $\checkmark\bullet^4$ award 3/4 $\times\checkmark\checkmark\checkmark$

2. There must be an explicit comparison stated for the award of $\bullet^3$

3. For the award of $\bullet^3$ accept eg
   (a) $\sqrt{65} \neq \sqrt{64}$
   (b) $\sqrt{65} \neq 8$
   (c) $a^2 + b^2 \neq c^2$ or $AC^2 + CB^2 \neq AB^2$ (labelling consistent with diagram)
   (d) $65 > 64$

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

5. Inappropriate use of RAD or GRAD should only be penalised once in Qu 4, 8, 11 or 15
   (a) 1.55… (RAD), no, as angle is not a right angle
   (b) 98 (.86…) (GRAD), no, as angle is not a right angle

Commonly Observed Responses:

1. (a) $4^2 + 7^2 = 65 \rightarrow 8.06\ldots = 8;\ 8 = 8 \rightarrow$ yes, as angle is a right angle — award 3/4 $\checkmark\checkmark\times\checkmark1$
   (b) $4^2 + 7^2 = 65 \rightarrow 8;\ 8 = 8 \rightarrow$ yes, as angle is a right angle — award 3/4 $\checkmark\times\checkmark1\checkmark1$

2. **If** triangle is right-angled then $4^2 + 7^2 = 8^2 \rightarrow 65 \neq 64;$ No, as angle is not a right angle — award 4/4

3. (a) $4^2 + 8^2$ **and** $7^2 \rightarrow 80,\ 49 \rightarrow 80 \neq 49 \rightarrow$ no, as angle is not a right angle — award 3/4 $\times\checkmark1\checkmark1\checkmark1$
   (b) $4^2 + 8^2 = 7^2 \rightarrow 80,\ 49 \rightarrow 80 \neq 49 \rightarrow$ no, as angle is not a right angle — award 3/4 $\times\checkmark1\checkmark1\checkmark1$

4. (a) $\dfrac{4^2 + 7^2 - 8^2}{2 \times 4 \times 7} = \dfrac{1}{56} = 0.017(\ldots)^\circ$ or $C = 0.017(\ldots) \rightarrow$ no, as angle is not a right angle — award 3/4 $\checkmark\checkmark\times\checkmark1$
   (b) $\dfrac{4^2 + 7^2 - 8^2}{2 \times 4 \times 7} = \dfrac{1}{56} = 0.017(\ldots) \rightarrow$ no, as angle is not a right angle — award 2/4 $\checkmark\checkmark\wedge\times$

Question			Generic scheme	Illustrative scheme	Max mark
9.			•¹ correct substitution into formula for volume of small pyramid •² consistent substitution into formula for volume of large pyramid •³ know to subtract volume of small pyramid from volume of large pyramid •⁴ all calculations correct (must involve sum or difference of two different calculations both involving a fraction) **and** state correct units	•¹ $\frac{1}{3}\times 40\times 40\times 48 \ (=25600)$ •² $\frac{1}{3}\times 90\times 90\times 108 \ (=291\,600)$ •³ $\frac{1}{3}\times 90\times 90\times 108-\frac{1}{3}\times 40\times 40\times 48$ •⁴ 266 000 cm^3	4

Notes:

1. Correct answer without working — award 0/4

2. •² is available for eg $\left(\frac{90}{40}\right)^3\times 25600$

3. Where a candidate substitutes 60 for the height of the larger pyramid, •² is not available eg

   (a) $\frac{1}{3}\times 90\times 108-\frac{1}{3}\times 40\times 48=2600\ cm^3$ — award 3/4 ×✓1✓✓1

   (b) $\frac{1}{3}\times 90\times 60-\frac{1}{3}\times 40\times 48=1160\ cm^3$ — award 2/4 ××✓✓1

Commonly Observed Responses:

1. $\frac{1}{3}\times 90\times 90\times 60-\frac{1}{3}\times 40\times 40\times 48=136\,400\ cm^3$ — award 3/4 ✓×✓✓1

2. $\frac{1}{3}\times 90\times 90\times 108+\frac{1}{3}\times 40\times 40\times 48=317\,200\ cm^3$ — award 3/4 ✓✓×✓1

3. (a) $\frac{1}{3}\times 90\times 108\times 108-\frac{1}{3}\times 40\times 48\times 48=319\,200\ cm^3$ — award 3/4 ×✓1✓✓1

   (b) $\frac{1}{3}\times 90\times 60\times 60-\frac{1}{3}\times 40\times 48\times 48=77\,280\ cm^3$ — award 2/4 ××✓✓1

