



GCSE MARKING SCHEME

SUMMER 2023

**GCSE
MATHEMATICS
UNIT 2 – HIGHER TIER
3300U60-1**

INTRODUCTION

This marking scheme was used by WJEC for the 2023 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

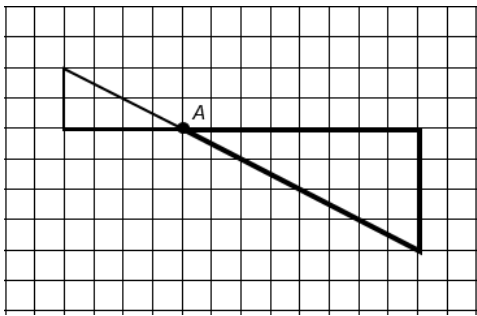
WJEC GCSE MATHEMATICS
SUMMER 2023 MARK SCHEME

| Unit 2: Higher Tier | Mark | Comments |
|--|-------------------------------|---|
| <p>1.(a)</p> $7 + 5x - 10 = 3x + 8 \text{ or equivalent.}$ $2x = 11 \quad \text{OR} \quad -11 = -2x$ $x = \frac{11}{2} \text{ or } 5.5 \text{ or equivalent.}$ | <p>B1</p> <p>B1</p> <p>B1</p> | <p>FT until 2nd error.</p> <p>Bracket must be expanded or correct division by 5 e.g. $x - 2 = \frac{3x}{5} + \frac{1}{5}$ (but not $x - 2 = \frac{3x+1}{5}$)</p> <p>Or equivalent Correctly simplifying the equation to a single x term and number term (e.g. $2x - 11 = 0$).</p> <p>Mark final answer. Correct answer implies B1B1B1. Do not allow $-x = \frac{-11}{2}$ or $x = \frac{-11}{-2}$ A final answer of '11 ÷ 2' is B1B1B0.</p> <p>If FT leads to a whole number answer, it must be shown as a whole number. Otherwise, accept a fraction. Allow any decimal answer to be rounded or truncated to 1 or more decimal place.</p> <p>Allow B1B1B1 for a correct embedded answer BUT only B1B1B0 if contradicted by $x \neq \frac{11}{2}$ or equivalent.</p> <p>Note: $12x - 24 = 3x + 8$ B0 $9x = 32$ B1 (FT) $x = \frac{32}{9}$ or $3.5(55....)$ or 3.6. B1 (FT)</p> <p>If no marks awarded, award SC1 for sight of one of the following:</p> <ul style="list-style-type: none"> $5x - 10$ $12x - 24$. |
| <p>1.(b)</p> $2f = 13 - h \text{ or } h - 13 = -2f$ $f = \frac{13 - h}{2} \text{ or } \frac{h - 13}{-2} = f$ <p style="text-align: right;">or equivalent</p> | <p>B1</p> <p>B1</p> | <p>Or equivalent.</p> <p>Or equivalent. Must not come from incorrect working. Mark final answer. FT only from $\pm 2f = \pm 13 \pm h$. Unsupported $f = \frac{\pm 13 \pm h}{\pm 2}$ implies B0B1 unless B2. Award B1B0 for $-f = \frac{h - 13}{2}$ or equivalent.</p> <p>If no marks, award SC1 for a final answer of either:</p> <ul style="list-style-type: none"> $f = (13 - h) \div 2$ with or without brackets $f = (h - 13) \div -2$ with or without brackets $\frac{13 - h}{2}$ ('f=' missing). $\frac{h - 13}{-2}$ ('f=' missing). |
| <p>1.(c)</p> $5(3x - 7y)$ | <p>B1</p> | <p>Mark final answer. Allow $-5(-3x + 7y)$ or $5(3x + -7y)$.</p> |