4. (a) $\frac{1}{3}\times\pi\times 90^2\times 108-\frac{1}{3}\times\pi\times 40^2\times 48\left(=266000\pi\right)=835663(.6\ldots)\ cm^3$ — award 3/4 ×✓1✓✓1

   (b) $\frac{1}{3}\times\pi\times 90^2\times 60-\frac{1}{3}\times\pi\times 40^2\times 48\left(=136400\pi\right)=428\,513(.2\ldots)\ cm^3$ — award 2/4 ××✓✓1

   (c) $\frac{1}{3}\times\pi\times 45^2\times 108-\frac{1}{3}\times\pi\times 20^2\times 48\left(=66500\pi\right)=208\,915(.9\ldots)\ cm^3$ — award 3/4 ×✓1✓✓1

   (d) $\frac{1}{3}\times\pi\times 45^2\times 60-\frac{1}{3}\times\pi\times 20^2\times 48\left(=34100\pi\right)=107\,128(.3\ldots)\ cm^3$ — award 2/4 ××✓✓1

Question	Generic scheme	Illustrative scheme	Max mark
10.	•¹ correct denominator •² correct numerator •³ remove brackets and collect like terms in numerator	•¹ $\dfrac{\ldots}{x(x-3)}$ •² $\dfrac{7x-2(x-3)}{\ldots}$ •³ $\dfrac{5x+6}{x(x-3)}$	3

Notes:

1. Correct answer without working — award 3/3

2. Accept $\dfrac{7x}{x(x-3)}-\dfrac{2(x-3)}{x(x-3)}$ for the award of •¹ and •²

3. Do **not** accept $\dfrac{7x}{x-3}-\dfrac{2(x-3)}{x}$ for the award of •²

4. Where a candidate chooses to expand the brackets in the denominator, then •³ is only available for a correct expansion eg

   (a) $\dfrac{5x+6}{x(x-3)}=\dfrac{5x+6}{x^2-3x}$ — award 3/3

   (b) $\dfrac{5x+6}{x(x-3)}=\dfrac{5x+6}{x^2-3}$ — award 2/3 ✓✓×

   (c) $\dfrac{7x}{x^2-3}-\dfrac{2(x-3)}{x^2-3}=\dfrac{5x+6}{x^2-3}$ — award 2/3 ×✓1✓1

5. For subsequent incorrect working do not award •³

   eg $\dfrac{7x}{x(x-3)}-\dfrac{2(x-3)}{x(x-3)}=\dfrac{5x+6}{x(x-3)}=\dfrac{11}{x-3}$ — award 2/3 ✓✓×

Commonly Observed Responses:

1. $\dfrac{7x}{x(x-3)}-\dfrac{2(x-3)}{x(x-3)}=\dfrac{5x-6}{x(x-3)}$ — award 2/3 ✓✓×

2. $\dfrac{7x-2x-6}{x(x-3)}=\dfrac{5x-6}{x(x-3)}$ — award 2/3 ✓×✓1

3. $\dfrac{7x}{x(x-3)}-\dfrac{2x-3}{x(x-3)}=\dfrac{5x\pm3}{x(x-3)}$ — award 1/3 ✓××

Question			Generic scheme	Illustrative scheme	Max mark
11.			•1 substitute h = 150 into formula •2 rearrange equation •3 calculate one value of x •4 calculate second value of x	•1 150 = 20 $cos\ x$ + 147 •2 $\cos x = \frac{3}{20}$ •3 81 •4 279	4

Notes:

1. Correct answers
   (a) without working — award 1/4 ××✓2✓
   (b) by repeated substitution — award 1/4 ××✓2✓

2. Degree signs are not required

3. If $\cos x$ < 0 then •3 and •4 are only available for consistent 2nd and 3rd quadrant angles eg
   (a) $150 = 20\cos x + 147 \rightarrow \cos x = -\frac{3}{20} \rightarrow 99, 261$ — award 3/4 ✓×✓1✓1
   (b) $147 = 20\cos x + 150 \rightarrow \cos x = -\frac{3}{20} \rightarrow 99, 261$ — award 3/4 ×✓1✓1✓1

4. Do not penalise incorrect rounding provided given answers round to 81 and 279.

5. Where more than two **final** values are stated, •4 is not available
   eg $150 = 20\cos x + 147 \rightarrow \cos x = \frac{3}{20} \rightarrow 81, 99, 279$ — award 3/4 ✓✓✓×

6. Inappropriate use of RAD or GRAD should only be penalised once in Qu 4, 8, 11 or 15
   (a) 1.4(202...), 358.579 [RAD]
   (b) 90(.41...), 269.585 [GRAD]

Commonly Observed Responses:

1. (a) 20 cos 150 + 147 = 130 — award 0/4
   (b) 20 cos 150 + 147 = 130, 230 — award 1/4 ×××✓1

Question			Generic scheme	Illustrative scheme	Max mark
12.			•[1] factorise numerator •[2] factorise denominator •[3] cancel brackets correctly	•[1] $(x - 4)\ (x + 4)$ •[2] $(x + 5)\ (x - 4)$ •[3] $\frac{x+4}{x+5}$	**3**

Notes:

1. Correct answer without working — award 0/3

2. For subsequent incorrect working •[3] is not available

   eg $\frac{(x-4)(x+4)}{(x+5)(x-4)} = \frac{x+4}{x+5} = \frac{4}{5}$ — award 2/3 ✓✓×

Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max Mark
13.			**Method 1** •[1] factorise •[2] substitute and simplify **Method 2** •[1] expand •[2] substitute and simplify **Method 3** •[1] substitute •[2] expand and simplify	**Method 1** •[1] $2(\sin^2 x + \cos^2 x)$ •[2] 2 **Method 2** •[1] $\sin^2 x + \cos^2 x + \sin^2 x + \cos^2 x$ •[2] 2 **Method 3** •[1] $2(1 - \cos^2 x) + 2\cos^2 x$ or $2\sin^2 x + 2(1-\sin^2 x)$ •[2] $2 - 2\cos^2 x + 2\cos^2 x = 2$ or $2\sin^2 x + 2 - 2\sin^2 x = 2$	2

Notes:

1. Correct answer without working — award 0/2

2. Do not penalise omission of degrees signs.

3. For $2(\sin x^2 + \cos x^2) = 2$ — award 1/2 ×✓1
4. •[1] is not available if there are no variables eg $2(\sin^2 + \cos^2) = 2$ — award 1/2 ×✓

Commonly Observed Responses:

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

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

3. $\sin^2 x + \cos^2 x = 1 \rightarrow 2 \times 1 = 2$ — award 2/2

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

Question			Generic scheme	Illustrative scheme	Max mark
14.	(a)		•[1] use the dimensions of the cuboid to find an expression for the volume •[2] construct equation and rearrange into required form	•[1] $(x+7)\times x\times 2$ or equivalent •[2] $2x^2+14x=45 \Rightarrow 2x^2+14x-45=0$	**2**

Notes:

1. Correct answer without working — award 0/2

2. If solution to part (a) appears in (b) then both marks are available.

3. For the award of •[1]
   (a) accept x+7×x×2 with further evidence of (x + 7)×x×2
   (b) do **not** accept x+7×x×2 with no further evidence

Commonly Observed Responses:

1. $2x^2+14x-45=0 \Rightarrow 2x(x+7)=45$ — award 0/2

Question			Generic scheme	Illustrative scheme	Max mark
14.	(b)		•3 correct substitution into quadratic formula •4 evaluate discriminant •5 solve for x •6 select correct value of x, to one decimal place	•3 $\dfrac{-14 \pm \sqrt{(14)^2 - 4(2)(-45)}}{2(2)}$ •4 556 (stated or implied by •5) •5 2.39(4…) and −9.39(4…) •6 2.4	**4**

Notes:

1. Correct answer without working — award 0/4

2. For a solution obtained by guess and check — award 0/4

3. •4 is available for $\dfrac{-7 \pm \sqrt{139}}{2}$

4. •5 is only available when $b^2 - 4ac > 0$

5. •6 is only available when the positive root is selected and it requires rounding.

6. If solution to part (b) appears in (a) then all four marks are available. However, if a different value of x is stated in (b) then •6 is not available. General marking principle (l) should not be applied in this special case.