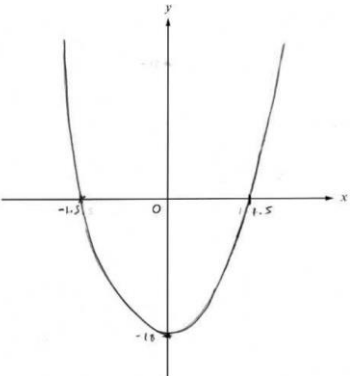
| 2.(a) $P(\text{Bronze}) = 0.2$ AND $P(\text{No Prize}) = 0.6$ or equivalent | B2 | The values in the table takes precedence. Award B1 for one of the following: <ul style="list-style-type: none">$P(\text{Bronze}) = 0.2$ (must be clearly identified)$P(\text{No Prize}) = 0.6$$P(\text{Bronze}) + P(\text{No Prize}) = 0.8$$P(\text{Bronze}) = \frac{1}{3} P(\text{No Prize})$ provided both < 1. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|------------------------------|---|-----------------|----------------|--|--|---|----|--|--|-----|--------|------|------------|-----|--------|------|------------|-----|--------|------|-----------|-----|--------|------|-----------|-----|--------|------|-----------|------------|---------------|-------------|-----------------|------------|--------------|------|---------|-----|-------|--|--|-----|-------|--|--|---|---|--|--|
| 2.(b) $15 \div 0.02 \times 0.18$ or 15×9 or equivalent $= 135$ | M1 A1 | Must be for a complete method e.g. <ul style="list-style-type: none">$15 \div 2 = 7.5$ $7.5 \times 18 = 135$$750 - (450 + 150 + 15)$$0.02 : 0.18$ $15 : 135$ (e.g 0.18×750, or 15×9) Award M1 A1 for a final answer of $15 : 135$. Sight of 135 as a numerator in a fraction < 1 implies M1A0. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3. One correct evaluation $2 \leq x \leq 3$ 2 correct evaluations $2.55 \leq x \leq 2.75$, (one evaluation < 0, one evaluation > 0) 2 correct evaluations $2.55 \leq x \leq 2.65$, (one evaluation < 0, one evaluation > 0) $x = 2.6$ | B1 B1 M1 A1 | <i>Correct evaluation regarded as enough to identify if negative or positive.</i> <i>If evaluations not seen accept 'too high' or 'too low'.</i> <i>Look out for equating $x^3 - 8x = -3$</i> <table><tr><th>x</th><th>$x^3 - 8x + 3$</th><th></th><th></th></tr><tr><td>2</td><td>-5</td><td></td><td></td></tr><tr><td>2.1</td><td>-4.539</td><td>2.55</td><td>-0.818....</td></tr><tr><td>2.2</td><td>-3.952</td><td>2.61</td><td>-0.1004...</td></tr><tr><td>2.3</td><td>-3.233</td><td>2.62</td><td>0.0247...</td></tr><tr><td>2.4</td><td>-2.376</td><td>2.63</td><td>0.1514...</td></tr><tr><td>2.5</td><td>-1.375</td><td>2.64</td><td>0.2797...</td></tr><tr><td>2.6</td><td>-0.224</td><td>2.65</td><td>0.409...</td></tr><tr><td>2.7</td><td>1.083</td><td>2.75</td><td>1.796..</td></tr><tr><td>2.8</td><td>2.552</td><td></td><td></td></tr><tr><td>2.9</td><td>4.189</td><td></td><td></td></tr><tr><td>3</td><td>6</td><td></td><td></td></tr></table> Unsupported $x = 2.6$ is awarded B0B0M0A0. An answer of $x = 2.6$ can only be awarded M1A1, following sight of 2 correct evaluations $2.55 \leq x \leq 2.65$ (one evaluation < 0, one evaluation > 0). | x | $x^3 - 8x + 3$ | | | 2 | -5 | | | 2.1 | -4.539 | 2.55 | -0.818.... | 2.2 | -3.952 | 2.61 | -0.1004... | 2.3 | -3.233 | 2.62 | 0.0247... | 2.4 | -2.376 | 2.63 | 0.1514... | 2.5 | -1.375 | 2.64 | 0.2797... | 2.6 | -0.224 | 2.65 | 0.409... | 2.7 | 1.083 | 2.75 | 1.796.. | 2.8 | 2.552 | | | 2.9 | 4.189 | | | 3 | 6 | | |
| x | $x^3 - 8x + 3$ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | -5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.1 | -4.539 | 2.55 | -0.818.... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.2 | -3.952 | 2.61 | -0.1004... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.3 | -3.233 | 2.62 | 0.0247... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.4 | -2.376 | 2.63 | 0.1514... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.5 | -1.375 | 2.64 | 0.2797... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.6 | -0.224 | 2.65 | 0.409... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.7 | 1.083 | 2.75 | 1.796.. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.8 | 2.552 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.9 | 4.189 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.(a) 1.2 | B2 | Mark final answer. Award B1 for one of the following: <ul style="list-style-type: none">sight of $1.1(5519.....)$.an answer of 1.20. Do not award B2 or B1 for answers obtained from incorrect work (e.g. rounding and/or estimating). | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.(b) 0.043 | B2 | Mark final answer. Award B1 for sight of one of the following: <ul style="list-style-type: none">$\frac{1}{23}$$1 \div 23$$0.0434(...)$0.04350.04. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.(c)(i) 12 | B1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.(c)(ii) 5 | B1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| <p>5. Method to eliminate one variable e.g. equal coefficients AND <u>appropriate intention to add or subtract or use a method of substitution.</u></p> <p>First variable found $x = 4 \cdot 3$ or $y = 2 \cdot 6$ or equivalent</p> <p>Substitute to find the 2nd variable.</p> <p>Second variable found</p> | <p>M1</p> <p>A1</p> <p>m1</p> <p>A1</p> | <p>Allow one error in one term (not the term with equal coefficients).</p> <p>CAO Award A0 for expressing the final answers in a form such as $y = \frac{33 \cdot 8}{13}$.</p> <p>FT substitution of their '1st variable' if M1 gained.</p> <p>No marks for 'trial and improvement'. No marks for an unsupported answer.</p> | | | | | | | | | |
|---|---|---|--------|---------|----------|--|-----------|------------|---|----------|--------|
| <p>6.(a)</p> <p>$(x =) \sin^{-1} \frac{7 \cdot 7}{11 \cdot 3}$ or $\sin^{-1} \frac{7 \cdot 7 \times \sin 90}{11 \cdot 3}$ or equivalent</p> <p>Allow an answer between $42 \cdot 8$ and $43(^{\circ})$ ISW</p> | <p>M2</p> <p>A1</p> | <p>Check diagram for answers Award M1 for one of the following:</p> <ul style="list-style-type: none"> $\sin x = \frac{7 \cdot 7}{11 \cdot 3} (= 0 \cdot 68(1 \cdot \cdot))$ $\frac{\sin x}{7 \cdot 7} = \frac{\sin 90}{11 \cdot 3}$ or equivalent <p>Allow correct angles given in radians or gradians:</p> <table border="1" data-bbox="858 869 1437 1039"> <thead> <tr> <th>Method</th><th>Radians</th><th>Gradians</th></tr> </thead> <tbody> <tr> <td>$\sin^{-1} \frac{7 \cdot 7}{11 \cdot 3}$</td><td>0.7496...</td><td>47.727....</td></tr> <tr> <td>$\sin^{-1} \frac{7 \cdot 7 \times \sin 90}{11 \cdot 3}$</td><td>0.655...</td><td>47.001</td></tr> </tbody> </table> | Method | Radians | Gradians | $\sin^{-1} \frac{7 \cdot 7}{11 \cdot 3}$ | 0.7496... | 47.727.... | $\sin^{-1} \frac{7 \cdot 7 \times \sin 90}{11 \cdot 3}$ | 0.655... | 47.001 |
| Method | Radians | Gradians | | | | | | | | | |
| $\sin^{-1} \frac{7 \cdot 7}{11 \cdot 3}$ | 0.7496... | 47.727.... | | | | | | | | | |
| $\sin^{-1} \frac{7 \cdot 7 \times \sin 90}{11 \cdot 3}$ | 0.655... | 47.001 | | | | | | | | | |
| <p>6.(a) <u>Alternative method</u> Correct use of a 'two-step' method.</p> <p>Allow an answer between $42 \cdot 8$ and $43(^{\circ})$ ISW</p> | <p>M2</p> <p>A1</p> | <p>A partial trigonometric method is M0.</p> <p>Allow $42 \cdot 8(\dots^{\circ})$</p> <p>Allow correct angles given in radians or gradians.</p> | | | | | | | | | |

| <div>6.(b)</div> <div>$DBE = (90 - 43) = 47(^{\circ}) \quad \text{OR}$ $BED = 43(^{\circ})$</div> <div><div>Valid method to find the length DE</div><div>$DE = 13.1 \times \tan 47$</div><div>$DE = \frac{13.1}{\tan 43}$</div><div>$DE = \frac{13.1 \times \sin 47}{\sin 43}$</div></div> <div><div>$DE$ in the range 14.04 to 14.1 (cm) ISW</div></div> | <div><div>B1</div><div>Check diagram for answers. Strict FT for $DBE = 90 -$ 'their x' or $BED =$ 'their x', provided 'their x' $\neq 45^{\circ}$. Note: DBE must be acute for B1. May be implied in further work.</div></div> <div><div>M2</div><div>If B1 already awarded for 'their angle DBE' but then 'their angle BED' is incorrect and 'their BED' is then used (or vice versa) for either M2 or M1, then award B0 previously. Or award M2 for correct use of a 'two-step' method (e.g. 'Pythagoras and similar triangles' or 'Pythagoras and correct trigonometric relationship'). FT 'their angle DBE' or 'their angle BED' provided not 0°, 45°, 90° or 180°. Award M1 for one of the following:<ul style="list-style-type: none">$\tan 47 = \frac{DE}{13.1}$$\tan 43 = \frac{13.1}{DE}$$\frac{DE}{\sin 47} = \frac{13.1}{\sin 43}$ or equivalent For all M2 or M1 scenarios, FT their clearly stated or shown angle BED or DBE where appropriate. For $\frac{13.1 \times \sin 47}{\sin 43}$ FT their clearly stated or shown angles BED and DBE only if $BED + DBE = 90^{\circ}$.</div></div> <div><div>A1</div><div>Allow 14 from correct workings. FT from M2 only and provided that angle is acute and leads to a positive answer. Award B1M2A0 for any of the following unsupported answers:</div><table><thead><tr><th>Method</th><th>Radians</th><th>Gradians</th></tr></thead><tbody><tr><td>$13.1 \times \tan 47$</td><td>-1.63 to 1...</td><td>11.92 to 12</td></tr><tr><td>$\frac{13.1}{\tan 43}$</td><td>-8.743 to -5.36</td><td>16.35 to 16.5</td></tr><tr><td>$\frac{13.1 \times \sin 47}{\sin 43}$</td><td>-1.95 to 1.08</td><td>14.1 to 14.21</td></tr></tbody></table></div> | Method | Radians | Gradians | $13.1 \times \tan 47$ | -1.63 to 1... | 11.92 to 12 | $\frac{13.1}{\tan 43}$ | -8.743 to -5.36 | 16.35 to 16.5 | $\frac{13.1 \times \sin 47}{\sin 43}$ | -1.95 to 1.08 | 14.1 to 14.21 |
|--|--|---------------|---------|----------|-----------------------|---------------|-------------|------------------------|-----------------|---------------|---------------------------------------|---------------|---------------|
| Method | Radians | Gradians | | | | | | | | | | | |
| $13.1 \times \tan 47$ | -1.63 to 1... | 11.92 to 12 | | | | | | | | | | | |
| $\frac{13.1}{\tan 43}$ | -8.743 to -5.36 | 16.35 to 16.5 | | | | | | | | | | | |
| $\frac{13.1 \times \sin 47}{\sin 43}$ | -1.95 to 1.08 | 14.1 to 14.21 | | | | | | | | | | | |