7. For:

   (a) $\dfrac{-14 + \sqrt{(14)^2 - 4(2)(-45)}}{2(2)} \to 2.4$ — award 2/4 ✓✓××

   (b) $\dfrac{-14 + \sqrt{(14)^2 - 4(2)(-45)}}{2(2)} \to 2.4$; with explicit justification of why second root has not been calculated eg 2nd substitution leads to a negative solution — award 4/4

Question	Generic scheme	Illustrative scheme	Max mark

14. (continued)

Commonly Observed Responses:

1. 556 (b^2 - $4ac$) award 1/4 ^✓^^

2. $$\frac{-14 \pm \sqrt{(14)^2 - 4(2)(-45)}}{2(2)} \left(\rightarrow \frac{-14 \pm \sqrt{-164}}{2(2)} \right) \rightarrow \frac{-14 \pm \sqrt{164}}{2(2)} \rightarrow -0.29(8\ldots),\ -6.70(1\ldots)$$

award 1/4 ✓×××

3. $$\frac{-14 \pm \sqrt{(14)^2 - 4(2)(45)}}{2(2)} \rightarrow \frac{-14 \pm \sqrt{-164}}{2(2)} \left(\rightarrow \frac{-14 \pm \sqrt{164}}{2(2)} \right) \rightarrow -0.29(8\ldots),\ -6.70(1\ldots)$$

award 1/4 ×✓1××

4. $$\frac{-14 \pm \sqrt{(14)^2 - 4(2)(45)}}{2(2)} \rightarrow \frac{-14 \pm \sqrt{164}}{2(2)} \rightarrow -0.29(8\ldots),\ -6.70(1\ldots)$$

award 1/4 ××✓1×

5. (a) $$-14 \pm \frac{\sqrt{(14)^2 - 4(2)(-45)}}{2(2)} \rightarrow -14 \pm \frac{\sqrt{556}}{2(2)} \rightarrow 2.39(4\ldots),\ -9.39(4\ldots) \rightarrow 2.4$$

award 4/4

(b) $$-14 \pm \frac{\sqrt{(14)^2 - 4(2)(-45)}}{2(2)} \rightarrow -14 \pm \frac{\sqrt{556}}{2(2)} \rightarrow -8.10(5\ldots),\ -19.89(4\ldots)$$

award 2/4 ×✓✓1×

6. $$\frac{-14 \pm \sqrt{(14)^2 - 4(2)(-45)}}{2(2)} \rightarrow \frac{-14 \pm \sqrt{556}}{2(2)} \rightarrow -8.10(5\ldots),\ -19.89(4\ldots)$$

award 2/4 ✓✓××

Question			Generic scheme	Illustrative scheme	Max mark
15.			•1 correct trig. ratio •2 correct substitution into formula for area of triangle ADE •3 form equation •4 solve to find length of AE	•1 $\sin A = \frac{8}{18}$ or equivalent •2 $\frac{1}{2}\times 24\times AE\times \sin A$ stated or implied by •3 •3 $\frac{1}{2}\times 24\times AE\times \frac{8}{18} = 160$ •4 30 (cm)	4

Notes:

1. Correct answer without working award 0/4

2. For the award of •1 accept $\sin A = \frac{8\sin 90}{18}$ or A = 26 (.38…) using a valid strategy involving a trigonometric calculation

3. Premature rounding must be to at least 2 significant figures eg

   (a) $\frac{1}{2}\times 24\times AE\times \sin 26 = 160 \rightarrow 30(.41\ldots)$ award 4/4

   (b) $\frac{1}{2}\times 24\times AE\times \frac{8}{18} = 160 \rightarrow 5.3\times AE = 160 \rightarrow 30(.18\ldots)$ award 4/4

   (c) $\frac{1}{2}\times 24\times AE\times 0.4 = 160 \rightarrow 4.8\times AE = 160 \rightarrow 33(.33\ldots)$ award 3/4 ✓✓✓✓2

4. Do not penalise incorrect rounding in the final answer

5. For subsequent incorrect working, the final mark is not available

6. Where candidate estimates the size of angle BAC, •3 is only available if the angle is acute

   (a) $\frac{1}{2}\times 24\times AE\times \sin 30 = 160 \rightarrow 26.6(6\ldots)$ award 2/4 ××✓1✓1

   (b) $\frac{1}{2}\times 24\times AE\times \sin 90 = 160 \rightarrow 13.3(3\ldots)$ award 1/4 ×××✓1

7. Alternative method (similarity):

   •1 identify scale factor •1 eg $\frac{24}{18}$

   •2 find height of triangle ADE •2 $\frac{32}{3}$

   •3 form equation •3 $\frac{1}{2}\times AE\times \frac{32}{3} = 160$

   •4 solve to find length of AE •4 30 (cm)

Commonly Observed Responses:

1. (a) $\sqrt{18^2-8^2} = 16(.12\ldots)$ award 0/4

   (b) $\sqrt{18^2-8^2} = 16(.12\ldots) \rightarrow \frac{1}{2}\times 24\times AE\times \sin 16 = 160 \rightarrow 48(.37\ldots)$ award 2/4 ××✓1✓1

[END OF MARKING INSTRUCTIONS]