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| 7.(a) | $\times 0.95^4$ | B1 | |
| 7.(b) | <p>Sight of 0.83 OR 83%</p> <p>$\frac{3569}{0.83}$ or $\frac{3569}{83} \times 100$ or equivalent</p> <p>= 4300</p> | <p>B1</p> <p>M1</p> <p>A1</p> | <p>Allow (100 – 17 =) 83</p> <p>FT 'their 1 – 0.17' provided <1 or 'their 100% – 17%' provided < 100%.</p> <p>Award B1M1A1 for an embedded answer (e.g. $0.83 \times 4300 = 3569$ or $\frac{3569}{4300} \times 100 = 83$), BUT only B1M1A0 if contradicted by stating original amount $\neq 4300$.</p> <p>Unsupported 4300 is awarded B1M1A1.</p> |
| 8. | <p>$\frac{\pi \times r^2}{2} = 77$ or equivalent</p> <p>$r^2 = 49(0\dots)$ or $r^2 = \frac{154}{\pi}$</p> <p>$r = 7(0\dots)$</p> <p>(Area of trapezium =) $\frac{2 \times 7(0\dots) + 22}{2} \times 7(0\dots)$</p> <p>or equivalent</p> <p>= 126.0(…)(cm²)</p> | <p>M1</p> <p>m1</p> <p>A1</p> <p>M1</p> <p>A1</p> | <p>Check diagram for answers.</p> <p>Sight of 49(0…) implies M1m1.</p> <p>FT 'their r^2' provided M1 awarded. 7 must not be from incorrect working.</p> <p>FT 'their derived or stated r'.</p> <p>Accept 126.1 or 126 (cm²) Mark final answer.</p> |
| 9. |  | B2 | <p>B1 for 2 correct vertices within a triangle, e.g. A and 1 other vertex</p> <p>OR for a triangle of correct shape, size and orientation in incorrect position</p> <p>OR consistent correct use of an incorrect negative scale factor</p> <p>OR for 3 correct vertices (A implied) in the correct location not joined to form the triangle.</p> |

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| <p>10.(a) (Reflex angle D =) $180 + 360/5$ OR $360 - 3 \times 180/5$</p> <p style="text-align: right;">$= 252(^{\circ})$</p> <p>(Arc length CE =) $252/360 \times \pi \times 2 \times 11$</p> <p>$48 \cdot 3(\dots)$ OR $48 \cdot 4$ OR $77\pi/5$ OR $15\frac{2}{5}\pi$ OR $15 \cdot 4\pi(\text{cm})$ o.e.</p> | <p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> | <p>Or any other complete method. May be seen in stages.</p> <p>Award for sight of $252(^{\circ})$ if not contradicted by further incorrect work.</p> <p>FT for M1 for 'their derived angle'.</p> <p>ISW Accept $48(\text{cm})$ from correct working. $12089/250$ from using $3 \cdot 14$ Allow a FT for this mark provided the angle used is $>180^{\circ}$. If no marks award SC1 for sight of $108(^{\circ})$ OR $72(^{\circ})$</p> |
| <p>Organisation and Communication</p> <p>Accuracy of writing</p> | <p>OC1</p> <p>W1</p> | <p>For OC1, candidates will be expected to:</p> <ul style="list-style-type: none"> present their response in a structured way explain to the reader what they are doing at each step of their response lay out their explanation and working in a way that is clear and logical write a conclusion that draws together their results and explains what their answer means <p>For W1, candidates will be expected to:</p> <ul style="list-style-type: none"> show all their working make few, if any, errors in spelling, punctuation and grammar use correct mathematical form in their working use appropriate terminology, units, etc. |
| <p>10.(b) $\left(\frac{671}{11}\right)^2$ (= 450241/121) OR 61^2</p> <p style="text-align: right;">$= 3721$</p> | <p>M1</p> <p>A1</p> | <p>Answer in the sentence takes precedence. If no marks, allow SC1 for $3721/25$ OR $148\frac{21}{25}$ OR $148 \cdot 84$ [from $(671/55)^2$].</p> |
| <p>11. $x^2(a + 1) = b$ OR $-x^2(a + 1) = -b$ OR $x^2(-a - 1) = -b$</p> <p style="text-align: center;">$x^2 = \frac{b}{a+1}$ OR $-x^2 = \frac{-b}{-a-1}$</p> <p style="text-align: center;">$x = \pm \sqrt{\frac{b}{a+1}}$</p> | <p>B1</p> <p>B1</p> <p>B1</p> | <p>FT until 2nd error. x^2 or $-x^2$ factorised.</p> <p>Isolating the x^2 or $-x^2$. Allow a FT from $2x^2 = \frac{b}{a}$.</p> <p>B0 for $\sqrt{[b \div (a + 1)]}$ (use of the division sign). Allow omission of \pm. Mark final answer.</p> <p>Note:</p> <p>$2x^2 = \frac{b}{a}$ B0</p> <p>$x^2 = \frac{b}{2a}$ B1 (FT)</p> <p>$x = (\pm)\sqrt{\frac{b}{2a}}$ B1 (FT)</p> |

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| <p>12.(a) $2(2x + 3)(2x - 3)$</p> | <p>B3</p> | <p>Award B3-1 for a correct answer followed by further incorrect work.</p> <p>Award B2 for the sight of any one of the following:</p> <ul style="list-style-type: none"> • $(4x + 6)(2x - 3)$ • $(4x - 6)(2x + 3)$ • $8(x + 3/2)(x - 3/2)$ • $(2x + 3)(2x - 3)$ • $2(2x + 3)(2x + 3)$ • $2(2x - 3)(2x - 3)$ <p>Award B1 for the sight of any one of the following:</p> <ul style="list-style-type: none"> • $2(4x^2 - 9)$ • $8(x^2 - 9/4)$ • $(4x + 6)(2x + 3)$ • $(4x - 6)(2x - 3)$ • $(x + 3/2)(x - 3/2)$ <p>If no marks: Allow SC2 for $(2\sqrt{2}x + 3\sqrt{2})(2\sqrt{2}x - 3\sqrt{2})$ o.e. OR other valid, equivalent 'factorisation', e.g. $(8x - 12)(x + 1.5)$ o.e. Allow SC1 for $(\sqrt{8}x + \sqrt{18})(\sqrt{8}x - \sqrt{18})$ o.e.</p> |
| <p>12.(b) $3/2$ AND $-3/2$</p> | <p>B1</p> | <p>Or equivalent for either roots. FT if possible, provided exactly 2 possible distinct solutions.</p> |
| <p>12.(c) A <u>positive</u> quadratic curve passing through $(0, -18)$ as a minimum with -18 indicated on the y-axis AND passing through $(-3/2, 0)$ and $(3/2, 0)$ which are indicated on the x-axis.</p>  | <p>B2</p> | <p>FT for x-axis intersections, provided exactly 2 possible distinct solutions.</p> <p>Award B1 for any one of the following: A positive quadratic curve passing through $(0, -18)$ as a minimum with -18 indicated on the y-axis OR A quadratic curve (either positive or negative) passing through $(-3/2, 0)$ and $(3/2, 0)$ which are indicated on the x-axis.</p> <p>If the conditions for B2 are met, then only allow B1 for concave and/or convex curvature above the x-axis.</p> |

[illegible]

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| <p>15.</p> $3x - 7 + x - 2 = (x - 2)(3x - 7) \text{ oe}$ <p>Sight of $3x^2 - 7x - 6x + 14$ $3x^2 - 17x + 23 = 0$ OR $-3x^2 + 17x - 23 = 0$</p> $x = \frac{-(-17) \pm \sqrt{(-17)^2 - 4 \times 3 \times 23}}{2 \times 3}$ $x = \frac{17 \pm \sqrt{13}}{6}$ $x = 3.43 \text{ with } x = 2.23$ | <p>B1</p> <p>B1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>A1</p> | <p><i>A correct common denominator may be shown throughout for first 3 marks.</i> <i>Also, look out for alternative, correct methods leading to the same quadratic equated to zero.</i></p> <p>For multiplying throughout the numerator of all terms by the common denominator.</p> <p>Or equivalent. May be seen in the denominator.</p> <p>'= 0' required, but may be implied by an attempt to use the quadratic formula or if $a = 3, b = -17, c = 23$ used in the quadratic formula.</p> <p>FT from B1B0 from one error only.</p> <p>This substitution into the formula must be seen for M1, otherwise award M0A0A0.</p> <p>FT 'their derived quadratic equation equated to 0', (but not $3x^2 - 13x + 14 = 0$), provided of equivalent difficulty (a, b and c must be non-zero).</p> <p>Allow one slip in substitution for M1 only, but must be correct formula.</p> <p>Can be implied from at least one correct value of x evaluated.</p> <p>CAO for their quadratic equation.</p> <p>Answers must be given to 2 decimal places.</p> <p>On FT solutions must require rounding.</p> |
| <p>16. <u>Initially calculating angle BDC</u></p> $\cos \text{BDC} = \frac{5^2 + 7^2 - 11^2}{2 \times 5 \times 7} \quad (= -47/70)$ $(\text{BDC} =) 132(\cdot 17 \dots^\circ)$ $\sin \text{BAD} = \frac{7 \times \sin [180 - 132(\cdot 17 \dots^\circ)]}{13}$ <p>(BAD =) Answers in the range 23.4° to 23.6°</p> | <p>M2</p> <p>A1</p> <p>M2</p> <p>A1</p> | <p>M1 for $11^2 = 5^2 + 7^2 - 2 \times 5 \times 7 \times \cos \text{BDC}$</p> <p>The correct angles given in: Radians ($2.3038 \dots$ to $2.3073 \dots$) or Gradians ($146.6666 \dots$ to $146.8888 \dots$).</p> <p>Allow a trial and improvement method for M2A1 but length of side BC must be in the range $10.95(\text{cm})$ to $11.05(\text{cm})$.</p> <p>Sight of $28(\cdot 13 \dots^\circ)$ OR $132(\cdot 17 \dots^\circ)$ OR $19(\cdot 68 \dots^\circ)$, calculated from <u>one</u> use of the rearranged cosine rule in triangle BCD and attributed to the wrong angle, stated or seen on the diagram, is M0 SC1.</p> <p>FT 'their stated or derived BDC'.</p> <p>M1 for $\sin \text{BAD} = \frac{\sin [180 - 132(\cdot 17 \dots^\circ)]}{13}$ o.e.</p> <p>Mark final answer for angle BAD.</p> <p>Allow a correctly rounded answer to a whole number provided an answer in the range 23.4° to 23.6° is seen.</p> |

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| <p><u>Alternative method 1</u> 16. <u>Initially calculating angle BCD</u></p> $\cos BCD = \frac{5^2 + 11^2 - 7^2}{2 \times 5 \times 11} \quad (=97/110)$ $(BCD =) 28(\cdot 13 \dots^\circ)$ $\sin BAD = \frac{11 \times \sin 28(\cdot 13 \dots^\circ)}{13}$ <p>(BAD =) Answers in the range 23·4(°) to 23·6(°)</p> | <p>M2</p> <p>A1</p> <p>M2</p> <p>A1</p> | <p>M1 for $7^2 = 5^2 + 11^2 - 2 \times 5 \times 11 \times \cos BCD$</p> <p>The correct angles given in: Radians (0·4886... to 0·4911...) or Gradians (31·1111... to 31·2666...).</p> <p>Allow a trial and improvement method for M2A1 but length of side BD must be in the range 6·95(cm) to 7·05(cm).</p> <p>Sight of $28(\cdot 13 \dots^\circ)$ OR $132(\cdot 17 \dots^\circ)$ OR $19(\cdot 68 \dots^\circ)$, calculated from <u>one</u> use of the rearranged cosine rule in triangle BCD and attributed to the wrong angle, stated or seen on the diagram, is M0 SC1.</p> <p>FT 'their stated or derived BCD'. M1 for $\frac{\sin BAD}{11} = \frac{\sin 28(\cdot 13 \dots^\circ)}{13}$ o.e.</p> <p>Mark final answer for angle BAD. Allow a correctly rounded answer to a whole number provided an answer in the range 23·4(°) to 23·6(°) is seen.</p> |
| <p><u>Alternative method 2</u> 16. <u>Multistep method to calculate angle BDC</u> (First BCD, then CBD or vice versa)</p> $\cos BCD = \frac{5^2 + 11^2 - 7^2}{2 \times 5 \times 11} \quad (=97/110) \text{ OR}$ $\cos CBD = \frac{7^2 + 11^2 - 5^2}{2 \times 7 \times 11} \quad (=145/154)$ <p>(BCD =) $28(\cdot 13 \dots^\circ)$ OR (CBD =) $19(\cdot 68 \dots^\circ)$</p> $\sin CBD = \frac{5 \times \sin [28(\cdot 13 \dots^\circ)]}{7} \quad \text{OR}$ $\sin BCD = \frac{7 \times \sin 19(\cdot 68 \dots^\circ)}{5}$ <p>(CBD =) $19(\cdot 68 \dots^\circ)$ OR (BCD =) $28(\cdot 13 \dots^\circ)$</p> <p>(BDC =) $180 - [28(\cdot 13 \dots^\circ) + 19(\cdot 68 \dots^\circ)]$ $= 132(\cdot 17 \dots^\circ)$</p> $\sin BAD = \frac{7 \times \sin [180 - 132(\cdot 17 \dots^\circ)]}{13}$ <p>(BAD =) Answers in the range 23·4(°) to 23·6(°)</p> | <p>M2</p> <p>A1</p> <p>M2</p> <p>A1</p> | <p>A complete, correct method must be seen for the first M2. M1 for one of the following: $7^2 = 5^2 + 11^2 - 2 \times 5 \times 11 \times \cos BCD$ OR $5^2 = 7^2 + 11^2 - 2 \times 7 \times 11 \times \cos CBD$</p> <p>The correct angles given in: Radians (BCD \approx 0·49 or CBD \approx 0·34) or Gradians (BCD \approx 31·2 or CBD \approx 21·9).</p> <p>This M2 (or M1 below) is for a complete multistep method, i.e. it includes all the previous steps. FT 'their stated or derived BDC'. M1 for $\frac{\sin BAD}{7} = \frac{\sin [180 - 132(\cdot 17 \dots^\circ)]}{13}$ o.e.</p> <p>Mark final answer for angle BAD. Allow a correctly rounded answer to a whole number provided an answer in the range 23·4(°) to 23·6(°) is seen.</p> |

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| <p><u>Alternative method 3</u></p> <p>16. <u>Multistep method to calculate angle BDC</u> <u>(First BCD, then BDC OR first CBD, then BDC)</u></p> $\cos BCD = \frac{5^2 + 11^2 - 7^2}{2 \times 5 \times 11} \quad (=97/110) \text{ OR}$ $\cos CBD = \frac{7^2 + 11^2 - 5^2}{2 \times 7 \times 11} \quad (=145/154)$ <p>(BCD =) $28(\cdot 13 \dots^\circ)$ OR (CBD =) $19(\cdot 68 \dots^\circ)$</p> $\sin BDC = \frac{11 \times \sin [28(\cdot 13 \dots^\circ)]}{7} \quad (=47 \cdot 82 \dots^\circ) \text{ OR}$ $\sin BDC = \frac{11 \times \sin 19(\cdot 68 \dots^\circ)}{5} \quad (=47 \cdot 82 \dots^\circ)$ <p>(BDC = $180 - 47(\cdot 82 \dots^\circ)$) = $132(\cdot 17 \dots^\circ)$</p> $\sin BAD = \frac{7 \times \sin [180 - 132(\cdot 17 \dots^\circ)]}{13}$ <p>(BAD =) Answers in the range $23 \cdot 4^\circ$ to $23 \cdot 6^\circ$</p> | <p><u>Ambiguous case</u></p> <p>M2 A complete, correct method must be seen for the first M2. M1 for one of the following: $7^2 = 5^2 + 11^2 - 2 \times 5 \times 11 \times \cos BCD$ OR $5^2 = 7^2 + 11^2 - 2 \times 7 \times 11 \times \cos CBD$</p> <p>A1 The correct angles given in: Radians (BCD $\approx 0 \cdot 49$ or CBD $\approx 0 \cdot 34$) Gradians (BCD $\approx 31 \cdot 2$ or CBD $\approx 21 \cdot 9$).</p> <p>M2 This M2 (or M1 below) is for a complete multistep method, i.e. it includes all the previous steps. FT 'their stated or derived BDC'. M1 for $\sin BAD = \frac{\sin [180 - 132(\cdot 17 \dots^\circ)]}{13}$ o.e.</p> <p>A1 Mark final answer for angle BAD. Allow a correctly rounded answer to a whole number provided an answer in the range $23 \cdot 4^\circ$ to $23 \cdot 6^\circ$ is seen.</p> |
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